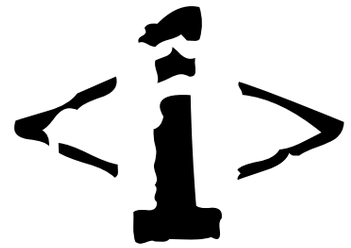
Lecture 2

Review


<i>

peter singer

one world

the ethics of globalization

SECOND EDITION

"Timely and thoughtful."—Andrés Martinez, *New York Times Book Review*

GLOBALIZATION

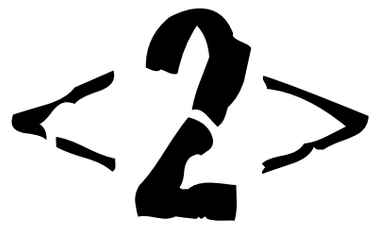
Drivers of globalization

Democratization

technological innovation
- computerization
- telecommunication
- miniaturization
- compression technology
- digitization

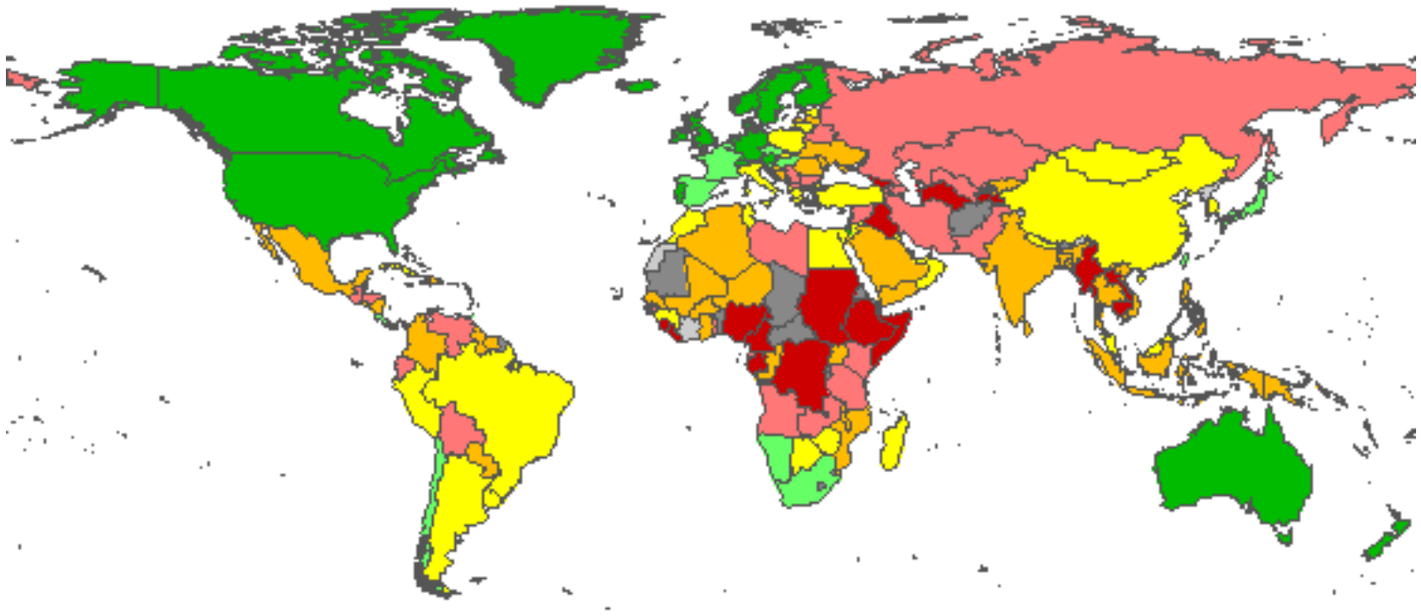
information
- satellite dishes, tv
- internet

finance
- creditworthy good-old-boys network
- automated loan kiosks,
- E*trade,
-individual hold a countries bonds

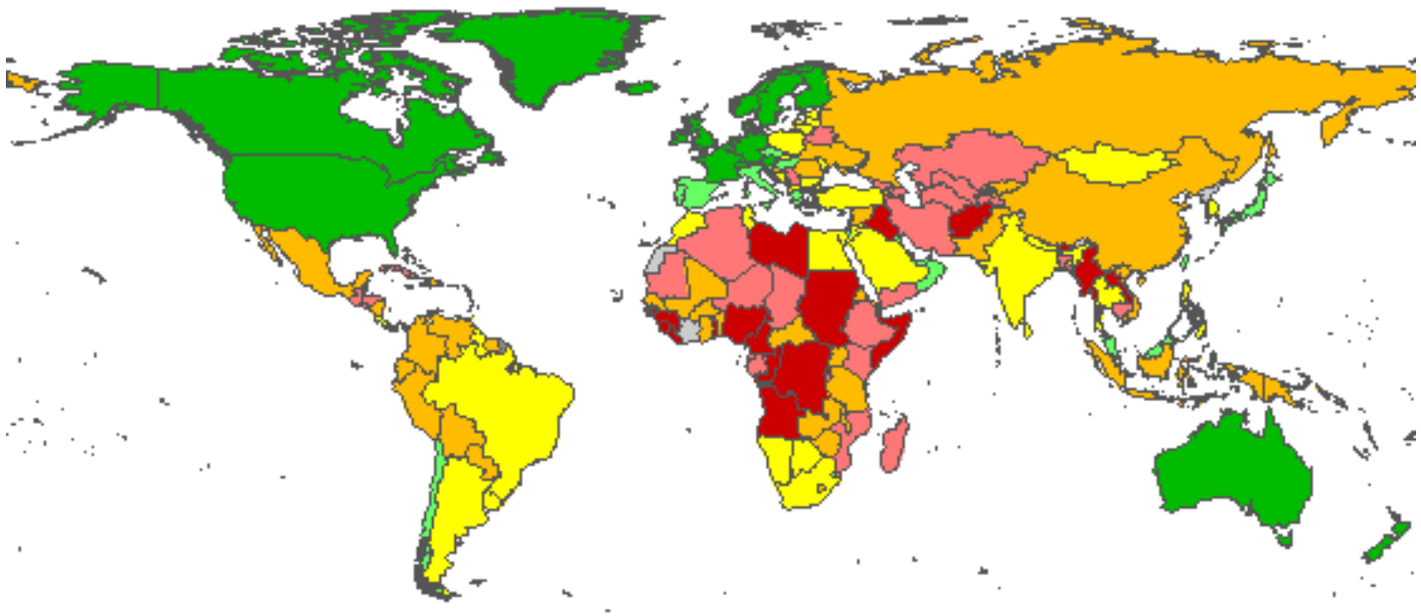

2

CORRUPTION

Control of Corruption (1996)

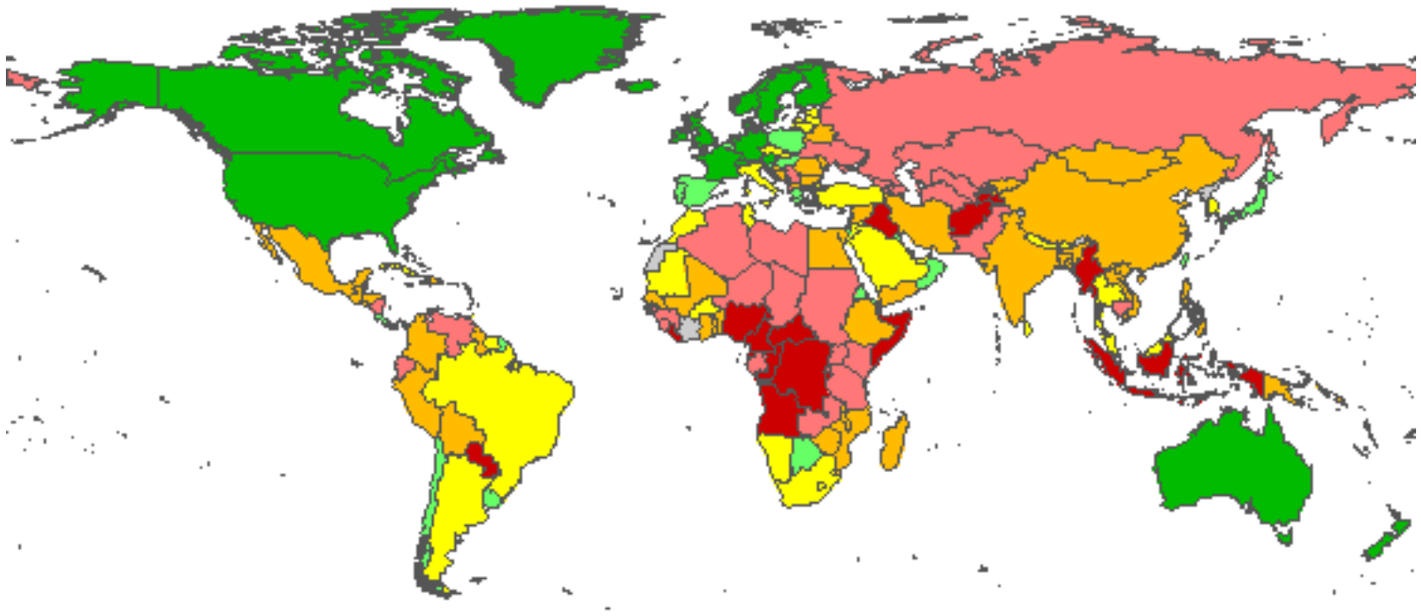


Rule of Law (1996)

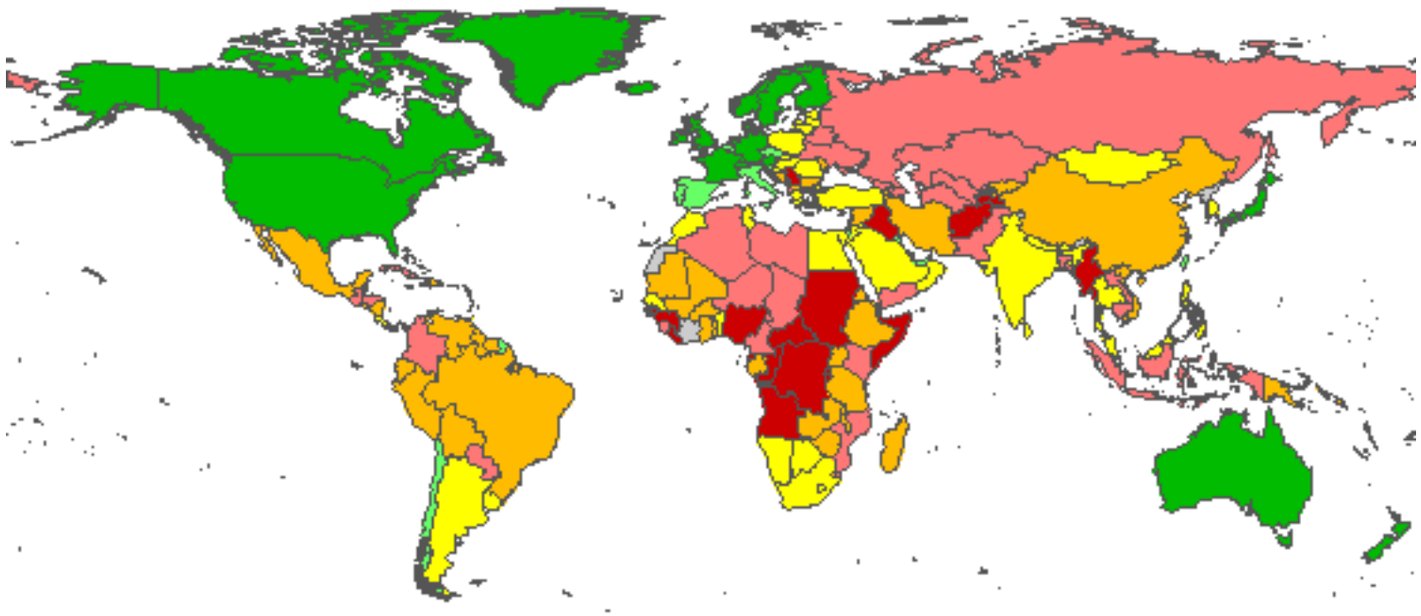


Source: Kaufmann D., A. Kraay, and M. Mastruzzi 2009: Governance Matters VIII: Governance Indicators for 1996-2008

Control of Corruption (1998)

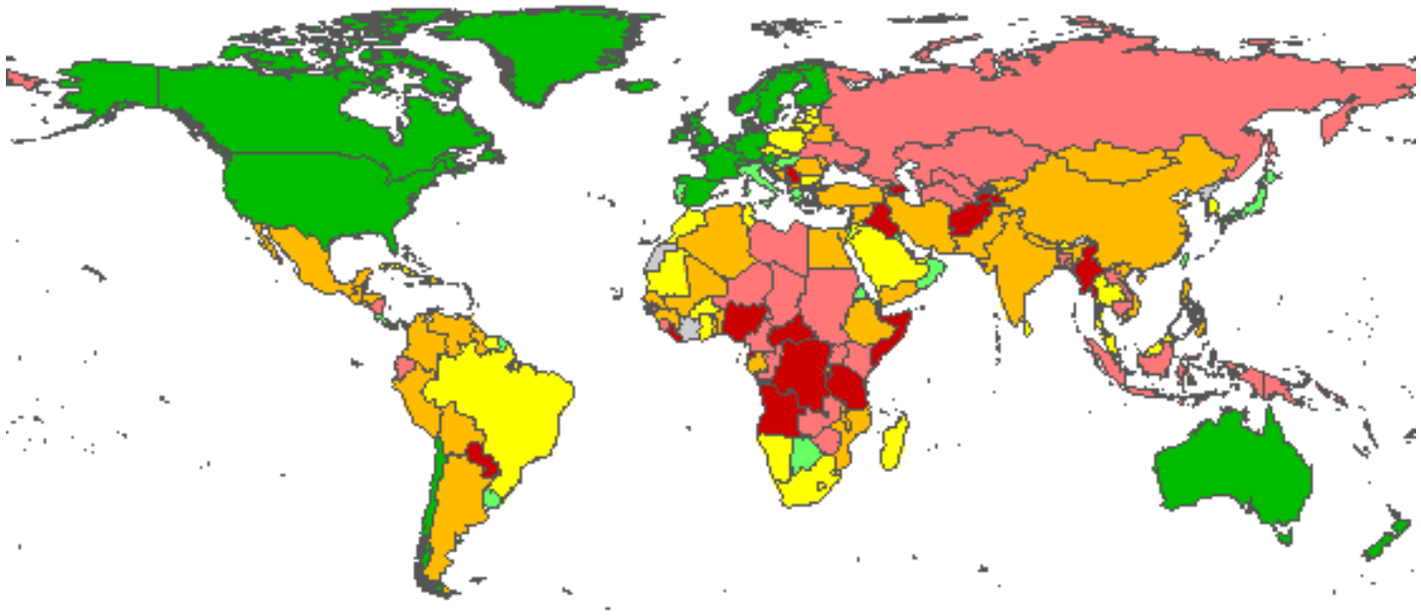


Rule of Law (1998)

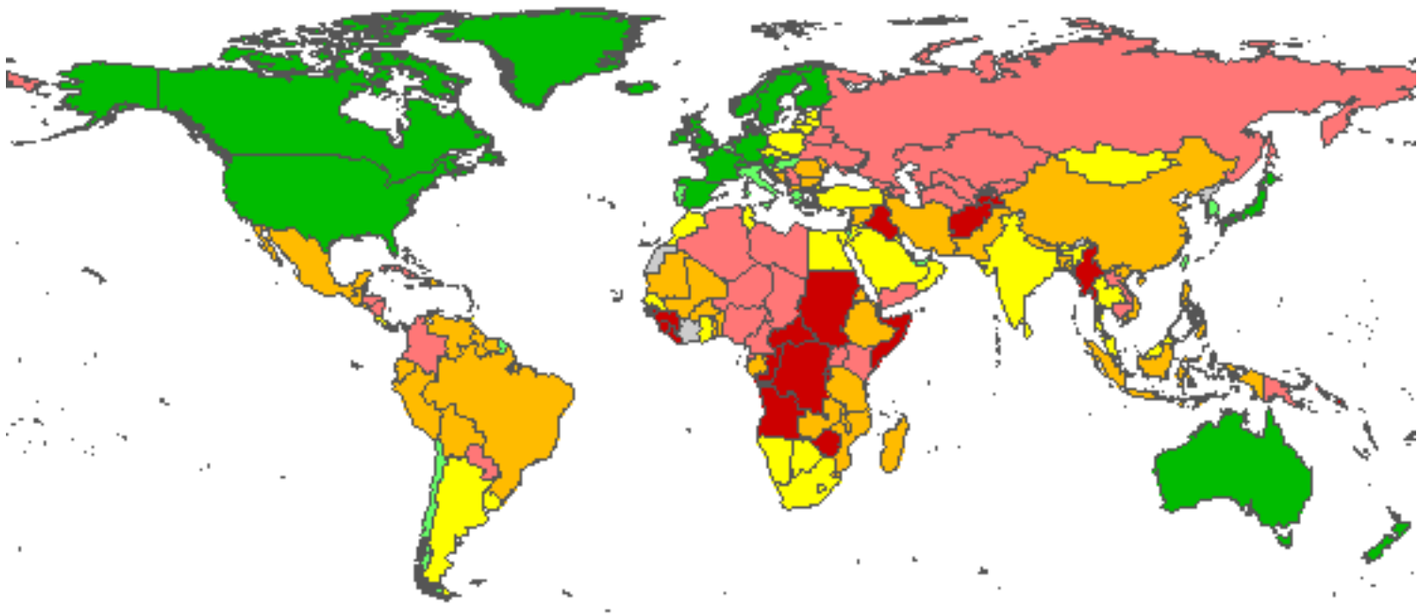


Source: Kaufmann D., A. Kraay, and M. Mastruzzi 2009: Governance Matters VIII: Governance Indicators for 1996-2008

Control of Corruption (2000)

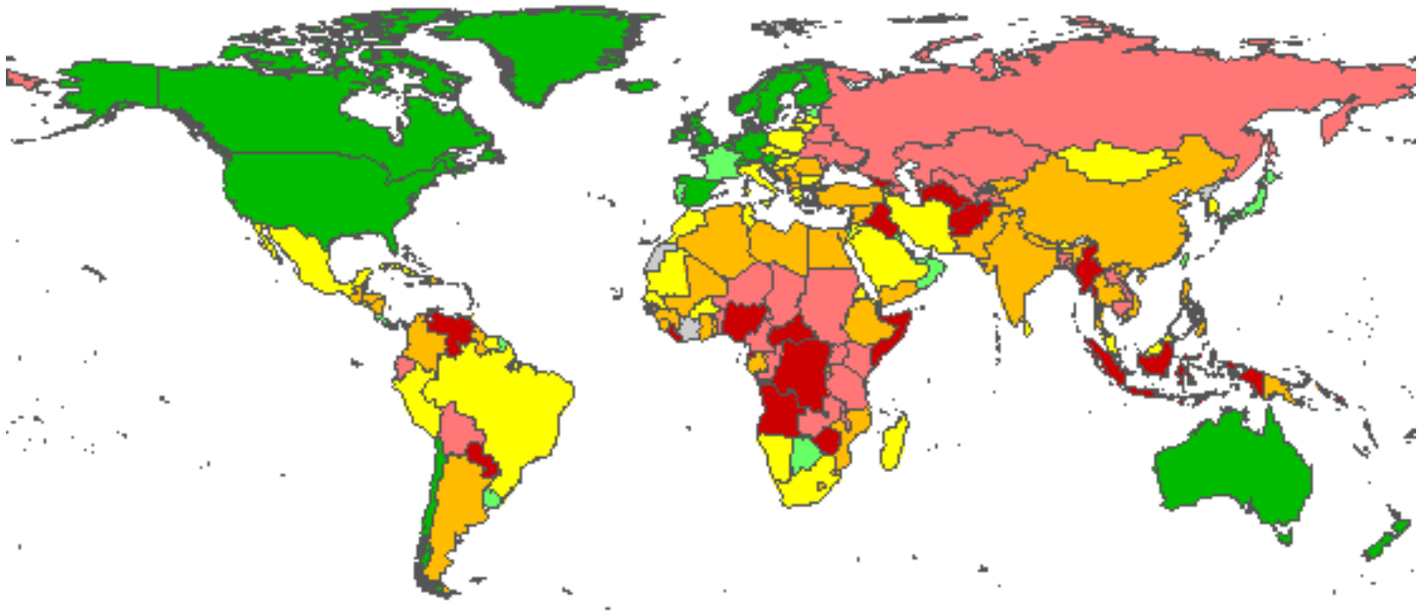


Rule of Law (2000)

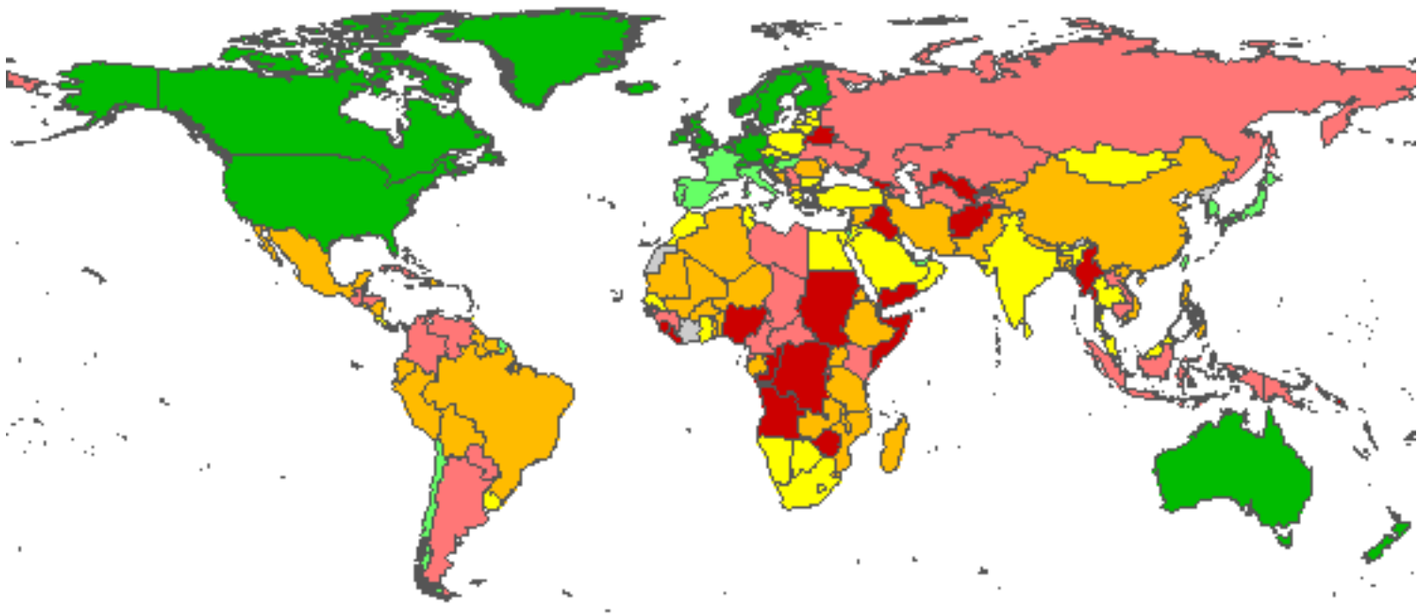


Source: Kaufmann D., A. Kraay, and M. Mastruzzi 2009: Governance Matters VIII: Governance Indicators for 1996-2008

Control of Corruption (2002)

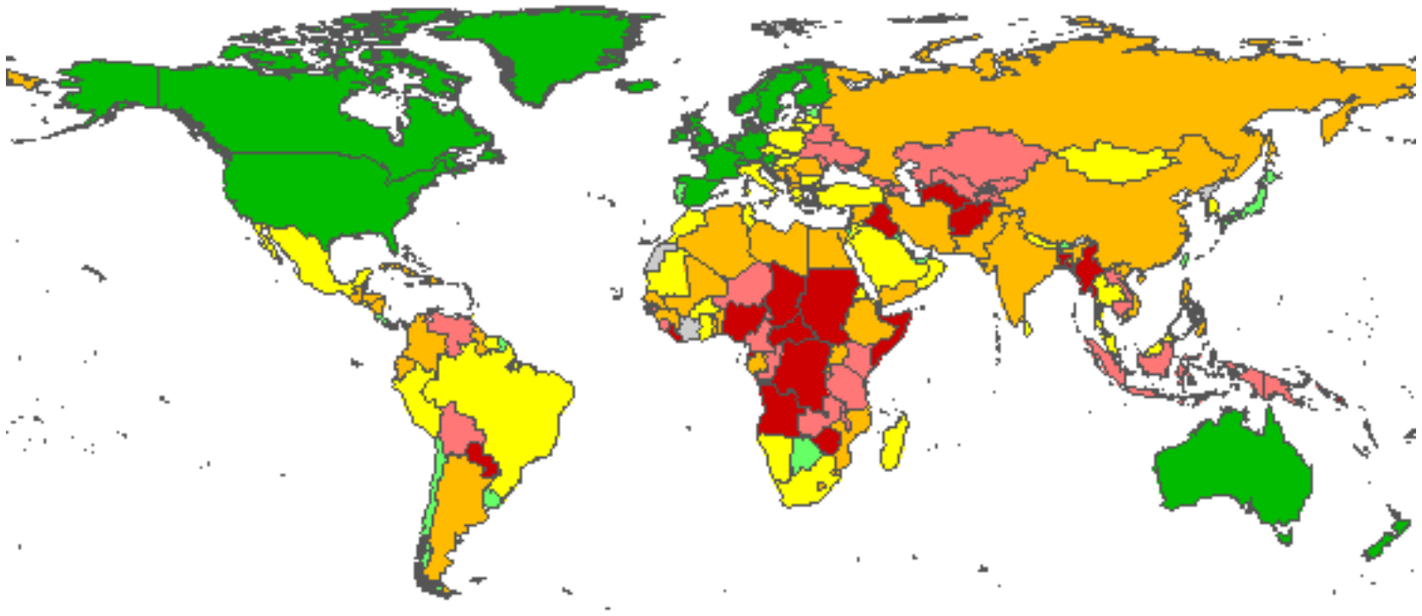


Rule of Law (2002)

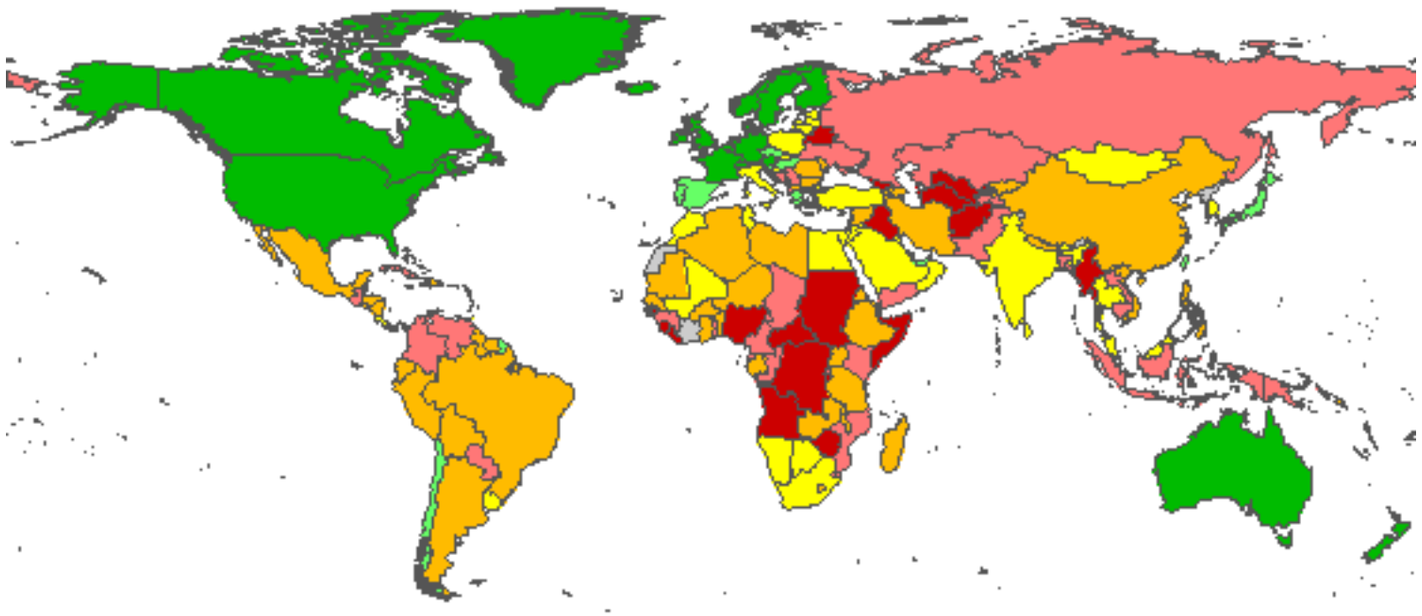


Source: Kaufmann D., A. Kraay, and M. Mastruzzi 2009: Governance Matters VIII: Governance Indicators for 1996-2008

Control of Corruption (2003)

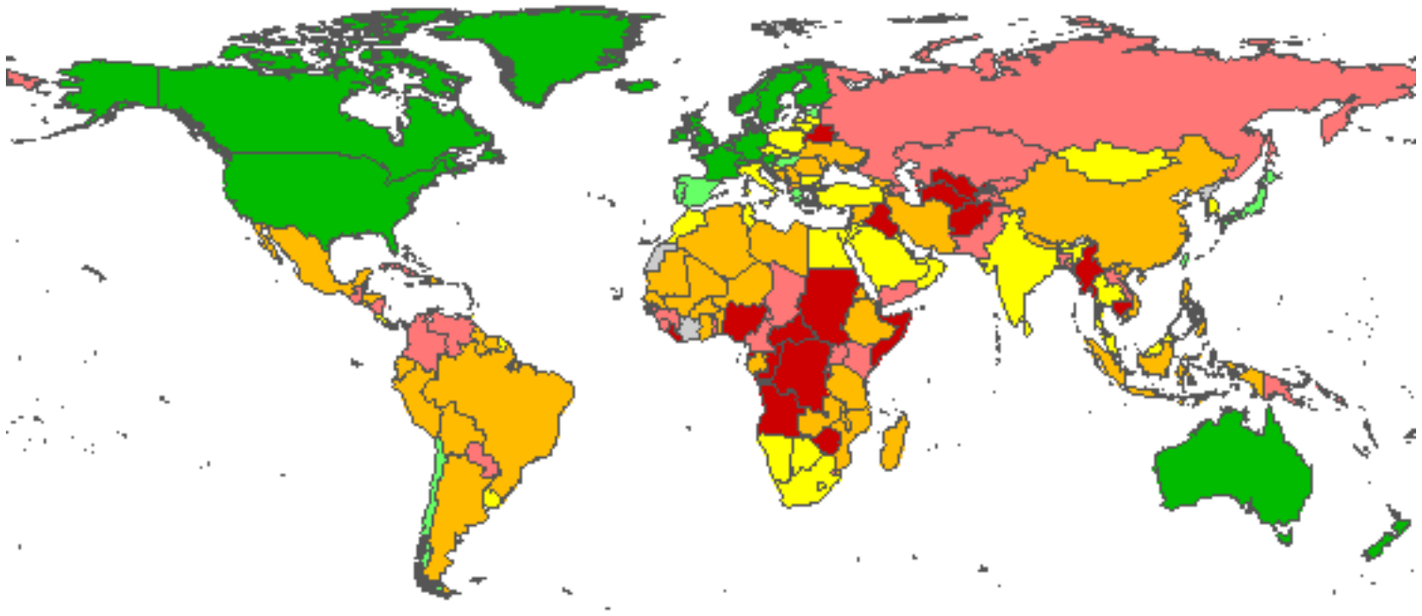


Rule of Law (2003)

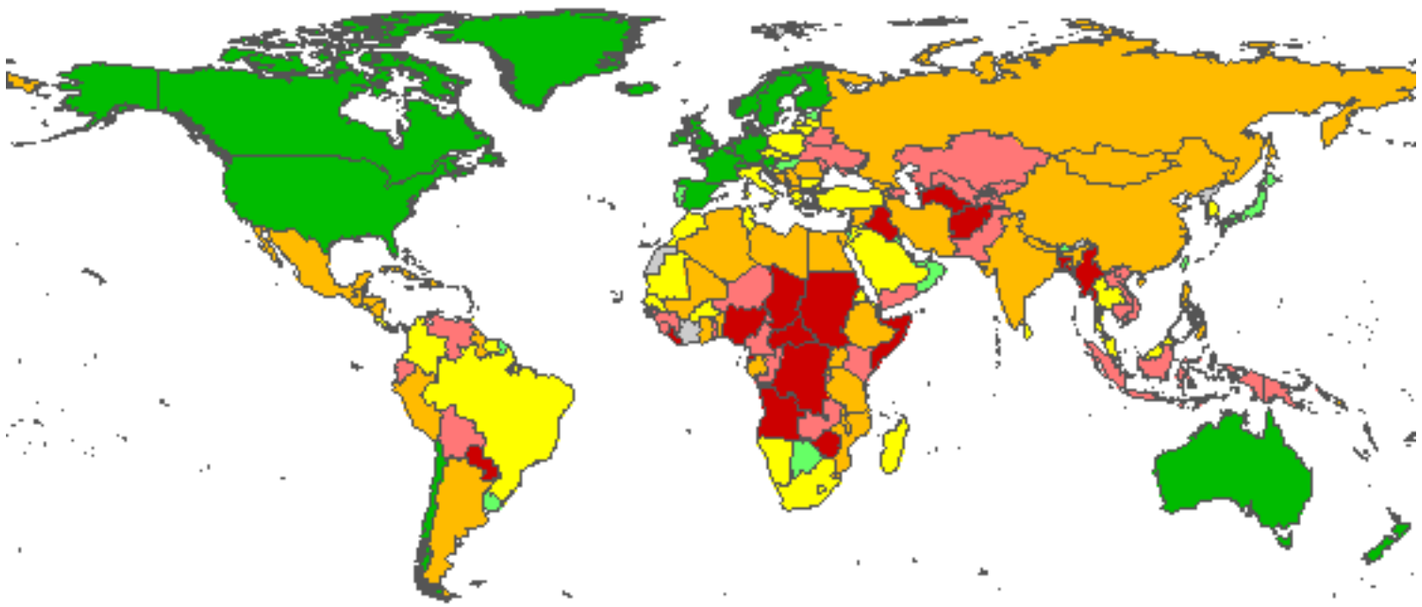


Source: Kaufmann D., A. Kraay, and M. Mastruzzi 2009: Governance Matters VIII: Governance Indicators for 1996-2008

Rule of Law (2004)

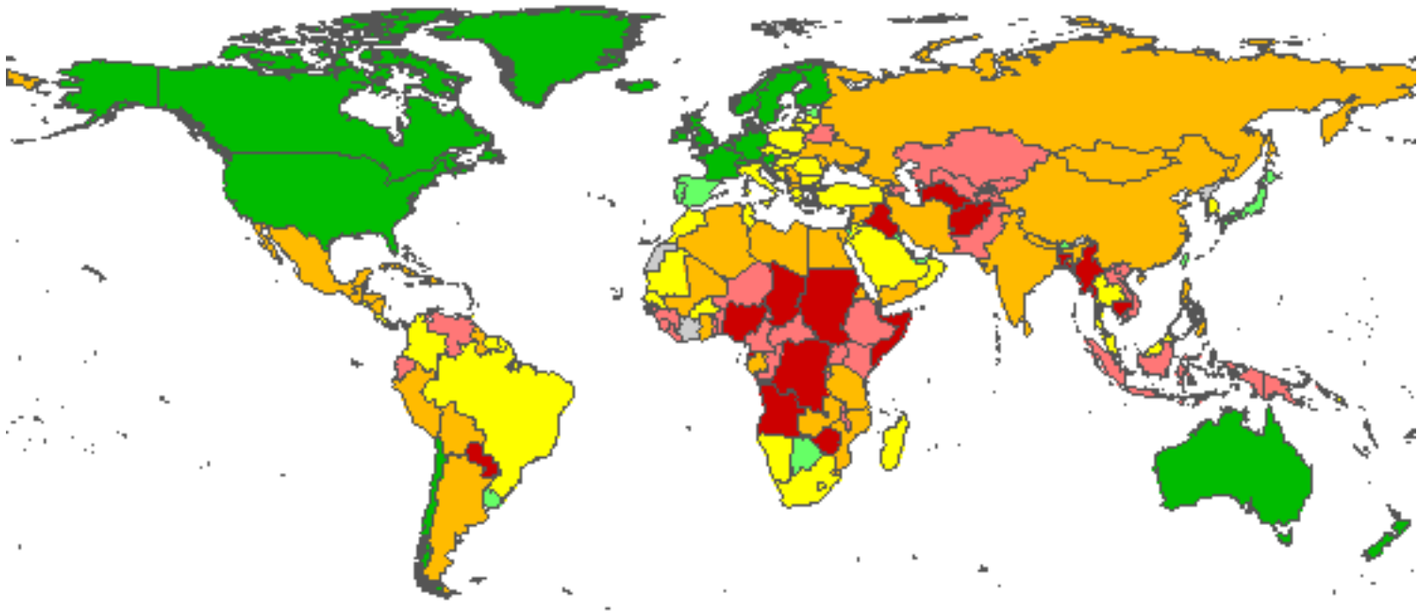


Control of Corruption (2004)

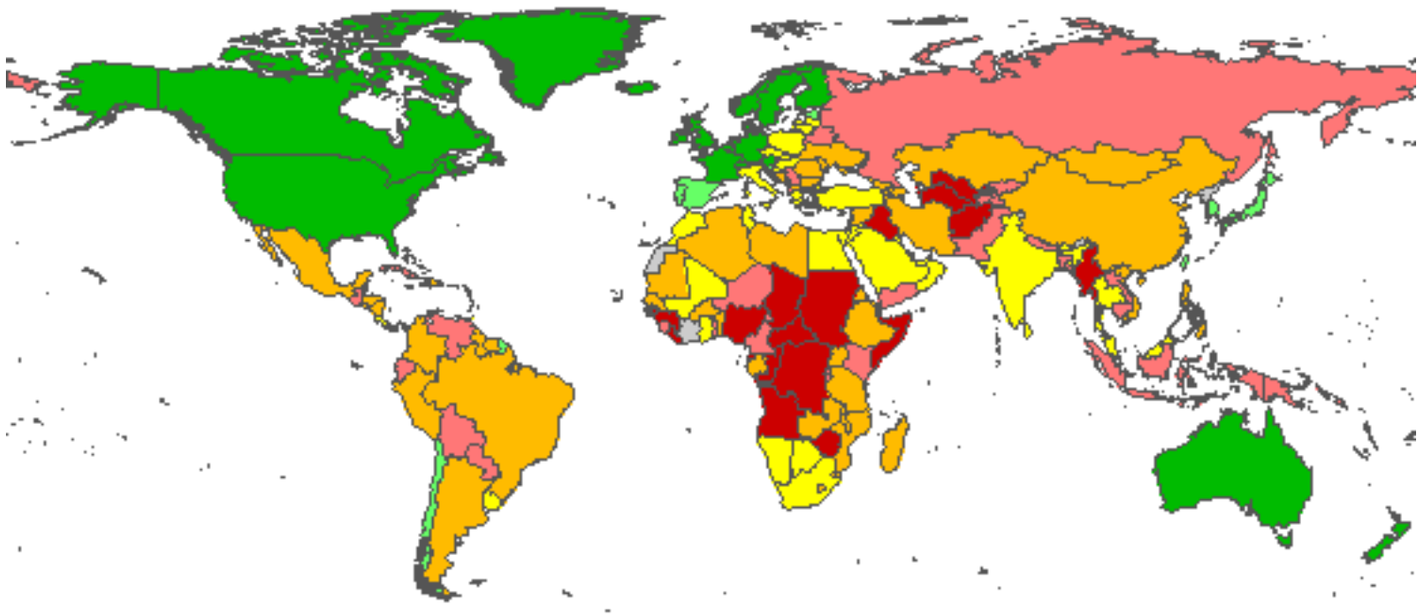


Source: Kaufmann D., A. Kraay, and M. Mastruzzi 2009: Governance Matters VIII: Governance Indicators for 1996-2008

Control of Corruption (2005)

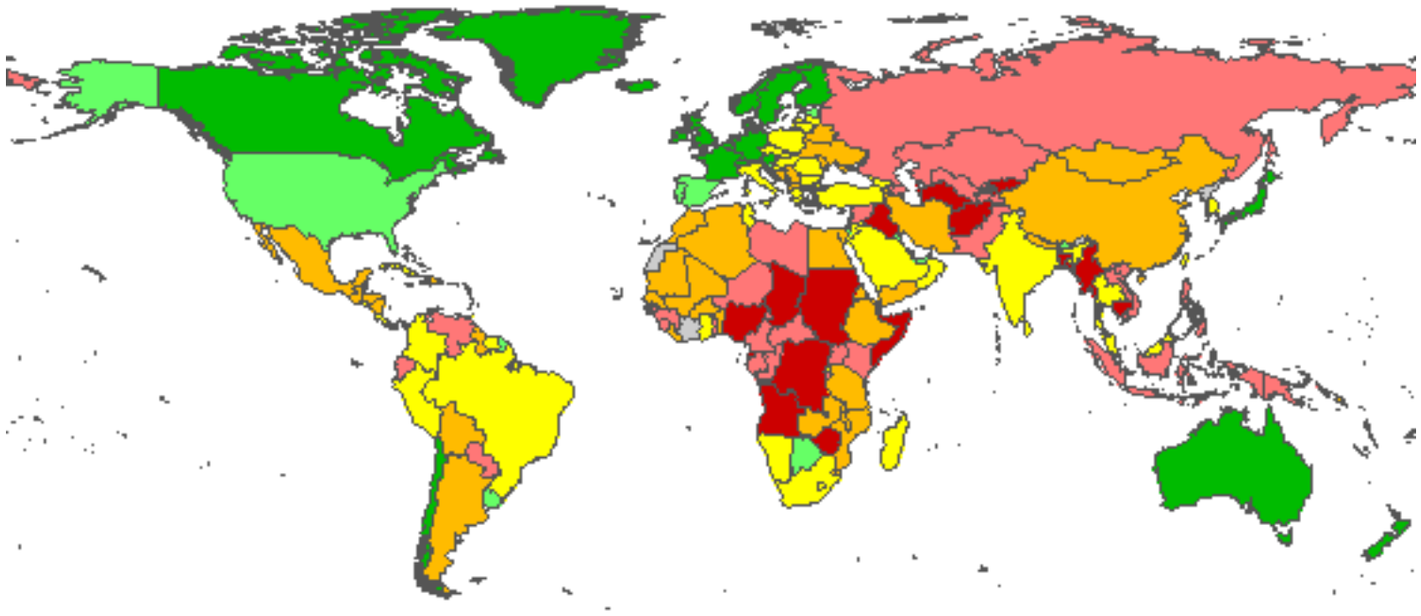


Rule of Law (2005)

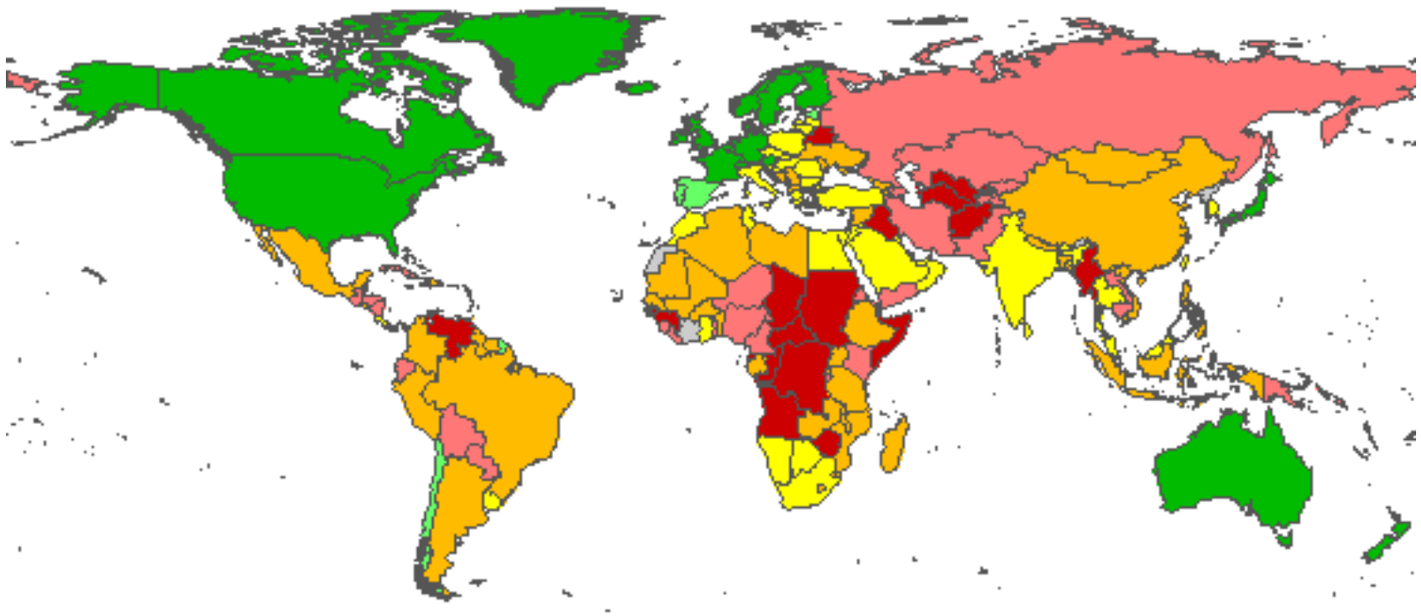


Source: Kaufmann D., A. Kraay, and M. Mastruzzi 2009: Governance Matters VIII: Governance Indicators for 1996-2008

Control of Corruption (2006)

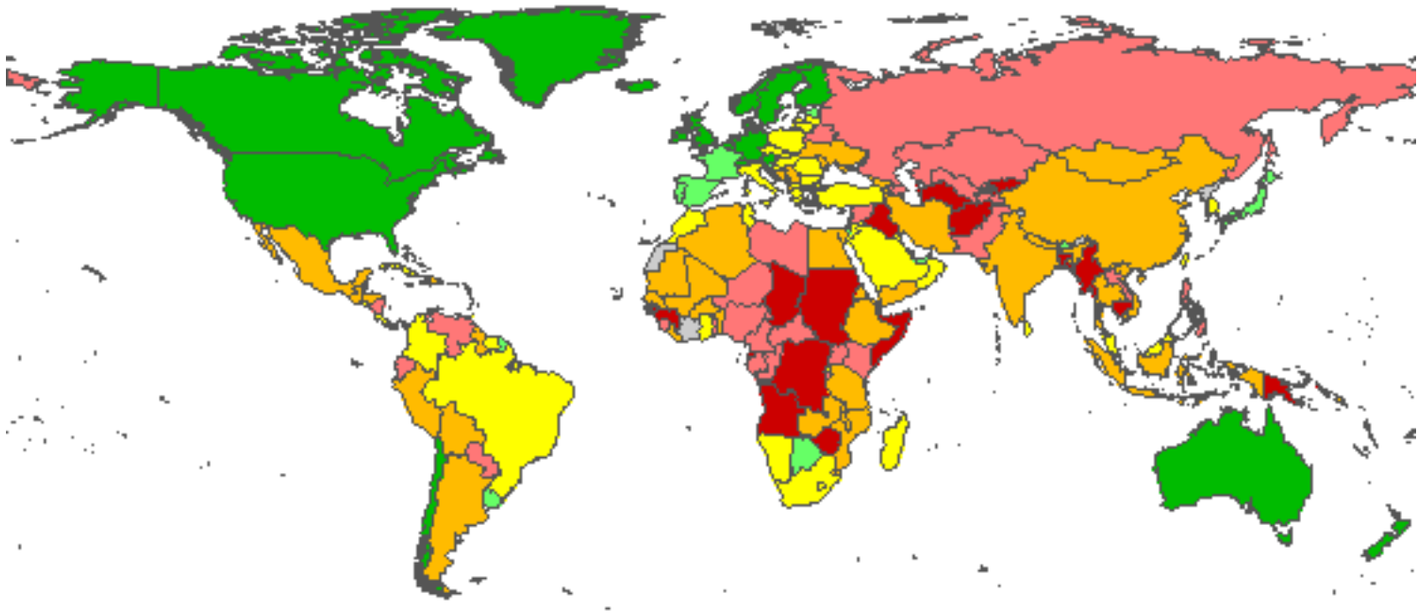


Rule of Law (2006)

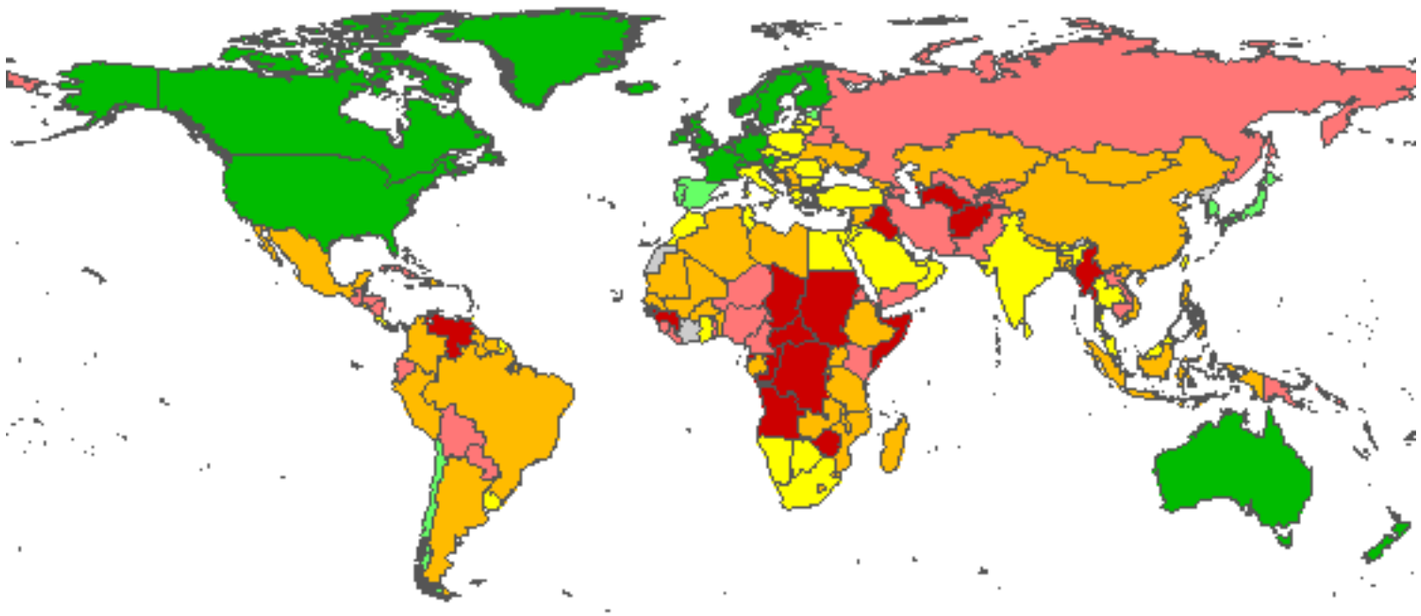


Source: Kaufmann D., A. Kraay, and M. Mastruzzi 2009: Governance Matters VIII: Governance Indicators for 1996-2008

Control of Corruption (2007)

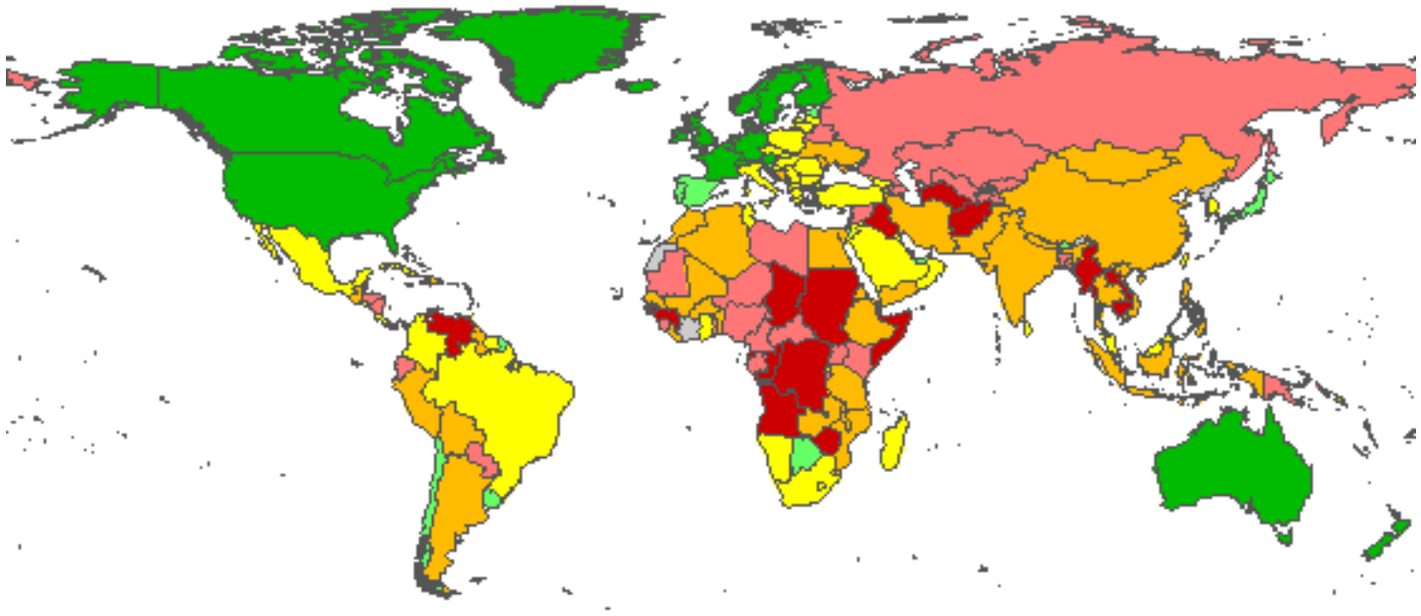


Rule of Law (2007)

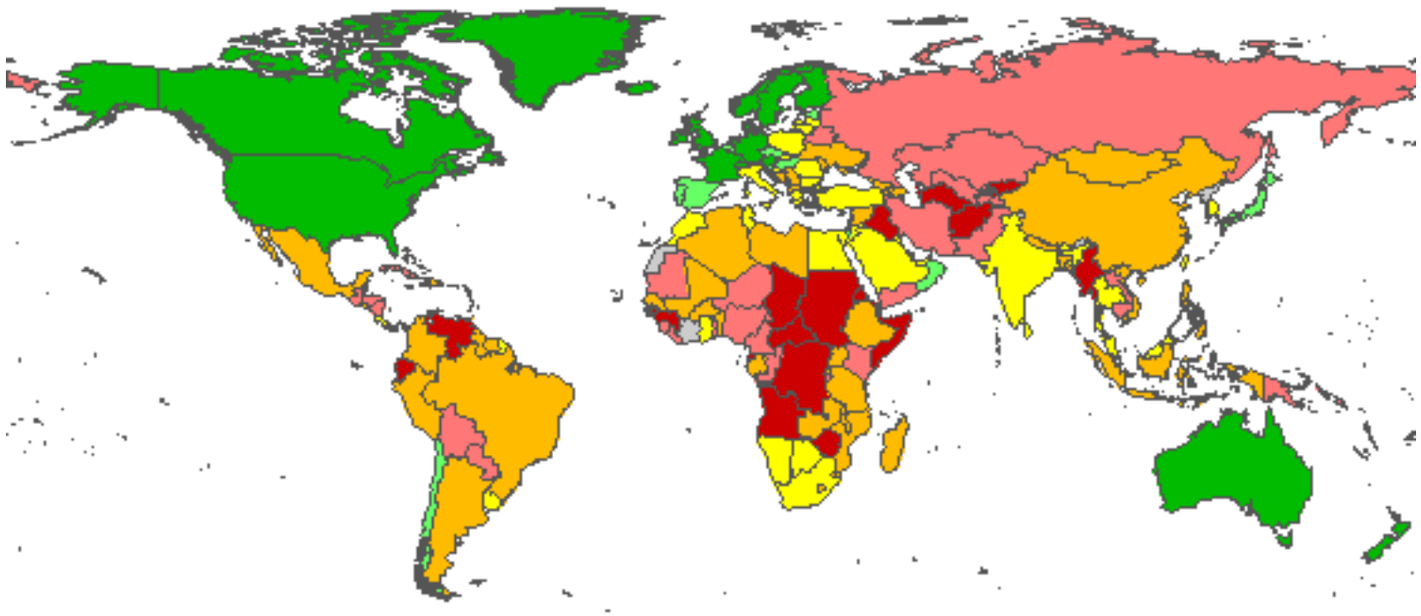


Source: Kaufmann D., A. Kraay, and M. Mastruzzi 2009: Governance Matters VIII: Governance Indicators for 1996-2008

Control of Corruption (2008)

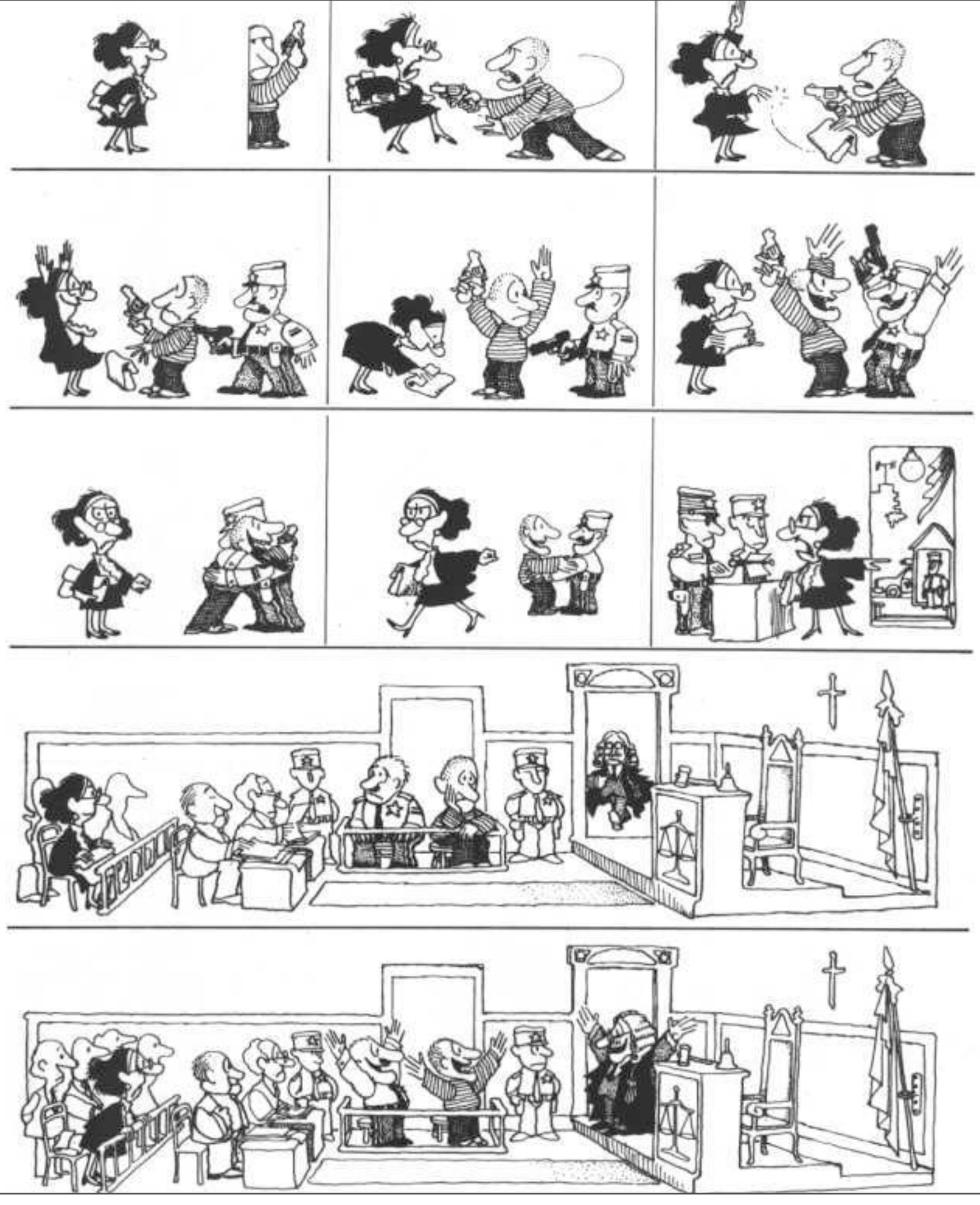


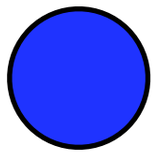
Rule of Law (2008)



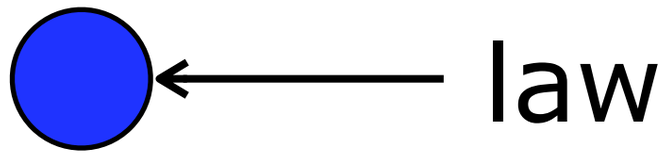
Source: Kaufmann D., A. Kraay, and M. Mastruzzi 2009: Governance Matters VIII: Governance Indicators for 1996-2008

Economy of influences





Adapted from L. Lessig, “Institutional Corruption”



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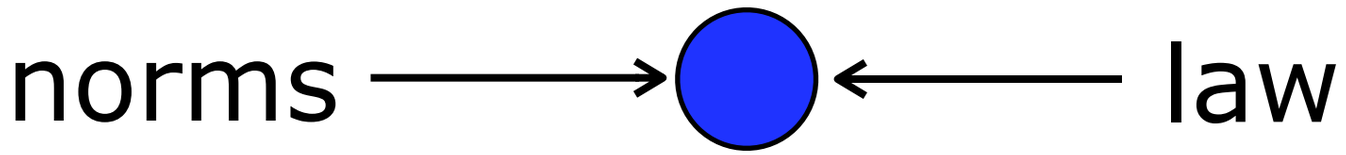

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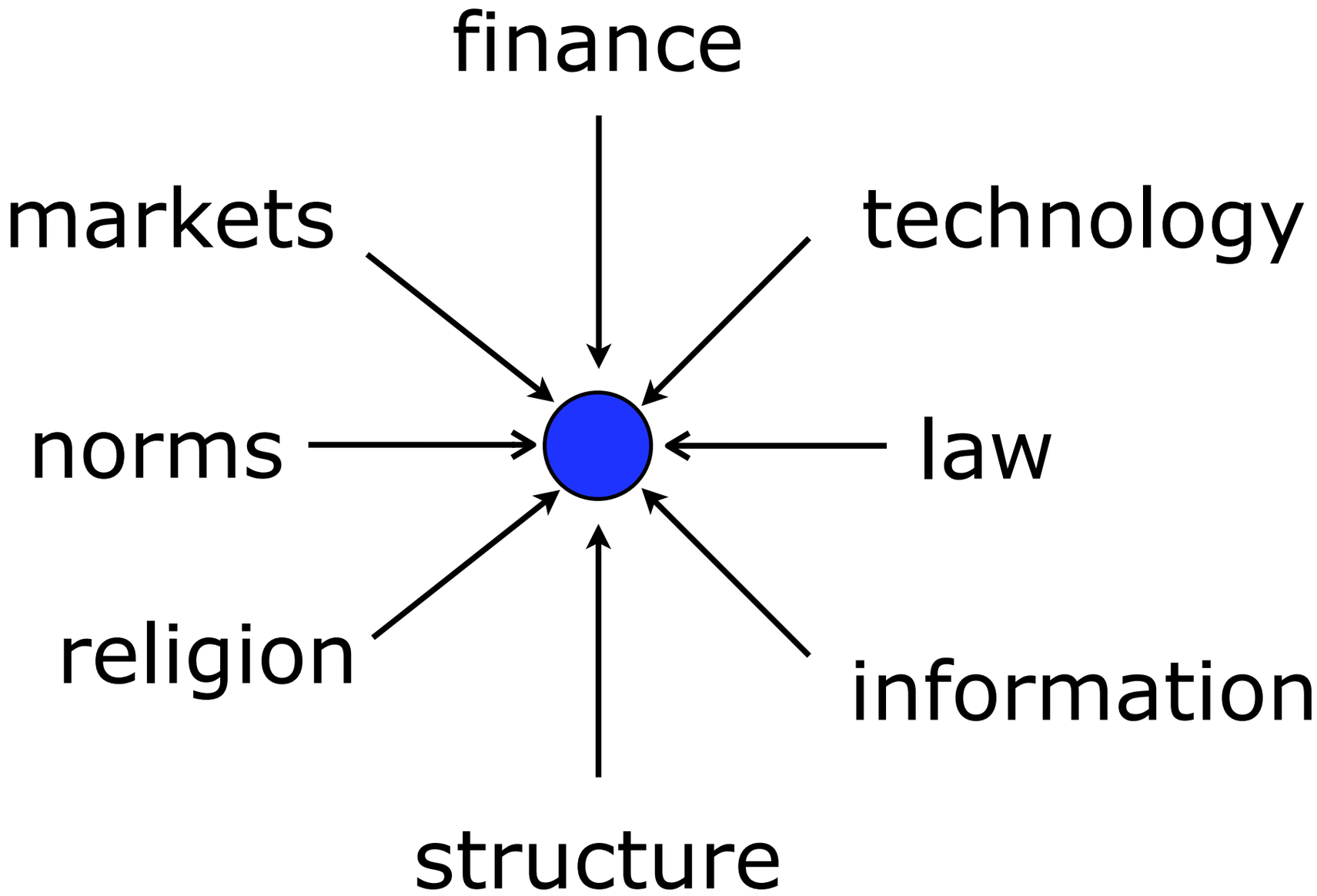
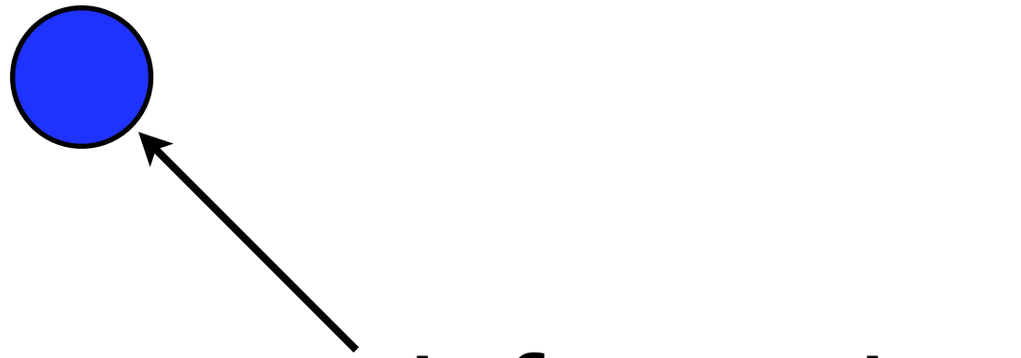
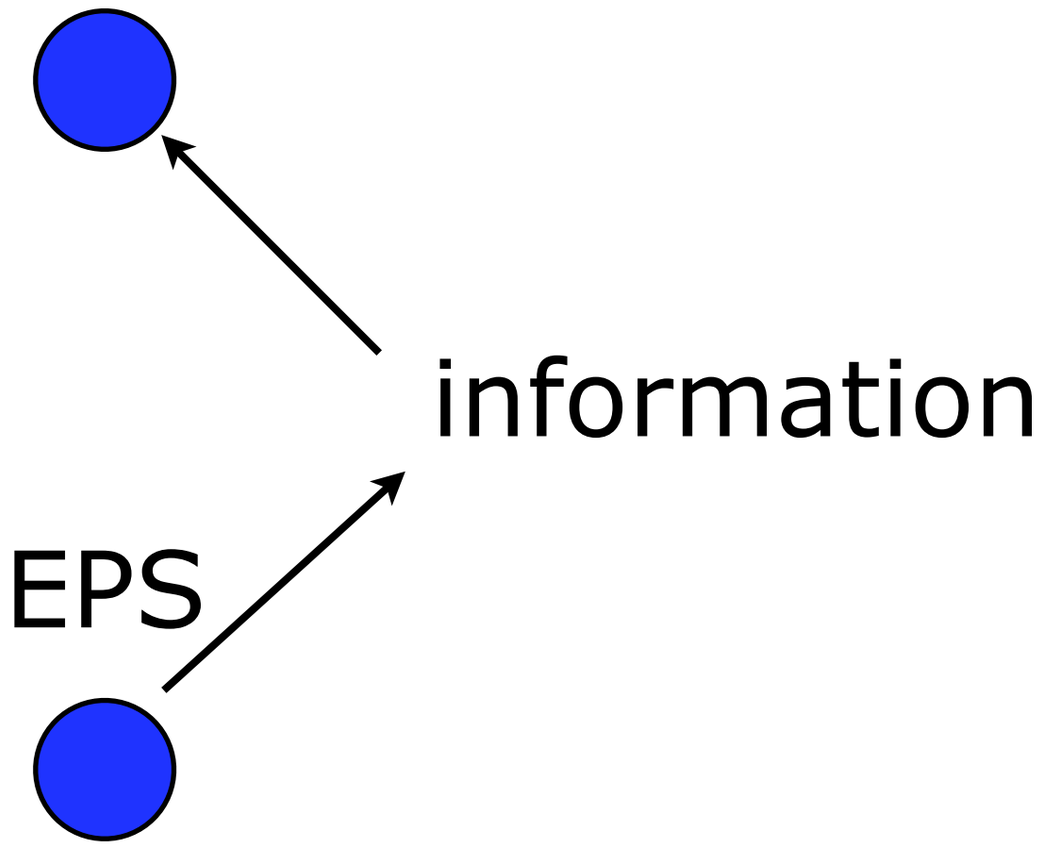


Adapted from L. Lessig, "Institutional Corruption"

Colombian health system



Colombian health system

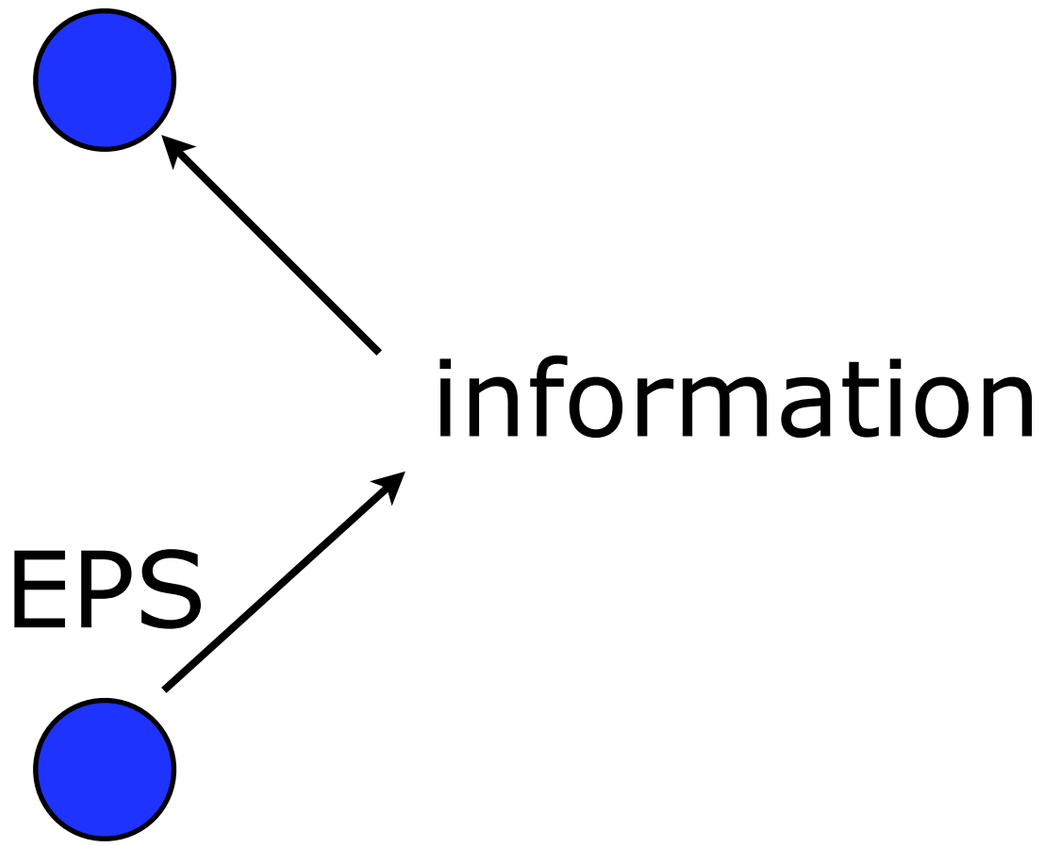


Health promoting entities

sell health service packages to the public, and contract such services with the healthcare-providing institution.

"conflicting interests"

Colombian health system



Health promoting entities

sell health service packages to the public, and contract such services with the healthcare-providing institution.

A scholar's greatest asset is his or her intuition about what questions to study and with what methodology

Roger B. Myerson

From The Nobel Prizes 2007,
Editor Karl Grandin, Nobel Foundation, Stockholm, 2008

Network Science

Why study networks?

- Capture relationships / non-spatial interactions
- Understand structure and function
- Metrics exist that capture structure
- Structure or metrics can be related to important properties of the system or its behavior

Lots of things have structure...

- Physical: large natural systems
- Human designed: products, systems, missions, organizations, projects, infrastructures, software, databases, political and economic systems
- Natural: cells, organisms, herds, ecosystems

Changes in technology may be altering the way we line out social networks and may have profound effects on the way we govern ourselves

N. Christakis and J. Fowler
Connected (2009), p. 31

Lawmakers have not yet considered the consequences of [network location]. Still understanding the way we are connected is an essential step in creating a more just society and in implementing public policies affecting everything from public health to the economy

N. Christakis and J. Fowler
Connected (2009), p. 31

[A network science approach to public health] targets neither socioeconomic inequality nor behavioral vulnerability per se, but rather structural inequality and structural vulnerability. People are placed at risk for bad or good health by virtue of their network position, and it is this position that public health interventions might beneficially be oriented.

N. Christakis and J. Fowler
Connected (2009), p. 132

Some do not...

- Perfect gases
- Crowds of people
- Random networks

Real-world networks are not random!

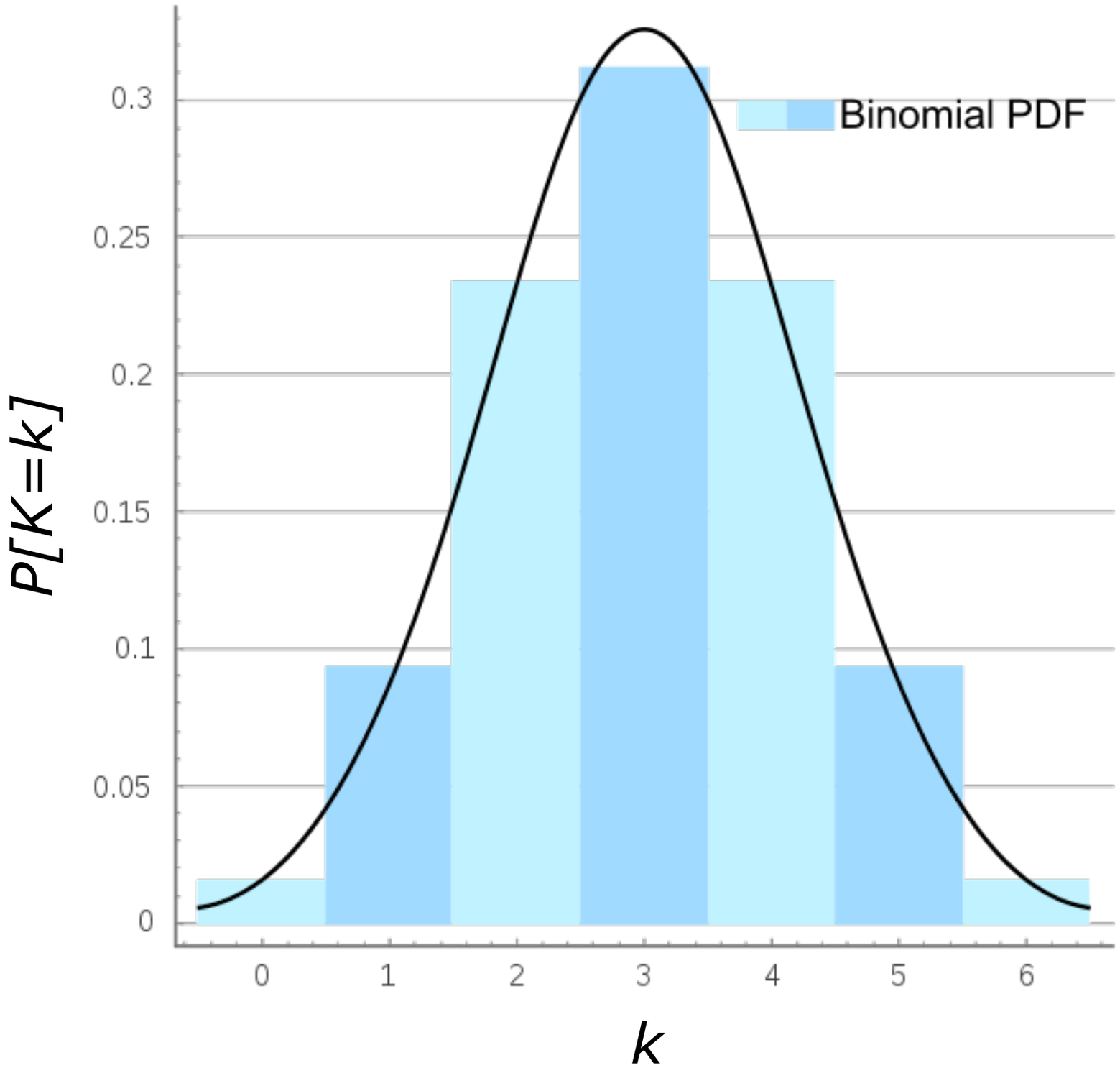
Real-world networks are not random!

Their behavior can still be analyzed to form a baseline for comparison

Today

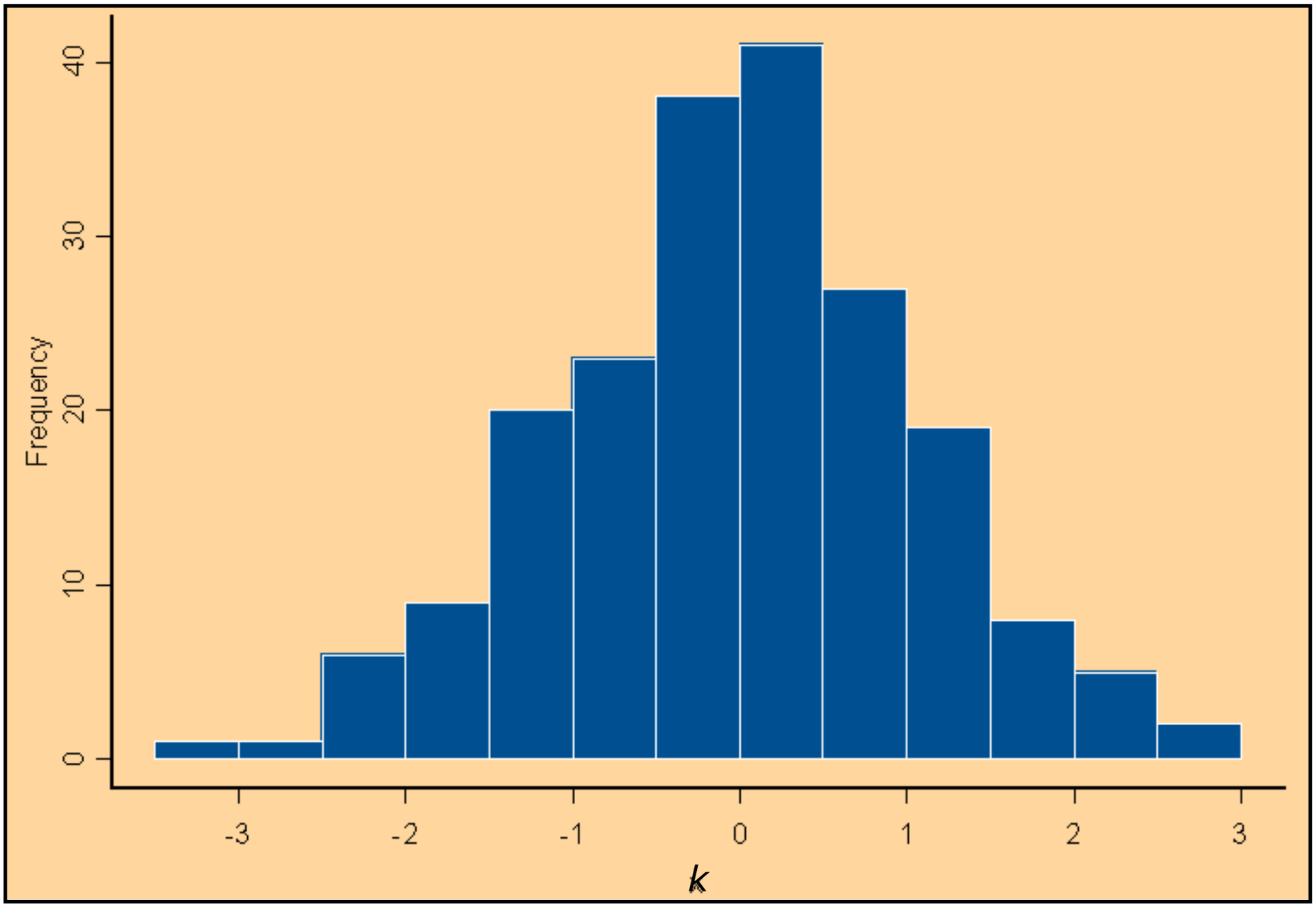
Common Properties:

- degree distribution
- heavy-tailed
  - power-law
  - exponential


Binomial PDF
P[K=k]
0.3
0.25
0.2
0.15
0.1
0.05
0
0
1
2
3
4
5
6
k

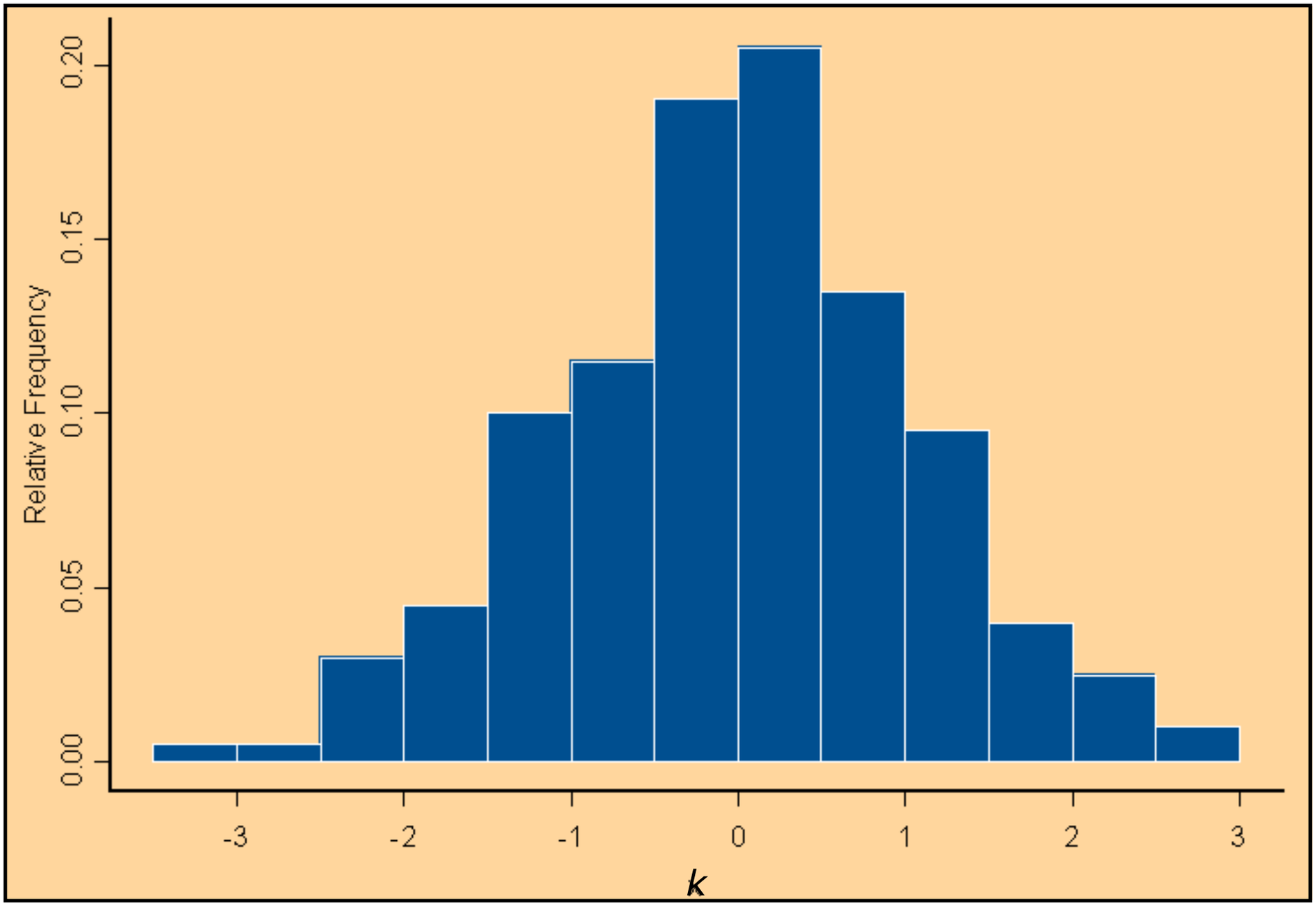
Data binning

Frequency histograms



Simple interpretation
Can't be directly related to probabilities or density functions

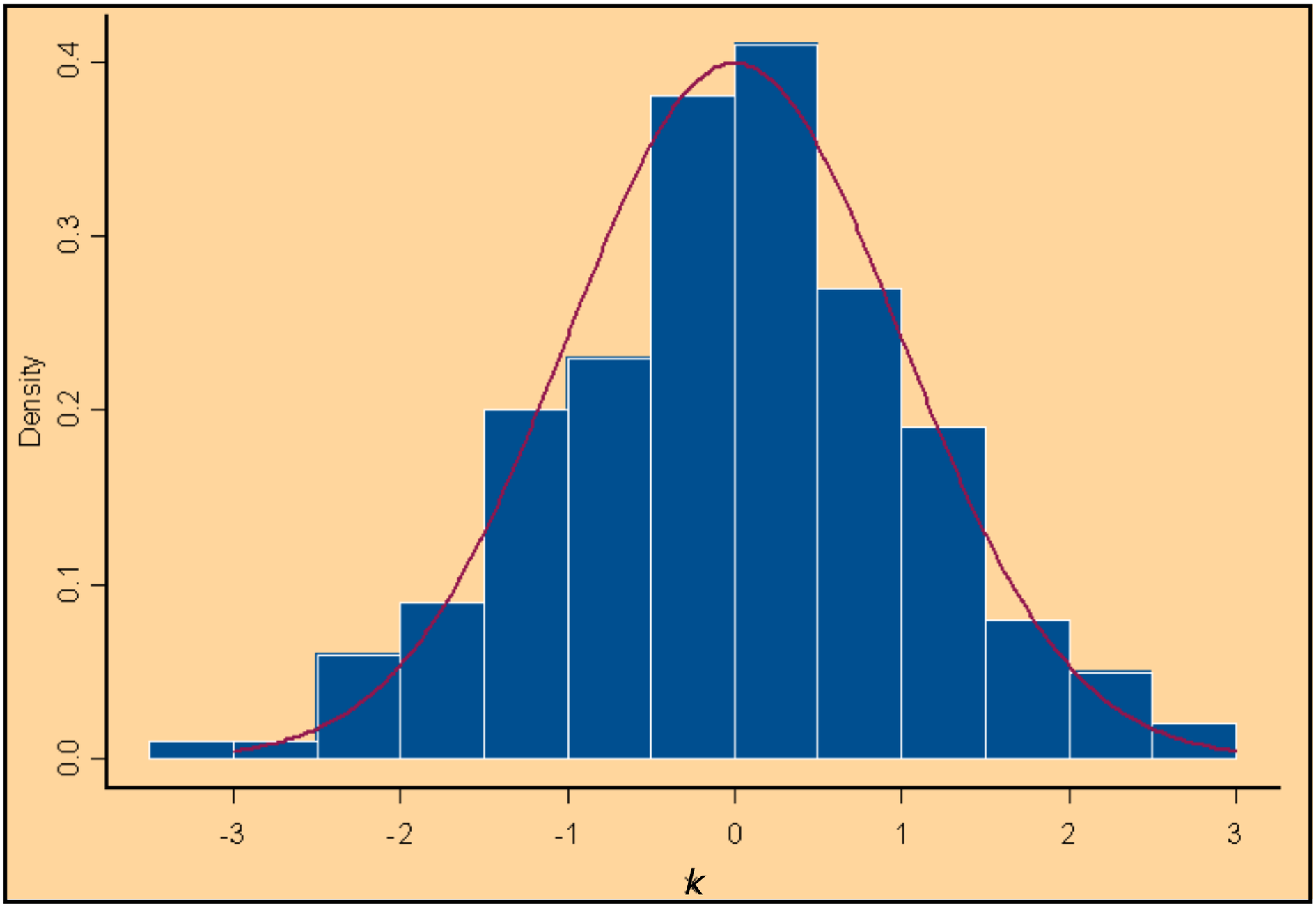
Relative frequency histograms



Divide counts by total number of observations

- Can be interpreted as probabilities for each range
- Can't be directly related to density function
  - Bar heights sum to 1 but won't integrate to 1 unless bar width = 1

Density histograms



Divide counts by (total number of observations times bar width)

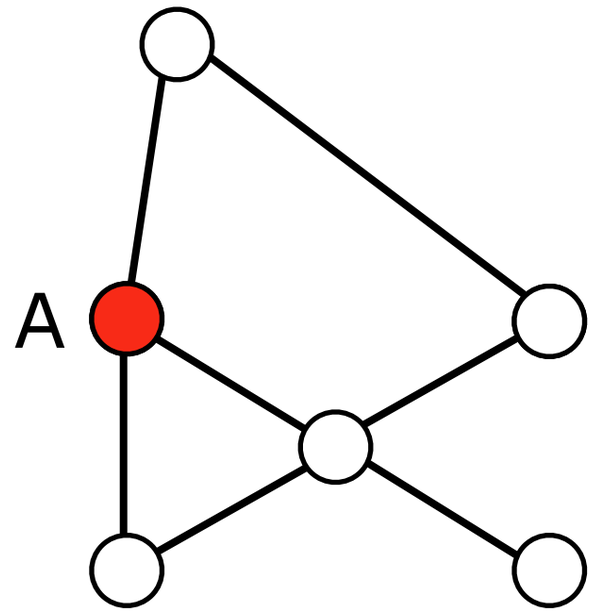
- Bar height X bar width gives probability for each range
- Can be directly related to density function
  - Bar areas sum to 1

Real-world are mostly found to be very unlike the random graph in their degree distribution

Degree distribution

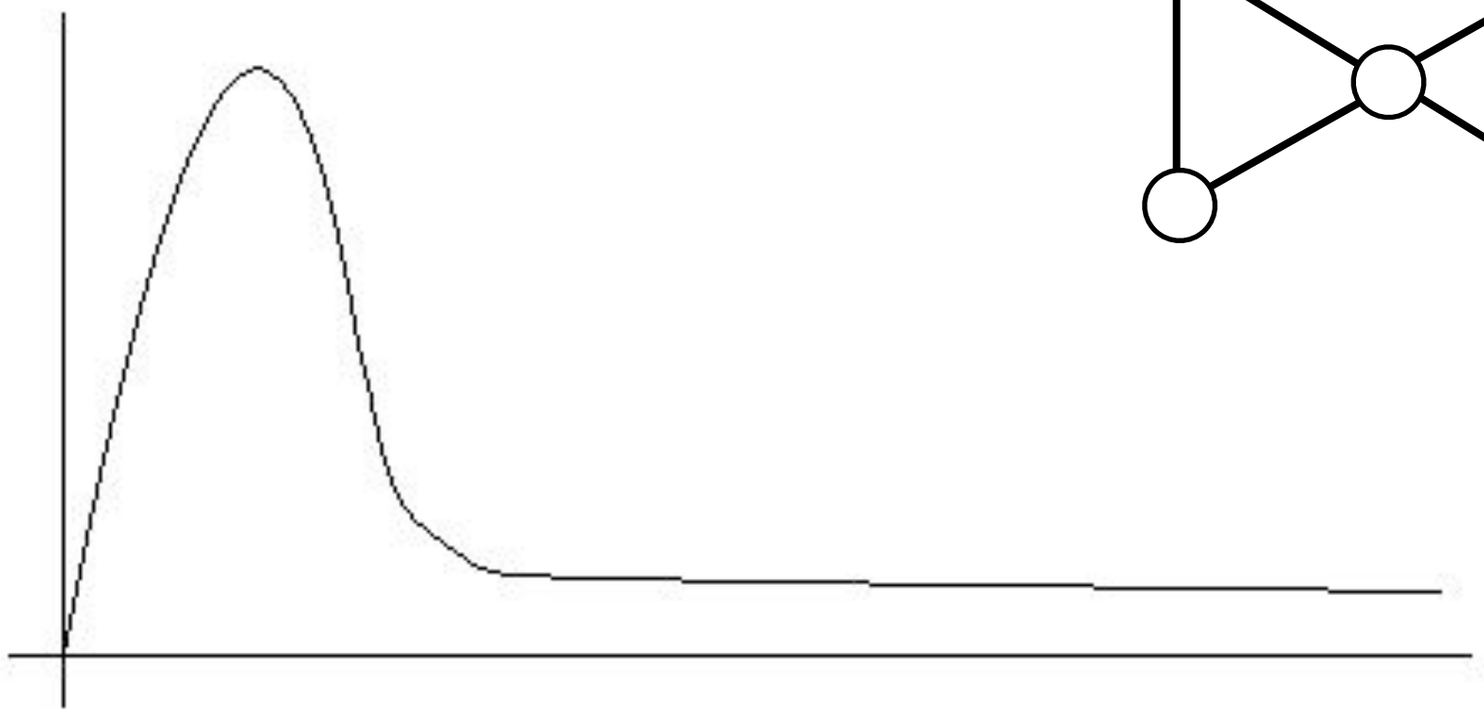
K=degree of a randomly selected node

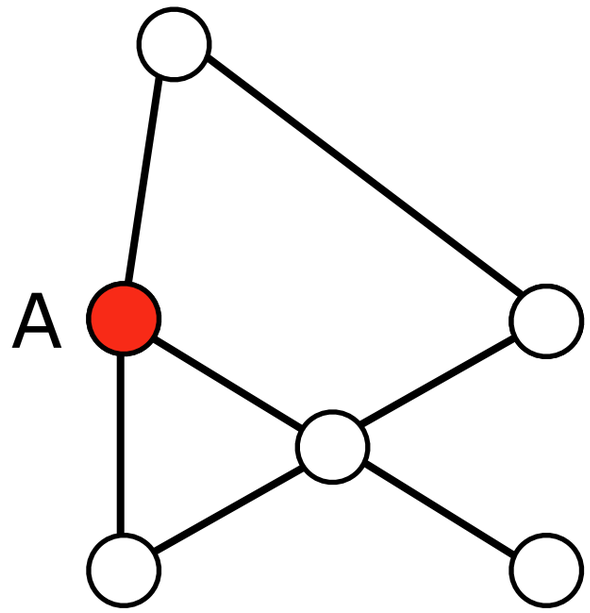
$p_k = P[K=k]$



K=degree of a randomly selected node

$p_k = P[K=k]$

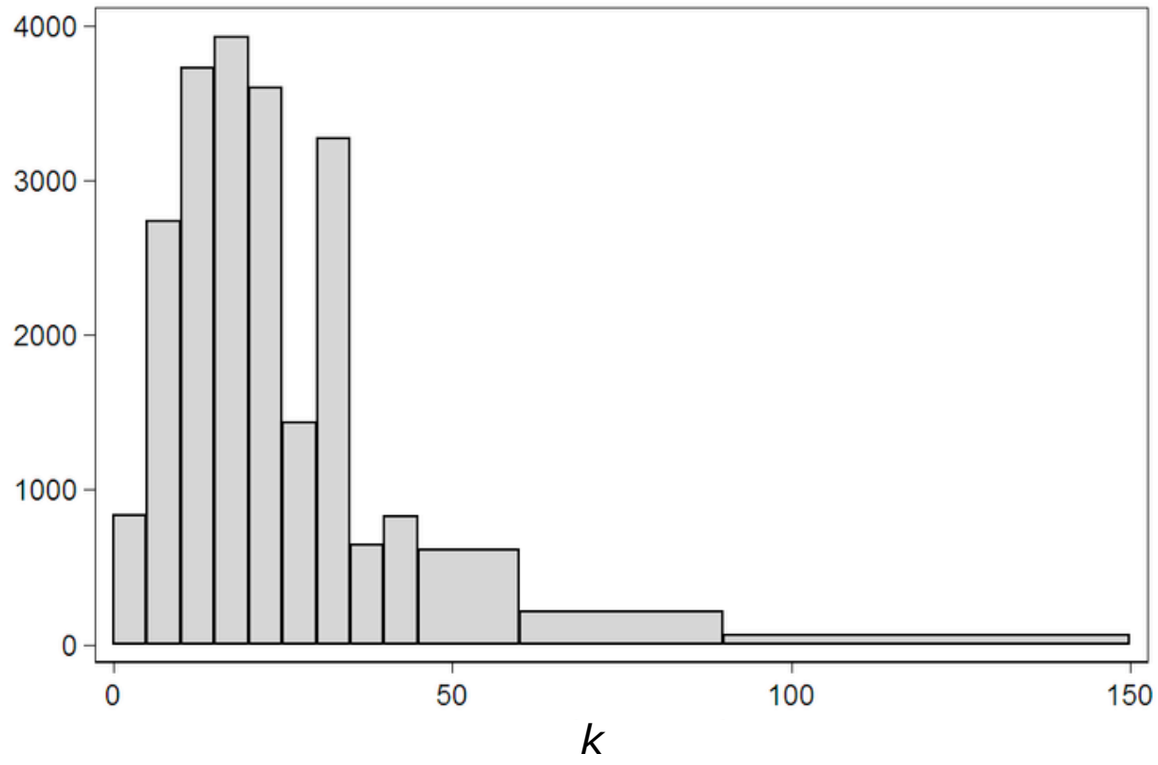




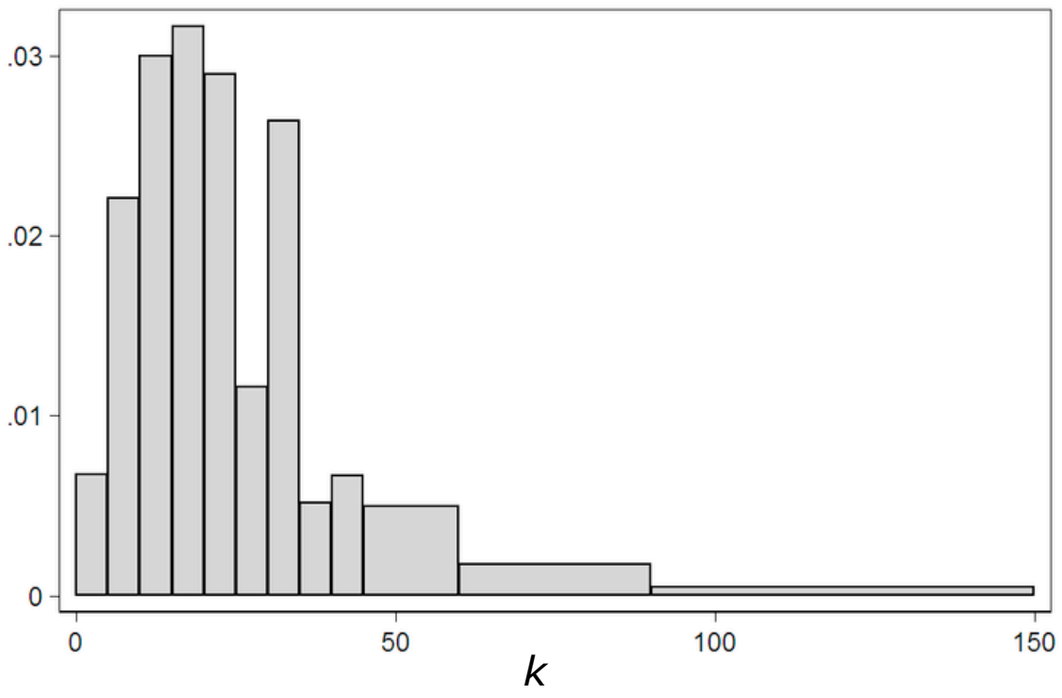
The distribution of a random variable *K* is said to have a heavy right tail if

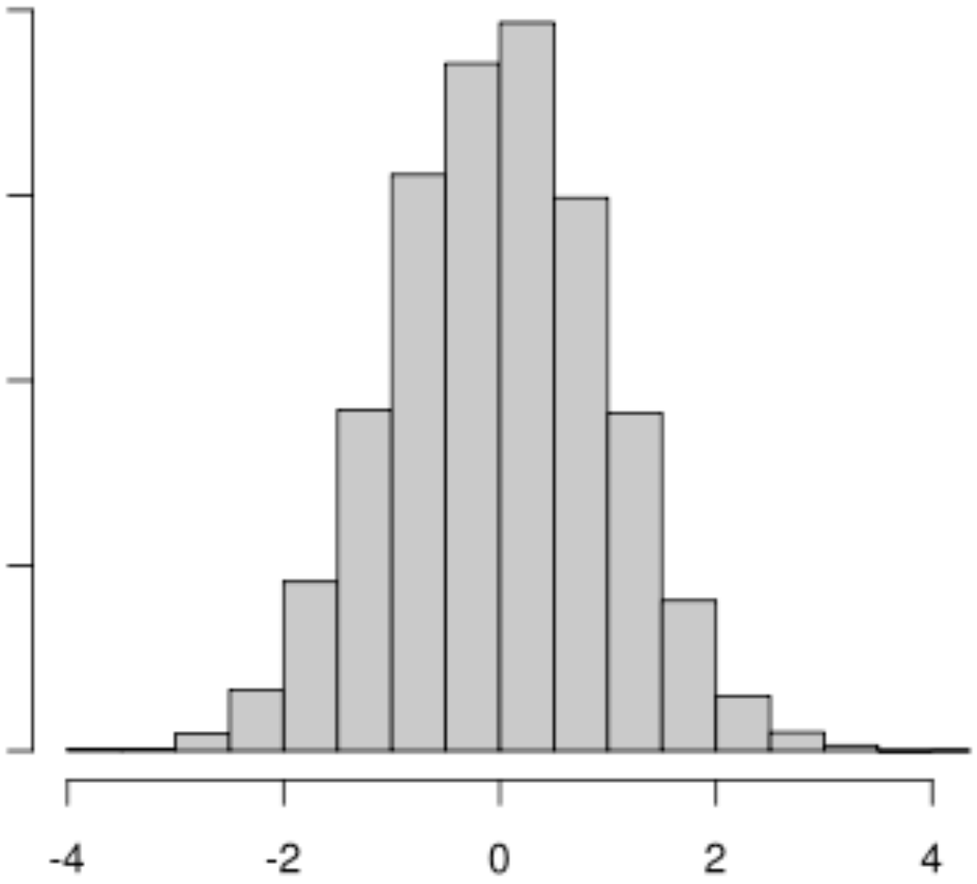
$$\lim_{x\to\infty} e^{\lambda x} \Pr[X > x] = \infty \quad \text{for all } \lambda > 0.$$

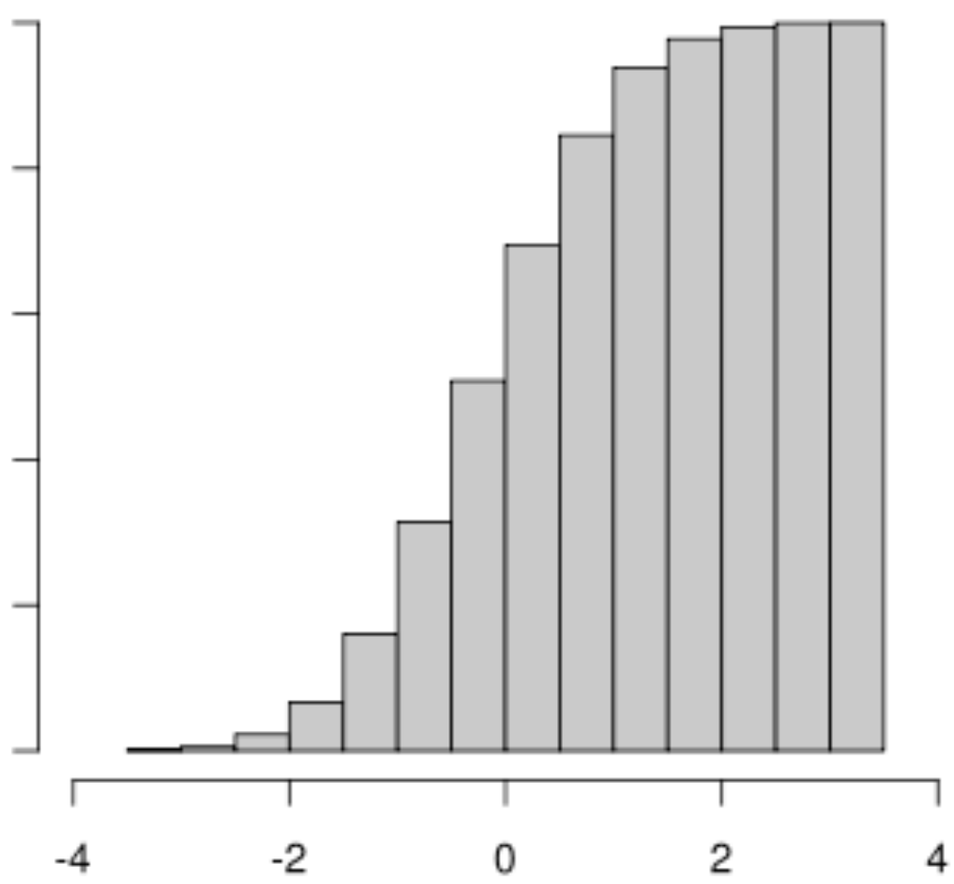
Interval	Width	Quantity	Quantity/ width
0	5	4180	836
5	5	13687	2737
10	5	18618	3723
15	5	19634	3926
20	5	17981	3596
25	5	7190	1438
30	5	16369	3273
35	5	3212	642
40	5	4122	824
45	15	9200	613
60	30	6461	215
90	60	3435	57

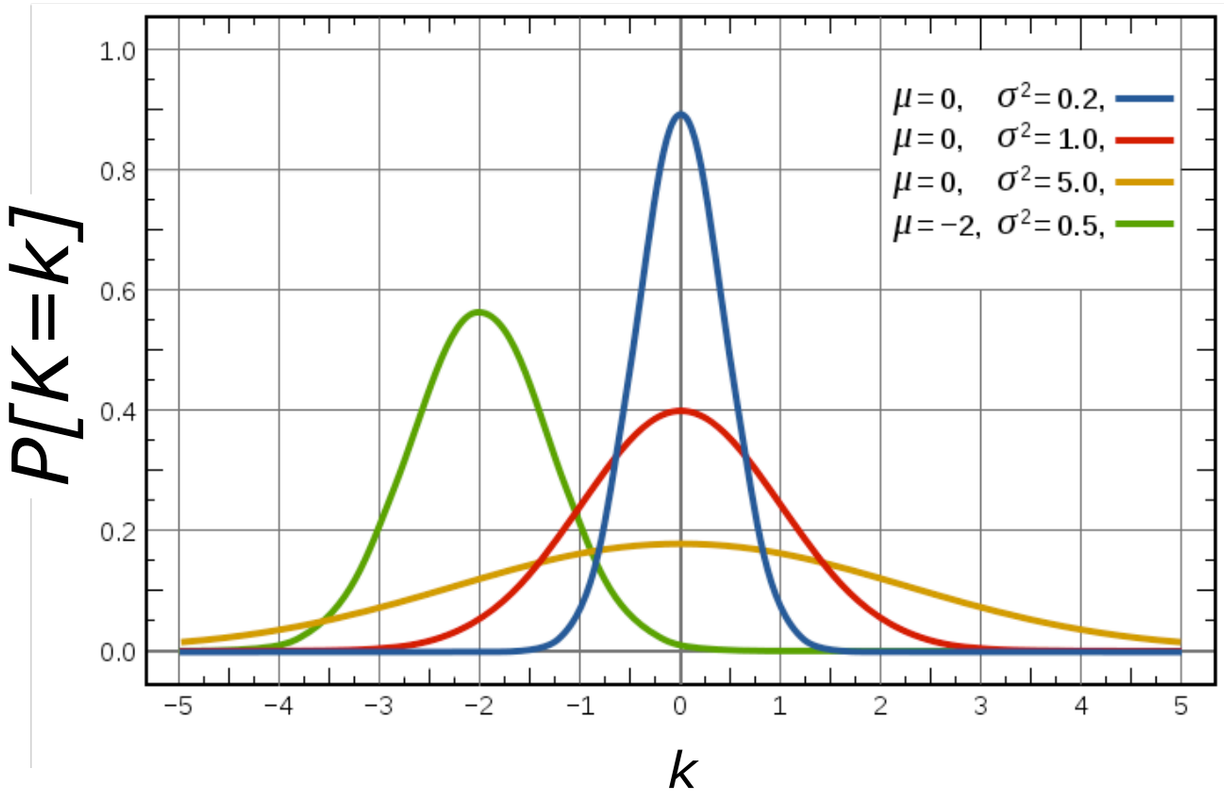


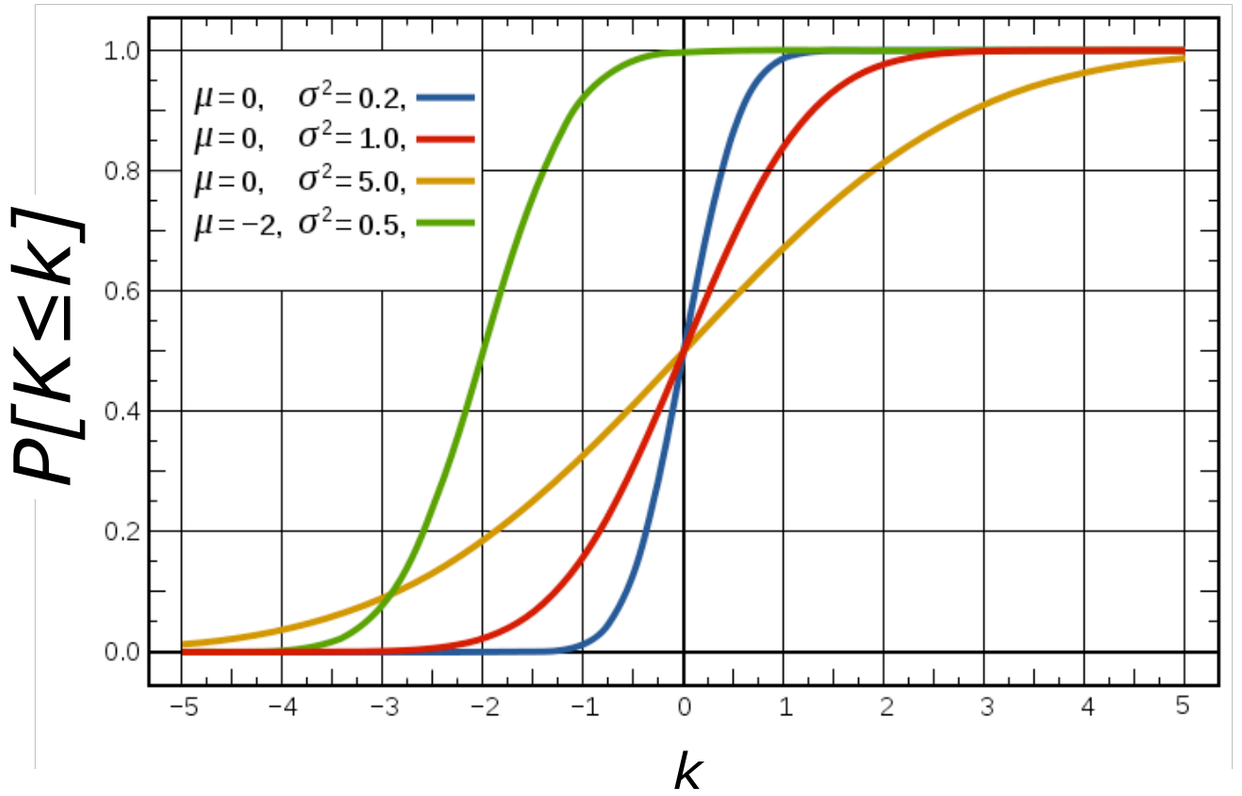
Interval	Width	Quantity (Q)	Q/total/width
0	5	4180	67
5	5	13687	221
10	5	18618	300
15	5	19634	316
20	5	17981	290
25	5	7190	116
30	5	16369	264
35	5	3212	52
40	5	4122	66
45	15	9200	49
60	30	6461	17
90	60	3435	5



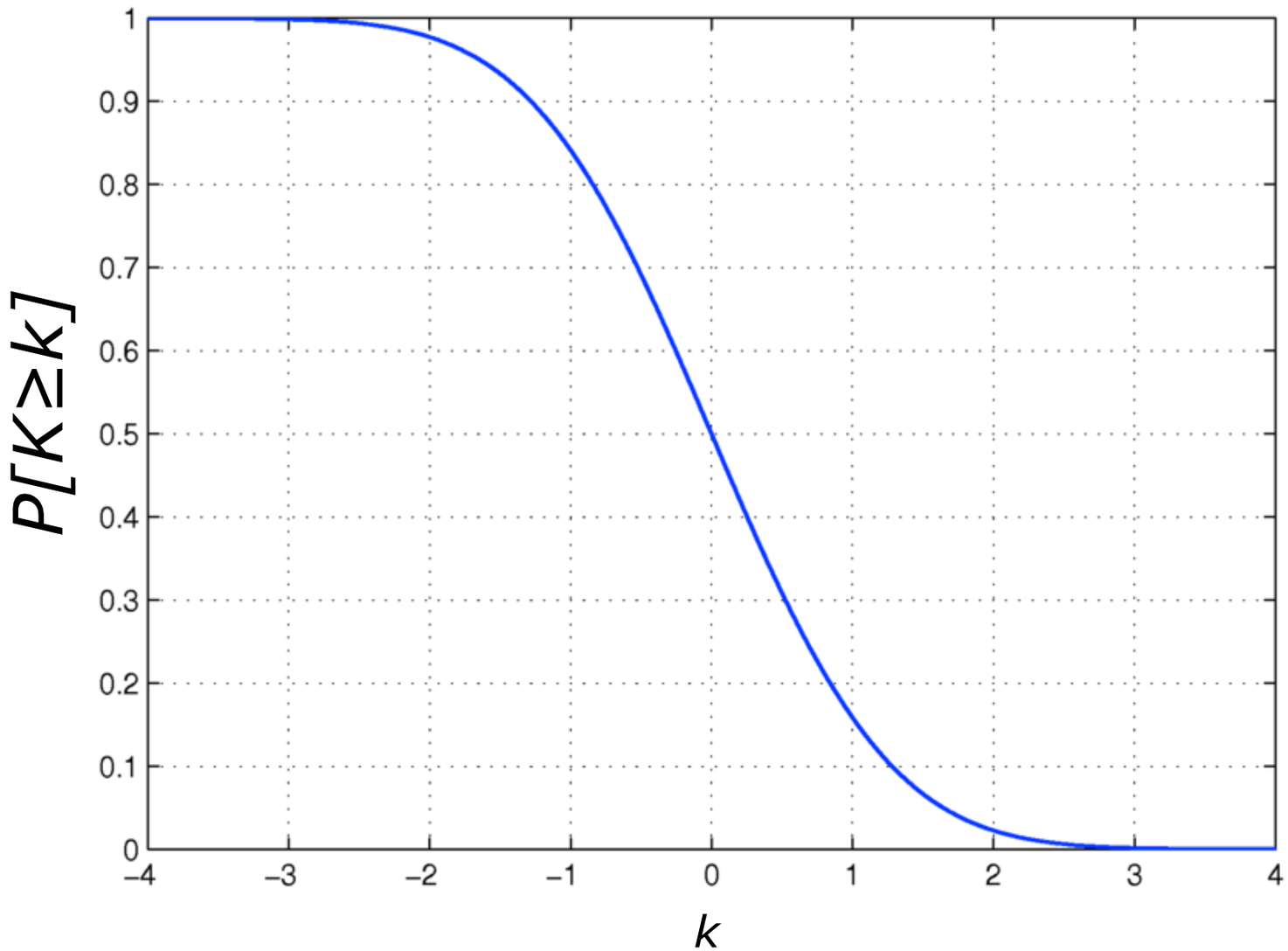

Ordinary histogram
-4
-2
0
2
4
k


Cumulative histogram
-4
-2
0
2
4
k


$P[K=k]$
1.0
0.8
0.6
0.4
0.2
0.0
−5 −4 −3 −2 −1 0 1 2 3 4 5
k
$\mu=0,\ \sigma^2=0.2,$
$\mu=0,\ \sigma^2=1.0,$
$\mu=0,\ \sigma^2=5.0,$
$\mu=-2,\ \sigma^2=0.5,$

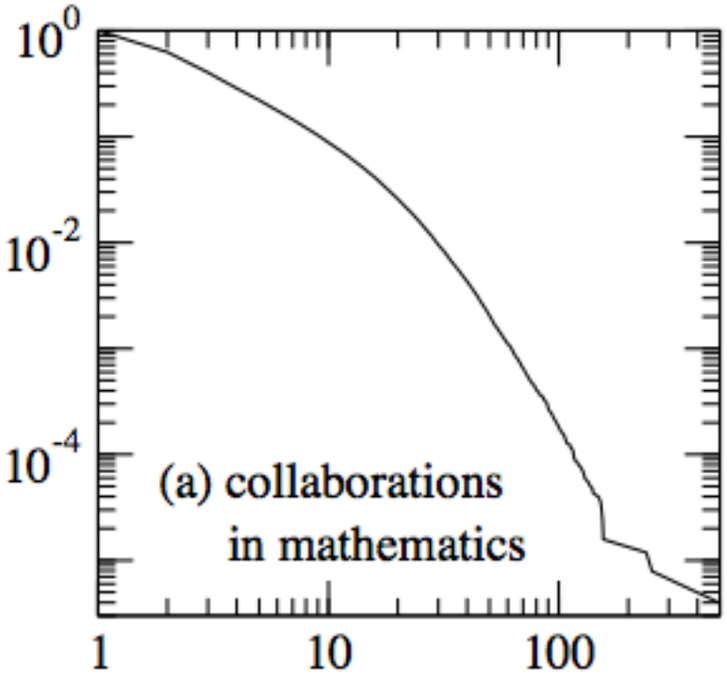

$P[K\leq k]$
1.0
0.8
0.6
0.4
0.2
0.0
−5 −4 −3 −2 −1 0 1 2 3 4 5
k
$\mu=0,\ \sigma^2=0.2,$
$\mu=0,\ \sigma^2=1.0,$
$\mu=0,\ \sigma^2=5.0,$
$\mu=-2,\ \sigma^2=0.5,$

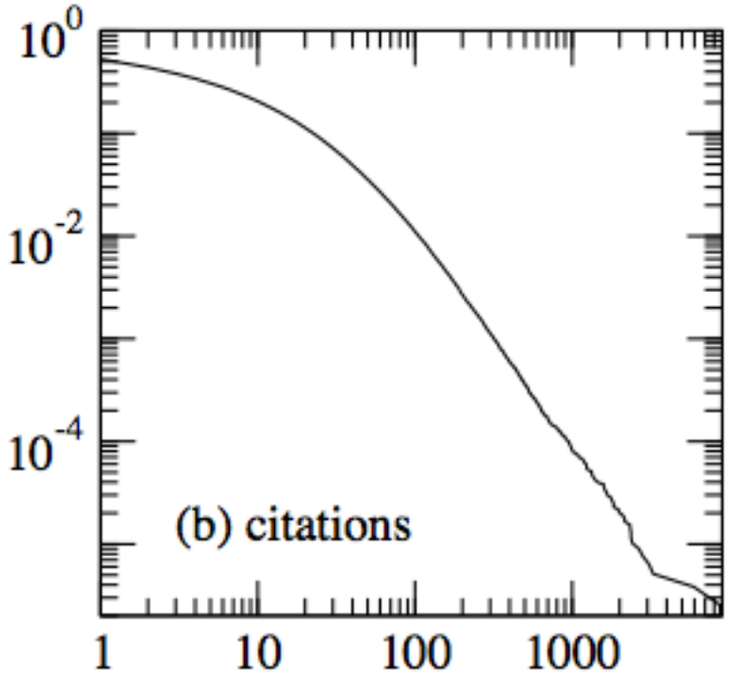
Tail probability

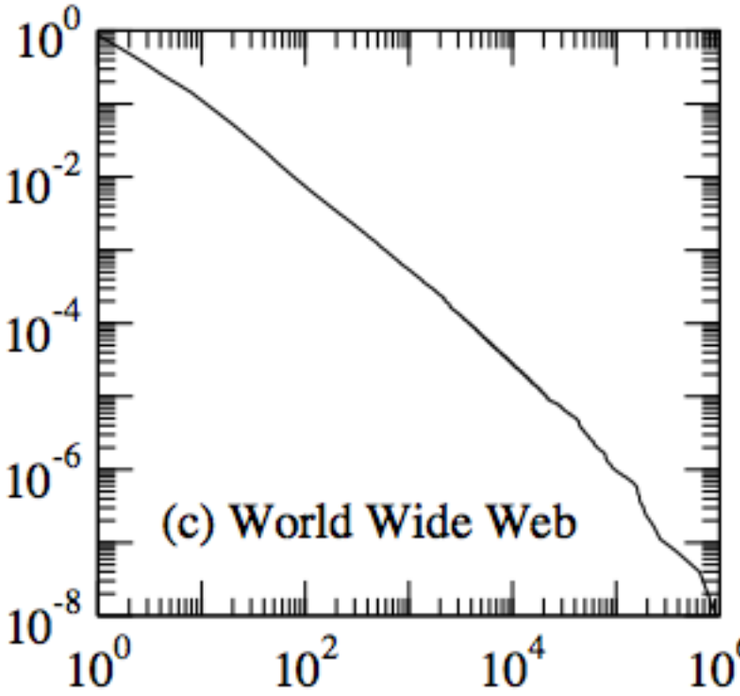


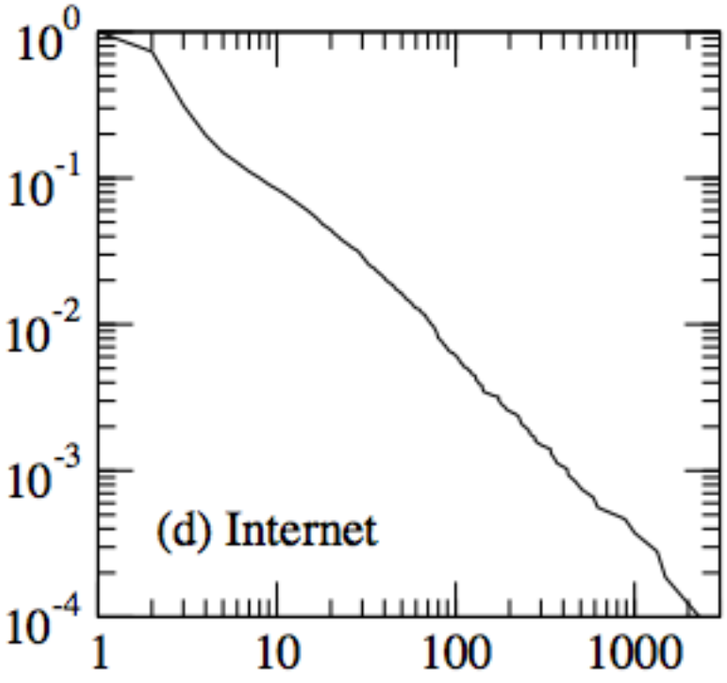
probability that a standard normal random variable will obtain a value larger than *k*

heavy-tailed?


10^0
10^{-2}
10^{-4}
(a) collaborations
in mathematics
1
10
100


10^0
10^{-2}
10^{-4}
(b) citations
1
10
100
1000


10^0
10^{-2}
10^{-4}
10^{-6}
10^{-8}
(c) World Wide Web
10^0
10^2
10^4
10^6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10^{-2}
10^{-3}
10^{-4}
(d) Internet
1
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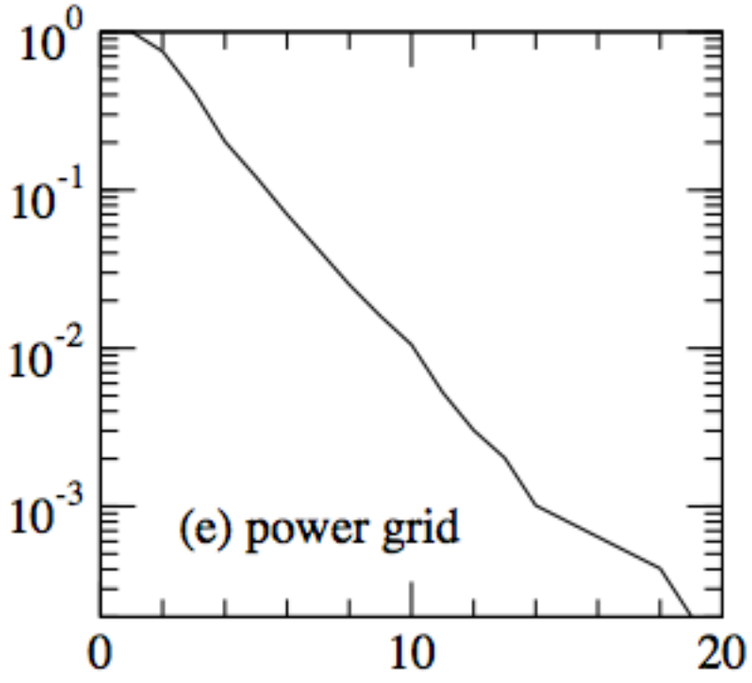
100
1000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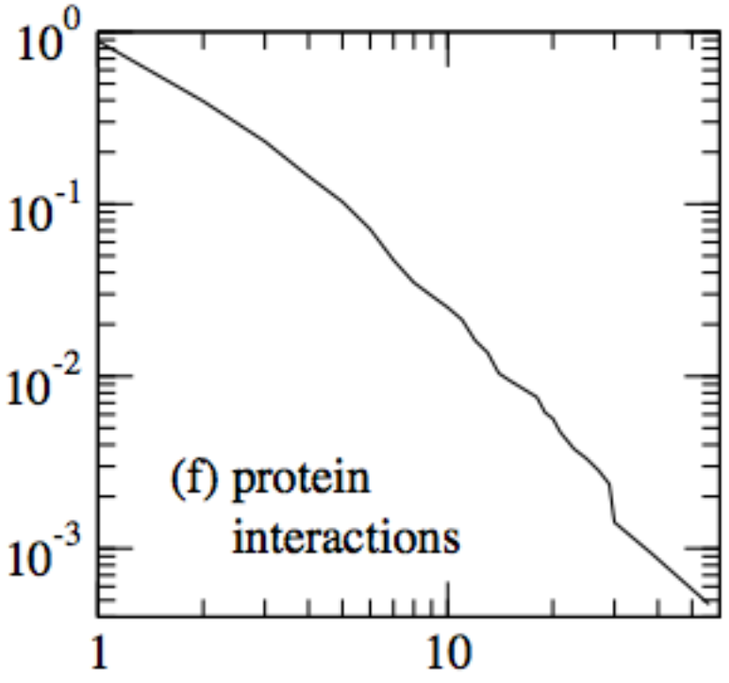
10^{-2}
10^{-3}
(e) power grid
0
10
20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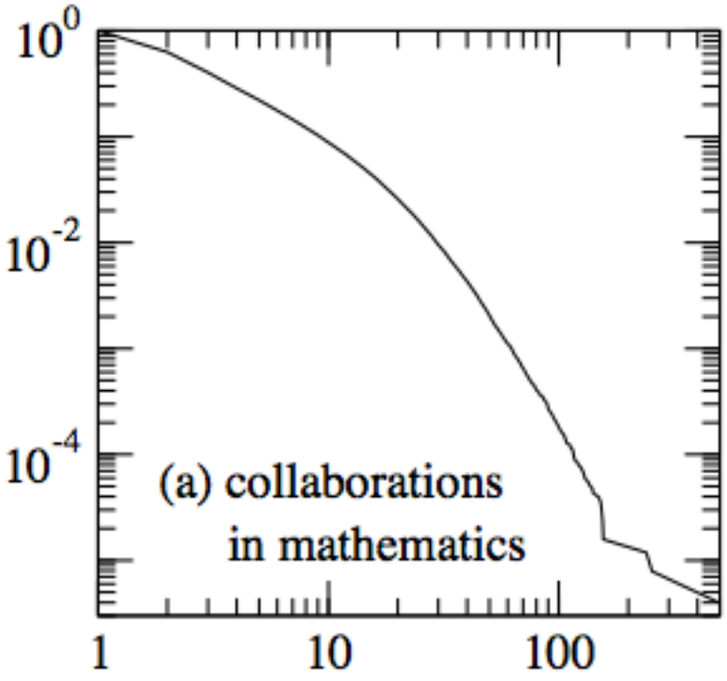
10^{-2}
10^{-3}
(f) protein
interactions
1
10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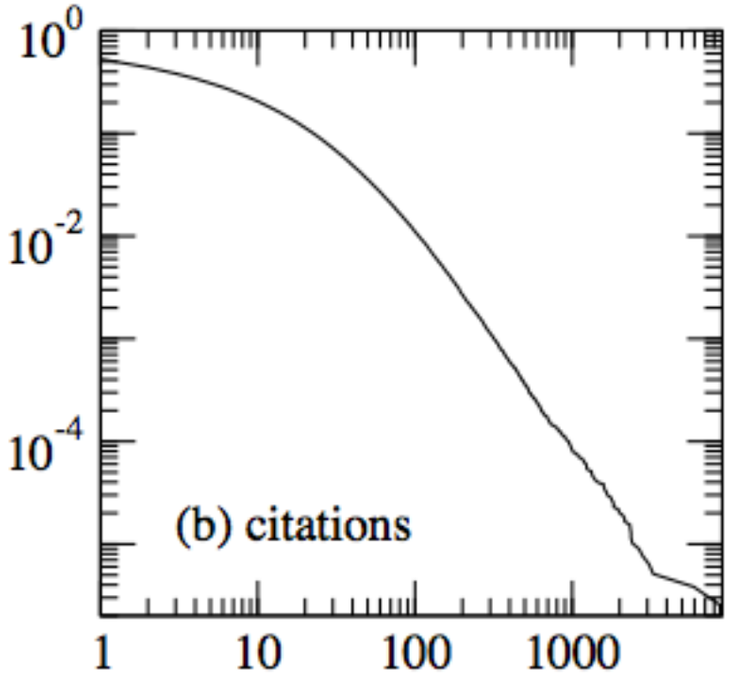
10^{-4}
(a) collaborations
in mathematics
1
10
100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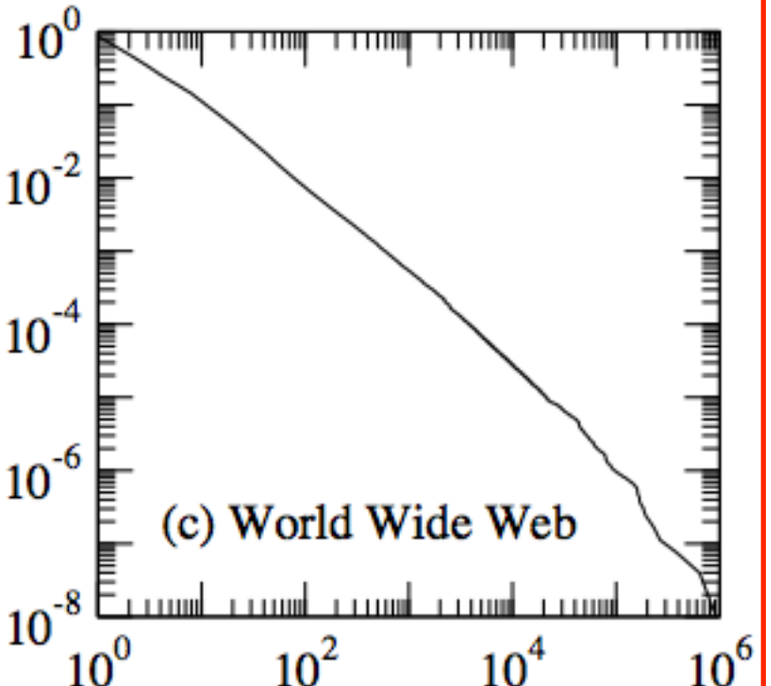
10^{-2}
10^{-4}
(b) citations
1
10
100
1000


10^0
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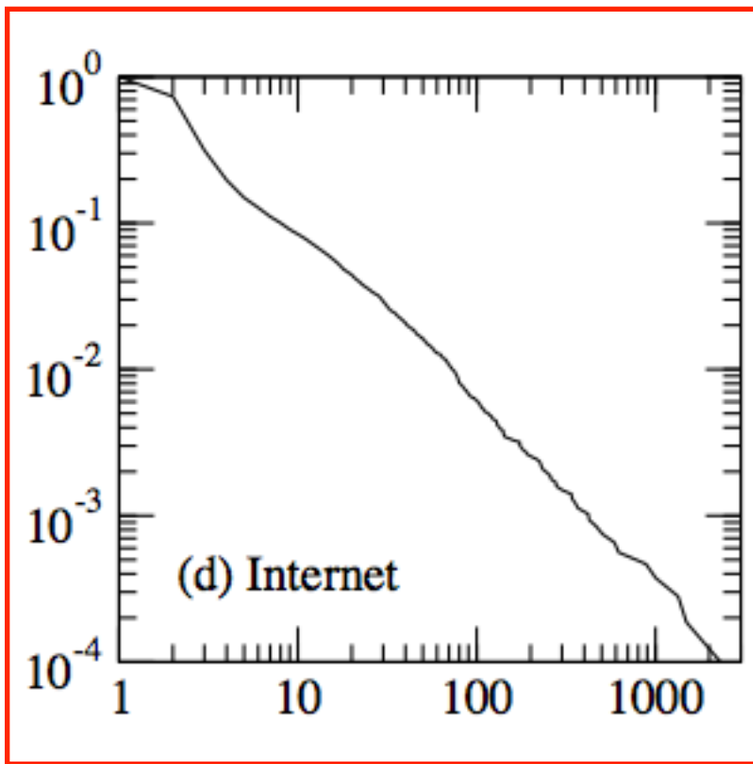
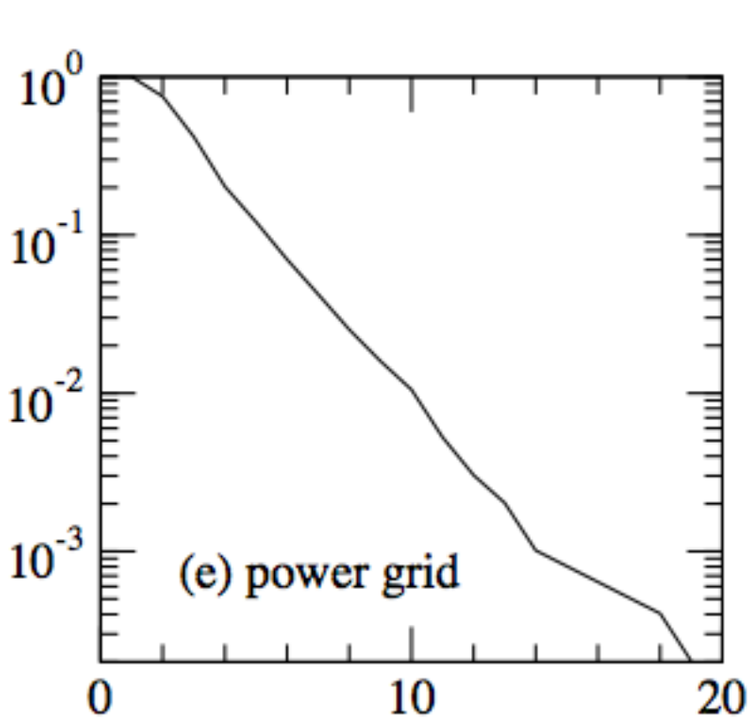
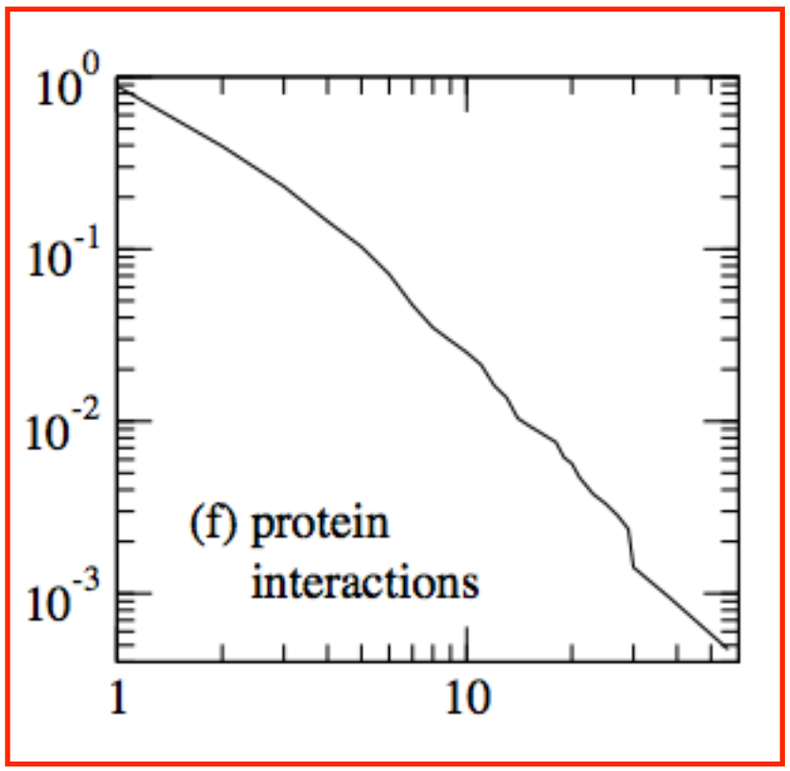
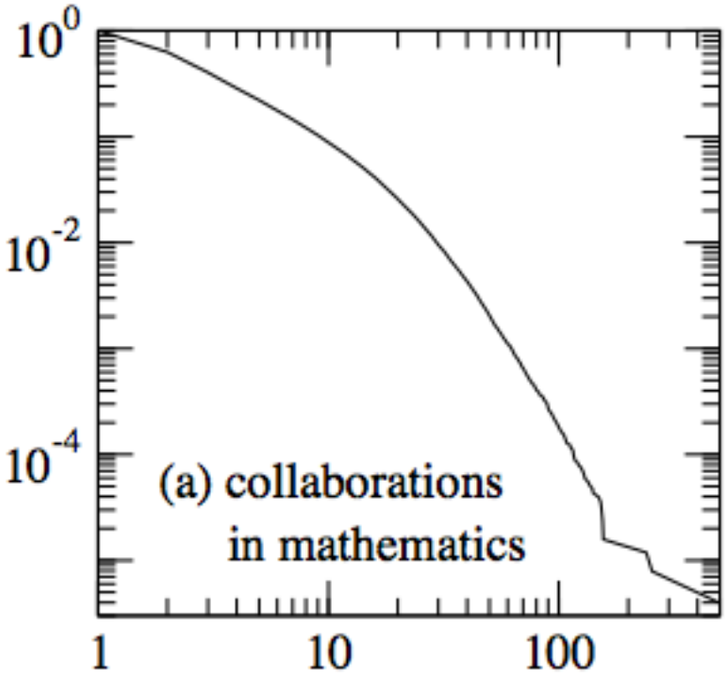
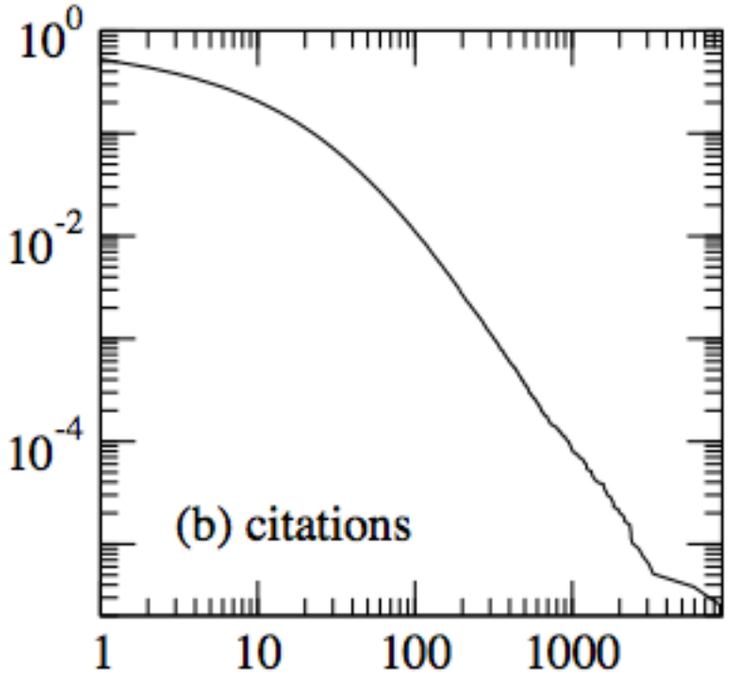
10^{-4}
10^{-6}
10^{-8}
(c) World Wide Web
10^0
10^2
10^4
10^6

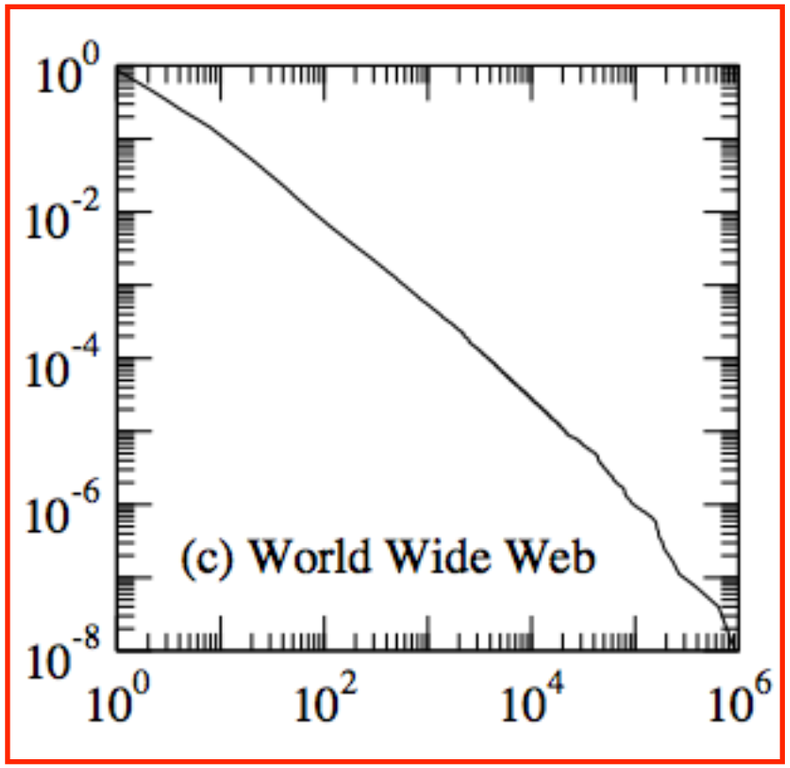

10^0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
(d) Internet
1
10
100
1000

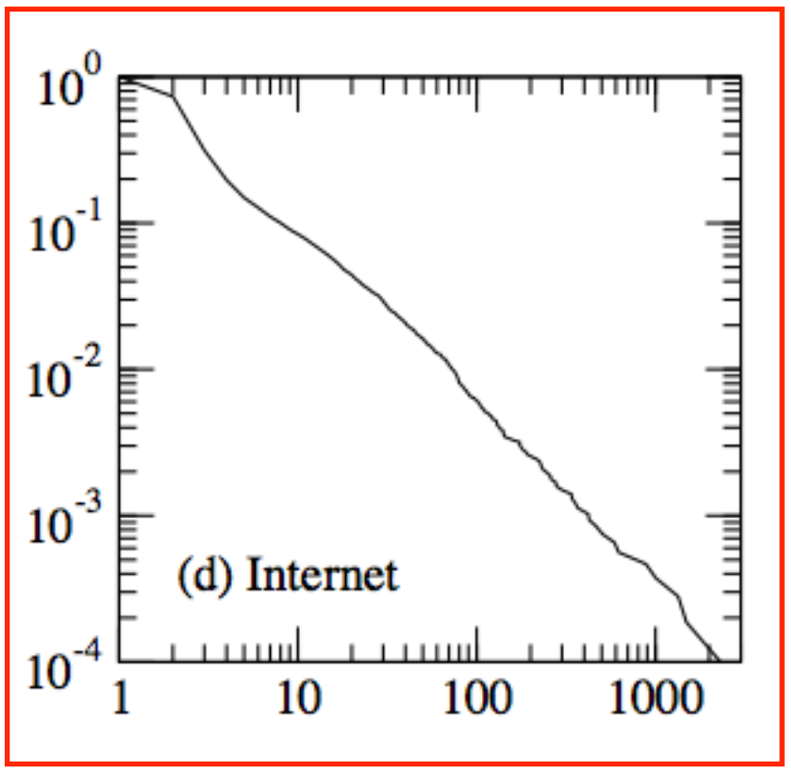

10^0
10^{-1}
10^{-2}
10^{-3}
(e) power grid
0
10
20

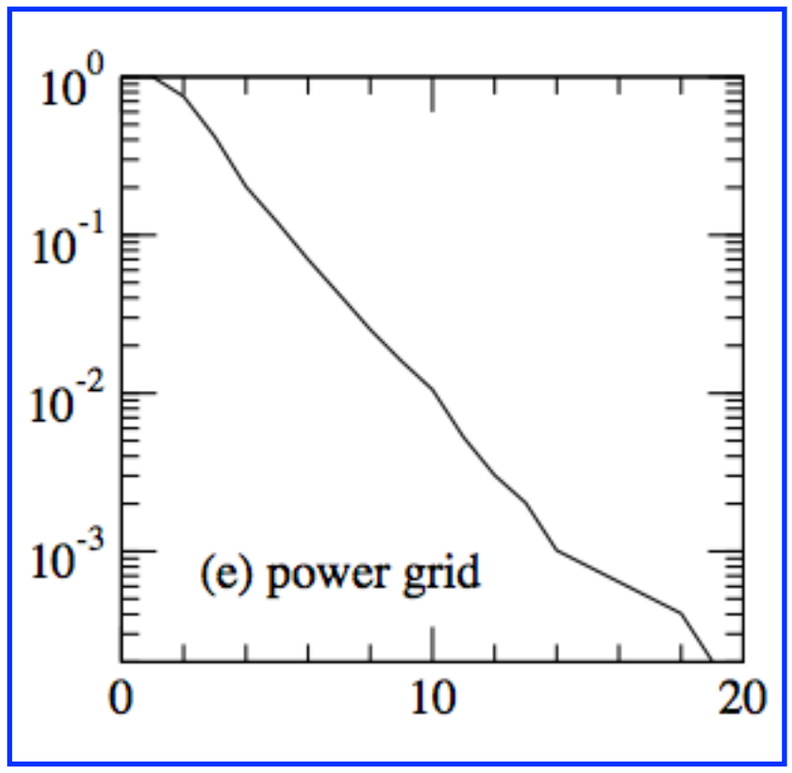

10^0
10^{-1}
10^{-2}
10^{-3}
(f) protein
interactions
1
10

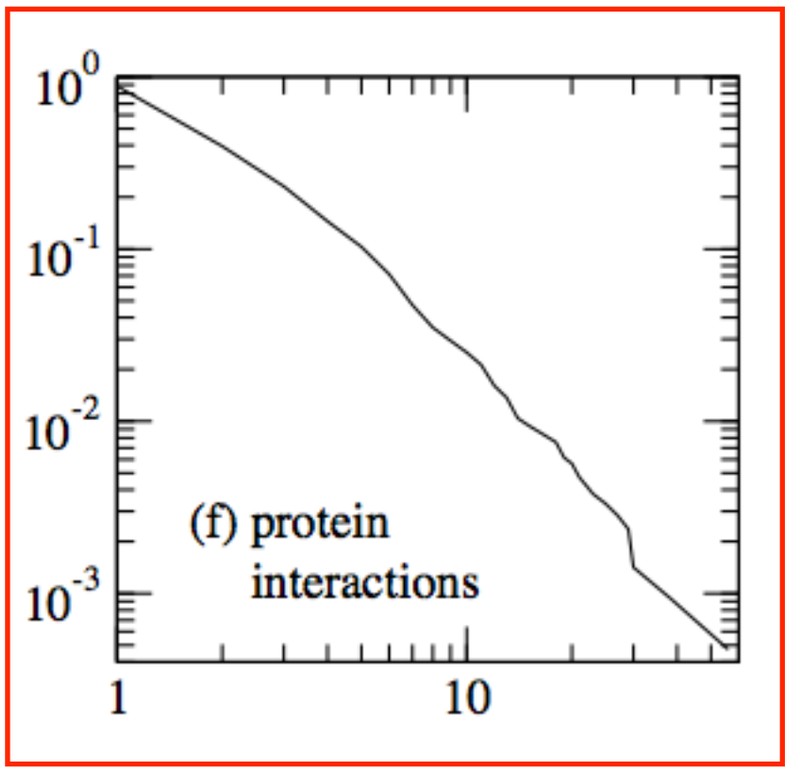

10^0
10^{-2}
10^{-4}
(a) collaborations
in mathematics
1
10
100


10^0
10^{-2}
10^{-4}
(b) citations
1
10
100
1000


10^0
10^{-2}
10^{-4}
10^{-6}
10^{-8}
(c) World Wide Web
10^0
10^2
10^4
10^6


10^0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
(d) Internet
1
10
100
1000


10^0
10^{-1}
10^{-2}
10^{-3}
(e) power grid
0
10
20


10^0
10^{-1}
10^{-2}
10^{-3}
(f) protein
interactions
1
10

network	type	n	m	z	ℓ	α	$C^{(1)}$	$C^{(2)}$	r
film actors	undirected	449 913	25 516 482	113.43	3.48	2.3	0.20	0.78	0.208
company directors	undirected	7 673	55 392	14.44	4.60	–	0.59	0.88	0.276
math coauthorship	undirected	253 339	496 489	3.92	7.57	–	0.15	0.34	0.120
physics coauthorship	undirected	52 909	245 300	9.27	6.19	–	0.45	0.56	0.363
biology coauthorship	undirected	1 520 251	11 803 064	15.53	4.92	–	0.088	0.60	0.127
telephone call graph	undirected	47 000 000	80 000 000	3.16		2.1			
email messages	directed	59 912	86 300	1.44	4.95	1.5/2.0		0.16	
email address books	directed	16 881	57 029	3.38	5.22	–	0.17	0.13	0.092
student relationships	undirected	573	477	1.66	16.01	–	0.005	0.001	−0.029
sexual contacts	undirected	2 810				3.2			
WWW `nd.edu`	directed	269 504	1 497 135	5.55	11.27	2.1/2.4	0.11	0.29	−0.067
WWW Altavista	directed	203 549 046	2 130 000 000	10.46	16.18	2.1/2.7			
citation network	directed	783 339	6 716 198	8.57		3.0/–			
Roget's Thesaurus	directed	1 022	5 103	4.99	4.87	–	0.13	0.15	0.157
word co-occurrence	undirected	460 902	17 000 000	70.13		2.7		0.44	
Internet	undirected	10 697	31 992	5.98	3.31	2.5	0.035	0.39	−0.189
power grid	undirected	4 941	6 594	2.67	18.99	–	0.10	0.080	−0.003
train routes	undirected	587	19 603	66.79	2.16	–		0.69	−0.033
software packages	directed	1 439	1 723	1.20	2.42	1.6/1.4	0.070	0.082	−0.016
software classes	directed	1 377	2 213	1.61	1.51	–	0.033	0.012	−0.119
electronic circuits	undirected	24 097	53 248	4.34	11.05	3.0	0.010	0.030	−0.154
peer-to-peer network	undirected	880	1 296	1.47	4.28	2.1	0.012	0.011	−0.366
metabolic network	undirected	765	3 686	9.64	2.56	2.2	0.090	0.67	−0.240
protein interactions	undirected	2 115	2 240	2.12	6.80	2.4	0.072	0.071	−0.156
marine food web	directed	135	598	4.43	2.05	–	0.16	0.23	−0.263
freshwater food web	directed	92	997	10.84	1.90	–	0.20	0.087	−0.326
neural network	directed	307	2 359	7.68	3.97	–	0.18	0.28	−0.226

Next class

- small-world effect
- transitivity or clustering
- network resilience
- mixing patterns
- degree correlation
- community structure
- network navigation

Later...

- revisit random graphs
- small-world model