Excel in Calculus III

Plotting 3D Data in Excel

Excel has surface plot facilities that are quite easy to use with students. You can work with a function or directly with a table of data. If you have a function, you start by creating a table of data. Enter the values you prefer to use for the first variable and the second variable in a table as follows:

	A	B	C	D	E
1		y1	y2	y3	y4
2	x1				
3	x2				
4	x3				

These values can be constants that you type in one at a time, or can be generated by a formula. For example, suppose we want to plot evenly x and y values from 0 to 1 with spacing 0.1. We can create a named cell called "spacing" that holds the value 0.1, put 0 in the first x and y cells, and then use the formula `A2+spacing` in the cell A3 to generate the x values down the column and the formula `B1+spacing` in the cell C1 to generate the y values across the row.

	A	B	C	D	E
1		0	0.1	0.2	0.3
2	0				
3	0.1				
4	0.2				

Once the values of the variables are initialized, build the formula for the function in the upper left cell of the table, in this case cell B2. For example, if the function is $\sin(3x)\cos(2y)$, the formula can be composed as follows:

$$\texttt{=sin(3*\$A2)*cos(2*B\$1)}$$

Notice the careful use of relative and fixed addressing in anticipation of copying down and across. When we copy down, the x values in the first column and the y values in the first row need to be used repeatedly. Copying across would shift the letters in the address (hence $A1), and copying down would shift the numbers in the cell address (hence B$1). Note: If you have data rather than an explicit function, put the data in a table like the one generated above and continue.

Highlight all of the data including the x and y date, and create a surface plot using the chart wizard. Choosing the overhead and perspective views give:
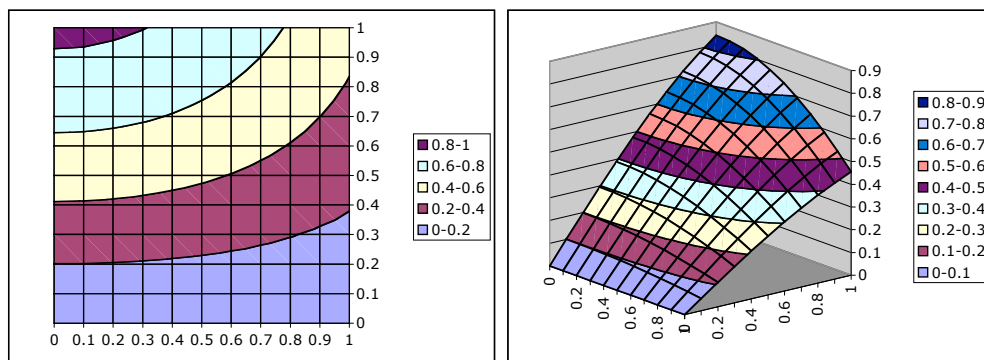
There are several options that are not obvious how to invoke:
- o To change the granularity of the plot, double clicking on the legend brings up the scale window. Changing the major and minor unit to something smaller increases the number of divisions on the vertical axis.
- o To change the view of the perspective plot, move the mouse over the corner of the plot "closest" to the front, and then click. Now you can drag the graph by this corner to change the viewpoint.
- o If the table was built as above using the "spacing" named cell, you can "zoom" in and out by changing that value.

Many models in science can be thought of as diffusion: Some source is present – a pollution emitter, electrical charge, magnet, etc. – and the goal is to see how the surrounding environment is changed by the source. One simple approach is to place the source on a grid and assume that the surrounding grid points are affected in a continuous way.

To model this in Excel, start by building a boundary, and set the boundary to the desired level, for example 0.

	A	B	C	D	E	F	G	H	I
1	0	0	0	0	0	0	0	0	0
2	0								0
3	0								0
4	0								0
5	0								0
6	0								0
7	0								0
8	0								0
9	0	0	0	0	0	0	0	0	0

Then we are going to build a formula approximating the second derivative with a centered difference that averages the values in each of the N,S,E,W neighbor cells. In cell B2, type:

```
=AVERAGE(B1,B3,A2,C2)
```

What happens? Excel complains about the circular reference. How do we fix this? We need to change the calculation settings to iterative in the preferences/options windows (depending on your version of Excel). A panel similar to the one shown to the right will appear. Set the calculation to manual and turn on iterations, setting the maximums if desired. Be sure to note what the key sequence is for calculation (in this version command and =).
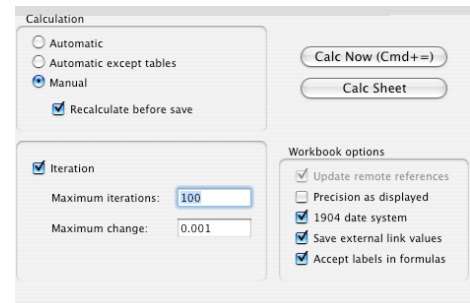
Now Excel will allow the pasting. Next choose a location for the point source, say C3, and set it equal to 20 and hit enter.

	A	B	C	D	E	F	G	H	I
1	0	0	0	0	0	0	0	0	0
2	0	3.53	7.05	4.69	2.71	1.51	0.81	0.35	0
3	0	7.05	20.00	8.99	4.63	2.54	1.36	0.60	0
4	0	4.69	8.99	6.64	4.29	2.64	1.51	0.69	0
5	0	2.71	4.63	4.29	3.25	2.22	1.35	0.64	0
6	0	1.51	2.54	2.64	2.22	1.63	1.05	0.51	0
7	0	0.81	1.36	1.51	1.35	1.05	0.70	0.34	0
8	0	0.35	0.60	0.69	0.64	0.51	0.34	0.17	0
9	0	0	0	0	0	0	0	0	0

A surface plot from these data gives the graph below. Notice the location of the source. If desired, you can put a row above the table and a column to the left of the table for *x,y* values for the axes.