Course Orientation and Overview

CE 391F

January 17, 2012

INTRODUCTIONS

1. Who are you?
2. Where are you from?
3. How long have you been at UT?
4. Who is your advisor?
5. Something interesting about yourself...

COURSE OVERVIEW

SYLLABUS AND ADMINISTRATIVE DETAILS

Office hours: MW 12:30-2:00 or by appointment

Course website:

`http://webspace.utexas.edu/~sdb382/teaching/ce391f/index.html`

(*not* Blackboard)

Text: Revised Monograph on Traffic Flow Theory, and papers and notes as posted.

`http://www.fhwa.dot.gov/publications/research/operations/tft/`

Category	Weight
Homeworks	30%
Exam	30%
Project	30%
Paper presentation	10%

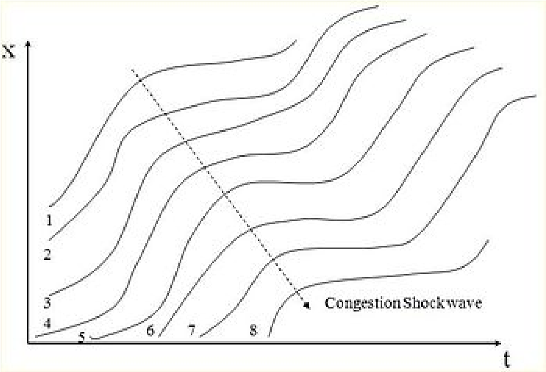
$+/-$ grading will be used. If you need an extension, you must ask at least 48 hours in adavnce.

Miscellanea

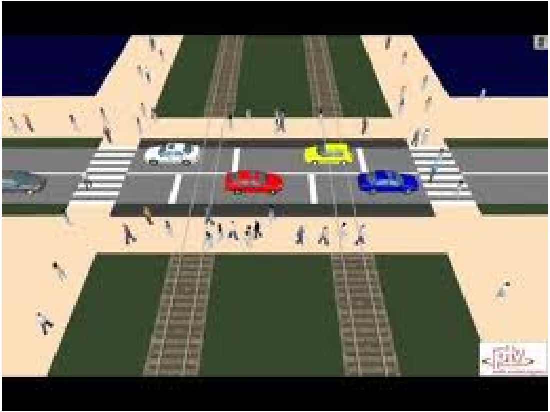
- Consult catalog and departmental advisors for add/drop policy.
- Please coordinate with me and Services for Students with Disabilities if you have a disability requiring alternate accomodations.

WHAT IS TRAFFIC FLOW THEORY?

What is traffic flow theory?



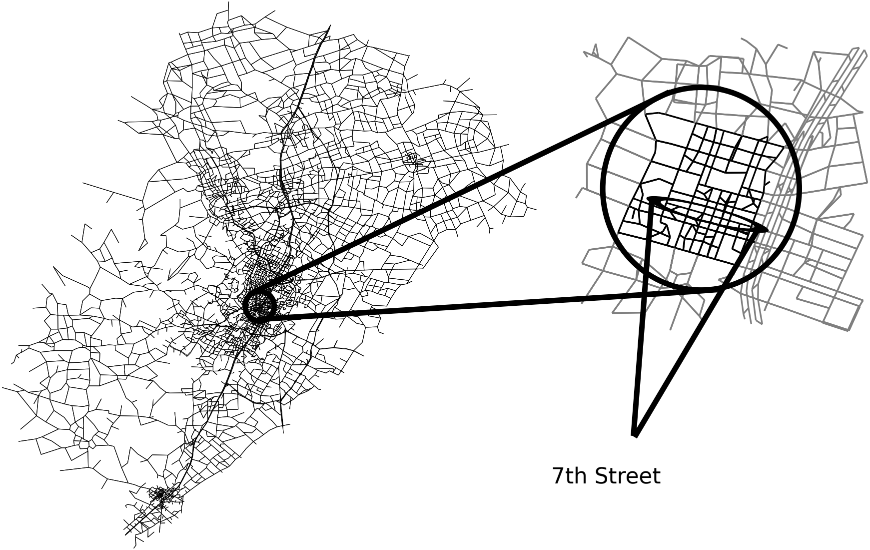
Mathematical descriptions of the interactions between vehicles, operators, and infrastructure.



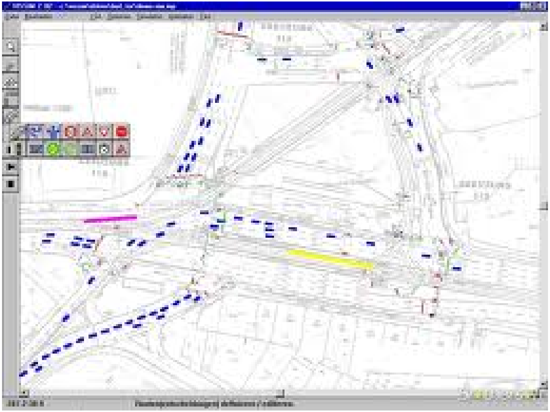
These include models for car following, speed selection, lane changing, gap acceptance, signalized and unsignalized intersections, and so forth.

How does traffic flow theory relate to traffic assignment?

Traffic assignment requires some kind of flow model, often simplified versions of the ones we will see in this course.

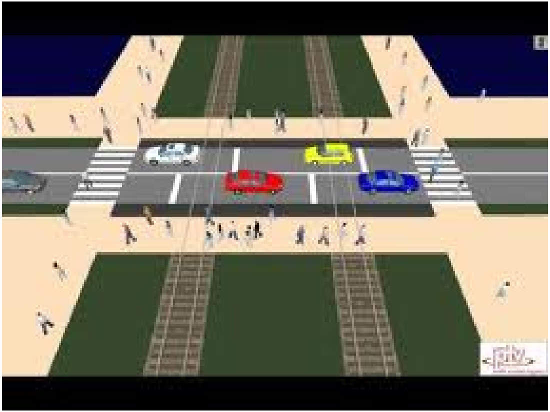


Some applications of traffic flow theory...



Development of traffic simulation software. (By the end of this course, you will have the methodological knowledge to write a simulator.)

Some applications of traffic flow theory...



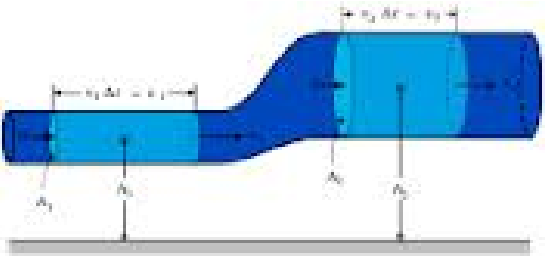
Operational analysis

Some applications of traffic flow theory...

Safety and emissions modeling

COURSE PREVIEW

Continuum flow models



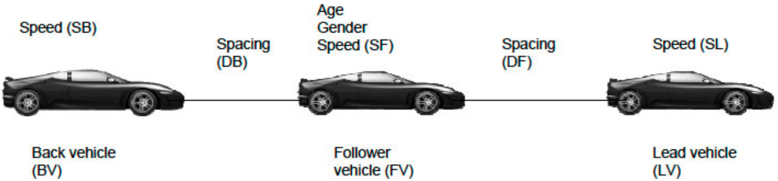
This includes the quintessential LWR model.

Driver behavior and vehicle dynamics

How can we represent human and vehicle limitations in these models?

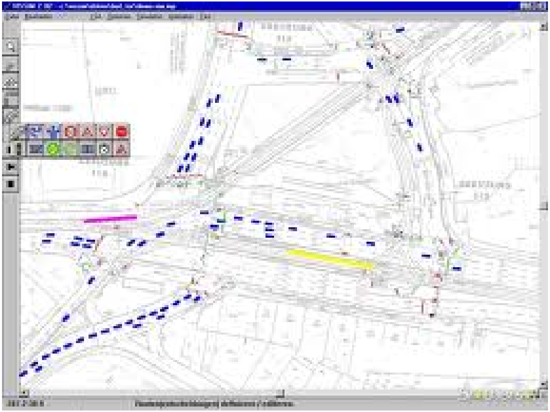
Moving beyond continuum models

Figure 1
Car-following vehicle dynamics



Car-following, cellular automata, gap accpetance...

Developing a simulator



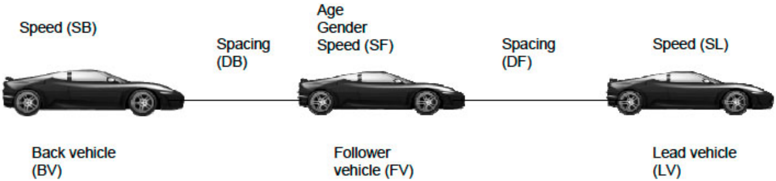
Random number generation, Monte Carlo sampling

FUNDAMENTAL CONCEPTS

Consider a single-lane, one-way roadway

Figure 1

Car-following vehicle dynamics



There are several ways to describe the vehicle stream.

Flow: Rate at which vehicles pass a *fixed point*, denoted q. [veh/hr]

Volume: Another term for flow

Density: Spatial concentration of vehicles at one point in time, denoted k [veh/mi]

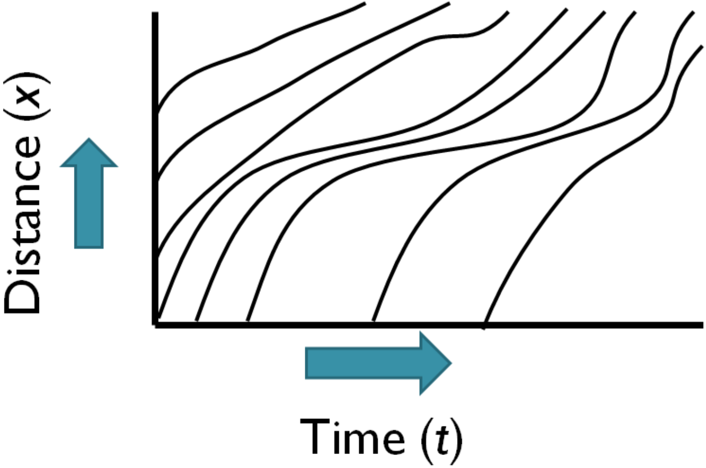
Speed: Velocity of a single vehicle, denoted u [mi/hr]

Time headway: Time between vehicle arrivals at a single point. [sec]

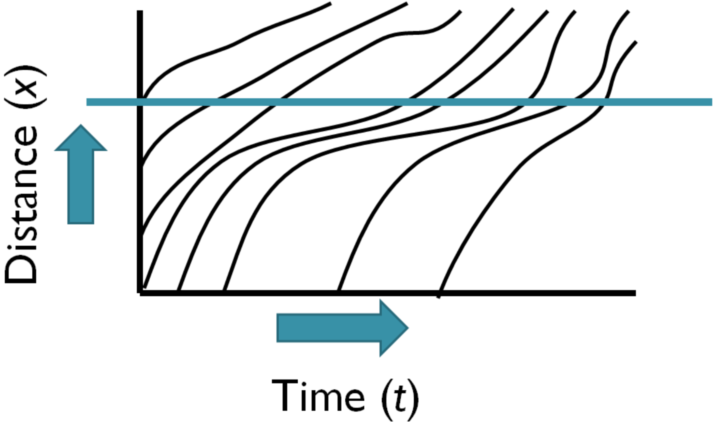
Space headway: Physical distance between vehicles (front bumper to front bumper). [ft]

Cumulative count: Total number of vehicles which have passed a given point since a given reference time, denoted N. [veh]

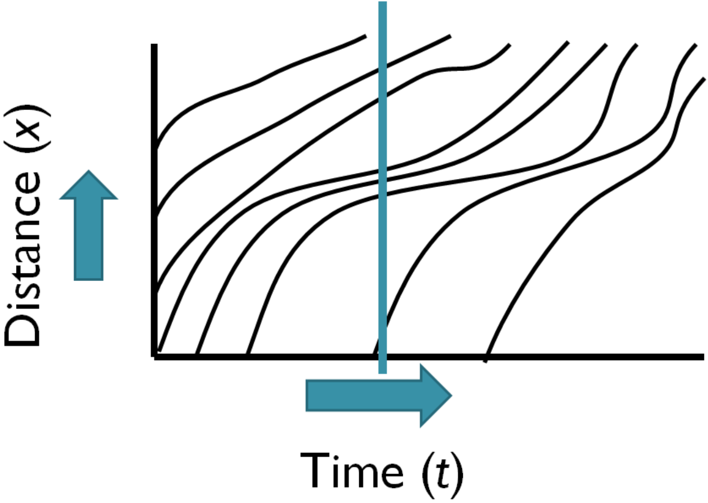
These quantities can be visualized on a *trajectory diagram*.



The flow q is the rate trajectories cross a horizontal line.



The density k is the rate trajectories cross a vertical line.



How is speed represented in a trajectory diagram? What about time and space headway?

Time headway, space headway, and speed are characteristics of *individual* vehicles.

Volume is an aggregate measure of time headways; density is an aggregate measure of space headways; what is an aggregate measure of speed?

How do we compute average speed? On the surface, it seems easy enough. For instance:

I travel from A to B at 10 mi/hr; I then return from B to A at 5 mi/hr. What is my average speed?

Answer 1: You drive ten miles at 10 mi/hr and ten miles at 5 mi/hr. Therefore the average speed is **7.5 mph**

Answer 2: You drive one hour at 10 mi/hr and two hours at 5 mi/hr. Therefore the average speed is **6.7 mph** $(6.7 = (2*5 + 10)/3)$

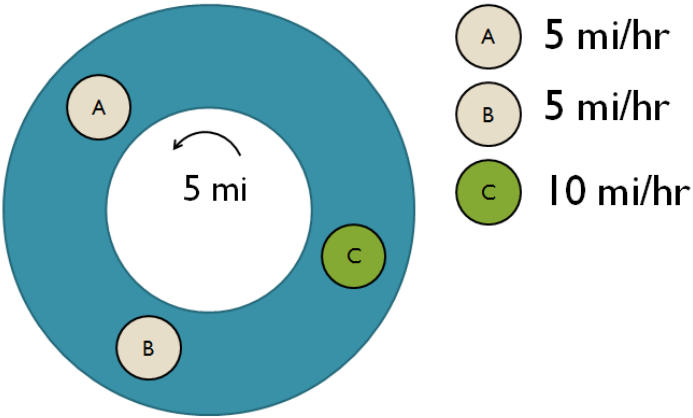
Which answer is right?

It depends on what we're trying to measure. Both are valid in some sense... but the usual definition of average speed is total distance divided by total time.

Total distance: 20 mi
Total time: 3 hr
Average speed: 6.7 mi/hr

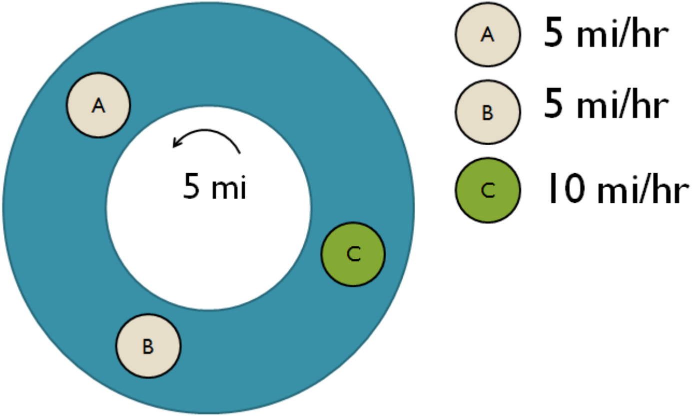
This is not to say that Answer 1 is completely wrong; it's just not what we're usually interested in.

Another way to look at average speed



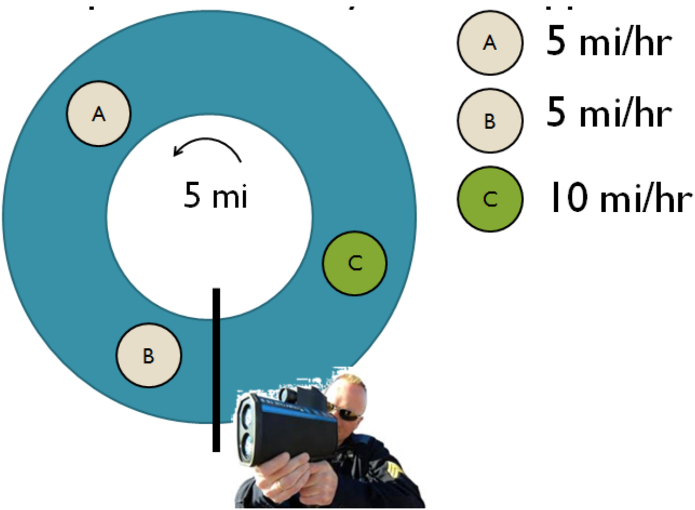
Track circumference: 5 mi

Another way to look at average speed

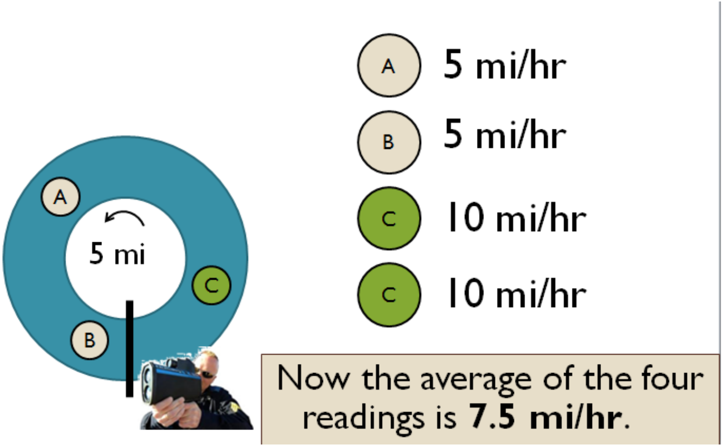


From the aerial photo, it seems obvious that the average speed is $(5 + 5 + 10)/3 = 6.7$ mph

What if we couldn't get an aerial photo with speeds? Let's try another approach.



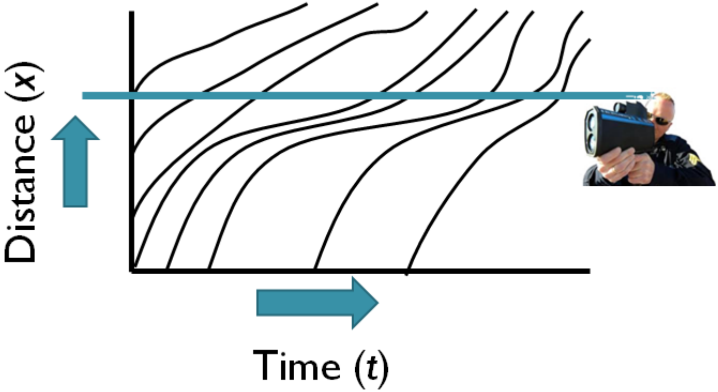
After one hour, what speeds will be recorded?



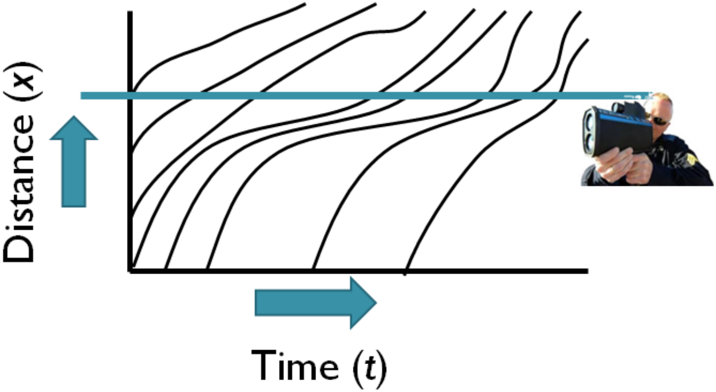
So, there are two different types of average speed... we call them **time-mean speed** and **space-mean speed**

Time-mean speed is what the radar gun gives us; space-mean speed is what an aerial photo would give us.

Why do they have these names?



The radar gun is **fixed in space** but records speeds **over time**. Therefore you get **time-mean speed.**



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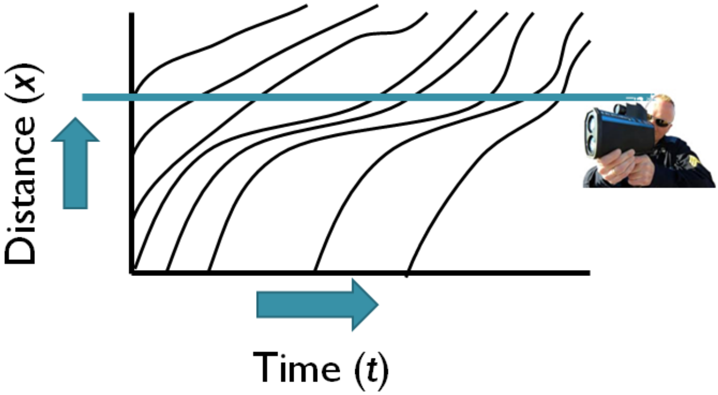
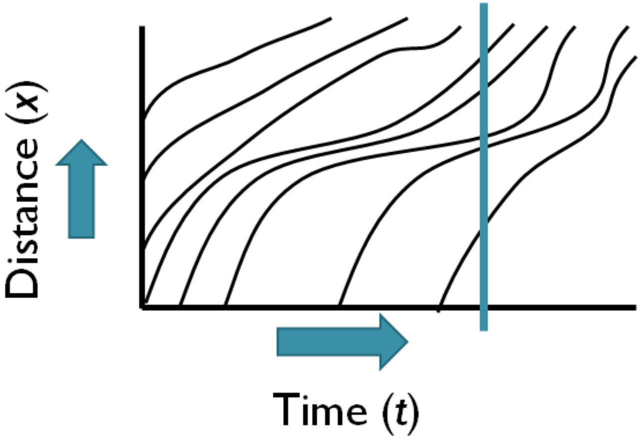
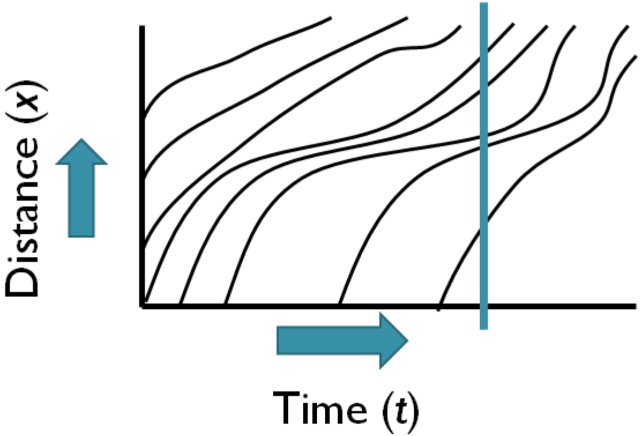


One way to remember this is by analogy with **time headway** (which was also measured horizontally)

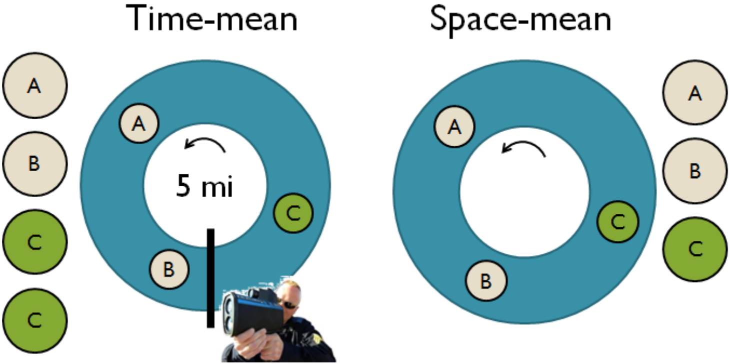


The aerial photo is **at a single instant in time** but records speeds **over space**. Therefore you get **space-mean speed.**



One way to remember this is by analogy with **space headway** (which was also measured vertically)

Generaly, space-mean speed is what we are interested in. (Time-mean speed is **biased toward faster vehicles**.)



However, time-mean speed is easier to measure and automate.

Luckily, we can calculate space-mean speed from time-mean measurements. Let u_i be the speed of the i-th vehicle measured by a point detector (out of n total readings.)

The time-mean speed is just the simple (arithmetic) average of these:

$$\overline{u}_t = \frac{\sum_{i=1}^{n} u_i}{n}$$

The space-mean speed is the harmonic average: the reciprocal of the average of the reciprocals:

$$\overline{u}_s = \frac{1}{(\sum_{i=1}^{n}(1/u_i)/n)} = \frac{n}{\sum_{i=1}^{n}(1/u_i)}$$

Example:
$\overline{u}_t = (5 + 5 + 10 + 10)/4 = 7.5$
$\overline{u}_s = 4/(1/5 + 1/5 + 1/10 + 1/10) = 6.7$