

## Workshop Notes Hewlett Packard HP 38G

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### Background and purposes

What is a graphics calculator?  
How should we think of it?  
What kinds of capabilities does it have?  
What is its educational significance?

### Getting started

Reset the calculator by pressing simultaneously **ON** and the 3rd key from the left in the top row of keys.

Adjust the contrast to suit yourself: Hold down **ON**, and press either **+** or **-**.

Hold down **A...Z** and write DEMO (using the pink key labels). Then press **ENTER** to see some of the calculator features. Press **HOME** at any stage to return to the home screen.

### Entering and editing commands

Commands are typed into a command line, and then the line is executed by pressing **ENTER**. Try some elementary commands like these. Use conventional mathematical syntax; note the stack of commands and results:

$2(7 + 5)$   
 $(3^2 + 4^2)$   
 $\sin( /3)$

Notice carefully the effect of the following sequence:

$4*5$  **ENTER**  
 $+2$  **ENTER**  
**ENTER**  
**ENTER**

Notice also the effects of

- using the cursor keys  $\leftarrow$  and  $\rightarrow$  in an expression.
- pressing the  $\boxed{\text{ON}}$  key to clear the command line
- pressing the  $\boxed{\text{DEL}}$  key to backspace or erase a character
- pressing  $\boxed{2\text{nd}} \boxed{\text{DEL}}$  to clear the whole stack. (The  $\boxed{2\text{nd}}$  key is pale blue.)

Move up and down the stack with  $\boxed{\uparrow}$  and  $\boxed{\downarrow}$ .

Highlight a command in the stack and then press the  $\boxed{\text{COPY}}$  key (an unlabelled key right under the word COPY in the menu bar at the bottom of the screen). This will retrieve a command and place it into the command line.

Highlight a command or result and then press the  $\boxed{\text{SHOW}}$  key to show it in conventional mathematical syntax.

## Fractions

Results can be displayed in several ways. Press  $\boxed{2\text{nd}} \boxed{\text{HOME}}$  to access the MODES. Notice the effect of now pressing  $\boxed{+} \boxed{+} \boxed{+} \boxed{+} \dots$ . You can also use the  $\boxed{\text{CHOOSE}}$  key.

Use  $\boxed{\downarrow}$  to move down, and press  $\boxed{+}$  a few times until Fraction mode appears. Press  $\boxed{\text{HOME}}$  when finished.

Notice now the effect of fraction operations like  $2/3 + 3/4$ . Use  $\boxed{\text{SHOW}}$  to see fractions in conventional format.

Change back to Standard when you have finished.

## Complex numbers

When results are complex numbers, the calculator gives them as ordered pairs. To see how this works, find the square root of  $3 - 7i$ ; then square your result.

## Memories

On a graphics calculator, memories are labelled alphabetically. The keys with pink writing designate memories, and the  $\boxed{\text{A...Z}}$  key needs to be used to access them. Memories can be manipulated using the same syntax as elementary algebra. Values are stored into memories using the  $\boxed{\text{STO}}$  key on the left of the menu bar (at the bottom of the screen).

To see how this works, store 3 into memory A (which is accessed with  $\boxed{\text{A...Z}} \boxed{\text{HOME}}$ ) and 2 into memory B. To recall the values, enter the appropriate letters into the command line. Notice that expressions like 5AB are interpreted conventionally by the calculator.

## MATH menu

Most calculator functions are not shown on the keyboard, but are obtained via menus. Press the  $\boxed{\text{MATH}}$  key to access many of these. There is not time in one workshop to explore

all of the functions contained in the HP 38G.

Notice the effect of using the cursor keys. The left side of the menu contains menu names, while the right side contains commands. Selections are shown by shading. When the menu is first entered, Real functions are selected.

It is necessary to know the syntax to use functions. In many cases, this follows standard mathematical conventions.

For example, the syntax for the floor function is  $\text{FLOOR}(value)$ . For example, to determine  $\text{FLOOR}(-2.4)$ , select REAL on the left, move across with  $\leftarrow$  and then down with  $\downarrow$  to select FLOOR on the right and press  $\square$  or  $\square$  to register your selection into the command line. Complete the command and enter it to get the result of -3.

To leave the MATH menu without making a selection, press  $\square$  or the  $\square$  key.

Note that, within a menu, on either side, pressing an alphabetically labelled key will jump to the corresponding part of the menu. To see this work, press  $\square$ , followed by  $\square$  (which is the key for P).

Some syntax is more complicated, since there are several arguments. For example, the command  $\text{FNROOT}(X^2-X-1,X,0)$  gives a root of  $f(x) = x^2 - x - 1$ , when  $x$  is the variable, starting iterative search procedures at  $x = 0$ . (The  $\square$  key gives X while the comma key is on the bottom row.)

Similarly, the command  $\text{UTPN}(0,1,2)$  gives the upper tail probability for the normal distribution function for a distribution with mean 0, variance 1 and z-value 2. The command UTPN is one of the choices in the Prob menu.

Once a command is known, you do not need to select it from the menus, as the calculator will interpret a literal version. For example, type into the command line  $31 \text{ MOD } 7$ , making sure to put a space (with  $\square$   $\square$ ) before the M and after the D. This will have the same effect as selecting the function from the Real menu.

The command  $\text{HELPWITH}$  will give the syntax for a command. To see how this works, type  $\text{HELPWITH FNROOT}$  into the command line and then press  $\square$ .

## Another way of accessing some functions

Some functions can be accessed via their mathematical symbols on the CHARS menu, which appears above the ( key. Make selections from the characters using the cursor keys.

To see how this works, enter the command  $\int_0^1 (1-X^2)$ . Both the  $\int$  and the = symbol are located in the CHARS menu, while the comma is located on the bottom row of the keyboard. Notice that conventional summation syntax is given when the SHOW command is used.

Then enter the command  $\int_0^1 (1-X^2)$  and again use SHOW to see how the integral is displayed.

## Symbolic manipulation

Some elementary symbolic manipulation capabilities are built into the calculator. An example is the command POLYFORM in the Polynom. menu, obtained after pressing MATH.

Try some examples such as the following to see the capacity (and some of the limitations) of this command:

POLYFORM ((X+1)^3,X)  
POLYFORM ((X+Y)^3,X)  
POLYFORM ((3X+Y)^3,X)  
POLYFORM ((3X+2Y)^3,X)  
POLYFORM ((3X+2Y)^3,Y)

A more sophisticated example is given by the command TAYLOR (SIN(X),X,5).

## Representing functions

To access the function graphing capabilities, first make sure that the appropriate Aplet (mini application) has been selected from the Aplet library. To do this, press **LIB**, highlight Function in the list of Aplets, and press **START**, the menu choice on the far right.

As the word 'Graphics' suggests, the HP 38G can represent functions graphically. It can also do so numerically, with a table of function values. The other form of representation is symbolically, completing the so-called 'Rule of Three'. These three representations are accessed with the three keys, **PLOT**, **SYMB** and **NUM**. The representations are controlled by the SETUP screens, each of which is accessed by pressing **2nd** before pressing the appropriate one of the three keys.

Enter functions with X as the variable using the **X.T.** key or the menu choice 3rd from the left. The **CHK** key checks which functions will be plotted. Try these two:

F1(X) = X^3-3X+1  
F2(X) = X + 1/2

**2nd** **PLOT** accesses the two pages of switches for setting up plots. Use the cursor keys to move around. For now, press **2nd** **DEL** to set them all to the default values.

Press **PLOT** to see the two functions plotted. Then press **NUM** to see them tabulated. Press **HOME** if you want to return to mathematical calculations.

## Exploring functions

Once a function is represented on either a graph or in a table, it can be explored, using the menu keys at the bottom of the screen. When a plot is showing, the following kinds of exploration are available:

ZOOM allows for various kinds of zooming on the graph  
TRAC when turned on, allows graphs to be traced using the **◀** and **▶** keys. Use the **▲** and **▼** keys to change which graph is traced.  
(X,Y) Shows coordinates

FCN      accesses automatic graph analysis functions  
 DEFN    gives a function definition on the screen  
 MENU    displays or hides the menu.

When a table is showing, the explorations available are:

 allow table values to be displayed  
 ZOOM    allows for various kinds of numerical zooming  
 BIG      changes the font size for numbers  
 DEFN    displays definitions instead of table values

Notice that, for some menus, choices are indicated by a small square in the menu command. The detailed use of these facilities for exploring functions will be explained in the workshop.

## Multiple views of functions

It is possible to see a plot and a table or two plots at the same time. The VIEWS menu is accessed with **2nd** **LIB**. To see how this works, choose Plot-Table from this menu, and notice the effect of cursor movements.

Other choices in VIEWS provide default scales.

For example, Decimal chooses the original default scale for Plot, and so is the easiest way to get back to having just a graph rather than a graph and a table together.

Choosing Auto Scale will adjust the Y scales to suit choices already made in Plot SETUP for the X scales, so that all of the graph is showing on the screen.

## Equation solving

Other Aplets provide other kinds of mathematical capabilities. Press **LIB** and select the Solve Aplet to access the equation solver. Press **START** to register your choice.

Enter an equation of your choice, using the = symbol on the menu bar as appropriate. An 'equation' may actually be an equation (e.g.,  $X^2 - 2 = \text{LN}(X)$ ) or a formula (e.g.,  $V = R^2H$ ).

Press NUM, and all variables in your equation are displayed. For each variable, either give it a value or press the **SOLVE** key (on the far right) to 'solve' the equation.

Once all but one of the variables has been given a value, the calculator will find a numerical value for the remaining variable to satisfy the equality, within the limits of accuracy of the machine. The iterations start with the current value of the variable, so you need to choose this carefully if multiple solutions are involved.

The **PLOT** key will allow you to explore the situation graphically to check how many solutions there appear to be.

## Saving and transferring Aplets

A powerful feature of the HP 38G is the capacity to save a configuration as a new Aplet. For example, you can save your own set of equations as an Aplet for retrieval later or for transferring to another calculator.

To do so, press **LIB** and then **SAVE**, giving the Aplet a suitable name. Notice that your Aplet then appears in your Aplet Library, and can be retrieved in the same way as existing Aplets.

To transfer an Aplet to another calculator, line up the infra-red ports at the top of the calculators (shown with a small arrow). Make sure that the calculators are no more than a few centimetres apart and are flat and still on a table. Select the Aplet to be transferred, press **SEND**, select HP 38G as the destination, and finally press **OK**. The other calculator has to be set to receive the Aplet, by pressing **LIB**, choosing **RECV**, selecting HP 38G as the source, and pressing **OK**.

## Statistics

Another Aplet concerns statistics. Once again, the three controlling keys are **PLOT**, **SYMB** and **NUM**.

The numerical display shows the data in columns, and is also where you designate the analysis as univariate (1VAR) or bivariate (2VAR). A range of numerical statistics is available with the **STATS** command.

The symbolic display controls the analyses. In the case of univariate data, each analysis is described with H (for histogram), and appropriate columns for data and frequencies are entered (using C for column). Thus if the data are in column 1 and their frequencies in column 2, designate these by C1 and C2 respectively. For bivariate data, analyses are described with S (for scatter plot); Regression models for each analysis are chosen with Symbolic SETUP.

The Plot SETUP menu allows a choice between Histograms and Box and Whisker plots for univariate data, as well as controlling axes and other graphical elements. For bivariate data, it controls the symbols used on scatter plots as well as axis characteristics.