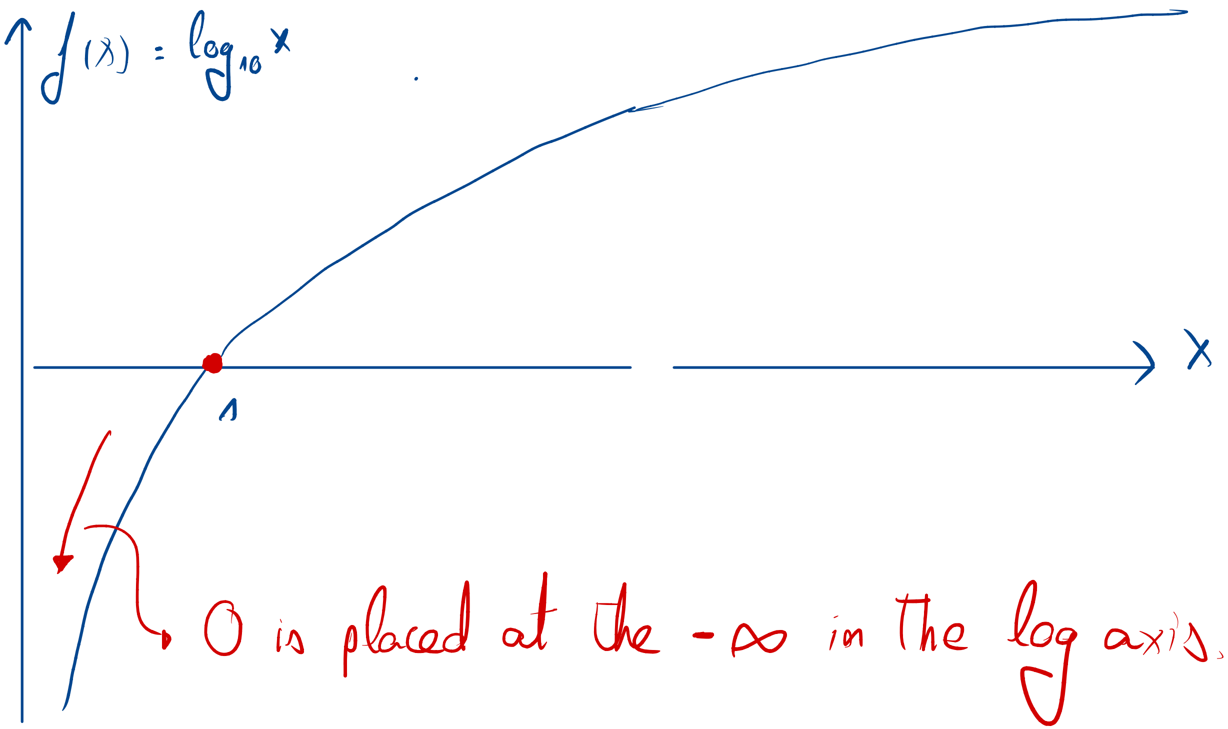
LOGARITHMIC SCALE - THEORY LESSON:

1. HOW POINTS ARE MAPPED TO THE AXIS
2. INTERPRETATION OF MOVEMENTS ALONG THE AXIS
3. THE GRID OF A LOGARITHMIC AXIS
4. USE CASES (some)
    - 4.1 → Plot large numbers and small numbers Together (different scales)
    - 4.2 → Data linearisation

...

1. How points are mapped to the axis

x	0.01	0.1	1	10	100	1000	10000
$\log_{10} x$	-2	-1	0	1	2	3	4



$$f'(x) = \frac{Ln(10)}{x}$$

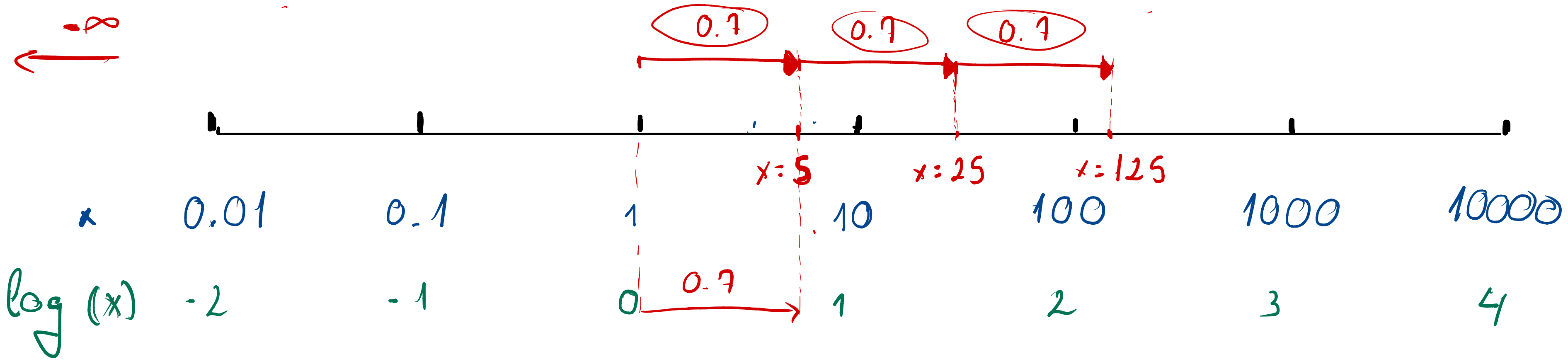
2. INTERPRETATON OF MOVEMENTS ALONG THE AXIS

$$0.01 \xleftarrow{\div 10} 0.1 \xleftarrow{\div 10} 1 \xleftarrow{\div 10} 10 \xleftarrow{\div 10} 100 \xleftarrow{\div 10} 1000 \xleftarrow{\div 10} 10000$$

$$0.01 \xrightarrow{\times 10} 0.1 \xrightarrow{\times 10} 1 \xrightarrow{\times 10} 10 \xrightarrow{\times 10} 100 \xrightarrow{\times 10} 1000 \xrightarrow{\times 10} 10000$$

x	0.01	0.1	1	10	100	1000	10000
log (x)	-2	-1	0	1	2	3	4

2. Interpretaton of movements along the axis



Geometric progression

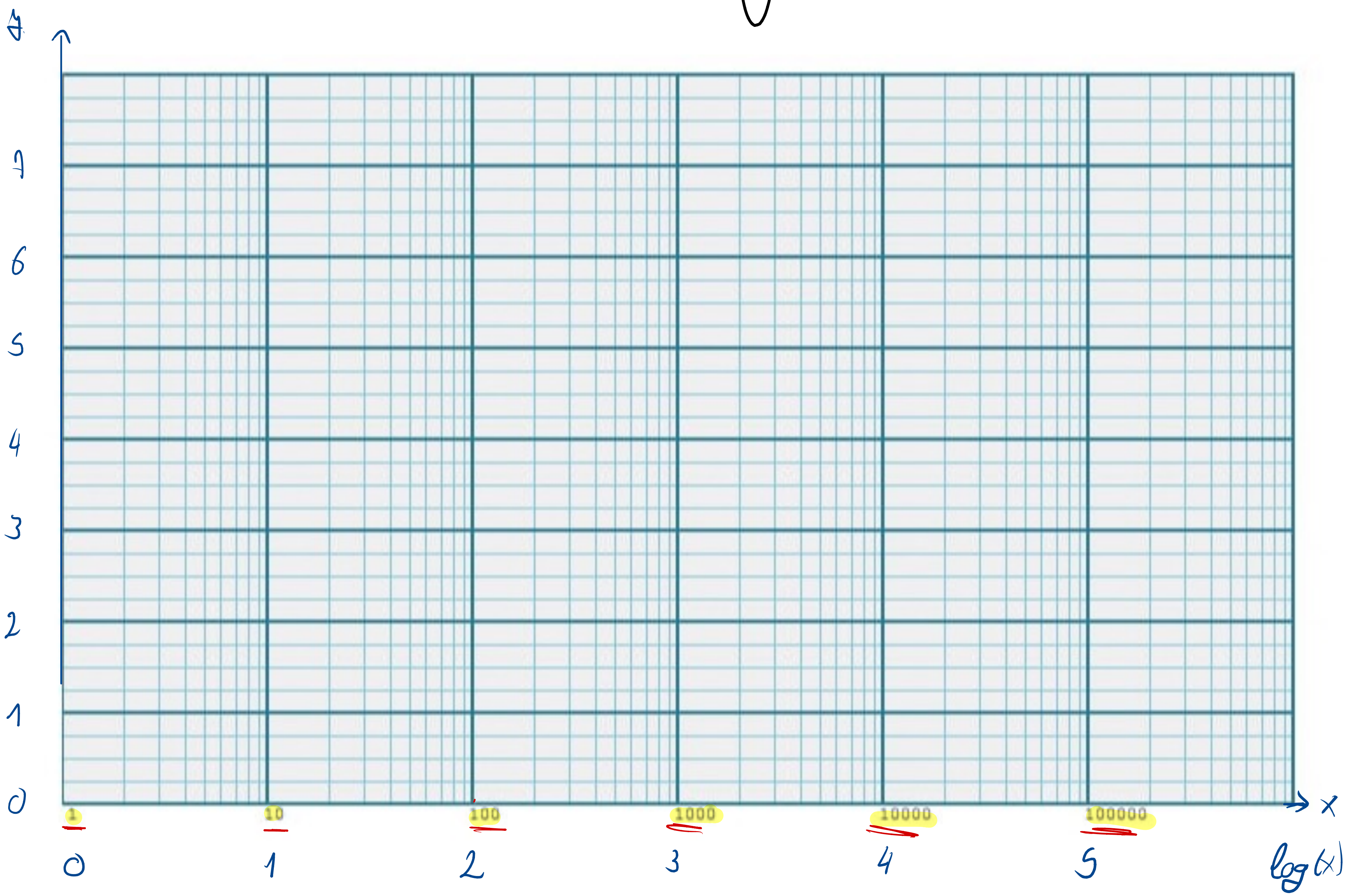
$5 \longrightarrow \log(5) = 0.7$

$25 \longrightarrow \log(5^2) = 2 \cdot \log(5) = 1.4$

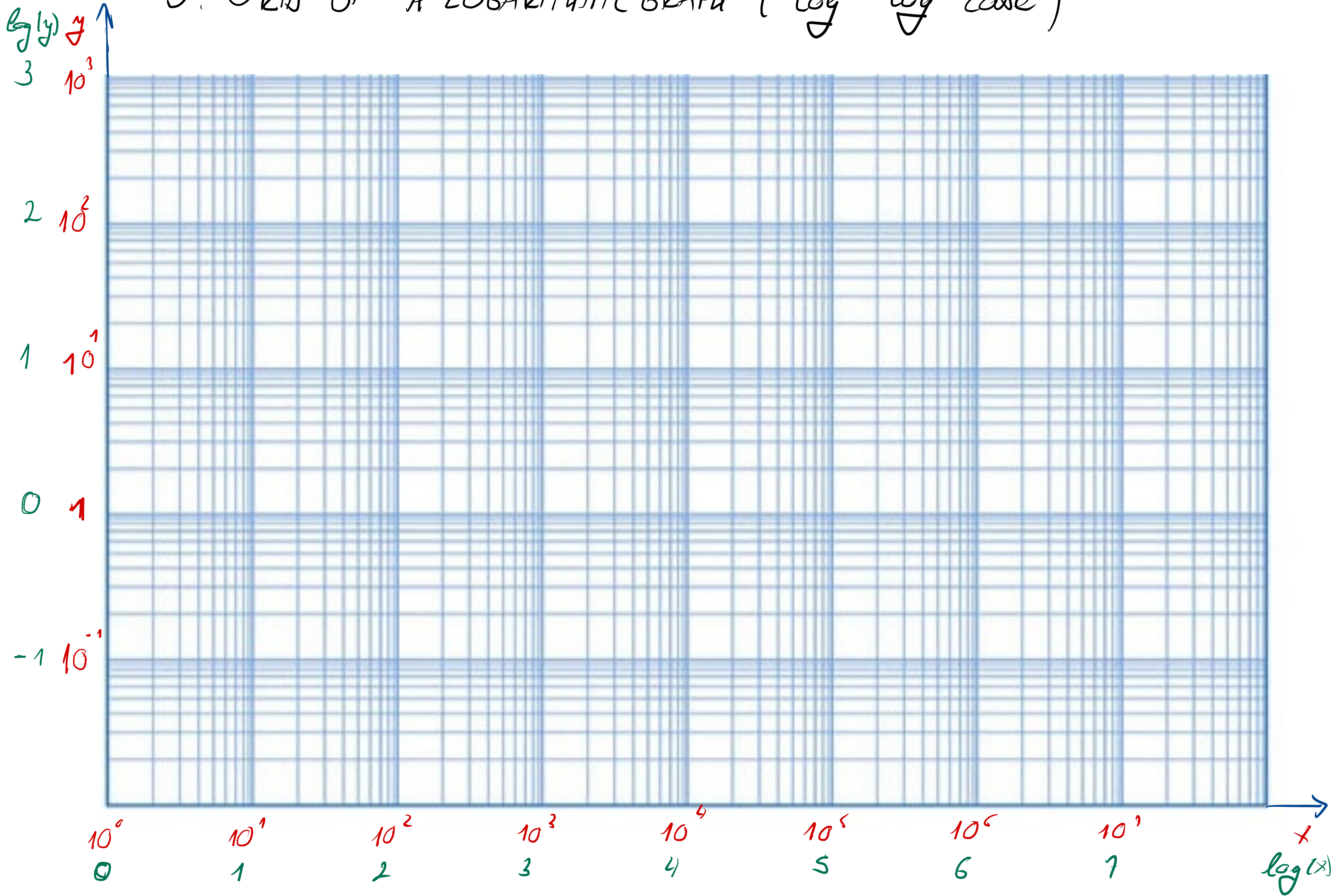
$125 \longrightarrow \log(5^3) = 3 \cdot \log(5) = 2.1$

$625 \longrightarrow \dots$

3. Grid of a logarithmic graph (log-linear case)



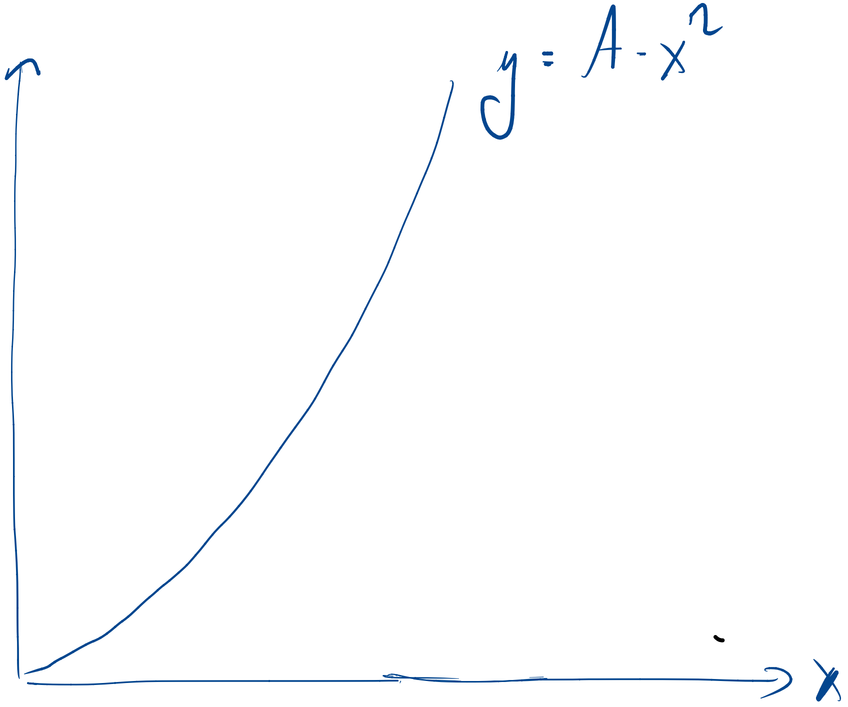
3. GRID OF A LOGARITHMIC GRAPH (log - log case)

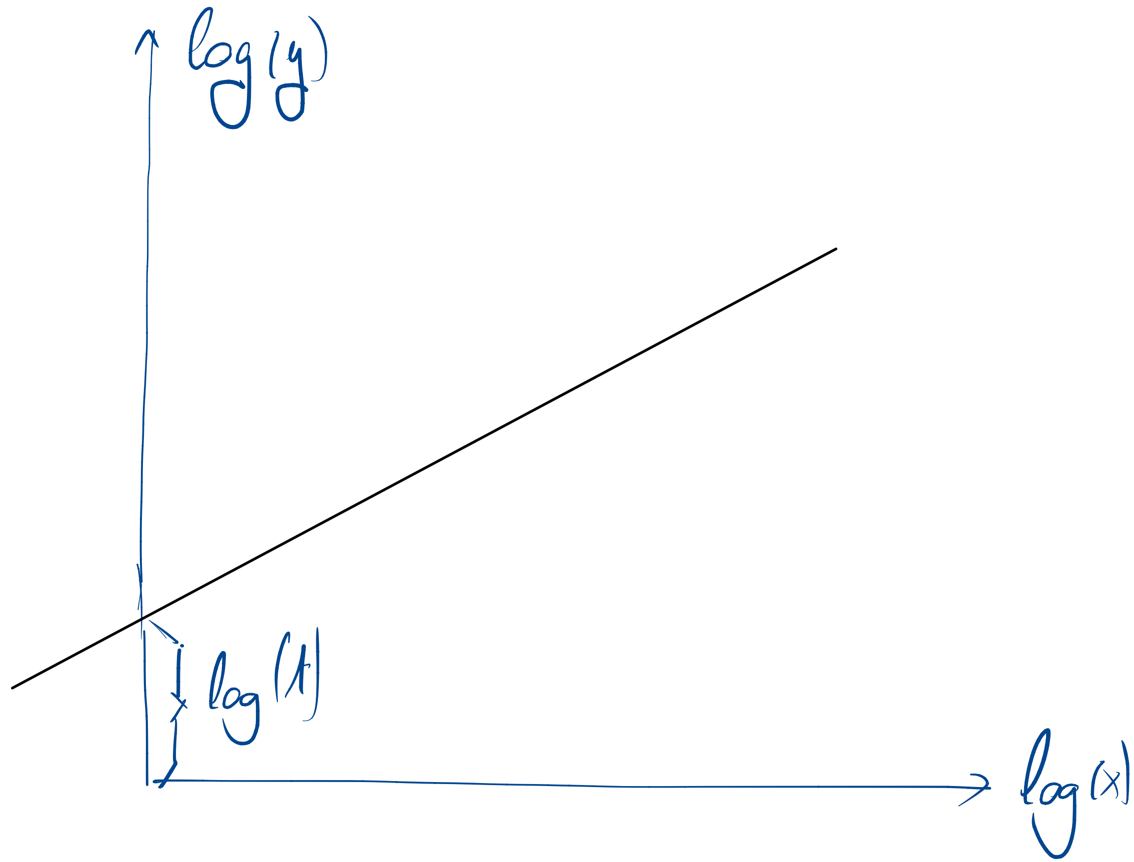


4. Use case I → linearisation

x	0.01	0.1	1	10	100	1000	10000
log (x)	-2	-1	0	1	2	3	4

$y = A \cdot x^n$



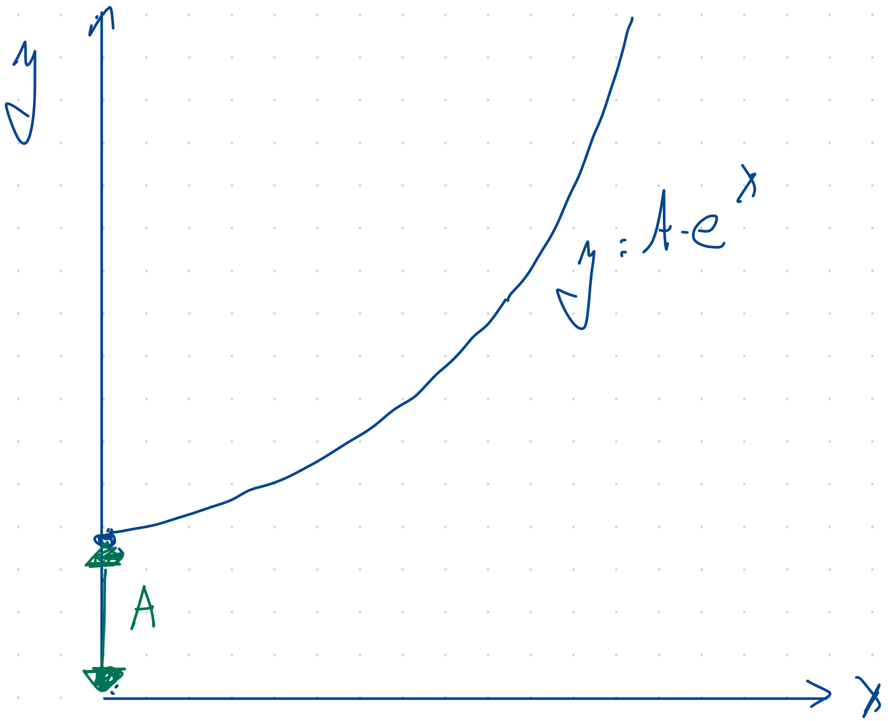


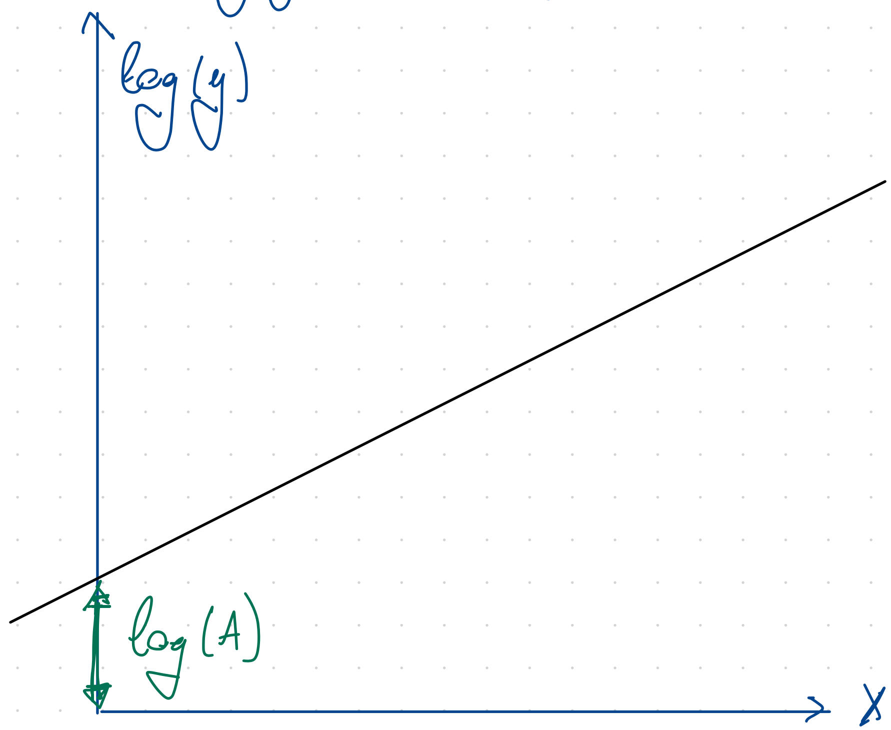
4. Use case II → linearisation

x	0.01	0.1	1	10	100	1000	10000
log (x)	-2	-1	0	1	2	3	4

$$y = A \cdot c^x$$

$$\log(y) = x + \log(A)$$

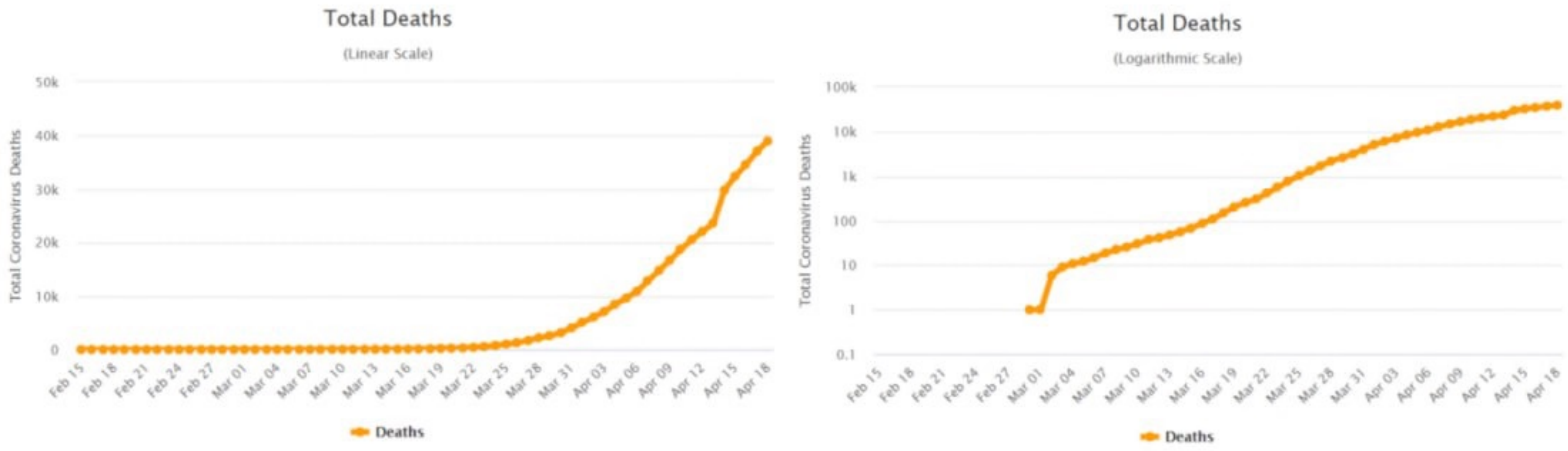




4. Use case III → Covid and exponential growth

→ linearisation
→ values of different scales plot together

Figure 1: COVID-19 Related Deaths in United States Between February 15th and April 18th in a linear scale (left panel) and in a log scale (right panel). Source: www.worldometers.info



4. Use case III (cont'd)

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PMID: 32844495

The scale of COVID-19 graphs affects understanding, attitudes, and policy preferences

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Mass media routinely present data on coronavirus disease 2019 (COVID-19) diffusion with graphs that use either a log scale or a linear scale. We show that the choice of the scale adopted on these graphs has important consequences on how people understand and react to the information conveyed. In particular, we find that when we show the number of COVID-19 related deaths on a logarithmic scale, people have a less accurate understanding of how the pandemic has developed, make less accurate predictions on its evolution, and have different policy preferences than when they are exposed to a linear scale. Consequently, merely changing the scale the data is presented on can alter public policy preferences and the level of worry about the pandemic, despite the fact that people are routinely exposed to COVID-19 related information. Providing the public with information in ways they understand better can help improving the response to COVID-19, thus, mass media and policymakers communicating to the general public should always describe the evolution of the pandemic using a graph on a linear scale, at least as a default option. Our results suggest that framing matters when communicating to the public.

Keywords: COVID-19, framing, media, public understanding

4. Use case III (cont'd)

Logarithmic scales in ecological data presentation may cause misinterpretation

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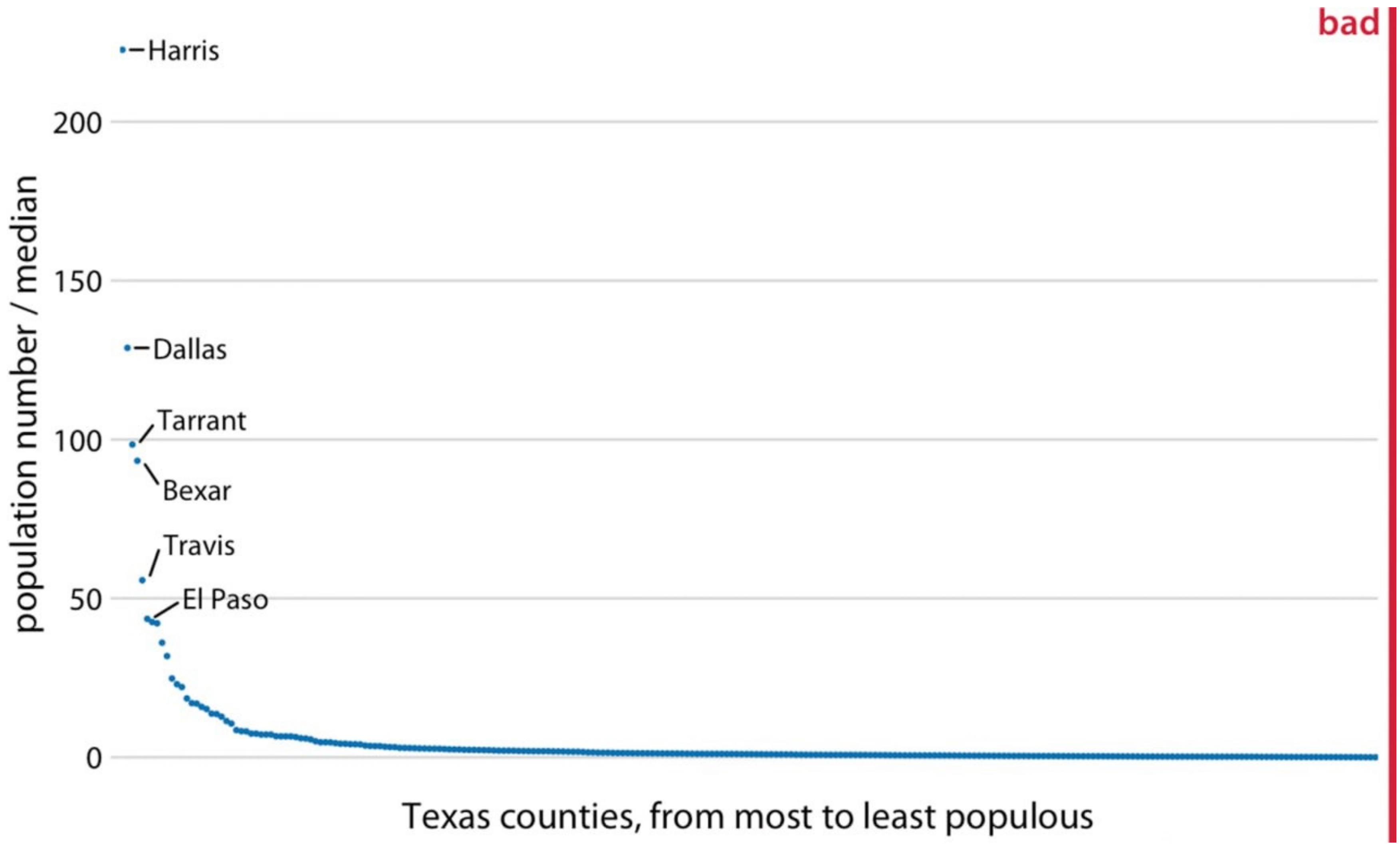
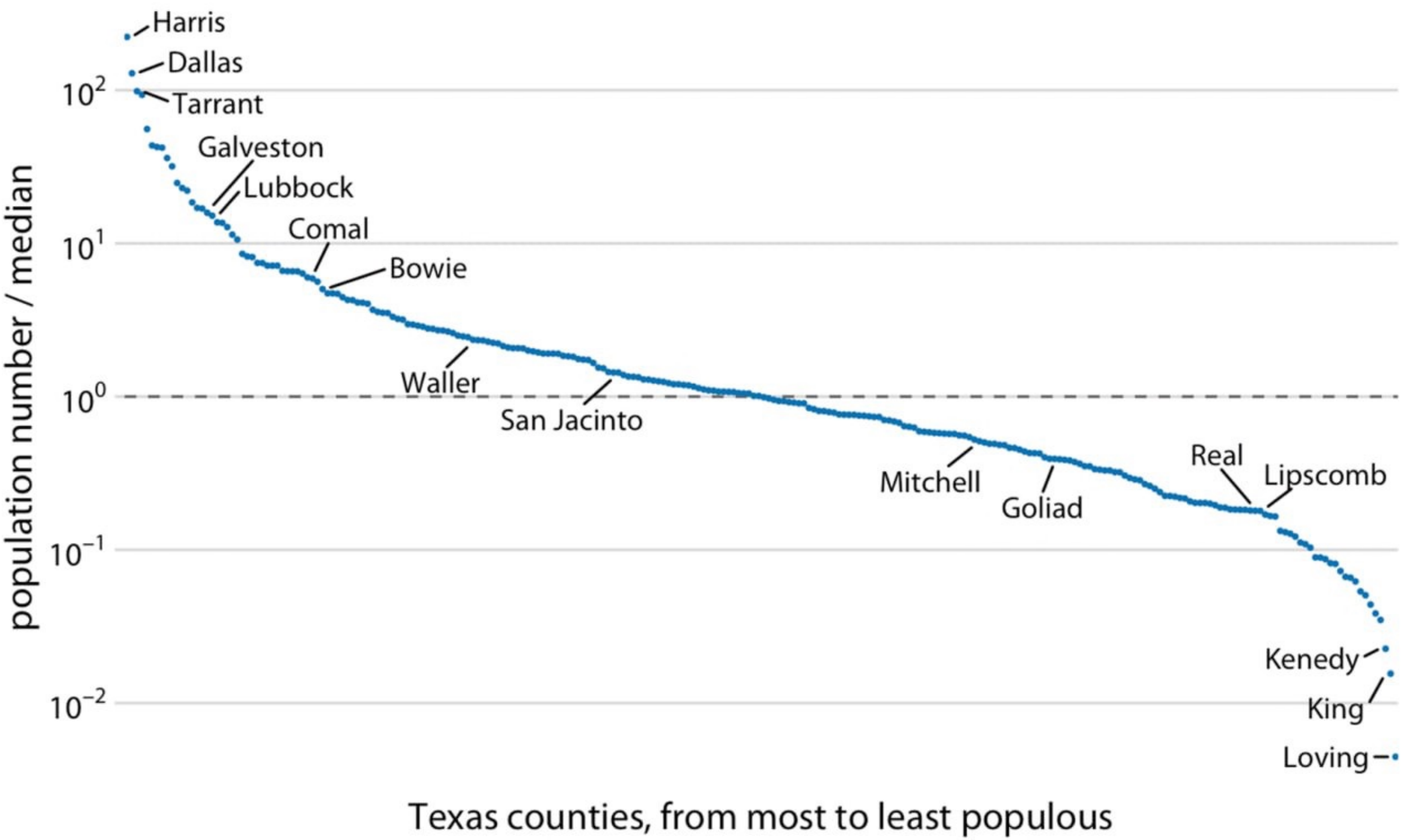
Scientific communication relies on clear presentation of data. Logarithmic scales are used frequently for data presentation in many scientific disciplines, including ecology, but the degree to which they are correctly interpreted by readers is unclear. Analysing the extent of log scales in the literature, we show that 22% of papers published in the journal Ecology in 2015 included at least one log-scaled axis, of which 21% were log-log displays. We conducted a survey that asked members of the Ecological Society of America (988 responses, and 623 completed surveys) to interpret graphs that were randomly displayed with linear-linear or log-log axes. Many more respondents interpreted graphs correctly when the graphs had linear-linear axes than when they had log-log axes: 93% versus 56% for our all-around metric, although some of the individual item comparisons were even more skewed (for example, 86% versus 9% and 88% versus 12%). These results suggest that misconceptions about log-scaled data are rampant. We recommend that ecology curricula include explicit instruction on how to interpret log-scaled axes and equations, and we also recommend that authors take the potential for misconceptions into account when deciding how to visualize data.

4. Use case IV: data with multiple scales → e.g.: population



4. Use case IV: data with multiple scales → e.g: population



4. Use case V:

Fatigue curves in engineering