Simple Finite Buffers

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Assume that the ordering of vehicles is fixed for each lane, which means that there cannot be any *merging onto a lane*, where traffic from different lanes continuous on the same lane. Stated more formally, we only allow common paths of length one. Under this assumption, finite buffers can be easily formulated using the followin *delayed precedence constraints*.

To illustrate the idea, consider two intersections in tandem and suppose that all vehicles follow the same route. Therefore, we can simply identify each vehicles as $j = 1, \dots, n$ with corresponding route $R_j = (1, 2)$. Suppose that vehicles are able to accelerate and decelerate instantaneously, then each vehicle spends precisely $d(1, 2)$ time driving on this lane, any additional time is spend on waiting. At the crossing time y_{ij}, the front of vehicle j is entering the intersection zone and we assume that at time $y_{ij} + p$, the front of the vehicle is entering the adjacent lane. Let the maximum number of vehicles that can be at the lane between the intersections be given by a positive integer b. When there are currently b vehicles in the lane, we must require that a vehicle starts leaving the lane before the next vehicle arrives to the lane, which can be stated as

$$y_{2j} \leq y_{1,j+b} + p,$$

for each vehicle $1 \leq j \leq n - b$.

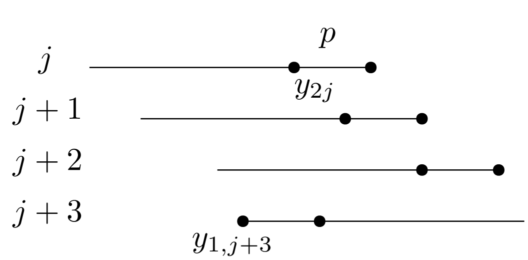

Figure 1: Illustration of the delayed constraint for $b = 3$. Vehicle $j + 3$ can enter the lane at $y_{1,j+3} + p$ after job j enters intersection 2 at y_{2j}, ensuring there are at most 3 vehicle on the lane at all times.