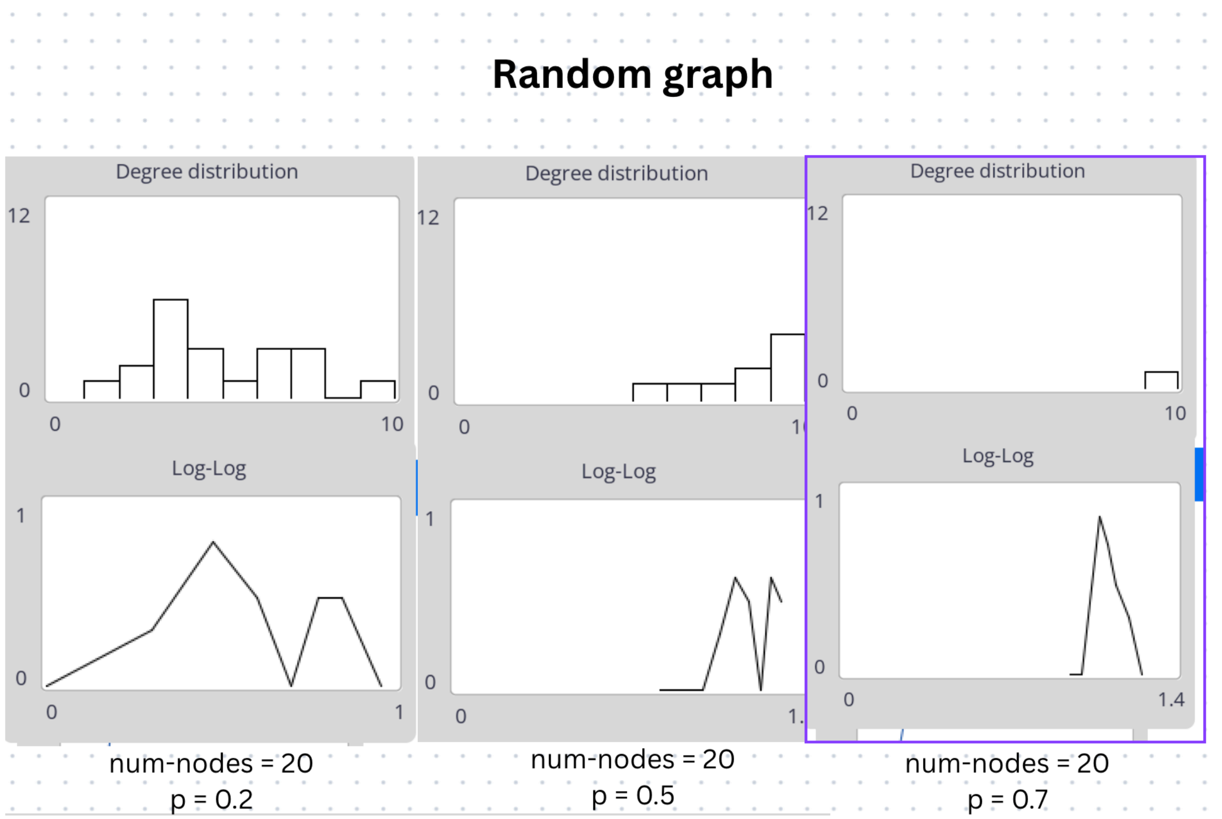
HW4

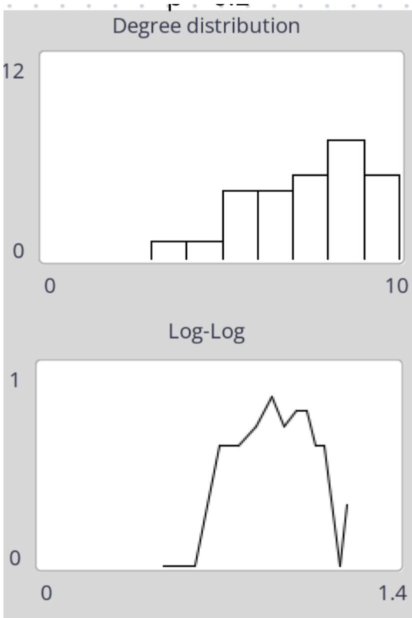
Part 1

I used the code we were provided on seminars for networks generation. I added slider to account for parameter k-neighbours in Watts-Strogatz Small-World Networks. The code will be attached in submission

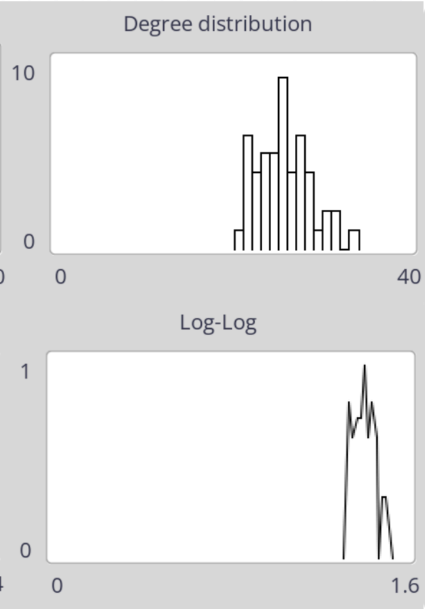
Part 2

Task1

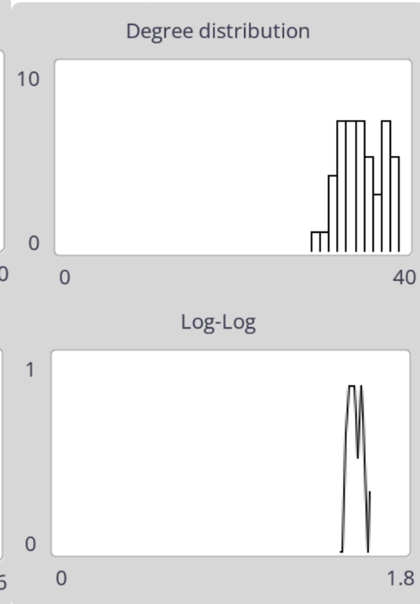




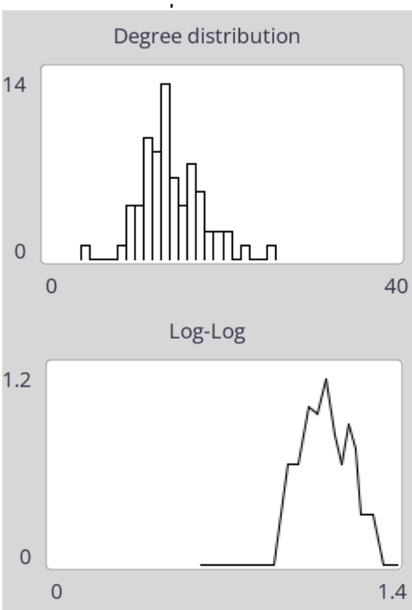
num-nodes = 50
p = 0.2



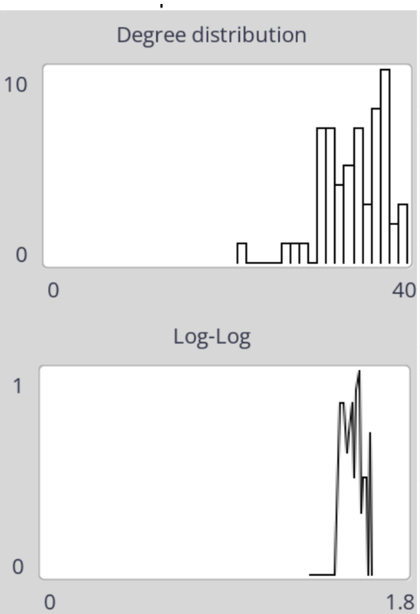
num-nodes = 50
p = 0.5



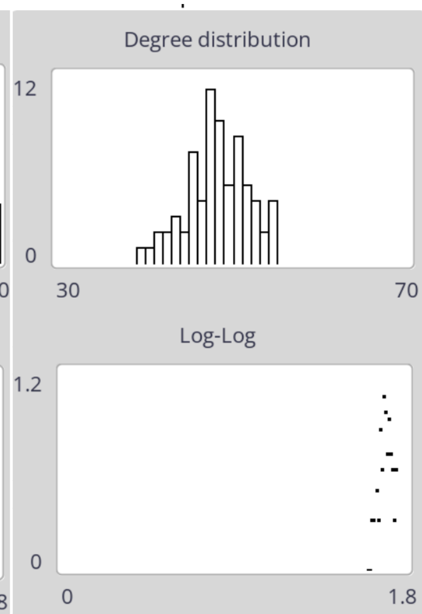
num-nodes = 50
p = 0.7



num-nodes = 70
p = 0.2

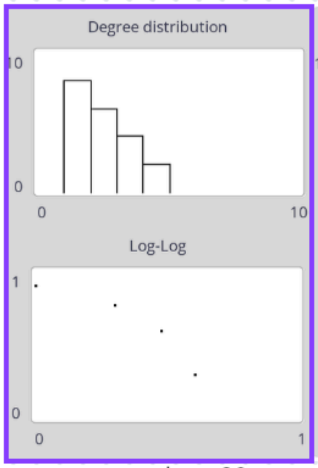


num-nodes = 70
p = 0.5

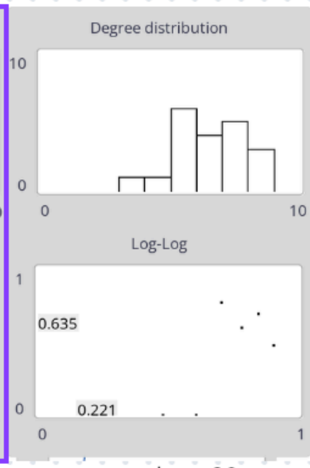


num-nodes = 70
p = 0.7

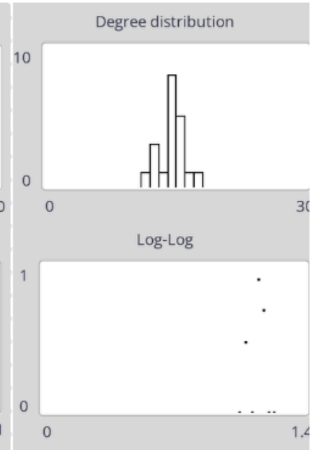
Small world



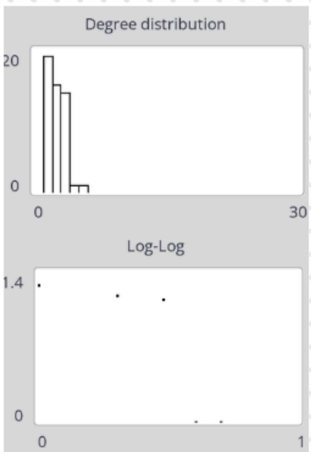
num-nodes = 20
num-edges = 2
k-neighbours = 2



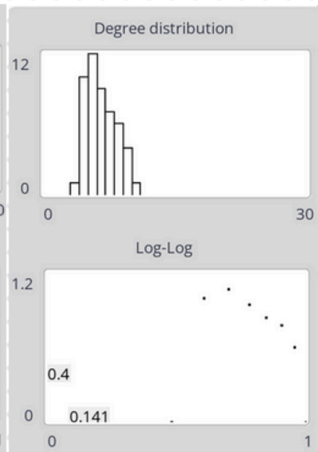
num-nodes = 20
num-edges = 2
k-neighbours = 7



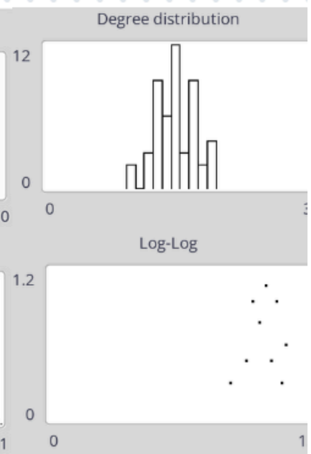
num-nodes = 20
num-edges = 2
k-neighbours = 15



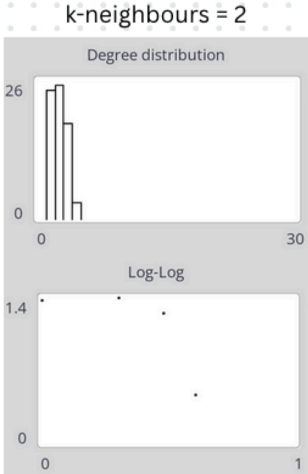
num-nodes = 50
num-edges = 2
k-neighbours = 2



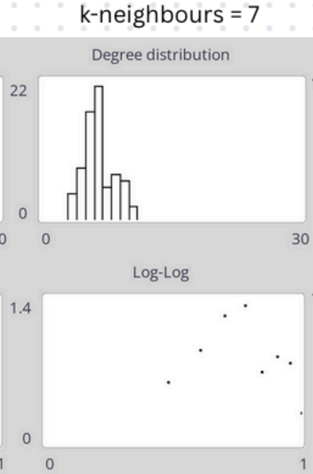
num-nodes = 50
num-edges = 2
k-neighbours = 7



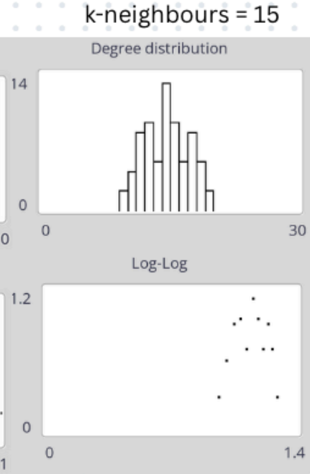
num-nodes = 50
num-edges = 2
k-neighbours = 15



num-nodes = 70
num-edges = 2
k-neighbours = 2

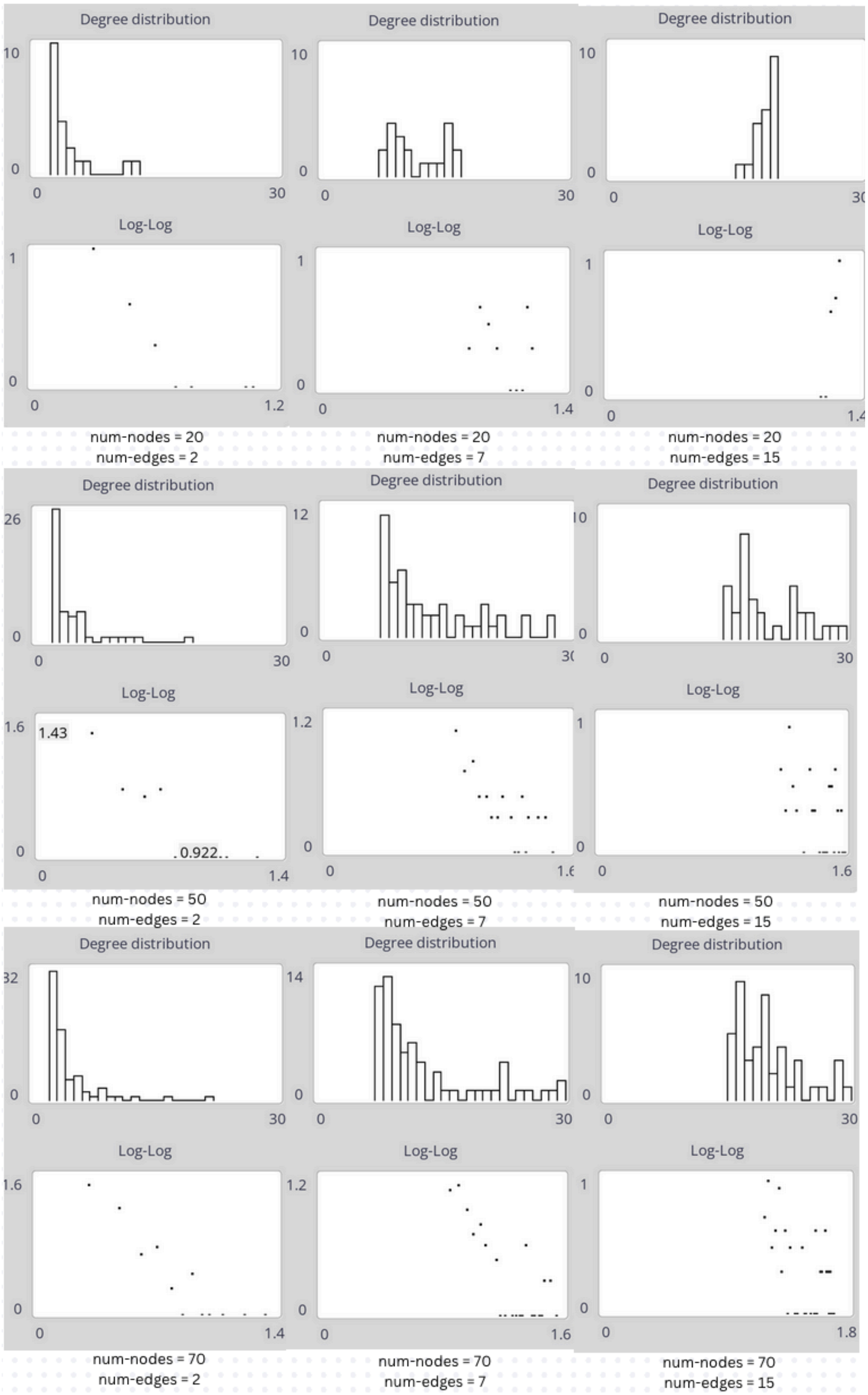


num-nodes = 70
num-edges = 2
k-neighbours = 7



num-nodes = 70
num-edges = 2
k-neighbours = 15

Barabasi-Albert



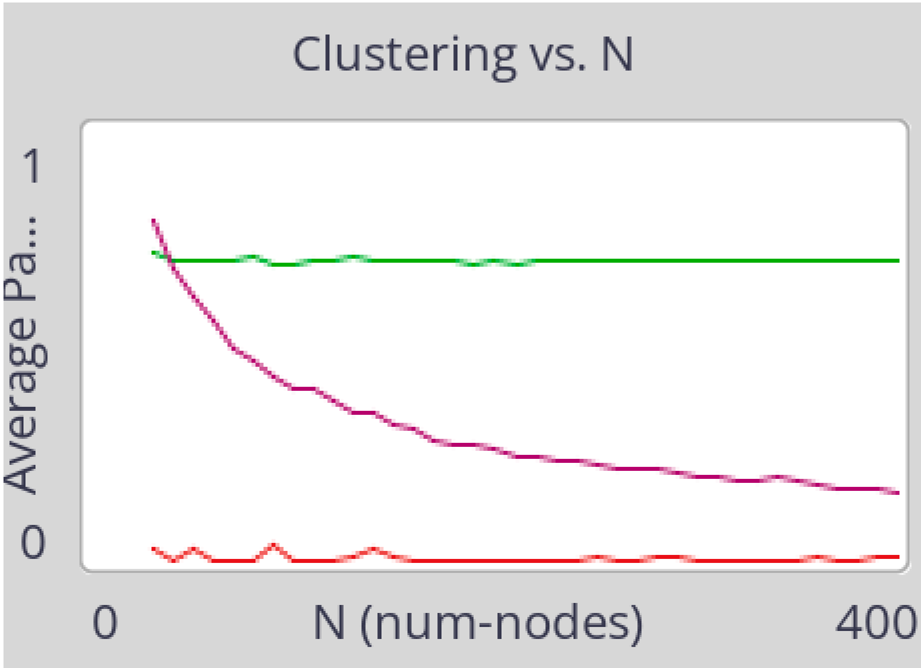
Part 2

Green - Random graph

Red - Small world

Purple - Barabasi Albert

Part 3



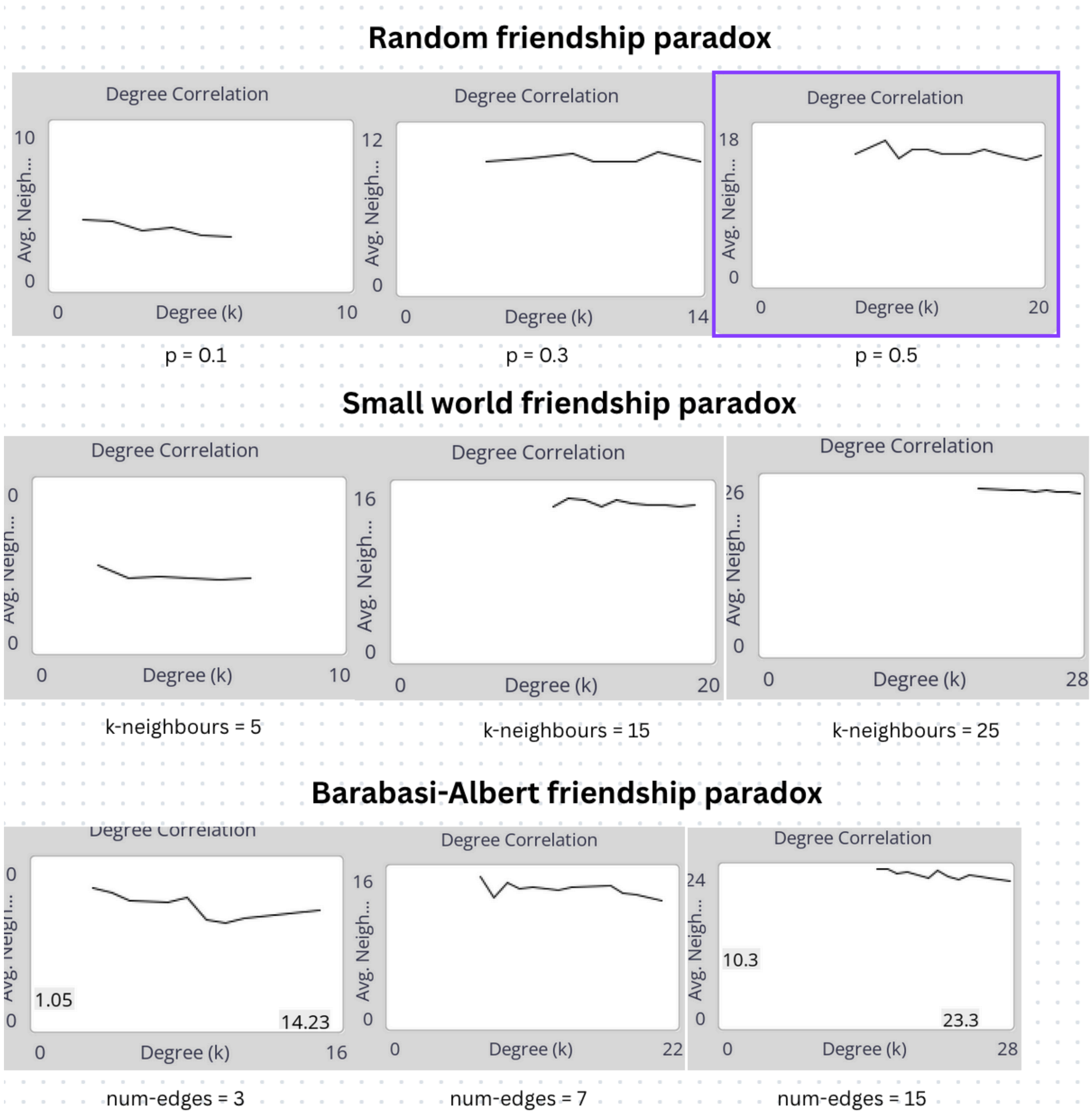
Green - Random graph

Red - Small world

Purple - Barabasi Albert

Task 3

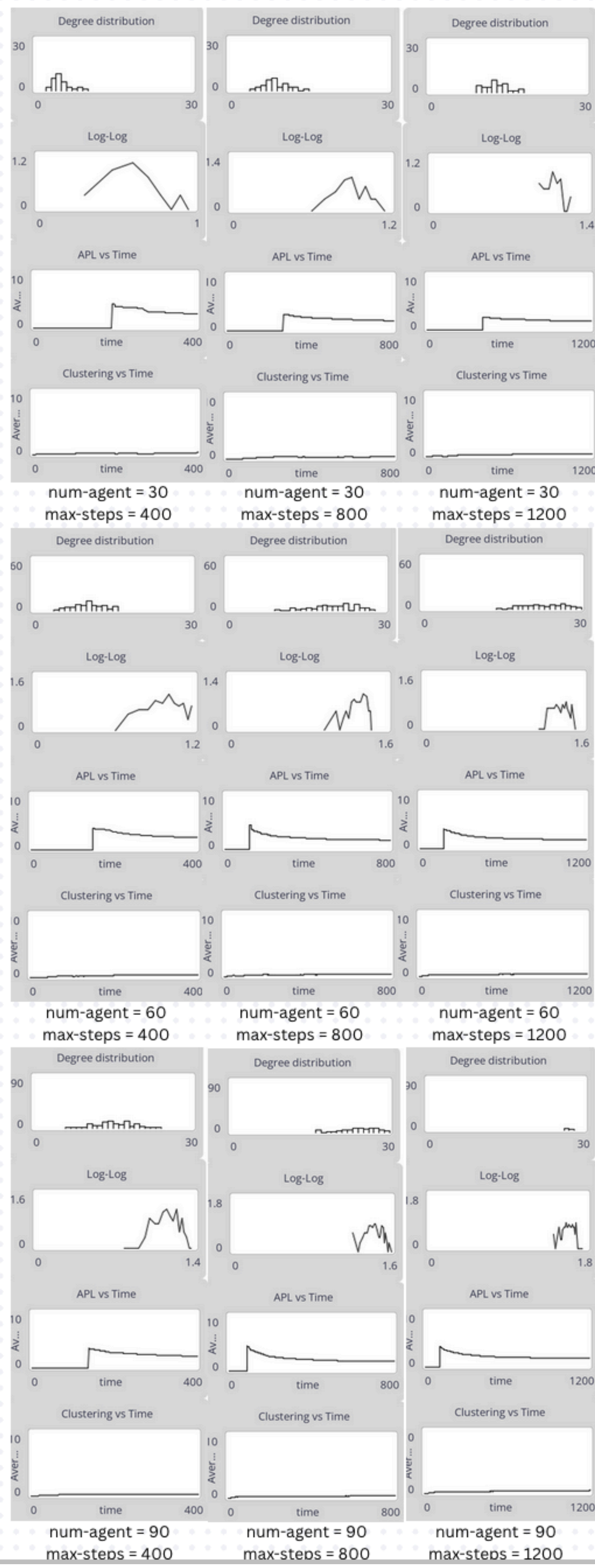
1. For the small world model, from the plot presented above, it seems that the scale is logarithmic
2. From the plots of distribution of degree for Barabasi-Albert we can see, it has exponential distribution, and the log-log plot is (almost) linear function.
3. num-nodes = 30

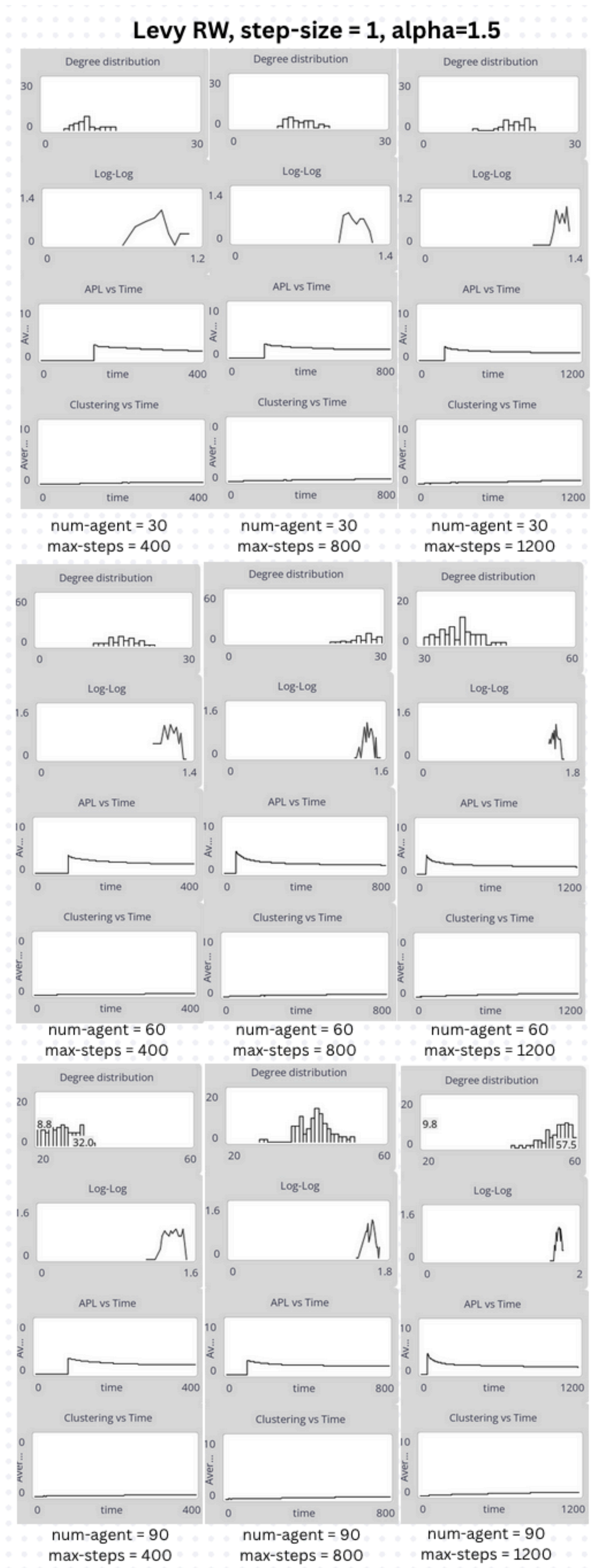


We can see that for random graph and small world we get function of form $y = C$, we also notice that for small world the constant is bigger. For the Barabasi-Albert we not that it decreases, which is an expected result.

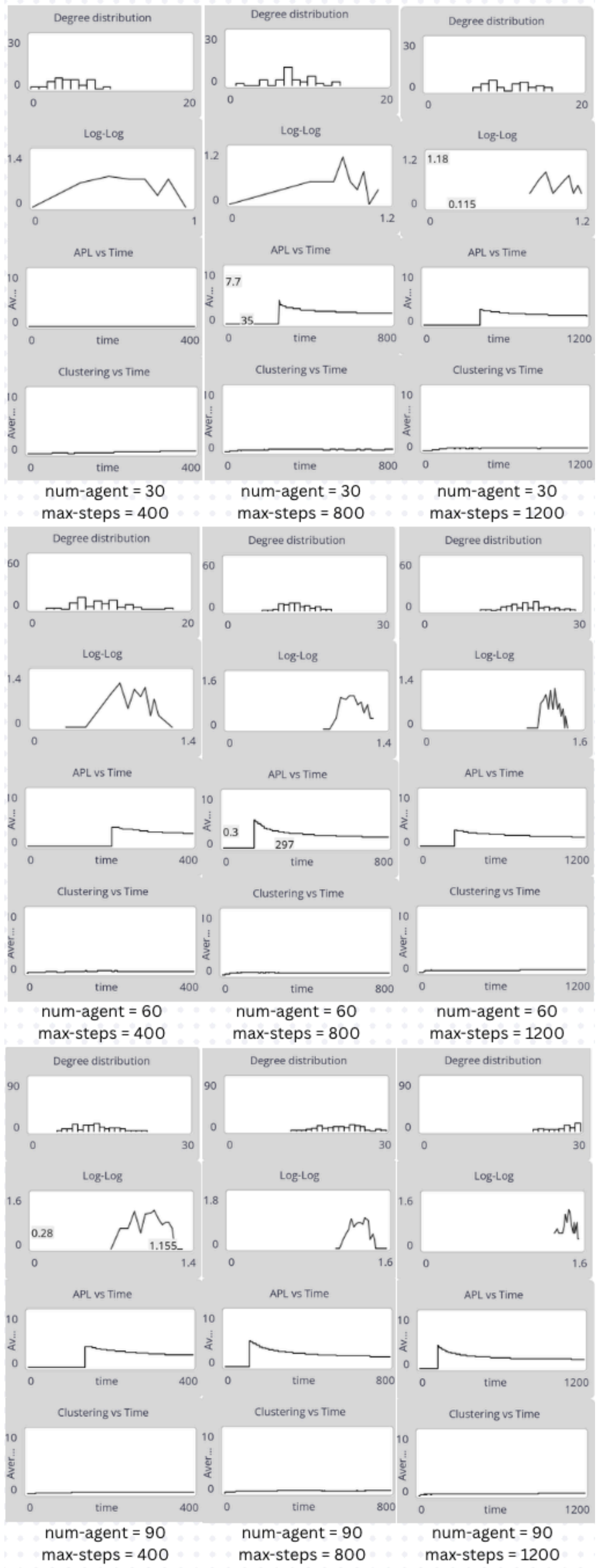
Task 4

Pearson RW, step-size = 1




Levy RW, step-size = 1, alpha=1.5
Degree distribution
Log-Log
APL vs Time
Clustering vs Time
num-agent = 30
max-steps = 400
num-agent = 30
max-steps = 800
num-agent = 30
max-steps = 1200
num-agent = 60
max-steps = 400
num-agent = 60
max-steps = 800
num-agent = 60
max-steps = 1200
num-agent = 90
max-steps = 400
num-agent = 90
max-steps = 800
num-agent = 90
max-steps = 1200

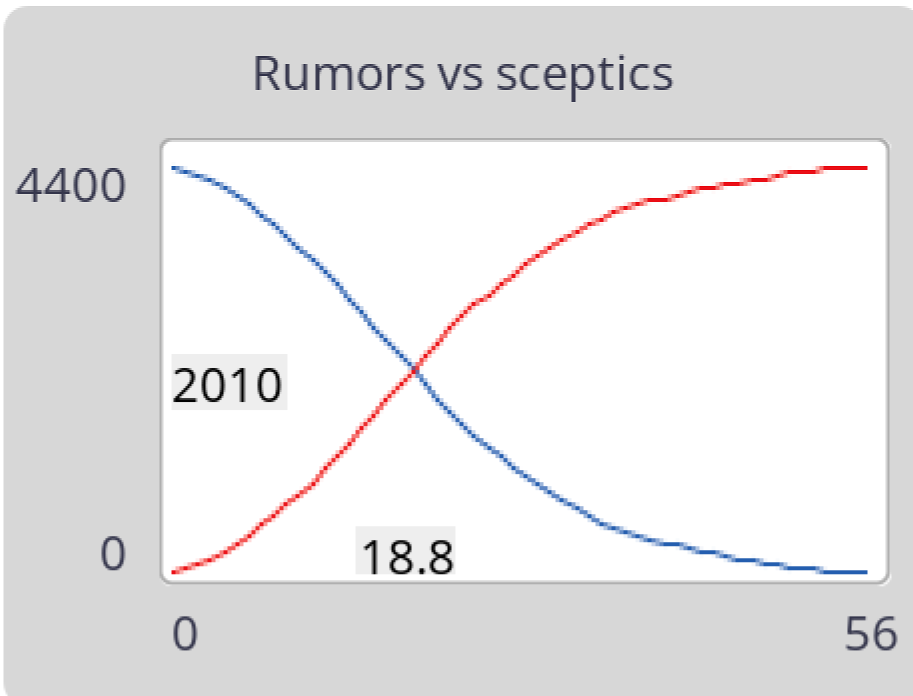
Lattice RW, step-size = 1, alpha=1.5



For Peason and Lattice random walks, I would say it gets similar result to small world networks, as it gets “symmetric” distribution with peak at the center. Levy random walk looks similar to Barabasi-Albert, because its distribution looks like exponential.

Rumors spread model

Standard model

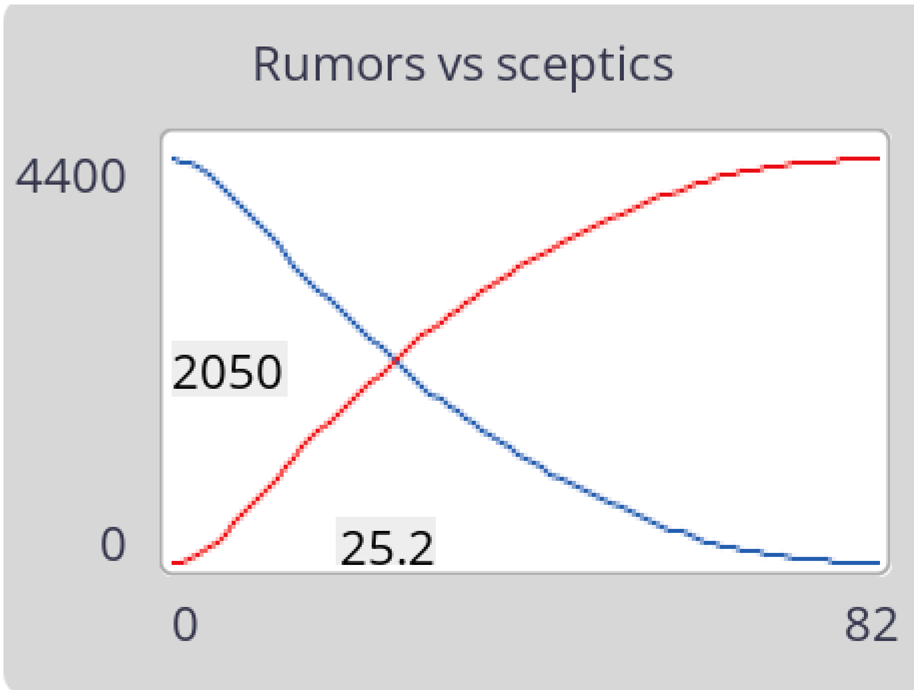


Red -- rumor spreaders

Blue -- non-belivers

Changing number of initial rumor spreaders and changing type of neighborhood only shifts the intersection point of red and blue lines.

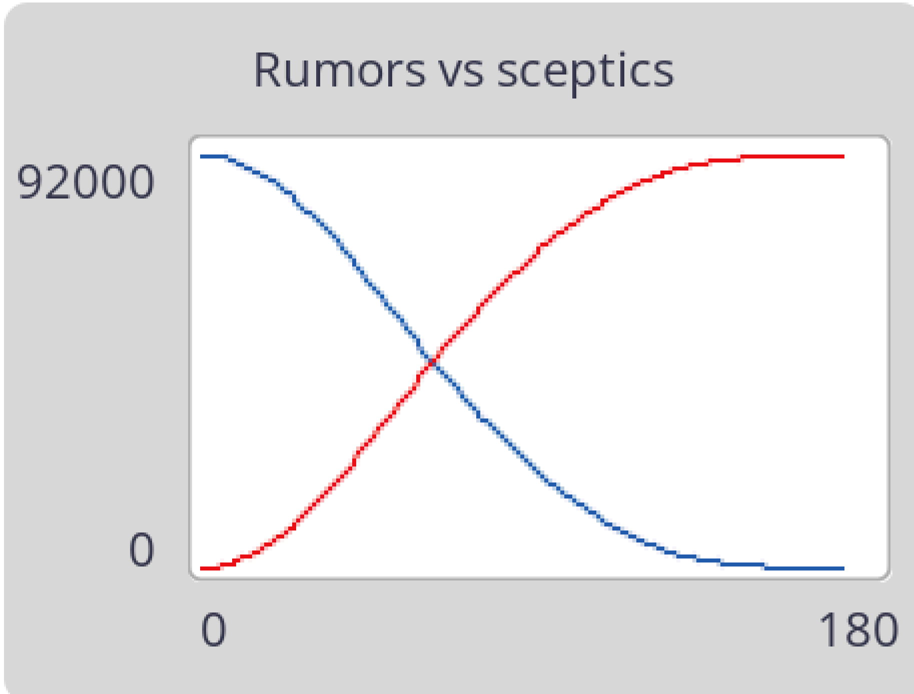
Thresholded model

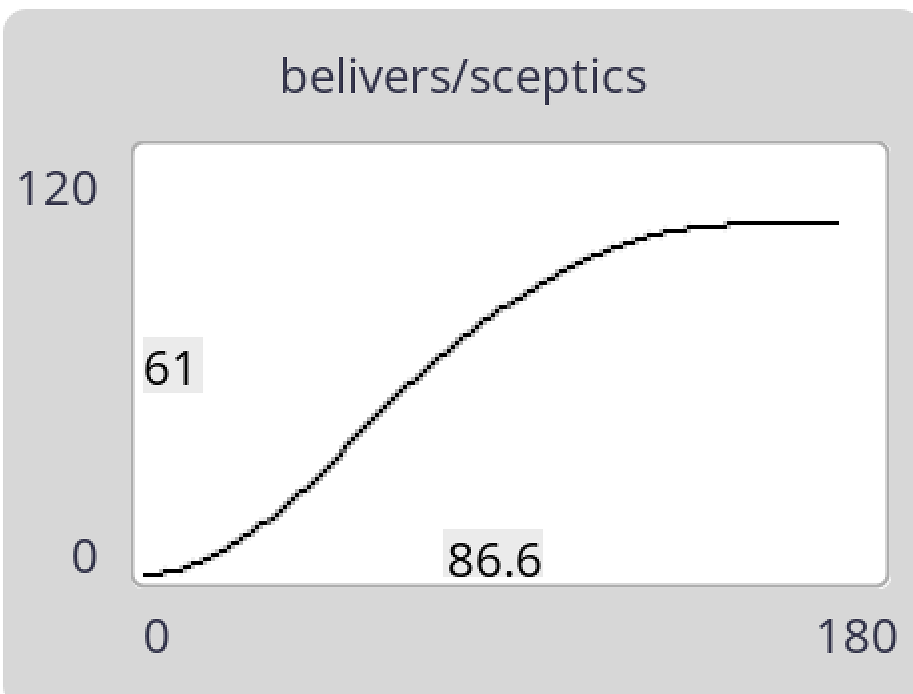


480 sceptics

I see that it takes more time to make all people believe the rumor. This is expected result, as it takes generaly more beliver neigbhours to turn non-beliver to beliver.

I made 300×300 sized map, 9 spreaders and 897 sceptics





And ran simulation few times. Usually it takes ≈ 200 ticks to get all the patches to be belivers.

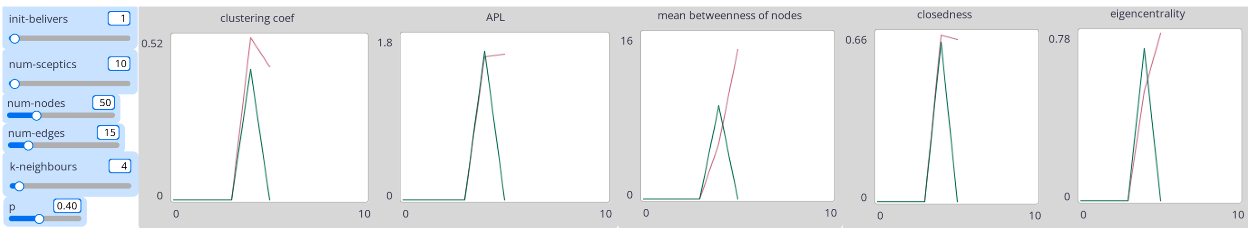
Belivers/sceptics plot show ration of belivers to sceptics on each tick.

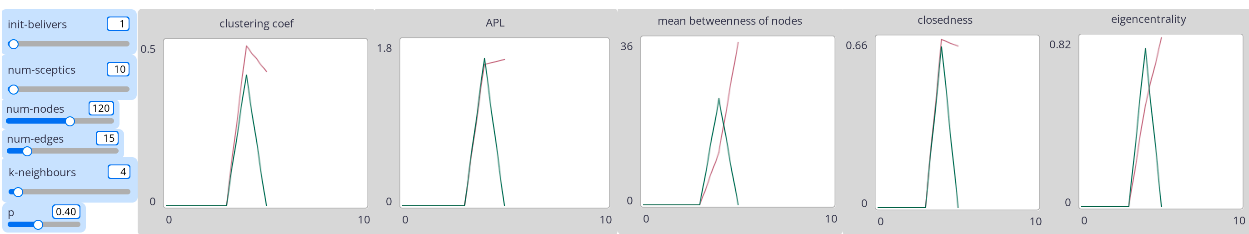
Task 6

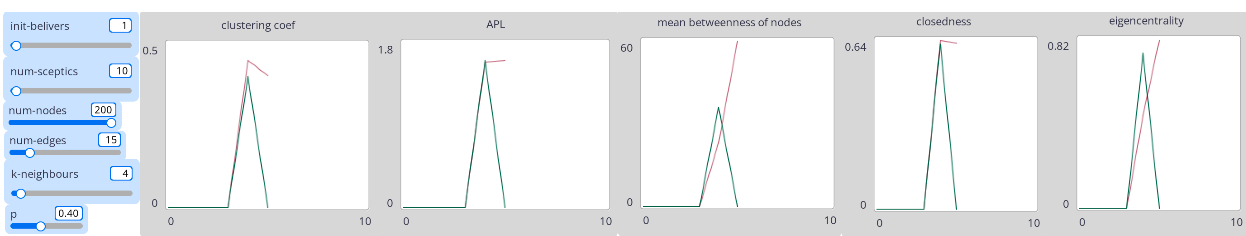
Believers - red

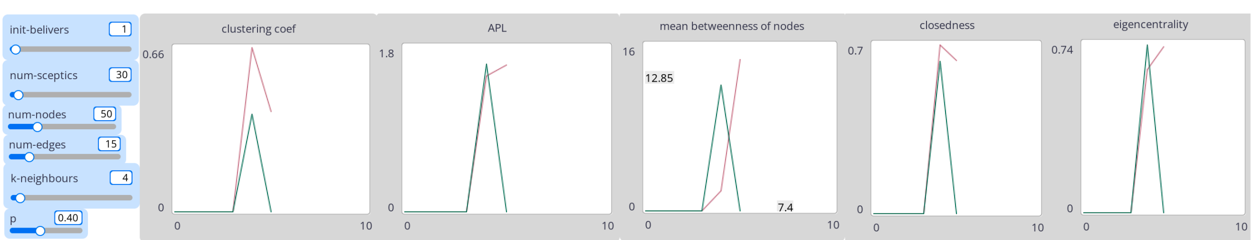
Non-believers - green

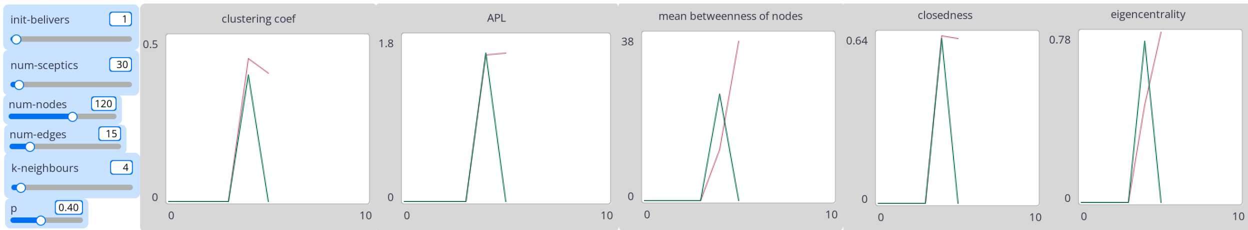
Random network, p = 0.4



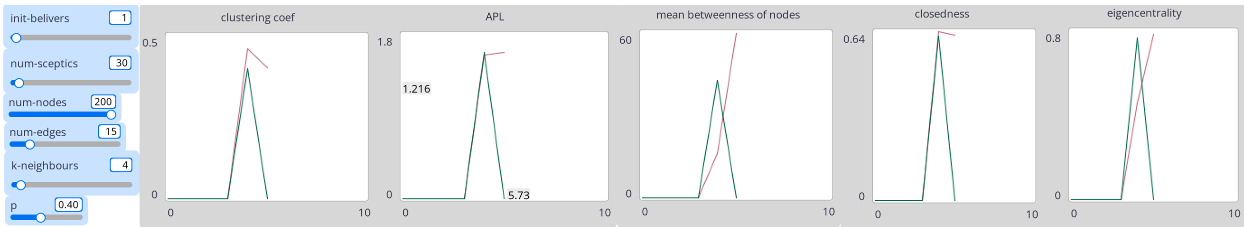




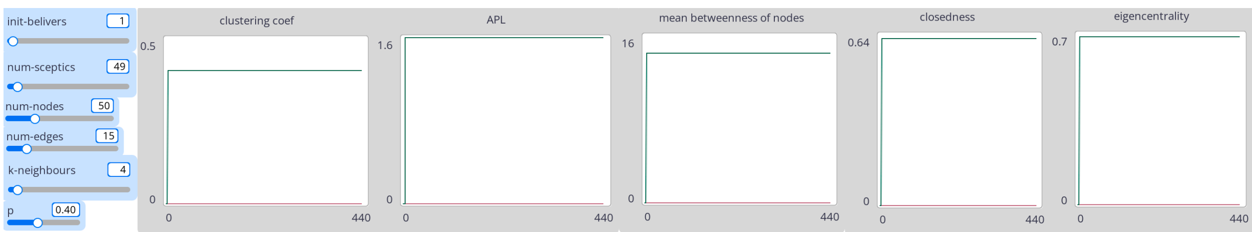




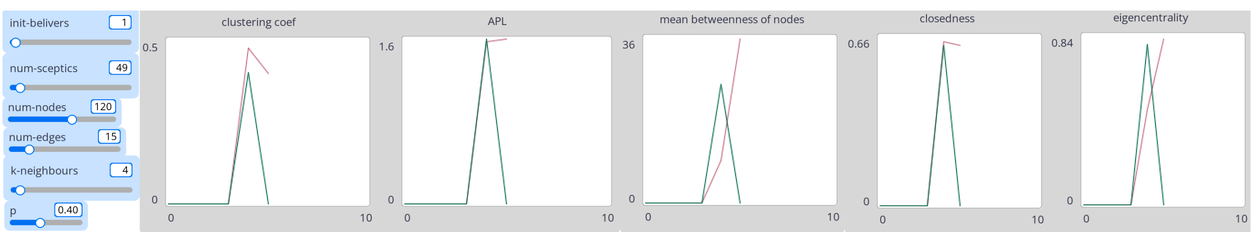
init-belivers 1
num-sceptics 30
num-nodes 120
num-edges 15
k-neighbours 4
p 0.40
clustering coef
APL
mean betweenness of nodes
closedness
eigencentrality
0.5
1.8
38
0.64
0.78
0
10



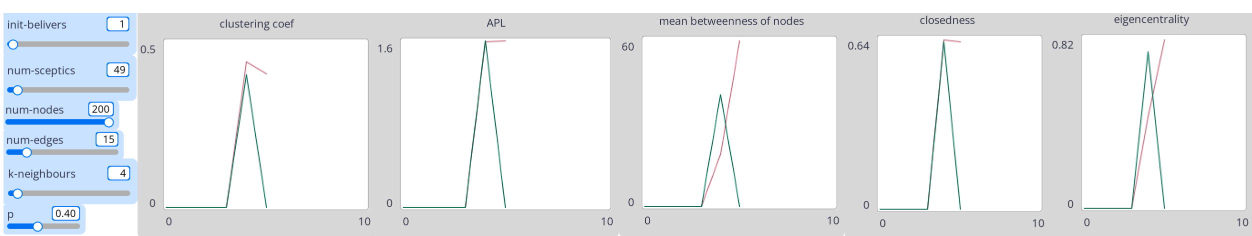
init-belivers 1
num-sceptics 30
num-nodes 200
num-edges 15
k-neighbours 4
p 0.40
clustering coef
APL
mean betweenness of nodes
closedness
eigencentrality
0.5
1.8
1.216
5.73
60
0.64
0.8
0
10



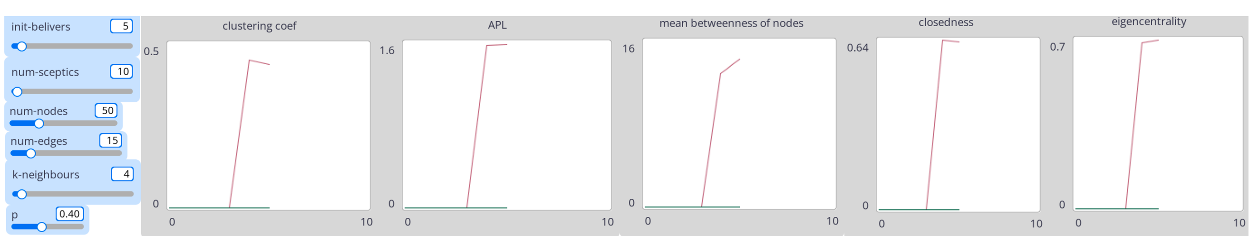
init-belivers 1
num-sceptics 49
num-nodes 50
num-edges 15
k-neighbours 4
p 0.40
clustering coef
APL
mean betweenness of nodes
closedness
eigencentrality
0.5
1.6
16
0.64
0.7
0
440



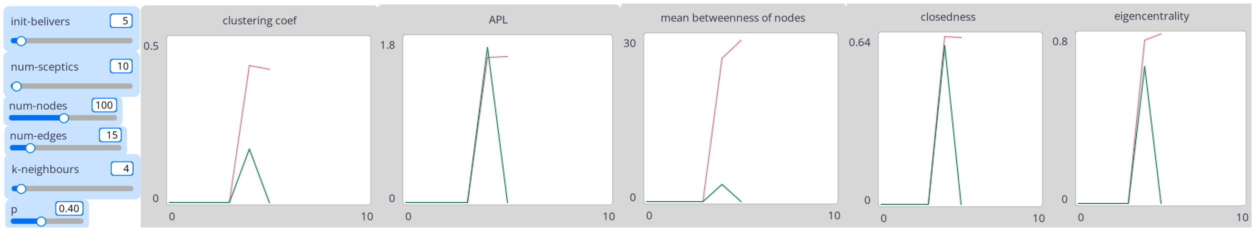
init-belivers 1
num-sceptics 49
num-nodes 120
num-edges 15
k-neighbours 4
p 0.40
clustering coef
APL
mean betweenness of nodes
closedness
eigencentrality
0.5
1.6
36
0.66
0.84
0
10

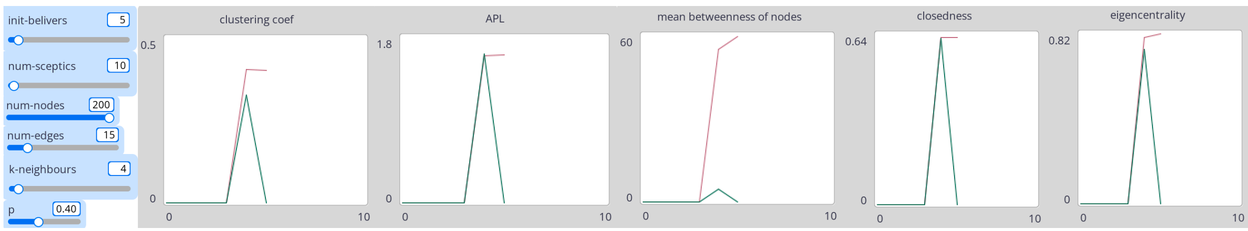


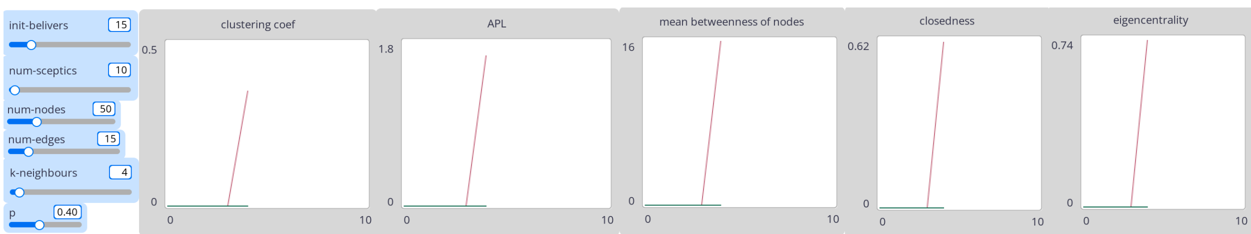
init-belivers 1
num-sceptics 49
num-nodes 200
num-edges 15
k-neighbours 4
p 0.40
clustering coef
APL
mean betweenness of nodes
closedness
eigencentrality
0.5
1.6
60
0.64
0.82
0
10

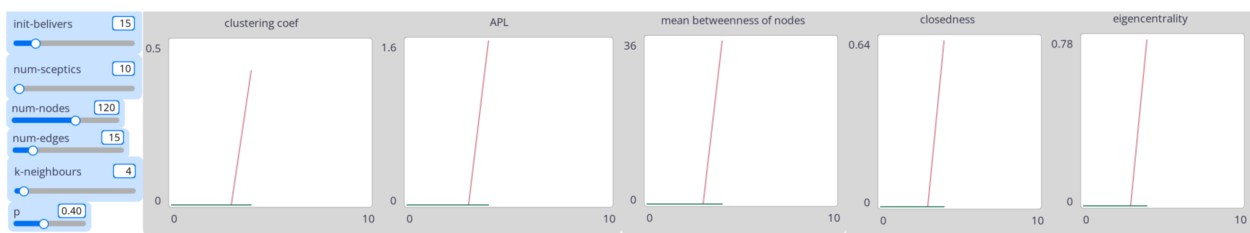


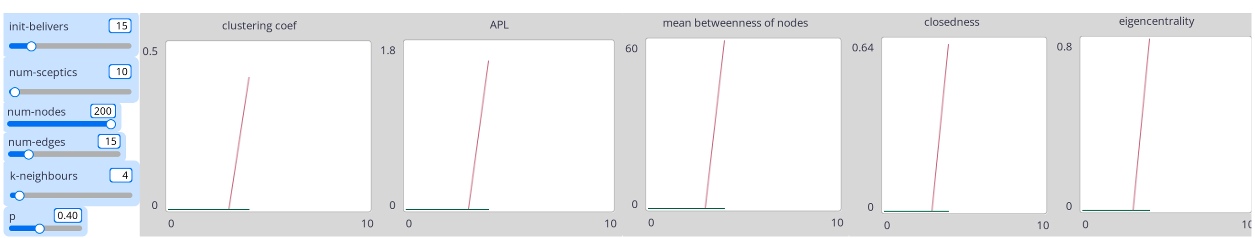
init-belivers 5
num-sceptics 10
num-nodes 50
num-edges 15
k-neighbours 4
p 0.40
clustering coef
APL
mean betweenness of nodes
closedness
eigencentrality
0.5
1.6
16
0.64
0.7
0
10


init-belivers 5
num-sceptics 10
num-nodes 100
num-edges 15
k-neighbours 4
p 0.40
clustering coef
0.5
0
0
10
APL
1.8
0
0
10
mean betweenness of nodes
30
0
0
10
closedness
0.64
0
0
10
eigencentrality
0.8
0
0
10

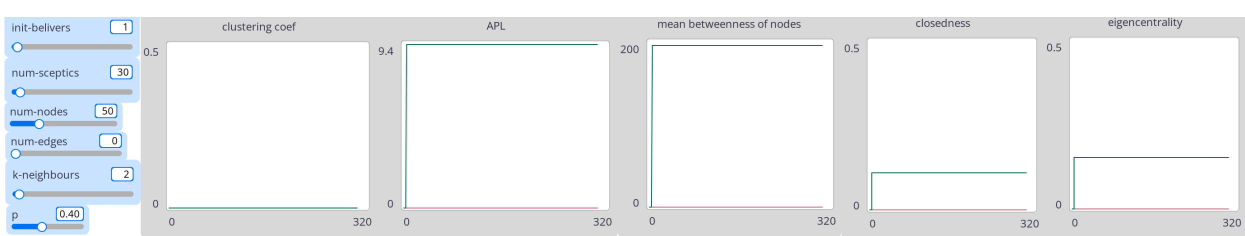

init-belivers 5
num-sceptics 10
num-nodes 200
num-edges 15
k-neighbours 4
p 0.40
clustering coef
0.5
0
0
10
APL
1.8
0
0
10
mean betweenness of nodes
60
0
0
10
closedness
0.64
0
0
10
eigencentrality
0.82
0
0
10


init-belivers 15
num-sceptics 10
num-nodes 50
num-edges 15
k-neighbours 4
p 0.40
clustering coef
0.5
0
0
10
APL
1.8
0
0
10
mean betweenness of nodes
16
0
0
10
closedness
0.62
0
0
10
eigencentrality
0.74
0
0
10

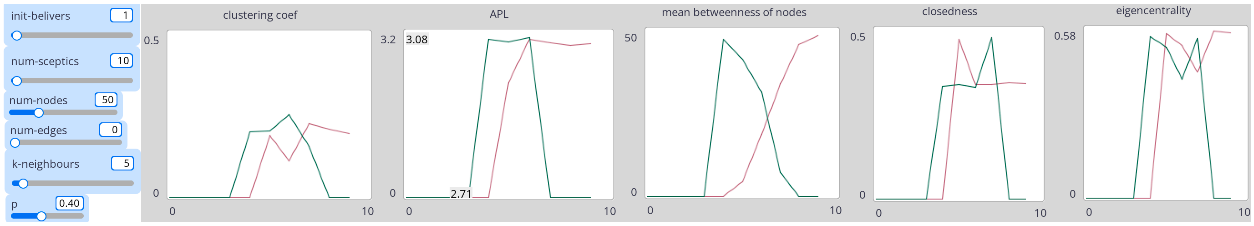

init-belivers 15
num-sceptics 10
num-nodes 120
num-edges 15
k-neighbours 4
p 0.40
clustering coef
0.5
0
0
10
APL
1.6
0
0
10
mean betweenness of nodes
36
0
0
10
closedness
0.64
0
0
10
eigencentrality
0.78
0
0
10

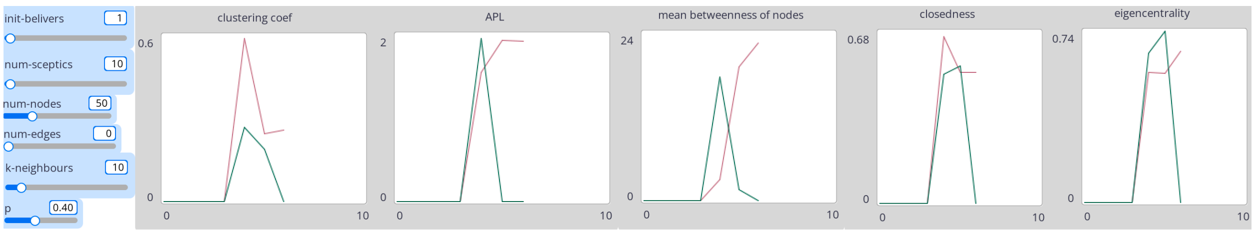

init-belivers 15
num-sceptics 10
num-nodes 200
num-edges 15
k-neighbours 4
p 0.40
clustering coef
0.5
0
0
10
APL
1.8
0
0
10
mean betweenness of nodes
60
0
0
10
closedness
0.64
0
0
10
eigencentrality
0.8
0
0

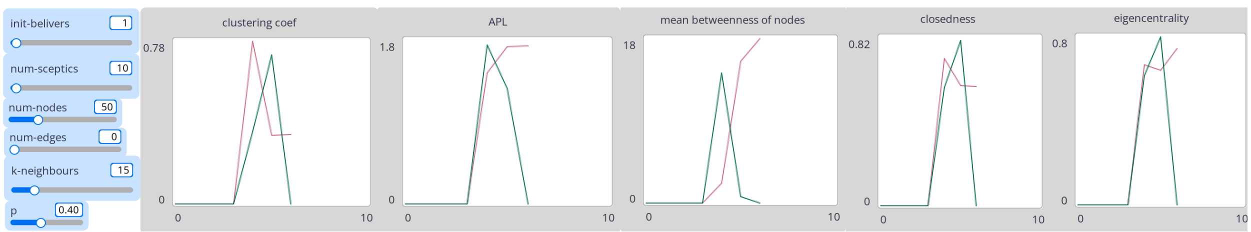
Small World

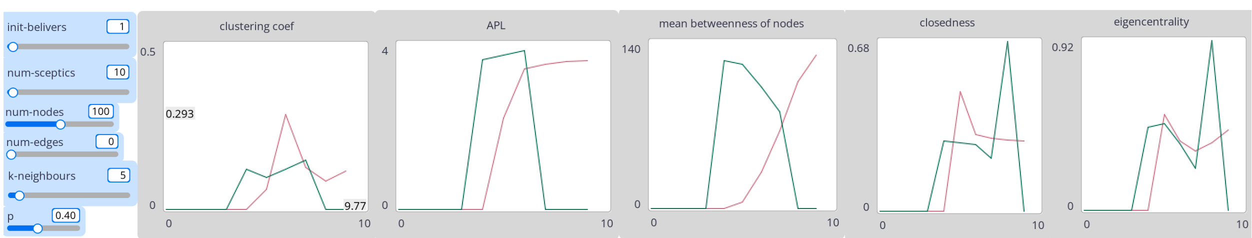

init-belivers 1
num-sceptics 30
num-nodes 50
num-edges 0
k-neighbours 2
p 0.40
clustering coef
0.5
0
0
320
APL
9.4
0
0
320
mean betweenness of nodes
200
0
0
320
closedness
0.5
0
0
320
eigencentrality
0.5
0
0
320

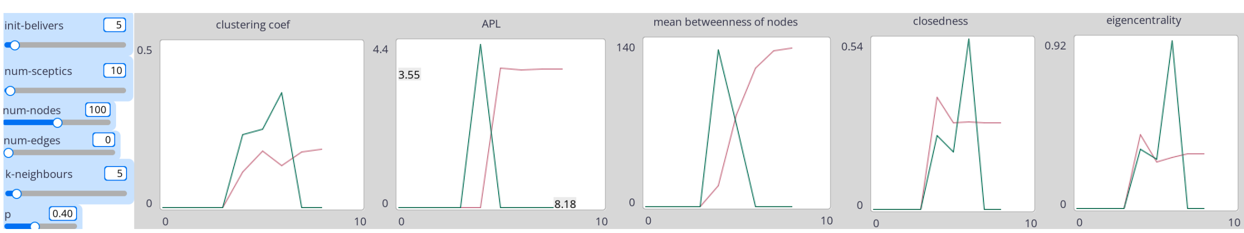
Never converges

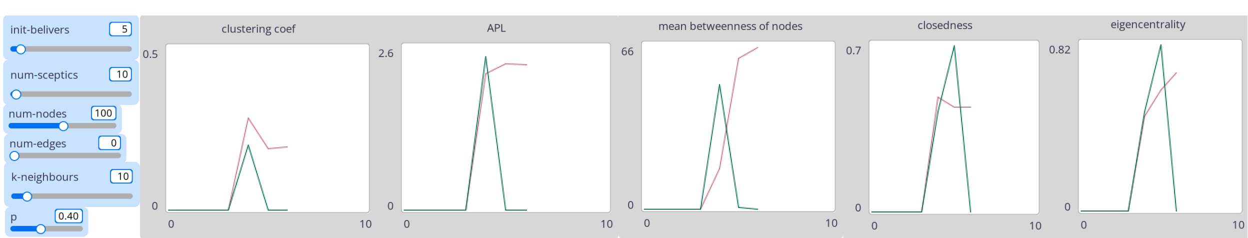


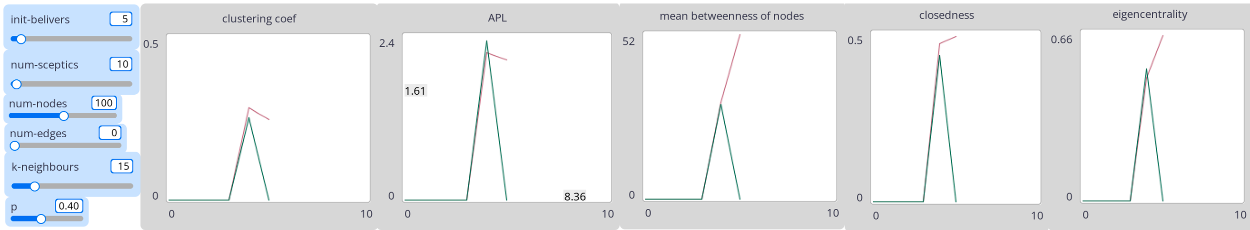


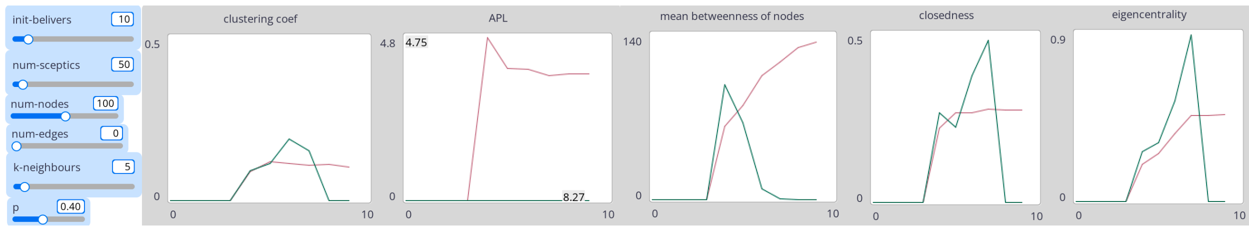


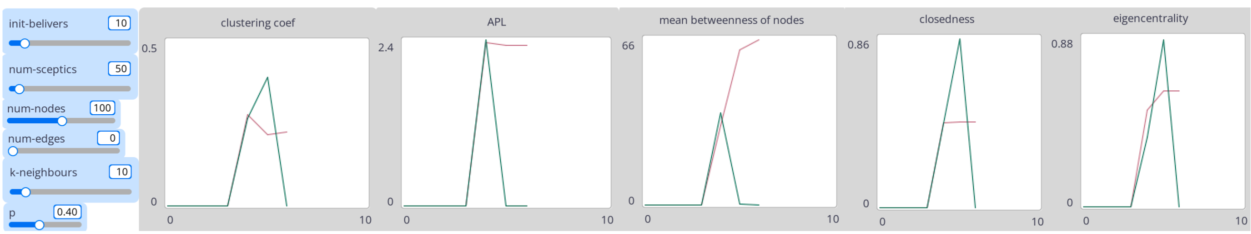


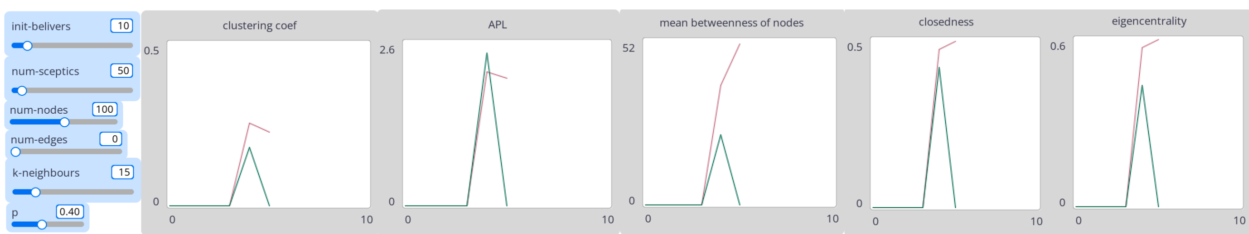


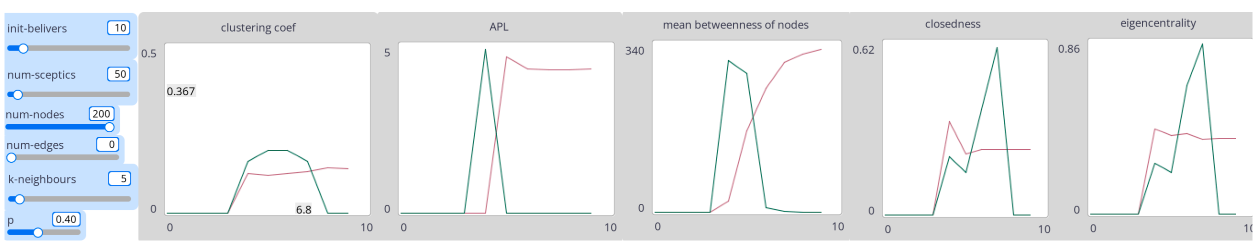


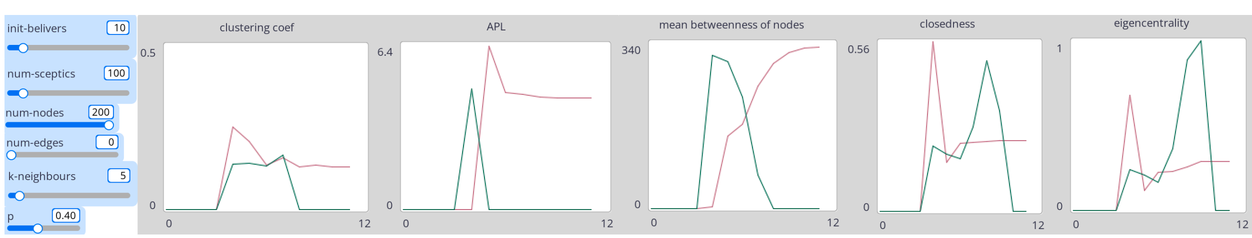

init-belivers 5
num-sceptics 10
num-nodes 100
num-edges 0
k-neighbours 15
p 0.40
clustering coef
0.5
0
0
10
APL
2.4
1.61
8.36
0
0
10
mean betweenness of nodes
52
0
0
10
closedness
0.5
0
0
10
eigencentrality
0.66
0
0
10

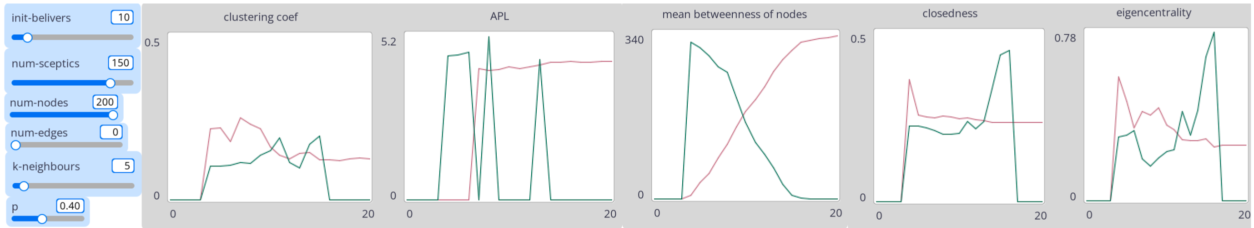

init-belivers 10
num-sceptics 50
num-nodes 100
num-edges 0
k-neighbours 5
p 0.40
clustering coef
0.5
0
0
10
APL
4.8
4.75
8.27
0
0
10
mean betweenness of nodes
140
0
0
10
closedness
0.5
0
0
10
eigencentrality
0.9
0
0
10

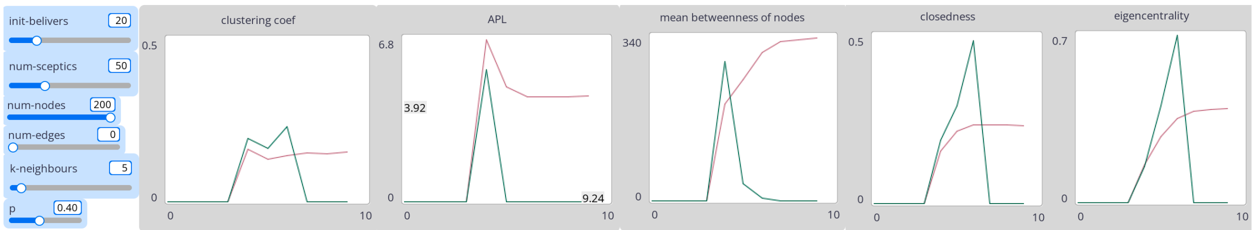

init-belivers 10
num-sceptics 50
num-nodes 100
num-edges 0
k-neighbours 10
p 0.40
clustering coef
0.5
0
0
10
APL
2.4
0
0
10
mean betweenness of nodes
66
0
0
10
closedness
0.86
0
0
10
eigencentrality
0.88
0
0
10

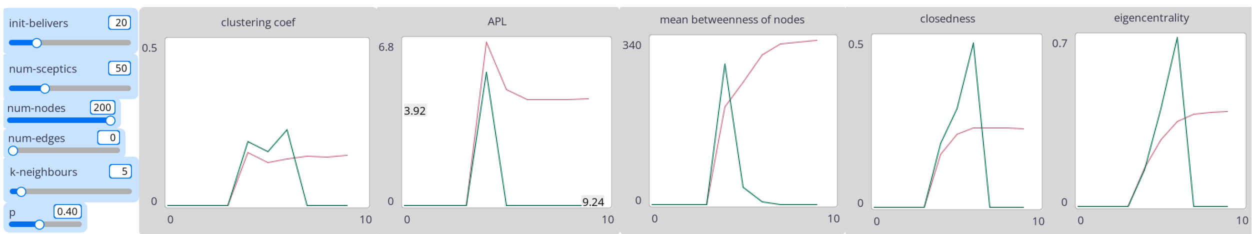

init-belivers 10
num-sceptics 50
num-nodes 100
num-edges 0
k-neighbours 15
p 0.40
clustering coef
0.5
0
0
10
APL
2.6
0
0
10
mean betweenness of nodes
52
0
0
10
closedness
0.5
0
0
10
eigencentrality
0.6
0
0
10

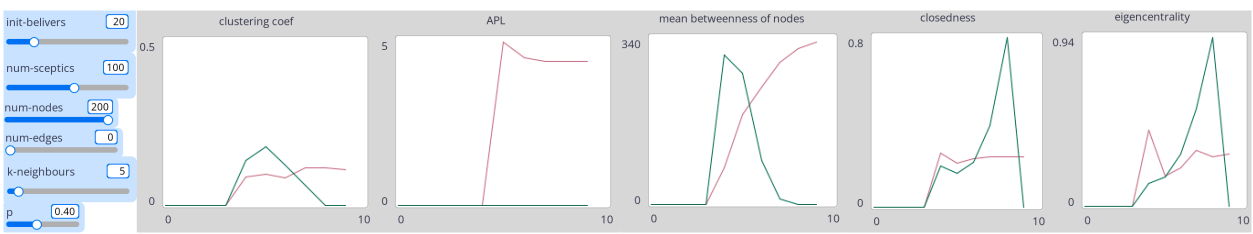

init-belivers 10
num-sceptics 50
num-nodes 200
num-edges 0
k-neighbours 5
p 0.40
clustering coef
0.5
0.367
6.8
0
0
10
APL
5
0
0
10
mean betweenness of nodes
340
0
0
10
closedness
0.62
0
0
10
eigencentrality
0.86
0
0

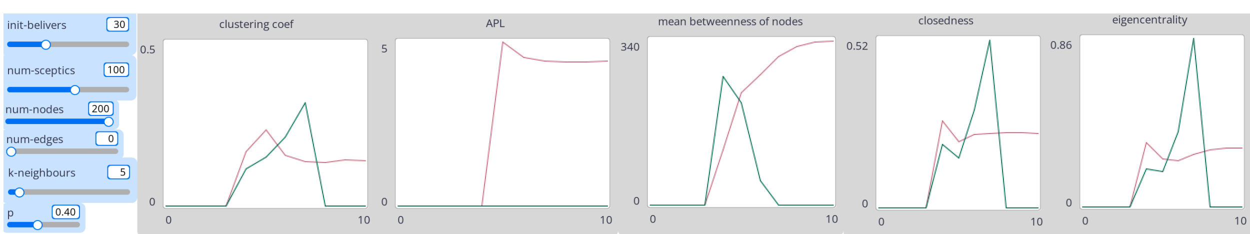

init-belivers 10
num-sceptics 100
num-nodes 200
num-edges 0
k-neighbours 5
p 0.40
clustering coef
0.5
0
0
12
APL
6.4
0
0
12
mean betweenness of nodes
340
0
0
12
closedness
0.56
0
0
12
eigencentrality
1
0
0
12

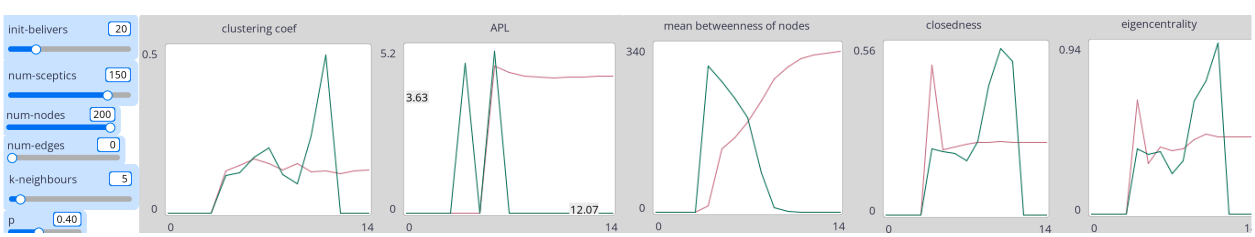

init-belivers 10
num-sceptics 150
num-nodes 200
num-edges 0
k-neighbours 5
p 0.40
clustering coef
APL
mean betweenness of nodes
closedness
eigencentrality

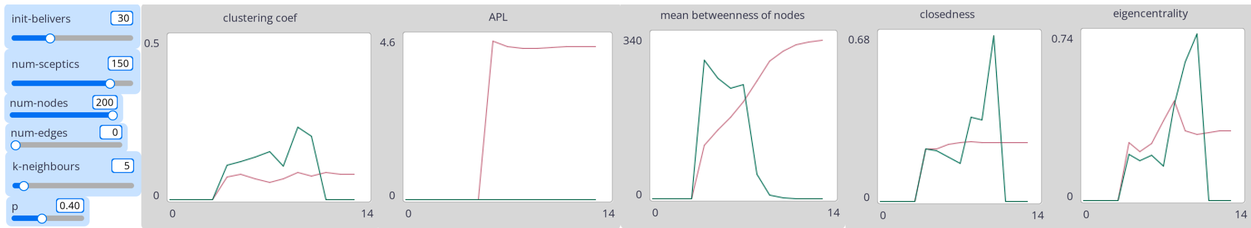

init-belivers 20
num-sceptics 50
num-nodes 200
num-edges 0
k-neighbours 5
p 0.40
clustering coef
APL
3.92
9.24
mean betweenness of nodes
closedness
eigencentrality

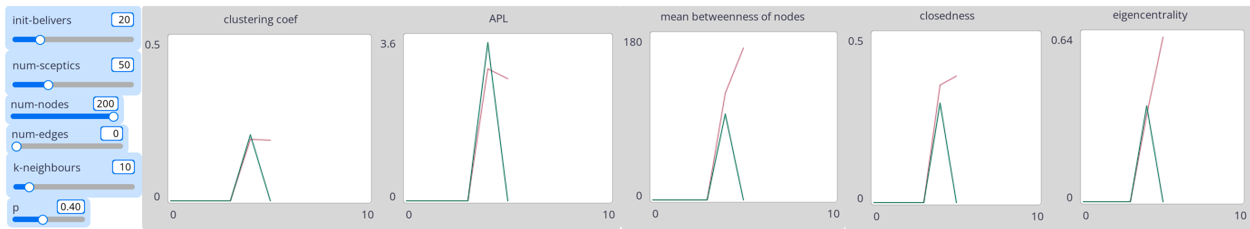

init-belivers 20
num-sceptics 50
num-nodes 200
num-edges 0
k-neighbours 5
p 0.40
clustering coef
APL
3.92
9.24
mean betweenness of nodes
closedness
eigencentrality

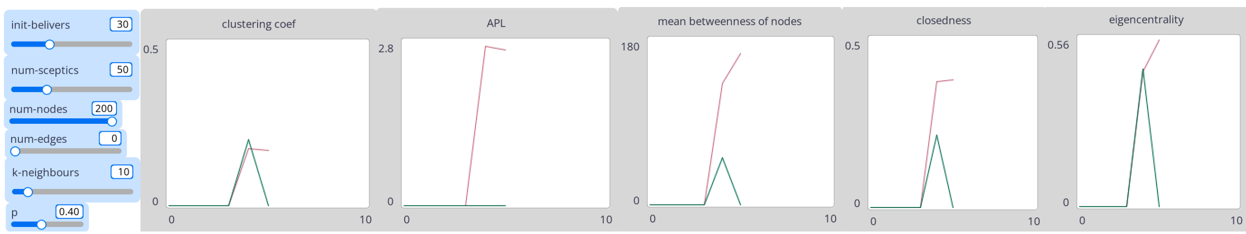

init-belivers 20
num-sceptics 100
num-nodes 200
num-edges 0
k-neighbours 5
p 0.40
clustering coef
APL
mean betweenness of nodes
closedness
eigencentrality

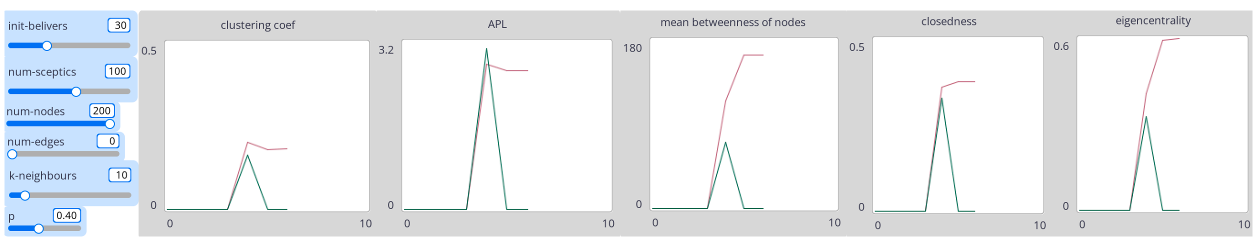

init-belivers 30
num-sceptics 100
num-nodes 200
num-edges 0
k-neighbours 5
p 0.40
clustering coef
APL
mean betweenness of nodes
closedness
eigencentrality

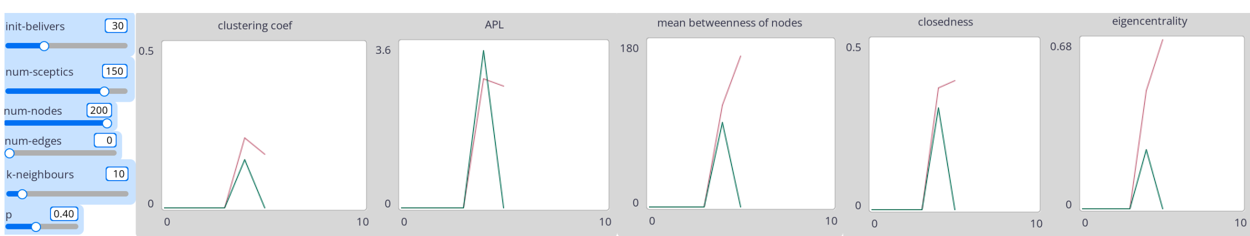

init-belivers 20
num-sceptics 150
num-nodes 200
num-edges 0
k-neighbours 5
p 0.40
clustering coef
APL
3.63
12.07
mean betweenness of nodes
closedness
eigencentrality



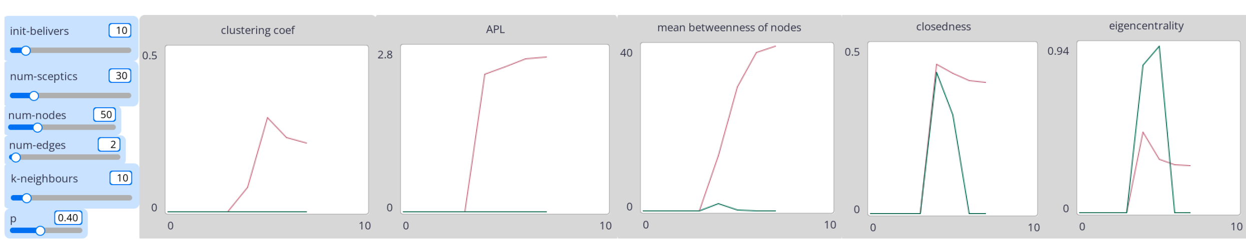


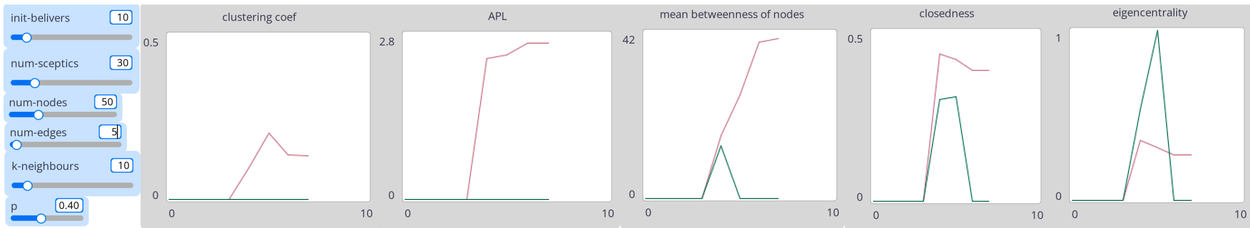


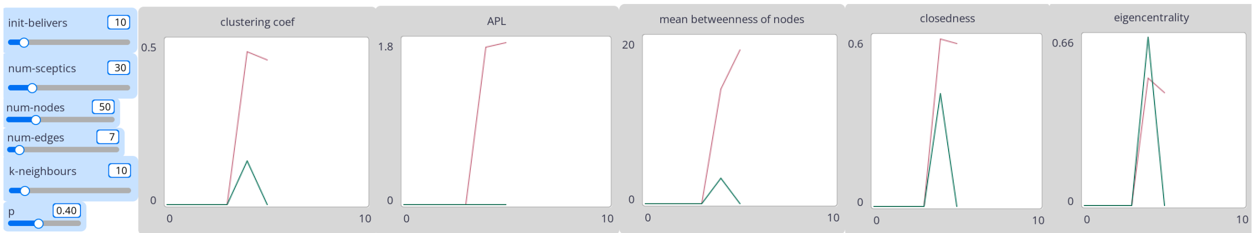


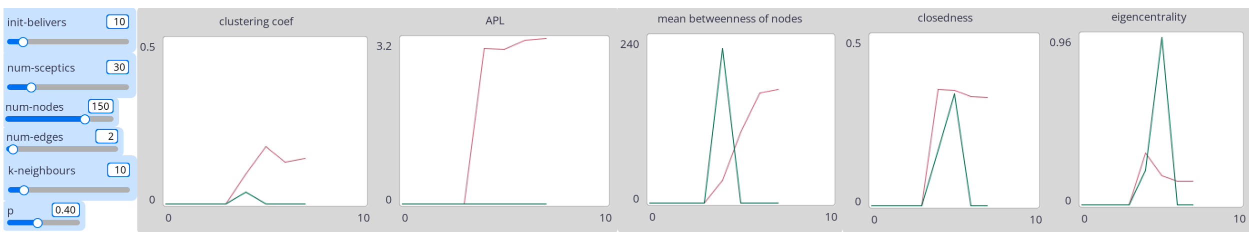


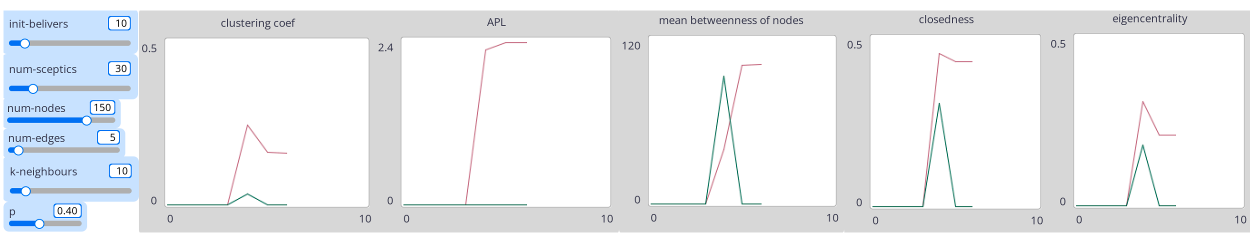
Barabasi-Albert

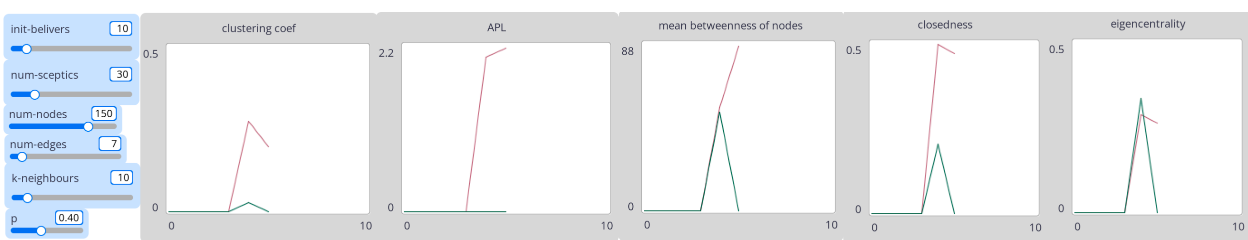


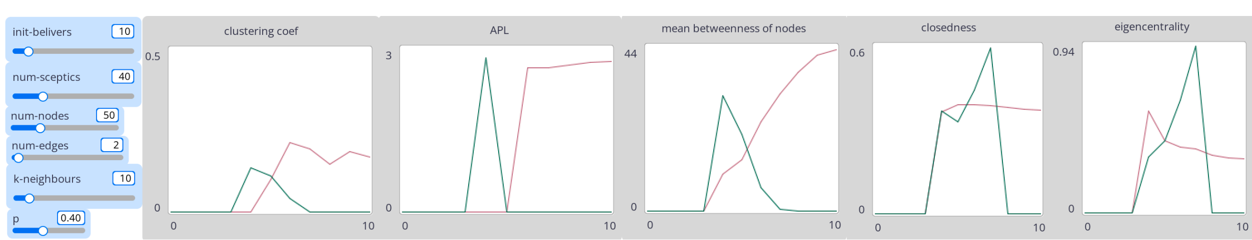

init-belivers 10
num-sceptics 30
num-nodes 50
num-edges 5
k-neighbours 10
p 0.40
clustering coef 0.5 0 0 10
APL 2.8 0 0 10
mean betweenness of nodes 42 0 0 10
closedness 0.5 0 0 10
eigencentrality 1 0 0 10

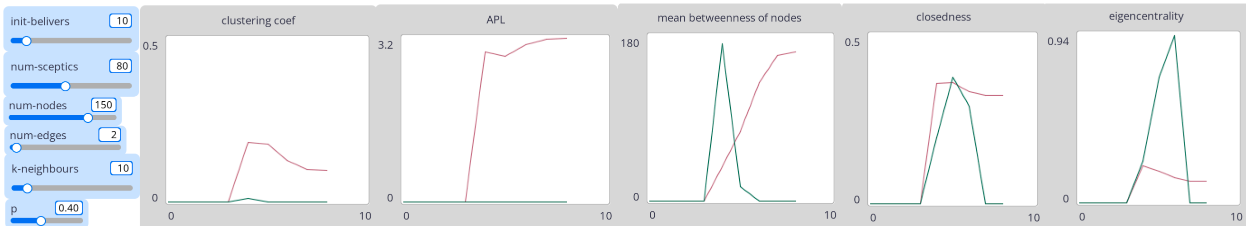

init-belivers 10
num-sceptics 30
num-nodes 50
num-edges 7
k-neighbours 10
p 0.40
clustering coef 0.5 0 0 10
APL 1.8 0 0 10
mean betweenness of nodes 20 0 0 10
closedness 0.6 0 0 10
eigencentrality 0.66 0 0 10

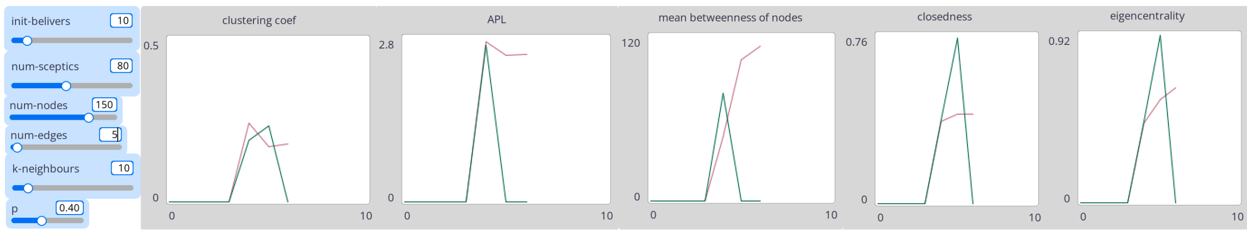

init-belivers 10
num-sceptics 30
num-nodes 150
num-edges 2
k-neighbours 10
p 0.40
clustering coef 0.5 0 0 10
APL 3.2 0 0 10
mean betweenness of nodes 240 0 0 10
closedness 0.5 0 0 10
eigencentrality 0.96 0 0 10

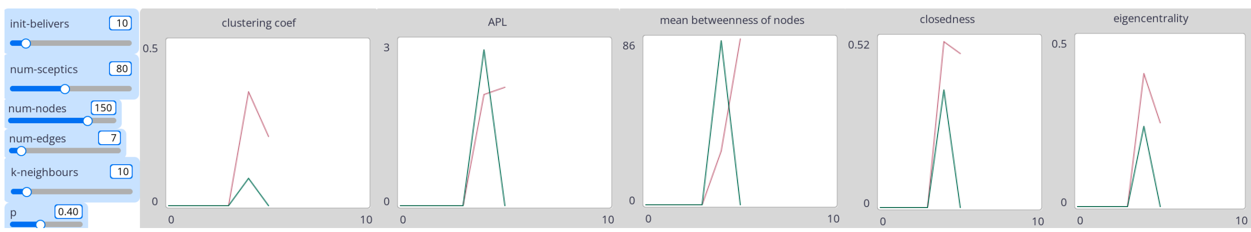

init-belivers 10
num-sceptics 30
num-nodes 150
num-edges 5
k-neighbours 10
p 0.40
clustering coef 0.5 0 0 10
APL 2.4 0 0 10
mean betweenness of nodes 120 0 0 10
closedness 0.5 0 0 10
eigencentrality 0.5 0 0 10

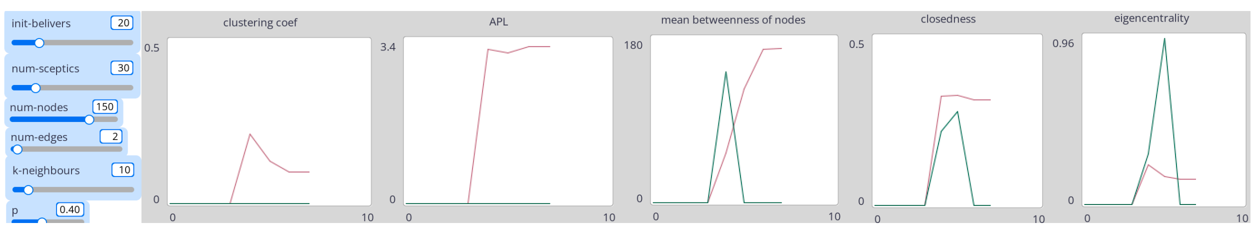

init-belivers 10
num-sceptics 30
num-nodes 150
num-edges 7
k-neighbours 10
p 0.40
clustering coef 0.5 0 0 10
APL 2.2 0 0 10
mean betweenness of nodes 88 0 0 10
closedness 0.5 0 0 10
eigencentrality 0.5 0 0 10


init-belivers 10
num-sceptics 40
num-nodes 50
num-edges 2
k-neighbours 10
p 0.40
clustering coef 0.5 0 0 10
APL 3 0 0 10
mean betweenness of nodes 44 0 0 10
closedness 0.6 0 0 10
eigencentrality 0.94 0 0 10









Report

On the plots you can see metrics described in assignment over time for two groups: believers and non-believers (marked by respective colors specified above). First thing I want to notice, for random graphs the simulation always end in 1-2 ticks. Thus, I decided that testing on higher probability of connection is meaningless.

For Barabasi-Albert I see that it tends to have higher eigencentrality, showing that rumors spread through some “well known” nodes, which is expected by networks construction. I also see, that mean closedness of Barabasi-Albert rumor believers is higher than in small world model.