RKBS.8XP

by thornahawk

Introduction:

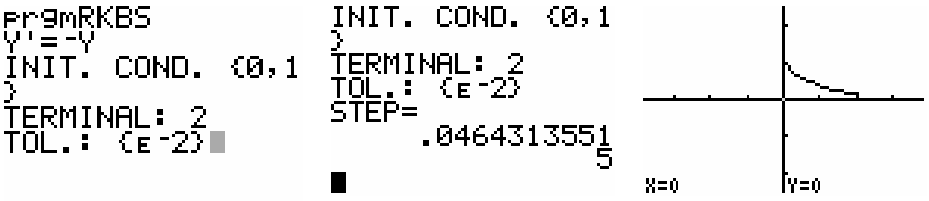
This TI 83+ program is an adaptation of the algorithm used by the TI 85, TI 86 and TI 89 calculators for graphing solutions to differential equations. The underlying algorithm is an adaptive third-order Runge-Kutta algorithm using coefficients due to Bogacki and Shampine (see (1)). The Butcher table for this method is:

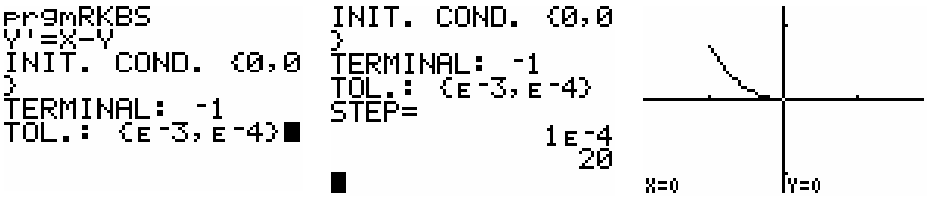
c_i	a_{ij}			
$\frac{1}{2}$	$\frac{1}{2}$			
$\frac{3}{4}$	0	$\frac{3}{4}$		
1	$\frac{2}{9}$	$\frac{1}{3}$	$\frac{4}{9}$	
b_i	$\frac{2}{9}$	$\frac{1}{3}$	$\frac{4}{9}$	0
$\hat{b}_i$	$\frac{7}{24}$	$\frac{1}{4}$	$\frac{1}{3}$	$\frac{1}{8}$

The program also makes use of suggestions regarding step control and initial step guess from (2) and (3).

How To Use:

The program works by prompting. See screenshots.





The program prompts for the expression for the differential equation (independent variable X, dependent variable Y), the initial conditions (input as a list, $\{x_{initial}, y_{initial}\}$), the terminal point (can be greater or less than $x_{initial}$), and a tolerance (input either a list with a single number to specify the relative tolerance, or two numbers for the relative and absolute tolerances). Allow the program to run (**this can take a long time!**), and the program will terminate showing how

many steps (accepted and rejected) were taken. The output points are stored in lists ʟXS and ʟYS. To view the solution curve, plot the lists as a Scatter (") or xyLine (Ó) statistical plot in the STAT PLOT menu.

Suggestions and Known Issues:

–Being a relatively low order method, specify tolerances that are not exceedingly small. Around .01 to 10^{-6} should be fine.

–The program saves all points accepted by the algorithm. This can be taxing to calculator memory. Ensure that ample memory is available before running this program. (This may be fixed in a later version)

–Simultaneous differential equations are not (yet) supported.

–This program, like all Runge-Kutta programs, is unsuitable for so-called “stiff” equations. If the program takes too long to run (e.g. 10 minutes), the equation is probably stiff (or the integration interval is too long). The program can also fail if the solution curve has singularities, which may be flagged with the appearance of a “STEP TOO SMALL” error message.

References:

1. P. Bogacki and L. F. Shampine, "A 3(2) pair of Runge-Kutta formulas". Appl. Math. Letters, **2**, 1989, 1-9.

2. I. Gladwell, L. F. Shampine and R. W. Brankin, "Automatic selection of the initial step size for an ODE solver". J. Comp. Appl. Math. **18**, 1987, 175-192.

3. E. Hairer, S. P. Nørsett and G. Wanner, *Solving Ordinary Differential Equations I, Nonstiff Problems*, Springer-Verlag, Berlin, 2nd ed., 1993.

I hope this program can be very useful. Please send suggestions, comments, and criticism to thornahawk@yahoo.com.