## PREPARATION

This activity models driver behaviors to see how they affect traffic congestion quantitatively.

Instructor: You may decide whether you want to use this virtual simulation with the whole class at once, or whether you want to split students into small groups. In addition to downloading the desktop file, students may use the model with NetLogo Web. This is quick and easy, but has some feature limitations.

Download the free educational simulation application NetLogo for desktop at https://ccl.northwestern.edu/netlogo/.This is slower, but could be useful if you want added customization.

Select the "Traffic Basic Adaptive Individuals" mode. Allow students a few moments if needed to get acquainted with the idea of running the simulation by clicking "setup" and "go." After your demonstration, students can use the "adaptive go" function to simulate how different drivers adapt their acceleration to what they see in front of them.
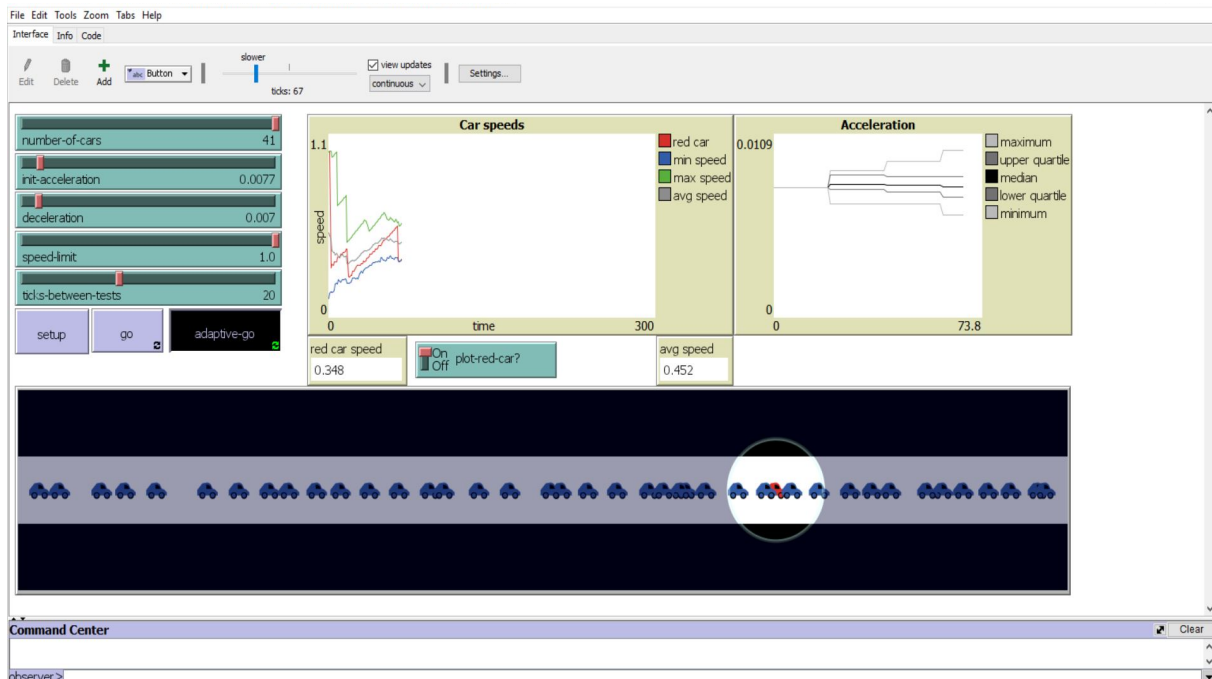
PART 1 - ORIENTATION

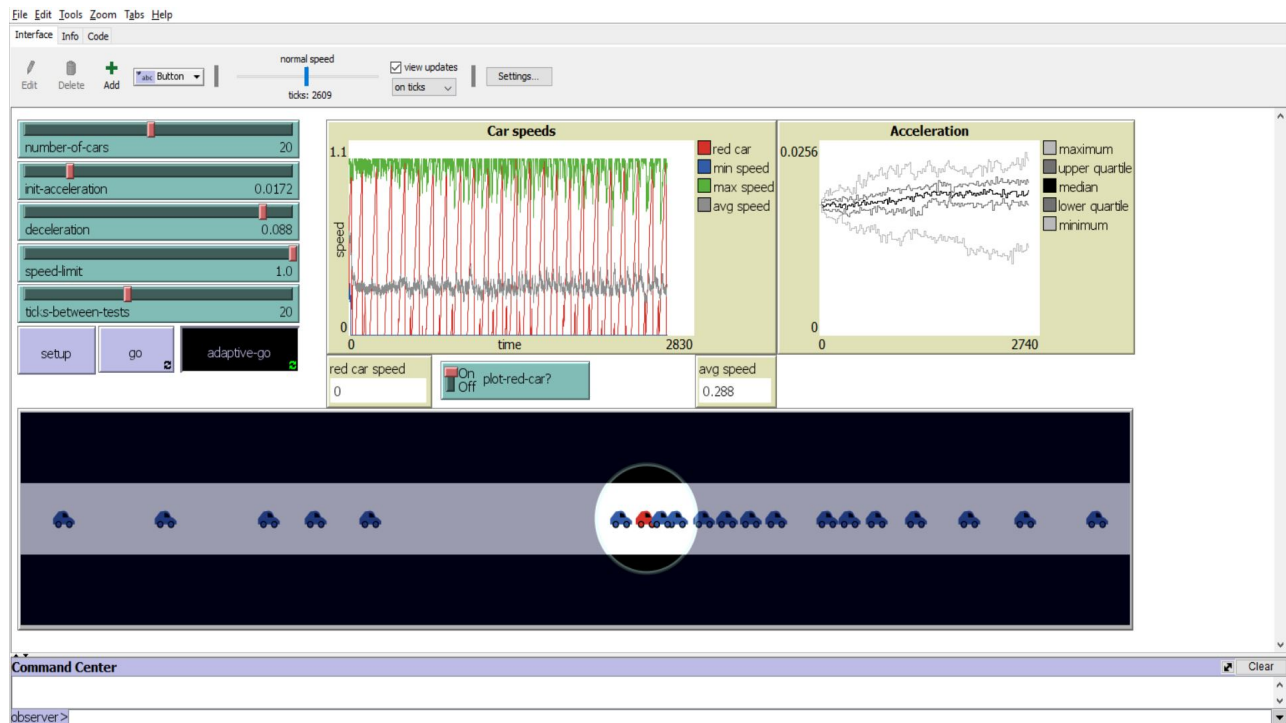Begin by demoing the software so that the sliders on the top left are set to:

number-of-cars: 20
init-acceleration: 0.0172
deceleration: 0.088
speed-limit: 1.0
ticks-between-tests: 20

Now set the speed in the top left side of the gray toolbar to "slower" as shown in the slide. Make sure that the "view updates" checkbox is active. In the dropdown menu below "view updates," set it to "continuous."

In the middle of the screen, the switch "plot-red-car?" should be set to "On."

PART 2 - HIGH DECELERATION MODEL RESULTS

In this simulation, traffic jams are modeled for a hypothetical road with a single long stretch of highway. The model can vary the number of cars, initial acceleration, deceleration, and even the speed limits. Results are continuously plotted in the windows in the middle and the right. Direct students to monitor the speed of the red car related to the average speed. There are two counters below the "Car Speeds" plotting window that display the speed of the red car and the average speed numerically. Click "go" (avoid "adaptive go" for now) and let the model run for about a minute and wait until the car speed lines look like those shown in this slide.

Ask:

What can we say about the speeds of the red car and the average car?

Answer:

When we set the acceleration to a low value and deceleration to a high value, the red car starts and stops. This leads to high variation in its speed. The average speed is well below the max possible speed.

PART 3 - LOW DECELERATION MODEL RESULTS

Ask:

What will happen to the queues/traffic if we suddenly decrease the deceleration to 0.005? Think about it as if you were in traffic. This means that you will *slow down* or decelerate your car much more slowly (lower value on the slider).

What do you think will happen to the speed of the red car?
And what do you think will happen to the average car speed?

Answer:

Click the button " go" to pause the simulation. Decrease "deceleration" to 0.005. Click "go" again to resume the simulation.

Ask:

What happened in this model?

Student(s):

The red car speed and average car speed optimized or reached the maximum possible value/speed limit of 1.0.

Instructor:

If you were driving, which situation would you prefer? The one with high deceleration or low deceleration?

Answer/Student:

We would prefer low deceleration situations.

Instructor:

Instead of each driver slamming on their brakes when getting to a car that is close, they are slowing down *gradually* and adding more space in front of them. Even though this might seem counterintuitive, if helps to slow down in heavy traffic jams because if you decelerate quickly and stop, you'll waste time accelerating (speeding up).

Ask:

What will happen if we now change the number of cars to a much higher value like 41?

Student(s): any guess will work

Pause the model by clicking "go".
Then click "setup" to reset the road patches.
Change the number-of-cars slider to 41.
Click "go".

Observe the results and note that the number of cars can increase to 41 but the average speed (and speed of the red car) will be very low.

Instructor:

Constant speed driving helps, but more has to be done. Scientists and engineers have been

exploring how self-driving cars with artificial intelligence can improve traffic flow and safety.

NOTE: DIFFERENTIATED INSTRUCTION

For advanced students interested in some light programming, they can try clicking the "Code" tab on the top left of the NetLogo interface. They can try finding the parts of the code that make the counters (boxes with numbers), sliders, and graphs work. One simple challenge may require them to express the speed limit in miles/hour or kilometers/hour with a range of 0-200.