CE 391F: Homework 4
Due Thursday, April 25

Problem 1. Consider 10 vehicles initially stopped at jam density (20-foot headways). These vehicles follow the car-following equation $\ddot{x}_f(t+T) = \frac{\lambda}{[x_\ell(t)-x_f(t)]^3}(\dot{x}_\ell(t) - \dot{x}_f(t))$. The lead vehicle accelerates at a uniform rate, reaching 60 ft/s after 10 seconds. After reaching 60 ft/s, the lead vehicle maintains a constant speed.

(a) Identify values of λ and T that result in asymptotic stability, and plot the results. (Note: the formulas derived in class only applied to the basic car-following equation, not this one.)

(b) What are the space headways at the new steady-state?

(c) Derive the fundamental diagram associated with steady-state conditions under this car-following equation.

(d) Are your answers to the previous two parts consistent?

Problem 2. Use the linear congruential method with $a = 16645$, $c = 12345$, $m = 2^{14}$, and $X_0 = 54321$ to generate 19 uniform real numbers between 0 and 1.

(a) Convert the first four random numbers to integers uniformly distributed between 3 and 5, inclusive.

(b) Convert the next three random numbers to real numbers exponentially distributed with a mean of 2.

(c) Convert the last twelve random numbers to real numbers normally distributed with a mean of 8 and a standard deviation of 2.

Problem 3. Simulate a two-lane roadway using the cellular automata technique described in class, and plot the trajectories of each vehicle (noting whenever a lane change occurs). Use the following additional rules:

- There are 4 vehicles and 30 cells.
- The four uniform integers generated in Problem 2 are the desired speeds of each vehicle.
- The three exponentially-distributed numbers are the times between entries of successive vehicles. Round each of these *up* to the nearest integer.
- The next four random numbers are the l values used for lane-changing (round to the nearest *positive* integer (so -0.5 would round to +1))
- The next four random numbers are the l_o values for lane-changing (round to the nearest positive integer)
- The last four random numbers are the $l_{o,back}$ values (round to the nearest positive integer)
- Use asymmetric lane changing (ignore lane changing rule 1 for left-to-right move)
- Use stochastic lane changing with probability 0.7.
- Use stochastic decleration with probability 0.2.
- All vehicles start in the right lane if possible (if there is already a vehicle in that cell, the vehicle starts in the left lane instead).