ENGR W 3 MIDTERM

PROBLEM 4: ANALYSIS

TYLER PRUITT

UNIVERSITY OF CALIFORNIA, SANTA BARBARA

August 20, 2020

Once you have gotten your code working for the provided value of dt, try increasing and decreasing the value of dt. How does changing this affect the simulation? What does this suggest to you about the forward Euler method? Write a brief response to these questions. Later in the course, we will utilize numerical solvers that avoid some of the problems that you have (hopefully!) identified with the forward Euler method.

Increasing the value of dt, decreases the run time of the program and it visually speeds up the simulation. However, increasing the value of dt also increases error because the time step size is bigger and thus our approximation that the dynamics are constant across that time interval dt become more and more unrealistic. In terms of our simulation of the three-body problem, a larger value for dt increases our error and our approximations become worse. For larger and larger values of dt, the simulations end at smaller and smaller values of the final t value. This means that a simulation with dt = 5 will simulate for a longer time (a larger final t) than a simulation with dt = 10. In contrast, decreasing the value of dt, as expected, visually slows down the simulation, decreases error, improves accuracy, and increases the final t value (meaning we get to see more dynamics of the three bodies).

This suggests to me that the forward Euler method is only a good approximation for small dt and that for smaller dt it takes more time to compute. My findings suggest to me that the forward Euler method has a fundamental trade-off: as dt decreases, the accuracy (or approximation) of the simulation increases, but the computation time increases. Thus, if we want to run our calculation quickly, we use a larger dt (say 0.05 compared to 0.0005) but it will not be that accurate/precise because we are not considering as many time intervals. However, if we want to run our calculation to be very accurate, then we use a smaller dt (say 0.000005 compared to 0.0005) but it will take a much longer time and use more computational power because we are considering many more time intervals in which to do our calculations about the dynamics. So, there is a trade-off here between accuracy/precision and computational resources (time and computational power).