Dfield/Pplane
User Manual

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Math 19
Fall 2004

Introduction

Dfield & pplane are programs designed for phase plane analysis of differential equations. Dfield is used on first order differential equations of the form $x' = f(t,x)$, while pplane is used for a system of differential equations of the form $x' = f(x,y)$, $y' = g(x,y)$. As pplane includes all functions available in dfield, a discussion of pplane will be sufficient.

Getting Started

Free Java version is available at http://math.rice.edu/~dfield/dfpp.html

Browser Specifications

Java 1.1.6 enabled

•PCs: Netscape 6 works best, but IE works too (you do need to configure for printing)

•Macs: only works on Mozilla

When the program first starts, it opens 4 windows: PPLANE Equation Window, PPLANE Messages, PPLANE Phase Plane, and a PPLANE copyright window. Click **OK** to continue.

•PPLANE Equation Window: here you enter in your equations, specify parameters and set window size for your graph

•PPLANE Messages: displays coordinates, possible solutions, eigenvalues, etc. when you calculate orbits or equilibrium points

•PPLANE Phase Plane: the actual graph. You can graph nullclines, trajectories (aka orbits), x(t) vs t, find equilibrium points, etc.

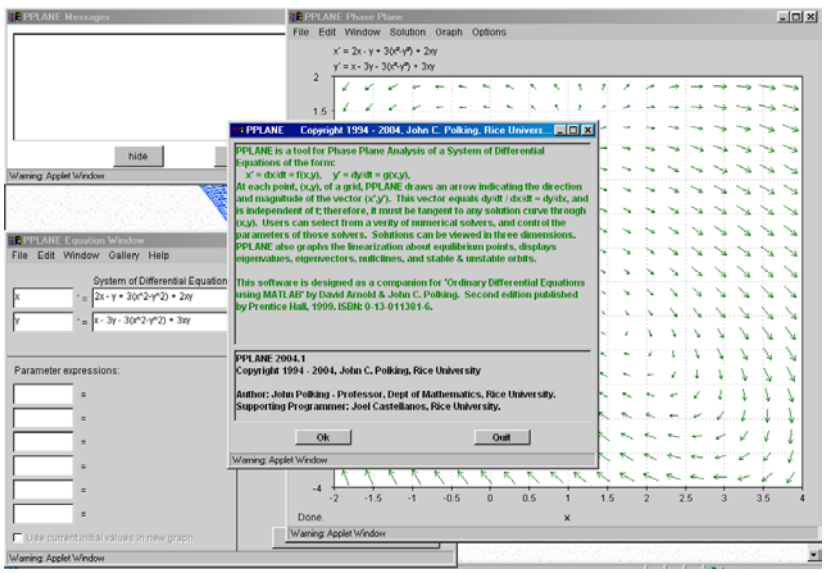


Fig. 1: windows at the start of pplane

Graphing Systems of Differential Equations

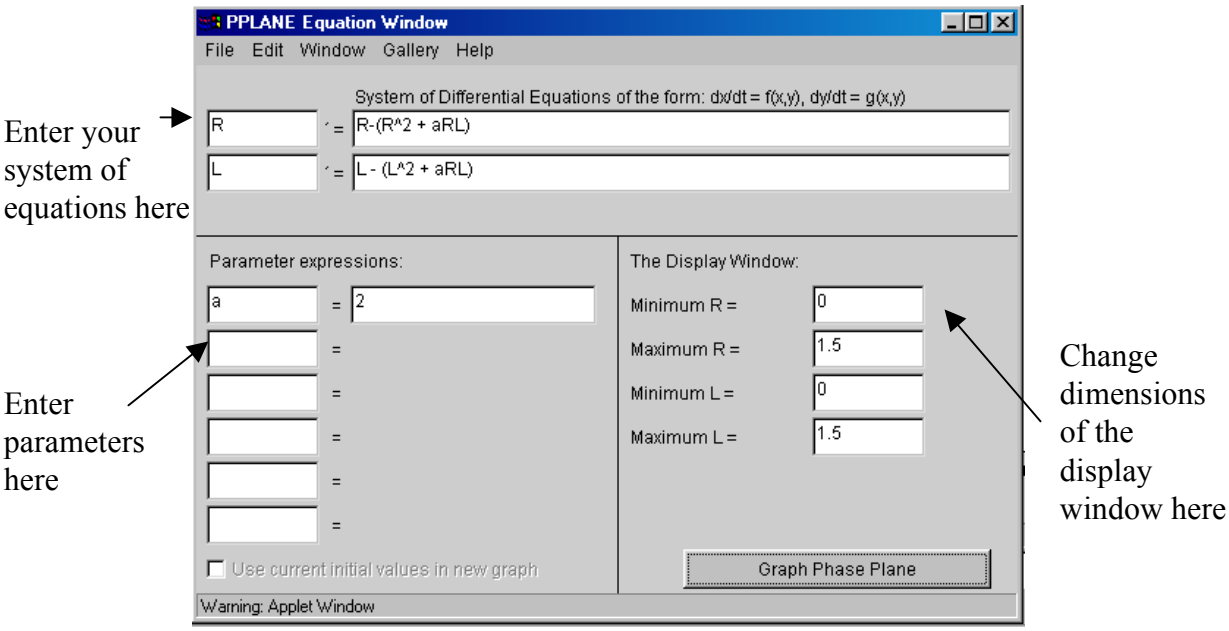


Fig. 2: the PPLANE Equation Window showing how to graph a system of differential equations.

Entering in the Equations

Type in your equations at the top part of the PPLANE Equation Window. You can use whatever variables you want; there's no need to stick to x & y. You'll get red error messages as you're typing in the equation—ignore them.

Defining Parameters

You may have constants in your equations (e.g. a for the system of equations describing populations of right-handed & left-handed snails). Be sure to define them in the "Parameter Expressions" section of the PPLANE Equation Window. This is useful because you can easily study several different systems (e.g. snail populations for different a values).

Changing the Display Window

In the "Display Window" section of the PPLANE Equation Window, you can define the range of x & y values you want to graph. It's pretty self-explanatory.

Graphing

Finally, click **Graph Phase Plane** to graph your system.

Graphing Trajectories/Orbits

Note: Everything from now on refers to the PPLANE Phase Plane window unless specified otherwise.

Changing the Slope Field

From the **Options** menu, select **Direction Field Settings** to change the number of rows and columns, the way the field is displayed and computation settings

Graphing solution curves (trajectories/orbits)

Click on the point from which you want a trajectory. The PPLANE Messages window will display the point you clicked on and any possible equilibrium points or solutions nearby.

Erasing Orbits

Go to **Edit** and select **Delete Orbit** or **Delete All Orbits**

Changing directions

To specify whether you want to graph the orbit in the forward (t>0), backward (t<0), or both directions, go to **Options** then **Solution Direction** to choose.

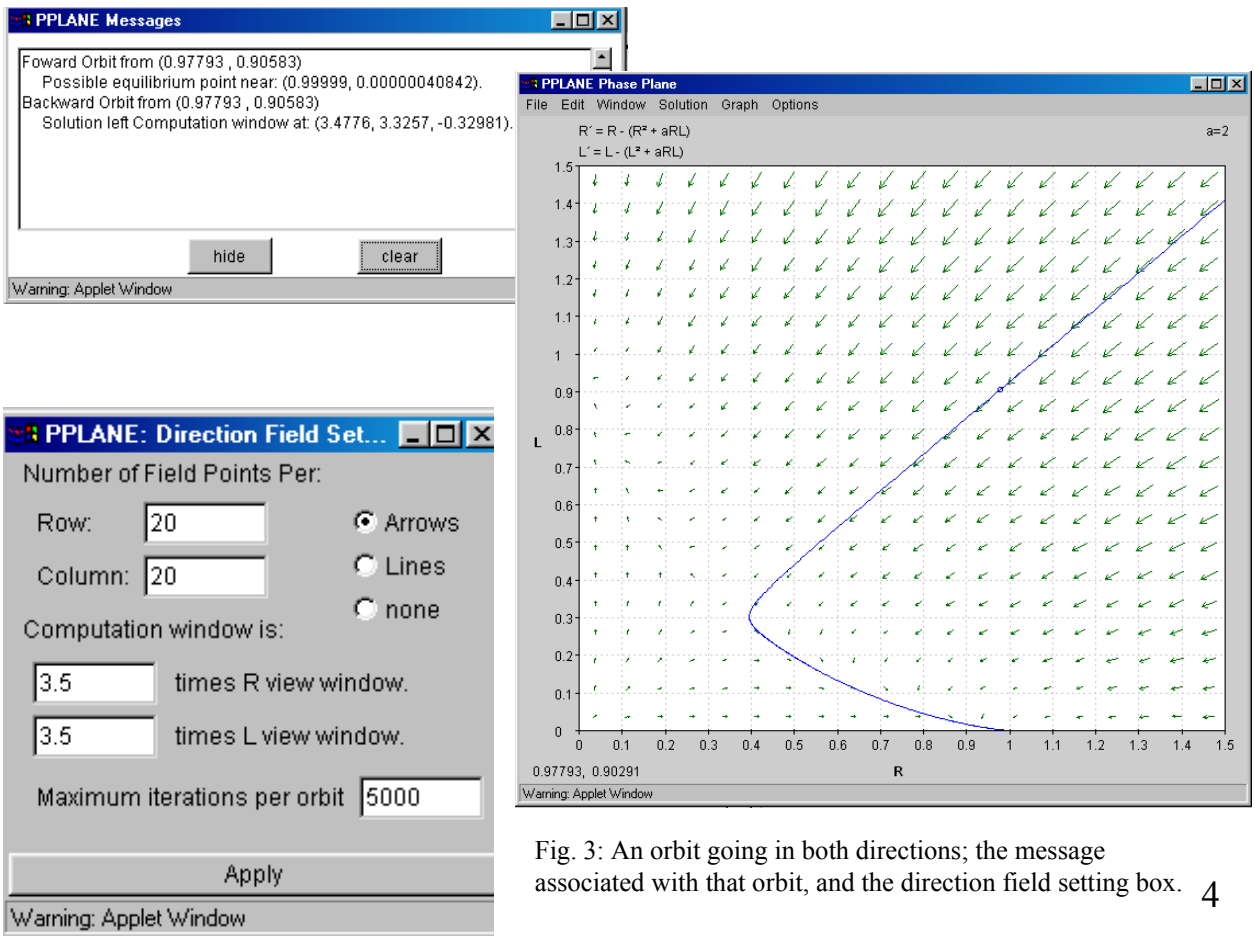


Fig. 3: An orbit going in both directions; the message associated with that orbit, and the direction field setting box.

Changing time delay

You can make the orbit move slower so you can watch its motion. Go to **Options** and click on the desired speed at **Delay Time per Point.**

Inputting the initial value

To manually choose the starting point for a solution curve, go to the **Solution** menu and click on **Keyboard Input of Initial Value**. Enter in the initial value and then click **Solve**.

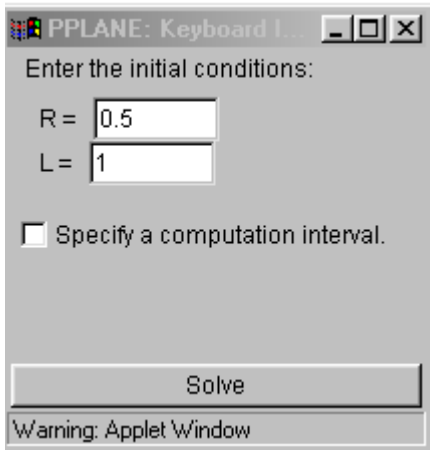
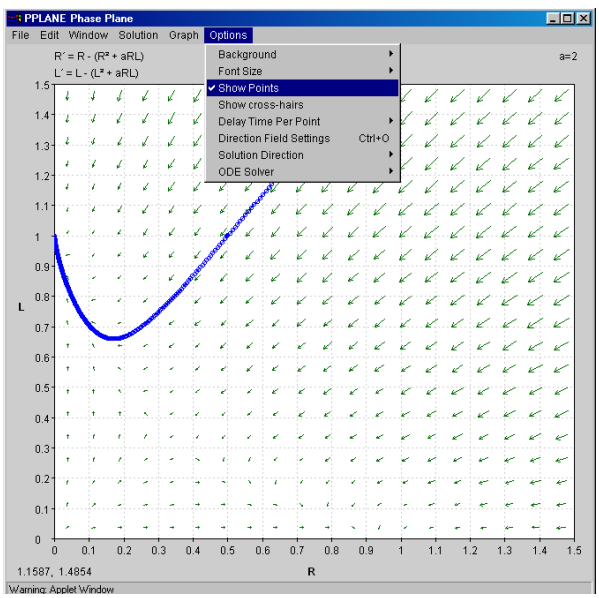


Fig. 4: Initial value input box.

Other options

- Points
  - From the **Options** menu, click on **Show Points** to show each point on an orbit.
- Cross hairs
  - To make it easier to see the coordinates of your mouse (as you move it around the graph), click on **Show cross-hairs** in the **Options** menu.
- Zoom
  - To zoom in, go to **Edit** and pick the zoom you want.



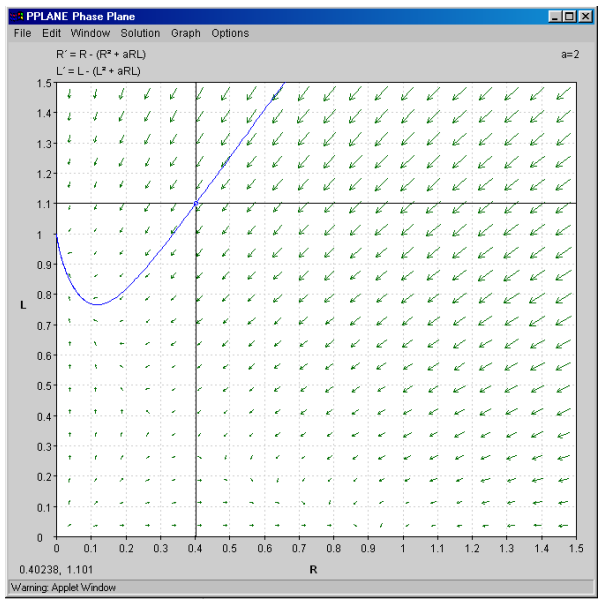


Fig. 5: (left) Options menu & orbit with points shown. (right): Crosshairs give the location of the mouse.

Analyzing Stability

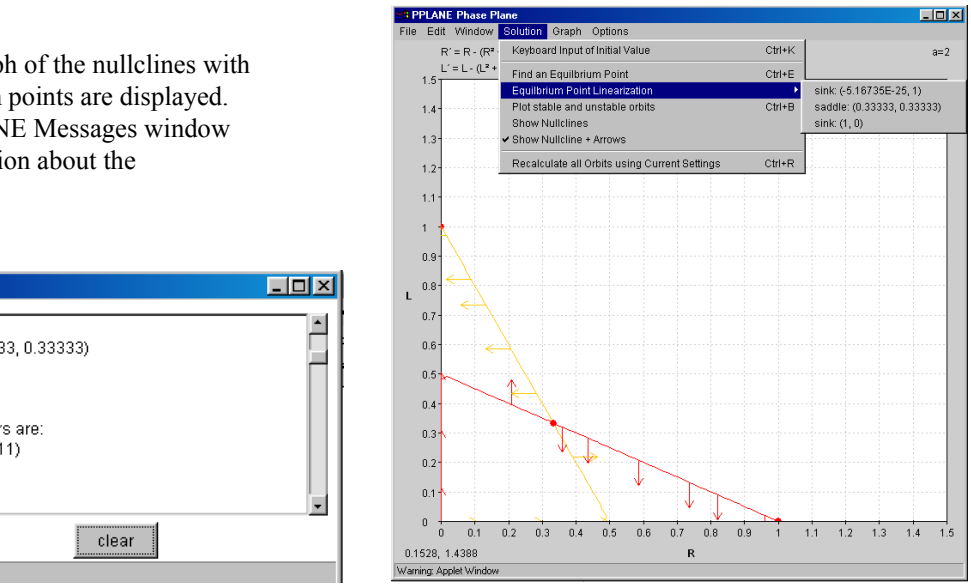
Graphing nullclines

From the **Solutions** menu, click **Show Nullclines** for just the nullclines or **Show Nullclings + Arrows** for the arrows as well.

Finding equilibrium points

You can find equilibrium points by selecting **Find an Equilibrium Point** from the **Solutions** menu and clicking at a point on the graph. The coordinates of the point, the Jacobian, eigenvalues and eigenvectors for the point are displayed in the PPLANE Messages window. An easy way to view the equilibrium points is to click on **Equilibrium Point Linearization** in the **Solutions** menu.

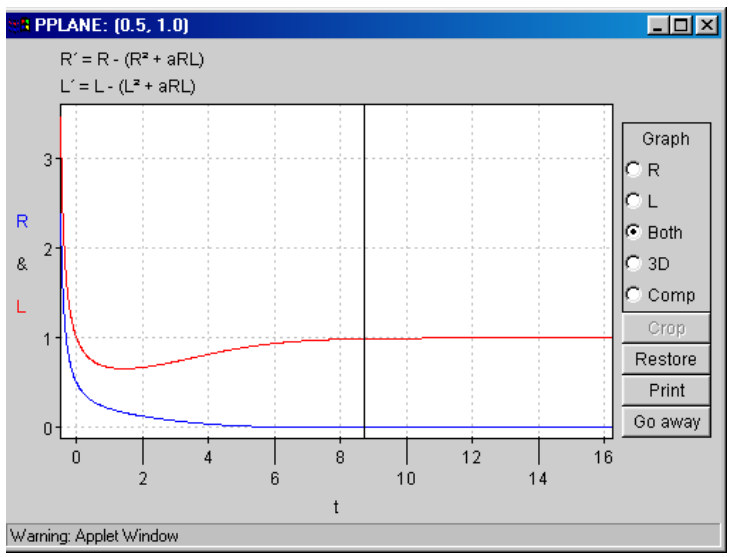
Fig. 6: (right) a graph of the nullclines with arrows. Equilibrium points are displayed. (bottom) the PPLANE Messages window displaying information about the equilibrium point.



Graphing x vs t

From the **Graph** menu, select **x vs. t** or whatever option you want. Then click on the desired solution curve, and a window with the graph should pop up. The vertical lines made by clicking on the graph can be erased by clicking **Restore**.

Fig. 7: a graph of x vs. t and y vs. t



Other Stuff

Printing

Click **File** and then **Print**. Note that IE users may need configuration before printing:

•From the Tools menu choose "Internet Options".

•Click the button labeled "Security".

•Near the bottom, click the button labeled "Custom Level ...".

•Click the button labeled "Java Custom Settings" on the bottom left of the screen.

•Click the tab labeled "Edit Permissions".

•In the menu look for "Unsigned Content --> Run Unsigned Content --> Additional Unsigned Permissions --> Printing". Under this heading, click "Enable.".

•Exit out of all of the windows, making sure that your new option is activated.

•Restart your computer.

Templates of Common Differential Equation Systems

In the PPLANE Equations Window, the **Gallery** menu contains many common systems of differential equations such as the predator-prey system. You can even save other systems (e.g. the right-handed & left-handed snails model) in the gallery.

That's all Folks

That pretty much covers the basics of pplane that you'll need. The best way to learn pplane is just to play around with it. You'll find that it's pretty simple.

If you have any other questions, don't hesitate to ask me, Ana or Prof. Judson for help.

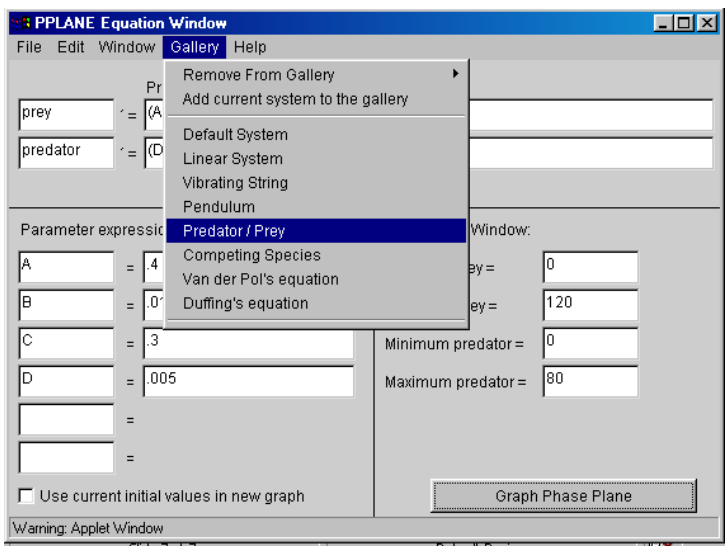


Fig. 8: the gallery menu