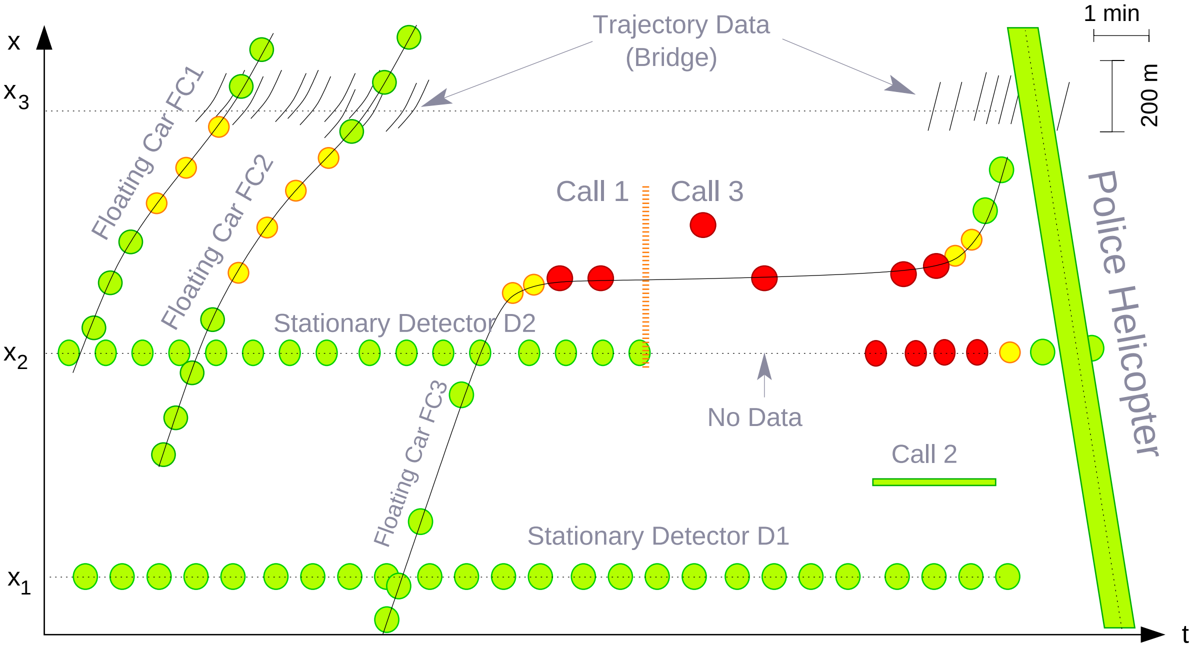
Traffic Flow Dynamics and Simulation

Summer semester, Tutorial 4, page 1

Problem 4.1: Locating a temporary bottleneck

The figure below shows a situation where an accident leads to a temporary complete road closure which has been recorded by different sorts of moving and stationary detectors. Besides the traffic state (green data points correspond to free, yellow points to dense, and red points to congested traffic), it is known that the stationary detector D1 records essentially constant traffic flow during the displayed time period.



(a) In which direction and at about which speed does the helicopter fly?

(b) Charakterize the three data sources where information on the traffic state came via phone calls. How precisely are they located. How long did they call? Which state did they report?

(c) One of the callers has also transmitted the information that an accident with a complete road block has occurred, However, neither the position nor the time of the accident are known. Can you help out and also reconstruct the time where the road block has been lifted?

Hint: Make use of following *stylized fact* of traffic flow dynamics: downstream congestion fronts (transition free → cogested) are either pinned at a bottleneck, or move against the traffic direction at a constant velocity.

Problem 4.2: Dealing with inconsistent information

When a floating car passes the location x_D of a stationary detector at time t_D, the data for (x_D, t_D) from the two different sources are usually inconsistent. Assume that the floating-car speed data V_2 has a standard deviation of errors σ_2 that is twice as large as those of the stationary detectors (speed V_1, variance $\sigma_1^2 = \frac{1}{4}\sigma_2^2$), and that the errors are independent and do not lead to a bias, i.e., the variances are additive.

(a) How do the errors in the fused data improve (or worsen) when using (i) equal or (ii) the weighting FCD:SDD=1:4. Also show that the latter weighting is optimal (it is best to start by formulating the variance for general fractions and then insert the values)

(b) Derive the optimal weightings w_i of several unbiased and independent data sources i with standard errors σ_i by minimizing the total variance $\sum_i w_i^2 \sigma_i^2$ under the restraint $\sum_i w_i = 1$