

# Math 2280 - Maple Project 1

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This project will introduce us to Maple, and how we can use Maple and Maple programming to help us solve differential equations. The goal of this project is to introduce you to Maple programming, and to give you some experience of Maple programming by writing Maple programs that implement the various numerical methods we learned for solving first-order ODEs at the end of chapter 2.

## 1 Maple Programming

We won't be going in depth (at all) in this project or in this class on how to program in Maple. That's a subject for another class, and frankly a subject that your instructor would be unqualified to teach. We're just going to learn the minimum you'll need to know to start writing and hacking around with your own programs to do differential equations.

The first thing you'll want to do is open up Maple on one of the computers in the math department. Then, you'll want to open up a new document in *worksheet* mode. It's very important that for programming we're in worksheet mode. Next, you'll want to go to the edit menu, and make sure you're in text mode. So, if the edit menu says "switch to math mode F5", then you're good. If the edit menu says "switch to text mode F5", then you're going to want to click on that option to switch to text mode.

When this is done, enter in the following program:

```

EulersMethod := proc(x0,y0,h,n) local xk, yk, k;
xk := x0;
yk := y0;
k := 0;
while k < n do
k := k+1;
yk := yk + h*f(xk,yk);
xk := xk + h;
end do;
[xk,yk];
end;

```

This program implements Euler's Method for the function  $f$ . However, before you run it, you need to specify what this function  $f$  is. If we want to specify the function  $f(x, y) = y$ , then we'd do so by typing into Maple:

```
f := (x,y) -> y;
```

Do, this, and then run Euler's method with a step size of .5 and a number of steps 2, starting at the point  $x_0 = 0$ , and  $y_0 = 1$ . You would do this by entering:

```
EulersMethod(0,1,.5,2);
```

If you do this, you'll get the final result we derived in class. If we want to instead do this for a step size of .1, and 10 steps we would enter:

```
EulersMethod(0,1,.1,10);
```

Again, we'd get the final answer we derived in class.

## 2 Maple Project

First, read through and do all the homework problems for sections 2.4, 2.5, and 2.6, so that you know something about Euler's method, improved

Euler's method, and Runge-Kutta. Then, read through the corresponding application segments for each of these sections.

What you should do for this project is implement Euler's method, improved Euler's method, and Runge-Kutta to calculate the values of the "famous" numbers  $e$ ,  $\ln 2$ , and  $\pi$  out to three decimal points.

To calculate this for  $e$  using Euler's method you'd start with the differential equations  $f(x, y) = y$  like we had before with the initial point  $(0, 1)$ , and then use Euler's method to estimate  $y(1) = e$ . Use Euler's method with a step size of 50 steps between 0 and 1 and see what you get. Then, cut the step size in half and double the number of steps, and see what you get then. Keep doing this (recording the final values, number of steps, and all of that) until you get no change in the first three decimal places. Then, report the result that doesn't change as your value for the "famous" number. Do the same thing for  $\ln 2$  and for  $\pi$  in the manner described in the textbook.

Then, you should modify the code above so that it implements improved Euler's method, and the Runge-Kutta method, and use these methods to estimate the values of these famous numbers. For the improved Euler's method you should calculate the value to five decimal places, and for the Runge-Kutta method you should calculate the value out to *nine* decimal places. Report what you get, and how long it takes you to get there.

Please note that for the Runge-Kutta method you may find that the values of the last few decimal places don't settle down. There's a reason for this, and it's rounding error, which we discussed in class and is discussed in the textbook. If you find this happening, just make note this and explain why.

If you have any questions about this project, please let me know. The project will be due on Thursday, February 26th.