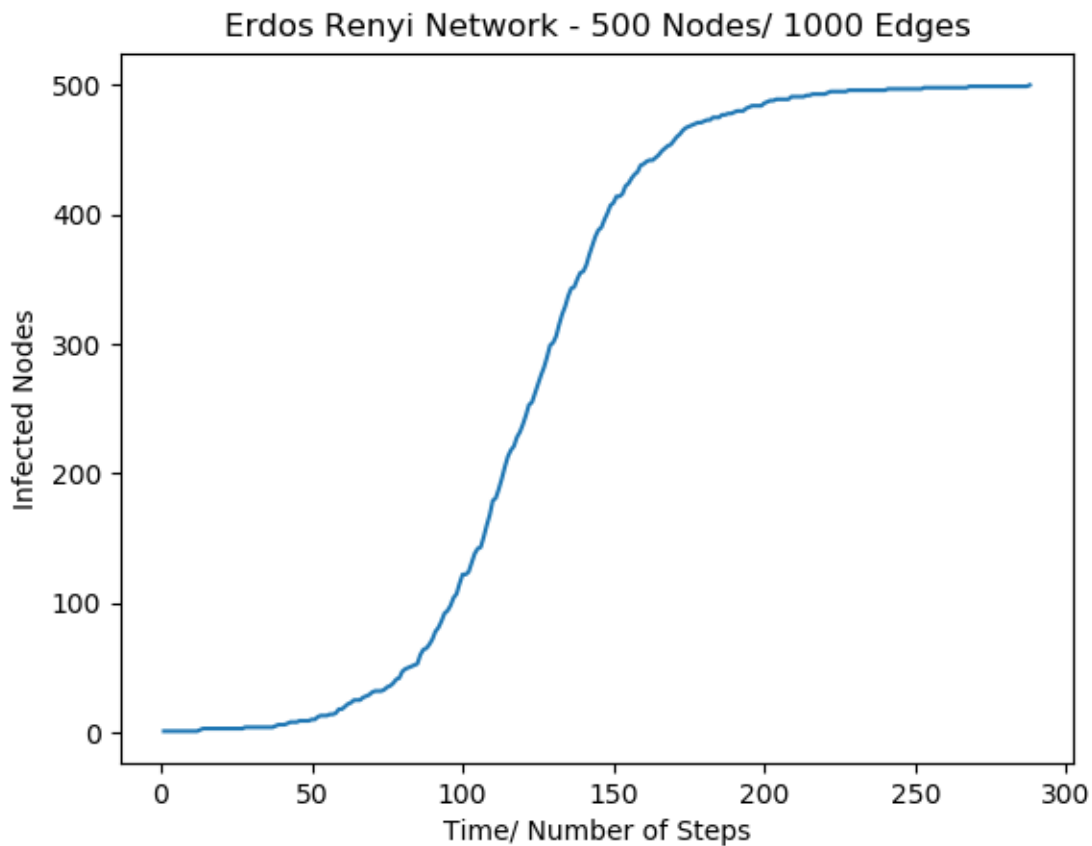
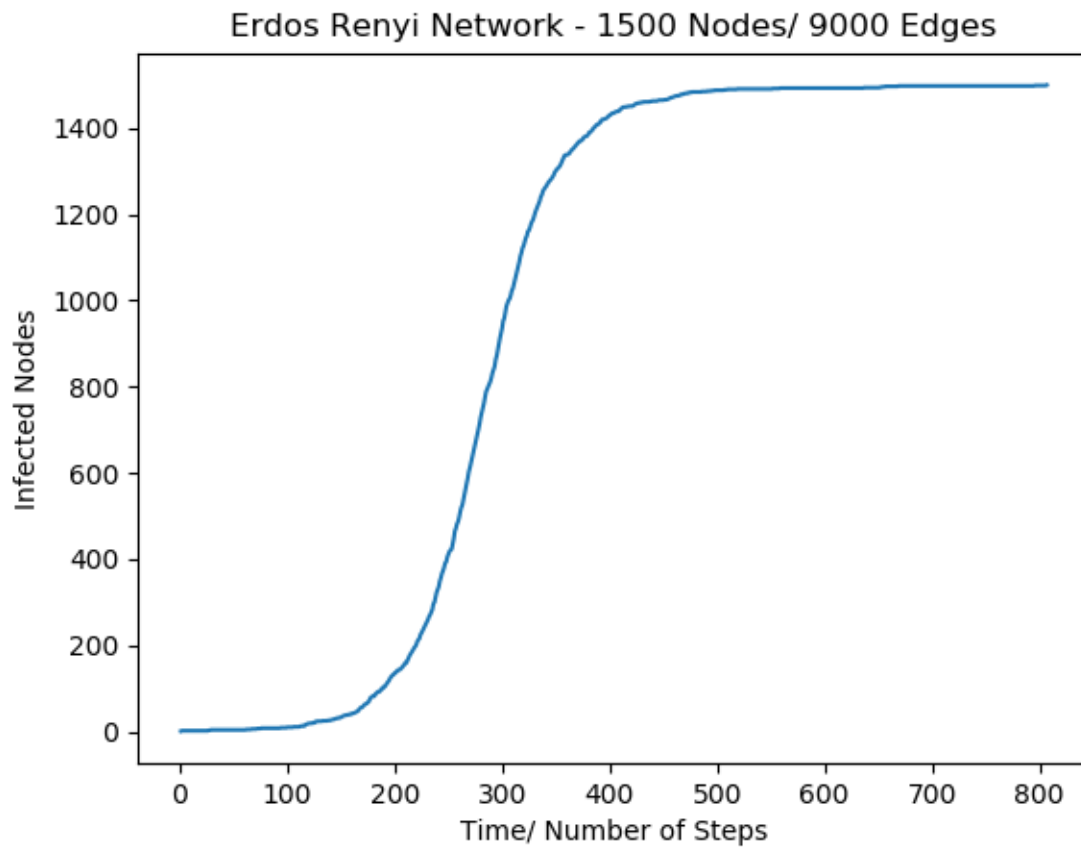
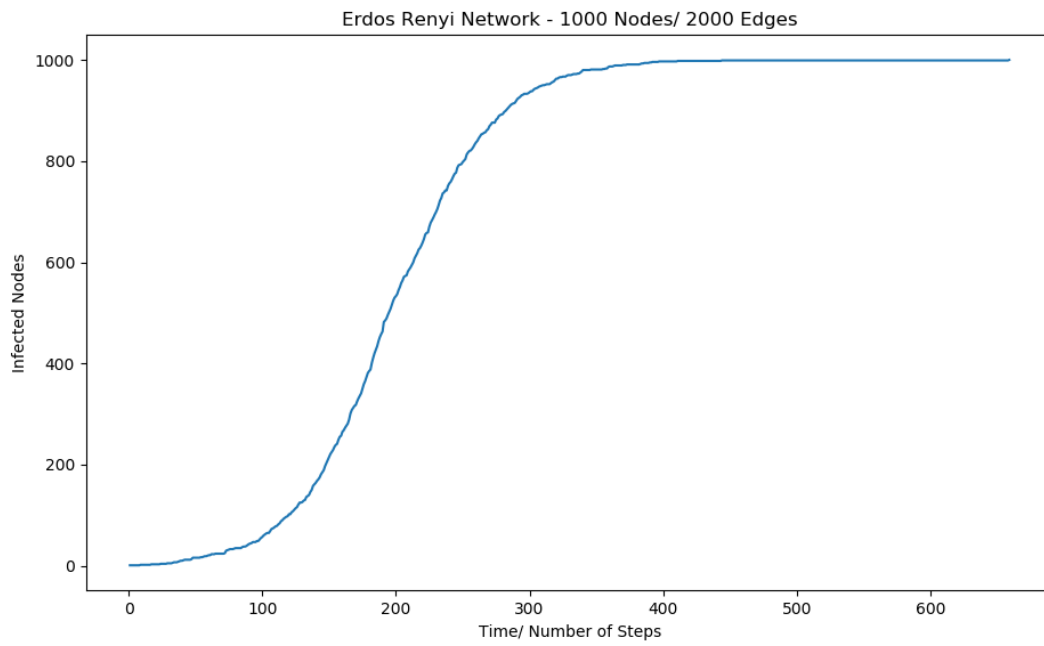
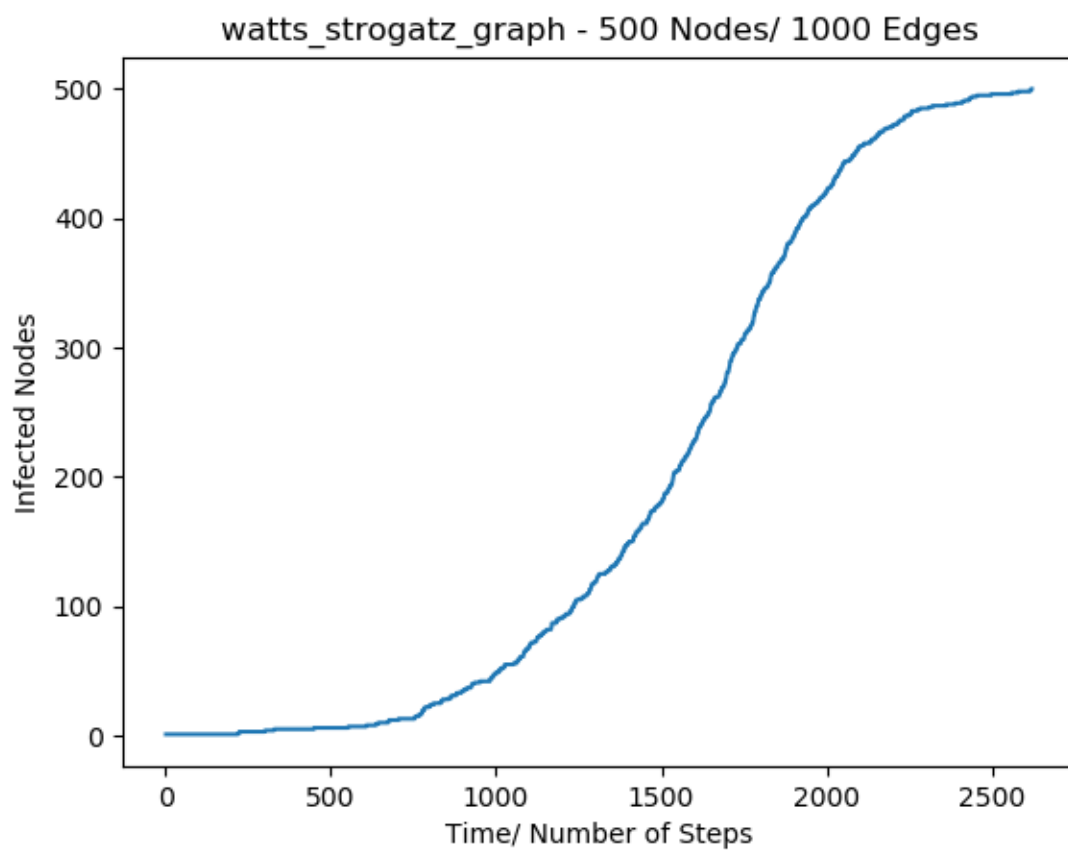


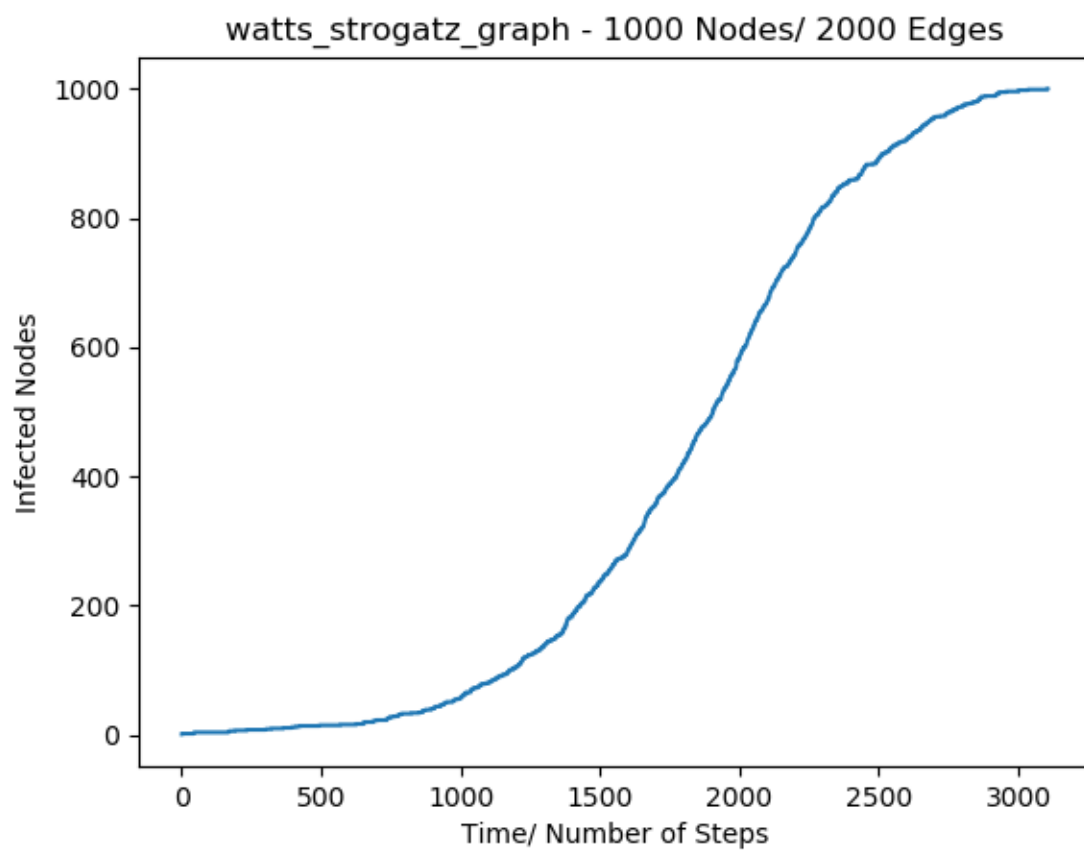
a)

This program was intended to simulate how the worm propagate and infects in large computer networks. The part A of the assignment is intended to experiment with 3 various kinds of networks that reflect practical network such as Erdos-Renyi network reflects biological population , Barabasi-Albert reflects world-wide web. and Watts-Strogatz networks reflects online social networks. The network graph below describes number of nodes and edges for each of the network and spreading rate of worm.

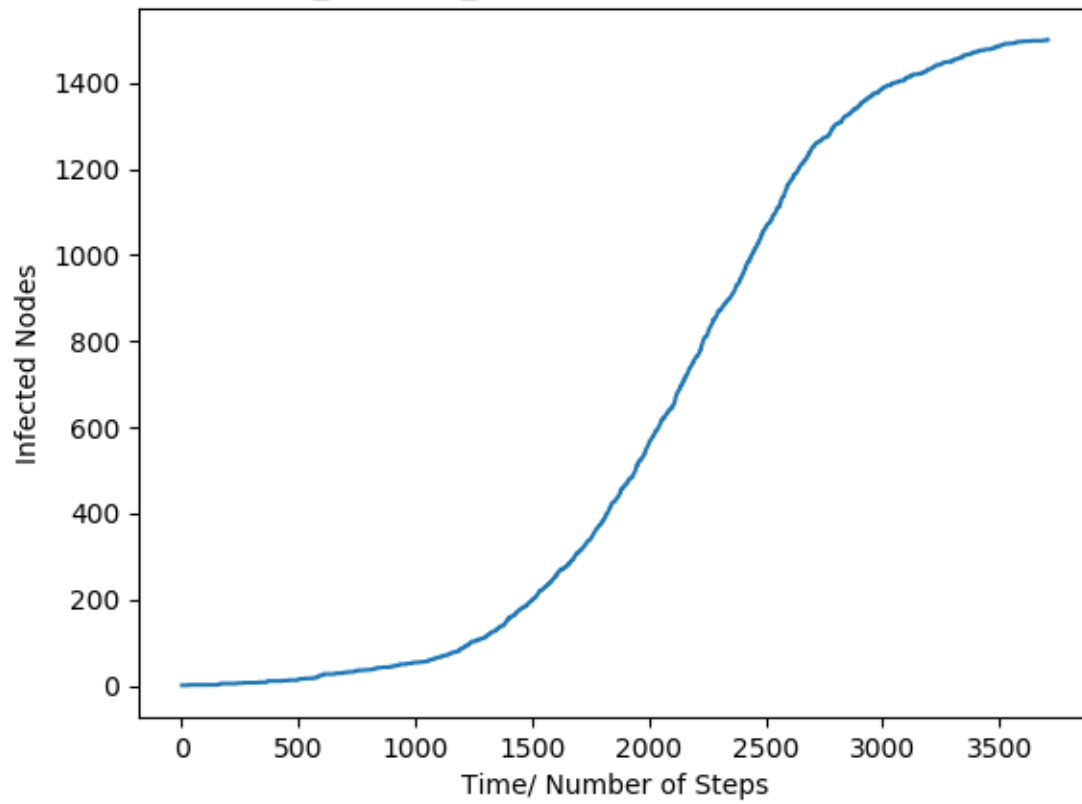


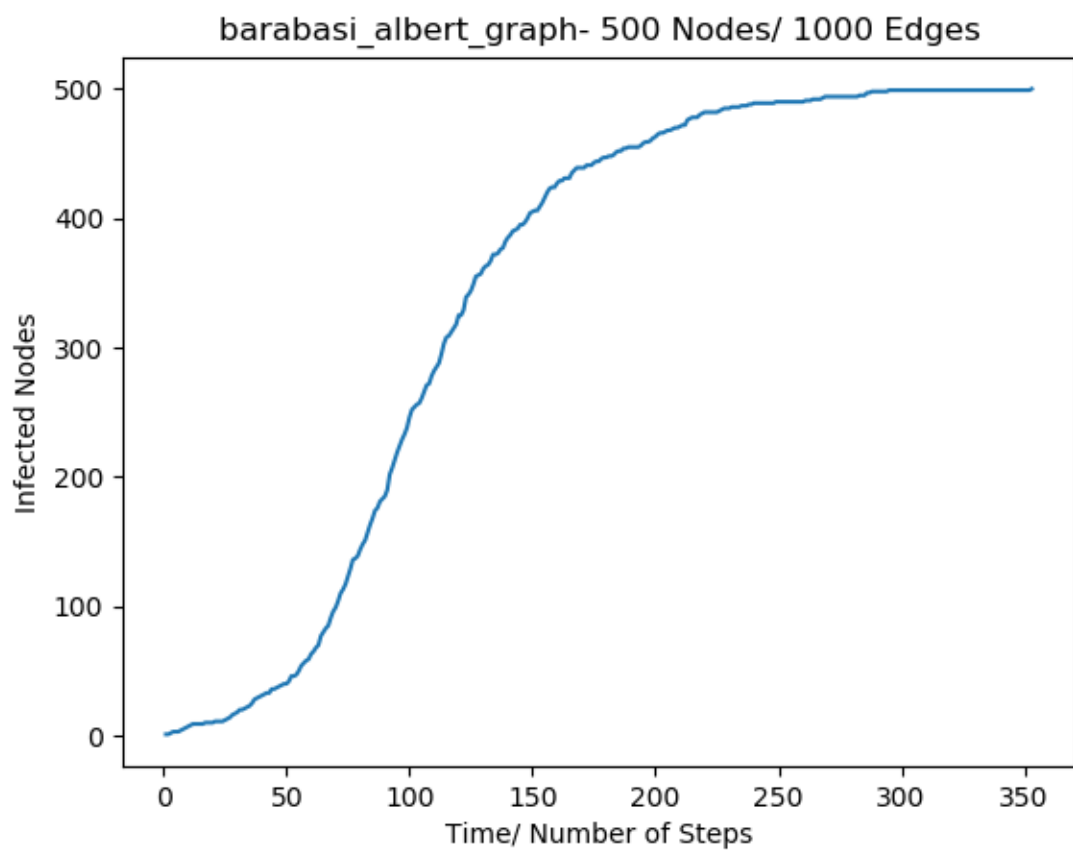


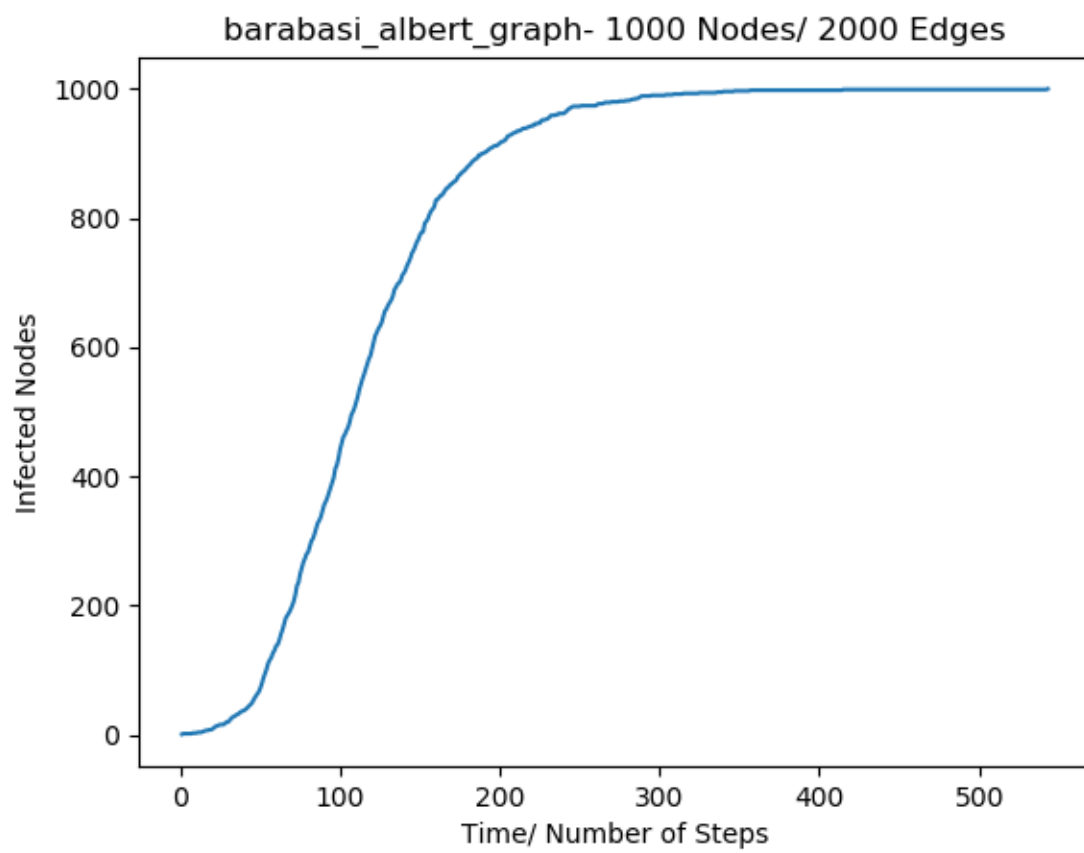


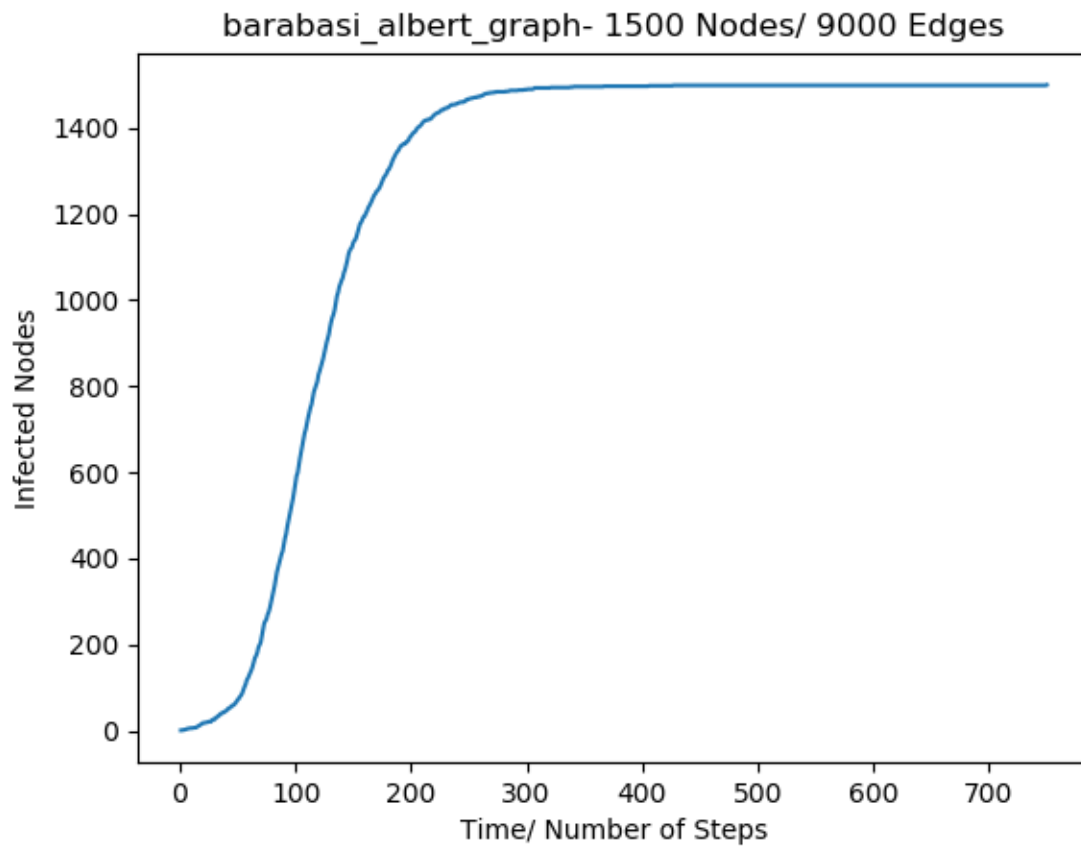


watts_strogatz_graph - 1500 Nodes/ 9000 Edges





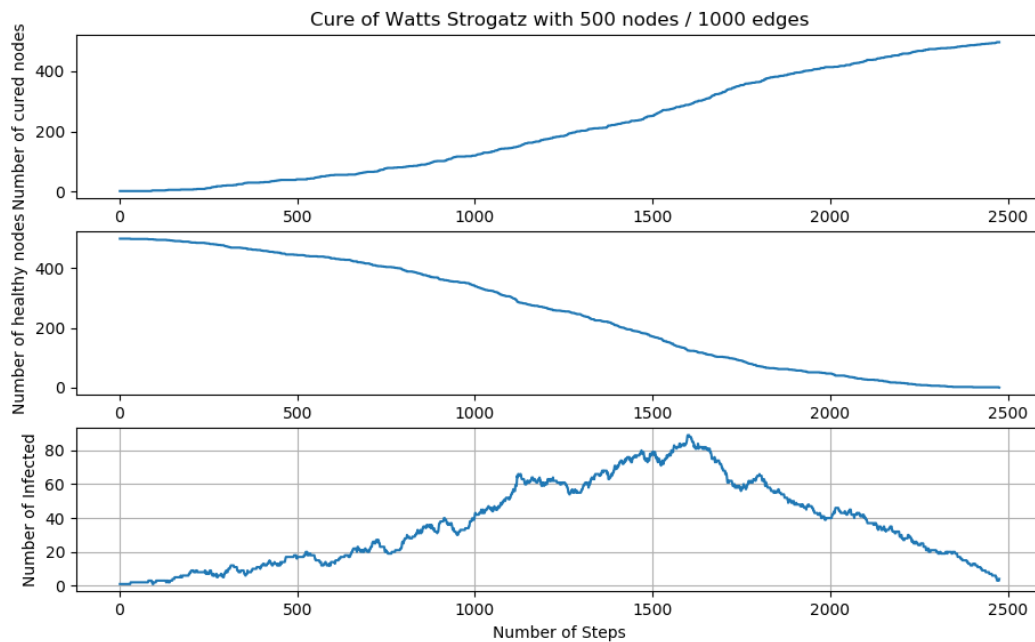


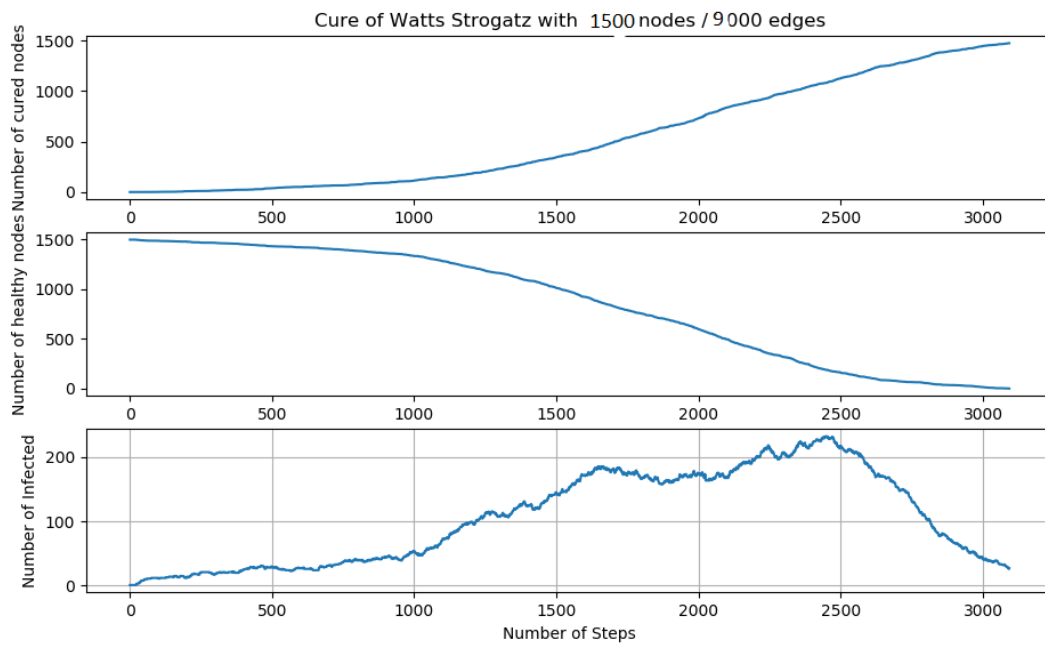
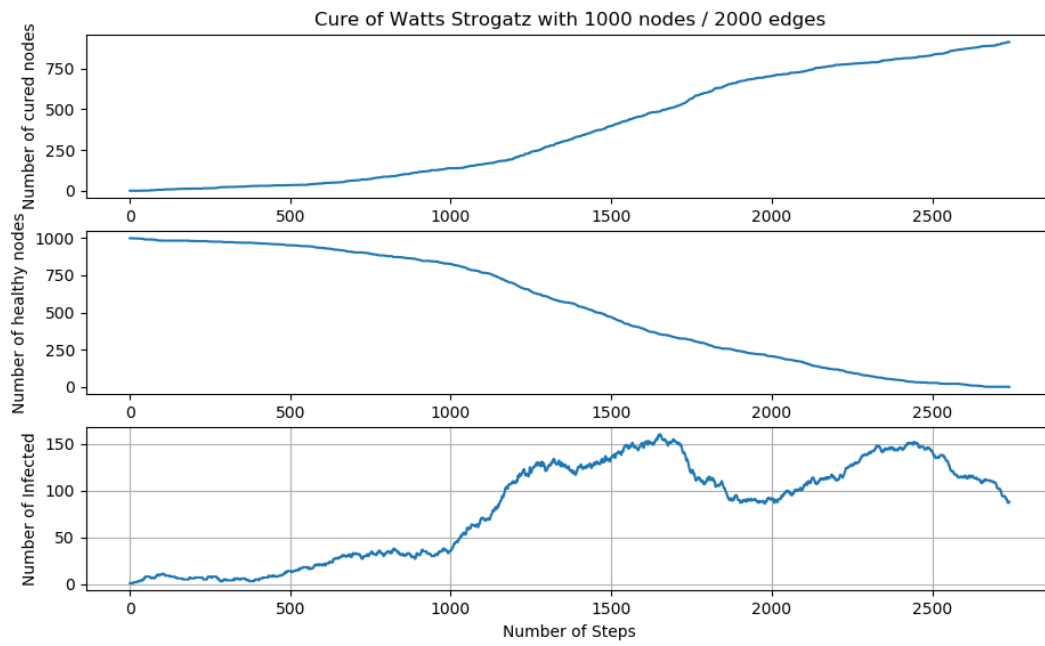


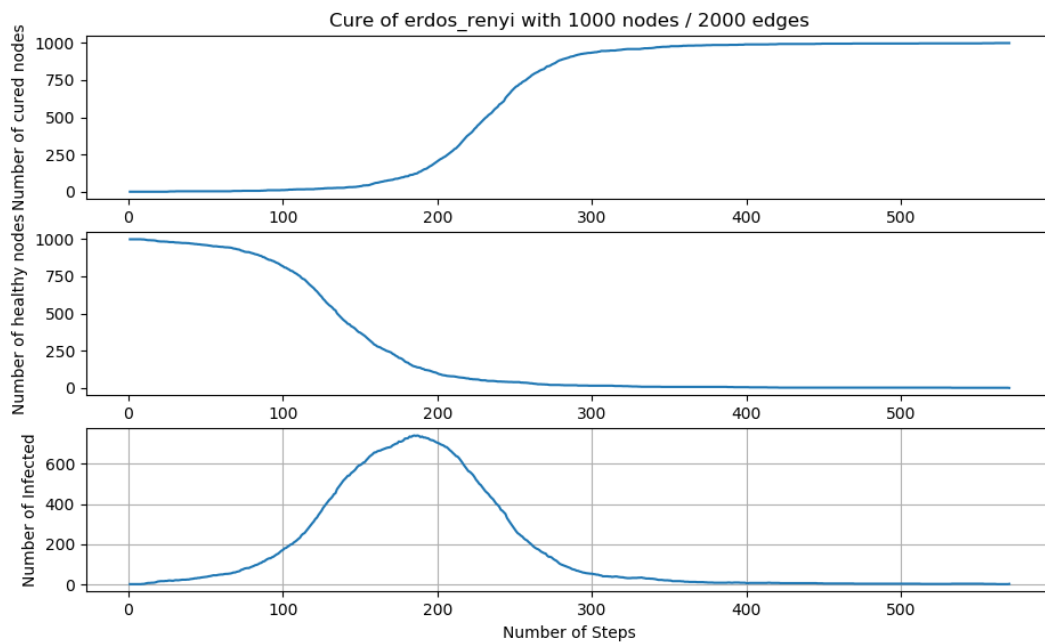
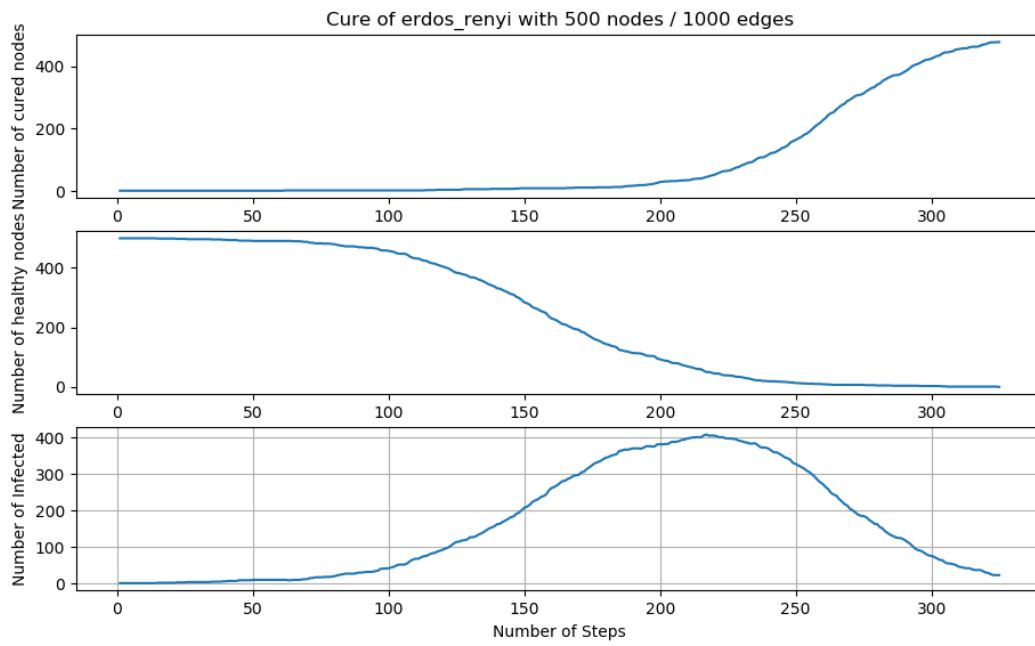
From above graph it can be clearly seen that as time increases the number of affected node also increases. All the graph reflects S-Shaped curved. The graph represents the worm infects exponentially at the beginning and after some time it gets saturated and remain nearly constant. Moreover, as the number of edges increases the time taken by worm to propagate reduces as it simultaneously infects multiple child node and more and more nodes will get affect at same time. Also, the graphs indicate that as the number of nodes increases the time taken by nodes to propagate also increases.

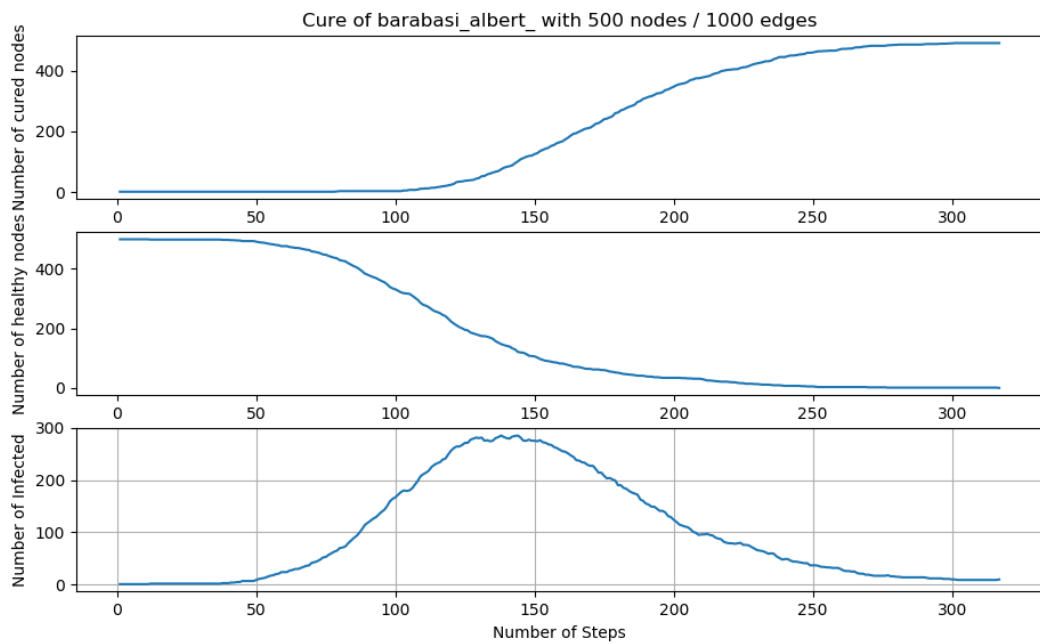
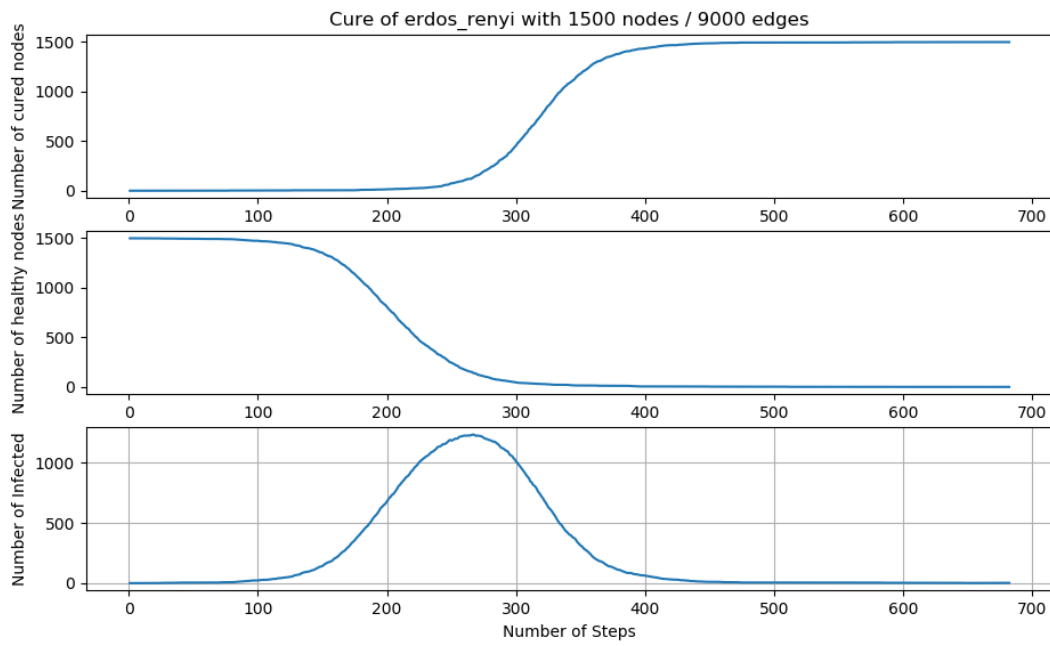
b)

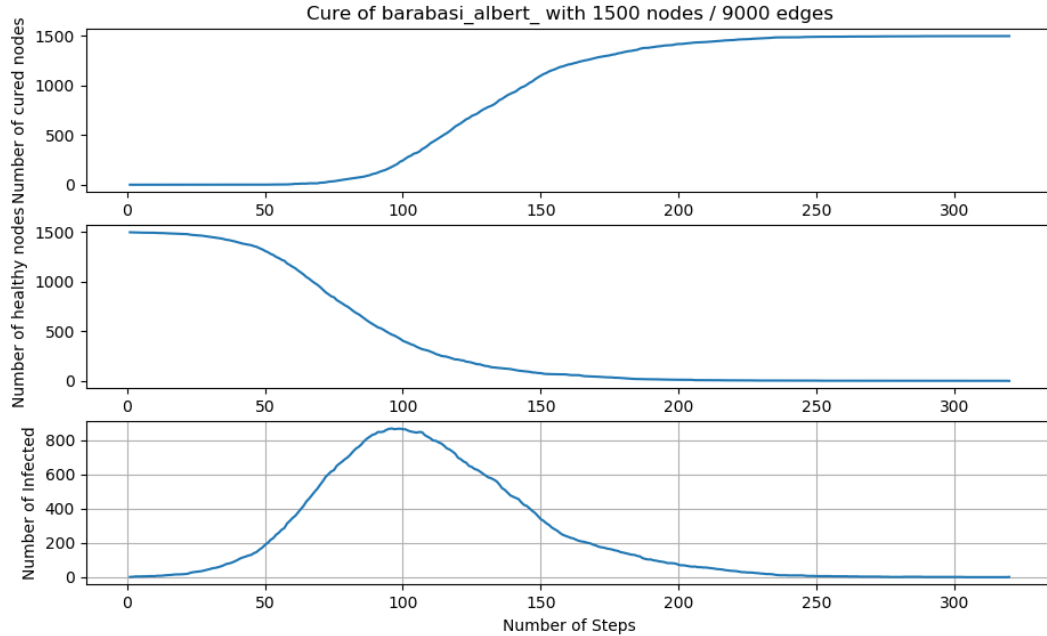
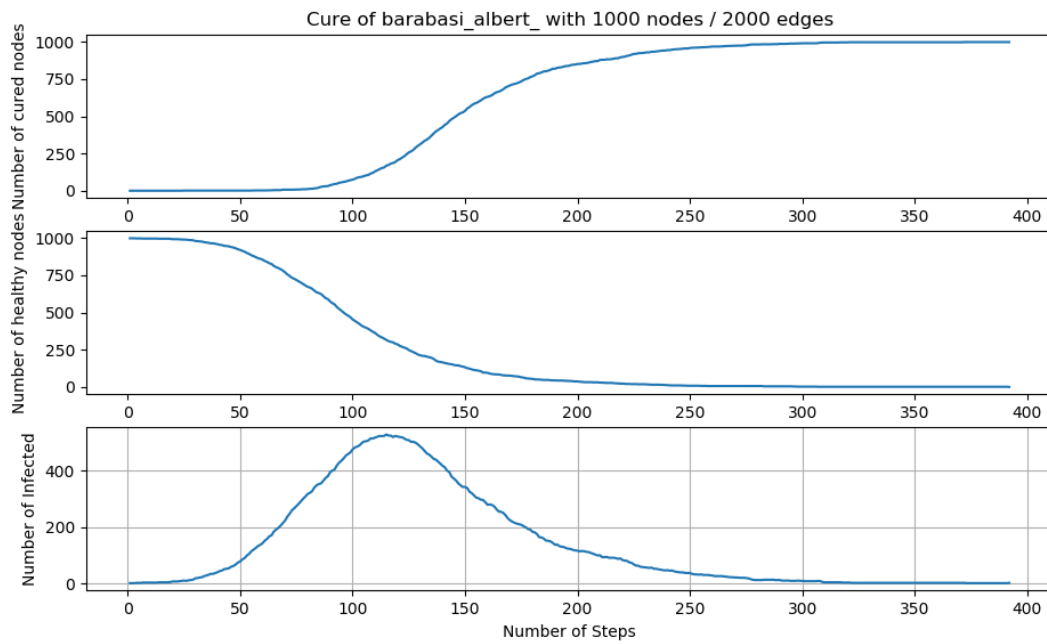
The second program is intended to cure the infection spread by first by first worm. The defense program propagates simultaneously in the network to cure the infected nodes. The graph below shows the infected nodes, healthy nodes and cured node for each node size and edges for each of the three networks. As the time increases the graphs represents S shape curve. The probability of curing the node will be different from affecting it.











From the above graph it is clearly seen that when the cure program is propagated into the network the process of infecting slows down as cured machine cannot be infected again. The above graphs show that when the cure program is applied the maximum number of node affected at its peak are lowered. The Watts-Strogatz network spread the worm and cure slowly into the network.

c)

From the above diagram it is clear each network type takes different time to propagate infection because they have their own time for simulation. As we increase the probability the time taken by worm to propagate decreases because number of connecting edges increases which increases the spreading rate of worm. In Erdos Renyi network the nodes are connected randomly therefore each edge has individual probability of connecting the nodes not dependent on other edges. Watts-Strogatz network is made from clustering property. It maintains short average path length. Watts-Strogatz network takes highest time to spread the worm as well as to cure the worm due to its unrealistic degree distribution caused by clustering property. Barabási–Albert network is a scale free network which utilizes preferential attachment mechanism. This network has least spreading time and curing time due to few nodes with high degree compared to others.

d)

From the above result in the form of graphs clearly reflects that the type of network has Influence on spreading mechanism of worm. The key idea from above result we can provide is that to put the cure program in the node/machine which has highest number of nodes so that it will take least time to cure the infected nodes as the cure will be simultaneously propagated to multiple nodes. The simulation also indicates that the placement and probability play important role in cure spreading. For the Online Social Network OSN the highest important node (highest Page Rank Score) must be chosen for curing as highest Page Rank machine will have highest number of connections.

References:

Wikipedia.