

The Practice of Basic Informatics 2021

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0. Foreword

Kyoto University provides courses on ‘The Practice of Basic Informatics’ as part of its Liberal Arts and Sciences Program. The course is taught at many schools and departments, and course contents vary to meet the requirements of these schools and departments. This textbook is made open to the students of all schools that teach these courses.

As stated in Chapter 1, this book is written with the aim of building ICT skills for study at university, that is, ICT skills for academic activities. Some topics may not be taught in class. However, the book is written for self-study by students. We include many exercises in this textbook so that instructors can select some of them for their classes, to accompany their teaching plans.

The courses are given at the computer laboratories of the university, and the contents of this textbook assume that Windows 10 and Microsoft Office 2016 are available in these laboratories. In Chapter 15, we include an introduction to computer programming; we chose Python as the programming language because on the one hand it is easy for beginners to learn, and on the other, it is widely used in academic research. To check the progress of students’ self-study, we have attached assessment criteria (a ‘rubric’) of this course as an Appendix. Current ICT is a product of the endeavors of many people. The “Great Idea” columns are included to show appreciation for such work.

Dr. Yumi Kitamura and Dr. Hirohisa Hioki wrote Chapters 5-6 and 15, respectively. The remaining chapters were written by Dr. Hajime Kita. In revision for 2018 edition and after, Dr. Hiroyuki Sakai has participated in the author group, and Dr. Donghui Lin has also joined for English edition 2019. The authors hope that this textbook helps you to improve your academic ICT skill set.

The content included in this book is selected based on the reference course plan discussed in the course development team for informatics at the Institute for Liberal Arts and Sciences. In writing this textbook, we obtained advice and suggestions from staffs of the Network Section, Information Infrastructure Division, Department of Planning and Information Management Department, Kyoto University on Chapters 2 and 3, from Mr. Sosuke Suzuki, NTT Communications Corporation also on Chapter 3, Rumi Haratake, Machiko Sakurai and Taku Sakamoto of the User Support Division, Kyoto University Library on Chapter 4. Dr. Masako Okamoto of Center for the Promotion of Excellence in Higher Education, Kyoto University helped us in revision of 2018 Japanese Edition. The authors would like to

express their sincere gratitude to the people who supported them.

Notes for English Version

This textbook is a translation of the Japanese version referred to as “Jyohou-Kiso-Enshu 2019 (情報基礎演習 2019).” Chapter 7 in the Japanese version is not included in English version because the introduced service by University Library may change.

The original version cited several Japanese references. We have retained some quotes and references in Japanese. Some files provided for use as exercises are also in Japanese.

To Instructors

In Japanese “Standards for Establishment of Universities (大学設置基準),” one credit assumes contents requiring 45-hour learning including learning outside class hours. This textbook is written for use in seminar class that award two credits considering learning outside class hour. To introduce all the contents included in this textbook in class hour will be difficult, and we recommend instructors to use some part for homework or assignments.

Higher ICT skills for academic activities will be needed according to students' grades, and students have to learn such skills as well as new technologies and services, and important points for adequate use of them by themselves. Chapter 1 of this textbook requires students **to acquire the capability to learn ICT skills by yourself on an ongoing basis**. From this point of view, the authors think it is important to ask students to learn contents which are not introduced in class hours.

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1. Aims, Assessment and How to Study for This Course

1.1 The Three Objectives of This Course

Study at university requires learners to search through academic information; analyze statistical data; write assignment essays and term papers based on such activities; and present their work. ICT skills are intrinsic to carrying out such activities. This means that the learners have to **acquire those ICT skills needed for academic activities**. Further, students extend their activities outside class, i.e., in clubs, social circles, part-time jobs and NPOs. Such activities also require the ICT skills used in formal situations, which are very similar to those needed for academic activities. The first objective of this course is thus **to acquire basic ICT skills for academic activities**.

Second, many students start their life away from their parents' home to study at university, and they use their own personal computers (PCs) which are connected to the Internet. Hence, they have to be able to properly and independently operate their own PCs. This requires **acquisition of skills as Independent ICT Users**. This is the second objective of the course.

The level of academic activities at universities is rising and becoming more specialized every year, and greater skill is thus required. However, it's difficult to acquire such skills during the limited study hours provided in the first year, and students may also not understand the importance of such skills. After the first year, courses for learning higher ICT skills may not be available, and students then have to acquire such skills by themselves. The third objective of this course is **to help you acquire the ability to learn ICT skills on your own, according to your needs**.

Summarizing the above, the objectives of this course are as follows:

- **To acquire the basic ICT skills needed for academic activities.** You

must acquire ICT skills so as to be able to fully utilize the information services provided by the university, to search for the information needed during academic activities, to process data, to write papers, and to present your studies.

- **To be an independent ICT user.** Learn to manage and operate your personal computer and network properly as an independent user.
- **To acquire the capability to learn ICT skills by yourself on an ongoing basis.** That is, to learn ICT skills not dealt with in this course on your own, as your studies progress.

This textbook assumes a semester-long course with one hour of classes per week. Figure 1 summarizes the objectives of this course. We aim to improve the productivity of your study at an early stage in your study at university through acquisition of ICT skills, resulting in successful studies at university, as shown in Figure 2.

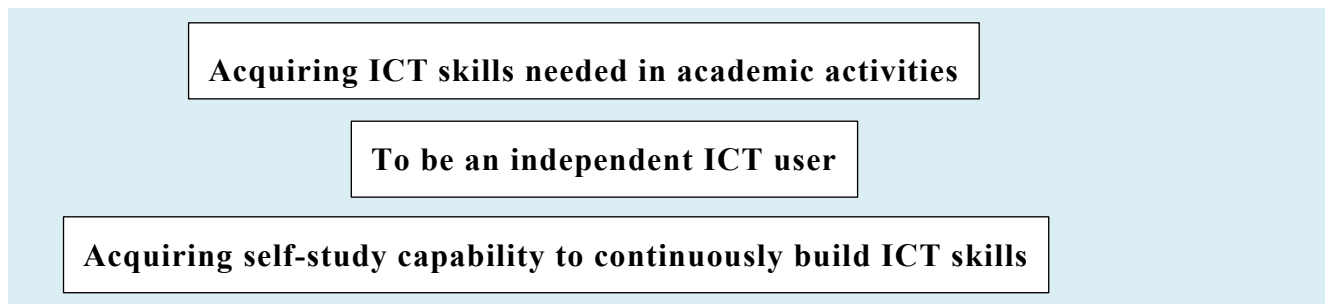


Figure 1 Three Objectives of This Course

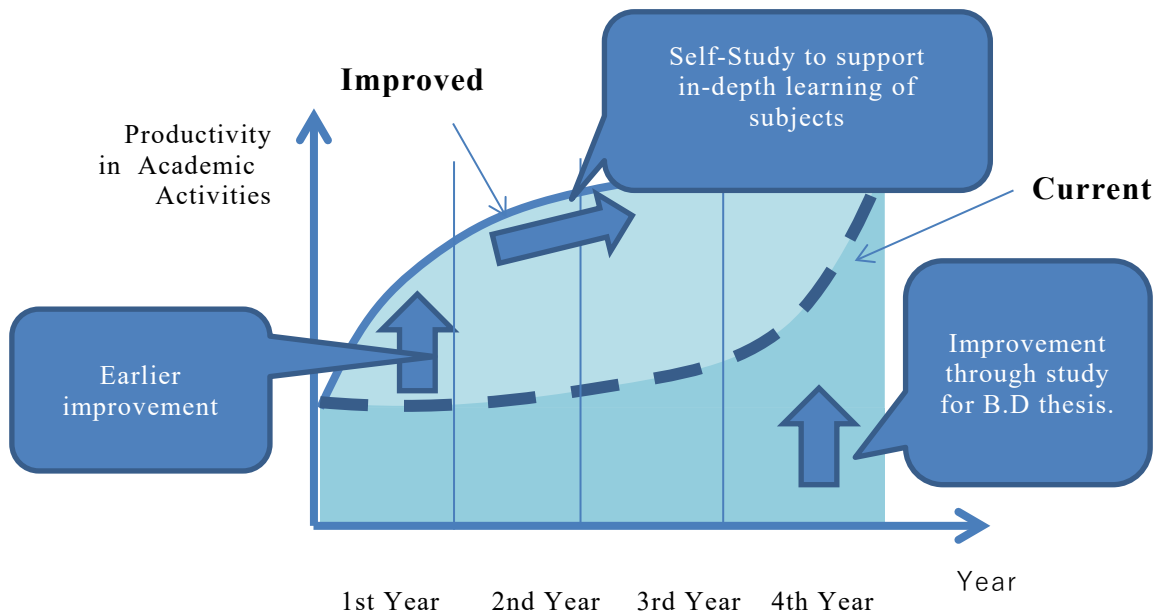


Figure 2 Improvement in productivity of academic activities

1.2 Assessment Criteria

How can we obtain such skills? In the appendix 2, there is a table in which learning subjects are arranged vertically, and levels to be achieved, horizontally. Each cell in the table describes an achievement level corresponding to the subject and the level. Level C is the minimal level we require students to achieve in our course. Level A is the goal of this course, or that to be achieved during your first year of study. Level S is the goal to be achieved by graduation.

Exercise 1. Self-assessment of your ICT skills

Use the Appendix 2 to check your current level of ICT skills so that you can understand the differences between your current level and the study goals.

1.3 How to Study for This Course

Study for university courses consists of study during class hours and that outside these hours. While different instructors may run their classes differently, this textbook is organized under the assumption that students study the course

content through this textbook and do some exercises allocated by their instructors. You may also be asked to submit answers to course exercises using our course management system called Panda. Some exercises may not be completed during class hours. We assume that students will continue these outside class hours and submit their work to Panda, as well as doing exercises allocated as homework.

1.4 Improvement from Viewpoints of “Effectiveness” and “Efficiency”

In building your skills, we recommend you to assess your activities from two viewpoints: “Effectiveness” and “Efficiency”:

- **Effectiveness** means that what you produce meets the activity objectives.
- **Efficiency** means that you produce results quickly and correctly with minimal effort.

Assess your own activities from the above two viewpoints, and improve them by:

- Continually learning the necessary skills, to make your activities more effective and efficient. Computers can deal with huge amounts of information quickly, and because of this characteristic, it’s very important that you continually learn and improve your skills at using your personal computer, and other digital devices and services.

1.5 Organization of This Textbook

Each of the following chapters contains study aims and content to be learnt for the chapter topic. Exercises are also provided in each chapter. Your class instructor may ask you to do certain exercises during class hours or as homework.

2. Computer Basics

2.1 Study Aims

This section describes what are required to be an independent personal computer user:

- We explain the skills needed for independent use of a personal computer;
- In addition, to acquire more systematic understanding, the reader will learn:
- The structure of personal computers, and
 - The role of operating systems.
 - Finally, the learner will also learn to type on a keyboard, so as to use the personal computer efficiently for academic activities.

2.2 Progress in Information and Communication Technologies

This section outlines the historical progress of information and communication technologies (ICT), provides insights into imagined future usage of ICT, and invites learners to think about the skills they already have.

2.2.1 The Birth of the Computer

Current computers are machines that process information at very high-speed using electronics. This started in about 1940. Initial developments were used to aid computing in the field of science.

Initially, vacuum tubes were used for electronic logical operations. Vacuum tubes have problems related to their size, power consumption and lifetime, but later semiconductor technologies such as transistors replaced the vacuum tube, and the associated problems diminished considerably. In the 1960s, usage spread to the office with the availability of computers called “mainframes.” In the 1970s personal computing started—each person used a small computer for

various tasks. See Figure 4.

2.2.2 Progress in Semi-Conductor Technology

The spread of computer use has a background in technological progress. The integrated circuit, a semiconductor technology, allowed us to make complex electronic circuits on a wafer of silicon, giving birth to the microprocessor, which allows creation of an on-chip computer. With this technology, large numbers of computers can be made at a very low cost. Integrated circuit technology continues to progress. Figure 3 shows how the numbers of transistors on a chip have improved exponentially over time. See Figure 3.

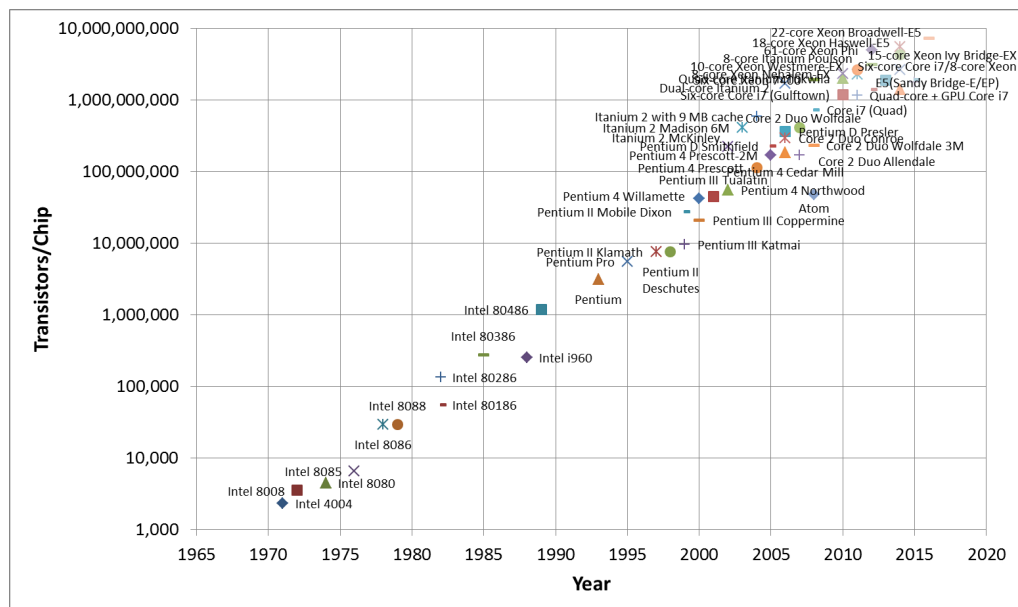


Figure 3 Transistors on Microprocessors

Plotted for Intel microprocessors using

https://en.wikipedia.org/wiki/Transistor_count#Microprocessors

(last access Jan. 2, 2017)

2.2.3 The Internet

Another big advance since the 1970s is the Internet. It is a digital communication network that interconnects computers, unifying computing and communication. In the 1990s, the Internet could be used for commercial

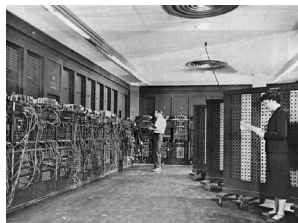
purposes, and with progress in personal computers, it quickly spread worldwide. Various services such as electronic mail (e-mail) and the World Wide Web (WWW) have been disseminated via the Internet. Currently, various services are provided using the WWW as infrastructure. Furthermore, in the 1990s cellphones became connected to the Internet. Smartphones, which are portable, easy to use, and always connected to a network have extended usage of the Internet, surpassing use by formerly the domain of those with personal computers.

2.2.4 Digitalization of Media

Progress in computer and digital communication has unified various media including documents, photographs, sounds, and videos, all of which were treated separately before—this has likewise extended the usefulness of computers.

2.2.5 ICT and Society

Emergence of a world-scale computer network has caused various problems in society. To use ICT properly, we need to address information security and ethical considerations.



* ENIAC 1946



** IBM System/360 1962



*** XEROX Alto 1973



**** Apple II 1977

Figure 4 Progress in Computers

* <https://commons.wikimedia.org/wiki/File:Eniac.jpg>

** https://commons.wikimedia.org/wiki/File:Bundesarchiv_B_145_Bild-F038812-0014,_Wolfsburg,_VW_Autowerk.jpg

*** https://commons.wikimedia.org/wiki/File:Xerox_Alto_mit_Rechner.JPG

**** https://commons.wikimedia.org/wiki/File:Apple_II_transparent_800.png (2017/1/3 last access)

2.3 Structure of Personal Computers

2.3.1 Structure of Computer

Computers are composed of their **hardware (physical devices such as electronic circuits)** and **software (programs)**.

1) Hardware

Personal computer hardware has the components shown in Figure 5.

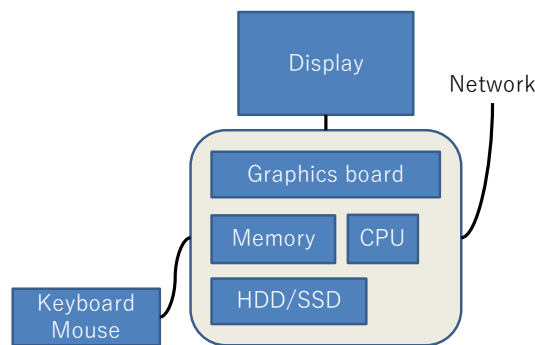


Figure 5 Components of a Computer (Hardware)

- **CPU (Central Processing Unit):** The CPU obtains a single step in a program from the main memory, decodes the instruction, and executes it. In other words, it performs numerical and logical operations on data, or transfers data between the main computer memory and local storage (registers) within the CPU. It also determines the next operation according to the result of the current operation. The CPU is the beating heart of the computer.
- **Main Memory:** This device stores programs to be executed by the CPU, and data to be processed. Fast reading and writing are required, so semiconductor memory is used.
- **External Storage Devices:** These are used to store large numbers of programs and vast amounts of data. They need to retain information when the power is off so magnetic discs, flash memory and optical drives such

as CD or DVD drives are used.

- **Input/Output (IO) Devices:** These devices input external data and send information externally. Keyboards, mice, printers and touch panels are commonly used IO devices; the graphic board sends data to the external display.
- **Network:** Network connections allow the computer to access e.g., the Internet. Most personal computers have wired or wireless interfaces to local area networks (LANs).

2) How a Computer Works

The basic behaviors of a computer are quite straightforward:

- The program to be executed is set up in main memory in some way, together with the required data;
- The CPU is given the *starting address* of the program;
- The CPU repeats the following steps:
 1. Read one program instruction from the main memory and depending on the instruction, carry out the relevant operation, such as an arithmetic operation or transfer of data:
 - Depending on the instruction, write the result of the operation to the main memory.
 - The CPU may also carry out an input or output operation;
 2. Move to the next step of the program:
 - The address of the next step to execute may change depending on the outcome of the operation just executed.

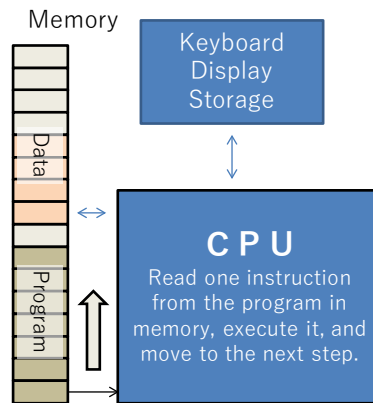


Figure 6 Behavior of Computer (Hardware)

Great Idea! Stored Program Architecture

The above computer structure is called **“Stored Program Architecture.”** Just by changing the program, the computer can meet a variety of requirements. From small computers embedded in home equipment to supercomputers, the same approach is commonly used.

2.3.2 Software

“Software” refers to the programs executed by computers. With the stored program architecture, a computer with fixed hardware can be used for various purposes just by changing programs. As technology has progressed, hardware speed has evolved, and allowed a huge variety of applications to be realized in software. Currently the most complicated software has around 100 million lines of code in the program.

On personal computers, software is of various types, allowing efficient and effective operation.

- **Application Software:** This is software that meets the user’s actual needs—examples are Word and Excel.
- **Operating System:** An operating system such as Windows is interposed between the hardware and application software, providing application software with a unified environment in which it can execute.

The following software supports the operating system, or provides functions that

are commonly needed by various applications:

- **Middleware:** Middleware is software that provides functions (“library functions”) commonly needed by various application;
- **Device Drivers:** Device drivers are software applications that drive hardware such as printers, under the control of the operating system.

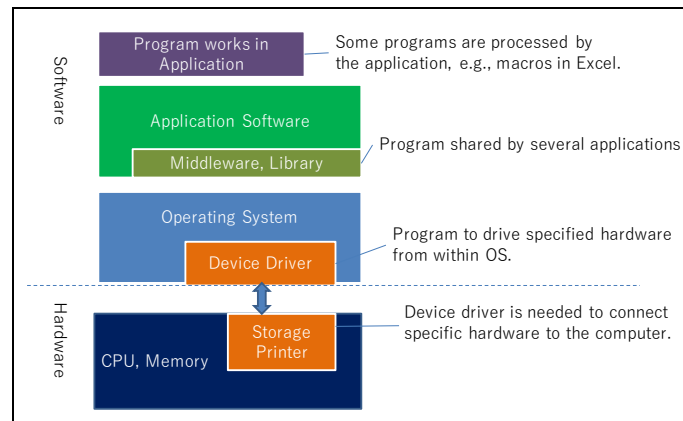


Figure 7 Software Structure of Personal Computers

2.4 The Role of the Operating System

2.4.1 Benefits of Learning about the OS

It may not seem very useful to learn about the operating system (OS), in comparison with learning about application software. However, by understanding the operating system,

- You can operate your computer efficiently;
- You can manage your computer properly;
- You can solve problems that arise with your computer.

Indirectly, you can raise your computer productivity by learning to use the OS.

2.4.2 Roles of the OS

The operating system of personal computer does the following things:

- It starts and stops application software, and assigns them memory and CPU time;
- Files are created, moved and deleted;

- Application software is installed and removed;
- Network communication is supported;
- Mouse and keyboard input;
- Printing;
- Creation and deletion of user accounts, authentication and control of permission to do various things;
- Controlling graphics and handling of copy & paste actions.

Figure 8 illustrates this.

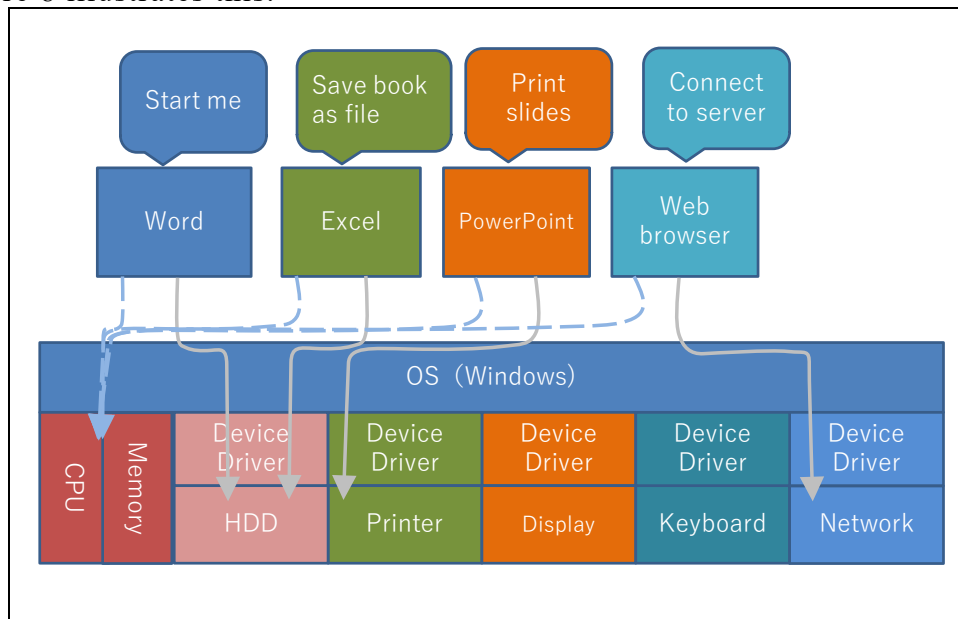


Figure 8 Roles of Operating System

Great Idea! Operating Systems

In early computers, software was developed for each computer.

Currently the operating system enables developers:

- To develop hardware and applications considering only the OS.
- To develop applications without writing programs that control graphics.

For users, OS allows them to:

- Operate various applications in a similar manner.

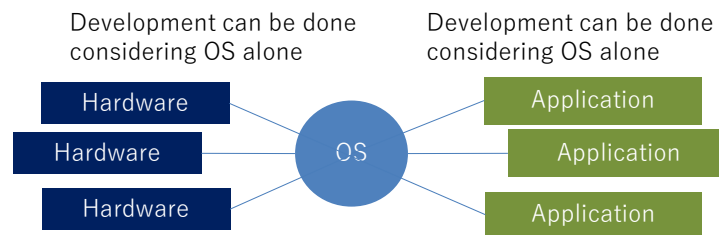


Figure 9 OS as a mediator

2.4.3 Software Behavior

Next, let's look at how software works.

Once the personal computer is turned on:

1. First, the firmware starts. This is a small program built into the computer;
2. The firmware reads the boot loader from the disk drive, and passes control to the boot loader;
3. The boot loader reads the OS from the disk drive, and passes control to the OS;
4. When the OS starts, it makes various preparations. It then allows users to interact with windows and start applications.

Currently the OS carries out many background tasks hidden to the user. To stop their personal computer, the user must **shutdown** properly and only turn off the power once the OS has stopped.

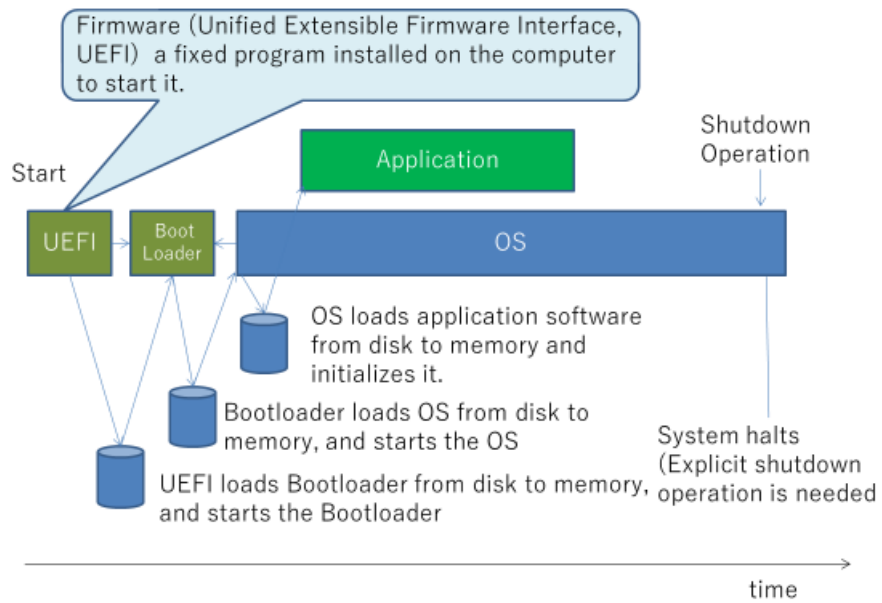


Figure 10 Behavior of software

2.4.4 Concurrent Execution of Programs and Utilization of CPU and Memory

With a personal computer, we can use various applications in parallel. To achieve this, the OS allocates memory areas for each executing program and its data. During execution, the OS switches execution between all of the applications very often. Thus, all applications appear to work concurrently.

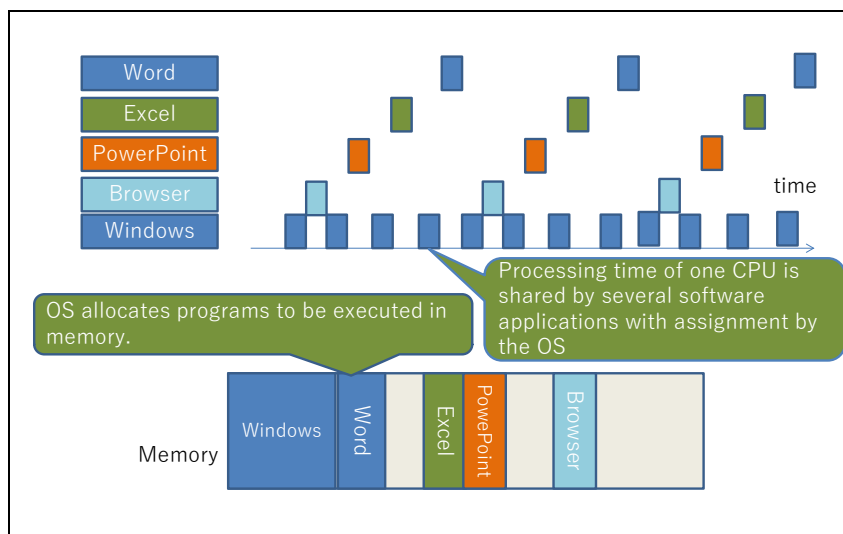


Figure 11 Concurrent execution of programs

2.5 Files and File System

2.5.1 Files

Documents, images, sounds, programs (software), etc. used on a computer are stored as “files” on a storage device such as a hard disk. File system is a mechanism for managing these files as “folders” and storing them on disks.

2.5.2 File Size

The amount of data recorded in a file, the capacity of a storage device such as a disk, and the maximum size of a file restricted by the OS and the file system (described later) are represented in units of “byte.” One byte has eight binary digits (eight bits), which is a suitable size for storing one character by using character codes (described later) like ASCII.

To represent a large amount of data, supplementary units are used such as k (Kilo), M (Mega), G (Giga) and T (Tera). For example, 1 Mbyte is 10^6 bytes, which means the size is about 1 million alphanumeric characters.¹

Table 1 Supplementary units

Notation	Name	Decimal
k	Kilo	10^3
M	Mega	10^6
G	Giga	10^9
T	Tera	10^{12}
P	Peta	10^{15}

2.5.3 File Format and Extension

1) File Format

A computer stores various data such as documents, images, sounds, videos,

¹ Since binary numbers are often used on a computer and $2^{10} = 1024 \div 1000 = 10^3$, 1024 bytes can be regarded as 1 kbyte.

and programs as files. The file format defines the way how to store data in a file in order to operate the file by the corresponding program properly.

Since different file formats may be used for the same data like images, it is important whether the program that processes the data can handle a specified file format. In particular, we need to be careful when the machine or software that generates the data differs from the machine or software that reads the data.

- Document files
 - **Text files:** A text file is composed of characters and control codes such as line feed. It does not include document format information. Although some documents like e-mail messages and HTML format files that describe Web pages include format information, they are represented in readable and writable characters, which means that they are text files.
 - Document files for word processors: For example, document files in Word format. Since different formats are used depending on the software and the software version, it is necessary to select an available format when passing document files to people who use different word processing software.
 - Printing formats: The **Portable Document Format (PDF)** is widely used as a format close to the image when printed. There are other formats for e-books such as EPUB.
- Data for spreadsheet software
 - Each spreadsheet software such as Excel defines its own data format. When handling the spreadsheet data, the same consideration as the word processor document files is required.
 - **CSV formats:** CSV is an abbreviation of Comma Separated Values, which is a text file format. In a CSV file, each line is a data record of a table, which consists of one or more cells of character strings or numbers, separated by commas (,).
- Image files
 - **Vector graphics:** Data composed of geometric information with the elements that make up graphics, such as lines and curves. In addition

to files that store data of drawing software, there are also formats for common use of data such as SVG.

- **Raster graphics:** Raster images are pictures and images read by a scanner that are represented by data of color and brightness of grid points (pixels). Raster images are stored in images files with various formats such as JPEG, TIFF, PNG, BMP, GIF. The lossy compression (described later) is often used to reduce the amount of data.
- **Audio files:** There are various formats such as WAV, AIFF, MP3, etc. MIDI is a format for playing electronic musical instruments, not for audio itself.
- **Video files:** There are various formats such as AVI, MP4, MOV and FLV.
- **Programs:** It is a format for a computer program that can be executed as it is. Windows OS uses the EXE format.
- **Archive files:** There are several formats for archiving multiple files and folders collectively in one file, such as the ZIP format. Data compression is often applied while archiving files.

2) Extension

A filename extension is an identifier for file formats, which is specified as a suffix to the name of a file with a period and a string of several characters, such as “.jpg.” The OS determines the file format from the extension and calls the corresponding application software.

We need to note that changing only the extension does not change the data itself, so the file cannot be opened with appropriate application software.

3) File Compression and Encryption

For digitized information, it is possible to **compress the amount of data** using the features of the data. For example, the eight-character string “00000000” can be represented by a two-character string “08” if it can be defined to represent eight “0s.” We can reduce the amount of data in this way for text files where the same character frequently continues.

- Lossless compression: Document files, numerical data, or computer programs need to be able to correctly restore from the compressed data. Data compression that can be restored accurately is called “lossless compression.”
- Lossy compression: For images, sounds, and videos, it is possible to significantly reduce the amount of data by allowing the quality degradation during playback using the characteristics of human senses. Such data compression is called “lossy compression.” When dealing with images and videos, we can handle the data effectively by choosing the level of the compression method considering the balance between the desired quality and the amount of data.

Moreover, we may use **encryption** to protect data. This can make it difficult to view the contents of the file even if the file is leaked.

In Word, Excel, etc., we can encrypt the data by selecting “Encrypt with Password” from the file menu. It is important to use a password that cannot be easily guessed when encrypting the data. When passing the encrypted files to others, it is important to handle passwords properly, such as passing passwords and files separately.

4) **Metadata**

In addition to the image itself, data of various attribute information may be added to image data such as JPEG. Data that is used to provide information about the original data is called “metadata.” The image captured with a digital camera is added with metadata such as shooting time in the **Exchangeable image file format (EXIF)**. **Information may be inadvertently leaked without understanding that such metadata is added.**

2.5.4 Character Codes

Inside the computer (including files), characters are represented and stored using character codes in which binary codes are assigned.²

1) Alphanumeric Character Codes

ASCII (American Standard Code for Information Interchange) codes are normally used for alphanumeric characters (called Latin letters). It uses 7 bits per character (128 possible combinations), and accommodates numbers, upper- and lower-case letters of the alphabet, symbols and control codes. In Japan, the JIS standard code (JIS X 0201) that conforms to this standard is used, but the ASCII code “backslash” and “tilde (~)” are replaced with “¥” and “overline” respectively. However, the latter is assigned a tilde in Windows OS.

2) Japanese Character Codes

In Japanese, which handles a large number of kanji characters, multiple character codes have been developed as technology advances. Therefore, the situation of character codes that handle Japanese is complicated. In particular, the character codes adopted by various operating systems are different, so there is a problem of so-called “garbled text (Mojibake)” where the character code is processed incorrectly and cannot be read.

- **JIS X 0201:** It is the oldest standard, which defined katakana etc. as 7-bit codes in addition to the ASCII code. It is a code used for so-called “half-width kana.”
- **JIS X 0208:** This character code extended JIS X 0201 by assigning kanji using 2 bytes.
- **ISO2022-JP:** It was designed to communicate Japanese over the Internet, such as e-mail, and includes JIS X 0201 Latin characters (alphanumeric characters) and JIS X 0208 Kanji, etc., but cannot use JIS X 0201 katakana. It is called “JIS code” by e-mail software etc. Since it assumes the use of

² Standardization of character codes makes it possible to exchange information. However, the reality is complicated with many issues such as handling of kanji, the increasing needs for character codes with the advancement of technology, and the coexistence of the industry standards and standards of public institutions etc. Here, we will introduce only the main points about the character codes when using a personal computer.

7-bit, character sets are switched by inserting a code in the middle of the document.

- **Shift-JIS Code:** A character code created to handle kanji on a personal computer. This code coexists with the use of 1-byte (8-bit) for JIS X 0201 Latin characters and Katakana, and it is a code that can handle 2-byte kanji without inserting a code to switch character sets.
- **EUC-JP Code:** A widely used character code on an operating system called UNIX, which enables ASCII code and JIS X 0208 kanji code to be used without inserting a code for character set switching. The handling of JIS X 0201 katakana and the code area assigned to kanji are different from the Shift-JIS code.
- **Unicode:** A character code designed to handle characters of various countries in a unified manner. Regarding kanji, it handles Chinese, Japanese and Korean collectively. It also defines a method for converting Unicode characters into data strings that are actually handled by computers. It is widely used because the method called UTF-8, which handles characters with a variable length of 1 to 4 bytes, is upwardly compatible with the ASCII code.

3) Handling of the Same Character

As the character code standard has been gradually expanded, the same character can be represented by different codes. We need to keep in mind the following operations when creating documents with a word processor.

- Express alphanumeric characters in ASCII code (half-width characters), and avoid alphanumeric characters in kanji code (full-width characters). We can choose a font suitable for English expression in the word processor, and also apply spelling and grammatical checks to the parts written in ASCII code.
- Avoid JIS X 0201 kana characters (so-called half-width kana). Some character codes such as ISO 2022-JP may not be usable.

4) Garbled Text (Mojibake)

The character code for handling Japanese differs depending on the operating systems such as Windows, macOS, and Linux. When exchanging files between these operating systems or exchanging Japanese files with a Web server, the phenomenon of gabled text (Mojibake) occurs. We need to note that it occurs not only with the contents of the file but also with the file name.

For example, gabled text (Mojibake) occurs in the following cases.

- Files exchanged between different OSs;
- E-mail messages;
- Web pages that do not specify the character code clearly.

Some software automatically determines the character code based on the fact that the binary representation in data differs depending on the character code, but it does not work perfectly.

2.5.5 Storage Device and File System

There are various storage devices that store files. When using a computer, it is necessary to understand where files are stored and what the advantages and disadvantages of the storage devices are.

1) Built-in HDD and SSD

Storage devices mainly used for storing personal computer OS and user files include built-in HDD (hard disk drive, devices that store data on magnetic disks) and SSD (solid state drive) that can use semiconductor flash memory in the same way as HDD. SSD has advantages such as higher operating speed and resistance to shock because there are no mechanical moving parts compared to HDD. However, the unit price per capacity of SSD is higher.

2) Removable Storage Media

In addition to external drives that connect HDDs and SSDs to personal computers via USB, there are other types of drives such as USB memory and SD card that store data in flash memory. Moreover, media such as CD and DVD are also used as removable storage media. There are various types of CDs and

DVDs, such as read-only ones, single-write ones, and multiple-write ones.

3) File Server

A file server connects to the network and provides files to personal computers via the network. NAS (Network Attached Storage) is a type of file servers.

4) Storage Service

There are various storage services available via the Internet such as OneDrive, Google Drive, Dropbox.

5) File System

It is important to understand how to record file information on a hard disk in order to manage a large number of files properly on a storage device such as HDD. The mechanism for this purpose is called “file system.” For example, Windows OS uses a file system called NTFS widely, but other operating systems use different technologies for file systems. In removable storage media, a file system called FAT32 is adopted because it can be used by many different types of computers. The file system not only handles files, but also has functions such as access control, file encryption, data compression, and troubleshooting to storage device failures.

“Folder” is a mechanism for file management on the file system. It is also called “directory,” where several files can be handled together as a folder. Moreover, the file system enables to put several folders into a folder, and it can manage files hierarchically.

2.5.6 File Manipulation

1) File Manipulation and Things to Keep in Mind

Files are used in various forms in intellectual production using a computer. In Windows OS, we use Explorer to manipulate files.

We will introduce the following manipulations that can be conducted on files, along with things to keep in mind when manipulating files.

- Create and obtain files: We may often create files in the form of Word documents or Excel spreadsheet data. We may also download files from the network in many situations. In the latter case, we need to remember two things.
 - Downloads should be appropriate without violation of the copyright law.
 - Security should be confirmed without being infected with virus.
- Rename the files: Changing the filename extension will lose the association with the application software that opens the file.
- Duplicate files and move files: Duplicating and moving files are often conducted by similar operations, so it is necessary to confirm which operation was conducted.
- Make backups: We will explain the backup in a separate sub-section.
- Archive/unarchive files: Creates an archive file in ZIP format, etc., and expands the archive file.
- Delete files: We will explain the file deletion in a separate sub-section.
- Restrict file access: We may want to restrict access to prevent accidental changes to important file contents.

2) Backup

When using a personal computer, there is a risk that files such as documents may be deleted accidentally or become unreadable due to damages of personal computers or disks. For example, the following cases can be considered.

- The user accidentally deletes the file or overwrites it with another file.
- Files cannot be read due to damages of personal computers or disks.
- A file is tampered with by malicious software such as a virus. **Recently, there are attacks using ransomware, which encrypts the user's files, makes them inaccessible, and demands a ransom payment to decrypt them.**

To deal with such problems, it is necessary to conduct “**backup**” to periodically make copies of files.

- What should be backed up?

It is necessary to back up files to protect the necessary data, and to back up

the entire system (disk) to restore the personal computer.

- Where should the copies be created?

Backing up on the same disk is convenient for restoration. However, the backup will also be lost if damages occur in the disk. Backing up to an external HDD or storage on the network can avoid this problem. Some ransomwares search for drives that are accessible from the user's personal computer and attack them. It is required not to connect a backup disk when unnecessary.

- Backups need to be managed properly.

If the files are backed up to other media, it is necessary to properly manage the backup itself. Information leakage may occur if the user forgets that the backup is stored and inadvertently passes it to others or disposes of it.

3) File Deletion

In Windows OS, deleted files are moved to the “recycle bin” so that they can be restored even after they are deleted. If the recycle bin is emptied, files cannot be restored, and occupied disk space can be reused.

However, it does not mean that all the written data is erased. Emptying the recycle bin only provides reusable disk space, **while the data itself may be remained**. This means that **there is a risk of information leakage when disposing of a personal computer**. At the time of disposal, it is necessary to erase the data completely and physically destroy the disk.

2.5.7 File Sharing and Transfer

Many people use both laptops and smartphones. There are various ways to transfer and share files among them as follows. There are pros and cons for each way.

1. Transfer files using removable storage media such as SD cards.
2. Connect a personal computer and a smartphone with a USB cable to read and write files.
3. Set up shared folders on the personal computer and access it from the smartphone via Wi-Fi.

4. Provide a file server (NAS) that can be accessed in common on the LAN.
5. Use storage services on the cloud.

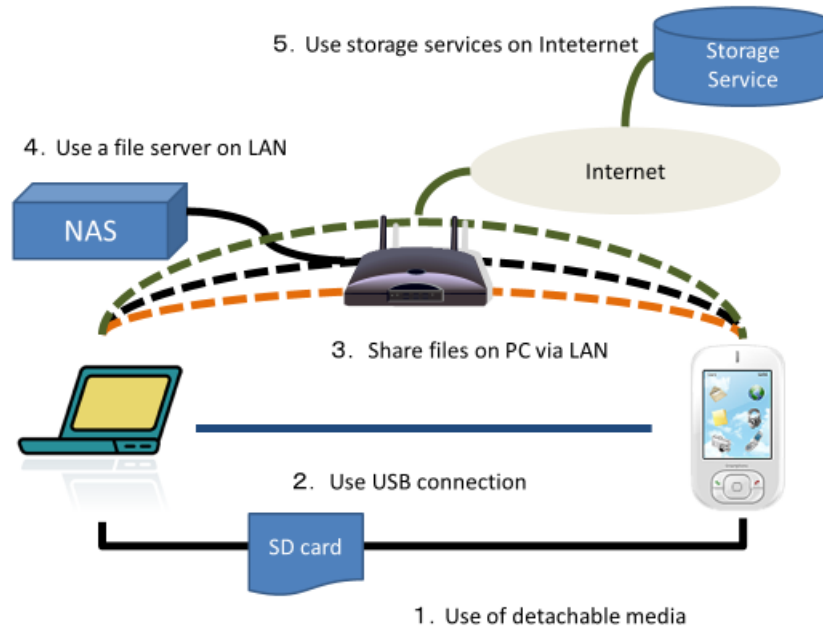


Figure 12 File sharing and transfer

2.5.8 OS and User Interface

The OS also provides users with a unified user interface for operating the computer as follows³.

- Operation of windows;
- Starting and stopping an application;
- Menu selection;
- Keyboard operation;
- Printing;
- Management of files;
- Copy and paste, etc.

The OS enables users to operate various applications in the same way without having to know how to operate each application separately.

³ In the LINUX environment, a standard window system X-Windows is software that is independent from the OS.

Great Idea! Window, Icon, Menu & Pointer

WIMP (Window, Icon, Menu & Pointer) is a user interface commonly used for personal computers. It was adopted on the 'Alto', developed by the Xerox Palo Alto Research Center in 1973. See Figure 4. Later, it was used in the Apple Macintosh, and is widely used as the standard user interface for personal computers.

2.5.9 Acquiring OS Skills

The OS provides you with basic control over the computer. You need to learn the following:

- How windows work;
- How to start and stop applications;
- File operations;
- Typing;
- Copy and paste;
- How to set up a printer and control its properties;
- Monitoring and forced termination of applications using Task Manager.

2.6 Skills Needed by Independent PC Users

What do you use your personal computer for? It may be word processing, spreadsheets, presentations, handling of photographs, watching videos, WWW browsing, and e-mail messaging. These can all be understood as processing, storing, and communicating information.

Exercise 2. Can you answer the following questions concerning usage of personal computers?

- If you want to use your personal computer (PC) for a purpose new to you, what should you do?
 - You may install a new application on your PC, and learn how to use it. It is a salient characteristic of computers that they can be used for various purposes simply by changing the software. But how do you actually do

this?

- You have edited a document with your PC. Where are the data in your document stored?
 - On the HDD or SSD in your PC, in detachable media such as the USB memory of an SD card, or on the server of your network?
 - How do you know this?
 - What are the pros and cons of these different forms of storage?
- On PCs, operating systems such as Windows and MacOS are working all the time. What are they actually doing?
 - As a user of a PC, what do you need to understand about the OS?

As university students, many of you have your own PC, and some of you live alone, away from your parents' home. This means that you have to be **an independent PC user**. What knowledge and skills are needed as an independent PC user? Beyond the ability to use certain applications, you are asked the following:

- Purchasing, Setting Up, and Disposal of your PC:
 - Can you choose a PC, taking your budget restrictions into account and the reasons you need to use it?
 - Can you set up your PC?
 - Can you dispose of your PC properly?
- Connecting your PC to networks:
 - Can you connect your PC to the networks available at home and on campus?
- Connecting devices to your PC:
 - Can you connect printers or external DVD drives to your PC?
- Installation, updating and removal of applications:
 - Can you select applications according to your need, obtain them appropriately, install them onto your PC, update them and remove them when you don't need them anymore?
- Ensuring security of your PC:
 - Do you take actions to secure your PC?

- Do you understand and are you aware of the operation of your PC?
- Can you take the appropriate actions when a security incident occurs on your PC?
- Management of Data:
 - You will handle various data on your PC. How can you make handling of data more effective and efficient using your PC?
 - Can you select appropriate drives or services on the network, to store data?
 - Can you backup your data in anticipation of problems with your PC?
 - Can you take appropriate actions to protect important data?
- Management of user accounts on your PC:
 - Can you set appropriate account handling on a PC shared with your family or friends?
 - Can you set appropriate permissions for the PC accounts used by your family or friends?
- Usage of OS and Applications:
 - Can you use the OS of your PC effectively and efficiently, with good understanding of its functions?
 - Can you use applications and network services effectively and efficiently?

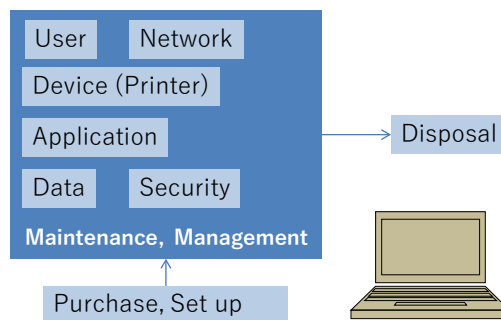


Figure 13 Skills required by independent PC users

It will be difficult to acquire the skills shown above in a short time. However, a basic understanding of your PC, such as hardware and software, and of the network will help you to build such skills efficiently. Let's learn the following so you can use your PC better:

- Understanding the basics of the computer and network;
- Confirmation of basic computer operation, and finding more efficient ways to do things;
- Know how to use the PC for university learning;
- Check your understanding and skills continuously, considering what skills you want to have, and how best to use your PC.

2.6.1 Choosing a Computer

In choosing a computer, what should you consider?

- What does CPU performance affect?
- What does memory capacity affect?
- What does HDD capacity affect?
- Are there any requirements for power consumption and network interfaces?
- Are there any requirements for the display specification?
- Is there a requirement for the battery life of a laptop PC?

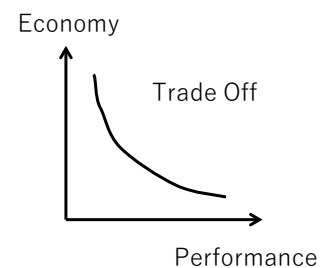


Figure 14 Trade-off

What is the relationship between the performance of the PC and what you want to do with it?

- What applications do you want use, what volume of data will there be?
- Where will you use it, and on what occasions?
- What devices do you want to use with it?
- How will you learn to use it?
- Do you need to transfer data from an old PC to new one?

In deciding something, there is usually a trade-off. For example, trade-offs between cost and performance, between portability and usability, etc. You'll need to make a good decision, taking these factors into consideration.

2.7 Typing Keyboard

In using a personal computer, typing on a keyboard is the key process used to convey information from the user to the computer. Recently, the use of

smartphones, which operate using touch panels, may have outstripped use of PCs, but in inputting a large amount of information, a human operating a keyboard is still important. Understanding how to type and improving your skill through exercises will enhance your productivity while using a PC. In this section, we introduce touch typing, the basic rules for English typing, and how to control Windows using a keyboard.

2.7.1 Touch Typing

“Touch typing” is a typing technique where you type on a keyboard without looking at it. With this technique, you can type while keeping the screen in focus, and continue to type efficiently.



Figure 15 Touch typing to reduce visual line movement

The basis of touch typing depends on a standard way of using your fingers. Fingers are assigned to columns of keys as shown in Figure 16. For example, keys ‘1’, ‘q’, ‘a’ and ‘z’ are typed by the little finger of the left hand. Fingers which don’t type stay on the keys in the second row. This is called the home position. To make it easy to find the ‘f’ and ‘j’ keys with your forefingers in their home positions, these keys have small raised bumps.

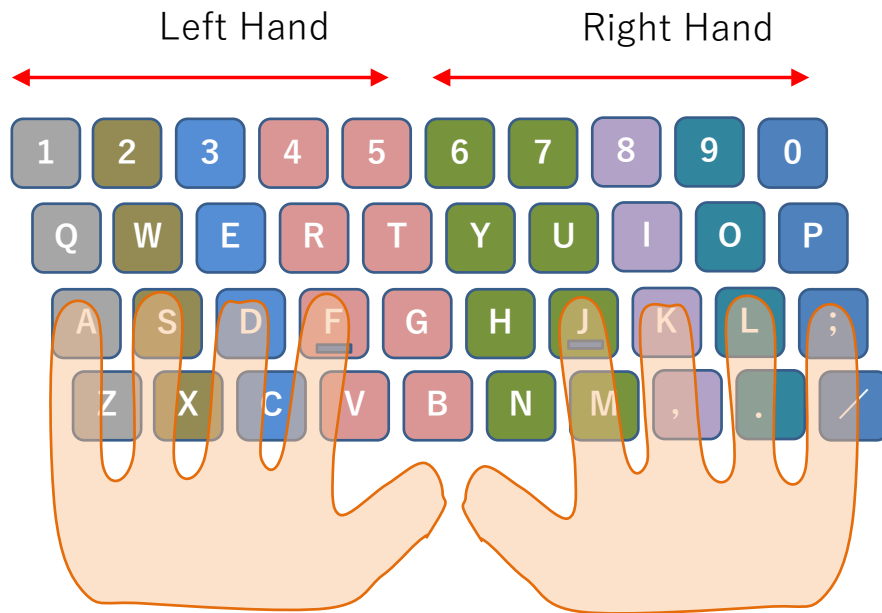


Figure 16 Home position in touch typing

To learn touch typing you will need exercises. Training software exists, and some programs are free. On the computer terminals of the Educational Computer System provided by the Institute of Information Management and Communication software called ‘TypeTrainer’ is installed.

The usual layout of keys on the keyboard is often called ‘QWERTY’ after the key layout in the relevant row. During the development of typewriters, various layouts were tried but the current layout predominates. For the history of the typewriter, see [2].

2.7.2 Rules for English Typing

During university study, you will often type English words. Word processing software such as Word assumes that the user types English following several rules for typesetting and grammar checking of the documents. The following are the basic rules for English typing:

- Type English in **HANKAKU (single byte) characters**.
- Capital letters can be typed by **pressing the character key with shift-key** as shown in
- Figure 17.

- When writing with Word, **use the Enter key only to enter a new paragraph**, and don't use it to adjust the right margin of the paragraph.
- **After periods and commas for punctuation, insert a space.**
Don't use spaces before periods and commas.
- Use periods for decimal points and commas to separate sequences of three digits; no space is needed before and after these.
- No space is placed before and after hyphens.⁴
- When words are enclosed by Quotation Marks ‘ ’ or parenthesis (), place spaces outside the marks, and do not put spaces inside the marks.



Figure 17 Entering capital letters by pressing Shift key

2.7.3 CapsLock and NumLock

In typing English words, sometime we need to type only capital letters. In such cases use the CapsLock key. Once you've press the CapsLock key with the Shift Key⁵, you can type capital letters without having to press the shift key. **If you press CapsLock by accident, you may be surprised at your inability to type in lower case letters.** To return to the original mode, press the CapsLock key again.⁶

Similarly, if you want to type numbers continuously on the numeric keypad, use the NumLock key. Knowledge of this feature will also allow you to deal with accidental activation.

⁴ Other than the hyphen, there are similar characters with a different length—the em dash and the en dash. In Word, if you place spaces before and after a hyphen, Word makes an en dash as in 0 – 1.

⁵ With Japanese keyboard, the CapsLock key works in this way. In English keyboard, it works without pressing the Shift key.

⁶ Changing alternating states like this is called toggling. In Word, the Ins key allows toggling between insertion and overwriting of characters.



Figure 18 Beware Caps Lock and NumLock. NumLock key may be allocated differently in laptop PCs.

2.7.4 Controlling Windows with a Keyboard

Certain mouse operations in Windows can also be performed using the keyboard. Keeping your hands on the keyboard, you can operate windows—this will improve the efficiency of your work. Important operations are listed below. In the following Ctrl-~ means “Press the ~ key together with the Ctrl key” as shown in Figure 19.

- Copy (Ctrl-C) / Cut (Ctrl-X) / Paste (Ctrl-V)
- Undo (Ctrl-Z), Redo (Ctrl-Y)
- Move to next input position (Tab key)
- To invoke task manager (Ctrl + Alt + Delete; Press Delete key with Ctrl and Alt keys)



Figure 19 Using Ctrl key and Tab key

2.7.5 Quickly Take Minutes

The ability to type quickly is useful in taking the minutes of a meeting. Don't do this after the meeting but **take the minutes during the meeting by**

typing the discussion in real time. If you display the typed minutes on a projector, the meeting can continue after confirmation of the minutes. At the end of the meeting, all members can agree what was discussed, what has been decided and what matters are still open, and who actions the tasks, simply by looking at the minutes. This technique should be called ‘on-site minute taking.’ If you work in a group at the learning commons, please try this technique.

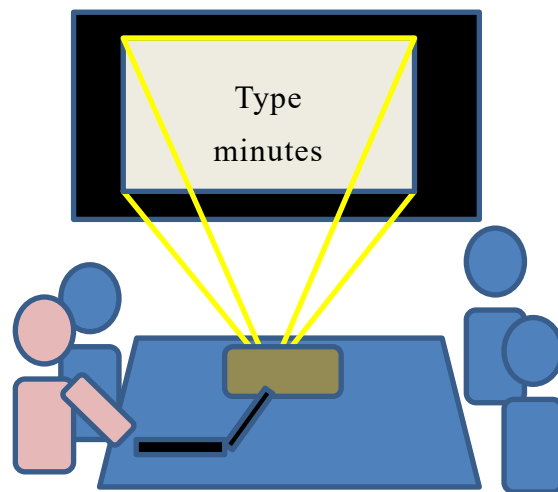


Figure 20 Share information by taking minutes instantaneously at a meeting.
Typing is an essential skill here.

Great Idea! Kana-Kanji Conversion

“The Art of Intellectual Production (知的生産の技術)” written by anthropologist Tadao Umesao in 1969 is a famous book which is still read by many people[1]. In it, he introduced a way to write Japanese using alphabetical characters (ROMA-JI) or a typewritten form of KANA, as a method to handle Japanese with technologies then available. In English, office work that involves document creation was supported by typewriters as they provide the alphabet, numbers and a small number of other symbols. Compared to this, supporting Japanese, which uses a vast number of Kanji, was then quite difficult.

The turning point was the development of the Japanese word processor JW-10 by Toshiba in 1978, with the technology for

Kana-Kanji Conversion developed by Kenichi More et al.[3] In common use now, this involves entering Japanese as Kana with conversion to Kanji, aided by a computer. Japanese has many different Kanji words which share the same pronunciation. This problem is solved by the computer, which chooses a candidate after referring to the frequencies of use of the words.

If development of this technology had been delayed, we might now write Japanese in ROMA-JI or KANA. This might in turn have had a big influence on our culture. Now people can use computers for many other languages, not just Japanese. This pioneering work in developing Japanese word processors may have contributed to the culture of the whole of humanity.

2.8 Licenses and Maintenance of Software

2.8.1 Protection of Software

As we've seen above, a computer consists of hardware and software. Current software is complicated, and the largest programs have 100 million lines of source code. Necessarily, development and maintenance of such software needs the collaboration of many people, at huge cost.

At the same time, software can be treated in the same way as data, and it is easily copied. To protect the rights of software developers, software is protected as copyrighted material.

In using software, users should acquire a **license** from the copyright holders as a contract that permits use of the software, and they should follow the conditions of this contract.

When you install new software on your computer, the licensing conditions are displayed, and you are asked to agree. The conditions describe to users what is allowed and what is not, what rights the licensor holds, and disclaimers, for example that the licensor doesn't take responsibility for problems that arise from use of the software.

2.8.2 Types of Software License

There are various approaches to software licensing.

1) Licensing by Mode of Use

- **Licensing for one computer:** Your own computer may contain this sort of software—licensing that allows installation of the software on one particular computer.
- **A floating license:** In computer laboratories on campus, we want to make software available to all the computers but the total number of users that use the software in parallel is limited. For such usage, some software suppliers offer a floating license. The management server monitors and limits the total number of copies of software executing at any one time.
- **Site license:** This is a licensing approach that allows unlimited number of computers to install the software within the contracted organization such as a university department.

2) Licensing by Purpose of Use

- **Licensing for academic organizations:** This is a license offered to public organizations such as universities for educational and research use, and not for commercial use. With this restriction, the license is offered at a lower price than that charged for general commercial use.

3) Software Freely Available

- **Licensing of freely available software:** Various types of software are available at no charge. However, other licensing conditions may apply.

2.8.3 Necessity of Maintenance

Once you install software on your computer, you will need to maintain this software continually for several of the following reasons. As a user, you should update installed software according to information provided by the software supplier.

- Vulnerability of software: Software may be vulnerable to attack from outside. Software used by many people, such as operating systems, office software and web browsers, is at a greater risk of attack.
- Dependency on other software: Application software works with an operating system and specific library software. Once such software is updated, the application may also need to be updated.

To continue using software not maintained by the supplier is dangerous because the user can't take effective countermeasures against vulnerabilities.

2.8.4 Information Gathering through Software

Recent software often works in collaboration with suppliers' servers. Such software often gathers information about users. In the licensing agreement, information about who gathers what information for what purposes is revealed to you. On installing software, you should check for such statements.

Exercise 3. Personal Computer Hardware

If you have your own PC, check the following:

- Type of CPU;
- Capacity of main memory;
- Type and capacity of storage such as HDD or SSD;
- Resolution of display.

Exercise 4. Personal Computer Software

If you have your own PC, check the following:

- Type of operating system and its version;
- Type of office software and its version;
- Type of antivirus software and its version;
- Licensing conditions of the above types of software;
- How you update the software.

Exercise 5. Roles of Operating Systems

Make a brief summary of the roles of operating systems on personal computers.

Exercise 6. Connection to External Devices

If you have a personal computer, check the interfaces for connecting a printer, an external display, an external storage device, etc.

Exercise 7. Use of Printers

If you have a PC, and can connect a printer to it, check the following:

- How you connect the printer to your PC;
- How you adjust its settings.

Exercise 8. Media for Storing Information

Study the following media used to store information such as CD, DVD, USB memory and SD cards:

- Types, capacities of the media, and whether they are writable or not;
- Risks of virus infection through such media, and countermeasures;
- Risks of information leak through such media, and countermeasures.

Exercise 9. File Management

Check how to do the following tasks regarding file management on your personal computer or university PC.

- Create files and folders;
- Confirm the information of files with filename extensions;
- Move and duplicate files;
- Delete files;
- Handle multiple files collectively;
- Archive and unarchive files.

Exercise 10. File Transfer and Sharing

Consider how to transfer files between the following devices. If there are multiple ways, consider the pros and cons. Access to the file is not permitted except to the transfer source and transfer destination.

- Transfer of files between PC terminal of educational computer system and your personal computer;
- Sharing files among group members in group works.

Exercise 11. Use of Graphical User Interface

Check how to do the following tasks on your personal computer.

- Adjustment of the window size and layout (location etc.);
- Start and stop of application software;
- Operation of each mouse button;
- Operation of the touch panel.

Exercise 12. Typing

Concerning keyboard typing, check the following:

- Keystroke inputs, using multiple keys such as how to type capital letters;
- Finger assignment for touch typing;
- Rules for typing English;
- Copy and paste using the keyboard.

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- [2] Koichi Yasuoka and Motoko Yasuoka: Myth of the QWERTY Keyboard, NTT-Shuppan (2008, in Japanese) (安岡孝一, 安岡素子著: キーボード配列 QWERTY (クワ-ティ) の謎, NTT 出版, 2008.)
- [3] Toshiba JW-10, Japanese Word Processors, IPSJ Computer Museum <http://museum.ipsj.or.jp/en/computer/word/0049.html> (last access Jan. 11, 201

3. Basics of Information Networks

3.1 Study Aims

By connecting computers worldwide, the Internet is inducing vast changes in our society. Various services are now provided via the Internet, but at the same time we also face many problems, and we are asked to take appropriate actions based on our understanding of information security and information ethics. In this chapter, to understand such situations and to take appropriate measures, we learn:

- The basics of information networks such as LANs and the Internet; and
- Risks and countermeasures associated with the use of ICT.

Furthermore, in modern societies, we use various media for communication. In this context, we also learn about:

- Use of e-mail for formal communication
- Network services provided by Kyoto University and requirements to student users.

3.2 Safe Driving in a Virtual World

The connection between computers and people all over the world by the Internet forms a large “cyber-world”. The computer is a tool for enhancing the intellectual ability of people. In other word, it is like a power-suit for intellectual ability. In analogy to the way people move, the computer is something like a big truck or a jet aircraft. The Internet can be seen as a cyber-highway where people are running around freely in armored intellectual power-suits.



This means that each person can perform amazing things, but at the same time, safe driving is also very necessary. As in, or even more so than in the physical

world, malicious behaviors such as crimes occur often in the cyber world.

Assault of a specific person by many others is a problem that occurs especially in the cyber world rather than the physical world.

To survive in the cyber world, we need to have basic understanding of the information networks and services available there.

3.3 Information Security e-Learning Course

Concerning information ethics and information security, there are many things to learn. In this course, course content covers some of this, but you also have to study the information security e-learning provided by the Institute of Information Management and Communication. We ask you to complete that course as a necessary condition for this course.

Complete Information Security e-Learning!

3.4 Information Systems on the Network

Modern information systems consist of interconnecting computers via a network. In this book, the term “server” is often used, which refers to a computer that plays the role of the “server” in the “server-client type” information systems. In this section, we will introduce several types of information systems, including the server-client type and the peer-to-peer type. We will also introduce the concept of “cloud computing” which is frequently used in recent years.

3.4.1 Server-Client Type Information Systems

In a server-client type information system as shown in Figure 21, the computers (clients) that receive services are connected to a core computer called a “server” that provides services. A client personal computer uses services on the network by connecting to various servers such as DHCP servers (described later) that automatically assign an IP address, DNS servers that search IP addresses from

domain names, and Web servers that provide Web pages. Invocations and executions of various services are conducted in a multi-layered server-client type information system.

3.4.2 Peer-to-Peer Type Information Systems

In a server-client type information system, client computers connect to a core computer called a server. However, the computers can also directly connect to each other to provide and receive services, which is the peer-to-peer (P2P) type information system as shown in Figure 22.⁷

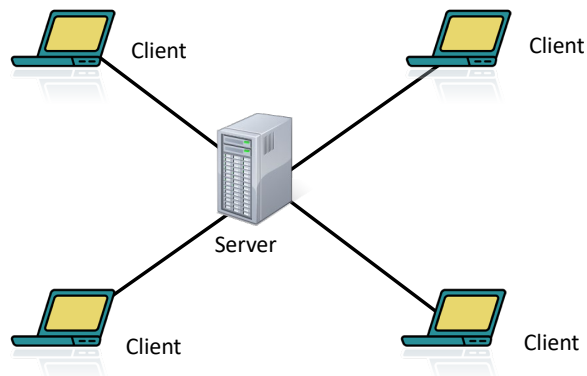


Figure 21 Server-client type information systems

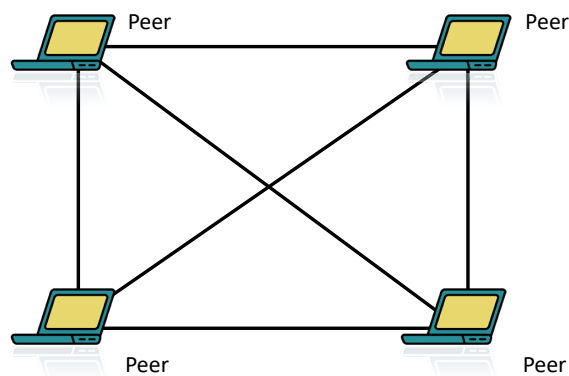


Figure 22 Peer-to-peer type information systems

⁷ Many potential problems may occur with software that exchanges files using the P2P method, such as a large amount of communication, copyright infringement, and high risk of virus infection. Kyoto University prohibits the use of P2P file exchange software from KUINS III.

3.4.3 Cloud Computing

In the past, information systems within organizations such as universities and companies have been operated by setting up servers inside the organizations. In recent years, various services operating on data centers have been widely used by a lot of organizations and individuals. This type of information systems, as shown in Figure 23, is called cloud computing. The name of cloud computing comes from the idea to illustrate the Internet as a “cloud.” The services provided by cloud computing are called cloud services.

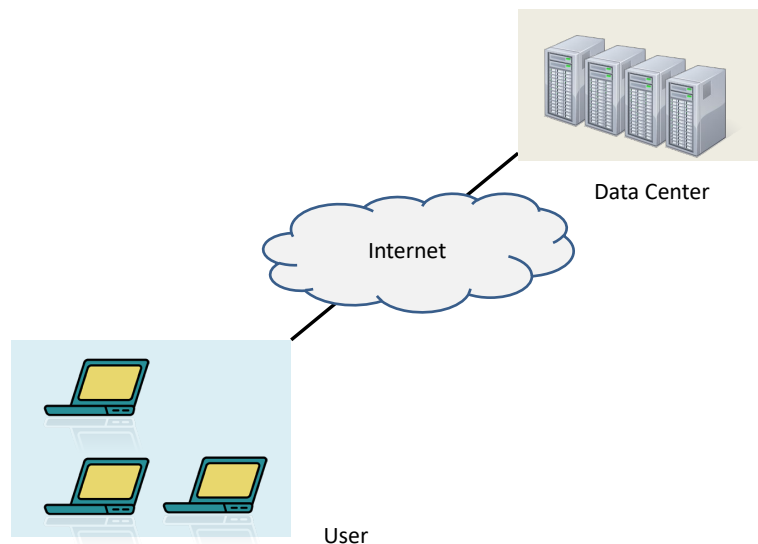


Figure 23 Cloud computing

3.5 Basics of Local Area Network (LAN)

To connect a personal computer to the Internet performs the following two steps:

- Connect the PC to a wired LAN or a wireless LAN (Wi-Fi); and
- Connect the PC to the Internet via the LAN.

In the following, the basics of LANs and the Internet are explained.

3.5.1 Types of LAN

1) Wired LAN

The wired LAN commonly used is Ethernet.

- Ethernet uses LAN cables having RJ45 connectors. Ethernet has several specifications of different speeds as shown in Table 2. Usually through

negotiation between the LAN switch and the PC, an adequate specification is automatically selected.

- The quality (named category) of the LAN cable depends on the Ethernet specification.
- A network is constructed by connecting computers and other devices to the equipment called hub or switch with cables.



Figure 24 RJ45 Connector

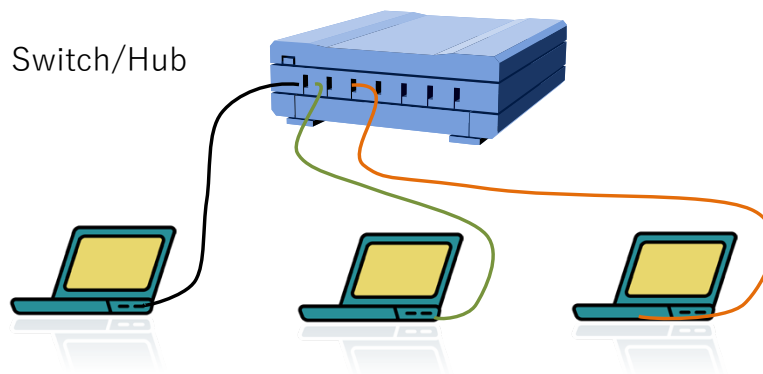


Figure 25 Wired LAN (Ethernet)

Table 2 Types of Wired LAN (Ethernet)

Specification	Speed	Required Cable
10 BASE-T	10 Mbps	Category 3
100 BASE-TX	100 Mbps	Category 5
1000 BASE-T	1000 Mbps	Category 5e

2) Wireless LAN (Wi-Fi)

A wireless LAN indicates a LAN in which devices such as personal computers with wireless LAN interfaces communicate with each other wirelessly through access points.



Figure 26 Wireless LAN (Wi-Fi)

There are several Wireless LAN specifications that differ based on frequency band and speed. Usually, the appropriate specification is automatically decided between the PC and the Wi-Fi access point.

Table 3 Specifications of Wireless LAN(Wi-Fi)

Specification	Frequency Band	Maximum Speed
802.11a	5GHz band	54Mbps
802.11b	2.4GHz band	11Mbps
802.11g	2.4GHz band	54Mbps
802.11n	2.4GHz band, 5GHz band	600Mbps
802.11ac	5GHz band	6.9Gbps

SSID, ESSID : In the same physical space, multiple Wi-Fi connections can be used. SSID, ESSID are the identifiers (names) used to distinguish wireless LAN groups.

3) Encrypted Communication over Wi-Fi

With a wireless LAN, information is transmitted locally using radio waves, implying that information can be tapped into easily by others. To avoid this problem, cryptography is available with wireless communication. To use such wireless LANs, the user has to specify a cryptographic key as well as the SSID identifier of the LAN group. There are several cryptographic specifications but use of some, e.g. WEP should be avoided because they are vulnerable. You may use a Wi-Fi access point of your own at home. Use of cryptography is highly recommended, avoiding vulnerable specifications.

Table 4 Specifications for Wi-Fi Cryptography

Specification	Note
WEP	Early, marked vulnerability
WPA	An improvement on WEP, TKIP cryptography was adopted
WPA2	Enhanced over WPA, supports stronger (AES) cryptography

Wi-Fi without cryptography is also used for e.g., public Wi-Fi. To make communication secure in such environment, — a Virtual Private Network (VPN) is used.

3.5.2 MAC Address

Every LAN device has a unique number called MAC address (Media Access Control Address), which is set by the manufacturer. In many cases, the MAC address is set in advance for a corresponding machine. A MAC address is a value in 48 bits (6 bytes) represented as “○○-○○-○○-○○-○○-○○,” in which each byte in two hexadecimal digits is connected with another byte by “-” or “:”.

The term “physical address” sometimes refers to a MAC address.

On Windows OSs, we can obtain the MAC address of the computer's network interface by launching a command prompt and entering the “getmac” command.

3.5.3 Components and Devices for LAN

- **Hub, switch:** A device that delivers packets (called a frame in LAN) between machines connected via a wired LAN. There are two types of them. One just amplifies the electrical signal and the other keeps the packet internally and sends it out again. The latter one can be called a switch.

- **Access point:** A device that delivers frames between wired LAN and machines such as computers connected via wireless LAN.
- **Router:** A device that delivers IP packets between a LAN and an external line (WAN, Wide Area Network) or another LAN.
- **DHCP server:** A device that automatically assigns an IP address to a machine connected to a LAN. We will introduce DHCP later.
- **WAN connection equipment:** Equipment for connecting to an external network (WAN) according to the line type such as “Optical Network Unit (ONU)” for the optical fiber line or “Cable Modem” for the cable TV line.

Using above devices, the LAN can be constructed as shown on the left part of Figure 27. Wi-Fi routers can include these functions collectively for small networks, as shown on the right part of Figure 27.

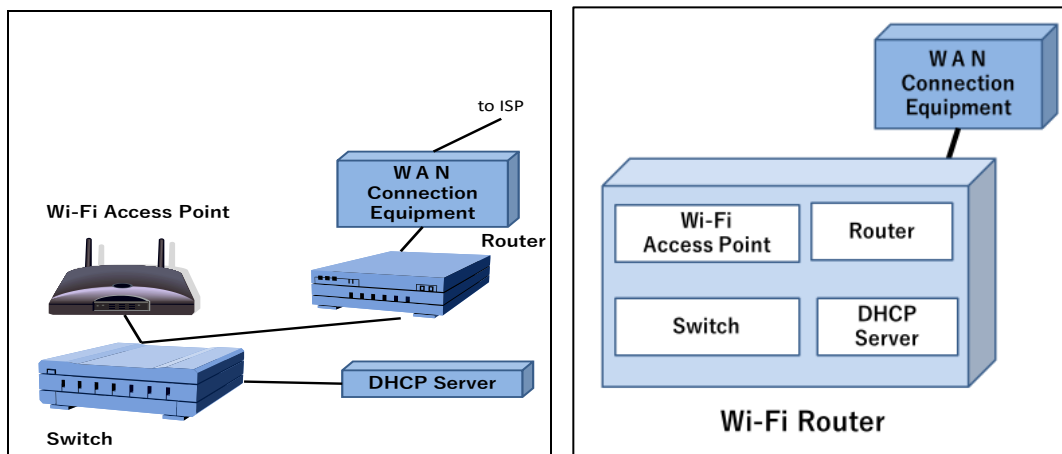


Figure 27 Components and devices for LAN

3.5.4 Tethering

There is a function called “tethering” that connects a PC to the Internet through the smartphone. Tethering using Wi-Fi⁸ is a mechanism that allows a PC to connect to the Internet via Wi-Fi by enabling the smartphone to act as a Wi-Fi access point, router, or DHCP server.

⁸ Besides Wi-Fi, tethering can also be realized with USB and Bluetooth.

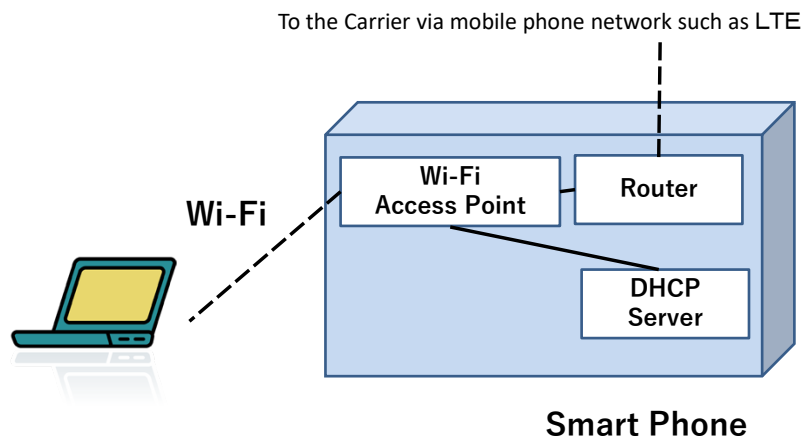


Figure 28 Wi-Fi tethering using a smartphone

3.5.5 VPN (Virtual Private Network)

In networks within organizations such as universities, WWW servers that allow access only from within the organization are often used. Such servers cannot be accessed directly from outside the organization.

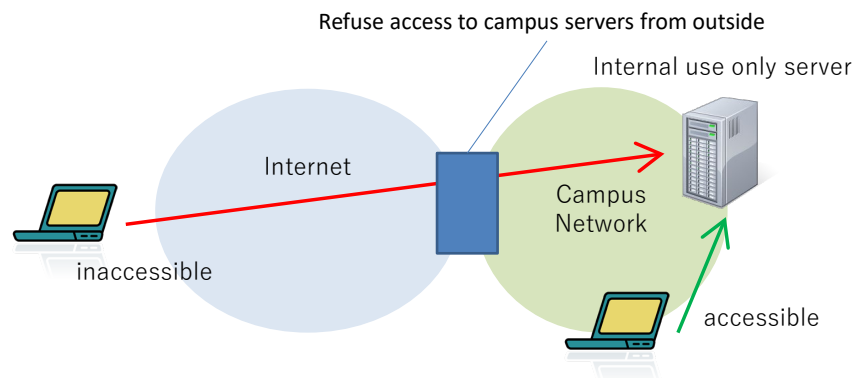
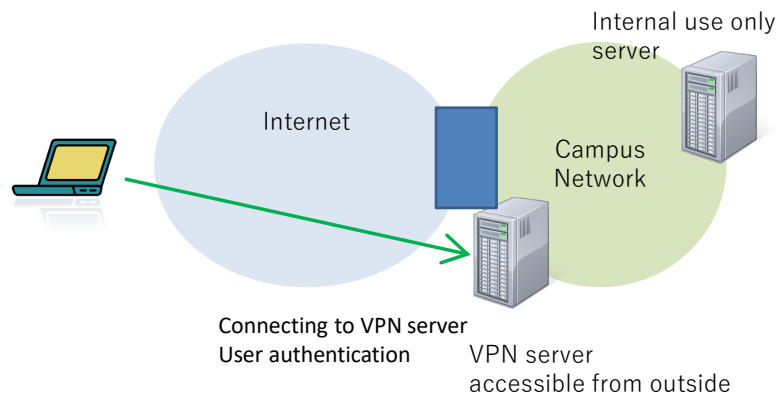


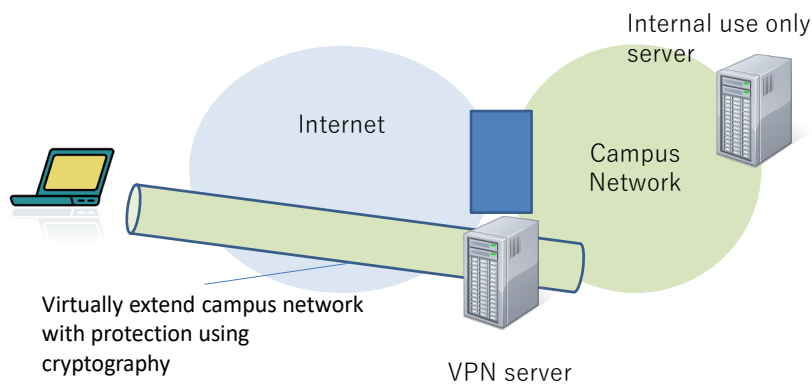
Figure 29 Servers that can only be accessed from within an organization

VPN (Virtual Private Network) is a mechanism that enables secure access to the network within such organizations via the Internet. The following procedure is for accessing to a network in an organization (campus network) via the Internet by using a VPN.

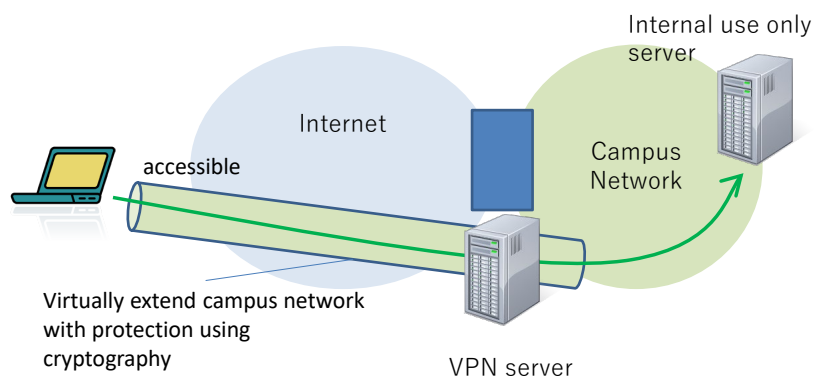
1. First, access the VPN server of campus network published to the Internet, and authenticate that you are a user with access rights.



- The VPN server allows communication from the personal computer to the campus network by using the communication path with the connected personal computer protected by cryptography as a virtual path on the Internet.

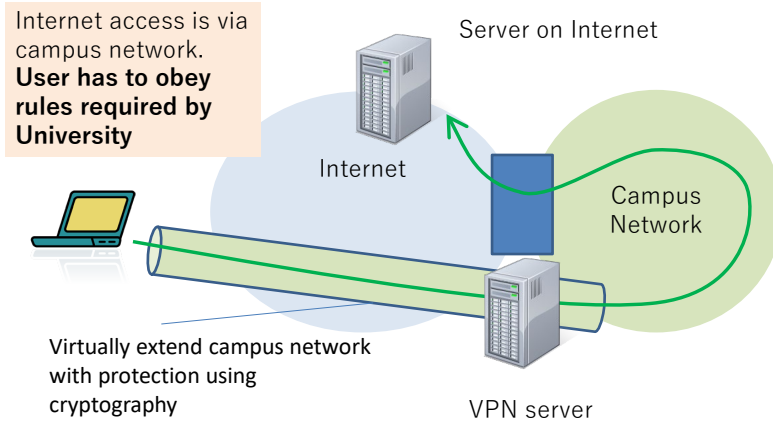


- Access the campus network from your personal computer via this communication path.



Note: If you connect to the network in your organization using VPN, the access from your personal computer to the Internet is also via VPN, so the

restrictions of the organization apply. Communication prohibited by the organization must not be conducted.



3.6 Internet Basics

Many machines are mutually connected by the Internet as shown in Figure 30. In the following, we learn the basics of the Internet.

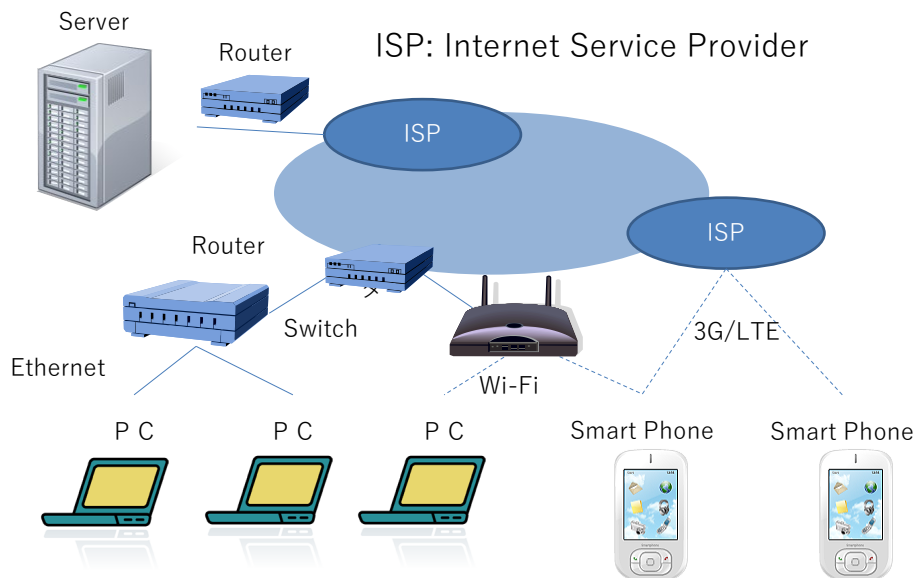


Figure 30 Various machines make up information networks

3.6.1 Internet Mechanism 1: TCP/IP

The Internet provides a way to communicate that is used in common on various networks such as LANs. Information is transferred as a small unit called a packet. Using this method, a computer can communicate with various targets in parallel, sharing a single communication channel. See Figure 31.

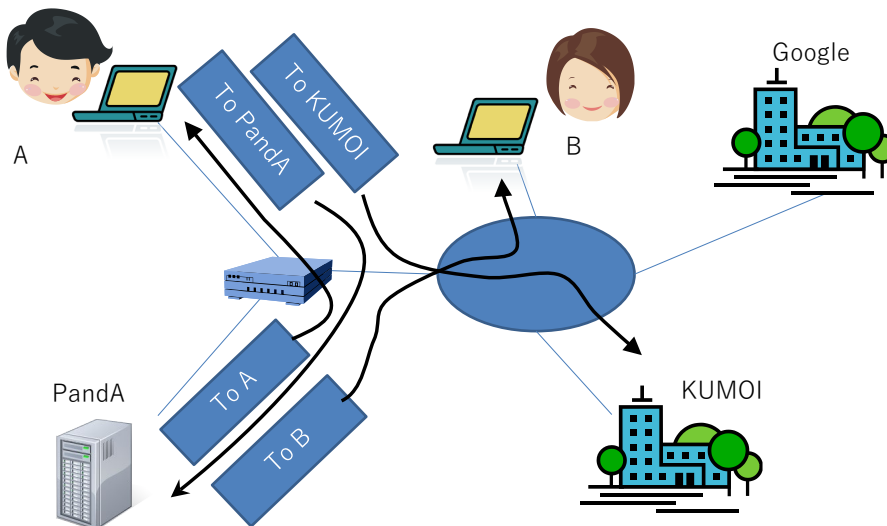


Figure 31 Packet exchange

The basis task of the Internet is delivery of packets from one end to another.

- To identify the devices at each end, a number called 'IP address' is uniquely assigned to each device.
- IP (Internet Protocol): This protocol fulfils the role of transferring packets. Communication takes place as best possible, but doesn't guarantee arrival of packets, or the order of arrival.
- TCP (Transmission Control Protocol): This protocol assumes the responsibility of ensuring information is sent, and that the data sequence is maintained. Because this isn't guaranteed at the IP level, resending of packets and recovery of order are performed under this protocol. To permit multiple communications using TCP, a single TCP communication is identified by a number called a 'Port', as well as referring to an IP

address.

- HTTP (Hypertext Transfer Protocol): This is a communication protocol used to exchange information on the World Wide Web. It uses TCP communication as its basis.

Various protocols used for various purposes are adopted as Internet standards with the basis being TCP/IP.

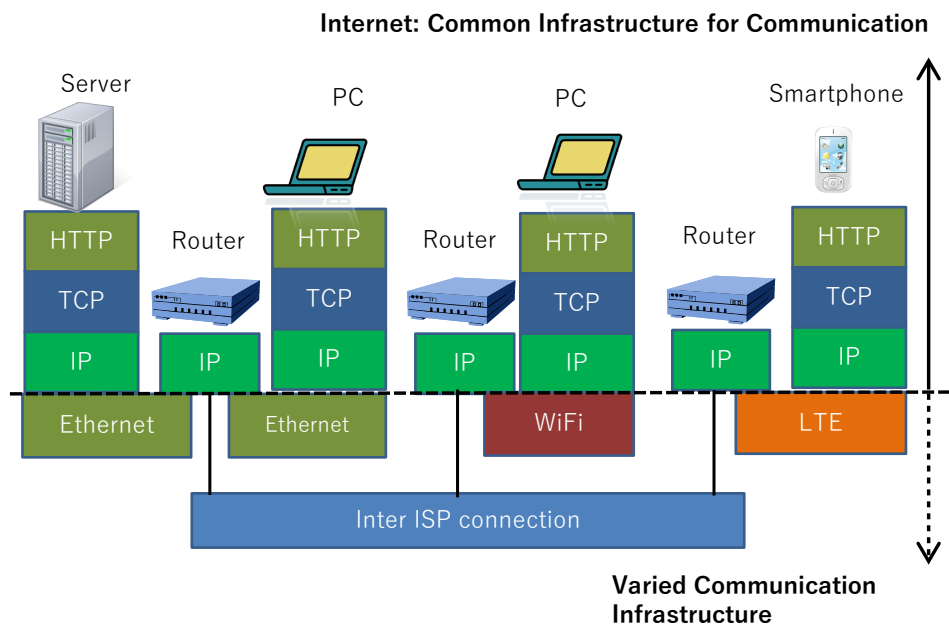


Figure 32 Protocols composing the Internet

Great Idea! Internet Protocol

Internet Protocol (IP), the basis of the Internet, is designed to: **Deliver packets with the least amount of effort, but doesn't guarantee arrival of the packets, nor their order.**

In all nodes that relays packets, realization of IP becomes very simple owing to the above design principles. Sending long messages with guaranteed arrival and order should only be achieved at both ends of such communication using Transmission Control Protocol (TCP). Both are representative Internet protocols, together called

TCP/IP.

These mechanisms have enabled users to develop various applications (software) independently, and support advancement of the Internet.

3.6.2 Communication inside LAN and Role of Router

Inside a LAN using ethernet or Wi-Fi, machines connected to the LAN communicate each other with frames specifying senders and receivers with MAC addresses. Communication using IP addresses in a LAN is realized as follows:

1. The sender knows the MAC address of the receiver having particular IP address. It is achieved by broadcasting a query of MAC address of the machine that has the IP address (ARP, Address Resolution Protocol is used for it⁹).
2. The sender sends a LAN frame specifying the receiver's MAC address embedding the Internet Protocol Packet as a data of the frame.
3. The receiver extracts the IP packet from the received LAN frame, and process it as an IP packet.

For communication with machines outside the LAN such as WWW servers in the world, The LAN frame is sent to the router (or the gateway) that connects the LAN with an outside network.

The router extracts the IP packet from the received LAN frame, and forwards it to the outside network such as WAN by embedding the IP packet in an appropriate format of the network.

⁹ ARP is used in IPv4 explained later. For IPv6, Neighbor Discovery Protocol (NDP) is used for such purpose.

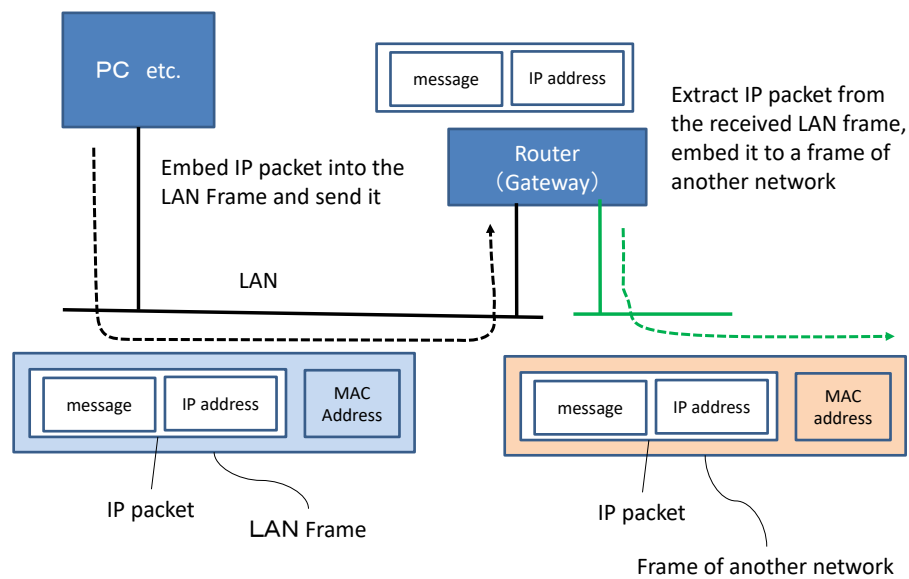


Figure 33 Role of router

3.6.3 IP Address

1) IP Address and Its Description

In the Internet Protocol, a number called IP address is used to specify sender and receiver. In IPv4, which is widely used in Japan, IP address of four bytes is used. It is described with decimal expression of each byte (from 0 to 255) connecting with period (.). For example,

192.0.2.0

2) IP Address Assignment

IP addresses provide the basis of the network for packet delivery; they should be assigned systematically on the network (worldwide if they are global addresses). You may not even notice address assignment while using your PC, nor need to assign an address manually. Address assignment is done automatically when the PC connects to the LAN by searching for a server that assigns an address to the PC. The protocol that achieves this function is called DHCP (Dynamic Host Configuration Protocol). A server for IP address assignment is called a DHCP server.

3) Global IP Address and Private IP Address

IP addresses are assigned systematically for global communication. IP address for such use is called global IP address. Further, some range of IP address are reserved for free use in a closed network. IP packet using such IP address should not be delivered outside. Such IP address is called private IP address. A network operated with private IP address is often called a private network.

4) Pros and Cons of Global and Private IP Addresses

Connection to a network operated with global IP addresses is necessary for services to the outside such as WWW servers. However, such servers require highly secure operation because they might be attacked from the outside.

Contrary to this, the network operated with private IP addresses is flexible because addresses can be used without assignment based on applications. Private IP addresses are used because the number of global IP addresses is quite limited and many global IP addresses have already been used. Computers connecting to a private network is inaccessible directly from the Internet. Therefore, private networks are used for connecting personal computers inside offices and homes.

In many private networks, to allow access to outside services such as WWW servers, bridging mechanisms explained later are introduced between a private network and a network of global IP addresses. Computers in the network of private IP addresses cannot be attacked directly from the outside. However, by activating malwares via infection of computer virus, even such computers can be operated remotely from outside attackers. Therefore, computers in the private networks should also be operated carefully to avoid such risks.

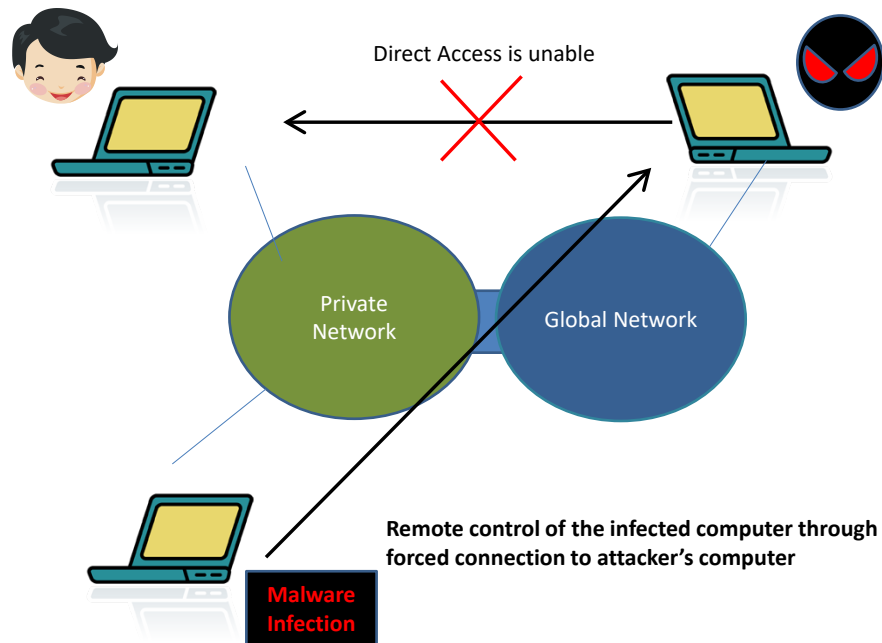


Figure 34 Attack to a computer inside a private network

Personal computers and smartphones that connect to wired or wireless routers for family use (or personal use) are usually operated with private IP addresses.

5) Addresses used as Private IP Addresses

The following addresses can be used as private IP addresses. It is guaranteed that these IP addresses are not assigned as global IP addresses.

- 10.0.0.0 - 10.255.255.255
- 172.16.0.0 - 172.31.255.255
- 192.168.0.0 - 192.168.255.255

Upper address ranges are used for large-scale private networks, and lower ones are used for small private networks.

6) Bridging the Private Network and the Internet

Machines operated with private IP addresses cannot directly access to

services on the Internet such as WWW servers. Access to a WWW server on the Internet can be relayed with the following methods.

(a) Address Translation

In a relaying apparatus such as a router, a translation table is placed for possessing the translation between private IP addresses (with port numbers) and global IP addresses (with port numbers). When an IP packet is received from one network (e.g. the private network), the IP address inside the packet is rewritten by referring to the translation table. Then, the rewritten packet is sent to the other network (e.g. the global network). This method is called NAT (Network Address Translation) (NAPT (Network Address Port Translation) in case of using port numbers).

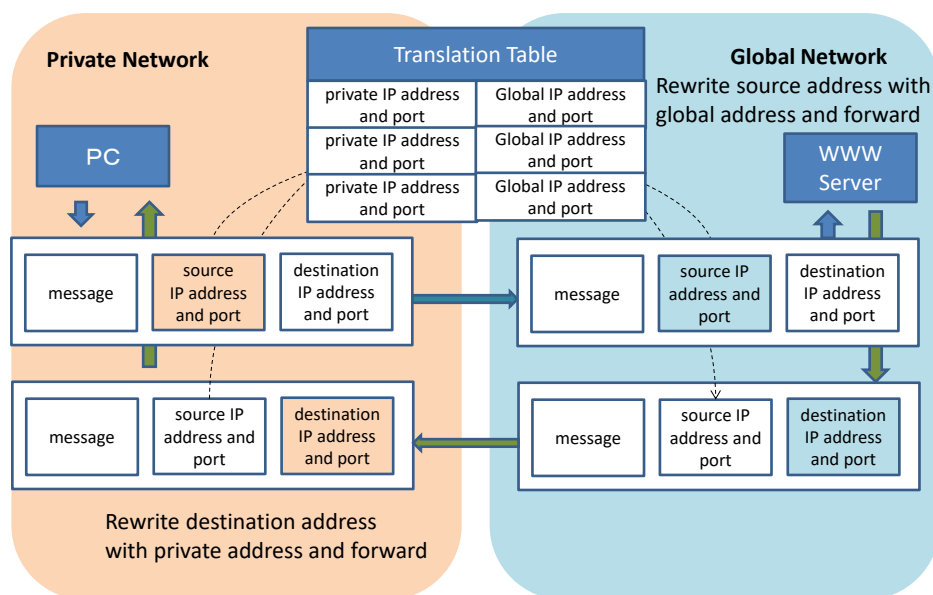


Figure 35 Address Translation (NAPT)

(b) Proxy Server

A proxy server is a relaying server that connects both the private network and the global network. It receives accesses to the WWW servers from computers on the private network, and send the same accesses to the WWW servers on the global network. Then, it gets responses from the WWW servers and sends the responses back to the computers on the private network.

3.6.4 IPv4 and IPv6

The Internet Protocol currently used widely is Version 4 (IPv4). Explanation of the Internet Protocol in this textbook is mainly about this version. In IPv4, the length of an IP address is 4 bytes (32 bits). However, IP addresses have been exhausted with the rapid growth of Internet use. Successor protocol after IPv4 is called Version 6 (IPv6). IPv6 uses an address of 16 bytes (128 bits) to provide sufficient addresses.

An address of IPv6 is described by connecting hexadecimal numbers of each 16 bits with `:`. To make the description short, leading zeros in each 4 digits can be omitted, and a series of all zeros can be described as `::` only once.

For example

2001:0db8:0000:0000:0001:0000:0000:0001

can be shorten as

2001:db8::0:1:0:0:1

3.6.5 The Domain Name System (DNS)

IP addresses are represented as numbers, and are difficult for people to understand. Therefore, domain names are used instead. A domain name can be converted to its corresponding IP address by searching the DNS (domain name system), a distributed database system operated on the Internet. A server that converts a domain name to an IP address is called a name server (DNS server). Depending on the network, the name server can either be automatically identified or explicitly set manually.

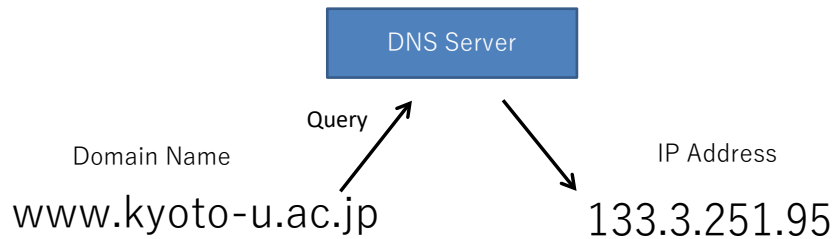


Figure 36 Converting a domain name to an IP address with DNS

3.6.6 How the WWW Works

The World Wide Web is a system that accesses Web pages using a protocol called HTTP (Hyper Text Transfer Protocol). It has following characteristics:

- The web page is described in a format termed HTML (Hyper Text Markup Language).
- Based on the URL (Uniform Resource Locator) rules, the websites or the pages on it are described.
- Links to other pages can be constructed as ‘hyperlinks.’

The application software that accesses websites (servers) and displays the contents on them is called a ‘Web browser.’ Major Web browsers include:

- Microsoft Edge and Internet Explorer provided by Microsoft;
- Mozilla Firefox provided by Mozilla Foundation;
- Google Chrome provided by Google;
- Safari provided by Apple etc.

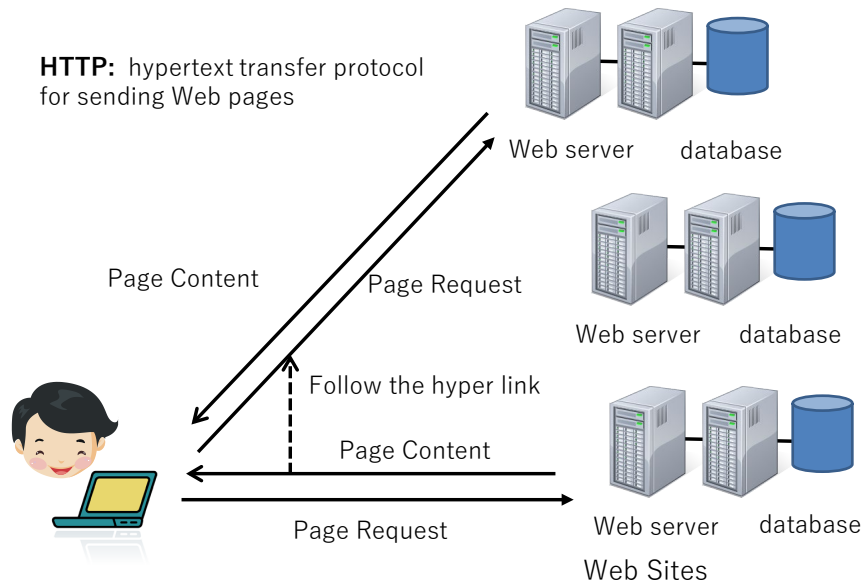


Figure 37 World Wide Web Mechanisms (Hyper-Link)

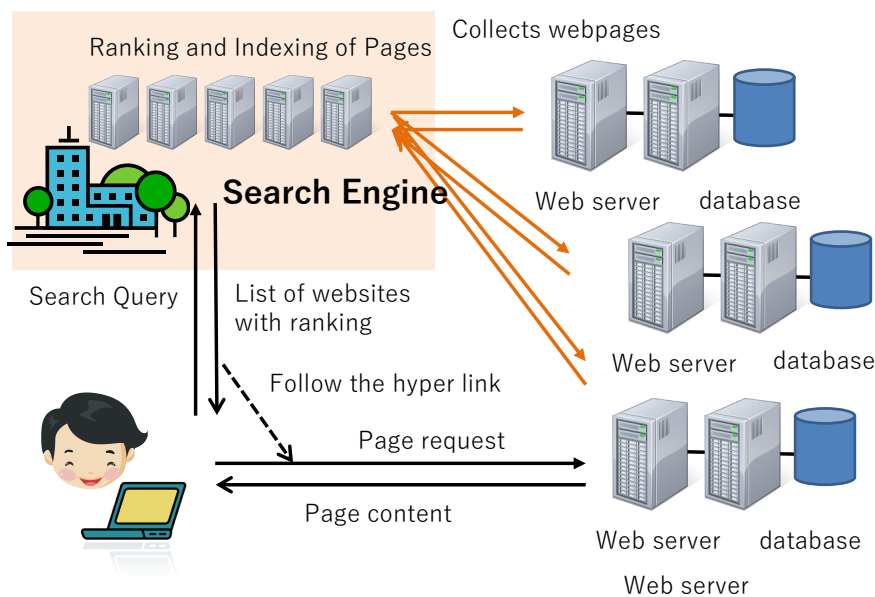


Figure 38 World Wide Web Mechanisms (Search Engine)

Currently, various services are provided on the World Wide Web. For example, a search engine such as Google gathers WWW pages, evaluates them, and makes indexes. With these, the search engine provides candidate pages in response to a given search query.

- For encrypted communication on the Internet (WWW), TLS/SSL¹⁰ is commonly used.
- The URL of a website that uses SSL starts with “HTTPS.”
- POPS, IMAP4S, SMTPS: these are the encrypted (TLS/SSL) versions of the POP, IMAP, and SMTP protocols used for mail.

1) Public-Key Cryptography

Public key cryptography is a very important technology for secure communication over the Internet. It is like a safety box with two keys—one key locks it, and the other key unlocks. It’s very difficult to guess the key (requiring a vast amount of computation) from the information you have in the encrypted message.

One of the two keys is made public, and the other is a secret. For example

- Key A : open
- Key B : secret

With this

- Encrypted communication
 - Encryption by Key A (anyone can do it) →
Decryption by Key B (only the owner of secret key can do it).
- Electronic signature
 - Encrypted by Key B (only the owner can do it) →
Decrypted by Key A (anyone can do it)

Thus, we can communicate securely with many people.

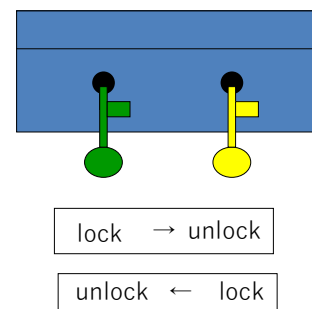


Figure 40 Public-Key Cryptography

¹⁰ TLS and SSL are acronyms of ‘transport layer security’ and ‘secure socket layer’, respectively. Historically SSL was developed first, and TLS followed after it. Both words are commonly used and hence in this textbook they are described as TLS/SSL.

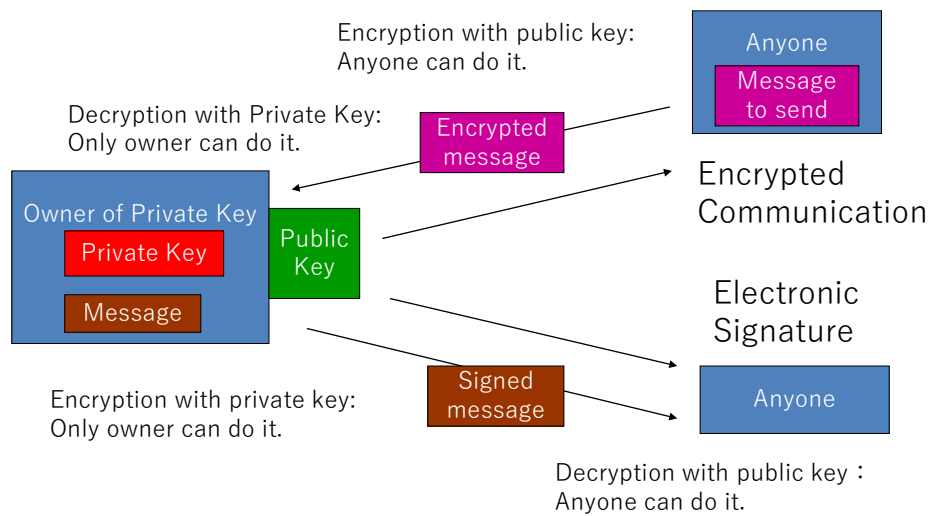


Figure 41 Encrypted Communication and Electronic Signature with Public-Key Cryptography

Great Idea! Public-Key Cryptography

Before invention of public-key cryptography, a common key was used for encryption and decryption. This makes sharing the key securely difficult, and in particular, encrypted communication with an unspecified number of people is almost impossible. The public-key cryptography currently used is based on the mathematical theory that factorization of two big prime numbers is computationally difficult.

2) Certificate and Certificate Authority

Even if a site uses public-key cryptography, it doesn't mean this site is reliable. A way to demonstrate the validity of the public key is a 'Certificate and Certificate Authority.' This is the electronic implementation of certification using a registered seal.

- First, one needs to establish a trusted organization called the "Certificate Authority" (CA) that issues certificates. The CA makes a public-key and distributes it in some way to public users.
- If a site requires a certificate for its public key, the site registers the key with the CA. The CA then issues the certificate with its electronic signature that identifies the site.

- The site presents the certificate, with its public key, to the public users.
- Users can confirm that the public-key is valid based on the certificate signed by the CA.

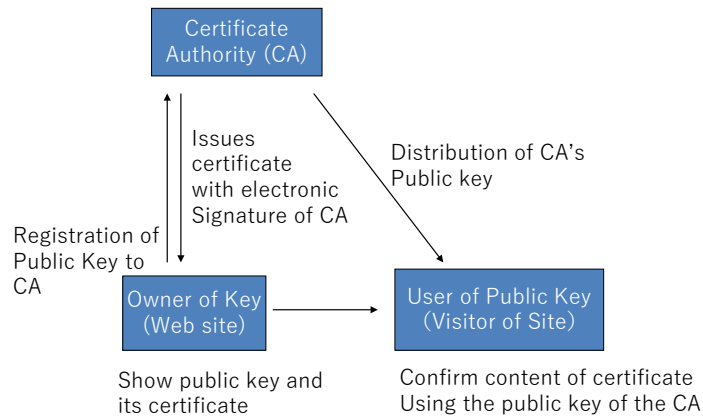


Figure 42 Certificate Authority and Certificate

3) Confirm TLS/SSL Usage and Certificate

TLS/SSL is a mechanism that uses cryptography in accessing Websites. You can confirm that access to a particular website is protected by TLS/SSL, and you can confirm the correctness of the public-key based on a certificate issued by a particular CA.

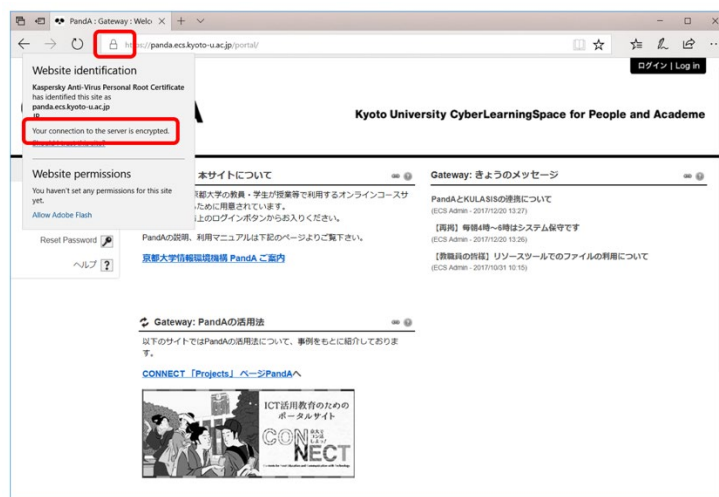


Figure 43 Confirming Usage of Cryptography and a Certificate on the WWW

3.7 Connecting a PC to a Network

As stated before, connection of a PC to the Internet consists of the following two steps:

- Connect to the LAN
- Connect to the Internet

That is,

- First, connect your PC to a wired or wireless LAN
- The PC then obtains necessary information such as the assignment of an IP address by the server on the LAN. With this information, the PC can start communicating over the Internet.

Usually the above steps are carried out automatically. However, if the server on the LAN doesn't work, or you have mistakenly connected your PC to a LAN that has no Internet service, the situation arises that your PC is connected to a LAN but no Internet connection occurs.

Furthermore, domain names (for example, www.kyoto-u.ac.jp) included in URLs of WWW servers are translated to IP addresses using DNS (Domain Name System). If DNS settings are not appropriate, you cannot obtain the IP address and cannot access the WWW site.

It is important to understand the multi-layered mechanism in the network so as to make it easier to identify, consult and solve problems when using the network.

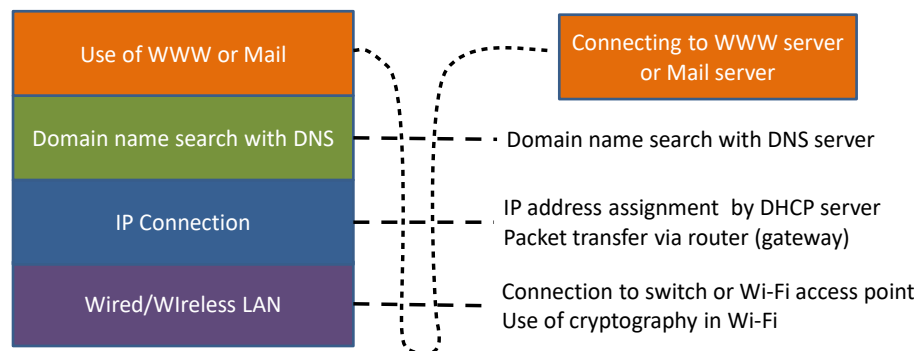


Figure 44 Multi-layered network connection and use

3.8 Using E-Mail

3.8.1 Check Arrival of Messages

The University mail service provides important communication from the University. You should check arrival of messages regularly (at least once a day). You may even receive messages during the summer vacation.

3.8.2 Safe Operation

1) Attacks using E-mail

Virus infection and fraud are often encountered while using e-mail. You need to safeguard your use of e-mail. Since the core e-mail protocols do not have any mechanism for authentication, it is easy to conduct e-mail spoofing, which is the creation of e-mail messages with a forged sender address for sending spam and phishing e-mails. You need to understand the important knowledge about e-mail spoofing so that you can pay attention when checking e-mail messages.

For example, never open attachments to suspicious messages, and never visit websites links in suspicious messages.

- Targeted attacks: In recent years, there have been many attacks that have targeted individuals. In such an attack, it is difficult to eliminate the damages from the attached virus with anti-virus software;
- Phishing: A type of attack in which the attacker spoofs a bank and leads the user to a fake site to steal bank account information;
- Ransomware: An attack that uses a virus as an attached file, arbitrarily encrypts the files in the infected computers, and request a ransom for decrypting the files. Once the files are encrypted, they are difficult to be recovered. Therefore, backing up your files on a regular basis is an important precaution.

If your e-mail account (ID and password) is leaked, other people may impersonate you and do some annoying things. In this sense, account management is also important.

It may also happen that someone sends e-mail to you many times as an act

like stalking. If you are in such circumstances, you need to take actions such as changing your e-mail address.

2) Mistakes due to Careless Operation

The following mistakes may occur in the operation of e-mail. Be careful with the handling of important messages and messages from others.

- **Wrong destination:** Once an e-mail is sent out, it is difficult to cancel it. When dealing with important messages, you need to be careful not to send to the wrong destination addresses. If you are using a mailing list, be aware that the information will be passed to many people.
- **Forward messages without the sender's consent:** While e-mail is easy and convenient to forward, e-mail senders may be sending messages that only you can read. If you are careless, you may forward e-mails that the original sender does not want you to send to others, such as secrets. Please make sure to obtain the sender's consent before forwarding e-mail messages.

3.8.3 Proper Message Composition

1) E-mail as a Formal Communication Method

Faculty and staff of the university **encounter some problems with messages students send to them**. Up until now, you've likely used e-mail (and other communication methods) for:

- Private communication with your family and friends,
- Short messages using smartphones.

However, with e-mail communication at university:

- This constitutes formal communication for various social activities including your study at university;
- Recipients may find it difficult to identify the sender if just the e-mail address is provided;
- Recipients are often working at various things in parallel.

You will need to write comprehensible messages that acknowledge the above.

2) Rules for Message Composition

Take the following rules in actual composition of messages:

- Write the ‘subject’ of the message;
- Make the names of the recipient(s) explicit, and ensure they are correct;
- Write necessary information about the sender;
- Make it clear to the recipient what ‘business’ you’re dealing with in your e-mail;
- Make a line break with a reasonable number of characters.

3) E-mail Destination Addresses

The handling of e-mail messages differs depending on the e-mail destination addresses. You need to understand the following items when sending e-mails.

- To: Use as a destination of the main receivers of your e-mail message;
- Cc: Use as a destination for sending a copy of the message (carbon copy). The e-mail addresses written here will be made visible to other recipients written in To: and Cc;;
- Bcc: Abbreviation for blind carbon copy. Bcc: is also used as a destination for sending a copy of the message as Cc:. However, other recipients will not see the destination addresses written here;
- Reply-to: Use this when you want the e-mail receivers to send a reply to another address instead of the address in From:.

Exercise 13. A mail message

If you receive a message shown in pink, what is your reaction? Does a light blue message work better?

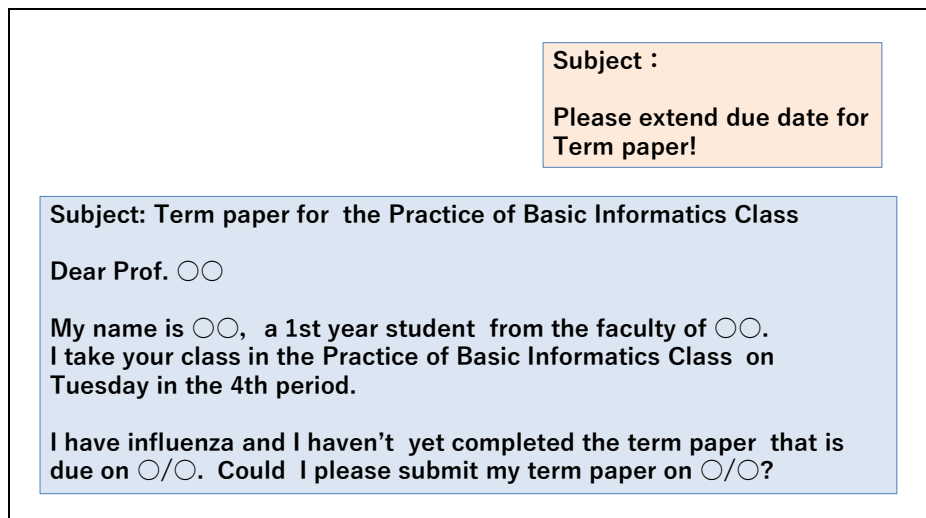


Figure 45 Problematic message

3.9 Desktop Virtualization

Although it has become possible to use various services on the WWW, there are also a lot of tasks that need to be conducted in the desktop environment using windows of personal computers. Desktop virtualization is a mechanism for constructing such a desktop environment on a server that can be used from remote terminals. The infrastructure for desktop virtualization is called virtual desktop infrastructure (VDI).

Virtual desktop infrastructure has following features.

- The user can use it without choosing places;
- The user does not have to bring out the data, which can help prevent the information leakage;
- Computer resources can be shared among users. CPU can be used efficiently by running the desktops of multiple users on the server;
- Operation management such as installation and update of software for personal computers can be centralized at the administrator side.

On the other hand, since the display screen on the desktop is transmitted to the terminals via the network, the refresh rate may be restricted depending on the communication speed, and usability may be degraded.

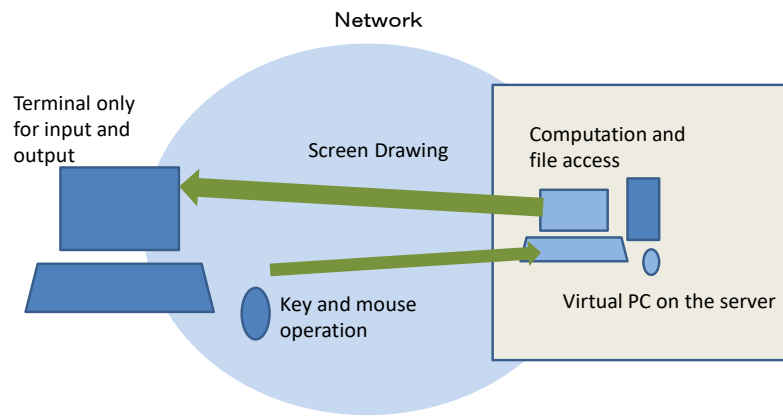


Figure 46 Virtual desktop infrastructure (VDI)

3.10 Kyoto University Network Services

3.10.1 Kyoto University Networks KUINS

1) KUINS Overview

There are three types of KUINS (Kyoto University Integrated Network System) connection services at Kyoto University.

- **KUINS-II:** LAN for providing Web servers etc., with global IP addresses;
- **KUINS-III:** LAN for connecting personal computers etc., with private IP addresses;
- **KUINS-Air:** Wireless LAN service for connecting to the network with private IP addresses in the same way as KUINS-III. Since there are many devices of university students and faculty members connected to KUINS-Air, direct communication between personal computers and smartphones is not allowed for security reasons.

A relay system is provided among KUINS-II, KUINS-III and KUINS-Air so that personal computers connected to KUINS-III can access external Web servers. Currently, a transparent proxy server method is used as a relay method.

2) Wireless LAN Access Points at Kyoto University

There are several types of the university Wi-Fi access points.

- **KUINS-Air:** You can connect it with ECS-ID and SPS-ID. You can also browse campus-specific websites.
- **eduroam:** A service that enables mutual use of wireless LAN between universities. You need to obtain a dedicated eduroam account from KUINS. You can also use it at other universities participating in eduroam.
- **Public wireless LAN:** Wireless LAN service provided by NTT DOCOMO, KDDI (au), SoftBank can be used on campus.

3) VPN use in Kyoto University

Kyoto University provides VPN connection services such as IKEv2 for secure connection to campus networks from outside the university.

3.10.2 E-Mail Service Provided by Kyoto University

At Kyoto University, students are given accounts on KUMOI, a mail system for students. Important information is sent from various organizations to KULASIS or KUMOI.

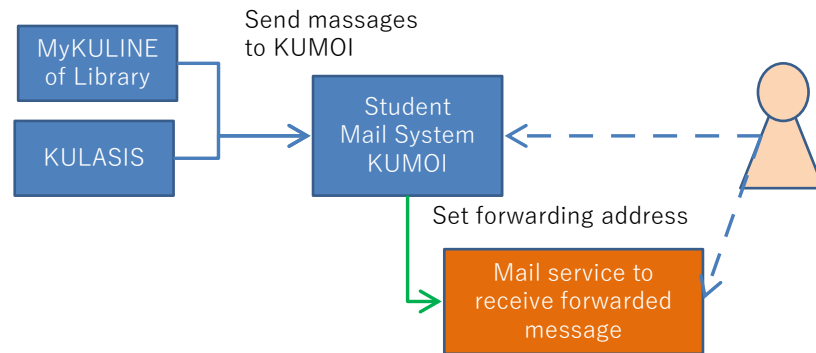


Figure 47 E-Mail Service by Kyoto University

3.11 Utilization of ICT and Its Risks

1) Characteristics of Information

Information has various values. On the one hand, we have **economic value** and **privacy**, which is important to **various people**. On the other hand, digital information has the following characteristics:

- It is easy to make a copy;
- Once spread widely, it is difficult to delete;
- Once destroyed, it is difficult to recover;
- It is difficult to determine whether it's true or false.

2) How the Risks of ICT Usage Turn into Problems

With the Internet, computers are connected globally, and various people are using them—this engenders risk. Risks become substantial problems because:

- The network extends throughout the world, where high speed communication and fast information processing are occurring;
- A vast amount of information is stored;

- Various people with different values are using the Internet.

It is very difficult to reduce such risks because:

- Computer software is complex, making it difficult to remove its vulnerabilities;
- Users may take inadequate measures, and make mistakes;
- Many people with malicious intent use the Internet.

3) What Do We Protect?

In managing information security, we view information from the following three aspects:

- **Integrity** : the risk that information has been corrupted;
- **Availability** : the risk that we can't access the information;
- **Confidentiality** : The risk of leaking secret information.

4) Risk Factors

Risk factors can be categorized into physical risks and human risks.

- Physical risks: Machines may break, or electricity may be cut off;
- Risks related to human behavior:
 - Failure of decision-making and use, related to insufficient understanding;
 - Malicious behavior;
 - The responses of many people.

5) How to Avoid Risks

Now that we understand the above characteristics of information and the related risks, we need to take appropriate measures in dealing with information and operating machines. For details, take information security e-learning.

Exercise 14. The Network Interface of a PC

If you have a PC, check the following:

- The wired LAN and available specifications
- The Wi-Fi connection and available specifications.

- If you connect your PC to a network at home, determine how you connect to it. If it is Wi-Fi based, find the cryptographic specification.

Exercise 15. Completion of Information Security e-Learning

Complete the information security e-learning required by Kyoto University.

Exercise 16. Connecting Your PC to the Campus Network

If you have a PC or a smartphone, check the following procedure:

- Learn how to connect a PC to Wi-Fi access points in campus (KUINS Air).

Exercise 17. Check the Use of Cryptography and Web Certificates

Investigate what cryptography is used and the validity of the certificates used by the services provided by the University such as KULASIS and Panda.

Exercise 18. Appropriate Use of E-mail

Write down how you would compose an appropriate message if you want to communicate with the instructor of a specific class you take.

Exercise 19. File Transfer

Think of ways of transferring files between the following machines. If there are several ways discuss their pros and cons. In transferring, files should not be accessible by anyone other than the sender and the receiver. Examine:

- File transfer between your PC and your smartphone;
- File transfer between a PC terminal of the Educational Computer System of Kyoto University and your PC;
- Sharing files among the members of a group in a particular class.

4. What is Intellectual Production?

4.1 Study Aims

In this chapter, we treat activities such as writing papers as Intellectual Production. The aims of this chapter are to learn the following as underlying concepts for actual skills introduced in the succeeding chapters:

- What is intellectual production?
- What activities that we do constitute “intellectual production”?
- How can ICT make intellectual production effective and efficient?
- What should your aims be in acquiring ICT skills relevant to intellectual production?

4.2 What is Intellectual Production?

Intellectual production (Chiteki-Seisan, 知的生産) is a word invented by Tadao Umesao, an anthropologist. In his book “The Art of Intellectual Production (知的生産の技術),” he explains it as follows:

Here, I think I can call human intellectual activities that aim to produce new information “intellectual production”. In this case, information means many things—wisdom, thoughts, ideas, news, descriptions and others things—when considered in sufficient breadth. (Tadao Umesao, The Art of Intellectual Production, Iwanami-Shinsho, Iwanami-shoten (1969, in Japanese)) Translated by the author of this chapter, the original Japanese is as follows:

「ここで知的生産とよんでいるのは、人間の知的活動が、なにかあたらしい情報の生産にむけられているような場合である、とかんがえていいであろう。この場合、情報というのは、なんでもいい。知恵、思想、かんがえ、報道、叙述、そのほか、十分ひろく解釈しておいていい。」(梅棹 忠夫: 知的生産の技術 (岩波新書) 岩波書店 (1969))¹

In modern society, many people are working primarily for the purpose of intellectual

¹This book is a famous one, but was written in 1969. We didn't then have personal computers, the Internet or mobile phones. The author was an anthropologist and wrote academic papers and books after studies in the field. He wrote this book in the context of this background.

production.

The word ‘Production’ may refer to production of food, energy, houses, clothes, machines etc. in agriculture or industry. However, in modern society most people don’t work directly at producing such things. Figure 48 shows changes in the ratios of workers by occupation, within Japan. This figure shows that the number of people working in agriculture has already been reduced, and even working for production in industry is diminishing. The area marked in red is the proportion of people working for intellectual production, such as those working in offices, professional jobs, and sales. The proportion is already large and is increasing.

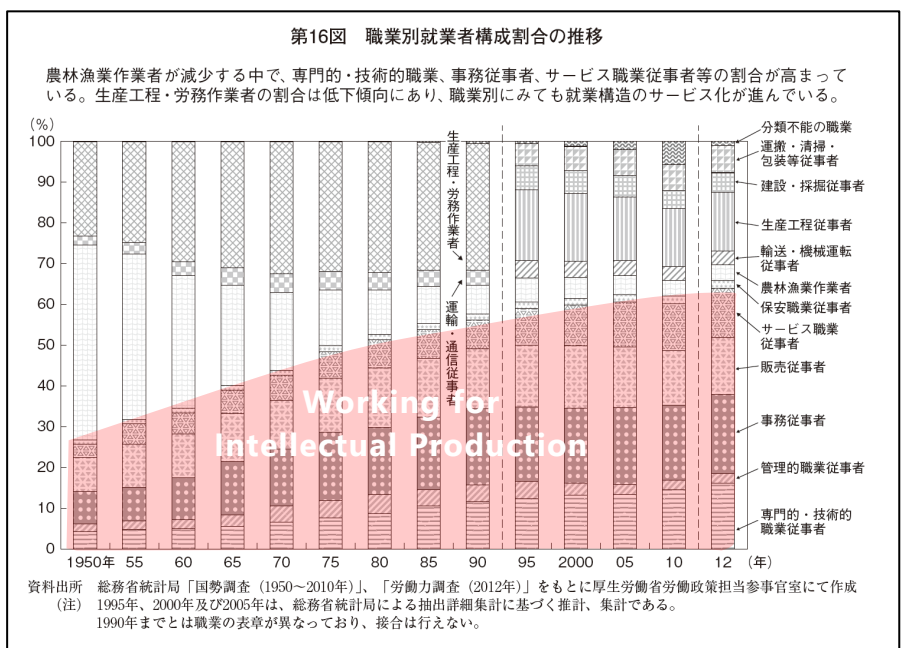


Figure 48 Change in proportion of workers by type of occupation.

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<http://www.mhlw.go.jp/wp/hakusyo/roudou/13/dl/13-2-4.pdf> (last access 2017/1/5)

4.3 Activities for Intellectual Production at the University Festival

In order to think about intellectual production from the viewpoint of campus life, we can consider having a refreshment stall at a university festival. This idea implies various activities as follows:

- Making a team to run the refreshment stall;
- Checking the requirements of the festival committee;
- Coming up with an idea for the stall;
- Generating a proposal document, submitting it to the committee, and obtaining permission;
- Acquiring the necessary equipment;
- Understanding and implementing management of safety and health matters;
- Assignment of roles to staff;
- Budget planning, deciding on prices, printing tickets and selling them;
- Operating the stall;
- Finalizing the accounts, obtaining feedback, and reflection;
- Reporting the outcome of the operation.

So many activities that need to be undertaken! Among these, the items shown in bold letters are those that don't involve treating objects or processing them, but intellectual production such as having meetings, studying something, making arrangements, creating a budget based on assumptions about sales and expenditure, and making documents that deal with information.

In doing intellectual production, it is important how effective/useful the product is, and how efficiently things can be done (with minimal work). Intellectual production is production of information, and therefore it becomes important how we use information and communication technologies (ICT) such as personal computers and the Internet.

4.4 Academic Life and Intellectual Production

In the previous example, we see that many activities of intellectual production accompany the activities of the University festival. Studying at a university, we also have to conduct various intellectual production activities:

- Writing **term papers** in classes, or writing a **thesis** are major examples of such activities.

Besides these,

- We may conduct a **literature search** or a **social survey**, and **report** the results.
- Participating in certain events and projects, we may do the following:
 - Write **proposals** for such events or projects in order to initiate them;

- Write **planning documents** that describe intended actions;
- Design a questionnaire to survey participants in the event;
- Make materials for public relations;
- Create a report that documents the events or project; and
- **Evaluate the whole activity.**
- If you create software (a computer program) or an information system, you have to make:
 - A specification—a document describing what the system should achieve;
 - A document that describes the design of the system;
 - The program itself;
 - An operation manual and
 - Questions and Answers.

More recently, as well as reports you are often required to:

- Make presentations with slides.

If the activities are performed as part of a team, we also need:

- To make materials for meetings, and take the minutes of each meeting.

We also need:

- To run productive meetings, and
- To manage the project using appropriate methodology.

4.5 Activities of Intellectual Production

There are various types in activities associated with intellectual production:

- Study:
 - Literature searches;
 - Study in the field—questionnaire surveys, interviews and observation;
 - Experiments;
 - Computer Simulation;
- Organization of materials, analysis and thinking:
 - Using methods for thinking such as brainstorming, the KJ-method etc.
 - Knowledge acquisition from data, with statistical analysis and text mining;
- Proposing problem-solving solutions;
- Writing reports;

- Making slides or posters for presentation;
- Running meetings, and writing minutes;
- Management of projects.

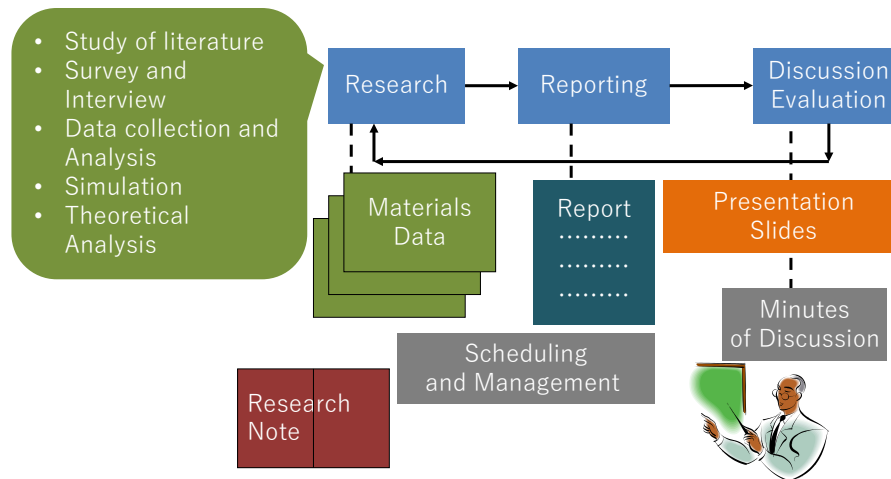


Figure 49 Process of Intellectual Production

4.6 Using ICT for Intellectual Production

Intellectual production is work that mainly deals with information, and therefore use of ICT is important. Assume that you're creating an assignment essay as part of a group and that you're making a class presentation. You will then use ICT as follows, and realize the importance of the following skills:

- **Literature Searches:** Search books, journals, and databases in the library. Search for information available on the Web.
- **Utilization of Data** such as statistics produced by the government: National and local governments release various statistics on the web. Analyze such data and make charts using a spreadsheet.
- **Organizing Materials and Note Taking:** File such materials and data on a computer, organize and search through these data. Make note of the materials studied together with bibliographic information, allowing you to write papers.
- **Computer Simulation:** With a spreadsheet, using a program created by yourself, or using other software, carry out numerical computation for simulation.
- **Making Charts and Tables:** Summarize the analysis of the data or the simulation in tables or charts. Drawn diagrams, for example organizational diagrams, will often

be used.

- **Writing Reports**
- **Making Slides, and Presentations**
- **Group Activities:** Share information among the members, communicate with each other, have meetings and take minutes. Mutually review the report and presentation materials.

4.7 Acquiring Skills and Learning Strategies for Intellectual Production

4.7.1 Viewpoints for Acquiring Skills

Acquire skills for intellectual production within the following perspective:

- Does your intellectual production activity successfully produce effective products?
- Is your intellectual production activity efficient?
- Are you continually conducting skill acquisition for intellectual production?

4.7.2 Set Clear Goals

As you acquire ICT skills for intellectual production, you should pay clear attention to your goal. That is:

- What do you want to achieve? Consider the products you are asked to make;
- How do you conduct by yourself? Consider how you can use ICT to achieve your goals.

References

- [4] Tadao Umesao: The Art of Intellectual Production, Iwanami-Shinsho, Iwanami-Shoten (1969, in Japanese) (梅棹 忠夫: 知的生産の技術 (岩波新書) 岩波書店 (1969))

5. Academic Information Seeking

5.1 Aims of Study

This chapter builds on what we learned about intellectual production at universities in the previous chapter by looking at the academic information that is essential to such intellectual production and how we 1) seek out, 2) assess, and 3) appropriately utilize that information. In this chapter, among the various intellectual production generated at we will focus on the term papers or theses which demonstrate your level of achievement in learning and research. More specifically, this chapter covers the following topics:

- Understanding what academic information is;
- Mastering how to select terms for use in searches, by organizing the concepts within and related to the topic you are researching;
- Learning how to make citations and create reference lists.

Once you have covered these topics, we provide some practical tips and information for you to master the fundamentals of searching for materials online, through hands-on practice.

5.2 Academic Information and Libraries

5.2.1 What is Academic Information?

Before looking at the characteristics of academic information, let us think a little about what is studied at universities in the era of information technology. In our daily lives, it has become customary to search online for information about any topics we don't know much about, to get a general outline. When we look at the long lists of search results, we often try to somehow connect each of the results—which may all use the same vocabulary but are each written in a slightly different context—as opposed to considering the respective contexts in which each was written. In contrast, in the pursuit of learning and research at university level, emphasis is placed on the process of understanding information in context or within theoretical frameworks in each academic field, and positioning your own opinion and discoveries within those context or frameworks.

There are of course many research topics that span a number of different fields. For instance, we can see a topic such as “Issues relating to distribution and environments in the

shrimp farming business in Southeast Asia,” covers fields of economics, environmental science, and area studies. It is likely that most of the research that deals with phenomena in today’s globalized society involves such cross-disciplinary themes. However, to build up the basic capacity for tackling such topics that transcend the boundaries between academic fields, it is necessary to acquire the habit of approaching topics using the contexts and frameworks of the specific academic disciplines. Context and framework can be likened to the rules and venues when playing sports. While competitive swimming events and baseball games involve completely different rules and venues, they are similar in that they must be carried out in a certain type of venue, and that participants follow certain rules and decide how to compete by referring to examples from previous contests. The same can be applied to the different fields of academic disciplines.

Given this characteristic of academic activity, academic information can be defined as “information created with the purpose of sharing the progress of academic research in a certain field with the public.” More specifically, academic information takes the following forms:

- Presentations at academic conferences;
- Papers published in academic journals;
- Specialist/technical books;
- Entries in encyclopedias and special encyclopedias written by experts.

(While encyclopedias may constitute academic information, the online encyclopedia Wikipedia is not considered to be “academic information” because it can be edited by any user.)

Intellectual production at universities is a process of navigating this mass of academic information by comprehensively investigating precedents and assembling one’s own argument or conducting new research on the basis of this investigation.

5.2.2 Establishment of Knowledge and Academic Resources

In the previous section, we gave several specific examples of the types of resource that are considered to constitute academic information. The establishment of knowledge—the process of new insights become accepted theory—is similar to the flow of a river, and in many cases state-of-the-art research published at academic conferences and in academic journals becomes established as accepted theory with the passage of time. Near to the source of the “river,” new insights presented at academic conferences and published as

research papers undergo a process known as “peer review,” in which researchers in the same field evaluate and verify fellow researchers’ findings or theories to be credible information within academic circles. Those findings and theories are then published in academic or specialist publications. While they may not be widely accessible to the general public, these publications allow the insights to become common knowledge among experts in areas in related academic fields. Moving further “downstream,” the insights are published in textbooks, encyclopedias and other such publications and media that are more accessible to the general public, allowing the insights that have survived all the previous stages to become established as general knowledge.

Let us take the example of induced pluripotent stem cells (iPSCs). The generation of iPSCs was first reported in 2006 in a paper published in the scientific journal *Cell*. At that point, such findings were only shared within a restricted scope, consisting largely of experts. However, once Professor Shinya Yamanaka, the author of the paper published in *Cell*, and British scientist Professor John B. Gurdon, who wrote a paper in the 1960s that served as the prior research to Professor Yamanaka’s work, were awarded the 2012 Nobel Prize in Physiology or Medicine, the term “induced pluripotent stem cells (iPSCs)” became widely known. It is currently included in a large number of non-specialist publications, encyclopedias, and other such materials.

It helps to keep this relationship between the passage of time and the establishment of knowledge in the back of your mind, as understanding such a connection alongside the different types of materials helps us to seek out academic information according to our own knowledge level. When tackling a topic that is completely new to you, starting downstream and making your way up toward the source will ensure that you arrive at the kind of information you are seeking without going off course.

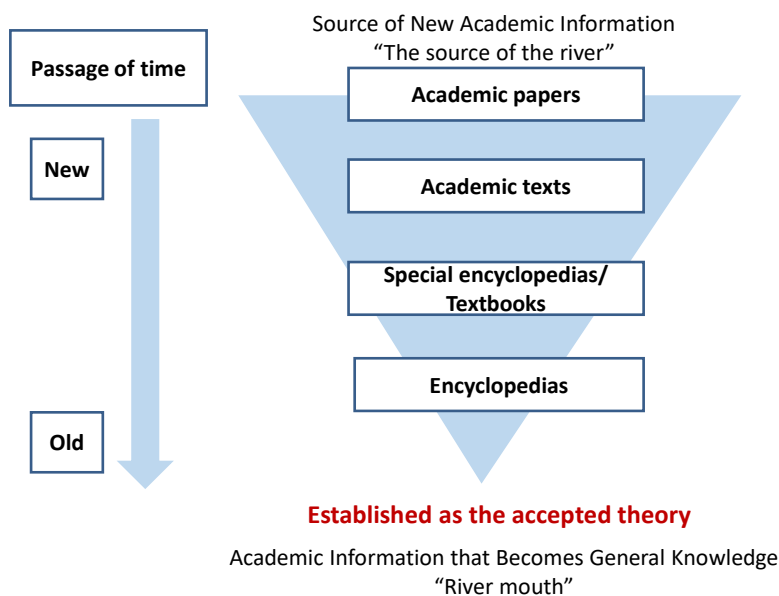


Figure 50: The establishment of knowledge with the passage of time

5.2.3 The Difference between Academic Information Available Online and Academic Information Provided by Libraries

Now that we have a certain amount of understanding about academic information, let us briefly describe the distinction between the information available online and academic information provided by libraries. Simply put, academic information obtained through a library is highly reliable. From within the vast amount of information available, libraries purchase and provide academic publications, electronic journals, and other materials that already have an established reputation. This is also information that has undergone peer review by experts in the same field. In contrast, academic information that can be obtained online is a jumbled mixture of both the reliable and the unreliable. This means that it is often difficult to pick out truly important academic information unless you already have a certain amount of knowledge on the topic.

Given that libraries offer sources of highly-reliable academic information, such as those listed below, it only makes sense to make use of those resources. These academic information sources provided by libraries are also often very expensive resources that are difficult for individual students or researchers to purchase:

- Reference materials (resources for referencing, such as dictionaries, maps, and statistics, as opposed to materials for reading);

- Books;
- Academic journals;
- E-books;
- E-journals;
- Online databases;
- Newspaper databases;
- Reports by government ministries and agencies;
- Institutional repositories.

Newspaper databases, reports by government ministries and agencies, and other such resources are also helpful materials that can be used for research when looking and applying for jobs and after you have started work. Developing the habit of starting research at a library, a place that gathers resources that have been put through a “reliability” filter allows us to acquire the ability to select high-quality information, not only from academic information, but also in other fields.

5.3 Before Conducting a Search

5.3.1 Methods of Searching for Materials

You should now have acquired an understanding of academic information and libraries. The problem is that even after information has been through the library’s “reliability” filter, there is still an inordinate amount of information available to access. How can we gather material from prior research comprehensively in such a sea of information? There are three main methods of finding material in the library: 1) browsing, 2) “following the information chain,” and 3) conducting an online search. Online searches will be explained in detail in the next section, but first we will briefly explain the other two methods, as it is essential to combine the three effectively.

1) Browsing

- Browsing is looking through books on library shelves.
- **Advantages:** In the library, books from similar fields are placed on the same shelf according to a classification system. This helps you to reinterpret the topic you are

considering from a broader perspective, and often allows you to come across resources that you would not have discovered through an online search.

- **Disadvantages:** In the case of material on topics that cover various fields, it is sometimes difficult to know which field material is classified under. You should also take care to avoid the feeling that you have comprehensively gathered resources just by looking at the books on the shelves.

2) **Following the information chain**

“Following the information chain” refers to the approach of starting with the reference list or bibliography of a certain work, and searching for the prior research that is listed there (an explanation of reference lists is provided in the following section). Citation databases also allow users to follow the chain of information. For more information on such databases, see the special article at the end of this chapter.

Advantages: It is an efficient means of obtaining key materials in the topic you are addressing.

Disadvantages: There is a risk of overlooking important material because it is not covered in prior research.

5.3.2 **Online Searches and Organizing Keywords**

Let us now look at the third option: online searches. In order to conduct an effective online search, you need first to convert the topic you are considering into keywords, and then by considering broader, equivalent, and narrower terms that resemble those keywords, organize terms and concepts related to search keywords. Unlike browsing and following the information chain, online searches will produce dramatically different search results depending on the keywords entered.

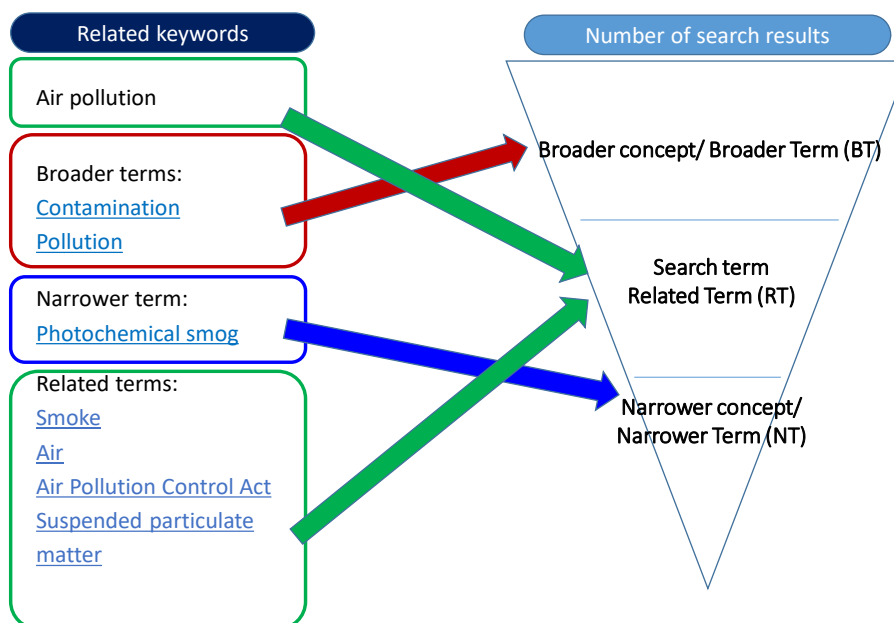
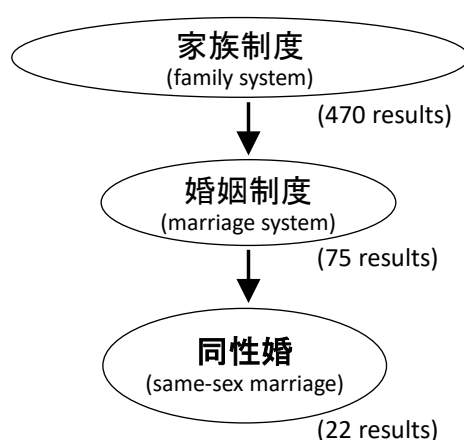


Figure 51: Broader and narrower concepts

Let us say that you have been given an assignment to write a report about “minorities and law in contemporary society,” and in the process of organizing your thoughts on the topic, after considering what scope is covered by the term “contemporary society,” what kind of minority you want to discuss, and what kind of laws you want to look at, you decide to research the topic “same-sex marriage.” However, a search using only the keyword “same-sex marriage” does not really lead you to the kind of material you were hoping to find. In such cases, try thinking of broader concepts or terms related to the keyword being searched for. Conversely, in some cases you may find that the keyword you have chosen generates so many hits that you are not sure what you should read. In such cases, try thinking of narrower terms related to the keyword you devised.

The left-hand side of Figure 51 shows the broader terms, narrower terms, and related terms that are displayed when one conducts a search with the keyword “air pollution” in the National Diet Library bibliographic database NDL Search (URL: <http://iss.ndl.go.jp/?locale=en>). A search for “pollution,” a broader term than “air pollution,” generates a greater number of results because it finds a wide range of materials related to the topic “pollution” including those on “air pollution.” In contrast, a search for the narrower term “photochemical smog” generates a smaller number of results, as it only finds those materials on “air pollution” that refer to “photochemical smog.”

When seeking out material, it is necessary to use this approach of moving between the levels of the search concepts as you conduct a search. As you can often discover other effective keywords in the process of making online searches, try to examine the material and keywords closely, and look at which keywords led to which material, in order to find the information you need. Among material you obtain through such an approach, material frequently cited by papers on the same topic is highly likely to have originated close to the source of the “river” of academic information—namely, material that is considered to be a “essential resource” in that field. Thus, you should try to adopt the habit of utilizing both the latest research findings and such essential material.



Based on the search conducted in Japanese in KULINE on December 17, 2018.

Figure 52: Search terms and numbers of search results

* Numbers in parentheses are the numbers of results from a Kuline search
(in Japanese) on October 3, 2016

5.4 Reading and Writing Reference Lists

5.4.1 The Importance of Citations and Reference Lists

One more point that you need to learn before starting to search for materials is how to read and write reference lists. Reference lists and bibliographies are provided at the end of papers or books to list the sources that the author has cited. These lists provide us with a clear view of the kinds of prior research the author referred to, and the new discoveries they

have presented on that basis. The previous section provided an explanation of the method of “following the information chain” to seek out materials. It is no exaggeration to suggest that the work of writing assignments and papers starts with reading reference lists and ends with writing reference lists. The guide to referencing by the Japan Science and Technology Agency (2011), *Sankō bunken no yakuwari to kakikata* [The roles and methods of listing reference sources], also sets out the following five points regarding why it is important to show what materials were referenced.

1. To clarify the novelty, originality, and reliability of your paper
2. To show respect for authors who wrote on the topic before you (predecessors and seniors)
3. To specify your sources
4. To provide information to readers
5. To comply with the Copyright Act.

It is also important to follow a certain style guide when reading and creating citations and reference lists. The style used may differ according to your specialist field, so confirm which style to use with your teacher in advance before submitting your assignment.

Typical citation and reference list styles

- American Psychological Association (APA): Used in psychology and other areas of social sciences as a whole
- Chicago: Used in the humanities (history and languages) and social sciences
- Modern Language Association of America (MLA): Used in the humanities (literature, linguistics, and philosophy)
- The Institute of Electrical and Electronics Engineers (IEEE): Used in the fields of electricity, communications, electronics, and information engineering
- Standards for Information of Science and Technology (SIST): General rules for scientific papers in Japan

All resources that are cited in the main body must be included in the reference list. Many styles specify the style of both citations and reference lists; in such cases the citations and reference lists should both be written in the same style.

Examples of citation and reference list styles for texts in English

- APA

In main body: (Klaus, 1981)

In reference list: B. Klaus. (1981). Robot Vision. Cambridge, MA: Little, MIT Press.

◆ IEEE

In main body: as shown

by Klaus [4]

In reference list: [4] B. Klaus, Robot Vision. Cambridge, MA: MIT Press, 1981.

Examples of citation and reference list styles for journal papers in Japanese

● 『社会学評論』 (*Shakaigakuhyōron* [Japanese Sociological Review])

In main body: (西川編 2001)

(Nishikawa, ed. 2001)

In reference list: 西川潤編, 2001, 『アジアの内発的発展』 藤原書店。

Nishikawa Jun, ed., 2001, *Ajia no naihatsuteki hatten* [Endogenous development in Asian countries] Fujiwara shoten.

● 『東南アジア—歴史と文化—』 (*Tōnan ajia: rekishi to bunka* [Southeast Asia: History and Culture])

In main body: [生田・松澤 2000]

[Ikuta and Matsuzawa 2000]

In reference list: 生田真人・松澤俊雄編. 2000. 『アジアの大都市 3 クアラルンプール, シンガポール』 日本評論社.

Ikuta Masato and Matsuzawa Toshio, eds. 2000. *Ajia no daitoshi 3 Kuararunpuru Shingapōru* [Metropolises in Asia 3: Kuala Lumpur and Singapore] Nippon Hyoronsha Co., Ltd.

When writing reference lists, it is also necessary to remember that even within the same style, different types of reference material are listed in different formats. When no particular style guide is specified, use the Standards for Information of Science and Technology (SIST; only available in Japanese).

Reference lists in accordance with SIST

(The line breaks in the following examples are to make them easier to read.)

● For books

◆ Single author books, when the entire book was consulted:

山崎茂明. 論文投稿のインフォマティクス. 中外医学社, 2003, 167p.

Yamazaki Shigeaki. Ronbun tōkō no infomatikusu [Informatics of paper submissions]. Chugai-Igakusha, 2003, p. 167

Author's name. Title of publication (edition statement), publisher, year published, total number of pages.

- ◆ When a certain chapter or section of a book was consulted:

山崎茂明. “国際ルールへの理解”. 論文投稿のインフォマティクス.
東京, 中外医学社, 2003, p.71-101.

Yamazaki Shigeaki. “Kokusai rūru e no rikai [Understanding of international rules].”
Ronbun tōkō no infomatikusu [Informatics of paper submissions].
Tokyo, Chugai-Igakusha, 2003, p.71-101.

Author's name. “Chapter heading.” Title of publication (edition statement)

Place of publication, publisher, year published, first page of chapter-last page of chapter.

- **For journal papers**

- ◆ When a Japanese journal article by a single author was consulted:

根本信乃. 寿命関連遺伝子と「老化の代謝説」. 実験医学.
2003, vol.24, no.11, p.1624-1629.

Nemoto Shino. Jumyōkanrenidenshi to “rōka no taishasetsu” [Lifespan-related genes and “the metabolic hypothesis of aging”]. Experimental Medicine.
2003, vol.24, no.11, p.1624-1629.

Author's name. Title of paper. Title of journal.

Year published, volume number, issue number, first page of paper-last page of paper.

- ◆ When a Japanese online journal article by multiple authors was consulted:

荒川正幹ほか. Hopfield Neural Network を用いた新しい分子重ね合わせ手法の 3D-QSAR への応用. Journal of Computer Aided Chemistry, 2002,
vol.3, p.63-72. <http://joi.jlc.jst.go.jp/JST.JSTAGE/jcac/3.63>, (参照 2016-12-03).

Arakawa Masamoto, et al. Hopfield Neural Network o mochiita atarashii
bunshikasaneawase shuhō no 3D-QSAR e no ōyō [The application of a new molecular
superpositioning method using the Hopfield Neural Network to 3D-QSAR]. Journal of
Computer Aided Chemistry, 2002.
vol.3, p.63-72. <http://joi.jlc.jst.go.jp/JST.JSTAGE/jcac/3.63>, (Accessed on Dec 3, 2016).

Authors' names, title of paper

Title of journal, year published

Volume number (issue number), first page of paper-last page of paper, URL (date accessed).

- **Articles that are parts of webpages**

中央教育審議会. “教育振興基本計画について－「教育立国」の実現に向けて－（答申）”. 文部科学省. 2008-04-18.

http://www.mext.go.jp/b_menu/shingi/chukyo/chukyo0/taishin/08042205.htm, (参照 2008-08-13).

Central Council for Education. “Kyōikushinkōkihonkeikau ni tsuite: Kyoiku rikkoku no jitsugen ni mukete (tōshin) [About the Basic Plan for Promoting Education: Toward the Realization of “Education-based National Development—(Report)]” Ministry of Education, Culture, Sports, Science and Technology. April 18, 2008.

http://www.mext.go.jp/b_menu/shingi/chukyo/chukyo0/taishin/08042205.htm, (Accessed on August 13, 2008).

Author’s name. “Title of webpage.” Name of website. Date of update.

URL, (date accessed)

5.5 Searching in Practice

Now you can try actually searching academic information provided by our libraries. When performing such a search, you start with the online catalog for the Kyoto University libraries, known as Kuline (Kyoto University Libraries Information NETWORK system). Kuline allows you to search the academic information within Kyoto University introduced in 5.2.3, and provides links to the major databases. The list below provides the link to Kuline and several major databases that can be accessed from Kuline. Please also note that many of the paid-subscription databases that Kyoto University is subscribed to can only be accessed from a certain number of terminals at the same time, so you should log out promptly once you have finished.

To access these subscribed databases, you will need to download a plugin for your browser beforehand and log in via the authentication system. This plugin is available for Firefox and Chrome. Please note that there is no plugin for tablets and smartphones yet. The plugin is available at <https://ninsho-log4.kulib.kyoto-u.ac.jp/plugin/plguide.html>

- Kuline (Kyoto University Libraries Information NETwork system) (<http://kuline.kulib.kyoto-u.ac.jp/?lang=english>)
- Cinii Articles (database for papers in Japanese in all fields)
- JapanKnowledge Lib (database for a number of dictionaries and encyclopedias)
- Ichushi-Web (database for medical science papers in Japanese)
- Kikuzo II Visual (database of articles from the Asahi Shimbun, AERA, and Chiezo, etc.)
- Nikkei Telecom (newspaper database provided by Nikkei Shimbun Inc. Inc. English newspaper is included.
- PubMed (database for medical science papers in English)
- Web of Science (citation index and bibliographical database for wide range of academic subjects in English)
- ProQuest Research Library (database of a wide range of popular academic subjects)

5.6 When in Doubt, Consult the Library

This chapter has provided an overview of how to search for and handle academic information. If you follow the steps described here to look for materials, but find that the resources you are looking for are not available at the university, you can obtain those materials or copies from another university through the library network. If there is anything else that you don't understand, start by consulting the library. The University Library also provides a Learning Support Desk, which is staffed by graduate students who can advise you how to search for academic information, how to write assignments, and other such queries. The Learning Support Desk is located in the Learning Commons on the 1st floor of the University Library, and is open on weekdays from 13:00-19:00.

The Learning Support Desk also offers online counseling. Please use this service if you are unable to visit the library.

<https://www.kulib.kyoto-u.ac.jp/form/1385901?lang=en>

5.7 Recommendations for Improving Academic Information Literacy Skills with the Route Map

The Kyoto University Library Network has created the "Route Map for Academic Information Literacy Education Support (currently only available in Japanese)" (Appendix 2) as a guide for acquiring information literacy skills according to the stage of your university life. This chapter focuses on the academic information seeking skills among various information literacy skills in our academic life. For other information literacy skills, please refer to this route map. In addition, you can also check the list of short courses or workshops available for each category of the route map at [\[https://www.kulib.kyoto-u.ac.jp/uploads/routemap_ver1_detail_2020.pdf\]](https://www.kulib.kyoto-u.ac.jp/uploads/routemap_ver1_detail_2020.pdf). Many of them are offered every year.

References

If you would like to find out more about seeking out reference materials, we also recommend books [5] and [6] (only available in Japanese):

- [5] 井上眞琴. 図書館に訊け. ちくま書房, 2004, 256p.
Inoue, Makoto. *Toshokan ni kike* [Ask the library]. Chikumashobo Ltd., 2004, p. 256.
- [6] 市古みどり編. アカデミック・スキルズ 資料検索入門—レポート・論文をかくために. 慶應義塾大学出版会, 2014, 151 p.
Ichiko, Midori. *Akademiku Skiruzu: Shiryō kensaku nyūmon, repōto / ronbun o kaku tame ni* [Academic skills, An introduction to searching for resources: For writing essays and papers]. Keio University Press, 2014, p. 151.
- [7] 独立行政法人科学技術振興機構 参考文献の役割と書き方. 独立行政法人科学技術振興機構, 2011, 24p. jipsti.jst.go.jp/sist/pdf/SIST_booklet2011.pdf, (参照 2016-10-10).
Japan Science and Technology Agency. *Sankō bunken no yakuwari to kakikata* [The roles and methods of listing reference sources]. Japan Science and Technology Agency, 2011, p. 24. jipsti.jst.go.jp/sist/pdf/SIST_booklet2011.pdf, (Accessed October 10, 2016).

Great Idea! Dr. Garfield and the Development of Citation Databases

One of the indicators currently used in evaluating universities on an international scale is the citation database. Citation databases quantify the impact of papers written by the faculty members of evaluated universities in terms of the type of journal they are published in and how frequently they are cited (the citation count), and allow the users to trace from a cited reference to the source it was cited from.

In other words, citation databases allow users both to trace from a certain paper to the original source paper by working their way upstream, and also conversely to start with a certain paper and investigate how the research subsequently developed. The former approach allows us to ascertain “essential source” in a certain field.

A major example of such citation databases is the Web of Science. Web of Science originates from a booklet entitled the *Science Citation Index*, first published in 1961. This booklet was published by Eugene Garfield, who was in his thirties at the time. Garfield realized that as all papers cite and refer to other papers written previously, creating a citation index and thereby elucidating the relationships between different papers, would allow us to structure the field of science. He presented this theory in a paper in 1955, and the *Science Citation Index* was later published by drawing on the *Shepard's Citation*, a booklet which enables the search and referencing of precedents from all US state and federal courts from an index. The Web of Science online database currently provides a significant collection of papers not only in the natural sciences but also the social sciences.

Eugene Garfield. *Citation Indexes for Science- New Dimension in Documentation through Association of Ideas*. SCIENCE. 1955, vol. 122, no. 3159, p.108-111.

6. Reference Management Tools

6.1 Study Aims

We learned the importance of citation and list of reference in “5.4 Reading and Writing Reference Lists” and “11.8 References and Citations.” In addition, we also learned the necessity of formatting your reference lists according to the specific format. However, you may inadvertently forget to include the references you cited in your reference lists when the number of reports and papers you write increase, or when you repeatedly revise your papers. When you are working on reports or papers with similar themes, you might recite references that you have cited before. In such cases, you might not be able to remember which report or paper you have cited the references, or you might make a mistake when transcribing them. In addition, the specified format might differ from one report to another.

This chapter provides an overview of the reference management tools by learning how to use EndNote basic. We learn the following process by using the reference management tools.

- Import bibliographic information from various sources to create your own bibliographic database.
- Export bibliographic information in a specific format to create a reference list.

6.2 What are Reference Management Tools

There are two main functions of reference management tools.

- 1) To accumulate and manage bibliographic information collected for writing reports and papers by creating your own database.
 - 2) To extract necessary information from the database created in 1) to create a reference list.
- In other words, the major functions of reference management tools are to manage and utilize the bibliographic information. By using reference management tools, the flow of collecting literature, writing a paper, and creating a reference list can be done more smoothly.

Figure 54 illustrates the process from literature collection to reference list creation using a reference management tool.

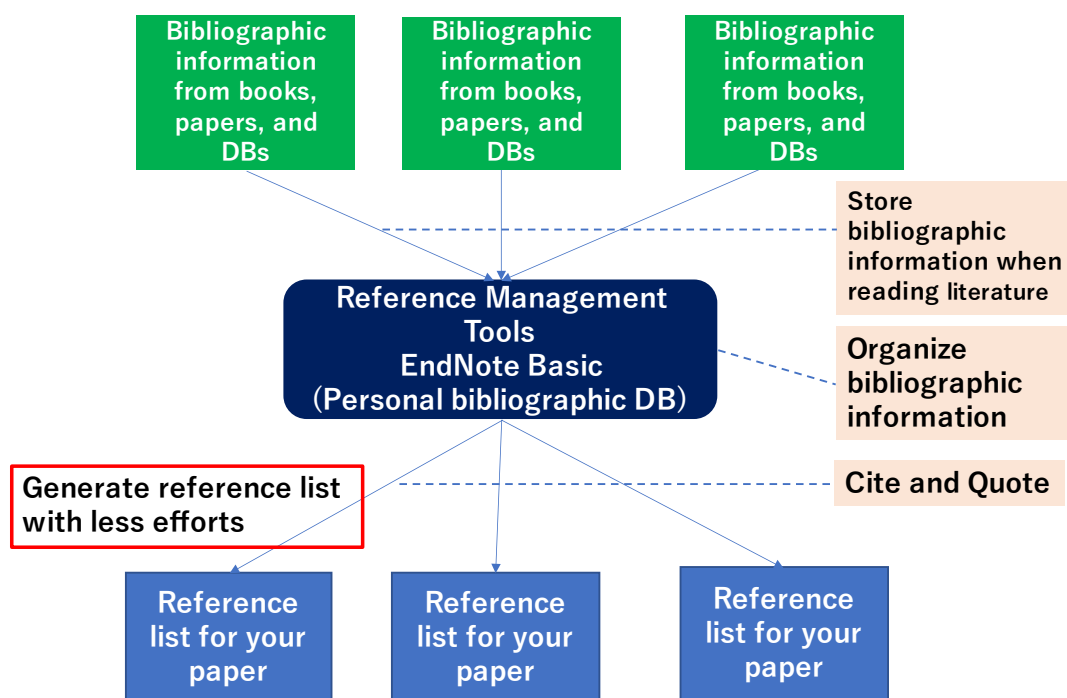


Figure 53: Search terms and numbers of search results

6.3 How to use EndNote Basic

✧ Create an EndNote Basic Account

There are various reference management tools, such as RefWorks, EndNote (commercial software), and Mendeley (free software) [1]. In this chapter, we will use EndNote basic, the free version of EndNote, to illustrate the use of reference management tools. Since Kyoto University library subscribes to the Web of Science, a citation index provided by Clarivate Analytics, Kyoto University users can use an institutional version of EndNote basic.

The major difference between the institutional version and the general free version is the number of available styles for citation and reference formats: the institutional version offers more than 3300 styles, while only 21 styles are available in the free version. To use the institutional version, you will need to register your own EndNote basic account via the campus network or access from the campus network after creating an account. After you access the EndNote basic via the campus network for the first time, you can use the

institutional version anywhere for the following one year. Please refer to Chapter 3 for the remote access to the campus network.

To use EndNote basic, you will first need to create an account by following the steps described below.

1. Access EndNote from the KULINE. When accessing from KULINE, select “Citation Tool” from the menu on the left side of the screen, and then click on “EndNote Basic” in the Kyoto University Library Network website.

Menu in The Kyoto University Library Network Website



2. Select “Register, enter your e-mail address ending with [[.kyoto-u.ac.jp](mailto:kyoto-u.ac.jp)]” on the user information screen, and enter the necessary user information.

Sign in to continue with EndNote

Not a member yet?

Email address

Password

Forgot Password?

Sign in

OR

Register

or sign in using

By signing in, you acknowledge and agree to our Terms of Use and Privacy Statement.

Need help? Contact EndNote Customer Care.

Try EndNote desktop for 30 days, we think you'll like it.
Access anywhere, on your desktop and online. [Download](#)

Smarter Teamwork
Share selected groups of references, manage team access, and track activity and change

Smarter Workflow
Automatically create, format, and update bibliographies, with the convenience of remote access

Smarter Insights
Powered by Web of Science, uncover the impact of references and find the best-fit journal for your papers

3. Open the EndNote activation request email sent to the email address you entered and activate it.
4. Once your account has been created, you can login to it.

✧ Utilizing EndNote Basic

Now, let's try to use EndNote basic. We will go through the following three steps through exercises.

Step 1: Import bibliographic information from DB search results

Step 2: Organize the bibliographic information

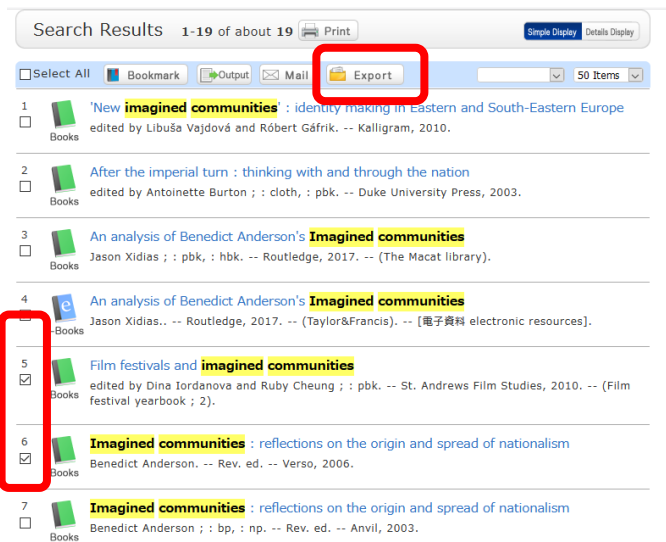
Step 3: Create a reference list and in-text citations

Step 1: Import bibliographic information from DB search results

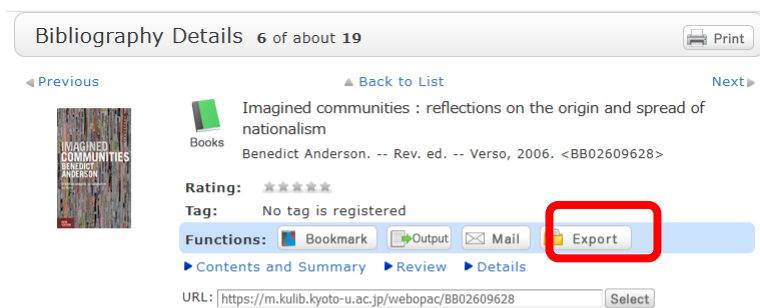
Part 1: Importing bibliographic information from KULINE

First, let's import bibliographic information from the search results of the library collection.

1. Access KULINE [<https://kuline.kulib.kyoto-u.ac.jp/>] and conduct a search for materials related to the theme of your report or the subject.
2. On the search result screen, select the bibliographic information you want and mark it as , then click the "Export" button.



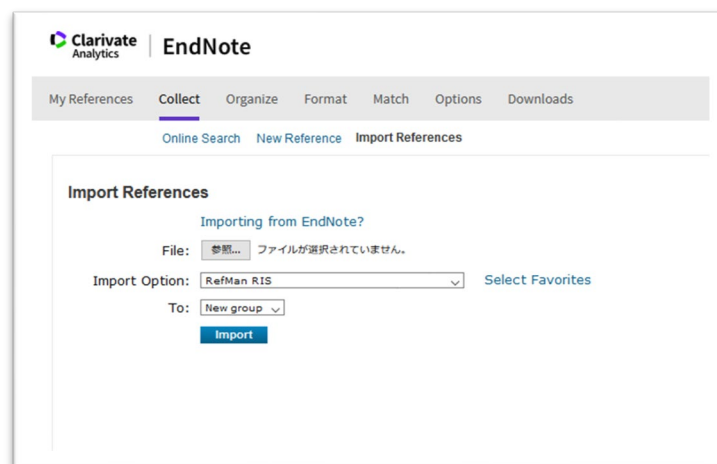
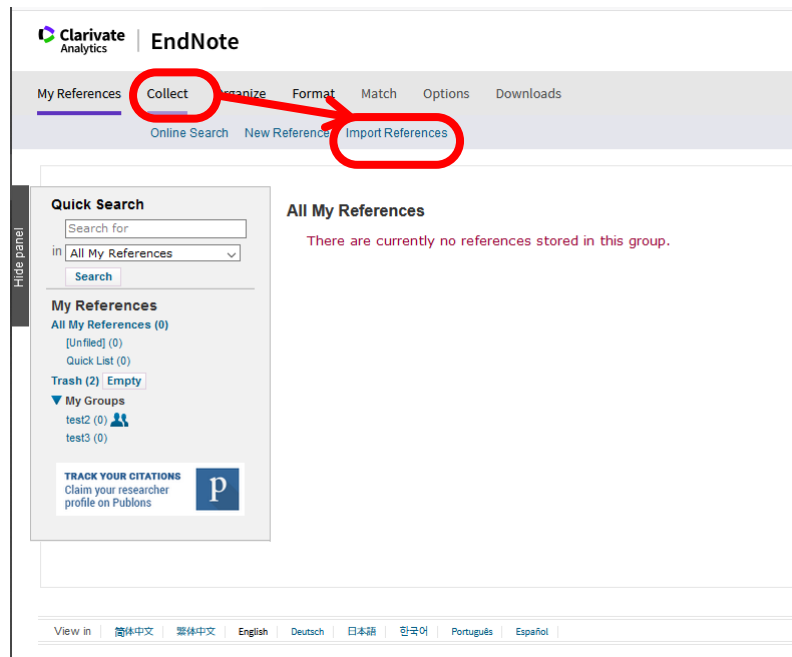
3. You can also import the bibliographic information at the “Bibliographic details” screen.



HoldingsList 1-2 of about 2

No.	Volumes	Library	Location	Call No	Material ID	Status	Due Date	Reservati on
0001		ASAFAS	Library of Asian Area Studies/Stack A	COE-SA 311.3 And	200031069446			
0002		KIER	3F Foreign Books	311 3 A 46	200038328063			

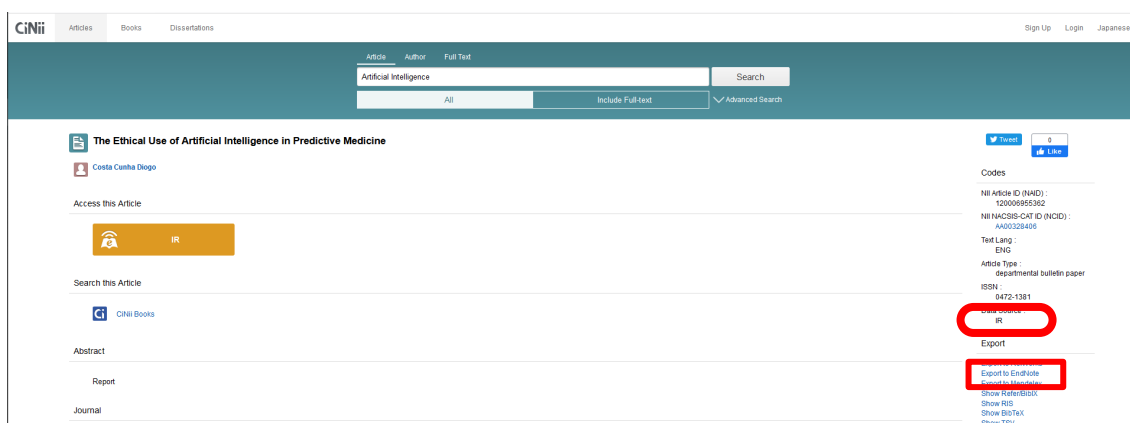
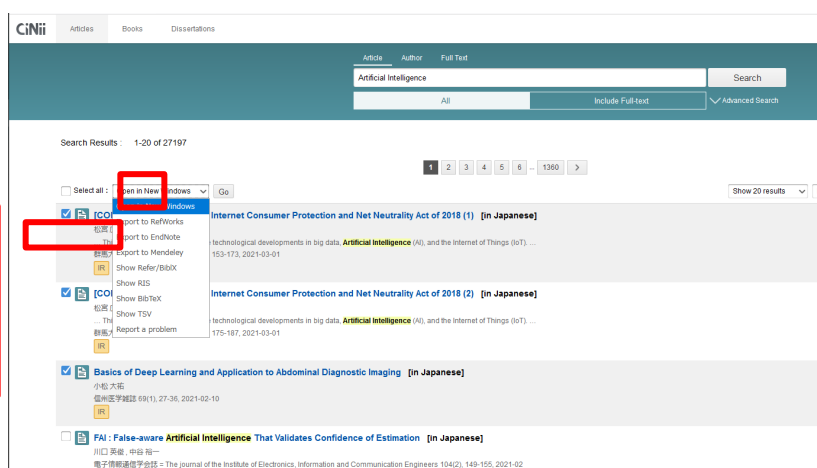
4. When the pop-up window opens, save the file to the location easy to remember, such as the desktop of your computer.
5. Open EndNote basic, select “Import References” from the “Collect” tab, and import the file you just saved. Select “RefMan RIS” for the import option.



Part 2 Import bibliographic information from CiiNii Articles

In EndNote basic, you can import bibliographic information from external bibliographic databases in the same way as in KULINE.

1. Access CiiNii Articles at [<https://ci.nii.ac.jp/en>] and search for materials related to the topic of your report or the subject you would like to research.
2. Select the items from the search result and select “Export to EndNote” from the pulldown menu or select “Export to EndNote” from the menu on the right side of the details screen.



Part 3 Add bibliographic information from your collection or websites

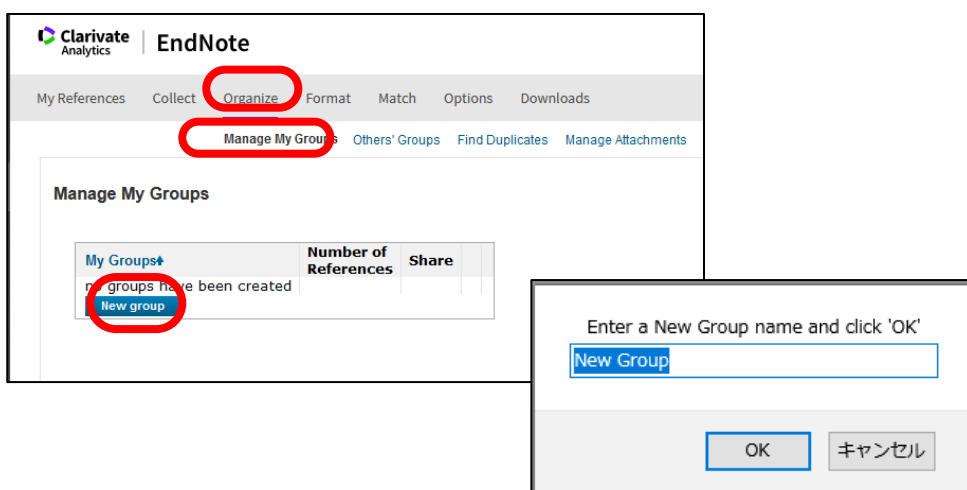
In EndNote basic, in addition to importing from the online databases, you can add the bibliographic information from your collection and the websites.

1. Select “New Reference” from the “Collection” tab.
2. Select the “Reference Type” appropriate for the type of literature you have and enter the bibliographic information.
3. If you want to enter information about the website you used as a reference, such as a newspaper or online journal, select “Newspaper Article” or “Web Page” from the “Reference Type” pull-down menu.
4. To save related files, select “Attachments” to upload the file after entering the bibliographic information.

Step 2: Organize the bibliographic information

The next step is to organize the bibliographic information imported to the EndNote basic. In “2.5. Files and File System,” we learned how to manage files in hierarchical structures with folders. Using the same concept in EndNote basics, you can create a “group” and manage bibliographic records in the group. One bibliographic record can be stored in multiple groups, so you can create a group for each class project or research theme, and add bibliographic records to multiple groups.

1. Click “New Group” in the “Manage My Groups” section of the “Organize” tab.
2. Enter a group name, such as the class name or the research theme.



Step 3: Create reference lists and in-text citations

It is very important to create reference lists in a specified format when submitting papers. EndNote basic has a function to generate reference lists and in-text citations with specified format. Please be reminded that there might be mistakes when using these functions and that you always check them before submitting papers. In particular, you need to carefully check the format of Japanese references.

Part 1. Create a reference list

Let's create a reference list to be attached to the end of the paper by selecting the references you actually used in your paper.

1. Select “Bibliography” from the “Format” tab.
2. Select a group name from “References.”
3. Select “Format Style” and “File Format,” then save.

4. Copy and paste the reference list you created to your paper.

Part 2: Create in-text citations

EndNote basic provides a plugin called CWYW (Cite While You Write) to simplify in-text citations when writing in Word. You can download it and make use of it. Note that CWYW cannot be used offline (or in airplane mode).

1. Click the “Downloads” tab to download the CWYW appropriate for your OS environment.
2. Open the “EndNote” tab at the place where you want to cite in the text you created in Word.
3. Click “Insert Citations.”
4. Click “Insert” to insert the citation.

References

- [8] Mendeley <https://www.mendeley.com/>

This chapter is based on the materials of the regular seminar held at the library. The recording of the seminar “How to use the literature management tool - EndNote basic” held in FY2020 is available via campus network, and the materials are widely available at Kyoto University Academic Information Repository KURENAI.

Recording:

<https://cls.iimc.kyoto-u.ac.jp/portal/site/6c851694-057e-4a42-885e-0f38d4a61af4/page/c7c5d1d-c671-4380-9f2e-df795a3e4118>

Material: <https://repository.kulib.kyoto-u.ac.jp/dspace/handle/2433/255602>

7. Data Processing with a Spreadsheet (1)

7.1 Study Aims

- To understand how to use a spreadsheet for academic purposes.
- To understand the content of cells and how to refer to the values in other cells—spreadsheet basics.
- To understand how to construct sheets for data input, and how to restrict values to a valid range.
- To understand ways of sorting data, referring to particular fields.
- To understand aggregation of data using a spreadsheet.
- To understand cross-tabulation using a pivot table.

7.2 Aims of Using a Spreadsheet

In this textbook, we consider the following three uses of a spreadsheet as academic ICT skills:

- Inputting a lot of data efficiently into a spreadsheet, and aggregating them for analysis;
- Carrying out simulation using a spreadsheet;
- Plotting data as a chart.

7.3 Basic Structure of a Spreadsheet

7.3.1 Cell Contents

A single spreadsheet consists of cells arrayed in a grid. A horizontal group of cells is called a ‘row’ and a vertical group, a ‘column.’

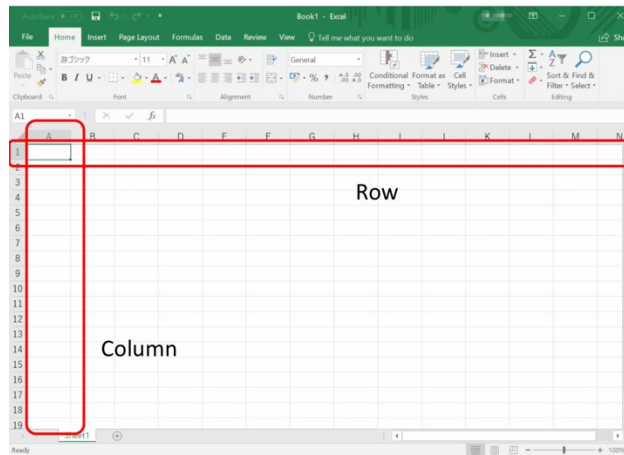


Figure 54 Worksheet, Column, Row and Cell in a Spreadsheet

A cell can store a numerical value or string. It can also store a formula that calculates its values by referring to values in other cells. As an example, cell A6 in Figure 54 doesn't contain a value but a formula.

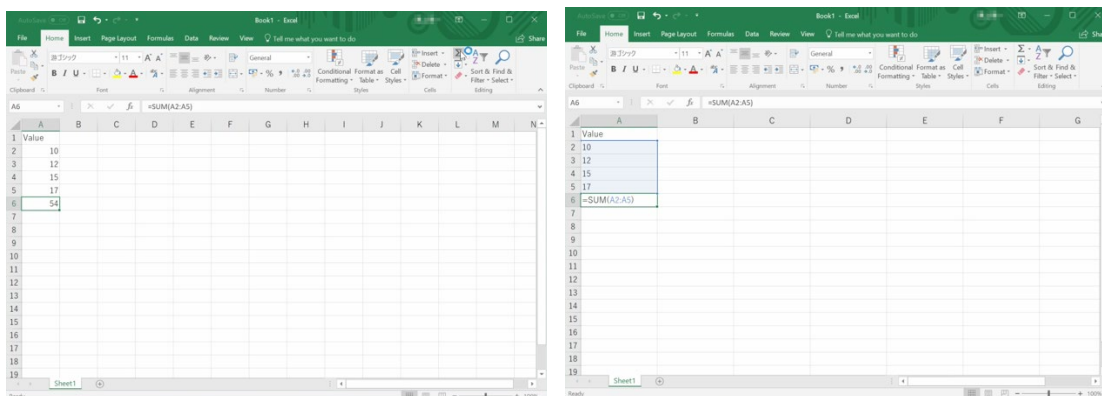


Figure 55 Content of a Cell

(The figure on the right shows the formula instead of the calculated value).

From the 'FILE' menu, choose 'Option', and 'Advanced'—then in the section 'Display options for this worksheet', check 'Show formulas in cells instead of their calculated results'.

7.3.2 Referencing Values in Other Cells

1) Referencing Values in Other Cells

In a formula, values in other cells can be referred to by specifying the column and the row for each cell. For example,

=A2+A3+A4+A5

calculates the sum of the values of cells of row A and columns 2 through 5.

2) Specifying a Rectangular Region

To specify a rectangular cell region, for example for use by the sum function, specify the top left and bottom right cells, connecting the two with a colon ':' thus:

=sum(A2:A5)

3) Relative and Absolute Cell References

If a cell with a formula is copied to another cell, the cell referred to in the formula is **copied keeping the relative position from the cell**. For example, if the A6 cell with the following formula is copied to the B6 cell,

=sum(A2:A5)

The formula in the B6 cell becomes

=sum(B2:B5)

This reference is called **a relative cell reference**.

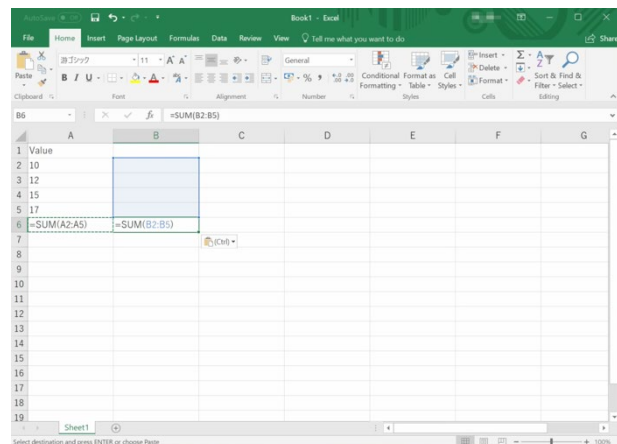


Figure 56 Referencing a Region

In contrast, if we want to refer to the *same* cell in the copied reference, we put '\$' in front of the row and/or the column. This is called an 'absolute cell reference.' In the following example, the B2 cell calculates the value of the cell to the left, multiplied by a constant value of 1.2 stored in cell C2, which is referred to by an absolute cell reference:

=A2*\$C\$2

If this formula is copied to cells B3 through B5, the reference to A2 is a relative reference and consequently changes to A3 through A5 while the reference to C2 is kept unchanged.

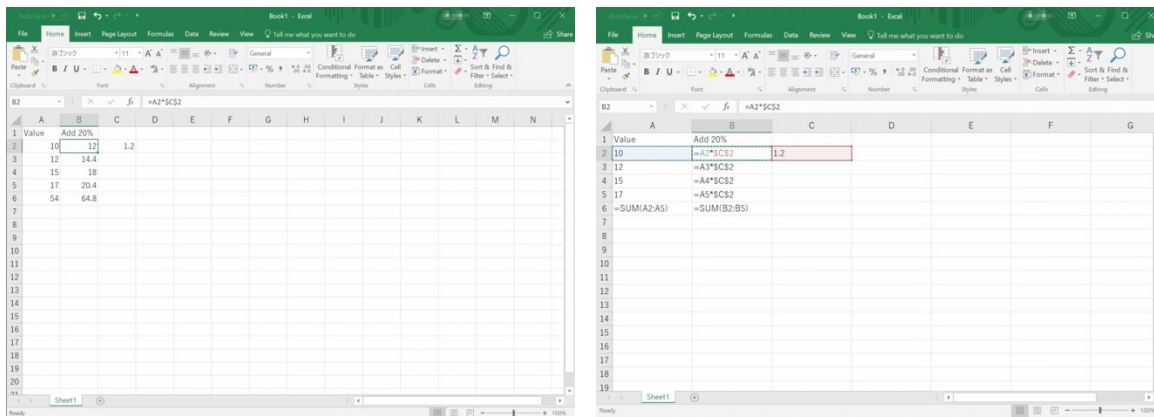


Figure 57 Relative and Absolute Cell References

Great Idea! Invention of the Spreadsheet

Dan Bricklin and Bob Frankston developed Visicalc—software in which cells contained not only values but also formulas referring to other cells in a table. This was released as an application for the Apple II personal computer in 1979. This software became a killer application on the Apple II. The ability to describe other cells using terms like ‘A1’ in Excel is inherited from VisiCalc. The spreadsheet concept allows ordinary people to handle vast amounts of data easily, and revolutionized personal computing.

Exercise 20. Relative and Absolute Cell References

Work through the Excel examples shown in this section to make sure you understand both how you reference other cells in a formula, and the difference between relative and absolute cell references.

7.4 Entering Data

7.4.1 Collection and Analysis of Data

Here, we consider how we might collect data for a research project, input them into a spreadsheet, and analyze them. The process consists of the following actions:

- Record necessary information—for example, describe the research;
- Input data into the spreadsheet considering:
 - **How to compose the sheet** in a way that makes analysis of data easy;
 - **How you might improve the input process** to minimize the risk of error;

- **How to check for correctness** of data entered into the spreadsheet.

7.4.2 Composition of a Table

1) Usage of a Sheet

- The research outline should also be described in a worksheet within the Excel file. For example, use Sheet1 for this purpose and change the name of the sheet to an appropriate one.
- Research data obtained are input to e.g. Sheet2. Rename it too.
- Use Sheet3 and beyond for aggregation etc.

Figure 58 Usage of a Sheet

2) Composition of a Data Table

In a questionnaire survey, one record consists of several items and the full data set consists of many records. Usually, the following approach is used to input such records:

- Use one row for one record;
- Use the first row for **headings of items** in the record;
- It is convenient to use the first column for the serial numbers of records;
- Data are input from the second row.

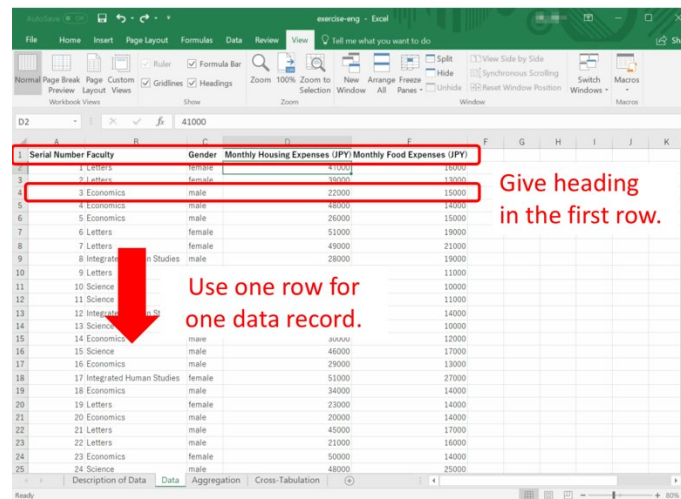


Figure 59 Basics of Data Table Composition

We can input sequential number as follows. Set ‘1’ at A2 cell in the column of ‘Serial Number’ and pressing Ctrl key and drag right-lower corner of the selected region down. Another way is to select ‘Home’ ribbon, ‘Fill’ menu, and ‘Series...’ In this method, you can set direction of dat, and maximum (stop) number.

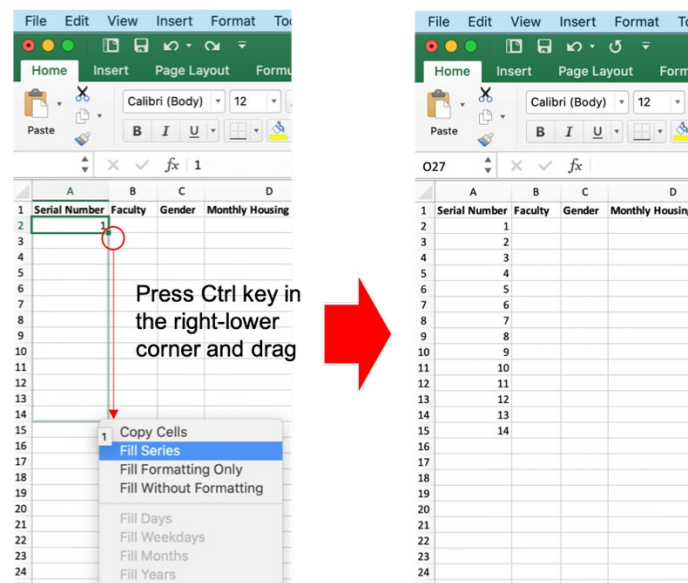


Figure 60 Input sequential numbers

7.4.3 Controlling Input Values

To input data manually is labor-intensive, and **usually generates errors** because of the human work. It is thus important to consider ways of carrying out this task efficiently and to

minimize errors.

1) Freezing Panes

It's easier to input and check data if you can show the header row and the column containing the serial number column all the time. We can do this with the 'Freeze Pane' function. Select the top left cell below the heading row and to the right of the serial number column (e.g. B2), and choose the 'VIEW' tab and 'Freeze Panes' button in the ribbon.

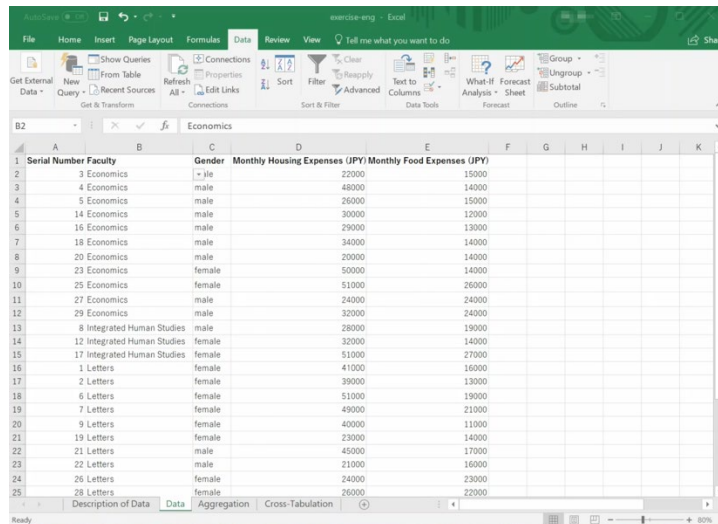


Figure 61 Freezing a Pane

2) Setting Input from Lists

If variation of data is **limited within a set of candidate strings** such as names of faculties and genders, **asking someone to type them in directly may cause many errors**. Here we learn how to restrict input strings by choosing from a list of candidate strings so as to avoid this type of error.

- Put the candidate strings in a spreadsheet (sheet), e.g., 'description sheet' (Sheet1).
- In the sheet for data input, select the top cell in which data will be entered.
- Select the 'DATA' tab, choose 'Data Validation' in the ribbon, select the 'Settings' tab in the dialog that appears, and choose 'List' in the 'Allow' field.
- In the 'Source' field select the candidate strings set up previously. You can set this by moving to the 'description' sheet, selecting the top cell, and—keeping the SHIFT key pressed—select the bottom cell of the candidate data.
- Copy the cell with its input restriction to all of the cells below it—those cells where you want the rule to apply.

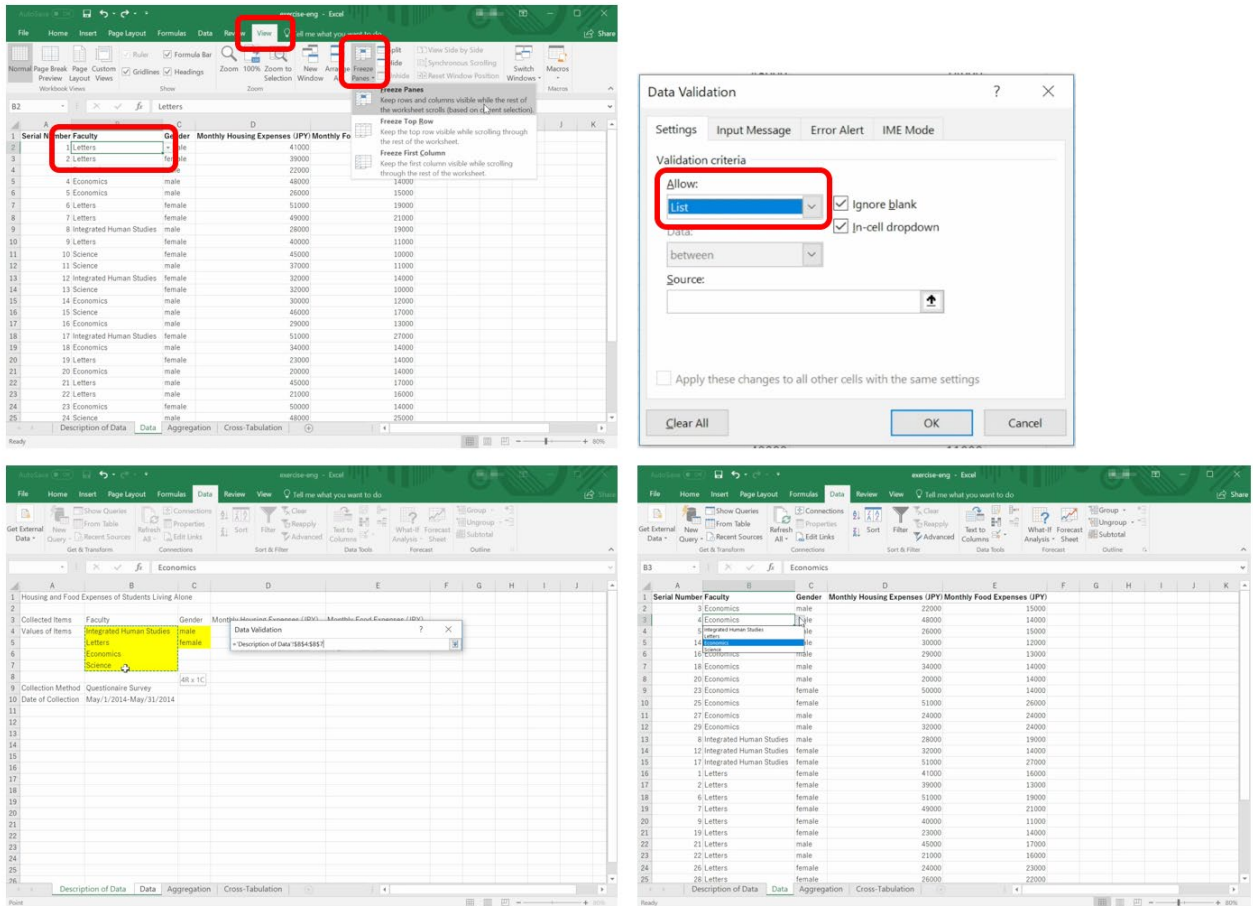


Figure 62 Data Validation

If you cooperate with another person in inputting the data, the following approach is very effective:

- One person reads the data, and inspects the input data;
- The other operates the spreadsheet;

Once you've finished data input, check carefully whether the data are input correctly.

Exercise 21. Data Table Composition

Make up a spreadsheet using the data shown in Table 5 using the approach described above, setting up data validation. Here ‘Integrated Human Studies’, ‘Letters’, ‘Economics’ and ‘Science’ are the only values allowed to appear in the faculty column.

Table 5 Sample Data for Exercise (fictitious values)

Serial Number	Faculty	Gender	Monthly Housing Expenses	Monthly Food Expenses
1	Letters	female	41000	16000
2	Letters	female	39000	13000
3	Economics	male	22000	15000
4	Economics	male	48000	14000
5	Economics	male	26000	15000
6	Letters	female	51000	19000
7	Letters	female	49000	21000
8	Integrated Human Studies	male	28000	19000
9	Letters	female	40000	11000
10	Science	female	45000	10000
11	Science	male	37000	11000
12	Integrated Human Studies	female	32000	14000
13	Science	female	32000	10000
14	Economics	male	30000	12000
15	Science	male	46000	17000
16	Economics	male	29000	13000
17	Integrated Human Studies	female	51000	27000
18	Economics	male	34000	14000
19	Letters	female	23000	14000
20	Economics	male	20000	14000
21	Letters	male	45000	17000
22	Letters	male	21000	16000
23	Economics	female	50000	14000
24	Science	male	48000	25000
25	Economics	female	51000	26000
26	Letters	female	24000	23000
27	Economics	male	24000	24000
28	Letters	female	26000	22000
29	Economics	male	32000	24000
30	Letters	female	45000	23000

7.5 Sorting Data

In analysis of data, we often want to change the array of records according to the order of values in a particular field.

- This operation is called ‘sorting’;
- Sorting can be done from the smallest to the largest (ascending), or
- The largest to the smallest (descending);
- Strings are sorted based on the order of the character codes. Kanji is sorted by the code, and not the order in which it is read. If we want to sort strings according to how they are read, we have to add a field (column) written in Kana.

Let’s try to sort the data from Exercise 21.

- Select a cell that contains a datum;
- Select the ‘DATA’ tab, and choose ‘Sort’ in the ribbon;
- Select the field we want to use for the sorting key as ‘Sort by’, and choose ‘Smallest to Largest’ or ‘largest to Smallest’;
- Make sure that the option ‘My data has headers’ is selected;
- If you press the ‘OK’ button, the data will be sorted.

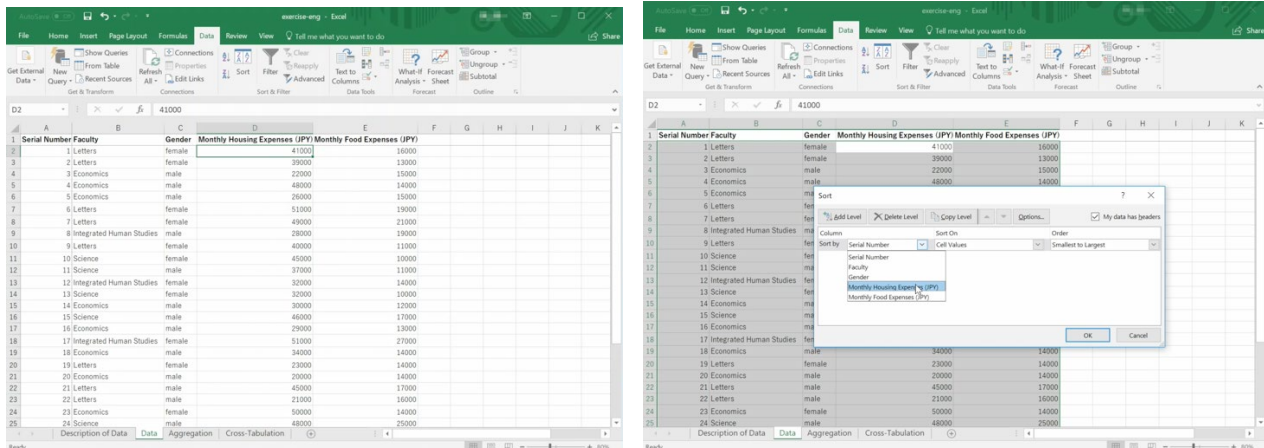


Figure 63 Sorting Data

Exercise 22. Sorting Data

Sort the data made in Exercise 21 using either the field ‘Monthly housing expenses’ or ‘Monthly food expenses’, and find the largest three records and the smallest three records.

Highest 3 monthly housing expenses			
Lowest 3 monthly housing expenses			
Highest 3 monthly food expenses			
Lowest 3 monthly food expenses			

7.6 Aggregating Data

We can use various functions for data aggregation in Excel.

7.6.1 Counting Data

Table 6 Excel Functions to Count Data

Function	Meaning	Example
Count	Count cells in the given region	count(A2:A31)
Counta	Count non-blank cells in the given region	counta(A2:A31)
Countif	Count cells that satisfy the given condition in the given region	countif(B2:B31,"Engineering") countif(D2:D31,">20000")
Countifs	Count cells that satisfy multiple given conditions in the given region	countifs(B2:B31,"Engineering", D2:D31,">20000")

In the countifs function, conditions that refer to other columns can be used. In the example in the above table, we count:

- Rows 2 through 31, where the value in column B is “Engineering,” *and*
- The value in column D is more than 20000.

7.6.2 Adding up Data

Table 7 Excel Functions for Adding up Data

Function	Meaning	Example
Sum	Add up cell values in the specified region	sum(D2:D31)
Sumif	Add up cell values in the regions that satisfy the given condition	sumif(D2:D31,">20000") sumif(B2:B31,"Engineering",D2:D31)
Sumifs	Adding up cell values in the regions that satisfy multiple conditions	sumifs(D2:D31,B2:B31,"Engineering",C2:C31,"male")

The second example of the sumif function checks conditions in another column. It checks conditions in column B (B2:B31), but adds up values in the D column.

In the sumifs function, we can specify multiple conditions. The first argument is the region to add up, and the remainder consists of pairs of regions and conditions.

7.6.3 Taking the Average of Data

To obtain averages, we can use the functions average, averageif, averageifs. Usage is similar to sum, sumif, sumifs, and we can obtain averages instead of sums.

Exercise 23. Aggregation of Data

Calculate the following in sheet3:

For the spreadsheet in Exercise 21, rename sheet3 as Aggregation, and calculate the following in the sheet:

- Number of all records; sums and averages of monthly housing expenses and monthly food expenses for all records.
- Number of records, sums and averages of monthly housing expenses and monthly food expenses by faculty.
- Number of records, sums and averages of monthly housing expenses and monthly food expenses by gender.

To refer to a region in another sheet, put the name of the sheet with ‘!’ before the cell reference. For example ‘Data!B2:B31’.

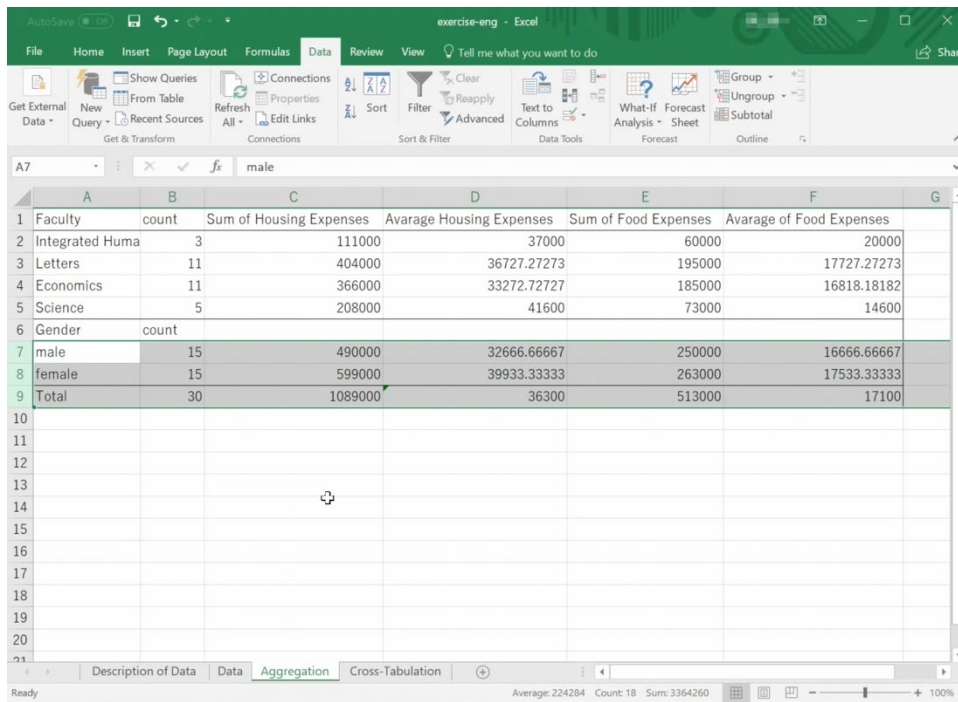


Figure 64 Aggregation of Data

Instead of writing a condition directly, we can refer to another cell in which the condition is specified. In the above example, the formula in cell C2 refers to cell A2 as the condition.

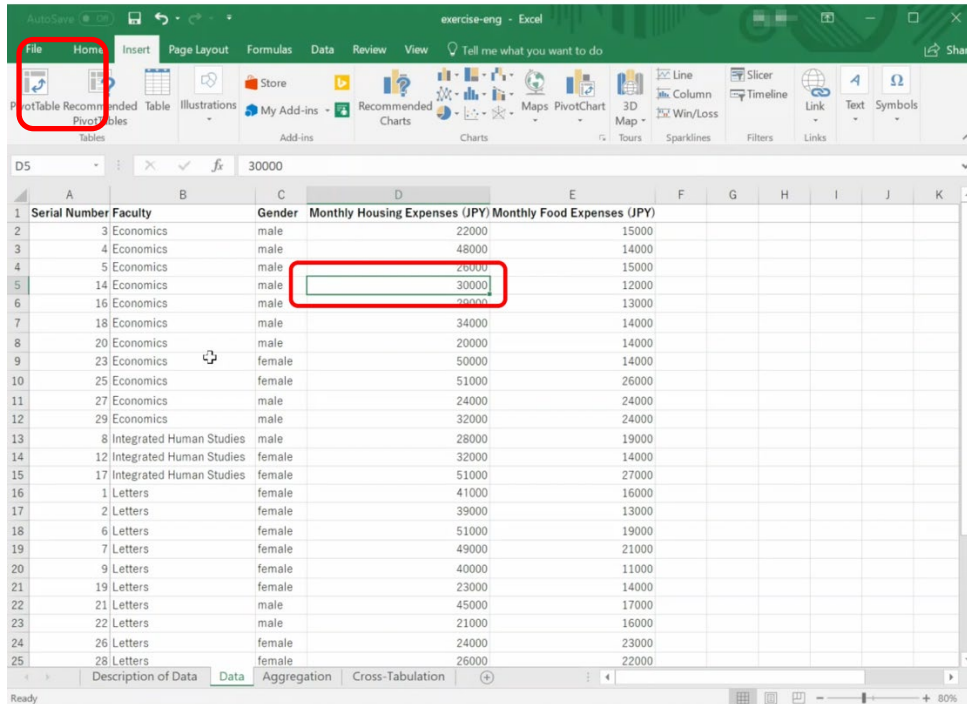
$$=SUMIF(Data!B2:B31,A2,Data!D2:D31)$$

In the above example, references to the data are written as absolute cell references. These regions won't change when this cell is copied to cells below it, but reference A2 will be changed to A3 through A5 due to the use of a relative cell reference.

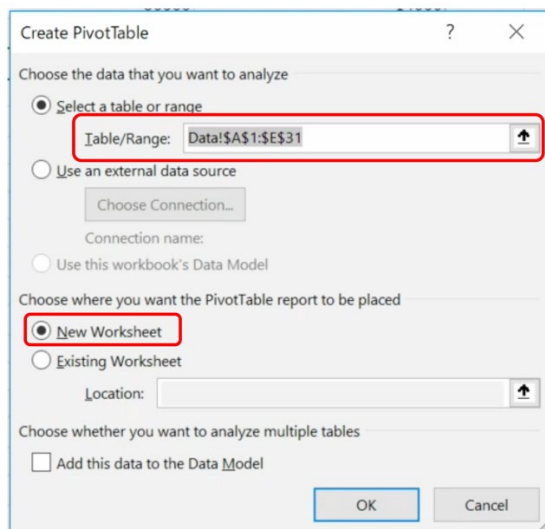
7.7 Cross Tabulation

For the data entered during Exercise 21, we now need to count records, calculate sums and average according to both faculty and gender. Such operations are referred to as ‘cross tabulation’. In Excel we can use ‘Pivot Tables’ for cross tabulation.

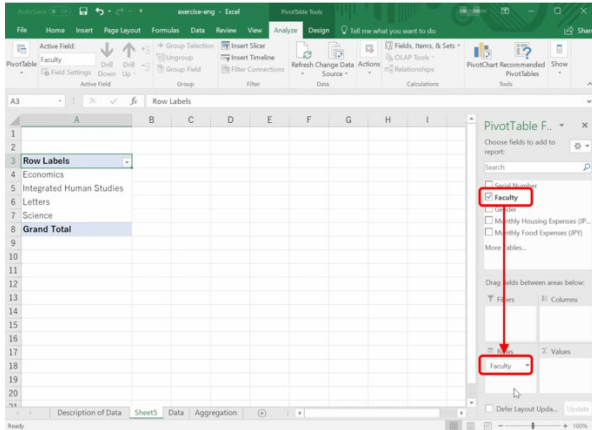
- Select a cell that contains a datum on the data sheet.
- Select ‘INSERT’ tab, and choose ‘Pivot Table’ in the ribbon.



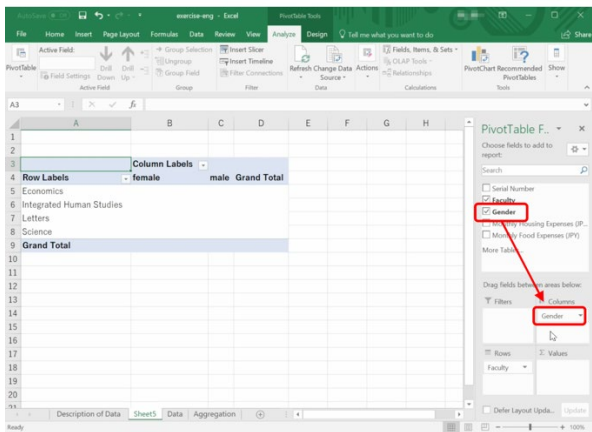
- Confirm ‘Table/Range’ and ‘New Worksheet’, and press ‘OK’.



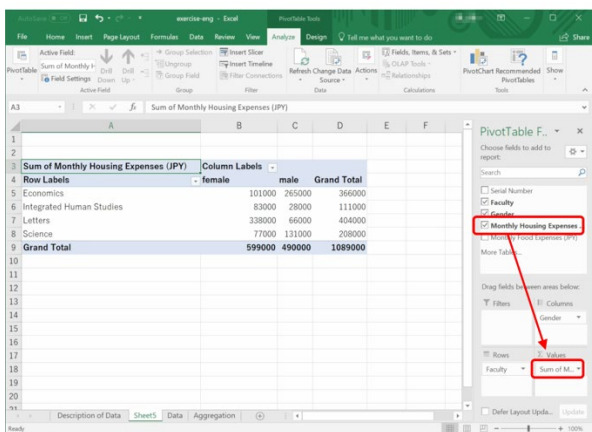
- In the field list of the pivot table
- Choose 'Faculty' and drop it on the Row Label pane.



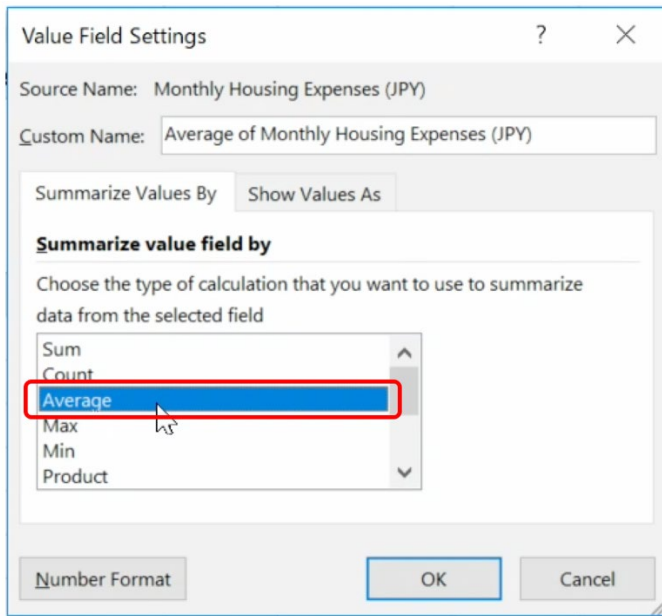
- Choose Gender and drop it on the Column Label pane.



- Choose monthly housing expenses, and drop it on the Σ value pane.



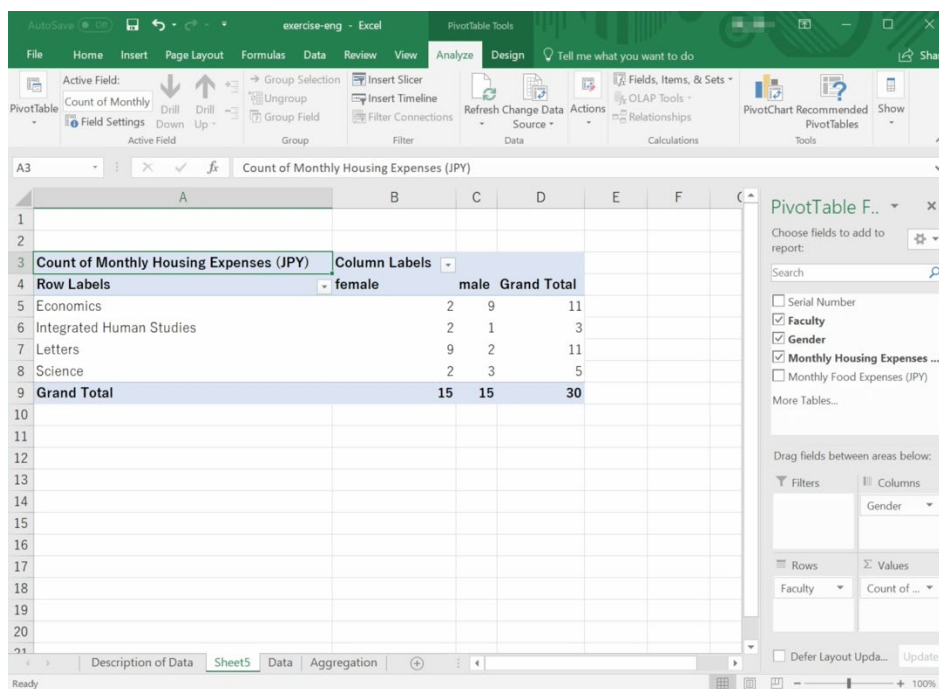
- In Σ value, click sum/monthly housing expenses, and choose average instead of sum.



- When you click a cell outside the table you've made, the field list disappears. Choose a cell in the table again, and the field list re-appears.

Exercise 24. Cross Tabulation

Using the data input in Exercise 21, create a pivot table that counts the number of records for each pairing of faculty and gender.



8. Data Processing with a Spreadsheet (2)

8.1 Study Aims

- In this section, we learn simulation using spreadsheets.

8.2 What is Simulation?

Simulation is to mimic a particular phenomenon using a model of what we want to study. The target of simulation may be a physical system or a social system that includes people in the model. Depending on what we're interested in, we can simulate:

- A static state where the system is stationary; or
- A dynamic situation where the system evolves over time; or
- The inclusion of random factors.

Here we consider 'simulation of a dynamic situation' using a spreadsheet.

8.3 Elements Needed in Simulation of Dynamical Systems

The following are the model elements used to represent a dynamic system:

- Variables that change their values over time;
- Rules that describe the change. For example, equations or functions that calculate the values of variables after the next step in time, given the current values of the variables;
- Initial values of the variables;
- Parameters. Particular values referred to in the rules that describe how things change are called 'parameters.' While a parameter doesn't change its value during a particular simulation, we often want to study how the behavior of the system changes with different parameter values.

8.4 Simulation of Repayment of Debt

In repaying a debt, we add a certain amount of interest to the principal. Let's create a

simulation of the case where we repay portions of the debt in several steps, and study how the debt changes:

- At the start, the debt is 10 million Japanese Yen;
- The annual interest rate is 3%. In calculating interest, we omit fractions;
- The repayment is a Japanese Yen annually;
- We incur the debt at the beginning of the year, and at the end of the year, the interest is added to the debt. We then subtract the debt repayment and what is left becomes the debt for the next year:

$$(\text{Debt in the next year}) = \text{int}((\text{Debt in the previous year}) \times (1 + 0.03) - a)$$

where $\text{int}()$ is a function that omits the fraction.

Figure 64 calculates the above with Excel and shows the results as a chart. The top panel shows the result of the calculation, and the bottom one shows the formulas. You can switch between showing the results and the formulas by pressing $\text{Ctrl} + \text{SHIFT} + ``$

- In the cells without a formula, enter strings or numerals directly. Enter the interest rate and annual repayment in cells E1 and E2 respectively;
- Set the formulas as follows:

B3 cell `=MAX(INT(B2*(1+E1)-E2),0)`

C2 cell `=MIN(E2,INT(B2*(1+E1)))`

To refer to the interest rate in cell E1 and the annual repayment in E2, use absolute cell references, entering them as $\$E\1 and $\$E\2 . In the formulas, we use the functions `MAX` and `MIN` so as not to make the debt negative, and adjust the repayment if this happens;

- Complete the sheet by copying these cells downward;
- Draw a chart after consulting the following section.

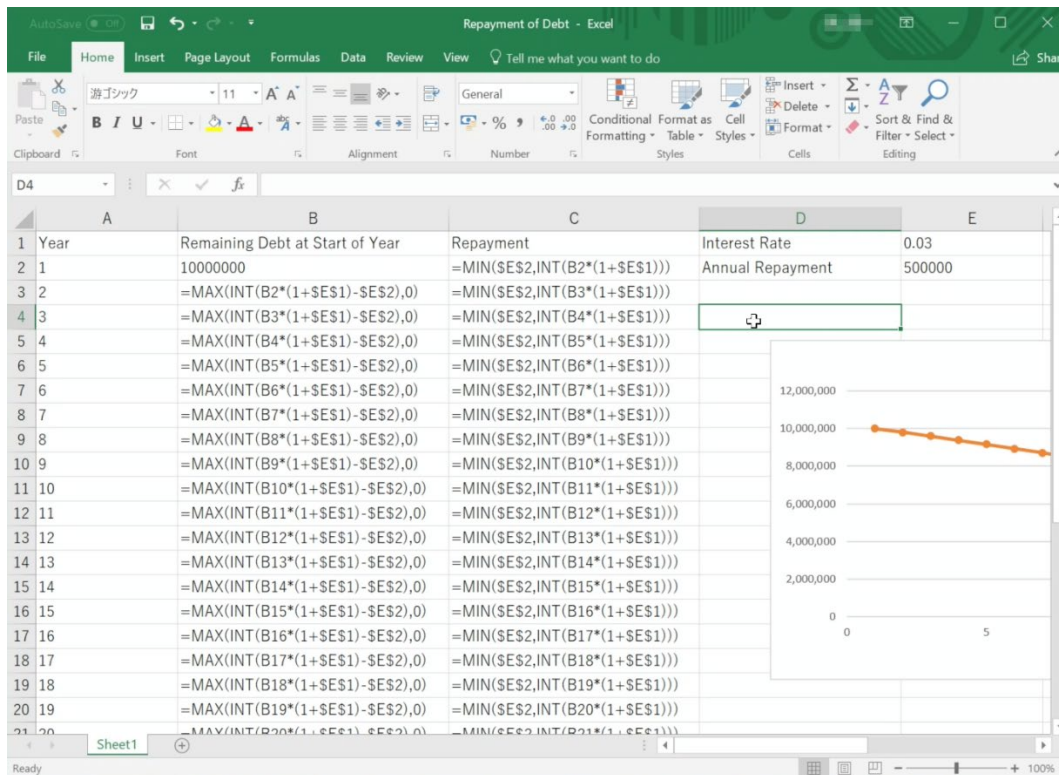
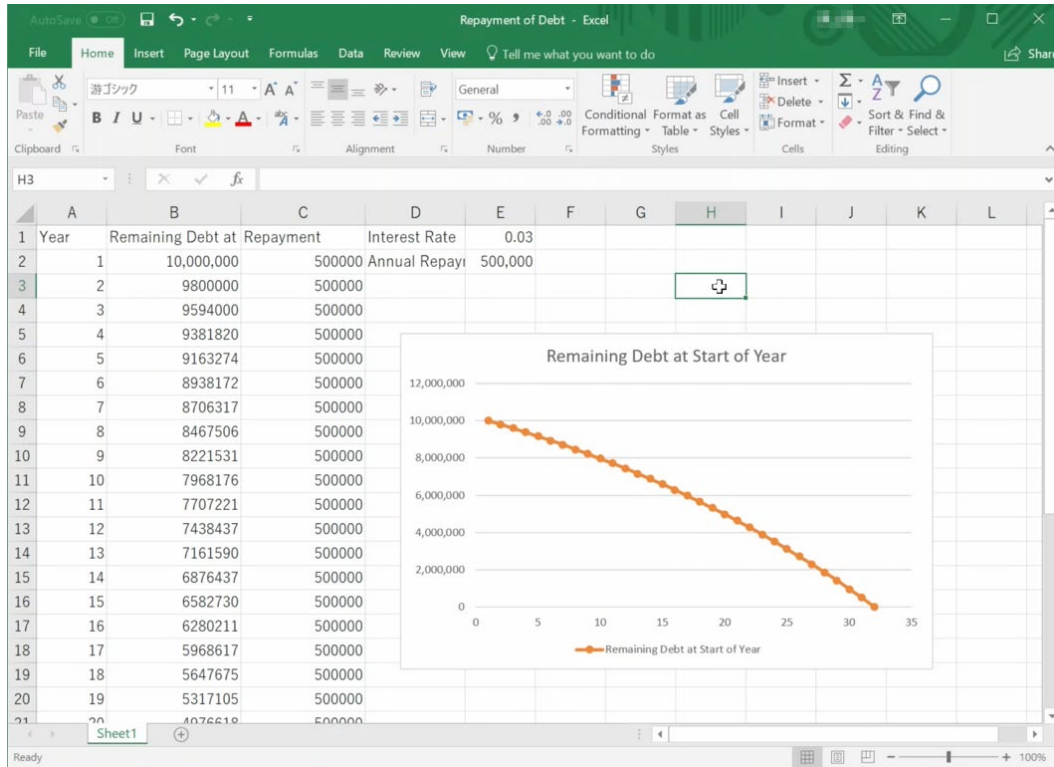


Figure 65 Simulation of Repayment of Debt. The bottom picture shows formulas in cells.

Exercise 25. Simulation with various repayment values

Simulate the repayment for various values of the repayment, and discuss the result.

8.5 Simulation of Mass-Spring-Damper Model

In this section, we treat a mass-spring-damper model as an example of a mechanical system.

8.5.1 Model

If we hang a weight on a spring, we can measure the weight from how much the spring stretches—the principle of the spring scale. However, if we consider only the ideal weight (mass) and spring, it vibrates and doesn't stop at the equilibrium point where weight and spring tension balance. To suppress this oscillation, we use a damper that generates resistance in proportion to the motion. In this section, we simulate movement of the weight in such a system.

Let the mass of the weight be m ; the spring constant is k , the acceleration due to gravity is g , the damping coefficient is c . The position of the weight and its velocity are respectively x and v , assuming that a vertical, downwards displacement is positive. Taking the natural length of the spring as the origin of position x , the motion of the weight is given by the following equations. Equation (1) is just the definition of velocity. Equation (2) represents the acceleration (derivative of the velocity) on the left, given by the right hand side—that is, the sum of the acceleration due to gravity; the tension of the spring, which is proportional to the position; and the resistance from the damper that is proportional to the velocity.

$$\frac{dx(t)}{dt} = v(t) \quad (1)$$

$$\frac{dv(t)}{dt} = g - \frac{k}{m}x(t) - \frac{c}{m}v(t) \quad (2)$$

We assume the initial values of the variables are given by $x(0) = 0$, $v(0) = 0$.

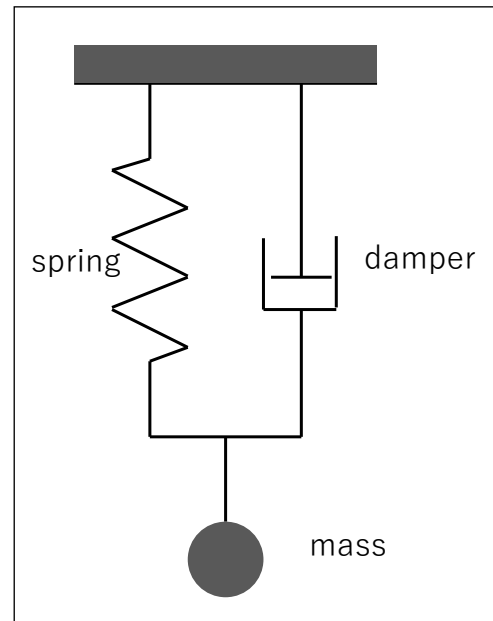


Figure 66 Mass-Spring-Damper Model

8.5.2 Solving Differential Equations with the Euler Method

Differential equations are equations that describe functions that change over time; taken in this form, we can't perform a numerical computation. We here assume that we can make calculations about the system using a small time interval Δt , i.e., $x_0 = x(0)$, $x_1 = x(\Delta t)$, $x_2 = x(2\Delta t)$, ..., $v_0 = v(0)$, $v_1 = v(\Delta t)$, $v_2 = v(2\Delta t)$, ... We also assume the derivatives in Equations (1), (2) do not change substantially during the tiny interval between $n \Delta t$ and $(n + 1) \Delta t$, so we can use the value obtained at time $n \Delta t$. With this approximation, we obtain the following difference equations that can be calculated by a computer.

$$x_{n+1} = x_n + \Delta t v_n \quad (3)$$

$$v_{n+1} = v_n + \Delta t \left(g - \frac{k}{m} x_n - \frac{c}{m} v_n \right) \quad (4)$$

This method is called 'the Euler method' and is the simplest approach used to calculate differential equations. However, if we use a large value for the time interval Δt , the approximation becomes poor; conversely if we use a minuscule interval, we need more computation to simulate a given range of times. There are many other, more accurate methods for numerical computation of differential equations.

8.5.3 Simulation with Spreadsheet

Figure 66 shows a simulation of the model using equations (3) and (4) in Excel. Parameters are set as in Table 8.

Table 8 Assignment of Cell Parameters in a Mass-Spring-Damper Model

Parameter	Cell
The mass of the weight m	E2
The spring constant k	E3
The gravity constant g	E4
The damping coefficient c	E5
Time step Δt	E6

With this approach, evolution of time, position and velocity are calculated in the third row of the sheet (A3, B3, C3) as below. For references to the parameters, we use absolute cell references to refer to fixed cells as we did with the repayment simulation.

$$A3 = A2 + \$E\$6$$

$$B3 = B2 + \$E\$6 * C2$$

$$C3 = C2 + \$E\$6 * (\$E\$4 - \$E\$3 * B2 / \$E\$2 - \$E\$5 * C2 / \$E\$2)$$

Copying these cells downward, we can make a simulation spreadsheet.

Exercise 26. Parametric analysis of the damping coefficient

Carrying out simulation runs, progressively increase the damping coefficient from 0 (in which case the weight vibrates), and discuss how the behavior of the system changes.

Exercise 27. Examine the case where the damping coefficient is zero

In this case, theoretically the weight undergoes simple harmonic motion. Observe the behavior of the weight during the numerical simulation.

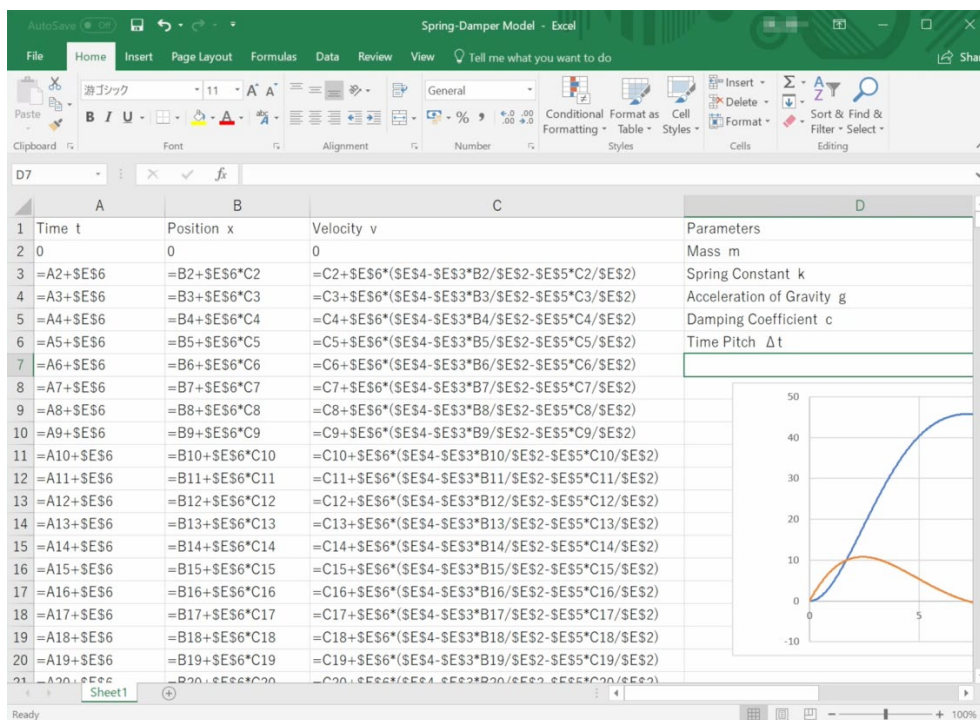
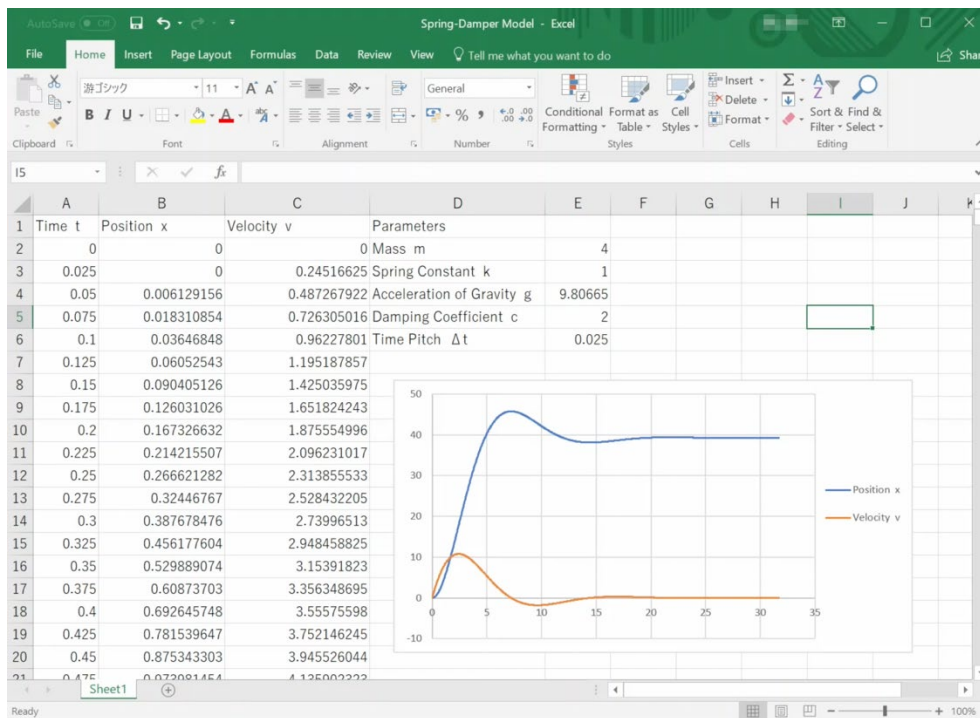


Figure 67 Simulation of the Mass-Spring-Damper Model

8.5.4 Treatment of the Static Situation

Let's think about the static situation with the mass-spring-damper model. Here, there is no change over time, and this is represented by setting the derivatives (left hand sides) of

Equations (3), (4) to zero. That is,

$$0 = v(t) \tag{5}$$

$$0 = g - \frac{k}{m}x(t) \tag{6}$$

Looking at these equations, they simply represent the balance of gravity and tension. This case can be solved easily. However, in treating more complex systems, equations obtained by setting derivatives of the differential equations of the system to zero will produce a system of algebraic equations that we will need to solve.

9. Data Processing with a Spreadsheet (3)

9.1 Study Aims

- To consider the value of plotting data for academic communication.
- To learn the terminology used in plotting charts with Excel.
- To learn how to plot scatter charts with Excel.
- To learn how to plot column charts and line charts with Excel.
- To learn how to make a histogram with Excel.

9.2 Benefits of Plotting Data as a Chart

Exercise 28. We often use charts in scientific papers. Why do we do this?

Exercise 29. What are benefits of showing data as a chart in our ‘intellectual production activities’?

9.3 Labels Used in Plotting Charts

The next chart is a plot of the data from Exercise 21, with the monthly housing expenses on the horizontal axis, and the monthly food expenses on the vertical axis. If you use this chart in your paper, will your readers be able to easily understand the information conveyed by the data?

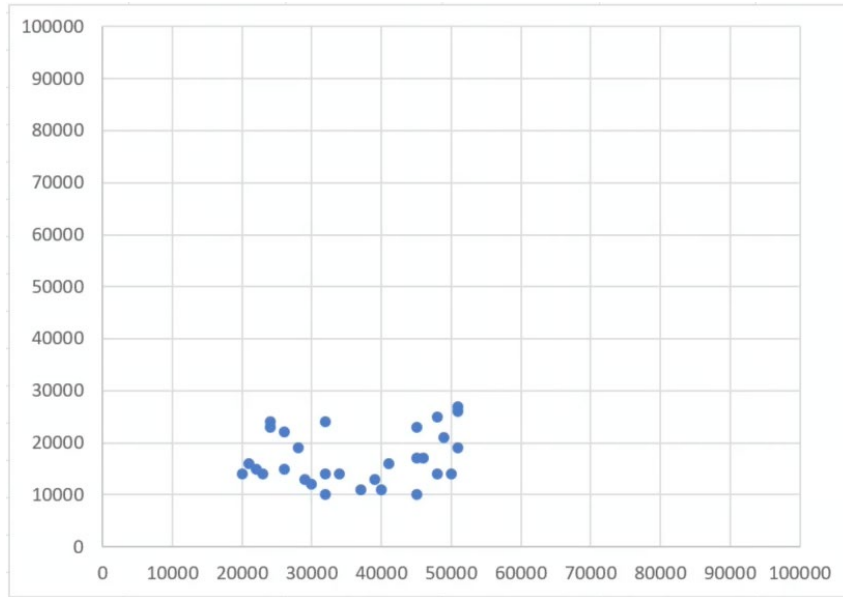


Figure 68 Chart with Inappropriate Plotting

Exercise 30. Discuss why the plotting used in this chart is inappropriate.

9.4 Terminology Used in Plotting a Chart with Excel

In plotting charts with Excel, we need to learn the names of the parts of charts. Figure 68 shows these. To see these clearly, the background colors of the relevant parts have been modified.

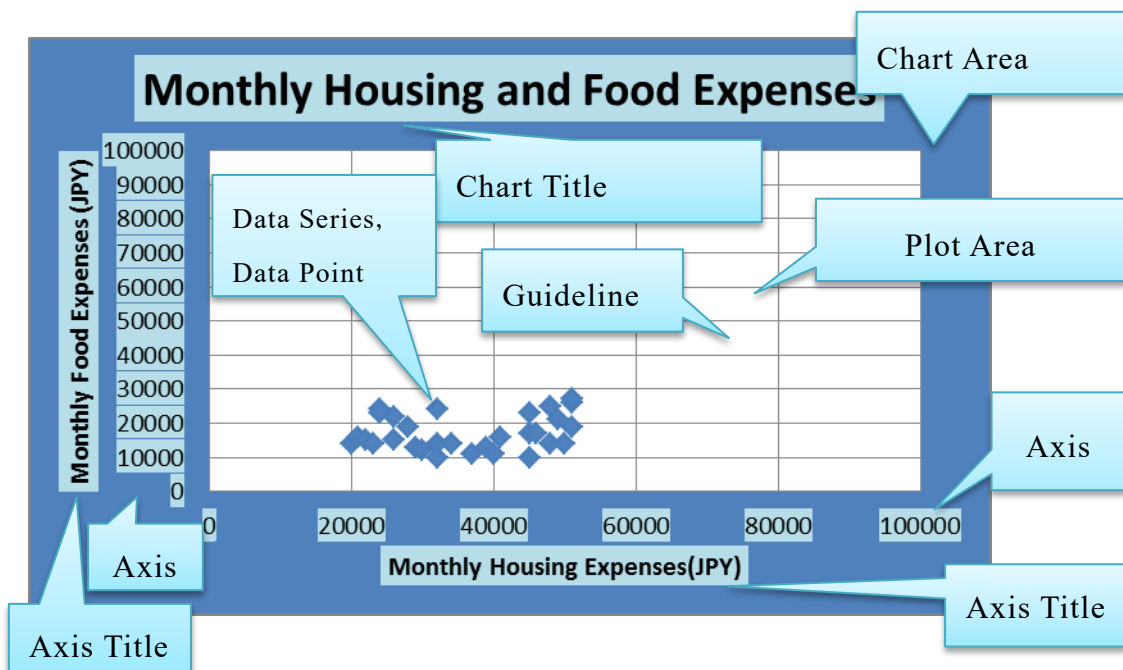


Figure 69 Names of Parts in an Excel Chart

9.5 Plotting Scatter Chart with Excel

9.5.1 Using a Scatter Chart

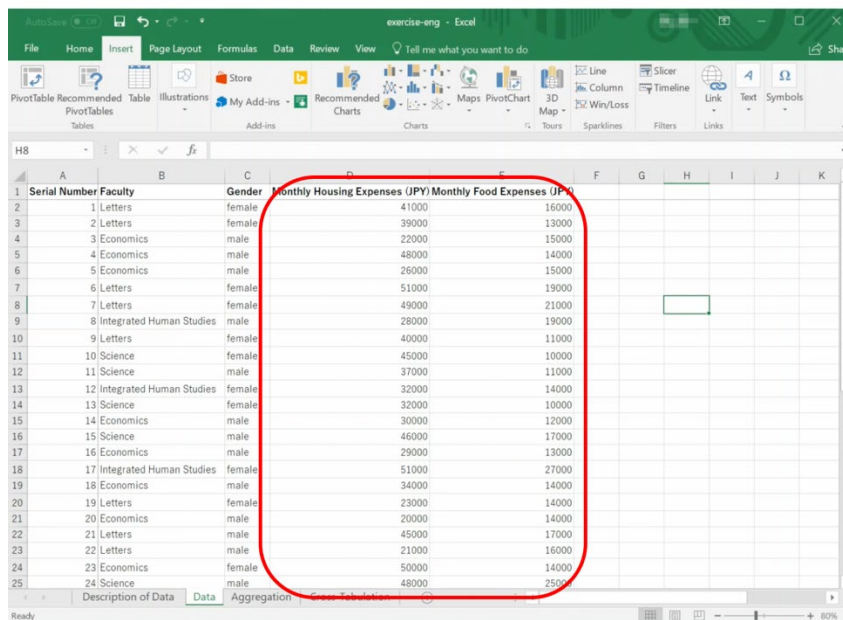
The above chart is plotted by **providing both the values for horizontal and vertical axes**. This type of chart is called a scatter chart. It will be used in the following two ways.

- To examine the relationship between two attributes of data obtained e.g., in a questionnaire survey.
- To show the relationship between data obtained in an experiment where the value of the horizontal axis variable is changed and then the resulting value of the variable plotted on the vertical axis is measured. Usually such charts are considered as line charts, but to plot the data giving values on both axes, we need to use a scatter chart.

9.5.2 Making a Scatter Chart

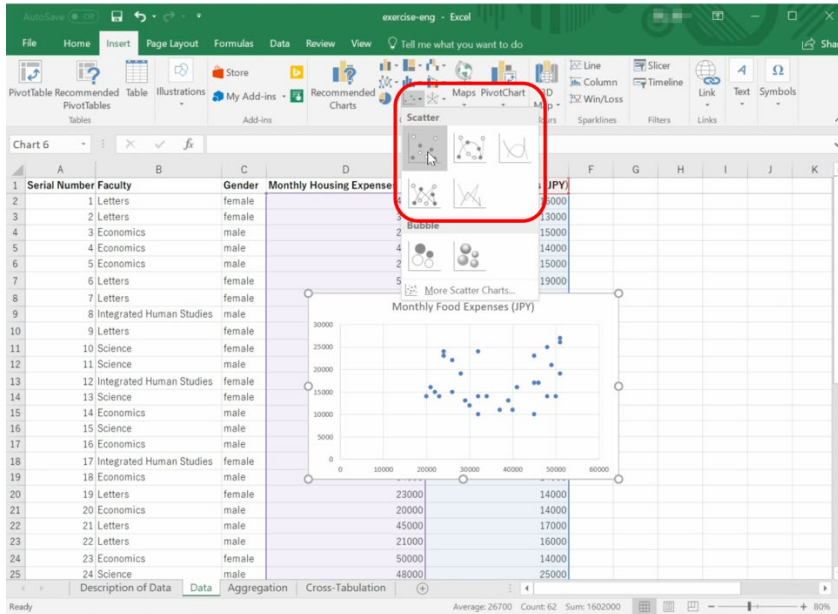
With the data entered in Exercise 21, the procedure used to make a scatter chart is as follows:

1. Select two columns e.g., monthly housing expenses and monthly food expenses, to make a scatter chart;

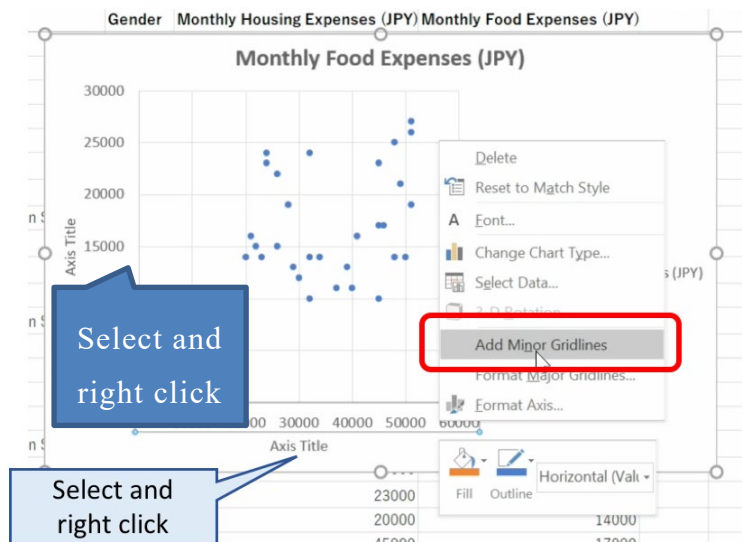


Serial Number	Faculty	Gender	Monthly Housing Expenses (JPY)	Monthly Food Expenses (JPY)
1	Letters	female	41000	16000
2	Letters	female	39000	13000
3	Economics	male	22000	15000
4	Economics	male	48000	14000
5	Economics	male	26000	15000
6	Letters	female	51000	19000
7	Letters	female	49000	21000
8	Integrated Human Studies	male	28000	19000
9	Letters	female	40000	11000
10	Science	female	45000	10000
11	Science	male	37000	11000
12	Integrated Human Studies	female	32000	14000
13	Science	female	32000	10000
14	Economics	male	30000	12000
15	Science	male	46000	17000
16	Economics	male	29000	13000
17	Integrated Human Studies	female	51000	27000
18	Economics	male	34000	14000
19	Letters	female	23000	14000
20	Economics	male	20000	14000
21	Letters	male	45000	17000
22	Letters	male	21000	16000
23	Economics	female	50000	14000
24	Science	male	48000	25000

2. Select the 'INSERT' tab and choose 'Scatter' in the 'Chart' part of the ribbon. Choose 'only marks' as 'plot style'



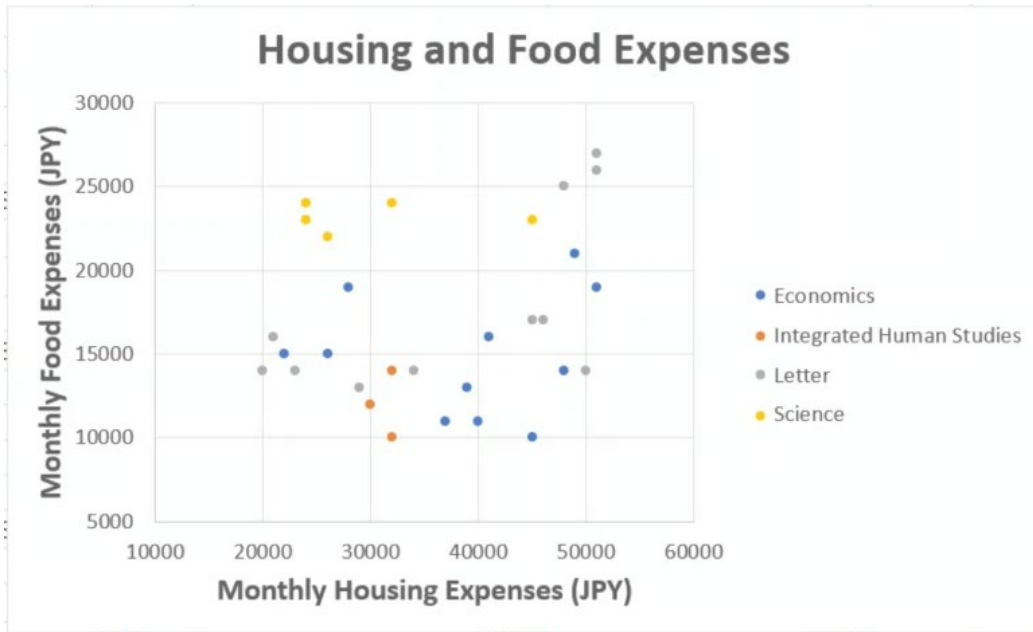
- Choose the drawn chart, and set up an appropriate layout in the ribbon.
- Select the horizontal axis, and choose 'add major guideline'.



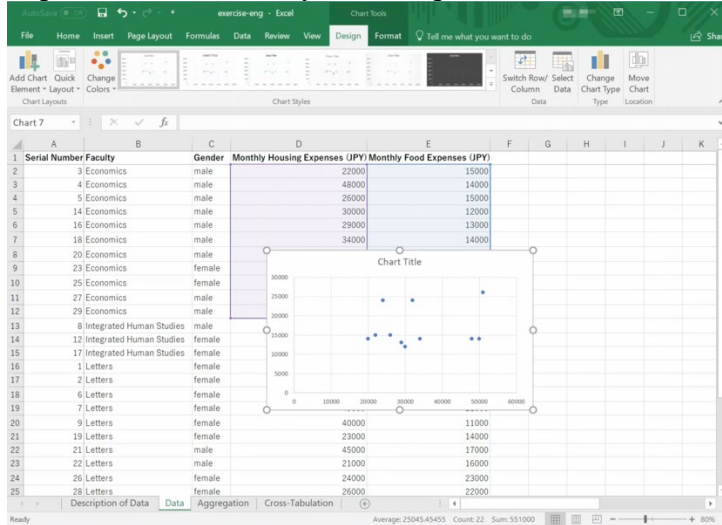
- Edit the graph title, axis labels and legend.

9.5.3 Scatter Charts of Multiple Data Series

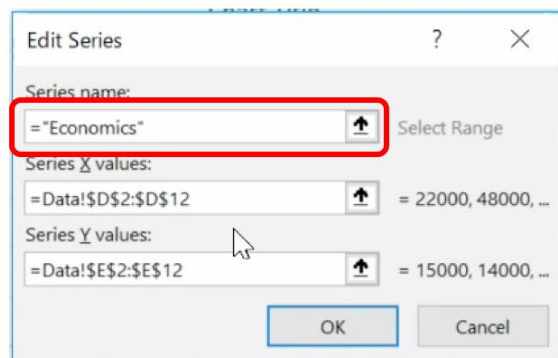
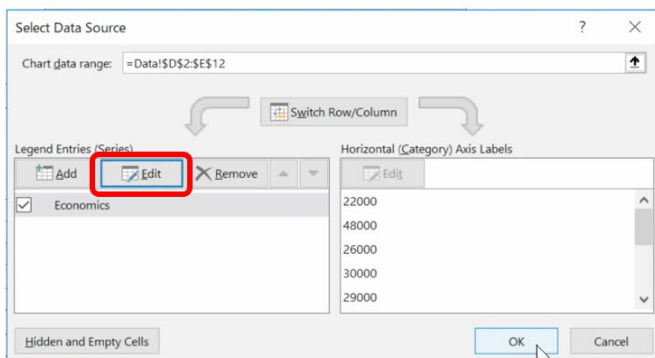
Make the scatter chart show different indicators for the various faculties.



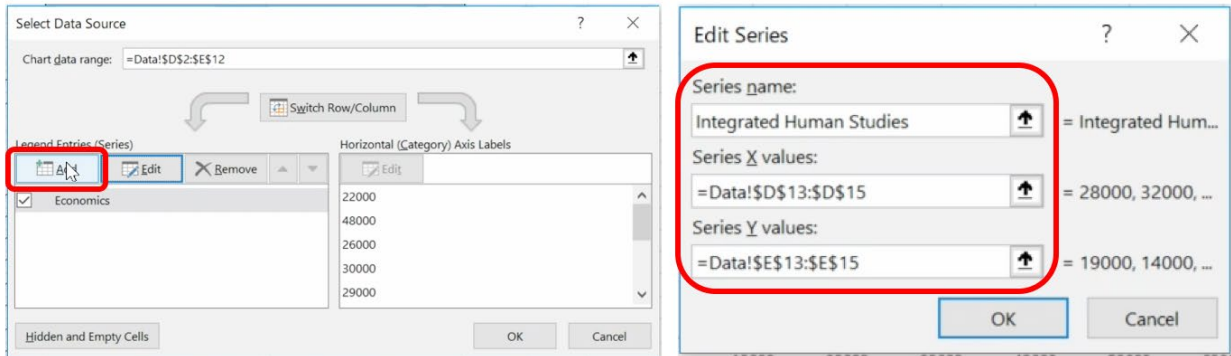
- Sort the data by faculty.
- For the records with 'Economics' in the faculty field, select the monthly housing expenses and monthly food expenses, and draw a scatter chart.



- Choose a data point in the chart, right click with the mouse, and choose 'select data' in the menu. Edit 'series 1' and change its name.

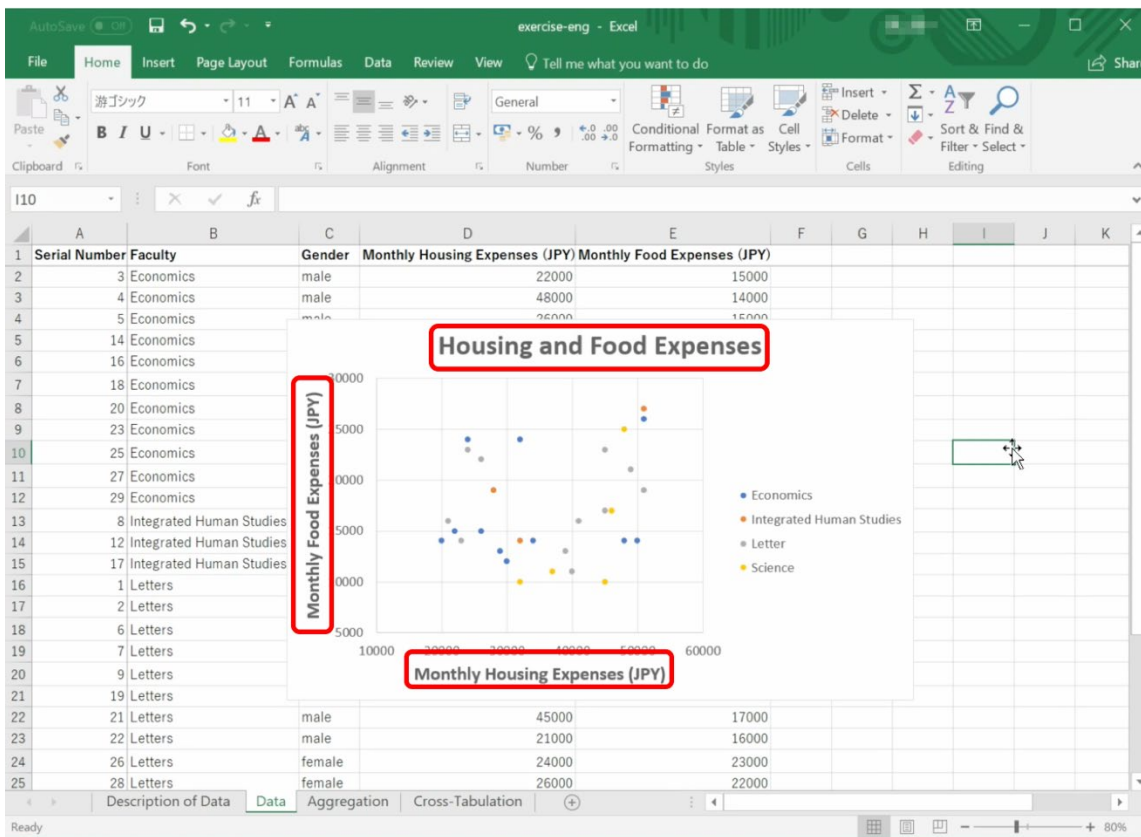


4. Choose 'add series' and select the data for the faculty of 'Integrated Human Studies'



5. Similarly set up data for the 'Letters' and 'Science' faculties.

6. Choose Layout, and set title, labels for axis, and guidelines.



9.6 Plotting Column and Line Charts with Excel

Making column charts or line charts with Excel is somewhat easier than creating a scatter chart. The following shows a Line chart of monthly housing expenses, sorted from smallest to largest.

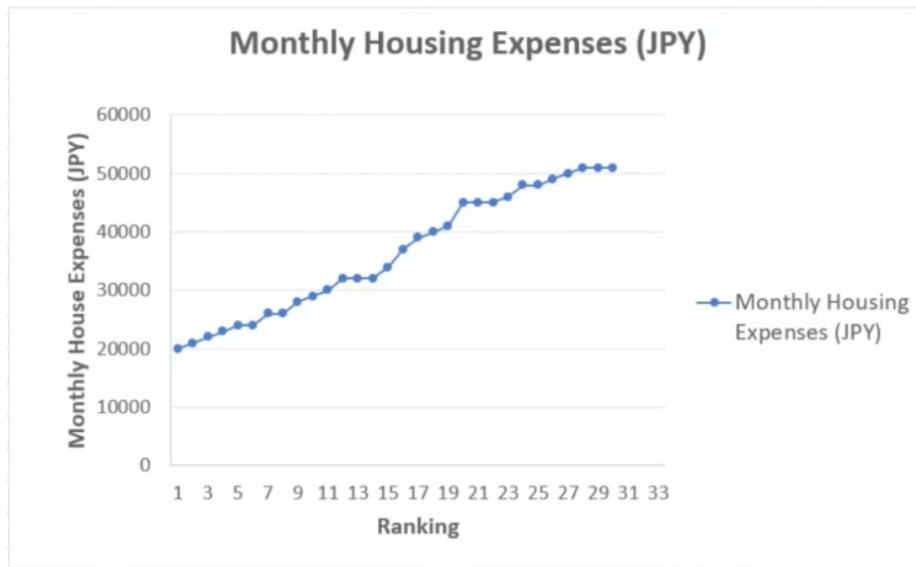


Figure 70 Example of a Line Chart

The next chart, a column chart, displays the result of cross tabulation using a pivot table. To draw it, select data in the pivot table, choose ‘INSERT’ menu, and then ‘Column’ chart followed by ‘Clustered Column’. We obtain the following chart.

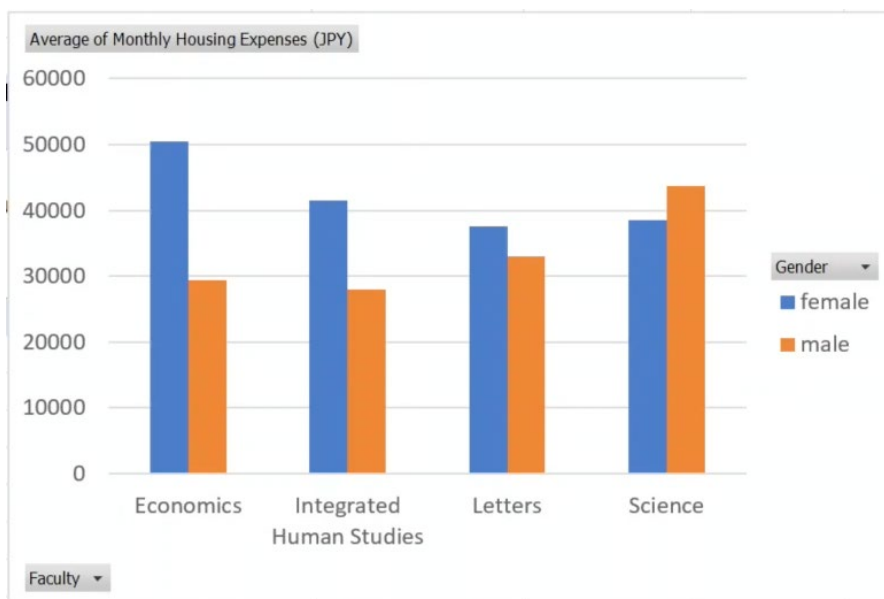


Figure 71 Example of a Column Chart

9.7 Plotting Histograms

Let's make a histogram of the distribution of monthly housing expenses.

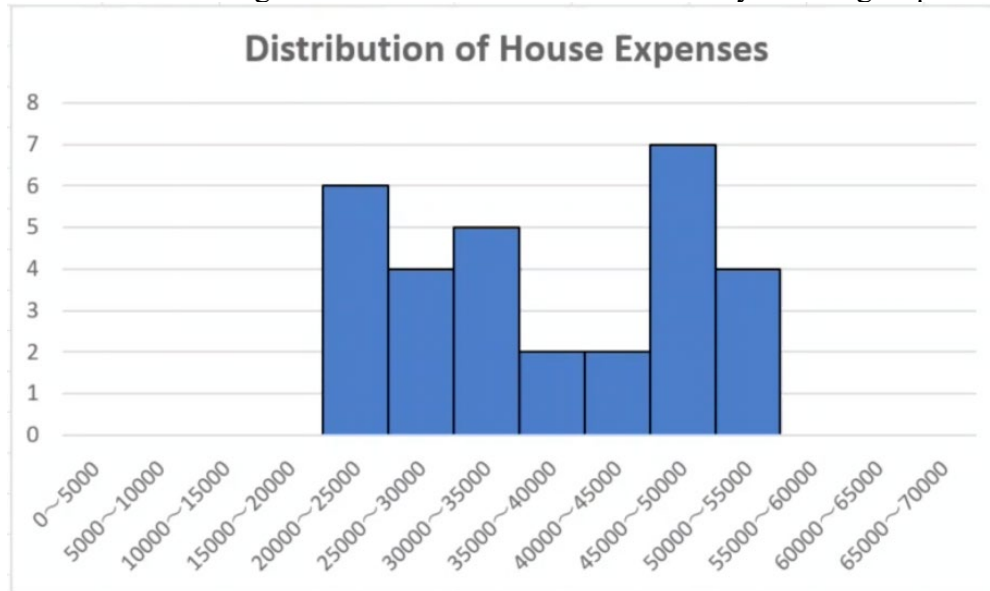


Figure 72 Histogram

9.7.1 What is a Histogram?

A histogram is a column chart with the class in the horizontal direction, and data frequency for each class on the vertical axis. The interval defining a class is called a 'bin.' If we take bins with smaller intervals, we are able to see details of the data but the frequency of the records in each bin is smaller, making it difficult to capture the whole distribution structure. On the other hand, with larger bins, we won't see details of the data.

9.7.2 Making Data for Plotting

First, we count the records in each bin by referring to the monthly and housing expenses.

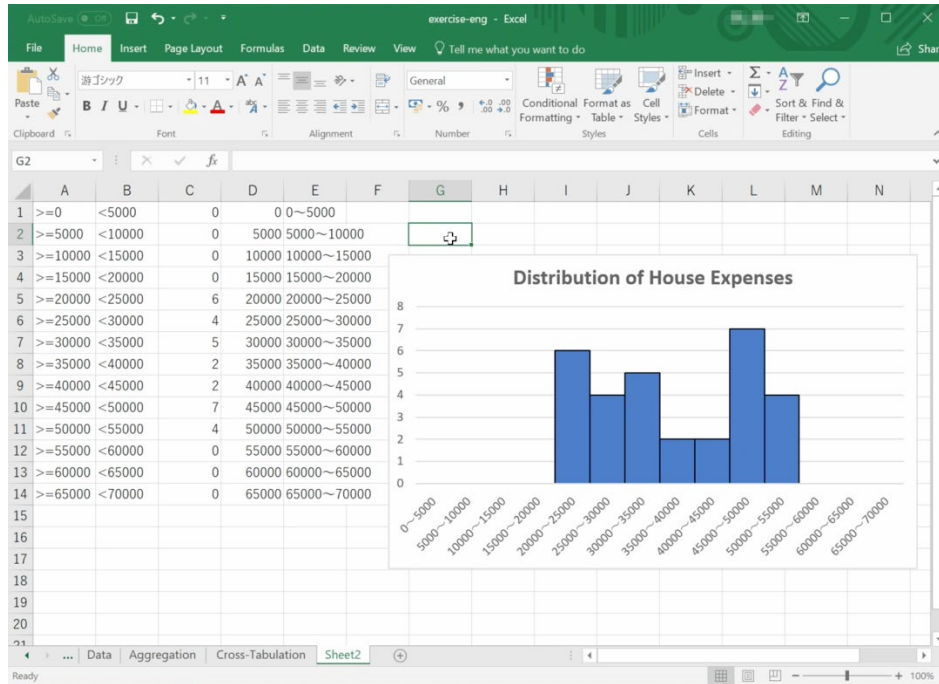


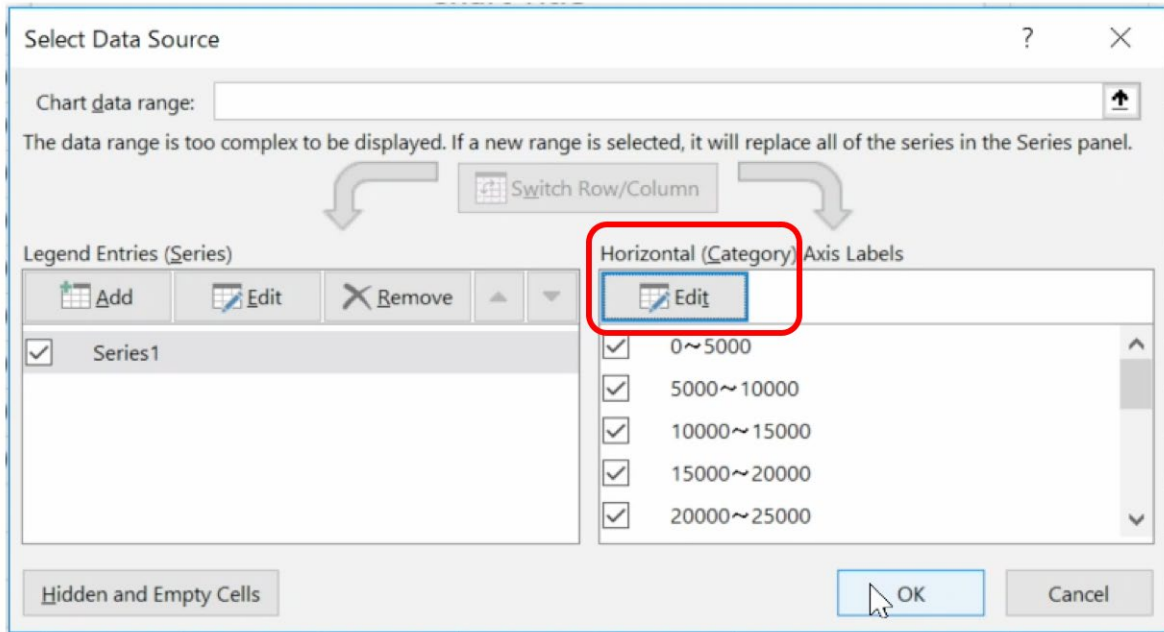
Figure 73

The above example uses a new sheet (Sheet2) to make data for a histogram.

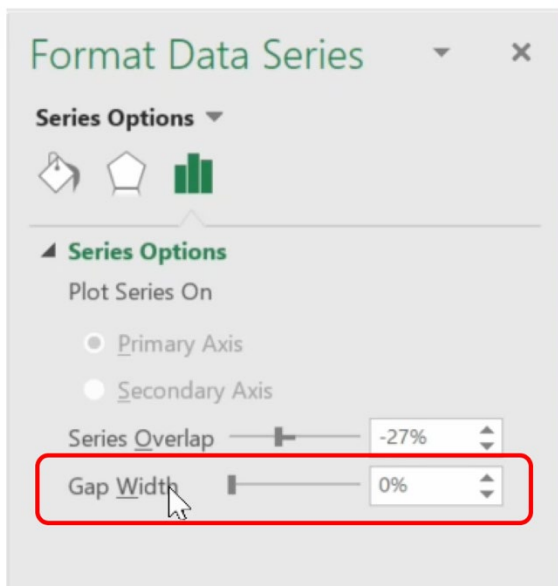
- In column A, enter a formula that defines the lower limit of a bin (“>=0” for the A1 cell);
- In column B, enter a formula for the upper limit (“<5000” for B1),
- In a cell from column C, for example C1, enter the following formula
`=COUNTIFS(Data!D2:D31,Sheet2!A1,Data!D2:D31,Sheet2!B1)`
 —this counts records that meet the given conditions;
- In the D column, enter just the values for a lower limit;
- In column E, enter a formula for the label in a cell e.g. E1
`= D1&"~"&(D1+5000)`

9.7.3 Plot Chart

1. Select the data in column C, and plot it as a column chart.
2. Select the data series, right click, choose ‘Select Data’, and then ‘Horizontal (Category) Axis Label’; finally set the data in the E column to appropriate label values.



3. A histogram is drawn with no gap between columns. To do this, select the data series, right click, and choose 'Format Data Series', setting 'No Gap' as the 'Gap Width'. Set an appropriate 'Border Color' too.



Exercise 31. Make a histogram which shows distribution of the monthly housing expenses.

10. Data Processing with a Spreadsheet (4)

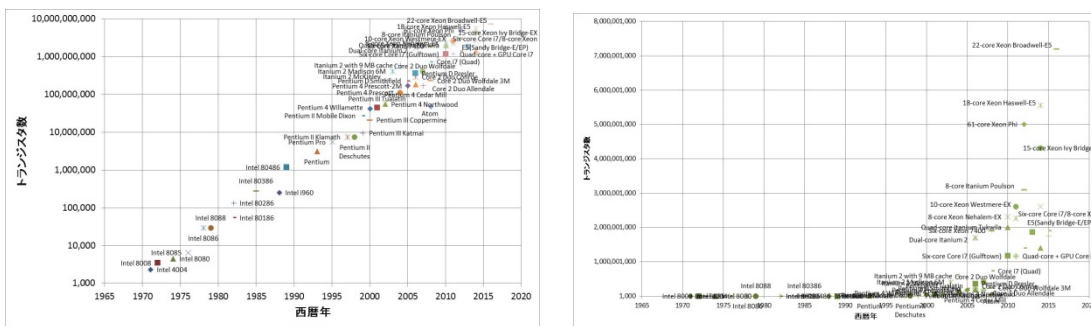
10.1 Study Aims

- To understand the effect of charts using logarithmic scales.
- To know how to draw charts with logarithmic scales with Excel.
- To learn how to show physical quantities divided by unit as axis labels.

10.2 What is a Chart with Logarithmic Scales

10.2.1 Chart for Data that Covers a Wide Range

The left panel of the figure below is the one that has been shown as Figure 3 in Chapter 2. What can you find from this chart? Different from the ordinary plot, one division of scale for the vertical axis means ten times of the value. For comparison, data is plotted in an ordinary way (linear scale) in the right panel.



(a) Using logarithmic scale

(b) Using linear scale

Figure 74 Charts with logarithmic and linear scales

From the above data and charts, we can know that:

- The data in the vertical axis covers the values whose numbers of digits vary in a wide range.
- The data in the vertical axis significantly varies with the change of the year.

In the chart using linear scale (b), most of the plotted data stays near the horizontal axis, which makes it difficult to interpret the data.

Contrary to this, in the left panel,

- Data that covers a wide range is distributed evenly in the graph area, and
- The data is plotted on a line.

If plots are arrayed on a line, people can easily understand the data. It means that we can discuss characteristics of data by devising ways of plotting data.

The chart like (a), in which one division of scale means a constant multiplication of the value (here, 10 times), is called a chart with logarithmic scale.

10.2.2 Linear Scale and Logarithmic Scale

In ordinary plot, value of a plot and its position on graph has a linear relation, i.e., a constant increase in value corresponds to a constant increase of the plot position. That is, for value x , its position p is expressed by a linear function of x , say $p = ax + b$. Such a scale of chart is called a linear scale.

A logarithmic scale is a scale that a constant multiplication of value corresponds to a constant increase in the plot position. It is calculated by obtaining the logarithmic function of the value.

Logarithm is a value of y for x with a constant a that fulfills the following equation:

$$x = a^y \quad (7)$$

It is denoted by

$$y = \log_a x \quad (8)$$

The constant a is called the ‘base’ of logarithm.

Logarithm using 10 as the base a is called ‘common logarithm’. In this case, common logarithms of 1, 10, 100, 1000 are 0, 1, 2, 3, respectively, as shown below.

$1 = 10^0$	$0 = \log_{10} 1$
$10 = 10^1$	$1 = \log_{10} 10$
$100 = 10^2$	$2 = \log_{10} 100$
$1000 = 10^3$	$3 = \log_{10} 1000$

‘Logarithm’ may seem difficult, but it can be understood as ‘number of digits of the data -1’ and can be extended rationally for intermediate values.

Using the logarithmic function, for a value x , we can obtain its corresponding position p by a linear function of $\log_{10} x$, say $p = a \log_{10} x + b$.

The domain of the logarithmic function $\log_{10} x$ is positive numbers, and x cannot be 0 or negative. Hence, 0 does not appear in a logarithmic scale.

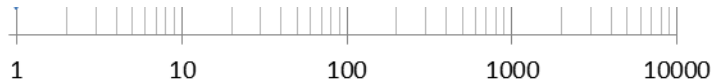


Figure 75 Logarithmic scale (0 does not appear)

10.2.3 Semi-Log Chart

A chart that uses a logarithmic scale for one axis like the previous example is called a semi-log chart. Let us consider the value y that changes according to an exponential function of variable x .

$$y = c a^x \tag{9}$$

By applying the logarithmic function to the both sides of the equation,¹ we obtain

$$\log y = \log c + x \log a \tag{10}$$

Thus, $\log y$ becomes a linear function of x . The data is represented by a straight line with a semi-log chart. The slope of the line is given by the logarithm of the index a .

10.2.4 Log-Log Chart

A chart that uses logarithmic scales for both axes is called a log-log chart.

Let us consider the value y that changes according to a power function of variable x .

$$y = c x^a \tag{11}$$

By applying the logarithmic function to the both sides of the equation, we obtain

$$\log y = \log c + a \log x \tag{12}$$

Thus, $\log y$ is proportional to $\log x$. The data is represented by a straight line with a log-log chart. The slope of the line is given by the index a .

10.3 Create a Logarithmic Scale Chart with Excel

10.3.1 Create a Semi-Log Chart

We use the example data as shown in Figure 75. In column A, it has a series from 0 to 20. For each cell in the third row or lower rows in column B, apply the formula that multiplies 1.5 to the value of its upper cell.

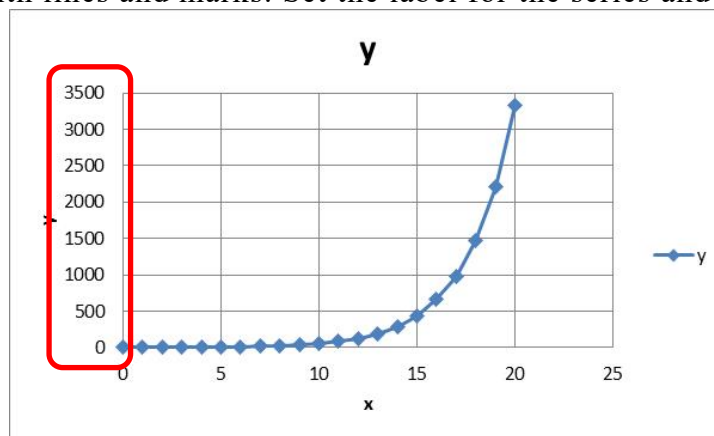
¹ In the following, base of logarithm is omitted.

	A	B	C
1	x	y	
2	0	1	
3	1	1.5	
4	2	2.25	
5	3	3.375	
6	4	5.0625	
7	5	7.59375	
8	6	11.39063	
9	7	17.08594	
10	8	25.62891	
11	9	38.44336	
12	10	57.66504	
13	11	86.49756	
14	12	129.7463	
15	13	194.6195	
16	14	291.9293	
17	15	437.8939	
18	16	656.8408	
19	17	985.2613	
20	18	1477.892	
21	19	2216.838	
22	20	3325.257	
23			

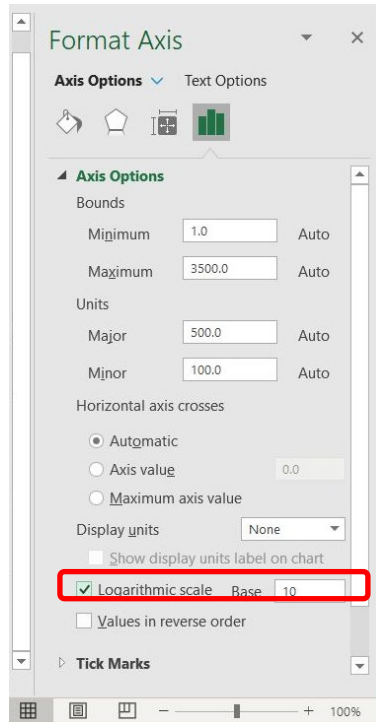
	A	B
1	x	y
2	0	1
3	1	=B2*1.5
4	2	=B3*1.5
5	3	=B4*1.5
6	4	=B5*1.5
7	5	=B6*1.5
8	6	=B7*1.5
9	7	=B8*1.5
10	8	=B9*1.5
11	9	=B10*1.5
12	10	=B11*1.5
13	11	=B12*1.5
14	12	=B13*1.5
15	13	=B14*1.5
16	14	=B15*1.5
17	15	=B16*1.5
18	16	=B17*1.5
19	17	=B18*1.5
20	18	=B19*1.5
21	19	=B20*1.5
22	20	=B21*1.5
23		

Figure 76 Set data growing exponentially.
 (The left sheet shows values, and the right one, the formula)

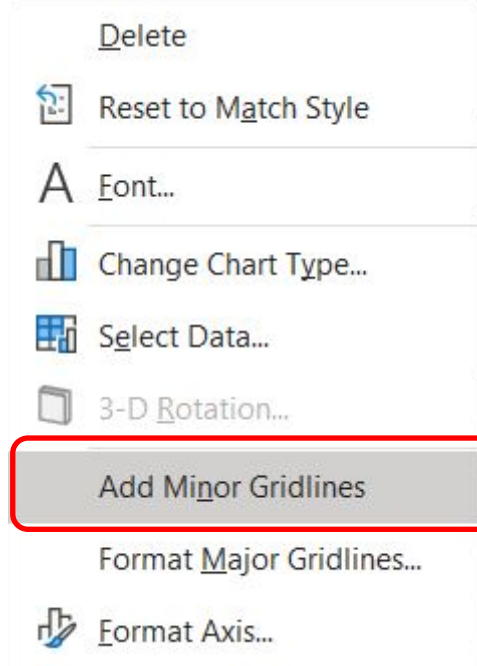
Next, draw a chart using A2:A21 for the horizontal axis and B2:B21 for the vertical axis, with scatter chart with lines and marks. Set the label for the series and axes if necessary.

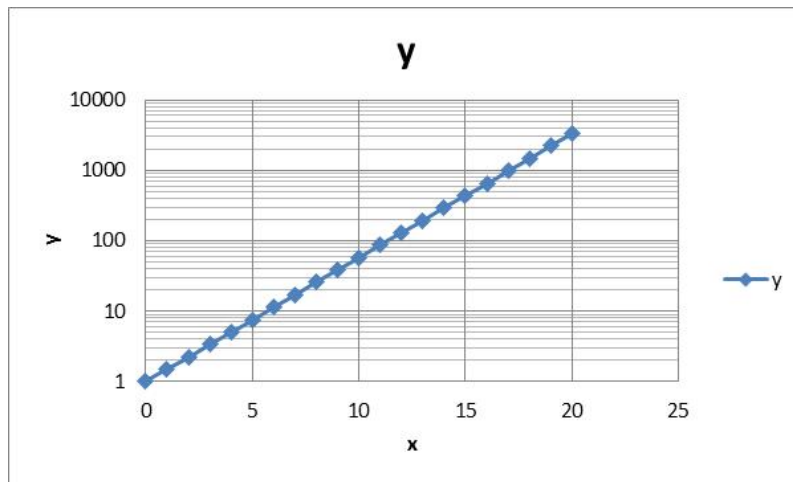


Select the vertical axis of this graph, click right, and select 'Format Axis'. Then mark the option "Logarithmic Scale".



Select the vertical axis again, right click, and select "Add Minor Guidelines".





10.3.2 Create a Log-Log Chart

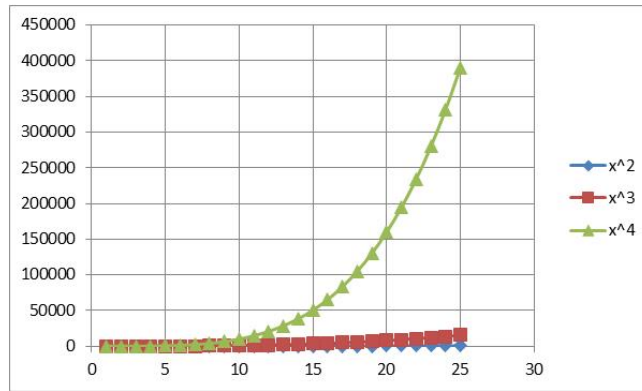
Let us now create a log-log chart. To confirm the effectiveness of the chart, create power functions of data x, i.e., x^2, x^3, x^4 .

	A	B	C	D
1	x	x ²	x ³	x ⁴
2	1	1	1	1
3	2	4	8	16
4	3	9	27	81
5	4	16	64	256
6	5	25	125	625
7	6	36	216	1296
8	7	49	343	2401
9	8	64	512	4096
10	9	81	729	6561
11	10	100	1000	10000
12	11	121	1331	14641
13	12	144	1728	20736
14	13	169	2197	28561
15	14	196	2744	38416
16	15	225	3375	50625
17	16	256	4096	65536
18	17	289	4913	83521
19	18	324	5832	104976
20	19	361	6859	130321
21	20	400	8000	160000
22	21	441	9261	194481
23	22	484	10648	234256
24	23	529	12167	279841
25	24	576	13824	331776
26	25	625	15625	390625

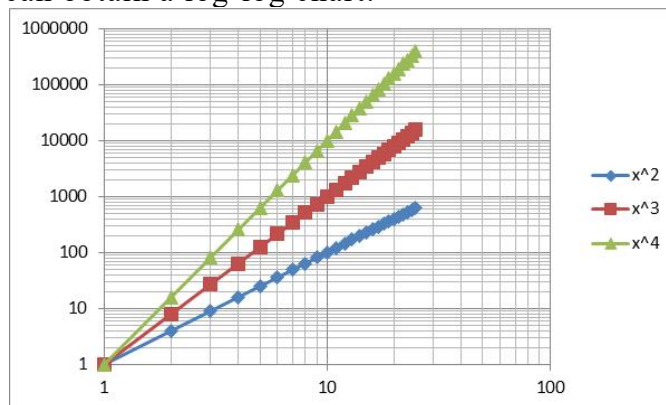
	A	B	C	D
1	x	x ²	x ³	x ⁴
2	1	=A2^2	=A2^3	=A2^4
3	2	=A3^2	=A3^3	=A3^4
4	3	=A4^2	=A4^3	=A4^4
5	4	=A5^2	=A5^3	=A5^4
6	5	=A6^2	=A6^3	=A6^4
7	6	=A7^2	=A7^3	=A7^4
8	7	=A8^2	=A8^3	=A8^4
9	8	=A9^2	=A9^3	=A9^4
10	9	=A10^2	=A10^3	=A10^4
11	10	=A11^2	=A11^3	=A11^4
12	11	=A12^2	=A12^3	=A12^4
13	12	=A13^2	=A13^3	=A13^4
14	13	=A14^2	=A14^3	=A14^4
15	14	=A15^2	=A15^3	=A15^4
16	15	=A16^2	=A16^3	=A16^4
17	16	=A17^2	=A17^3	=A17^4
18	17	=A18^2	=A18^3	=A18^4
19	18	=A19^2	=A19^3	=A19^4
20	19	=A20^2	=A20^3	=A20^4
21	20	=A21^2	=A21^3	=A21^4
22	21	=A22^2	=A22^3	=A22^4
23	22	=A23^2	=A23^3	=A23^4
24	23	=A24^2	=A24^3	=A24^4
25	24	=A25^2	=A25^3	=A25^4
26	25	=A26^2	=A26^3	=A26^4

Figure 77 Data growing as power function.
(The left sheet shows values, and the right, formula)

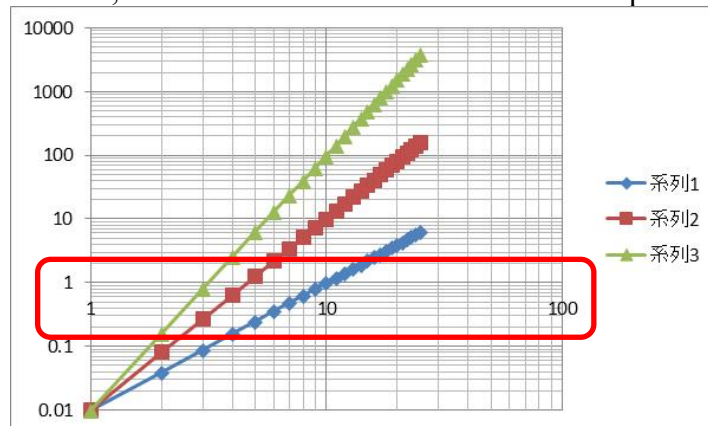
Create a scatter chart of multiple serieses as follows.



Check "Logarithmic scale", and "Add minor guidelines" for both the horizontal axis and the vertical axis, we can obtain a log-log chart.

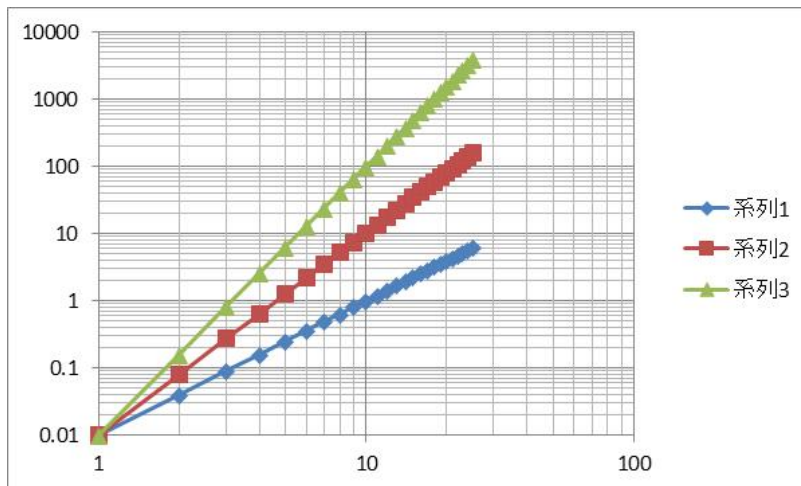
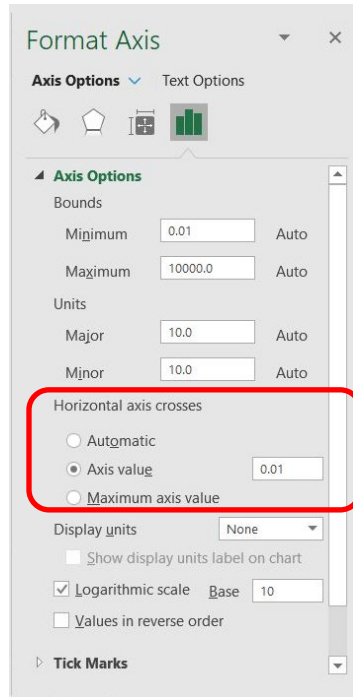


If we plot values less than 1, the horizontal axis is set inside the plot area.



To move the axis to the below, select "VerticalAxis", and set "horizontal axis cross"¹.

¹ To find this operation is difficult because adjustment of horizontal axis is done by option in vertical axis.



Exercise 32. Find examples of charts using logarithmic scale around you.

Exercise 33. Find an example of the data that changes according to exponential or power functions, and plot the data with adequate charts using logarithmic scales.

10.4 Description of the Unit in Chart

It is necessary to show the unit of the values in scientific documents. We sometimes see the following expression as the label of an axis (for example Fig. 9.3 in [1]).

$$V/10^3\text{mh}^{-1} \tag{13}$$

Here, variable V for velocity is divided by a unit of 10^3mh^{-1} . This formula obtains

dimensionless numbers, shown as values in the axis.

That is,

- Velocity V is a physical quantity having dimension of (length L) / (time T)
- The unit of 10^3mh^{-1} also has the same dimension of L/T and is used as a measure of the quantity:

$$\frac{V}{10^3\text{mh}^{-1}}$$

Thus, a dimensionless number, which expresses the multiple of the unit, is obtained and plotted in the chart.

Reference

- [9] Koreo Kinoshita: Chuo-Koron-Sha (1981) in Japanese (木下是雄：理科系の作文技術，中央公論社 (1981))

11. Writing Structured Documents

11.1 Study Aims

- Learn how academic documents such as papers are structured.
- Learn how to manage paragraphs, chapters and sections in Word.
- Learn to make references and cite them in Word.
- Learn to review documents in Word.

11.2 Structure of Papers and Reports

Academic documents such as papers and reports have a particular structure that allows you to express content logically.

- **Title, Author(s), and Date**
- **Abstract**
- **Chapters, Sections and Headings:** Academic documents use structures such as chapters and sections. Headings often have numbers. These numbers are used to refer to chapters and sections in other parts of documents. Even if the author doesn't need such cross-references, others may want to use them for citation in their writings or reviews. The format of the headings such as fonts, sizes and alignment should be consistent throughout the entire document. Apart from the main body of the text, acknowledgements and appendices are often included in the document;
- **Paragraphs:** Academic documents are written using **paragraphs**. One paragraph consists of several sentences and as a whole, covers a particular topic. At the beginning of the paragraph, and **indent** or wider line spacing is used to delineate the paragraph clearly;
- **Listings** are used to express items arrayed in parallel or in some order. So as to make the order explicit, or to make cross references easy, numbering is often used in listings;
- **Notes**, such as footnotes or end notes are used to add some information to the main body when inserting them into the main body would make the logic of the main body unclear;

- **References and Their Citations:** In papers and reports information sources should be made clear as the evidence under discussion. Usually a list of references is attached to the end of the document, and the main body of the text refers to these references. The references listed should include sufficient bibliographical information that readers can identify them without ambiguity. Some standards for writing references are proposed, and academic journals ask the authors to follow their guidelines;
- **Inserted Figures and Tables, and Cross-referencing them:** In academic documents, a number and caption are usually attached to an inserted figure, and a number and title are attached to an inserted table. A figure caption is often placed below the figure; in contrast, the title of a table is placed above the table. In the main body, these figures and tables are referred to using the numbers;
- **Mathematical Formulas:** Mathematical formulas are inserted inline, or as an independent line of equations.

Exercise 34. Examine the Structure of a Document

Examine the structure and format of an academic document recommended by your instructor.

11.3 What People Should Do, and What You Should Get Computers to Do

We'll often write an e-mail message to inform people of the date of an event or a meeting. In such messages, we sometimes encounter mistakes where we write the wrong day of the week, making it inconsistent with the corresponding date. Later we receive correction messages. Why do we make such errors, and how can we avoid such errors? The error occurs because both the date and the day of week are typed manually by an individual. Once we have fixed a date, the day of the week is also fixed. Hence it would be a good way of doing things to ask the person to input just the date and to ask the computer to attach the day of week automatically.

In writing an academic paper, we need to number the headings sequentially, and refer to chapters by number in other parts of the text. To put in a number is rather a simple task. However, during authoring, we may add a chapter or remove it. Then we have to renew the numbers and their cross-references. If the paper is short, it may be acceptable to do this manually. But in writing longer papers, this task is labor-intensive and may cause errors. **Asking a computer to number and resolve cross-references** is a good idea.

In writing papers, we use headings. To highlight them, we often write headings in larger sizes or using different fonts, as well as inserting numbers. In doing so, **1) the author specifies particular parts of the document as headings, and 2) separately allocates styles for headings.** You can then ask the computer to adjust the format of the headings according to these styles consistently throughout the document.

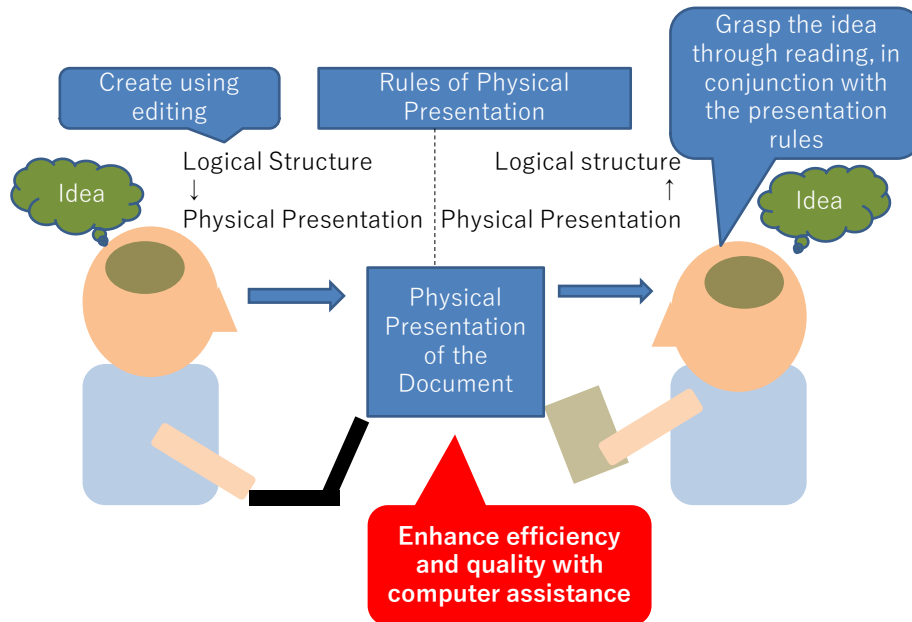


Figure 78 Making Documents from an Idea, and Obtaining Ideas from Documents.

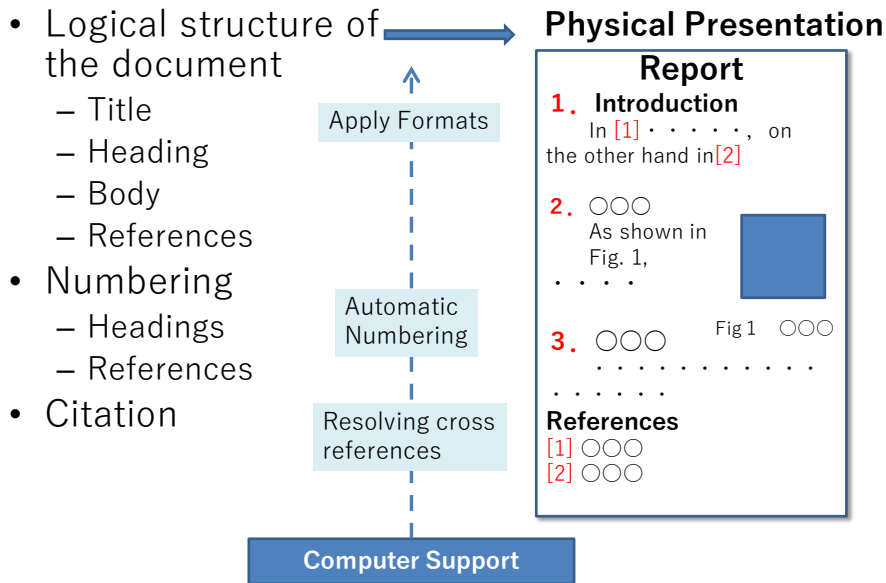


Figure 79 Conversion from a Logical Structure to Physical Expression of a Document.

11.4 Styles and Templates

Word has a mechanism for effectively and efficiently formatting a document’s title, headings, main body, references etc. These are called ‘Styles’. A collection of styles for a particular type of document is called a ‘Template.’ In creating a new document, you may choose ‘blank document.’ This is actually a template called ‘Blank Document’ and means that you create a new document using this template.

11.4.1 The Need for Styles, Taking Readability into Account

Documents for academic or business purposes should be written considering **readability**.

In Word, we can use various fonts, but for academic writing we recommend:

- Use 明朝体 for Japanese and Times New Roman for English, for normal text;
- Use ゴシック体 for Japanese and Segoe UI for English headings and highlighting.

Using English fonts for English instead of Japanese Fonts improves readability. To mix Japanese and English, use Japanese fonts and English fonts similar to the Japanese ones. The next table shows such combinations. In Japanese Fonts, “游明朝” and “游ゴシック” are not installed in Windows7. Recommendations for English fonts are listed after those in [10].

Table 9 Recommended Fonts for Papers

Japanese Type	Japanese Font	Japanese Font	English Font
明朝体	游明朝	MS 明朝	Times New Roman
ゴシック体	游ゴシック	MS ゴシック	Segoe UI

Regarding the font size, 10.5 points ~ 12 points are often used. Select 0.5 ~ 1 times the character width for the space between lines[8].

11.4.2 Specifying Styles in “Blank Document” Template

If you create a document using the ‘Blank document’ template, styles defined in the template are available. Styles that are often used are shown in the ‘Style Gallery’ in the Styles part in the ribbon. To see all the available styles, click the arrow in the bottom-right corner of the Style section.

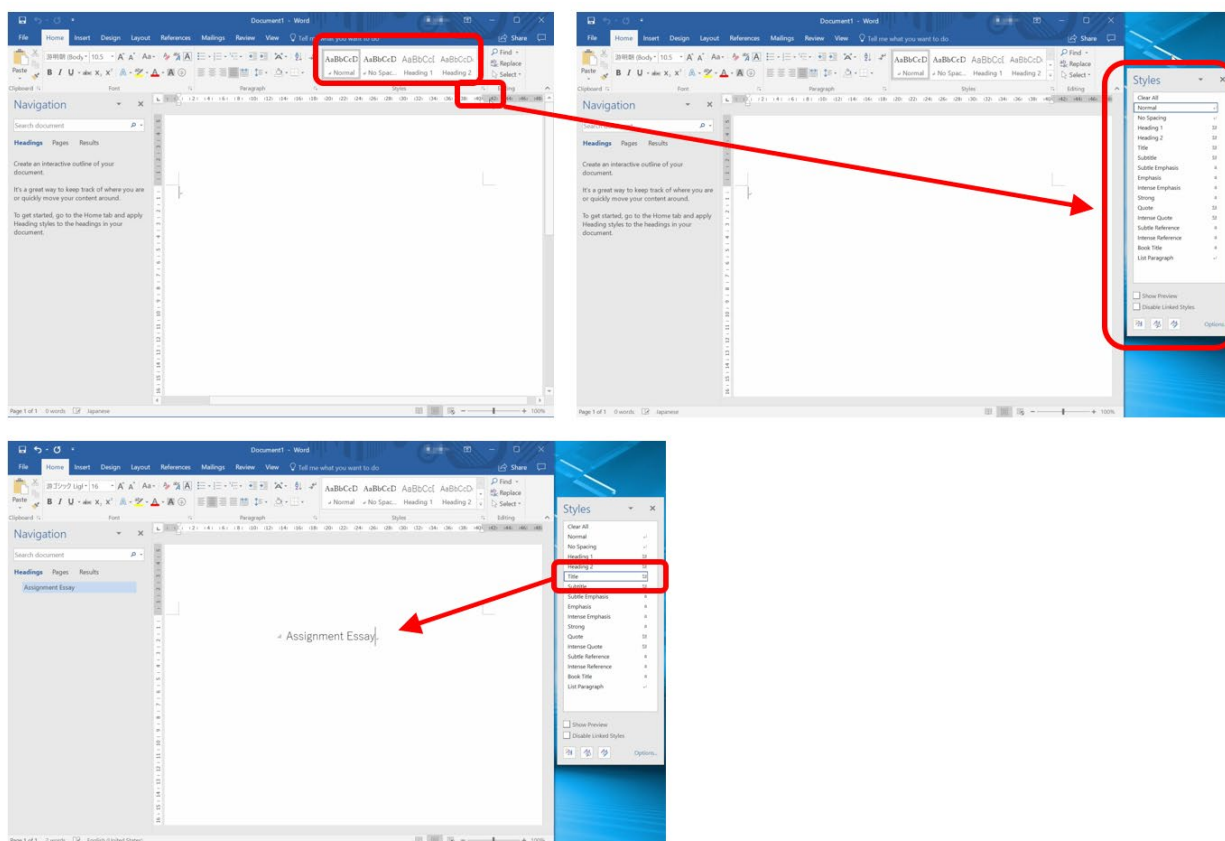


Figure 80 Applying a Style

11.4.3 Template for Papers

The styles defined in the template ‘Blank Document’, will not meet the requirements for a paper written by university students. To support writing reports and papers, we have therefore prepared another template named:

paper-without-coversheet20160402.dotx

Refer to the document ‘how-to-use-template-paper-without-coversheet.pdf’ to learn how to use this template.

11.5 Typesetting Paragraphs

In Word, you must type a single paragraph without pressing enter (newline) as you move from line to line. Select the ‘normal’ style, and adjust the indentation of the top of the paragraph using the ruler. Some typists may insert space(s) to obtain an indent, but this is not desirable because it causes errors when we add a single sentence at the top of the paragraph, or we reorganize the paragraph structure. The space inserted for purposes of indentation may remain in between, and it may be difficult to locate.

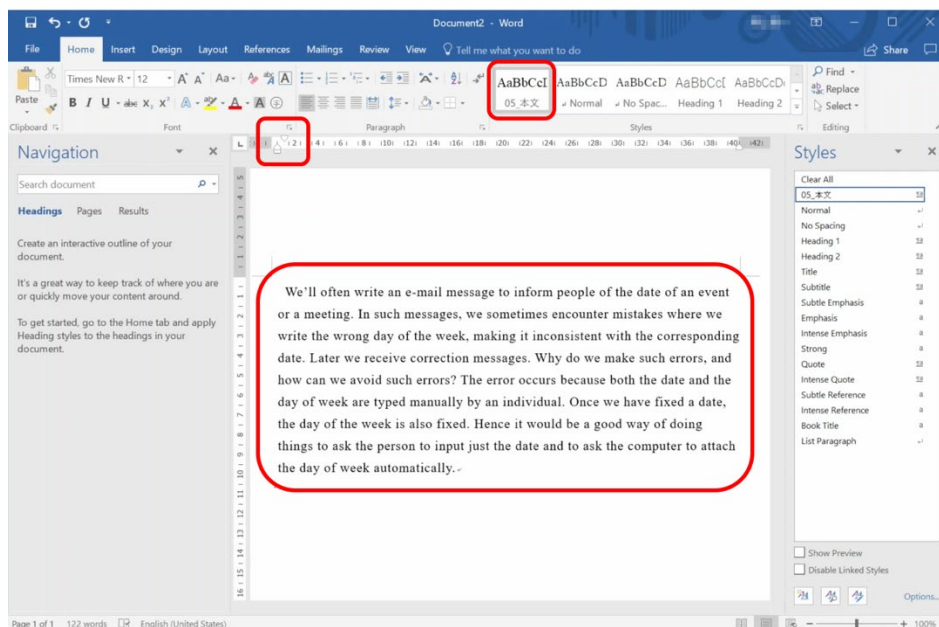


Figure 81 Indenting a Paragraph

11.6 Typesetting Headings

Headings of chapters or sections are formatted as follows:

1. Write the heading text;
2. Choose a heading style e.g., Heading1 or Heading2 according to the level of the heading;
3. In the paragraph part of the ribbon, select an outline button with the appropriate style. **Among the buttons, choose that button which contains the word “Heading”.** The others are styles used for listing.

In the ‘Blank Document’ template of Word there is no setting that uses numbering like 1. or 2.3—the styles often used for papers. We’ll therefore introduce our own style. Within the menu that appears when the outline button is pressed, choose ‘Define New List Style’ and set up the style you want.

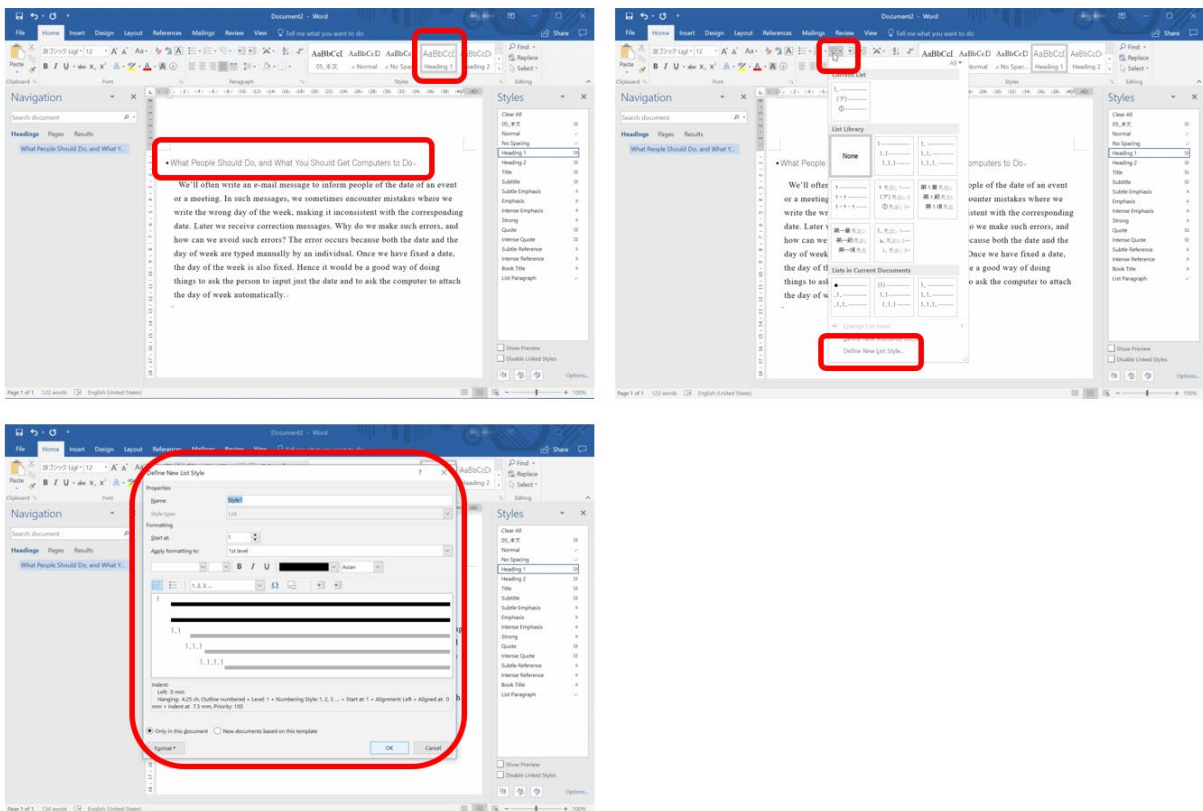


Figure 82 Style Adjustment for Headings

Usually the heading for References has no number. Here, select ‘None’ in the outline menu.

Exercise 35. Set paragraphs and headings

Set paragraphs and headings in the example documents, in accordance with your teacher’s instructions.

11.7 Using Outlines

11.7.1 Outlining

To write a document that refers to various references using a logically clear structure, as is done in academic papers, is not an easy task. Based on the elements, thinking about the outline of the document, and then writing detailed paragraphs is a good way to write such documents.

11.7.2 Using Outline View

For such tasks, Word has a VIEW named Outline. Select the 'VIEW' menu, and then choose 'Outline' in the ribbon.

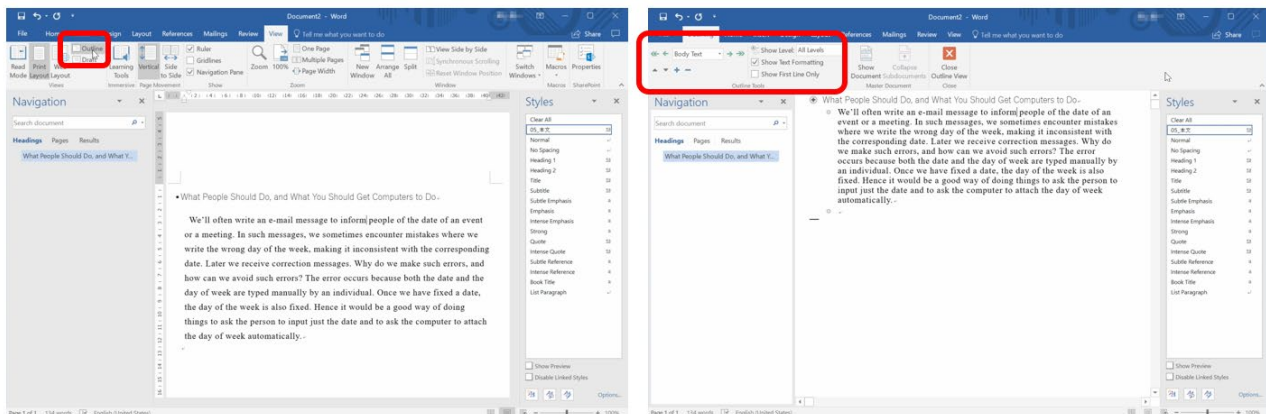


Figure 83 Outline View

- Using the '+' or '-' button, we can collapse or reveal chapters and sections.
- By clicking on the ▾ or ▴ buttons, we can move whole chapters or sections up or down.

11.8 References and Citations

11.8.1 How to Write References

Here we simply create a reference list as a numbered listing. Put 'References' as heading1, and suppress numbering as shown above.

References may take on various forms such as those used in books, papers in academic journals, and pages on some web sites. All the materials used for your document should be

listed. Information about the references (bibliographic information) should be provided to allow readers to access the material without ambiguity. ‘Standards for Information of Science and Technology’[13] is a good reference for describing bibliographic information.

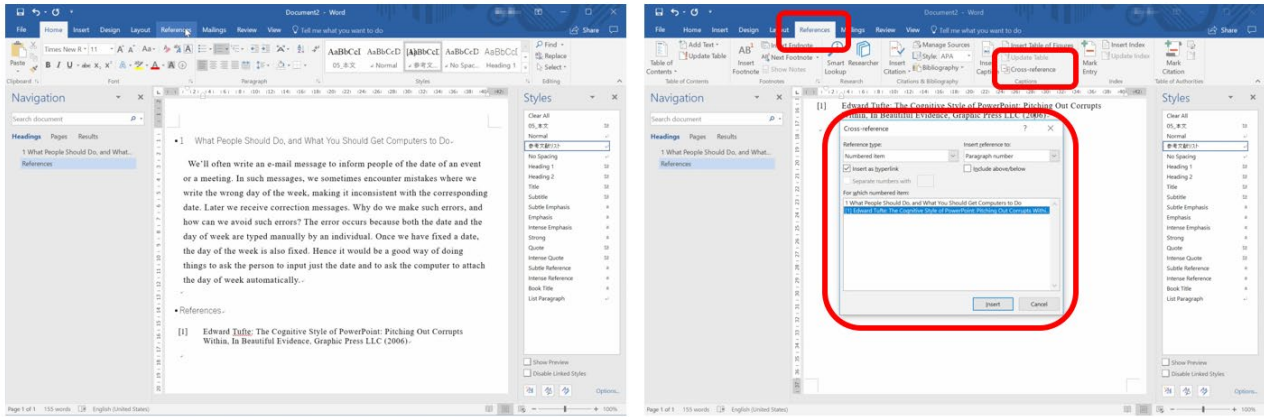


Figure 84 Writing References and Inserting Cross-References

11.8.2 Writing Citations

If you refer to some source material from within the main body, you should insert the number of the material in the reference list as a citation. If you write the references as numbered list, you can insert a reference by selecting the REFERENCES menu, and by choosing the Cross-reference button in the ribbon.

11.8.3 Updating Cross-References

If you add or remove some references in the list, we have to renew the cross-references. This can be done by selecting the section where you wish to renew the cross-reference (for the entire document, choose ‘Select All’), pressing the right button of the mouse, and selecting ‘Update Field’. The cross-references are adjusted to accommodate the new references.

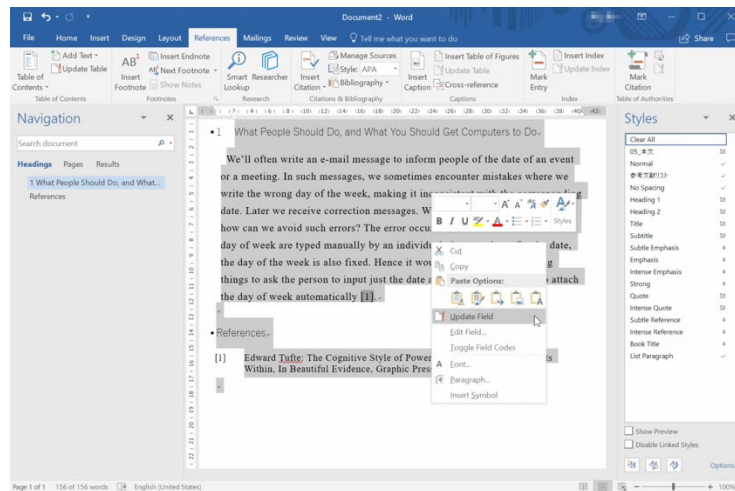


Figure 85 Updating Cross-references with “Update Field”

Exercise 36. Create references and insert cross-references

In the example document used as an exercise, rewrite the references as a numbered list, and replace the citations as cross-references. Confirm the function of updating fields.

11.9 Reviewing Documents

11.9.1 Document Review and Word Functions

Academic documents are created by repeated reviewing and rewriting. During the process, it's desirable to show the rewritten part, especially if reviewing is done in a group, or by an instructor. This approach improves communication between the author and reviewer(s).

In Word, we can record the editing history by choosing ‘Track Changes’ in the ribbon shown by selecting the ‘REVIEW’ menu. There is also a function called ‘Comments’ that lets you insert marginal notes at a specific point in a document.

Exercise 37. Use of Track Changes and Comments

Set “Track Changes” in your practice document. In the document, there is a quote from the book by Tadao Umesao. Set the margins on both sides to clearly show the quote. Add a comment to explain this change.

11.10 Converting Documents to PDF

Documents created by Word can be reviewed only with software that recognizes this format. On a web site, public documents often use the PDF format. Submission of assignment essays and term papers may also require PDF format. PDF format files can be

made from Word documents in the following way:

- Select the 'FILE' menu, choose 'Save As', and then select PDF as the Type.

Notice: In Windows, the file name includes an extension that conveys the file format. If we change the extension from '.doc' or '.docx' that identifies a word file to '.pdf' with explorer, the file icon is changed to that for PDF, but the *content of the file is unchanged*. Such operations are confusing, and it becomes unclear which application should be used to handle the file. Therefore, don't change the extension of the file.

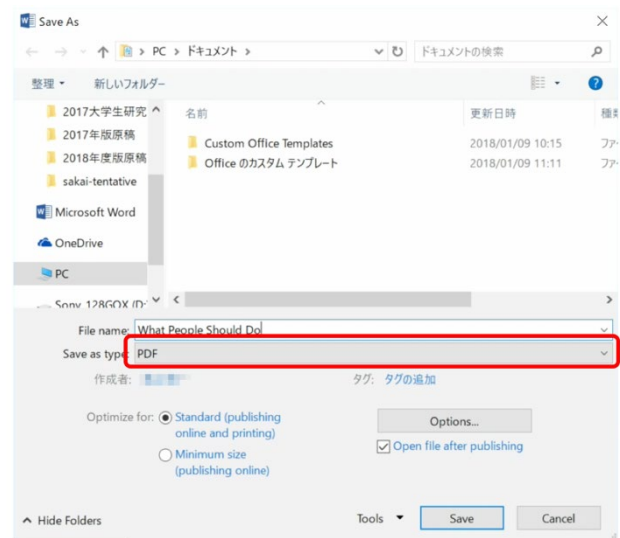


Figure 86 Save a document in PDF

References

The books [11] and [12] explain how to use Word for structured documents such as academic papers. The book [10] explains layout of characters, and highlighting for the purpose of creating reports.

- [10] Yuma Takahashi, Natsu Katayama: Rules for layout to Make Good Documents. Basics of Design for Communication, Revised Edition, Gijyutu-Hyoron-Sha (2016, in Japanese) (高橋 佑磨, 片山なつ: よい資料を作るためのレイアウトのルール 伝わるデザインの基本, 増補改訂版, 技術評論社 (2016))
- [11] Hiroaki Nishiuehara: Making Long Documents with Word, Gijyutu-Hyoron-Sha (2011, in Japanese) (西上原裕明: Wordで作る長文ドキュメント, 技術評論社(2011))
- [12] Yusuke Aizawa: Using Word 2013 for Writing Papers and Reports, CUTT-SYSTEM (2013, in Japanese) (相澤裕介: 論文・レポート作成に使う Word 2013 活用法, カットシステム (2013))
- [13] Japan Science and Technology Agency: Standards for Information of Science and Technology (last access 2016/10/26, in Japanese) (科学技術情報流通技術基準 http://sti.jst.go.jp/sist/menu_purpose/index.html (2016年10月26日アクセス))

12. Inserting Figures and Tables into Documents

12.1 Study Aims

This section teaches the basics of inserting figures and tables into academic documents using Word:

- Know the rules for numbering and adding captions to figures and tables inserted into an academic document, and how to refer to them;
- Learn how to insert figure and table captions in Word documents, and how to cross-reference them;
- Learn how to insert figures and tables into Word documents;
- Learn various ways to insert tables and charts made using Excel, and graphics made in PowerPoint.

12.2 Numbering, Titles and Captions of Tables and Figures

12.2.1 Positioning Titles and Captions

In academic documents, figures and tables are handled in the following manner¹:

- Put numbers and titles or captions into figures and tables.
 - The number and caption for a figure are **placed below the figure**.
 - The number and title of a table are placed **above the table**.

12.2.2 Cross-References in the Body

All the inserted figures and tables should be referred to in the body. A cross reference should be expressed as e.g. “Fig. 1” or “Fig. 2”.

12.2.3 Specifying References

Some figures or tables may have been acquired from other information sources, or were

¹ These are commonly used conventions in the fields of science and engineering. However, you should obey conventions in your field of study, or follow the guidelines for the authors of the academic journals or proceedings to which you intend to submit your paper.

created by plotting published data as charts. For the copied figures and tables, the sources should be shown. Any data source should also be shown, with an added explanation that the chart was plotted from the data provided by the author.

12.3 Numbering Tables and Figures, and Cross-references in Word

12.3.1 Inserting Captions in Word

To insert a caption for a figure or table, select the “REFERENCES” menu, choose “Captions” in the ribbon, and select “Insert Caption.”

12.3.2 Cross-Referencing Captions in Word

To make a cross-reference, select the “REFERENCES” menu, choose “Captions” in the ribbon, and then select “Cross-reference.” Under “Reference type”, select “Figure” or “Table”, and select “Paragraph number” in relation to “Insert reference to.” Then choose the appropriate item from the list.

12.4 Inserting Tables and Figures in Word

To insert figures and tables, select “INSERT” and choose the relevant item in the ribbon.

If you want to make a diagram, choose “Shapes” in the ribbon that appears when you select the “INSERT” menu. The item “Figure” allows insertion of a picture file. For a picture made with PowerPoint or a table or a chart made with Excel, see the next section. If you want the text body to flow around the inserted figure or table, select the corresponding figure, click the right button of your mouse, and use the menu that appears.

12.5 Using Excel and PowerPoint Data in Word Documents

12.5.1 Object Types, Conversion, Copying and Linking

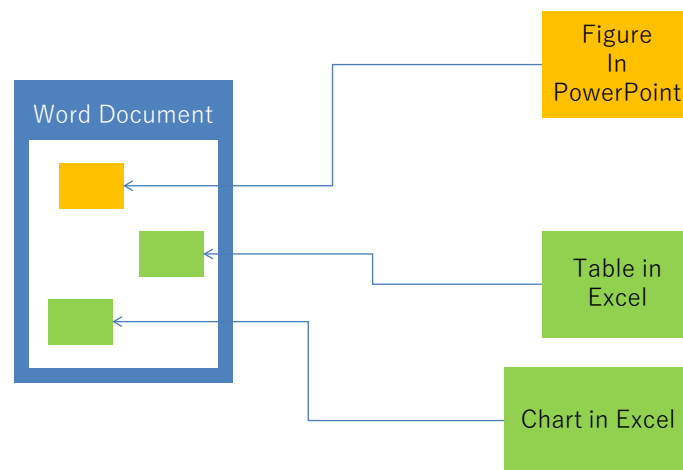


Figure 87 Using Data in PowerPoint and Excel Files

In Windows, data that can be copied or pasted are called “OBJECTS.” Various data types can be used as an object. Examples include objects that are editable with PowerPoint or Excel, objects that can be handled with Word, and images that can be handled in the same way as a photograph.

If you paste a copy of an object into a Word document, you can use it:

- in the same way you would the original object; or
- as an image or some other type of object, by converting it from the original type.

In addition:

- you can either paste a *copy* of the original object; or
- you can paste a link to the original data.

In the former case, the pasted copy can be edited independently from the original object. In the latter case, as the link to the original object is pasted, editing is performed on the original object.

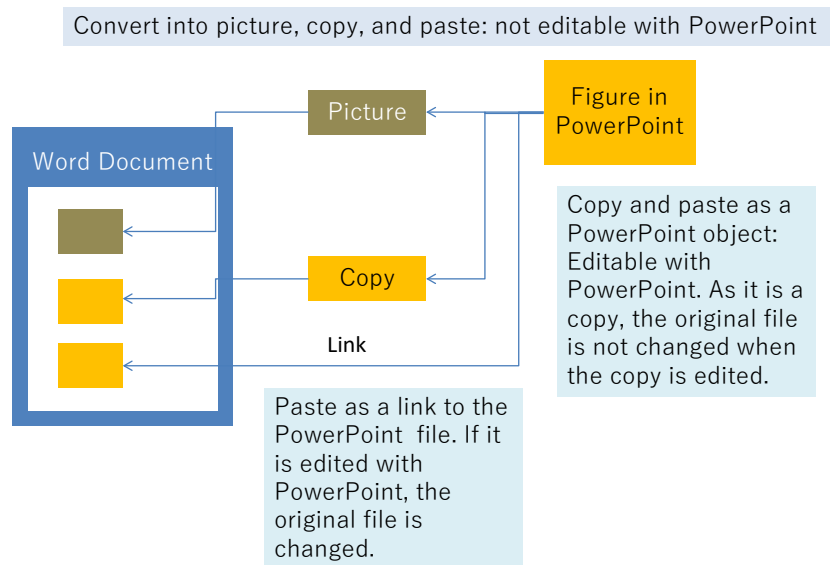


Figure 88 Types of objects to paste, and their pros and cons

12.6 Inserting PowerPoint Pictures

To insert a picture created with PowerPoint, select a standard view in PowerPoint, and in the left column that shows the slides, select and copy the slide you want to insert into the Word document.

Then in the Word document that you're editing:

- If you want to insert the slide as an image, move the cursor to where you want to insert the slide, and paste it there;
- If you want to insert the slide as an object that is editable using PowerPoint, click the ▼ symbol below “Paste” under “Clipboard” in the ribbon, revealed by selecting the “HOME” menu, followed by “Paste Special” and “Microsoft PowerPoint Slide Object”;
- If you choose the “Paste Link” option in the dialog above, you can paste the slide as a link to the original PowerPoint file.

To adjust the margin of the picture, select the pasted object, and right click (click the right mouse button). Then select the “trimming” button in the window that appears.

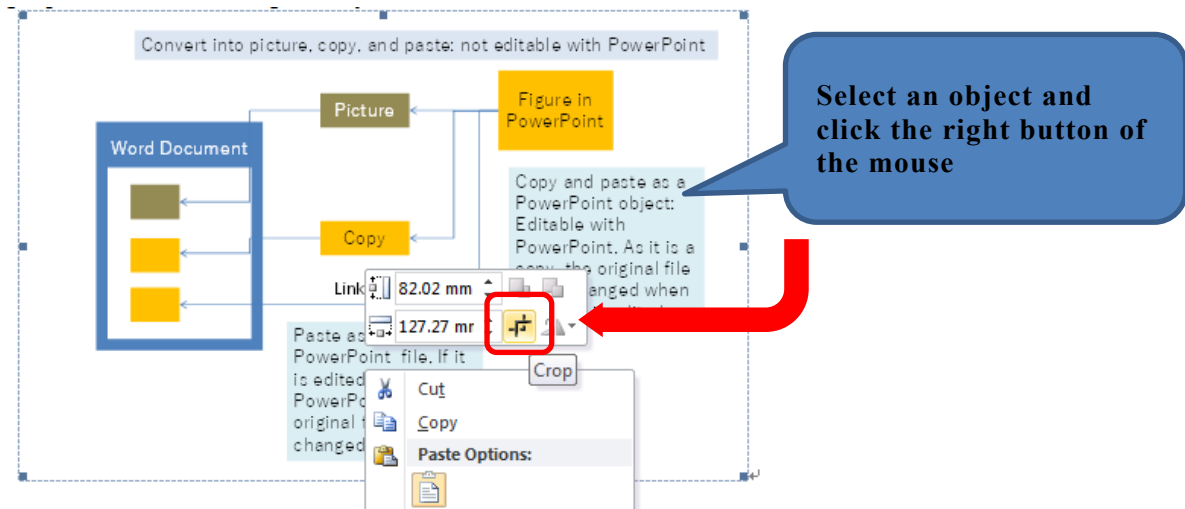


Figure 89 Margin adjustment with trimming

12.7 Inserting Excel Tables and Graphs

As with PowerPoint, you can paste in tables and charts from Excel. To do this:

- Copy the section you want to paste from Excel;
- Paste it into the Word document;
- By selecting the type of datum to paste, you can paste it as an object that is editable with Excel or as a link to the original Excel file.

13. Handling Mathematical Expressions in Documents

13.1 Study Aims

- Learn how to handle mathematical expressions in academic documents;
- Learn font usage in mathematical expressions;
- Insert mathematical expressions in a document, number equations, and refer to them in the document using Word.

13.2 Mathematical Expression as a Presentation Method

At high school, you may have used mathematical expressions in mathematics and science classes. However, you likely used them mostly to make calculations or prove theorems based upon the mathematical expression provided. In writing essays and papers during study at university, you should be aware **that mathematical expressions are very important tools used to express numerical relationships effectively, before providing solutions**. In this sense, mathematical expressions take on a role similar to that of figures and tables.

In writing mathematical expressions in your documents, you should make sure that the variables you use are properly explained. For example, in the following, the meanings of the variables are *not* clear:

The relationship between travel time and distance of an object moving a constant velocity is given by the following equation

$$l = vt$$

As we do here, you should explain the meaning of the variables l, v, t in your text.

The relationship between travel time t and distance l of an object moving at a constant velocity v is given by the following equation

$$l = vt$$

13.3 Variables are Shown in Slanted Text

Look at the equations in your mathematics textbooks. For example, a quadratic function may be represented as follows:

$$f(x) = ax^2 + bx + c$$

Without being told, you may not notice that variables such as “ x ” and “ y ” are shown in a slanted font (or in italics)—examine the “ x ” and “ y ” in the example. This convention shows that such symbols are variables that represent values. In other words, such symbols may actually take on various values. Mathematical expressions use both roman and italic fonts. The following are the commonly used rules:

- Variables that represent values are written in an italic font;
- Functions and constants having definition such as “sin” and “cos” are written in a roman font;
- Units such as “m” and “kg” are also written in a roman font.

13.4 Description of Physical Quantity and Unit¹

Mathematical expressions in mathematics express ‘numbers.’ Mathematical expressions can also express physical ‘length’ and ‘quantity,’ where a concrete value is expressed by combining the ‘number’ and the ‘unit’ like 1.0 m.

Hence, it is easier to understand by treating the physical values as expressions of quantity rather than expressions of number. For example, let S be the area of a rectangular with the height a and the width b . These variables express quantities and have dimensions. Here, the ‘height’ is an example of the quantity with a dimension. The ‘area’ is another example of the quantity with a dimension, which is obtained by multiplying the ‘height’ and the ‘width’, and can be expressed as:

$$S = ab$$

Since the width and the height can be regarded quantities with dimensions, their physical quantities can be expressed as follows:

$$a = 2.0 \text{ m}$$

$$b = 3.0 \text{ m}$$

¹ For detail of this discussion, refer section 6.2 of [14] and [15].

Then, the area is obtained by

$$S = ab = 2.0 \text{ m} \times 3.0 \text{ m} = 6.0 \text{ m}^2$$

Considering that a unit refers to ‘the standard measure of a quantity’, dimensions of the both sides of the above expression coincides. Conversion of units can be easily calculated in this manner. For example, by using the following conversion equation

$$1 \text{ m} = 1000 \text{ mm}$$

and substituting the units in the expression, we obtain:

$$S = 6.0 \text{ m}^2 = 6.0 (1000\text{mm})^2 = 6.0 \times 10^6\text{mm}^2$$

13.5 Typesetting Mathematical Expressions in Word

To write mathematical expressions that contains italics, super- and subscripts in Word, use the “mathematical formula” tool.

- The tool can be invoked using one of the following methods:
 - In “INSERT” tab, choose “mathematical formula”, or
 - Press the “=” key with “Alt” and “Shift”.
- To enter variables in italics, use one of the following methods:
 - Press Ctrl-i (press the “i” key with the “Ctrl” key)

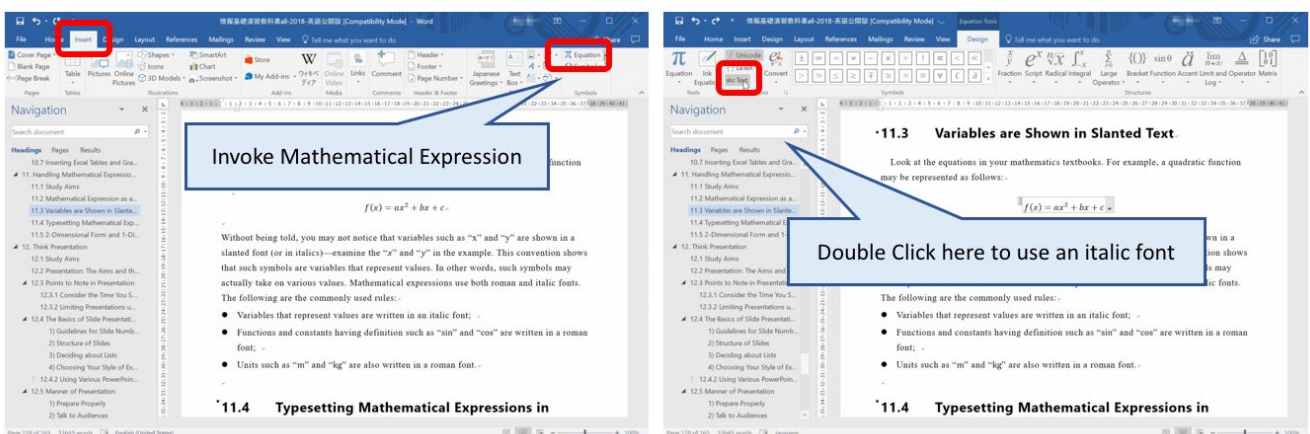


Figure 90 Inserting mathematical expressions

13.6 2-Dimensional Form and 1-Dimensional Form

In mathematical formulae entered in Word, mathematical expressions have two forms. One is the two-dimensional form that directly shows super- and subscripts. The other is a one-dimensional form that represents a mathematical expression as a sequence of codes. Once you enter a mathematical expression in one-dimensional mode, Word converts it to the corresponding two-dimensional mode with its auto-correction function. For example, if you enter the following mathematical formula:

$$y = ax_1^2 + bx_1x_2 + cx_2^3$$

then, “_” and “^” are interpreted as commands to render the following characters in subscript and superscript¹, and we obtain the two-dimensional form:

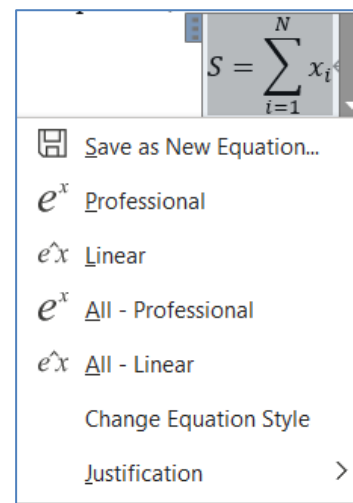
$$y = ax_1^2 + bx_1x_2 + cx_2^2$$

13.7 Inline Mode and Display Mode

In mathematical equations, we use Σ for summation. In an equation written in an independent line, we use larger fonts for symbols, and place super- and subscripts widely. Contrary to this, we use rather compact typesetting for mathematical expressions in line. To switch the typesetting, we can use the ‘inline’ mode and the ‘display’ mode. For example, the equation $S = \sum_{i=1}^N x_i$ is typeset as an inline equation. In the typesetting using an independent line, we obtain

$$S = \sum_{i=1}^N x_i$$

We can switch the typesetting with a menu for equations as shown in the right figure.



13.8 Equation Number and Cross Reference

To refer equations in main body of the text, we need to number the equations. (Version before Word 2016 has the menu of numbered equation in the tool of mathematical formula).

¹ LaTeX is a famous typesetting tool for mathematical expressions, and the one-dimensional form of Word adopts commands similar to those of LaTeX.

- You can make a mathematical equation with number and set labels as follows (Figure 90) .
 - Make a mathematical equation with mathematical formula tool as stated in Section 12.5.
 - Place ‘#’ at the end of an equation.
 - In "References" tab, select "Insert Caption".
 - From the "Option", go to "Label" and select "Equation".
 - Check "Exclude label from caption"(To refer only the number).
 - Click ‘Ok’, then the number is set after # (place parentheses at both side of the number if necessary).
 - Finally, at the right end of equation, press the ENTER key.

Thus, the equation number is shown in flush right format.

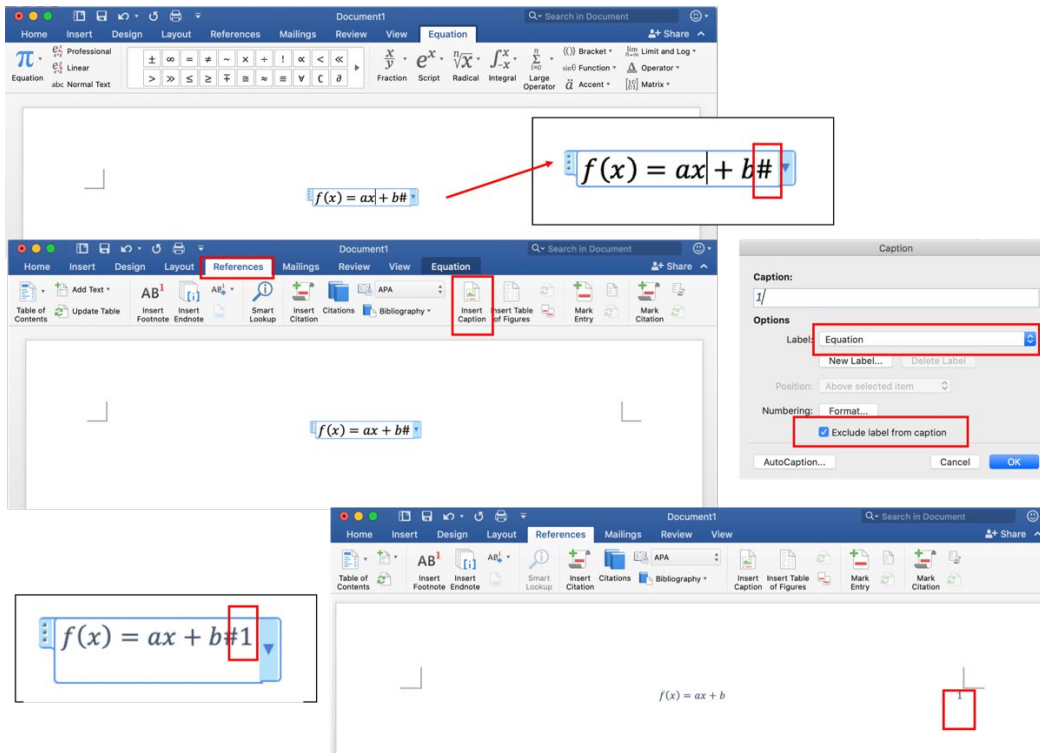


Figure 91 Writing mathematical equation with number, and set label

- By giving names to equations, we can simplify tasks of making equations with numbers (Figure 91).
 - With the mark ▼ shown in lower right side of the equation with number, select “Save as new equation”.

- In a window of “Create New Building Block”, enter arbitrary name, for example “numbered equation”, and click “OK”. (Confirm the value of “Gallery” is “Equations”).
- Select “Equation” in “Insert” tab, the name of the saved equation is shown.
- By choosing this item, you can create a new mathematical equation with a number (the number is automatically assigned).

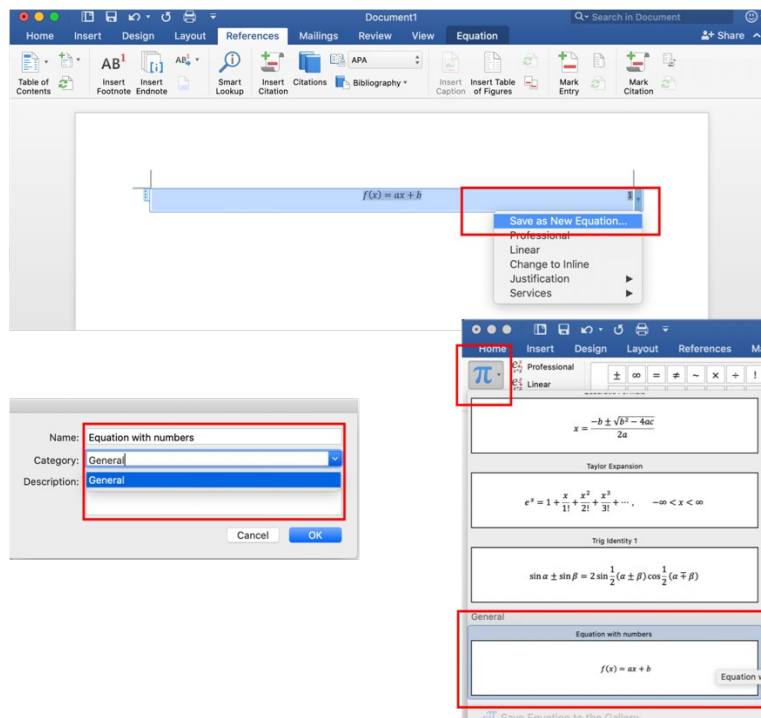


Figure 92 Save equation with name.

- Refer equations from the main body of text (Figure 92).
 - Choose the line number of the frame of the equation you want to refer.
 - Select “Bookmark” in “Links” menu of “Insert” tab.
 - In “Bookmark” window, give arbitrary “bookmark name” and click “add”.
 - Move the cursor to the place where you want to refer an equation, and select “Cross-reference” in “Links” menu of “Insert” tab.
 - In “Cross-reference” window, select “Bookmark” as for “Reference type”, and “Bookmark text” as for “insert reference to”.
 - Check “Insert as hyperlink”.
 - Select the equation that you want to refer in the area “For which bookmark” shown below.

➤ Click “Insert”, the equation number is placed.

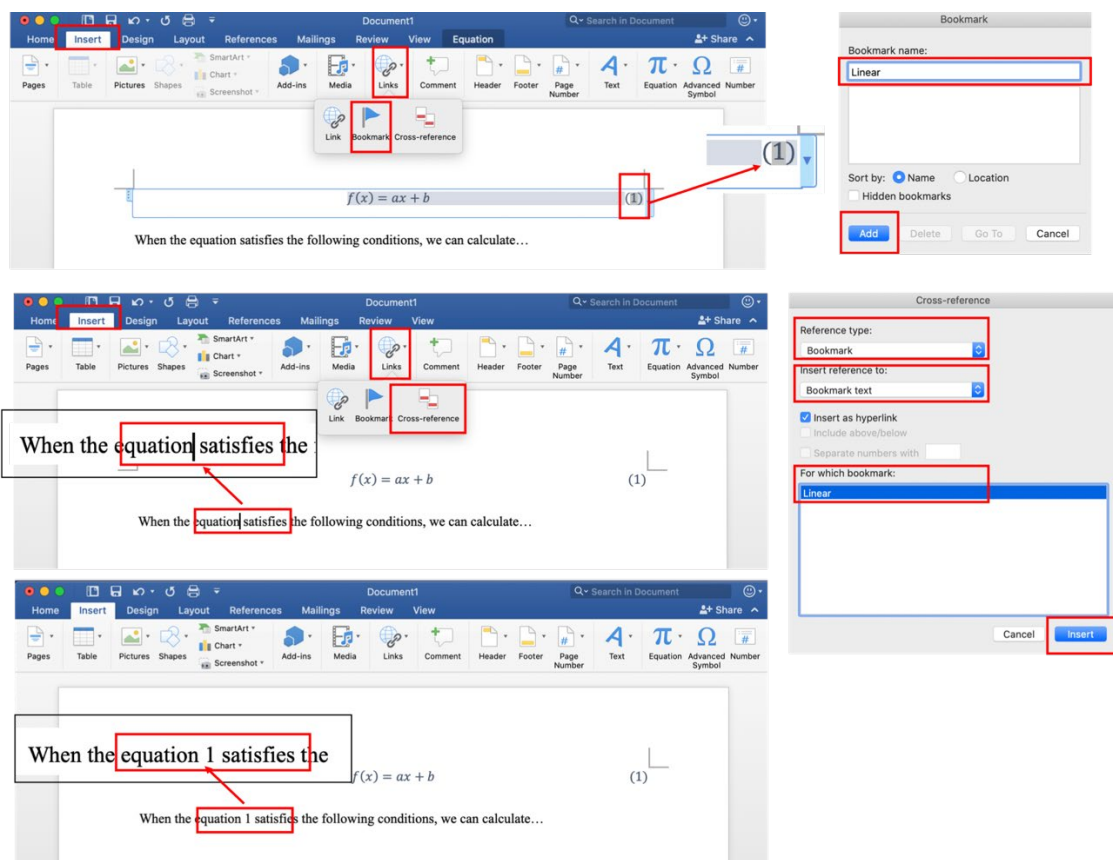


Figure 93 Cross reference of equation from the main body of text.

- By clicking the equation number in the main body with Ctrl key, you can jump to the corresponding equation.

References

[14] Fumitaka Sato and Masao Kitano, Iwanami (2018) in Japanese (佐藤文隆, 北野正雄:「新 SI 単位と電磁気学」, 岩波書店 (2018))

[15] Tetsuo Morilawa and Yasuko Nishiyama: Quantity Calculas in Science Education, Bull. Joetsu Univ. Edu. Vol. 17, No. 1, pp.365-375 (1997) in Japanese (森川鉄朗, 西山保子: 科学教育における量の計算法について, 上越教育大学研究紀要, 第 17 卷, 第 1 号, pp. 365-375 (1997))

14. Think Presentation

14.1 Study Aims

- Learn the objectives of presentation and its points;
- Learn the basics needed to create presentation slides;
- Learn how to present;
- Find out what audiences want.

14.2 Presentation: The Aims and the Audience

Exercise 38. What is the aim of presentation?

Exercise 39. In making a presentation, what do we need to know about the audience?

- What are the characteristics of an audience?
- What do they expect from our presentation?

14.3 Points to Note in Presentation

14.3.1 Consider the Time You Share with Audiences

A presentation must be performed within a limited period. Presentation is an activity that compels the audience to consume their time. It's an important responsibility of the presenter to make the presentation meaningful for the audience.

Exercise 40. How do we make the presentation effective if our time is limited?

14.3.2 Limiting Presentations under Time Constraints

Presenting under time constraints makes it necessary to provide concise information. We should be aware that presentation slides contain very little information compared to well-written reports [14]. To adequately communicate complex information, documents are the better medium.

14.4 The Basics of Slide Presentations

1) Guidelines for Slide Number and Font Size

You should select the number of lines and the font size used in slides, taking readability into consideration. We recommend **about 10 lines** per slide. If you count the lines on the flip charts used in TV shows, you'll see that they contain a substantial number of lines.

Regarding the time needed for presentation, **about one minute is needed to explain a ten-line slide**. The time taken may vary depending on content, and “one minute per slide” is a rough estimate. You should estimate and check the presentation time through rehearsals.

2) Structure of Slides

Slide content should be decided on using the following guidelines for academic presentation, and taking presentation time into account:

1. If necessary, make slides and talk about them;
2. If slides are not needed, don't include them;
3. The presentation should flow logically— don't make jumps in your logic;
4. Make the presentation comprehensible from the way you sequence the slides and talk about them;
5. Consider the level of knowledge of the audience;
6. Make a clear distinction between your opinion based on facts, and the opinions of others.

If your talk doesn't flow, rethink the structure of the presentation.

In the above, item 1. is obvious from the reason for giving a presentation, but item 2. is also required so that the limited time is used effectively. Given that the presentation time is limited, the talk and its slides should **focus on important matters**. In an academic presentation, items 3. and 6. are essential. In presenting academic topics, item 5. i.e., consideration of the audience's level of knowledge is also important. The basis of a presentation is that the presenter talks, and the audience listens, and it's a linear process. The sequential relationship between topics talked about should therefore be considered carefully in the light of item 4.

3) Deciding about Lists

Presentation slides often use lists. The followings are relevant:

- **Homogeneity.** List items are physically arranged in parallel. This should imply that the items have similar meanings.
- **Is the order relevant?** As an example, steps in a procedure have order and if we change this order, the procedure may fail. Another case where order is significant is in an array of items. We should carefully consider the relevance of order in a list.
 - Even if there is no particular meaning in the order, a numbered list may be helpful in referring to a particular item during discussion.
 - In quoting a list, the original order should be retained. If you have to alter the order so as to discuss your idea, you should explicitly express it in your discussion.
- **Hierarchy of items.** Some items have a hierarchical structure, and this can be represented by levels of listing. For example, the previous item has some sub items represented at a deeper level.
- **Number of items.** If very few items are listed, the reason for this may be unclear. If there are too many items, this may be difficult to understand. If you can allocate the number of items, consider the following:
 - If there are few items, this is often due to insufficient discussion. Re-visit the topic.
 - If there are too many items, this is often caused by bad organization. Review the relationship(s) between the items once more.

4) Choosing Your Style of Expression

Numerical data should be presented in charts. If the values themselves are important, use tables.

Exercise 41. Both slides in Figure 93 show the same data. What are the pros and cons of each slide?

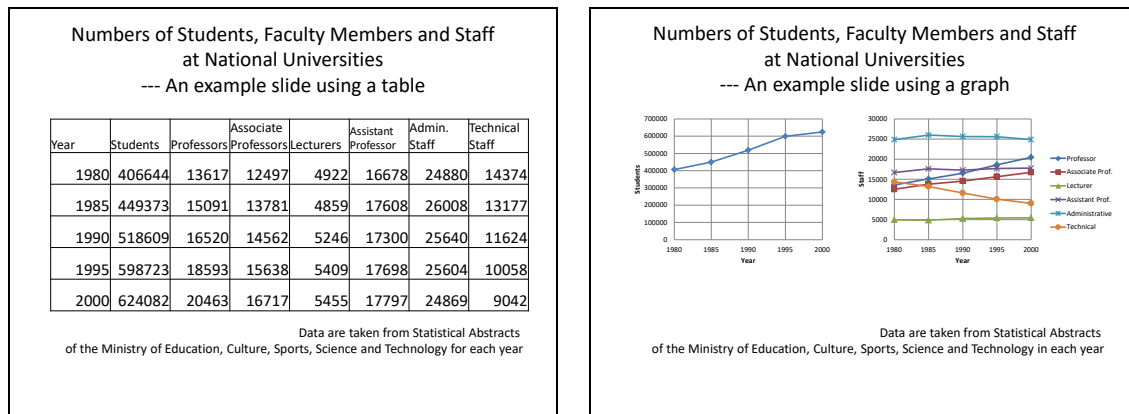


Figure 94 Using tables and charts in slides.

Another good way of doing this is to display numbers adjacent to data points.

Highlighting in a Slide

There are several ways *to highlight certain words* in a slide.

- To use Larger Font,
- To use **another font**,
- To use **another color**.

It is unwise to highlight many parts of a single slide. **Highlight the most important part.**

Figure 95 Different forms of highlighting in slides

- **Highlighting.** There are several ways we can highlight a specific part of a slide. The following are important:
 - As shown in Figure 94, highlighting can involve changing the character size, font, or color.
 - You should **use the same method for highlighting** throughout your slides.
 - Multiple areas of highlighting in a slide makes it difficult for audiences to read. **Select and highlight the most important part.**

- An effective method of highlighting is to use a different color in a slide.

However, use of various highlighting colors with different meanings impairs readability.

- **Use of Animation.** Animation of slides seems fun. However, if it is used poorly, animation prevents the audience from concentrating on the presentation content. In addition, animation makes it difficult to transition from the subsequent discussion to the next slide. Animation should be used effectively:
 - To present content with a dynamic nature; or
 - To focus the attention of the audience on a particular part of the slide.
- **Use of pictures, photographs and videos.** Use of these media is an effective way to give reality to your presentation, but for this reason, you should be careful not to use inappropriate content. Re-use of photographs and other media often impinges on the rights of others. Pay attention to the following:
 - **Respect copyright.** If you include illustrations and photographs, references should follow the Copyright Law. Take note that use of copyrighted material in your presentation slides, distributing a printed handout of the slides to the audience, and uploading your presentation to a server, making it available to others, are all treated differently under the law.
 - **Consideration of the rights of people in photographs.** If someone is shown in a photograph you want to use, you should protect his or her right to be depicted.

14.5 Using Various PowerPoint Functions

1) Using the Outline View

In composing presentation slides, the outline view (Figure 95) makes the following operation efficient:

- You can easily type text into multiple slides;
- List levels can be altered by pressing the TAB key, and Shift + TAB keys;
- Slide order can be adjusted easily.

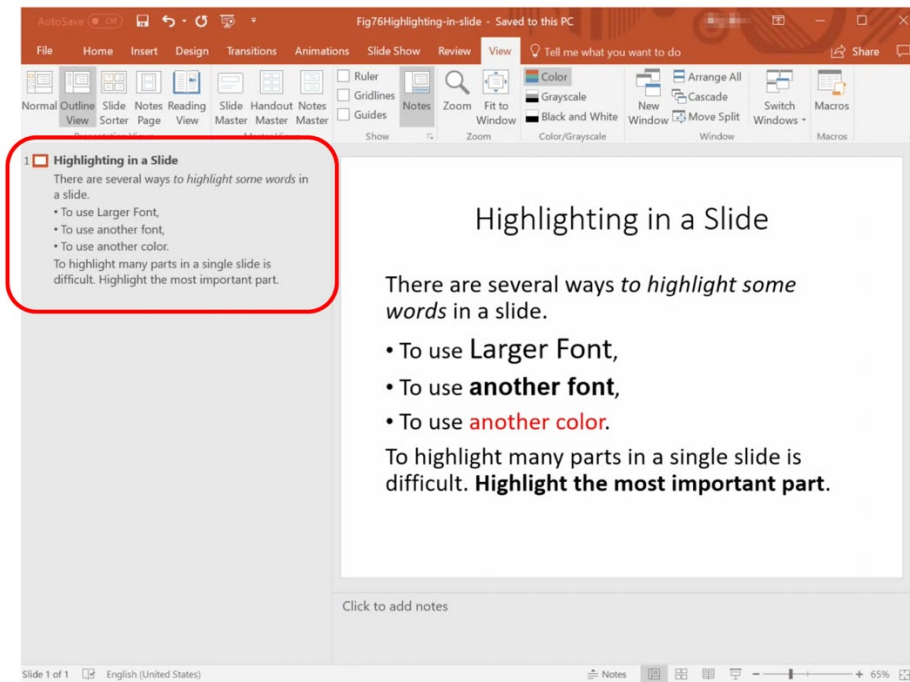


Figure 96 Using outline view

2) Use of the Slide Sorter View

- Order of slides can be adjusted easily;
- You can find the relevant slide quickly during discussion.

14.6 Manner of Presentation

1) Prepare Properly

Recognize that **presentation is an activity that consumes others' time**, and prepare properly.

- **Rehearsal:** Before presentation, rehearse, check the time required, and improve your presentation. **Make sure that you can present within the prescribed time.**
- **Preparation for discussion:** Think of possible questions, and prepare your answers and material for them, even if this isn't included in your presentation.
- **Check devices:** Determine whether you need to bring your own laptop PC to the presentation or whether you can use the local PC. If using your own laptop, check the interface, i.e., VGA or HDMI, that connects the projector to the laptop. **Don't forget the adaptor** if your laptop needs one, for example with a Mac. If you include video in your presentation, check how to replay sound as well as the image.
- **Pointer:** Check the availability of a pointer such as a laser pointer.

- **Handout:** Do you need to prepare a printout of slides or other materials as a handout?
- **Writing materials:** Have a pen to write questions during discussion.
- **Operating the PC:** Before the presentation, check that you've connected your laptop to the projector. Pay attention to the following:
 - **PC Display Mode:** When you connect a projector to your laptop, check the display mode—is the same screen shown on both your laptop and the projector or do the screens differ? Practice checking and switching screens.
 - **Projector Signal Selection:** Projectors usually have many input channels. Make sure that your laptop is selected.
 - **Match Your Laptop and the Projector:** The video signal from the laptop may have various resolutions. Usually projectors detect the resolution used and adjust appropriately. However, this may take time, or fail. In the latter case, you should change the projector's screen resolution.
- **Prepare for Problems:** The laptop may not work well during the presentation. Prepare a USB memory stick containing a copy of the file that contains your presentation slides.

2) Talk to Audiences

Sometime students talk looking only at the screen of their laptop or the projector. However, you can't adequately communicate your ideas to the audience this way. Make eye contact with the audience, and speak clearly.

3) Responses during the Discussion

Answering questions in discussion is as important as your presentation because obtaining feedback from the audience is one of the objectives of presentation.

- Write questions and comments during the discussion;
- It is wise to confirm that you understand questions before answering them;
- It's possible that you may not understand the question well. If this is the case, confirm that you understand it by asking the person who posed the question;
- If the question asked relates to things you didn't do or consider, you should explain this honestly.

14.7 Group Presentations

During coursework, you may be asked to study in a group, and you may need to make a group presentation. Think about making a presentation as a group of four members: A, B, C and D.

The following is a presentation format we often see:

- Each member makes slides for his or her part and talks (one quarter of the whole talk), each in turn.

Exercise 42. From the viewpoint of audiences, is the above presentation format effective?

Exercise 43. Are there better presentation formats in which the four team members can collaborate?

14.8 Audience Attitudes

It is also important that members of the audience improve their skills. You should try to acquire such skills by actively listening to presentations.

- **A Critical Attitude Isn't a Negative Attitude:** Concerning the content of a talk, listen to it critically. That is, is it true? Is it logical? Is there supporting evidence?
- **Be Prepared to Ask Questions:** If you listen critically to a presentation, you will have things you want to confirm, to understand more thoroughly. After a lengthy presentation, it is difficult to construct questions. Make notes during the talk so that you can ask questions.

14.9 Assessing a Presentation

If you are asked to assess presentations, what perspective will you assume in order to make the assessment? The following are suggested:

- The content of the presentation:
 - Is it interesting, or useful?
 - Does the audience understand?
 - Is it logically constructed and is there enough evidence?
 - Does the presenter distinguish among his/her opinion, facts and the opinions of others?

- The presentation method:
 - Is the allocated time used effectively?
 - Are the slides well structured?
 - Does the presenter talk clearly?
 - Are figures and tables used effectively?
 - Does the use of visual effects support the aims of the presentation?
- Discussion:
 - Does the presenter answer the questions satisfactorily, and is the discussion constructive?

14.10 Poster Presentation

14.10.1 What is Poster Presentation?

As well as oral presentations, in which the presenters talk with slides, poster presentations are also used for academic activities. A presenter prepares an A0- or A1-size poster, and talks to the audience in front of his/her poster. In contrast to an oral presentation, many presenters can talk about their posters simultaneously. This allows the audience to freely select presentations they find interesting.

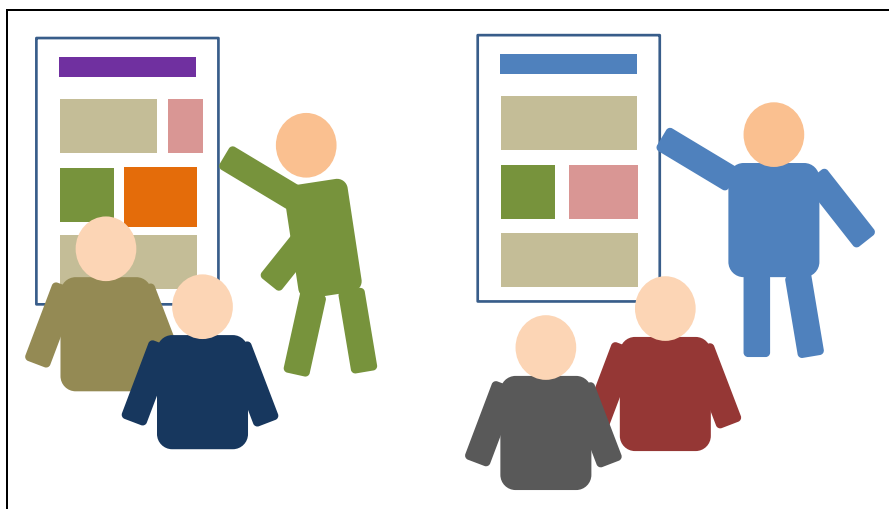


Figure 97 Poster presentation

14.10.2 Making Posters

The following are relevant to making posters.

- The poster size is usually specified by the organizer of the meeting. A0 and A1 are commonly used paper sizes. In the A series of paper sizes, paper size halves with each increment in the number. The size of A1 paper is 8 times, and A0 is 16 times as large as A4, as shown in Figure 97;
- If you prepare a poster using PowerPoint, specify the

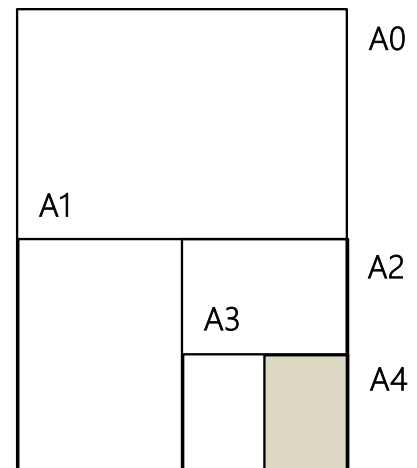


Figure 98 “A” series of paper sizes

paper size and direction using the Layout tab;

- The size of letters and charts should be chosen to make them legible to audiences at an appropriate distance;
- At the top of the poster, print the title and author(s) of the presentation;
- Assign text and charts to the poster as if planning for a talk lasting several minutes;
- Printing on large paper sizes is expensive and takes time. Check the poster carefully first, by printing it as A4 or A3.

14.10.3 Presenting Posters

The following are relevant to presenting posters:

- Prepare a talk that covers the entire content of the poster in a few minutes;
- Following the organizer’s guidelines, confirm and prepare for how the poster will be placed, e.g., whether presenters have to bring push pins, or there will be means to hold the poster in place;
- Prepare a case to carry the poster;
- Confirm the instructions about poster removal after the presentation;
- If you need to, prepare detailed explanatory material;
- Talk to members of the audience reading your poster, and ask them whether they want to listen to your talk in a few minutes’ time;
- During your poster presentation, talk to members of the audience. Confirm that they understand you;

- During discussion, take notes about questions and comments.

References

For further instruction about slide presentations, see [17][18], and for posters, see [19]. Regarding layout and usage of fonts, see [20]. Titles of Japanese references were translated by the author of this textbook.

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- [20] Yuma Takahashi, Natsu Katayama: *Rules for Layout. How to Make Good Materials: Basics for Design and Conveying Content Well*, Revised Edition, GIJYUTSU-HYORON-SHA (2016, in Japanese) (高橋佑磨，片山なつ：よい資料を作るためのレイアウトのルール 伝わるデザインの基本，増補改訂版，技術評論社 (2016))

15. Basics of Programming

We are going to learn the basics of programming in this chapter. The aim of this chapter is to introduce an overview of programs and programming along with some important basic technical aspects of programming. You will also encounter several advanced topics that extend what will be covered in class.

15.1 Before Start

In learning programming, it's really important that you try and see what happens—don't just read texts. This chapter therefore includes an introduction to preparing your own programming environment and starting programming by yourself. Note that, at Kyoto University, each class on the “Practice of Basic Informatics” may use its own learning material and the details of the programming course may be different from class to class. So, in your class, the tools you will use may be different from ones shown later in this chapter.

15.2 Why Programming?

The following list explains why we learn programming in the final part of “Practice of Basic Informatics”:

- By learning to program, you will know how to make your computer automatically do your own tasks—things that cannot be covered by ready-made tools;
- You will be freed from tedious work that might otherwise take up a lot of your time; and
- Programming is just full of fun! (You bet!)

It is desirable to learn programming in depth by taking time to acquire practical skills. In this course, however, there won't be enough time to cover even the fundamental, basic topics in programming. You will, however, still see how programming skills can enhance your ability to process data, how interesting it is to create programs and, at the same time, how difficult it can be. We anticipate that this course will act as a trigger to your learning more about programming in another course; we believe that learning to program brings you a deeper understanding of how computers work.

15.3 What Are Programs and Programming?

Let's start our study with an overview of the topics of programs and programming. We will see what a program *is*, what learning means in the field of programming, and the details of how programs are interpreted to perform tasks in computers. We also look into problems that might be found in programs. We'll examine the following:

- Software (a program) — how it works on the computer;
- Programming and programming languages;
- Learning to program;
- How programs are interpreted;
- Problems that might arise from programs.

15.3.1 Software (a Program) — How It Works on the Computer

We can find analogies between data processing in computers and cooking according to recipes:

- data processing in computers \approx cooking according to recipes;
- software (program) = recipe = manual;
- various software \rightarrow various data can be processed by a single computer
various recipes \rightarrow various types of food can be cooked by a single person

Table 10 shows several analogies between data processing and cooking.

Table 10 Data processing in computers and cooking according to recipes

Data Processing		Cooking
Raw data	Stuff to be processed	Ingredients
Hardware	Subject that works	Cook
Software (Program)	Procedural information	Recipe
Final output	Product	Food

In cooking, a recipe tells a cook what he/she is supposed to do at each step during the process of cooking (such as cutting, mixing or boiling ingredients). If the recipe is well written, the cook can complete his/her work successfully by simply following the

instructions in the recipe without thinking a lot, even if he/she does not understand how things are proceeded at each step. In this sense, recipes can be regarded as manuals that are written so that anyone with ordinary cooking skills can cook successfully—simply by following them.

15.3.2 Programming and Programming Languages

Section topics are:

- Programming = act of creating programs;
- Programming language = artificial language for describing programs;
- A large number of programming languages;
- Strictness about grammar.

We can usually start to use various software tools from the day we purchase a computer (after some initial setup procedures). But then, where do the software products (programs) already there come from? You might think that they are installed by software companies. Then, how do software companies create their products? Hardware products are fabricated by dedicated machine tools. Does this mean software products are created in an automatic fashion? Never! (This is just too bad). Software products (programs) are created by hand.

The activity of creating programs is called programming. As already mentioned, programs are used as manuals for computers, programming thus means writing programs. Can you guess how we might describe programs? In English, in Japanese or some international language used by humans?

Programs are written in dedicated artificial languages collectively called ‘programming languages.’ Just as there are many human languages of different types, we have a large number of programming languages with various features. See Table 11 for just a tiny list of the major programming languages.

Table 11 Major programming languages

C	C++	C#	FORTRAN
Haskell	Java	JavaScript	Lisp
Matlab	Perl	PHP	Python
R	Ruby	Scratch	Visual Basic

In the academic fields of information science and information engineering, human languages are collectively called natural languages, in contrast with programming

languages.

1) Programming Languages Are *Strict*

Each programming language has its own grammar, as does each natural language. We have to write programs according to the syntax of the programming language we use. You might think that it is obvious that you have to follow such rules. But let us think about our own language—the language we use every day. In our language, there are indeed grammatical rules, but these are not observed strictly in our daily use. We can understand what others mean even when we encounter some mistakes in the grammar. But when we say that programs are written according to the syntax, it means that we must *strictly* follow the rules. Even a minor error, which might seem quite trivial to correct, is not permitted. Any program with syntax errors will never be accepted for execution. Computers will not automatically correct mistakes nor deduce something implicitly expressed behind what is described. (There are no such sophisticated functions!) You are not allowed to modify the syntax of a programming language even slightly to make it easier for you to write programs. You might expect that computers understand what you mean if modifications you made look quite obvious to you, but you cannot (Too bad!) Even so, you still have your own choice of writing style—to a degree, but again, a program is acceptable only when it follows the grammar. The simple conclusion is that grammatical strictness is *required* in writing programs.

15.3.3 Learning to Program

Topics in this section include:

- Programming is *the* skill that enables us to make full use of computers;
- Learning to program means learning languages, data structures and efficient ways of computing.

If you have enough skill at programming, you can write a purpose-built program to make your computer do your own work, something that cannot be performed easily by ready-made tools. Having skill at programming means that you know how to make full use of computers.

It is obvious that you have to learn a programming language to write programs. A programming language is defined by its grammar. Does this mean it is enough to learn the grammar to become a programmer (i.e., a person who writes programs)? The answer is no. The commonly used programming languages are indeed fully developed and complete. In other words, learning a programming language means learning a foreign language. In

general, it would be difficult to use a foreign language fluently even if you learned its grammar in depth. In order to acquire practical knowledge of programming languages, you are supposed to learn the grammar, but this just isn't enough.

There is no shortcut to become fluent at programming languages, as in the case with natural languages. You have to read and write programs day-to-day in order to acquire the living skill of programming in a language. That is to say, practice makes all things easy. As you read and write programs more, you will obtain a wider vocabulary and programming language idioms that makes it easier to write your own programs.

There is another important aspect of programming skill that is not intrinsic to the languages themselves. You cannot write a program to solve a problem if you do not know how to solve it, because a computer cannot think for you—it just performs operations, as you instruct it through programs. You therefore need to learn various methods of computing depending on your intentions; how to represent information as data in programs and how to process these data. By the way, there is usually more than one way to solve a specific problem. In some cases, it may be just enough to get an answer to a problem at any cost, but it is often the case that efficiency matters. Using different approaches may lead to vast differences in computing times. As you know, time is money.

You may devise your own ways of computing. While you learn programming, it may be worthwhile trying methods you have devised and just seeing how the things go. Meanwhile, various useful ways of computing have been developed by computer scientists and engineers. Learning well-known computing methods is thus important if you wish to write practical programs.

You may come to understand that it requires much effort to acquire the skill to program in practical sense. This is the case, but once you acquire your own programming skills, you will retain them.

Programming skills are not only for solving complicated problems. You can write casual programs that do tedious work, instead of manually doing just the same thing repeatedly with a large amount of data. With your knowledge of programming, you may find ways to use ready-made software tools, like spreadsheets, in a more sophisticated way by searching for the advanced functionality available for your specific purpose. Having programming skills thus makes you more capable of using a computer.

1) Learning from Mistakes

We usually make many mistakes while we learn something—programming is just the same¹. When you try to execute your own program (or convert your program to make it executable), syntax errors are detected automatically, and it won't start (or conversion terminates with failures). An error message will be provided, and you are supposed to correct errors by reading the message. However, even programs without syntax errors are not guaranteed to work correctly. Your program may encounter an error while running and then abort. Even so, it is almost impossible that your computer will be damaged as a result². You are *supposed* to make mistakes while learning, and will learn a lot from them.

15.3.4 How Programs are Interpreted in Computers — Machine Language Bridges the Gap between Programming Language and Hardware

What you will learn here:

- Programming languages are for humans.
- Programs written in a programming language are translated into 'machine language' programs and then executed.

What you see below is just a simple program written in the Python programming language.

List 1 A program in Python

```
n = int(input("n? "))

fact = 1
for j in range(1,n+1):
    fact = fact * j

print('{0}!={1}'.format(n, fact))
```

Understanding this program may seem hard if you don't know Python or any other programming language (Don't worry, you do not have to understand this program yet). This program, however, contains common words and mathematical expressions, so you can

¹ We cannot be free from errors even after learning a lot, as you know, guys...;-P

² Errors in a program which physically controls a machine can damage it. But it is seldom the case that beginners learn by such kinds of programs.

```
000000001101100011010010110001001100011001011100111001101101111
001011100011011000000000111001101100101011101000111010101101001
01100100000000001100101011110000110100101110100000000001100101
011110000110010101100011011101100000000011001100110111101110000
011001010110111000000000111001101110100011100100110111001100011
011011010111000000000000111000001100101011100100111001001101111
0111001000000000010111110101111101101001011100110110111101100011
0011100100111001010111110111001101110011011000110110000101101110
```

Figure 99 A part of a machine language program

anticipate that you will be able to understand it if you learn Python.

As already stated, we write programs in programming languages—Python or any other language we can use. Computers process data according to the program provided. Here an important question may arise. How are programs, like the one shown above, interpreted inside computers? Remember that the entity that processes data is hardware. We know that hardware is a complicated compound of electronic circuits. How can such a device interpret languages? Are computers wise enough to learn language in some way?

The above discussion makes it clear that there is a large gap between the programming language we use and what hardware can do. Here, machine language bridges the gap. Programs written in programming languages are thus not directly interpreted by hardware.

Before explaining machine language, let us examine in detail how instructions to hardware are represented and how operations are executed there. Hardware consists of circuits of various kinds that alter data or transfer data to storage devices. What happens in a computer at a specific time depends on which circuits are triggered at that time. How a circuit is activated and what it processes at a specific time is controlled by instructions—data provided as a sequence of zeroes and ones (bits) stored in memory devices. In short, hardware is designed so that a particular sequence of bits triggers corresponding computing circuits electronically.

The machine language of a computer is defined to be the set of bit sequences that are used to trigger computing circuits. In machine language, there must be a defined instruction (a bit sequence) that sends data from a memory device to another and another that adds data in a register (a kind of fast memory device) to data in another register. We can thus compile a list of such instructions needed to accomplish a task, and then obtain a genuine program that

consists of the bits needed to drive the hardware directly.

Below you can see how a program looks in machine language. This is not randomly generated, but part of an actual program. The bit sequences of a machine language program either encode an instruction or data, both of which are possible to read in principle. But in a practical sense, it is impossible to understand millions of bits arranged in sequence. You should now agree that programs written in programming languages should be easy to understand.

Programming in machine language is quite hard. For your task, you are required to write instructions for hardware one by one, as bits—zeroes and ones. You have to know the structure of hardware to write programs in machine language. A program in a machine language becomes much longer than the same program described in a programming language, because each operation triggered by a single instruction is simple and we have to describe many more instructions in detail.

At the beginning of the computer era, all programs were written in machine language, which was quite inconvenient. The main problem in machine language programming is that it takes a lot of effort to read and write, as already explained. Another problem is that a program in a specific machine language works only on computers with the same hardware. Because machine language is designed to describe operations performed by hardware, it won't make sense on a computer that consists of different hardware.

To make programming tasks easier, early in the age of computers, *assembly languages* were invented where the instructions and data of machine language are replaced by words and numbers consisting of alphanumeric characters. At the same time, machine language programs called assemblers were developed, which automatically translate programs in assembly language into the binary digits of machine language. Remember that the programs that actually run are only those written in machine language.

Assembly language is much easier to understand than machine language, but as programs in assembly language are just literal translations of machine language, dependencies on hardware remain a serious problem. Subsequently, so-called high-level programming languages (or just 'programming languages' as we call them now) have been developed to eliminate hardware dependencies in programs and improve the efficiency of programming tasks. Programs that translate programs written in high-level programming languages into machine language¹ were also developed simultaneously. The first programming language

¹ There are mainly two types of translation programs. One is the compiler, which generates machine language programs. We then execute the programs generated. Another is the interpreter. An interpreter reads a program in a programming language and executes machine language instructions that are built into it. No machine language program is generated.

was FORTRAN, which was released in 1957¹.

In conclusion, real instructions for computers are thus described in machine language that can be directly interpreted by hardware. Programs we write in programming languages are translated into machine language and then executed.

Great Idea! — Automatic Programming

Programming in high-level programming languages is sometimes called automatic programming in the sense that we do not have to write programs directly in machine language (to be executed on computers), but write programs in high-level languages instead and let our programs be translated automatically by computers themselves. This approach to programming sets us free from the world of mysterious hardware instructions, allowing us to practically design, develop and maintain useful programs that are complicated and large in scale.

15.3.5 Problems That Might Arise from Programs

Computers simply follow any instruction in the program. Any data will be processed as they are provided. The validity or authenticity of an instruction or data value is not checked at all during execution. Computers do not think about instructions and data, for example, “This instruction seems strange” or “These data are suspicious.”

When ‘wrong’ programs are executed, various kinds of problems may happen. One of such problems is that a program aborts before it comes to the end. A program may wrongly fall into an infinite loop that will never end. The method needed to compute something may be wrongly described in a program. We may suffer serious damage in consequence. For example, there was an accident in 2016 where a satellite broke and was abandoned because of anomalous behavior caused by incorrect signs in several numerical data in its control program². Even if a program works perfectly in normal use, it does not necessarily mean that the program is free from errors. There may be residual errors that are missed and cause problems only in exceptional cases, for example when irregular data are provided in an unexpected pattern. Such kinds of undiscovered errors may be detected and misused by black-hat hackers to inject instructions or data into programs for malicious use.

¹ IBM100 FORTRAN The Pioneering Programming Language
<http://www-03.ibm.com/ibm/history/ibm100/us/en/icons/fortran/> (Last access: 2016-08-29)

² The verification results of the subcommittee for anomalous behaviors of X-ray astronomy satellite “Hitomi”
http://www.jaxa.jp/press/2016/06/20160614_hitomi_j.html (in Japanese, last-access:2017-01-21)

An error in a program is generally called a bug. The work of correcting and eliminating bugs in programs is called debugging. Bugs (flaws) that can cause security risks are specifically called vulnerabilities.

In our society, many systems in various fields are controlled by computers. Bugs in programs can thus seriously damage our life. Programs are supposed to be bug free, but eliminating bugs totally from programs is very difficult, especially when programs are large and complicated.

15.4 Variables

In this section, as one of important basic elements in programs, let us look into the topic of variables. What are variables? How are they used in programs? Why are they required and how they can be beneficial to programs?

15.4.1 Example — Collatz Conjecture

Let us here examine a mathematical question called the Collatz conjecture as an example of problems that can be explored through programming.

Collatz conjecture

Take any positive integer n . Divide n by 2 if n is even, otherwise (if n is odd) triple n and add 1. The conjecture is that repeating this process indefinitely always reaches 1 regardless of the initial integer.

For example, when $n=3$, we can easily confirm that the above statement is true:

$$3 \rightarrow 10 \rightarrow 5 \rightarrow 16 \rightarrow 8 \rightarrow 4 \rightarrow 2 \rightarrow 1$$

This problem looks rather simple. You may try it yourself by picking integers randomly and seeing whether this conjecture is likely to be true. This conjecture, however, is not proved mathematically, i.e. this is an open question.

It is quite difficult to prove this conjecture, but we can test integers to see if the conjecture is true for them. The following program tests the Collatz conjecture for a given integer.

List 2 A test program for the Collatz conjecture

Line	Program code	Explanation
1	<code>n = int(input("n? "))</code>	Read the value of n
2	<code>while n != 1:</code>	While n is not 1, repeat for lines 2--7
3	<code> print(n, end=" -> ")</code>	Display the current value of n
4	<code> if n % 2 == 0:</code>	If the remainder is 0 when n is divided by 2
5	<code> n = n // 2</code>	Divide n by 2 and then let n be the quotient
6	<code> else:</code>	If the remainder is not 0 when n is divided by 2
7	<code> n = 3*n+1</code>	Triple n and add 1 then let n be the result
8	<code>print("1 OK")</code>	When program reaches this line, n must be 1

Assuming that a positive integer is provided to the first line as the value of n, this program computes the calculations for the Collatz conjecture repeatedly until n reaches 1. For each step, the value of n at that moment will be displayed. If the conjecture is true for given n, this program ends by displaying “OK”¹.

In the following sections, the need for variables in a program is explored. How variables can be beneficial to programs is also explained.

15.4.2 Variables — Why We Need Them

- Most data in programs are associated with variables;
- Variables links data values with names, thereby providing a model of data.

In the above test program for the Collatz conjecture, we can provide an integer for testing it at the initial step. This means that the value of n is unspecified in the program, but is ‘memorized’ after the program is started. The initial value is different from one trial to another. In the main process of the program, the value of n is modified repeatedly (either by division by 2 or multiplication by 3 followed by addition of 1). Here the modification of the value is accomplished by assigning the result of the arithmetic operations on n to n itself.

As we have already seen in this example, data subject to changes in programs are described by names that signify their meanings. When a program is executed, data values are assigned to names and are processed. The system of linking names and data values is called a variable, which is much like the variables used in mathematics. We can consider

¹ For n (n>1), if n returns to the initial value during the process, we know that the process will never reach 1 and the conjecture is false, i.e., we find a counterexample. But as you can see, the program will not detect if this situation happens. In the program, ‘//’ is the quotient operation.

that variables model data in programs.

15.4.3 Benefits of Variables

- Benefits of variables in running programs:
 - We can use variables to import data external to programs and process them;
 - The same program can be used to process various data by assigning them to variables;
 - In a program, intermediate results assigned to variables can be reused later, thereby saving computational time.
- Benefits of variables in writing programs:
 - The meaning of data can be indicated by the names of variables;
 - By describing expressions using variable names, we can see the relationships within data clearly;
 - Correction of programs becomes easier when we use variables than when we use immediate values.

1) Benefits of Variables in Running Programs

As we have already seen in the case of the program for the Collatz conjecture, data external to programs are imported via variables. Within programs, it is impossible to describe the values of data that are provided at run-time.

For each execution of the same program, it is usual that we can assign different values to each variable and obtain results for each data set, which enhances the applicability of the program. By describing methods of computations using variable names, we can see the relationships within data clearly. The computation process is modeled like a mathematical function, which brings us the expressive power of abstraction.

We can reduce the required time for a computing process if we use variables effectively. For example, let us assume that we have a mathematical function $f(x)$ which takes 100 seconds to compute its value for $x=10000$. Then think the following computation task:

$$f(10000) \times f(10000) \times f(10000)$$

It would take about 300 seconds to complete this task (A multiplication operation is done just in an instant). You would think that the computation of $f(10000)$ doesn't need to be

repeated three times, because it is obvious that we obtain the same value for each computation. But, remember that computers simply follow the instructions they are given. The description $f(10000)$ tells a computer to find the value of $f(x)$ for $x=10000$, and that's all it's told. The above process thus does include three computation processes of the same function value separately¹.

Now, for the same computation task described above, let us once assign the value of $f(10000)$ to a variable, say y , as an intermediate step:

$$y = f(10000)$$

The whole computation process is now turned into:

$$\begin{aligned} y &= f(10000) \\ y \times y \times y \end{aligned}$$

The computation time would then be reduced to about 100 seconds since it includes the computation of $f(10000)$ just once. As we see here, we can save computational time by assigning intermediate results of computation to variables and reusing them later.

Among programmers, writing (executing) the same thing repeatedly is considered to be bad form. There is a well-known basic rule of programming saying such repetitions should be avoided, called the DRY principle (Don't Repeat Yourself).

2) Benefits of Variables in Writing Programs

Variables are useful not only for execution of programs, but also for writing programs.

Different data may happen to have the same value. But if we describe data directly by their values in our program, the data that have the same values cannot be distinguished from each other. As a result, we may misinterpret the program. In contrast, if we describe data using variables, we can name each of them so that their meanings become clear.

Relationships within data also become clear when data are related via expressions that use variables.

For example, let us examine the following tiny programs (a) and (b). Assume that "print" is the function that displays a data value given this as its argument. The symbols '*' and '/' denote the operators for multiplication and division respectively.

¹A smart translation program may find the duplication of the same computation and may generate optimized machine instructions to eliminate it.

List 3 A program without variables and one with variables

(a)	<code>print(100 * 12 / 2)</code>
(b)	<code>base = 100</code> <code>height = 12</code> <code>area = base * height / 2</code> <code>print(area)</code>

When we run each of these two programs, the same value emerges from both. Program (a) is shorter and simpler, but it is not clear what is computed. In contrast, you find that it is easy to understand what program (b) computes.

Numerical values whose meanings are obscure in programs are called magic numbers. You should not leave magic numbers as they are. At the time you write numerical values in your program, you might think that their meanings are obvious, but later you may find that you cannot understand what you meant.

Describing data using variables makes it easier to correct programs. Suppose that your program has data that appear many times and are written as immediate values, and then you find that the values should be corrected. In such a case, you have to modify all occurrences of the data one by one (Be careful! You should modify only the occurrences of the same data and must not modify other data whose values happen to be the same). In contrast, when we use a variable, to correct the program, all we have to do is to modify the value we assign to the variable.

As we have seen in this section, variables are indispensable in programs and programming.

15.5 Control Structures — Processes That Depend on Conditions

This section introduces *control structures* as essential elements of programs. Control structures are needed in processes that depend on conditions. A typical example of a control structure is a *conditional branch* where, depending on a condition, different instructions are performed. Another type of control structure is where something is repeated. One of the most powerful abilities of computers is the ability to repeat things: a sequence of instructions can be repeated as often as required (at extremely high speeds) to process a huge amount data or to perform a long sequence of calculations.

We will explore the following topics:

- How to perform different instructions depending on a condition;
- How to repeat a sequence of instructions while a condition is true;
- Why repetition makes a computer a really powerful data-processing device;
- Programs that will never stop.

15.5.1 Control Structures — Why We Need Them

The program for the Collatz conjecture in the previous section includes processes that depend on conditions. The integer n is processed differently depending on whether it is even or odd. The computational process is repeated indefinitely until n reaches 1, i.e., the process depends on the condition: Is n equal to 1? This type of conditional process is an indispensable element in programs, as this example shows.

If a program does not include a control structure, when it is run its instructions are executed one by one from the beginning to the end; each instruction is executed just once. This situation is much like the case where we simply work through a manual from the first step to the last, in sequence. In this kind of process, the workflow progresses in a straight line.

In contrast, when conditional processes are included in a program, the workflow is not that simple. Different instructions may be executed depending on conditions and some instructions may not be executed as a result, which is like skipping some steps in a manual depending on the situation. A part of program may be executed repeatedly depending on conditions; i.e., some instructions are executed more than once.

The workflow of a program with control structures thus includes forks and loops and the flow is controlled by conditions. This is why the structures of conditional processes are called control structures.

15.5.2 The Power of Loops

The most impressive aspect of computers is that they can process thousands or millions of instructions, a huge amount of data, and can perform an extended sequence of computations at lightning speed. This powerful feature of computers arises from the ability of control structures to repeat things.

It is tedious and boring for us simply to repeat the same thing again and again, and we are likely to make mistakes during such repetitive tasks. Computers are free from such

problems. Regardless of the amount of work, computers can repeatedly perform tasks precisely as they are instructed without feeling tired (provided the hardware works correctly and electric power is supplied). This is the power of the loop.

For example, providing the following number (n) to the Collatz conjecture test program, we can determine that it reaches 1 after 2813 iterations¹:

```
5293237546378456534784553489308590438902375927369027359027902375429185097690729571298679027590211819
```

For large numbers like this one, it is likely impossible to check by hand whether the conjecture is true. But if you write your program and let a computer do the test for you, you will know the answer instantly. This kind of computing task really shows the power of computers.

15.5.3 Programs That Never Stop

Let us look at one more advanced topic related to loops. A loop is repeated while a given condition holds. Think about a looping process where lines of a text file are read one by one, and the same operation, for example searching for a keyword, is applied to each line. During such a loop, each line of a file is read starting at the head of the file and the process is repeated while lines remain to be read. To be more specific, if there is a line following the one just read, the condition “whether a line can be read from the file” is true and the loop process continues. Otherwise, i.e. when the last line is read and no more lines are left, the condition becomes false and the loop ends. Such a loop will eventually stop for any text file however long it is.

From the above example, can we say that any loop process will eventually end? As you would expect from the question, the answer is “No”. There are loops that never stop. We can simply provide a condition that is always true to intentionally make such an infinite loop. Let’s try a tiny example:

¹ You’ll need to add code that counts the number of iterations by the program. If you write the same program in another programming language, you may also need to write a substantially different program in order to perform computation with “big numbers” like the one provided here. This is because the data representation of “small numbers” and “big numbers” may differ depending on programming language. In Python, you don’t need to concern yourself about the “size” of numbers because Python automatically selects data representations for you.

List 4 A program that will never stop

Line	Program code	Explanation
1	<code>i = 1</code>	Let <code>i</code> be 1
2	<code>while i > 0:</code>	Repeat lines 3 and 4 while <code>i > 0</code>
3	<code> print(i)</code>	Display the current value of <code>i</code>
4	<code> i+=1</code>	Increment the value of <code>i</code> by 1

You can actually execute this program, although it is useless. In this program, the value of `i` is incremented by 1 with each iteration. Because the initial value of `i` is 1 and the value of `i` is incremented as 2, 3, ... , `i` is always positive. It is obvious that the condition `i > 0` never fails, which theoretically makes the program run infinitely in the loop¹. Our Collatz conjecture test program will never stop if we give a counterexample, provided the conjecture is wrong.

Don't worry if you happen to encounter an infinite loop, as any program that is run within an OS can be terminated during execution by sending a signal to the OS (Even more definitively, any program will stop if you cut the power!... but never try this.)²

You might think that it is a problem that we can write programs that may fall into infinite loops. We do however know that if we limit ourselves to writing just the "safe programs" that won't go into infinite loops, this makes our computing ability very limited.

15.6 Getting Ready for Programming Exercises

This section explains how to install a Python programming environment under Windows and how to use installed programming tools, to prepare for programming exercises (Installation on MacOS or Linux should be similar)³. The information provided in this section is valid as of 2016-07-15. When you read this document, the Python packages will have been updated and the following information may have become outdated.

15.6.1 Installing Python

First of all, install the Python package which includes the core system of the Python

¹Because the data size of `i` increases as the value of `i` becomes larger and the memory space is limited, the program will abort when the memory space is exhausted. But it would take a tremendously long time (The author has never tried this)

²There are different ways to terminate programs depending on the tool you use. In the case of "IDLE" that is introduced at the end of this chapter, try [Restart Shell] in the [Shell] menu to do this.

³Here we are going to install Python3, the current version. Python2, the previous version, is still in use a lot. Note that the differences between Python3 and Python2 are not insignificant.

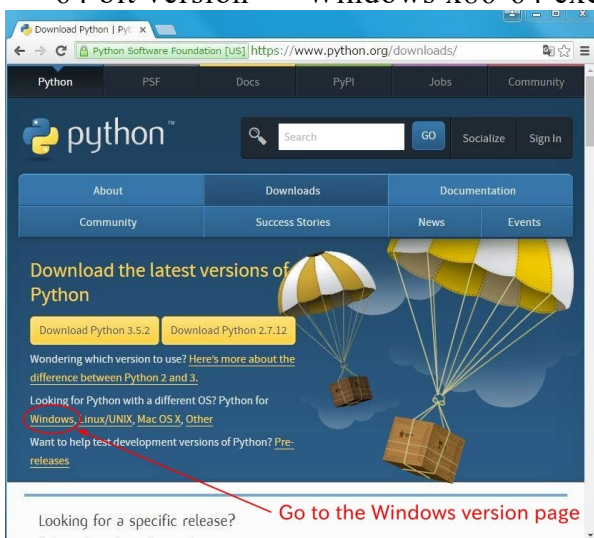
language and tools for editing and executing Python programs.

1) Downloading Installer

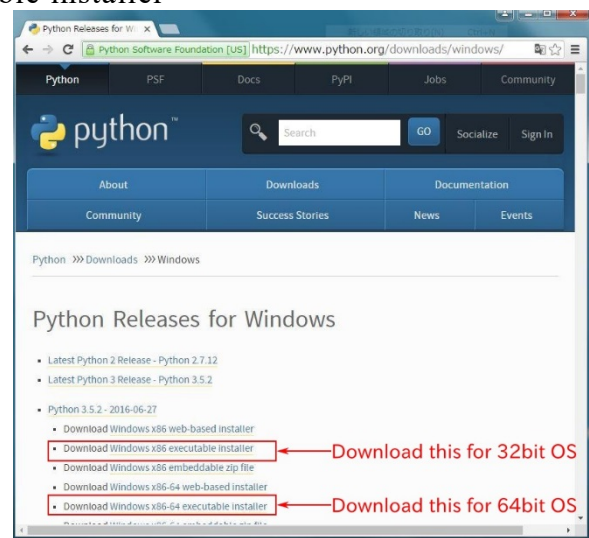
Open the official Python web site and go to the “Downloads” page at <https://www.python.org/downloads/> (Figure 99 (a)). Next, open the “Python for Windows” page to download an installer (Figure 99 (b)). There are 32 bit and 64 bit versions. Select the “executable installer” suitable for your OS. You can find your OS version from the “System” tab of the “Control Panel.”

32 bit version Windows x86 executable installer

64 bit version Windows x86-64 executable installer



(a)



(b)

Figure 100 Download page of the official Python website

2) Checking Installer (Optional)

After you downloaded the installer, for your safety, you may optionally check its integrity before installation. You can use system security software to scan it. You can also check the MD5 hash value and/or the GPG signature of the installer. Read the “Latest Python 3 Release” page of the Python web site for details.

3) Installation

Run the installer to start the installation process. In the “Install Python” window, turn off the check box “Install launcher for all users” and select “Add Python 3.5 to PATH,” and then proceed with “Install Now” (Figure 100 (a)). Installation then starts and will soon finish (Figure 100 (b)). Close the window when installation is complete. You will then see

that “Python” has been added to your “All Apps” menu¹.

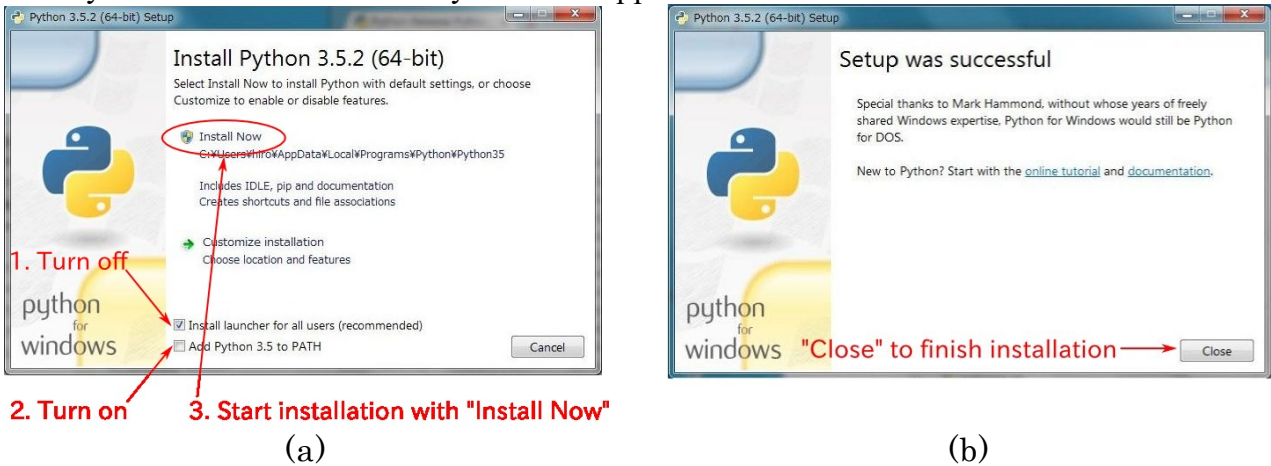
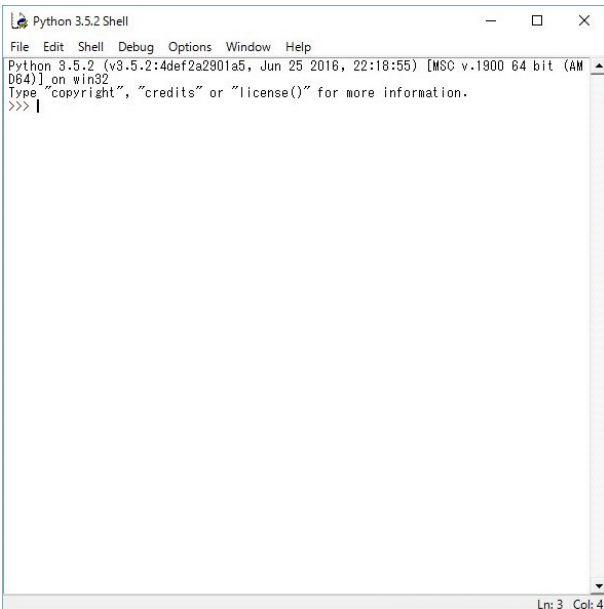


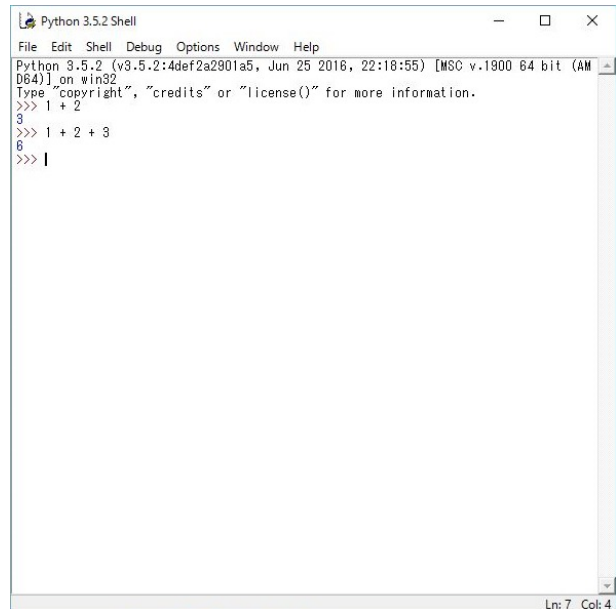
Figure 101 Python installation process

15.6.2 Hello, Python

Let’s now test the installed tools using an example. Launch “IDLE” from the “Python” menu—you will then see the window shown in Figure 101 (a). The “Python shell” is now running. The symbol “>>>” is called a prompt, and it indicates that the shell is waiting for you to input Python code. Type some code and press [Enter]. The code is then evaluated immediately. Figure 101 (b) shows tiny examples of evaluation of expressions.



(a)



(b)

¹ For Windows 7, “All Programs” instead

Figure 102 Startup screen of IDLE and an example expression

Except for tiny tests, we normally do not type program code directly into the shell. We instead usually write a program as a file, and run it. Select [New File] in [File] menu of the shell window. A new window then comes up as shown in Figure 102 (a). This is the IDLE editor that we use to create/edit programs. Let’s now type our Collatz conjecture test program into the editor window¹.

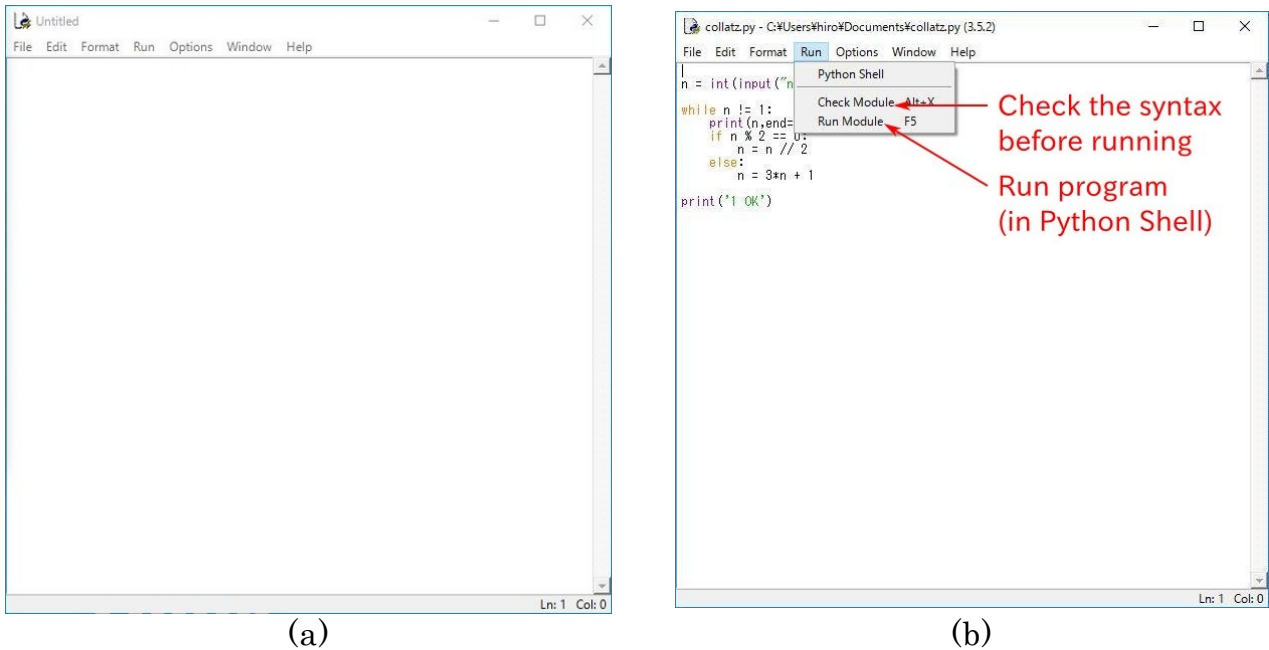


Figure 103 Editor of IDLE

List 5 The Collatz conjecture test program (the same as of List 2)

line	Program code	Explanation
1	<code>n = int(input("n? "))</code>	Read the value of n
2	<code>while n != 1:</code>	While n is not 1, repeat for lines 2-7
3	<code> print(n, end=" -> ")</code>	Display the current value of n
4	<code> if n % 2 == 0:</code>	If the remainder is 0 when n is divided by 2
5	<code> n = n // 2</code>	Divide n by 2 and then let n be the quotient
6	<code> else:</code>	If the remainder is not 0 when n is divided by 2
7	<code> n = 3*n+1</code>	Triple n and add 1 then let n be the result
8	<code>print("1 OK")</code>	When program reaches this line, n must be 1

¹ You will find that some lines are automatically indented. That’s because the indentation of lines is used to structure programs in Python.

Make sure you save the file when you are finished. Check if the program is syntactically correct using [Check Module] in the [Run] menu as shown in Figure 102 (b). If errors are reported, correct them; then save and check your file again.

If no errors are detected, you can run the program using [Run Module] in the [Run] menu. The program starts in the shell window. You’ll first see the message “n?”. Type an integer greater than or equal to 2 and press [Enter]. Computation then starts and will soon finish (provided the Collatz conjecture is true).

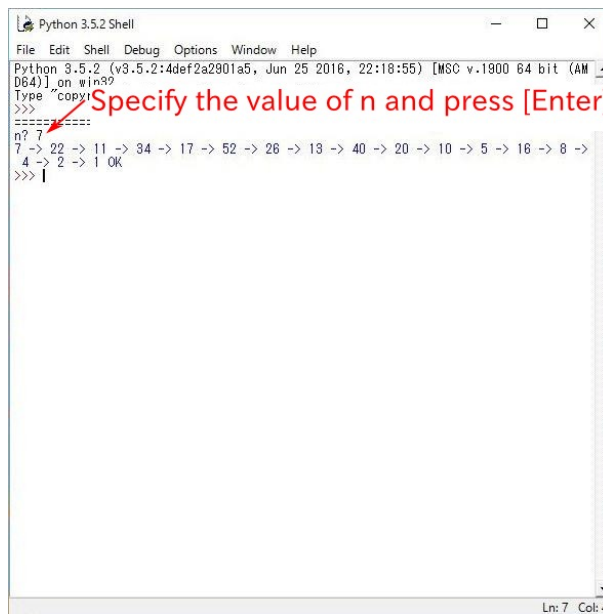


Figure 104 Running the Collatz conjecture test program

List 6 Collatz conjecture test program (modified version)

line	Program code	Explanation
1	<code>n = int(input("n? "))</code>	Read the value of n
2	<code>while n != 1:</code>	While n is not 1, repeat for lines 2--7
3	<code> print(n)</code>	Display the current value of n
4	<code> if n % 2 == 0:</code>	If the remainder is 0 when n is divided by 2
5	<code> n = n // 2</code>	Divide n by 2 and then let n be the quotient
6	<code> else:</code>	If the remainder is not 0 when n is divided by 2
7	<code> n = 3*n+1</code>	Triple n and add 1 then let n be the result
8	<code>print(1)</code>	When program reaches this line, n must be 1

Finally, as another test, modify the 3rd and 8th lines of the program as shown in List 6 (Changes are indicated in red). Save and run it again.

The modified program outputs one integer per line. This style of output is more convenient if, for example, you want to feed the output into a spreadsheet tool that analyzes how values change during the Collatz process. This test shows you that changes in a program do change its behavior.

References

What you see below is a tiny list of textbooks about Python programming.

- [21] “Think Python, 2nd Edition”
Allen B. Downey, O’Reilly & Associates Inc (2015)
ISBN 978-1491939369
- [22] “Python: The Fundamentals of Python Programming”
Paul Jones, CreateSpace Independent Publishing Platform (2016)
ISBN 978-1539530268
- [23] “Introducing Python”
Bill Lubanovic, O’Reilly & Associates Inc, (2014)
ISBN 978-1449359362
- [24] “Learning Python, 5th Edition”
Mark Lutz, O’Reilly & Associates Inc (2013)
ISBN 978-1449355739
- [25] “Python Programming: An Introduction to Computer Science, 3rd Edition”
John M. Zelle, Franklin Beedle & Associates (2016)
ISBN 978-1590282755

16. Afterword

This textbook has introduced you to basic ICT skills for academic activities. As stated in Section 1.1, we think students should acquire further ICT skills by themselves as their studies progress, together with specialties, and interests. The aim of the assessment criteria shown in the Appendix 2 is to help the student to evaluate this process of acquisition. Although the followings topics might be learnt by students, they should perhaps not learn all of them:

- Effective use of online storage and other cloud services;
- Cooperative use of a personal computer and a smartphone;
- Typing languages other than English and Japanese;
- Software for management of references;
- Construction and use of a database;
- Editing of video footage;
- Using CAD and 3D printing;
- Creation of Web pages and writing programs for them;
- Effective use of Social Network Services (SNS) and other social media;
- Management of projects and use of associated tools.

To acquire these skills, you will need to search learning resources, and network with people who want to learn them with you.

One of the most salient characteristics of ICT that is centered around computers is that you can create new tools by yourselves. In this textbook, we introduced some topics in the “Great Idea” columns to underline the fact that such technologies were indeed developed by people with great ideas. Don’t you think it would be fantastic if your contribution could be introduced as a “Great Idea” in future textbooks?

Appendix 1 Acronyms

This list contains the most common abbreviations used in computers and networks.

Abbreviation	Name	Description
Units of Information		
bit		the amount of information in 1 binary digit
byte		the amount of information in 8 binary digits
bps	bit per second	speed of transmitting information, number of bits sent per second
byte/sec		speed of transmitting information, number of bytes sent per second
k	kiro	10^3 (supplementary SI units)
M	mega	10^6 (supplementary SI units)
G	giga	10^9 (supplementary SI units)
T	tera	10^{12} (supplementary SI units)
P	peta	10^{15} (supplementary SI units)
Character Code and Keyboard		
ASCII	American Standard Cord for Information Interchange	character code established in the US that represents alphabets and numbers
JIS X0201	Japanese Industrial Standard	character code of JIS standard that adds katakana to alphabet and number according to ASCII code, so-called half-width kana code, with a part of codes different from ASCII code
JIS X0208		character code containing kanji using 2 bytes
Shift_JIS		character code that handles JISX0201 (so-called half-width character) and JISX 0208 (so-called full-width character) collectively
Unicode		code that allows common use of various character codes used in the world
UTF-8		one of the Unicode expressions, which uses 1 to 4 bytes per character, upwardly compatible with ASCII
ASCII layout		layout of symbols on keyboards used in the US, US layout
JIS layout		layout of symbols on keyboards normally used in Japan
Ctrl, Alt, Esc, Ins,	Control, Alternate, Escape, Insert	

ISO2022-JP		character code designed for communication in Japanese over the Internet, also known as JIS code
EUC-JP	Extended UNIX Code Packed Format for Japanese	character code in UNIX (EUC) for Japanese
QWERTY layout		character layout in which the third row of characters from the bottom of the keyboard is arranged in the order of QWERTY from the left

File Format and Extension

HTML	hyper text markup language	language for describing web pages including formatting
XML	extensible markup language	markup language with generality
PDF	portable document format	portable document format developed by Adobe
TXT		extension abbreviated from text
JPEG	joint photographic experts group	one of the still image formats, a lossy compression format that degrades the image quality and reduces the amount of data
BMP	Microsoft Windows Bitmap Image	one of the image file formats, often used without compression
GIF	graphic interchange format	one of the image file formats, losslessly compress images of 256 colors or less
PNG	portable network graphics	one of the image file formats, losslessly compress images
ZIP		one of the formats for archiving multiple files into one
MP3	MPEG1/2 Audio Layer-3	one of the audio file formats
MP4		one of the video file formats
MPEG	moving picture expert group	working group for setting standards for video formats such as MPEG-1, MPEG-2 and MPEG-4
EXE	executable	executable file format such as windows application software
ISO	International Organization for Standardization	
EPUB	electronic publication	one of the electronic book formats
DOC, DOCX, XLS, XLSX, PPT, PPTX		Word, Excel, PowerPoint file extensions, extensions with an X represented in xml format
wav, aiff		audio file formats

AVI	Audio Video Interleave	one of the video file formats, standard format on Windows
MOV		one of the video file formats, mainly used by Apple QuickTime Player
FLV	Flash Video	one of the video file formats, supported by Adobe Flash Player
CSV	comma separated value	the format of a file in which numbers and strings contained in cells of each row are separated by commas (,) for data in a database or spreadsheet software, easily exchangeable between different applications
EXIF	Exchangeable image file format	one of the image file formats, metadata such as model of digital camera and shooting date is stored
SVG	Scalable Vector Graphics	one of the image file formats, described in XML and used to support for interactivity and animation of images on websites
TIFF	Tagged Image File Format	one of the image file formats
MIDI	Musical Instrument Digital Interface	international standard for exchanging musical instrument data between different devices
LaTeX		tool for creating academic documents with excellent typesetting of mathematical expressions

Storage Media

SD card, Mini SD,
Micro SD

CD	compact disc
DVD	digital versatile disc
BD	Blu-ray Disc

PC Components

PC	Personal Computer	personal computer
CPU	central processing unit	central processing unit
GPU	graphic processing unit	device for processing graphics
HDD	hard disk drive	magnetic disk drive
SSD	solid state drive	drive using flash memory
BIOS	basic input output system	program written to read-only memory for starting PC etc.
OS	operating system	operating system
NTFS	NT File System	one of the file systems adopted by Windows
FAT	File Allocation Table	one of the file systems that can be read and written even with macOS

PC Interfaces		
USB	universal serial bus	
VGA	video graphics array	VGA terminal, analog RGB is used
HDMI	high definition multimedia interface	standard of cable / terminal for sending and receiving video and audio collectively, digital signal is used
DVI	digital video interface	
Thunderbolt		
Bluetooth		
DisplayPort		
PCIe	PCI Express, PCI is 'Peripheral Component Interconnect'	
IEEE 1394/Firewire/i.LINK		
NFC	Near Field Communication	standard for wireless communication for a short distance of about several centimeters used in IC cards and smartphones
VGA, SVGA, XGA, WXGA, HD FWXGA, SXGA		
RGB	red green blue	three primary colors of light
CMYK	cyan magenta yellow key plate	black color added to primary colors (cyan, magenta, yellow) for subtractive color mixing such as printer ink

Networks		
LAN	local area network	network in a local area such as in a building or office
WAN	wide area network	wide area network
FTTH	fiber to the home	high-speed digital communications over fiber optic circuits for general consumers
CATV	cable television	used for Internet connection service as well as distribution of cable television and television programs
ADSL, VDSL	Asymmetric Digital Subscriber Line very high bit rate DSL	digital communication method using subscriber line
PHS, 3G, LTE		mobile phone line method
WiMAX		
ONU	optical network unit	communication unit receiving optical fiber connection with FTTH

WiFi	wireless fidelity	wireless LAN
IEEE 802.11(a,b,g,n,ac),		standard of the wireless LAN with the last alphabets indicating the communication speed and the standard for each frequency band used (IEEE: abbreviation of The Institute of Electrical and Electronics Engineers)
WEP	Wired Equivalent Privacy	wireless LAN encryption standard
WPA, WPA2	Wi-Fi Protected Access	wireless LAN encryption standard
WPS	wifi protected setup	standard that facilitates encryption settings between wireless LAN devices
AOSS	AirStation One-touch Secure System	buffalo scheme that facilitates encryption settings between wireless LAN devices
Ethernet, 10Base-T, 100Base-TX, 1000Base-T		wired LAN standard with numbers indicating communication speed (bps)
UTP	Unshielded Twisted Pair	twisted pair wire used in Ethernet, the whole of which is not shielded by a conductor
IP	internet protocol	protocol for delivering packets (datagram) over the Internet, packet arrival not guaranteed (the term TPC/IP is used because TCP is often used together)
TCP	transmission control protocol	protocol for realizing continuous communication on IP with maintaining the order of data
UDP	user datagram protocol	protocol for using packet (datagram) communication on IP from user program
DHCP	dynamic host configuration protocol	protocol for dynamically configuring IP address of computer provided by server
NTP	network time protocol	protocol for receiving time information from server via the network
DNS	domain name system	mechanism for accessing by domain name instead of IP address
HTTP	hypertext transfer protocol	protocol for accessing Web pages, protocol with TLS/SSL written as HTTPS
PPTP	point to point tunneling protocol	one of the protocols for configuring VPN
SMTP	simple mail transfer protocol	protocol for delivering messages between mail servers, and sending messages from mail software to mail servers, protocol with TLS/SSL written as SMTPSs

POP	post office protocol	protocol for receiving messages from the mail server, currently version 3 is used and written as POP3, protocol with TLS/SSL is written as POP3s
IMAP	internet message access protocol	protocol for receiving messages from a mail server, currently version 4 is used and written as IMAP4, protocol with TLS/SSL is written as IMAP4s
TLS, SSL	transport layer security secure sockets layer	communication method for encrypting and protecting WWW communication etc.
FQDN	fully qualified domain name	domain name without omission in DNS
WWW	world wide web	information space for providing pages mutually referred by hyperlinks on the Internet
SNS	social network service	service for supporting communication of specific intellectuals
URL	uniform resource locater	description of the website location based on certain rules
ISP	internet service provider	internet service provider
VPN	virtual private network	technology for constructing a network for a specific organization protected by encrypted communication on the Internet
NAS	network attached storage	storage such as a disk drive connected to the network
SMS	short message service	delivery service for sending short text messages to telephone numbers between mobile phones
To, Cc, Bcc,	To, carbon copy, blind carbon copy	headers for writing e-mail destinations
DoS, DDoS	denial of service distributed DoS	attack that interferes with a server or other functions, attack from multiple computers called a DDoS attack
IoT	internet of things	Internet of Things with various things connected to the network
M2M	machine to machine	Machines are directly connected by a network, similar concept to IoT
CPS	cyber physical system	system that combines the virtual space and real-world devices
P2P	peer to peer	system in which end computers directly communicate with each other without using servers
SSID, ESSID	(Extended) Service Set Identifier	name for identifying each wireless LAN group
TKIP	Temporal Key Integrity Protocol	encryption method adopted in WPA (standard for wireless LAN encryption)

IPv6	Internet Protocol Version 6	IP version 6 with IP addresses possible to be expressed in 16 bytes (128 bits), migration being progressed as a successor to IPv4 that faces the problem of address space exhaustion
ARP	Address Resolution Protocol	protocol for identifying the MAC address of the receiver from the IP address in IP communication on the network
NAT	Network Address Translation	technology for converting private IP address to global IP address during Internet communication
MAC address	Media Access Control Address	unique number assigned by the manufacturer in advance for each LAN device, a numerical value in 48 bits represented as “〇〇-〇〇-〇〇-〇〇-〇〇-〇〇” with one byte in two hexadecimal digits connected by “-” or “:”
VDI	Virtual Desktop Infrastructure	platform for realizing an environment in which processing performed by each user’s terminal is centralized on a virtualized PC in the server, and the user only performs input/output on the screen displayed on the terminal
IKEv2	Internet Key Exchange Version 2	one of the VPN connection technologies, protocol for realizing a secure connection with the other party by personal authentication, encryption, etc.
AES	Advanced Encryption Standard	one of the common key cryptosystems

Other		
GPS	global positioning system	positioning system using artificial satellites
Felica		IC cards developed by Sony, used for transportation cards and Kyoto University student certificates
QR Code		one of 2D barcode types
IR	infra-red	infrared (UV: Ultra Violet)
CGM	consumer generated media	consumer generated media
FAQ	frequently asked question	frequently asked question
CC	creative commons	mechanism in which the author indicates in advance the conditions of use for credit display, modification, etc. in order to promote the distribution of multimedia contents
ICT	Information and Communication Technology	Information and Communication Technology
CAD	Computer-Aided Design	method or software for designing a machine using a computer

Information Systems for University and Academic Use		
IR	institutional research	research conducted at universities for campus decision-making and planning in various areas
HPC	high performance computing	high performance computing using super computers etc.
LMS	learning management system	learning management system, system similar to Course Management System
CMS	course management system	course management system (for example, PandA of Kyoto University)
CMS	content management system	system for managing web pages
MOOC	massive open online courses	public online courses such as EdX provided by Kyoto University
SPOC	small private online courses	online course that uses the same technology as MOOC for internal use within the university

Information Services in Kyoto University and Academic Institutes		
KUINS	Kyoto University Integrated Network System	wired and wireless LANs at Kyoto University
KULASIS	Kyoto University's Liberal Arts Syllabus Information System	syllabus information system for course registration and syllabus browsing
KUMOI	Kyoto University Mail cLOUD Interface	nickname of the student mail system
KULINE	Kyoto University Libraries Information NETWORK system	book collection search system of the university library
KURENAI	Kyoto University Research Information Repository	repository of Kyoto University which publishes papers etc.
PandA	People and Academe	course management system of Kyoto University
Gorilla	Global Online Resources for International Language Learning Assistance	system for language learning at Institute for Liberal Arts and Sciences
CiNii	Citation Information by NII	academic information database of the National Institute of Informatics
eduroam		international academic wireless LAN system developed in Europe. Wireless LAN connection possible at other higher education institutions that are members of eduroam

ECS-ID	Educational Computer System ID	account for students provided by Kyoto University
SPS-ID	School Personnel System ID	account or faculty members provided by Kyoto University

Appendix 2 Assessment Criteria

Appendix Assessment Criteria of Practice of Basic Informatics

These assessment criteria are used to assess achievement of learners in topics treated in the course Practice of Basic Informatics. Level C is the level required to pass the course, level A is a goal of this course. Level S shows the goal that learners should acquire in the whole undergraduate program. Topics with a white background color are not covered in this course.

Topic Category	Subcategory	Topic	Level C	Level A	Level S	Notes
			Necessary skills have been acquired but are insufficient (at the level needed to pass the course)	Level that meets necessary basic skills (goals of this course)	Level to be achieved in the undergraduate program	Considered in teaching and assessment methods
Using in-campus information services and network						
		in-campus information services	The learner understands in-campus services but can use only some of them.	The learner understands and uses in-campus information services.	The learners use the in-campus information services effectively for his/her learning.	Assessed by usage of KULASIS, PandA(LMS), and KUINS (campus network).
		Connecting PC to the campus network	The learner can connect his/her PC or smartphone to the campus network and VPN services with help of supporting staff.	The learners understands the necessity of encryption, and can connect his/her PC and smartphone to the campus network and VPN services.	The learner can connect his/her devices choosing methods adequately if multiple methods are available.	Assess through practice.
Formal communication with e-mail						
		Composing appropriate messages	The learner can compose messages explicitly describing subject, sender and recipient(s).	The learner can compose messages explicitly describing subject, sender and recipient(s), and write appropriate content formally.	The learner can use fields for recipients such as Cc, Bcc, Reply-to adequately and can use e-mail for communication among groups	Assess through practice.
		Proper handling of received messages	The learner understand proper handling of receives messages, and practices it.	Same as on the left	Same as on the left	Assess with tests
		Consideration of attachments	The learners can attach files of adequate sizes, but can't compress them or encrypt them.	The learners can attach files of adequate sizes, and can encrypt important files	The learner understands how to send files other than attachments, their safe usage, and can use them appropriately in e-mails.	Assess through practice.
		Operation of LMS used in classes.	The learner can see files and submit assignments with LMS, but does not fully meet the requirements.	The learner can see files and submit assignments with LMS adequately.	The learner can effectively organize usages of KULASIS, LMS and the Student Mail System.	Assess through usage of LMS(PandA)
		Rules about using information networks.	The learner is aware of the notices about using the information network to some extent but is insufficiently practiced.	The learners knows the rules about using information network, and adheres to them.	The learners continuously acquires the rules by him/herself and improves his/her practice.	Completion of information security e-Learning
Intellectual production (知的生産, words invented by Tadao Umesao) in university and utilization of ICT			The learner partly understands and practices the usages of ICT for intellectual production in courses and extracurricular activities	The learner understands and practices the usages of ICT for intellectual production in courses and extracurricular activities	The learner actively understands and practices the usages of ICT for intellectual production in courses and extracurricular activities	Assess in the following topics
Basics of the personal computer and OS						
Basic knowledge of computer and OS and their secure operation (such as information security and proper use of software licenses) as an independent PC owner						
		Understanding the basic mechanism of the computer and the role of the OS	The learner has basic knowledge of the mechanism of computer and roles of OS to some extent, but needs other's assistance for safe operation.	The learner has basic knowledge of the mechanism of the computer and the role of the OS, and can operate them safely.	The learner has basic knowledge of the mechanism of the computer and the role of OS, and can troubleshoot and improve their performance.	Assess with tests
		Proper use of software licenses	The learner understands software licensing, and uses it properly	The learner understands software licensing, and use it appropriately	The learner understands software licensing, and use software which is licensed to university, and open source software appropriately	Assess with tests
		Connecting external devices to a PC.	The learners can operate networks, printers and external storage, while he/she needs assistance in connecting them to the PC	The learners can connect networks, printers and external storage to the PC by him/herself.	The learners can set up a wired or wireless network, and can connect a PC a printer etc. by him/herself.	Assess with tests
		Operation of OS as the basis for using applications (files, devices such as printers, networks, processes, memory, users, start up, shutdown, and GUI) . Type of OS such as Windows or Linux is an option.	The learner can set up required OS functionality, with assistance.	The learner can set up required OS functionality by him/herself.	The learner can set up required OS functionality, for effective and efficient use of the PC.	Assess with tests
		Touch typing, shortcut keys, and typing in English	The learner 1) understands touch typing, and practices to some extent, 2) uses shortcut keys, 3) knows the rules for English typing and practices these and 4) can use character codes adequately.	The learner 1) understands touch typing and practices it. 2) ~ 4) same as on the left	The learner 1) practices touch typing well, 2) can operate the PC to some extent without a mouse, 3) same as on the left 4) can select appropriate character codes, and can convert them if necessary	Assess with typing speed, and composing documents in English
Academic information seeking and use of University library			The learner understands information resources provided by the University library, and can seek necessary information to some extent.	The learner understands information resources provided by the University library, and can seek necessary information comprehensively and systematically.	The learner understands information resources provided by the University library, can seek necessary information effectively and efficiently, and use these critically.	Assess with tests and information search practices.
Information processing with a spreadsheet						
		Data presentation adequate for processing, skills for validation of data	The learner can compose a spreadsheet taking data processing into account.	The learner can compose a spreadsheet taking data processing into account, and can set up input validation to avoid orthographic variants.	In addition to level A, the learner can check input data effectively	Assess through making of spreadsheets

	Basic operation of data, sorting, aggregation and cross tabulation	The learners can sort data for analysis, and can operate simple aggregation	In addition to level C, the learner can operate cross-tabulation	In addition to level C, the learner can operate aggregation with multiple conditions according to his/her need for analysis.	Assess through making of spreadsheets
	Numerical simulation using a spreadsheet	The learner can carry out simulation of given difference equations.	The learner can operate simulations, changing model parameters.	The learner can construct simulations according to his/her need.	Assess through making of spreadsheets
	Plotting data as charts for visualization, requirements for charts for academic documents	The learner can plot data as a chart, but fails in selecting an adequate format.	The learner can plot data as a chart, and formats such as axes are adequately set and necessary information is provided.	The learner can select chart types according to his/her need, and can make charts with appropriate formatting.	Assess through making of spreadsheets
Using word processor for academic writing					
	Skills of using word processor for academic writing. Converting logical structure to physical presentation, using templates and styles, cross references				
	Creation of structured documents	The learner can compose paragraphs and headings with physical expression by inserting spaces and newlines.	The learner can use templates for paragraphs and headings, and edit them with the outline view.	In addition to level A, the learner can adjust templates according to his/her need.	Composition of documents
	Inserting figures and tables	The learner can make document with figures and tables. The learner inserts captions and numbers of figures and tables manually.	The learner can insert captions and numbers of figures and tables using styles and resolving cross-references automatically.	In addition to level A, the learner can adjust the format of figures and tables according to his/her need.	Composition of documents
	Appropriate writing of references, citations, and proper quoting of copyrighted materials	The learners can make references with adequate bibliographical information. The learner understands difference of plagiarism and quote, and can make adequate quote.	In side a document, the learner can solve cross-references among citations and references automatically. The learners can manage references adequately.	In addition to level A, the learner can manage references efficiently and utilize them using tools for reference management. The learner understands the format required in his/her academic field, and can make documents accordingly	Assess with tests and composition of documents
	Communication skills such as review of created documents	According to review on the printed document, the learner can revise his/her document.	The learner can use review functions of the word processor, such as recording changes, attachment of comments and reflecting on the changes.	The learner can review documents written by others.	Assess by practice of review
Collaboration over network					
	Skills for collaboration over a network such as file and document sharing	The learner can access files using services available to him/her.	The learner can share files with adequate control of access and respecting copyright with available services.	The learner can organize group work using services on the information network.	Assess through usage of LMS(PandA)
	Alerts about use of social media	The learner understand risks of using social media and take ethical behaviors.	The learner understand risks of using social media and can offer information appropriately	The learner can use social media adequately and actively.	Completion of information security e-Learning
Skills for presentation					
	Creation of slides				
	Structuring slides	The learner can create almost logically structured slides, while some inadequacies remain.	The learner can create logically structured slides.	The learner can create slides structured effectively, considering their audience.	Assess through presentation or composition of slides.
	Use of charts and tables in slides	The learner can insert charts and tables into slides, but their use in presentations is insufficient.	The learner can insert charts and tables into slides and use them in his/her presentation.	The learner can present his/her slides effectively using charts and tables.	Assess through presentation or composition of slides.
	Use of visual effects	The learner uses visual effects, but usage is not fully adequate.	The learner can use visual effects adequately in his/her presentation.	The learner can use visual effects in his/her presentation effectively.	Assess through presentation or composition of slides.
	Presentation				
	Making a presentation within an allocated time	The learner can use presentation time almost adequately.	The learner can use presentation time effectively.	The learner use his/her time with an effective schedule for his/her presentation.	Assess through presentation
	Responses to questions	The learner take time to refer to slides. He/She doesn't take note of questions.	The learner can answer questions adequately on referring to slides, and records this.	The learner can prepare slides for possible questions and discuss things constructively.	Assess through presentation
	Presentation by a team	The learner can collaborate with team members to make a presentation effective, to some extent.	The learner can collaborate with team members to make an effective presentation.	The learner can make a presentation even if some of the members absent.	Assess through presentation and peer evaluation
	Use of graphical expression such as diagrams and charts	The learner can use graphical expression such as diagrams in his/her presentation, but this is not sufficient.	The learner can use graphical expression such as diagrams in his/her presentation.	The learner can make a presentation using graphical expression effectively and creatively.	Assess through presentation or composition of slides.
	Basics of programming (optional)	The learner has experience of programming, but can't write a program by him/herself.	The learner understand basic elements in a programming language and can write small programs.	The learner can make small programs as his/her problem solving tools.	Assess thorough programming assignments