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Abstract

Dissertation Karsten Tiemann "Selfish Routing with Incomplete Information"

To study *selfish routing* scenarios in *networks* we use and extend in this thesis two well-known classes of games modeling such routing scenarios: network congestion games and Wardrop games. In both games, we are given a *network* with *edge latency functions*. In a *network congestion game*, each *player* selects as its *strategy* one path from its origin to its destination node and experiences as its *private cost* the sum of edge latencies on this path. In a *Nash equilibrium*, no player can decrease its private cost by unilaterally deviating to another path. In a *Wardrop game*, amounts of traffic are associated with pairs of network nodes. The traffic from an origin to a destination node is modeled as a splittable network flow and the cost on an origin-destination path is again given by the sum of edge latencies on this path. In a *Wardrop equilibrium*, no fraction of the traffic assigned to some path, however small, can decrease its cost by unilaterally switching to another path.

This thesis is primarily concerned with network routing scenarios where the players have *incomplete information*. One possibility to model such scenarios is to assume that a player who does not know some relevant parameter of the game is at least aware of a probability distribution over the possible outcomes of this parameter. In such a setting, it is reasonable to assume that the decisions of a player are based on the expected values of the unknown parameters. We apply this approach for network routing games where the players have incomplete information about the edge latency functions. Since each player obtains for each edge his own expected latency function we get games with *player-specific* latency functions. For both network congestion games and Wardrop games with player-specific latency functions, we show positive and negative results concerning the convergence to equilibria, the existence and polynomial-time computability of equilibria. We also prove bounds on the so-called *price of anarchy* that measures the worst-possible inefficiency of equilibria with respect to a social welfare measure.

We use an incomplete information model different from the aforementioned one for games where, in contrast to congestion games, the players do not know each other's weight. Based on Harsanyi's incomplete information concept of Bayesian games, each player in our *Bayesian routing games* has a set of possible types and each *type* of a player corresponds to some weight. The players' uncertainty about each other's weight is described by one *probability distribution* over all possible type profiles that is known to all players. In this setting, we focus on the price of anarchy, the existence and the computational complexity of equilibria.

We also study in this thesis, as a complete information setting, *bottleneck games with splittable traffic* where the latency on a path is given by the *maximum* latency of an edge on this path. We characterize for which games the social welfare of equilibria is unique and we give results on the *price of stability* that measures the worst-possible inefficiency of the best equilibrium.