

A Program for Plotting Histograms "HIST"

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A versatile FORTRAN program called "HIST", which plots histograms in various mode on line-printer papers, has been developed. This program is not only used in the course of the analysis of bubble chamber data, but also applicable to most of the other data reduction processes in physical science.

I. INTRODUCTION

We present here a FORTRAN program, called "HIST", which is used to plot various kinds of histograms in the course of the analysis of bubble chamber data by the high-energy physics group of Nara Women's University.

Generally speaking, the data reduction process is one of the most important but cumbersome process in physical science. In bubble chamber physics, for example, the events on films are scanned and measured manually or automatically by using scanning and measuring projectors.¹⁾ Then these measured data are geometrically reconstructed into three dimensional space and the kinematical variables are computed by large computer program chain, *e.g.* THRESH-GRIND,²⁾ or TVGP-SQUAW.³⁾ After these routine processes, the data are accumulated in data-summary-tapes, called DST. Physical analyses of the data are then performed by using these DST's. Since the interactions of elementary particles are statistical phenomena, the first step of the physical analyses is to plot the frequency distributions of dynamical variables, *e.g.* momenta, angles, energies *etc.*, of particles emitted in the final states of the interactions. It is very efficient and time-saving for the analyses to list the various results in a visual form rapidly. We developed a program called "HIST", which plots one or two dimensional histograms on line-printer papers.

The characteristics of this program are as follows.

- a) It is completely written in FORTRAN. No other languages are used.
 - b) It can plot four kinds of histograms, *i.e.*;
 - linear scale, one dimensional histogram,
 - semi-log scale, one dimensional histogram,
 - linear scale, one dimensional histogram which is the difference between two different histograms.
 - linear scale, two dimensional histogram.
 - c) The distributions of both weighted and unweighted numbers can be plotted.
- In the following sections, we show the details of this program.

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II. DESCRIPTION OF PROGRAM

(1) The Program: SUBROUTINE HIST(ICALL)

This program is FORTRAN subroutine program with one argument and is entirely written in FORTRAN IV. The memory size required for standard version is 34300 words where the number of bits in a word is 32. No other special subroutines or functions except for intrinsic or basic external functions are used.

The argument ICALL controls the entry of the program;

ICALL=—1: Initialization part. Read in data cards.

= 0: Accumulation part. Counts and accumulates the numbers or weights.

= 1: Printing-out part of histograms.

= 2: Printing-out part of detailed numbers and weights.

(2) Calling Sequence.

Main program or subprograms which call HIST should have the following labeled common block;

```
COMMON/BLDIST/X(50), W(50)
```

where $X(i)$ correspond to the i -th variable to be plotted and $W(i)$ is the weight for the i -th variable.

EXAMPLE

C MAIN PROGRAM FOR HIST

```
COMMON/BLDIST/X(50), W(50)
```

```
CALL HIST (-1)
```

```
1 CONTINUE
```

```
   READ (5,5,END=99, ERR=2) X1, X2, W1, W2
```

```
5 FORMAT (8F10.5)
```

```
   X(1)=X1
```

```
   X(2)=X2
```

```
   W(1)=W1
```

```
   W(2)=W2
```

```
   CALL HIST(0)
```

```
   GO TO 1
```

```
99 CONTINUE
```

```
   CALL HIST(1)
```

```
   CALL HIST(2)
```

```
2 STOP
```

```
END
```

III. INPUT DATA SPECIFICATIONS

There are four kinds of input data cards which specify the output histograms. They are HEADER LABEL card, OUTPUT FORMAT card, VARIABLE DEFINITION card and DATA END card. The detailed specifications are as follows.

A) The first card of input data cards must be the HEADER LABEL card. The header label is printed on the top of every histogram. INPUT FORMAT (20A4).

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B) The OUTPUT FORMAT card defines the output format of histograms. Four kinds of histograms are defined by the words, DIST, SLOG, DIFF, and MAP, which are punched on the card.

- DIST : linear scale, one dimensional.
- SLOG : semi-log scale, one dimensional.
- DIFF : linear scale, one dimensional, the difference between two histograms.
- MAP : linear scale, two dimensional.

These characters should be punched from the first column of the card, one word per one card.

$$\left. \begin{array}{l} 1 \\ /DIST \\ SLOG \\ DIFF \\ MAP \end{array} \right\} : \text{INPUT FORMAT (A4)}$$

The card is valid until another OUTPUT FORMAT card is read in.

C) The VARIABLE DEFINITION card defines the values of maximum, minimum and interval of the variable. There are three types of input format according to the preceding OUTPUT FORMAT card.

1. Preceded by "DIST" or "SLOG": INPUT FORMAT (15A4, 15, 3F5.0)

$$/(\text{HEAD}(J), J=1,15) \quad i \quad X_{min} \quad X_{max} \quad D_x$$

where HEAD, i , X_{min} , X_{max} , and D_x represent label for the histogram, i -th variable, maximum, minimum, and interval values of the variable.

They must satisfy the following conditions:

$$0 < i \leq 50 : \text{integer}$$

$$D_x > 0$$

$$(X_{max} - X_{min}) / D_x \leq 125$$

2. Preceded by "DIFF": INPUT FORMAT (13A4, 3X, 215, 3F5.0)

$$/(\text{HEAD}(J), J=1, 13) \quad i \quad j \quad X_{min} \quad X_{max} \quad D_x$$

where $0 < i, j \leq 50$, $D_x > 0$ and $(X_{max} - X_{min}) / D_x \leq 125$.

The output histogram is the difference between the histograms of i -th and j -th variables.

3. Preceded by "MAP": INPUT FORMAT (10A4, 2(15, 3F5.0))

$$/(\text{HEAD}(J), J=1, 10) \quad i \quad X_{min} \quad X_{max} \quad D_x \quad j \quad Y_{min} \quad Y_{max} \quad D_y$$

where $0 < i, j \leq 50$, $D_x, D_y > 0$, $(X_{max} - X_{min}) / D_x \leq 25$, and $(Y_{max} - Y_{min}) / D_y \leq 25$.

The abscissa and ordinate represent i -th and j -th variables, respectively.

Note that the first character of HEAD should be blank in order not to confuse with OUTPUT FORMAT card.

D) The DATA END card is a blank card, and must be placed at the end of input data cards for HIST.

IV. NOTE TO USERS

- (1) Total number of output histograms should be less than or equal to 50. Furthermore, in the case of two dimensional histogram, the maximum number of outputs is limited to 20.
- (2) The ordinates of "DIST" or "DIFF" are automatically scaled in the program so as to include maximum and minimum values of counts or weights.
- (3) The maximum number of ordinate of "SLOG" is fixed to 10000. When the number of counts or weights overflows at some intervals, then these intervals are represented by the character "0" in the histogram.
- (4) In the case of two dimensional histogram, the maximum number of counts or weights is limited to 999, and if it overflows at an interval, then the number is replaced by "***".
- (5) The boundary value between ($i-1$)-th and i -th intervals is included in the i -th interval, *i.e.*;

$$\begin{array}{ccc} | & & | \\ r_{i-1} & & r_i \\ | & & | \\ a & & b & & c \end{array} \quad \begin{array}{l} a \leq r_{i-1} < b \\ b \leq r_i < c \end{array}$$

- (6) The numbers printed under individual intervals are weighted numbers which are rounded off to integer. If one wants to know the values under the floating point, call HIST(2).
- (7) When there is no data in the defined region, no histogram is printed out and the warning message shown below is printed out.

" i -TH CARDS.....THERE IS NO DATA IN THIS REGION"

Note that i represents the sequential number of input VARIABLE DEFINITION cards, not i -th variable.

- (8) If the VARIABLE DEFINITION card contains some errors, the error message; "*** ERROR ***" is printed out for that card. When $N = (X_{max} - X_{min})/D_x > 125$, X_{max} is modified so that $N = 125$, and this card is effective. In other cases, *e.g.* $N \leq 0$ or $D_x \leq 0$, the card is neglected. In APPENDIX, we show some examples of input cards and output histograms. Source list of the program is available on request.

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APPENDIX 1

An example of the input list and part of the output list in the execution of the program HIST.

```

TEST CALCULATION OF PROGRAM HIST      ICRKU FACOM 230/48
1)  DIST      GAUSSIAN RANDOM (0., 1.)   WT=0.5           2 -10.00000  10.00000  0.20000
2)  GAUSSIAN RANDOM (0., 2.)   WT=0.5           4 -10.00000  10.00000  0.20000
3)  GAUSSIAN RANDOM (1., 1.)   WT=0.5           6 -10.00000  10.00000  0.20000
    SLOG
4)  GAUSSIAN RANDOM (0., 1.)   WT=1.           1 -10.00000  10.00000  0.20000
5)  GAUSSIAN RANDOM (0., 2.)   WT=1.0          3 -10.00000  10.00000  0.20000
6)  GAUSSIAN RANDOM (1., 1.)   WT=1.0          5 -10.00000  10.00000  0.20000
    DIFF
7)  HIST( X(1) - X(3) )          1 3 -10.00000  10.00000  0.20000
8)  HIST( X(3) - X(5) )          3 5 -10.00000  10.00000  0.20000
9)  HIST( X(1) - X(5) )          1 5 -10.00000  10.00000  0.20000
    MAP
10) MAP( X(1) * X(2) )           1 -5.00000  5.00000  0.40000  2 -5.00000  5.00000  0.40000
11) MAP( X(1) * X(3) )           1 -5.00000  5.00000  0.40000  3 -5.00000  5.00000  0.40000

*** WARNING FOR THE DATA *****
    
```

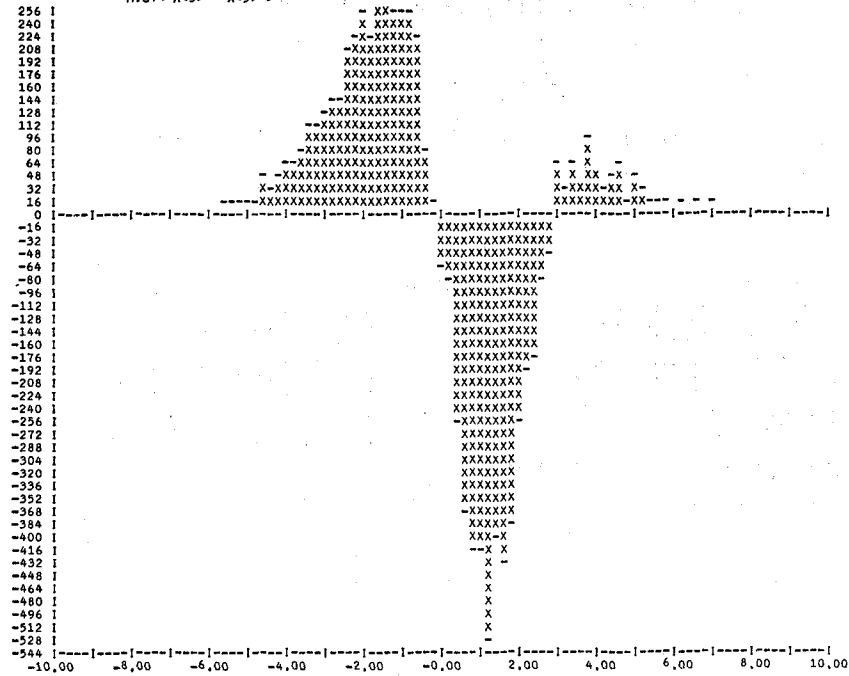
```

TEST CALCULATION OF PROGRAM HIST      ICRKU FACOM 230/48
GAUSSIAN RANDOM (0., 2.)   WT=0.5

250 |
245 |
240 |
235 |
230 |
225 |
220 |
215 |
210 |
205 |
200 |           -
195 |           X X
190 |           X X
185 |           -X X-
180 |           XXX--XXX -
175 |           XXXXXXXX X
170 |           XXXXXXXX X
165 |           XXXXXXXXX-
160 |           XXXXXXXXXXXX
155 |           X XXXXXXXXXXXXX
150 |           XXXXXXXXXXXXXXXX
145 |           XXXXXXXXXXXXXXXX -
140 |           XXXXXXXXXXXXXXXX X
135 |           XXXXXXXXXXXXXXXX X
130 |           -XXXXXXXXXXXXXXXXXX-XX
125 |           -XXXXXXXXXXXXXXXXXXXXX
120 |           XXXXXXXXXXXXXXXXXXXX
115 |           -XXXXXXXXXXXXXXXXXXXXX
110 |           XXXXXXXXXXXXXXXXXXXX-
105 |           -XXXXXXXXXXXXXXXXXXXXX
100 |           XXXXXXXXXXXXXXXXXXXXXXX
95 |           XXXXXXXXXXXXXXXXXXXX
90 |           XXXXXXXXXXXXXXXXXXXX
85 |           XXXXXXXXXXXXXXXXXXXX--
80 |           XXXXXXXXXXXXXXXXXXXX-
75 |           --XXXXXXXXXXXXXXXXXXXXX
70 |           XXXXXXXXXXXXXXXXXXXX
65 |           XXXXXXXXXXXXXXXXXXXX
60 |           -XXXXXXXXXXXXXXXXXXXXX--
55 |           XXXXXXXXXXXXXXXXXXXX
50 |           X-XXXXXXXXXXXXXXXXXXXXX -
45 |           XXXXXXXXXXXXXXXXXXXX-X
40 |           XXXXXXXXXXXXXXXXXXXX
35 |           XXXXXXXXXXXXXXXXXXXX
30 |           --XXXXXXXXXXXXXXXXXXXXX -
25 |           -XXXXXXXXXXXXXXXXXXXXX -X -
20 |           X XXXXXXXXXXXXXXXXXXXX XX X
15 |           X-XXXXXXXXXXXXXXXXXXXXX-X X-
10 |           --XXXXXXXXXXXXXXXXXXXXX XX
5 |           XXX-XXXXXXXXXXXXXXXXXXXXX--
0 |-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
-10,00  -8,00  -6,00  -4,00  -2,00  -0,00  2,00  4,00  6,00  8,00  10,00

11111111211121111111111111111111
2122245457701229568089808786659243088755442122 21
756363227700991112375059024029027058810913898266346511121 1 1 1
NO= 4  DX= 0.200  XMIN= -10,000  XMAX= 10,000,  NO.UDF= 0  NO.IJ= 10000  NO.OVF= 0
WT.UDF= 0.0  WT.IJ= 5000.0  WT.OVF= 0.0
    
```

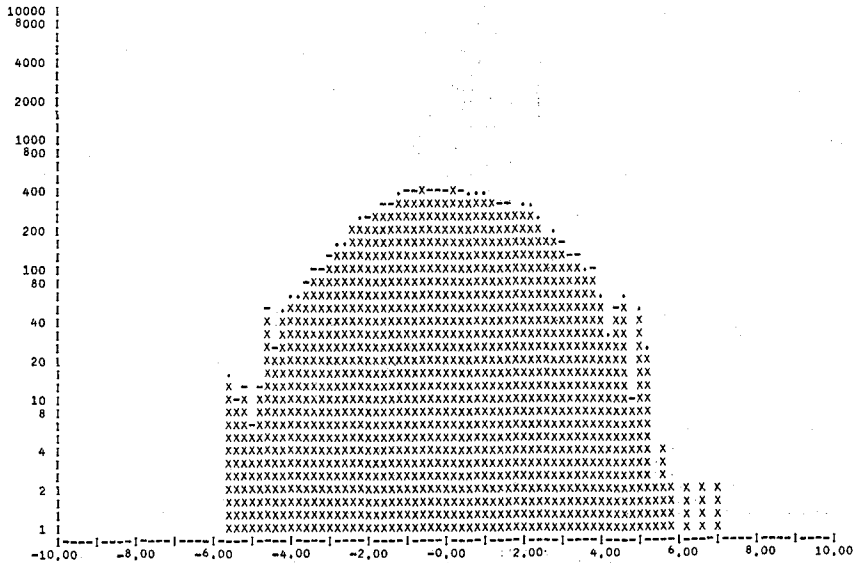
TEST CALCULATION OF PROGRAM HIST ICRKU FACOM 230/48
HIST(X(3) - X(5))



111222222222 23445343211
111 142455799144024178554271664601192747674526394245 42
4026264443997712135896029275279091427578861600218070812242 2 2 2

NO= 8(3)-(5) DX= 0.200 XMIN= -10.000 XMAX= 10.000 NO.IN= 7952 NO.IN(+)= 3976 NO.IN(-)= 3976
WT.IN= 7952.0 WT.IN(+)= 3976.0 WT.IN(-)= 3976.0
NO. OF DIST(3)= IN=10000 UDF= 0 OVF= 0 WT. OF DIST(3)= IN=10000.0 UDF= 0.0 OVF= 0.0
NO. OF DIST(5)= IN=10000 UDF= 0 OVF= 0 WT. OF DIST(5)= IN=10000.0 UDF= 0.0 OVF= 0.0

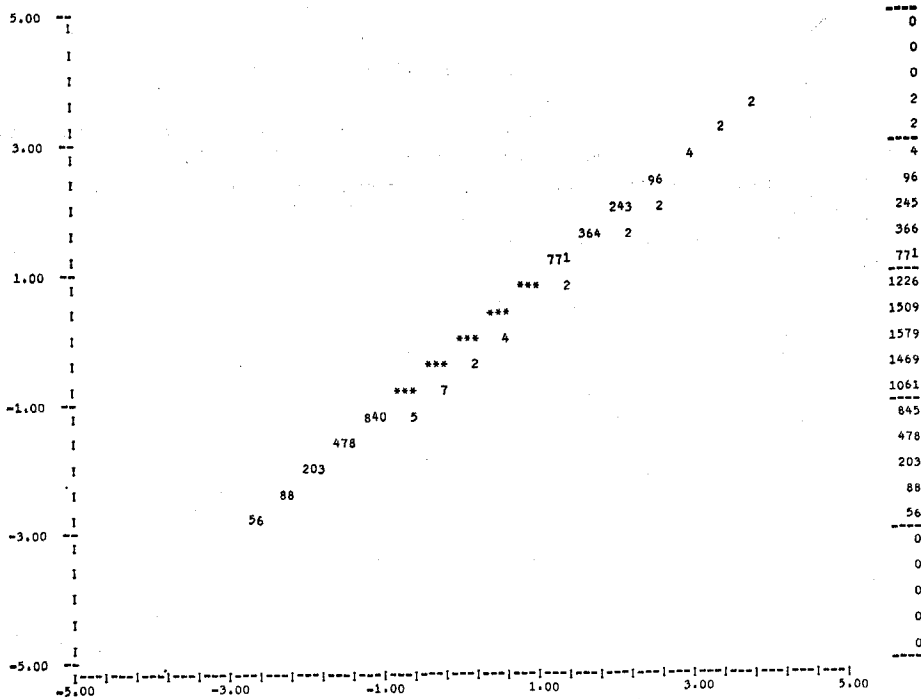
TEST CALCULATION OF PROGRAM HIST ICRKU FACOM 230/48
GAUSSIAN RANDOM (0., 2.) WT=1.0



11122223233433433433333222211111
111 142455799144024509377066707363211585166511895245142
4026264443997712135499008047948934006519715586422672012242 2 2 2

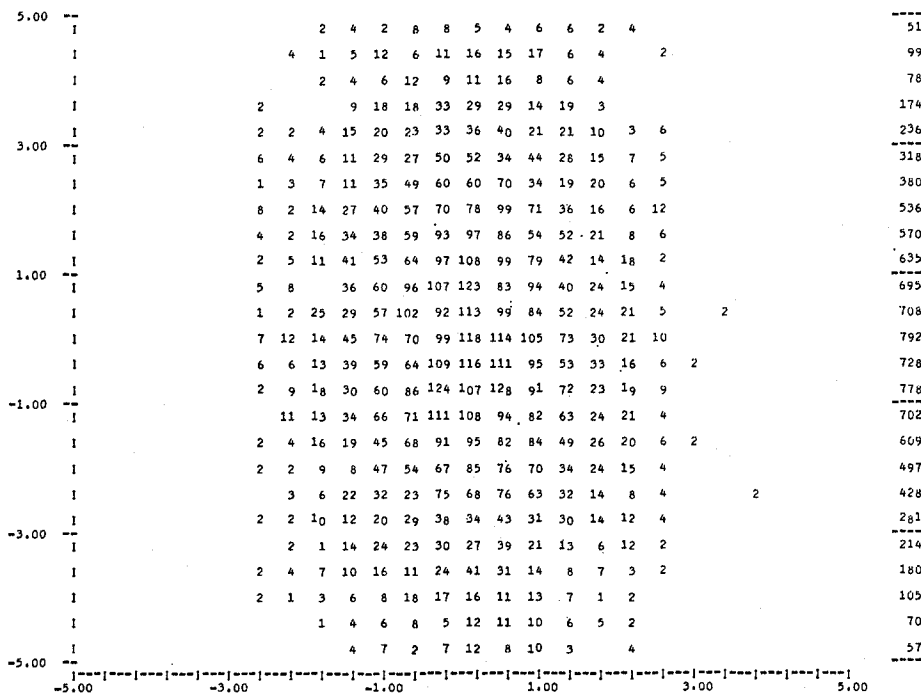
NO= 3 DX= 0.200 XMIN= -10.000 XMAX= 10.000 NO.UDF= 0 NO.IN= 10000 NO.OVF= 0
WT.UDF= 0.0 WT.IN= 10000.0 WT.OVF= 0.0

TEST CALCULATION OF PROGRAM HIST ICRKU FACOM 230/48
 MAP(X(1) , X(2))



NO.= 10 NO.OF X= 1 DX= 0.400 XMIN= -5.000 XMAX= 5.000 XUDEF= 0 XIN=10000 XOVF= 0
 NO.OF Y= 2 DY= 0.400 YMIN= -5.000 YMAX= 5.000 YUDEF= 0 YIN=10000 YOYF= 0

TEST CALCULATION OF PROGRAM HIST ICRKU FACOM 230/48
 MAP(X(1) , X(3))



NO.= 12 NO.OF X= 1 DX= 0.400 XMIN= -5.000 XMAX= 5.000 XUDEF= 0 XIN= 9921 XOVF= 0
 NO.OF Y= 3 DY= 0.400 YMIN= -5.000 YMAX= 5.000 YUDEF= 43 YIN= 9921 YOYF= 36

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SQUAW: O. I. Dahl *et al.*, *ibid*, p-126.