Computing lecture 2

Histograms, etc.

I. In general

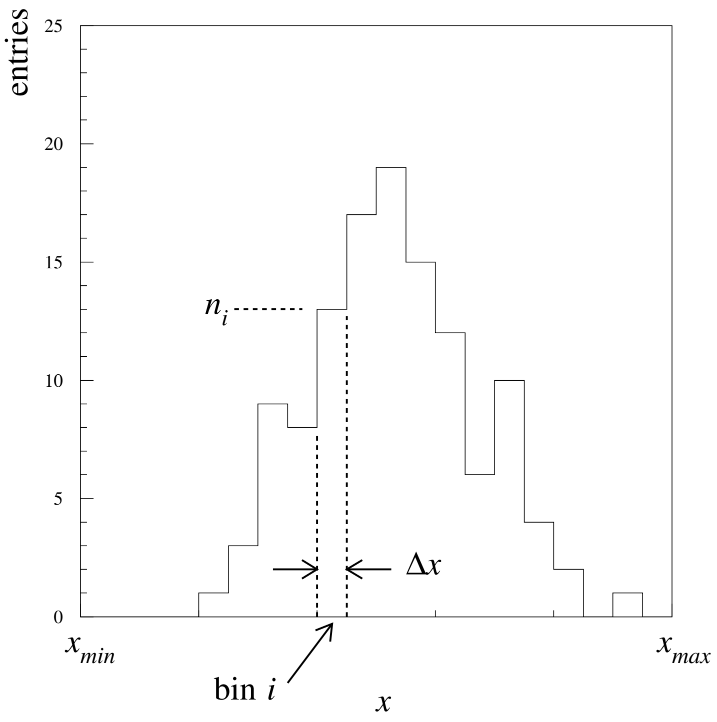
II. In FORTRAN

III. In PAW

Histograms

- Consider a data sample $\vec{x} = (x_1, \ldots, x_m)$ (m can be large)

$\rightarrow$ summarize information as a histogram (N bins)



- Generic computer implementation:

  I. Define bins, e.g. N bins of width Δx from x_{min} to x_{max}.

  II. Declare variables to hold $n_1, \ldots, n_N$, initialize all n_i to 0.

  III. Loop over $x_1, \ldots, x_m$; if x value in bin i, $n_i \rightarrow n_i + 1$.

- In practice, not trivial $\Rightarrow$ use packages HBOOK, HTL, ...

Histograms with HBOOK

- The HBOOK package (from CERN): user-callable FORTRAN subroutines for creating/manipulating:

  histograms (1-dimensional)
  scatter-plots (2-dimensional)
  n-tuples

- The basic steps to get a histogram:

  I. 'Book' histogram: define bins, allocate memory for $n_1, \ldots, n_N$.

```
call HBOOK1(17, 'x values', 100, xmin, xmax, 0.)
```

  id number   title   number of bins

  II. 'Fill' the histogram:

```
do i = 1, m
  call HF1(17, x(i), 1.)
end do
```

  'weight' (usually 1.0)

- Steps also needed to set up output file and store results (see example on next page)

An example program using HBOOK

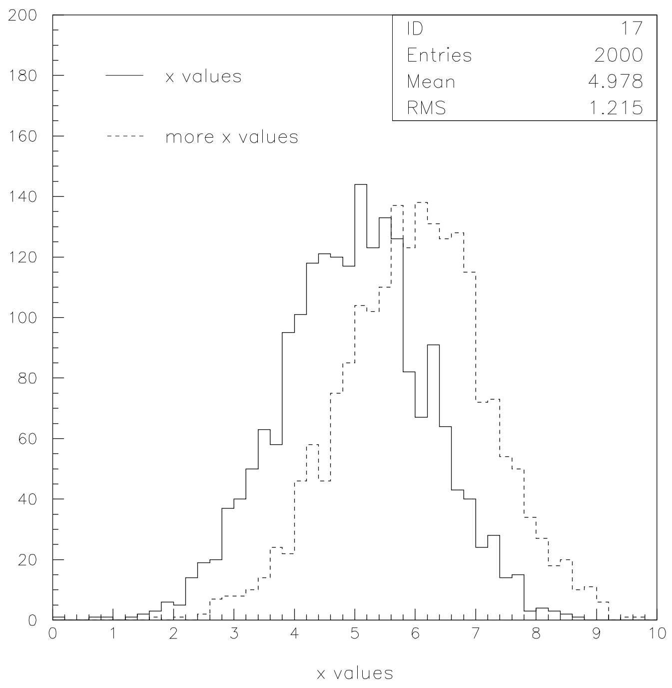
```
      program TEST_HBOOK

c   Glen Cowan
c   5 October, 1999
c   Test program for using HBOOK

      implicit        NONE

c   Needed for HBOOK routines

      integer         hsize
      parameter       (hsize = 100000)
      integer         hmemor (hsize)
      common  /pawc/  hmemor

c   Local variables

      character*80    outfile
      integer         i, icycle, istat, num_values
      real            x

c   Initialize HBOOK, open histogram file, book histograms.

      call HLIMIT (hsize)
      outfile = 'test_hbook.his'
      call HROPEN (20, 'histog', outfile, 'N', 1024, istat)
      call HBOOK1 (17, 'x values', 100, 0., 10., 0.)

c   Get x values and enter into histogram.

      write (*, *) 'enter number of x values to get'
      read (*, *) num_values
      do i = 1, num_values
        call GET_ANOTHER_X_VALUE (x)       ! subroutine supplied by user...
        call HF1 (17, x, 1.)
      end do

c   Store histogram and close.

      call HROUT (0, icycle, ' ')
      call HREND ('histog')

      stop
      END
```

Looking at the histograms with PAW

- Running the sample program creates the file `test_hbook.his`.

  To view/manipulate the histograms with PAW,

```
h/file 1 test_hbook.his      ← read in file
h/list                       ← show list of histograms
===> Directory :
17 (1) x values
23 (1) more x values
h/pl 17                      ← plot histogram 17
h/pl 23 s                    ← put 23 on same plot
```



- See documentation for details on commands like:

  `opt stat, set dmod, h/set max, key, ...`

Two-dimensional histograms (scatter plots)

- Bins are now cells in 2-d plane. HBOOK routines similar to 1-d:

I. To book:

id number title

```
  call HBOOK2 (37, 'y vs. x', nx, xmin, xmax,
& ny, ymin, ymax, 0.)
```

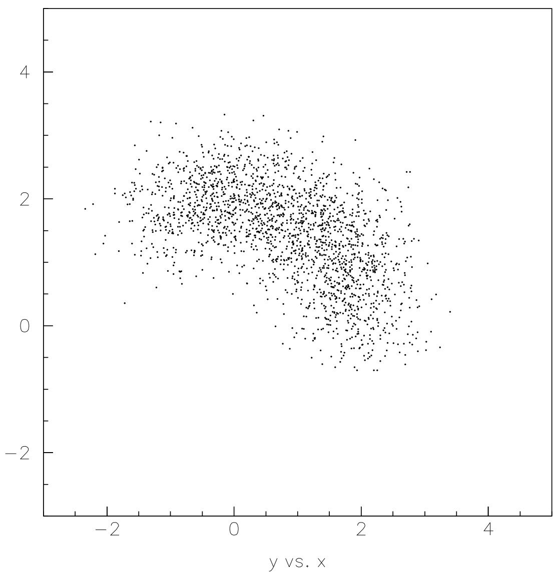
number of bins in x

same stuff for y

II. To fill:

```
  call HF2 (37, x, y, 1.)
```

- Viewing with PAW same as in 1-d case:



N.B. Exact x, y values not recorded, only numbers of entries in each bin ($N_x \times N_y$ values stored).

Access to information

- In FORTRAN (see HBOOK manual for details)

Open file and read in the histograms:

```
call HROPEN (30, ' ', 'myfile.his', ' ', lrec, istat)
call HRIN (0, icycle, 0)
```

Access contents of histograms, errors, etc.

```
call HNOENT (id, num_entries)          ← number of entries
call HUNPAK (id, contents, ' ', 0)     ← unpack into array
call HGIVE (id, title, nx, xmin, xmax, ny,
& ymin, ymax, nwt, loc)                ← get booking info
```

- In PAW (see PAW manual or online help)

Read histograms into memory, use variables and system functions, best used in macros ('kumac' files).

```
h/file 1 myfile.his
hrin 0                   ← read histograms into memory
id = 17                  ← define variable id, use brackets to evaluate.
nx = $HINFO([id],'XBINS')       ← system function HINFO
vec/create myvector([nx]) R     ← vector to hold histogram
vec/print myvector              ← show vector contents
mess 'events =' $HINFO([id],'EVENTS')     ← # entries
```