Assignment #11

Due Monday 6 December, 2021 at 5 pm.

Submit by email: `elbueler@alaska.edu`

Exercise 6.3.5. Do part (a) only. Make a note of how many time steps were used by `ode45()`. The "final state" is the final value of $x(t), y(t)$.

Exercise 6.4.1. Do part (b) only. This by-hand problem asks only for the first time step. Use a calculator etc. for any arithmetic.

Exercise 6.4.7. Do parts (b) and (d) only. Note the performance will be *much* better than from the Euler method in Exercise 6.3.3.

P14. (a) Assume we are numerically solving some differential equation $u'(t) = f(t, u(t))$. Describe in your own words, and in one or two sentences, the difference between $u(t_i)$ and u_i.

(b) Describe in your own words, and in one or two sentences using appropriate notation, the meaning of *local truncation error* for a numerical method.

(c) In your own words, and one or two sentences, explain why the local truncation error does not by itself bound the error at the end of a run, i.e. $|u(t_n) - u_n|$.

P15. (a) Solve the problem in Exercise 6.3.3 (b) using Function 6.5.1, the textbook's adaptive `rk23()` method. (*Exercise 6.3.3 (b) was done on Assignment 10. Feel free to use my solution.*) In Function 6.5.1 use `tol` $= 10^{-2}, 10^{-4}, 10^{-6}$, and note both the maximum error in y and the number of time steps.

(b) Make a table comparing 6 runs: Exercise 6.3.3 (b), the three runs in part **(a)**, and the same problem solved with `ode23()` and then `ode45()`. In fact, fill in this table:

method	maximum error in y	number of time steps
`eulersys()` with $n = 100$		
`rk23()` with `tol` $= 10^{-2}$		
`rk23()` with `tol` $= 10^{-4}$		
`rk23()` with `tol` $= 10^{-6}$		
`ode23()` (default settings)		
`ode45()` (default settings)		

(c) What *are* the default tolerance settings for `ode23()` and `ode45()`? How do you set them to different values? (*Explain in at most 3 sentences. You will need to either read `help ode45` or go online to answer this part.*)