Dijkstra’s Shortest Path as a Simulation Problem
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11/13/98

Dijkstra’s Shortest path problem can be seen as a simulation of a physical
system, as follows. Let a ray of light start from the source and travel along its
outgoing edges; length of an edge is the amount of time taken by the ray to tra-
verse that edge. Whenever a ray is received for the first time at a node rays are
sent along all of its outgoing edges. (This description is due to Papadimitriou.)

Claim: The shortest path to a node is the time at which the first ray arrives
at that node. This is proven by induction on the number of edges on the shortest
path.

Simulation: The algorithm is described as concurrent physical processes
evolving in time. Let an event be the arrival of the first ray at a node. The
processes can be simulated by an event-driven simulator. Let \((t, v)\) denote that
at node \(v\) the first ray arrives at time \(t\).

initially: the event list contains the pair \((0, \text{source})\), \((\infty, v)\), for all other
nodes \(v\). All nodes are unscanned.

iterate: as long as there is an unscanned node. Remove the earliest event
\((t, v)\) from the event-list. Node \(v\) is then scanned. For each outgoing edge of
length \(c\) to \(u\) where \(u\) is unscanned: if the event list contains \((t', u)\) then add
\((t + c, u)\) to the event list provided \(t + c < t'\).