Math 30650
Spring, 2009

USING MATLAB TO PLOT TRAJECTORIES

There is a MATLAB program, pplane, written by John Polking at Rice University, to do plots of trajectories of an autonomous system of 2 ODE. (Autonomous means that the equations are of the form $x' = F(x, y),\ y' = G(x, y)$, so the independent variable t doesn't appear explicitly in the equation.) Download **pplane8** (the most recent version) from http://math.rice.edu/∼dfield/ and make sure it is in your MATLAB path.

Once MATLAB has started and you have the MATLAB prompt >>, give the command **pplane8** (in MATLAB). (The name pplane stands for phase plane for MATLAB.) This program is very easy to use and self explanatory. However, in case you want it, here's some documentation.

A **PPLANE8 Setup** window will pop up. In the **differential equations** box it has a sample system. In the **display window** box it has sample range for the dependent variables. Replace the sample system and range with the ones you want. If there are parameters in the equations, give their values in the **parameters** box. (The first time you use pplane, you might want to try the sample.) In the **direction field** window you can choose whether you want arrows (the default), line segments, nullclines (which we won't use) or none, and also how many you want per row and column. Click on the **Gallery** button in the upper left to get a list of systems **pplane8** knows. The **linear system** is particularly useful; it gives you a general constant coefficient linear system, with the coefficients as parameters. You enter the values you want for the coefficients in the **parameters** box.

Then click on the **proceed** button. A **PPLANE8 Display** window will pop up, and, assuming you did not change the arrows setting in the PPLANE8 Setup box, the direction field will be drawn. (At a point (x_0, y_0) the direction field will point in the direction $(F(x_0, y_0), G(x_0, y_0))$. It is tangent to the trajectory through (x_0, y_0).)

To get a plot of the trajectory through a given point, click at the point. Some information about the trajectory might appear in a box below the plot.

Under **Solutions** there is a menu which includes various options. Here is a description of some of the options. An equilibrium point is a point which is a trajectory. To find equilibrium points, use **Find an equilibrium**, then click near where there is an equilibrium point. A little circle will appear at the point on the plot and a **PPLANE8 equilibrium point data** window will appear with information about the point. It also allows you to display the linearization. To find trajectories which tend to a saddle point as $t \to \infty$ or as $t \to -\infty$, use the **Plot stable and unstable orbits** option, then click on the saddle point. The **Keyboard input** option can be used to enter the coordinates of a point for the start of a trajectory, rather than using the mouse to choose the start. The **List computed equilibrium points** option gives a list of the equilibrium points and their types in the MATLAB command window.

One option under the **Insert** menu is the **TextBox** which you can use to type text on the plot. Another is **Title**.

Under **Graph** there are options for plotting components of trajectories, so, for example, x **vs** t plots $(t, x(t))$. There is also a **3D** option, for plotting $(t, x(t), y(t))$.

Use the **Print** button to send a copy of your plot to the printer.

If you want to print several plots on one sheet of paper, download **multigraf** from http://math.rice.edu/∼dfield/. Give the command **multigraf** at the matlab prompt. This will get you a window into which you can insert several (up to six) plots produced by pplane8. If clicking "Insert a PPLANE graph here" doesn't work, click "Insert a MATLAB graph here." You can also add text to the plots in this window. Be sure to click on **Finish** before you print the graphs.