

## Course Notes For Math 2066

### Using DFIELD to plot direction fields and solution curves

DFIELD is a Java applet that can plot direction fields and solution curves for a first-order DE of the form  $y' = f(x, y)$  where  $y' = dy/dx$ . In DFIELD solution curves are called orbits.

**STEP 1** Go to web site <http://math.rice.edu/~dfield/dfpp.html>. Click on the DFIELD 2005.10 button to run the applet. Close the copyright text window (click "OK") and you should have the windows

DFIELD Equation	For entering the DE and the range of variables
DFIELD Direction Field	For displaying the direction field and solution curves (orbits)

**STEP 2** Now enter the data defining the DE in the "DFIELD Equation Window". As an example we will use the DE  $y' = 0.2xy$  with the initial condition  $y(0) = 1$ . Enter the data as follows

- The independent variable should be set to  $x$
- The left hand side of the DE should be set to  $y$  (Note that the prime is automatically shown and should not be entered).
- The right hand side of the DE can be entered as  $0.2 * x * y$ .
- Set values for the plot size:

Minimum  $x = -4$   
 Maximum  $x = 4$   
 Minimum  $y = -4$   
 Maximum  $y = 4$

Now click the "Graph Phase Plane" button and the direction field appears in the "Direction Field Window". It can be printed by choosing "Print" from the "Direction Field Window" File menu.

**STEP 3** To plot the single solution satisfying  $y(0) = 1$ :

- From the "Options" menu select "Orbit Direction" and select "Forward"
- From the "Solution" menu select "Keyboard input of initial value"
- From the window that appears use 0 for  $x$  and 1 for  $y$ .
- Click the "Solve" button and the solution curve appears on the direction field.
- Try choosing the initial value  $y(0) = 2$  and draw another solution curve.

**STEP 4** Each time you click on the direction field a solution curve is drawn beginning at the point clicked as initial value. Try it.

**STEP 5** To remove a single orbit select "Delete Orbit" from the "Edit" menu then click the orbit to be removed.

To remove all orbits select "Delete All Orbits" from the "Edit" menu.

**STEP 6** To fill the direction field with orbits

- First select "Delete All Orbits" from the "Edit" menu.
- From the "Options" menu select "Orbit Direction" and select "Both".
- Now begin clicking the direction field many times to fill it with orbits. Now each time you click the direction field a backward and forward orbit is drawn.

**STEP 7** Try plotting direction fields and solution curves for the DE  $y' = \sin(x + y)$ .

**STEP 8** Try plotting direction fields and solution curves for the DE

$$\frac{dP}{dt} = P(a - bP)$$

for parameter values  $a = 2$  and  $b = 1$  (now the independent variable is time  $t$ ).

Try the initial conditions  $P(0) = 3$ ,  $P(0) = 1$ , and  $P(0) = -1$ .

**WARNING** To exit DFIELD use the "Quit" item on the "File" menu. If you click the "X" to close the window your browser may take a while to close the windows.