DYNAMIC APPLETS FOR DIFFERENTIAL EQUATIONS AND DYNAMICAL SYSTEMS (CREATE YOUR OWN EASILY!)

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Background

- Non java applets (still available at my website). Run as stand-alone programs.
- Collaboration with students (Victor Sklutovsky, Tim Andrews, Andrew August) to create java applets – can imbed in web page, add text, project instructions.
- Go to uhaweb.hartford.edu/rdecker /javaMathlets.html for instructions on creating your own applets and running already created ones

Purpose of applets (mathlets)

- Get students to make connections, discover new properties, see solutions from different points of view (must be dynamic/interactive).
- Can be used as tool for doing homework.
- Demonstrate during lecture.
- Provide method to deliver projects (text and applets together).

Capabilities of applets

- Plot more than one coordinate system at a time (make connections, multiple representations)
- Plot functions, parametric functions, first order differential equations, differential equations systems, iterate maps and systems of maps, iterated function systems, bifurcation diagrams for iterated maps (and more) together.
- Interactive initial conditions for differential equations.
- Parameters and sliders (can be animated).

Creation of new applets

- Eclipse (makes debugging easier), but could use any text editor.
- Make changes in one file.
- Specify functions (differential equations, etc.), coordinate systems, parameters, and which functions are plotted on which coordinate systems (and how).
- Create .htm file.
- Enhance .htm file with text, graphics, etc.
- Post to website.

Your first applet

- Create an applet that shows that the derivative of a function has zeros at the same x-values for which the original function has a max or min.
- Use at least one parameter in the original function so that you can demonstrate that the relationship is independent of the parameter value.
- Add some text, giving the user of the applet some information about what they are seeing.
- See my applet f.htm on my website. How did I create the vertical lines?

Case study: A highly damped pendulum (applet Pendulum)

- An equation for a damped pendulum is $x'' + cx' + k\sin(x) = 0$ It can be rewritten in system form as $x' = y,\ y' = -cy - k\sin(x)$
- Investigate this equation for various values of the damping constant c . You may set the constant k=1.
- Explain your phase portraits in terms of the pendulum.
- What do you see when c gets large? Drag your initial condition around to see what is happening.

Case study: Euler versus Rk2 versus Rk4 (applet EulerRk2)

- Investigate $\frac{dy}{dx} = ay(1-y)$ using Euler, Rk2, and Rk4
- Fix the step size at 1 (too large practically speaking)
- Increase the parameter a continuously and observe/explain what is happening
- Results obtained by one of my students (using computer algebra after making conjectures based on the graphs)

Case study: Gone fishing (applet LogisticDE)

- Investigate $\frac{dy}{dx} = 0.5y(1-y) - d$ which can be used to model the number of fish in a lake with initial population growth rate *a* and fishing rate *d*.
- Explain what is happening for *d*=0 using many well-chosen solution curves.
- Increase the parameter *d* continuously and observe/explain what is happening
- Find the *d* value beyond which no fish can survive in the long term (called the bifurcation value). Explain how you came up with your answer.

THANKS!
(GO GET SOME JAVA)

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