Microsoft Excel 2013 Intermediate Level 2

Contents

INTRODUCTION

This intermediate level guide deals with some of the more scientific facilities available in Excel. It also covers database facilities (sorting and selection) plus customization of charts.

OPENING THE EXAMPLE FILE

Log into an **E508 with password: pa$$word** as usual and start up Excel 2013:

1. Click on the **Start** button, choose **All Programs** then **Microsoft Office 2013** and **Excel 2013**
2. Click on **Open Other Workbooks** (or you can use **<Ctrl o>**) then **Computer** and **[Browse]**
3. Click on **My Computer** then *double click* on **Data (D:)**
4. *Double click* again on the **Training** folder and choose **phoenix.xlsx**
5. Press **<Enter>** for **[Open]**

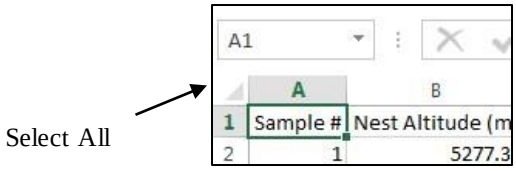
Note: For those using these notes on a computer not run by Information Technology, the example file can be downloaded from the link provided on the web page at step 4 above.

The set of data which appears is information on the size, weight and color of 50 (mythological) birds eggs recorded from nests at a variety of altitudes. The initials of the collectors are also included.

SELECTING CELLS

Excel has various shortcuts for selecting a range of cells (besides the usual method of dragging through the required cells). These include:

- *entire rows/columns*: click on the row/column heading number/letter (or press **<Shift/Ctrl space>**)
- *a block of cells*: click in the top left corner of the block then, holding down **<Shift>**, press ***<arrow>*** keys to extend the selection in the directions of the arrows. Alternatively, select the top left cell then hold down **<Shift>** and click in the bottom right cell
- *a row/column range*: click on the starting row/column heading then either hold down **<Shift>** and use the ***<arrow>*** keys or **<Shift>** click on the end row/column heading
- *non-adjacent cells or blocks*: hold down **<Ctrl>** as you make your selection
- *part rows/columns*: click on the cell at the start of the selection then hold down both **<Ctrl>** and **<Shift>** and press the ***<arrow>*** key in the direction required. Alternatively, hold down **<Shift>** and *double click* on the active cell border in the direction required. Repeat this, using either method, to extend the new selection to a block of cells
- *the data set*: hold down **<Ctrl>** and press the **<a>** key. Note that **<Ctrl *>** can be used to select just part of the data - up to a blank column/row
- *the entire worksheet*: click on the *Select All* button (the grey blue rectangle in the top left corner of the worksheet, where the row and column headings meet) or you can press **<Ctrl a>** *twice* (if the current cell is within the data) or *once* if it is an empty cell



You can also select a range of cells using a command – on the far right of the **HOME** tab on the *Ribbon* choose **[Find & Select]** then **Go To…**. In the *Reference:* box, type in the cell or range of cells you wish to select. Note that when using this method, the selection is added to the *Go to:* list so that you can easily make the same selection again. Named ranges also appear in this list. **Go To…** is also activated by **<Ctrl g>** or **<F5>**.

Try using some of the above methods to select different areas of the worksheet.

SIMPLE DATA MANIPULATION

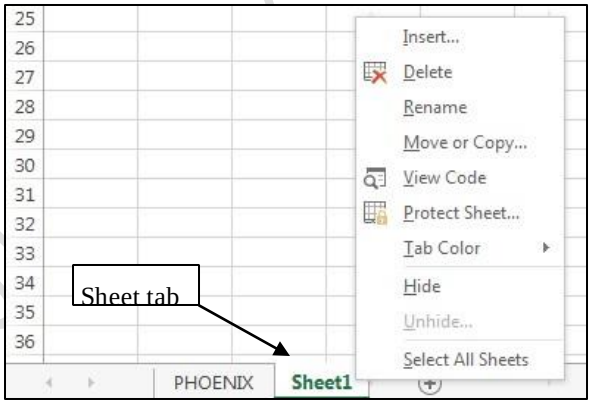
USING MULTIPLE SHEETS

In the *Essential Guide*, everything was done on a single worksheet, however a workbook can contain several sheets, each with different sets of data, charts etc. Indeed, charts are usually stored on separate *chart sheets*.

The *sheet tab* (at the foot of the screen) shows the worksheet name. New sheets can be created; old ones renamed, copied or deleted. In the exercise below, you will create a copy of the *phoenix* sheet (this is a good idea with any worksheet as it allows you to play around with the data while preserving a copy of the original).

To create a new worksheet:

1. Click on the **[New sheet]** button to the right of the *PHOENIX* tab (you can also use **<Shift F11>**)



To rename the worksheet:

2. *Right click* on the new *Sheet1* tab and select **Rename** from the shortcut menu (note that you can *Insert* new sheets here). Alternatively, *double click* on the tab name to select it - *Sheet1* is now highlighted 3. Type in the new name (call it **`Red-Brown`** - you'll be using this later) then press **<Enter>**

To make a copy of a worksheet:

4. Position the cursor over the *PHOENIX* tab, press the *right* mouse button then, from the shortcut menu, select **Move or Copy…**

5. In the *Move or Copy* window, click on the ***Create a copy*** check box in the bottom left corner and set *Before sheet:* to **(move to end)** - note that you can also copy or move a worksheet to an entirely new workbook or one already open under *To book:*

6. Press **<Enter>** for **[OK]** and a copy, *PHOENIX (2)*, will be created on the right

To delete a worksheet (e.g. the copy of the data):

7. *Right click* on the *PHOENIX (2)* tab then select **Delete** from the shortcut menu

8. You need all the sheets here, so press **<Esc>** or click on **[Cancel]** - normally you would press **<Enter>** for **[Delete]** to confirm the deletion

Note: No warning message appears if a sheet is empty.

The order of the sheets can be altered simply by dragging and dropping the sheet tabs.

9. Position the mouse cursor over the *Red-Brown* sheet tab

10. Hold down the mouse button and drag the sheet to the right hand side

11. Release the mouse button to drop the sheet tab in the new position

You can also color-code the sheet tabs. This aids sheet identification if you have a lot of sheets. Note that the active sheet tab name turns **green** when selected:

12. *Right click* on the *Red-Brown* sheet tab and choose **Tab Color**

13. From the selection of *Standard Colors* choose **Dark Red** on the far left

14. Click on the *PHOENIX* sheet tab to see its full color (the active sheet tab is always colored white)

Other options when you right click on a sheet tab include *Protect Sheet* (you can protect a sheet with a password), *Hide* (to hide a sheet) and *Select All Sheets* (if you have several sheets identically laid out and want to carry out the same calculations on each – any action on the one sheet is repeated on the others).

CELL REFERENCES WHEN USING MULTIPLE SHEETS

If you want to use a cell on another sheet in a formula, then you have to include the sheet name in the cell reference. The full reference is of the form *Sheet*!*Cell* (you may have already noticed such references, e.g. when you have used the *Chart Wizard*). Usually it's easiest to fill in the reference by moving to the sheet concerned and clicking on the required cell:

1. Move to the empty sheet by clicking on the *Red-Brown* tab

2. In cell *A1* type **=10***

3. Click on the *PHOENIX* tab then on cell *D2* - note how the cell reference is added to the formula

4. Press **<Enter>** and cell *A1* on the *Red-Brown* sheet is filled in

5. Move up to *A1*, note the cell reference in the formula again, then press **<Delete>** to empty the cell contents (they are not needed here)

SORTING THE DATA

Sort & Filter: 

It's often useful to have data displayed in some order - alphabetical or increasing/decreasing numbers. To sort the data based on a particular column, the active cell must be in that column. Here, you are going to sort the data in order of increasing nest altitude:

1. Move to the original copy of the data by clicking on the *PHOENIX* tab
2. Move the active cell into column *B* - click on any cell containing data (**don't** select more than one cell)
3. Click on **[Sort & Filter]** on the far right of the **HOME** tab (or *right click on a cell* and choose **Sort**) then choose **Sort Smallest to Largest** - note: for more complex sorts use **Custom Sort...**

The eggs should now be ranked in order of nest altitude, with the lowest at the top. Note how the sample numbers in column A have changed.

4. Repeat step **3** but choose **Sort Largest to Smallest** – the highest mountains now appear at the top

Tip: Occasionally you may want to sort only part of the data, leaving the surrounding data exactly as it is. To do this you must first select the data before you click on a sort button. Try this out if you like, but make sure you reverse any sort before you continue the course - use the **[Undo]** button to undo any changes.

SORTING DATA IN EXCEL

When sorting data in Microsoft Excel, it's very important to decide whether you want just part of the data sorted or the whole dataset. To understand how sorting works, try it out on an example file:

1. Load up Excel and **[Open]** the file called **phoenix.xlsx** in the **D:\Training** folder
2. Decide which column you want to sort on (e.g. Column **B**) and click on *any cell* in that column
3. Click on the **[Sort & Filter]** button in the *Editing* group on the right of the **HOME** tab and choose **Sort Smallest to Largest** to sort the data into increasing values
4. Repeat step **3** but choose **Sort Largest to Smallest** to sort the data into decreasing values
5. Press **<Ctrl z>** (or click on the **[Undo]** button) *twice* to return the data to its original order - or, with this data, you could use **[Sort & Filter]** on Column **A**

Note how all the data in the rows moved together as the sort was applied. Excel sorts blocks of data, delimited by blank rows or columns. This next exercise demonstrates this very clearly:

1. Select all the data - press **<Ctrl a>**
2. Press **<Ctrl c>** to **[Copy]** the data, click on cell **I1** and press **<Enter>** to paste in the copied cells
3. *Right click* on the **15** in the row numbers down the left and choose **Insert** to insert a blank row
4. Click on any cell with data in column **J** then on **[Sort & Filter]** and choose **Sort Smallest to Largest** - you will find that only the area of data containing that cell is sorted
5. Press **<Ctrl z>** (for **[Undo]**) to return the data to its original order then again to remove the empty row

SORTING SELECTED DATA

If you only want to sort part of the data, you have to select it first:

1. Click on the column heading letter **B** to select that column
2. Click on **[Sort & Filter]** and chose **Sort Smallest to Largest** - a warning message appears:

3. Select **Continue with the current selection** - press **<Enter>** for **[Sort]**

You will find column B is now sorted but the rest of the data hasn't moved. This could be a disaster if the rows represented data records (as they do here - the data is now corrupted). Fortunately, the default is to sort all the columns (you had to reset this option at step **3**).

4. Press **<Ctrl z>** (or click on **[Undo]**) to return the data to its original order

The warning doesn't appear if cells in two or more columns are selected, as you'll see next. You can sort on more than one column in a selection, but the columns must be next to each other (ie you can't **<Ctrl>** select – if necessary, move the columns around to get them in a suitable order) and sorting is carried out based on the left-most column:

5. Drag through the column heading letters **B** to **E** to select those columns
6. Click on **[Sort & Filter]** and choose **Sort Smallest to Largest** - all four columns are sorted, based on column B, with no warning
7. Press **<Ctrl z>** (or click on **[Undo]**) to return the data to its original order

You can also sort on part of one or more columns

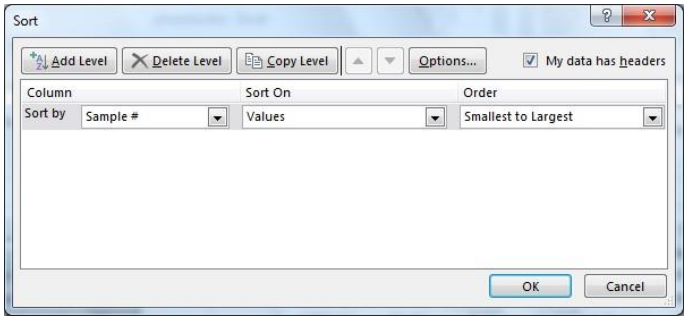
8. Drag through cells **A1** to **G15**
9. Click on **[Sort & Filter]** and choose **Sort Largest to Smallest** - just those cells are sorted
10. Press **<Ctrl z>** (or click on **[Undo]**) to return the data to its original order

If you wanted the sort based on column B then you have to use **Custom Sort…**, as you'll see next.

ADVANCED SORTS

If you use **Custom Sort** then you have various additional options available. This command even allows you to carry out sorts within sorts:

1. Click on any cell in column **A** then click on **[Sort & Filter]** and choose **Custom Sort…** The Sort dialog box appears:



2. Using the *list arrow* attached to the *Sort by* box, set the column for the initial sort – eg **Color**
3. Leave *Sort On* as it is but decide whether you want the *Order* to be **A to Z** or **Z to A**
4. Next, click on the **[Add Level]** button to add another sorting level
5. Set the column and order for the second sort level – e.g. **Collector, A to Z**
6. Click on **[Add Level]** for a further sorting level
7. Set the column and order for the third sort level – e.g. **Mass (g), Largest to Smallest**
8. The *My data has header* should already be set on, so press **<Enter>** for **[OK]** to carry out the sort

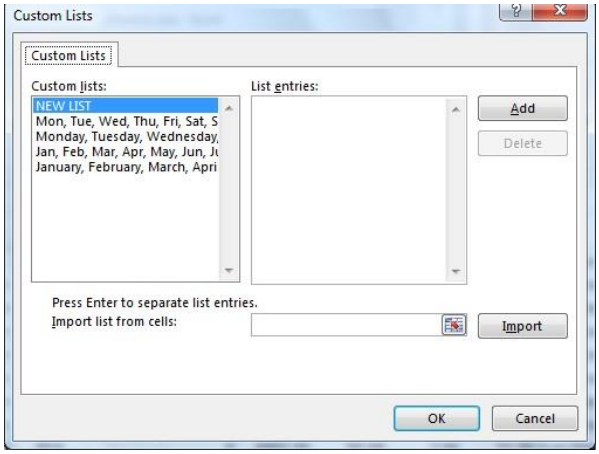
The Red-Brown and Blue-Green eggs should now be separated out, with each sorted first by Collector then Mass. Next, try sorting on part of the data - repeat the example at the end of the previous section but this time sort on column B:

9. Press **<Ctrl z>** (or click on **[Undo]**) to return the data to its original order
10. Drag through cells **A1** to **G15**
11. Click on **[Sort & Filter]** and choose **Custom Sort…**
12. Set the *Sort by* to **Nest Altitude (m)**
13. Press **<Enter>** for **[OK]** to carry out the sort
14. Press **<Ctrl z>** (or click on **[Undo]**) to return the data to its original state

FURTHER SORT OPTIONS

Custom Sort has various options which can sometimes be of interest. For example, you might not want to sort alphabetically at all but on a completely different criterion – e.g. based on the Months of the Year or on the Days of the Week. These two examples are built into the system, but you can specify your own criterion by creating a custom list:

1. Click on any cell in the data
2. Move to the **FILE** tab then choose **Options** at the foot of the list on the left
3. Click on **Advanced** , scroll down to the bottom, then click on **[Edit Custom Lists…]** in the *General* section – the *Custom Lists* dialog box appears



4. Click in the *List entries:* area and type **`RFA, BN, FLC, CDS, BRV`** then click on **[Add]**
5. Finally, click on **[OK]** *twice* to close the *Custom Lists* and *Excel Options* windows
6. Now click on **[Sort & Filter]** and choose **Custom Sort…**
7. Set *Sort by* to **Collector** and *Order* to **Custom List…**
8. Select **RFA, BN, FLC, CDS, BRV** then click on **[OK]** *twice* to carry out the sort – note the sorted values in column G
9. Finally, press **<Ctrl z>** (or click on **[Undo]**) to return the data to its original order

Note that you can make a custom list (or indeed any sort) *Case sensitive* by clicking on the **[Options…]** box. This allows you to specify that *xyz* and *XYZ* should be treated as two distinct entries in the list. Note also that if you turn case sensitive sorting on then you have to explicitly turn if off when you've finished.

The **[Options…]** box also allows you to sort from *left to right* instead of *top to bottom* (if your data happens to have been typed in that way). To demonstrate this:

1. Click on any cell containing data then press **<Ctrl a>** to select the surrounding data range
2. Press **<Ctrl c>** to **[Copy]** the data then move down to cell **A54** – click on it to make it the active cell
3. Click on the *more arrow* attached to the bottom of the **[Paste]** button and choose **Paste Special…**
4. Turn on the **Transpose** option then press **<Enter>** or click on **[OK]**
5. Select all the data except the first column - click in **B54**, hold down **<Ctrl>** and **<Shift>** and press the ***<down arrow>*** key followed by **<Ctrl Shift <*right arrow*>>**
6. Click on the **[Sort & Filter]** button, select **Custom Sort…** then click on the **[Options…]** button

7. Under *Orientation* in the *Sort Options* window, select **Sort left to right** – press **<Enter>** for **[OK]**
8. Set *Sort by* to **Row 55** (i.e. *Altitude*) and *Order* to **Smallest to Largest** then press **<Enter>** for **[OK]**

This option is also useful for moving columns of data around a worksheet (instead of cut and paste). To do this you would create a dummy row above your data (to set up the required sort order). Here:

9. Press **<Ctrl Home>** to move to cell *A1* then press **<Ctrl a>** to select *A1:G51*
10. Click on the **[Sort & Filter]** button, select **Custom Sort…** then click on **[Options…]** and check that *Sort left to right* is still set - press **<Enter>** for **[OK]**
11. Set *Sort by* to **Row 1** and *Order* to **A to Z** then press **<Enter>** for **[OK]** You should find the columns are now sorted by the column names!

SORTING BY ICONS OR COLORS

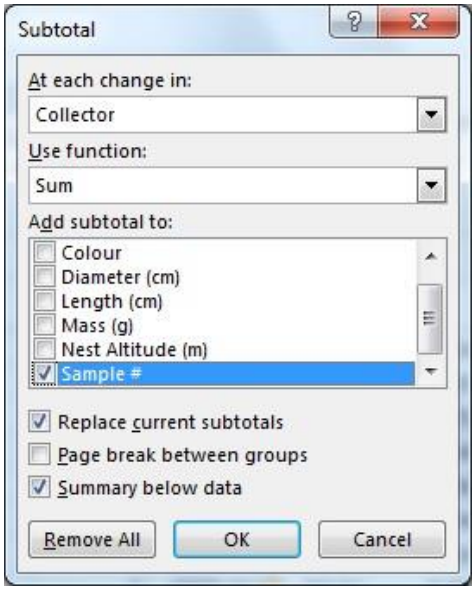
Another sort option allows you to sort data by its color – either the color of the cell background or the font color. You can also sort by an icon sets. First, you need to color your data:

1. Select the *Mass* data in column *K* – click on cell *K1* then press **<Ctrl Shift *down-arrow* >**
2. Click on the **[Conditional Formatting]** button in the *Styles* group on the **HOME** tab and select **Icon Sets** then any of the pre-set scales – the cells will have icons added
3. Click on any data cell in the right block of data then on **[Sort & Filter]** and choose **Custom Sort…**
4. Click on **[Options…]** and reset the *Orientation* to **Sort top to bottom** - press **<Enter>** for **[OK]**
5. Check that *My data has headers* is checked on – if it isn't, click on the words or in the little box
6. Now set *Sort by* to **Mass** and *Sort On* to **Cell Icon**
7. In *Order*, choose the icon you want to be **On Top**
8. Click on **[OK]** to carry out the sort – the rows with that icon should be listed first
9. To also sort by further icons/values, choose **Custom Sort…** then **[Add Level]** and repeat steps **6** and **7** If you want, try using a color set at step **2** and sort on that at step **6.**

CREATING SUBTOTALS

Microsoft Excel will automatically create subtotals on data which has been previously sorted into the required order. First, choose the data range to which subtotals are to be applied:

1. Press **<Ctrl Home>** to move to cell *A1* then click on **[Sort & Filter]** and choose **Sort A to Z**
2. Next, move to the **DATA** tab and click on **[Subtotal]** in the *Outline* group - the *Subtotal* window appears:



3. Using the *list arrow* provided, set *At each change in:* to **Collector**
4. Set *Use function:* to **Count**
5. Change *Add subtotal to:* to **Color** (you also need to untick *Sample #*)
6. Press **<Enter>** for **[OK]** to calculate the subtotals

You can have more than one subtotal in each row, but cannot vary the functions used in each. Count would obviously give the same result whichever column you had chosen. If you want to include different subtotal functions then you have to calculate them on separate rows:

7. On the **Data** tab, click on **[Subtotal]**
8. Using the *list arrow* provided, set *Use function:* to **Sum**
9. Change *Add subtotal to:* from *Color* to **Diameter, Length** and **Mass** (tick them on)
10. Turn off *Replace current subtotals*
11. Press **<Enter>** for **[OK]** to calculate the subtotals
12. Press **<Page Down>** to see the *Grand Totals* in rows *62* and *63*

OUTLINES

Whenever you calculate subtotals, Microsoft Excel automatically gives you special outline bars, which can be used to hide unwanted data. These are placed to the left of the row numbers:

1. Click on outline number **1** (to the left of Column A heading) - only the *Grand Totals* are displayed for that block of data
2. Click on outline number **2** - the *Counts* and *Totals* appear for each Collector
3. Click on outline number **3** - the *Totals* also appear for each Collector
4. Click on outline number **4** - all the data reappears

You can also use outlines to display the information for one (or more) Collectors:

5. Click on outline number **3** - only the subtotals are shown
6. Click on one of the plus signs (**+**) in outline **3** - the data for that Collector reappears

7. Click on another plus sign (**+**) in outline **3** to show data for a second Collector
8. Click on a minus sign (**-**) in outline **3** to again hide the data for a particular Collector
9. Redisplay all the data - click on outline number **4**

Subtotals are recalculated automatically whenever a data value is changed:

10. Type a new value of **20** in cell **D2** and watch how the *Subtotal* (and *Grand Total*) changes
11. Press **<Ctrl z>** to **[Undo]** the change and return the data to its original value

Note that once subtotals have been calculated, they can be moved to other cells on the worksheet - so that a single row could contain a variety of subtotal functions (e.g. you could drag the Count into the Sum row). You can also calculate subtotals by using the relevant SUBTOTAL function (see below).

If you only want subtotals for parts of your data, you use grouping:

1. Drag through rows **11** to **19** (to select the *BRN* data)
2. Click on the **[Group]** button – the outlines appear just for that data
3. Repeat steps **1** and **2** for the *FLC* data (rows **30** to **39**)
4. Use the minus (-) and plus (+) signs to show/hide these groups
5. Click on outline number **2** to display all the data
6. Press **<Ctrl a>** to select all the data then click on **[Ungroup]** and choose **Clear Outline** to return to normal

To turn off the outlines and subtotals:

7. On the **DATA** tab, click on **[Subtotals]**
8. Click on the **[Remove All]** button

Finally, you should be aware of the facilities provided by Pivot Tables. These produce summary statistics very similar to subtotals. Follow the link provided to learn more about these.

THE SUBTOTAL FUNCTION

Another way of obtaining subtotals is to use the *Subtotal* function with *filters*:

1. Make sure the current cell is in the block of data (press **<Ctrl Home>** to move to cell **A1**)
2. Move to the **HOME** tab on the *Ribbon* then click on **[Sort & Filter]** and select **Filter**
3. Set up a filter on the *Color* - click on the *list arrow* in cell **B1** then turn off **(Select All)** and turn on **Blue-Green** – press **<Enter>** for **[OK]**
4. Move to cell **C52** and press **<Alt =>** (or click on the **[Sum]** button, next to **[Sort & Filter]**)
5. Press **<Enter>** to accept the formula which appears: **`=SUBTOTAL(9,C2:C51)`**
6. Repeat step **3** but this time choose **Red-Brown** - note how the subtotal is recalculated
7. Try using further filters on the *Collector* (cell **A1**) and note the new totals
8. Edit the *Subtotal* function to read **`=SUBTOTAL(1,C2:C51)`** – note the other value settings, *1* is for *Average* while *2* is for *Count* etc.
9. Finally, turn off the filtering by repeating step **2**

Note: Always check that all the data rows have been included in the *Subtotal* function - if necessary, amend the formula which appears.

10. **[Close]** the *phoenix* example file - there is no need to save the changes you have made

CREATING DATA SUBSETS

Excel offers limited database facilities whereby you can extract a subset of the data to work on. As an example, let's store a copy of the red-brown eggs on the sheet created earlier.

1. Make sure that the active cell is somewhere within the data on the *PHOENIX* tab
2. Click on the **[Sort & Filter]** button and choose **Filter** - a *filter arrow* is added to each column heading
3. Click on the *filter arrow* in cell *F1* and turn off *Blue-Green* and press **<Enter>** for **[OK]** - only red-brown eggs are now shown (the row numbers turn blue and it tells you *29 of 50 records found* at bottom left)
4. Select all the *Red-Brown* records - press **<Ctrl a>**
5. Press **<Ctrl c>** or click on the **[Copy]** button (or *right click* and choose **Copy**)
6. Move to the *Red-Brown* worksheet by clicking on its tab
7. Make sure you are in cell *A1* then just press **<Enter>** for **[Paste]**
8. To resize (*autofit*) all the columns in one go, press **<Ctrl a>** to select all the cells then *double click* on any of the dividing lines separating one column heading from its neighbor
9. Click on the *PHOENIX* tab to move back to the original data and click on any cell to end the selection You'll see later an easier way to make a copy of the blue-green eggs on a new *Blue-Green* sheet.

Excel allows you to set selection criteria on more than one column - for example, you might want eggs that are both red-brown and which have a diameter of more than 8.5cm. To do this:

10. Click on the *filter arrow* in cell *D1* and choose **Number Filters** then **Greater Than…**
11. In the *Custom AutoFilter* window which appears type a value of **8.5** in the right-hand box
12. Press **<Enter>** for **[OK]** - only red-brown eggs over 8.5cm in diameter are now displayed

Finally, turn off both selection criteria and redisplay all the original data as follows:

13. Click on the **[Sort & Filter]** button and choose **Clear**

Note: you can turn off the criteria one at a time by using the list arrow at the top of each column and choosing **Clear Filter From …**

14. To remove the filter arrows, click on the **[Sort & Filter]** button and choose **Filter**

More complicated selections can be made using **[Advanced]** in the *Sort & Filter* section on the **Data** tab. To learn more about filters, see the *Microsoft Excel 2013: Filters* advanced notes.

INTRODUCTION

Microsoft Excel provides a very simple mechanism for selecting data subsets. Filters can be set up to choose specific values or a range of values. Several filters can be used, each acting further on the current data subset. An advanced filter is provided for more complicated selections.

SIMPLE FILTERS

The simplest way to understand how filters work is to try them out on an example file:

1. Load up Excel and **Open** the file called **phoenix.xlsx** in the **D:\Training** folder
2. Make sure the active cell is within the set of data (e.g. click on cell *A1*)
3. On the **HOME** tab click on the **[Sort & Filter]** button on the right and choose **Filter**

Filter arrows are now attached to the column headings in row 1. Filtering textual data and numeric data is usually slightly different and is dealt with in turn below.

FILTERING TEXT

1. Click on the *filter arrow* attached to cell *F1*
2. Turn off **(Select All)** then turn on **Blue-Green** – press **<Enter>** for **[OK]**

You now only have the rows whose color is Blue-Green. Note the row numbering down the left hand side of the screen has turned blue, while the filter arrow in cell *F1* now has a filter symbol added. These changes indicate that a filter is in operation on this column. Note also that the number of filtered records displayed is shown in the bottom left corner of the Excel window - here it says *21 of 50 records found*.

To redisplay all the data:

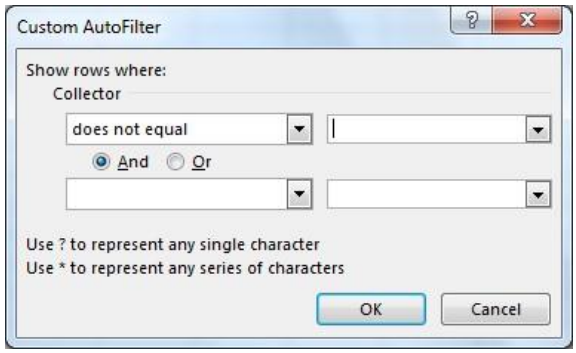
3. Click on the *filter arrow* attached to cell *F1* and turn on **(Select All)** – press **<Enter>** for **[OK]**

You can, similarly, set a filter for more than one value:

4. Click on the *filter arrow* attached to cell *G1* and turn off **(Select All)**
5. Next, turn on **BN** and **BRV** - press **<Enter>** for **[OK]**

Here you have data rows where collector matches *either* BN *or* BRV. Sometimes, however, you may require to set other matching criteria (apart from 'equals'):

6. Click on the *filter arrow* attached to cell *G1* and choose **Text Filters**
7. From the list that appears choose **Does Not Equal...** - the *Custom AutoFilter* dialog box appears:



8. Into the upper box on the right type **`*R*`** (the * is a wildcard, as explained on screen)
9. Press **<Enter>** or click on **[OK]**

Only collectors without an *R* as the initial are displayed (29 records). You might have thought that the *R* needed to be surrounded by other characters, such that collector *RFA* would have been shown. To see how to solve this:

10. Repeat step **6** and note that Excel has changed the criteria to **Does Not Contain…**
11. Repeat steps **7** to **9** but this time set a match of **`?*R*?`**

The ? stands for a single character, indicating that Excel shouldn't apply the criteria to the first (or, in this case, last) character in the text. You now have 41 records, including collector *RFA*.

Here's another example:

12. Click on the *filter arrow* attached to cell *G1* and choose **Text Filters** then **Custom Filter…**
13. Click on the *list arrow* attached to the upper box on the left and choose **is greater than**
14. Click on the *list arrow* attached to the upper box on the right and choose **BRV**
15. Make sure the **And** option button is set on
16. Click on the *list arrow* attached to the lower box on the left and choose **is less than**
17. Click on the *list arrow* attached to the lower box on the right and choose **RFA**
18. Press **<Enter>** or click on **[OK]**

Note that *greater than* and *less than* work with words (alphabetically). Only the records for collectors CDS and FLC are displayed (BRV and RFA, used in the criteria, are *not* included). You could also have used the ordinary filter mechanism to show these (and the previous) results but this first method isn't satisfactory when you have lots (e.g. 50+) of different values.

Note also the options *begins with* (and *does not begin with*) and *ends with* (and *does not end with*) which work exclusively with text. Incidentally, you cannot reference a cell or calculate a value in the boxes on the right.

19. Click on the *filter arrow* attached to cell *G1* and turn on **(Select All)** – press **<Enter>** for **[OK]**

FILTERING NUMBERS

When you click on a filter arrow for a numeric set of data, you are given a long list of different values. Often, each number is unique (whereas *color* can be only one of two values and *collector* one of five). If you select one value from the list you get just the one row. In these circumstances, you have to customize your filter:

1. Click on the *filter arrow* attached to cell *D1* and choose **Number Filters** then **Greater Than…**
2. In the upper box on the right type **`8`** then press **<Enter>** for **[OK]**

The 23 records displayed have a diameter value greater than 8. You can find data less than a particular value using *Less Than*, or data between two values using *Between* (this wasn't in the list of text filers). To find data outside a range the *Or* option must be used:

3. Click on the *filter arrow* attached to cell *D1* and choose **Number Filters** then **Between…**

Note how the filter is automatically set up with *is greater than or equal to* and *is less than or equal to*.

4. In the upper box on the right type **`8`**
5. Click in the lower box on the right and type **`10`** - press **<Enter>** or click on **[OK]**

Only 20 records should now appear - those between 8 and 10. To see the other 30 values:

6. Click on the *filter arrow* attached to cell *D1* and choose **Number Filters** then **Custom Filter…**

7. Click on the *list arrow* attached to the upper box on the left and choose **is less than**
8. Turn on the **Or** option
9. Click on the *list arrow* attached to the lower box on the left and choose **is greater than**
10. Press **<Enter>** or click on **[OK]**

Another filtering option for numbers is above/below average and Top 10 (the largest 10 values). Options here also let you choose more or less than 10 values, the bottom 10 values, or a percentage (e.g. top 10%): 11. Click on the *filter arrow* attached to cell *D1* and choose **Number Filters** then **Above Average** 12. Repeat step **11** but choose **Top 10…** - a dialog box appears:

13. Choose **Bottom** then set the number of values required to `20` – press **<Enter>** for **[OK]**

Tip: Whenever a filter is running, if you use the **[Sum]** button to total a column, you get the **Subtotal** function instead. As the filter criteria change, so does the total. Make sure the function includes all the rows.

MULTIPLE FILTERS

In the examples to date, a filter has been applied to a single column of data but you can set several filters on different columns. With the data still filtered for the 20 bottom values:

1. Click on the *filter arrow* attached to cell G*1*, turn off **(Select All)** and turn on **BRV** – press **<Enter>**
2. Click on the *filter arrow* in cell *F1*, turn off **(Select All)** and turn on **Red-Brown** – press **<Enter>**

You now have three filters in operation. Each of these can be turned off individually by using the filter arrows attached to the heading cells and choosing **(Select All)**. To turn off all filtering in a single step:

3. Click on the **[Sort & Filter]** button then select **Clear**

Note: The *Sort & Filter* buttons are also available on the *DATA* tab on the *Ribbon* (as you'll see later).

FILTERING DATES

You've already seen how the filtering criteria change when dealing with text and numbers. An even wider set of criteria is provided for dates. The current example file doesn't have any dates to filter, so create some:

1. In cell *A1* replace the current column heading with `Date` – press **<Enter>**
2. In cell *A2*, press **<Ctrl #>** to format the cell as a date (day 1 is 1 January 1900)
3. Now press **<Ctrl ;>** to insert today's date – hold down **<Ctrl>** and press **<Enter>** to stay in *B2*
4. Now *double click* on the *cell handle* to copy the dates down the column
5. Click on the *filter arrow* attached to cell *B1* and choose **Date Filters**
6. Try out an appropriate *Date Filter* (e.g. **Next Week** or **Next Month**) using the filter arrow in *A1* 7. Repeat steps **5** and **6** but choose **All Dates in the Period** and select a month
8. End by removing the filter - click on the filter arrow in *A1* and select **Clear Filter from "Date"**

FILTERING BY COLOR AND ICONS

Another feature in Excel allows you to apply a filter based on the background color of the cells:

1. Move to any *Blue-Green* cell then click on the list arrow attached to the **[Fill Color]** button and choose a suitable color
2. *Double click* on the **[Format Painter]** button in the *Clipboard* group on the left of the **HOME** tab
3. Click on some of the other *Blue-Green* cells then click on **[Format Painter]** again to turn it off
4. Repeat steps **1** to **3** coloring some of the *Red-Brown* cells a suitable color
5. Click on the *filter arrow* in cell *F1* and choose **Filter by Color** then select a color
6. End by redisplaying the data - click on the *filter arrow* in cell *F1* and select **Clear Filter from "Color"**

You can also filter on conditional format icons:

7. Select first column by clicking on the letter *A* at the top of the column
8. Next, click on the **[Conditional Formatting]** button, choose **Icon Sets** then **5 Quarters** (bottom left)
9. Click on the *filter arrow* in cell *A1* and choose **Filter by Color** then select an icon
10. Remove the icons by clicking on **[Conditional Formatting]** then choose **Clear Rules** followed by **Clear Rules from Entire Sheet**

Finally, turn off the filter arrows:

11. Click on the **[Sort & Filter]** button then select **Filter**

ADVANCED FILTERING

Advanced filters allow you to construct more complicated filters. They work by creating two special cell ranges - one defines the data area and the other the filter criteria. The filter criteria can be created anywhere on the spreadsheet, but the convention is to place them above the data area (to match the filters on the column headings). The first step, therefore, is to create space above the existing data:

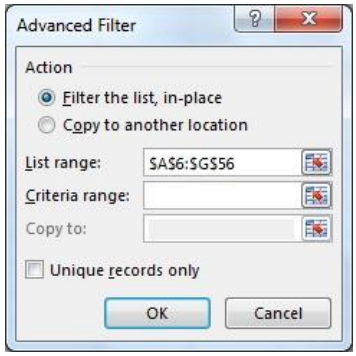
1. Drag through row numbers **1** to **5** down the far left-hand side of the worksheet
2. *Right click* on the selection and choose **Insert** - 5 blank rows should appear

Next set up the filter area, in which the column headings are repeated in the top row with criteria typed into the rows below.

3. *Right click* on the **6** of row 6 and choose **Copy**
4. Click in cell *A1* then press **<Enter>** to **[Paste]** in the headings
5. Click in cell *F2*, type `Blue-Green` and press **<Enter>**

You now have a very simple filter set up - one matching the first simple filter example. To run it:

6. Move to the **DATA** tab and, in the *Sort & Filter* group, click on **[Advanced]** - a dialog box appears:



7. Set up the *List Range:* as **A6:G56** (as above) and the *Criteria Range:* as **A1:G2** then press **<Enter>** or click on **[OK]** to carry out the filter

Tip: Note the *Unique records only* option. This can be used to remove duplicate records from a dataset.

Having seen how advanced filtering works, here's a more complicated example. Each row in the criteria range can be set up to give a particular criterion (similar to the *Or* option you met earlier), while within each row, more than one test can be applied (equivalent to *And*).

8. Click in cell *D2*, type **>8** and press **<Enter>**
9. Click on the **[Advanced]** button again then press **<Enter>** for **[OK]** to run the filter
10. In cell *D3,* type **<8** then move to cell *F3*, type **Red-Brown** and press **<Enter>**
11. Click on the **[Advanced]** button again
12. Amend the *Criteria Range:* to **A1:G3** then press **<Enter>** for **[OK]** to run the filter

You now have rows where the diameter value is less than 8 and the color red-brown plus rows with the diameter more than 8 and the color blue-green. This couldn't be achieved using simple filters.

If you need to find data between two values in an advanced filter then you have to duplicate the column heading concerned. Again, it's easiest to see how this works by carrying out an example:

13. *Right click* on cell *D1* and **Copy** the column heading
14. Click on cell *H1* and press **<Enter>** (for **[Paste]**) to duplicate the heading
15. Click in cell *H3* and type **>7.5** - press **<Enter>**
16. Click on the **[Advanced]** button then amend the *Criteria Range:* to **A1:H3** - press **<Enter>** for **[OK]**

The result gives you rows where the diameter value is between 7.5 and 8 and the color red-brown plus rows with the diameter more than 8 and the color blue-green (as before).

Warning: It's very easy when using advanced filters to forget to redefine the criteria area.

17. Drag through cells *D3* to *H3* and press **<Delete>** to clear the red-brown criteria
18. Click on the **[Advanced]** button then press **<Enter>** for **[OK]** to carry out the filter

You will find you have ALL the data records displayed. This is because the filter is still set up to use row 3, which is now empty - i.e. include any records!

USING MULTIPLE SHEETS

With an advanced filter you can set up criteria on a different worksheet from the data, and can show the results on the separate sheet if you want:

1. Drag though row numbers **1** and **2** then *right click* and **Copy** them
2. Click on the **[Insert Worksheet]** tab (to the right of *PHOENIX*) then press **<Enter>** to **Paste** in the rows
3. Click on the *PHOENIX* tab to view the data
4. Drag through row numbers **1** to **5** then *right click* on the selection and choose **Delete**
5. Click on the *Sheet1* tab (*you must start the filter from the sheet where you want the results to appear*)
6. Click on any cell to release the current selection then click on the **[Advanced]** button
7. Under *Action* turn on the **Copy to another location** option
8. Click in the *List range:* then click on the *PHOENIX* tab and type in **`A1:G51`** (i.e. PHOENIX!A1:G51)
9. Set the *Criteria range:* to **`A1:G2`**
10. Set *Copy to:* to **`A5`** then press **<Enter>** for **[OK]**

You will find the filter is carried out on *Sheet1*, with the original data still intact on *PHOENIX*.

11. You've completed this training, so press **<Ctrl F4>** to **Close** the file – there's no need to save it

EXERCISES

This exercise uses the file **advanced.xlsx** which is available on IT Services PCs in the **D:\Training** folder.

Once the file is loaded, move to the *students* tab (note that the data does not refer to real people).

1. Filter the data to find out how many students have **Foot** as their tutor.
2. How many of tutor **Smith**'s students live in **Private** accommodation?
3. How many students live in a Hall of Residence (i.e. not Private accommodation)?
4. How many students are called **Claire** or **Clare**?
5. Filter the data to show only the students who have one or more middle initials.
6. Filter the students to show just those whose surname begins with **S**.
7. How many students came in **2014**?
8. How many overseas students are female?
9. Filter the students to show the **12** oldest.

   Hint: you will need to convert the dates to numbers first (and then back again after filtering)

10. Using an advanced filter, filter the data to show both male students living in Bridges Hall and unmarried female students living in Wessex Hall.
11. List the overseas students who are taking option 2, 4, 6 or 8.
12. Filter the students to show all those with a birthday in **April**. (if you don't know how dates are stored and used in formulae, work through the notes on *Microsoft Excel 2013: Dates and Times*). **Hint:** you will need to create a new column of data using the **Month** function.

    Try to amend this to show all those students with a birthday coming up later this month.

    Hint 1: you will need to create another new column using the **Day** function.

Hint 2: a criteria such as **`<30`** can be entered directly into a cell; if it has to be calculated then use **`="<"&xxx`** where *xxx* could be a cell reference or function, for example. Answers to filtering exercises

TEXT ROTATION AND WRAPPING

Orientation: 

One feature which you may find useful, especially if you have a column heading which is much wider than the data beneath, is text rotation. Using this you can display more columns on a screen (or print more on a page):

1. Select row *1* by clicking on the row number **1**
2. Click on the **[Orientation]** button in the *Alignment* group and choose **Rotate Text up**

Though the headings are now very narrow, you would have to turn your head sideways to read them. There's a better solution as you'll see in a minute.

3. Press **<Ctrl z>** to **[Undo]** the orientation – you can try some of the other options, if you like
4. The final option, **Format Cell Alignment**, gives you even more options – try that next

Here, under *Orientation* on the right-hand side, note that you can rotate the text to any angle.

5. Press **<Esc>** for **[Cancel]** to close the dialog box
6. If necessary, press **<Ctrl z>** for **[Undo]** button to reset the text orientation to normal

An even more useful feature is *Wrap text*. This allows text to wrap onto more than one line within a cell:

7. With row *1* still selected, click on the **[Wrap Text]** button to the right of **[Orientation]**
8. Next, *right click* on the letter **B** at the top of the second column and choose **Column Width …**
9. Set the *Column Width:* to **8** – press **<Enter>** for **[OK]** (only the first word of the heading appears)
10. Finally, *right click* on the number **1** at the left of the first row and choose **Row Height…**
11. Set the *Row Height:* to **50** – press **<Enter>** for **[OK]**

You can also force text onto a new line by holding down **<Alt>** and pressing **<Enter>**. This would allow you to store an address, for example, in a cell. Excel automatically adjusts the row height for you in this case.

12. Click on cell *D1* and press **<F2>** to enter edit mode

Tip: *Double clicking* on a cell also lets you edit its contents without having to use the *Formula Bar*.

13. Move the insertion point to immediately before *(cm)* then hold down **<Alt>** and press **<Enter>**
14. Repeat steps **12** and **13** on cell *E1* - you can then *autofit* the column widths, if you want
15. Finally, select row *1* then click on **[Middle Align]** (above **[Center]**) to display the headings perfectly

FURTHER GRAPHICS

SCATTER (X-Y) CHARTS

A quick examination of the sorted data should show you that a clear relationship exists between nest altitude and the other variables - the eggs get smaller the lower the altitude. Try plotting this on a chart next. With scientific data, both the independent and dependent variables often vary over a *continuous* range. This contrasts with the business data used in the *Essential Guide*, where the dependent variables (income, costs, etc.) applied to equal time periods (years). To activate the horizontal X-axis, a *Scatter* chart must be used.

1. Select the data needed for the chart (*B1* to *E51*) – drag through the range *B1* to *E1*, then hold down **<Ctrl>** and **<Shift>** and press **<*down_arrow*>** to select the whole columns
2. Click on the **[Quick Analysis]** button attached to the selected data (or press **<Ctrl q>**)
3. Click on **CHARTS** then choose **[More …]**

Note the results shown as *Recommended Charts*. Both the *Line* and *Stacked Column* charts are rubbish. The middle *Scatter* plot is better (columns C to E are plotted against the Altitude) but the points have been joined by a jagged line, which is not required. To see more charts:

4. Click on the **All Charts** tab then on **X Y (Scatter)**
5. The selected chart is perfect - press **<Enter>** for **[OK]**

A chart now appears on the *Phoenix* sheet and extra *CHART TOOLS* tabs are added to the *Ribbon*. To move the chart to a new sheet and add labels:

6. Click on the **[Move Chart]** button on the far right of the **DESIGN** tab (or *right click* on the chart and choose **Move Chart…**)
7. Choose the *New Sheet* option and name the sheet **`EggPlot`** - press **<Enter>** for **[OK]**
8. Also on the **DESIGN** tab, click on **[Quick Layout]** and choose the first (**Layout 1)** – this automatically gives you placeholders for a title and the axis labels
9. Click in the *Chart Title* placeholder (there's no need to delete the existing text) and type **`Phoenix Eggs`** - press **<Enter>**
10. Click in the horizontal *Axis Title* placeholder and type **`Metres`** - press **<Enter>**
11. Finally, click in the vertical *Axis Title* placeholder and type **`Centimetres`** - press **<Enter>**

Note how *Diameter* and *Length* appear on 2 lines in the legend because you forced new lines in the cells.

CUSTOMIZING YOUR CHARTS

Excel offers various facilities, including adding or changing text (titles, axis labels etc.) or the legend; modifying the axes (range, tick marks etc.); changing line and shading patterns; and adding trendlines and error bars. You can also select different font, foreground, background and infill colors.

SECONDARY AXES

Though all three measurements correlate positively with nest altitude, the length and diameter are on a much smaller scale than the mass and as such look a bit silly on the same chart. To overcome this, you can add a second y-axis.

1. *Right click* on any of the (blue) egg mass points and choose **Format Data Series…**
2. In the new *Format Data Series* pane, under *SERIES OPTIONS* choose *Plot Series On* **Secondary Axis**

3. To label the new axis, click on the **[Chart Element]** button (the green cross)
4. Move the mouse over **Axis Titles** and click on the arrow (►) which appears on the right
5. Check on **Secondary Vertical** then type `Grams` and press **<Enter>**
6. In the **Format Axis Title…** task pane, set the *Text Direction:* to **Rotate all text 90°**

The chart is now much clearer. Note that once a secondary Y-axis has been turned on, you can also have a secondary X-axis. This can be useful for comparing a single data series over two time periods, for example.

TRENDLINES

Excel gives you the opportunity of adding best-fit lines (lines which show the trend of your y values as the x values increase, calculated using regression analysis) to your plotted data. To do this:

1. *Right click* once on any of the blue egg mass data points and choose **Add Trendline…**

You can now choose from a variety of options

2. First, turn on the **Display Equation on chart** and **Display R-squared value on chart** check boxes at the foot of the pane

To get the best results, you need to maximize *R-squared* (this shows the proportion of the trend represented by the line). See what happens if you choose a different line:

3. Click on **Exponential** at the top of the lines and note how *R-squared* reduces from **0.9886** to **0.9066**
4. Try the other lines, if you like, but end by choosing **Linear**
5. Once you have found the best fit, turn off *Display R-squared* (unless you need it shown)

Knowing the Equation is also useful. If you have a mountain nearby, of altitude 12000 metres, you can plug that value (x) into the equation to calculate the likely mass (y) of an egg laid on its summit (this gives 120g). Similarly, you could plug a value for y (mass) into the equation and calculate x (the altitude).

The final trendline option is forecasting forwards or backwards. This lets you extend the line back to the axis or on to higher values. This can be used, for example, to show what would happen to future house prices if the trend over the period covered by the data were to continue. To see this:

6. Next, set the *Forecast* to extend the line *Backward:* by `1158` units (to meet the Y-axis)
7. Press **<Enter>** or click on **[Close]**
8. Repeat the above steps for the other data series, if you want to fully annotate your chart

CHANGING THE LEGEND

You may have spotted that a new entry (*Linear (Mass)*) has appeared in the legend, To remove this:

1. Click once on the *Legend* then click again on the new *Linear (Mass)* entry
2. Press **<Delete>** to remove this entry

To change the position of the *Legend*:

3. Click on the *Legend* to display *the Format Legend* task pane

4. Click on **Legend Options** – the third button showing a column chart

MODIFYING THE AXES

To change the settings for an axis simply *click* on it to display the *Format Axis* task bar. Here:

1. Click on the left *vertical* axis (click on the numbers) to select that axis
2. In the *Format Axis* task pane, click on **Axis Options** – again, the button showing a column chart
3. Under *Bounds*, set the *Minimum* to `5.0` and the *Maximum* to `16.0`

You are now making full use of the plot area. Note what other options are available.

CHANGING DATA MARKERS AND LINE STYLE

To change the point markers or line style:

1. Click on one of the points to be changed - the **Format Data Series** task pane appears
2. Click on **Fill & Line** – the first button showing a paint pot
3. No line is needed for this data, so click on **MARKER**
4. Click on **MARKER OPTIONS** to change the marker **Type** and/or **Size**
5. Click on **FILL** to change the **Color**

Note: Excel also allows you to format a single data point in a series. Select the data series, then select the required point – try this here, if you like. Better still, work through the next section.

ADDING DATA LABELS

Sometimes, you may want to add labels to points on your chart. You can add labels to a whole series or just to specific points. Try this next:

1. With a data series already selected, click on the point in the series to which you want to add a label
2. Next, click on the **[Chart Elements]** (green cross) button and check on **Data Labels** - you can position it using the arrow (►) on the right of this

The numeric value of that data point is now shown. To change this to your own label:

3. Click on the label to select it then again to enter edit mode
4. *Double click* and you have a choice of which label to use
5. Here, ignore these (click the mouse button once) and type in your own label – e.g. `Point A`
6. Repeat the process for any other point you wish to label

CHANGING CHART AND PLOT AREA

The Chart and Plot Areas form the background to the chart itself. By default, a white *Plot Area* is placed on a white *Chart Area*, but you may prefer to have these colored. To do this:

1. Click on the chart background (outside the axes) - the *Format Chart Area* task pane
2. Click on **[Fill & Line]**, if necessary, then on **FILL** to change the **Color**

Note: you can also change the background color from the shortcut menu by *right clicking* on the *Chart Area*.

To change the *Plot Area*:

3. Repeat steps **1** and **2** but, this time, begin by clicking inside the axes to display the *Format Plot Area* pane

CHANGING TEXT

To modify the main title, for example:

1. *Right click* on the words *Phoenix Eggs* on the chart to display the pop-up menu

Note that the *Format Chart Title* task pane also appears if you need to change more obscure settings.

2. Use **Font** to change the style, size or font itself or **Fill** to set a colored background 3. Press **<Enter>** for **[OK]** to enforce your changes

ERROR BARS

Error bars are another feature which you may need on a chart. These show the range of values represented by each of your data points (i.e. if you had collected another egg from the same nest, its mass etc. would be expected to lie within the error bar range). To show the error bars:

1. Select the (blue) egg mass series by clicking on any of the points on the chart
2. Next, click on the **[Chart Elements]** button then move the mouse over **Error Bars** and click on the arrow (►) which appears on the right
3. Choose **More Options…** to display the *Format Error Bars* task pane
4. Click on **Error Bar Options** – the third button showing a column chart

Here you can decide which sort of error bars you require (*Plus*, *Minus* or *Both* based on the *Standard error*, *Standard deviation*, *Percentage* or a *Fixed value*). If you have calculated the values yourself, choose **Custom** then click on **[Specify Value]** and type in or drag through the cells containing the values.

5. Leave the *Display* settings as the defaults but set the *Error Amount* to **Standard Error**
6. To end this section close the task pane by clicking on its **[Close]** button

FURTHER DATA MANIPULATION

NAMING RANGES

In the *Essential Guide* you saw how to name a single cell; you can apply the same procedure to a cell range and then use this in your formulae. A range of cells is also known as an array.

1. Move to the *PHOENIX* sheet and select cells *C2* to *C51* - click on *C2* then hold down **<Ctrl>** and **<Shift>** and press ***<down_arrow>***

2. Click on the active cell name (*C2*) in the *Name Box* (just above the heading to column A) - the name will be highlighted (or *right click* on the selection and choose **Define Name…**)

3. Type in the new name for the range, call it **`mass`**, and press **<Enter>** - note that cells *D2:D51* and *E2:E51* have already been named **diameter** and **length** for you.

The next section demonstrates the use of named ranges in formulae and functions.

USING RANGES IN FORMULAE AND FUNCTIONS

A wide range of functions is available within Excel. These can either be typed in directly, or can be invoked by clicking on the **[Insert Function]** button (or use **<Shift F3>**). Examples include MAX and MIN (the largest and smallest values); SQRT; LOG/LN (logarithms); PI (i.e. 3.14159); RAND (a random number); and SIN/COS/TAN (the trigonometric functions). Note that all functions use brackets - PI and RAND need dummy brackets ().

1. Move to cell *H2* and type in the formula **`=mass/length`** (as you type, a list of ranges/functions appears – ignore them) then press **<Ctrl Enter>** (pressing **<Ctrl Enter>** keeps you in the same cell)

2. Check you are in cell *H2* – if not, move to it

3. Copy the formula a few rows using *autofill* (i.e. dragging the cell *handle* - the mouse cursor changes shape to a **+** when over the handle)

4. To fill down the whole column, *double click* on the range/cell's *handle* – this automatically fills down until Excel finds an empty cell in the column to the left

If you didn't know this trick already, it's a very useful one. You wouldn't want to drag down hundreds or even thousands of rows! It's also one reason why you should avoid empty rows in your data. If the autofill stops at an empty cell, simply *double click* on the handle again to jump across the row and continue downwards.

Note how, for each row, the value for the mass is divided by that of the length. As an example of using named ranges in a function, work out average values for egg mass, diameter and length at the base of each column:

5. Move down to cell *A53*

6. Enter the label **`Average`** then press ***<right_arrow>*** *twice* to move to cell *C53*

7. In *C53* type **`=AVERAGE(mass)`** and press ***<right_arrow>*** (the result should be 51.79)

8. In cells *D53* and *E53*, type **`=AVERAGE(diameter)`** and **`=AVERAGE(length)`** respectively (the values should be 7.84 and 11.21)

When using ranges in complex formulae, it is sometimes necessary to enter the formula as an *array formula*. You do this by holding down **<Shift>** and **<Ctrl>** as you press **<Enter>** to end typing. To illustrate this:

9. Move to cell *H53*

10. Type the formula **`=AVERAGE(mass/length)`**

11. Press **<Enter>** and you will find Excel cannot do the calculation - a *#VALUE!* error message appears showing you that you haven't entered the formula as an array

12. Move back to cell *H53*, press **<F2>** to enter *edit mode* then hold down **<Ctrl>** and **<Shift>** then press **<Enter>** again

The resultant value of 4.41 represents the average of (C2/D2) + (C3/D3) +… + (C51/D51). Note how Excel has surrounded the formula by { and } on the command line – sadly, you *cannot* type these in directly yourself.

Although using named ranges seems a user-friendly way of typing in formulae, they do not change when a formula is copied. Whenever you need a formula to change according to its position, the range should be specified explicitly (e.g. as *C2:C51*). To demonstrate this, carry out the following:

13. Move to cell *C54* and type in the formula **=AVERAGE(C2:C51)** – press **<Ctrl Enter>**
14. Copy the formula into *D54* and *E54* simply by dragging C54's cell *handle* across the cells

When you release the mouse button, the formula will be copied across (giving the same values as in row 53). Move between the cells and note how the formula has been modified for each column; compare these formulae with those in row 53. You could even copy the formula to cell H54.

TRACING ERRORS

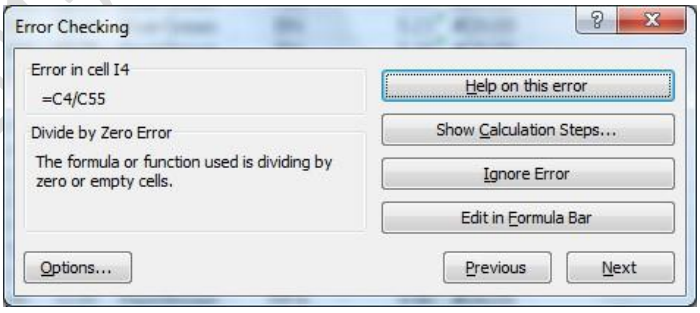
As a spreadsheet is developed, it becomes more and more difficult to see how the values are built up. Excel provides a very useful facility that clearly shows which cells are dependent on which and the source of an error.

First, *standardize* some of the data. Standardization is a statistical technique that involves dividing each value by the average for that set of data. It is often used to compare data which varies widely in scale - here, for example, mass ranges up to over 100, while the maximum length is just over 15. Dividing by the respective averages (51.79 and 7.84), produces values between 0 and around 2 for both series. These could then be plotted on a chart using a single vertical y-axis.

1. Move to cell *I2*
2. Enter the formula **=C2/C53** then press **<Ctrl Enter>** to stay in *I2*
3. *Double click* on the *cell handle* to fill down the column

You will find that an error **(#DIV/0!)** occurs in all but the top two cells. To trace the error:

4. Move to any cell reporting the error (e.g. *I4*)
5. Move to the **FORMULAS** tab on the *Ribbon* and click on **[Error Checking]** in the *Formula Auditing* section – the following window appears:



6. To get further information, click on **[Show Calculation Steps...]** – this isn't much help here!
7. Press **<Esc>** twice to close the *Error Checking* windows

To see the source of the problem more clearly:

8. Click on the arrow attached to the **[Error Checking]** button and choose **Trace Error**

The arrows show that *I4* is calculated from the values in *C4* and *C55* (which is empty - hence the *division by zero* error). Each of the values should have been divided by the average (in *C53* ... or *C54*). You will see how to fix a value in a formula in a minute.

9. End by turning off the tracing by clicking on **[Remove Arrows]**

Other error messages which might appear include **#NAME?** (unrecognized text in a formula), **#NUM!** (invalid numeric values in a formula or function), **#REF!** (an invalid cell reference) and **#VALUE!** (the wrong type of argument or operand has been used).

FIXING A ROW/COLUMN IN A FORMULA (*ABSOLUTE REFERENCES*)

As has just been seen, when entering a formula it is sometimes necessary to fix either the row or the column or both. In Excel, this is achieved either by using a named cell or by using a *$ notation*.

1. Move to cell *I2* and press **<F2>** to enter *edit mode*
2. Correct the formula to read **=C2/C$53** and press **<Ctrl Enter>**

The $ notation fixes row 53 - had you also wanted to fix column C you would have used *C53*. When both the row and column are fixed, this is known as a *fully absolute reference*.

Tip: You can also fix a cell reference by pressing **<F4>** immediately after typing the reference when entering a formula. This circles round the possible notations each time the key is pressed.

3. *Double click* on the *cell handle* to copy the amended formula down the column - the error messages should disappear

For practice, you could drag the formula in cell *I2* across to *J2* and *K2* then complete the standardized data by *double clicking* on the *cell handles* in *J2* and *K2*

Move around the new cells and note how the formulae have automatically been adjusted for their relative position - the column reference varies while the row reference remains fixed. To show how these relate:

4. Move to any cell in column *C* then click on the **[Trace Dependents]** button on the **FORMULAS** tab
5. Do this again then to show all the cells which would be affected if the cell in column C were to change
6. End this section by clicking on the **[Remove Arrows]** button

Note that you can also use **[Trace Precedents]** to work your way back through a spreadsheet, to see exactly how a value has been calculated at each stage.

FREEZING THE COLUMN HEADINGS

When you have data which stretches down more than one screen, you lose the column headings as you scroll down. You can permanently display these headings by freezing them:

1. Move to the **VIEW** tab on the *Ribbon* and choose **Freeze Panes** then **Freeze Top Row**
2. Try using the scroll bars to move down the data - the column headings do not disappear
3. Press **<Ctrl Home>** - this now moves you to cell *A2* (not *A1*)

SPLITTING THE WINDOW

Start by opening the *advanced.xls* example file (note that does not refer to real people):

1. Load up Excel and **[Open]** the file called **advanced.xlsx** in the **D:\Training** folder
2. Check you are viewing the **students** data - click on the *students* tab, if necessary - and that the active cell is *A1*

3. Move to the **VIEW** tab and click on **[Split]** in the *Window* group

The current window is now split into four separate panes. There are two horizontal and two vertical scroll bars, which control the display in the four panes. Each scroll bar controls two panes at a time.

4. Try using the scroll bars to alter the display in the panes

5. Use the *arrow keys* to move the active cell around - sometimes this appears in just one pane, sometimes in two or more

6. Click on any cell in the top left pane then press **<Ctrl Home>** to make *A1* the active cell

The default split is to have 4 equally-sized panes, but you can vary this to suit your requirements. You can even set it so that just a single row is shown at the top (and/or single column at the left):

7. Position the mouse cursor on the horizontal dividing line - the shape will change to a double-headed arrow

8. Hold down the mouse button and drag the line up to row **2** (leaving just row **1** showing in the top pane)

9. Repeat steps **7** and **8** but this time drag the vertical dividing line to column **B** (leaving column **A** showing in the left pane)

You still have the 4 scroll bars showing, so you can display a different row/column if you want to:

10. To the right of the very small horizontal scroll bar below column **A**, click *once* on the **[ ]** icon to move the display to the right - the students' surnames should now be showing

Often you only need to split the worksheet into two panes, just keeping either the row or column headings showing. With this data you don't really have row headings, so remove the vertical split:

11. Position the mouse cursor on the vertical dividing line and drag it to the far left - the split disappears

REMOVING THE SPLIT

You've just seen how to remove the vertical split by dragging the split line. You can, of course, do the same with the horizontal line to get back to a single pane. More normally, however, you remove splits via the **[Split]** button:

1. On the **VIEW** tab, click on **[Split]** – this acts as a toggle, turning splitting on/off Any horizontal and vertical splits disappear.

In the previous section, you saw how to create four equally-sized panes. This occurred because the active cell was *A1*. Had it been any other cell, a different split would have occurred:

- If the active cell is a non-edge cell, the worksheet splits into four with the lines drawn above and to the left of the cell
- If the active cell is in row *1*, it splits into two with the split line to the left of the cell

- If the active cell is in column *A*, it splits into two with the split line above the cell

Try splitting with the active cell in the following positions:

2. Press **<Ctrl Home>** to make sure you can see cell *A1*
3. Move to cell **B2** then, on the **VIEW** tab, click on **[Split]**
4. Click on **[Split]** again to remove the split
5. Repeat steps **3** and **4** starting with the active cell in **C1**
6. Repeat step **5** starting in cell **A2**

VIEWING DIFFERENT WORKSHEETS

Sometimes you use a split screen to view two (or more) different worksheets at the same time. These could be sheets within the same file or two completely different files. This then lets you compare the data within the sheets or easily copy information between them.

To view sheets from two different files at the same time:

1. Press **<Ctrl n>** for a new blank workbook (or **[Open]** an existing file)
2. On the **VIEW** menu, click on **[Arrange All]** The following dialog box appears:

3. Select **Horizontal** if you want a horizontal split or **Vertical** if you want a vertical one
4. Press **<Enter>** for **[OK]**

The screen now splits into two, as before, with each file occupying one half. If you have more than two files open then the screen splits appropriately - into three, four etc. Practically it's rarely sensible to have more than three sheets showing.

You can now work with the two files at once, copying data between them or putting values from one file in a formula in the other. For example:

5. Click on any empty cell in the new workbook and type `=10*`
6. Now click on any cell containing a number in the *advanced.xls* worksheet - you have to click *twice*, once to activate the window and then to select the cell

7. Note the format of the formula in the *Formula Bar* then press **<Enter>** to carry out the calculation

You can also use *drag and drop* to move or copy data between the files:

8. Click on the required cell in the *students* worksheet
9. Move the mouse cursor over the dark border (it changes shape from a cross to an arrow)
10. Hold down the mouse button and drag the cell to the required destination cell on the other file
11. Press **<Ctrl z>**to **[Undo]** this and restore the data to the *students* worksheet

To copy data, you hold down **<Ctrl>** as you drag the cell:

12. Hold down **<Ctrl>** and repeat steps **9** and **10** to copy the data into the other file
13. **[Close]** the new workbook window (there's no need to save it)

Displaying different worksheets from the same file isn't quite so obvious:

1. **[Maximize]** the *advanced.xls* window
2. On the **VIEW** tab, click on **[New Window]** - a full-screen copy of the file is made
3. Again on the **VIEW** tab again, click on **[Arrange All]** - the *Arrange Window* dialog box appears
4. Select either **Horizontal** or **Vertical** then turn on the **Windows of active workbook** option
5. Press **<Enter>** for **[OK]**

You now have two copies of the same file displayed.

6. Select the required worksheets by clicking on the appropriate sheet tabs
7. Position the mouse cursor on the line dividing the two windows and drag it to the left/right (or up/down) if you want windows of different sizes
8. Press **<Ctrl F4>** to **[Close]** one of the windows then **[Maximize]** the remaining one

Note: When you arrange the windows, as above, each can be *split* into two or four panes (as described in the previous sections).

FREEZING PANES

When you *split* a worksheet you get up to four panes, each of which scrolls up, down and sideways.

Sometimes you want to fix the cells shown - for example, you only ever want the row of column headings. You can do this by using *freeze* instead of *split*.

1. Press **<Ctrl Home>** to move the active cell to *A1*
2. On the **VIEW** tab, click on **[Freeze Panes]** then select **Freeze Panes**

The screen will split into four equally-sized panes, as before, but this time you only have two scroll bars. Also, the cells are not duplicated in any way - you can't display the same information in each of the panes.

3. Use the scroll bars to move the panes around - you will find that the top left pane never changes
4. Position the mouse cursor over one of the split lines and try to move it - you'll find that you can't

5. On the **VIEW** tab, click on **[Freeze Panes]** then select **Unfreeze Panes** - the split lines disappear

Positioning the freeze lines across the center of the screen wasn't very clever - normally you freeze just the top row and/or left column. You can do this in exactly the same way as you did when splitting, by selecting a cell (other than *A1*) before you use freeze. In this particular example, you would probably just want the column headings and Excel also gives you this option:

6. On the **VIEW** tab, click on **[Freeze Panes]** the choose **Freeze Top Row**
7. Use the scroll bars to alter the display - note how the column headings are always present
8. End by unfreezing the panes – click on **[Freeze Panes]** and select **Unfreeze Panes** Note that another option lets you **Freeze First Column** (as you'll see next).

Sometimes it's useful not to see some of the data. Here, for example, you might want to show the student's surname as a row heading down the left-hand side (without showing their student number). You could always **Hide** the unwanted column (or row) but an easier way here is:

9. Using the horizontal scroll bar, move the display to the right, so that column B is on the left
10. Move to cell *C2* then, simply, click on **[Freeze Panes]** and select **Freeze Panes**

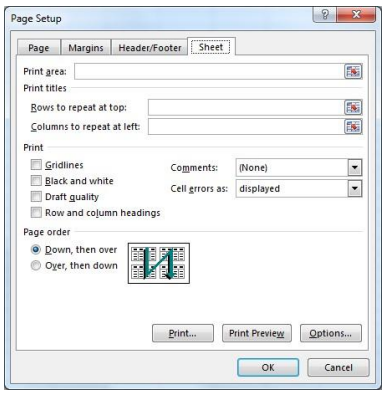
You should now find that both row **1** and column **B** are fixed as you use the scroll bars to move around your data. The one problem with this is that you can no longer display column **A**, though you can move into it using the arrow keys - a cell's current value is shown on the *Formula Bar*.

11. End by removing the freeze - on the **VIEW** tab, click on **[Freeze Panes]** and choose **Unfreeze Panes**

PRINTING ROW AND COLUMN HEADINGS

If you have data which stretches over several printed pages you might want the row or column headings printed on every page. This is done under *Page Setup*. For this data you just need the column headings:

1. Move to the **PAGE LAYOUT** tab and click on **[Print Titles]** – the *Page Setup* dialog box appears:



2. On the *Sheet* tab, under the heading *Print titles*, click in the **Rows to repeat at top:** box
3. Click on the number **1** on the worksheet to select *row 1* - this appears as **`$1:$1`** in the box
4. Click on the **[Print Preview]** button to see the effect
5. Use the **[Next Page]** button to verify that the headings appear on each page

6. Finally, press **<Esc>** to return to normal working then **[Close]** the *advanced.xls* file - there's no need to save the changes

DATA ANALYSIS

Although Excel is not a comprehensive statistical package, it does provide some rudimentary analysis tools - including Anova, Fourier Analysis, Regression and T-tests. For more thorough analyses of your data, a statistical package such as SAS, SPSS, Genstat or Minitab should be used. Consult the Statistical Advisory Service for help with this. They can advise you on the suitability and limitations of Excel for your work.

Many of the data analysis tools are not installed by default. They can, however, easily be added in:

1. Move to the **FILE** tab, choose **Options** then **Add-Ins** on the left
2. At the bottom of the screen under *Manage*, click on **[Go...]**, then check on **Analysis ToolPak**

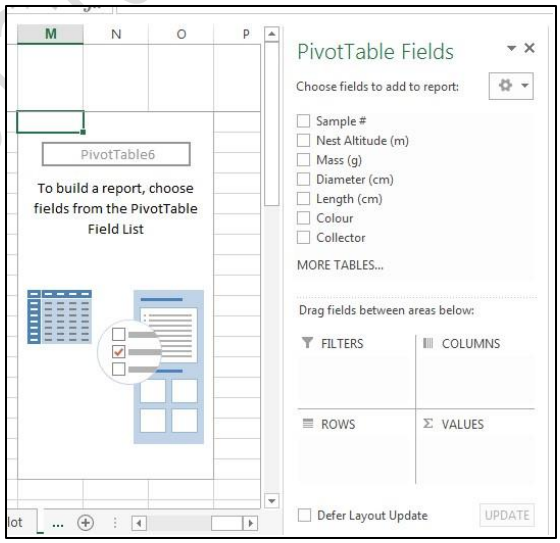
Note: *Analysis ToolPak – VBA* is a very advanced feature offering you the opportunity to make functions available to your own programming (with *Visual Basic*) . The *Euro Currency Tools* give you the exchange rates when each currency joined the Euro and are useful for converting historical data. The *Solver Add-in* 3. Click **[OK]** to add in the *Analysis ToolPak*

PIVOT TABLES

Pivot tables allow you to create interactive summary tables of your data. Here is a simple example:

1. Check you are using the *PHOENIX* data and the current cell is inside the data (e.g. in *A1*)
2. Move to the **INSERT** tab on the *Ribbon* and click on the **[PivotTable]** button on the far left
3. In the *Create PivotTable* window turn on the **Existing Worksheet** option and set the *Location* to **M2** then press **<Enter>** for **[OK]**

A skeleton Pivot Table appears, starting in *M2* (scroll right and up to see it), while two extra PivotTable Tools tabs appear on the *Ribbon*. A *Pivot Table Fields List* task pane also appears on the right:



You now have to select which data series you are summarizing by dragging the field buttons from the *Field List* pane and dropping them into the areas below the field list. For this particular set of data, it's easy to summarize by collector and egg color.

4. Drag and drop the **Color** field button down into the area marked *Columns*

5. Drag and drop the **Collector** field button into the area marked *Rows*

6. Drag and drop the **Collector** field button again, this time into the *∑ Values* The end result should look like this:

Count of Collector	Column Labels		
Row Labels	Blue-Green	Red-Brown	Grand Total
BN	1	8	9
BRV	6	3	9
CDS	9	1	10
FLC	1	9	10
RFA	4	8	12
Grand Total	**21**	**29**	**50**

Because you used a text field (the initials of the collectors) for the summary data, the default is to count the number of cells for each collector. Had you used a numeric field, the default would have been to sum the values. Various other measures are available, including average, maximum and minimum. You can have several of these showing by dragging further field buttons into the data area.

7. *Right click* on **Count of Collector** in cell *M2* and choose **Value Field Settings**

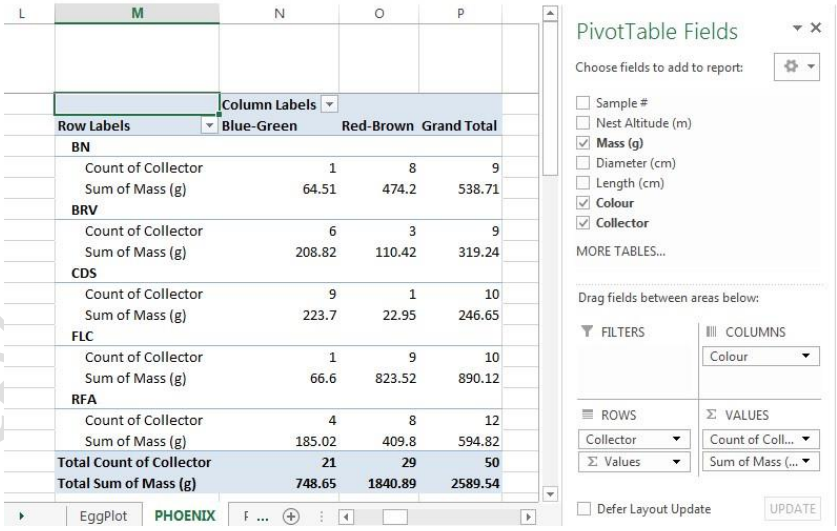
Explore (but don't change) the list of measures on the *Summarize Values by:* tab. Further options are available on the *Show Values as:* tab.

8. Press **<Esc>** or click on **[Cancel]** to leave **Count** as the chosen option

9. Next turn on the check box for **Mass (g)** in the *Pivot Table Field List* – the data is automatically added to the table

You now have both a count of the eggs for each collector and the sum of their mass. The results might look clearer if the two sets of figures are separated out:

10. Drag the **∑ Values** from the **Columns** to below *Collector* in the **Rows** Your Pivot Table should now look like this:



If you change any of your data values, the Pivot Table is not updated automatically. Instead, you have to use the **[Refresh]** button:

11. Move to cell *G11* and change the collector from FLC to **BN** and press **<Enter>**

12. Click on the pivot table (to activate it) then *right click* on it and choose **Refresh** - note how the values are updated (collector BN now has two blue-green eggs)

13. Reset the value in *G11* to **FLC** and update the pivot table again

Pivot Tables have one other very useful feature. If you *double click* on any of the calculated cells in a table, a copy of that data is pasted onto a new sheet. To see this:

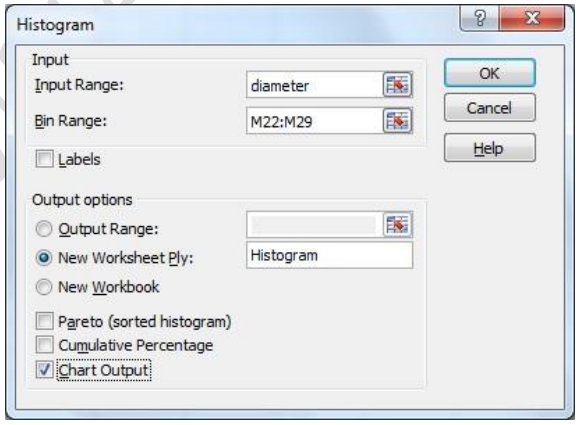
14. *Double click* on the number **21** (the *Grand Total* of *Blue-Green* eggs) – the data is copied to a new sheet
15. *Right click* on the new sheet tab and **Rename** it then choose an appropriate **Tab Color**
16. End by moving back to the *Phoenix* tab

For more about pivot tables, see the *Microsoft Excel 2013: Pivot Tables* advanced notes.

HISTOGRAMS

Before running the histogram tool, you should first set up *bin values* (to define the divisions for each histogram range). As you will see, Excel can also draw a chart for you, if requested.

1. Starting in *M22*, type the number **5** - press **<Ctrl Enter>**
2. Drag the *cell handle* down to cell *M29* then click on the **[Auto Fill Options]** button which appears next to the bottom of the selection and choose **Fill Series**
3. Check you have the rest of the bin numbers: **6**, **7**, **8**, **9**, **10**, **11** and **12** in *M22:M29*
4. Click on the **DATA** tab on the *Ribbon* and then on **[Data Analysis]** on the far right
5. From the list of analysis tools, choose **Histogram** - press **<Enter>** or click on **[OK]**
6. In the *Histogram* window, set the *Input Range:* to **diameter** and *Bin Range:* to **M22:M29**
7. Under *Output options*, keep the default of output to a **New Worksheet Ply:** but name the sheet **Histogram**
8. Click on the **Chart Output** check box for a chart The *Histogram* window should look as follows:



9. Press **<Enter>** or click on **[OK]** and watch what happens
10. Enlarge the chart - click on it (to activate it) then drag the bottom handle downwards

The Histogram tool works very well but it can be annoying to have a *More* category. To remove this from the chart (and frequency table):

11. Select cells *A10* and *B10*

12. *Right click* on the selection and choose **Delete…**
13. Leave *Delete* as **Shift cells left** - just press **<Enter>** or click on **[OK]**

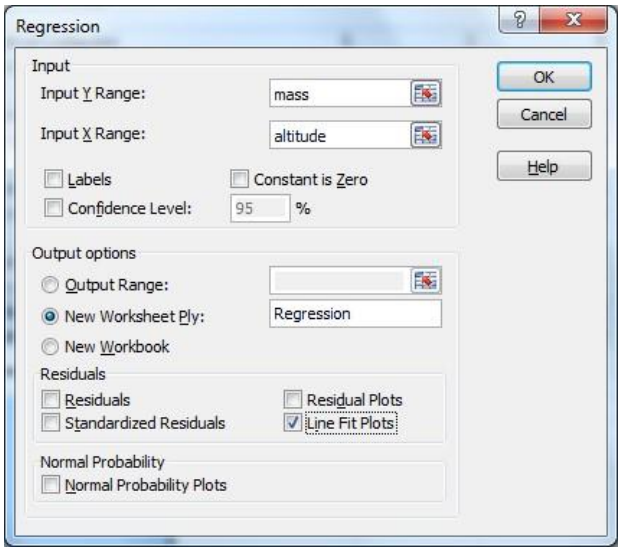
The labelling on the X-axis could be improved further by editing the bin values in cells *A2* to *A9*:

14. Move to cell *A2* and type **`<5`** then press **<Enter>**
15. In cell *A3* type **`'5-6`** (the quote is vital - without it you get a date) and press **<Enter>**
16. Continue typing **`'6-7, '7-8 ... '10-11, >11`** into cells *A4* to *A9*
17. Move the chart onto its own sheet – *right click* towards the edge then choose **Move Chart…**
18. Select *New sheet:* and name it **`Histogram Plot`** - press **<Enter>** for **[OK]**
19. Change the *Title* to **`Histogram Showing Egg Diameters`** and *Bin* to **`Centimetres`**
20. Finally, remove the *Legend* – click on it to select it then press **<Delete>**

REGRESSION ANALYSIS

Regression is a commonly-used statistical tool in the scientific world. If you are not familiar with this statistical technique, ignore this next exercise. The hypothesis you'll be testing out is that egg mass is dependent on the nest altitude.

1. Click on the *PHOENIX* tab to return to your data
2. Move to the **DATA** tab on the *Ribbon* and select **[Data Analysis]**
3. Select **Regression** from the list of *Analysis Tools* - press **<Enter>** or click on **[OK]**
4. In the *Regression* window, set **Input Y Range:** to **`mass`** (or type **`C2:C51`**)
5. Press **<Tab>** then in **Input X Range:** type **`altitude`** (or type **`B2:B51`**)
6. Name the new sheet **`Regression`** against **New Worksheet Ply:** in *Output options*
7. To get a chart of the results, turn on **Line Fit Plots** under *Residuals* The *Regression* window should look as follows:



8. Press **<Enter>** or click on **[OK]** and watch what happens

The regression results are displayed on a new worksheet, with a chart plotted at the side.

9. Move the chart onto its own sheet - *right click* on it then select **Move Chart…**

10. Choose *New sheet:* and name it **`Regression Plot`** - press **<Enter>** for **[OK]**

To add a best-fit line to your chart:

11. *Right click* on one of the (red) *Predicted Y* values and choose **Format Data Series**

12. In the *Format Data Series* pane, click on **[Fill and Line]** (the paint bucket)

13. Set **Line** to **Solid line** then click on **Marker** then **Marker Options**

14. Set this to **None** then **[Close]** the *Format Data Series* pane

Note that Excel does allow rudimentary multiple regression - set up the *Input X Range* to a block covering more than one adjacent column. However, your data may not be suitable for this so always seek guidance from the Statistical Advisory Service.

PASTING WORKSHEETS AND CHARTS INTO OTHER DOCUMENTS

If you want to incorporate information from Excel into Microsoft Word (or other software), the procedure is as follows:

a) *Worksheets* can be copied across simply by using **[Copy]** and **[Paste]** - in Excel, select and copy the cells you require then switch to Word and paste in the data. In Word, this is displayed as a table (without borders), with any formatting preserved. Such tables can be edited as normal text. Note, however, that with certain packages some Excel formats cause problems and have to be cleared before the copy/paste is carried out.

If **Paste Special** is used instead of **Paste**, then the data can be moved as *Unformatted Text*. This does not appear as a table but is instead *tab separated*. Using **Paste Special** you can also copy a worksheet as a *Picture*. This can then be rotated, if required, to appear landscape (sideways) on a portrait (upright) page. Note that the data in a picture cannot be edited.

Note: If you **Paste** by *right clicking* then these options can be selected by choosing the matching icon from the *Paste Options*. Help tips appear as you place the cursor over an icon to explain which button is which.

If you want to preserve a link between the Excel worksheet and other document (such that changes made in the source file are passed to the other) then turn on **Paste link** in the *Paste Special* window. Note: the files need to be kept in the same relative position – take care not to rename or move one into a different folder.

Worksheets can also be saved in various formats readable by many other applications including space/tab/ comma separated values. The format type can be set in the *Save As* window.

b) *Charts* can also be copied to a Word document (or other software, such as PowerPoint or Access) by using **[Copy]** and **[Paste]**. When pasting into Word, it is advisable to use **Paste Special** via the **[Paste]** button, as this gives you the options of pasting the chart as a picture and/or as a linked object (see above).

The default is to paste the chart as a *Microsoft Office Graphic Object*. This allows you to make changes to the chart in the normal way (*right click* and choose **Format**) but can cause problems if you change its size. Another option is to paste it as a *Microsoft Excel Chart Object*. When you *double click* on this, to edit it, it loads up Excel where you can not only make changes to the chart but to the data on the other sheet tabs. Again, however, if you change the size of the chart in your Word document, the text (chart/axes titles, legend etc.) doesn't change causing the chart itself to shrink.

The best way to preserve how the chart looks is to paste it as a *Picture* (e.g. JPEG). Not only can you change the size with the layout intact but you can easily rotate it should you want it appearing sideways on an A4 page. The disadvantage of this is that any changes to the chart must be made in Excel – you would then have to copy it back into your Word document.

For details about copying Excel charts to Word see the document *Microsoft Word 2013: Graphics*.

LEAVING EXCEL

To quit from Excel:

1. Press **<Alt F4>** or click on the **[Close]** button in the top right corner

Tip: <Alt F4> can be used to close any program – you can even use it to log out of Windows.

2. Click on **[Don't Save]** when you are asked whether you want to save the changes to *phoenix.xls* - there's no need to keep the changes