Andrew Curtis

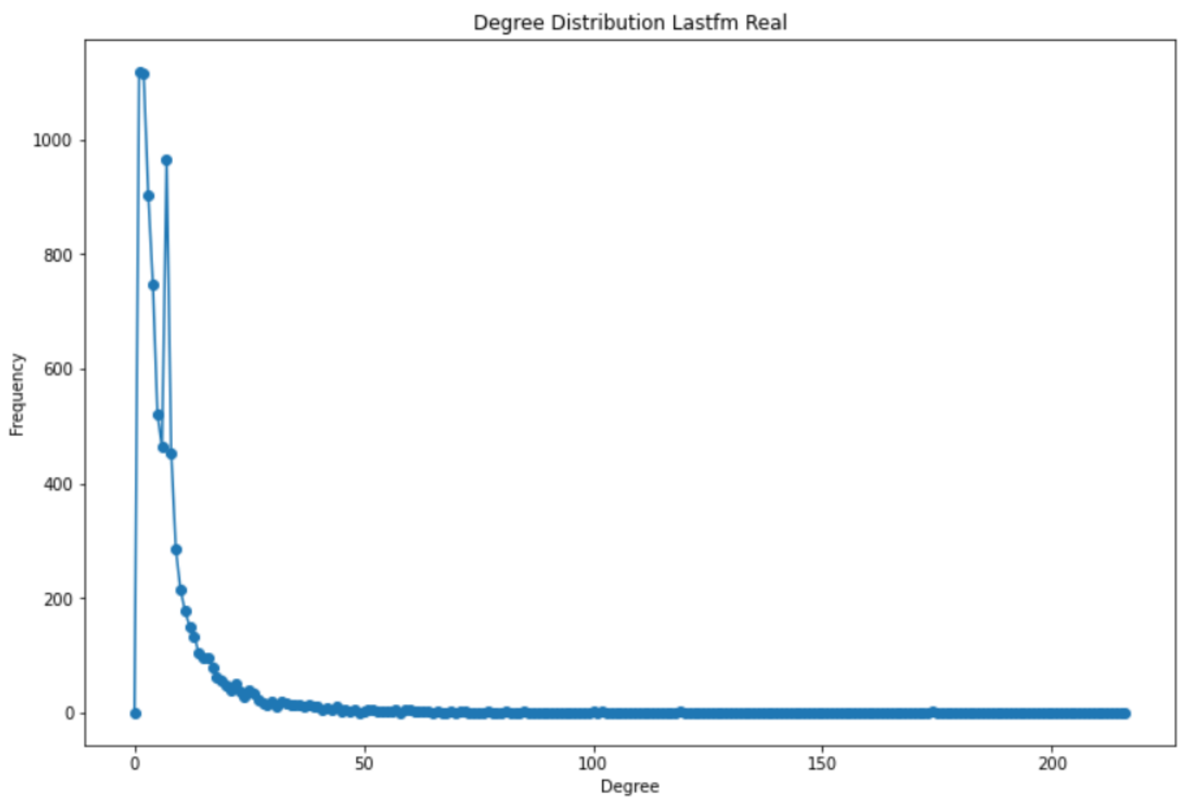
Problem 1

The random graph produced quite similar average node degrees to the real networks. The random graph was also fairly close on average path length but not exact. The biggest difference in the quantitative measures was a significantly lower clustering coefficient.

In terms of the graphs, the random graphs have a roughly gaussian distribution of node degrees centered about on the mean of the average degree of the real graphs. Whereas, the real graphs follow a power law distribution for node degree.

Real and Random Graph Generation

	Real-world network			Simulated random graph		
Network	Average Degree	Avg Path	CC	Average Degree	Avg Path	CC
Lastfm	7.294	5.232	0.2194	7.300	4.725	0.0009
Twitch	9.914	3.678	0.1309	9.889	4.127	0.0013



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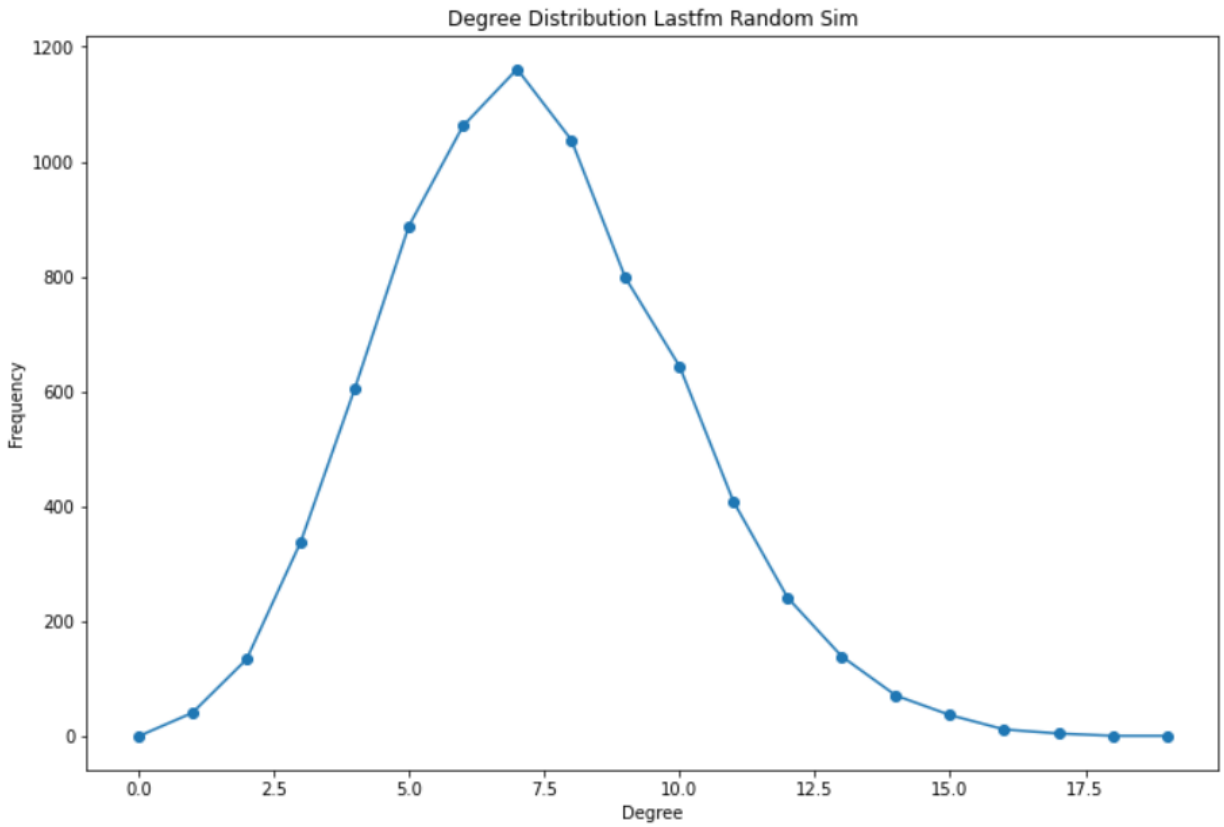

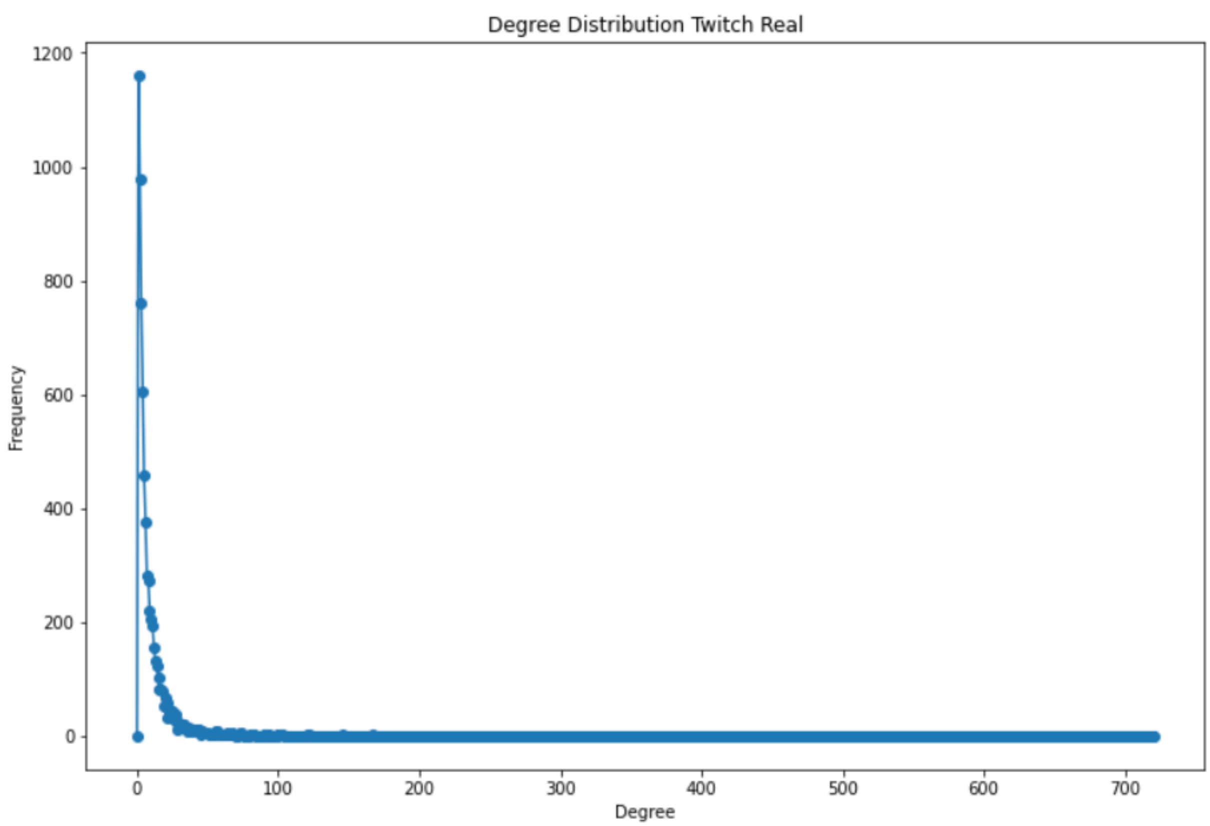

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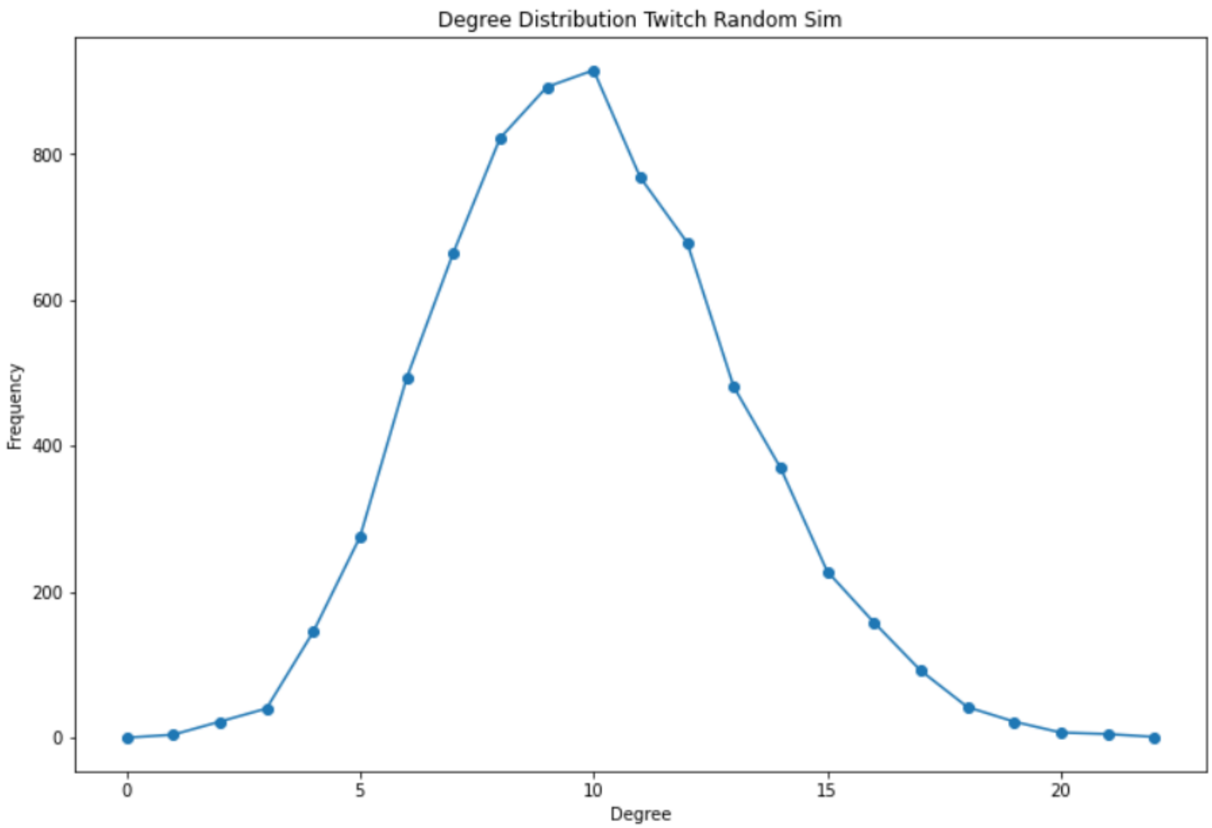

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Problem 2

The Preferential attachment graphs also produced quite similar average node degrees to the real networks. The Preferential attachment appears to be even better at producing similar average shortest path lengths to the real networks. The clustering coefficients are still a little low for preferential attachment compared to the real networks but much closer than the random graph.

In terms of the graphs, the preferential attachment has a very similar appearance to the real networks. They follow the power law distribution and are almost indistinguishable at least for this chosen value of t addition.

Real and Preferential Attachment Model

	Real-world network			Preferential attachment graph		
Network	Average Degree	Avg Path	CC	Average Degree	Avg Path	CC
Lastfm	7.294	5.232	0.2194	7.904	4.854	0.166
Twitch	9.914	3.678	0.1309	10.811	3.638	0.094

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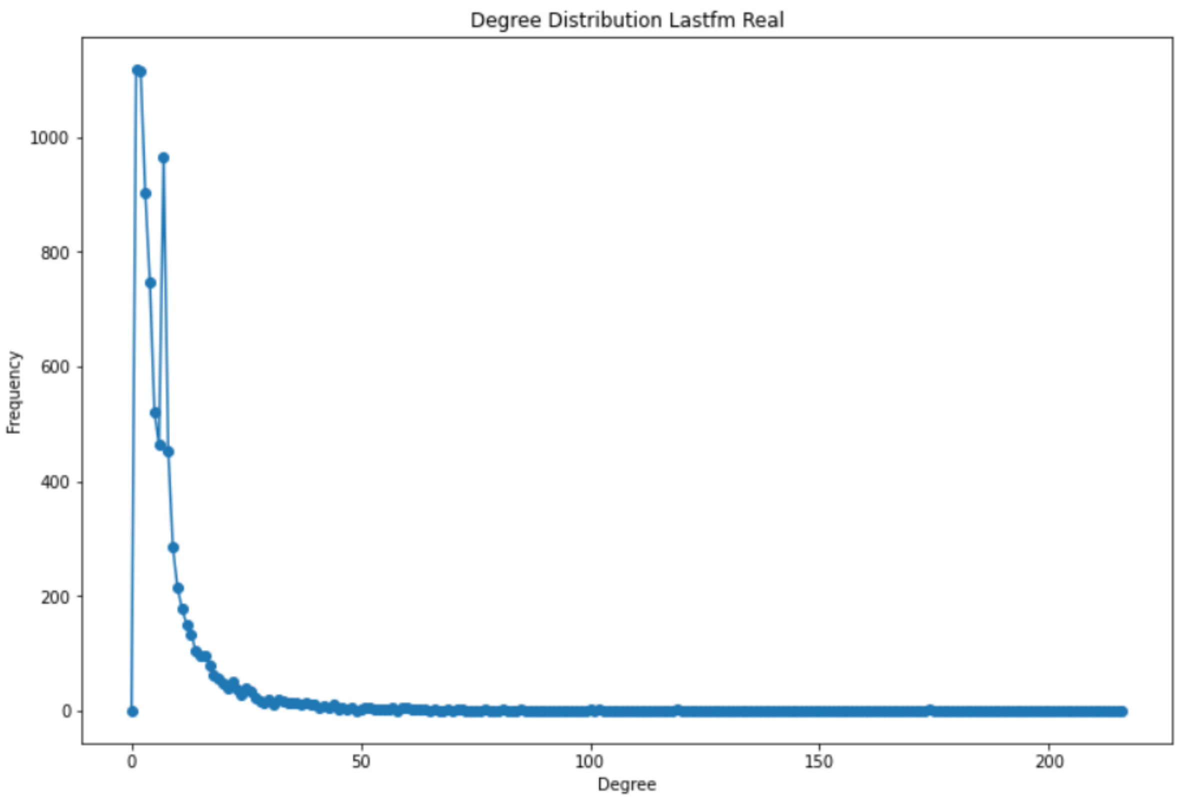

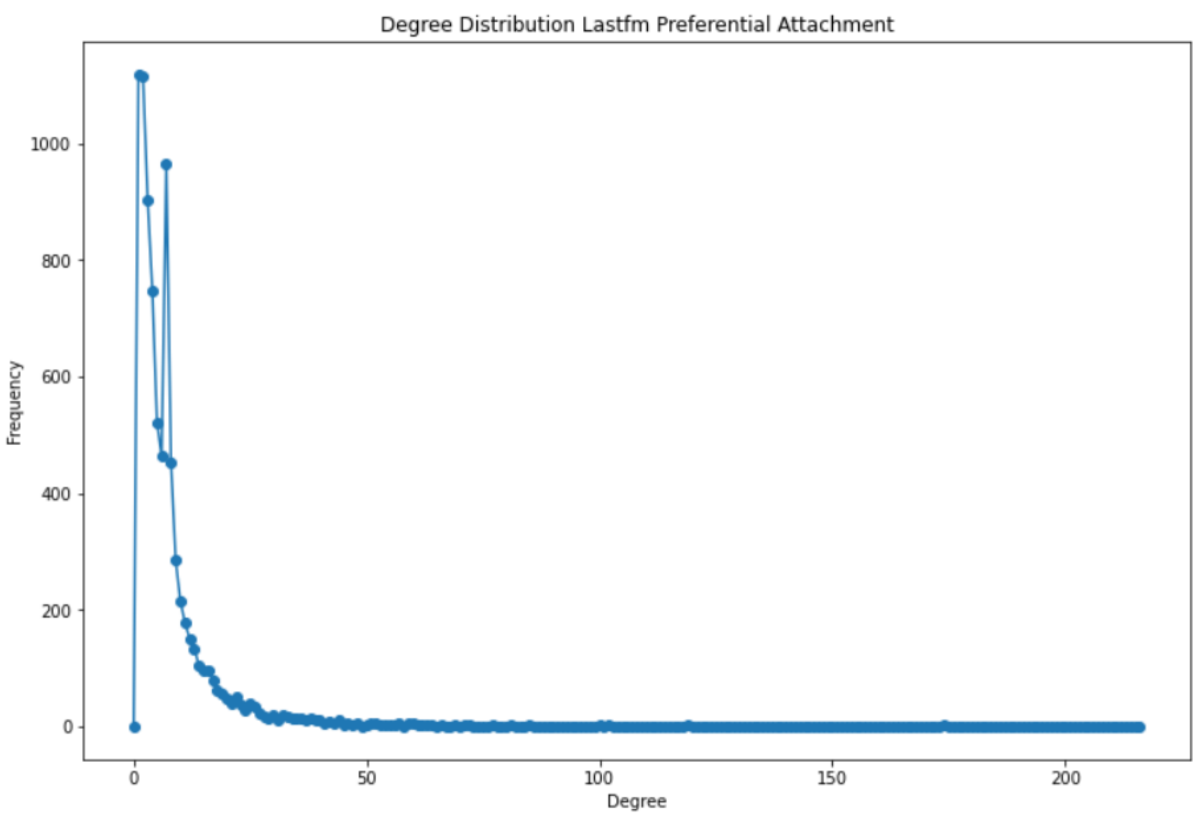

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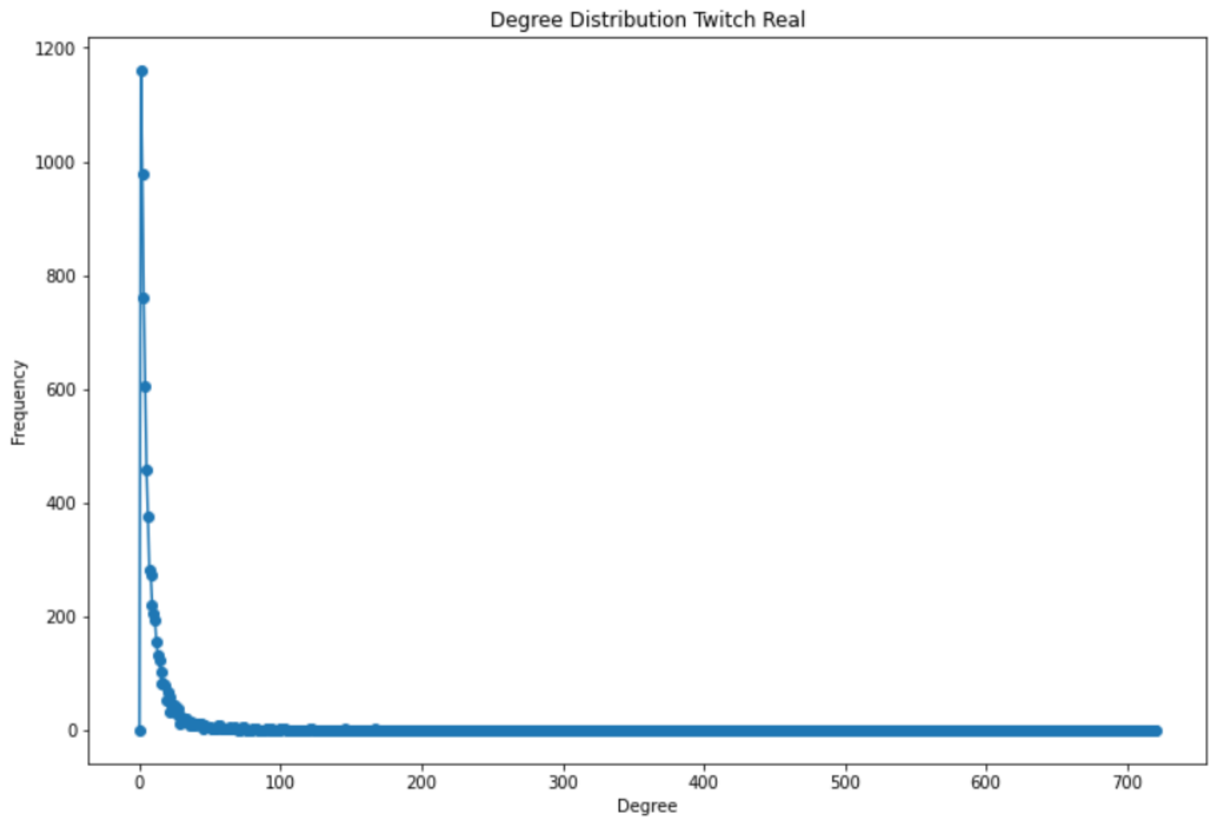

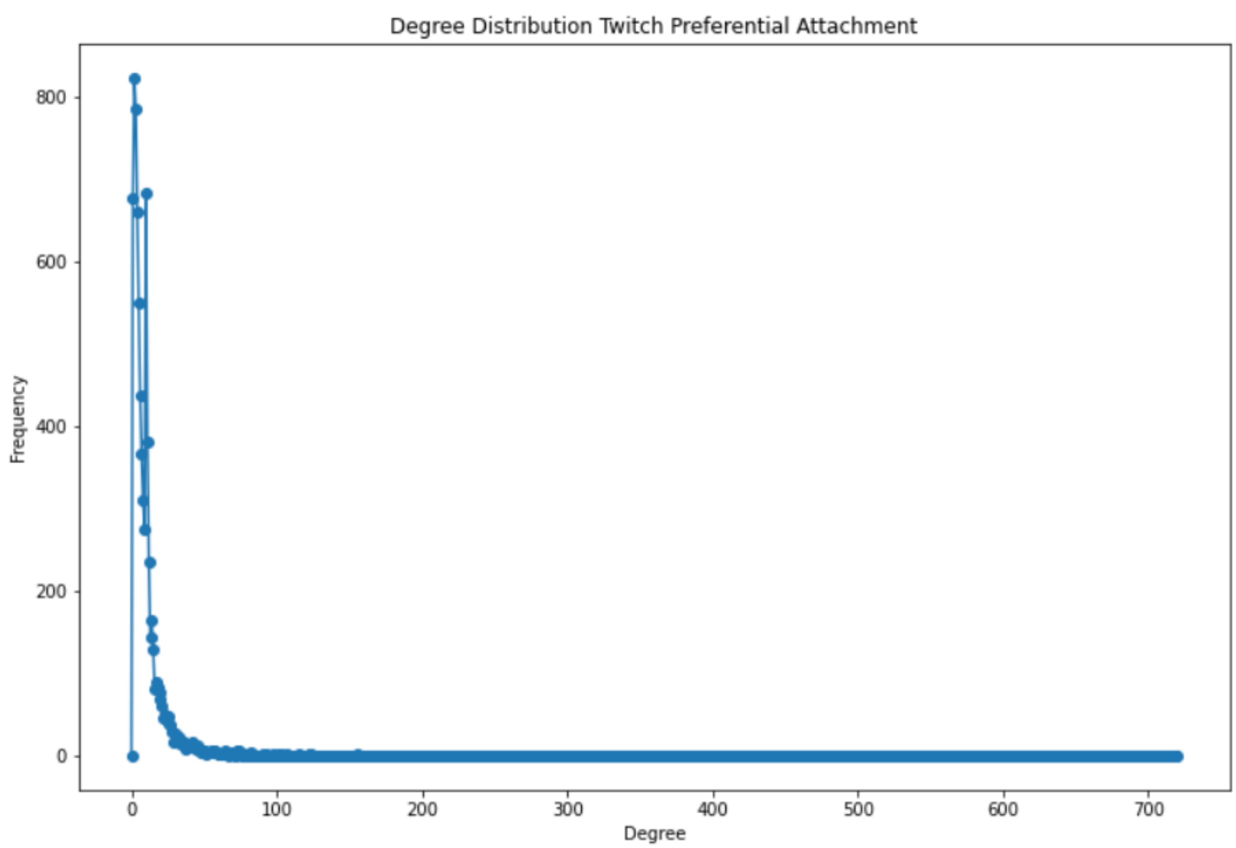

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Bonus Problem 1

For the quantitative measures, the small world model produces average degrees significantly lower than the real networks. The average shortest path lengths of the small world models are a bit higher than the real networks. The clustering coefficients are a bit lower than the real networks but still much higher than for the random graph approach.

For the graphs, the small world models are maybe roughly gaussian around the mean of the average degree of the small world. They have a little bit of a long right tail. However, they do not follow the power law distribution like the real networks.

Real and Small World Model

	Real-world network			Small World graph		
Network	Average Degree	Avg Path	CC	Average Degree	Avg Path	CC
Lastfm	7.294	5.232	0.2194	4.002	7.491	0.0998
Twitch	9.914	3.678	0.1309	4.008	6.975	0.0337

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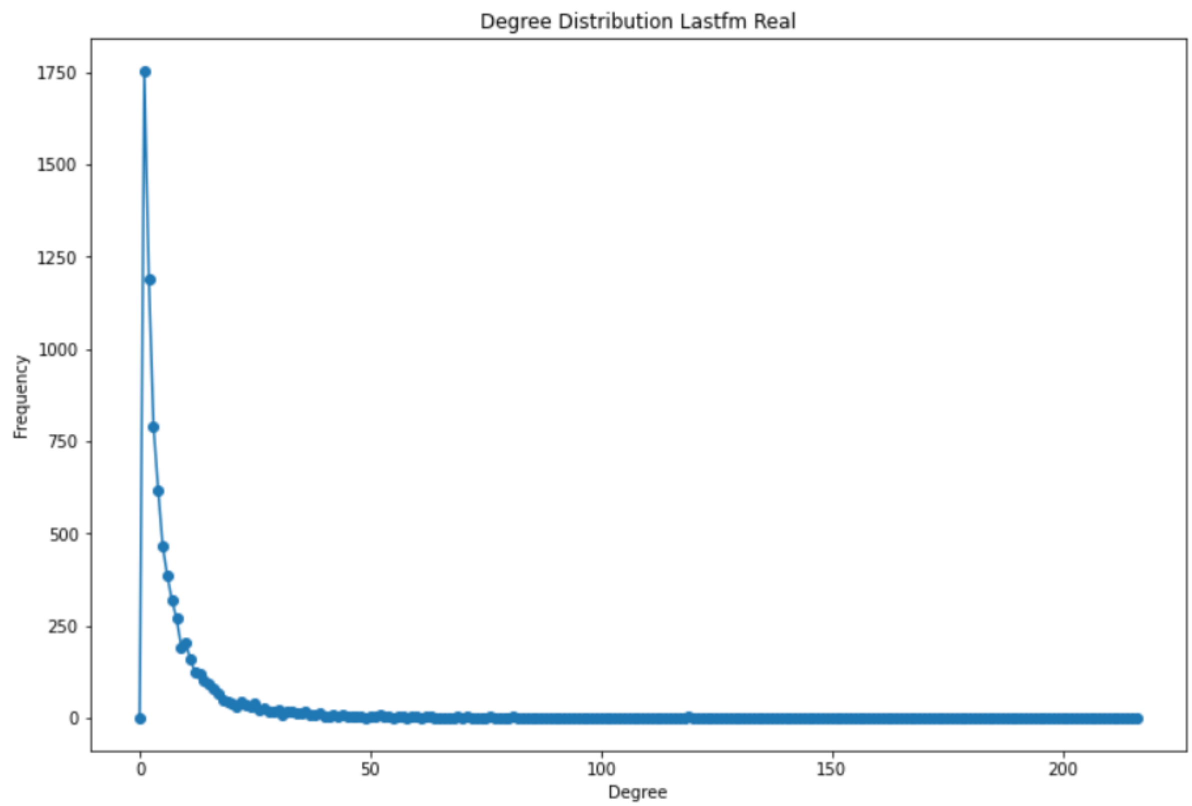

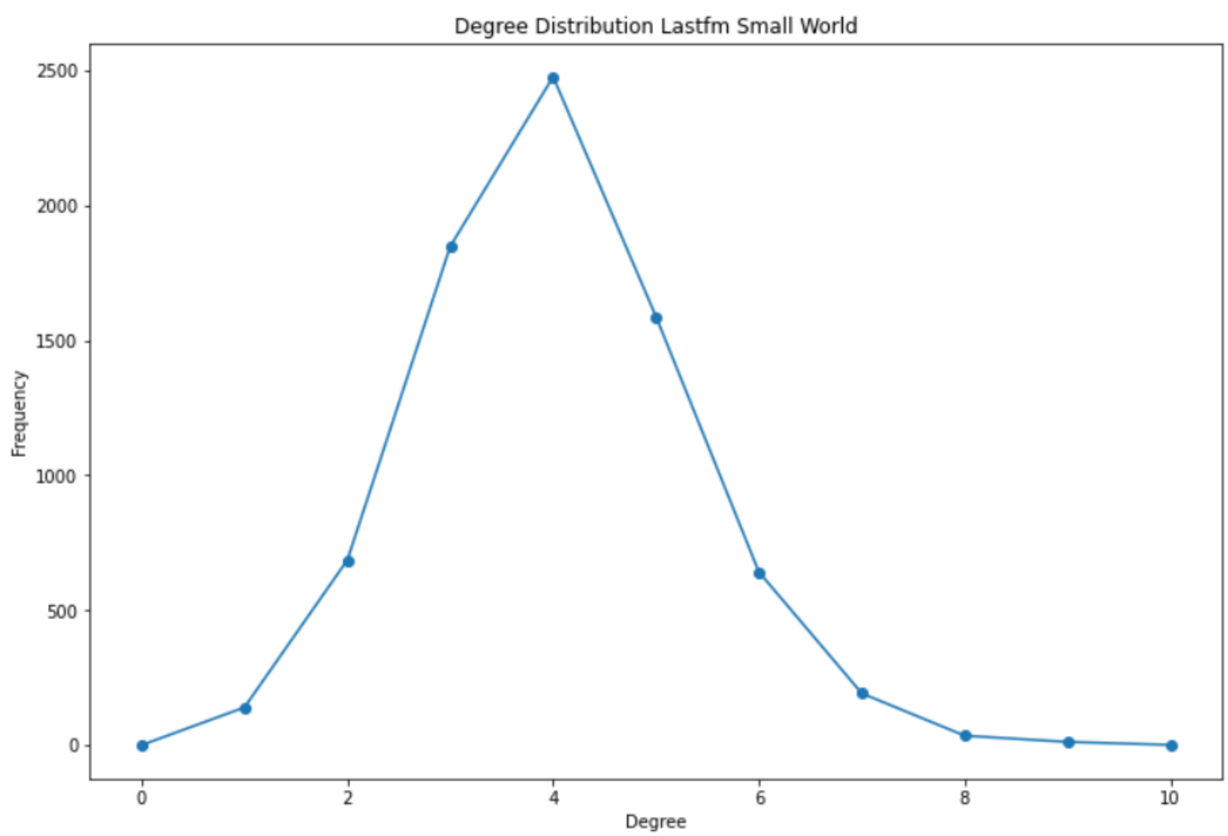

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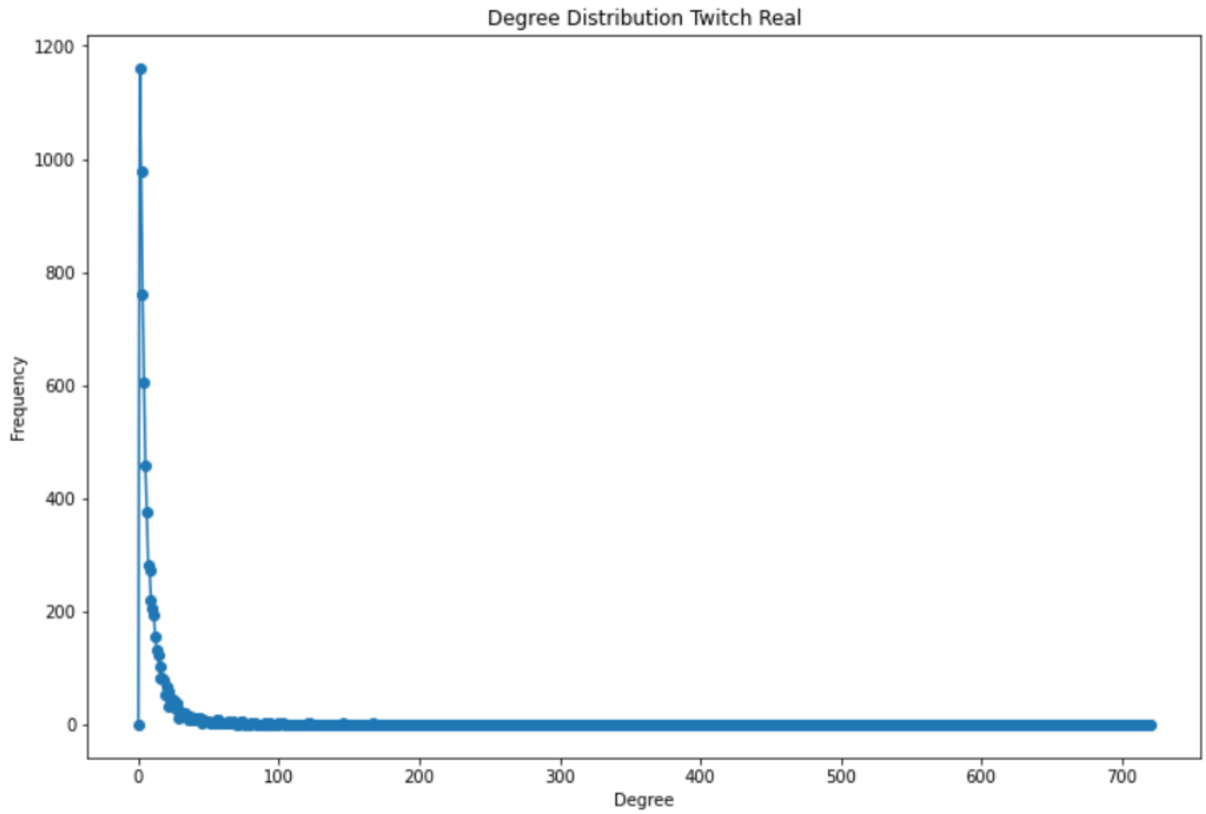

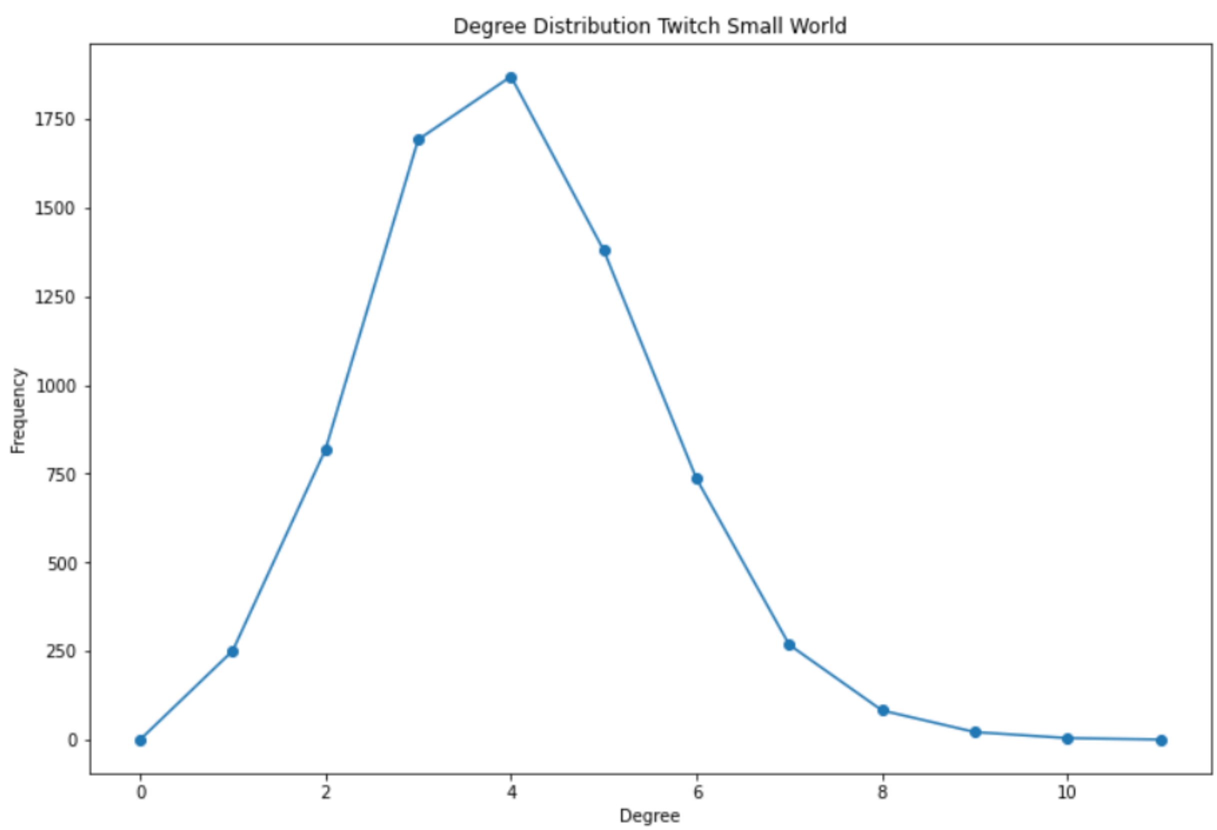

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Bonus Problem 2

For random graphs, the first phase transition happens when the average node degree is about 1. This is because the giant component has begun to arise and the average diameter is about at its maximum before it begins decreasing too much. These factors together mean that the path lengths will be long.

Before this point, you would observe small, isolated clusters and small diameters. This equates to short path lengths.

After the first phase transition, almost all nodes are connected and the diameter decreases fairly rapidly before flatting out. As a result, path lengths shorten.