Quiz 3 — Spring 2024

- Due Mar 5 at 3:30pm
- Points 6
- Questions 6
- Available after Feb 25 at 8:59pm
- Time Limit None
- Allowed Attempts Unlimited

Instructions

This quiz is about the Lighthill-Whitham-Richards model of traffic flow. Read through and run a Jupyter Notebook tutorial on this model, and then answer the questions in this quiz.

- LWR Jupyter Notebook on Google Colab: [Link (https://colab.research.google.com/drive/1nkdvyGtS2M4Nn4hnCx-3ZZZ9SiySrkYy?usp=sharing)]

If you do not have a Google account, you must create one to run the notebook. Once you have the notebook open and available in your Google account, use the **Runtime => Run all** menu option to execute the notebook. You should read through the results and then answer the questions in the quiz.

The quiz is due on **Tuesday, March 5, at 3:30 pm** (before class). There is no time limit, and you may submit as many times as you wish.

> **Note**: When you run the notebook, you may see a warning saying that the notebook may request access to your data. It will not.

Take the Quiz Again

Attempt History

	Attempt	Time	Score
KEPT	Attempt 7	less than 1 minute	6 out of 6
LATEST	Attempt 7	less than 1 minute	6 out of 6
	Attempt 6	2 minutes	5.33 out of 6
	Attempt 5	1 minute	5.67 out of 6

	Attempt 4	less than 1 minute	5 out of 6
	Attempt 3	1 minute	5.33 out of 6
	Attempt 2	5 minutes	4.5 out of 6
	Attempt 1	119 minutes	5.08 out of 6

Score for this attempt: 6 out of 6
Submitted Feb 26 at 4:28pm
This attempt took less than 1 minute.

Question 1
1 / 1 pts

The LWR model assumes a relationship between density $\rho(x,t)$and flow (or "flux") $f(\rho(x,t))$. According to that relationship, what is the flow if the density is 0.2?

- 0.1

Correct!

- 0.16
- 0.2
- 0.4
- 0.8

Question 2
1 / 1 pts

The LWR model assumes a relationship between density and velocity. According to that relationship, if the density of vehicles at location x is $\rho(x,t) = 0.2$, what is the average velocity $u(\rho(x,t))$ of a car at that location?

- 0.1
- 0.16
- 0.2
- 0.4

Correct!

0.8

Question 3
1 / 1 pts

Section 1.3 discusses the so-called ***Rankine-Hugoniot condition***. Refer back to the ***left*** subplot of Section 1.2; at what speed does the shock move?

Correct!

- [x] It moves at speed ρ_ℓ to the left (negative-x direction).
- [ ] It moves at speed ρ_ℓ to the right (positive-x direction).
- [ ] It moves at speed $\frac{1}{\rho_\ell}$ to the left (negative-x direction).
- [ ] It moves at speed $\frac{1}{\rho_\ell}$ to the right (positive-x direction).
- [ ] None of these is true.

Question 4
1 / 1 pts

Section 1.4 shows what the model predicts at a stop light, where cars up to the light are stopped (at full density) and then the light turns green at $t = 0$. Compare what happens in three different scenarios: when $\rho_r < 0.5$, when $\rho_r = 0.5$, and when $\rho_r > 0.5$. What do you observe? Check all that apply.

Correct!

- [x] In all instances, the rightmost point where $\rho = 1.0$ shifts toward the left at speed 1 (i.e., 1 unit of distance per 1 unit of time).

Correct!

When $\rho_r = 0.5$ and t increases from 0, the leftmost point where $\rho = \rho_r$ remains stationary at $x = 0$ (the location of the stop light).

Correct!

- [x] When $\rho_r < 0.5$ and t increases from 0, the leftmost point where $\rho = \rho_r$ shifts toward the right (to $x > 0$).

Correct!

- [x] When $\rho_r > 0.5$ and t increases from 0, the leftmost point where $\rho = \rho_r$ shifts toward the left (to $x < 0$).

Question 5
1 / 1 pts

Section 1.5 distinguishes between two phenomena realized in the LWR model: **shock waves** and **rarefactions**.

True or false: A shock wave indicates a traffic jam, whereas a rarefaction indicates a relief in a traffic jam.

Correct!

- (•) True
- ( ) False

Question 6
1 / 1 pts

Look at the interactive demo in **Section 1.2 ("Traffic Jam").** The right subplot depicts a red diagonal line. Which of these statements concerning this line is true? Mark all that apply.

Correct!

- [x] The line's slope is $-\dfrac{1}{\rho_\ell}$.
- [ ]

Let (x, t) be a point on this line, where $x < 0$. Suppose a car started initially at position x. Then it must first come to a stop at time t.

Correct!

Let (x, t) be a point on this red line. Suppose a car starts initially at position $-t$. It must *first* come to a stop at time t.

- [ ] The line's slope measures the density of cars at position x at time t.

Correct!

Suppose a car starts at position $x_0 < 0$. It must first come to a stop at time $t = -x_0$, and its stopping position will be $x = \rho_\ell x_0$.

- [ ] None of these statements is true.

Quiz Score: 6 out of 6