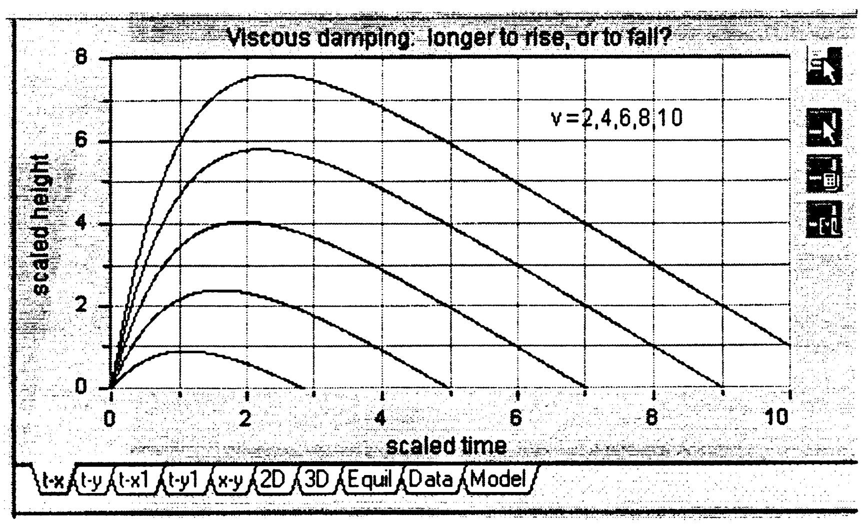
Modeling and Visualization

with

ODE Architect

An Example Set



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ODE Architect was designed and implemented by CODEE (a consortium of 15 mathematics faculty members at eight colleges and universities) and Intellipro Inc. (an educational software company) with support from the publisher John Wiley and Sons, Inc. and the National Science Foundation. The material in these notes is solely the responsibility of the authors, however, and not the responsibility of any of the four organizations mentioned above.

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For more information about ODE Architect visit the web site

http://www.intellipro-inc.com

Preface

The examples in this collection illustrate some of the features of ODE Architect. These units are independent of one another and for convenience are divided into three groups: elementary, intermediate, and advanced. Each unit includes several screen shots from ODE Architect. These shots illustrate how to supply data to the Architect solver tool which result in the pictured graphs.

The units can be used in several ways:

- As a learning tool for exploring the features of ODE Architect
- To construct a model appropriate for computer simulation by ODE Architect
- For student projects in a variety of courses
- For lectures or talks.

There are many other accessible examples and models within the ODE Architect package itself. The ODE Library in the tool contains over one hundred briefly described, illustrated, and editable examples appropriate for differential equations courses. See the Appendix in the User's Guide for a list of the library entries. The User's Guide gives detailed instructions on how to use the various features of the solver tool.

We want to especially thank Professor Michael Moody and our student Nathan Jakubiak for their help in preparing some material for these notes.

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Advanced

Van der Pol

A nonlinear model with a limit cycle. Effect of parameter on shape and period of the limit cycle, and animation of Hopf bifurcation. ODE Architect automatically calculates the eigenvalues of the linearized system.

Lorenz

ODE Architect finds equilibrium points and eigenvalues of the linearized Lorenz system and graphically illustrates how parameter changes affect stability. 3-D graphs of chaotic wandering, period doubling sequences.

Battle of the Bulge

Actual combat data from the battle is used to determine the coefficients for a combat model. The modeling linear system is solved by ODE Architect and the results are compared with the actual data.

Autocatalator

Interacting chemical species in an autocatalytic reaction lead to a nonlinear system which exhibits peculiar oscillatory behavior. ODE Architect shows how changing the rate constants can be used to turn the oscillations on and off.

Satiable Predation

Predator-prey model where the predator's appetite satiates. A sensitivity study shows a Hopf bifurcation followed by a reverse Hopf bifurcation. Illustrated via animation.

Rotational Stability

Examines the stability of steady rotations of a rigid body (like a book or tennis racket) when tossed in the air. 3-D graphics clearly shows which steady rotations are stable and which are unstable.

Fitzhugh-Nagumo (written by Michael E. Moody)

Uses ODE Architect to show how a planar system of ODEs representing a neuron responds to a stimulus.