COMP3121-Ass4-Q1

z5302513, Kihwan Baek

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1. Solution

Firstly, we construct a flow network as a directed graph where all computers are vertices 1,2,3,....N and the M one-directional links are edges. And also, we set the computer 1 as a source and the computer N as a sink. After that, we set each weight of edges as the cost of removing.

If there are connection from computer 1 to computer N, we must eliminate them to prevent sending a virus. To find the minimum total cost of removing edges, we run the Edmons-Karp algorithm to find the maximal flow through such a network. After the algorithm has converged, we construct the last residual network flow and look at all the vertices to which there is a path from the source S and this process takes O(NM^2) time.

Therefore, this will define a minimal cut and we can find all the edges crossing such a minimal cut. Hence, we need to remove the edges found on minimal cut to prevent sending a virus and the sum of weight of edges will be the minimum total cost of removing edges. At the worst case, we need to remove all edges from vertices 1,2,...N-1 to the vertex N and it takes O(M) time. So, the total time complexity is O(M) + O(NM^2) = O(NM^2).