UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH
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OPERATION & MANAGEMENT OF TRANSPORT SYSTEMS– FALL 2024– 250MUM012

Discussion Session #1 - Trajectories

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Problem 1. Scheduling freight trains

Imagine that the northbound AVE (i.e. high speed railway) between Barcelona and Girona (100 km apart) is scheduled every 30 minutes all day long (24h a day). The average travelling speed of the AVE between both stations is 200 km/h (neglect accelerations and decelerations). The same northbound track is used by freight trains, whose travelling speed is 100 km/h. Using an (x,t) diagram, you are to schedule the maximum number of freight trains on the line given the following restrictions:

- AVE trains have total preference.
- The safety spacing for an AVE train is 10 km (i.e. no other train can be within a 10 km distance of an AVE train while moving; the length of the train is included in the safety spacing).
- The safety spacing of a freight train is 5 km while moving and 1 km while stopped (the length of the train is included in the safety spacing).
- The only sidetrack on the northbound direction is located between km 45 and 55 (10 km sidetrack).

Determine:

a) The northbound capacity for freight trains (in terms of expeditions/day).
b) The new capacity if the sidetrack is extended between km 40 and 60 (20 km sidetrack).
c) 3 different options in order to increase this capacity.

Problem 2. Waiting at the freeway on-ramp

Imagine one driver waiting to enter a freeway at the very end of an on-ramp. The driver wants to enter the freeway without causing any disturbance to the passing traffic stream. The travelling speed on the freeway is "V", the maximum acceleration of the vehicle waiting is "a" and the minimum safe distance between vehicles travelling at "V" is "δ" (Note: "δ" is the gap distance, so that the minimum safe spacing is "$\delta + l$", where "l" is the average length of all vehicles).

Determine:

a) The vehicle spacing threshold on the freeway rightmost lane so that the driver can enter.
b) The maximum flow on the freeway rightmost lane so that the driver can enter.
c) Give numerical estimations for your results in parts a) and b).
d) Think of possible solutions to solve this problem at on-ramps.

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Problem 3. Cars & trucks

Cars and trucks travel in a one-directional avenue. The speed of cars is "V_c" while the speed of trucks is "V_t". Trucks travel slower than cars so that "$V_t=\alpha V_c$" with "$\alpha<1$". On an aerial photo of the avenue, one sees a fraction of trucks equal to "p". Then:

- Which is the fraction of trucks that a roadside observer would see?
- Is it possible for both flows (i.e. cars and trucks) to be equal? If yes, when?

Problem 4. Traffic signal & dilemma zones

Consider a one-directional avenue with an isolated traffic signal at an intersection. The signal consists of green, yellow and red phases. The duration of the yellow phase should allow the drivers to stop at the signal before it turns red. Given a maximum speed on the avenue of "V_{max}", a deceleration rate of vehicles of "a", and a reaction time of drivers of "t_r", which is the minimum duration of the yellow phase?