Temple CST 2100 Modeling & Simulation in Science and Technology Spring 2016

Problem Set 6

(Out Thu 03/17/2016, Due Thu 03/24/2016)

Problem 6

Modify the Matlab file `temple_abm_traffic_car_following.m` from the course website `http://math.temple.edu/~seibold/teaching/2016_2100/` in the following ways:

(a) Change the initial velocities of vehicles to `v = (1:n)'`. Explain what this change represents.

(b) Now change the time step `dt` to 0.1, and the number of compute steps per plotting event `np` to 1. This way, the same time passes between plotting events, but now with only one, rather than 10, time steps. Submit (i.e., email to the course instructor and TA) your code under the filename `yourfamilyname_problem6b.m` . Running the code should produce a weird behavior. Explain what happens and why.

(c) For the previous code, change the time stepping from Euler's method to Runge-Kutta 4. Submit your code under the filename `yourfamilyname_problem6c.m` , and explain why the new time stepping fixes the problem encountered in (b).

(d) Change your code from part (c) to have `dt = 1e-2` and `np = 10` again, but keep the Runge-Kutte 4 time stepping. With this code, conduct a parameter study how the characteristics of the traffic wave depend on the strength of the optimal velocity term. Specifically, vary the coefficient (which is 0.5 in the original file) in front of the term from 0 to 2, in steps of 0.05. For each choice, obtain the maximum and minimum vehicle velocity, $u_{\max}$ and $u_{\min}$, at the final time. Using these data, plot $u_{\max}$ and $u_{\min}$ as functions of the parameter. Describe your observations and explain the result. Submit your code under the filename `yourfamilyname_problem6d.m` .

(e) [optional, 10 bonus points] Add a detection of the propagation speed s of the traffic wave into your code. Plot the wave speed as a function of the parameter, and describe the observed behavior. Submit your code under the filename `yourfamilyname_problem6e.m` .