

# How to digitise graphs?



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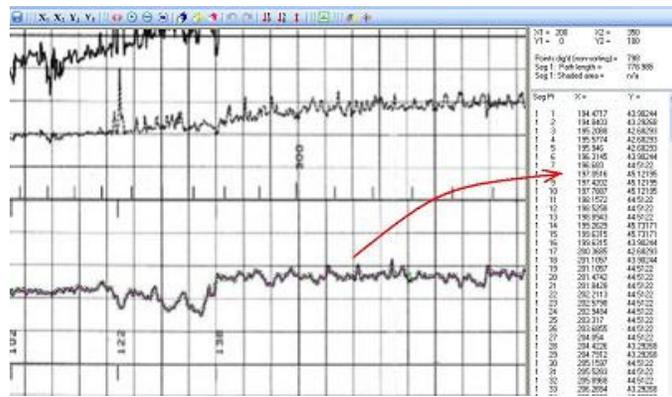
## 0) Your own notes of using [dcDigitiser](#):

You can write your own notes here and save this document for your own reference.

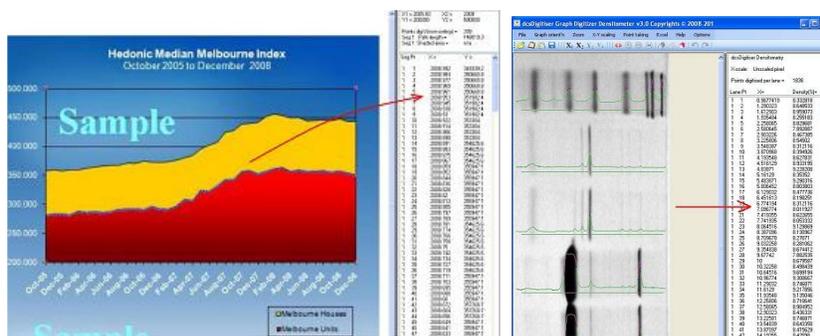
# 1) Overview of dcSDigitiser v4.0:

dcSDigitiser provides following functionalities:

- dcSDigitiser v4.0** provides following unique functionalities:
1. automatically digitises graphs into X-Y numerical numbers;
  2. automatically digitises gels into numerical density data;
  3. calculates area size enclosed by a graph with any shape;
  4. curve fitting including multi-peak curve fitting;
  5. math tools including probability functions, equation solving and matrices;
  6. wide range of analysis of graphs/images;
  7. and more ...

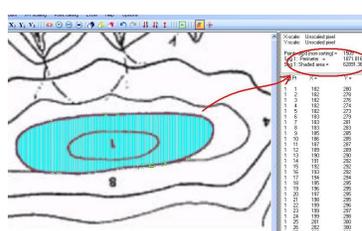


A geographical record is digitised to obtain X-Y numbers (798 points).

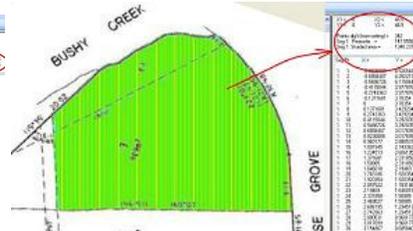


A graph of house price is digitised (399 points)

Gel stripes are digitised



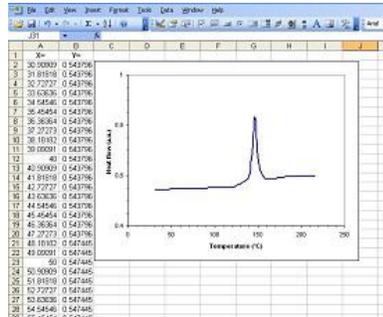
Digitising and area calculation



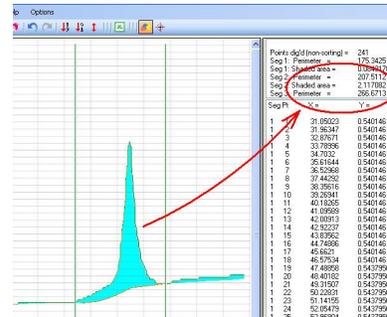
Digitising and area calculation



Measure Caspian Sea area size.



Graph and X-Y data in Excel



dcSDigitiser defines and calculates the peak volume.

## 2) Graph preparation:

Scan your graph and save it in any one of the following formats:

- |                              |      |
|------------------------------|------|
| Bitmap files:                | bmp; |
| JPEG Files:                  | jpg  |
| TIFF Files:                  | tif  |
| Gif Files:                   | gif  |
| PNG Files:                   | png  |
| Enhanced Windows Meta Files: | emf  |
| Exchangeable Image Files:    | exif |
| Windows Meta Files:          | wmf  |
| Icons files:                 | ico  |

Any graphs on computer screen can be copied to **Clipboard** by pressing **Ctrl+PrtScr** keys simultaneously; and pasted to **dcSDigitiser** pressing **Ctrl+V** keys simultaneously or clicking **Tool Bar** .

The maximum pixel size of an image has been set 3000 x 3000. Extension can be made on request to fit special needs.

## 3) Graph prerequisites:

**dcSDigitiser** assumes X-Y axes orthogonal (right angle), and oriented either horizontal or vertical. If not oriented either horizontal or vertical, use **Orientation > Any angle** to rotate the graph until satisfaction. This makes it much easier because one can determine X-scale at any points with different Y value, and determine Y-scale at any points with different X-value.

Most graphs naturally meet this prerequisite, so there is no need for rotation.

## 4) Tool Bars:

Functions of tool bars are as follows:

-  to open an image file;
-  to paste an image in **Clipboard** to **dcSDigitiser**;
-  to paste numerical X-Y data in **Clipboard** to **dcSDigitiser**;
-  to save digitised X-Y numbers to a CSV Excel file;
-  to assign a point and value for **X<sub>1</sub>**;

-  to assign a point and value for  $X_2$ ;
-  to assign a point and value for  $Y_1$ ;
-  to assign a point and value for  $Y_2$ ;
-  to split a graph into two or more segments. If a graph is not segmented, the graph is dealt with as within one segment.
-  to digitise points manually, one click for one point.
-  to digitise points automatically from left to right: Click on a point of the curve to start.
-  to digitise points automatically from right to left: Click on a point of the curve to start.
-  to erase unwanted points one by one.
-  to erase all the points in a segment.
-  to erase all the points and curve segmentations to make a fresh start.
-  to undo previous moves;
-  to redo;
-  to sort data in ascending order according to X value;
-  to sort data in descending order according to X value;
-  to resort data in order of digitisation;
-  to transfer data in the **List Box** of **dcSDigitiser** to **Excel**;
-  to calculate area size enclosed by a graph with at least 3 points;
-  to read X-Y values at the crosshair point.

## 5) Digitise a graph:

### 5.1 First practise:

Using the sample graph **dcSDigitiser** has provided, a user can practise digitising graph:

1. click **Tool Bar** , to digitise a graph automatically from left to right;
2. move the cross hair to a point on graph where you want to start;
3. click the mouse, digitising starts; you will see the X-Y numbers in the list boxes on the right hand side.
  
4. click **Tool Bar**  $X_1$
5. move the cross hair to a point you know the value, and click;
6. type in the number for  $X_1$ , and press **Enter** or click button **OK**;
7. repeat 4~6 for  $X_2$ ,  $Y_1$  and  $Y_2$ ;
  
8. click **Tool Bar**  to export digitised X-Y numbers to Microsoft **Excel**;

### 5.2 Procedures of graph digitization:

A typical process of digitising a graph is as follows:

- 1) Load the graph to **dcSDigitiser**; this can be done by:

**Tool Bar**  to load the graph file; or  
**Ctrl+V** to paste the graph to **dcSDigitiser** if there is a graph in your clipboard already.  
Press **Ctrl+PrtScr** buttons on your keyboard simultaneously to capture any graph on **Screen** to **Clipboard**.

2) Align X-Y axes of the graph horizontally or vertically by:

**Orientation → Any angle**

Most graphs naturally meet the prerequisite and this step can indeed be skipped.

3) Digitise the graph

The simplest way to digitise a graph is to click on the graph you wish to digitise, **dcSDigitiser** then automatically digitises the graph. However following knowledge and skills, and a combination of these skills, are useful when a complex graph is digitised.

-  to split a graph into two or more segments. If a graph is not segmented, the graph is dealt with as within one segment.
-  to digitise points manually: one click for one point.
-  to digitise points automatically from left to right: Click on a point of the curve to start.
-  to digitise points automatically from right to left: Click on a point of the curve to start.
-  to erase unwanted points one by one.
-  to erase all the points in a segment.
-  to erase all the points and curve segmentations to make a fresh start.

4) Determine the scales of X-Y axes;

- X<sub>1</sub>** to determine the point and its figure where **X<sub>1</sub>** reads
- X<sub>2</sub>** to determine the point and its figure where **X<sub>2</sub>** reads, **X<sub>1</sub> ≠ X<sub>2</sub>**
- Y<sub>1</sub>** to determine the point and its figure where **Y<sub>1</sub>** reads
- Y<sub>2</sub>** to determine the point and its figure where **Y<sub>2</sub>** reads, **Y<sub>1</sub> ≠ Y<sub>2</sub>**

5) Export data to, say, Excel. Simply click **Tool Bar**

Or move the mouse to the **List Box**, make a selection, press **Ctrl+C** to copy it into Clipboard, and paste it by pressing **Ctrl+P** keys to anywhere you want.

## 6) Skilful use of the Tool Bars:

For low quality graphs or graphs with intersections, overlapping and/or grids, combination of different tools may be helpful.

To digitise the b curve in Figure 6.1, following procedures are taken:

- a) Click ; place cross hair on the starting point of curve b.
- b) Click ; erase bad points in a way of point by point on letter "b".
- c) Click  again; place cross hair to continue automatic digitising.
- d) Click ; place a segmentation mark on the intersection point of the curves.
- e) Click ; move the cursor hand over any digitised point of the right hand size segment, all the points in this segment are then erased.
- f) Click  again; place cross hair to continue automatic digitising.

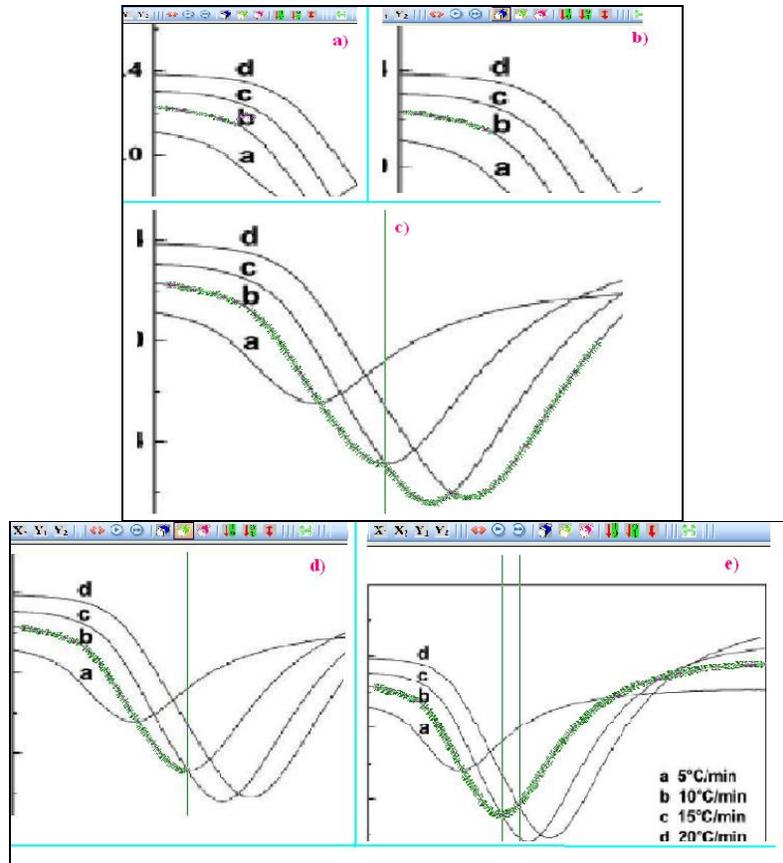


Figure 6.1

## 7) Calculate Area size of a graph:

Area size of a graph having more than 2 points can be calculated by clicking Tool Bar . It can be for an X-Y graph, map, SEM micrograph, photo or any drawing.

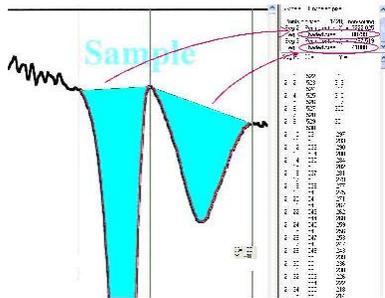


Figure 7.1

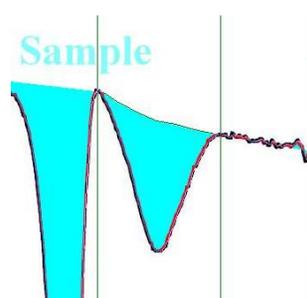


Figure 7.2



Figure 7.3

Procedures for Figure 7.1 to obtain the peak area are as follows:

1. Click the segmentation **Tool Bar** , place the cross hair at where the peak starts and where it ends, and click;
2. Click Tool Bar to digitise the graph;
3. Click Tool Bar to calculate the area size.
4. If the baseline for the peak, e.g the one in the right hand side, is thought not a straight line, one can redefine as he/she likes so that the area value is more physically meaningful (Figure 7.2).

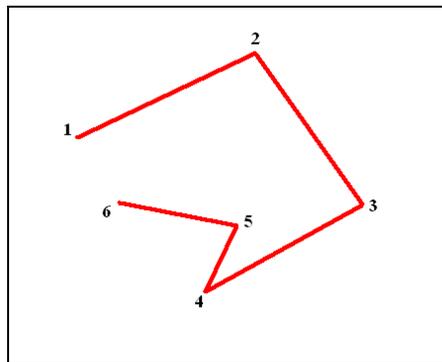
A Google satellite photo of Caspian Sea was copied and pasted to **dcDigitiser**, with a scale bar being attached. The coast line of Caspian Sea was then manually clicked against the photo to obtain the area size for Caspian Sea.

Note that no curvature of the Earth ground surface has been taken into consideration in **dcDigitiser**. For maps with large distance, curvature compensation must be taken. For technical support, contact [www.caotechnology.com.au](http://www.caotechnology.com.au).

## 8) Path length and perimeter of a graph:

Path length and perimeter of digitised points can be calculated and shown in the top left window. However, caution should be exercised in units. This is because the X-axis and Y-axis may not have the same unit. As shown in above figure, the definitions are:

**Path length:** Sum of the length of two successive points =  $L_{12} + L_{23} + L_{34} + L_{45} + L_{56}$   
**Perimeter:** Perimeter of the graph points =  $L_{12} + L_{23} + L_{34} + L_{45} + L_{56} + L_{61}$



## 9) Densitometry:

### 9.1 Digitise a gel:

1) Load a gel to **dcDigitiser**; this can be done by:

**Tool Bar** 

to open the gel file; or

**Ctrl+V**

to paste the gel to **dcDigitiser** if there is a gel in **Clipboard** already.

Press **Ctrl+PrtScr** buttons on your keyboard simultaneously to capture any graph on **Screen** to **Clipboard**.

2) Align the gel horizontally or vertically by:

**Orientation > Any angle** to align the gel vertically or horizontally as you like. Most gels naturally meet the requirement and this step can be skipped.

3) Option selection

**Options > Graph type** to select either vertical or horizontal densitometry

4) Click the segmentation Tool Bar  to define the gel lanes;

a) move the cross hair to the top left of a gel strip and click;

b) move the cross hair to the bottom right of a gel strip and click;

Further lanes can be defined.

For vertical gels:

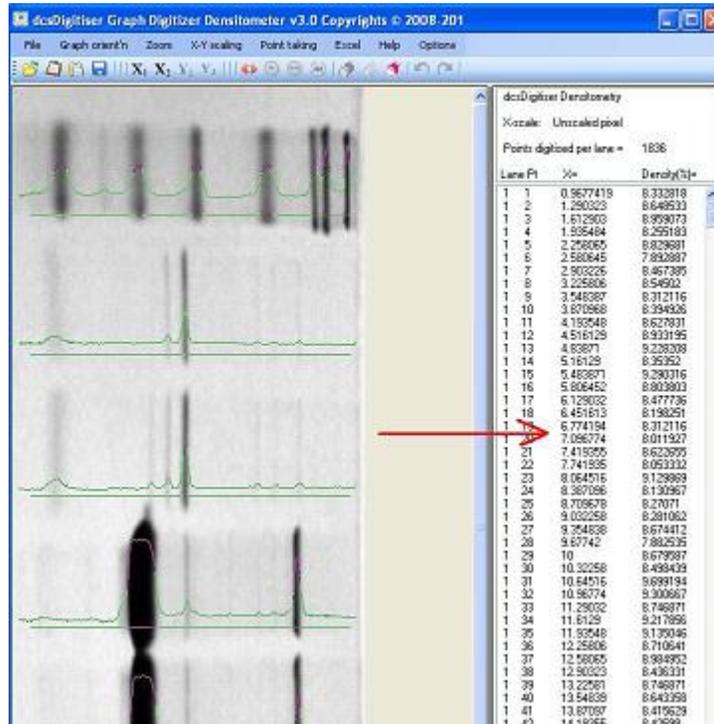
c) move the cross hair to the left of another gel strip and click;

d) move the cross hair to the right of the gel strip and click;

For Horizontal gels:

- c) move the cross hair to the top of another gel strip and click;
- d) move the cross hair to the bottom of the gel strip and click;

5) Scaling the distance if necessary



## 9.2 Definition of the density in densitometry:

Lane number:

An automatic sorting processor is coded in **dcDigitiser**, so that lanes are numbered from the left to the right for vertical gels and from top to bottom for horizontal gels regardless the order when lanes are defined.

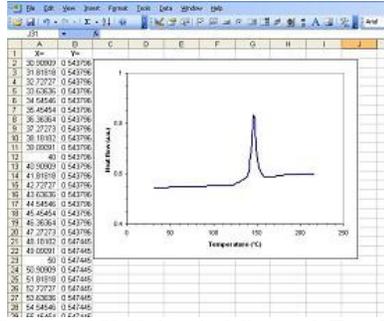
Density (%)

Darkness (or brightness for negative gels) is averaged cross the width of a lane defined. The averaged darkness is then expressed as a percentage figure of the darkest (brightest for negative gels) spot of all the lanes defined.

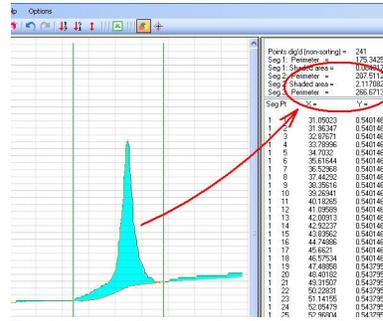
## 10) Input numerical data to dcDigitiser:

In many cases, users have numerical numbers for their graphs, but simply want to take advantages of the unique functionalities of **dcDigitiser**, e.g. calculation of the area size of a curve freely definable by users.

- Simply: 1) Copy the data into your **Clipboard**
- 2) Paste the data to **dcDigitiser** by pressing **Ctrl+P**
- or by clicking **Tool Bar** 

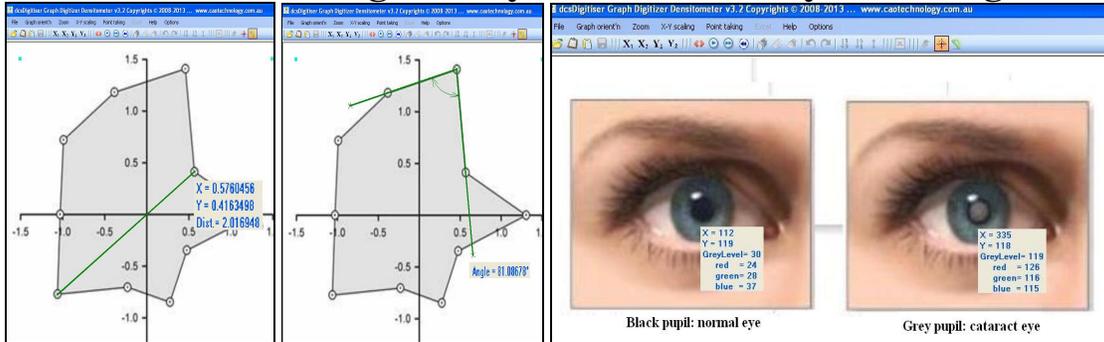


Graph and X-Y data in Microsoft Excel



dcSDigitiser defines and calculates the peak volume.

## Screenshots for geometry and colour analysis of images



## 11) Math tools – Matrices and Linear equation solving:

Screenshot for linear equation solving

dcDigitiser ... Matrix computation

**A =**

1	1	1	1	3	1
1	1	1	1	2	1
1	1	2	3	0	2
1	2	1	2	1	1
1	2	3	3	4	1
1	2	3	1	2	3

**B =**

1
1.256
1.2
0.25
2
0.3150

How to type your equation ?  
 Matrix operators: + - \* ^ ^T ^-1  
 Examples: C = B^T + 23.3 \* B^4 \* 3 A  
 C = A^-1  
 C = 2 \* (A + B) + AB

Tips for equation formats:  
 A \* B Number of columns of Matrix A and number of rows of Matrix B must be equal  
 A ^ n n - integer >= 1, except A^-1 for inverse matrices  
 A x = B For linear equations to calculate x

**Equation:** Ax = B

**C = (answer)**

x =	3.0152
	-0.9706
	1.4047
	-0.2914
	-0.256
	-1.3899

Buttons: Save as defts, Restore defts, Calculate, Clear screen, Exit

Screenshot for matrix computation

dcDigitiser ... Matrix computation

**A =**

1	1	1	1	3	1
1	1	1	1	2	1
1	1	2	3	0	2
1	2	1	2	1	1
1	2	3	3	4	1
1	2	3	1	2	3

**B =**

1	2	3	4	3	1
1	3	1	1	2	5
1.2	1	2	3	0	2
0.25	2	1	2	2.2	1
2	2	3	3	4	1
1.123	2	3	1	2	3

How to type your equation ?  
 Matrix operators: + - \* ^ ^T ^-1  
 Examples: C = B^T + 23.3 \* B^4 \* 3 A  
 C = A^-1  
 C = 2 \* (A + B) + AB

Tips for equation formats:  
 A \* B Number of columns of Matrix A and number of rows of Matrix B must be equal  
 A ^ n n - integer >= 1, except A^-1 for inverse matrices  
 A x = B For linear equations to calculate x

**Equation:** C = A \* B^-1 + 12.3 \* A^3

**C = (answer)**

1059.026	1649.072	2028.590	2175.596	2079.218	1536.906
885.7803	1377.955	1697.200	1795.379	1734.829	1303.580
996.5923	1525.259	1845.956	1857.161	1832.525	1549.805
895.5495	1389.058	1698.791	1761.721	1771.868	1328.830
1735.761	2693.994	3221.882	3467.906	3284.226	2533.824
1488.480	2300.136	2853.512	2927.315	2767.393	2313.403

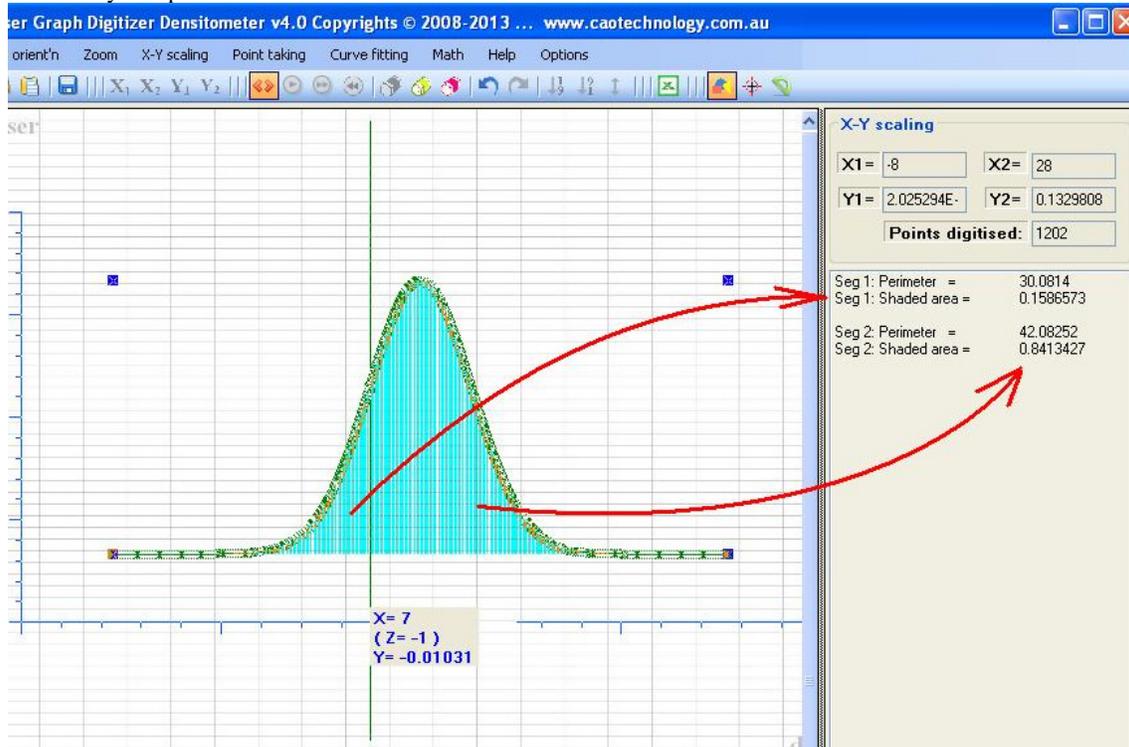
Buttons: Save as defts, Restore defts, Calculate, Clear screen, Exit

Unit conversions

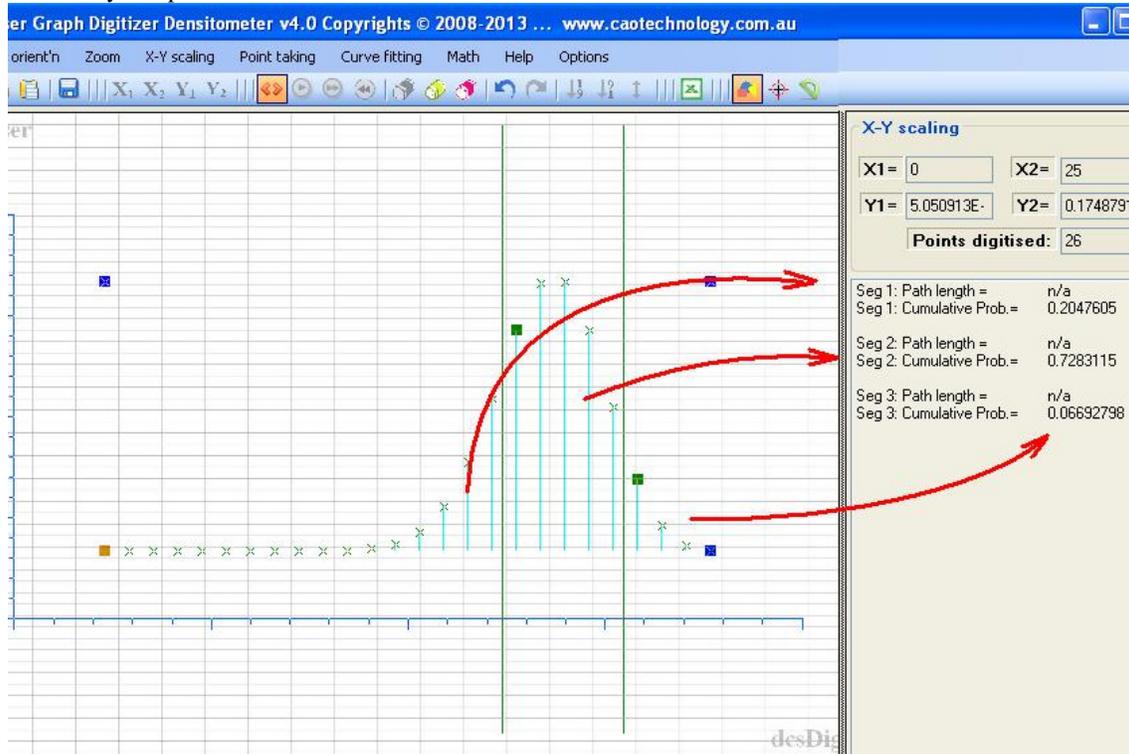
The screenshot shows the 'Unit Conversion Calculator' window with the following sections:

- Length:** 1 inch is converted to 25.4 millimeters.
- Area:** 1 hectare is converted to 10000 square meters.
- Volume and Capacity:** 1 cup (metric) is converted to 0.158987294928 cubic meters.
- Angle:** 1 degree is converted to 57.2957795130823 radians.
- Weight and Mass:** 1 kilogram is converted to 28.349523125 ounces.
- Time:** 1 hour is converted to 3600 seconds.

Probability computation for normal distribution



Probability computation for binominal distribution



Screenshot for permutation and combination calculator

The screenshot shows the 'Permutation and Combination Calculator' window. It contains the following mathematical formulas:

The number of permutations of  $n$  objects is commonly denoted as " $n$  factorial", and written as:

$$n! = n \times (n-1) \times (n-2) \times \dots \times 2 \times 1$$

The number of partial permutations of  $k$  objects out of a total of  $n$  objects is written as:

$$\frac{n!}{(n-k)!} = n \times (n-1) \times (n-2) \times \dots \times (n-k+1)$$

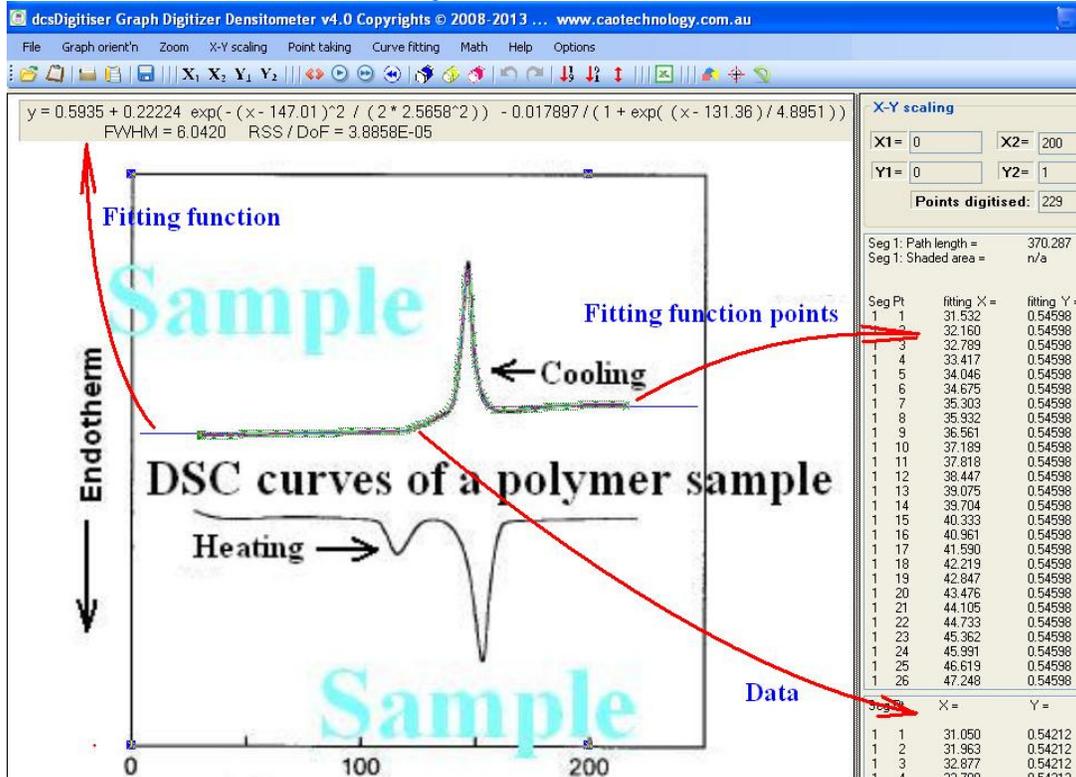
The number of combination of  $k$  objects out of a total of  $n$  objects is written as:

$$\binom{n}{k} = \frac{n!}{k! (n-k)!} = \frac{n \times (n-1) \times \dots \times (n-k+1)}{k \times (k-1) \times \dots \times 2 \times 1}$$

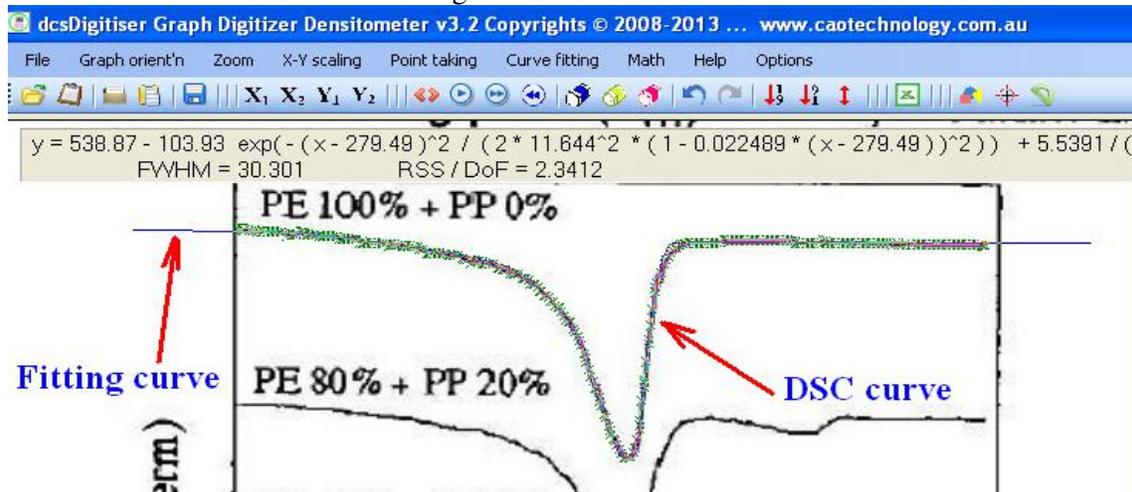
Below the formulas are input fields for  $n$  and  $k$ , and an 'Answer =' field. The calculator shows  $n=10000000$ ,  $k=635$ , and the answer  $1.20242340050367 \times 10^{65657059}$ .

## 12) Non-linear curve fitting:

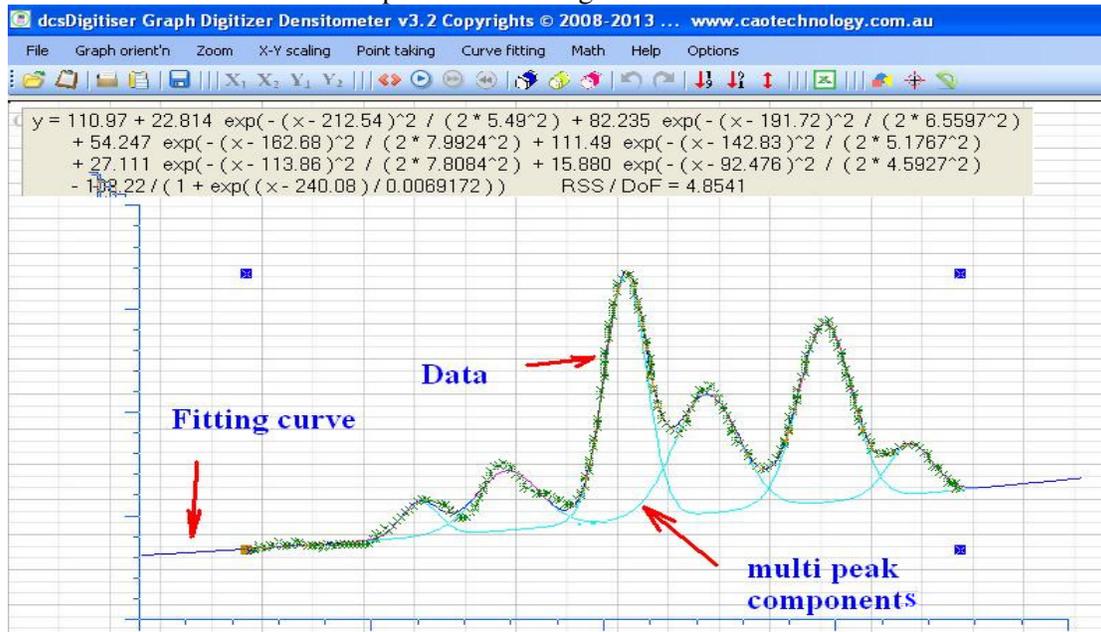
Screenshot for non-linear curve fitting



Screenshot for non-linear curve fitting



### Screenshot for non-linear multi-peak curve fitting



### **13) Further questions:**

If you have any doubt regarding the use of **dc**Digitiser, or any technical confusion requiring clarification, feel free to direct your further questions to: [info@caotechnology.com.au](mailto:info@caotechnology.com.au)