

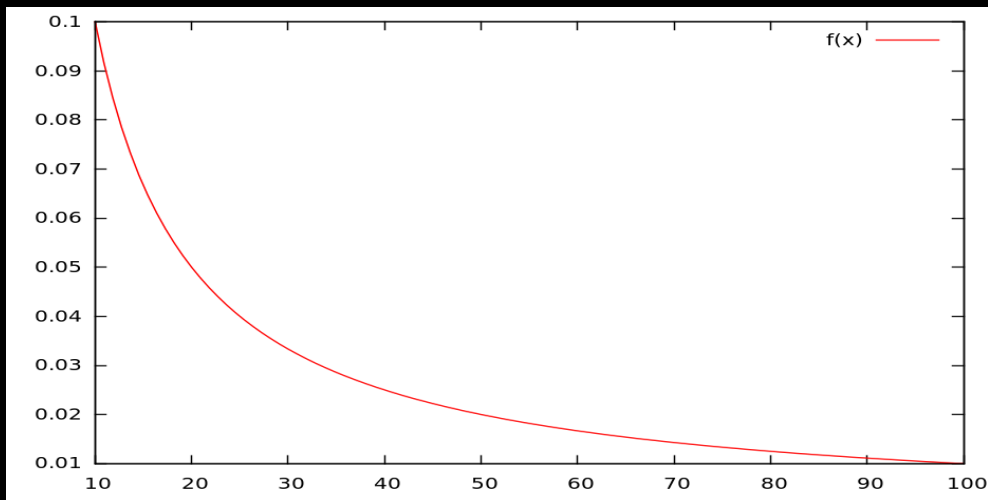
Leis de Potência

Prof. Fabiano Ribeiro

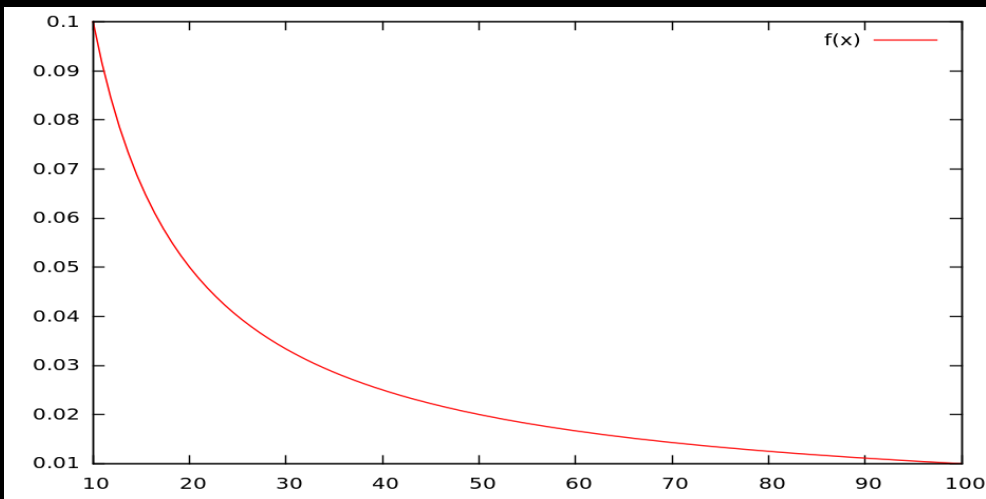
DEX- UFLA

Lei de Potência:

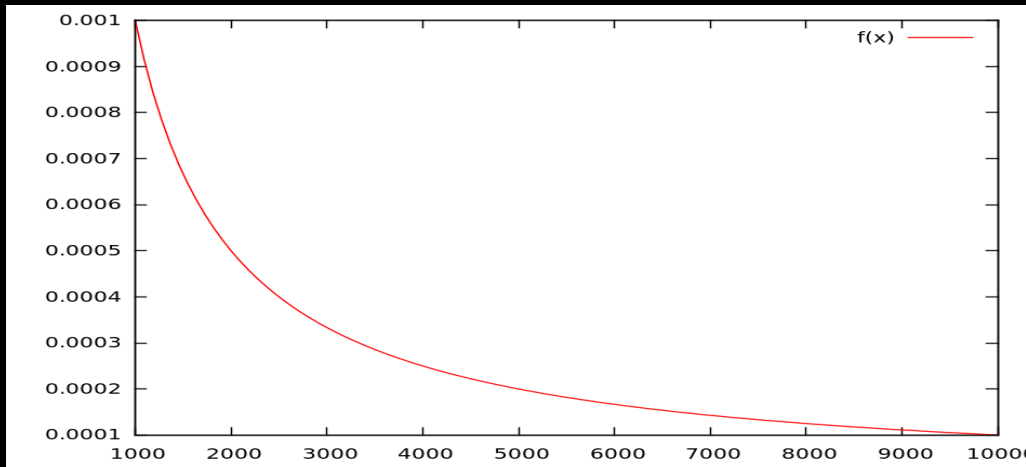
$$y(x) = a x^{\beta}$$

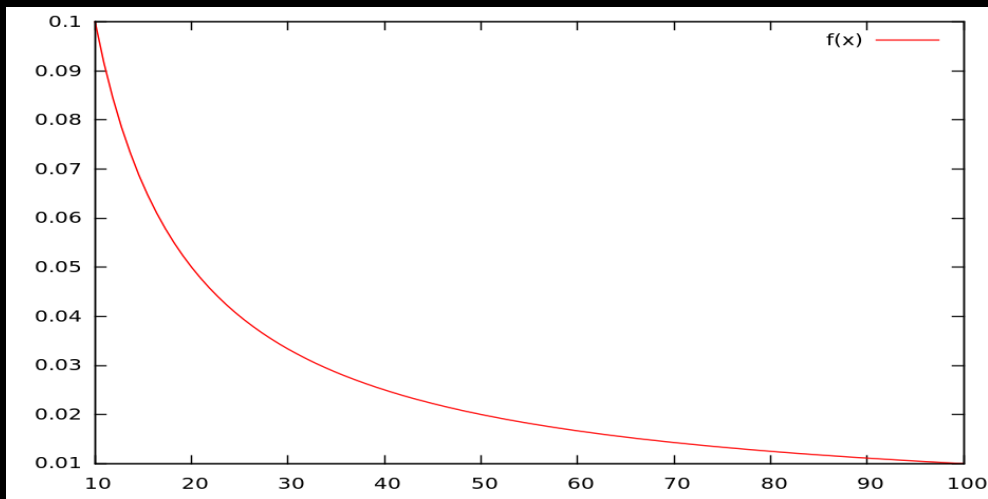


$$y(x) = x^{-1}$$

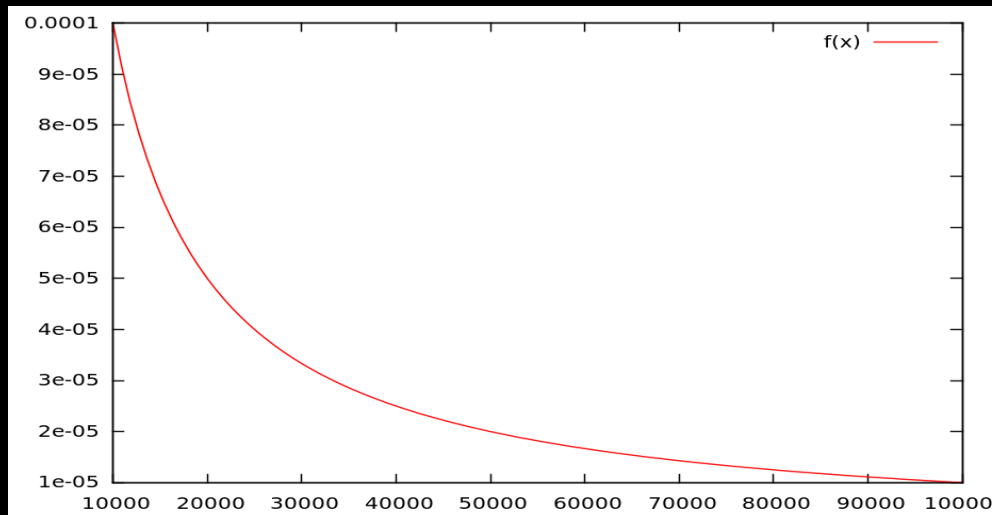
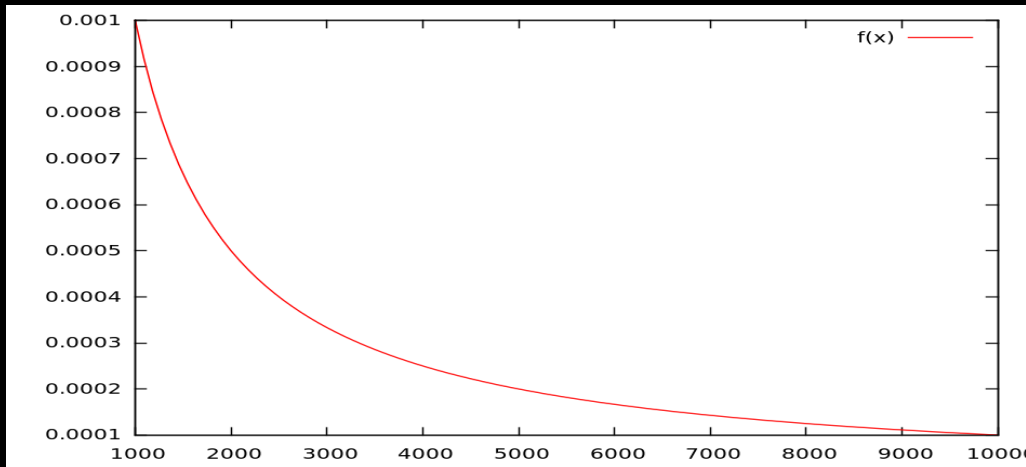


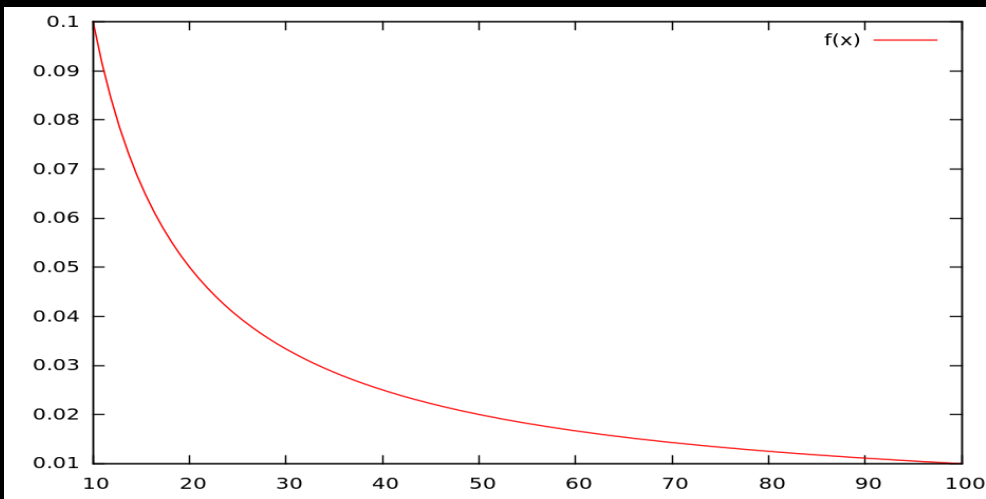
$$y(x) = x^{-1}$$



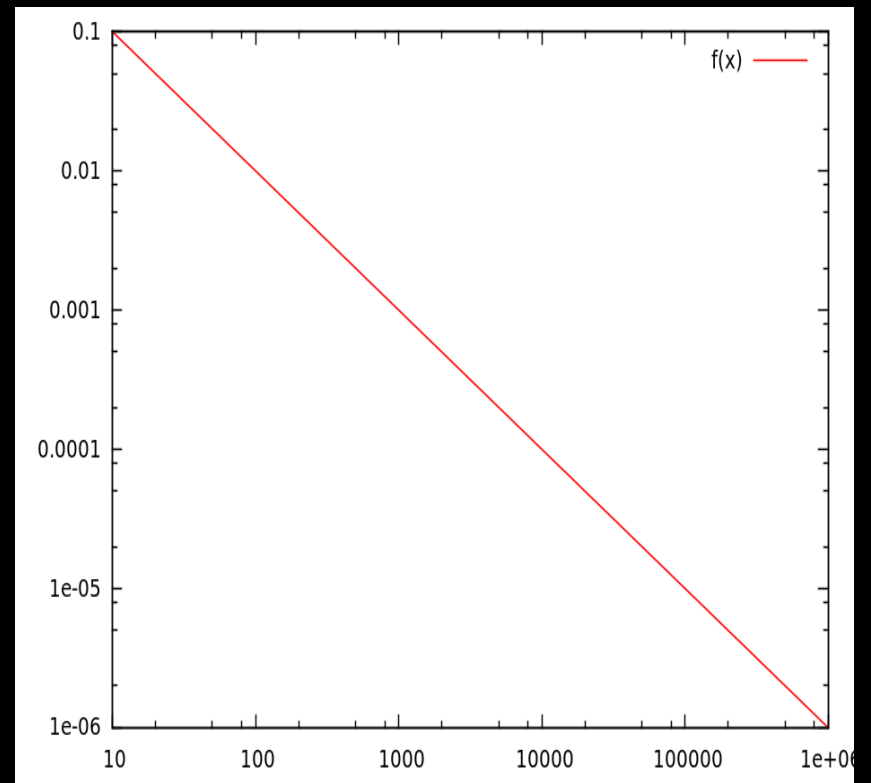
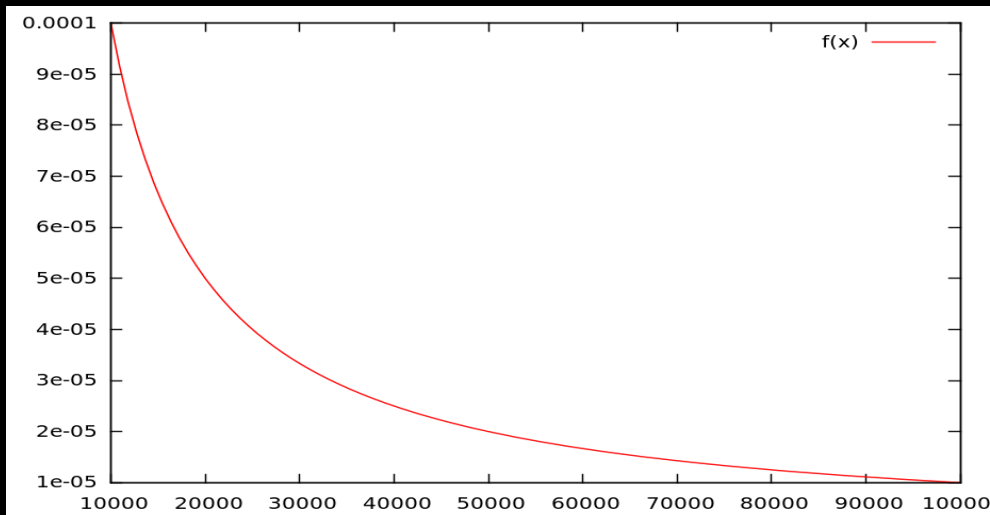
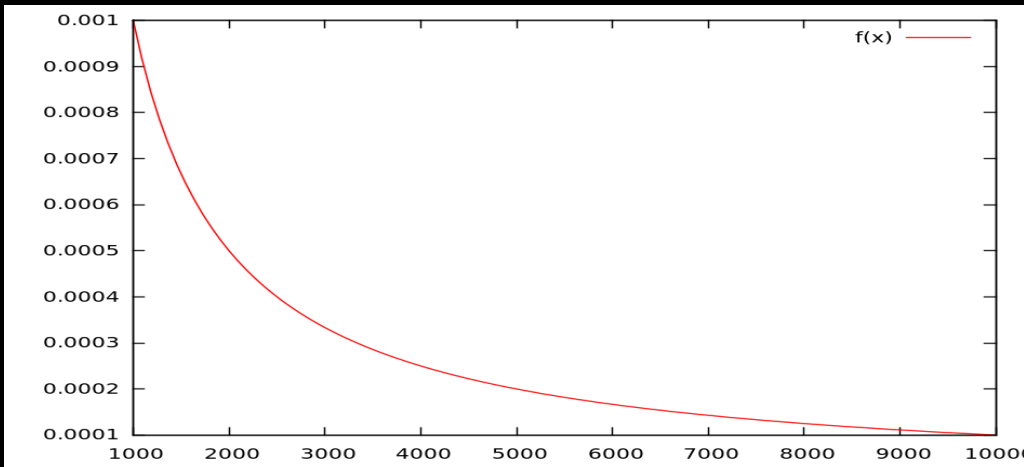


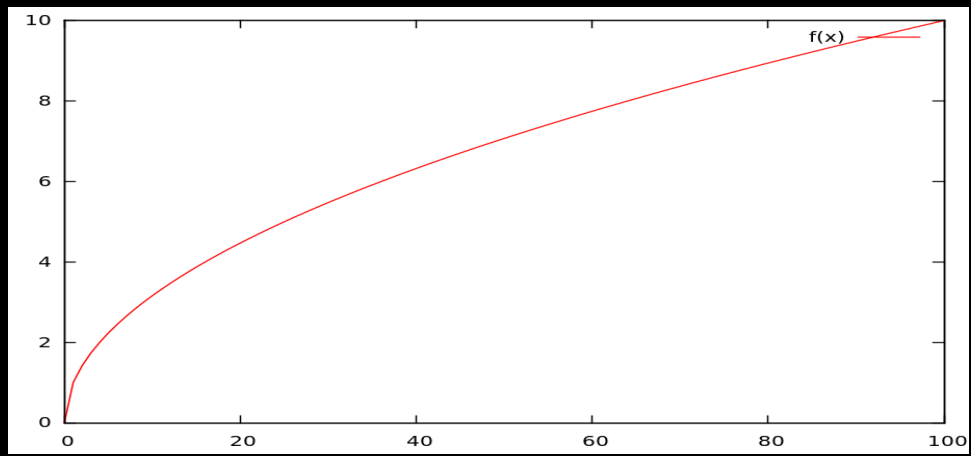
$$y(x) = x^{-1}$$



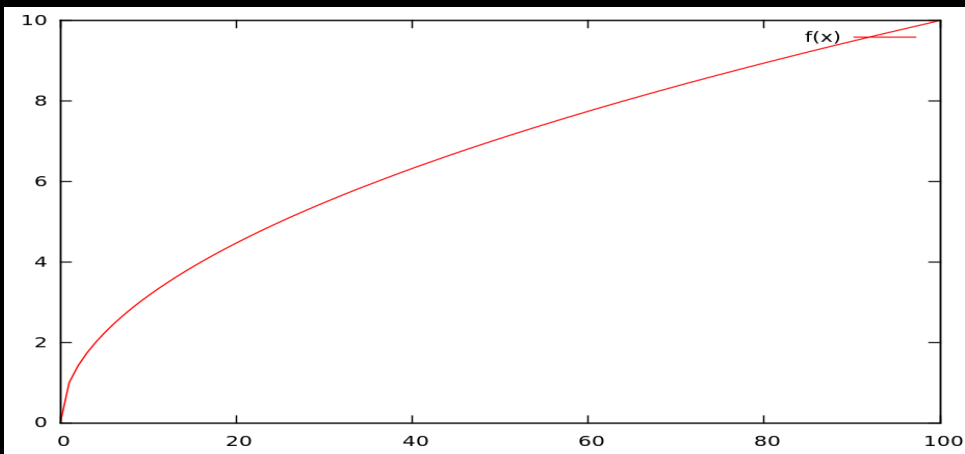


$$y(x) = x^{-1}$$

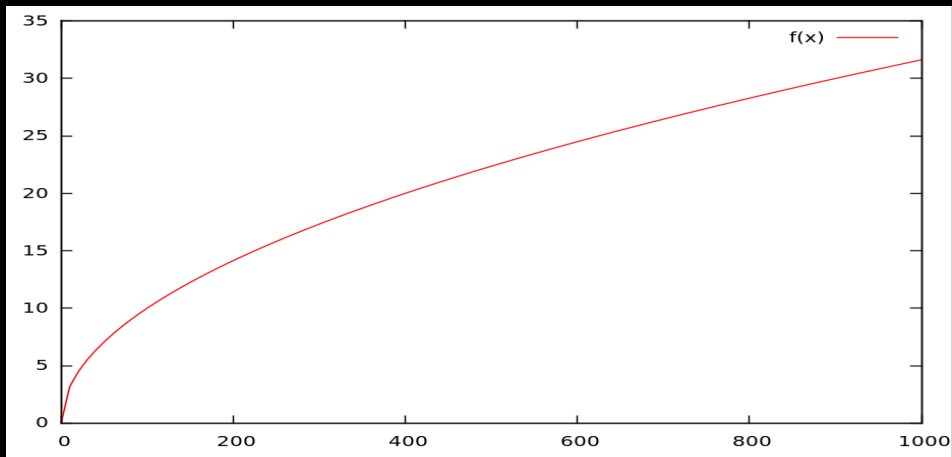


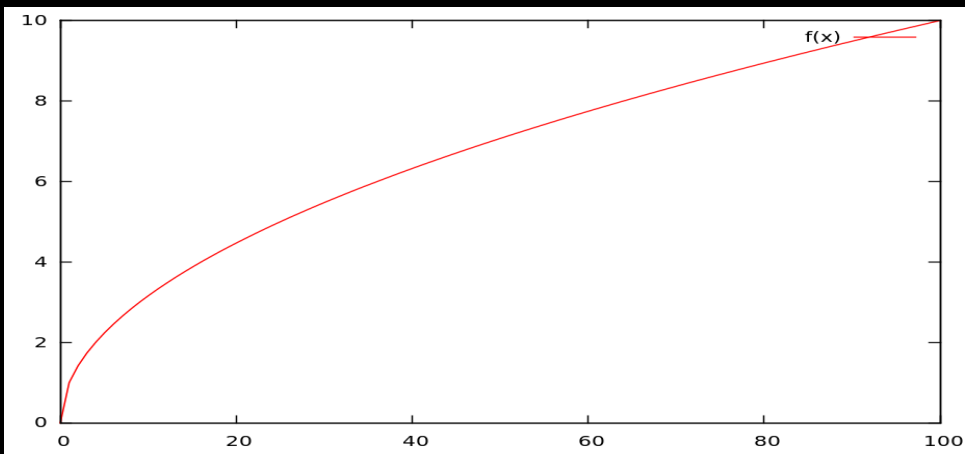


$$y(x) = x^{1/2}$$

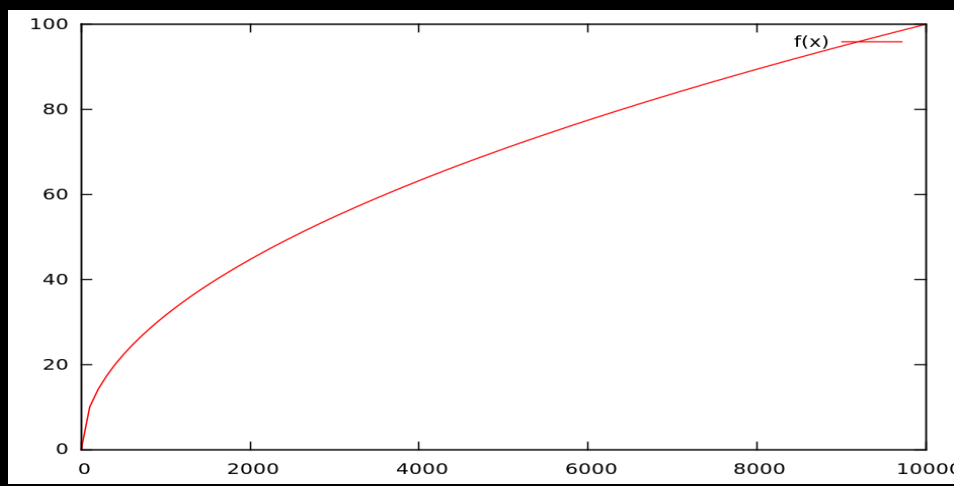
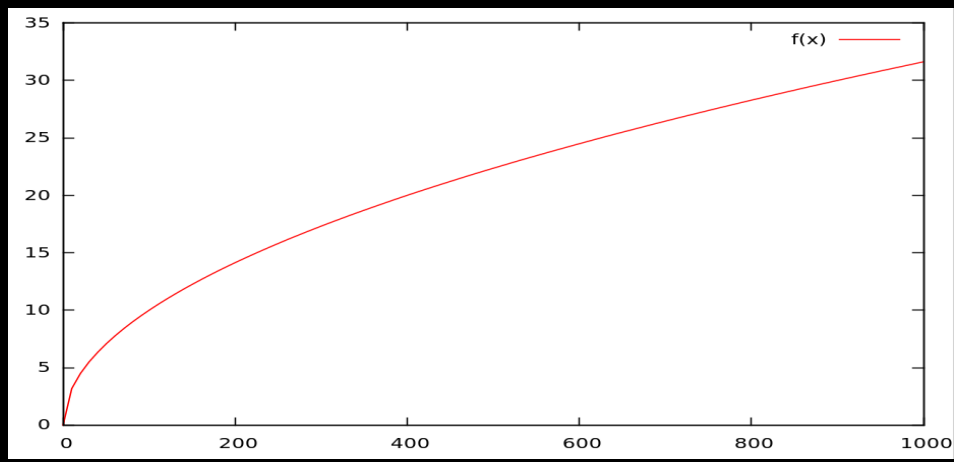


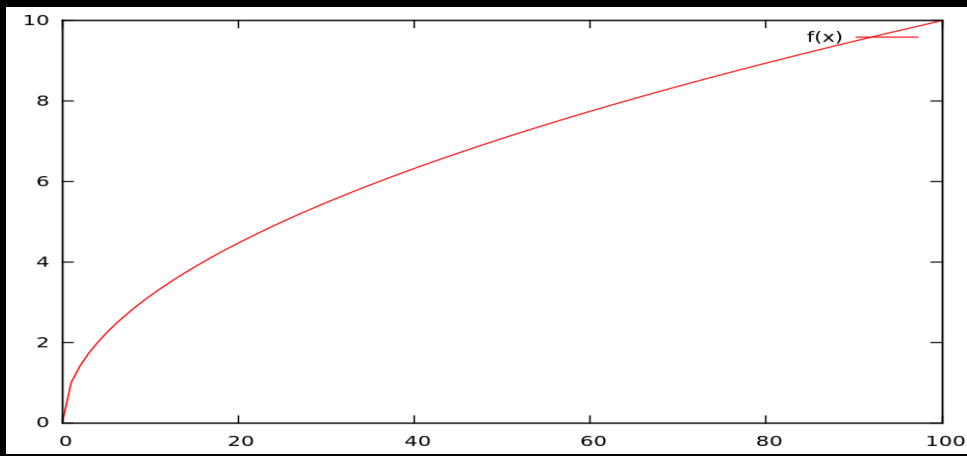
$$y(x) = x^{1/2}$$



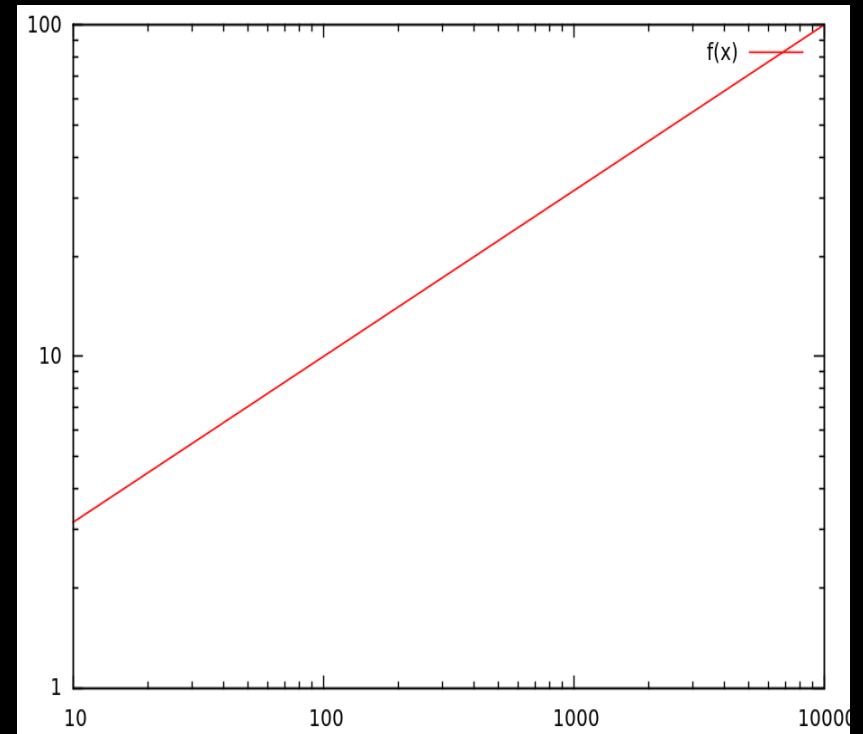
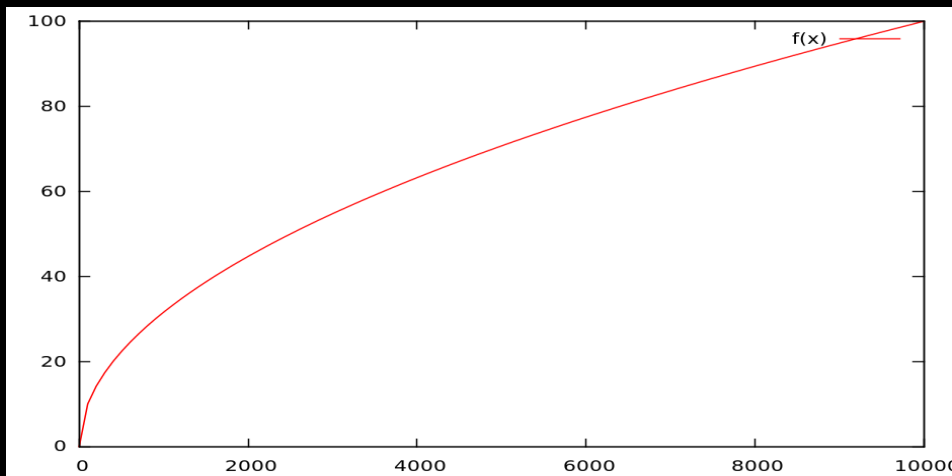
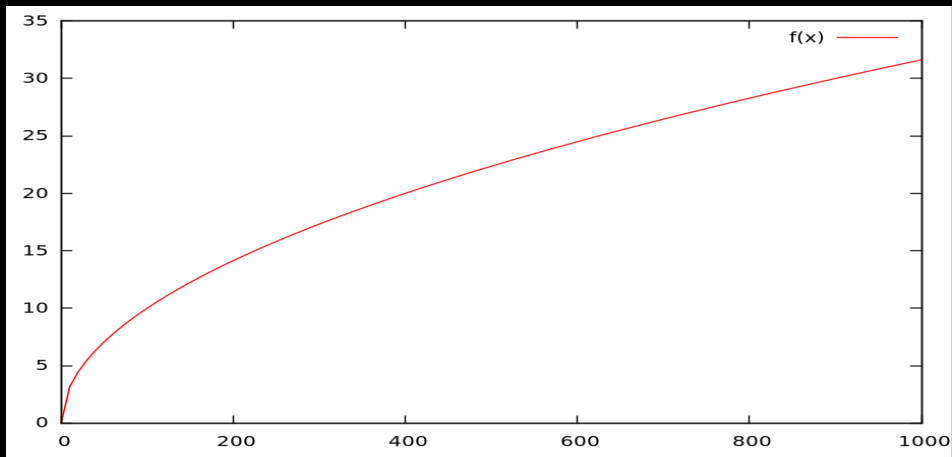


$$y(x) = x^{1/2}$$





$$y(x) = x^{1/2}$$

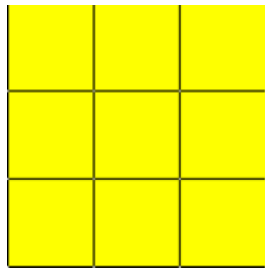
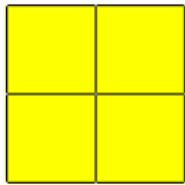


Lei de Potência:

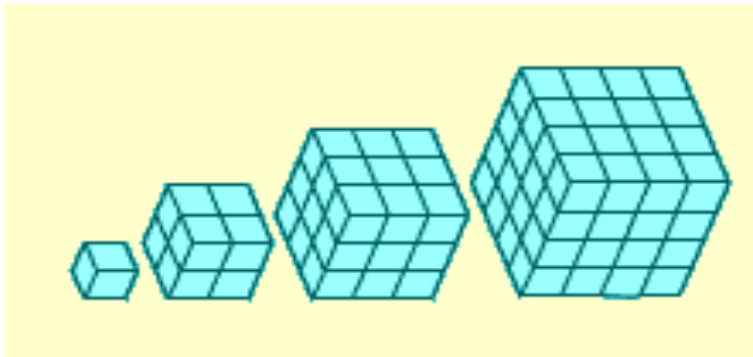
$$y(x) = a x^{\beta}$$

Conceito de Dimensão d

$$N = L^1$$



$$N = L^2$$



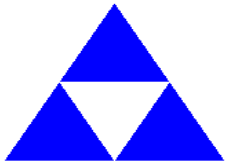
$$N = L^3$$

$$N = L^d \quad \text{ou} \quad d = \log(N)/\log(L)$$

Triangulo de Sierpinski



$L=1, N=1$



$L=2, N=3$

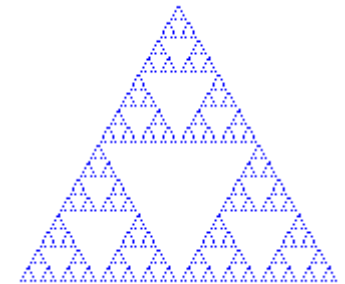


$L=4, N=9$



$$D_f = \log(N)/\log(L)$$

$$D_f = 1,585\dots$$



For example, James Joyce's novel *Ulysses* contains 260,430 words. If words such as *give*, *gives*, *gave*, *given*, *giving*, *giver*, and *gift* are considered to be different, there are, in *Ulysses*, 29,899 different words. Zipf data, taken from *Human Behavior and the Principle of Least Effort*, p. 24, are reproduced in the table below.

r	f	r	f	r	f
10	2653	200	133	3000	8
20	1311	300	84	4000	6
30	926	400	62	5000	5
40	717	500	50	10,000	2
50	556	1000	20	20,000	1
100	265	2000	12	29,899	1

A log-log plot of the word frequency f as a function of the word rank r is shown in Figure 8.2 with a straight line representing the least-squares fit. The slope of this line is equal to 1.02.

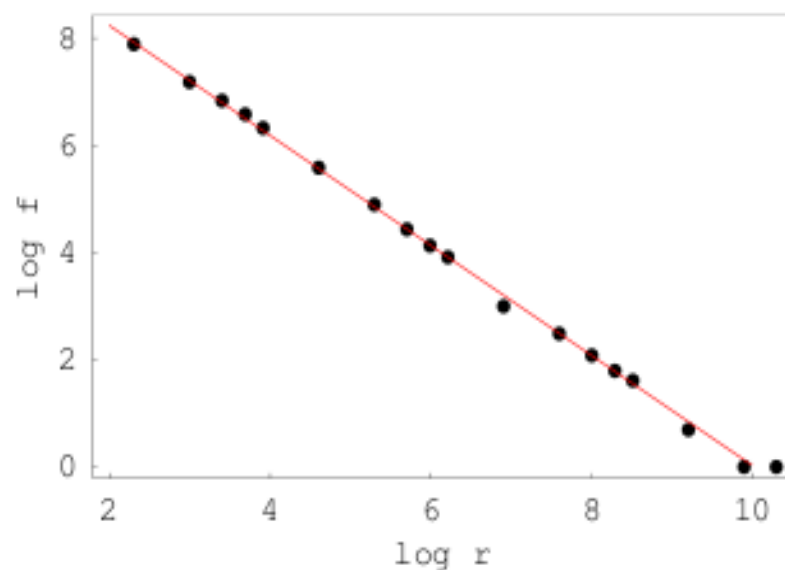
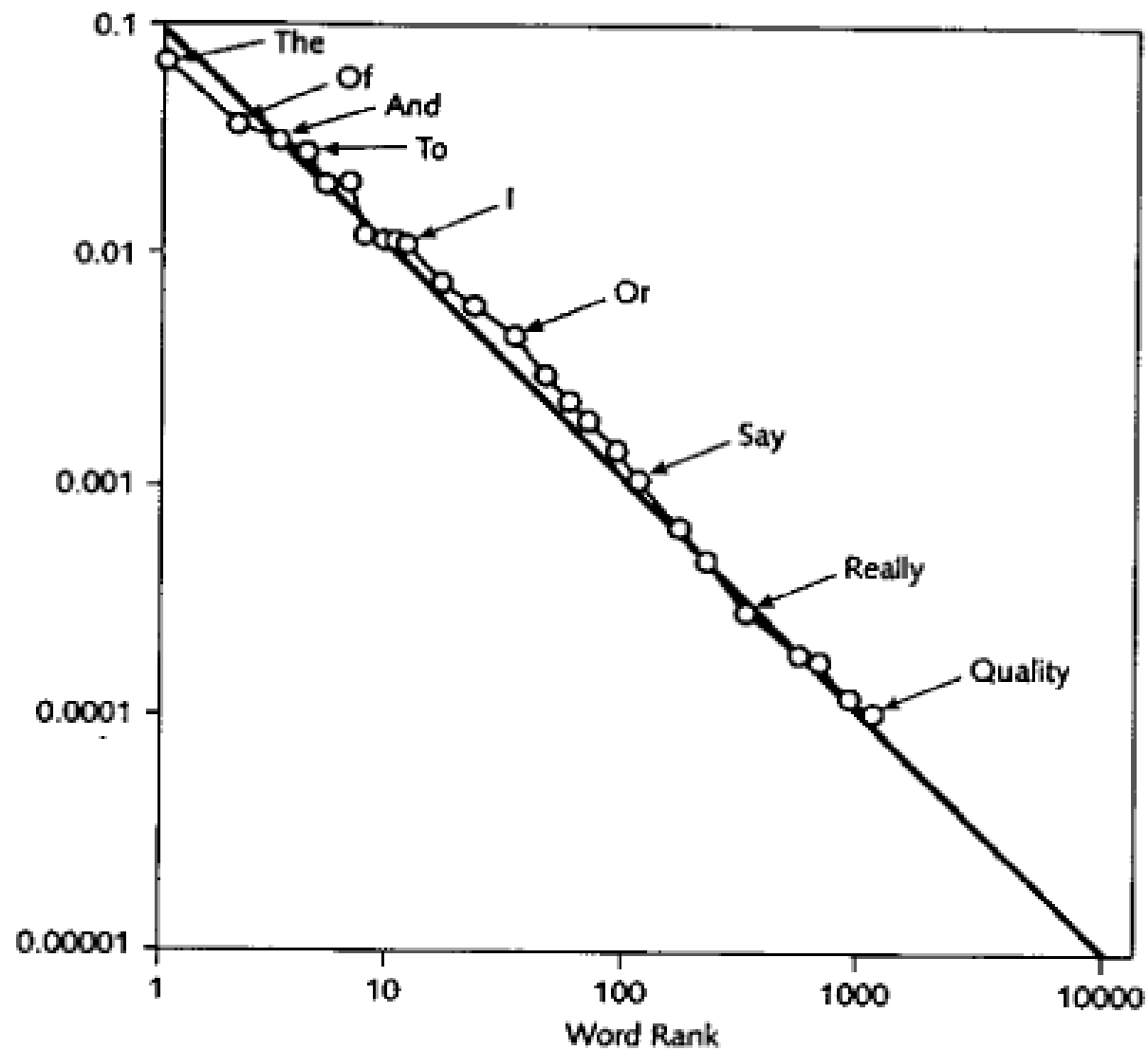
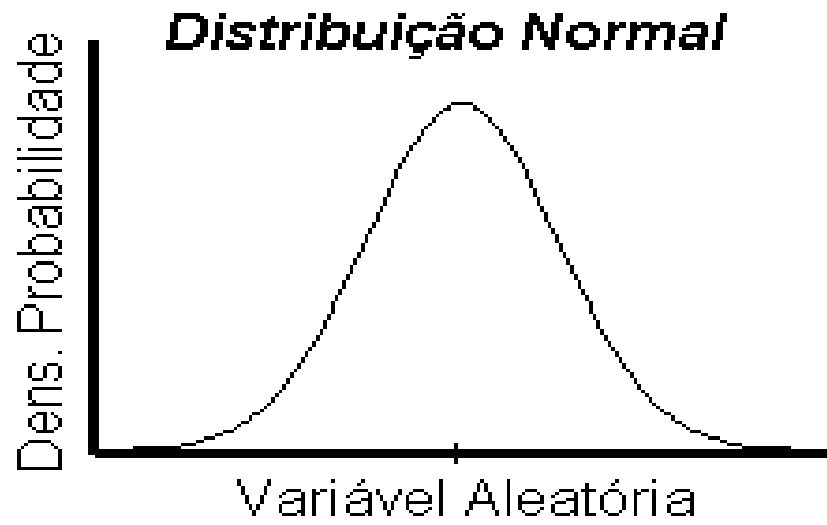


Fig. 8.2. Log-log plot of word frequency f as a function of word rank r (dots) and the least-squares fit (straight line). Zipf data taken from *Human Behavior and the Principle of Least Effort* are reproduced in the table above.

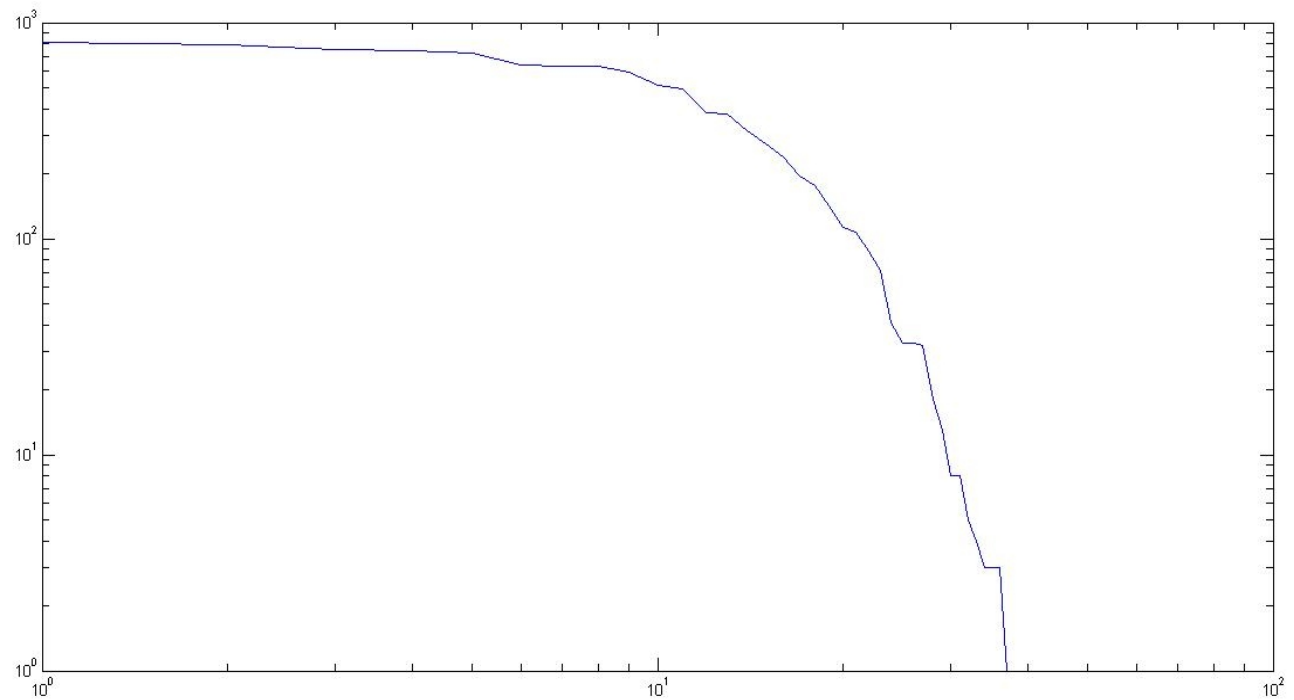


Zipf's Law for the English language.

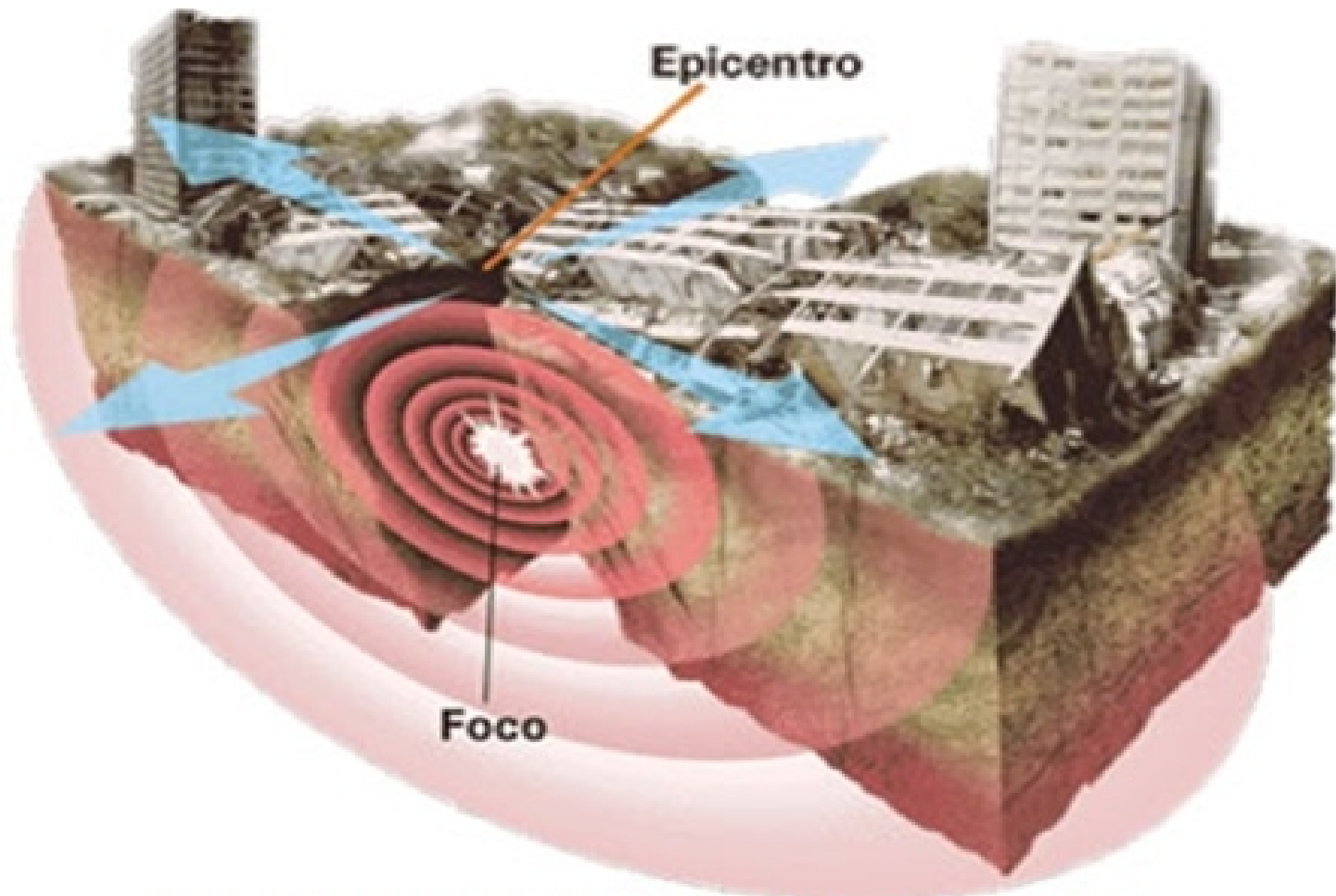
Figure 8. Continued (b) Ranking of words in the English language. The curve shows how many words appear with more than a given frequency.



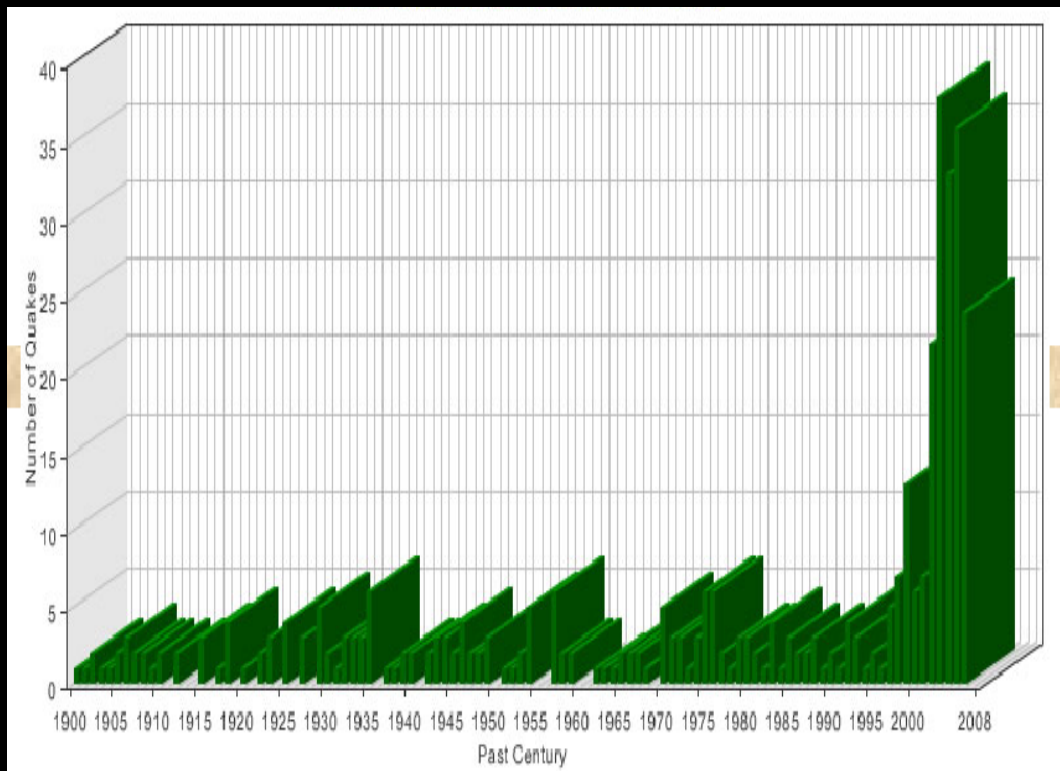
Frequencia



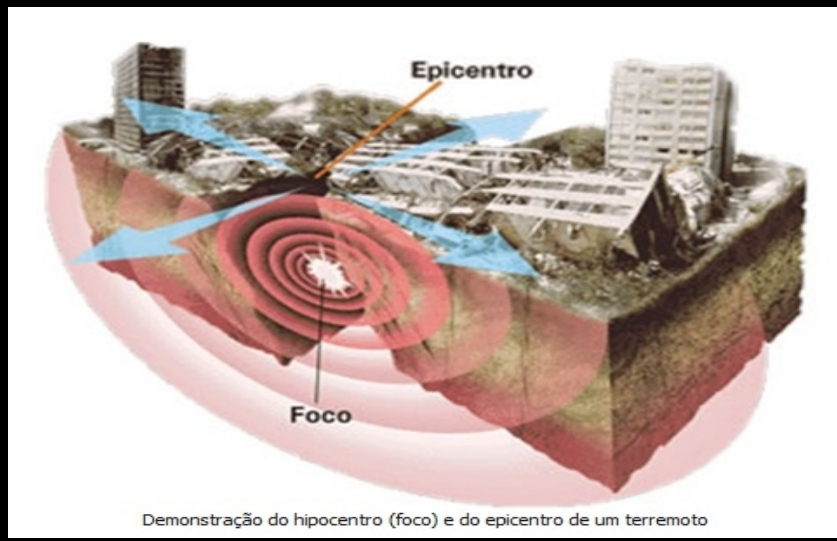
Ranqueamento



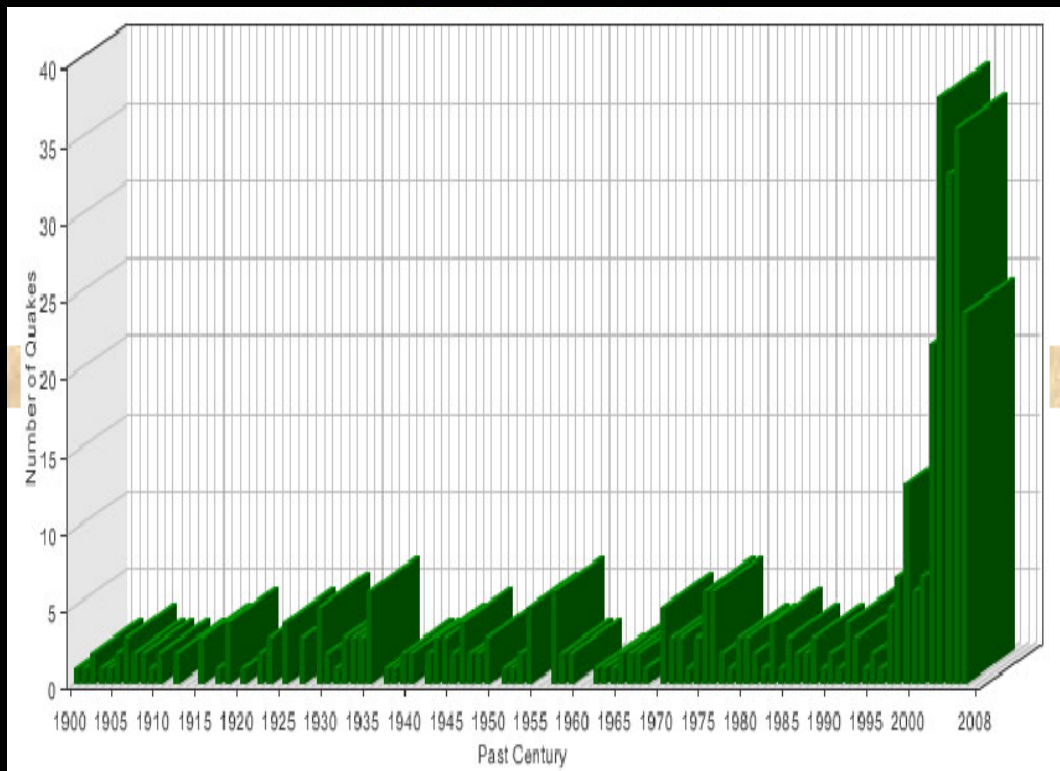
Demonstração do hipocentro (foco) e do epicentro de um terremoto



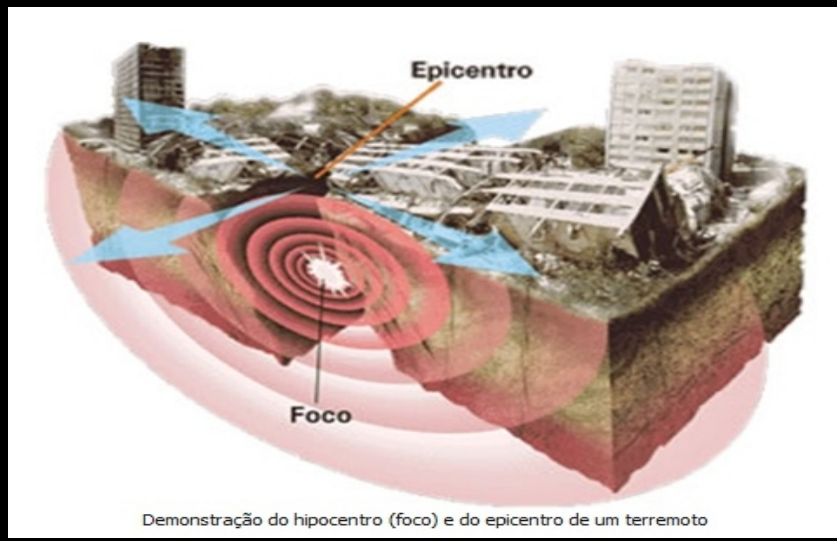
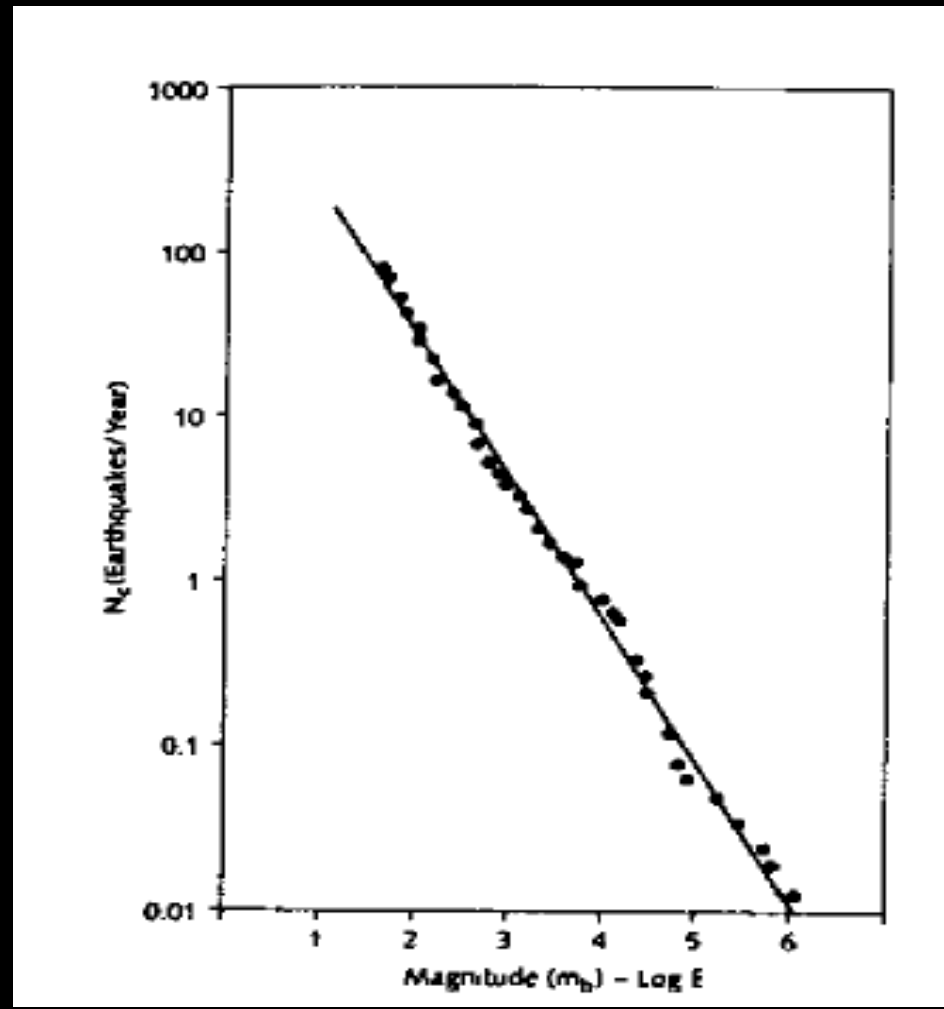
Incidência de terremotos de 1900 a 2008



Demonstração do hipocentro (foco) e do epicentro de um terremoto



Incidência de terremotos de 1900 a 2008



Demonstração do hipocentro (foco) e do epicentro de um terremoto

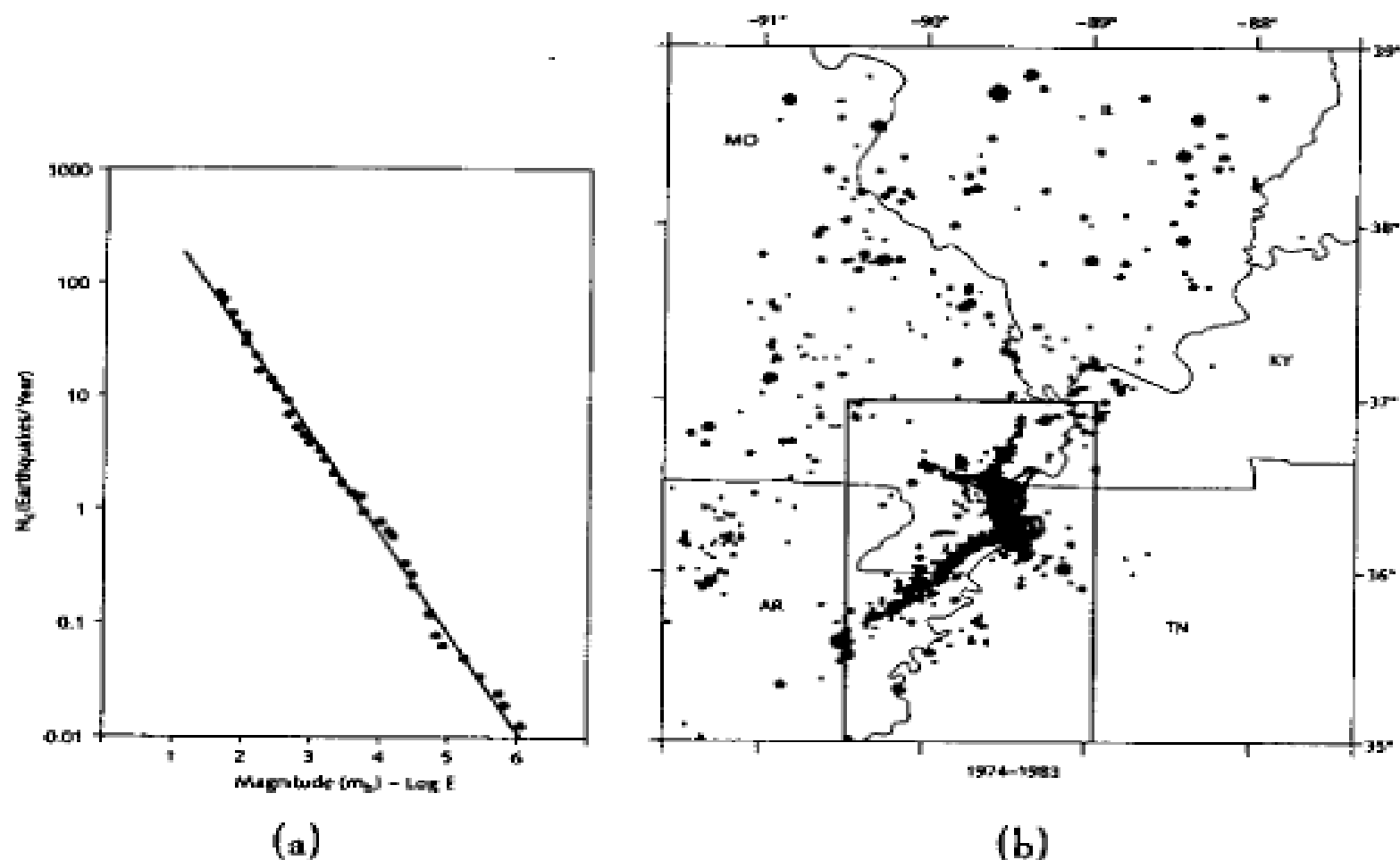


Figure 2. (a) Distribution of earthquake magnitudes in the New Madrid zone in the southeastern United States during the period 1974–1983, collected by Arch Johnston and Susan Nava of Memphis State University. The points show the number of earthquakes with magnitude larger than a given magnitude m . The straight line indicates a power law distribution of earthquakes. This simple law is known as the Gutenberg–Richter law. (b) Locations of the earthquakes used in the plot. The size of the dots represent the magnitudes of the earthquakes.

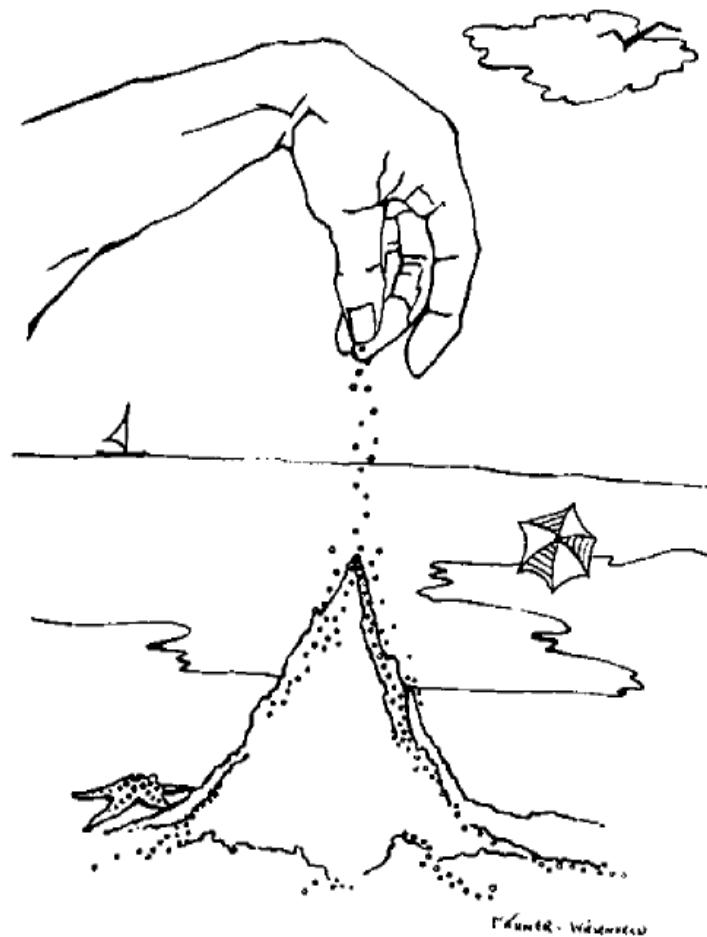


Figure 1. Sandpile. (Drawing by Ms. Elaine Wiesenfeld.)

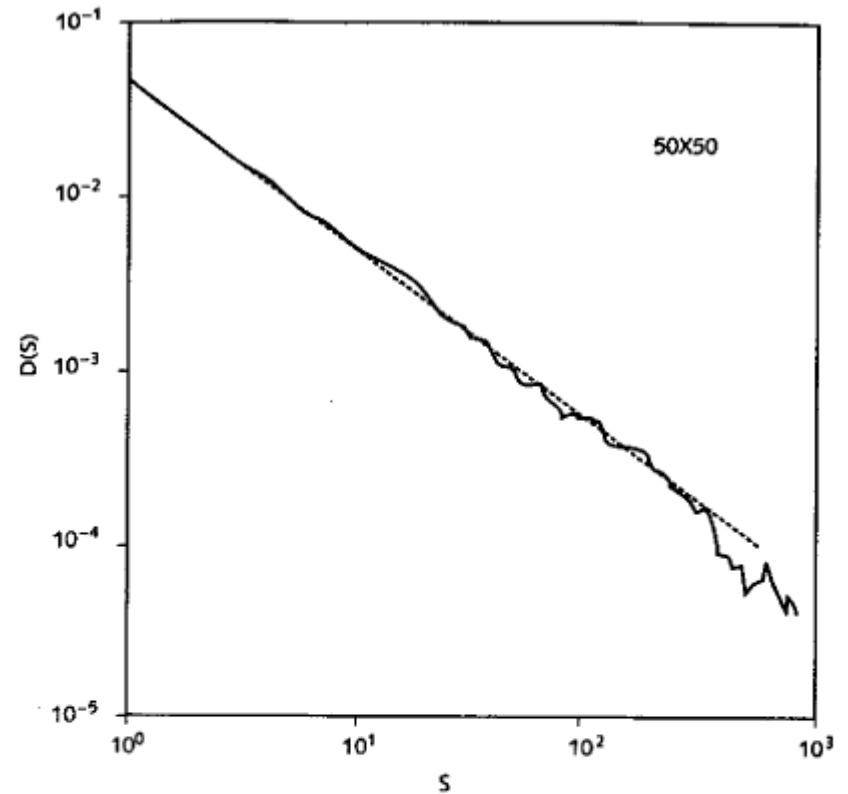
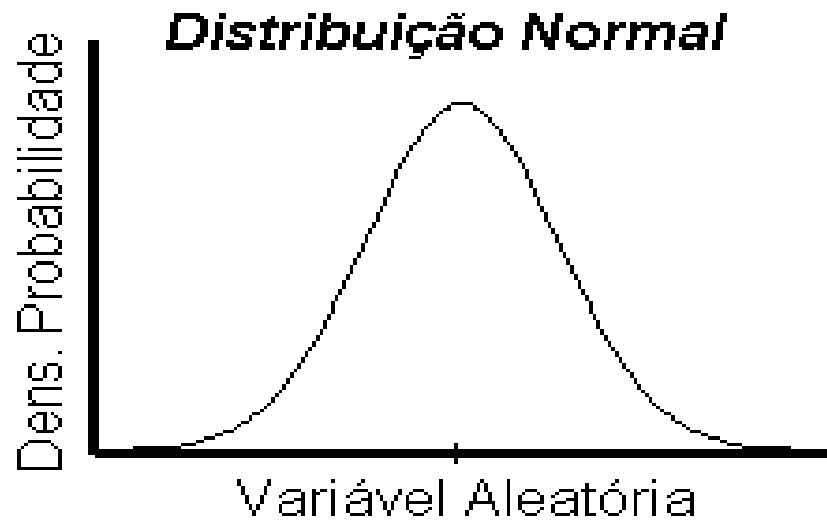


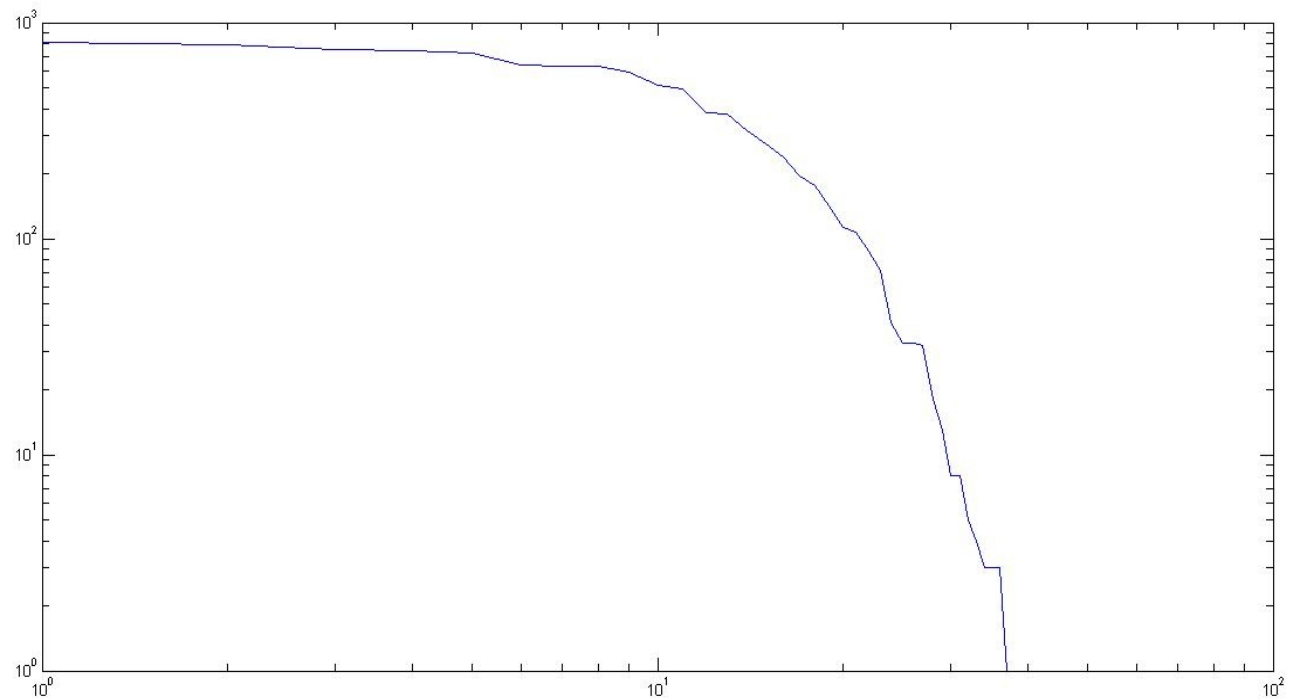
Figure 11. Size distribution of avalanches in systems of coupled pendulums or, equivalently, in the sandpile model. The figure shows how many avalanches there are of each size, on a logarithmic plot. The distribution is a power law with exponent 1.1. This is our very first plot. By performing longer simulations on bigger system one can extend the range of the power law.

Our data fall approximately on a straight line, which indicates that the number of avalanches of size s is given by the simple power law

$$N(s) = s^{-\tau}$$



Frequencia

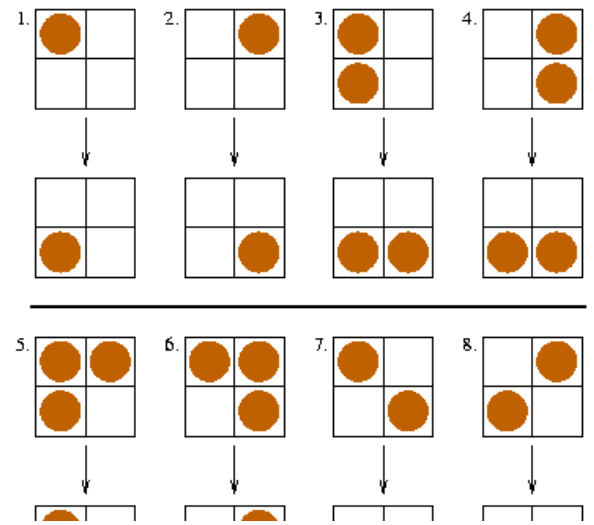


Ranqueamento

Cellular Automata Sand Pile Model*

This cellular automata models a granular material in a gravitational field. There are two kinds of cells. Immovable ground cells and movable sand grains. Grains fall from a source at the top of the window and proceed down to the ground. Grains pile up and redistribute themselves according to the cellular automata rules. Application of the rule is a little more sophisticated than the Game of Life or Forest Fire rules.

Here, at each iteration, the cell space is twice partitioned into 2x2 blocks. The first partition finds the 2x2 blocks centered at sites with even coordinates. The second partition finds the 2x2 blocks centered at sites with odd coordinates. This kind of partitioning scheme is called a Margolus Partition. Updates alternate between partitions. On each partition the following rules are applied to each 2x2 block.

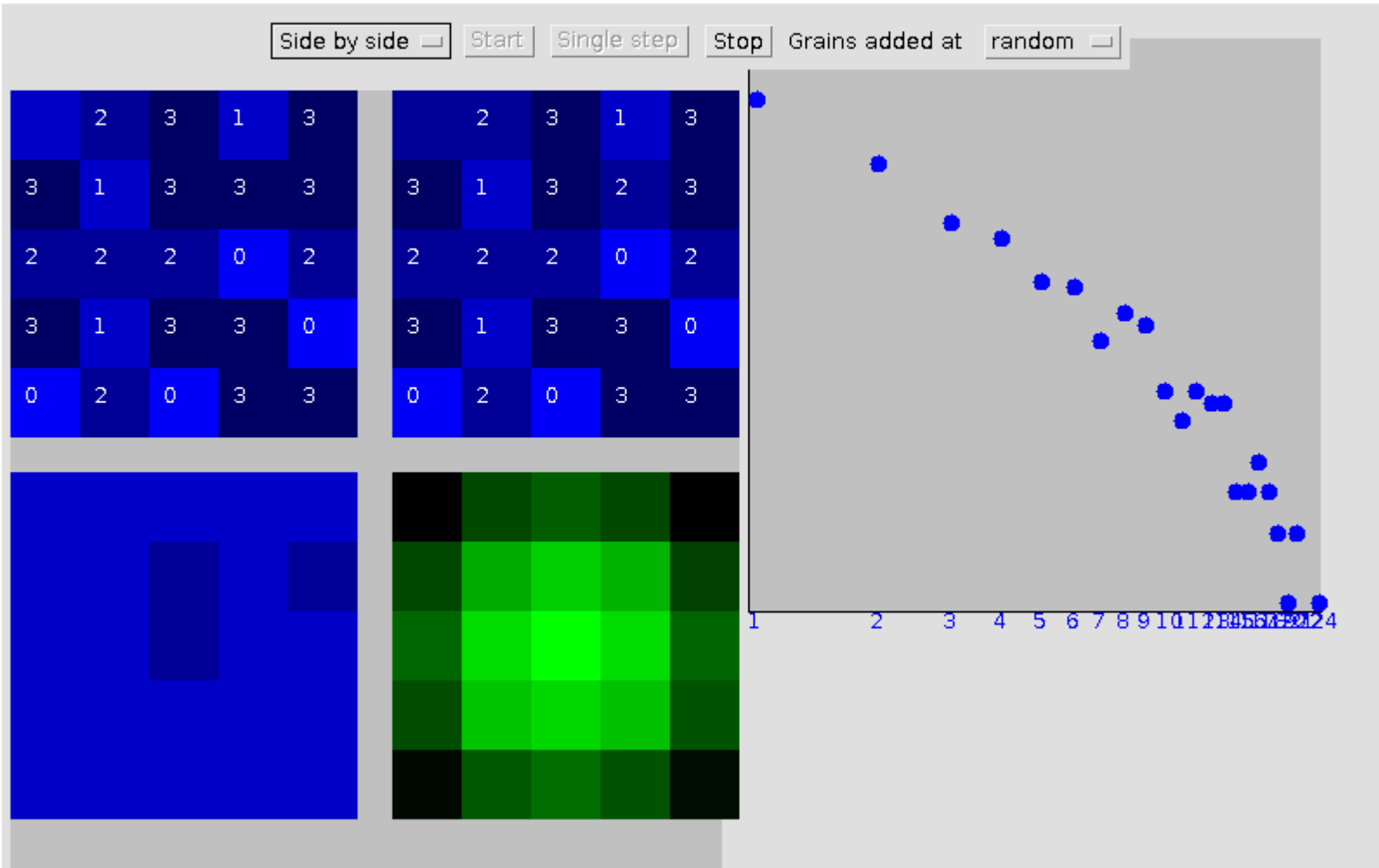


Presets: (none) Iteration: 342

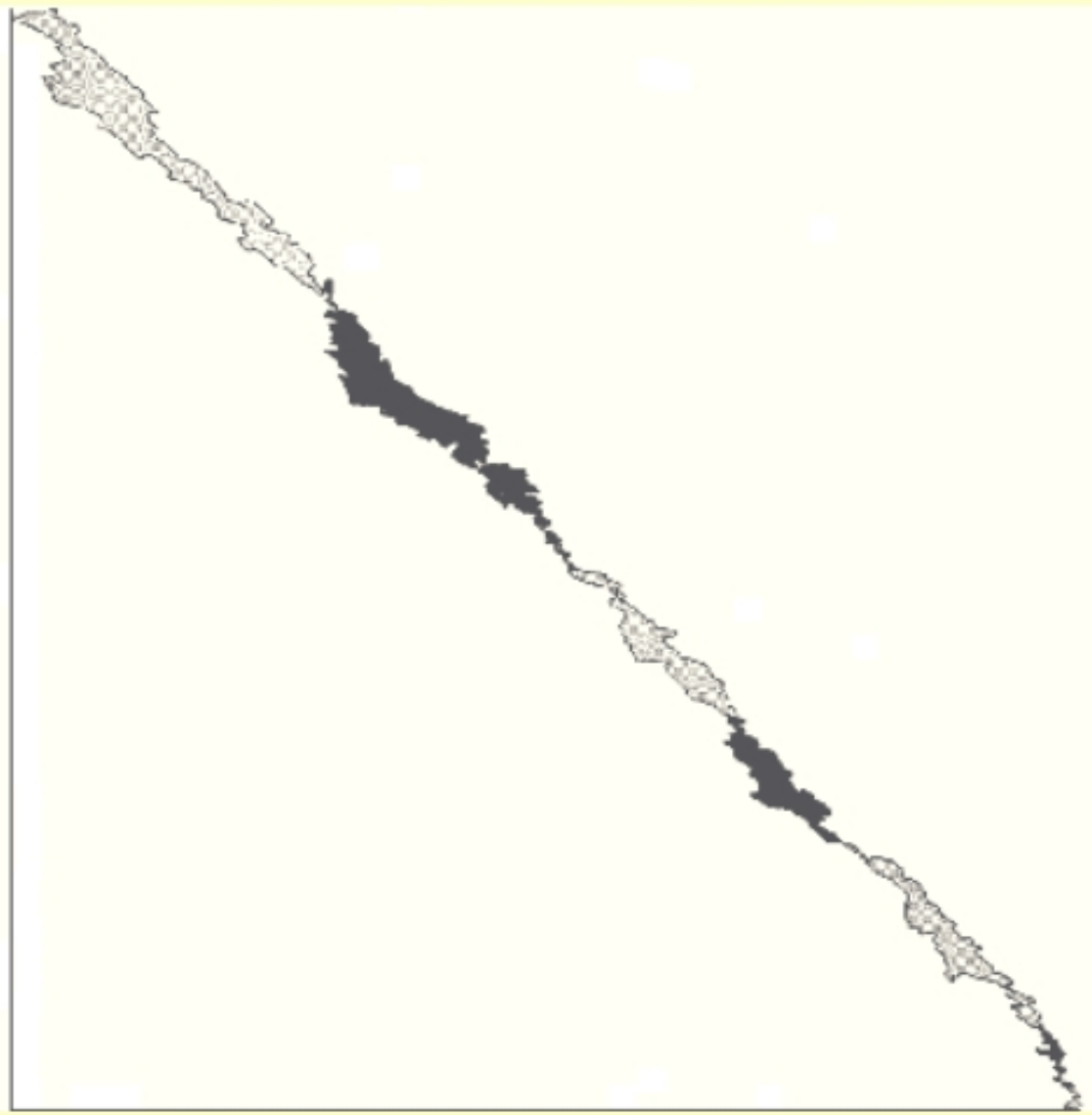
Start Step Stop Reset

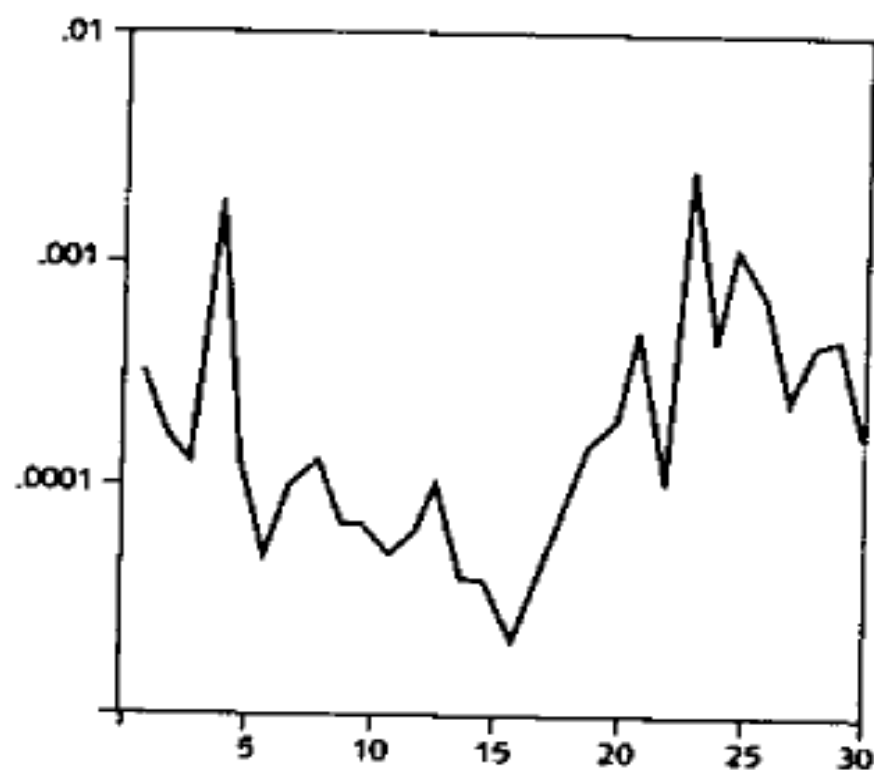
A chance to play with sand without getting your hands dirty. The black pipe at the top center is a source of sand grains. The black line at the bottom is the ground. Use the mouse to put pieces of ground wherever you want. A click will toggle the cell between ground and no ground. A click and drag will create a swath of ground cells.

Applet started

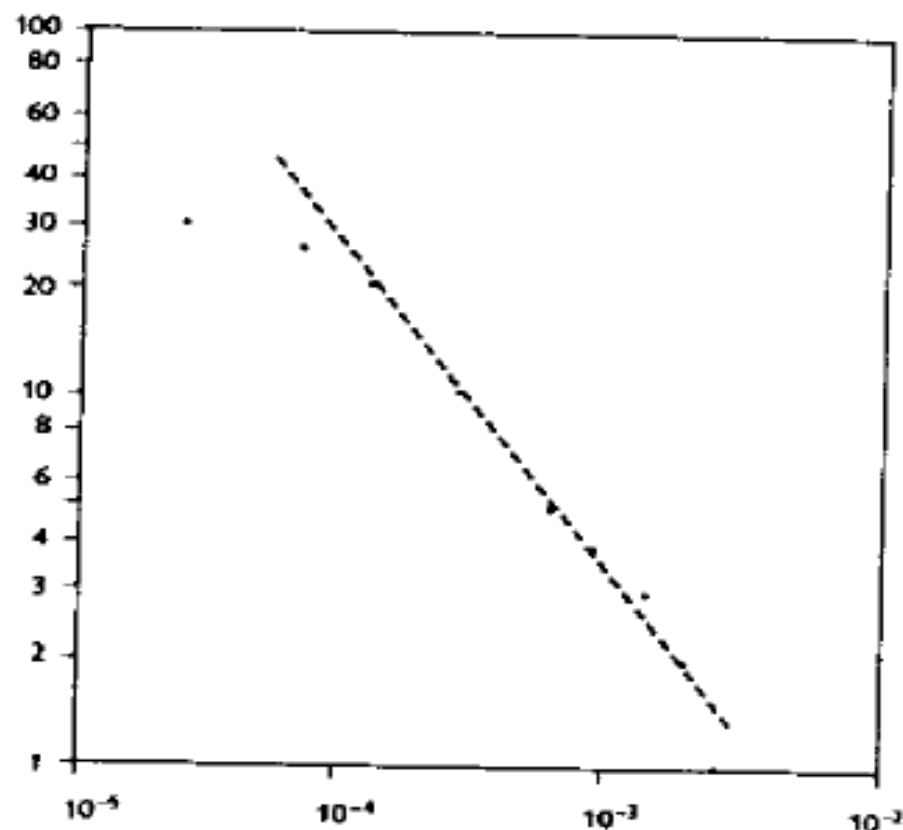


Sandpile





(a)



(b)

Figure 3. (a) Monthly variations of cotton prices (Mandelbrot, 1963) during a period of 30 months. (b) The curve shows the number of months where the relative variation exceeded a given fraction. Note the smooth transition from small variations to large variations. The straight line indicates a power law. Other commodities follow a similar pattern.

dinosaurs and many other species, occur with fairly well defined probability and regularity. He used data collected by Jack Sepkoski, who had spent "ten years in the library" researching the fossil records of thousands of marine species. Sepkoski split geological history into 150 consecutive periods of 4 million years. For each period, he estimated what fraction of species had disappeared since the previous period (Figure 4). The estimate is a measure of the extinction rate. Sometimes there were very few extinctions, less than 5 percent,

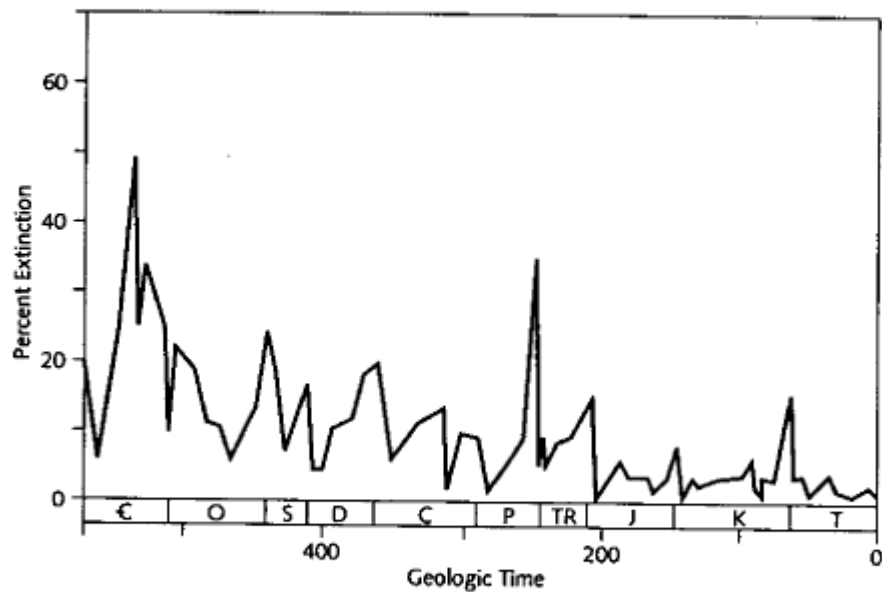


Figure 4. Biological extinctions over the last 600 million years as recorded by John Sepkoski, Jr. who spent 10 years in the library collecting the data from the fossil record. The curve shows the estimated percentage of families that went extinct within intervals of approximately 4 million years (Sepkoski, 1993).

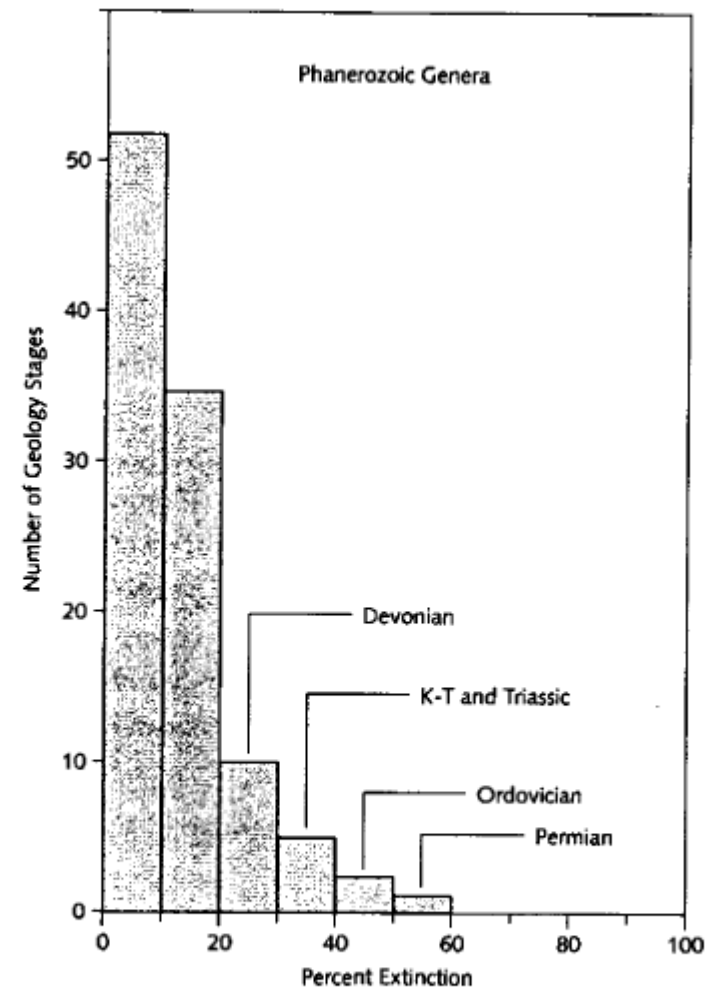


Figure 5. Histogram of the extinction events from Figure 4 as shown by Raup. The diagram shows the number of four-million-year periods where the extinction rate was within a given range. The large well-known extinction events appear in the tail of the curve.

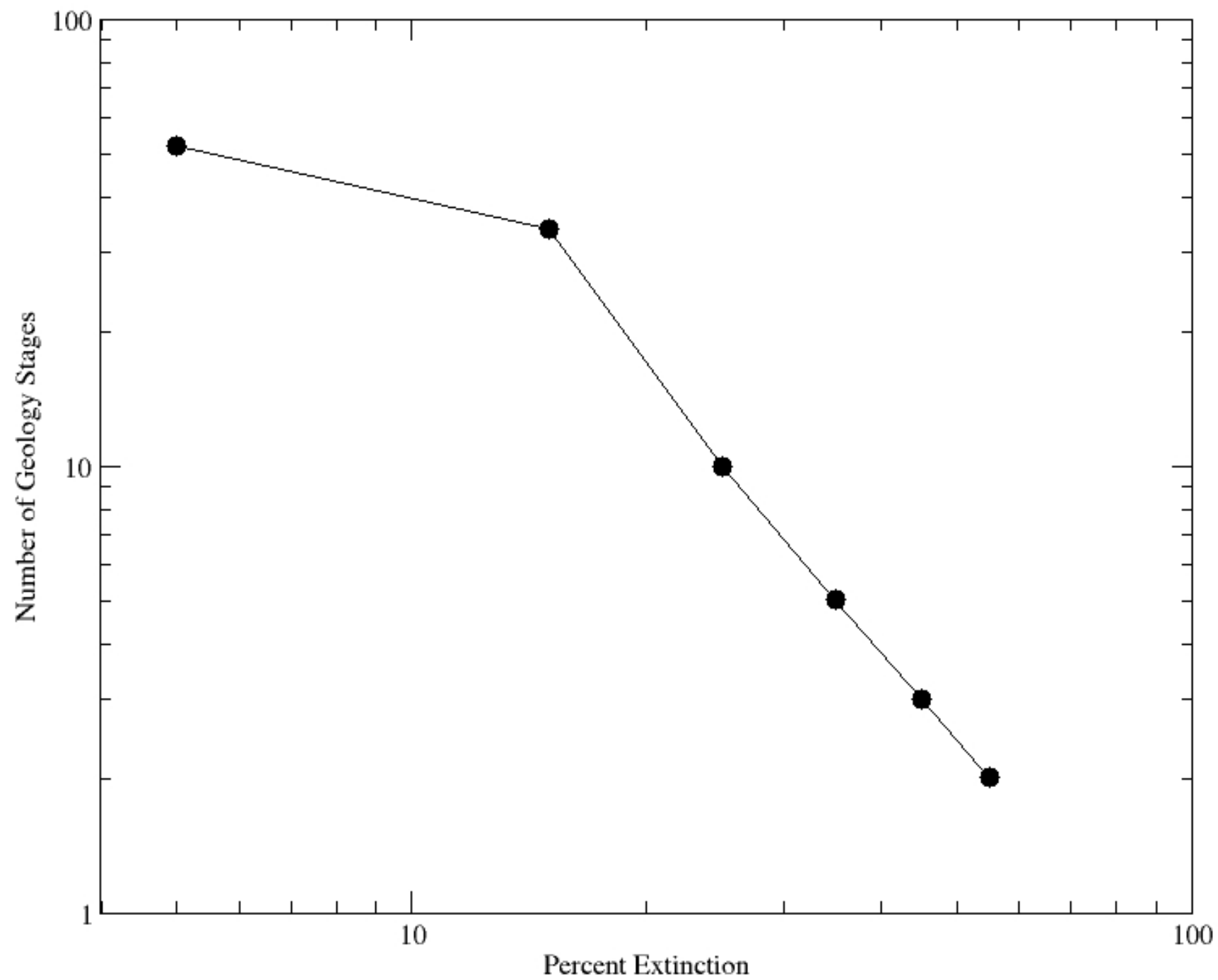




Figure 6. (a) The coast of Norway. Note the "fractal," hierarchical geometry, with fjords, and fjords within fjords, and so on. Mandelbrot has pointed out that landscapes often are fractals. (From Feder, 1988.)

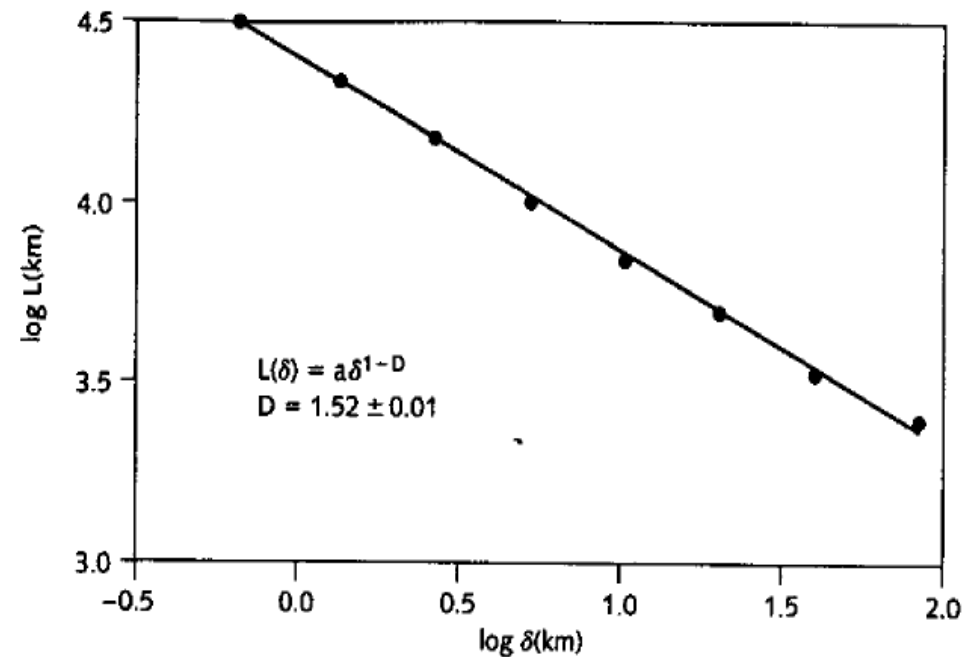
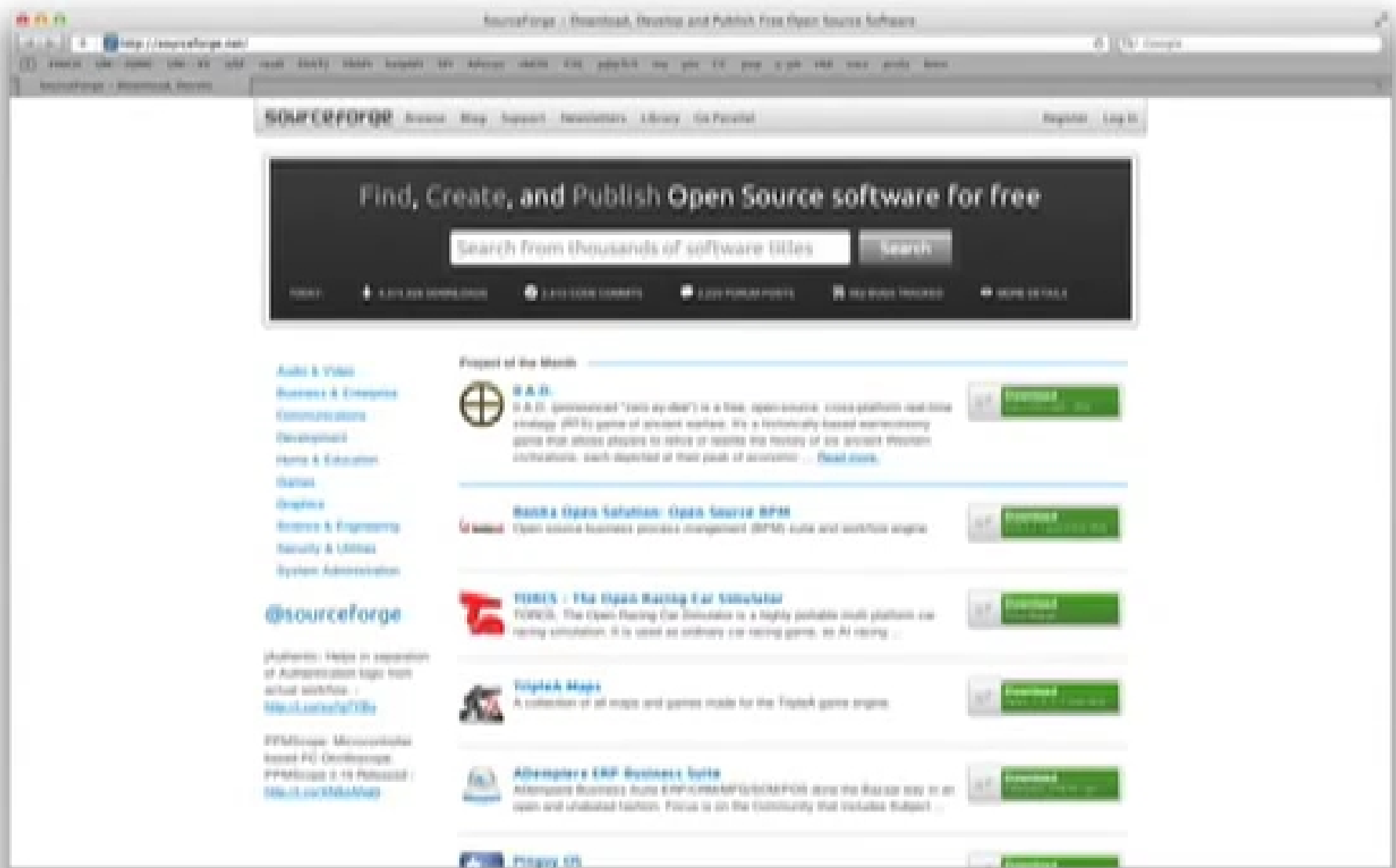


Figure 6. Continued (b) The length L of the coast measured by covering the coast with boxes, like the ones shown in (a), of various lengths δ . The straight line indicates that the coast is fractal. The slope of the line yields the "fractal dimension" of the coast of Norway, $D = 1.52$.

Choice of Language in Open Source Software



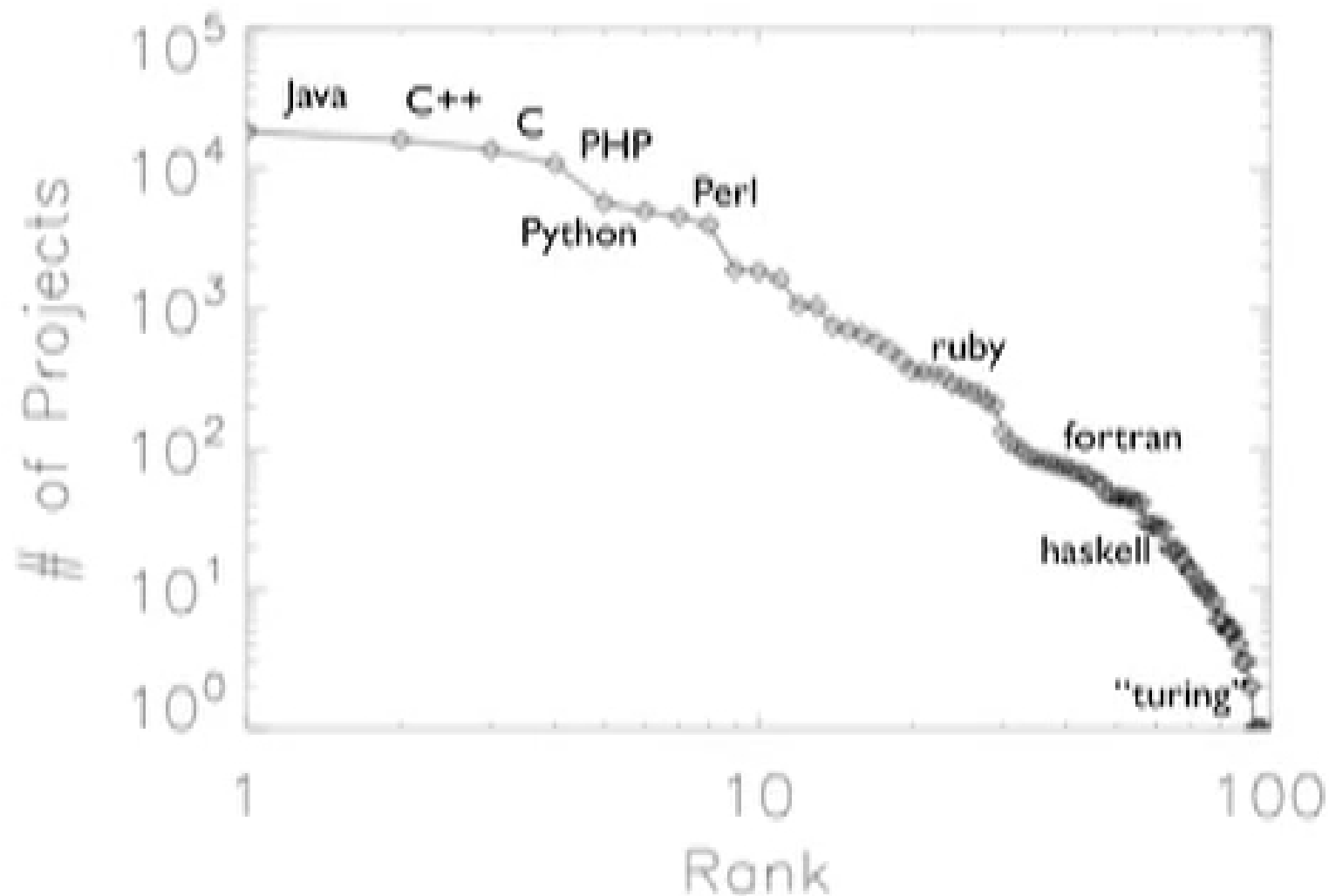
The image shows a screenshot of the SourceForge website. The browser address bar displays "http://sourceforge.net/". The website header includes the SourceForge logo and navigation links: "Browse", "Blog", "Support", "Newsletters", "Library", and "Get Personal". There are also links for "Register" and "Log In".

The main content area features a dark banner with the text "Find, Create, and Publish Open Source software for free". Below this is a search bar with the placeholder text "Search from thousands of software titles" and a "Search" button. Underneath the search bar are several filter icons: "Home", "Linux OS Distributions", "Linux Tools Utilities", "Linux Frameworks", "Web Apps Services", and "More Details".

On the left side, there is a vertical navigation menu with categories: "Audio & Video", "Business & Enterprise", "Communications", "Development", "Home & Education", "Games", "Graphics", "Science & Engineering", "Security & Utilities", and "System Administration". Below this menu is the "@sourceforge" logo and a note: "Authentic! Help in separation of Automation logs from actual websites." with a link to "MoreLinuxofLife". At the bottom of the left sidebar, there are links for "SPMSource - Microsofts based P2P Development" and "P2PSource v.19 Personal" with a link to "MoreLinuxofLife".

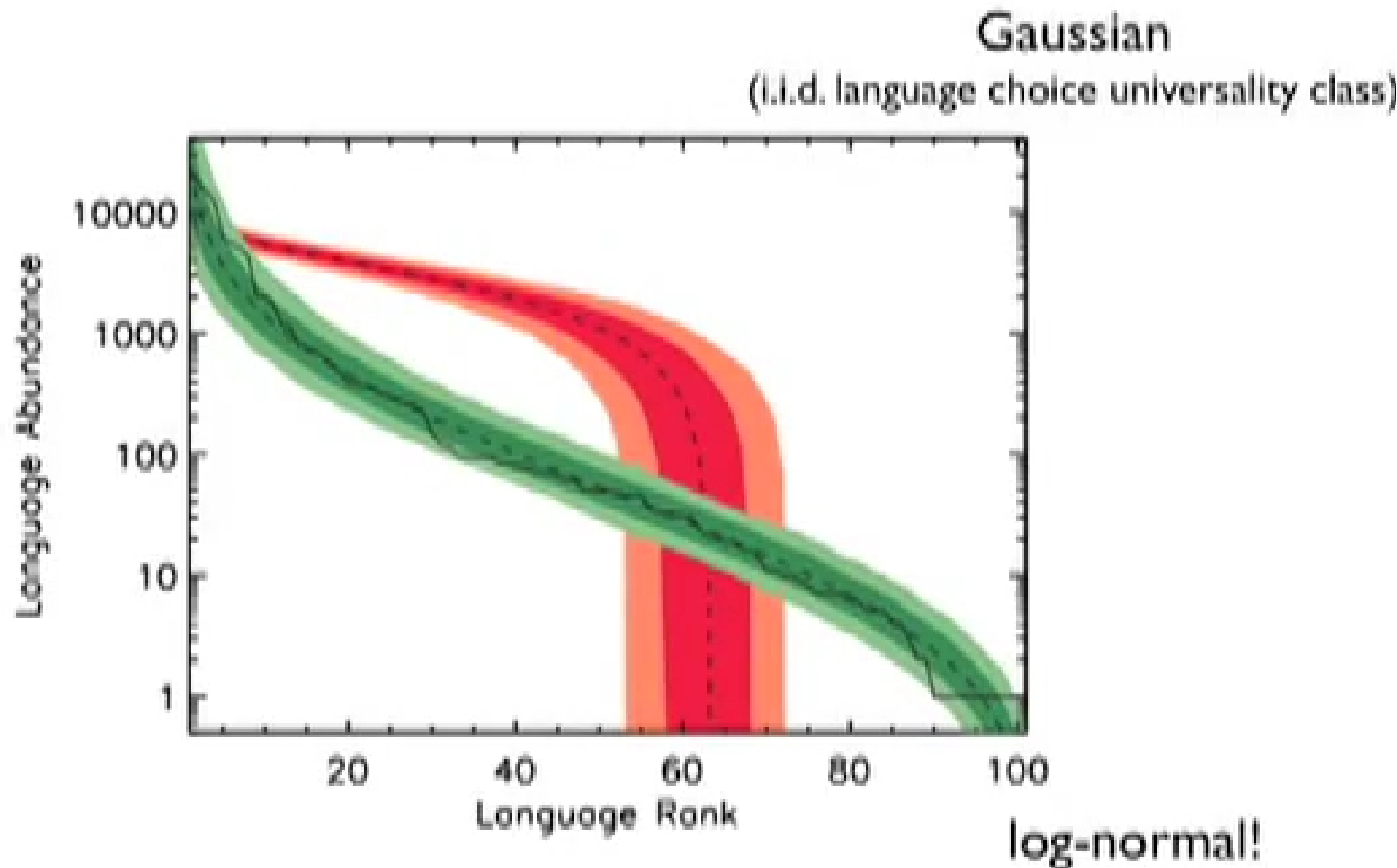
The main content area displays a "Project of the Month" section. The first project is "S & D", described as a "distributed 'zero by zero' in a free, open source, cross platform real-time strategy (RTS) game of ancient warfare. It's a technology-based war-torn strategy game that allows players to build or rebuild the forces of an ancient Persian civilization, each depicted at their peak of dominance..." with a "Read more" link. The second project is "Banda Open Solution: Open Source BPM", described as "Open source business process management (BPM) suite and workflow engine". The third project is "TETRIS - The Open Source Tetris Simulator", described as "TETRIS, The Open Source Tetris Simulator is a highly portable multi platform tetris simulation. It is used as ordinary tetris game, as AI tetris...". The fourth project is "Tropik Maps", described as "A collection of all maps and games made for the Tropik game engine". The fifth project is "Adaptive ERP Business Suite", described as "Adaptive Business Suite (ABS) is a flexible ERP suite that can be used in an open and unlimited fashion. Focus is on the community that includes Subject...".

Choice of Language in Open Source Software



projects found on Sourceforge

Choice of Language in Open Source Software





Preferential Attachment - Mozilla Firefox

Arquivo Editar Exibir Histórico Favoritos Ferramentas Ajuda

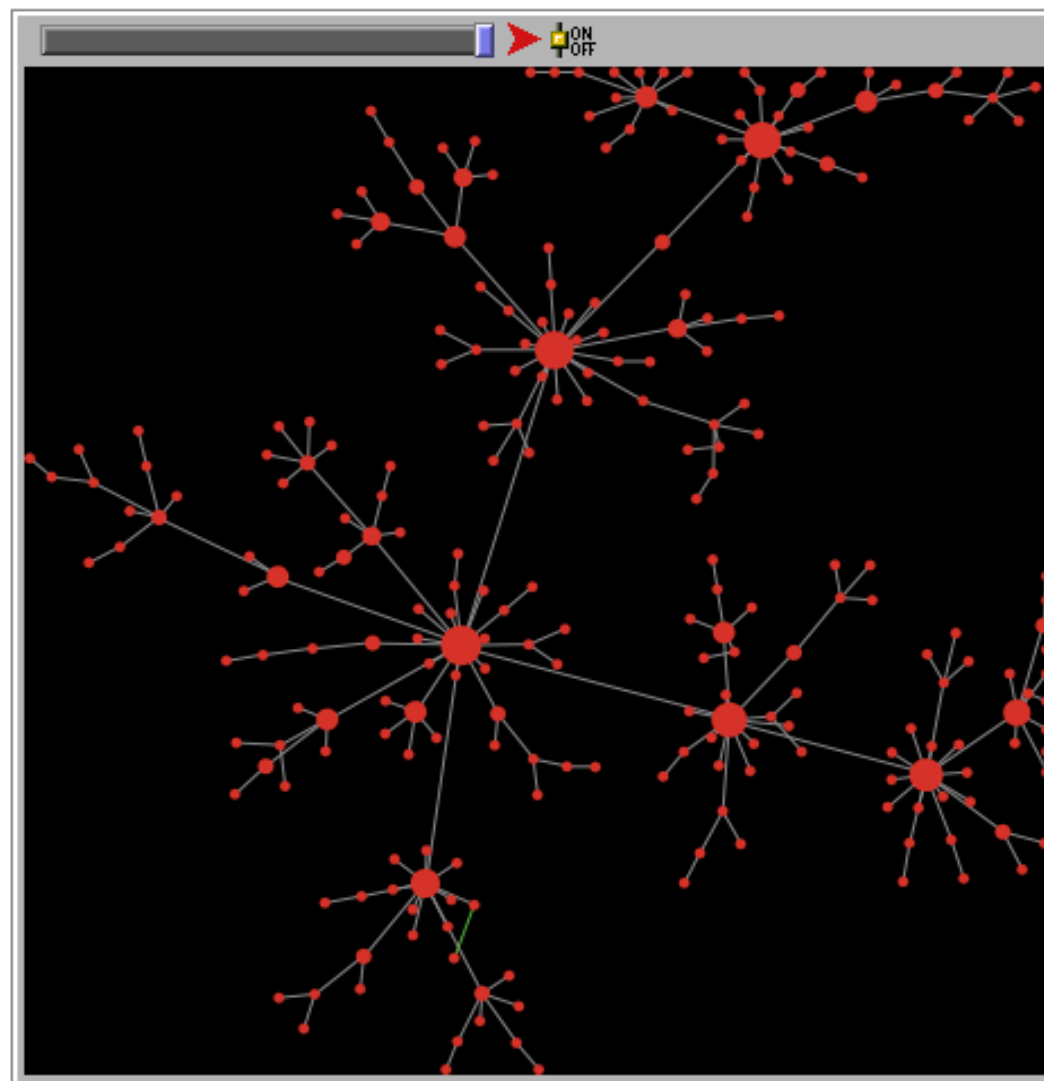
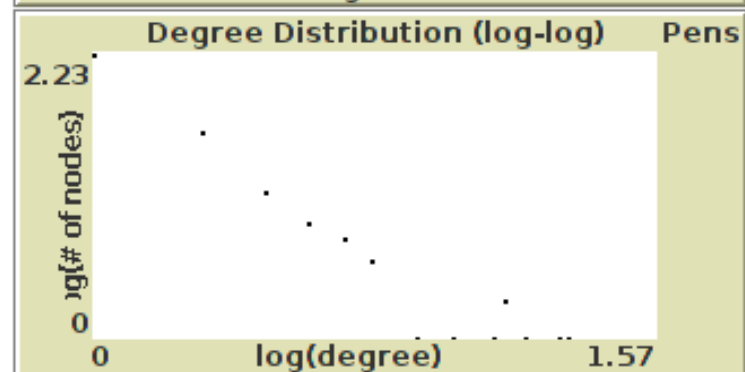
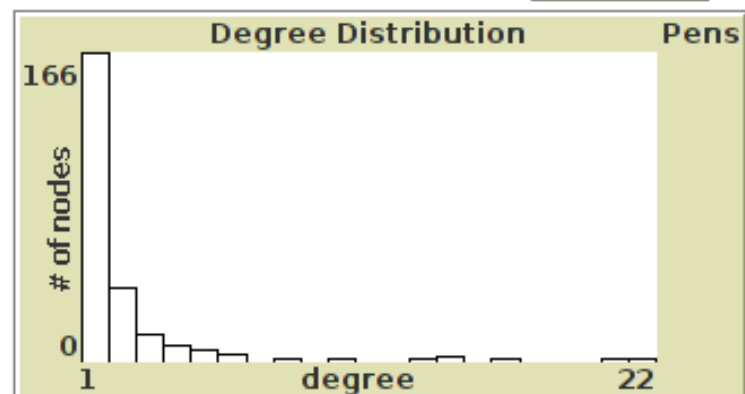
Preferential Attachment

oldweb.ct.infn.it/cactus/applets/Preferential Attachment.html

Mais visitados Getting Started

Control panel for the Preferential Attachment applet:

- Buttons: setup, go-once, redo layout, resize nodes
- Toggle switches: plot? (On/Off), layout? (On/Off)
- Field: go
- Field: # of nodes: 247



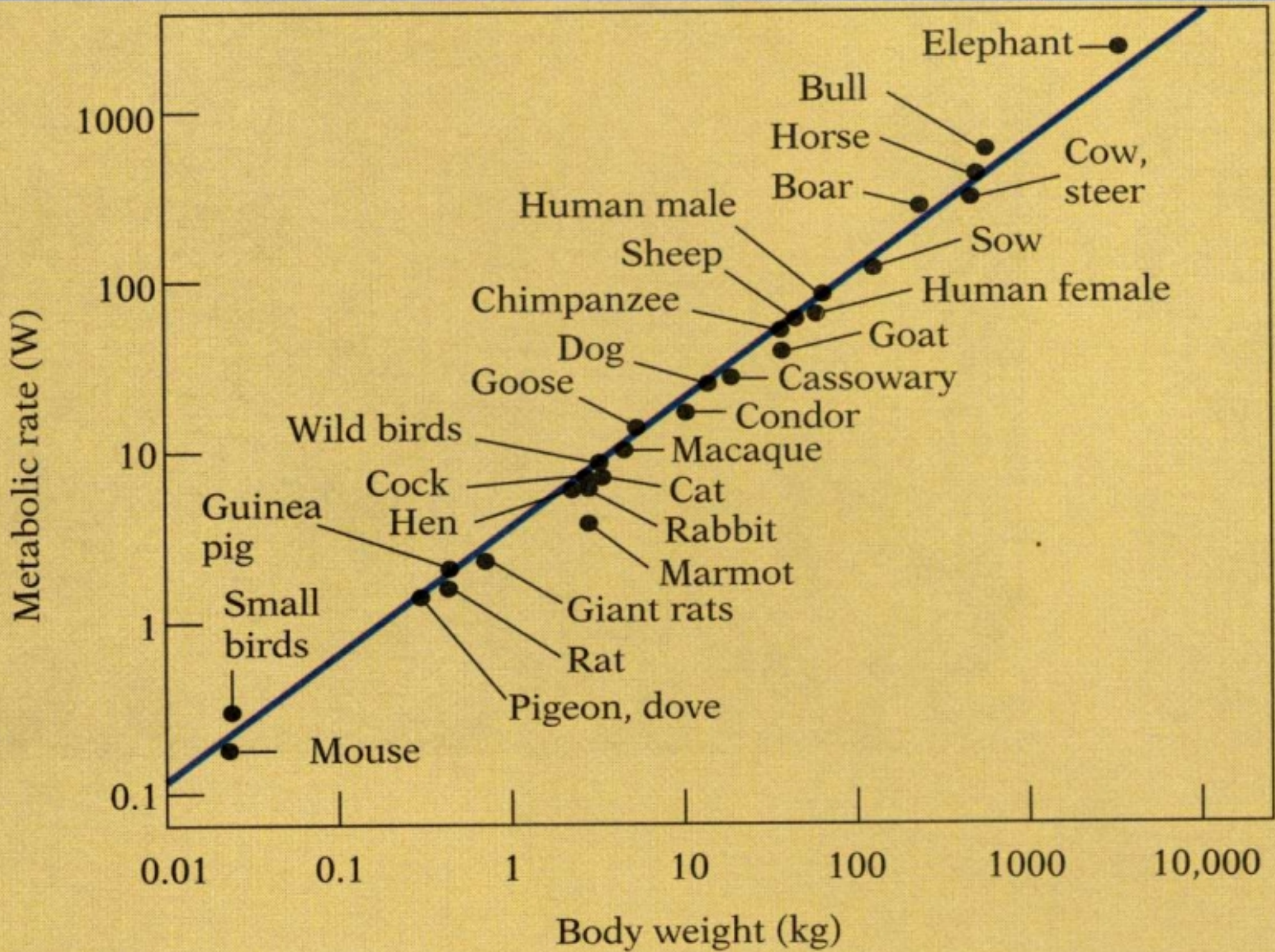
Leis de Escala em Biologia?

Mammals vary in size by 8 orders of magnitude

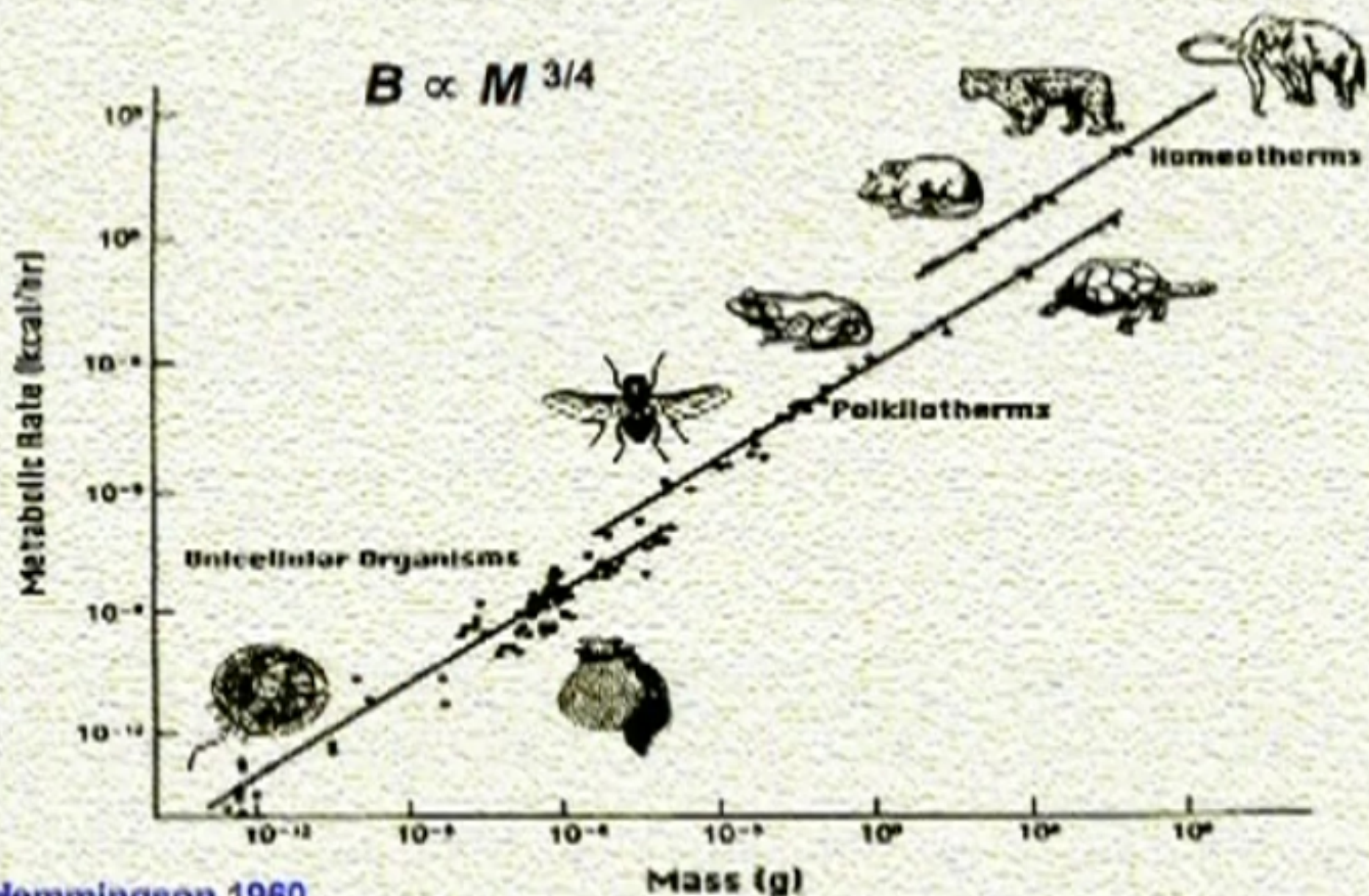


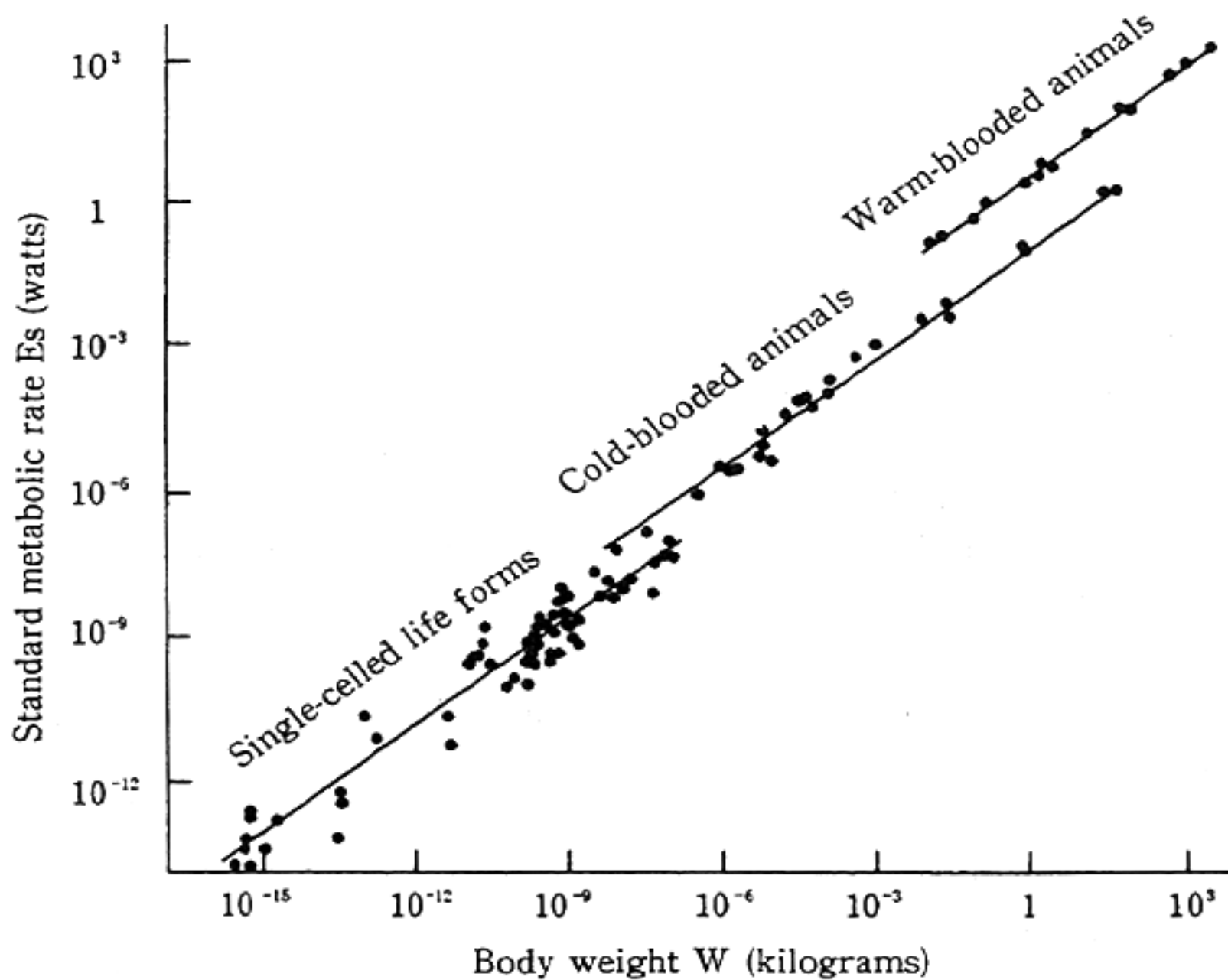
Blue Whale
200,000,000g

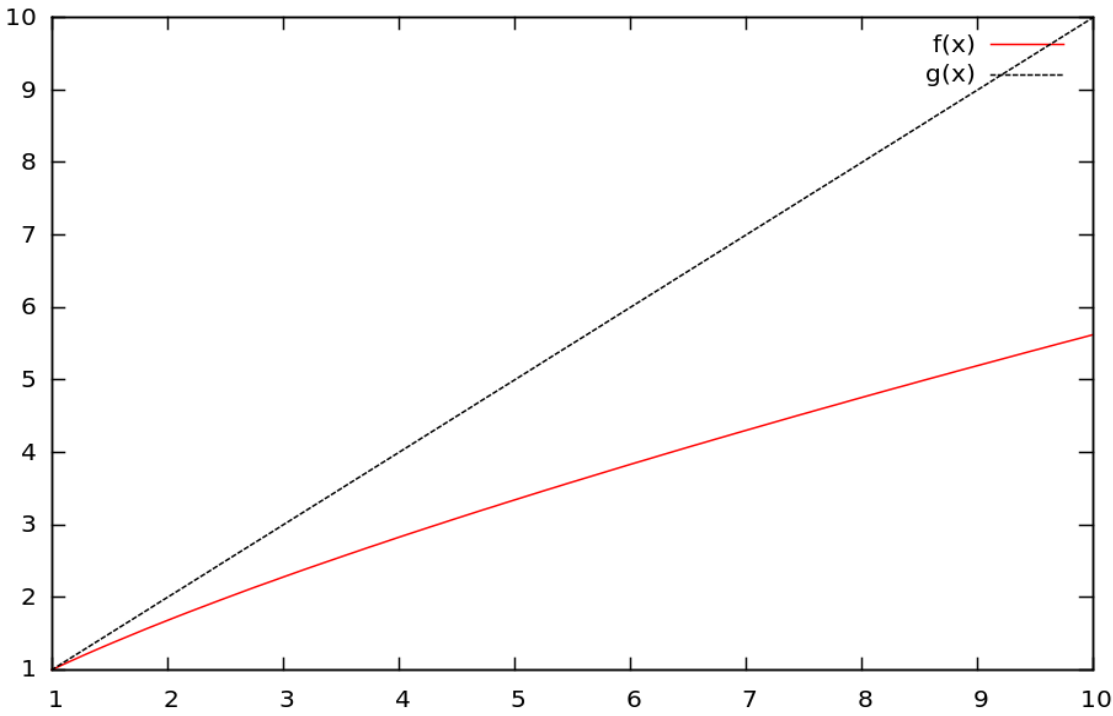




Whole-organism metabolic rate (B) scales as the $3/4$ power of body mass (M)



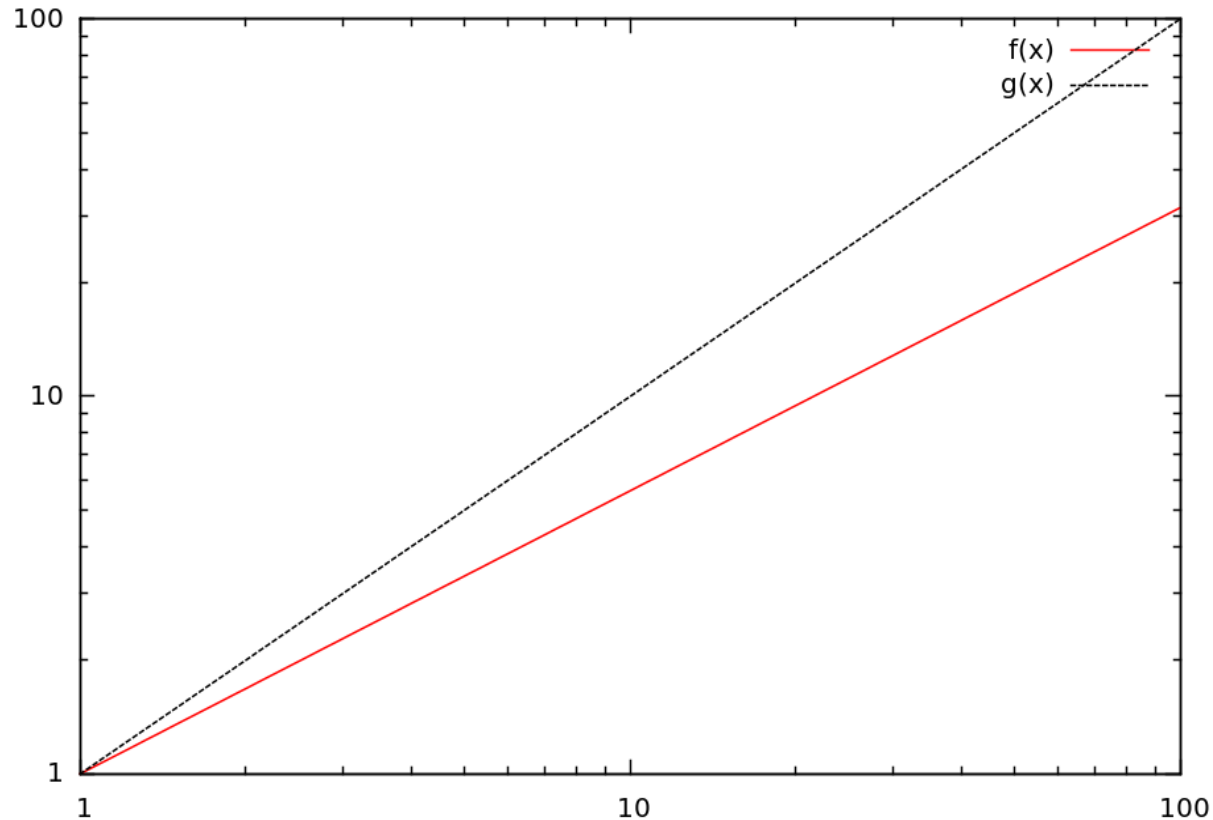




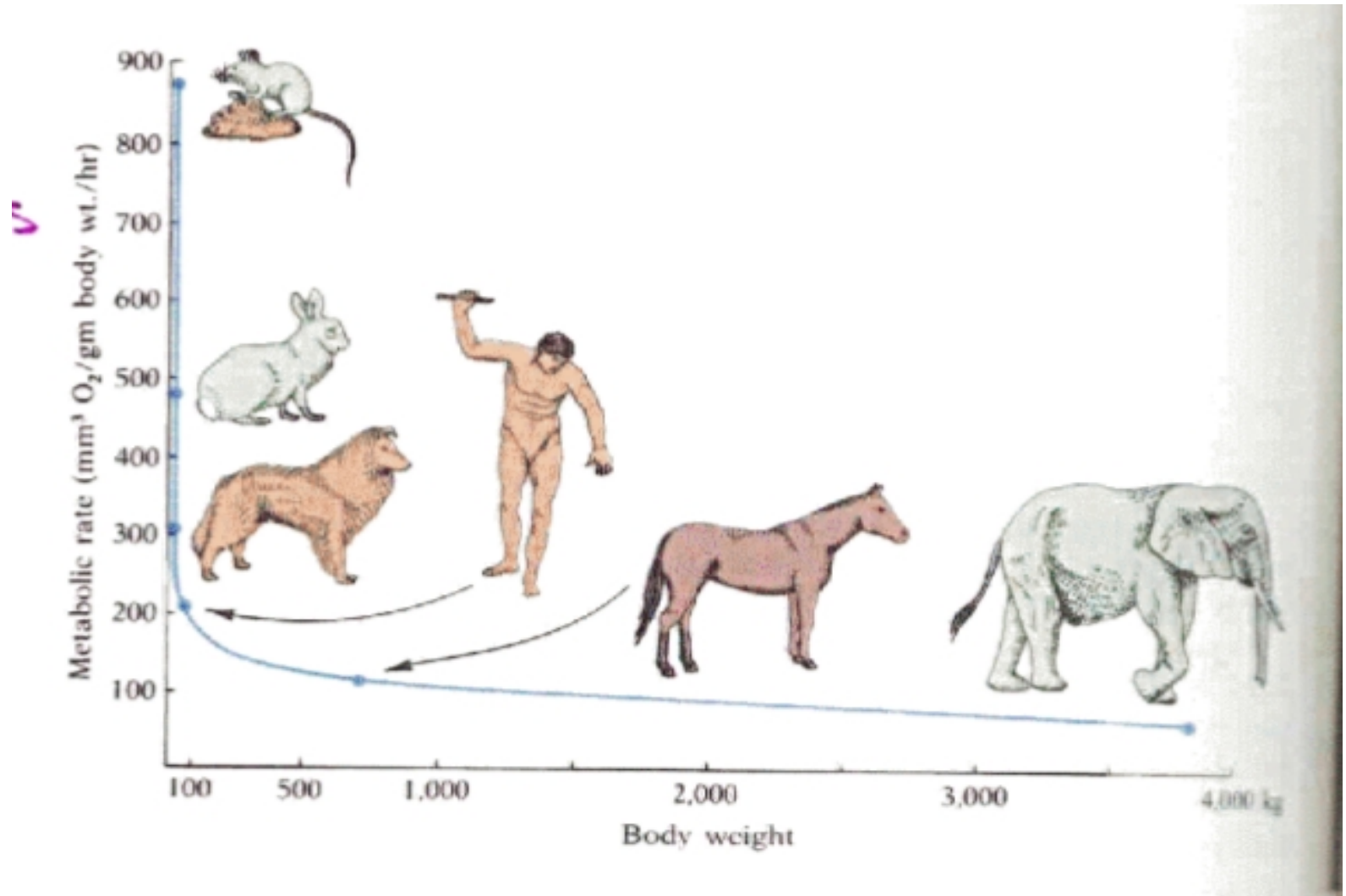
$$g(x) = x$$

$$f(x) = x^{3/4}$$

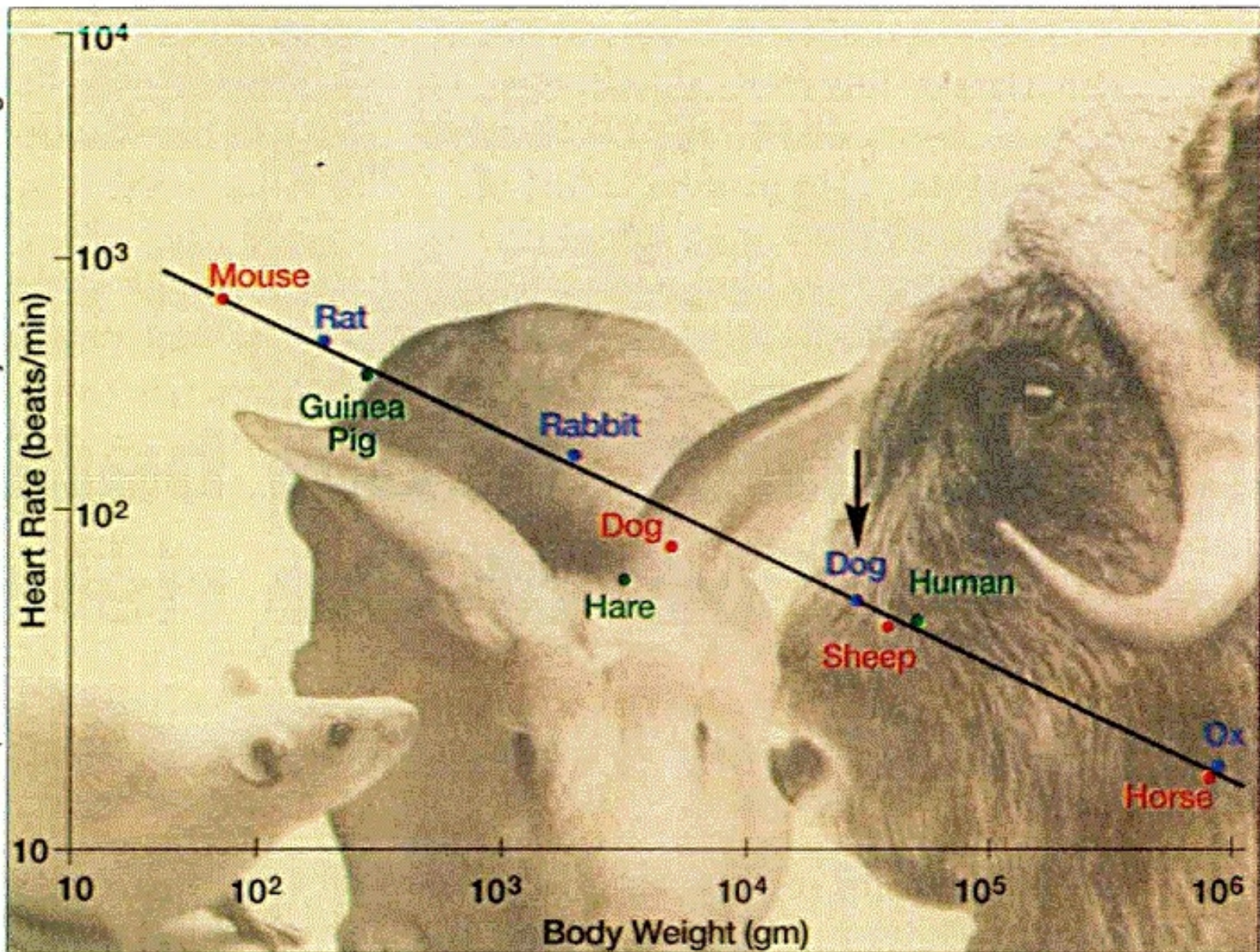
**Economia
Energética com
a Escala!**



Economia Energética com a Escala!



Adapted from: American Society of Mechanical Engineers



Small mammals live fast and die young compared to big ones. Because heart rate tracks weight by a 1/4-power law, a dog (arrow) about 1/16 as heavy as a horse has a pulse about twice as fast as the horse's, not 16 times faster.

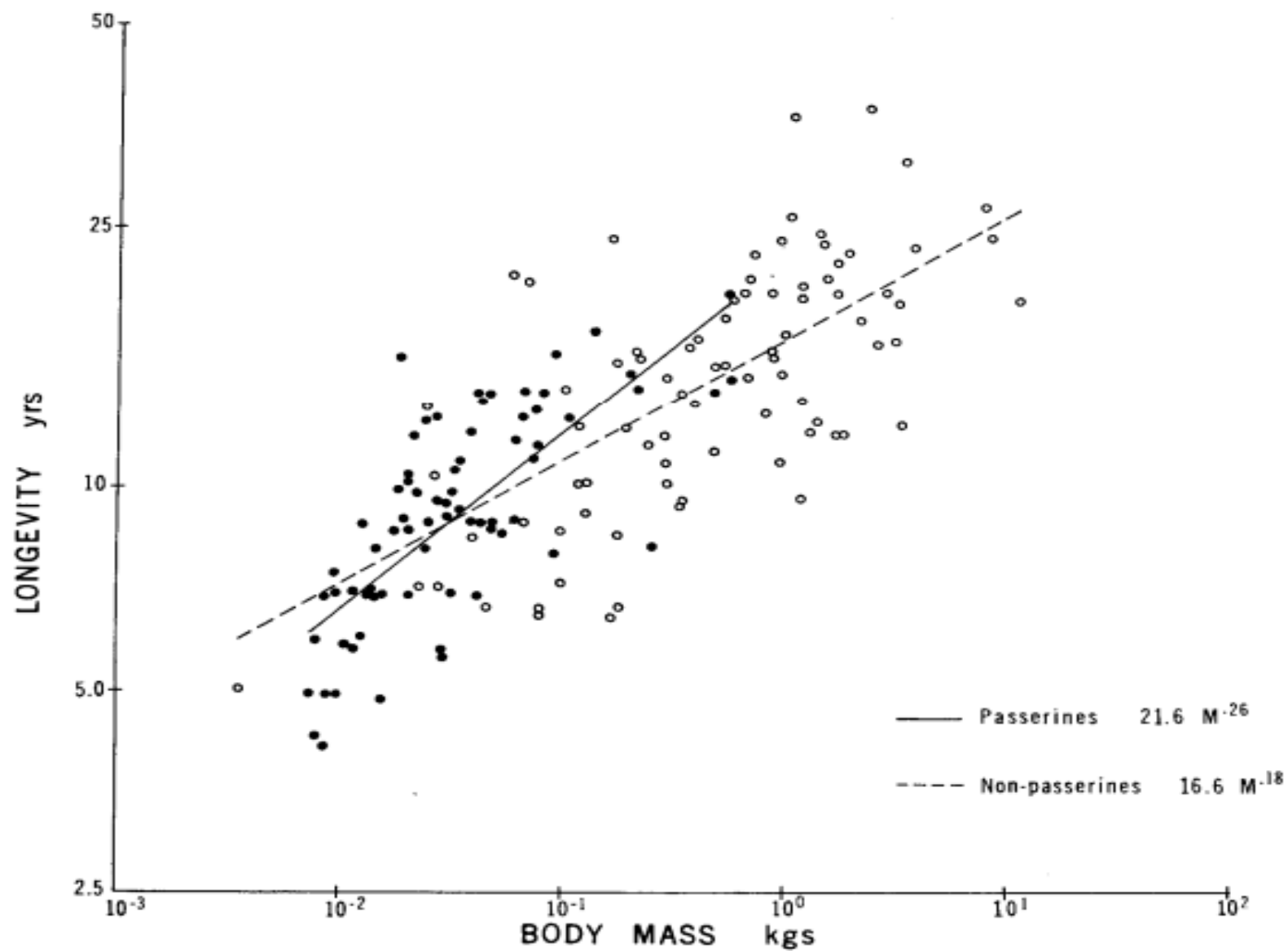


FIGURE 1. The relation of maximum longevity and body weight in wild birds, showing separate lines for passerine (solid circles) and nonpasserine (open circles) species.

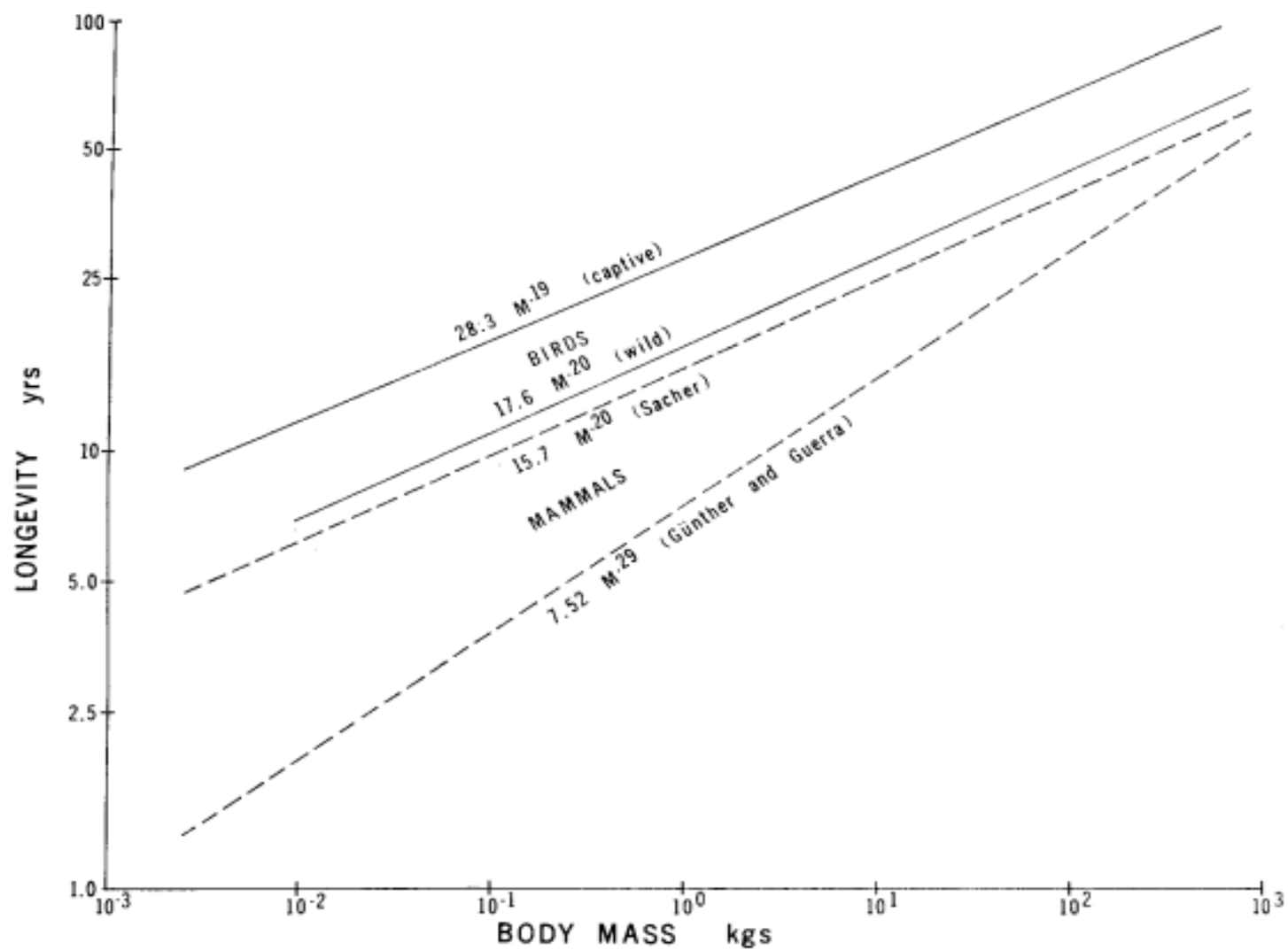
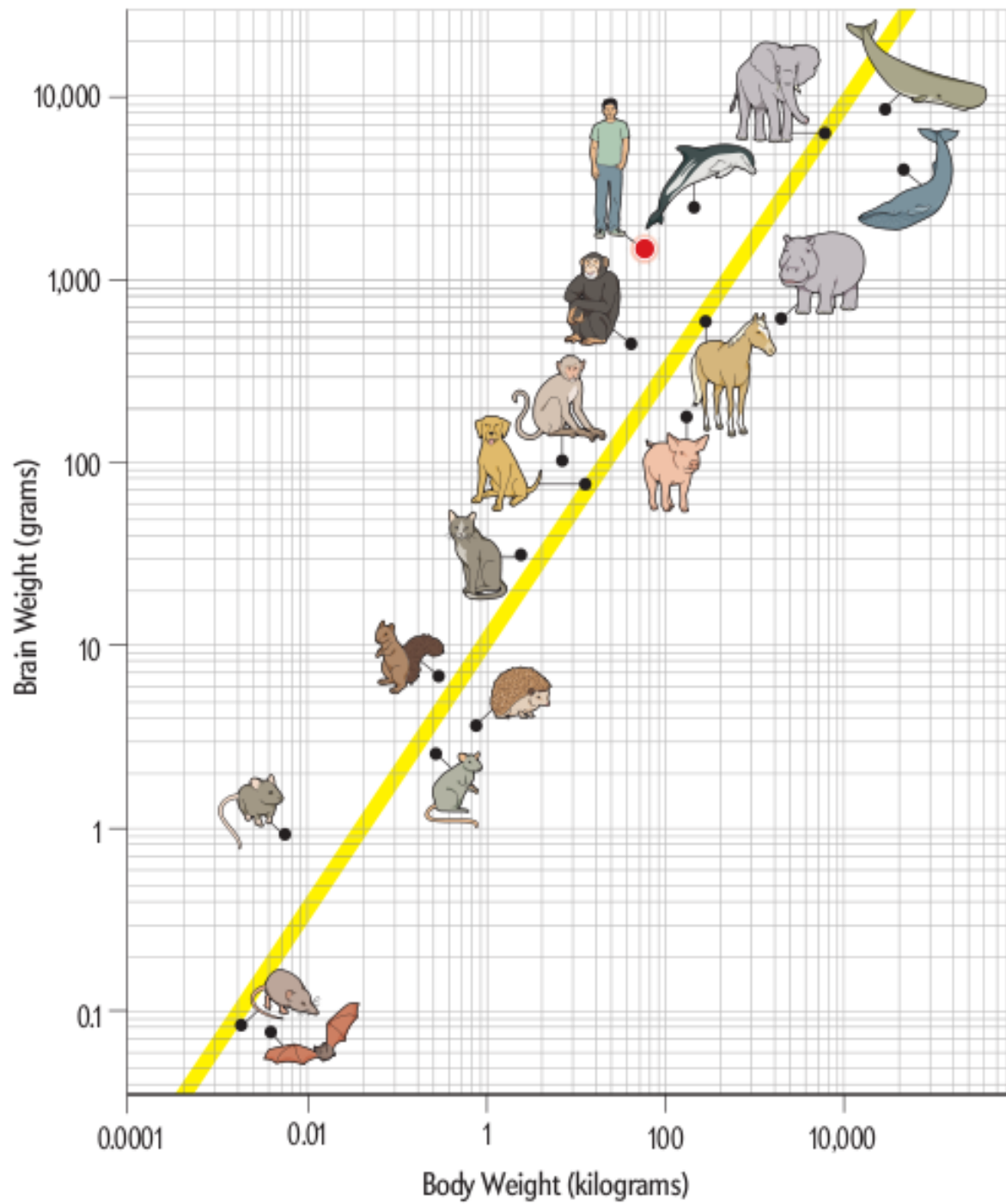
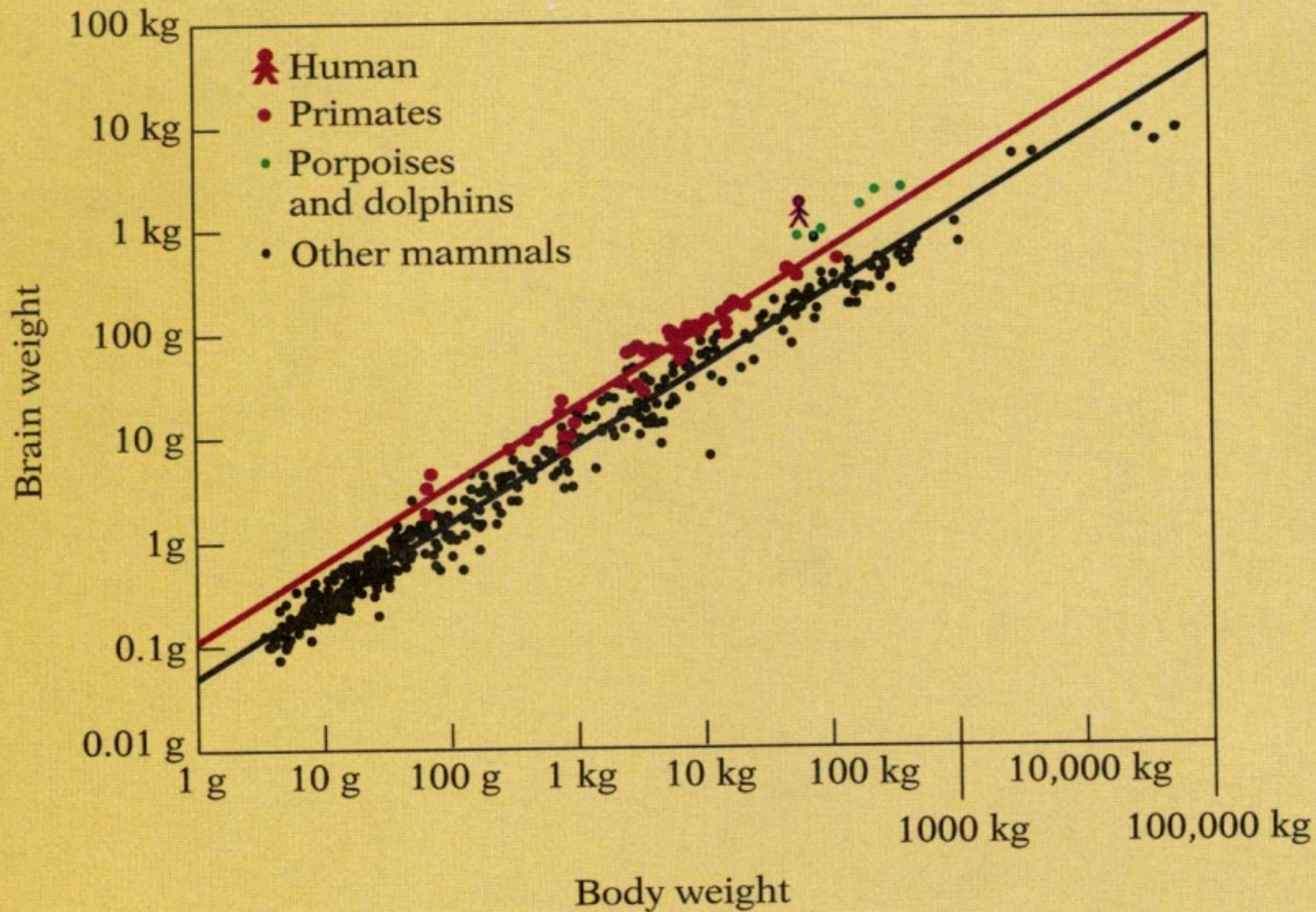
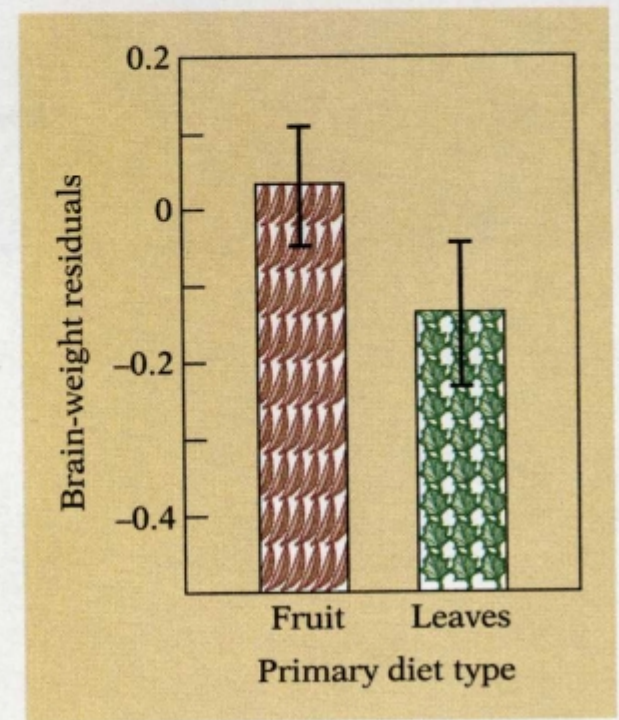
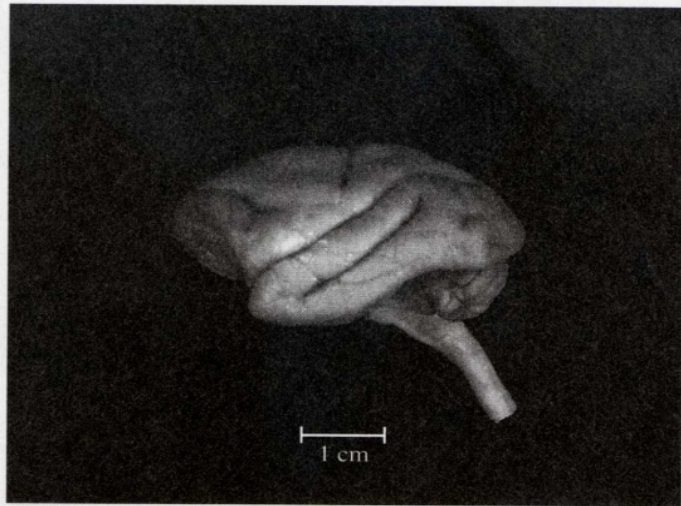
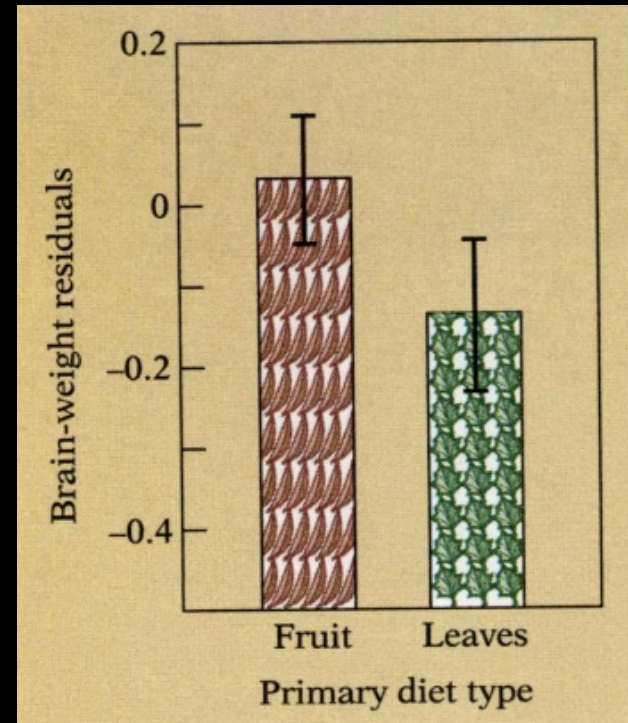


FIGURE 2. The relation of longevity and body weight in wild and captive birds compared with lines for mammals from equations by Günther and Guerra (1955) and Sacher (1959).

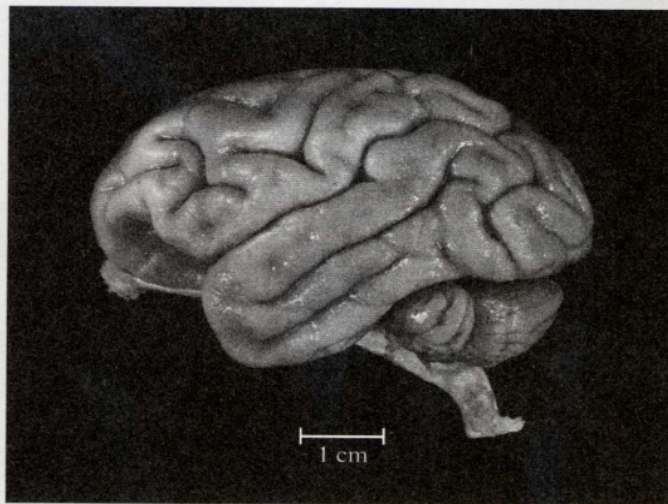








Howler monkey



Spider monkey

Leis de Escala na População Humana?

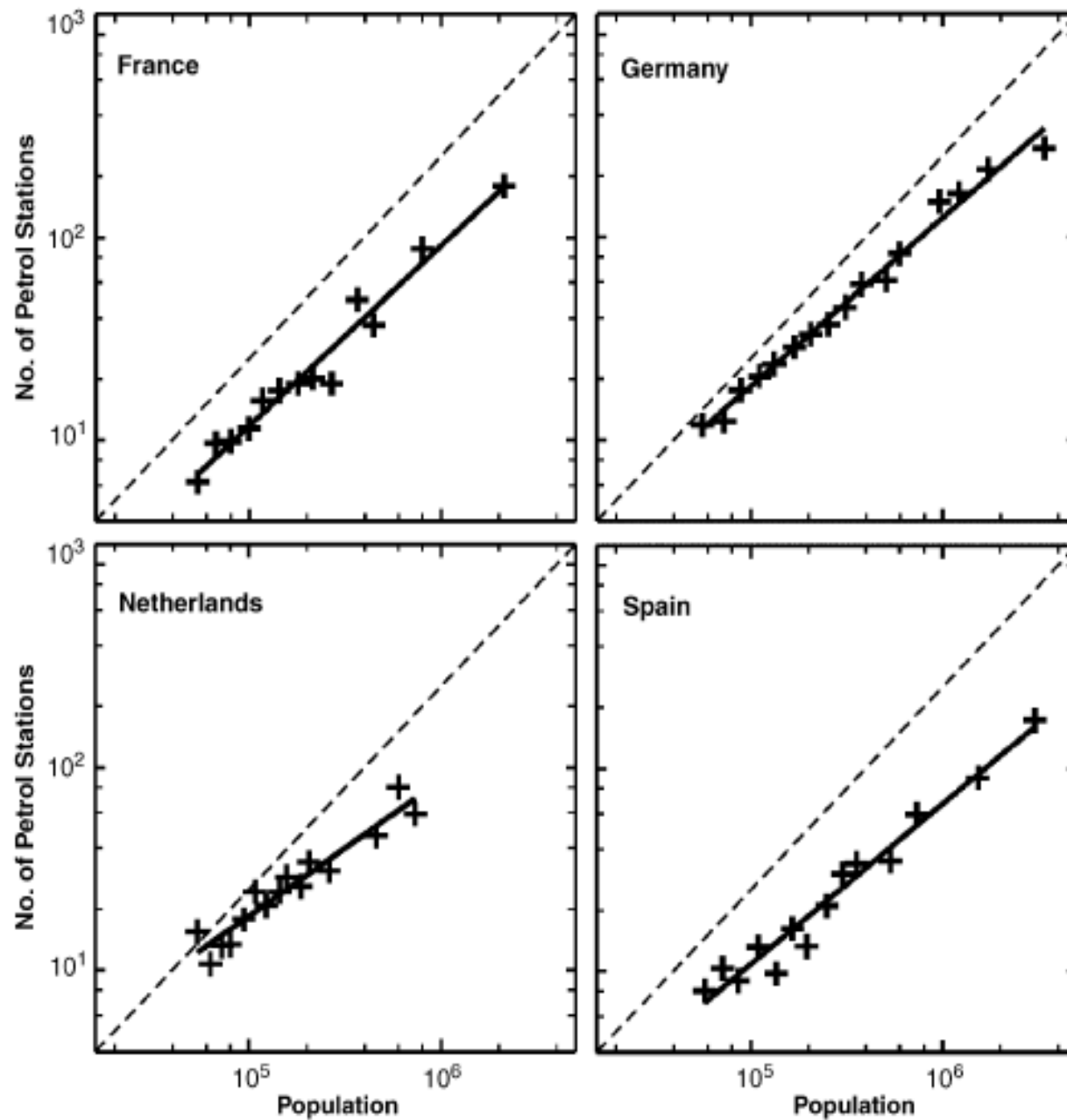
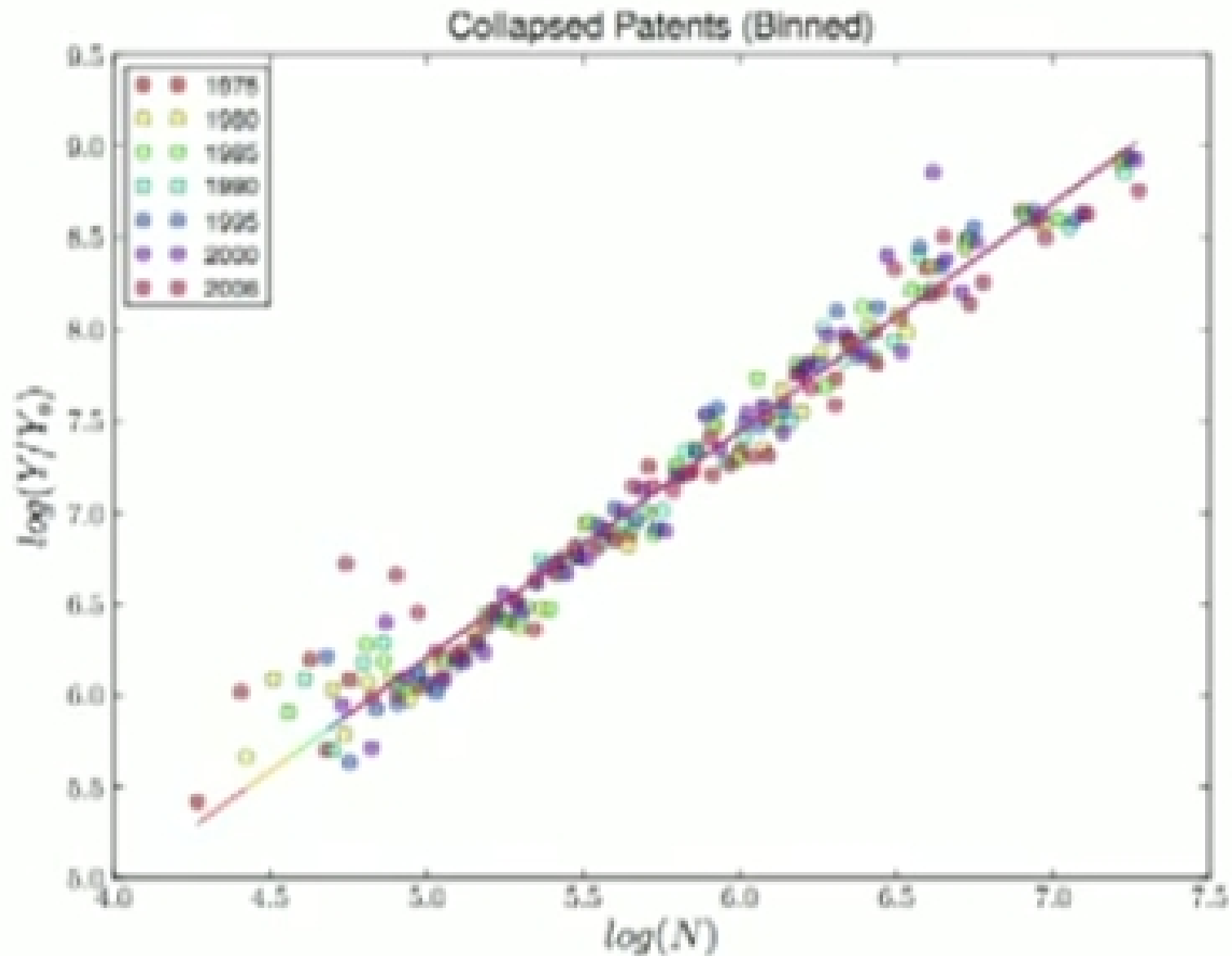
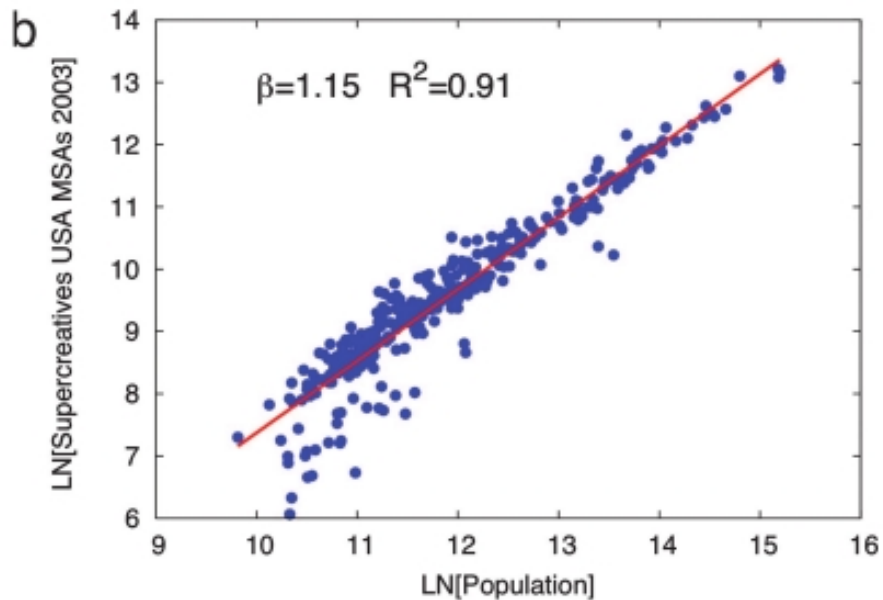
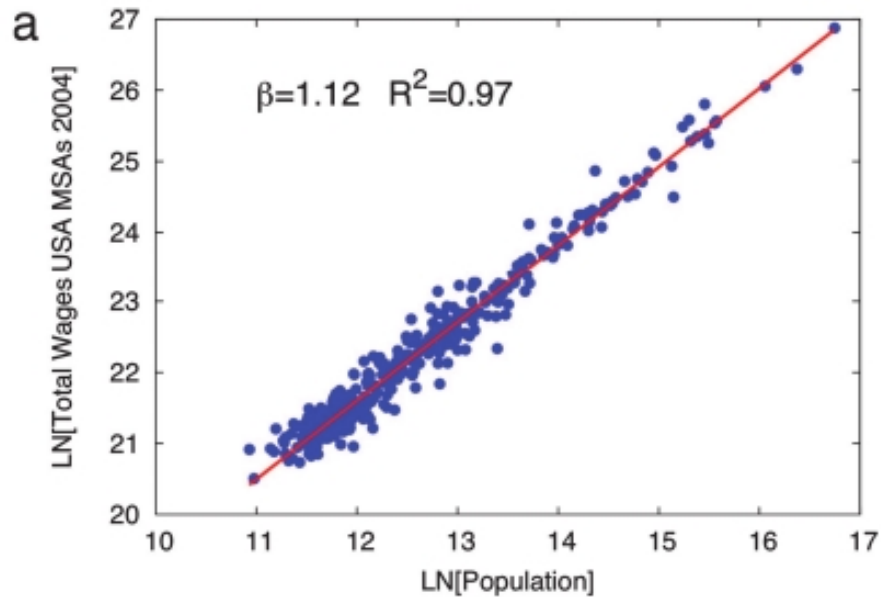


Fig. 4. Double-logarithmic representation of the number of petrol stations as a function of the population size of cities of France, Germany, Netherlands and Spain, after a logarithmic binning method has been applied. The solid lines correspond to the respective linear regression and the dashed lines indicate the slope 1.

Innovation measured by Patents





Example of scaling relationships

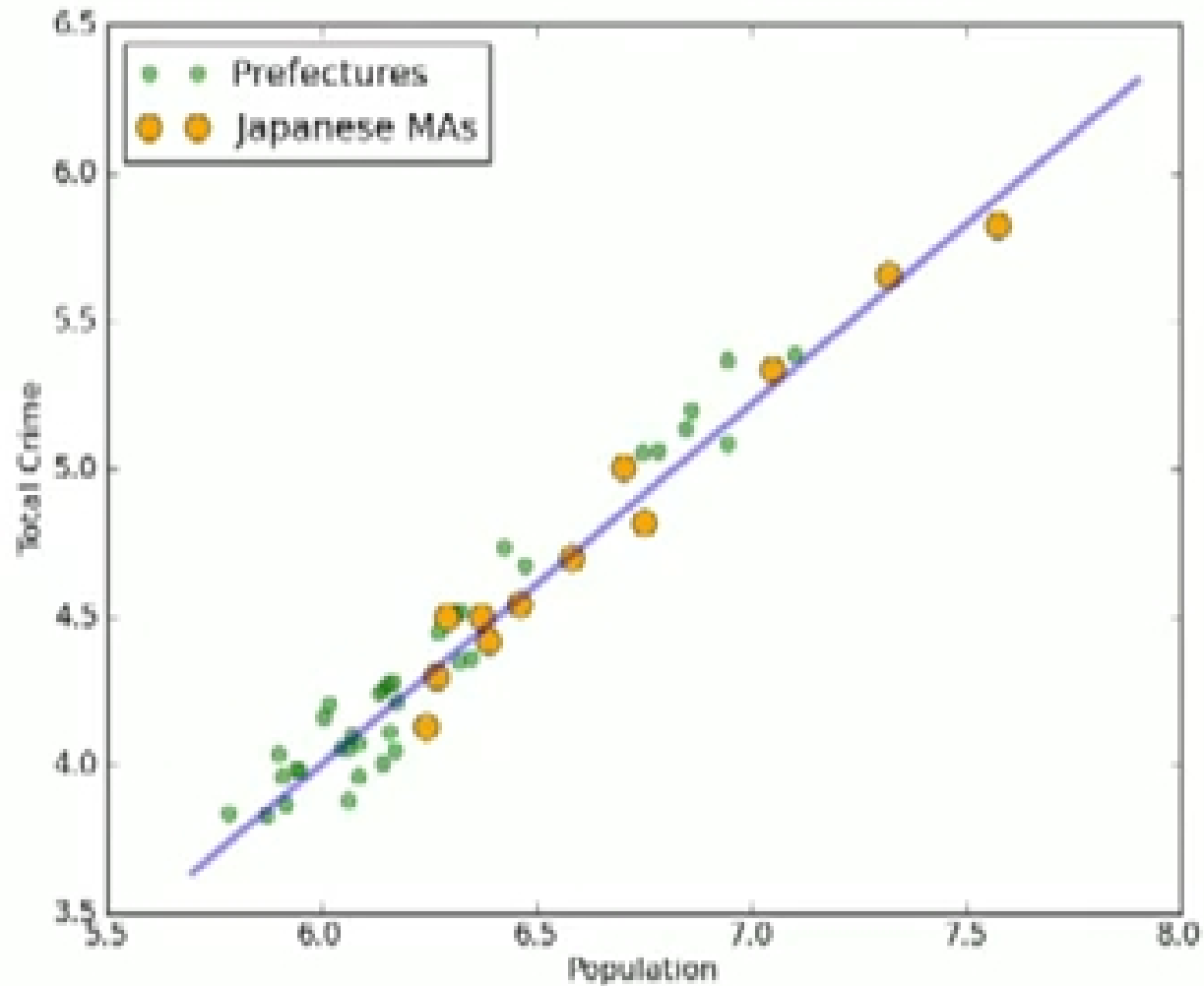
a) Total **WAGES** per MSA in 2004 for the USA vs. metropolitan population.

b) **SUPERCREATIVE** employment per MSA in 2003, for the USA vs. metropolitan population.

**SUPER-LINEAR
SCALING**

16

TOTAL CRIME (JAPAN)



Slope = 1.21 [1.08, 1.35]

$\beta > 1$
 Interação
 Social

Table 1. Scaling exponents for urban indicators vs. city size

Y	β	95% CI	Adj- R^2	Observations	Country-year
New patents	1.27	[1.25,1.29]	0.72	331	U.S. 2001
Inventors	1.25	[1.22,1.27]	0.76	331	U.S. 2001
Private R&D employment	1.34	[1.29,1.39]	0.92	266	U.S. 2002
"Supercreative" employment	1.15	[1.11,1.18]	0.89	287	U.S. 2003
R&D establishments	1.19	[1.14,1.22]	0.77	287	U.S. 1997
R&D employment	1.26	[1.18,1.43]	0.93	295	China 2002
Total wages	1.12	[1.09,1.13]	0.96	361	U.S. 2002
Total bank deposits	1.08	[1.03,1.11]	0.91	267	U.S. 1996
GDP	1.15	[1.06,1.23]	0.96	295	China 2002
GDP	1.26	[1.09,1.46]	0.64	196	EU 1999–2003
GDP	1.13	[1.03,1.23]	0.94	37	Germany 2003
Total electrical consumption	1.07	[1.03,1.11]	0.88	392	Germany 2002
New AIDS cases	1.23	[1.18,1.29]	0.76	93	U.S. 2002–2003
Serious crimes	1.16	[1.11, 1.18]	0.89	287	U.S. 2003

$\beta > 1$
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$\beta = 1$
 Necessidades
 individuais

Total housing	1.00	[0.99,1.01]	0.99	316	U.S. 1990
Total employment	1.01	[0.99,1.02]	0.98	331	U.S. 2001
Household electrical consumption	1.00	[0.94,1.06]	0.88	377	Germany 2002
Household electrical consumption	1.05	[0.89,1.22]	0.91	295	China 2002
Household water consumption	1.01	[0.89,1.11]	0.96	295	China 2002

$\beta > 1$
Interação
Social

Table 1. Scaling exponents for urban indicators vs. city size

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$\beta < 1$

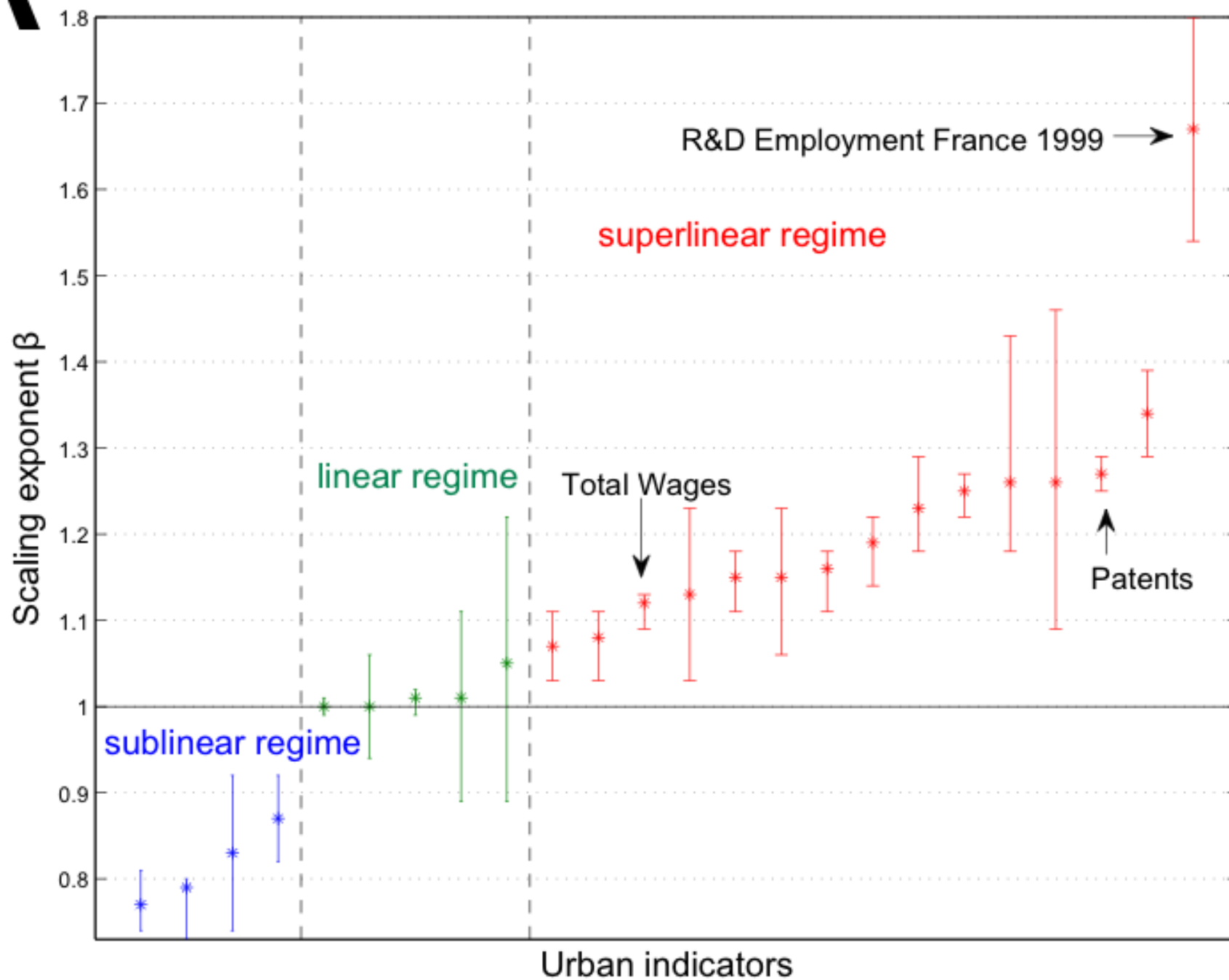
Gasoline stations	0.77	[0.74,0.81]	0.93	318	U.S. 2001
Gasoline sales	0.79	[0.73,0.80]	0.94	318	U.S. 2001
Length of electrical cables	0.87	[0.82,0.92]	0.75	380	Germany 2002
Road surface	0.83	[0.74,0.92]	0.87	29	Germany 2002

Data sources are shown in *SI Text*. CI, confidence interval; Adj- R^2 , adjusted R^2 ; GDP, gross domestic product.

Infro-estrutura

A

Results from Bettencourt et al PNAS 2007



Duplicando o tamanho da cidade
Aumenta-se sistematicamente
(aproximadamente 15%):



Duplicando o tamanho da cidade
Aumenta-se sistematicamente
(aproximadamente 15%):

- Salários;
- Riquezas;
- Número de Patentes;
- Número de Pessoas Criativas;



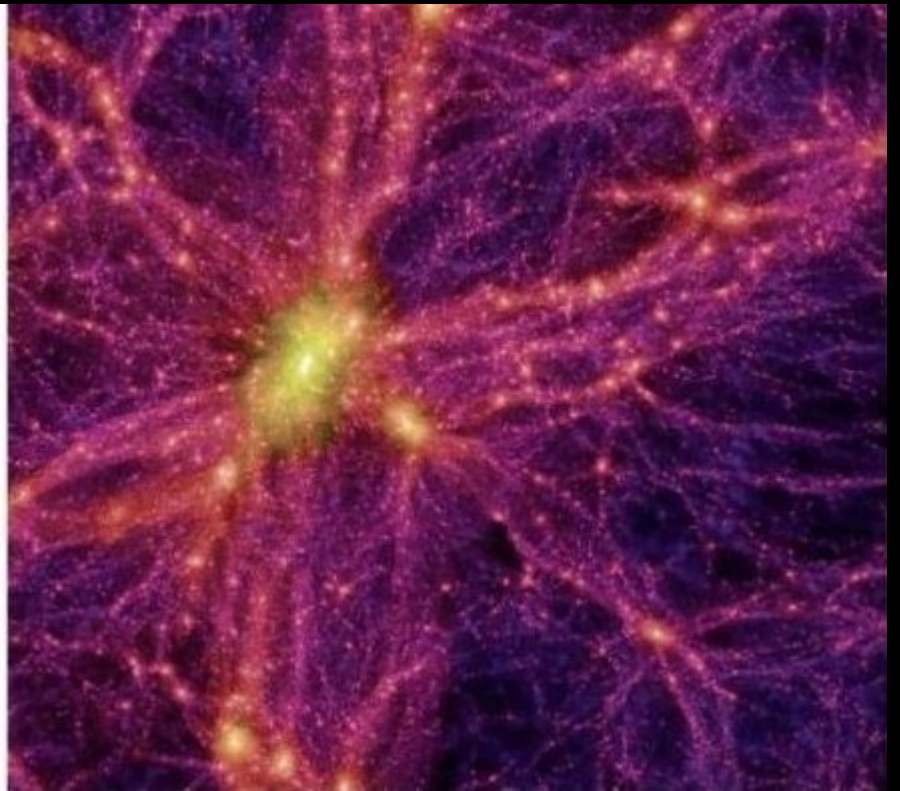
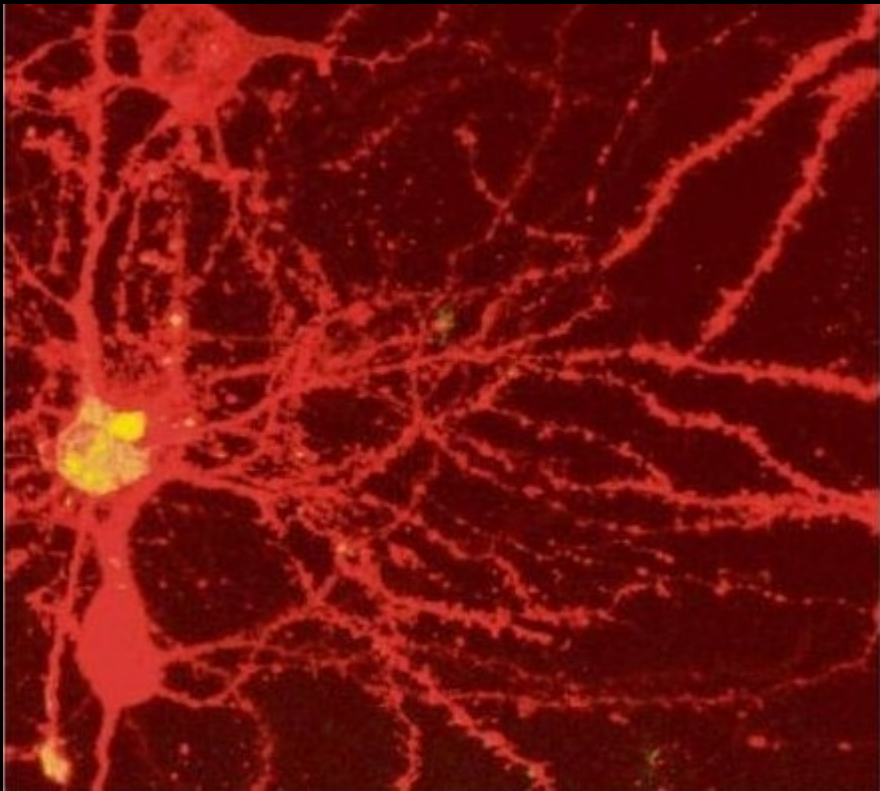
Duplicando o tamanho da cidade
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- Número de Patentes;
- Número de Pessoas Criativas;
- Número de Policiais;
- Número de crimes;
- Número de casos de AIDS e outros;

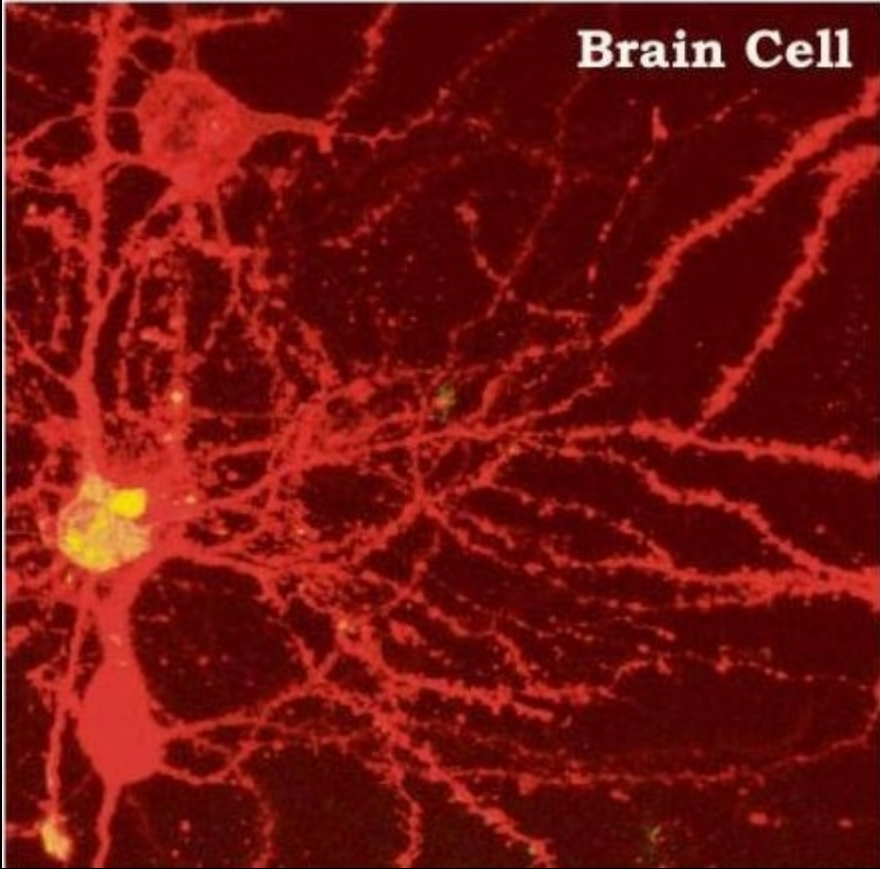


Leis de Potência :

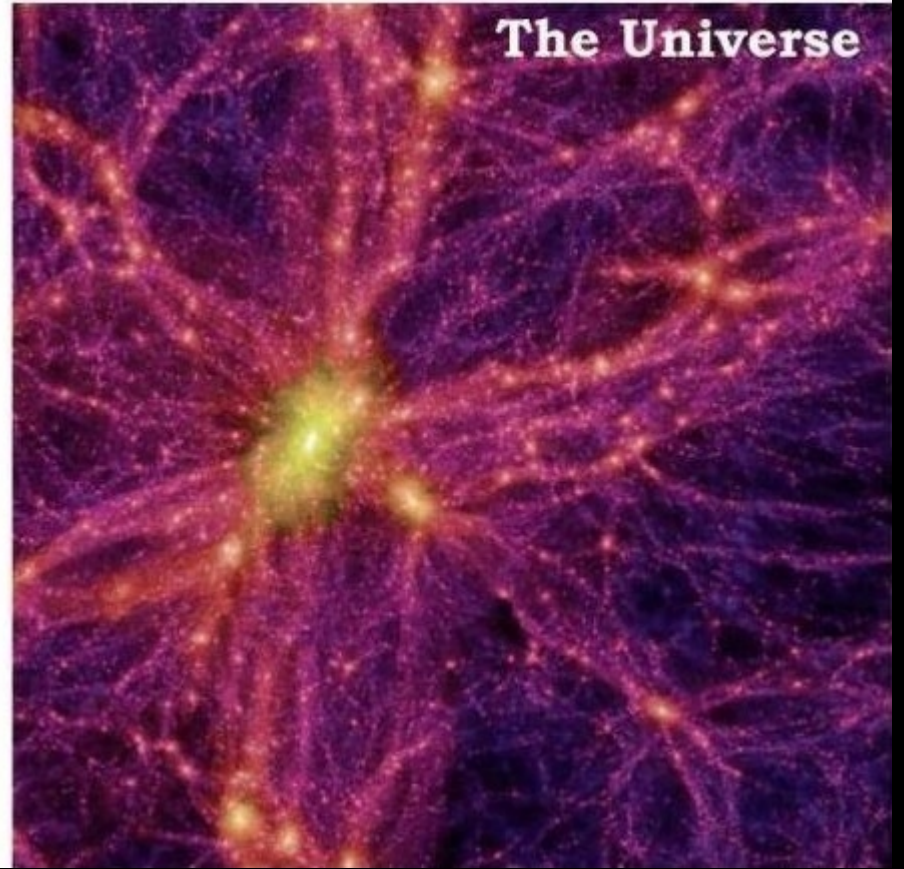
Invariância de Escala



Brain Cell



The Universe













“A radiosa infância daquelas crianças vai certamente ser transformada, pelo açúcar, em açúcar”, Muniz.

