Physics 4350 Computational Physics
Problem Set: Rubber-necking

1. We have all been annoyed by rubber-necking drivers who slow down to look at an accident and then cause a traffic backup (shock wave in the density profile) on the highway. Model this behavior using the code provided in the book (traffic.m). In order to model the backup we have to put in some assumptions:

a. We have uniform traffic flow before hand, at close to the maximum velocity. This means the density should be low, but not too low. You should set this up before doing anything else, and see if the density profile remains steady as a function of time. Show this for part (a).

b. Now we have to model the backup. To do this, let us assume that over some small space interval, say x=0 to x=L/L0 (the wreck is in a finite spatial location), that the maximum velocity drops by say 50%, or some other variable percentage q. You can control this through the flow rate in the code.

c. Finally we assume that the velocity drop only occurs for a finite period of time T.

Please provide the following in your write-up:

(a) Show that the constant density profile remains constant for no traffic accident.

(b) Code the backup and run it for a few select extreme values, say a very big velocity drop, and/or a very long time for T. Check that the solution makes sense and show plots that confirm this.

(c) Show that a finite time slow-down will resolve itself after long times t. ($T \ll t$)

(d) What is the difference between a very big drop in velocity and a very small drop in velocity?