A Frames Approach to the Semantics of Nouns

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Abstract: This article presents a theoretical extension of Frame semantics (cf. Fillmore 1982, 1985, Fillmore and Atkins 1992) to describe the semantics of nouns. In Frame semantics, word meaning is analyzed in relation to a situational concept, frame, which comprises roles called frame elements. We present an analytical framework for nouns in Frame semantics. The proposed model posits three classes in the category of noun: (i) common nouns, (ii) role nouns, and (iii) event nouns. Common nouns do not evoke a particular frame (e.g., *dog, cat, ...*). In contrast, role nouns and event nouns evoke a particular frame, and distinguished in terms of whether they denote a part [role] of a frame, namely, a frame element (e.g., *killer* for `Killing`) or a frame itself (e.g., *destruction* for `Destroying`).

Keywords: Frame semantics; semantics of nouns; common nouns; role nouns; event nouns

1. Introduction

This article presents a theoretical framework for analyzing senses of nouns in Frame semantics. Though many articles have addressed the nature of Frame semantics (cf. Fillmore 1982, 1985, Fillmore and Atkins 1992, Fillmore et al. 2003), most focus on verb meaning. This is because some nouns like *dog* or *cat* do not evoke a specific frame. The model proposed in this paper posits three classes of noun: (i) common nouns, (ii) role nouns, (iii) event nouns. Common nouns are modeled as nouns that do not evoke a particular frame (e.g., *dog, cat, ...*). In contrast, role nouns and event nouns evoke a particular frame, and distinguished in terms of whether they represent a part [role] of a frame (e.g., *killer* for `Killing`) or a frame itself (*destruction* for `Destroying`). The theoretical framework presented here is an application of analyses of FrameNet (Baker et al. 2003, Fillmore and Baker 2015, Ruppenhofer et al. 2016), as well as an extension (or inheritance) of Kuroda and his colleagues' work (cf. Kuroda and Isahara 2005, Kuroda et al. 2006a,b).

The paper is structured as follows: Section 2. reviews two major approaches used in the description of nouns: the "thesauri approach" and "dictionary approach." The proposed model falls under the latter. Section 3. reviews the basic idea of Frame semantics and introduces a semi-formal representation of frames. Section 4. presents the three classes of nouns. Finally, Section 5. provides a summary.

2. Two Approaches: Thesauri vs. Dictionary

Following Murphy (2003, 2010), this section introduces two approaches to the description of nominal semantics, namely **thesauri** approach and **dictionary** approach. The former describes the meaning of a word in relation to another word: for example, a *dog* is described as a special case of an *animal*. The latter describes the meaning of a word as a bundle of certain characteristics: a *dog* is described as a bundle of features such as {+ ANIMAL, + TAMABLE, ⋯ }. After a brief review of these approaches, it will be argued that both have certain drawbacks. In addition, the reason for adopting **Frame semantics** in the description of nominals is introduced.

2.1 Thesauri Approach

This section discusses the thesauri approach, which describes word meaning in relation to other word sense(s). It is argued that the major relations used in this approach are not sufficient in describing the relation observed in the role nouns.

The most frequent relations used in this approach are (i) **synonymy**, (ii) **antonymy**, (iii) **hyponymy**, and (iv) **meronymy**. These major relations are defined as (1).

(1) a. Synonymy: the relation that is characterized in terms of the similarity between words (e.g., *sofa–couch*, *dog–doggy*, ...).

b. Antonymy: the relation that is characterized in terms of oppositeness or contradiction (e.g., *love/hate*, *heaven/hell*, ...).[1]

c. Hyponymy: the relation that is characterized in terms of superordination and subordination (e.g., *dog* ⊂ *animal*, *water* ⊂ *liquid*, ...).

d. Meronymy: the relation that is characterized in terms of a part and whole (e.g., *hand* ⊆ *arm*, *arm* ⊆ *body*, ...).[2]

Descriptions of word senses based on these relations are proven useful in thesauri like WordNet (Fellbaum 1998). The most frequently used kind of relation in noun description is hyponymy (Miller 1998, Cruse 2002). Cruse (1986: 136) presents a lexical hierarchy of natural kind nominals which is shown as Figure 1.

Such analysis of nouns reveals some of the fundamental aspects of word meaning. However, the exhaustive application of this analysis does not sufficiently capture the word meaning. Words whose meanings denote a natural kind fit well into this kind of analysis, but those whose meanings denote a role or an event raise certain difficulties to yielding a lexical hierarchy like the one in Figure.1. For instance, answering a question like "*Is a buyer a kind of person?*" is not as straightforward as a question like "*Is a dog kind of an animal?*"

[1] The most typical antonym pair would be that of adjectives such as *hot/cold* or *dead/alive*. There is a room for discussion on the topic of whether pairs like *love/hate* and *heaven/hell* qualify as true antonym pairs.

[2] For convenience, the notation '$x \subseteq y$' is used to mean 'x is part of y.'

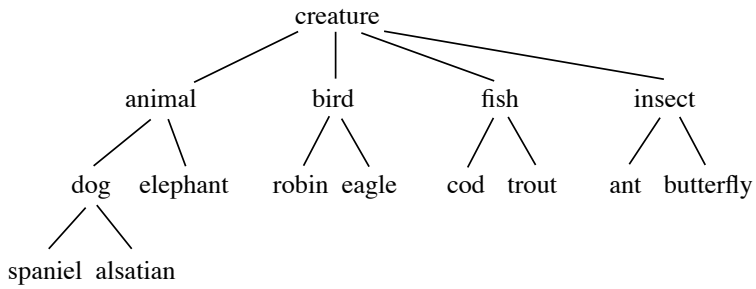

Figure.1 Lexical hierarchy of creatures (Cruse 1986: 136)

Fellbaum (2015: 356) states that there are at least three kinds of hyponymous relations: (i) types, (ii) instances, and (iii) roles. Types correspond to the inheritance relation between sortal classes, as observed in the relation between *dog* and *animal*. Then, instances correspond to the token in a type–token relationship. For example, the proper name *Obama* is a terminal leaf of the role *president*. Finally, roles correspond to the time-dependent type. If something is a *dog*, it will be a *dog* until it dies. In contrast, if someone is a *chairperson*, she will not necessarily be a *chairperson* forever. One cannot be certain if a given person is a chairperson without knowing relevant information on the time and event.

The importance and efficiency of the thesauri approach to nominal meaning should be recognized in the description of nouns. However one cannot employ the relations in (1) exhaustively. Specially, some kinds of relations observed in a group of words like {*waiter*, *customer*, *cook*} are left unanalyzed (cf. Croft and Cruse 2004: 7). As will be clear in Section 3. and 4., Frame semantics enables one to analyze these words in an intuitive and rigorous way by employing a situational concept.

2.2 Dictionary Approach

This section discusses the dictionary approach, which describes word meaning in terms of a finite set of features. It is argued that the qualia structure proposed by Pustejovsky (1995) carries unnecessary information.

Pustejovsky's innovative method to describing nominal meaning introduced the **qualia structure** as part of **Generative Lexicon** theory. This structure consists of four roles: (i) Formal, (ii) Constitutive, (iii) Telic, and (iv) Agentive. These are defined in (2). Using these criteria, one can describe the sense of the word *book* as in (3).

(2) i. Formal: the basic category of which distinguishes the object within a larger domain (i.e., what *x* is)

ii. Constitutive: the relation between the object and its constituents or proper parts (i.e.,

what x is made of)

iii. TELIC: the purpose or function of the object (i.e., function of x)

iv. AGENTIVE: the factors involved in the object's origins or "coming into being" (i.e., how x came into being)

(Pustejovsky 1995: 86–87)

(3)
$$\begin{bmatrix} \text{book(x, y)} \\ \text{QUALIA} = \begin{bmatrix} \text{FORMAL} = \text{information(y)} \\ \text{CONSTUTIVE} = \text{bound\_pages(x)} \wedge \text{disk(x)} \\ \text{TELIC= read(T, w, y)} \\ \text{AGENTIVE} = \text{artifact(x)} \wedge \text{write(T, z, y)} \end{bmatrix} \end{bmatrix}$$

(Cited from Pustejovsky (1995: 116) with a slight modification)

Pustejovsky's analysis is proven powerful. However, his approach may include some unnecessary information. Assuming that a qualia structure like (3) is obtained from corpus data, one faces difficulty in positing these qualia. For example, if an author dedicates the book to someone, should this information be stored as a TELIC role? If someone places the book on a bookshelf, should this information be stored as a TELIC role as well? Interactions between the object and event can be complicated. If one analyzes the word *book* in a generative lexicon style, each qualia role could become something like "$p_1 \vee \ldots \vee p_n$". Such union of propositions could become vast and ultimately lead to a reduction in efficiency. However, this aspect of the nouns is not a problem in Frame semantics because a noun can evoke multiple frames.

3. Frame Semantics

This section provides an overview of Frame semantics. As will be discussed in Section 4., Frame semantics can serve as an alternative descriptive method for nominal meaning. This section is intended to serve as a premise for such a model.

It is ordered as follows. Section §3.1 presents the basic characteristics of the theory through an analysis of verbs related to commercial transaction. Then, Section §3.2 describes representations of frames and frame elements. Finally, Section 3.3 discusses frames relations and frame element relations.

3.1 Basic Idea

This section explains the basic background of Frame semantics, with the goal of shedding light on the intuitive characteristics of the model.

Frame semantics is a theory of lexical analysis developed by Charles J. Fillmore and his colleagues (cf. Fillmore 1977, 1982, 1985, 2003). In Frame semantics, word meaning is described relative to a situational concept, **frame** (or **semantic frame**).[3]

For instance, the verb *sell* expresses a relation between a seller and goods in a commercial transaction. The situation can be described as "A Buyer trades her Money for Goods provided by a Seller." This situation involves at least four elements: ⟨Buyer⟩, ⟨Seller⟩, ⟨Goods⟩ and ⟨Money⟩. The elements that make up a frame are called **frame elements**. Hereafter, a frame element will be referred to as ⟨Frame_element⟩ with san-serif font and a frame as `Frame` with a typewriter font.

Verbs expressing the same situation have different patterns of realizing frame elements. In this case, *buy, charge, spend, pay* and *cost* express the same situation as *sell*. Table 1 summarizes the patterns of frame elements realized by each verb. Direct and indirect objects are notated as "D-Obj" and "I-Obj," respectively. Parentheses indicate optionality, and square brackets represent omissibility under definite anaphora. A preposition represents its realization pattern as a preposition phrase.

Table.1 `Commercial_transaction` and its frame elements (Fillmore and Atkins 1992: 72)

	⟨Buyer⟩	⟨Seller⟩	⟨Goods⟩	⟨Money⟩
BUY	Subj	(from)	D-Obj	(for)
SELL	(to)	Subj	D-Obj	(for)
CHARGE	(I-Obj)	Subj	(for)	D-Obj
SPEND	Subj	NULL	for/on	D-Obj
PAY_1	Subj	[I-Obj]	[for]	D-Obj
PAY_2	Subj	(to)	for	D-Obj
COST	(I-Obj)	NULL	Subj	D-Obj

The words analyzed in this fashion are **lexical units**, a pair of a sense and a form (cf. Cruse 1986: 49). When a sense of a word (e.g., *sell*) is related to a particular frame (e.g., `Commercial_transaction`), the lexical unit *lu* is said to **evoke** the frame *f*.[4] In this case, verbs such as *buy, sell, charge, spend, pay*, and *cost* are said to evoke `Commercial_transaction`.[5] In a sentence like '[⟨Buyer⟩ Alice] bought [⟨Goods⟩ Porsche]', *bought*

[3] Fillmore (1982: 111) defines a frame in a general way: *any system of concepts related in such a way that to understand any one of them you have to understand the whole structure it fits*. However, this definition is too general to constrain. The advantages of defining frame as a situational concept are discussed in previous studies (Kuroda and Isahara 2005, Kuroda et al. 2006a).

[4] Fillmore et al. (2012) discusses the possibilities of extending this analysis to morphemes and constructions. In this article, an evoker of a frame is assumed to be a lexical unit for the sake of simplicity.

[5] In the current FrameNet, this frame is treated as a complex object, which has two or more subframes. Here,

evokes Commercial_transaction, and *Alice* **instantiates** the frame element ⟨Buyer⟩, and *Porsche* instantiates ⟨Goods⟩.

In recent years, Frame semantics has been employed as the theoretical basis of FrameNet (Fillmore et al. 2003). FrameNet is a computational lexicography project based on Frame semantics and it offers descriptions of the relationships between lexical units and the frames they evoke (Ruppenhofer et al. 2016).[6] In this article, most frames are cited from FrameNet data.

3.2 Frames and Frame Elements

This section aims to provide more concrete definitions of the following important concepts: frames, frame elements, and **evocation**.

In the literature, a frame is sometimes interpreted in an all-encompassing way, which makes it difficult to evaluate an analysis of a given text. Fillmore (1985: 228) discusses the case of *hypotenuse* to argue that a lexical meaning needs a conceptual underpinning. This is because a knowledge about right angle triangles is required to understand the word *hypotenuse*. However, the conceptual structure required by *hypotenuse* and the other conceptual structures required by *sell* seem qualitatively different. One is a static structural concept, whereas the other is a situational concept, which causes a theoretical confusion.

To avoid such confusion, we redefine a frame as a data structure that comprise frame elements as (4-5). The part-whole relation between a frame and its n frame element(s) can be represented as '$\texttt{part\_of}(\{\langle \mathsf{FE}_1\rangle, \ldots, \langle \mathsf{FE}_n\rangle\}, \texttt{Frame}_i)$.' For example, Commercial_transaction is represented as 'part_of(⟨Buyer⟩, ⟨Seller⟩, ⟨Goods⟩, ⟨Money⟩}, Commercial_transaction).' The relation between frame elements can be interpreted in a meaningful way, but such relation is not described directly.

(4) Frame: A frame is a data structure of a situational concept, which consists of a finite number of roles. The relation between roles will be notated informally as "⟨Who⟩ did ⟨What⟩ to ⋯⋯" and its name as Frame.

(5) Frame Element: A frame element is role of a situational concept that makes up a part of a frame, notated as ⟨Frame_Element⟩.

A frame can also be interpreted as a **class**, a set of whose elements constitute a specific situational concept (cf. Mizoguchi 2004: 195). When a sentence contains a word that evokes a certain frame, the sentence is said to constitute an **instance** of the frame. This point is illustrated through a simplified version of Killing, defined in (6)

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a technical discussion regarding a complex frame and its subframes is ignored for the sake of simplicity. The characteristics of subframes are described in Section 3.2. Also, Fillmore and Baker (2015: 806–810) gives a brief overview of a complex frame.

[6] FrameNet data are available at https://framenet.icsi.berkeley.edu/fndrupal/

(6) `Killing`: ⟨Killer⟩ takes a life of ⟨Victim⟩ with or without an ⟨Instrument⟩

Let us assume we have observed two sentences like (7) in a given corpus. Since the verb *kill* evokes `Killing` in both sentences, each noun phrase is analyzed to instantiate some frame element. The results of the analysis using `Killing` are summarized as Table 2. These sentences are treated as instances of `Killing` in the sense that each of them realizes some frame elements somehow. Because these instances are not identical utterances, each instance is marked with indexes {1, 2}. In this case, `Killing` is treated as a kind of set whose instances are $\texttt{killing}_1$ and $\texttt{killing}_2$.

(7) a. Alice killed the creature with a gun.
b. The creature killed Bill.

Table.2 Instances of `Killing` obtained from (7)

		⟨Killer⟩	⟨Victim⟩	⟨Instrument⟩
(7a)	$\texttt{killing}_1$:	Alice	the creature	a gun
(7b)	$\texttt{killing}_2$:	the creature	Bill	ϕ

Each instance of `Killing` is instantiated through the realizations of each frame element. The instantiation of a frame element can be expressed as $\texttt{killing}_i.\langle \mathsf{FE}_j \rangle$, which denotes the realized value of $\langle \mathsf{FE}_j \rangle$ in $\texttt{killing}_i$. Index i corresponds to the numbering of the instance, and j corresponds to some frame element of the instantiated frame i. In this fashion, the realized value of each ⟨Killer⟩ is obtained as '$\texttt{killing}_1.\langle \mathsf{Killer} \rangle$ = *Alice*' and '$\texttt{killing}_2.\langle \mathsf{Killer} \rangle$ = *the creature*.'

In Section 3.1, *lu*'s evocation of f (i.e., *lu* evokes f) was characterized informally. Following the discussion above, two types of evocation can be distinguished. These are shown in (8)

(8) Evocation: A lexical unit *lu* evokes `Frame` when:
i. *lu* realizes the $\texttt{Frame}_i.\langle \mathsf{FE}_j \rangle$ or;
ii. *lu* denotes $\texttt{Frame}_i.\langle \mathsf{FE}_j \rangle$ or a relation between such roles.

(8) states the following: a set of noun phrases {*Alice, the creature, a gun, Bill*} evokes `Killing` in the sense of (8i), and deverbal nouns like *killer* and *killing* evoke `Killing` in the sense of (8ii).

How these lexical units evoke the frame can differentiate the strength of evocation. A lexical unit that evokes a frame in the sense of (8i) is called an **evoker**, and the other is called a **governor**. This distinction has not been made clear in the previous literature.

3.3 Relation Between Frames and Relation Between Frame Elements

Theoretical constructs such as frames and frame elements do not stand alone. They stand in some relation to another construct. This section discusses the relation between frames and the

relation between frame elements.

3.3.1 Relation Between Frames

A frame is characterized as a situational concept that consists of a finite number of frame elements and each frame does not exist in isolation. In the current version of FrameNet, four frame relations are posited between frames: (i) **inheritance**, (ii) **using**, (iii) **subframe**, and (iv) **perspective on**. This section introduces two relevant relations, inheritance and subframe.

Firstly, we look at inheritance, in which one frame is a special case of the other. For instance, the frame `Killing` inherits a general frame called `Transitive_action`, which is defined as "an ⟨Agent⟩ or ⟨Cause⟩ affecting a ⟨Patient⟩." `Killing` **inherits** `Transitive_action` in the sense that the former is a special case of the latter. This relation is called **inheritance** between frames (Ruppenhofer et al. 2016: 80–82). When $\texttt{Frame}_1$ inherits $\texttt{Frame}_2$, frame elements of $\texttt{Frame}_2$ corresponds to those of $\texttt{Frame}_1$.

Secondly, we look at subframes, where one frame functions as part of another concept. `Killing` is just one of many situational concepts worth verbalizing (at least in an English-speaking community). However, a sentence like (9) expresses a "bigger" concept that incorporates more than two frames.

(9) The creature's killing of Bill made Alice upset.

In (9), at least three concepts are involved. The first is an instance of `Killing` that is instantiated by *the creature* and *Bill*. The second is *Alice*'s emotional reaction towards the instance of `Killing`. The third is a causal relation where the first caused the second.

Differences between these concepts can be described by positing a **scenario**, which consists of instantiated frames. According to FrameNet, the construction [X make Y Z], where X is the cause and Y and Z are the effect, evokes ⟪`CAUSATION_SCENARIO`⟫.

As mentioned, (9) involves three types of concepts. The first is $\texttt{killing}_i$, instantiated by *the creature* and *Bill*. The second is $\texttt{emotion\_directed}_j$, instantiated by *Alice* and $\texttt{killing}_i$, and the third is ⟪`causation_scenario`⟫, instantiated by $\texttt{killing}_i$ and $\texttt{emotion\_directed}_j$. The relation can be captured through a subframe, which allows a frame to be part of a scenario.[7]

3.3.2 Relation Between Frame Elements

Section 3.3.1 discussed relations between frames, namely, inheritance and subframe. This section investigates the relation between frame elements. Since a concept that has a finite number of frame elements is defined as a frame in §3.2, only inheritance relation is relevant in frame

[7] Ruppenhofer et al. (2016: 76–78) discusses a case of a complex frame, which is defined as a bundle of subframes. `Criminal_process` consists of at least five subframes: `Arrest`, `Arraignment`, `Trial`, `Sentencing`, and `Appeal`. Since Ruppenhofer et al. (2016) do not provide an explicit definition of a scenario, I use this term to refer to a complex frame with certain number of subframes.

element relation.

As explained above, *Alice* in the sentence *"Alice killed the creature with a gun"* is an object that realizes killing$_i$.⟨Killer⟩. At the same time, Killing is a special case of Transitive_Action, which consists of ⟨Agent⟩ and ⟨Patient⟩. The goal of this section is to demonstrate how transitive_action$_i$.⟨Agent⟩ is treated in this inheritance relation.

Section 3.3.1 defined inheritance as "Frame$_1$ inherits Frame$_2$ when the former is a special case of the latter and each frame element of Frame$_2$ is bound to a corresponding frame element of Frame$_1$." This bounding relation between frame elements is another variant of the inclusion relation.

According to FrameNet, ⟨Agent⟩ in Transitive_Action is defined as "the entity that acts on another entity" and ⟨Patient⟩ is defined as "the entity that is being acted on." ⟨Killer⟩ in Killing is defined as "the entity that causes the death of the ⟨Victim⟩," and ⟨Victim⟩ is defined as "the living entity that dies as a result of the killing." In both cases, two inclusion relations can be observed (i.e., ⟨Killer⟩ ⊂ ⟨Agent⟩, ⟨Victim⟩ ⊂ ⟨Patient⟩).

As a result, *Alice* in (7a) realizes not only ⟨Killer⟩, but also ⟨Agent⟩. Redundancy of this kind is not subject to exclusion. Rather, it is merely a reflects how specific the analysis is. This suggests that Frame semantics provides a finer-grained analysis, than the approaches discussed in Section 2.

3.3.3 Representation of Frame Relations and Frame Element Relations

In this section, the relations observed in Section 3.3.1 and 3.3.2 are visualized with two relation functions, namely, 'is_a(x, y)' and 'instance_of(x,y).'

Inheritance can be defined as "a class *X* inherits another class *Y* when *X* is a special case (subclass) of *Y* by possessing all the semantic characteristics of *Y*." This is expressed as 'is_a(*X*, *Y*).' Also, "an object *x* instantiates a class *X* when all the characteristics of *X* is realized by *x*." This is expressed as 'instance_of(*x*, *X*).' When these relations are applied in the analysis of *"Alice killed the creature with a gun"*, the following is obtained.

(10) is_a(x, y)

a. Inheritance relationship between frame elements:
   i. is_a(⟨Killer⟩, ⟨Agent⟩)
   ii. is_a(⟨Victim⟩, ⟨Patient⟩)

b. Inheritance relationship between frames:
   is_a(Killing, Transitive_Action)

(11) instance_of(x, y)[8]

[8] Table 2 describes the instance of Killing as killing$_1$. However, (11) only shows the instantiation relationship between frame elements for the sake of simplicity. There is no problem with positing instance_of(killing$_1$, Killing).

a. Instantiation relationship observed in ⟨Killer⟩ and ⟨Agent⟩:
   i. `instance_of`(*Alice*, ⟨Killer⟩)
   ii. `instance_of`(*Alice*, ⟨Agent⟩)
b. Instantiation relationship observed in ⟨Victim⟩ and ⟨Patient⟩:
   i. `instance_of`(*the creature*, ⟨Victim⟩)
   ii. `instance_of`(*the creature*, ⟨Patient⟩)
c. Instantiation relationship observed in ⟨Instrument⟩:
   i. `instance_of`(*a gun*, ⟨Instrument⟩)
   ii. `instance_of`(*a gun*, ϕ)

Figure.1 visualizes (i) the `is_a` relation between frames, and (ii) the `instance_of` relations between frame elements and each noun. Note that full semantic specifications of each frame are not given due to the notational difficulty.

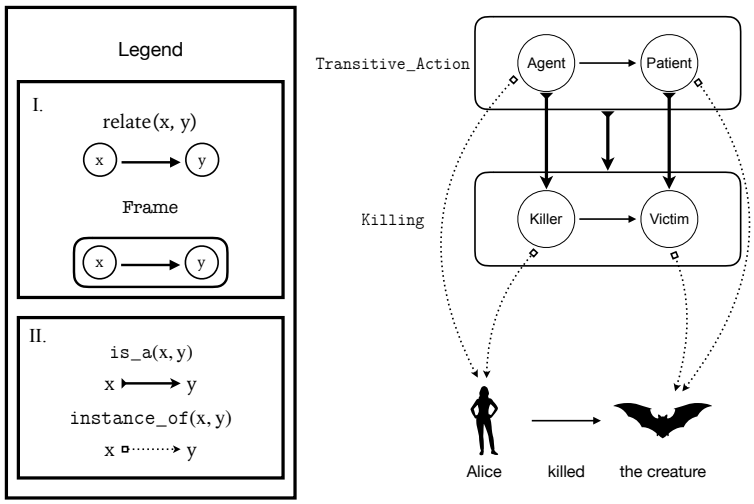

Figure.2 *"Alice killed the creature"* and `Killing`

4. Frames and Nouns

This section introduces the framework for nominal description in Frame semantics. It will be argued that three classes of nouns can be posited by considering the place in the instantiation relationship and the evoker/governor distinction. The first class, called **common nouns**, does not evoke a specific frame and does not instantiate any specific role (e.g., *dog, cat, ...*) The second class, called **role nouns**, evokes a specific frame and instantiates a specific frame element (e.g.,

killer, victim, ...). The third class, called **event nouns**, evokes and instantiates a specific frame (e.g., *annihilation, killing, ...*). It will be shown that these classes are useful in describing the meaning of nouns.

Section 4.1 contains an overview of the characteristics of each class, and Section 4.2 discusses the relations between the noun classes.

4.1 Three Classes of Nouns

The goal of this section is to overview a Frame semantics characterization of nouns. In Frame semantics, a noun is modeled as an entity that instantiates a certain frame element provided by frame(s) evoked by a sentence, as illustrated in Table 2. However, this characterization fails to capture the semantic contribution to frames evoked in a sentence.

For instance, (whether they are definite or indefinite) sense of nouns like *dog* and *cat* are easily modeled as instances of some frame element of some frame. However, nouns like *killer* not only behave the same way syntactically, but they also cannot be described properly without the existence of a certain frame. Nouns like *killing* and *annihilation* seem to denote some kind of event almost parallel to verbs.

To clarify this difference, (at least) three classes of nouns must be posited in a frame semantic analysis of nouns. These are defined as follows.

(12) I. Common nouns: nouns that do not evoke a specific frame and only instantiate a frame element of various frames (e.g., *dog, cat, book, knife, ...*).

II. Role noun: nouns that evoke a specific frame and instantiate at least more than one frame element (e.g., *killer, victim, student, ...*).

III. Event noun: nouns that evoke a specific frame and instantiate the frame (e.g., *destruction, killing, annihilation, ...*).

Characteristics of these classes are informally visualized as Figure 3. Following the definitions in (12), common nouns are distinguished from the others in terms of whether or not they evoke a specific frame. For example, consider the two sentences in (13). The number of frames evoked differs between (13a) and (13b). This is because the noun phrase *the dog* does not evoke a specific frame while the noun phrase *the student* does[9].

(13) a. The creature killed the dog.

b. The creature killed the student.

Since a common noun does not evoke a specific frame, only one frame is evoked in (13a) (assuming there is no contextually evoked frames or scenarios). In contrast, since a role noun evokes a specific frame (i.e., `Education_teaching`), two frames are evoked in (13b) under the same condition.

[9] Note that the sense of *dog* evokes various frames in the sense of (8i), not (8ii).

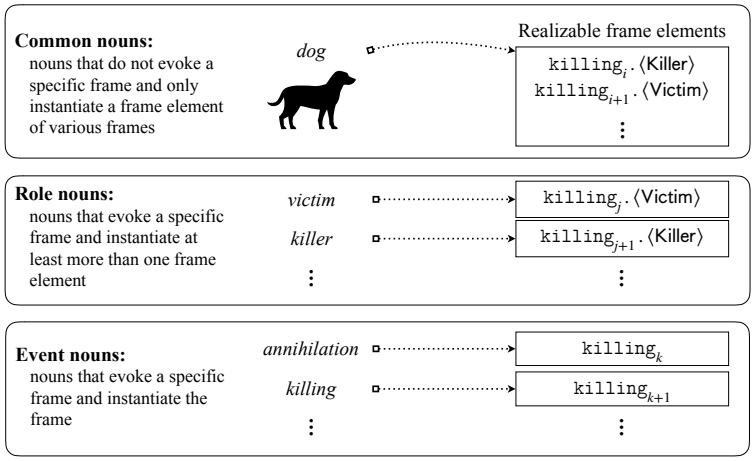

Figure.3 Three classes of noun

Unlike role nouns and event nouns, the semantics of common nouns is usually independent of frames. They are usually analyzable in terms of hyponymy or meronymy. For instance, *dog* is a hyponym of *animal*, and *nose* is a meronym of *dog*. As mentioned above, such analysis yields certain difficulties when one tries to analyze role nouns and event nouns. This is because the semantics of these nouns is dependent on some particular frames.

The following subsections give more detailed characteristics of these classes. Section 4.1.1 reviews common nouns, Section 4.1.2 role nouns, and Section 4.1.3 event nouns. However, note that these classes are (obviously) insufficient to describe the semantics of all nouns. The limitations of this model are briefly pointed out in Section 5.

4.1.1 Common Nouns

This section discusses the property of common nouns. It is argued that contextual variable interpretations of nouns can be captured as interaction between nominal semantics and evoked frame(s).

In general, nouns are not a very popular subject in linguistic analysis (cf. Murphy 2010: 149). However, it is well known that interpretation of some nouns varies greatly from one context to another. Examples from (14) to (16) demonstrate this phenomena.

(14) a. The lamb is running in the field.
b. John ate lamb for breakfast.

(15) a. Mary broke the bottle.
b. The baby finished the bottle.

(16) a. The window is rotting.
b. Mary crawled through the window.

(Pustejovsky 1995: 37)

(14) shows what is called count-mass alternation, (15) container-containee alternation, and (16) figure-ground alternation. Pustejovsky (1995) points to these labels as manifestations of polysemy in natural language.

The assumptions of Frame semantics are useful in this analysis. As mentioned, the subject of lexical analysis in Frame semantics is a lexical unit, a pair of form and sense (Fillmore et al. 2003: 236).[10] A common noun can instantiate multiple frame elements, which means it can evoke various frames in the sense of (8i). Then, one should be able to posit certain clusters of frames based on the interpretation pattern.

For instance, interpretations of *lamb* in (14) should be describable in relation to the evoked frame(s). Each cluster corresponds to an interpretation of the noun as illustrated in Figure 4. This analysis explicitly describes the contextual variability of the noun. The same methodology may be applied to countless examples.

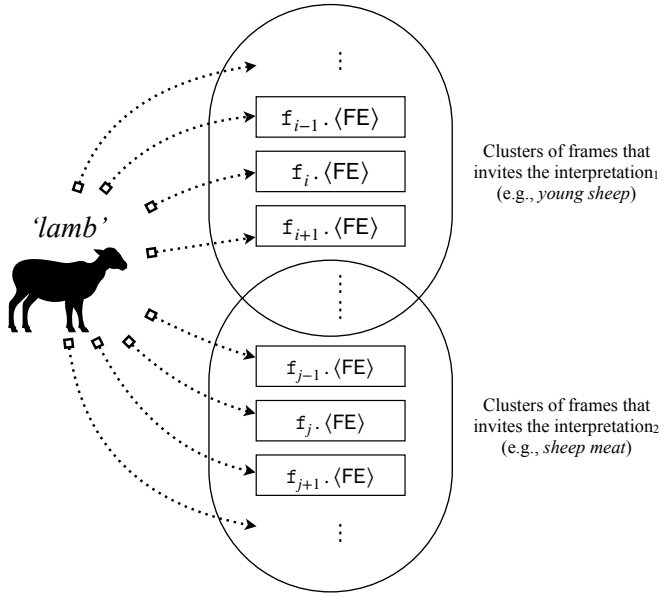

Figure.4 Interpretations of '*lamb*'

Barsalou (1992) described animal nouns {*human, horse, donkey, dog, cat, ...*} using the com-

[10] A detailed procedure for identifying a lexical unit is provided in Cruse (2011: Ch.5).

bination of four attributes SPECIES, SEX, AGE, NEUTURED and their values. The model proposed in this article cannot be used to capture these characteristics directly. However, these properties of nouns should be described indirectly as an instantiation pattern of certain frames.

In Barsalou's approach, the sense of *mule* is analyzed as a bundle of attribute-value pairs. In this case, the value of NEUTURED is 0, reflecting the biological nature of the animal. In our approach, the word *mule* is analyzed as an object that does NOT instantiate `Procreative_sex` unlike *dog* and *cat*. Each common noun has its own frame instantiation patterns, which reflects the structural and biological features.

As shown above, the semantics of common nouns is given in relation to frame(s) evoked in the context and the variability in the interpretation of words is seen as a result of interaction between evoked frames and its sense. This suggests Frame semantics should account for the contextual variability of nouns (cf. Cruse 1995, 2000, 2001, 2004).

4.1.2 Role Nouns

This section discusses the property of role nouns. Role nouns are special cases of relational nouns, which are characterized as nouns with an argument (e.g., *friend, mother, ...*). It is argued that the behaviors of such nouns are accounted for as an instantiation of an evoked frame's frame element(s).

It is well known that relational nouns behave in a syntactically interesting way (De Bruin and Scha 1988, Baker 2011). De Bruin and Scha (1988: 25) state that "[r]elational nouns are semantically unsatured," which means the referent cannot be determined unless a parameter provided by such noun is filled by some entity.[11] For this reason, relational nouns license an indefinite possessive construction unlike other nouns.

(17) a. a day (*of someone) / a birthday of someone
b. a person (*of someone) / a child of someone
c. an animal (*of someone) / a pet of someone

(Baker 2011: 1111)

The noun phrase *a birthday* in (17a) instantiates ⟨Time⟩ in `Being_born`. The *of* phrase specifies some frame element that belongs to the evoked frame. However, the same procedure cannot be applied to *a day* due to its property as a common noun.[12]

The analysis suggests that a relational noun usually instantiates a certain frame element in a specific frame. However, as this article limits the definition of a frame to a situational concept, a frame element should represent a kind of role in a situation. Following Kuroda and Isahara's

[11] Nishiyama (2003) makes a similar distinction between "satured nouns" and "unsatured nouns." Yamaizumi (2013) overviews interesting slot-filling constructions involving unsatured nouns in Japanese.

[12] The noun *day* could be analyzed as a role noun if it is seen as an instantiation of ⟨Time⟩ in `Event`. Though this issue must be considered thoroughly, let us assume *day* is a common noun for simplicity.

proposal, a noun that evokes a specific frame and denotes a frame element in the frame is referred to as a **role noun** (Kuroda and Isahara 2005). This is because words involved in meronymy (part-whole relation) do not necessarily evoke a frame, as in '*arm–body*' or '*leg–body*.'

Descriptions of such nouns are accomplished by a close inspection of an evoked frame and its instantiation of a role by a construction. Theoretically, some constructions are seen as a specification device for roles, and possessive constructions are just one among these constructions.

The word *student* is useful to clarify this point. In *Alice's students*, X in the construction [X's Y] instantiates ⟨Teacher⟩ in `Education_teaching` evoked by *student*. In *physics students*, the nominal modifier specifies ⟨Subject⟩. Patterns of specification can be revealed by an analysis of the given corpus.

Kuroda et al. (2006b) discusses that *victim* evokes a very general frame about harm, and it can denote many kinds of ⟨Victim⟩ (e.g., victim of public disaster, victim of physical destruction, victim of psychological attack, ...). Such a specification of role nouns can be describable in relation to instantiated frame element(s).

Also, this conception applies in the analysis of word formation. Lieber (2004: 28) states that a word with suffix *–er* can denote many things like [Agent] (e.g., *writer*), or [Instrument] (e.g., *opener*), [Experiencer] (e.g., *hearer*). These variants should be describable in relation to a frame evoked by a root verb. Note that Frame semantics can only provide a detailed description; it cannot provide a rule for word formation or similar phenomena.

4.1.3 Event Nouns

This section discusses the property of event nouns. The semantics of event nouns should be describable in relation to the instantiation patterns of frame elements, which are constrained by the construction in which the noun appears. Since there are many studies on this kind of noun, only two points are discussed here: (i) the instantiation of frame elements with periphrasal expression and (ii) support verb construction and its relation to the instantiation of frame elements.

Event nouns are analyzed in relation to the instantiation of their frame elements in a much more straightforward way. The category of event nouns include deverbal nouns like *destruction*. Many researchers have analyzed the argument structure of these nouns by looking at data such as "*the enemy's destruction of the city*" (cf. Chomsky 1970, Grimshaw 1990, Levin and Rappaport Hovav 2005, Taylor 1996, Lieber 2016).

A similar analysis of event nouns is done by Fillmore (Fillmore and Atkins 1992, Fillmore 1994). In Frame semantics, an event noun is described in relation to the instantiation patterns of frame element(s). Fillmore (1994) discusses an example like (18) and describes the realization pattern of frame elements in various constructions that contain the lexical unit *risk*. The underlined part in (18a) instantiates an unfortunate event that can happen if things go wrong (noted as BA), (18b) some possession that might become lost or damaged if things go wrong (noted as PO), (18c) an act that can bring about the danger of things going wrong (notated as DE), and (18d) an protagonist involved in this situation (noted as PR) (Fillmore 1994: 110). This analysis sug-

gests that periphrasal expressions such as *of*, *to*, *in*, and possessive are employed to realize frame elements.

(18) a. the risk of losing your job (BA)
b. the risk to your health (PO)
c. the risk in driving while under the influence (DE)
d. our major risk (PR)

(Fillmore 1994: 114)

Fillmore et al. (2003: 244) suggests that a support verb construction is another way to instantiate frame elements of an evoked frame. In (19), support verbs like *undergo* or *perform* determine the distribution of the frame elements. Without considering the semantics of verbs, one cannot determine whether *Sean* is a patient or a doctor. In FrameNet, event nouns are described as a pairing of support verbs and event nouns (Uchida 2010).

(19) a. Sean underwent a surgical **procedure**.
b. Sean performed a surgical **procedure**.

(Fillmore et al. 2003: 244)

4.2 Relation Between Classes

Three classes discussed so far exhibit some similarities (or some relationship) since a noun of one class behaves like a noun of another. This section overviews some interactions between each class.

4.2.1 Common Nouns and Role Nouns

This section discusses the case where a common noun exhibits a property similar to a role noun.

It is well known that some nouns in a given language form a lexical hierarchy (Cruse 1986, 2011, Miller 1998). For instance, a *spaniel* is a kind of a *dog* and a *dog* is a kind of an *animal* (Cruse 1986: 136). Logically, the more specific the sense of a lexical unit is, the more likely the lexical unit is to evoke a specific frame.

For instance, the lexical unit *knife* denote the concept of KNIFE, and it can participate in multiple frames like *dog*. However, one of its hyponyms *scalpel* is more likely to evoke a specific frame that has to do with a medical procedure. It should be the same for other hyponyms like *bayonet* or *slicer*. Yet it is not so clear if a lexical unit with a more general sense evokes a general frame. This is because frames evoked by a hypernym (e.g., *creature*) do not necessarily include frames evoked by a hyponym (e.g., *dog*) in a given corpus.[13]

[13] Since a frequency of a word cannot be predicted solely by its specificity of the sense, one cannot always observe

4.2.2 Common Nouns and Event Nouns

This section discusses the case where a common noun exhibits a property similar to an event noun.

As discussed above, a common noun does not evoke a specific frame. Some metonymyical expressions seem to be motivated by the instantiation of a certain frame. (i) THE PLACE FOR THE EVENT metonymy and (ii) conversion are discussed to clarify this point.

A proper noun like *Pearl Harbor* can be treated as a common noun in the sense of (12I). The metonymical extension like (20) is motivated by the instantiation relationship between a surprise attack and its location. Cases like these suggest the relationship between common nouns and event nouns.

(20) Pearl Harbor still has an effect on our foreign policy.

(Lakoff and Johnson 1980: 39)

A similar extension motivated by such frame knowledge is observed in conversion. The noun *egg* in (21) is converted to a verb meaning '*egg-throwing*.'

(21) When I was a kid, we often egged houses on mischief night.

(Nakajima 2019: 56)

4.2.3 Role Nouns and Event Nouns

This section discusses the case where the same word form exhibits the property of a role noun and that of an event noun.

Systematic alternation between role nouns and event nouns is a well-known phenomena called **event–result** alternation (Grimshaw 1990, Pustejovsky 1995, Lieber 2004, 2016). The descriptive model in this article describes the alternation in (22) in relation to the evoked frame.

(22) a. The company's merger with Honda will begin next fall.

b. The merger will produce cars.

The proposed model describes each sense as a different lexical unit. These lexical units are described to evoke the same frame, and one lexical unit denotes the result (a role noun) while the other lexical unit denotes the event (an event noun). Pustejovsky (1995) raises this phenomenon as a manifestation of the problem of polysemy in natural language, and argues the need for a generative model in lexical semantics. On the contrary, under the model proposed here, all senses are sufficiently describable.

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an interchangeable context where a set of hypernym(s) and hyponym(s) share the same syntactic environment.

5. Conclusion

This article presented a theoretical framework for analyzing the semantics of nouns using Frame semantics. Three classes of nouns are proposed: (i) common nouns, (ii) role nouns, and (iii) event nouns. These are distinguished based on the evocation and instantiation of a frame. Common nouns like *dog* or *cat* do not evoke a particular frame but can realize various frame elements. On the other hand, role nouns like *victim* or *student* evoke a specific frame and denote a specific frame element in the evoked frame. Then, event nouns like *destruction* or *killing* evoke and denote a specific frame.

However, the proposed model comes with certain drawbacks. First, it is not clear if it can describe attributive nouns like *color* and *size*. Second, hyponymy and meronymy fall out of the scope of the direct analyses. The proposed idea may contain more disadvantages as well. The effectiveness of the proposed model should be evaluated with further empirical analyses.

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