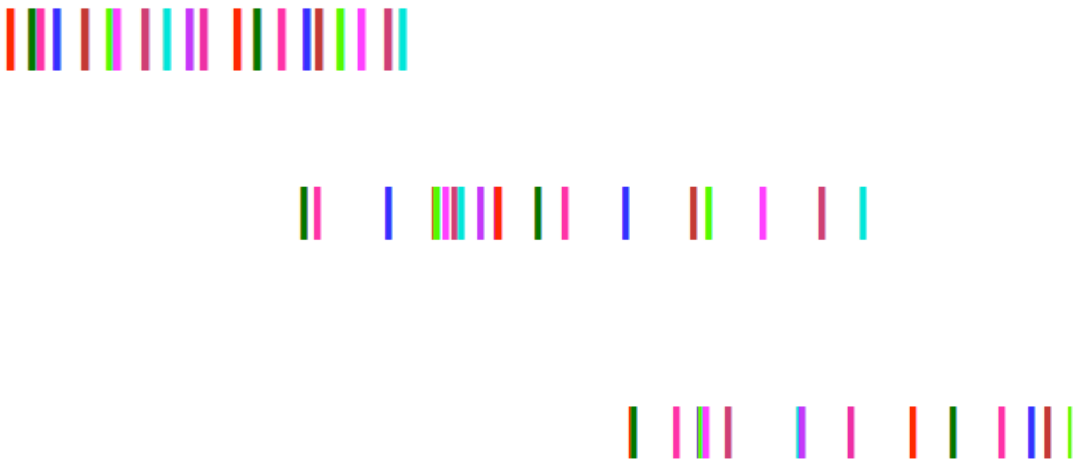
Accordion Effect in Single Lane Highway Traffic

Have you noticed that, when you are driving in heavy traffic on a single lane highway, your speed can vary periodically between 0 kph and 100 kph? If you looked at the traffic flow from a distance, you can see the cars slowing down and bunching up in some areas, and speeding up and expanding out in other areas. This can happen without any exceptional incident like a stop light, pedestrian crossing, or a car slowing to turn off.

Why would this happen? Just think of how people drive in heavy traffic – they usually keep a reasonable distance from the car in front. But how does this "reasonable" distance depend on speed? One suggestion is that one keeps a distance that would allow avoidance of an accident in the event of a sudden stop. In practice, this turns out to be about a gap of 2 or 3 seconds, and the distance clearly depends on the speed you are traveling.

Is this simple description of driving behavior enough to produce the accordion effect? We can simulate the experience to test out the idea. We set up, say, 20 cars all travelling the same speed in the same direction, and separated by a 2.5 second gap at that speed. We allow drivers to have a slight lag in adjusting to the 2.5 second gap and a slight inaccuracy in judging what that new target speed should be. This is all that is required to produce the accordion effect. I will show the simulation in class which will show the configuration of the cars at 5 second intervals (that is, 5 seconds of real time, but only a fraction of a second in simulation time – this produces a picture that is almost continuous motion).



The point? The simulation has involved the continuous uniform distribution and the normal distribution, and the simple description above, and has produced an explanation of the accordion effect. This is the kind of information traffic engineers need. Simple probabilty models can be useful once the power of simulation is understood.