Rational traffic advice for rush hour commuting

Dieter Fiems

Most urban areas suffer from traffic congestion, with peaks during the morning and evening commutes. At an individual level, commuters optimise their travel times by opting for the shortest routes in time. Up till recently, these route choices where often confined to a couple of routes per commuter, and the route choice at any day was at most influenced by experience of past commutes at similar times, or by generic reports on the radio on the traffic conditions around major cities. Hence, the chosen routes were frequently suboptimal. In contrast, nowadays, online applications like Waze and Google maps can direct commuters to the routes which offer the least expected travel times, given the present traffic situation, such that commuters can rationally opt for the best route.

By selecting the shortest routes, these online applications hold the promise to better spread traffic over different routes, and thereby reduce congestion. However, if more commuters rely on these applications, there is also a real risk that these applications create congestion by routing too many commuters to a non-congested route as routing decisions only affect congestion levels at a later time. One can argue that the online application should be better at forecasting future congestion levels. However, these congestion problems are not created by a lack of information on the future congestion levels, but by the routing decisions taken by these online applications. As routing decisions are taken by the individual commuters, this is a distributed control problem which can be studied by game-theoretic methods.

In particular, our modelling effort draws upon traffic flow theory to relate traffic density and traffic flow at a macroscopic scale, on queueing theory to relate traffic intensity and density at this scale, and on the concept of the time-dependent Wardrop equilibrium to model the routing choice of individual commuters. As an application, we study how park-and-ride systems can mitigate congestion levels, and how time-dependent pricing can be used to obtain the socially optimal traffic mix.