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Online and Distributed Algorithms

Exercise Session 4

1. *Maximum Flow:* Consider an orientation (with directed edges) of a weighted graph G such as the one in the minimum weighted tree problem, where now the weights represent flow maximum capacities c of those oriented edges of the new oriented digraph D obtained by orienting G. Suppose that there is exactly one node n_1 (called source) with no incoming edges in D as well as exactly one node n_n (called sink) with no outgoing edges in D. A flow in D is a function $f : \mathcal{V} \times \mathcal{V} \to \mathcal{R}$ such that: $f(n_i, n_j) \leq c(n_i, n_j) \forall n_i, n_j \in \mathcal{V}$, $f(n_j, n_i) = -f(n_j, n_i) \forall n_i, n_j \in \mathcal{V}$, and $\sum_{n_j \in \mathcal{V}} f(n_i, n_j) = 0 \ \forall n_i \in V - \{n_1, n_n\}$.

   - Give a synchronous algorithm for the maximum flow of the network D.
   - Is there a way to modify the algorithm to turn it into asynchronous?

2. How many agents are needed in a tree to identify the "bad node" called blackhole (which kills agents) if agents walk in a synchronous manner on the edges? What about if agents walk asynchronously?