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Principles of Distributed Computing
Exercise 12

1 Task 1

Consider the network failure problem for the special case of Tree Topology. That is, our network has the tree structure; however, it is not necessarily a binary tree. Your goal is to find a detection set that can detect all (ϵ, k) edge partitions; that is, for any network partition caused by removing at most k edges, if there are two components, each of size at least ϵn, then your detection set must have a vertex (detector) in each component.

Show that for the tree network, there is always a detection set with $O(k/\epsilon)$ vertices. Give an algorithm for finding such a set; analyze its time complexity; and give a proof of correctness that your chosen set of $O(k/\epsilon)$ vertices do form a detection set.

2 Task 2

Consider a slightly modified version of detection set than the one considered by Kleinberg. The set of elements Z destroyed by the adversary can include both edges and vertices.

A detection set D is called a Weak Detection Set if, for every (ϵ, k) partitioning set Z,

- either Z intersects D (adversary kills a detection node), or
- there are two nodes that lie in different components of $G \setminus Z$ (who cannot communicate, and hence act as witnesses).

Notice that this is different from Kleinberg's model, because Kleinberg's model allows the possibility that an adversary-captured node can become malicious and may not be detectable. Show that for this model, we can always find an (ϵ, k) detection set of size $O(k/\epsilon)$.