Review of MDEP

David R. Canright

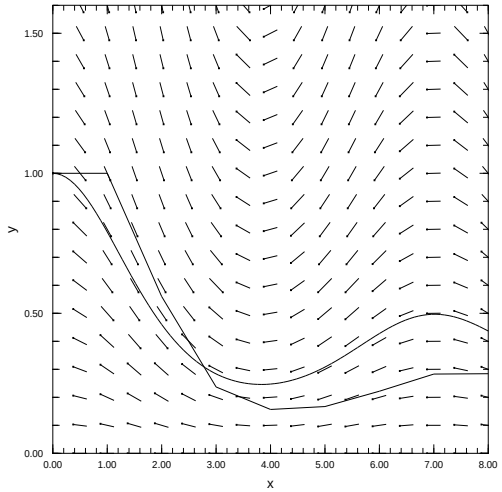
I know a bargain when I see one. And when I see a well-designed DOS program that can plot virtually any function of one variable, can solve ODE's or systems thereof by a choice of numerical methods, can show phase-plane trajectories and direction fields, and is user-friendly to boot, all for FREE (if you provide one floppy), now that's a bargain. The program is called **MDEP** (for "Midshipman Differential Equations Program"), and has been developed by Jim Buchanan of the U.S. Naval Academy as a visualization and calculational tool for teaching ODE's. And as a governmental product, it is public property, freeware, can be shared and given out to students without licensing restrictions. While that is a great advantage in itself, the real value of the program is in its combination of a wide range of capabilities with real ease of use.

The interface consists of two screens: one in text mode, primarily for defining functions and ODE's, setting parameters, naming variables, etc.; the graphics screen allows plotting functions and numerical solutions, changing parameters and replotting, and printing plots. Both screens use menus and include informative help.

The user can define up to eight functions, where each could be an explicit function of up to 4 variables, a parametric system (a 2D, 3D, or 4D vector function of one variable), an implicit function defined by an expression in two variables, an ODE (to fourth order), a system of first-order ODE's, or a 1D or 2D table of data read from a file. The functions and their variables can be given any names (as can eight definable parameters), and their definitions can refer to the other functions, as well as to the many built-in standard mathematical functions (including Bessel, Heaviside step, and numerical integrals). Functions can be defined as finite series, where the general term is given either explicitly or by a recurrence relation (for power series). Four different numerical methods are provided for solving ODE's (initial value problems only): Euler, Runge-Kutta fourth-order, Runge-Kutta-Fehlberg 4/5 (adaptive), and Adams-Bashforth-Moulton fourth-order (multi-step).

The heart of the program is a versatile plotter. Onscreen, different user-defined functions are plotted in different colors in a fixed-size box with adjustable limits in the x and y directions; axes and ticks are supplied automatically, and text labels can be added anywhere. Besides plotting any previously defined user functions of one variable, systems can be plotted versus the independent vari-

Sample MDEP Output:



An Illustration of the hazards of Eulers Method, showing how it extrapolates using the local direction field

able or versus one another in the phase plane, and for ODE's one can graph direction fields and automatically generate a set of trajectories through evenly spaced points in the phase plane (see figure). From the graphics screen one can change parameters, initial conditions, etc, and plot the new solution to compare with the old. Epson, Okidata, H-P LaserJet, and PostScript printers are supported, as well as PostScript file output.

All this adds up to a lot of power. Though **MDEP** was designed for ODE's, I have used it in teaching PDE's too, for plotting series solutions and solutions by characteristics, and hunting for eigenvalues. Now if it only had mouse support!

To get a copy of the program, send a request with a formatted floppy disk to:

J. L. Buchanan, Mathematics Department 9E, United States Naval Academy, Annapolis, Maryland 21402-5002; phone (301) 267-3892

*Also available is a calculus-level plotting/demonstration program called **MPP** (and a 3D version), by Howard Penn; call for more information.* ❑

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A Note From the Editors

Our goal is to share the rapidly growing wealth of computational instruction techniques with as many teachers of differential equations as is possible. Several texts and software packages show just what can be done in this area. In this and future issues of **C•ODE•E** you will find techniques and ideas, but there are also a few books that anyone investigating the field should be aware of. Authors of much of the recent work owe a debt of gratitude to the efforts of two pioneers in the area of computer experiments, computer graphics and ODEs: J.M.A. Danby (**Computing Applications to Differential Equations**; Reston, VA: Reston Publishing Co., 1985), and Huseyin Kocak (**Differential and Difference Equations through Computer Experiments**, 2nd ed.; New York: Springer-Verlag, 1989). Many of the other excellent works extant will be cited in future issues.