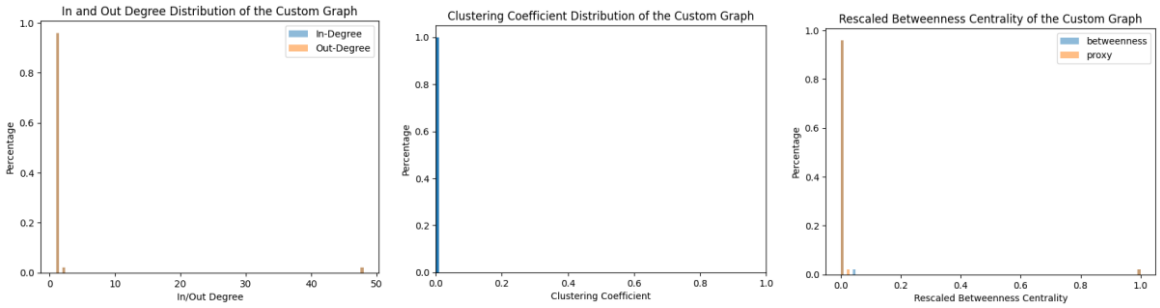
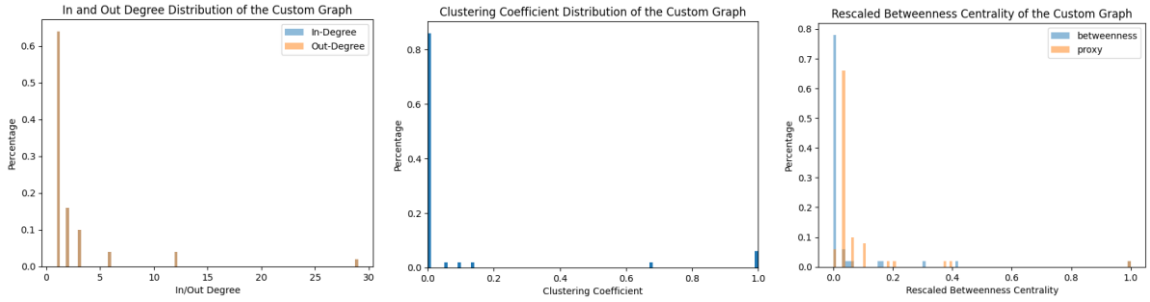
Question 3

a)

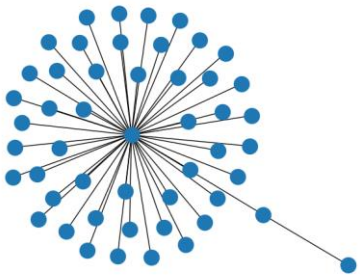


b)

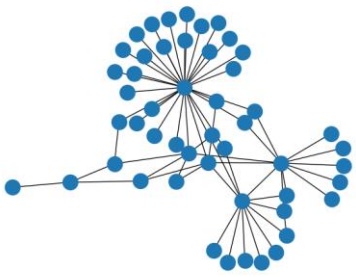


From our current metrics used so far – namely degree distribution, local clustering coefficient, and betweenness centrality – we see that there isn't much difference between the two networks. We see from the degree and betweenness centrality graphs that in both networks almost all nodes have a degree of 1 and a betweenness centrality of 0. However, for network b) we notice that there is a slightly wider distribution in both plots than for network a). This is a result of the initial parameter m since it increases the interconnectivity of the graphs by adding more edges between nodes. Note, the in and out degree are equivalent since these are undirected graphs. Again, we also see that our proxy closely follows the true betweenness centrality distributions.

a)

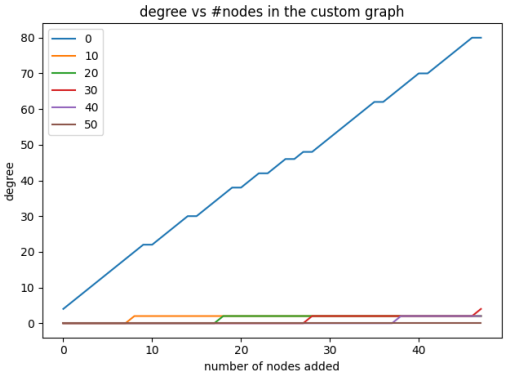


b)

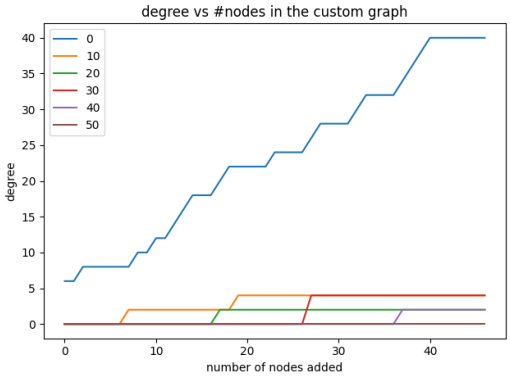


From the three graphs above, we observe that there are a few outliers. It is much easier to see these outlying nodes on a visual representation of our networks. We can easily verify that they have a high degree. We can also see that they have a high betweenness centrality since almost all shortest paths between nodes must pass through them. In fact, for a), all shortest paths between all but three pairs of nodes must pass through the one central node.

The biggest disparity between the networks is the clustering coefficient of these outliers. For a), the one central node has 0 centrality despite looking highly clustered around it – this is because none of the nodes in its neighbourhood are connected. On the other hand, for b), these central outliers have a much higher centrality. This is because of the increased interconnectivity of nodes in the neighbourhoods of these outlier since b) has a higher value of m which adds more edges.



a)



b)

Much like in the previous questions, we notice a (very strong) preferential attachment property. This is because new nodes select neighbours of an existing node chosen uniformly at random to attach to. This is equivalent to preferential attachment with respect to the degree of the node. Since nodes with a high degree have lots of neighbours, when a node is chosen uniformally at random, it is more likely to be one of its neighbours, thus giving it another neighbour and increasing its degree.

This is also due to the small size of the initial networks (2 and 3 nodes for a) and b) respectively). This allows for the neighbours of one of the initial nodes to quickly become a large proportion of the total number of nodes thus causing this preferential attachment property. Similarly, this is also due to the small values of m (1 and 2 for a) and b) respectively). This ensures that the the neighbours of the preferentially attached node are more likely to be attached only to this node.