## REVISION RECORD

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<th>DESCRIPTION</th>
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<td>A</td>
<td>17/03/75</td>
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<td>B</td>
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<td>NEW ENTRIES: H1, HIE, HINDEX, HLOCAT, HXE</td>
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HBOOK IS A FORTRAN-CALLABLE HISTOGRAMMING FACILITY, WHOSE
PURPOSE IS TO DEFINE, FILL AND EDIT HISTOGRAMS, SCATTER PLOTS AND
TABLES. IT IS WRITTEN IN ALMOST-ANSI FORTRAN 4, AND CAN BE
IMPLEMENTED, WITH MINOR MODIFICATIONS, ON ALL COMPUTER SYSTEMS THAT
OFFER A FORTRAN 4 COMPILER.

THE INPUT TO HBOOK IS ALWAYS A SUBROUTINE CALL OF THE
TYPE

CALL H.....(PAR1,PAR2,...,PARN)

WHERE PAR1,PAR2,...,PARN ARE INPUT PARAMETERS (IN ALMOST EVERY CASE

THE OUTPUT CONSISTS OF RESULTING HISTOGRAMS, SCATTER
PLOTS OR TABLES, EDITED ON THE LINE PRINTER FILE.

ERROR MESSAGES ARE PRINTED IN CASE SOME COMMANDS ARE
NOT APPLICABLE OR INCOMPATIBLE.

THE MAIN APPLICATION OF HBOOK IS TO SUMMARIZE DATA IN
CONJUNCTION WITH SEQUENTIAL PROCESSING OF SEVERAL EVENTS OF THE
SAME TYPE, ALTHOUGH IT CAN BE USED ALSO TO REPRESENT REAL FUNCTIONS
OF 1 OR 2 REAL VARIABLES.

ITS ESSENTIAL FEATURES ARE
- IT IS A SLAVE SYSTEM, I.E. YOU CALL IT WHEN YOU
 NEED IT
- THE INSTRUCTIONS ARE FORTRAN STATEMENTS , AND NO
 DATA CARDS IN SPECIAL FORMAT HAVE TO BE PROVIDED
- USING ONLY SOME OF THE OPTIONS, JUST THE RELEVANT
 PART OF THE PACKAGE IS LOADED.

* NO FANCY OUTPUT DEVICE IS NEEDED, ALTHOUGH AN
* INTERFACE WITH A GRAPHIC PACKAGE CAN EASILY BE
* MADE AVAILABLE (SEE SECTION 5.6).

IT PROVIDES ALSO A SIMPLE MECHANISM FOR SELECTIVE FILLING
( HDOCK/HMDOCK ), BUT THE LOGIC TO DECIDE WHETHER A HISTOGRAM HAS TO
BE FILLED OR NOT MUST BE WRITTEN IN FORTRAN.

1.1 LONG AND SHORT VERSION (HECOKL/HBOOK)

THE TOTALITY OF ENTRIES DESCRIBED IN THIS WRITELF
CONSTITUTE THE LONG VERSION OF THE PACKAGE ( HBOOK )
A REDUCED VERSION, CALLED HBOOK IS AVAILABLE TO USERS
THAT ARE CONTENT WITH THE BASIC UTILITIES OR HAVE SPACE PROBLEMS.

NOTE THAT HBOOKS IS A SUBSET OF HBOOKL ONLY AS FAR AS
EXTERNAL SPECIFICATIONS ARE CONCERNED, BUT SUBROUTINES WITH THE
SAME NAME BELONGING TO THE TWO VERSIONS ARE NOT IDENTICAL, SO THEY
CANNOT BE MIXED.

THE ENTRIES ACCEPTED BY HBOOKS ARE INDICATED IN THIS
MANUAL WITH AN $ AT THE RIGHT HAND SIDE OF CALL DEFINITION, AS
WELL AS IN THE INDEX. NOTE ALSO THAT HBOOKS PROVIDES NO ERROR
MESSAGES AND NO HISTOGRAM INDEX.

HBOOKS IS ALMOST EQUIVALENT TO THE OLD VERSION 1 OF HBOOK
(SEE REFERENCE 1), BUT IT IS NOT BACKWARD COMPATIBLE.
1.2 HOW TO READ THIS MANUAL

BASIC

READ CHAPTERS 1 AND 2 AND EXAMPLE 1, CONSULT CHAPTER 9 IN
* CASE YOU GET ERROR MESSAGES. IF YOU ARE USING IT AT CERN, PLEASE
* SEE APPENDIX A. FOR OTHER INSTALLATIONS, REFER TO LOCAL
* DOCUMENTATION.

ADVANCED

TO EXPLOIT MORE REFINED POSSIBILITIES OF THE PACKAGE,
READ CHAPTERS FROM 3 ON, AS FROM THE TABLE OF CONTENTS. IN
PARTICULAR SEE

CHAPTER 4  IN CASE OF TIME PROBLEMS.
CHAPTER 8  IN CASE OF SPACE PROBLEMS.

FOR REFERENCE PURPOSES THE INDEX AT THE END HELPS FINDING
THE PAGE WHERE EACH ENTRY IS DESCRIBED. CALLS THAT ARE ACCEPTED BY
HBOOKS ARE TAGGED WITH AN S.

AN ABBREVIATED, POCKET-SIZE VERSION OF THIS MANUAL,
CALLED HBOOK INSTANT IS AVAILABLE, BUT TO PROFIT FROM IT, IT IS
NECESSARY TO READ THE PRESENT DOCUMENT FIRST.

NEW FEATURES, AS WELL AS CHANGES, DELETION AND ADDITION
* TO INFORMATION IN THIS MANUAL ARE INDICATED BY ASTERISKS AT THE
* LEFT MARGIN.

THE AUTHORS WOULD APPRECIATE HEARING FROM ANY USERS WHO
EXPERIENCE TROUBLES WITH THE SYSTEM (PLEASE INCLUDE COPIES OF
RELEVANT INPUT AND OUTPUTS). ACKNOWLEDGMENT OF THE USE OF HBOOK IN
ANY PUBLICATION WOULD ALSO BE APPRECIATED.

1.3 FUNDAMENTALS

THE FUNDAMENTAL STEPS TO PRODUCE A HISTOGRAM, A SCATTER
PLOT OR A TABLE ARE BOOKING, FILLING, EDITING.

BOOKING

SPACE FOR HISTOGRAMS IS ALLOCATED VIA CALL HBOOK1, CALL
HBOOK2 OR CALL HTABLE WHERE TITLE, NUMBER OF CHANNELS AND LIMITS
ARE SPECIFIED AND THE HISTOGRAM IDENTIFIER (ID) IS DEFINED.

FILLING

AN HISTOGRAM THAT HAS BEEN BOOKED CAN BE FILLED WITH A
CALL HFILL THAT REFERENCES ITS IDENTIFIER. IF THE IDENTIFIER DOES
NOT EXIST, THE CALL DOES NOTHING.

EDITING

ALL BOOKED HISTOGRAMS, SCATTER PLOTS OR TABLES ARE EDITED
ON THE LINE PRINTER, VIA A CALL HEDIT. SINGLE HISTOGRAMS CAN BE
INDIVIDUALLY EDITED USING CALL HPRINT.
OTHER OPTIONS AVAILABLE ARE

- GENERAL TITLE HEADING EACH HISTOGRAM
- BOOKING OF PROJECTIONS AND SLICES OF SCATTER PLOTS AND TABLES.
- LOCK/UNLOCK OPTION FOR SELECTIVE FILLING
- FAST ( BUT UNPROTECTED ) FILLING COMMANDS
- MORE STATISTICAL INFORMATION THAN THE ONE GIVEN BY DEFAULT.
- WIDE RANGE OF GRAPHIC OPTIONS TO CHOOSE WHAT TO EDIT AND HOW TO DO IT, AND TO DEFINE THE SIZE OF THE PAGE.
- ACCESS TO THE CONTENT OF HISTOGRAMS AND OPERATIONS AMONG THEM.
- EXTENSION OF THE MEMORY ON DISK FILE.

THEY ARE DESCRIBED IN CHAPTER 3 TO 8. PLEASE SEE THE TABLE OF CONTENTS FOR REFERENCE.

1.5 USE OF THE MEMORY

HBOOK USES THE CENTRAL MEMORY TO LOAD THE PROCESSORS (SUBROUTINES AND FUNCTIONS OF THE PACKAGE) AND TO STORE THE HISTOGRAMS THEMSELVES.

SUBROUTINES

THE PACKAGE IS ORGANISED AS A LIBRARY THAT IS AT LOADING TIME UNSATISFIED EXTERNALS ARE SEARCHED FOR AND LOADED. IN THIS WAY ONLY THE SUBROUTINES THAT ARE GOING TO BE USED WILL BE LOADED, THEREFORE MINIMIZING THE SPACE. UNFORTUNATELY, GIVEN THE WAY FORTRAN WORKS, ALTHOUGH THE PACKAGE IS STRUCTURED AS MUCH AS POSSIBLE IN THE SENSE OF SELECTIVE LOADING, SOME USELESS SUBROUTINES WILL BE PRESENT.

ON COMPUTER SYSTEMS THAT DO NOT OFFER AUTOMATIC SELECTIVE LOADING, ALTERNATIVE WAYS TO AVOID LOADING useLESS SUBROUTINES MUST BE PROVIDED. THIS FEATURE IS INSTALLATION DEPENDENT.

THE REDUCED VERSION HBOOKS CAN BE USED IF BASIC FACILITIES ONLY ARE NEEDED. THIS WILL RESULT IN A CONSIDERABLE GAIN IN SPACE.

1.5 HISTOGRAM AREA

THE WORKING SPACE OF HBOOK IS AN ARRAY, NORMALLY ALLOCATED TO THE BLANK COMMON, THEREFORE IT IS NECESSARY TO RESERVE AS MANY LOCATIONS AS REQUIRED WITH A DECLARATIVE STATEMENT OF THE TYPE

```
COMMON // MEMCR{(5800)}
```

AT EXECUTION TIME, WHEN HISTOGRAMS ARE BOUND, THEY ARE ACCOMMODATED IN THE BLANK COMMON IN THE BOOKING ORDER, UP TO THE MAXIMUM CORE AVAILABLE (SEE 8.1).

IF THE OPERATING SYSTEM OF THE COMPUTER YOU ARE USING ALLOWS SO, MORE SPACE CAN BE OBTAINED DYNAMICALLY AT EXECUTION TIME AND/OR THE BUFFER CAN OVERFLOW ONTO A DISK FILE. TO EXPLOIT THESE FEATURES, PLEASE SEE CHAPTER 8.
1.6 MISCELLANEOUS

ID = 0

ID = 0 IS AN ILLEGAL IDENTIFIER AT BOOKING TIME. IN MOST OF THE ENTRIES DEFINING AN OPTION, ID = 0 MEANS THAT THE OPTION IS TO BE SELECTED ON ALL EXISTING HISTOGRAMS OR PLOTS PROVIDED IT IS MEANINGFUL. THIS POSSIBILITY WILL BE MENTIONED IN ALL ENTRIES IT APPLIES TO.

SHORTENED CALLING SEQUENCE

SOME ENTRIES ADMIT VARIABLE NUMBER OF PARAMETERS IN THE CALLING SEQUENCE, CORRESPONDING VALUES BEING ASSIGNED BY DEFAULT.

INTEGER OR FLOATING POINT PARAMETERS

TO ELIMINATE A COMMON SOURCE OF TYPING MISTAKES EXPERIENCED WITH PREVIOUS VERSIONS OF HECOK, ALL REAL PARAMETERS IN BOOKING AND EDITING ENTRIES WILL BE ACCEPTED BOTH IN FLOATING POINT AND IN INTEGER FORM. THIS DOES NOT APPLY TO FILLING, FOR OBVIOUS REASONS OF SPEED.

VALMAX

ALL BOOKING COMMANDS THAT RESERVE SPACE FOR HISTOGRAMS OR PLOTS REQUIRE THE PARAMETER VALMAX, THAT IS THE ESTIMATED MAXIMUM POPULATION OF EACH BIN, ON THE BASIS OF WHICH THE SUITABLE NUMBER OF BITS PER CHANNEL WILL BE ALLOCATED. 1 FULL COMPUTER WORD PER CHANNEL WILL BE RESERVED IF VALMAX IS SMALLER THAN 1. (OR MISSING).

2.1 BOOKING

CALL HBOOK1(ID,TITLE,NCHAN,XMIN,XMAX,VALMAX) I S

ACTION BOOKS 1-DIMENSIONAL HISTOGRAM

PARAMETERS ID = HISTOGRAM IDENTIFIER, INTEGER NON ZERO
TITLE = HISTOGRAM TITLE (VECTOR) ALPHANUMERIC
NCHAN = NUMBER OF CHANNELS, LESS OR EQUAL TO 100
XMIN = LOWER EDGE OF FIRST CHANNEL
XMAX = UPPER EDGE OF LAST CHANNEL
VALMAX = UPPER LIMIT OF SINGLE CHANNEL CONTENT.

SPECIAL VALUES

VALMAX=0. (OR MISSING) 1 WORD/CHANNEL
XMIN=0. (OR MISSING) AUTOMATIC LIMITS
XMAX=0. (OR MISSING) CALCULATION
NCHAN=0 (OR MISSING) NCHAN = 100

IF (XMAX.LE.XMIN) THE ORIGIN AND BINWIDTH ARE CALCULATED AUTOMATICALLY, AND 1 WORD IS RESERVED PER CHANNEL.

REMARKS

- ZERC IS AN ILLEGAL IDENTIFIER
- VALMAX IS USED TO COMPUTE THE SUITABLE NUMBER OF BITS PER CHANNEL TO ALLOCATE. IN CASE IT IS SMALLER THAN 1. (OR MISSING) 1 FULL WORD IS RESERVED PER CHANNEL. NOTE THAT WHEN FILLING A HISTOGRAM WITH HEIGHTS, THE WEIGHT IS TRUNCATED TO THE NEAREST INTEGER, UNLESS ONE FULL WORD IS RESERVED PER CHANNEL (I.E. VALMAX < 1).
- AUTOMATIC LIMITS CALCULATION FORCES 1 WORD/CHANNEL.
- THE NUMBER OF COMPUTER WORDS FOR THE
  TITLE (NWTITL) IS AN INSTALLATION
  PARAMETER, AS WELL AS THE NUMBER OF
  CHARACTERS PER WORDS (NCHWOR).
  THE TITLE CAN BE PASSED IN SEVERAL WAYS

  A) AS A HOLLERITH STRING UP TO NWTITL *
      NCHWOR CHARACTERS IN THE CALLING
      SEQUENCE

  B) AS A VECTOR OF NWTITL WORDS CONTAINING
      HOLLERITH INFORMAT

  C) AS A VECTOR OF N+1 WORDS,
      N+1.LE.NWTITL-1 WORDS CONTAINING
      HOLLERITH INFORMAT AND THE (N+1)TH
      BEING ZERO.

  D) AS A VECTOR OF 1+N WORDS (N+1.LE.NWTITL-1)
      THE FIRST ONE BEING THE INTEGER N.

      IF A DOLLAR SIGN IS PRESENT IN THE
      TITLE, IT IS TRANSFORMED INTO A BLANK,
      AND THE REST OF THE TITLE IS SET TO
      BLANK.

- NCHAN MUST BE LESS OR EQUAL TO 100. IF
  YOU NEED MORE, PLEASE SEE ENTRY HEXITEN.

CALL HBISG1,ID,TITEL,NCHANX,XMIN,XMAX,
       NCHANX,XMIN,XMAX,VALMAX)

PARAMETERS
  ID = HISTOGRAM IDENTIFIER, INTEGER
  TITLE = HISTOGRAM TITLE, VECTOR OF 80 CHARACTERS
  NCHANX = NUMBER OF CHANNELS IN X, LESS OR EQUAL
           TO 100
  XMIN = LOWER EDGE OF FIRST X CHANNEL

XMAX = UPPER EDGE OF LAST X CHANNEL
NCHANX = NUMBER OF CHANNELS IN Y, LESS OR EQUAL
         TO 100
YMIN = LOWER EDGE OF FIRST Y CHANNEL
YMAX = UPPER EDGE OF LAST Y CHANNEL
VALMAX = MAXIMUM VALUE TO STORE IN 1 CELL

SPECIAL
VALUES
  VALMAX MISSING (IF POSSIBLE) ALLOCATES 5
  BITS/CHANNEL.

REMARKS
  - SAME AS HBOOK1.

CALL HBISG2,ID,TITLE,NCHANX,XMIN,XMAX,
       NCHANX,XMIN,XMAX,VALMAX)

PARAMETERS
  ID = HISTOGRAM IDENTIFIER, INTEGER
  TITLE = HISTOGRAM TITLE, VECTOR OF 80 CHARACTERS
  NCHANX = NUMBER OF CHANNELS IN X, LESS OR EQUAL
           TO 100
  XMIN = LOWER EDGE OF FIRST X CHANNEL

ACTION
  BOOKS 2-DIMENSIONAL TABLE

SPECIAL
VALUES
  VALMAX MISSING (IF POSSIBLE) ALLOCATES 10
  BITS/CHANNEL.

REMARKS
  - SAME AS HBOOK1.

  WHEN EDITING THE TABLE, THE NUMBER OF
  COLUMNS USED TO WRITE THE CONTENT OF ONE
  CELL DEPENDS ON VALMAX

  NCOL = ALOG10(VALMAX) + 1

  HAVING SELECTED 1 WORD PER CELL, THE
  CONTENT IS PRINTED ON 10 COLUMNS IN
  FLOATING POINT FORMAT (INCLUDING SIGN).
  IF NECESSARY, ALL CONTENTS ARE
  MULTIPLIED BY A POWER OF 10 THAT IS
  REPORTED AT THE BOTTOM OF THE PLOT.
2.2 FILLING

ACTION
FILLS 1-DIMENSIONAL HISTOGRAM, SCATTER PLOT OR TABLE. THIS MEANS THAT THE CHANNEL THAT BEGINS THE SESSION IS THE ONE FROM WHICH THE HISTOGRAMS, OR TABLES, OR BOTH, WILL BE Filled. IT'S CONTENTS INCREASED BY WEIGHT. ALL BOOKED PROJECTIONS ARE Filled AS WELL.

PARAMETERS
IDENTIFIER

X = VALUE OF THE ORGANIZE
Y = VALUE OF THE ORGANIZE
WEIGHT = WEIGHT

REMARKS
- IF THE COMPUTER YOU ARE USING ACCEPTS VARIABLES AS PRINTED, THIS CALL CAN BE DIRECTED TO THE HISTOGRAM OF THE HISTOGRAM IS AN M-DIMENSIONAL AND OVERFLOW ON DISK IS FORCED, USE THE ENTRY (IF THE ALTERNATIVE CRES) DESCRIBED IN SECTION 4.3.
BOOKING OPTIONS INCLUDE

- SHIFT OF THE ORIGIN OF THE HBOOK MEMORY AREA
- ROUNDED BIN SIZE
- EXTENSION TO MORE THAN 100X100 CHANNELS
- PROJECTIONS OF SCATTER PLOTS AND TABLES, AS WELL AS SLICES
- MORE STATISTICAL INFORMATION

3.1 PRE-BOOKING

SOME OF THE COMMANDS DESCRIBED IN THIS SECTION SELECT OPTIONS TO BE APPLIED TO ALL HISTOGRAMS, AND THEREFORE NEED TO BE EXECUTED BEFORE THE BOOKING THEY SHOULD AFFECT.

I CALL HISTGO (IFIRST) I S
I

ACTION MOVES THE ORIGIN OF THE HBOOK DYNAMIC MEMORY TO LOCATION IFIRST OF THE BLANK COMMON.

PARAMETERS IFIRST = POINTER TO BEGINNING OF HBOOK DYNAMIC MEMORY.

REMARKS

- THIS FEATURE IS USEFUL IN CASE SOME LOCATIONS OF THE BLANK COMMON ARE USED TO STORE LOCAL VARIABLES, OR WHEN THE PROGRAM USES OTHER SYSTEMS WITH MEMORY AREA IN THE BLANK COMMON (E.G. HYDRA).

- THE ORIGIN OF THE DYNAMIC MEMORY CAN BE REDEFINED ANY TIME. IT IS PRESET TO 1.
### 3.1 More on Booking

**Pre-Booking**

---

**ACTION**

Bin size of following bookings will be rounded to a Decent value, i.e.

1. 1, 1.5, 2, 2.5, 3, 5.

Times an integer power of 10

**PARAMETERS**

- **3HYES** = Enables this feature
- **2HNO** = Enables it.

**REMARKS**

- HBINSZ controls a switch that, when on, rounds the bin size. The switch is initially off.

---

**ACTION**

ALLOWS THE NUMBER OF CHANNELS TO EXCEED 100 FOR 1-DIMENSIONAL HISTOGRAM, 100X100 FOR SCATTER PLOTS AND TABLES.

**PARAMETERS**

- None

**REMARKS**

- HEXTEN enables the extension, so it has to be called once and for all before any booking that requires this feature.

- AN EXTENDED HISTOGRAM OR SCATTER PLOT CANNOT BE PRINTED ON 1 PAGE, SO AT EDITING TIME IT WILL BE CUT INTO PIECES. 1-DIMENSIONAL HISTOGRAMS CAN BE PRINTED DOWN THE PAGE, TO AVOID CHOPPING (SEE WROTAY).

---

### 3.2 More on Booking

**Subhistograms (Projections, Slices)**

---

**ACTION**

Books also projections of scatter plot or table as 2 1-DIMENSIONAL HISTOGRAMS

**PARAMETERS**

- **ID** = Identifier of an existing scatter plot or table
- **VALMAX** = Maximum value to store in 1 channel

**SPECIAL VALUES**

- **ID = 0** Book projections for all existing scatter plots and tables

**REMARKS**

- If ID does not exist, or is a 1-DIMENSIONAL HISTOGRAM, the call is not executed.

**PLEASE SEE HB0CK1 FOR DETAILS ABOUT VALMAX**

---

**ACTION**

Books projection onto X or Y only

**SPECIAL VALUES**

- Same as HBPRO

**REMARKS**

- Same as HBPRO.
CALL HBANDX(ID,YMIN,YMAX,VALMAX)

ACTION
BOOKS A PROJECTION ONTO X, RESTRICTED TO THE Y INTERVAL [YMIN, YMAX]

PARAMETERS
ID = IDENTIFIER OF AN EXISTING SCATTER PLOT OR TABLE
YMIN = LOWER LIMIT OF Y INTERVAL
YMAX = UPPER LIMIT OF Y INTERVAL
VALMAX = MAXIMUM VALUE TO BE STORED IN 1 CHANNEL

SPECIAL VALUES
SAME AS HBPRO

REMARKS
SAME AS HBPRO.

CALL HBSLIX(ID,NSLICES,VALMAX)

ACTION
BOOKS ALSO SLICES ALONG X OF SCATTER PLOT OR TABLE AS NSLICES 1-DIMENSIONAL HISTOGRAMS.

PARAMETERS
ID = IDENTIFIER OF AN EXISTING SCATTER PLOT OR TABLE
NSLICES = NUMBER OF SLICES
VALMAX = MAXIMUM VALUE TO BE STORED IN 1 CHANNEL

SPECIAL VALUES
SAME AS HBPRO

REMARKS
SAME AS HBPRO.

CALL HBANDY(ID,XMIN,XMAX,VALMAX)

ACTION
SAME AS HBANDX, BUT THE PROJECTION IS ONTO Y

CALL HBSLIX(ID,NSLICES,VALMAX)

ACTION
SAME AS HBSLIX, BUT SLICES ARE ONTO Y.
3.3 STATISTICS

ACTION

ALSO SKEWNESS AND KURTOSIS WILL BE
CALCULATED.

PARAMETERS

ID = IDENTIFIER OF AN EXISTING HISTOGRAM

SPECIAL

ID = 0
APPLIES TO ALL HISTOGRAM BOOKED UP TO

REMARKS

- IF ID IS A SCATTER PLOT OR TABLE, HSTAT
ACTS ON ALL ITS PROJECTIONS.

----------

I CALL HBARX(ID) I

----------

ACTION

ERROR BARS FOR 1-DIMENSIONAL HISTOGRAMS,
PROJECTIONS, ETC., CAN BE SUPERIMPOSED TO THE

ERROR(I) = SUM (WEIGHT(J)**2)
J=1

NEV

= BIN NUMBER

NEV

= NUMBER OF ENTRIES IN CHANNEL I

WEIGHT(J)

= WEIGHT OF EVENT J IN BIN I

----------

IT IS CLEAR THAT ALSO THE SUM OF THE SQUARES
OF WEIGHTS IN EACH BIN MUST BE STORED TO
PERFORM THE CALCULATION, THIS IS DONE
SELECTING THIS OPTION OR THE FOLLOWING).

ERRORS CAN BE CALCULATED FROM BIN CONTENTS
ONLY, AND HBARX(HBARX) ARE NOT NEEDED. IN

IN BOTH CASES THE VALUES OF ERRORS
CAN BE PRINTED UNDER THE CONTENTS, VIA THE
EDITING OPTION HERR.

PARAMETERS

ID = IDENTIFIER OF AN EXISTING HISTOGRAM.

SPECIAL

ID = 0
APPLIES TO ALL HISTOGRAM BOOKED UP TO

REMARKS

- IF ID IS A SCATTER PLOT OR TABLE, HBARX
ACTS ON ALL X PROJECTIONS IT MIGHT

- IF AT BOOKING TIME ID (OR THE

PROJECTION, ETC.) WAS DEFINED TO BE
PACKED (VALMAX > 1.), HBARX REALLOCALES
I FULL WORD PER CHANNEL.

----------

I CALL HBARX(ID) I

----------

ACTION

SAME AS HBARX, IT IS USED TO ACT ON Y
PROJECTIONS OF 2-DIMENSIONALS.
3.4 MISCELLANEOUS

CALL HRESET(ID,TITLE) S

ACTION
RESETS THE CONTENTS OF ALL CHANNELS OF HISTOGRAM ID (AND PROJECTIONS) TO ZERO AND CHANGES OPTIONALLY THE TITLE

PARAMETERS
  ID = IDENTIFIER OF AN HISTOGRAM
  TITLE = NEW TITLE (UP TO 20 CHARACTERS).

SPECIAL VALUES
  ID = 0
  TITLE = (OR MISSING IF ALLOWED) MEANS THAT THE OLD TITLE IS KEPT.

REMARKS
SEE HBOOK1 ABOUT THE TITLE.

CALL HDELETE(ID) S

ACTION
DELETES PLOT ID, RELEASING THE CORRESPONDING SPACE

SPECIAL VALUES
  ID = 0
  DELETES ALL EXISTING PLOTS.

CALL HFUNC(ID,FUNC)

ACTION

PARAMETERS
  ID = IDENTIFIER OF AN EXISTING 1-DIMENSIONAL HISTOGRAM
  FUNC = EXTERNAL REAL FUNCTION, E.G. REAL FUNCTION FUNC(X)

SPECIAL VALUES
  ID = 0
  APPLIES TO ALL EXISTING 1-DIMENSIONAL HISTOGRAMS.

REMARKS
CHISQUARE WILL BE PRINTED

CHISQUARE = \sum_{i=1}^{NEV} \left( \frac{CONT(i) - FUNC(i)}{SUM WEIGHT(j) \times 2} \right)^2

NCH = NUMBER OF CHANNELS OF THE HISTOGRAM
CONT(i) = CONTENT OF CHANNEL i
FUNC(i) = VALUE OF THE FUNCTION AT CHANNEL i
NEV = NUMBER OF EVENTS IN CHANNEL i
WEIGHT(j) = WEIGHT OF EVENT J IN BIN i.

- THE FUNCTION FUNC CANNOT CONTAIN ANY CALL TO AN ENTRY OF HBOOK
4. FILLING OPTIONS

4.1 SELECTIVE FILLING

HBOOK HAS NO BUILT-IN LOGIC FOR SELECTIVE FILLING, AND
THE TEST TO DECIDE ABOUT FILLING OR NOT A GIVEN HISTOGRAM MUST BE
PROVIDED IN FORTRAN, E.G.

IF (PTRACK.LT.4.) CALL HFILL(2710,ZVERTX,0.,1.1)

IT CAN BE CONVENIENT TO DECOUPLE THE TEST FROM THE
FILLING SO THAT THEY CAN BE EXECUTED IN DIFFERENT PARTS OF THE
PROGRAM. THIS IS POSSIBLE USING

CALL HLOCK(ID)
CALL HUNLOCK(ID)

=---------------------=
ACTION FORBIDS / PERMITS FILLING OF HISTOGRAM ID
SPECIAL VALUES ID = 0 LOCKS / UNLOCKS ALL HISTOGRAMS
REMARKS - THE EXAMPLE ABOVE CAN BE WRITTEN
      IF (PTRACK.GE.4.) CALL HLOCK(2710)
      CALL HFILL(2710,ZVERTX,0.,1.1)

- LOCK HISTOGRAMS TO IGNORE SUBSEQUENT FILLING
  COMMANDS
- SPEED UP THE FILLING PROCESS LOOSING PROTECTION
- GLOBALLY TRANSFER ON ARRAY OR A MATRIX INTO A
  HISTOGRAM, SCATTER PLOT OR TABLE.

SPECIAL FILLING ENTRIES MUST BE USED WHEN THE DISK
OVERFLOW IS OPERATIONAL.
4.2 FAST FILLING ENTRIES

IF THE PROGRAM THAT IS USING HOOK FILLS MANY HISTOGRAMS, AND DOES THAT SEVERAL TIMES, A SUBSTANTIAL FRACTION OF THE TIME IS SPENT BY HFILL TO SEARCH FOR THE HISTOGRAM IT HAS TO FILL. DECIDE WHICH TYPE OF HISTOGRAM IT IS, UNPACK AND PACK BITS IF MORE CHANNELS ARE STORED IN 1 WORD.

TO REDUCE THE OVERALL FILLING TIME, THERE ARE SEVERAL ACTIONS THAT CAN BE TAKEN.

A - ORGANIZE THE PROGRAM SO THAT THE FILLING IS PERFORMED IN ASCENDING ORDER OF THE IDENTIFIER AS MUCH AS POSSIBLE, TO REDUCE THE TIME SPENT IN SEARCHING FOR THE HISTOGRAMS IN THE BUFFER.

B - BY-PASS PART OF THE LOGIC THAT FINDS OUT THE CHARACTERISTICS OF THE HISTOGRAM TO FILL. THIS CAN BE ACHIEVED USING, INSTEAD OF HFILL, THE SIX SPECIAL FILLING ENTRIES DESCRIBED IN THIS SECTION. PLEASE BE CAREFUL, BECAUSE IN THIS CASE, SINCE NO CHECK IS PERFORMED, THE USE OF THE IMPROPER ENTRY CAN LEAD TO UNPREDICTABLE RESULTS IF ANY.

C - AVOID PACKING OF MORE THAN 1 CHANNEL IN A WORD (VMAX < 1. IN THE BUFFER).

NOTE THAT THE FAST FILLING ENTRIES DO NOT CHECK WHETHER THE HISTOGRAM IS LOCKED OR NOT.

* PLEASE SEE APPENDIX A.4 WHERE ACTUAL FILLING TIME IN DIFFERENT CONDITIONS IS REPORTED FOR A GIVEN COMPUTER.

1-DIMENSIONAL HISTOGRAM (NO HBARX CALLED)

<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
</tr>
<tr>
<td>I</td>
</tr>
<tr>
<td>CALL HFILL(ID,X)</td>
</tr>
<tr>
<td>I</td>
</tr>
</tbody>
</table>

ACTION EQUIVALENT TO HFILL(ID,X,0..1.)

<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
</tr>
<tr>
<td>I</td>
</tr>
<tr>
<td>CALL HFIL1N(ID,X,WEIGHT)</td>
</tr>
<tr>
<td>I</td>
</tr>
</tbody>
</table>

ACTION EQUIVALENT TO HFILL(ID,X,0..WEIGHT).

1-DIMENSIONAL HISTOGRAM (HBARX CALLED)

<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
</tr>
<tr>
<td>I</td>
</tr>
<tr>
<td>CALL HFILL(ID,X,WEIGHT)</td>
</tr>
<tr>
<td>I</td>
</tr>
</tbody>
</table>

ACTION EQUIVALENT TO HFILL(ID,X,0..WEIGHT).
SCATTER PLOT OR TABLE (NO PROJECTIONS)

I CALL HFIL2(ID,X,Y)  I S  I

ACTION EQUIVALENT TO HFILL(ID,X,Y,1.)

REMARKS - PROJECTIONS OF ID (IF ANY) ARE NOT FILLED.

SCATTER PLOT OR TABLE (OPTIONS CALLED)

I CALL HFIL2N(ID,X,Y,WEIGHT)  I S  I

ACTION EQUIVALENT TO HFILL(ID,X,Y,WEIGHT).

REMARKS - PROJECTIONS OF ID (IF ANY) ARE NOT FILLED.

* 4.3 SUPER-FAST FILLING OF 1-DIM

SIMPLE 1-DIMENSIONAL HISTOGRAMS CAN BE FILLED WITH THE SUPER-FAST ENTRY

I CALL HF1(ID,X,W)  I S  I

ACTION EQUIVALENT TO HFILL(ID,X,0.,W)

REMARKS - IS INCOMPATIBLE WITH PACKING OF CHANNELS, AUTOMATIC BINNING CALCULATION, HBARK AND HBSTAT
- DOES NOT CALCULATE MEAN VALUE AND STANDARD DEVIATION.
- IT IS ALMOST TWICE AS FAST AS HFIL1N.
4.4 DISK FILLING

WHEN THE AUTOMATIC DISK OVERFLOW IS USED (SEE 8.1), FILLING MUST BE PERFORMED VIA SPECIAL DISK FILLING CALLS. THEY ARE

```
*-----------------------------*
I  CALL HFIDL(ID,X,Y,WEIGHT)
I  CALL HFID1(ID,X)
I  CALL HFID1M(ID,X,WEIGHT)
I  CALL HFID1W(ID,X,WEIGHT)
I  CALL HFID2(ID,X,Y)
I  CALL HFID2M(ID,X,Y,WEIGHT)
I  CALL HFID2W(ID,X,Y,WEIGHT)
*-----------------------------*
```

AND THEIR EFFECT IS EQUIVALENT TO

```
HFILL, HFILLH, HFILL1, HFILL2, HFILL2W
```

RESPECTIVELY. THE ONLY DIFFERENCE IS THAT THE DISK ENTRIES CHECK WHETHER ID IS IN MEMORY OR NOT, WHILE THE OTHERS ASSUME IT IS IN MEMORY.

IF YOU DO NOT WANT TO WORRY, AND YOU DO NOT CARE ABOUT TIME, USE ALWAYS THE DISK ENTRIES. IN CASE ID IS DEFINITELY NOT ON DISK, FILLING WITH NON-DISK ENTRIES WILL SAVE TIME.

4.5 GLOBAL FILLING

A VECTOR OR MATRIX CAN BE TRANSFERRED INTO A HISTOGRAM, SCATTER PLOT OR TABLE WITH A SINGLE CALL.

```
*-----------------------------*
I  CALL HPAK(ID,CONTENT)
*-----------------------------*
```

ACTION STORES THE ARRAY CONTENT AS THE CONTENTS OF HISTOGRAM ID

PARAMETERS ID = HISTOGRAM IDENTIFIER

CONTENT = LOCAL ARRAY, SUITABLY DIMENSIONED

- 1-D DIMENSION CONTENT(NCHAN)
- 2-D DIMENSION CONTENT(NCHANX,NCHANY)

REMARKS - IF ID IS 2-DIMENSIONAL, POSSIBLE PROJECTIONS AND SLICES ARE NOT AFFECTED.
HISTOGRAMS ARE EDITED ON THE LINE PRINTER CALLING HISTDO OR HPRINT, ACCORDING TO THE FOLLOWING SPECIFICATIONS:

1 DIMENSIONAL HISTOGRAMS

1 histogram per page is printed, writing the global title, date, title, drawing the contour of the histogram in the range between the minimum and the maximum content, with the contents scale adjusted to fit in 1 page, followed by channel number, contents, and low edge of each channel, plus some statistics about the histogram itself (entries, mean value, standard deviation and so on).

SCATTER PLOTS AND TABLES

They can use up to two pages, according to the number of channels in y, and in x and y both channel number and lower edge of each channel are printed.

The plot statistics reported at the bottom consists of a table of 9 numbers:

* N1 I N2 I N3
* ---------I--------I
* N4 I N5 I N6
* ---------I--------I
* N7 I N8 I N9

Giving the sum of contents corresponding to the following 9 classes:

* N1 = underflow x, overflow y
* N2 = x in range, overflow y
* N3 = overflow x, overflow y
* N4 = underflow x, y in range
* N5 = x in range, y in range
* N6 = overflow x, y in range
* N7 = underflow x, underflow y
* N8 = x in range, underflow y
* N9 = overflow x, underflow y
5.1 INDEX AND GENERAL TITLE

It is sometimes convenient to print just the index of plots, without editing all of them.

* I I CALL HINDEX

ACTION PRINT INDEX

REMARKS - Histdd generates the index automatically in the long version.

A title to be printed as the first line of each histogram, for reference purpose, can be defined using

* I I CALL HTITLE(GENTIT) I S

ACTION DEFINES GENERAL TITLE

PARAMETERS GENTIT = GENERAL TITLE (VECTOR) ALPHANUMERIC

REMARKS - See HBOOKI about different ways of passing the title.

5.2 WHAT TO PRINT (1-DIMENSIONAL HISTOGRAM)

Each 1-dimensional histogram consists of several parts, some compulsory, some optional but printed by default, some not printed by default, namely:

- General Title: Compulsory (if defined)
- Identifier and Title: Compulsory
- The histogram itself: Default = Yes
- Channel Numbers: Default = Yes
- Channel Contents: Default = Yes
- Errors: Default = No
- Value of the superimposed function (if any): Default = No
- Integrated Contents: Default = No
- Low edge of channels: Default = Yes
- Statistical Information: Compulsory

The following 7 entries can be used to suppress parts appearing by default and/or to ask for some non-standard ones. They all have the same parameters, that is the identifier and an hollerith variable that can be YES or NO.

Special values and remarks are the same for all these 7 entries, and are listed at the end of the section.
5.2 EDITING
WHAT TO PRINT (1-DIMENSIONAL HISTOGRAM)

CALL HPRI3(ID,2HNO)

ACTION  SUPPRESS PRINTING OF THE ACTUAL SHAPE OF THE
          HISTOGRAM

CALL HPRCHAI(D,2HNO)

ACTION  SUPPRESS PRINTING OF CHANNEL NUMBERS

CALL HPRCONID,2HNO)

ACTION  SUPPRESS PRINTING OF CHANNEL CONTENTS

CALL HPRRI(ID,2HNO)

ACTION  PRINT ALSO ERRORS IN EACH CHANNEL (IF ANY)

CALL HPRFRUN(ID,3HYES)

ACTION  PRINT ALSO VALUES OF THE SUPERIMPOSED
          FUNCTION (IF ANY)

CALL HINTGID,3HYES)

ACTION  PRINT ALSO INTEGRATED CONTENTS

CALL HPRLOWID,2HNO)

ACTION  SUPPRESS PRINTING OF LOWER LIMITS OF CHANNELS

SPECIAL VALUES
ID=0   APPLIES TO ALL EXISTING HISTOGRAMS

REMARKS  - IF ID CORRESPONDS TO A 2-DIMENSIONAL
          PLOT, THESE SPECIFICATIONS APPLY TO ITS
          PROJECTIONS (IF ANY).
5.3 EDITING
GRAPHIC CHOICES (1-DIMENSIONAL HISTOGRAM)

5.3 GRAPHIC CHOICES (1-DIMENSIONAL HISTOGRAM)

THE HISTOGRAM IS NORMALLY REPRESENTED DRAWING ITS
CONTOUR, AND EACH CHANNEL CORRESPONDS TO 1 CHARACTER ON THE
PRINTER, BUT ALTERNATIVE GRAPHIC PRESENTATIONS ARE AVAILABLE

ACTION
CALL HBLACK(ID)
REM
REMARKS
ACTION REPRESENTS EACH CHANNEL FILLING IT WITH X
SPECIAL VALUES
ID = 0 ALL EXISTING 1-DIM AND PROJECTIONS
REMARKS - UPPER CHARACTER OF THE BIN IS IN THIS
CASE 1 TO 9 OR X, CORRESPONDING TO 1/10
TO 10/10 RESPECTIVELY.

CALL HBIGBI(ID,MCOL)
REMARKS
ACTION THE 1-DIMENSIONAL HISTOGRAM ID IS PRINTED
WITH ONE CHANNEL OVER NCOL COLUMNS
SPECIAL VALUES
NCOL MISSING (IF POSSIBLE), NCOL = 5
REMARKS - FOR OBVIOUS EDITING REASONS, HBIGBI WILL
BE APPLIED TO HISTOGRAMS EDITED ACROSS
THE PAGE ONLY IF
NCHAN * NCOL > E 100
IF THIS IS NOT TRUE, NCHAN WILL BE
REDUCED TILL IT OBEYS THE INEQUALITY.
NO RESTRICTIONS IF THE HISTOGRAM IS
PRINTED DOWN THE PAGE (ROTATE)
- IF ID IS 2-DIMENSIONAL, BIG BIN IS
SELECTED ON ALL ITS PROJECTIONS, ETC.

ACTION
CALL HSTAR(ID)
REM
SPECIAL VALUES
ID = 0 ALL EXISTING 1-DIM AND PROJECTIONS
REMARKS - PARTICULARLY SUITABLE TO DRAW FUNCTIONS
5.4 SCALE DEFINITION AND NORMALISATION

NOTE THAT, WHENEVER A MULTIPLICATION BY A POWER OF TEN APPEARS IN THE OUTPUT, IT MEANS THAT THE QUANTITY IT REFERS TO HAS BEEN MULTIPLIED BY THAT FACTOR BEFORE BEING PRINTED.

1-DIMENSIONAL HISTOGRAM


THE OPTIONS THAT FOLLOW PERMIT TO

- CHOOSE LOGARITHMIC CONTENTS SCALE
- DEFINE THE LIMITS OF THE SCALE
- LIMIT TO 1. THE MINIMUM STEP OF THE SCALE
- FORCE SEVERAL HISTOGRAMS TO HAVE THE SAME SCALE FOR COMPARISON
- NORMALISE THE TOTAL CONTENTS TO A GIVEN VALUE

IF THE IDENTIFIER CORRESPONDS TO A SCATTER PLOT OR TABLE, THEY ACT ON PROJECTIONS, IF ANY.

<table>
<thead>
<tr>
<th>ACTION</th>
<th>CONTENTS SCALE IS LOGARITHMIC (BASE 10).</th>
</tr>
</thead>
<tbody>
<tr>
<td>VALUE</td>
<td>ID = 0 APPLIES TO ALL EXISTING HISTOGRAMS.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ACTION</th>
<th>THE CONTENT SCALE LIMITS ARE NOT CALCULATED AUTOMATICALLY, BUT WILL BE (AMIN, AMAX). HISTOGRAM CONTENTS ARE LEFT INTACT.</th>
</tr>
</thead>
<tbody>
<tr>
<td>VALUE</td>
<td>ID = 0 APPLIES TO ALL EXISTING HISTOGRAMS.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ACTION</th>
<th>THE STEP OF THE VERTICAL SCALE CANNOT BE SMALLER THAN 1 FOR HISTOGRAM ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>VALUE</td>
<td>ID = 0 APPLIES TO ALL EXISTING HISTOGRAMS.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ACTION</th>
<th>THE N HISTOGRAMS WHOSE IDENTIFIERS ARE CONTAINED IN ARRAY INDETECT WILL HAVE THE SAME SCALE. THE COMPARISON IS MADE ON THE BASIS OF CONTENTS AT THE TIME HCOMPA IS CALLED.</th>
</tr>
</thead>
</table>
EDITING
SCALE DEFINITION AND NORMALISATION

PARAMETERS
ID = DIMENSION OF I

VALUES
N = DIMENSION OF ID

SPECIAL
N=1, ID=0 ALL HISTOGRAMS HAVE THE SAME SCALE

REMARKS
- THE SUBROUTINE WHERE THIS CALL IS EXECUTED MUST CONTAIN THE DECLARATION DIMENSION ID(N) AND VALUES OF IDENTIFIERS HAVE TO BE ASSIGNED TO ID(N) BEFORE CALLING HCCMPA.
- ID ID IS 2-DIMENSIONAL, HCCMPA ACTS ON PROJECTIONS, SLICES, BANES.

SCATTER PLOT

IN A SCATTER PLOT THE CONTENTS SCALE STARTS AT 0. IN STEPS OF 1., AND THE CONTENT OF EACH CHANNEL IS REPRESENTED BY ONE CHARACTER, THE CORRESPONDENCE BEING

<table>
<thead>
<tr>
<th>CHARACTER</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ + 2, 3,</td>
<td>0, 1, 1</td>
</tr>
<tr>
<td>, 0, A, B, C,</td>
<td>OVERFLW</td>
</tr>
</tbody>
</table>

+ LARGER THAN 0. AND SMALLER THAN 1.
+ LARGER OR EQUAL TO 1. AND SMALLER THAN 2.
+ LARGER OR EQUAL TO 2. AND SMALLER THAN 3.
+...
+...

THE COMMAND HSCALE CAN CHANGE THE CORRESPONDENCE BY A CHOSEN FACTOR, REDEFINING THE ORIGIN AND THE STEP, TO SPAN THE COMPLETE RANGE OF CONTENTS.

ACTION
NORMALISE THE TOTAL CONTENTS OF THE 1-DIMENSIONAL HISTOGRAM ID TO FACTOR, WHEN PRINTING IT. ORIGINAL CONTENTS ARE LEFT INTACT.

SPECIAL
VALUES
ID = 0 ALL

REMARKS
- IF ID IS 2-DIMENSIONAL, HCNORMA ACTS ON ITS PROJECTION(S)
- FACTOR = 0 IS ILLEGAL.

ACTION IN SCATTER PLOT ID THE CONTENT SCALE IS MULTIPLIED BY FACTOR.
IF FACTOR = 0 OR MISSING, SCALING IS AUTOMATIC AND THE RANGE WILL BE FROM THE MINIMUM TO THE MAXIMUM OF THE ACTUAL CONTENTS.

SPECIAL
VALUES
ID = 0 APPLIES TO ALL EXISTING SCATTER PlOTS

REMARKS
- THIS CALL HAS NO EFFECT ON THE PROJECTION OF ID.
5.5 PAGE CONTROL

Plots are edited on the line printer file, each of them starting at the beginning of a new page. The page size is an installation default. One-dimensional histograms take 1 page, and are printed across the page.

All those defaults can be overwritten as follows.

ACTION 1-DIMENSIONAL HISTOGRAM ID, PRINTED ACROSS THE PAGE, EXTENDS OVER 2 PAGES TO IMPROVE THE RESOLUTION

SPECIAL VALUES ID = 0 APPLIES TO ALL EXISTING HISTOGRAMS

ACTION PAGE EJECT IS SUPPRESSED / REESTABLISHED

ACTION PAGE SIZE IS MODIFIED TO N_LINES X N_COLUMNS

SPECIAL VALUES ID = 0 APPLIES TO ALL EXISTING HISTOGRAMS
5.6 GRAPHIC OUTPUT ON DEVICES OTHER THAN THE LINE PRINTER

- THE QUALITY OF HBOOK LINE PRINTER OUTPUT IS PROBABLY NOT GOOD ENOUGH FOR PUBLICATION PURPOSES. TO PROVIDE FOR THIS, THE NPILOT PACKAGE MAY BE USED. THIS IS AN INTERFACE BETWEEN HBOOK AND A GRAPHIC INTERPRETER (GD3 AT CERN).

- OUTPUT CAN BE ON ANY GRAPHIC DEVICE, BUT IF THE PLOTTER IS CHOSEN, THE PICTURE WILL BE PRESENTED ON STANDARD A4 OR A3 SIZE.

- SEVERAL OPTIONS ARE AVAILABLE, WITH DEFAULTS WHERE APPROPRIATE, SO THAT DRAWINGS SUITABLE FOR PUBLICATION OR SLIDES FOR PROJECTION AT CONFERENCES CAN BE PRODUCED WITH AS LITTLE EFFORT AS POSSIBLE. OPTIONS INCLUDE

  - PICTURE TITLES
  - AXIS TITLES
  - COMMENTS ANYWHERE IN THE PICTURE
  - SEVERAL HISTOGRAMS ON ONE PICTURE WITH DIFFERENT SYMBOLS USED TO DRAW THEM, AND ALSO THE PROVISION OF A KEY SHOWING THE MEANING OF EACH SYMBOL.

- FOR FURTHER DETAILS CONSULT THE NPILOT USER GUIDE (REFERENCE 47).

6. ACCESS TO INFORMATION

- THE INFORMATION CONTAINED IN A HISTOGRAM CAN BE MADE AVAILABLE IN LOCAL VARIABLES VIA THE COMMANDS DESCRIBED IN THIS SECTION. IT IS POSSIBLE TO ACCESS CHANNEL CONTENTS (ALL TOGETHER OR INDIVIDUALLY), AND ALSO MEAN VALUE AND STANDARD DEVIATION OF 1-DIMENSIONAL DISTRIBUTIONS, AS WELL AS SKEWNESS AND KURTOSIS.

- MORE CAN BE OBTAINED USING FLCCAT, AND KNOWING THE MEMORY ORGANIZATION IN DETAIL (REFERENCE 51).

---

**LOGVAR** = **HEXIST**(ID)

**ACTION**

LOGICAL FUNCTION WHOSE VALUE IS

- **TRUE** IF ID EXIST AND
- **FALSE** IF IT DOES NOT.

**REMARKS**

LOGVAR HAS TO BE DECLARED LOGICAL.

---

**CALL HNOENT(ID,NOENT)**

**ACTION**

Provides number of entries of histogram ID

**PARAMETERS**

- **ID** = HISTOGRAM IDENTIFIER
- **NOENT** = NUMBER OF ENTRIES OF ID.
ACTION
THE CONTENTS OF THE HISTOGRAM (SCATTER PLOT OR TABLE) OR OF A SELECTED PROJECTION ARE TRANSFERRED INTO THE LOCAL ARRAY CONTENT.

PARAMETERS
ID = HISTOGRAM IDENTIFIER
CONTENT = ARRAY TO BE DIMENSIONED TO THE NUMBER OF CHANNELS OR CELLS OF THE HISTOGRAM (OR PROJECTION)
1-D DIEMNSION CONTENT(NCHAN)
2-D DIMENSION CONTENT(NCHAN,NCHAN)

CHOICE = HOLLERITH VARIABLE THAT SELECTS SUBHISTOGRAMS (IRRELEVANT FOR 1-DIMENSIONALS)
4HIST THE HISTOGRAM ITSELF
4HPROX X PROJECTION
4HPROY Y PROJECTION
4HSLIX X SLICE
4HSLIY Y SLICE
4HBANX X BAND
4HANY Y BAND

NUM = SERIAL ORDER OF THE SLICE OR BAND THAT IS REQUESTED

REMARKS
- IF CHOICE AND/OR NUM ARE MISSING
  CHOICE = 4HIST AND NUM = 1

ACTION
RETURN CHANNEL CONTENTS, GIVEN THE CHANNEL NUMBER FOR 1-DIMENSIONAL AND CELL NUMBER FOR 2-DIMENSIONAL

REMARKS
- HI APPLIES TO 1-DIM, HIJ TO 2-DIM.

ACTION
RETURN THE CONTENTS OF CHANNEL (OR CELL) THAT CONTAINS X (X,Y)

REMARKS
- HX APPLIES TO 1-DIM, HXY TO 2-DIM.

ACTION
RETURN THE SQUARE ROOT OF THE SQUARES OF THE WEIGHTS OF CHANNEL I OF HISTOGRAM ID

REMARKS
- VALID ONLY FOR 1-DIM WITH THE HBARX OPTION.
VARIAB = HXEDI(ID,X)  

ACTION  RETURN THE SQUARE ROOT OF THE SUM OF THE  
SQUARES OF WEIGHTS OF THE CHANNEL THAT  
CONTAINS X  

REMARKS  = SAME AS HIE.  

CALL HXI(ID,X,I)  
CALL HXIDJ(ID,X,Y,I,J)  

ACTION  RETURN CHANNEL (CELL) NUMBER I (I,J)  
CORRESPONDING TO A VALUE OF X (X,Y)  

REMARKS  = HXI APPLIES TO 1-DIM, HXIJ TO 2-DIM.  

VARIAB = HSTAT(ID,IMON,CHOICE,NUM)  

ACTION  REAL FUNCTION THAT RETURNS MEAN VALUE,  
STANDARD DEVIATION, SKEWNESS OR KURTOSIS OF A  
1-DIMENSIONAL DISTRIBUTION  

PARAMETERS  
ID  = HISTOGRAM IDENTIFIER  
IMON  = 1 MEAN VALUE  
2 STANDARD DEVIATION  
3 SKEWNESS  
4 KURTOSIS  
CHOICE  = SEE HUNPAK  
NUM  = SEE HUNPAK  

REMARKS  
N  = SUM WEIGHT(I)*X(I))  
I=1  

EXPECTATION VALUE  
E(X)  

E(X)  

N  = SUM WEIGHT(I)  
I=1  

MEAN VALUE  
= E(X)  

CENTRAL MOMENT OF ORDER N = E((X-E(X))^N)  
MOM(N)  

STANDARD DEVIATION  
= SORT (MOM(2))  

SKEWNESS  
= MOM(3) / (MOM(2))**3/2  

KURTOSIS  
= (MOM(4) / (MOM(2)**2) - 3  

ACTION  RETURN LOW EDGE X (X,Y) OF CHANNEL (CELL),  
GIVEN THE CHANNEL NUMBER I (CELL NUMBER I,J)  

REMARKS  = MIX APPLIES TO 1-DIM, HIJXY TO 2-DIM.
CALL HLOCAT(IO,IFIRST)

ACTION
RETURNS THE ADDRESS OF THE FIRST WORD OF
HISTOGRAM ID IN BLANK COMMON

PARAMETERS
ID = HISTOGRAM IDENTIFIER
IFIRST = FIRST LOCATION OF ID

REMARKS
- THIS COMMAND CAN BE USEFUL TO ACCESS
  DIRECTLY THE MEMORY AREA OF A GIVEN
  HISTOGRAM, TO EXTRACT ANY INFORMATION
  THAT CANNOT BE OBTAINED WITH THE
  PREVIOUSLY DESCRIBED ENTRIES. THIS
  REQUIRES A DETAILED KNOWLEDGE OF THE
  MEMORY ORGANIZATION, DESCRIBED IN THE
  HBOOK REFERENCE MANUAL (REFERENCE 5).

ARITHMETIC OPERATIONS CAN BE EXECUTED BETWEEN HISTOGRAMS.

SIMPLE FITTING ENTRIES ARE PROVIDED, TO FIT 1-DIMENSIONAL
DISTRIBUTIONS WITH POLYNOMIALS AND WITH A GAUSSIAN.

SMOOTHING CAN BE PERFORMED USING THE
353GH, TWICE
ALGORITHM (SEE REFERENCE 3).

FOR ALL OTHER MATHEMATICAL OPERATIONS, DO IT YOURSELF
USING HUNPAK.
7.1 ARITHMETIC

HISTOGRAMS THAT HAVE BEEN FILLED CAN BE ADDED, SUBTRACTED, DIVIDED OR MULTIPLIED, PROVIDED THEIR NUMBER OF CHANNELS AND SCALE ARE THE SAME. THIS IS DONE USING

CALL HOPERA,ID1,OPERATION,ID2,ID3,C1,C2)

ACTION FILLS THE HISTOGRAM ID3, ORIGINALLY EMPTY, WITH VALUES SUCH THAT

ID3 = C1 * ID1 (OPERATION) C2 * ID2

PARAMETERS ID1,ID2 = OPERAND HISTOGRAMS IDENTIFIERS
OPERATION= 1H++,1H--,1H*,1H/
ID3 = RESULT HISTOGRAM IDENTIFIER
C1,C2 = CONSTANTS

SPECIAL VALUES IF POSSIBLE, THE OMISSION OF C1 AND C2 IMPLIES C1 = C2 = 1

REMARKS
- ID1,ID2 AND ID3 MUST HAVE THE SAME NUMBER OF CHANNELS, SCALE, BOOKING OPTIONS.
- ID1, ID2, ID3 CANNOT RESIDE ON DISK. IF IT IS SO, A MESSAGE IS PRINTED AND NO ACTION IS TAKEN.
- IF ID3 IS NOT EMPTY, ITS CONTENTS ARE OVERWRITTEN.
- ID3 CAN BE ID1 OR ID2.
- MEAN, S.D., ETC ARE APPROXIMATELY CALCULATED ON RESULT HISTOGRAM.
- DIVISION BY ZERO GIVES ZERO.

IT IS SOMETIMES CONVENIENT TO HAVE SEVERAL COPIES OF THE SAME HISTOGRAM, AND THIS IS ACHIEVED BY

CALL HCOPY,ID1,ID2,TITLE)

ACTION GENERATE HISTOGRAM ID2 THAT IS A COPY OF ID1, APART FROM THE TITLE

PARAMETERS ID1 = EXISTING IDENTIFIER
ID2 = NOT EXISTING IDENTIFIER
TITLE = NEW TITLE

SPECIAL VALUES TITLE MISSING (IF POSSIBLE) THE OLD TITLE IS KEPT.
7.2 FITTING AND SMOOTHING

SOME SIMPLE FITTING AND SMOOTHING FACILITIES ARE AVAILABLE, ONLY FOR 1-DIMENSIONAL HISTOGRAMS. MORE SOPHISTICATED HANDLING CAN BE OBTAINED WITH THE COMBINED USE OF HUNPAK AND HFUNC, TOGETHER WITH ANY FITTING ALGORITHM.

ACTION
FITS 1-DIMENSIONAL DISTRIBUTION OF ID WITH POLYNOMIALS

\[ Y = A(1) + A(2)X + A(3)X^2 + \ldots \]

THE FITTED FUNCTION IS SUPERIMPOSED

PARAMETERS

NORD = NUMBER OF COEFFICIENTS (ORDER + 1)

A = ARRAY OF COEFFICIENTS, INCREASING ORDER OF POWERS

CHI2 = CHISQUARE

* SPECIAL
VALUES
A AND CHI2 CAN BE OMITTED

ACTION
SMOOTH HISTOGRAM ID ACCORDING TO THE ALGORITHM

35QIM, TWICE
(SEE REFERENCE 3)

PARAMETERS

ICASE = 1 REPLACE ORIGINAL BY SMOOTHED 2 SUPERIMPOSE AS A FUNCTION

CHI2 = CHISQUARE

* SPECIAL
VALUES
ICASE MISSING MEANS ICASE = 1
CHI2 CAN BE MISSING

REMARKS
MEAN VALUE AND STANDARD DEVIATION ARE RECALCULATED IF ICASE = 1.
This chapter describes the organisation of the memory, including automatic overflow of histograms on disk, activation and deactivation.

Entries are also provided to direct results and error messages on files other than the line printer file.
8.1 MEMORY MANAGEMENT AND FILE DEFINITION
MEMORY SIZE AND DISK OVERFLOW

---

ACTION
Defines size of memory area and intermediate filling buffer area.

PARAMETERS
NWMENO = Total number of words for the memory
NBUFF = Number of words for the intermediate filling buffer

SPECIAL VALUES
NBUFF = 0 or missing foretells the disk overflow

REMARKS
- HLIMIT must be called before all bookings.

---

CALL HLINIT(NWMENO,NBUFF)

---

8.2 STORE AND FETCH

HISTOGRAM CAN BE STORED EXPLICITLY ONTO A DISK
TO RESTORE THEM IN MEMORY, EITHER DURING THE SAME JOB OR IN ANOTHER ONE.

THIS PROCEDURE CAN BE CONVENIENT TO OPERATE UPON HISTOGRAMS RESULTING FROM DIFFERENT JOBS, AND ALSO, INSIDE A SINGLE JOB, AS AN ALTERNATIVE TO THE AUTOMATIC DISK OVERFLOW.

---

CALL HSTORE(ID,STFILE)

---

ACTION
Stores histogram ID onto the logical unit STFILE.

SPECIAL VALUES
ID = 0 stores all active histograms.

REMARKS
- ID still exist in memory unless is deleted explicitly.

---

CALL HDISKF(FILE1,FILE2)

---

ACTION
Defines names of disk files for overflow.

PARAMETERS
FILE1 = Names of files
FILE2 = Names of files

REMARKS
- FILE1 must be different from FILE2.
- Default values are defined at installation time (see Appendix A).

---

CALL HFETCH(ID,FCFILE)

---

ACTION
Fetches histogram ID from the logical unit FCFILE.

SPECIAL VALUES
ID = 0 fetches all histograms from FCFILE

REMARKS
- If ID already exists as an active histogram, and if the two have the same specifications, their contents will be added. In case the specifications do not coincide, the fetch operation is not executed.

---
8.3 OUTPUT FILES

THE OUTPUT FILE, CONTAINING THE HISTOGRAMS, IS BY DEFAULT
THE PRINTER FILE, WHERE ALSO ERROR MESSAGES WILL BE WRITTEN.

THE NAMES OF THE RESULT AND ERROR FILES CAN BE REDEFINED
USING

CALL MOVESTRING(outfil, using)
CALL HERMES(errfil, using)

ACTION
OVERWRITE NAMES OF RESULT AND ERROR MESSAGE FILE.

PARAMETERS
OUTFIL = LOGICAL UNIT NUMBER OF RESULT FILE
ERRFIL = LOGICAL UNIT NUMBER OF ERROR MESSAGE FILE.

LIST OF ERROR CONDITIONS

100 GENERAL

111 REFERENCE TO A NON-EXISTING ID
112 ID ALREADY EXISTING
113 ID=0 ILLEGAL BOOKING IDENTIFIER
114 ILLEGAL PARAMETER
115 REFERENCE TO NON-EXISTING SLICE OR BAND

200 BOOKING PARAMETERS

211 NEGATIVE NUMBER OF CHANNELS
212 TOO MANY CHANNELS IN X
213 TOO MANY CHANNELS IN Y
214 Y UPPER LIMIT .LT. Y LOWER LIMIT
215 PACKING OF BINS IS INCOMPATIBLE WITH AUTOMATIC
    LIMITS DEFINITION, 1 WORD PER BIN IS SELECTED

300 BOOKING OPTIONS

311 NON-POSITIVE PARAMETER FOR HISTO
321 ILLEGAL BOOKING OPTION FOR 1-DIMENSIONAL
322 ILLEGAL BOOKING OPTION FOR 2-DIMENSIONAL
323 BOOKING OPTION ALREADY ACTIVE
324 THIS OPTION MUST APPEAR BEFORE FILLING
ERROR MESSAGES

500 EDITING

541 COMPARISON OF HISTOGRAMS WITH DIFFERENT SPECIFICATIONS
542 ZERO IS ILLEGAL NORMALIZATION FACTOR
543 BAD SCALE FACTOR

700 OPERATIONS

711 OPERATION ON HISTOGRAMS WITH DIFFERENT SPECIFICATIONS
712 OPERAND HISTOGRAMS MUST RESIDE IN MEMORY
721 DEGREE POLYNOMIAL NON POSITIVE
722 NO OF CHANNELS SMALLER THAN DEGREE OF POLYNOMIAL

800 MEMORY AND DISK

811 BUFFER AREA TOO SHORT

THE CERN CENTRAL COMPUTER VERSION OF HBOOK IS IMPLEMENTED WITH THE FOLLOWING OPTIONS

MEMORY

THE WORKING AREA IS CONTAINED IN THE BLANK COMMON, AND AUTOMATIC MEMORY ALLOCATION IS AVAILABLE. SIZE AND POSITION ARE CONTROLLED BY MLIMIT AND MISTGO.

DISK OVERFLOW

IS AVAILABLE. DEFAULT DISK FILE NAMES ARE MDISK1, MDISK2.

SHORTENED CALLING SEQUENCE

THE FIN COMPILER ALLOWS VARIABLE NUMBER OF PARAMETERS, SO THE CALLING SEQUENCE OF SOME ENTRIES CAN BE ABBREVIATED.

IN PARTICULAR

CALL HBOOK1(ID)

WILL BOOK WITH NO TITLE, 100 CHANNELS, AUTOMATIC LIMIT DEFINITION AND 1 WORD PER CHANNEL. SHORTENED CALLING SEQUENCE CAN BE USED ALSO IN HBOOK2, HTABLE, HFILL, HUMPACK, HSTAT, HPERA.

REAL OR INTEGER PARAMETERS

ALL REAL PARAMETERS IN THE BOOKING CALLS AND OPTIONS ARE ALSO ACCEPTED IF INTEGERS.

TITLE

UP TO 80 CHARACTERS (8 COMPUTER WORDS)

FILES DEFAULTS

RESULTS ON OUTPUT
ERROR MESSAGES ON OUTPUT
DISK OVERFLOW ON MDISK1 AND MDISK2.
A.2 USE UNDER CDC SCOPE

HBOOK, VERSION LONG AND SHORT, ARE THE ENTRY Y 258 IN THE CERN PROGRAM LIBRARY, BUT SIT ON SEPARATE DISK FILES IN LIBRARY FORMAT. CONTROL CARDS TO USE IT ARE AS FOLLOWS

7600   FIND,HBOOKL,HBOOKL7600LIE,ID=PROGLIB.
   LONG   LIBRARY,HBOOKL,.....

7600   FIND,HBOOKS,HBOOKS7600LIE,ID=PROGLIB.
   SHORT  LIBRARY,HBOOKS,.....

* 6000   ATTACH,HBOOKL,HBOOKL6000LIB,ID=PROGLIB.
*  LONG   LIBRARY,HBOOKL,.....

* 6000   ATTACH,HBOOKS,HBOOKS6000LIB,ID=PROGLIB.
*  SHORT  LIBRARY,HBOOKS,.....

A.3 SPACE

THE SPACE TAKEN BY HBOOK DEPENDS ON THE VERSION USED (LONG/SHORT) AND ON THE OPTIONS ACTUALLY CALLED BY THE PROGRAM.

THE FOLLOWING TABLE INDICATES MINIMUM AND MAXIMUM SPACE REQUIREMENTS FOR BOTH VERSIONS, EXPRESSED IN CM WORDS DECIMAL.
MINIMUM MEANS JUST BOOK, FILL AND PRINT 1-DIM, AND MAXIMUM REFERS TO THE WHOLE PACKAGE

<table>
<thead>
<tr>
<th></th>
<th>MIN</th>
<th>MAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>HBOOKL</td>
<td>8600</td>
<td>15600</td>
</tr>
<tr>
<td>HBOOKS</td>
<td>5300</td>
<td>10500</td>
</tr>
</tbody>
</table>

THOSE FIGURES INCLUDE SUBROUTINES AND FUNCTIONS EXTERNAL TO THE PACKAGE, OBTAINED FROM THE 7600 LIBRARY, THAT MIGHT BE USED BY OTHER PARTS OF THE PROGRAM ALSO.

THE VALUE FOR HBOOKL, MIN CORRESPONDS TO THE CASE WHERE THE INTERNAL SUBROUTINE HPIROT, USED TO PRINT 1-DIM DOWN THE PAGE, IS DUMMY IN THE PROGRAM.
### A.4 FILLING TIME

As explained in Section 4.2, filling a histogram consists of 3 steps:

1. **Addressing** in the Dynamic Memory
2. **Flag Decoding Logic**
3. **Increment of Channel Content**

The following table accounts for the approximate time taken by one filling instruction execute via HF1, the fast filling entries or HFILL, in the two cases of packing and nCP packing, expressed in microseconds CPTIME 7600.

<table>
<thead>
<tr>
<th></th>
<th>HF1</th>
<th>FFE NOPACK</th>
<th>FFE PACK</th>
<th>HFILL NOPACK</th>
<th>HFILL PACK</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Addressing</strong></td>
<td>I</td>
<td>I</td>
<td>I</td>
<td>I</td>
<td>I</td>
</tr>
<tr>
<td><strong>Decoding</strong></td>
<td>I</td>
<td>I</td>
<td>I</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td><strong>Increment</strong></td>
<td>I</td>
<td>I</td>
<td>I</td>
<td>30</td>
<td>I</td>
</tr>
</tbody>
</table>

Note that the addressing time corresponds to a typical situation of about 20 histograms, and it increases logarithmically with the number of IO's.

### B. INSTALLATION ON OTHER COMPUTER SYSTEMS

Copies of the source of HBOOK, to be used outside CERN, both on COG and other manufacturers' computers, are available from the authors.

The modifications applied are minimal, and amount to:

- Change a few statements the in internal subroutine MMACHN, that defines the structure of the machine and file assignment.
- Replace some subroutines and functions external to the package, mainly array and bit manipulation utilities, that are necessarily machine dependent.

An overlay organization is recommended if the operating system does not provide for automatic selective loading.
1. R. Brun, M. Hansroul, P. Palazzi, HBOOK USER GUIDE, VERSION 1.2, CERN, DATA HANDLING DIVISION (1973)

2. W. T. Eadie, D. Drijard, F. E. James, M. Ross, B. Sadoulet, STATISTICAL METHODS IN EXPERIMENTAL PHYSICS (NORTH HOLLAND PUBLISHING COMPANY, AMSTERDAM, LONDON, 1971)


4. HBOOK USER GUIDE, CERN DATA HANDLING DIVISION (IN PREPARATION)

5. HBOOK REFERENCE MANUAL, CERN DATA HANDLING DIVISION (IN PREPARATION).

We would like to thank D. Drijard for his interest in this work and for useful discussions.

The authors are also indebted to F. G. de Bilio for the editing of this writeup, that has been produced using the CERN version of the Berkeley BARB TEXT FORMATTING PROGRAM.
PROGRAM ONE(INPUT,OUTPUT)

EXAMPLE OF BASIC HBOOK USE

AUTOMATIC MEMORY ALLOCATION NOT AVAILABLE

COMMON// HMEMOR(2300)

DATA XK,ALPHA,CCEF/5..6,7./

RESERVE 200 LOCATION FOR OTHER BUSINESS

CALL HISTGO(201)

BOOK 1-DIMENSIONAL HISTOGRAM

CALL HBOOK(110,30H1-DIMENSIONAL HISTOGRAM ,100,0,20,0.)

BOOK SCATTER PLOT

CALL HBOOK(120,13HSCATTER PLOT ,100,0,1,40,-5,5,15.)

BOOK TABLE

CALL MTABLE(130,10MTABLE ,20,-4,4,30,-3,14,3,14,200.)

FILLING

DO 100 ITIME=1,4000

RNDM IS A FLAT RANDOM NUMBER GENERATOR
RANFOR IS A SUBROUTINE GENERATING 2 GAUSSIAN RANDOM NUMBERS

CALL RANFOR(A,B)

CALL HFILL(110,2.*A+10.,0.,1.)
X=RNDM(ITIME)
Y1=X*CCEF-XK+ALPHA*A
Y2=-X*CCEF+XK+ALPHA*A
CALL HFILL(120,X,Y1,1.)
CALL HFILL(120,X,Y2,1.)
CALL HFILL(130,A,B,1.)

100 CONTINUE

EDIT ALL PLOTS WITH INDEX

CALL HISTDO

STOP

END
<table>
<thead>
<tr>
<th>NO</th>
<th>TITLE</th>
<th>ID</th>
<th>B/C</th>
<th>ENTRIES</th>
<th>DIM</th>
<th>NCPA</th>
<th>LOWER</th>
<th>UPPER</th>
<th>ADDRESS</th>
<th>LENGTH</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1-DIMENSIONAL HISTOGRAM</td>
<td>110</td>
<td>60</td>
<td>4000</td>
<td>1</td>
<td>X</td>
<td>100</td>
<td>0.000</td>
<td>2.000E+01</td>
<td>TOT</td>
<td>207</td>
</tr>
<tr>
<td>2</td>
<td>SCATTER PLOT</td>
<td>120</td>
<td>4</td>
<td>8000</td>
<td>2</td>
<td>X</td>
<td>100</td>
<td>0.000</td>
<td>1.000E+00</td>
<td>TOT</td>
<td>330</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Y</td>
<td>40</td>
<td>-5.000E+00</td>
<td>5.000E+00</td>
<td>TOT</td>
<td>350</td>
</tr>
<tr>
<td>3</td>
<td>TABLE</td>
<td>130</td>
<td>8</td>
<td>4000</td>
<td>2</td>
<td>X</td>
<td>20</td>
<td>-4.000E+00</td>
<td>4.000E+00</td>
<td>TOT</td>
<td>648</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Y</td>
<td>30</td>
<td>-3.140E+00</td>
<td>3.140E+00</td>
<td></td>
<td>668</td>
</tr>
</tbody>
</table>

MEMORY UTILIZATION

MAXIMUM TOTAL SIZE OF BLANK COMMON 2335
USER AREA IN BLANK COMMON 200
<table>
<thead>
<tr>
<th>TABLE</th>
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</thead>
<tbody>
<tr>
<td>PB0CK</td>
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<td></td>
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<tr>
<td>CHANNEls</td>
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<tr>
<td></td>
</tr>
</tbody>
</table>

* ENTRIES = 4000
* SATURATION AT = 0.255
* STATISTICS = 1 4 1
PROGRAM TWO(INPUT, OUTPUT, TAPE1)

EXAMPLE OF BOOKING OPTIONS

AUTOMATIC MEMORY ALLOCATION IS AVAILABLE

COMPILER PERMITS VARIABLE NUMBER OF PARAMETERS.

IN BOOKING CALLS INTEGERS CAN REPLACE REAL NUMBERS

DIMENSION TITLE(5)

EXTERNAL FGAUSS

DATA XMIN,XMAX,YMIN,YMAX/.1,.1,.1,.1,.175/
DATA A1,A2,A3,ALPHA/3,6,4,0,
DATA TITLE/10H1-DIM HIST,10HISTOGRAM WITH,10M ROUNDED B,
1 10MIN SIZE 0 /

DEFINE GLOBAL TITLE

CALL HTITLE(2) (EXAMPLES OF BOOKING OPTIONS)

BOOKING OF A 1-DIM HISTOGRAM WITH ROUNDED BIN SIZE
EXPECTED MAXIMUM VALUE IN ONE CHANNEL IS 400.

CALL HBINSZ(3)(YES)
CALL HBOOK1210,TITLE,40,3.16,4.62,4.00)

CALL HBINSZ(2HNC)

1-DIM HIST WITH FUNCTION FGAUSS SUPERIMPOSED
CALCULATION OF SKEWNESS AND KURTOSIS

CALL HBOOK1211,3HIST WITH SUPERIMPOSED FUNCTION,100,5.5)
CALL HSTAT(211)
CALL HFUNC(211,FGAUSS)

BOOKING OF A 1-DIM HIST WITH AUTOMATIC BIN CALCULATION
AND STORAGE OF SQUARES OF WEIGHTS.

NUMBER OF CHANNELS (BY DEFAULT) IS 100

CALL HBOOK1212,36H1-DIM WITH AUTOMATIC BIN CALCULATION
CALL HBARX(212)
BOOKING OF A SCATTER- PLOT WITH PROJECTION Y, 3 SLICES ON Y, AND 1 BAND ON X.
NUMBER OF BITS RESERVED BY CELL IS 5 (BY DEFAULT)
NOTE THAT A DOLLAR IS AT THE END OF THE TITLE.
THIS DOLLAR IS NECESSARY ON SOME COMPUTER SYSTEMS (IBM).

CALL HBOOK2(220, 26, HSCATTER PLOT WITH OPTIONS$, 100, XMIN, XMAX, 1.35, YMIN, YMAX)
CALL HPPROXY(220, 100)
CALL HBANDX(220, 1, 3, 4)
CALL HBSLIXY(220, 3, 100)
CALL HBARX(I, 220)

BOOKING OF A TABLE, FILLING WITH WEIGHT FORESEEN

CALL HTABLE(230, 15, THIS IS A TABLE, 12, -3, 3, 35, -3, 5, 3, 5, 0)

FILLING OF HISTOGRAMS PREVIOUSLY BOOKED

DO 10 I=1, 1000

CALL RANNOR(A, B)

CALL HFILL(210, A-2, 0, 2)
CALL HFILL(210, A, 0, 1)
CALL HFILL(212, A-2, 0, 1)

W=MOD(I, 3)+1
X1=RDOM(I)
X2=RDOM(X1)
X3=RDOM(X2)
Y1=A1/SORT(X1)
Y2=A2/SORT(X2)
Y3=A3/SORT(X3)

CALL HFILL(220, X1+ALPHA*A, Y1+ALPHA*E, W)
CALL HFILL(220, X2+ALPHA*A, Y2+ALPHA*E, W)
CALL HFILL(220, X3+ALPHA*A, Y3+ALPHA*E, W)

CALL HFILL(230, A, B, A)

CALL RANNOR(A, B)

CALL HFILL(210, A+2, 0, 2)
CALL HFILL(212, A+2, 0, 2)

10 CONTINUE
EDITING OF ALL HISTOGRAMS

CALL HISTDO

SAVE ALL PLOTS ON L.U.N. 1

CALL HSTOR(0,1)

CLEAR MEMORY

CALL HDEL(0)

FETCH ALL PLOTS PREVIOUSLY SAVED

CALL HFETCH(0,1)

FETCH PLOT ID=210 ALREADY EXISTING CONTENTS ARE ADDED.

CALL HFETCH(210,1)

EDIT ID=210 WITH BIGBIN OPTION

CALL HBIGBI(210)

CALL HPRINT(210)

STOP

END

FUNCTION FGAUSS(X)

FGAUSS=68.*EXP(-.5*X*X)

RETURN

END
<table>
<thead>
<tr>
<th>NO</th>
<th>TITLE</th>
<th>ID</th>
<th>B/G</th>
<th>ENTRIES</th>
<th>CIM</th>
<th>NCPA</th>
<th>LOWER</th>
<th>UPPER</th>
<th>ADDRESS</th>
<th>LENGTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1-DIM HISTOGRAM WITH ROUNDED BIN SIZE</td>
<td>210</td>
<td>9</td>
<td>2000</td>
<td>1</td>
<td>X</td>
<td>40</td>
<td>-3.200E+00</td>
<td>4.800E+00</td>
<td>TOT 11</td>
</tr>
<tr>
<td>2</td>
<td>HIST WITH SUPERIMPOSED FUNCTION</td>
<td>211</td>
<td>60</td>
<td>1000</td>
<td>1</td>
<td>X</td>
<td>100</td>
<td>-5.000E+00</td>
<td>5.000E+00</td>
<td>TOT 36</td>
</tr>
<tr>
<td>3</td>
<td>1-DIM WITH AUTOMATIC BIN CALCULATION</td>
<td>212</td>
<td>60</td>
<td>2000</td>
<td>1</td>
<td>X</td>
<td>100</td>
<td>-1.044E+01</td>
<td>5.560E+00</td>
<td>TOT 267</td>
</tr>
<tr>
<td>4</td>
<td>SCATTER PLOT WITH OPTIONS</td>
<td>220</td>
<td>5</td>
<td>3000</td>
<td>2</td>
<td>X</td>
<td>100</td>
<td>1.000E-01</td>
<td>1.100E+00</td>
<td>TOT 493</td>
</tr>
<tr>
<td>5</td>
<td>PROJECTION Y</td>
<td>9</td>
<td>3000</td>
<td>1</td>
<td>Y</td>
<td>35</td>
<td>0.000</td>
<td>1.750E+01</td>
<td>526</td>
<td>327</td>
</tr>
<tr>
<td>6</td>
<td>BAND X</td>
<td>60</td>
<td>450</td>
<td>1</td>
<td>X</td>
<td>100</td>
<td>1.000E-01</td>
<td>1.100E+00</td>
<td>856</td>
<td>206</td>
</tr>
<tr>
<td>7</td>
<td>SLICE Y</td>
<td>7</td>
<td>1286</td>
<td>1</td>
<td>Y</td>
<td>35</td>
<td>0.000</td>
<td>1.750E+01</td>
<td>1075</td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td>SLICE Y</td>
<td>7</td>
<td>1899</td>
<td>1</td>
<td>Y</td>
<td>35</td>
<td>0.000</td>
<td>1.750E+01</td>
<td>1091</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>SLICE Y</td>
<td>7</td>
<td>705</td>
<td>1</td>
<td>Y</td>
<td>35</td>
<td>0.000</td>
<td>1.750E+01</td>
<td>1091</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>THIS IS A TABLE</td>
<td>230</td>
<td>69</td>
<td>1000</td>
<td>2</td>
<td>X</td>
<td>12</td>
<td>-3.000E+00</td>
<td>3.800E+00</td>
<td>TOT 1098</td>
</tr>
</tbody>
</table>

**MEMORY UTILIZATION**

- **MAXIMUM TOTAL SIZE OF BLANK COMMON**: 2439
- **USER AREA IN BLANK COMMON**: 0
### EXAMPLES OF BOOKING OPTIONS

---

#### 1-DIM HISTOGRAM WITH ROUNDED BIN SIZE

<table>
<thead>
<tr>
<th>MBOOK</th>
<th>ID</th>
<th>DATE</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>210</td>
<td>29/05/75</td>
<td>1</td>
</tr>
</tbody>
</table>

| 180  | -   |            |    |
| 175  | I   |            |    |
| 170  | I   |            |    |
| 165  | I I  |            |    |
| 160  | I I  |            |    |
| 155  | I I  |            |    |
| 150  | I I  |            |    |
| 145  | I I I |         |    |
| 140  | I I I |         |    |
| 135  | I I I |         |    |
| 130  | I I I |         |    |
| 125  | I I I |         |    |
| 120  | I I I |         |    |
| 115  | I I   |         |    |
| 110  | I I   |         |    |
| 105  | I I   |         |    |
| 100  | I I   |         |    |
| 95   | I I   |         |    |
| 90   | I I   |         |    |
| 85   | I I   |         |    |
| 80   | I I   |         |    |
| 75   | I I   |         |    |
| 70   | I I   |         |    |
| 65   | I I   |         |    |
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### Examples of Booking Options

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* Bin Wdth = 5.0000E-01  * Mean Value = 8.1358E+00  * R.M.S. = 5.1653E+00  * Arrng Chs = 0.0000
EXAMPLES OF BOOKING OPTIONS
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* BIN WID = 5.0000E-01 * MEAN VALUE = 8.9690E+00 * OVERFLOW = 1.2700E+02
* AVG OR CHA = 8.9690E+00
EXAMPLES OF BOOKING OPTIONS

SCATTER PLOT WITH OPTIONS

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SLICE Y NO = 3 XMIN = 7.6667E-01 XMAX = 1.1000E+00

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121 I II II
111 I II II
112 I II II
100 I II II
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CHANNELS 10 0 1 2 3
1 1234567890123456789012345678012345

CONTENTS 100 1 11 111
10 221 225 225721
1 675 97729 3775772

LOW EDGE 10 11111111111111
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* BIN WID = 5.0000E-01 * MEAN VALUE = 1.3277E+01 * OVERFLOW = 0.0000
* R M S = 4.5255E+00 * ABNOR CHA = 0.0000
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* Entries = 1000
* Saturation at = INFINITY

**Statistics**

| I- | -1311 |
|---------------------
| 3.9781 | 36.9861 | 9.643 

| 1 | 1 |
**EXAMPLES OF BOOKING OPTIONS**

---

**1-DIM HISTOGRAM WITH ROUNDED BIN SIZE**

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340     II     --
330     II     II--
320     II     I I
310     I I I I
300     --     ---II I I
290     II I I I I
280     II I I I I
270     II I I I I
260     II I I I I
250     II I I I I
240     II I I--I I--
230     II I I--II
220     II I I--
210     II I I--
200     II I I--
190     I
180     I
170     I
160     I-- --II--
150     II I I I
140     I I I I--
130     I I I--II
120     I I---I--II
110     I I I I
100     I I-- I I--
90      I I-- I I--
80      I I-- I I--
70      I I-- I I--
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* ENTRIES = 4000
* ALL CHANNELS = 5.7340E+03
* UNDERFLOW = 2.6400E+02
* OVERFLOW = 2.0000E+00
* BIN WID = 2.0000E-01
* MEAN VALUE = -4.6886E-01
* R.M.S. = 2.0578E+00
* ABNOR CHA = 0.0000
PROGRAM THREE(INPUT,OUTPUT,TAPE1)

EXAMPLES OF EDITING OPTIONS AND OPERATIONS
ON HISTOGRAMS

DIMENSION X(35),Y(100),TITLE(4)

DATA TITLE/ 1HEXAMPLE OF,10H GLOBAL FI,10HLLING, 0 /

TRANSFER IN MEMORY OF HISTOGRAMS SAVED ON L.C.N. 1
IN PROGRAM TWO

CALL HFETCH(3,1)

BOOKING OF 1-DIM HIST

CALL HBOOK1(320,TITLE,35,0,1.75,200)

CALL HRROTAT(210)
CALL HERROR(210)
CALL HPRERR(210,3,YES)

CALL HRBLACK(211)
CALL HPFRUM(211,3,YES)
CALL HMINIM(211,5)
CALL HPROMA(211,2,NO)
CALL HLOGART(211)

CALL HCOPY(212,312)
CALL HDELET(212)
CALL HPRCOM(312,2,NO)
CALL HPRLOW(312,2,NO)

EXAMPLE OF OPERATION ON HISTOGRAM 230
CONTENTS OF EACH CELL ARE MULTIPLIED BY 0.00001

CALL HOPERA(230,1H+,230,230,0.00001,0.)

CONTENTS OF SLICE NO=1 OF SCATTER PLOT 220
ARE PUT IN A 1-DIM HIST 320 BY A GLOBAL FILLING

CALL HUNPAK(220,X,4,MSLIT,1)

CALL HPACK(320,X)
EXAMPLE OF 2-DIM HIST WITH AUTOMATIC CONTENTS SCALE
LIMITS OF THIS HISTOGRAM ARE CALCULATED FROM
LIMITS OF HIST ID=220. SAME THING FOR
CELL CONTENTS

CALL HIJXY(220,1,1,XMIN,YMIN)
CALL HIJXY(220,101,36,XMAX,YMAX)

CALL HBOOK2(321,0,100,XMIN,XMAX,35,YMIN,YMAX)

DO 10 I=1,100
   DO 10 J=1,35
      CALL HIJXY(220,I,J,XX,YY)
      W=HIJ(220,I,J)
      CALL HFILL(321,XX,YY,W)
   10 CONTINUE

CALL HSCALE(321)

CALL HOELT(220)

CALL HPRINT(320)
CALL HBLOG(320)
CALL HBI6(320)

CALL HISTDO

CALL HERROR(320)
CALL HPREM(320,3YES)
CALL HPRINT(320)

EXAMPLE OF UNPACKING AND SMOOTHING

CALL HUNPAK(312,Y)

CALL HBOOK1(313,30 THIS IS HISTOGRAM 312 SMOOTHED
   1 100,0,1,200)

CALL HPAK(313,Y)

CALL HSMOOF(313)

CALL HPRINT(313)

CALL HSMOOF(312,2,CHI)

CALL HPRINT(312)

STOP
END
EXAMPLE OF GLOBAL FILLING

BOOK  ID  =  320

124
120
116
112
108
104
100
96
92
88
84
80
76
72
68
64
60
56
52
48
44
40
36
32
28
24
20
16
12
8
4

DATE  29/05/75
NO  =  1

CHANNELS
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CONTENTS
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10 22000534322 1224456545331
1 1270651520748568577767784

LOW EDGE
1 1111111111111111
0 00112233445566778899101122334565667
0 05050505050505050505050505

* ENTRIES  =  35  * ALL CHANNELS  =  1.2590E+03  * UNDERFLOW  =  0.0000  * OVERFLOW  =  0.0000
* BIN WID  =  5.0000E-02  * MEAN VALUE  =  9.8691E-01  * R . M . S  =  4.1561E-01  * ABNORM CHA  =  0.0000
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MEMORY UTILIZATION

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* ENTRIES = 2000
* SATURATION AT= INFINITY
* CONTENTS *10** 4

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I I
### Example of Global Filling

**MBLOCK ID = 320**

```
  136  I
  132  I
  128  I
  124  0
  120  I
  116  I
  112  I
  108  I
  104  I
  100  0
  96  I
  92  I
  88  I
  84  I
  80  I
  76  1
  72  1
  68  I
  64  I
  60  I
  56  I
  52  0
  48  I
  44  I
  40  0
  36  0
  32  I
  28  I
  24  0
  20  I
  16  I
  12  I
   8  I
   4  I
```

**DATE 29/05/75**  
**NO = 1**

**Channels**

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**Error**

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**Low Edge**

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**Entries = 35**  
**All Channels = 1.2590E+03**

**Underflow = 0.0000**

**Overflow = 0.0000**

**Bin Width = 5.0000E-02**

**Mean Value = 9.6691E-01**

**R. M. S = 4.1561E-01**

**Absor Char = 0.0000**
1-DIM WITH AUTOMATIC BIN CALCULATION

*BLOCK ID = 312

DATE 29/05/75
NO = 1

152
148
144
140
136
132
128
124
120
116
112
108
104
100
96
92
88
84
80
76
72
68
64
60
56
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12
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4

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CHANN...
PROGRAM FOUR
INPUT,OUTPUT,TAPE4,TAPE5

EXAMPLE OF DISK UTILISATION

DYNAMIC MEMORY EXTENSION NOT AVAILABLE

COMMON//HME(4000)
DIMENSION TITLE(8)

DEFINE L.U.N. FOR EXTENSION ON DISK

CALL HDISKF(4,5)

FIX THE MAXIMUM LENGTH OF BLANK COMMON TO 4000
LENGTH OF INTERMEDIATE FILLING BUFFER =1000

CALL HLIMITER(3400,1000)

BOOKING OF SIMPLE 1-DIM AND 2-DIM HISTOGRAMS

DO 10 I=1,5

ENCODE(80,1000,TITLE1)
CALL HBOKK1(I,TITLE1,100,-5,5)

ENCODE(80,2000,TITLE2)
CALL HBOKK2(10*I,TITLE2,100,-5,5,100,-4,4,30)

10 CONTINUE

FILLING USING HFID ENTRIES

DO 20 I=1,100

CALL RANNOR(A,B)

DO 20 J=1,5

CALL HFIDOL(10*I,J,A,B,1,1)

CALL HFIDOL(J,A,B,1,1)

20 CONTINUE

CALL HINDEX

1000 FORMAT(2DIM1-DIM HISTOGRAM NO =13,57X)
2000 FORMAT(20HZ2-DIM HISTOGRAM NO =13,57X)

END
<table>
<thead>
<tr>
<th>No</th>
<th>Title</th>
<th>ID</th>
<th>B/C</th>
<th>ENTRIES</th>
<th>DIM</th>
<th>NCPA</th>
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<th>ADDRESS</th>
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**MEMORY UTILIZATION**

- Maximum total size of blank common: 3400
- User area in blank common: 0
- Intermediate filling buffer: 1000
- Parking area for disk residents: 907

**DISK UTILIZATION**

- Number of logical records: 16
- Number of words: 4136
PROGRAM FIVE(INPUT,OUTPUT,TAPE1)

CALLS TO HFILL IN EXAMPLE TWO ARE REPLACED BY FAST FILLING COMMANDS.

FILLING OF HISTOGRAMS PREVIOUSLY BOOKED

DC 10 I=1,1000

CALL RANNOR(A,B)

CALL HFILL1(Z10,A-2,2,1)

CALL HFILL1(Z11,A)

CALL HFILL1(Z12,A-2,0,1)

W=MODI(1,3)+1
X1=RNDM(I)
X2=RNDM(X1)
X3=RNDM(X3)
Y1=A1/SORT(X1)
Y2=A2/SORT(X2)
Y3=A3/SORT(X3)

CALL HFILL2W(Z20,W,X1+ALPHA*A,Y1+ALPHA*E,W)
CALL HFILL2W(Z20,W,X2+ALPHA*A,Y2+ALPHA*E,W)
CALL HFILL2W(Z20,W,X3+ALPHA*A,Y3+ALPHA*E,W)

CALL HFILL2W(Z230,A+B,A)

CALL RANNOR(A,B)

CALL HFILL1(Z10,A+2)

CALL HFILL1(Z12,A+2,0,2)

10 CONTINUE

STOP

END