Distributed Computing

ffgt86

February 12, 2020

1 Perform a precise analysis of the time complexity of the Flooding algorithm.

1.1 The synchronous model

In the synchronous model, process execution speeds and message delivery delays are upper-bounded by a fixed k.

Every processor receives M after at most D time and at most $|E|$ messages, where D is the diameter of the network, and E is the set of (directed) edges in the network. Proof is by induction.

Let $d(root, v) = k > 0$. Then v has a neighbour u such that $d(root, u) = k - 1$. By the induction hypothesis, u receives M for the first time no later than time $k - 1$. u sends M to all its neighbours, including v at k, so M arrives at v no later than time $(k - 1) + 1 = k$.

Each process only sends M to its neighbours once, so each edge carries at most one copy of M. The message complexity is therefore $|E$.

1.2 The asynchronous model

2 Consider an anonymous ring where processors start with binary inputs.

2.1 Give an argument that there is no uniform synchronous algorithm for computing the AND of the input bits.

2.2 Present an asynchronous (non-uniform) algorithm for computing the AND. The algorithm should send $O(n^2)$ messages in the worst-case.

2.3 Present a synchronous algorithm for computing the AND. The algorithm should send $O(n)$ messages in the worst case.