Theory Exercise 7

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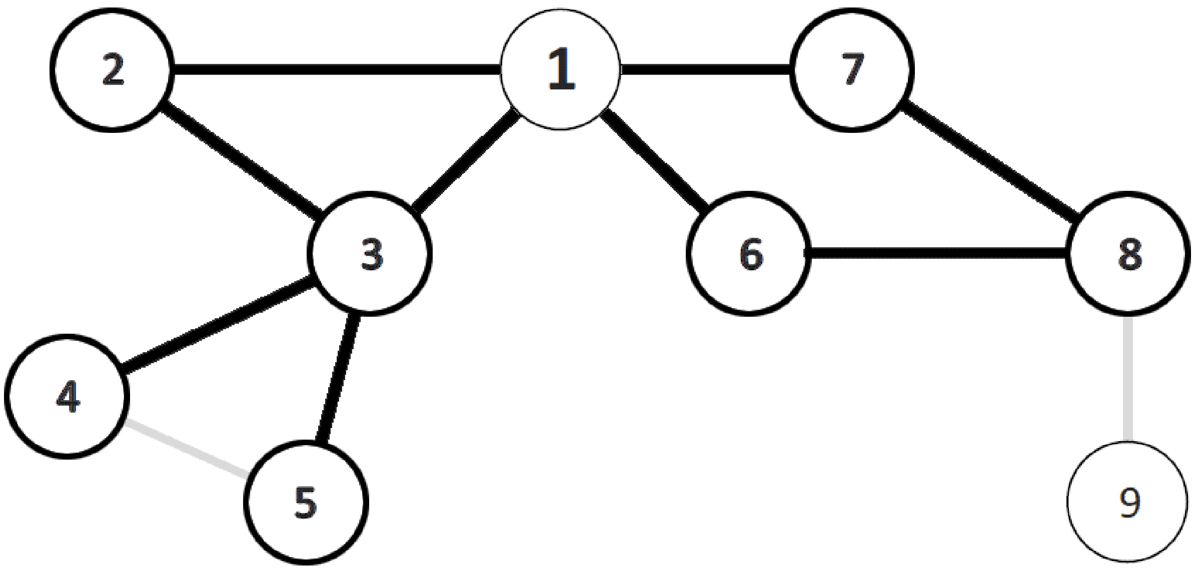
Task 1: Local View

In the graph below, the 2-hop neighborhood graph is formed only by the bold nodes and edges, i.e. node 9 and the edge between node 4 and 5 and do not belong to the 2-hop neighborhood graph (they were kept because the comparison to the original graph is more easy this way).



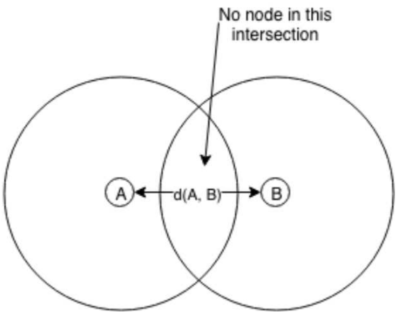
Task 2: LOCAL Model

First argument: **Inherently non-local Problem**
A problem is called inherently non-local if the output of a node *v* depends on the initial input of a node outside of $G_k(v)$. (Every LOCAL algorithm must depend only on the nodes in $G_k(v)$, with k in {0,1,2,3,..}).
The algorithm used to build a spanning tree in a network is such a problem, as a node *v* is only capable of getting a partial view of the network (depending on k). There is no constant upper bound k which solves this problem in general, i.e. for arbitrary large networks.

Second argument: **Impossibility of Symmetry Breaking**
As a general observation, the output of an algorithm in the LOCAL Model does depend only on the input available within a constant-radius neighbourhood ($G_k(n)$) of the node. This makes the LOCAL model deterministic and a given distributed algorithm produces the same result on nodes that have an equal view on the network, i.e. their neighborhood graph G_k looks alike.
For example, this problem comes into play for symmetric network graphs (e.g. n-cycle). A distributed algorithm which is used to self-assign an address for each node in the network would assign each node the same address because they all have the same view on the network.

Task 3: Topology Control

Relative Neighborhood Graph (RNG) is a topology control algorithm. An edge from node A to node B is only added if no node is in the intersection of the two circles with radius of d(A,B) that starts from A and B.



This algorithm can never add an edge that crosses another edge, because there would be always another node in the intersection. This property is important for the Greedy Perimeter Stateless Routing because if a graph contains crossing edges it can stay in an infinity loop while applying the right-hand rule.