Barabási–Albert Model

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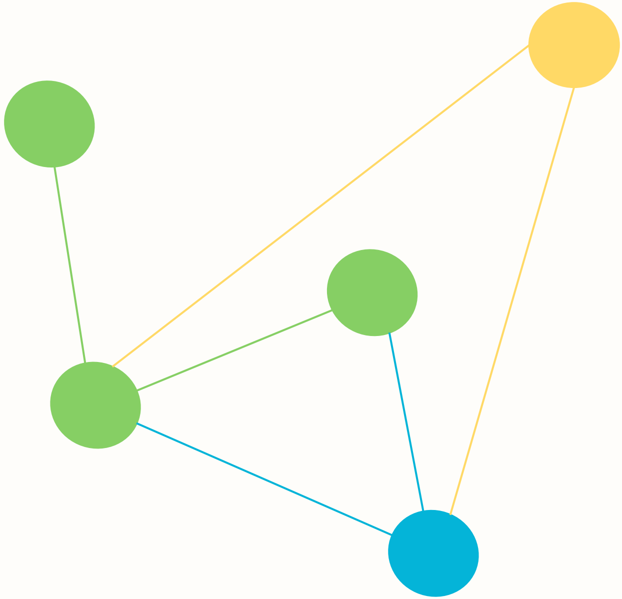
What is the Barabási–Albert model?

Barabasi-Albert model is an algorithm for generating random **scale-free** networks using a **preferential attachment** mechanism.

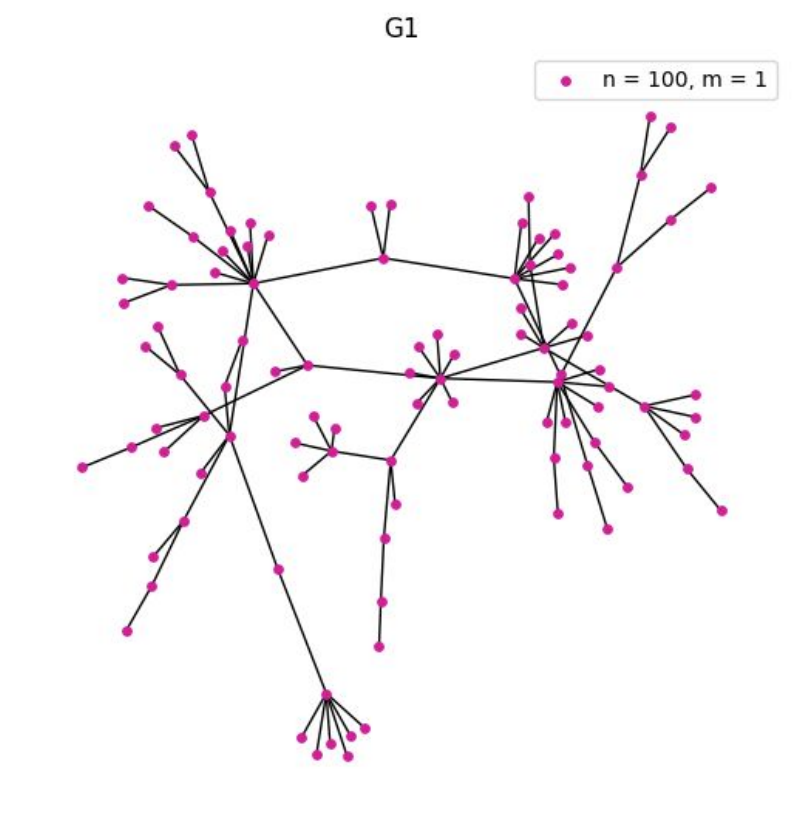
How is the Barabási–Albert model generated?



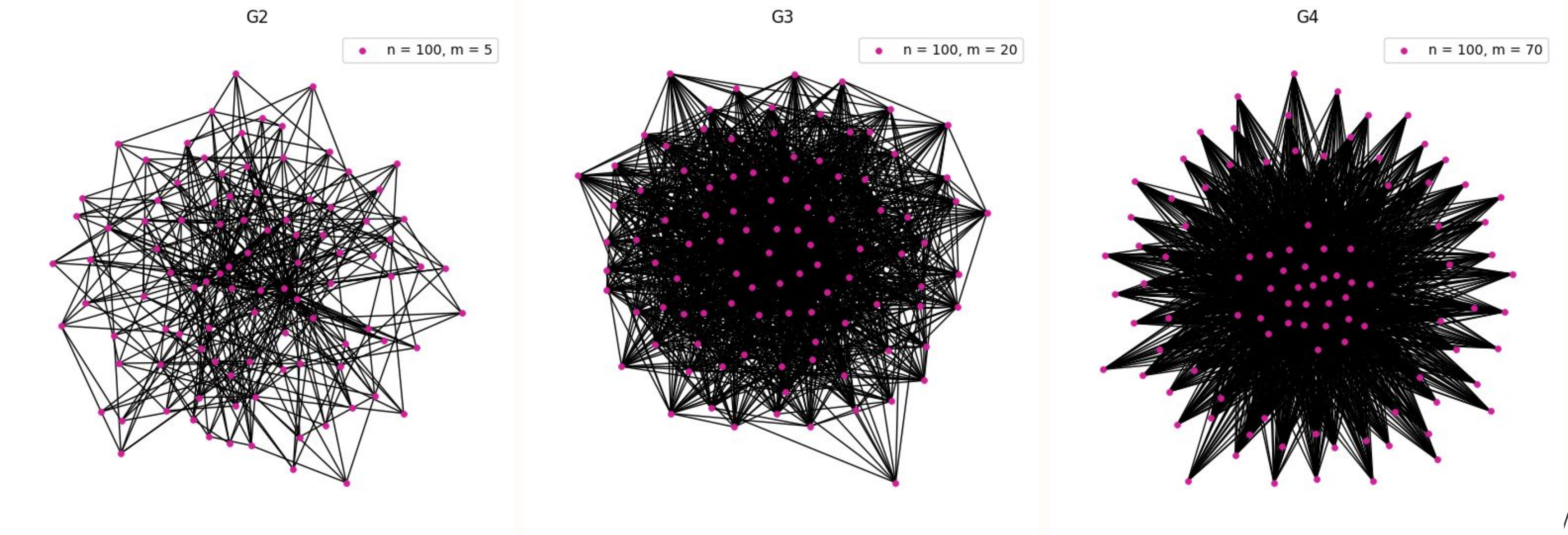
Phase 1

Introduction and Model Generation

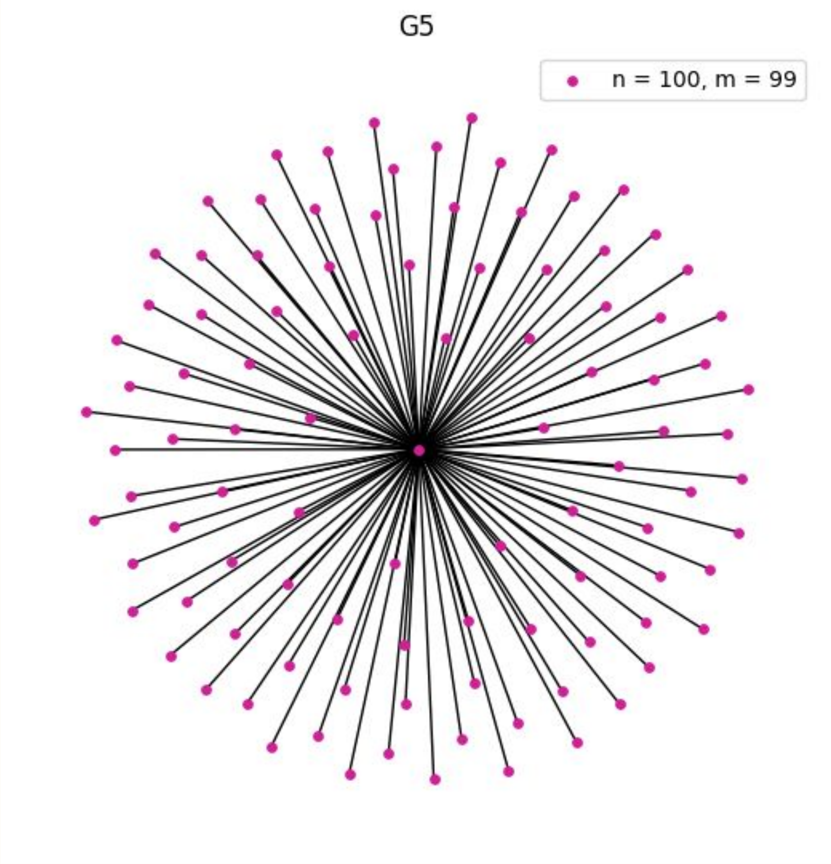
Task 1.1: Network Generation



Task 1.1: Network Generation



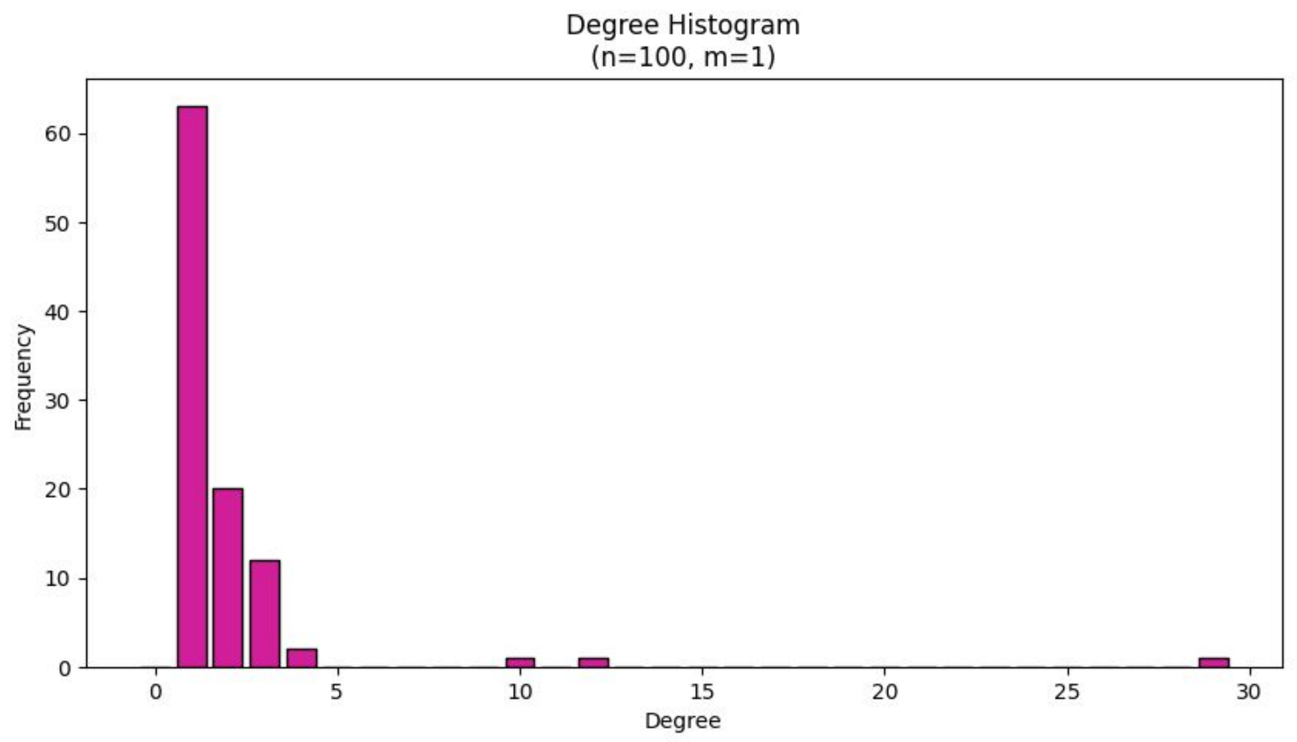
Task 1.1: Network Generation



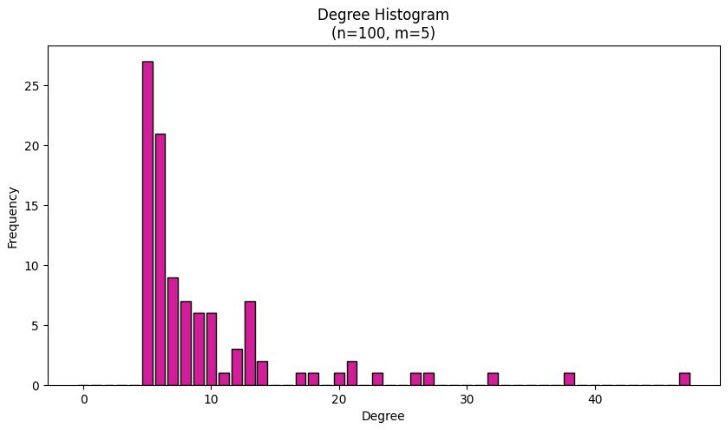
Phase 2

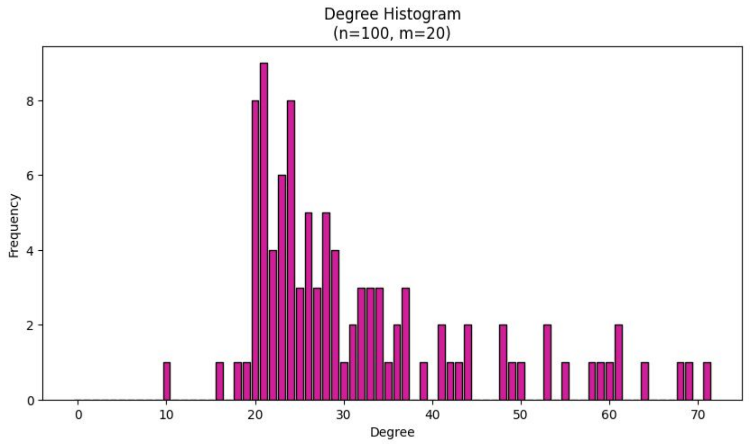
Structural Analysis

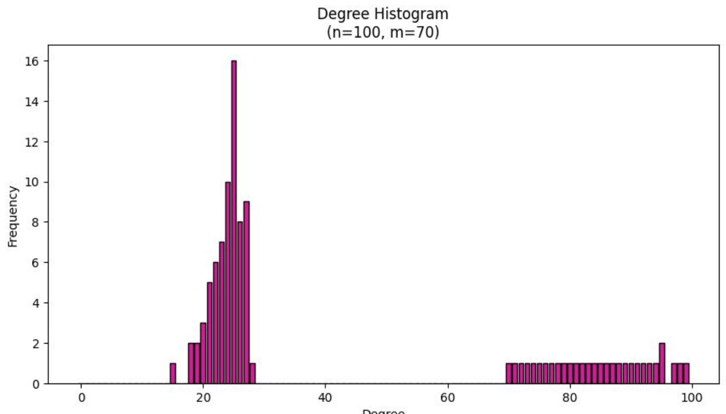
Task 2.1: Basic Metrics



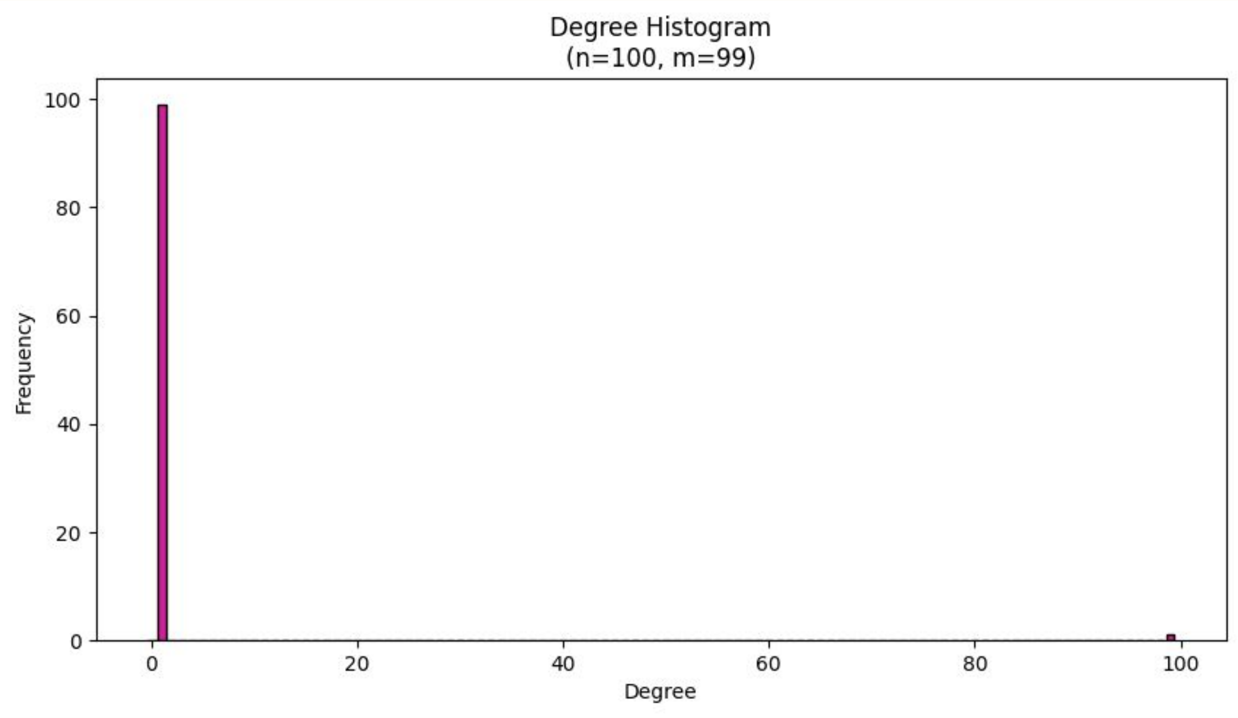
Task 2.1: Basic Metrics







Task 2.1: Basic Metrics



Task 2.1: Basic Metrics

	m=1	m=5	m=20	m=70	m=99
Average Path Length	5.37	2.22	1.68	1.58	1.98
Global Clustering Coefficient	0	0.15	0.41	0.55	0
Average Clustering Coefficient	0	0.18	0.44	0.84	0

Task 2.1: Basic Metrics – Closeness Centrality

	m=1	m=5	m=20	m=70	m=99
1st	0.31	0.62	0.81	1	1
2nd	0.3	0.59	0.74	0.99	0.5
3rd	0.28	0.57	0.72	0.98	0.5

Task 2.1: Basic Metrics – Betweenness Centrality

	m=1	m=5	m=20	m=70	m=99
1st	0.663	0.169	0.040	0.030	0.999
2nd	0.655	0.135	0.037	0.029	0
3rd	0.562	0.097	0.033	0.028	0

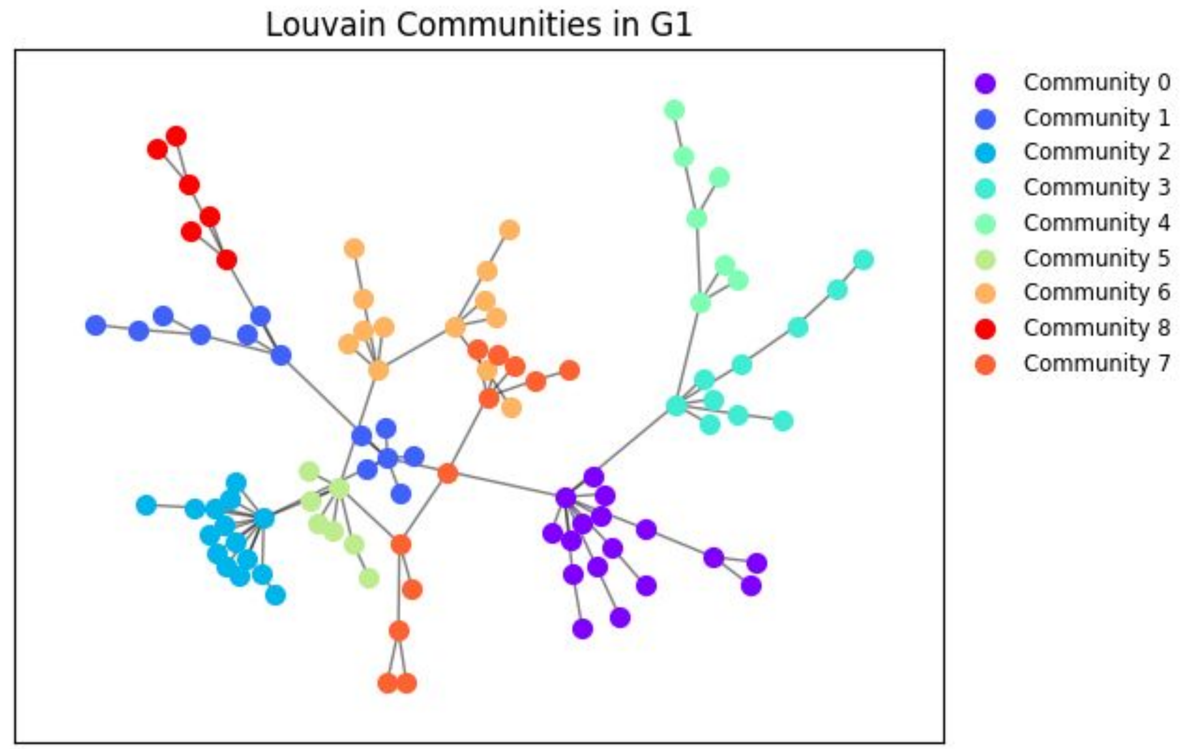
Task 2.1: Basic Metrics – Degree Centrality

	m=1	m=5	m=20	m=70	m=99
1st	0.141	0.384	0.768	1	1
2nd	0.121	0.303	0.657	0.99	0.01
3rd	0.081	0.253	0.616	0.98	0.01

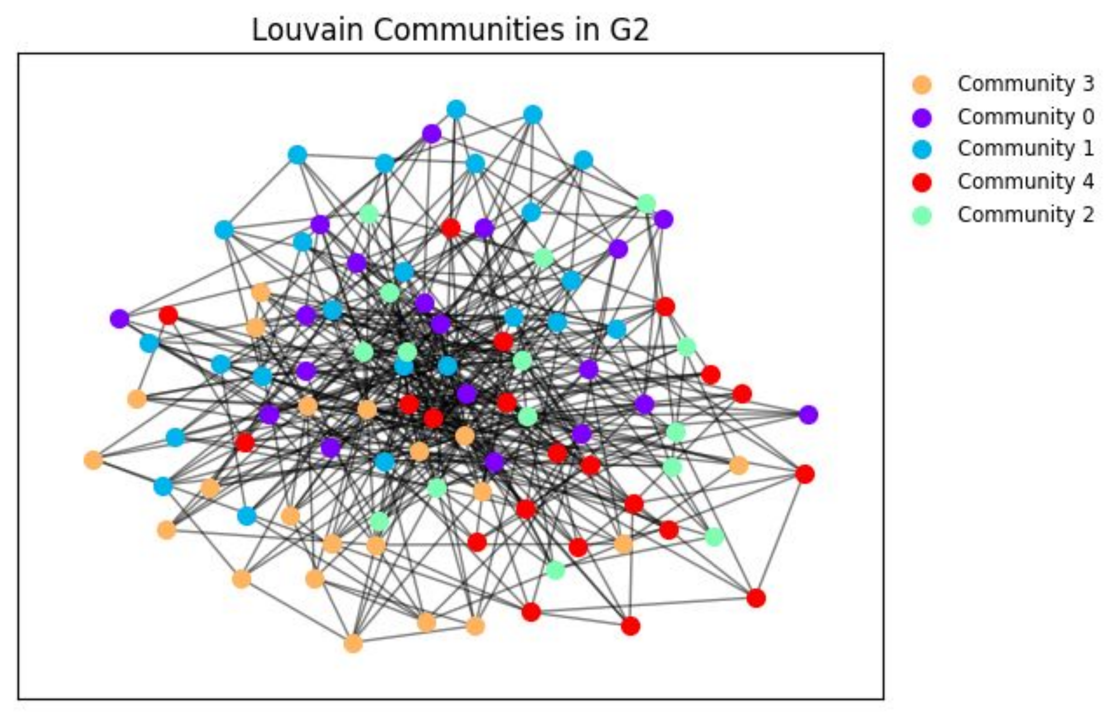
Task 2.1: Basic Metrics – Eigenvector Centrality

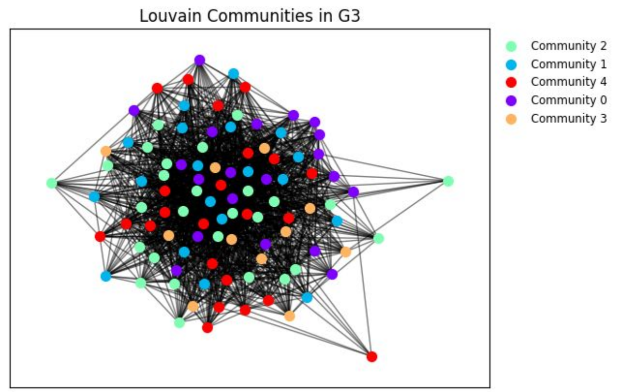
	m=1	m=5	m=20	m=70	m=99
1st	0.679	0.313	0.198	0.168	0.707
2nd	0.173	0.26	0.183	0.166	0.071
3rd	0.169	0.251	0.178	0.165	0.071

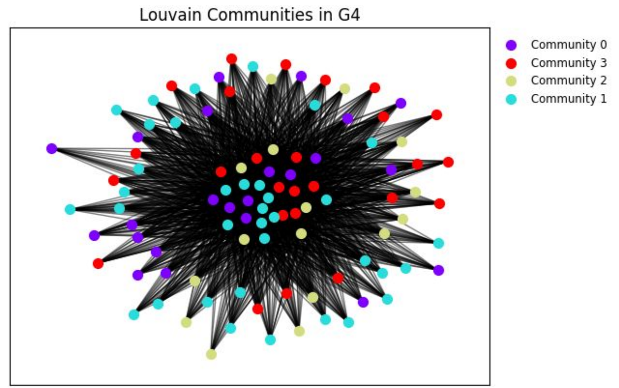
Task 2.2: Community Detection



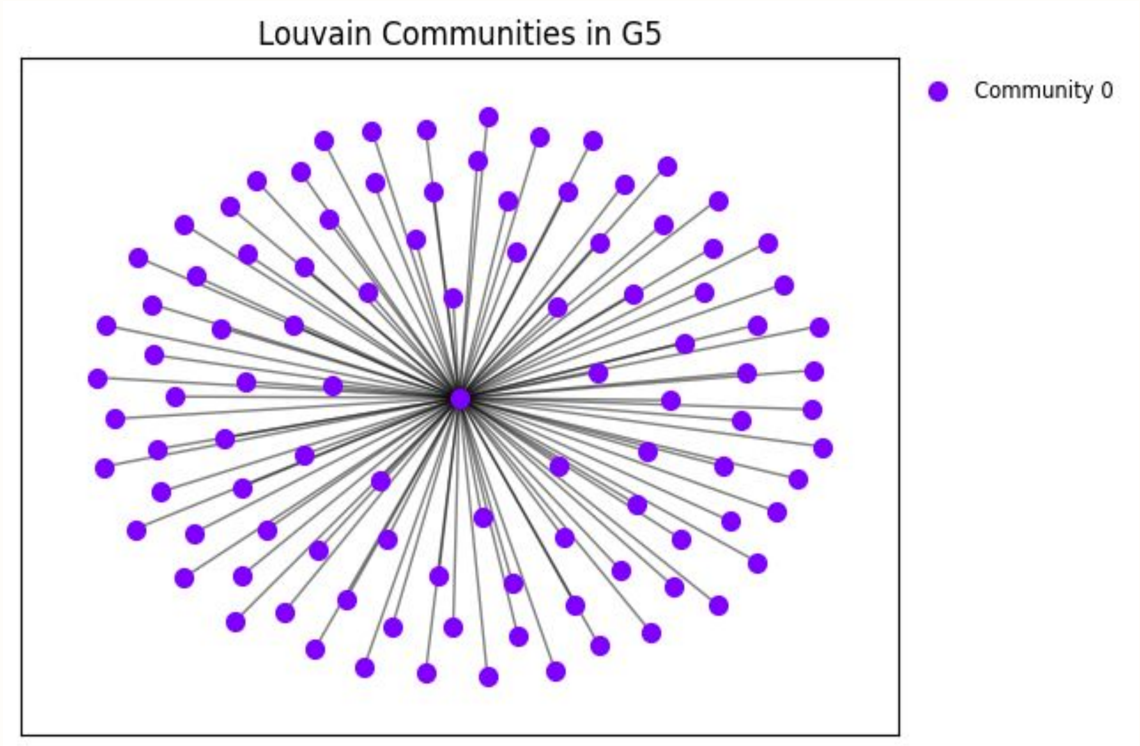
Task 2.2: Community Detection







Task 2.2: Community Detection

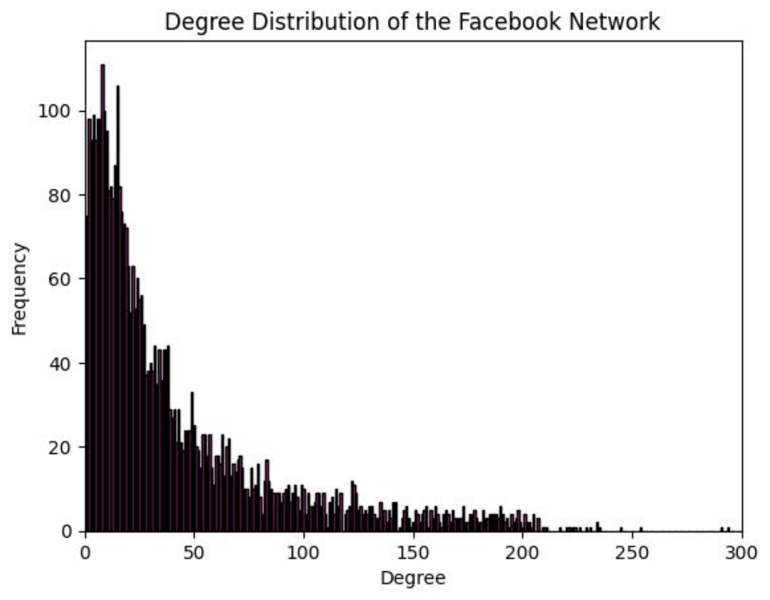


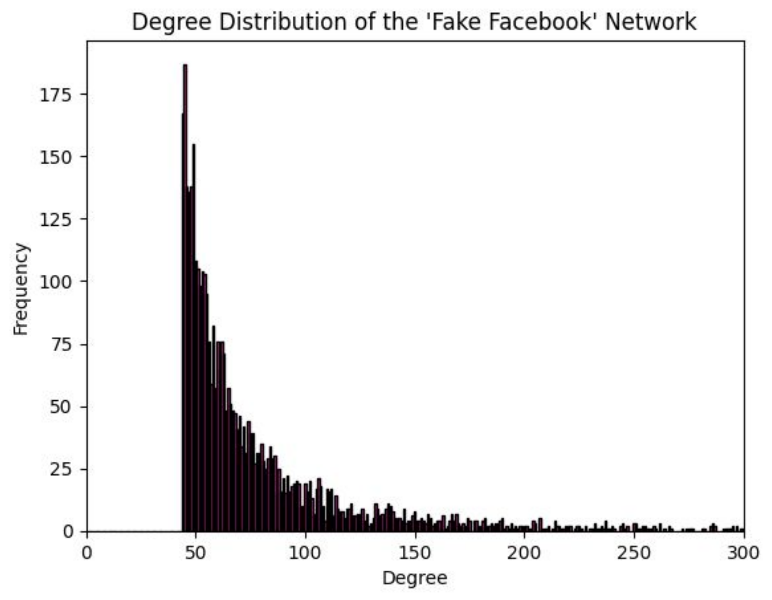
Phase 3

Real-World Data Application

Task 3.1: Comparison with Real-World Networks

- Facebook Network, 4039 nodes
- BA model with the same number of nodes and m = 44 (average connections per user in Facebook network)

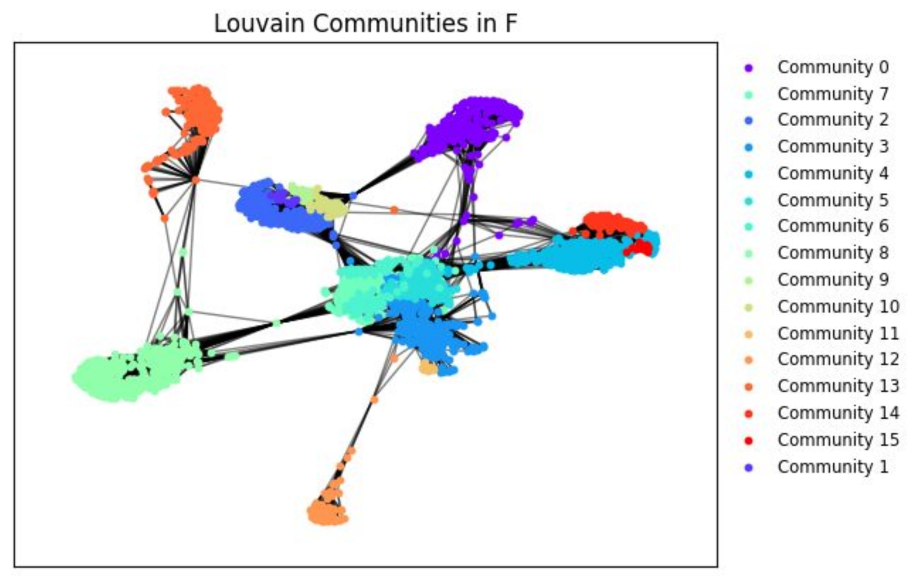


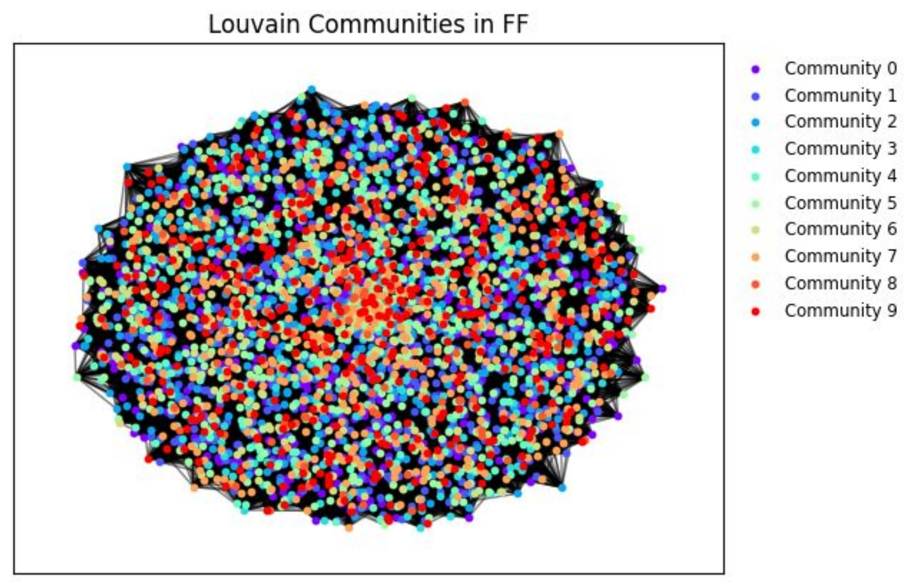


Task 3.1: Comparison with Real-World Networks

	Average Path Length	Global Clustering Coefficient	Average Clustering Coefficient	Diameter	Density
Facebook Network	3.69	0.52	0.6	8	0.01
BA Model	2.13	0.06	0.06	3	0.02

Task 3.1: Comparison with Real-World Networks





Phase 4

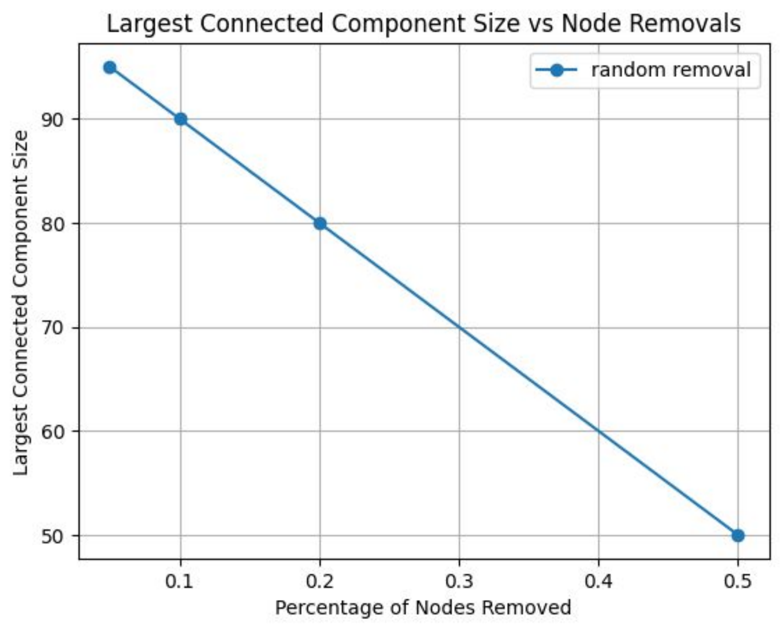
Advanced Analysis

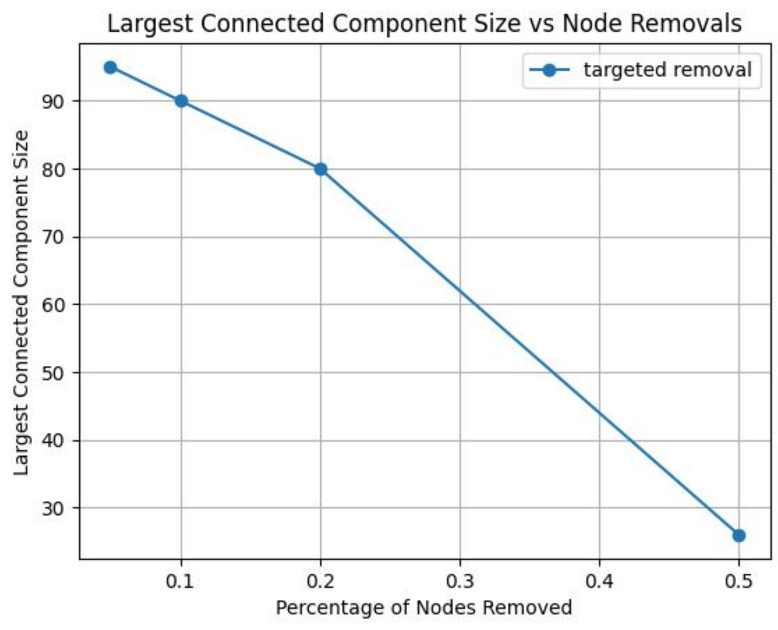
Task 4.1: Robustness Analysis

Removal of 5%, 10%, 20% and 50% random and targeted nodes from G2 (n=100, m=5) and showing the impact on the:

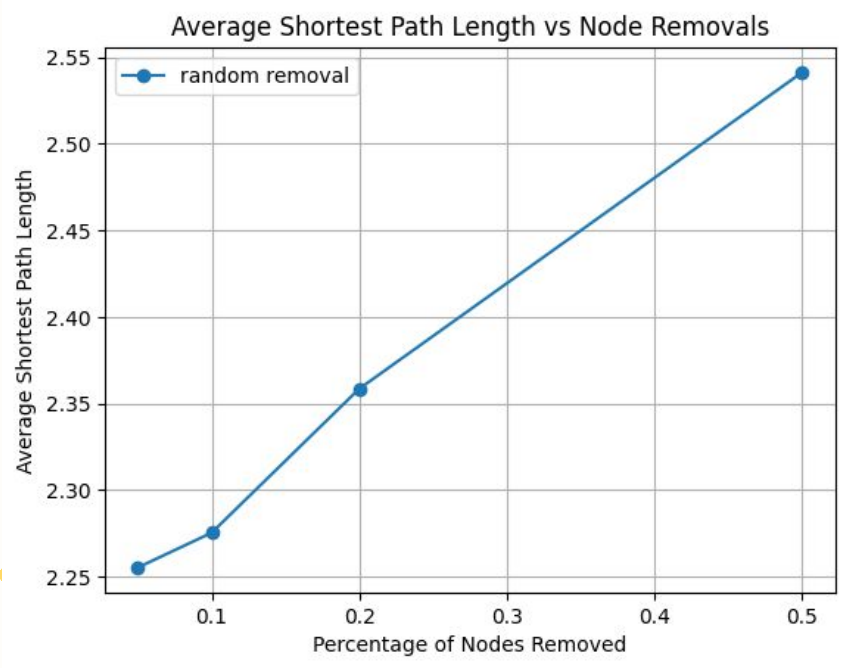
- Largest connected component
- Average shortest path length
- Density

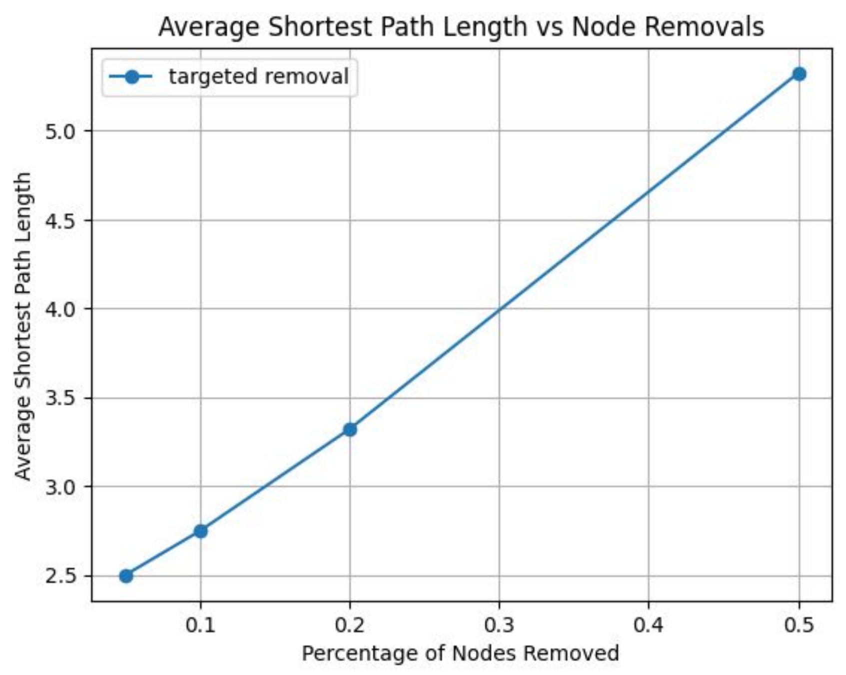
Task 4.1: Robustness Analysis – LCC



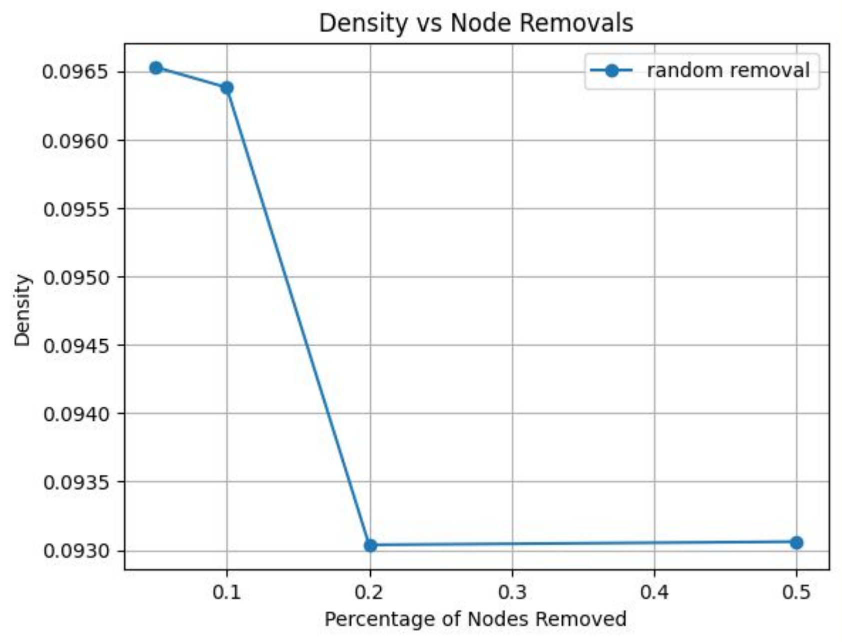


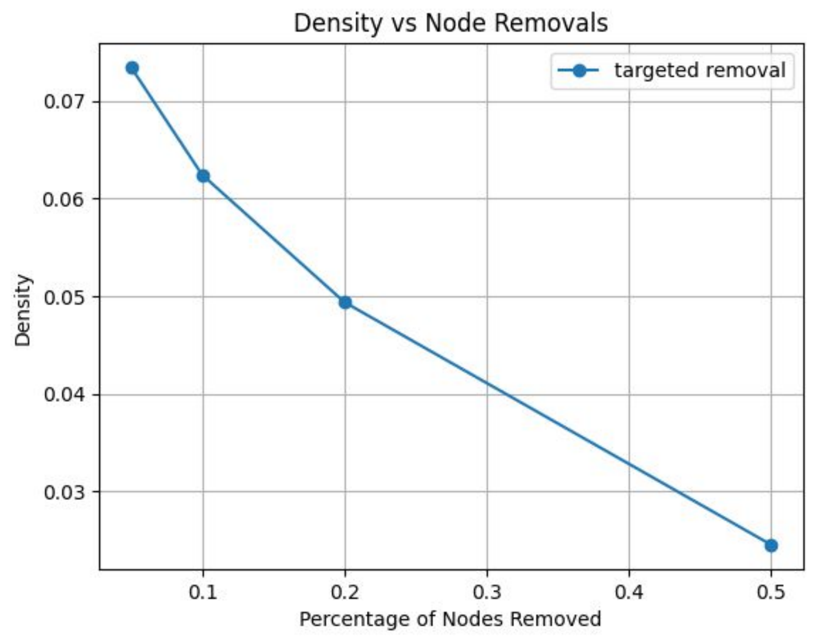
Task 4.1: Robustness Analysis – ASPL





Task 4.1: Robustness Analysis – Density





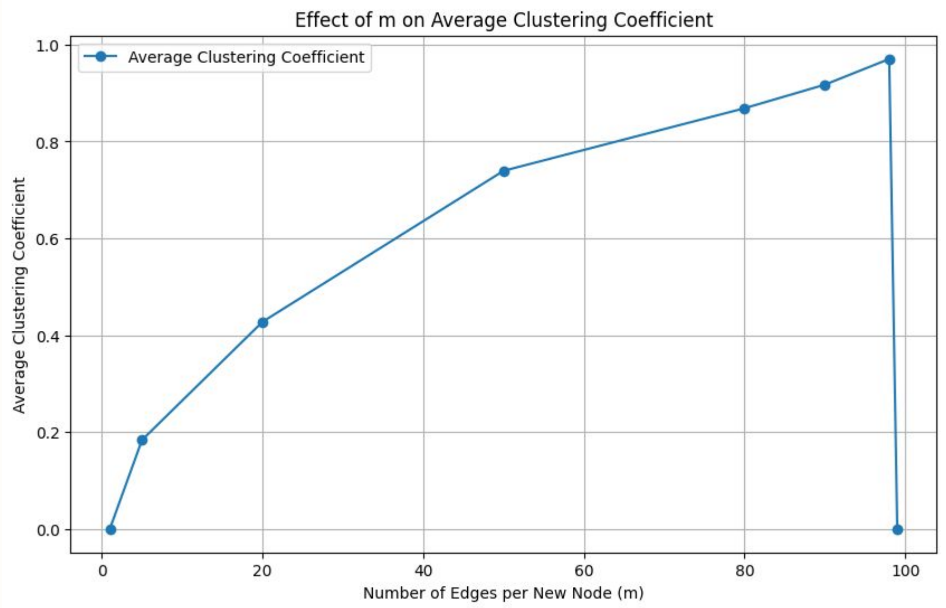
Task 4.2: Parameter Sensitivity Study

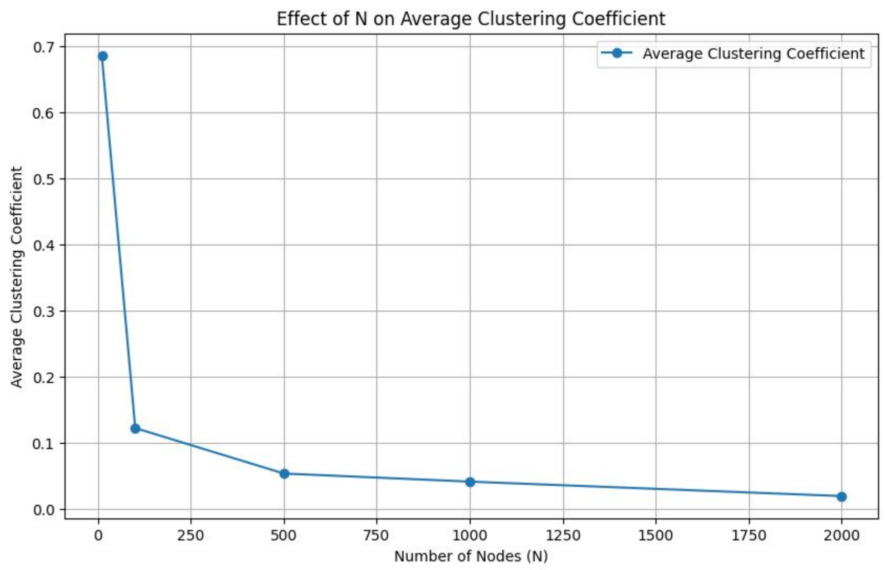
Impact of m and N on metrics:

- Average clustering coefficient
- Average shortest path length
- Diameter

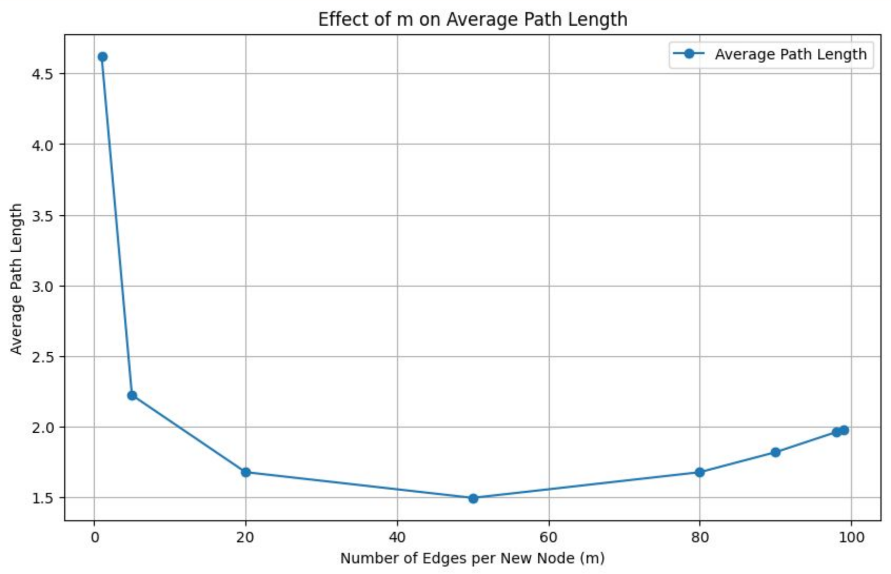
m_values = [1, 5, 20, 50, 80, 90, 98, 99], N=100
N_values = [10, 100, 500, 1000, 2000], m=3

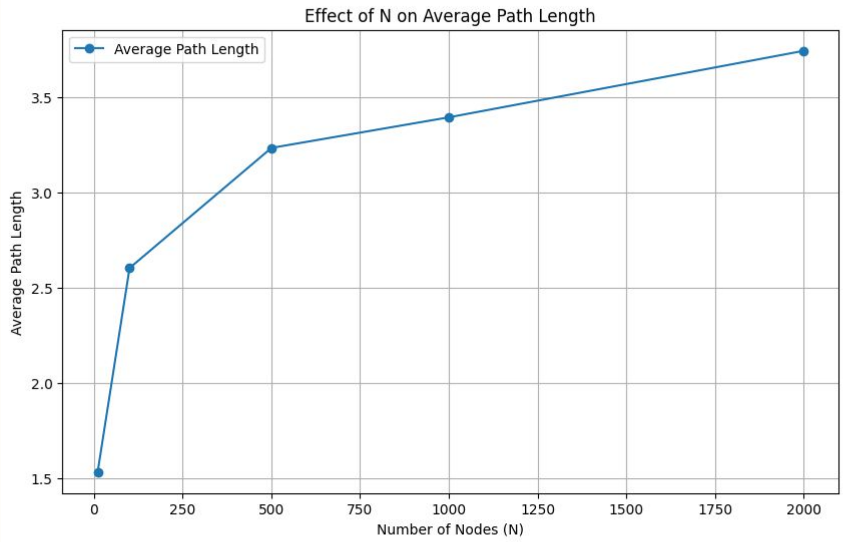
Task 4.2: Parameter Sensitivity Study – ACC



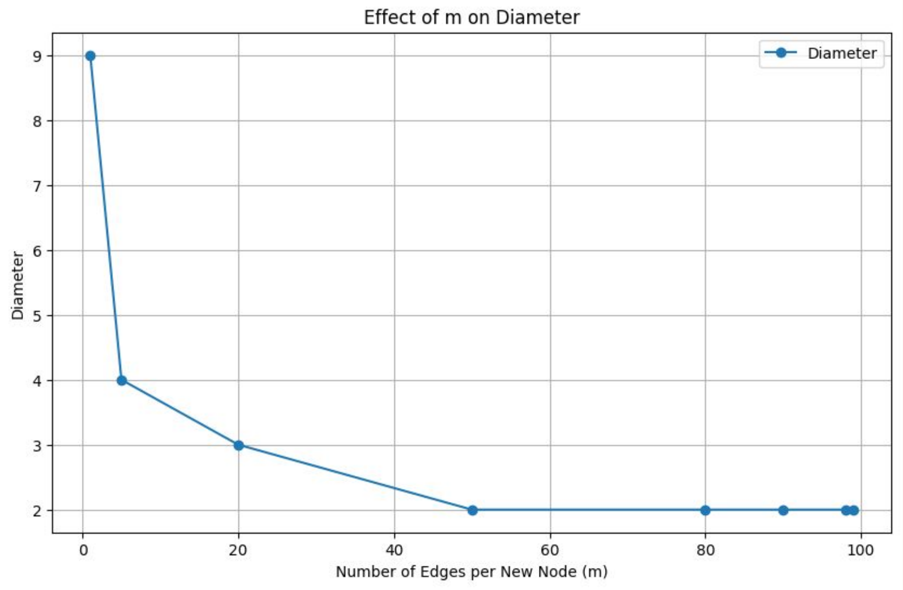


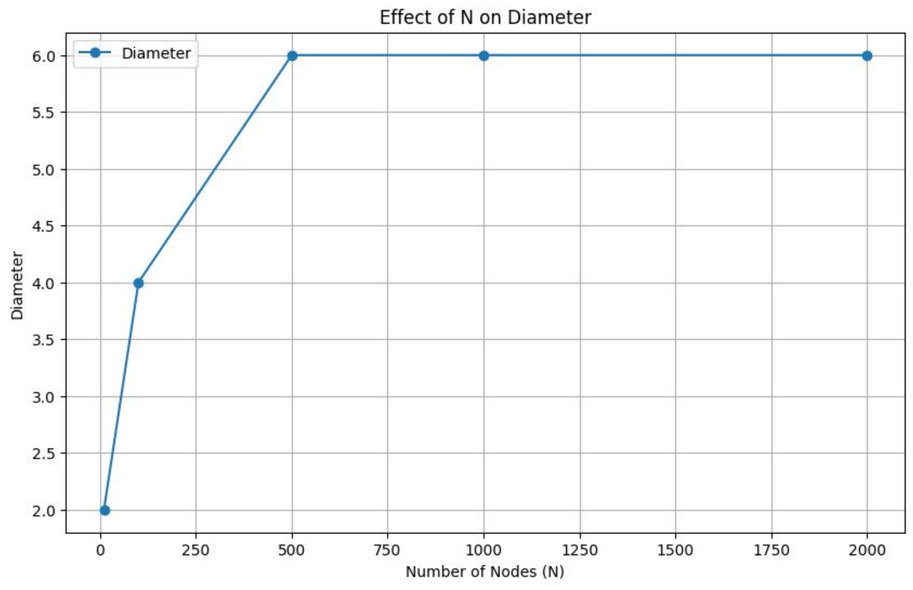
Task 4.2: Parameter Sensitivity Study – ASPL





Task 4.2: Parameter Sensitivity Study – Diameter





Thank you for your attention!