Appendix A

Sampling results

Com-LiveJournal graph (undirected)

	Original graph	Sample size: 0.3	Sample size: 0.5	Sample size: 0.8
Nodes	3,997,962	1,199,388	1,998,981	3,198,369
Edges	34,681,189	18,921,913	27,438,564	33,329,721
Avg. degree	17.35	31.55	27.45	20.84
Diameter	17	13*	15*	16*
Graph density	4.33e-06	2.63e-05	1.37e-05	6.51e-06
Connected components	1	5,045	3,928	1,452
Avg. CC	0.28	0.27	0.29	0.31
Avg. shortest path	5.57	4.80*	5.04*	5.32*

Table A.1: Properties of the Com-LiveJournal graph along different sample sizes.
*Obtained from 250 starting test nodes.

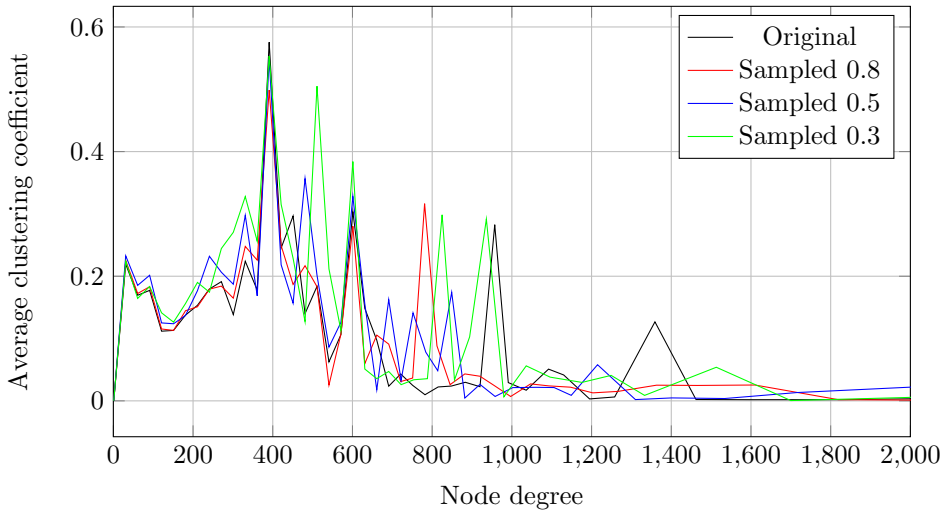

Figure A.1: Distribution of the average clustering coefficient of the Com-Livejournal graph with different sample sizes. For visualization purposes, the domain is restricted to a node degree of 2,000.

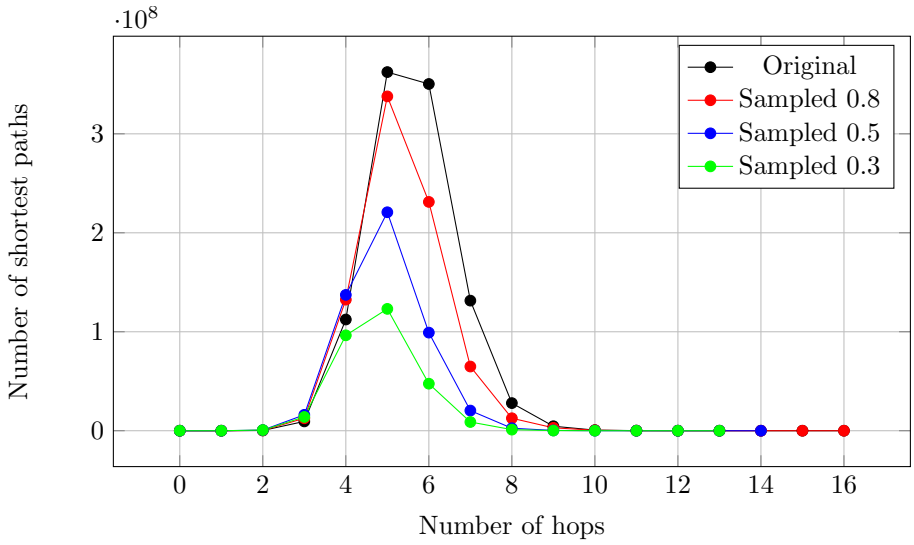

Figure A.2: Distribution of the shortest path lengths of the Com-Livejournal graph with different sample sizes.

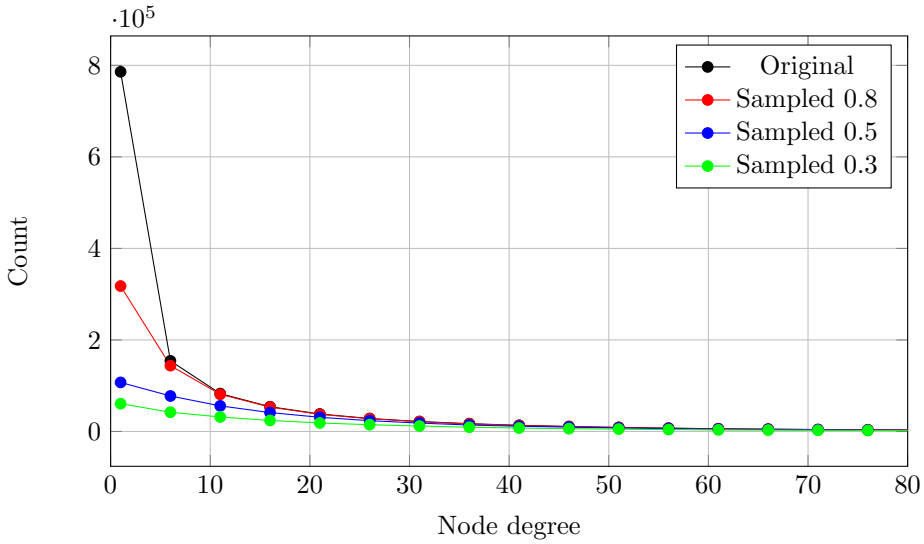

Figure A.3: Distribution of the degree Com-Livejournal graph with different sample sizes. For visualization purposes, the domain is restricted to a node degree of 80.

Enron-email graph (undirected)

	Original graph	Sample size: 0.3	Sample size: 0.5	Sample size: 0.8
Nodes	36,692	11,007	18,346	29,353
Edges	183,831	111,762	144,003	173,935
Avg. degree	10.02	20.31	15.70	11.85
Diameter	13	10	13	13
Graph density	2.73e-4	1.84e-3	8.55e-4	4.03e-4
Connected components	1,065	272	420	700
Avg. CC	0.49	0.51	0.55	0.56
Avg. shortest path	4.03	3.54	3.75	3.96

Table A.2: Properties of the Enron-email graph along different sample sizes.

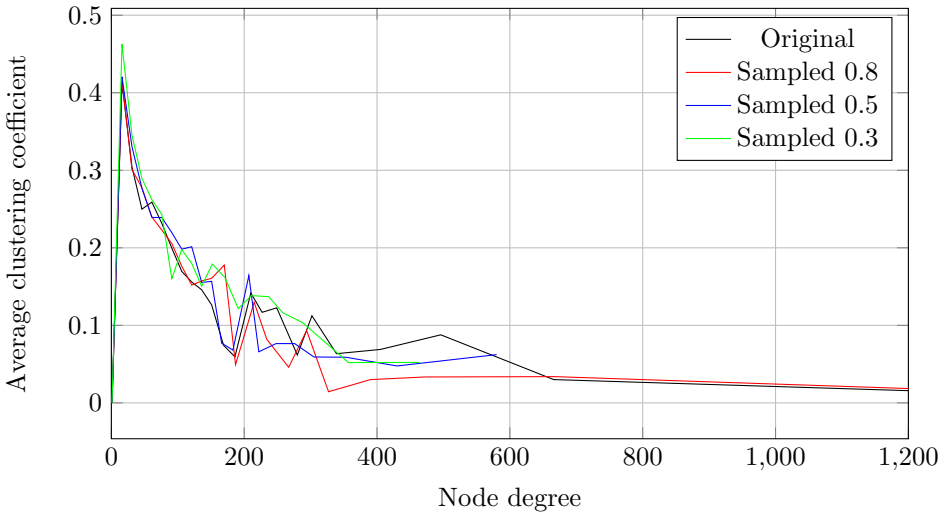

Figure A.4: Distribution of the average clustering coefficient of the Enron-email graph with different sample sizes. For visualization purposes, the domain is restricted to a node degree of 1,200.

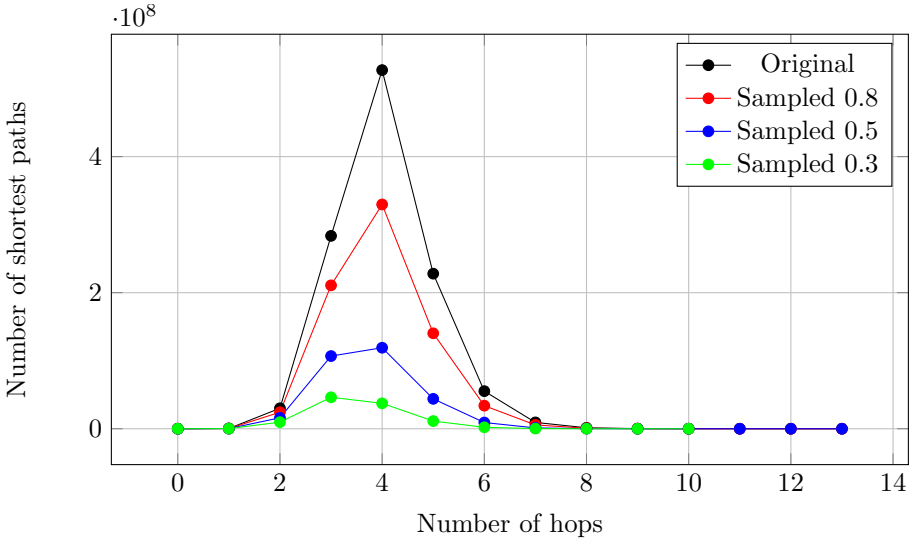

Figure A.5: Distribution of the shortest path lengths of the Enron-email graph with different sample sizes.

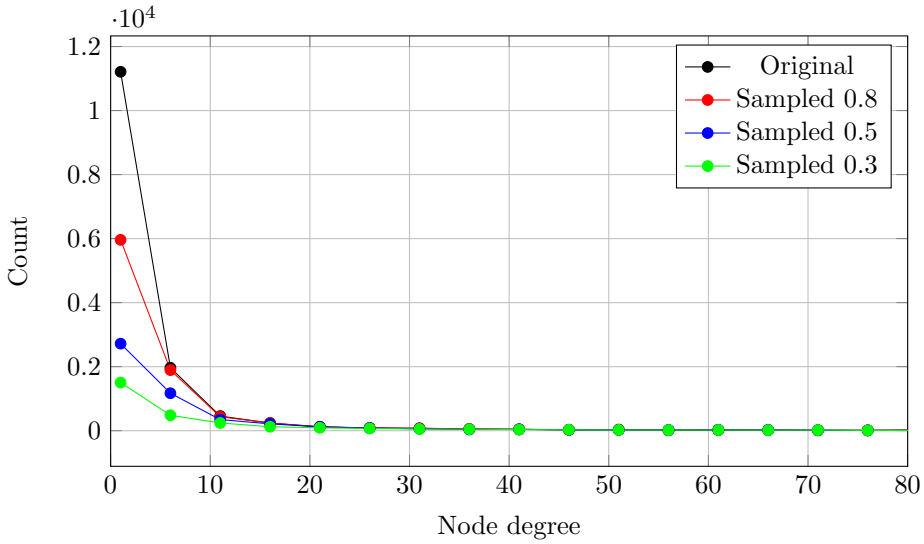

Figure A.6: Distribution of the degree Enron-email graph with different sample sizes. For visualization purposes, the domain is restricted to a node degree of 80.

Facebook graph (undirected)

	Original graph	Sample size: 0.3	Sample size: 0.5	Sample size: 0.8
Nodes	4,039	1,212	2,020	3,231
Edges	88,234	30,454	57,602	81,928
Avg. degree	43.69	50.25	57.03	50.71
Diameter	8	7	7	8
Graph density	1.08e-2	4.15e-2	2.82e-2	1.57e-2
Connected components	1	2	2	1
Avg. CC	0.60	0.66	0.63	0.60
Avg. shortest path	3.69	3.44	3.55	3.61

Table A.3: Properties of the Facebook graph along different sample sizes.

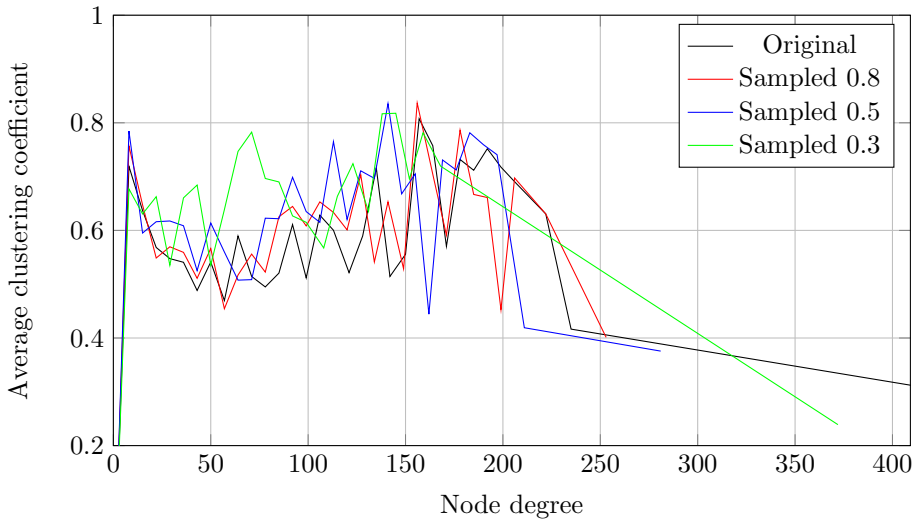

Figure A.7: Distribution of the average clustering coefficient of the Facebook graph with different sample sizes.

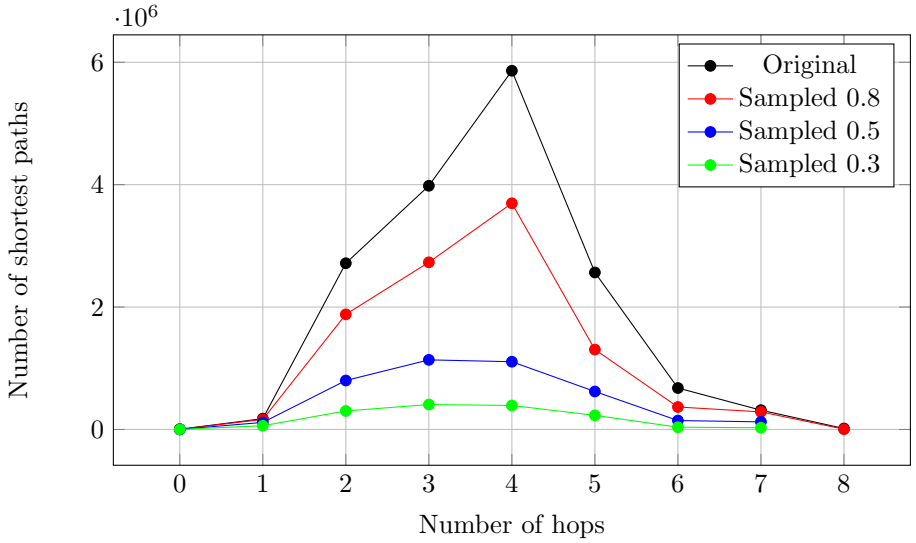

Figure A.8: Distribution of the shortest path lengths of the Facebook graph with different sample sizes.

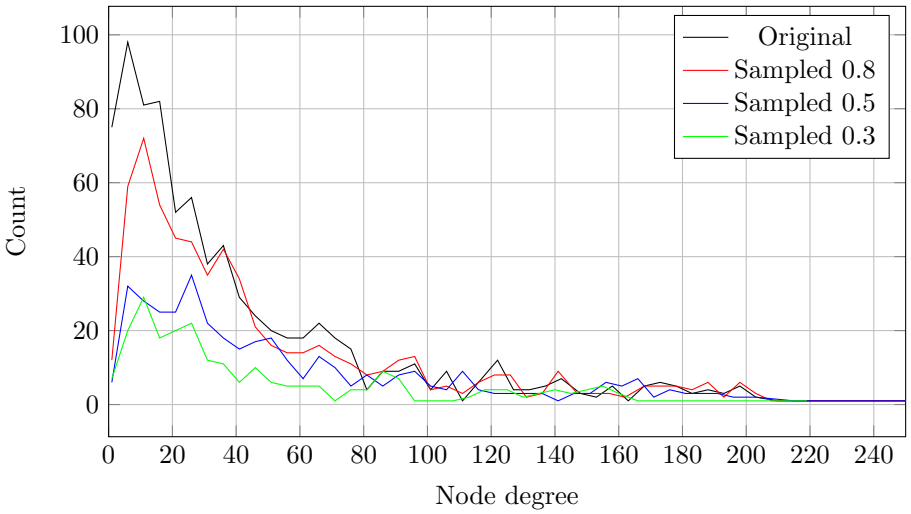

Figure A.9: Distribution of the degree of the Facebook graph with different sample sizes. For visualization purposes, the domain is restricted to a node degree of 250.

Wiki-talk graph (directed)

	Original graph	Sample size: 0.3	Sample size: 0.5	Sample size: 0.8
Nodes	2,394,385	718,315	1,197,192	1,915,508
Edges	4,659,565	2,548,886	3,271,060	4,154,637
Avg. degree	3.89	7.10	5.46	4.34
Diameter	9	8*	9*	9*
Graph density	8.12e-07	4.93e-06	2.28e-06	1.13e-06
Strongly connected components	2,281,879	638,427	1,098,736	1,804,903
Weakly connected components	2,555	680	1,133	1,953
Avg. CC	0.05	0.08	0.07	0.06
Avg. shortest path	4.02	3.84*	3.88*	3.99*

Table A.4: Properties of the Wiki-talk graph along different sample sizes. *Obtained from 3,000 starting test nodes.

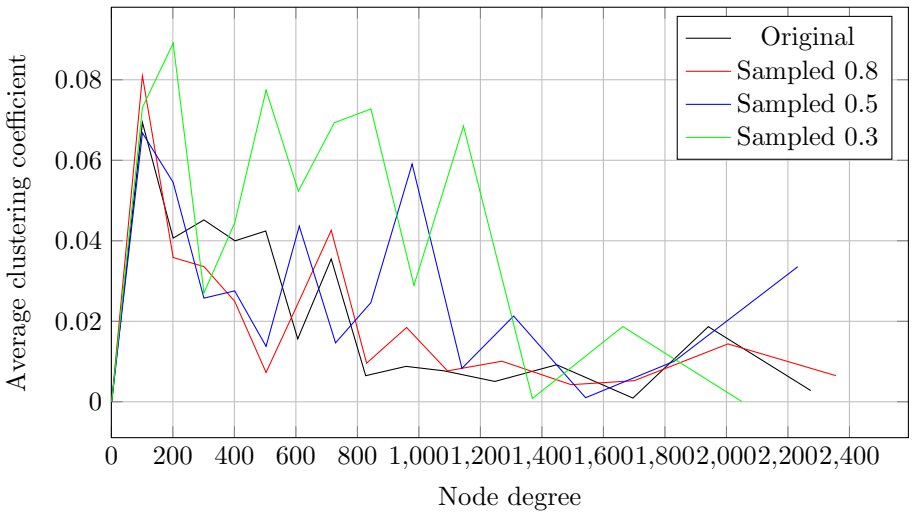

Figure A.10: Distribution of the average clustering coefficient of the Wiki-talk graph with different sample sizes.

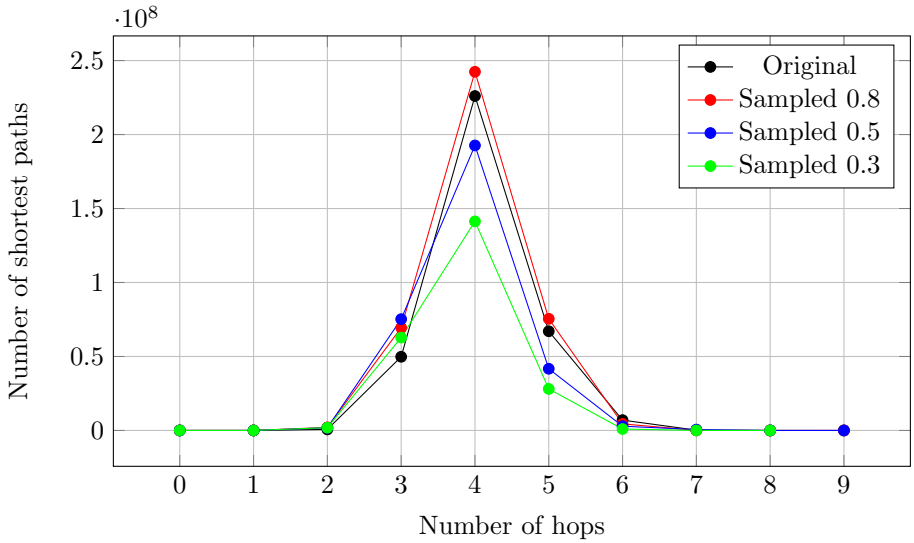

Figure A.11: Distribution of the shortest path lengths of the Wiki-talk graph with different sample sizes.

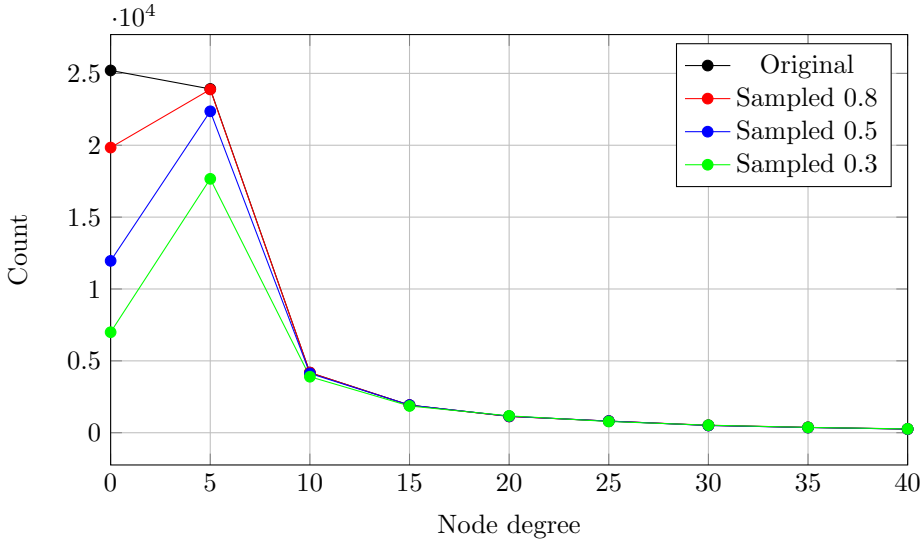

Figure A.12: In-degree distribution of the Wiki-talk graph with different sample sizes. For visualization purposes, the domain is restricted to a node degree of 40.

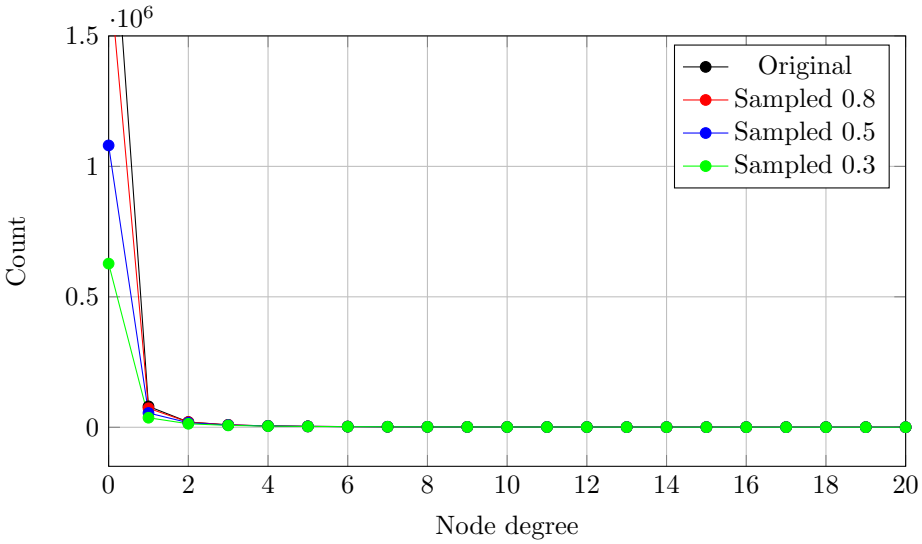

Figure A.13: Out-degree distribution of the Wiki-talk graph with different sample sizes. For visualization purposes, the domain is restricted to a node degree of 20.

Web-Stanford graph (directed)

	Original graph	Sample size: 0.3	Sample size: 0.5	Sample size: 0.8
Nodes	281,903	84,570	140,951	225,522
Edges	1,992,636	866,398	1,334,899	1,808,371
Avg. degree	14.14	20.49	18.94	16.04
Diameter	741	25*	37*	53*
Graph density	2.50e-05	1.21e-4	6.71e-05	3.55e-05
Strongly connected components	29,914	24,002	28,350	27,879
Weakly connected components	365	2,190	2,420	2,342
Avg. CC	0.59	0.66	0.66	0.64
Avg. shortest path	12.30	10.44*	11.07*	11.47*

Table A.5: Properties of the Web-Stanford graph along different sample sizes. *Obtained from 3,000 starting test nodes.

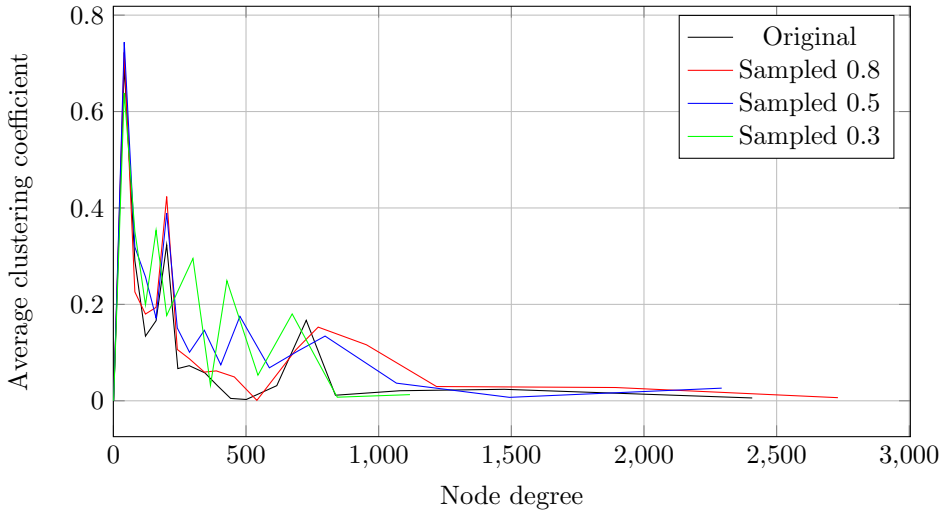

Figure A.14: Distribution of the average clustering coefficient of the Web-Stanford graph with different sample sizes.

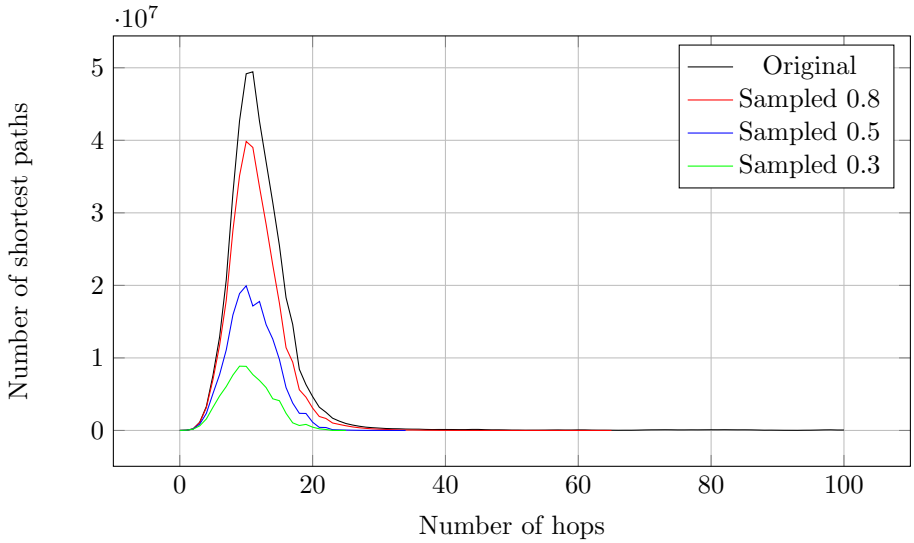

Figure A.15: Distribution of the shortest path lengths of the Web-Stanford graph with different sample sizes.

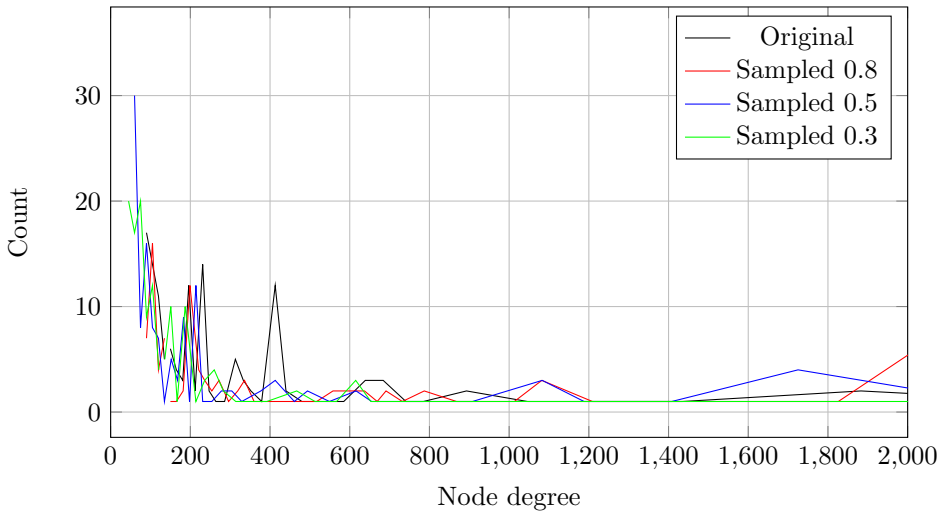

Figure A.16: In-degree distribution of the Web-Stanford graph with different sample sizes. For visualization purposes, the range is restricted to 30 and the domain to 2,000.

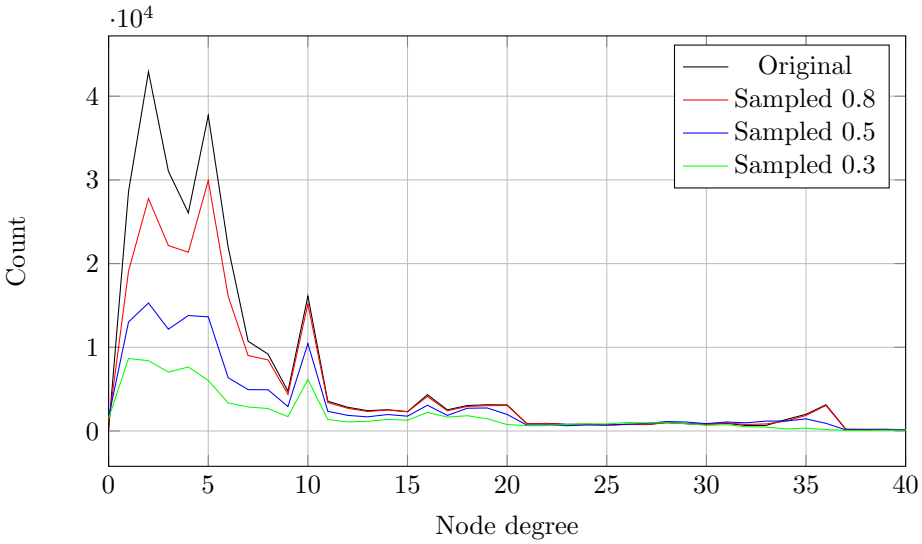

Figure A.17: Out-degree distribution of the Web-Stanford graph with different sample sizes. For visualization purposes, the domain is restricted to a node degree of 40.

Gnutella graph (directed)

	Original graph	Sample size: 0.3	Sample size: 0.5	Sample size: 0.8
Nodes	62,586	18,775	31,293	50,068
Edges	147,892	53,866	98,125	133,496
Avg. degree	4.73	5.74	6.27	5.33
Diameter	31	31	31	31*
Graph density	3.77e-05	1.52e-4	1.00e-4	5.32e-05
Strongly connected components	48,438	11,118	18,400	35,968
Weakly connected components	12	19	12	11
Avg. CC	5.46e-3	6.40e-3	7.38e-3	6.24e-3
Avg. shortest path	9.20	9.90	9.02	9.08*

Table A.6: Properties of the Gnutella graph along different sample sizes. *Obtained from 30,000 starting test nodes.

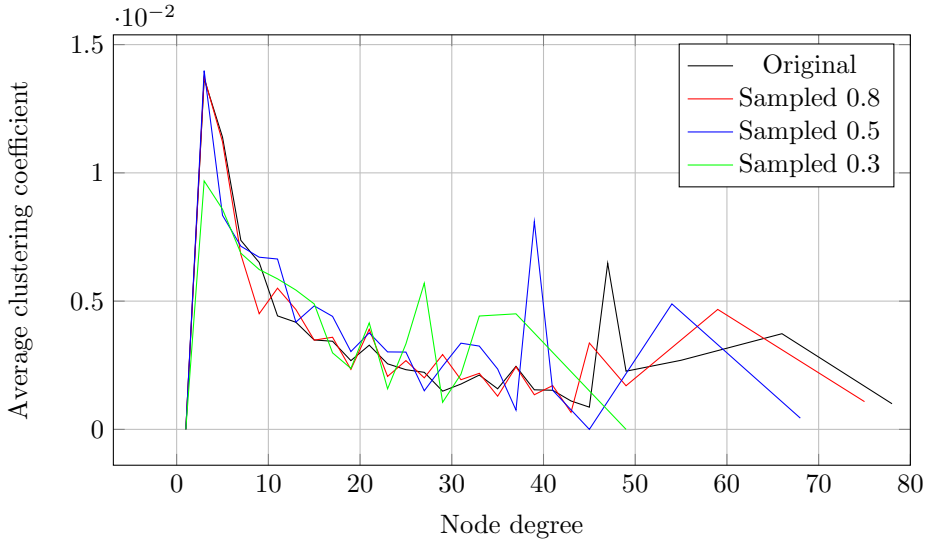

Figure A.18: Distribution of the average clustering coefficient of the Gnutella graph with different sample sizes.

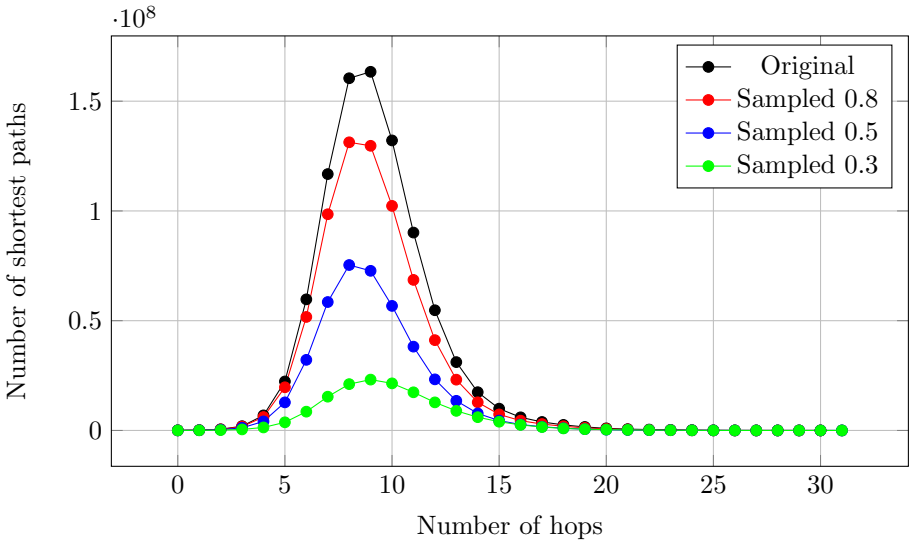

Figure A.19: Distribution of the shortest path lengths of the Gnutella graph with different sample sizes.

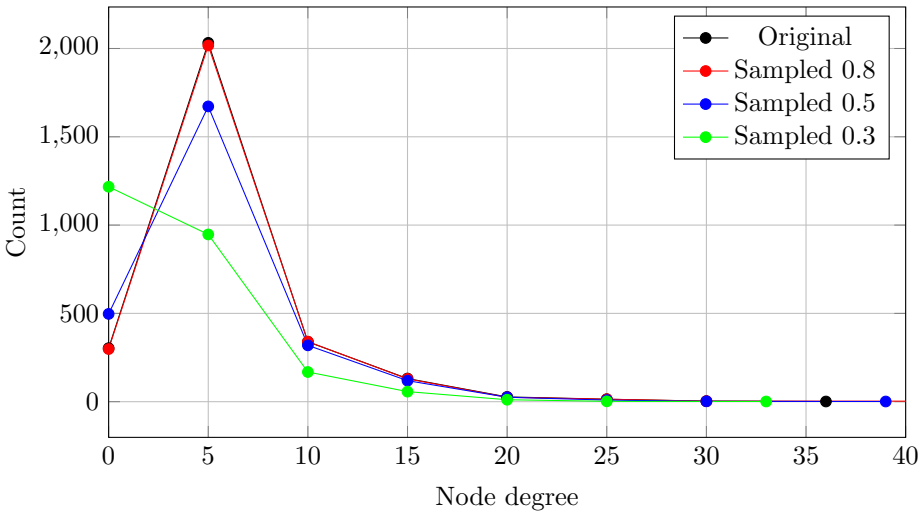

Figure A.20: In-degree distribution of the Wiki-vote graph with different sample sizes. For visualization purposes, the domain is restricted to a node degree of 40.

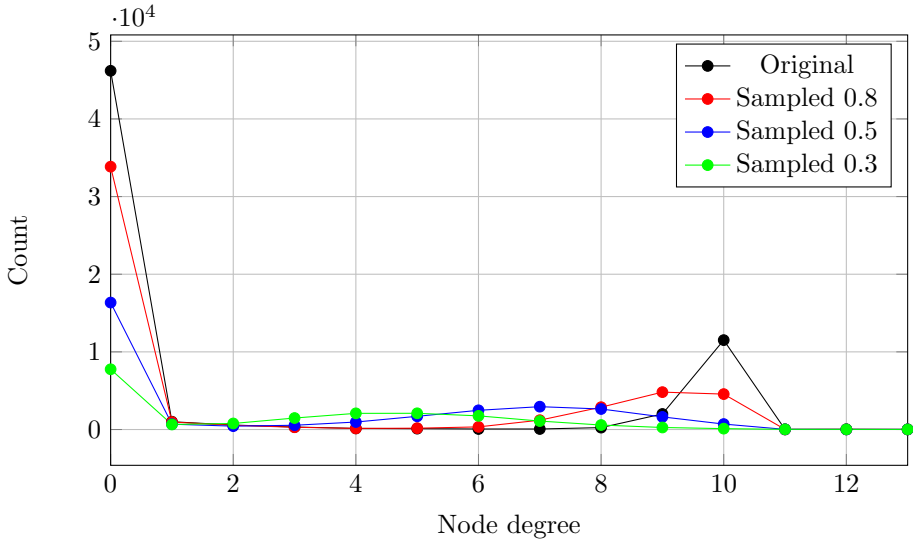

Figure A.21: Out-degree distribution of the Gnutella graph with different sample sizes. For visualization purposes, the domain is restricted to a node degree of 13.

Wiki-vote graph (directed)

	Original graph	Sample size: 0.3	Sample size: 0.5	Sample size: 0.8
Nodes	7,115	2,134	3,557	5,692
Edges	100,762	67,429	91,183	98,956
Avg. degree	28.32	63.20	51.27	34.77
Diameter	10	8	9	10
Graph density	1.99e-3	1.48e-2	7.20e-3	3.05e-3
Strongly connected components	5,816	1,134	2,313	4,393
Weakly connected components	24	2	1	14
Avg. CC	0.14	0.23	0.19	0.16
Avg. shortest path	3.34	2.73	2.96	3.22

Table A.7: Properties of the Wiki-vote graph along different sample sizes.

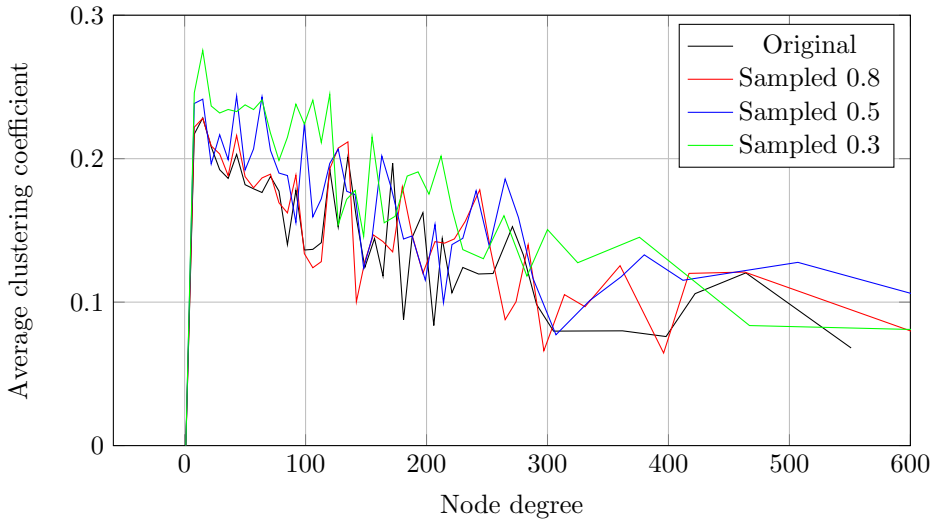

Figure A.22: Distribution of the average clustering coefficient of the Wiki-vote graph with different sample sizes. For visualization purposes, the domain is restricted to a node degree of 600.

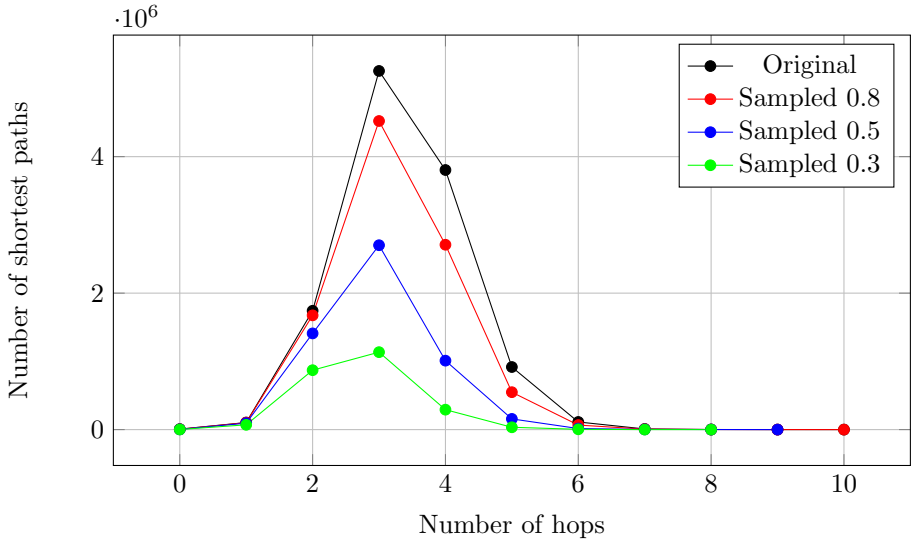

Figure A.23: Distribution of the shortest path lengths of the Wiki-vote graph with different sample sizes.

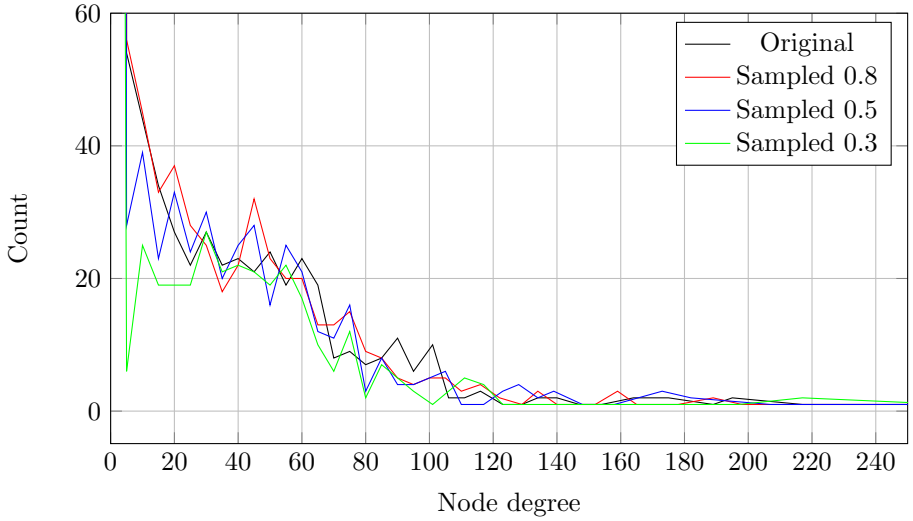

Figure A.24: In-degree distribution of the Wiki-vote graph with different sample sizes. For visualization purposes, the range is restricted 60 and the domain is restricted to a node degree of 250.

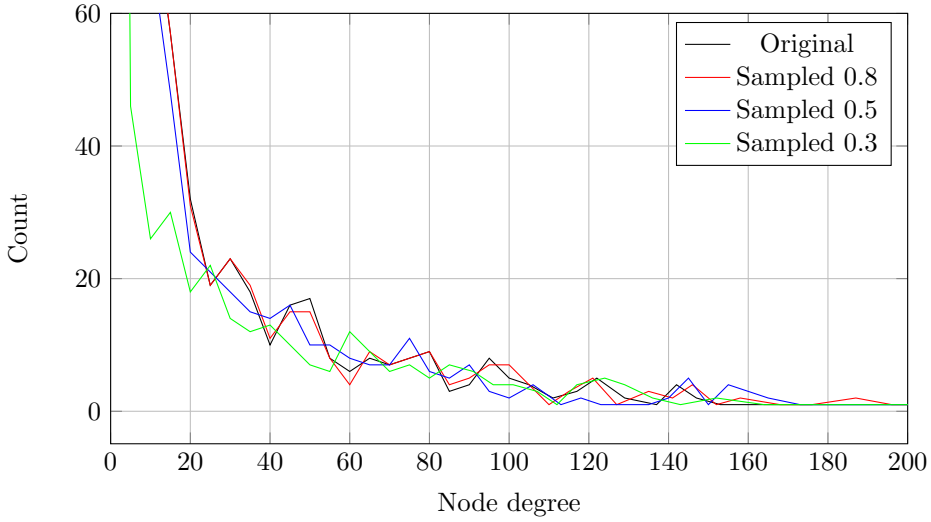

Figure A.25: Out-degree distribution of the Wiki-vote graph with different sample sizes. For visualization purposes, the range is restricted to 60 and the domain is restricted to a node degree of 200.

Appendix B

Expanding results

Com-Orkut graph (undirected)

	G	G_s	G_e (random)	G_e (random, denser)	G_e (high degree)	G_e (high degree, denser)
Topology	-	-	Star	Star	Star	Star
Bridge	-	-	Random	Random	High-degree	High-degree
Interconnections	-	-	1	700,000	1	700,000
Nodes	3,072,441	1,536,220	9,217,320	9,217,321	9,217,320	9,217,320
Edges	117,185,083	73,576,046	441,684,678	445,202,463	441,719,499	445,341,297
Avg. degree	76.28	95.79	95.84	96.60	95.85	96.63
Diameter	9	8	19*	10*	20*	10*
Graph density	2.48e-05	6.23e-05	1.03e-05	1.04e-05	1.03e-05	1.04e-05
Connected components	1	21	102	110	103	123
Avg. CC	0.16	0.14	0.14	0.14	0.14	0.14
Avg. shortest path	4.05	3.99	11.52*	4.44*	9.56*	4.98*

Table B.1: Properties of the Com-Orkut graph along different expanded versions using a star topology (3 times expansion using a sample size of 0.5). *Obtained from 10 starting test nodes.

	G	G_s	G_e (random)	G_e (random, denser)	G_e (high degree)	G_e (high degree, denser)
Topology	-	-	Chain	Chain	Chain	Chain
Bridge	-	-	Random	Random	High degree	High degree
Interconnections	-	-	1	700,000	1	700,000
Nodes	3072441	1,536,220	9,217,320	9,217,321	9,217,321	9,217,320
Edges	117,185,083	73,576,046	441,850,358	445,156,782	441,773,871	445,249,934
Avg. degree	76.28	95.79	95.87	96.59	95.86	96.61
Diameter	9	8	31*	12*	33*	12*
Graph density	2.48e-05	6.23e-05	1.04e-05	1.04e-05	1.03e-05	1.04e-05
Connected components	1	21	126	99	96	112
Avg. CC	0.16	0.14	0.14	0.14	0.14	0.14
Avg. shortest path	4.05	3.99	11.75*	5.25*	14.78*	5.25*

Table B.2: Properties of the Com-Orkut graph along different expanded versions using a chain topology (3 times expansion using a sample size of 0.5). *Obtained from 10 starting test nodes.

	G	G_s	G_e (random)	G_e (random, denser)	G_e (high degree)	G_e (high degree, denser)
Topology	-	-	Ring	Ring	Ring	Ring
Bridge	-	-	Random	Random	High degree	High degree
Interconnections	-	-	1	700,000	1	700,000
Nodes	3,072,441	1,536,220	9,217,321	9,217,322	9,217,321	9,217,320
Edges	117185083	73,576,046	441,782,848	445,975,604	441,679,662	446,079,856
Avg. degree	76.28	95.79	95.86	96.77	95.84	96.79
Diameter	9	8	21*	9*	22*	10*
Graph density	2.48e-05	6.23e-05	1.03e-05	1.04e-05	1.03e-05	1.05e-05
Connected components	1	21	97	116	103	102
Avg. CC	0.16	0.14	0.14	0.14	0.14	0.14
Avg. shortest path	4.05	3.99	10.06*	4.54*	10.52*	4.86*

Table B.3: Properties of the Com-Orkut graph along different expanded versions using a ring topology (3 times expansion using a sample size of 0.5). *Obtained from 10 starting test nodes.

	G	G_s	G_e (random)	G_e (random, denser)	G_e (high degree)	G_e (high degree, denser)
Topology	-	-	Fully connected	Fully connected	Fully connected	Fully connected
Bridge	-	-	Random	Random	High degree	High degree
Interconnections	-	-	1	700,000	1	700,000
Nodes	3,072,441	1,536,220	9,217,323	9,217,320	9,217,322	9,217,322
Edges	117,185,083	73,576,046	441,764,429	462,787,944	441,772,623	462,920,729
Avg. degree	76.28	95.78	95.86	100.42	95.86	100.45
Diameter	9	8	12*	10*	14*	10*
Graph density	2.48e-05	6.23e-05	1.03e-05	1.08e-05	1.03e-05	1.08e-05
Connected components	1	21	106	91	83	101
Avg. CC	0.16	0.14	0.14	0.13	0.14	0.13
Avg. shortest path	4.05	3.99	7.04*	3.97*	7.40*	4.33*

Table B.4: Properties of the Com-Orkut graph along different expanded versions using a fully connected topology (3 times expansion using a sample size of 0.5).

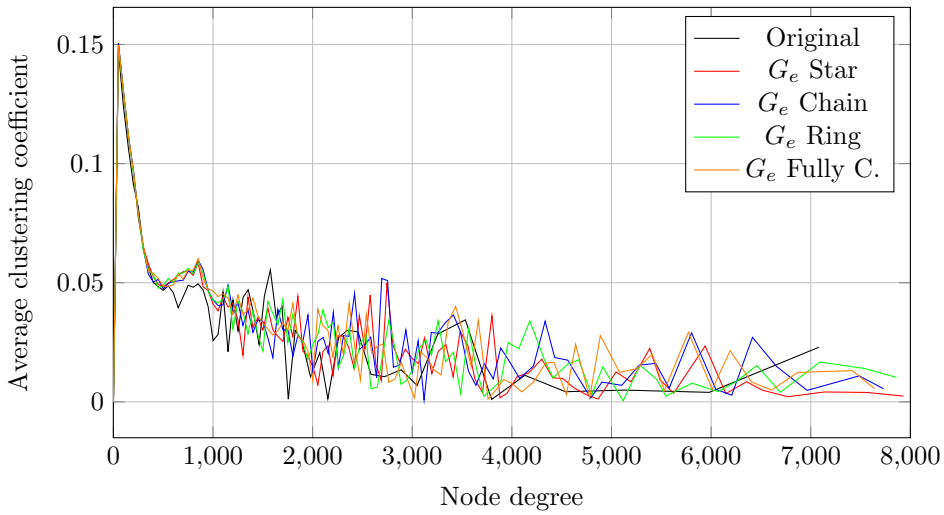

Figure B.1: Distribution of the average clustering coefficient of the expanded Com-Orkut graph using different topology with a single interconnection and random bridge selection (G_e random).

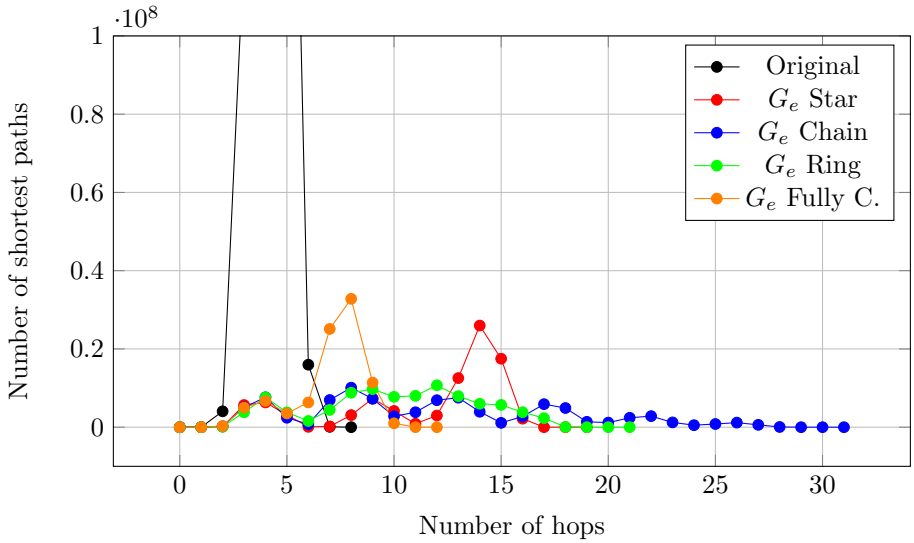

Figure B.2: Distribution of the shortest path lengths of the expanded Com-Orkut graph using different topology with a single interconnection and random bridge selection (G_e random).

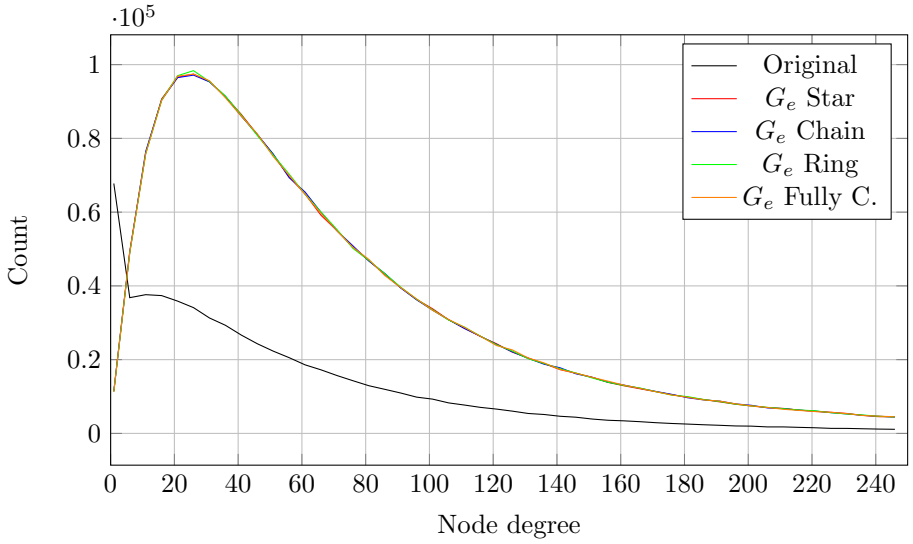

Figure B.3: Distribution of the degree of the expanded Com-Orkut graph using a different topologies with a single interconnection and random bridge selection (G_e random). For visualization purposes, the domain is restricted to a node degree of 250.

Expansion using a scaling factor of 6.5 and 10

	G	G_s	6.5x	10x
Topology	-	-	Star	Star
Bridge	-	-	Random	Random
Interconnections	-	-	1	1
Nodes	3,072,441	1,536,220	19,970,861	30,724,401
Edges	117,185,083	73,576,046	957,116,088	1,472,465,199
Avg. degree	76.28	95.79	95.85	95.84
Diameter	9	8	22*	21*
Graph density	2.48e-05	6.23e-05	4.79e-06	3.11e-06
Connected components	1	21	216	352
Avg. CC	0.16	0.14	0.14	0.14
Avg. shortest path	4.05	3.99	12.03*	11.59*

Table B.5: Example of expanding the Com-Orkut graph using a scaling factor of 3, 6.5 and 10 times, and star topology. *Obtained from 10 starting test nodes.

	G	G_s	6.5x	10x
Topology	-	-	Chain	Chain
Bridge	-	-	Random	Random
Interconnections	-	-	1	1
Nodes	3,072,441	1,536,220	19,970,862	30,724,401
Edges	117,185,083	73,576,046	957,135,693	1,472,597,664
Avg. degree	76.28	95.79	95.8532	95.85
Diameter	9	8	63*	96*
Graph density	2.48e-05	6.23e-05	4.79e-06	3.11e-06
Connected components	1	21	243	370
Avg. CC	0.16	0.14	0.14	0.14
Avg. shortest path	4.05	3.99	23.97*	33.38*

Table B.6: Example of expanding the Com-Orkut graph using a scaling factor of 3, 6.5 and 10 times, and chain topology. *Obtained from 10 starting test nodes.

	G	G_s	6.5x	10x
Topology	-	-	Ring	Ring
Bridge	-	-	Random	Random
Interconnections	-	-	1	1
Nodes	3,072,441	1,536,220	19,970,861	30,724,406
Edges	117,185,083	73,576,046	957,166,336	1,472,502,728
Avg. degree	76.28	95.79	95.85	95.85
Diameter	9	8	37*	54*
Graph density	2.48e-05	6.23e-05	4.79e-06	3.11e-6
Connected components	1	21	215	368
Avg. CC	0.16	0.14	0.14	0.14
Avg. shortest path	4.05	3.99	17.96*	26.43*

Table B.7: Example of expanding the Com-Orkut graph using a scaling factor of 3, 6.5 and 10 times, and ring topology. *Obtained from 10 starting test nodes.

	G	G_s	6.5x	10x
Topology	-	-	Fully connected	Fully connected
Bridge	-	-	Random	Random
Interconnections	-	-	1	1
Nodes	3,072,441	1,536,220	19,970,861	30,724,404
Edges	117,185,083	73,576,046	957,009,373	1,472,491,564
Avg. degree	76.28	95.79	95.84	95.85
Diameter	9	8	14*	15*
Graph density	2.48e-05	6.23e-05	4.79e-06	3.11e-6
Connected components	1	21	214	334
Avg. CC	0.16	0.14	0.14	0.14
Avg. shortest path	4.05	3.99	7.63*	7.83*

Table B.8: Example of expanding the Com-Orkut graph using a scaling factor of 3, 6.5 and 10 times, and fully connected topology. *Obtained from 10 starting test nodes.

Com-LiveJournal graph (undirected)

	G	G_s	G_e (random)	G_e (random, denser)	G_e (high degree)	G_e (high degree, denser)
Topology	-	-	Star	Star	Star	Star
Bridge	-	-	Random	Random	High degree	High degree
Interconnections	-	-	1	100,000	1	100,000
Nodes	3,997,962	1,998,981	11,993,887	11,993,886	11,993,886	11,993,886
Edges	34681189	27,438,564	164,606,570	165,100,440	164,605,142	165,110,154
Avg. degree	17.35	27.45	27.45	27.53	27.45	27.53
Diameter	17	15	24*	17*	25*	16*
Graph density	4.33e-06	1.37e-05	2.28e-06	2.29e-06	2.28e-06	2.29e-06
Connected components	1	3,928	24,032	23,587	23,900	23,836
Avg. CC	0.28	0.29	0.29	0.29	0.29	0.29
Avg. shortest path	5.57	5.04	12.31*	6.38*	15.91*	7.98*

Table B.9: Properties of the Live-Journal graph along different expanded versions using a star topology (3 times expansion using a sample size of 0.5). *Obtained from 100 starting test nodes.

	G	G_s	G_e (random)	G_e (random, denser)	G_e (high degree)	G_e (high degree, denser)
Topology	-	-	Chain	Chain	Chain	Chain
Bridge	-	-	Random	Random	High degree	High degree
Interconnections	-	-	1	100,000	1	100,000
Nodes	3,997,962	1,998,981	11,993,886	11,993,886	11,993,886	11,993,888
Edges	34,681,189	27,438,564	164,613,156	165,085,805	164,593,159	165,094,525
Avg. degree	17.35	27.45	27.45	27.53	27.45	27.53
Diameter	17	15	39*	19*	39*	20*
Graph density	4.33e-06	1.37e-05	2.28e-06	2.29e-06	2.28e-06	2.29e-06
Connected components	1	3,928	23,921	23,308	23,891	23,551
Avg. CC	0.28	0.29	0.29	0.29	0.29	0.29
Avg. shortest path	5.57	5.04	14.88*	7.12*	15.43*	10.23*

Table B.10: Properties of the Live-Journal graph along different expanded versions using a chain topology (3 times expansion using a sample size of 0.5). *Obtained from 100 starting test nodes.

	G	G_s	G_e (random)	G_e (random, denser)	G_e (high degree)	G_e (high degree, denser)
Topology	-	-	Ring	Ring	Ring	Ring
Bridge	-	-	Random	Random	High degree	High degree
Interconnections	-	-	1	100,000	1	100,000
Nodes	3,997,962	1,998,981	11,993,887	11,993,886	11,993,887	11,993,887
Edges	34,681,189	27,438,564	164,603,770	165,197,093	164,591,065	165,216,705
Avg. degree	17.35	27.45	27.45	27.55	27.45	27.55
Diameter	17	15	28*	15*	31*	17*
Graph density	4.33e-06	1.37e-05	2.28e-06	2.29e-06	2.28e-06	2.29e-06
Connected components	1	3,928	24,073	23,347	24,033	24,003
Avg. CC	0.28	0.29	0.29	0.29	0.29	0.29
Avg. shortest path	5.57	5.04	12.56*	6.33*	12.98*	6.89*

Table B.11: Properties of the Live-Journal graph along different expanded versions using a ring topology (3 times expansion using a sample size of 0.5). *Obtained from 100 starting test nodes.

	G	G_s	G_e (random)	G_e (random, denser)	G_e (high degree)	G_e (high degree, denser)
Topology	-	-	Fully connected	Fully connected	Fully connected	Fully connected
Bridge	-	-	Random	Random	High degree	High degree
Interconnections	-	-	1	100000	1	100,000
Nodes	3,997,962	1,998,981	11,993,888	11,993,886	11,993,886	11,993,886
Edges	34,681,189	27,438,564	164,607,407	167,609,568	164,616,525	167,598,989
Avg. degree	17.35	27.45	27.45	27.95	27.45	27.95
Diameter	17	15	18*	14*	21*	15*
Graph density	4.33e-06	1.37e-05	2.28e-06	2.33e-06	2.28e-06	2.33e-06
Connected components	1	3,928	24,149	22,318	23,856	23,650
Avg. CC	0.28	0.29	0.29	0.29	0.29	0.29
Avg. shortest path	5.57	5.04	8.63*	5.71*	9.07*	5.70*

Table B.12: Properties of the Live-Journal graph along different expanded versions using a fully connected topology (3 times expansion using a sample size of 0.5). *Obtained from 100 starting test nodes.

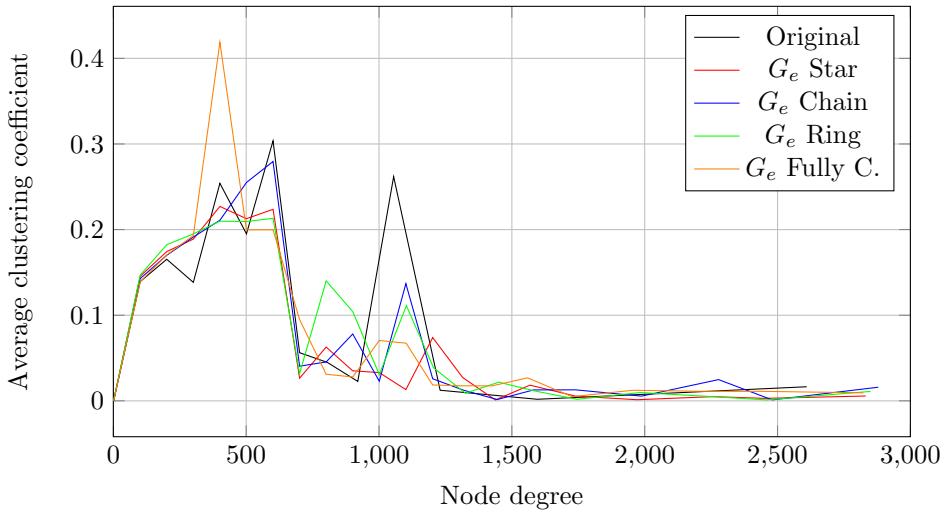

Figure B.4: Distribution of the average clustering coefficient of the expanded Live-Journal graph using different topologies with a multi interconnections and random bridge selection (G_e random, denser).

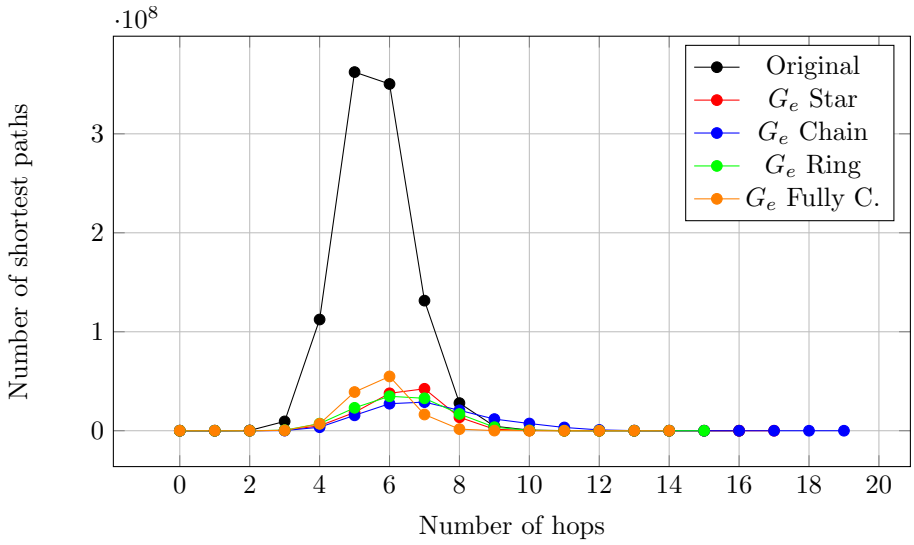

Figure B.5: Distribution of the shortest path lengths of the expanded Live-Journal graph using different topologies with multi interconnections and random bridge selection (G_e random, denser).

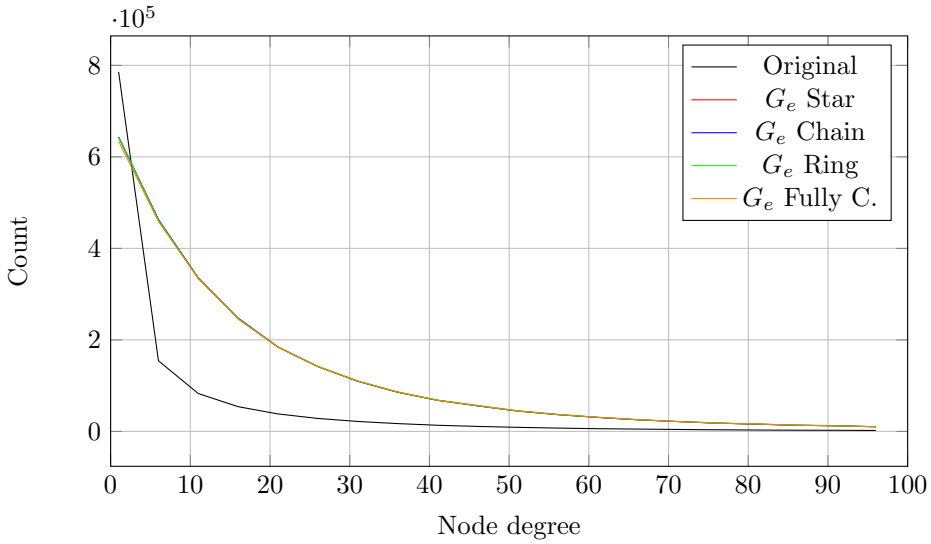

Figure B.6: Distribution of the degree of the expanded Live-Journal graph using a different topologies with multi interconnections and random bridge selection (G_e random, denser). For visualization purposes, the domain is restricted to a node degree of 100.

Enron-email graph (undirected)

	G	G_s	G_e (random)	G_e (random, denser)	G_e (high degree)	G_e (high degree, denser)
Topology	-	-	Star	Star	Star	Star
Bridge	-	-	Random	Random	High degree	High degree
Interconnections	-	-	1	70,000	1	70,000
Nodes	36,692	18,346	110,076	110,077	110,076	110,076
Edges	183,831	144,003	865,282	1,213,989	866,759	1,215,007
Avg. degree	10.02	15.70	15.72	22.06	15.75	22.08
Diameter	13	13	21*	11*	20*	11*
Graph density	2.73e-4	8.55e-4	1.42e-4	2.00e-4	1.43e-4	2.00e-4
Connected components	1,065	420	2,418	1,008	2,382	2,341
Avg. CC	0.49	0.55	0.56	0.34	0.56	0.38
Avg. shortest path	4.03	3.75	9.14*	3.69*	9.49*	4.05*

Table B.13: Properties of the Enron-email graph along different expanded versions using a star topology (3 times expansion using a sample size of 0.5). *Obtained from 3,000 starting test nodes.

	G	G_s	G_e (random)	G_e (random, denser)	G_e (high degree)	G_e (high degree, denser)
Topology	-	-	Chain	Chain	Chain	Chain
Bridge	-	-	Random	Random	High degree	High degree
Interconnections	-	-	1	70,000	1	70,000
Nodes	36,692	18,346	110,076	110,076	110,076	110,076
Edges	183,831	144,003	865,710	1,212,813	866,623	1,216,672
Avg. degree	10.02	15.70	15.73	22.04	15.75	22.11
Diameter	13	13	29*	12*	31*	12*
Graph density	2.73e-4	8.55e-4	1.42e-4	2.00e-4	1.43e-4	2.00e-4
Connected components	1065	420	2,463	851	2,416	2,280
Avg. CC	0.49	0.55	0.55	0.31	0.56	0.37
Avg. shortest path	4.03	3.75	10.97*	4*	11.78*	4.38*

Table B.14: Properties of the Enron-email graph along different expanded versions using a chain topology (3 times expansion using a sample size of 0.5). *Obtained from 3,000 starting test nodes.

	G	G_s	G_e (random)	G_e (random, denser)	G_e (high degree)	G_e (high degree, denser)
Topology	-	-	Ring	Ring	Ring	Ring
Bridge	-	-	Random	Random	High degree	High degree
Interconnections	-	-	1	70,000	1	70,000
Nodes	36,692	18,346	110,076	110,076	110,076	110,076
Edges	183,831	144,003	865,291	1,283,530	865,062	1,286,320
Avg. degree	10.02	15.70	15.72	23.32	15.72	23.37
Diameter	13	13	20*	10*	26*	11*
Graph density	2.73e-4	8.55e-4	1.42e-4	2.11e-4	1.42e-4	2.12e-4
Avg. shortest path	1,065	420	2,443	677	2,466	2,292
Avg. CC	0.49	0.55	0.56	0.28	0.55	0.35
Avg. shortest path	4.03	3.75	8.62*	3.72*	10.95*	4.13*

Table B.15: Properties of the Enron-email graph along different expanded versions using a ring topology (3 times expansion using a sample size of 0.5). *Obtained from 3,000 starting test nodes.

	G	G_s	G_e (random)	G_e (random, denser)	G_e (high degree)	G_e (high degree, denser)
Topology	-	-	Fully connected	Fully connected	Fully connected	Fully connected
Bridge	-	-	Random	Random	High degree	High degree
Interconnections	-	-	1	70,000	1	70,000
Nodes	36,692	18,346	110,078	110,077	110,076	110,076
Edges	183,831	144,003	865,962	2,941,541	865,927	2,964,830
Avg. degree	10.02	15.70	15.73	53.44	15.73	53.87
Diameter	13	13	14*	8*	16*	10*
Graph density	2.73e-4	8.55e-4	1.42e-4	4.85e-4	1.42e-4	4.89e-4
Connected components	1065	420	2417	11	2416	2314
Avg. CC	0.49	0.55	0.55	0.07	0.56	0.31
Avg. shortest path	4.03	3.75*	6.43*	3.02*	6.79*	3.53*

Table B.16: Properties of the Enron-email graph along different expanded versions using a fully connected topology (3 times expansion using a sample size of 0.5). *Obtained from 3,000 starting test nodes.

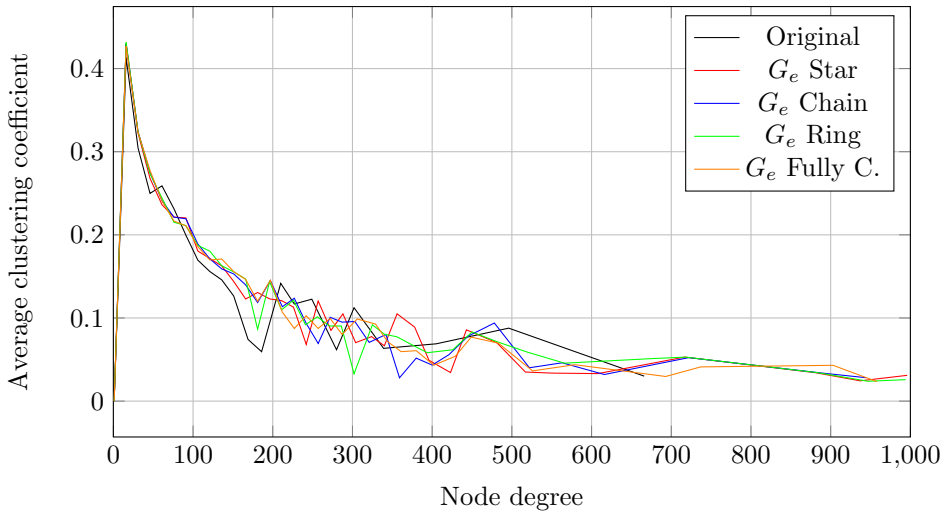

Figure B.7: Distribution of the average clustering coefficient of the expanded Enron-email graph using different topologies with a single interconnection and high-degree bridge-selection (G_e high degree). For visualization purposes, the domain is restricted to a node degree of 1,000.

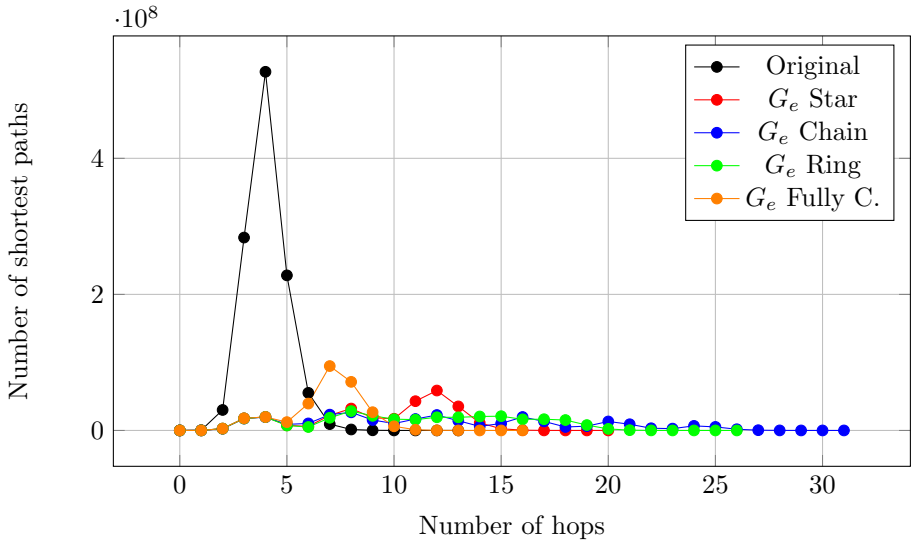

Figure B.8: Distribution of the shortest path lengths of the expanded Enron-email graph using different topologies with a single interconnection and high-degree bridge-selection (G_e high degree).

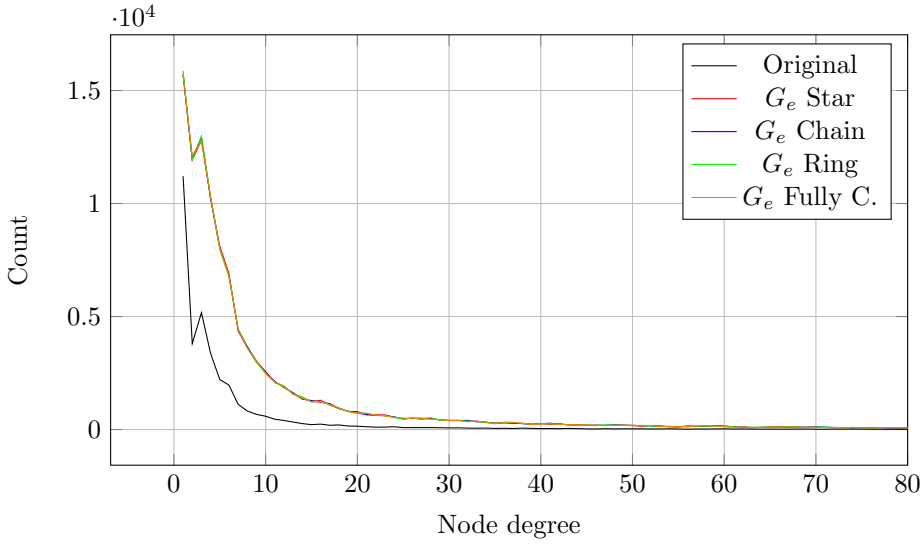

Figure B.9: Distribution of the degree of the expanded Enron-email graph using a different topologies with a single interconnection and high-degree bridge-selection (G_e high degree). For visualization purposes, the domain is restricted to a node degree of 1,000.

Wiki-talk graph (directed)

	G	G_s	G_e (random)	G_e (random, denser)	G_e (high degree)	G_e (high degree, denser)
Topology	-	-	Star	Star	Star	Star
Bridge	-	-	Random	Random	High degree	High degree
Interconnections	-	-	1	300,000	1	300,000
Nodes	2,394,385	1,197,192	7,183,152	7,183,152	7,183,152	7,183,152
Edges	4,659,565	3,271,060	19,629,941	21,121,974	19,628,519	21,130,393
Avg. degree	3.89	5.46	5.47	5.88	5.47	5.88
Diameter	9	9	11*	9*	8*	9*
Graph density	8.12e-07	2.28e-06	3.80e-07	4.09359e-07	3.80e-07	4.09e-07
Strongly connected components	2,281,879	1,098,736	6,592,530	6,593,065	6,593,043	6,593,240
Weakly connected components	2,555	1,133	6,912	5,914	6,874	6,338
Avg. CC	5.25e-2	7.88e-2	7.89e-2	7.30e-2	7.88e-2	5.54e-2
Avg. shortest path	4.02	3.88	7.62*	4.07*	3.98*	4.50*

Table B.17: Properties of the Wiki-talk graph along different expanded versions using a star topology (3 times expansion using a sample size of 0.5). *Obtained from 500 starting test nodes.

	G	G_s	G_e (random)	G_e (random, denser)	G_e (high degree)	G_e (high degree, denser)
Topology	-	-	Chain	Chain	Chain	Chain
Bridge	-	-	Random	Random	High degree	High degree
Interconnections	-	-	1	300,000	1	300,000
Nodes	2,394,385	1,197,192	7,183,152	7,183,152	7,183,152	7,183,153
Edges	4,659,565	3,271,060	19,628,123	21,120,665	19,628,361	21,130,087
Avg. degree	3.89	5.46	5.47	5.88	5.47	5.88
Diameter	9	9	25*	10*	12*	14*
Graph density	8.12e-07	2.28e-06	3.80e-07	4.09e-07	3.80e-07	4.09e-07
Strongly connected components	2,281,879	1,098,736	6,593,073	6,593,641	6,593,182	6,593,303
Weakly connected components	2,555	1,133	6,941	6,030	6,861	6,258
Avg. CC	5.25e-2	7.88e-2	7.88e-2	7.27e-2	7.88e-2	5.26e-2
Avg. shortest path	4.02	3.88	9.15*	4.44*	4.44*	6.36*

Table B.18: Properties of the Wiki-talk graph along different expanded versions using a chain topology (3 times expansion using a sample size of 0.5). *Obtained from 500 starting test nodes.

	G	G_s	G_e (random)	G_e (random, denser)	G_e (high degree)	G_e (high degree, denser)
Topology	-	-	Ring	Ring	Ring	Ring
Bridge	-	-	Random	Random	High degree	High degree
Interconnections	-	-	1	300,000	1	300,000
Nodes	2,394,385	1,197,192	7,183,152	7,183,152	7,183,152	7,183,152
Edges	4,659,565	3,271,060	19,629,860	21,420,437	19,629,438	21,430,748
Avg. degree	3.89	5.46	5.47	5.96	5.47	5.97
Diameter	9	9	19*	12*	8*	16*
Graph density	8.12e-07	2.28e-06	3.80e-07	4.15e-07	3.80e-07	4.15e-07
Strongly connected components	2,281,879	1,098,736	6,593,226	6,213,576	6,593,290	6,188,520
Weakly connected components	2,555	1,133	6,850	5,623	6,933	6,180
Avg. CC	5.25e-2	7.88e-2	7.88e-2	7.17e-2	7.88e-2	4.83e-2
Avg. shortest path	4.02	3.88	7.30*	5.00*	3.83*	7.62*

Table B.19: Properties of the Wiki-talk graph along different expanded versions using a ring topology (3 times expansion using a sample size of 0.5). *Obtained from 500 starting test nodes.

	G	G_s	G_e (random)	G_e (random, denser)	G_e (high degree)	G_e (high degree, denser)
Topology	-	-	Fully connected	Fully connected	Fully connected	Fully connected
Bridge	-	-	Random	Random	High degree	High degree
Interconnections	-	-	1	300,000	1	300,000
Nodes	2,394,385	1,197,192	7,183,152	7,183,152	7,183,152	7,183,152
Edges	4,659,565	3,271,060	19,628,772	28,537,563	19,628,081	28,628,277
Avg. degree	3.89	5.46	5.46	7.94	5.46	7.97
Diameter	9	9	15*	9*	17*	13*
Graph density	8.12e-07	2.28e-06	3.80e-07	5.53e-07	3.80e-07	5.54e-07
Strongly connected components	2,281,879	1,098,736	6,593,156	4,964,081	6,592,847	3,890,631
Weakly connected components	2,555	1,133	6,941	2,821	6,861	5,753
Avg. CC	5.25e-2	7.88e-2	7.88e-2	5.79e-2	7.88e-2	1.31e-2
Avg. shortest path	4.02	3.88	7.23*	4.13*	7.12*	6.26*

Table B.20: Properties of the Wiki-talk graph along different expanded versions using a fully connected topology (3 times expansion using a sample size of 0.5). *Obtained from 500 starting test nodes.

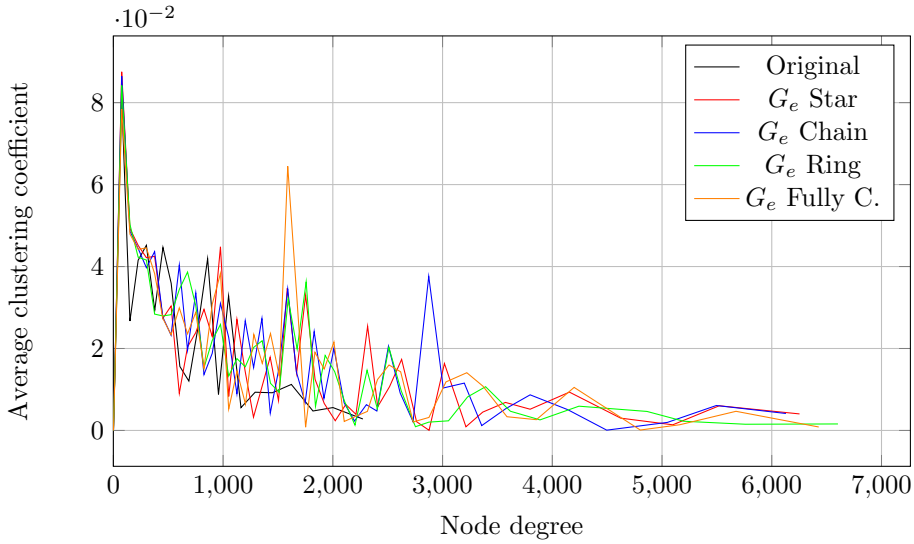

Figure B.10: Distribution of the average clustering coefficient of the expanded Wiki-talk graph using different topologies with multi-interconnections and high-degree bridge-selection (G_e high degree, denser).

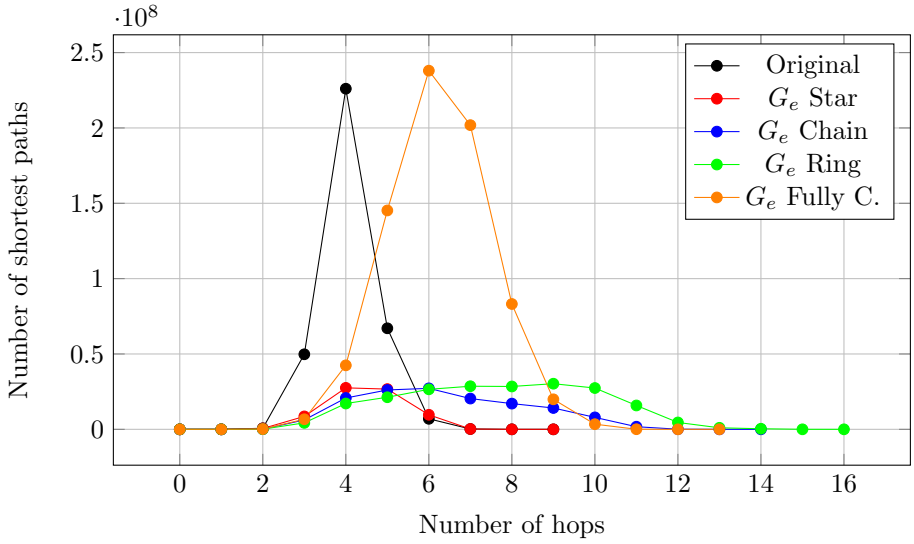

Figure B.11: Distribution of the shortest path lengths of the expanded Wiki-talk graph using different topologies with multi-interconnections and high-degree bridge-selection (G_e high degree, denser).

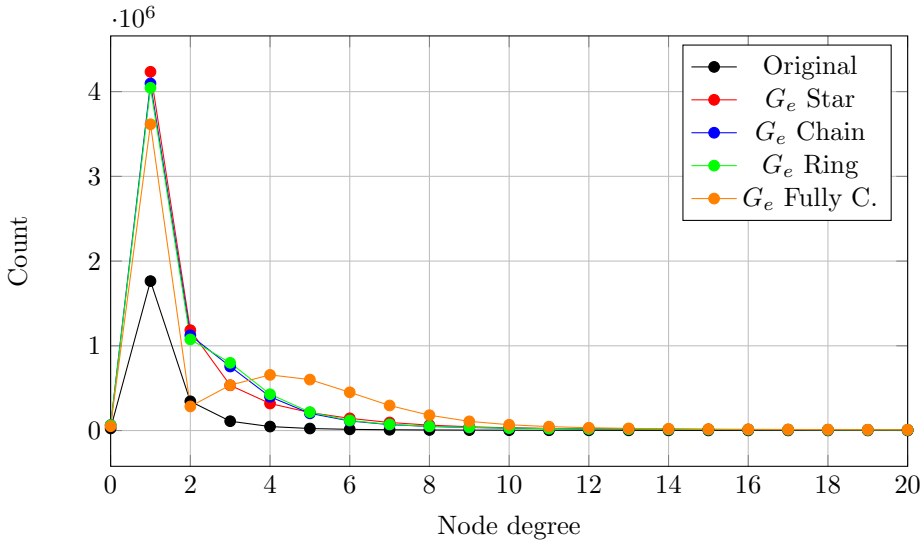

Figure B.12: Distribution of the in-degree of the expanded Wiki-talk graph using a different topologies with multi-interconnection and high-degree bridge-selection (G_e high degree, denser).

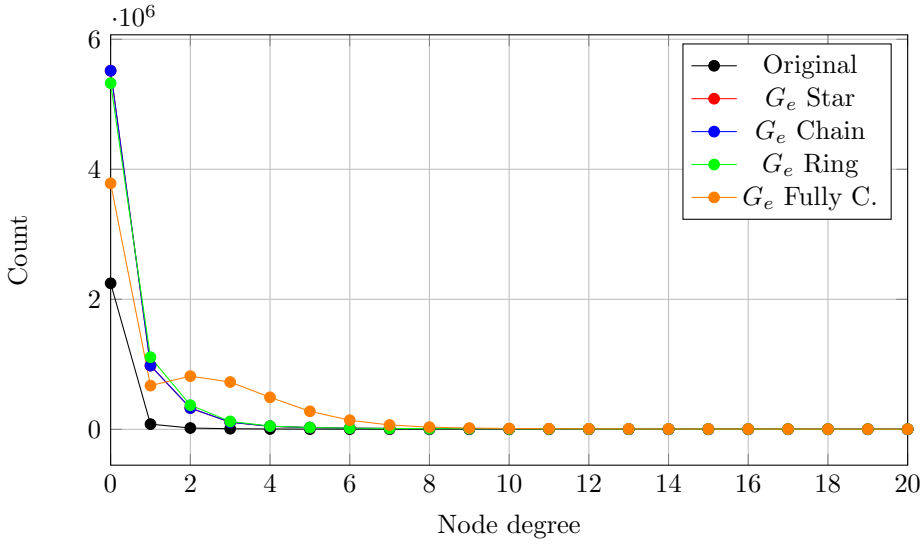

Figure B.13: Distribution of the out-degree of the expanded Wiki-talk graph using a different topologies with multi-interconnection and high-degree bridge-selection (G_e high degree, denser). For visualization purposes, the domain is restricted to a node degree of 20.

Web-Stanford graph (directed)

	G	G_s	G_e (random)	G_e (random, denser)	G_e (high degree)	G_e (high degree, denser)
Topology	-	-	Star	Star	Star	Star
Bridge	-	-	Random	Random	High degree	High degree
Interconnections	-	-	1	100,000	1	100,000
Nodes	281,903	140,951	845,707	845,707	845,707	845,707
Edges	1,992,636	1,334,899	8,016,794	8,516,610	8,021,738	8,524,364
Avg. degree	14.14	18.94	18.96	20.14	18.97	20.16
Diameter	741	37	43	39	54	34
Graph density	2.50e-05	6.71e-05	1.12e-05	1.19e-05	1.12e-05	1.19e-05
Strongly connected components	29,914	28,350	172,198	169,204	169,894	170,405
Weakly connected components	365	2,420	14,411	9,027	14,511	12,432
Avg. CC	0.59	0.66	0.66	0.59	0.66	0.59
Avg. shortest path	12.30	11.07	14.11*	8.51*	14.13*	9.13*

Table B.21: Properties of the Web-Stanford graph along different expanded versions using a star topology (3 times expansion using a sample size of 0.5). *Obtained from 1,000 starting test nodes.

	G	G_s	G_e (random)	G_e (random, denser)	G_e (high degree)	G_e (high degree, denser)
Topology	-	-	Chain	Chain	Chain	Chain
Bridge	-	-	Random	Random	High degree	High degree
Interconnections	-	-	1	100,000	1	100,000
Nodes	281,903	140951	845,706	845,707	845,708	845,706
Edges	1,992,636	1,334,899	8,018,396	8,521,594	8,018,425	8,528,906
Avg. degree	14.14	18.94	18.96	20.15	18.96	20.17
Diameter	741	37	114*	38*	81*	44*
Graph density	2.50e-05	6.71e-05	1.12e-05	1.19e-05	18.96	1.19e-05
Strongly connected components	29,914	28,350	194,481	181,365	171,716	168,637
Weakly connected components	365	2,420	14,514	8,668	14,670	12,246
Avg. CC	0.59	0.66	0.66	0.59	0.66	0.58
Avg. shortest path	12.30	11.07	30.74*	6.96*	24.84*	8.21*

Table B.22: Properties of the Web-Stanford graph along different expanded versions using a chain topology (3 times expansion using a sample size of 0.5). *Obtained from 1,000 starting test nodes.

	G	G_s	G_e (random)	G_e (random, denser)	G_e (high degree)	G_e (high degree, denser)
Topology	-	-	Ring	Ring	Ring	Ring
Bridge	-	-	Random	Random	High degree	High degree
Interconnections	-	-	1	100,000	1	100,000
Nodes	281,903	140,951	845,707	845,708	845,707	845,709
Edges	1,992,636	1,334,899	8,019,000	8,614,881	8,017,413	8,624,744
Avg. degree	14.14	18.94	18.96	20.37	18.96	20.40
Diameter	741	37	46*	27*	97*	47*
Graph density	2.50e-05	6.71e-05	1.12e-05	1.20e-05	1.12e-05	1.20e-05
Strongly connected components	29,914	28,350	192,263	106,889	845,707	120,306
Weakly connected components	365	2,420	14,499	8,106	8,017,413	12,530
Avg. CC	0.59	0.66	0.66	0.57	0.66	0.57
Avg. shortest path	12.30	11.07	13.59*	6.48*	30.53*	8.18*

Table B.23: Properties of the Web-Stanford graph along different expanded versions using a ring topology (3 times expansion using a sample size of 0.5). *Obtained from 1,000 starting test nodes.

	G	G_s	G_e (random)	G_e (random, denser)	G_e (high degree)	G_e (high degree, denser)
Topology	-	-	Fully connected	Fully connected	Fully connected	Fully connected
Bridge	-	-	Random	Random	High degree	High degree
Interconnections	-	-	1	100,000	1	100,000
Nodes	281,903	140,951	845,706	845,706	845,708	845,707
Edges	1,992,636	1,334,899	8,018,029	10,988,512	8,018,533	11,017,872
Avg. degree	14.14	18.94	18.96	25.99	18.96	26.06
Diameter	741	37	62*	15*	61*	27*
Graph density	2.50e-05	6.71e-05	1.12e-05	1.53e-05	1.12e-05	1.54e-05
Strongly connected components	29,914	28,350	169,519	49,657	182,150	110,525
Weakly connected components	365	2,420	14,585	2,326	14,426	12,293
Avg. CC	0.59	0.66	0.66	0.36	0.66	0.44
Avg. shortest path	12.30	11.07	20.32*	4.27*	22.13*	5.88*

Table B.24: Properties of the Web-Stanford graph along different expanded versions using a fully connected topology (3 times expansion using a sample size of 0.5). *Obtained from 1,000 starting test nodes.

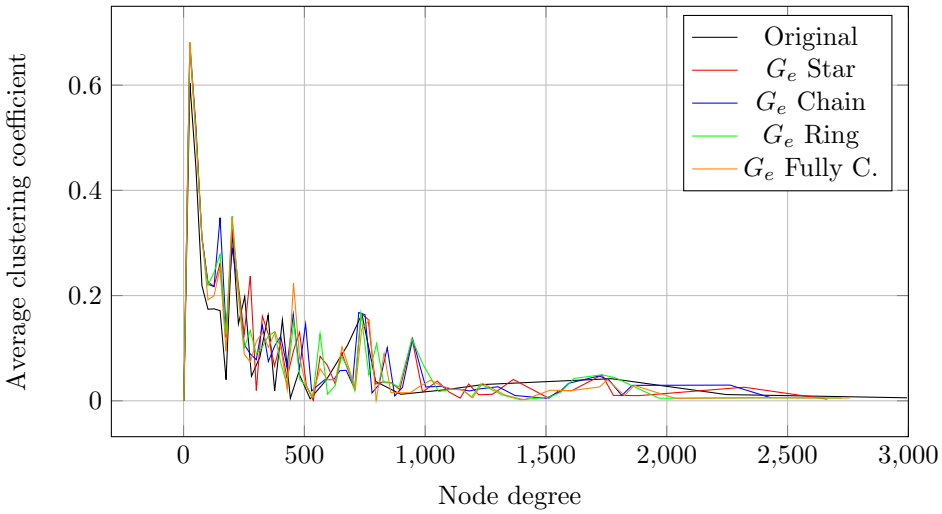

Figure B.14: Distribution of the average clustering coefficient of the expanded Web-Stanford graph using different topologies with a single interconnections and high-degree bridge-selection (G_e high degree). For visualization purposes, the domain is restricted to a node degree of 3,000.

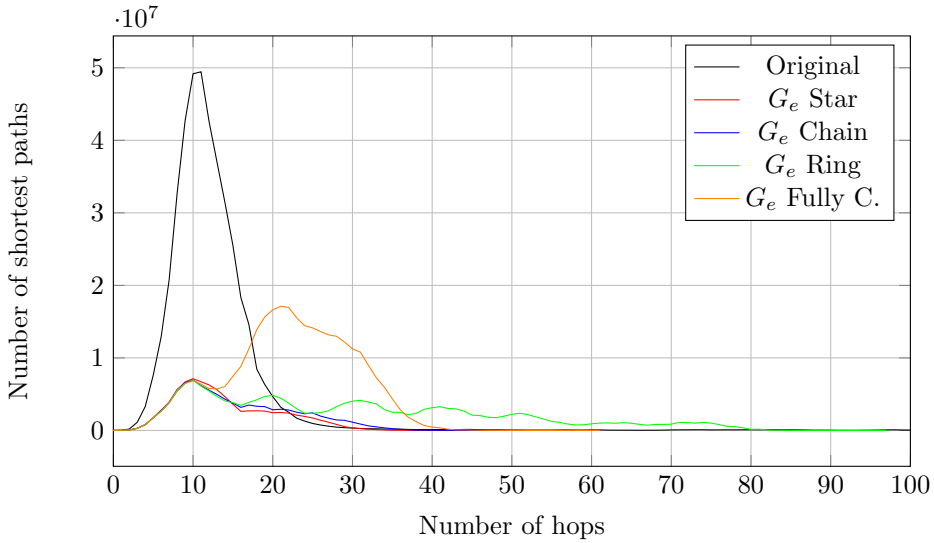

Figure B.15: Distribution of the shortest path lengths of the expanded Web-Stanford graph using different topologies with a single interconnections and high-degree bridge-selection (G_e high degree).

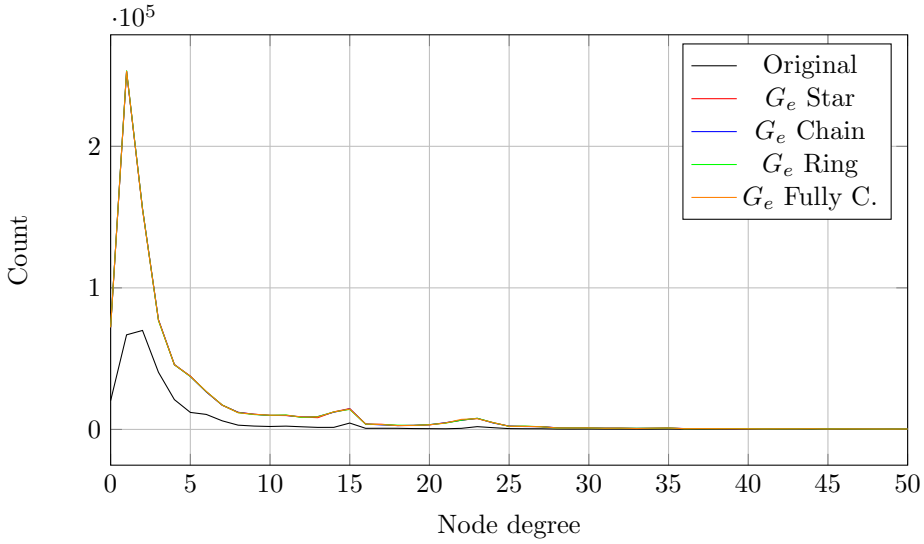

Figure B.16: Distribution of the in-degree of the expanded Web-Stanford graph using different topologies with a single interconnection and high-degree bridge-selection (G_e high degree). For visualization purposes, the domain is restricted to a node degree of 50.

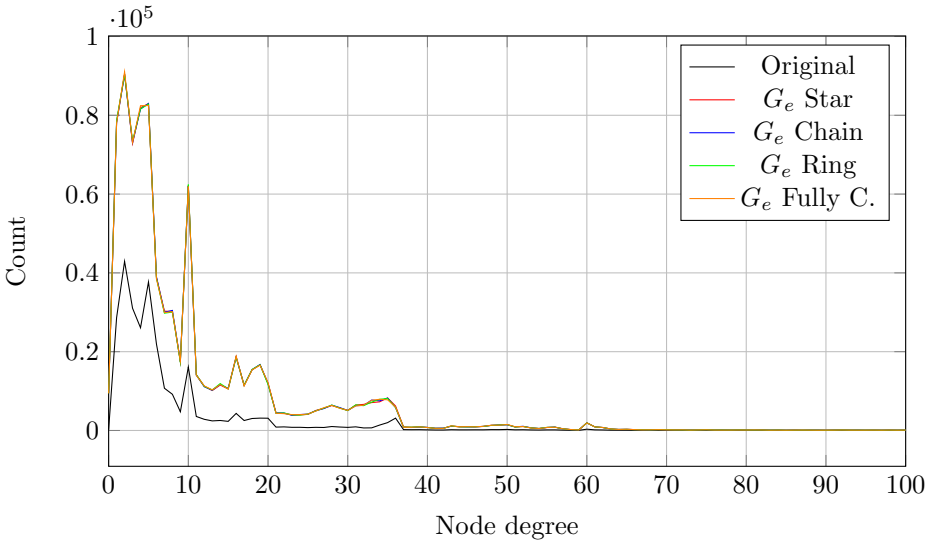

Figure B.17: Distribution of the out-degree of the expanded Web-Stanford graph using different topologies with a single interconnection and high-degree bridge-selection (G_e high degree). For visualization purposes, the domain is restricted to a node degree of 100.

Gnutella graph (directed)

	G	G_s	G_e (random)	G_e (random, denser)	G_e (high degree)	G_e (high degree, denser)
Topology	-	-	Star	Star	Star	Star
Bridge	-	-	Random	Random	High degree	High degree
Interconnections	-	-	1	70,000	1	70,000
Nodes	62586	31,293	187,758	187,758	187,759	187758
Edges	147,892	98,125	591,015	940141	590,282	940,482
Avg. degree	4.73	6.27	6.30	10.01	6.29	10.02
Diameter	31	31	42*	33*	46*	34*
Graph density	3.77e-05	1.00e-4	1.67e-05	2.66e-05	1.67e-05	2.66e-05
Strongly connected components	48,438	18,400	110,294	110,323	110,470	110,133
Weakly connected components	12	12	39	15	50	42
Avg. CC	5.46e-3	7.38e-3	7.02e-3	3.53e-3	7.07e-3	5.42e-3
Avg. shortest path	9.20	9.02	12.62*	8.20*	3.18*	7.96*

Table B.25: Properties of the Gnutella graph along different expanded versions using a star topology (3 times expansion using a sample size of 0.5). *Obtained from 30,000 starting test nodes.

	G	G_s	G_e (random)	G_e (random, denser)	G_e (high degree)	G_e (high degree, denser)
Topology	-	-	Chain	Chain	Chain	Chain
Bridge	-	-	Random	Random	High degree	High degree
Interconnections	-	-	1	70,000	1	70,000
Nodes	62,586	31,293	187,758	187,758	187,759	187,758
Edges	147,892	98,125	589,260	940,467	590,399	940,560
Avg. degree	4.73	6.27	6.28	10.02	6.29	10.019
Diameter	31	31	85*	37*	48*	34*
Graph density	3.77e-05	1.00e-4	1.67e-05	2.66e-05	1.67e-05	2.66e-05
Strongly connected components	48,438	18,400	110,385	110376	110,222	110,315
Weakly connected components	12	12	34	16	43	36
Avg. CC	5.46e-3	7.38e-3	6.95e-3	3.24e-3	7.02e-3	5.26e-3
Avg. shortest path	9.20	9.02	25.30*	7.21*	11.81*	6.97*

Table B.26: Properties of the Gnutella graph along different expanded versions using a chain topology (3 times expansion using a sample size of 0.5). *Obtained from 30,000 starting test nodes.

	G	G_s	G_e (random)	G_e (random, denser)	G_e (high degree)	G_e (high degree, denser)
Topology	-	-	Ring	Ring	Ring	Ring
Bridge	-	-	Random	Random	High degree	High degree
Interconnections	-	-	1	70,000	1	70,000
Nodes	62,586	31,293	187,758	187,758	187,758	187,758
Edges	147,892	98,125	590,187	1,010,281	589,480	1,009,785
Avg. degree	4.73	6.27	6.29	10.76	6.28	10.76
Diameter	31	31	80*	16*	47*	14*
Graph density	3.77e-05	1.00e-4	1.67e-05	2.86e-05	1.67e-05	2.86e-05
Strongly connected components	48,438	18,400	110,368	49,500	110,406	88,497
Weakly connected components	12	12	35	11	50	45
Avg. CC	5.46e-3	7.38e-3	7.1e-3	2.85e-3	7.13e-3	4.9e-3
Avg. shortest path	9.20	9.02	25.63*	6.68*	13.90*	6.32*

Table B.27: Properties of the Gnutella graph along different expanded versions using a ring topology (3 times expansion using a sample size of 0.5). *Obtained from 30,000 starting test nodes.

	G	G_s	G_e (random)	G_e (random, denser)	G_e (high degree)	G_e (high degree, denser)
Topology	-	-	Fully connected	Fully connected	Fully connected	Fully connected
Bridge	-	-	Random	Random	High degree	High degree
Interconnections	-	-	1	70,000	1	70,000
Nodes	62,586	31,293	187,758	187,758	187,758	187,758
Edges	147,892	98,125	589,662	2,689,675	590,258	2,689,748
Avg. degree	4.73	6.27	6.28	28.65	6.29	28.65
Diameter	31	31	67*	9*	51*	10*
Graph density	3.77e-05	1.00e-4	1.67e-05	7.62e-05	1.67e-05	7.62e-05
Strongly connected components	48,438	18,400	110,617	7,750	110,245	88,272
Weakly connected components	12	12	42	1	42	36
Avg. CC	5.46e-3	7.38e-3	7.14e-3	7.3e-4	6.92e-3	4.35e-3
Avg. shortest path	9.20	9.02	22.11*	4.58*	18.59*	4.32*

Table B.28: Properties of the Gnutella graph along different expanded versions using a fully connected topology (3 times expansion using a sample size of 0.5). *Obtained from 30,000 starting test nodes.

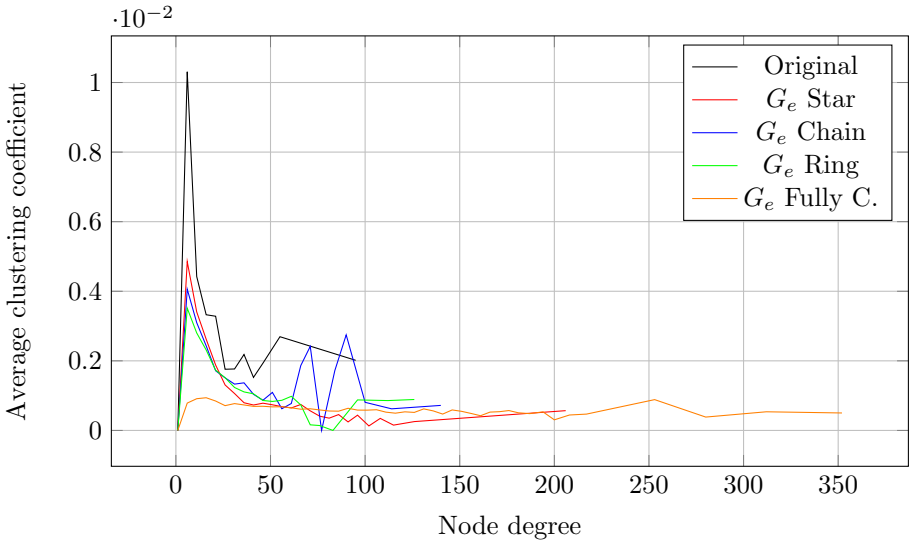

Figure B.18: Distribution of the average clustering coefficient of the expanded Gnutella graph using different topologies with multi-interconnections and random bridge selection (G_e random, denser).

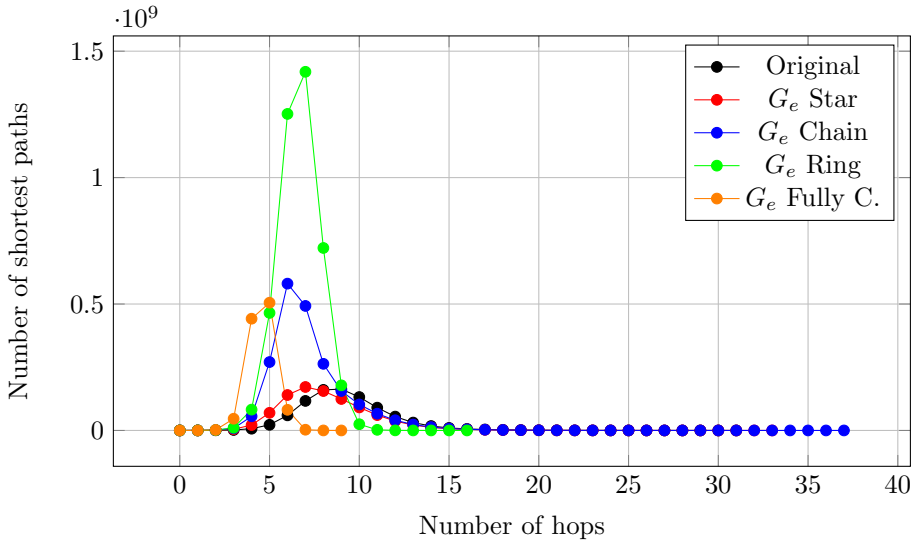

Figure B.19: Distribution of the shortest path lengths of the expanded Gnutella graph using different topologies with multi-interconnections and random bridge selection (G_e random, denser).

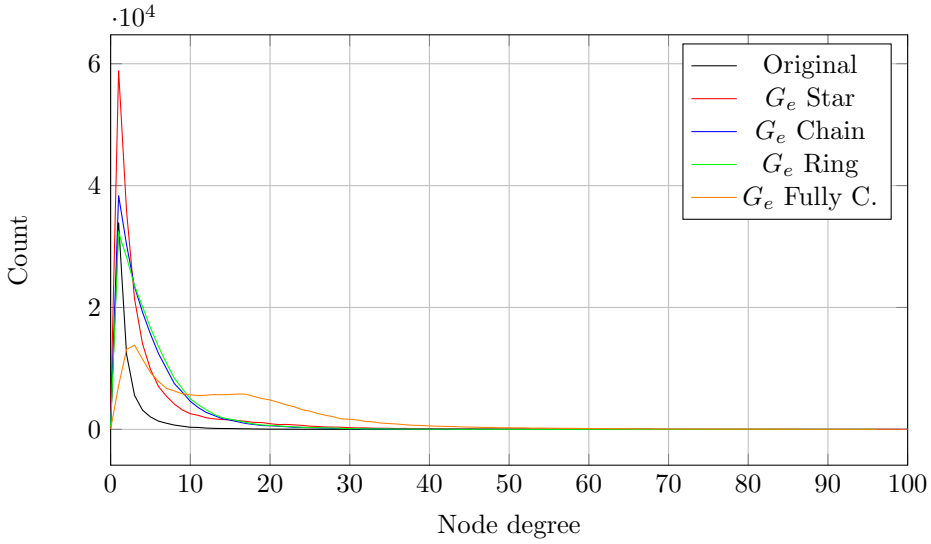

Figure B.20: Distribution of the in-degree of the expanded Gnutella graph using different topologies with multi-interconnections and random bridge selection (G_e random, denser). For visualization purposes, the domain is restricted to a node degree of 100.

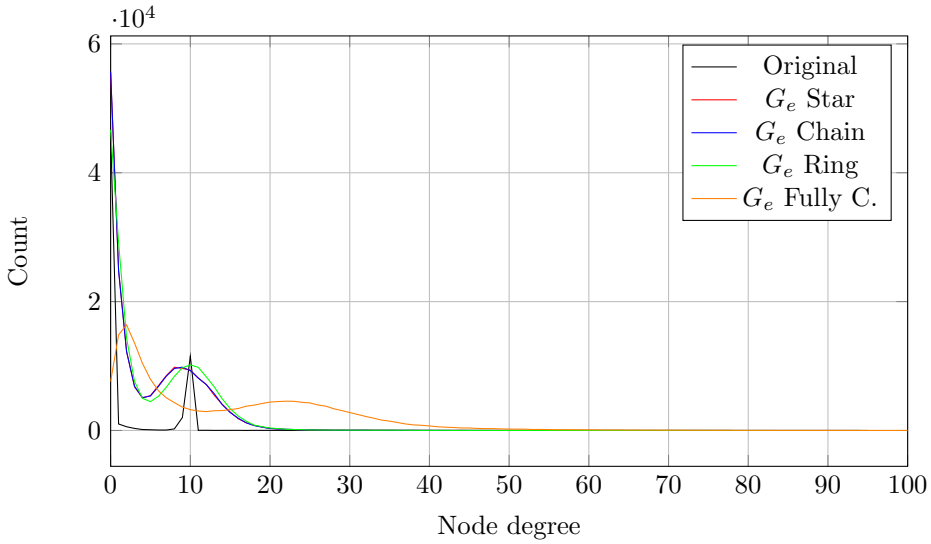

Figure B.21: Distribution of the out-degree of the expanded Gnutella graph using different topologies with multi-interconnections and random bridge selection (G_e random, denser). For visualization purposes, the domain is restricted to a node degree of 100.

Wiki-vote (directed)

	G	G_s	G_e (random)	G_e (random, denser)	G_e (high degree)	G_e (high degree, denser)
Topology	-	-	Star	Star	Star	Star
Bridge	-	-	Random	Random	High degree	High degree
Interconnections	-	-	1	50,000	1	50,000
Nodes	7,115	3,557	21,342	21,342	21,343	21,342
Edges	100,762	91,183	546,866	792,640	547,327	795,047
Avg. degree	28.32	51.27	51.25	74.28	51.29	74.51
Diameter	10	9	14	10	14	10
Graph density	1.99e-3	7.20e-3	1.20e-3	1.74e-3	1.20e-3	1.74e-3
Strongly connected components	5,816	2,313	13,835	13,835	13,844	13,849
Weakly connected components	24	1	11	10	16	19
Avg. CC	0.14	0.19	0.19	0.12	0.19	0.14
Avg. shortest path	3.34	2.96	4.54	2.91	4.35	2.86

Table B.29: Properties of the Wiki-vote graph along different expanded versions using a star topology (3 times expansion using a sample size of 0.5).

	G	G_s	G_e (random)	G_e (random, denser)	G_e (high degree)	G_e (high degree, denser)
Topology	-	-	Chain	Chain	Chain	Chain
Bridge	-	-	Random	Random	High degree	High degree
Interconnections	-	-	1	50,000	1	50,000
Nodes	7,115	3,557	21,342	21,342	21,342	21,342
Edges	100,762	91,183	547,510	793,443	546,992	794,521
Avg. degree	28.32	51.27	51.31	74.36	51.26	74.46
Diameter	10	9	28	11	25	10
Graph density	1.99e-3	7.20e-3	1.20e-3	1.74e-3	1.20e-3	1.74e-3
Strongly connected components	5,816	2,313	13,835	13,827	13,837	13,845
Weakly connected components	24	1	15	11	22	11
Avg. CC	0.14	0.19	0.19	0.11	0.19	0.14
Avg. shortest path	3.34	2.96	9.22	3.29	8.16	3.37

Table B.30: Properties of the Wiki-vote graph along different expanded versions using a chain topology (3 times expansion using a sample size of 0.5).

	G	G_s	G_e (random)	G_e (random, denser)	G_e (high degree)	G_e (high degree, denser)
Topology	-	-	Ring	Ring	Ring	Ring
Bridge	-	-	Random	Random	High degree	High degree
Interconnections	-	-	1	50,000	1	50,000
Nodes	7,115	3,557	21,342	21,342	21,342	21,342
Edges	100,762	91,183	546,923	842,328	546,790	844,777
Avg. degree	28.32	51.27	51.25	78.94	51.24	79.17
Diameter	10	9	29	11	18	10
Graph density	1.99e-3	7.20e-3	1.20e-3	1.84e-3	1.20e-3	1.85e-3
Strongly connected components	5,816	2,313	13,840	2,414	13,846	9,388
Weakly connected components	24	1	17	7	20	14
Avg. CC	0.14	0.19	0.19	0.10	0.19	0.13
Avg. shortest path	3.34	2.96	11.94	3.94	6.02	3.99

Table B.31: Properties of the Wiki-vote graph along different expanded versions using a ring topology (3 times expansion using a sample size of 0.5).

	G	G_s	G_e (random)	G_e (random, denser)	G_e (high degree)	G_e (high degree, denser)
Topology	-	-	Fully connected	Fully connected	Fully connected	Fully connected
Bridge	-	-	Random	Random	High degree	High degree
Interconnections	-	-	1	50,000	1	50,000
Nodes	7,115	3,557	21,342	21,342	21,342	21,342
Edges	100,762	91,183	546,844	2,000,118	546,549	2,023,183
Avg. degree	28.32	51.27	51.25	187.44	51.22	189.60
Diameter	10	9	11	6	16	7
Graph density	1.99e-3	7.20e-3	1.20e-3	4.39e-3	1.19e-3	4.44e-3
Strongly connected components	5,816	2,313	13,832	453	13,846	9,409
Weakly connected components	24	1	19	1	20	20
Avg. CC	0.14	0.19	0.19	0.07	0.19	0.11
Avg. shortest path	3.34	2.96	3.29	2.68	6.50	2.60

Table B.32: Properties of the Wiki-vote graph along different expanded versions using a fully connected topology (3 times expansion using a sample size of 0.5).

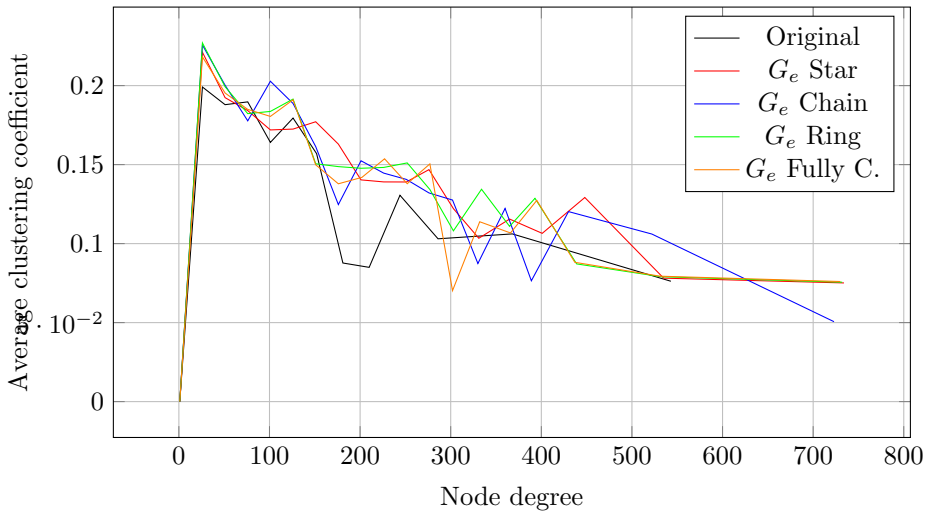

Figure B.22: Distribution of the average clustering coefficient of the expanded Wiki-vote graph using different topologies with a single interconnection and random bridge selection (G_e random).

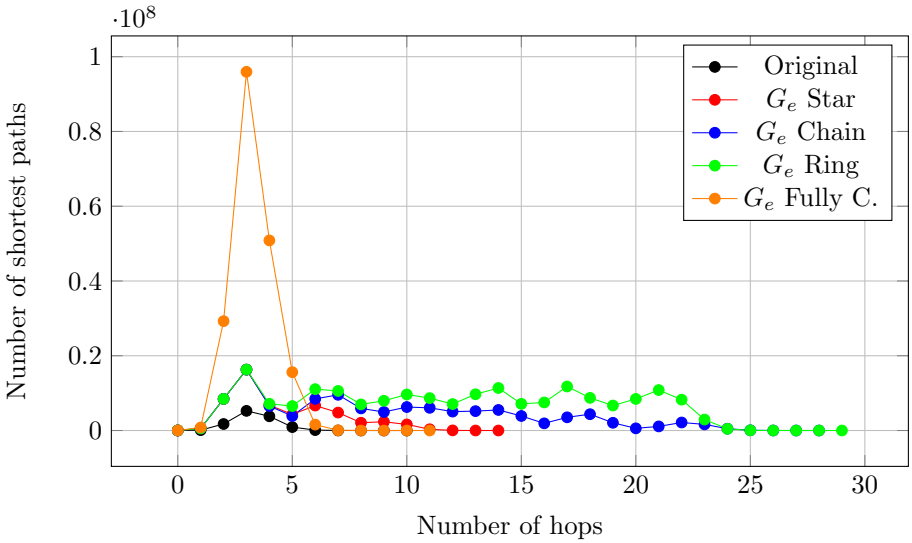

Figure B.23: Distribution of the shortest path lengths of the expanded Wiki-vote graph using different topologies with a single interconnection and random bridge selection (G_e random).

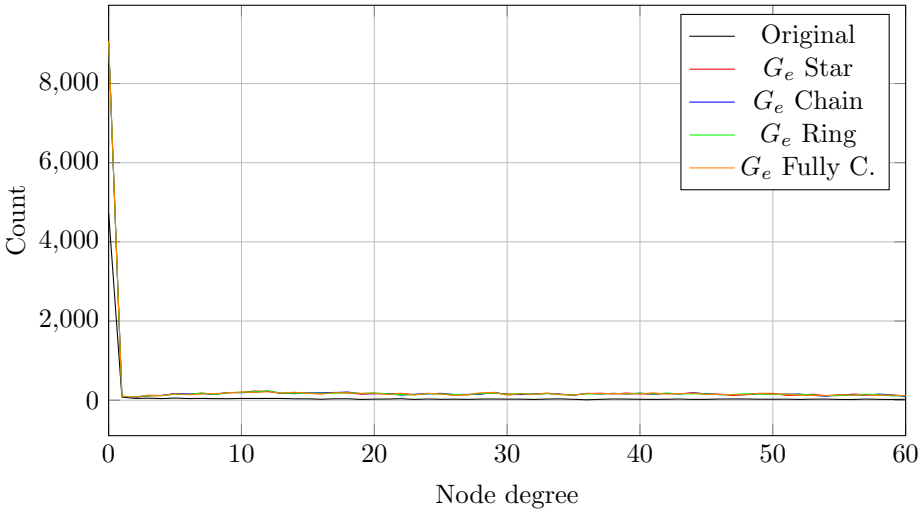

Figure B.24: Distribution of the in-degree of the expanded Wiki-vote graph using different topologies with a single interconnection and random bridge selection (G_e random). For visualization purposes, the domain is restricted to a node degree of 60.

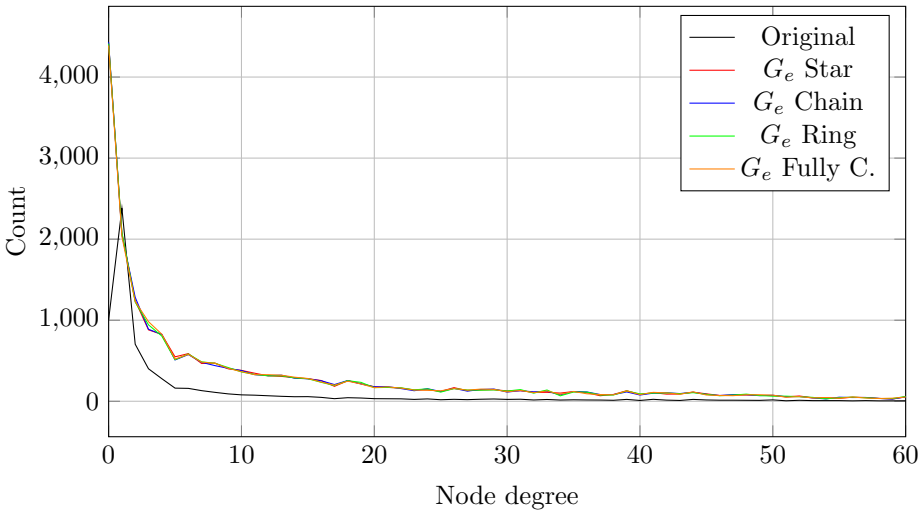

Figure B.25: Distribution of the out-degree of the expanded Wiki-vote graph using different topologies with a single interconnection and random bridge selection (G_e random). For visualization purposes, the domain is restricted to a node degree of 60.

Bibliography

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