Selfish load balancing under partial knowledge

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Abstract

A set of n agents, each having a load w_i, $i = 1, \ldots, n$, wish to decide which one of two buffers each can select in order to place her load. However, each agent decides locally, without any communication with other agents. She is only based on some information about the loads of agents. This can be either only statistical (i.e. loads come independently from the uniform distribution per agent) or exact knowledge about the loads of some agents and statistical for the others. We restrict ourselves to very simple, deterministic local decision making strategies (single-threshold strategies), and We examine the effect of threshold strategies on load balancing of the two buffers. We consider selfish agents, and buffers of unbounded queue capacity. The agents are rational but they have partial knowledge. Following the fundamental principles of statistical decision making theory, we then assume that each agent assigns a selfish cost to her decision which is the expected total load on the buffer she selects. We can then define an anarchy ratio for the implied game (of n players, each having uncountably infinite and only pure strategies, and each having only partial knowledge about loads of others).

We show that (1) when each agent knows only that loads come from n independent uniform distributions then the anarchy ratio is at most $1 + \frac{1}{n}$, and this bound is tight; (2) when each agent knows the exact value of her own load as well as the loads of a sufficiently small number of other agents, then the anarchy ratio can be as bad as n; (3) when each agent knows the exact loads of all agents, then the anarchy ratio is at most $\frac{4}{3}$, and this bound is tight.