Table S1. Robustness of five real-world networks of scale 10^4-10^5 under different node removal strategies

	Methods	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
dimacs10-astro-ph	KPD	92.51%	78.73%	62.94%	39.40%	10.76%	0.29%	0.10%	0.04%	0.03%	0.02%	6.23E-05
	KPDN	**92.41%**	70.73%	**34.59%**	**1.03%**	**0.14%**	**0.04%**	**0.02%**	**0.02%**	**0.01%**	**6.23E-06**	**6.23E-06**
	DC	92.51%	77.23%	60.54%	60.54%	2.46%	0.16%	0.06%	0.03%	0.02%	0.02%	0.01%
	KSHELL	92.51%	80.44%	67.14%	50.01%	30.61%	12.01%	0.29%	0.10%	0.04%	0.03%	0.01%
	DWT	92.51%	75.03%	48.49%	6.82%	0.16%	0.08%	0.05%	0.04%	0.03%	0.02%	0.02%
	WL	92.51%	78.38%	63.36%	40.93%	16.08%	1.67%	0.19%	0.08%	0.04%	0.03%	0.01%
	INCC	92.51%	83.33%	73.99%	62.45%	49.25%	34.94%	19.91%	6.34%	0.67%	0.04%	0.03%
	PR	92.51%	**70.60%**	37.77%	2.70%	0.39%	0.10%	0.06%	0.03%	0.02%	0.01%	6.23E-05
	Random	92.51%	81.53%	70.65%	60.05%	49.43%	38.58%	28.80%	19.03%	10.22%	2.90%	0.02%
	Methods	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
ca-Astroph	KPD	95.37%	82.23%	67.68%	47.93%	22.56%	2.91%	0.14%	0.05%	0.03%	0.02%	5.33E-05
	KPDN	**95.32%**	**77.57%**	**54.92%**	**14.72%**	**0.21%**	**0.06%**	**0.03%**	**0.01%**	**0.01%**	**5.33E-05**	**5.33E-05**
	DC	95.37%	81.66%	65.68%	44.33%	15.29%	0.48%	0.09%	0.03%	0.02%	0.02%	0.01%
	KSHELL	95.37%	83.35%	69.76%	53.88%	34.50%	15.58%	2.02%	0.14%	0.06%	0.02%	0.01%
	DWT	95.37%	81.33%	60.19%	31.31%	0.73%	0.14%	0.08%	0.04%	0.03%	0.02%	0.02%
	WL	95.37%	82.24%	67.36%	48.64%	26.02%	7.71%	0.75%	0.11%	0.06%	0.03%	0.01%
	INCC	95.38%	87.03%	76.05%	64.14%	50.97%	36.77%	22.47%	8.15%	0.66%	0.05%	0.02%
	PR	**95.32%**	77.77%	55.80%	24.45%	8.20%	0.17%	0.06%	0.03%	0.02%	0.01%	5.33E-05
	Random	95.37%	84.88%	74.27%	63.56%	52.88%	42.32%	32.03%	22.02%	12.87%	4.66%	0.10%
	Methods	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
gottron-reuters	KPD	100.00%	78.27%	56.39%	33.36%	9.51%	0.07%	0.02%	2.59E-05	2.59E-05	2.59E-05	2.59E-05
	KPDN	100.00%	**70.39%**	**46.10%**	**24.85%**	**0.15%**	**0.00%**	**2.59E-05**	**2.59E-05**	**2.59E-05**	**2.59E-05**	**2.59E-05**
	DC	100.00%	78.14%	55.66%	31.96%	6.43%	0.05%	0.01%	2.59E-05	2.59E-05	2.59E-05	2.59E-05
	KSHELL	100.00%	79.27%	58.75%	36.60%	13.17%	0.15%	0.02%	2.59E-05	2.59E-05	2.59E-05	2.59E-05
	DWT	100.00%	78.17%	55.61%	31.94%	6.79%	0.05%	0.01%	2.59E-05	2.59E-05	2.59E-05	2.59E-05
	WL	100.00%	77.27%	57.04%	36.84%	15.36%	2.03%	0.02%	2.59E-05	2.59E-05	2.59E-05	2.59E-05

	Methods	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	INCC	**99.99%**	79.08%	58.46%	39.19%	20.07%	2.93%	0.17%	0.16%	0.09%	0.07%	0.03%
	PR	100.00%	74.58%	50.21%	25.77%	1.18%	0.02%	2.59E-05	2.59E-05	2.59E-05	2.59E-05	2.59E-05
	Random	100.00%	87.65%	75.46%	64.13%	53.17%	42.55%	32.56%	22.92%	14.17%	6.34%	0.29%
	Methods	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
	KPD	99.46%	86.90%	73.22%	57.94%	39.59%	15.98%	0.17%	0.02%	0.01%	3.14E-05	1.57E-05
	KPDN	**99.46%**	**83.05%**	**67.56%**	**50.35%**	**26.45%**	**0.09%**	**0.01%**	**3.14E-05**	**1.57E-05**	**1.57E-05**	**1.57E-05**
	DC	99.46%	86.81%	73.10%	57.34%	37.83%	10.74%	0.06%	0.02%	0.01%	3.14E-05	1.57E-05
facebook-wosn-	KSHELL	99.47%	87.02%	73.65%	59.00%	42.38%	22.31%	4.67%	0.04%	0.02%	3.14E-05	1.57E-05
links	DWT	99.46%	86.56%	72.70%	56.51%	36.10%	9.78%	0.08%	0.02%	0.01%	4.71E-05	4.71E-05
	WL	99.46%	86.87%	73.18%	58.21%	41.36%	22.07%	3.33%	0.08%	0.02%	0.02%	3.14E-05
	INCC	99.47%	87.70%	75.05%	61.63%	47.22%	31.84%	15.68%	4.19%	0.03%	0.02%	0.01%
	PR	99.46%	84.98%	69.87%	52.20%	29.30%	2.87%	0.07%	1.10E-04	3.14E-05	1.57E-05	1.57E-05
	Random	99.47%	88.04%	76.77%	65.63%	54.73%	44.10%	33.54%	23.36%	13.96%	5.30%	0.04%
	Methods	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
	KPD	99.89%	85.98%	70.29%	53.08%	34.91%	17.73%	3.79%	2.02E-04	5.60E-05	3.36E-05	1.12E-05
	KPDN	**99.89%**	**81.70%**	**64.19%**	**45.67%**	**25.59%**	**0.46%**	**4.48E-05**	**1.12E-05**	**1.12E-05**	**1.12E-05**	**1.12E-05**
	DC	99.89%	85.83%	69.97%	52.38%	33.80%	16.17%	2.48%	1.01E-04	5.60E-05	3.36E-05	2.24E-05
	KSHELL	99.89%	86.68%	71.34%	54.60%	36.55%	19.55%	5.59%	3.14E-04	6.72E-05	5.60E-05	2.24E-05
prosper-loans	DWT	99.89%	85.84%	69.96%	52.37%	33.82%	16.19%	2.25%	1.57E-04	5.60E-05	3.36E-05	2.24E-05
	WL	99.89%	85.78%	69.47%	50.92%	31.93%	16.14%	4.51%	2.46E-04	1.01E-04	5.60E-05	5.60E-05
	INCC	99.89%	87.06%	72.84%	56.49%	39.16%	23.07%	10.18%	9.27%	7.15%	2.44%	0.02%
	PR	99.89%	84.78%	68.82%	51.58%	32.40%	11.94%	4.26E-04	4.48E-05	1.12E-05	1.12E-05	1.12E-05
	Random	99.89%	89.41%	78.97%	68.60%	58.25%	47.99%	37.71%	27.65%	17.75%	8.01%	0.31%

Table S2. Efficiency of five real-world networks of scale 10^4-10^5 under different node removal strategies

	Methods	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
dimacs10-astro-ph	KPD	99.70%	44.52%	24.68%	14.65%	8.59%	5.02%	2.99%	1.52%	0.74%	0.25%	0.00%
	KPDN	**99.89%**	**42.42%**	**22.78%**	**11.31%**	**5.68%**	**2.84%**	**1.35%**	**0.49%**	**0.13%**	**0.00%**	**0.00%**

	Methods	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	DC	99.70%	41.81%	23.33%	13.46%	7.74%	4.46%	2.50%	1.38%	0.65%	0.17%	5.77E-05
	KSHELL	99.93%	55.40%	30.60%	18.21%	11.18%	7.01%	3.41%	1.73%	0.76%	0.25%	5.77E-05
	DWT	99.70%	41.33%	23.42%	13.67%	8.13%	4.86%	2.95%	1.87%	1.13%	0.40%	0.17%
	WL	99.70%	45.71%	26.27%	15.95%	9.80%	6.06%	3.73%	2.35%	1.31%	0.53%	0.08%
	INCC	99.96%	69.14%	46.74%	29.88%	18.11%	10.32%	5.34%	2.46%	0.88%	0.26%	1.40E-04
	PR	99.73%	42.68%	23.74%	12.63%	7.87%	4.20%	2.01%	0.85%	0.25%	0.01%	0.00%
	Random	99.99%	79.79%	63.98%	49.48%	36.33%	25.10%	15.99%	8.86%	3.85%	0.95%	1.40E-04
	Methods	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
	KPD	99.75%	39.81%	21.74%	12.43%	6.99%	3.93%	2.18%	1.11%	0.59%	0.16%	0.00%
	KPDN	99.82%	39.11%	**19.64%**	**9.74%**	**4.70%**	**2.17%**	**0.91%**	**0.29%**	**0.05%**	**0.00%**	**0.00%**
	DC	**99.75%**	**37.42%**	20.33%	11.39%	6.29%	3.51%	1.85%	0.97%	0.41%	0.11%	5.05E-06
ca-Astroph	KSHELL	99.96%	48.89%	26.43%	15.13%	8.79%	5.13%	2.82%	1.40%	0.60%	0.14%	5.05E-06
	DWT	99.75%	38.25%	20.72%	11.66%	6.84%	3.86%	2.25%	1.32%	0.73%	0.34%	0.12%
	WL	99.75%	40.01%	22.86%	13.53%	8.02%	4.78%	2.85%	1.69%	0.96%	0.42%	0.06%
	INCC	99.99%	71.37%	42.86%	25.08%	14.34%	7.89%	4.21%	1.78%	0.62%	0.16%	2.02E-05
	PR	99.82%	38.36%	19.83%	9.98%	6.08%	2.99%	1.36%	0.54%	0.14%	3.53E-05	0.00%
	Random	99.98%	81.00%	64.71%	49.55%	36.27%	25.81%	16.78%	9.56%	4.18%	1.17%	0.02%
	Methods	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
	KPD	98.05%	11.42%	4.58%	1.95%	0.63%	0.07%	1.84E-05	0.00%	0.00%	0.00%	0.00%
	KPDN	98.05%	14.86%	5.88%	1.70%	**0.20%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**
	DC	98.05%	10.84%	4.35%	1.80%	0.54%	0.06%	1.23E-05	0.00%	0.00%	0.00%	0.00%
	KSHELL	99.97%	14.97%	5.83%	2.43%	0.85%	0.10%	2.66E-05	0.00%	0.00%	0.00%	0.00%
gottron-reuters	DWT	98.05%	10.78%	4.32%	1.79%	0.55%	0.06%	1.23E-05	0.00%	0.00%	0.00%	0.00%
	WL	98.05%	15.24%	6.59%	3.05%	1.01%	0.17%	1.53E-05	0.00%	0.00%	0.00%	0.00%
	INCC	99.55%	26.18%	12.90%	6.05%	2.18%	0.34%	0.02%	0.02%	0.01%	0.01%	0.00%
	PR	98.05%	**10.75%**	**4.06%**	**1.43%**	0.35%	0.02%	0.00%	0.00%	0.00%	0.00%	0.00%
	Random	100.00%	80.38%	62.75%	47.08%	34.93%	24.69%	15.44%	8.13%	3.75%	1.02%	0.02%
	Methods	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**

facebook-wosn-links	Methods	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	KPD	99.87%	36.99%	18.79%	9.70%	4.96%	2.49%	1.13%	0.50%	0.12%	0.01%	0.00%
	KPDN	99.87%	36.91%	16.54%	**7.58%**	**3.30%**	**1.22%**	**0.29%**	**0.02%**	**0.00%**	0.00%	0.00%
	DC	99.87%	35.58%	17.57%	8.95%	4.53%	2.24%	1.01%	0.37%	0.08%	2.20E-05	0.00%
	KSHELL	99.97%	46.13%	23.55%	12.23%	6.09%	2.97%	1.50%	0.67%	0.18%	2.20E-05	0.00%
	DWT	99.87%	35.43%	17.49%	9.05%	4.64%	2.29%	1.07%	0.43%	0.14%	0.02%	0.01%
	WL	99.87%	37.94%	19.77%	10.53%	5.62%	2.95%	1.47%	0.68%	0.28%	0.09%	0.01%
	INCC	100.00%	48.36%	26.28%	14.17%	7.56%	3.97%	1.95%	0.90%	0.25%	0.07%	4.65E-05
	PR	99.89%	**35.34%**	**16.05%**	7.59%	3.56%	1.51%	0.52%	0.12%	0.01%	0.00%	0.00%
	Random	100.00%	80.62%	63.34%	48.24%	35.69%	24.90%	15.77%	8.95%	3.99%	1.00%	0.01%
	Methods	**0%**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**100%**
prosper-loans	KPD	99.80%	27.58%	11.78%	4.99%	2.01%	0.70%	1.89E-03	0.03%	4.50E-05	2.10E-05	0.00%
	KPDN	**99.80%**	**29.15%**	**10.77%**	**3.68%**	**1.04%**	**0.20%**	**0.01%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**
	DC	99.80%	26.78%	11.15%	4.62%	1.81%	0.61%	1.62E-03	0.03%	4.38E-05	2.01E-05	2.10E-06
	KSHELL	99.98%	40.32%	15.34%	6.25%	2.51%	0.86%	2.29E-03	0.04%	5.77E-05	2.49E-05	2.10E-06
	DWT	99.80%	26.76%	11.15%	4.61%	1.81%	0.61%	1.58E-03	0.03%	4.50E-05	1.89E-05	9.01E-07
	WL	99.80%	30.77%	13.40%	5.61%	2.15%	0.71%	1.76E-03	0.03%	4.89E-05	2.31E-05	1.65E-05
	INCC	99.93%	44.43%	22.47%	10.28%	3.99%	1.34%	0.38%	0.35%	0.27%	0.09%	5.56E-05
	PR	99.80%	26.06%	10.28%	4.06%	1.46%	0.43%	0.09%	6.55E-05	0.00%	0.00%	0.00%
	Random	100.00%	81.05%	64.43%	49.26%	36.06%	24.98%	16.02%	9.02%	4.04%	1.01%	0.01%

Table S3. Extreme points of node removal subgraph sensitivity on five real-world networks under different strategies

Methods	dimacs10-astro-ph	ca-Astroph	gottron-reuters	prosper-loans	facebook-wosn-links
KPD	20.9460%	26.9032%	16.9687%	27.9795%	31.9860%
KPDN	**11.9718%**	**15.9448%**	**11.9787%**	**21.9841%**	**23.9899%**
DC	20.9460%	23.9145%	16.9687%	27.9795%	30.9865%
KSHELL	24.9346%	29.8919%	18.9648%	28.9787%	32.9855%
DWT	15.9604%	18.9335%	16.9687%	27.9795%	29.9870%

WL	21.9432%	23.9145%	16.9687%	27.9795%	30.9865%
INCC	38.8944%	42.8427%	17.9668%	31.9764%	35.9841%
PR	12.9690%	17.9372%	13.9747%	26.9803%	27.9879%
Random	22.9403%	32.8805%	29.9429%	43.9671%	31.9860%

Table S4. Extreme points of sensitivity under different strategies (real-world networks 10^3-10^4)

Methods	email-univ	US-airports	power-eris1176	bio-grid-worm	p2p-Gnutella08	fb-pages-government
KPD	21.4475%	7.6874%	11.3095%	**1.0265%**	22.0124%	31.7557%
KPDN	**18.5349%**	**3.8755%**	**1.0204%**	**1.0265%**	**11.0141%**	**27.7880%**
Degree	23.3892%	7.6874%	8.5034%	**1.0265%**	18.0130%	33.7395%
K-shell	27.2727%	9.5934%	11.3095%	2.0245%	25.0119%	37.7072%
CC	26.3019%	6.7344%	4.7619%	**1.0265%**	24.0121%	36.7153%
DWT	20.4766%	5.7814%	6.6327%	1.0265%	18.0130%	27.7880%
CI	21.4475%	7.6874%	11.3095%	**1.0265%**	23.0122%	31.7557%
WL	21.4475%	7.6874%	11.3095%	**1.0265%**	23.0122%	33.7395%
HC	27.2727%	4.8285%	12.2449%	**1.0265%**	24.0121%	34.7315%
INCC	32.1271%	6.7344%	2.8912%	7.0145%	20.0127%	40.6830%
Pagerank	21.4475%	**3.8755%**	5.6973%	**1.0265%**	12.0140%	30.7638%
random	34.0688%	32.4651%	14.1156%	25.9766%	26.0117%	48.6184%