

# CS 5630/6630

## Scientific Visualization

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Elementary Plotting Techniques I

# Motivation

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- Everyone uses plotting
- It is easy to lie or to deceive people with bad plots
- Default plotting tools are terrible
- Most people ignore or are unaware of simple principles

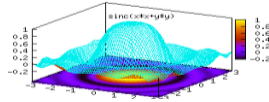


<http://plasma-gate.weizmann.ac.il/Grace/>

**gnuplot homepage**

FAQ  
Download  
Demo  
Contributed scripts and files  
Tutorials, learning, and help  
Building from CVS source  
More on patching and building

Documentation  
External Links  
Screenshots



<http://www.gnuplot.info/>



**QtPlot**

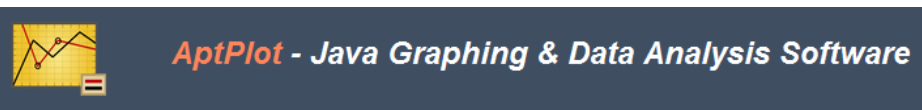
<http://soft.proindependent.com/pricing.html>



<http://office.microsoft.com/en-us/excel/default.aspx>



<http://www.mathworks.com/>



<http://www.aptpplot.com/>



<http://www.sigmaplot.com/products/sigmaplot/sigmaplot-details.php>



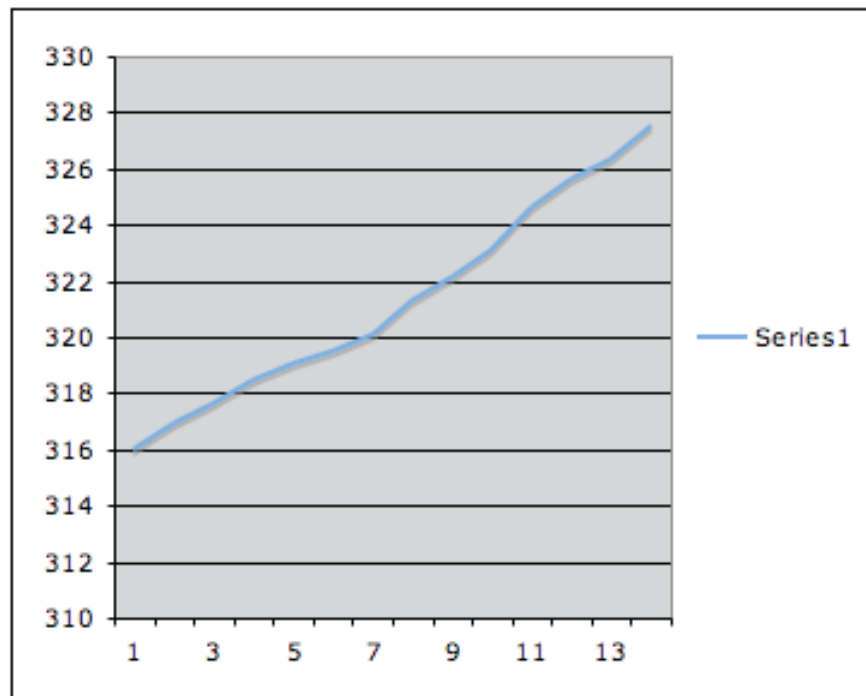
<http://matplotlib.sourceforge.net/>



<http://www.wolfram.com/>

# Motivation

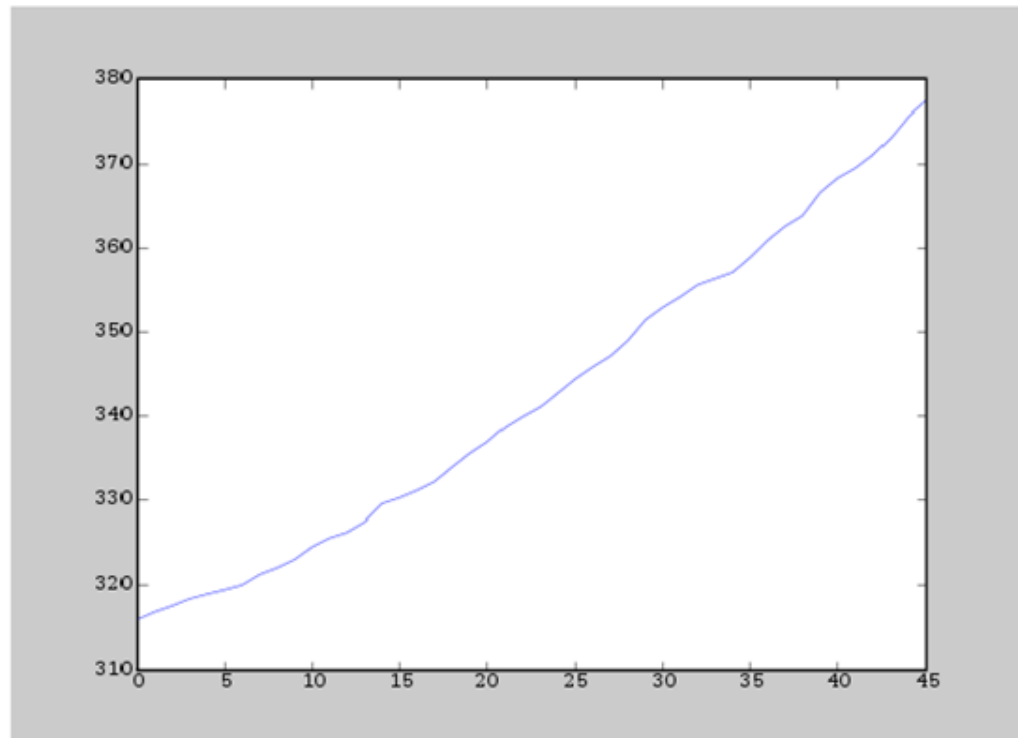
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Default Excel Plot

# Motivation

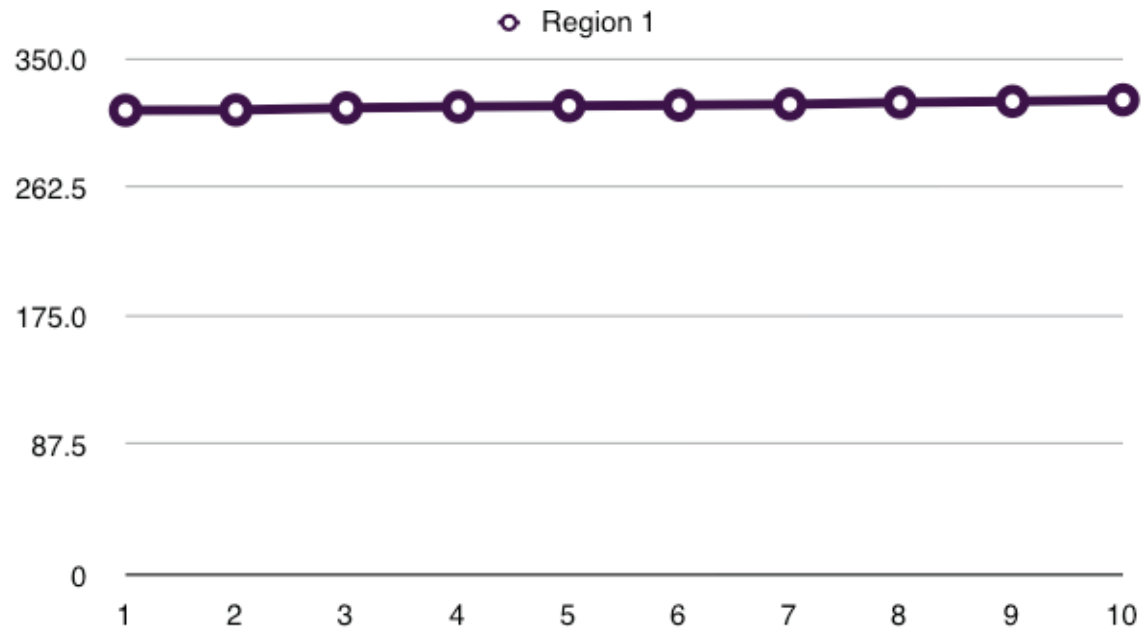
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Default Matplotlib/Matlab Plot

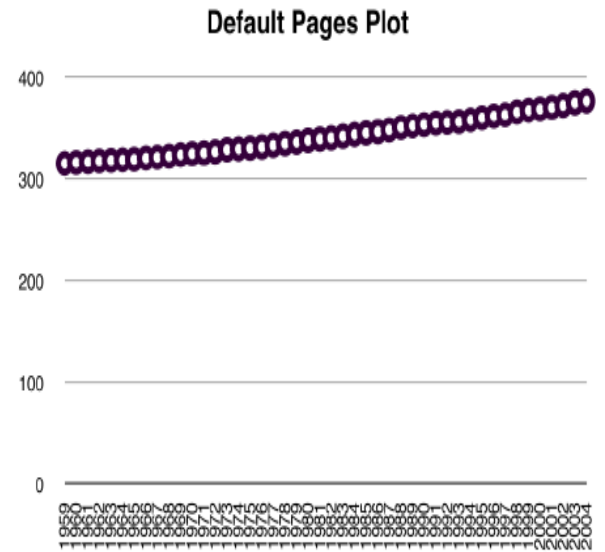
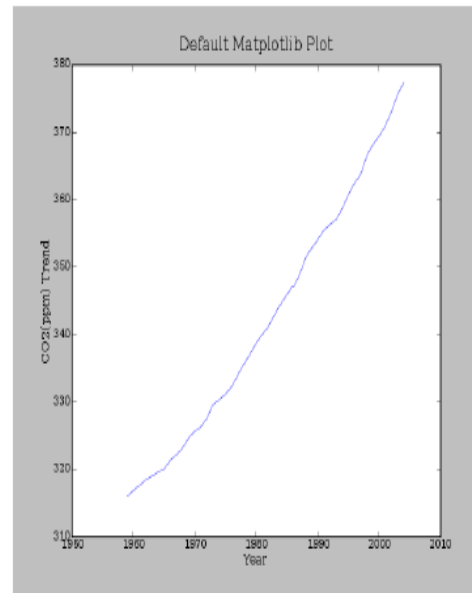
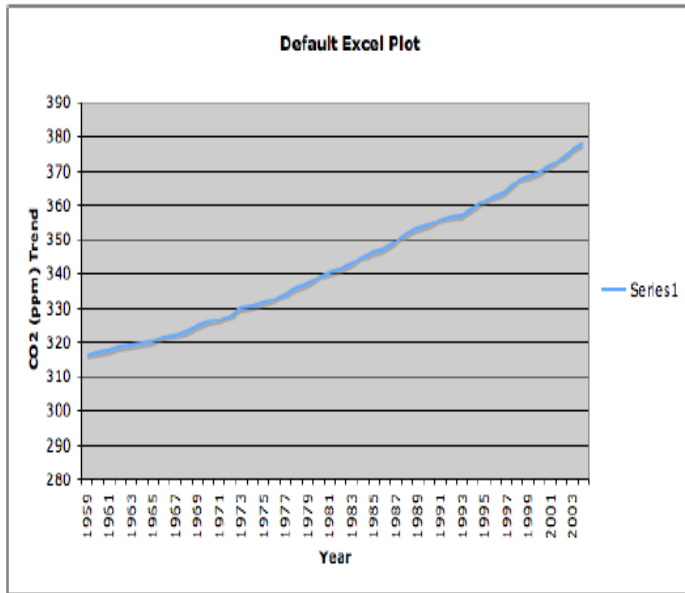
# Motivation

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Default Pages Plot

# Motivation

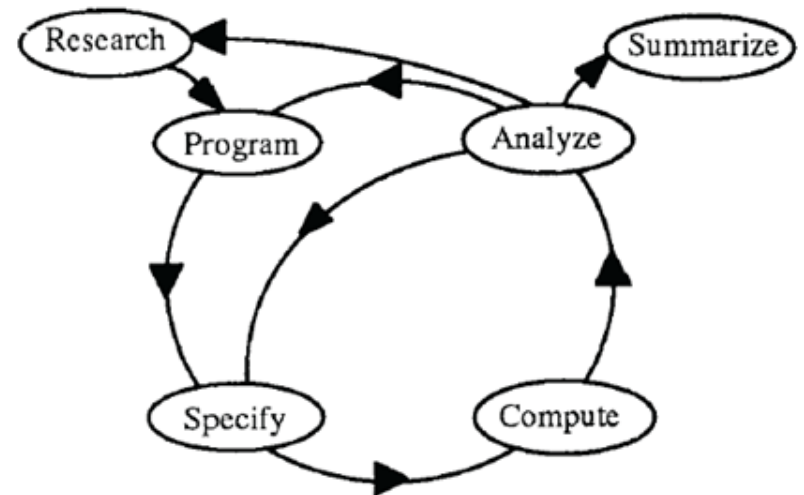


- Why are they all different?
- What is good/bad about each?

# Fundamentals of plotting

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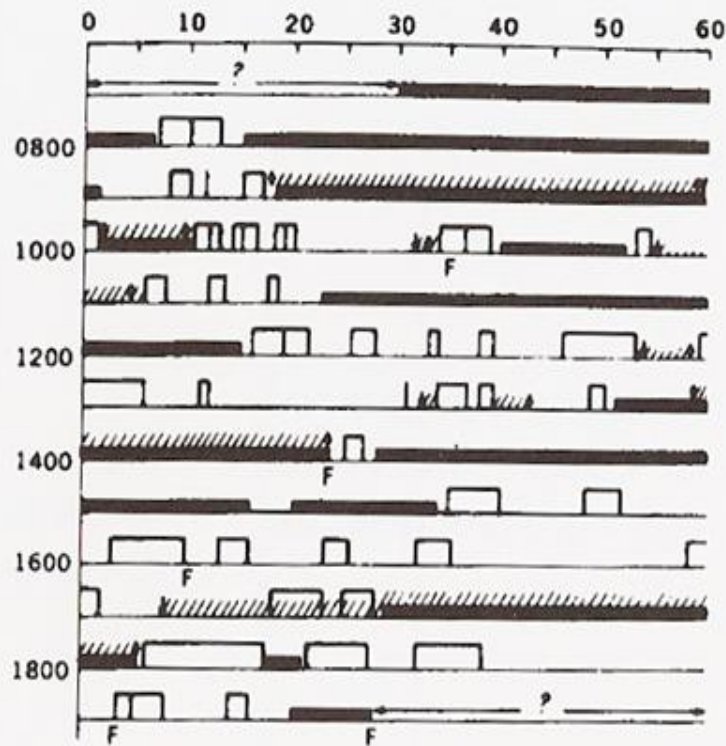
- Analysis vs. Communication
- Presenting data vs. Presenting correlation
- Vision vs. Understanding





# Clear Vision

- Principle 1: Make data stand out
- Avoid superfluity, clutter, or chartjunk.



## Activities of a !Kung woman and her baby

Open Bar and Vertical Lines: Nursing times

Closed Bars: Sleeping

F: Fretting

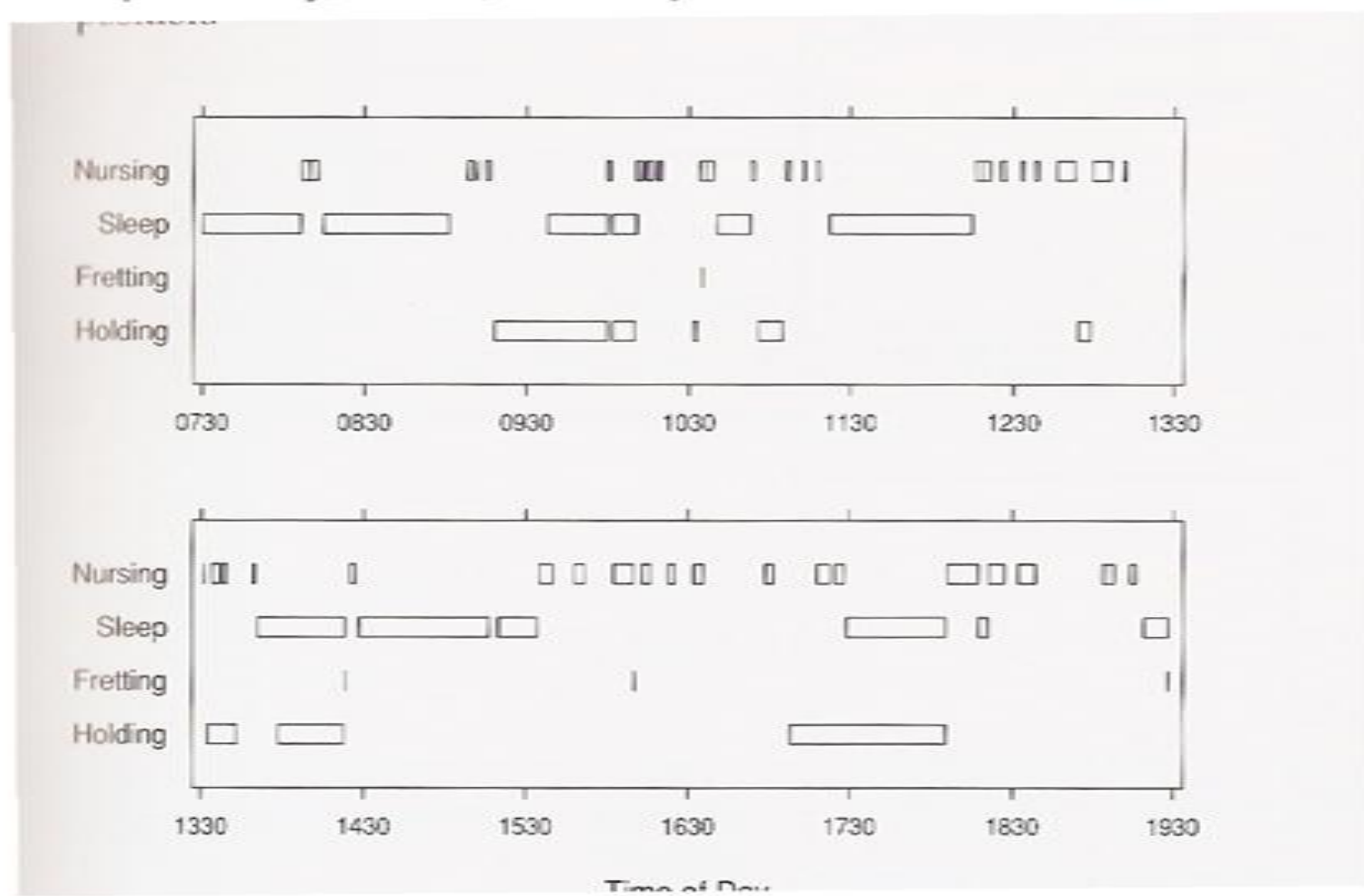
Slashed Lines: Held by mother

Arrows: Picking up and setting down

# Clear Vision

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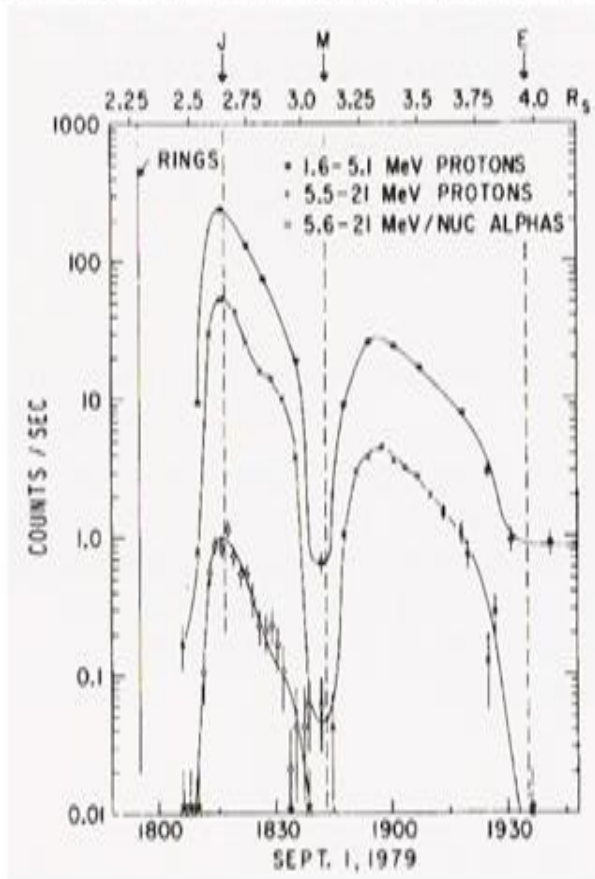
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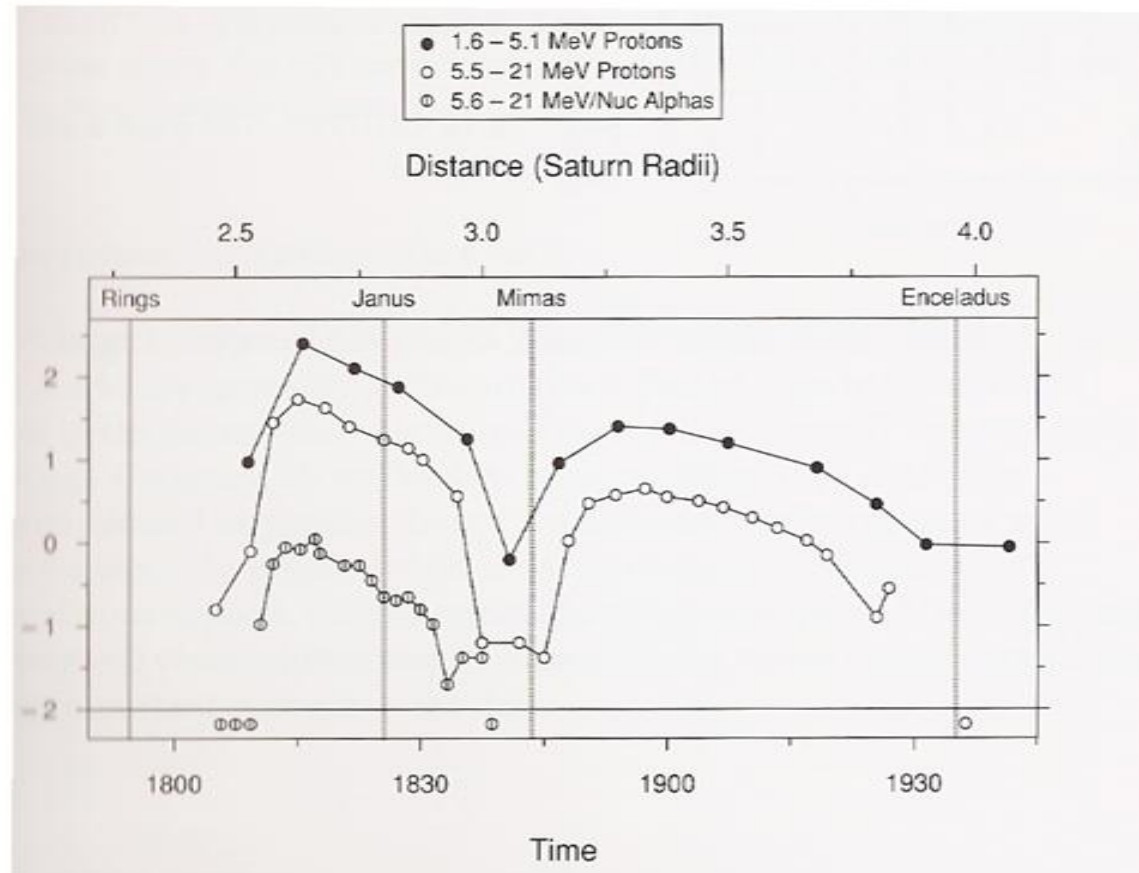
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# Clear Vision

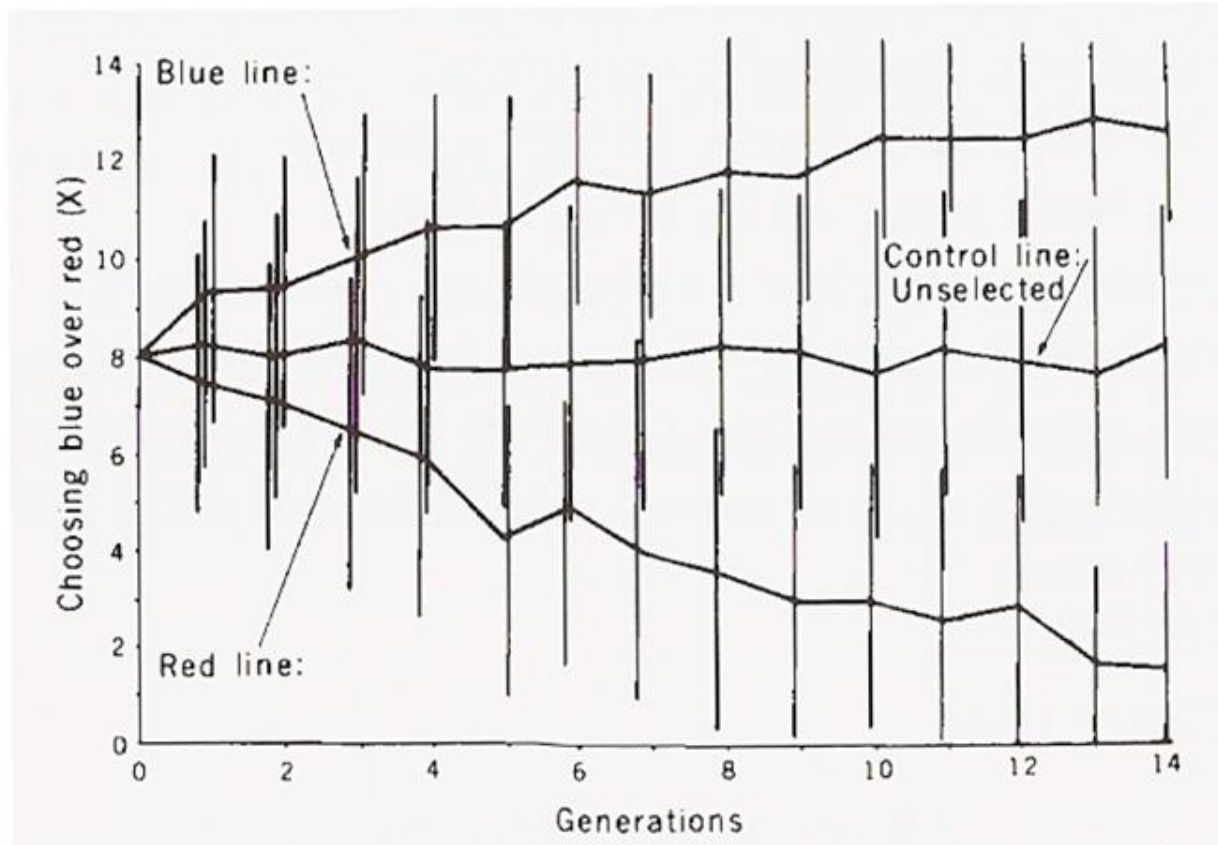
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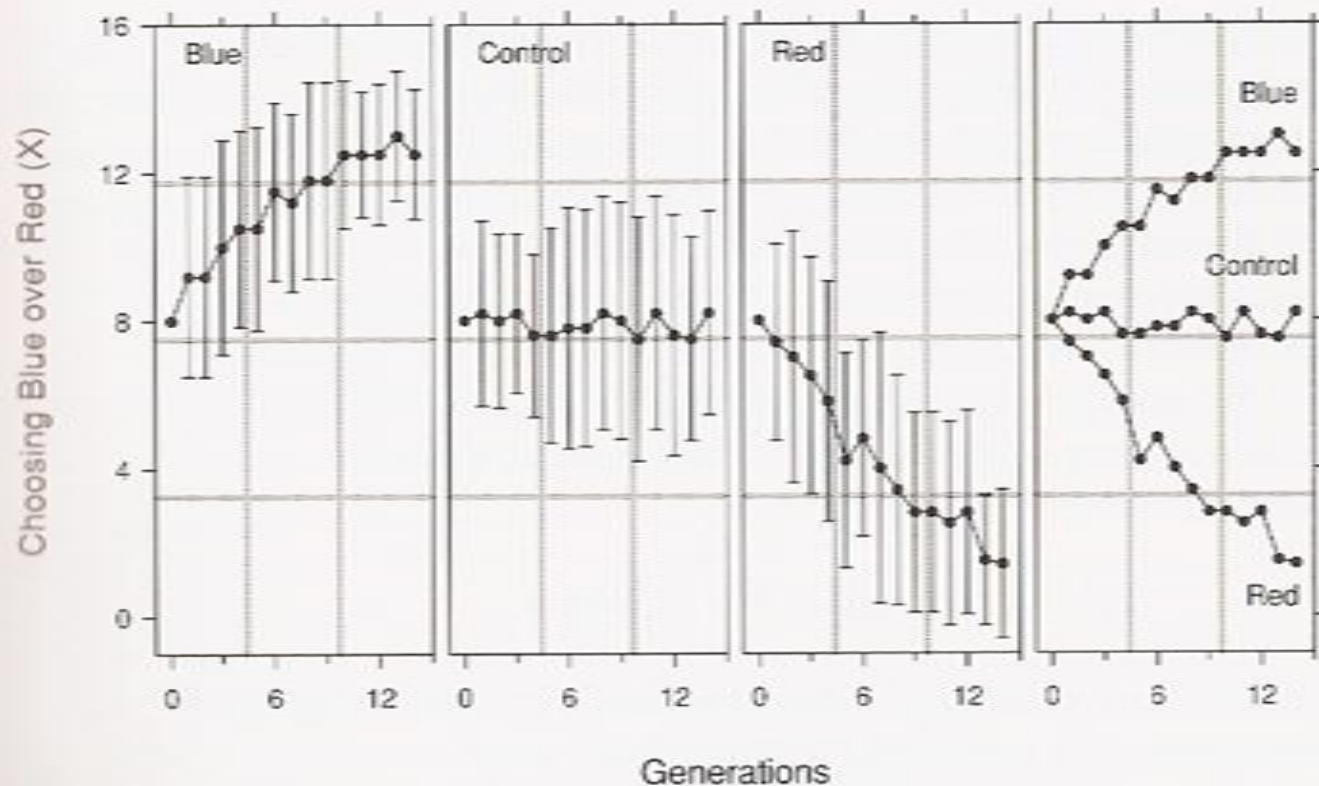
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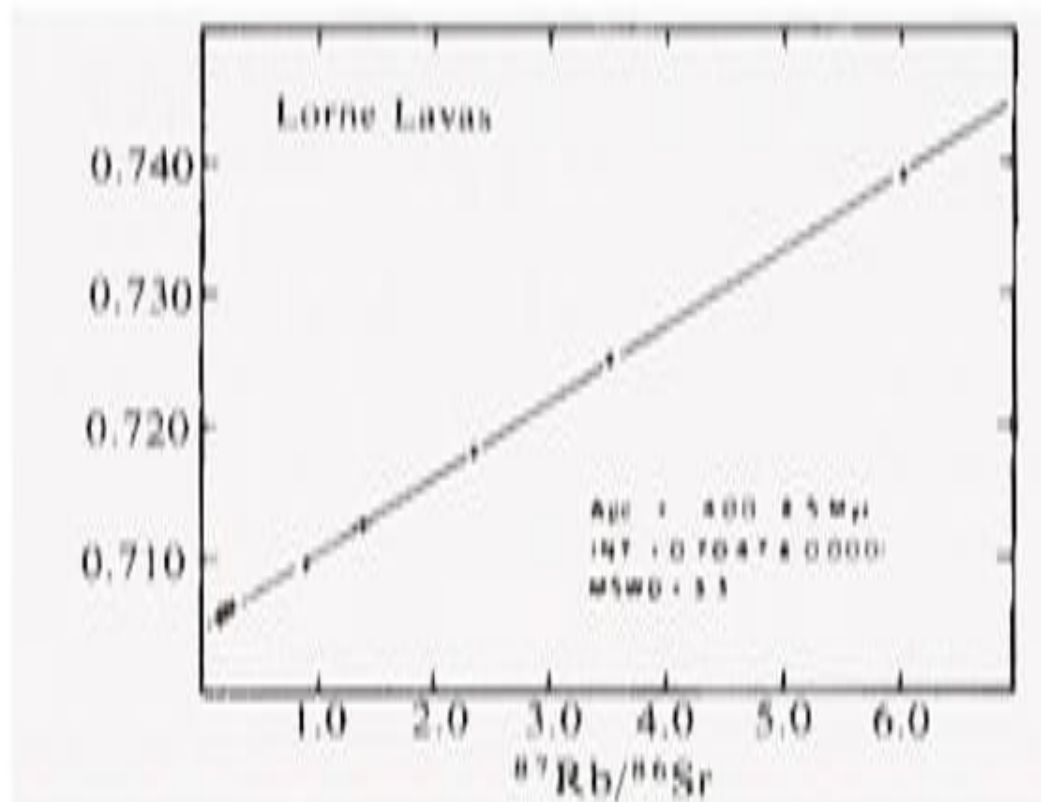
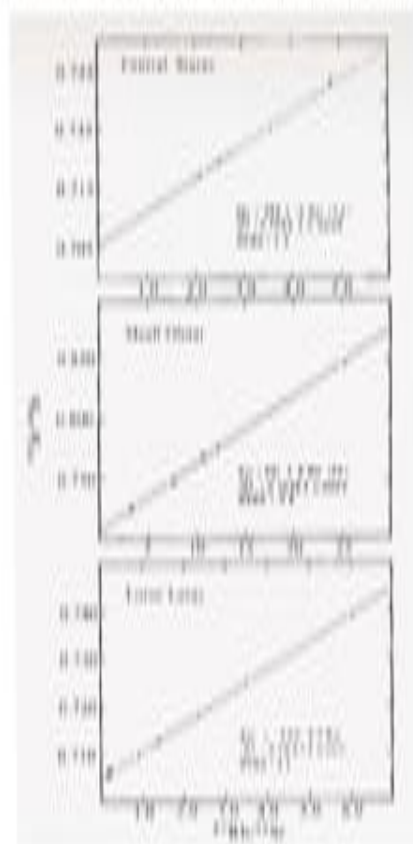
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# Clear Vision

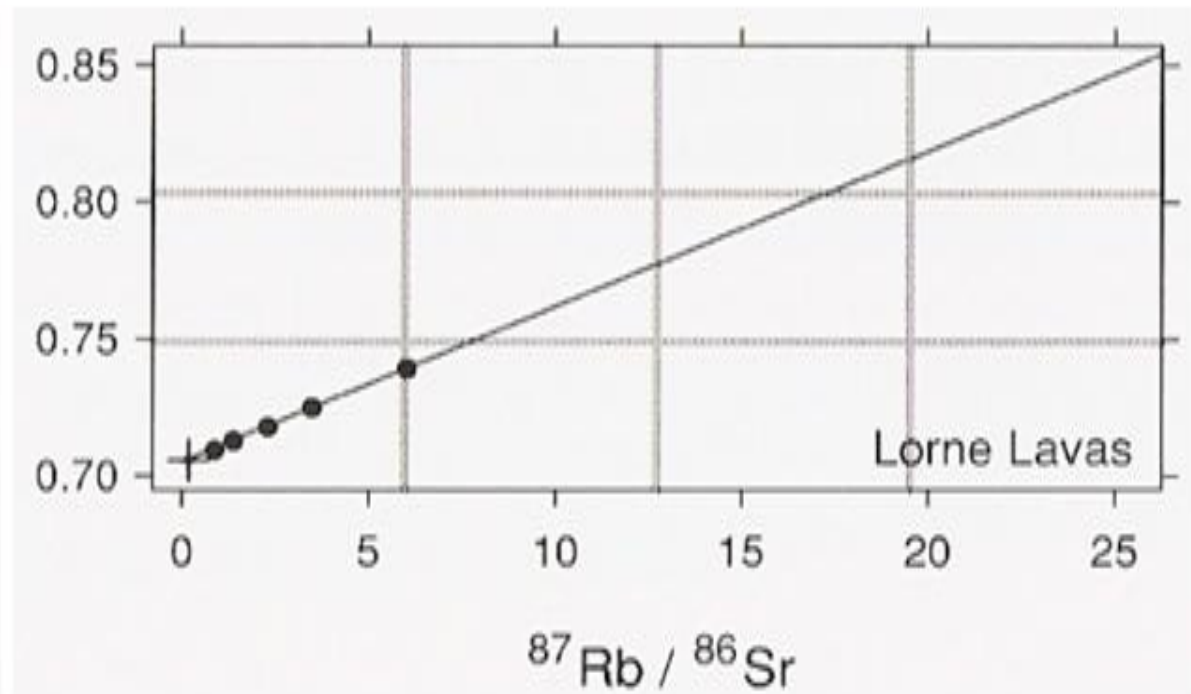
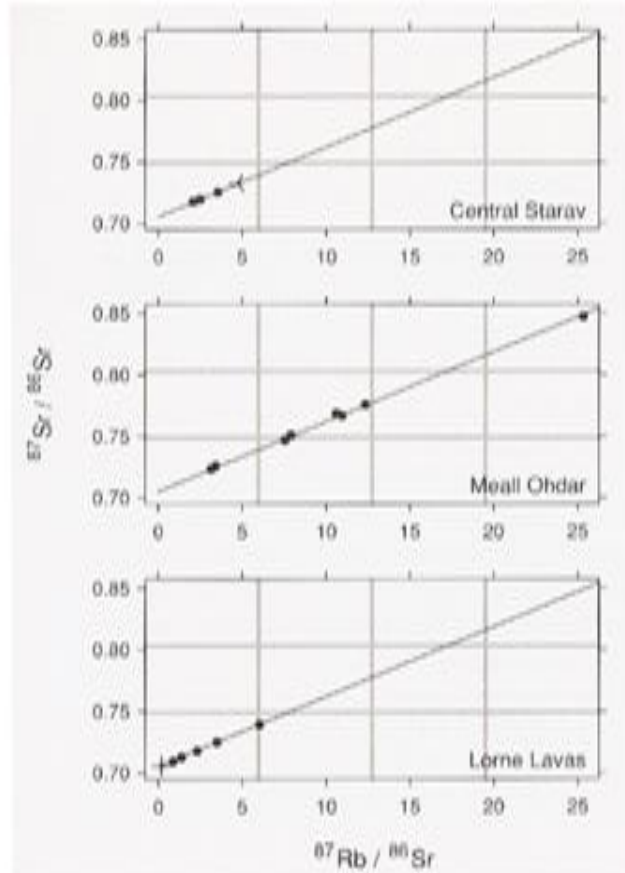
- Principle 2: Visual prominence
- Use visually prominent graphical elements to show the data.



# Clear Vision

- Principle 2: Visual prominence

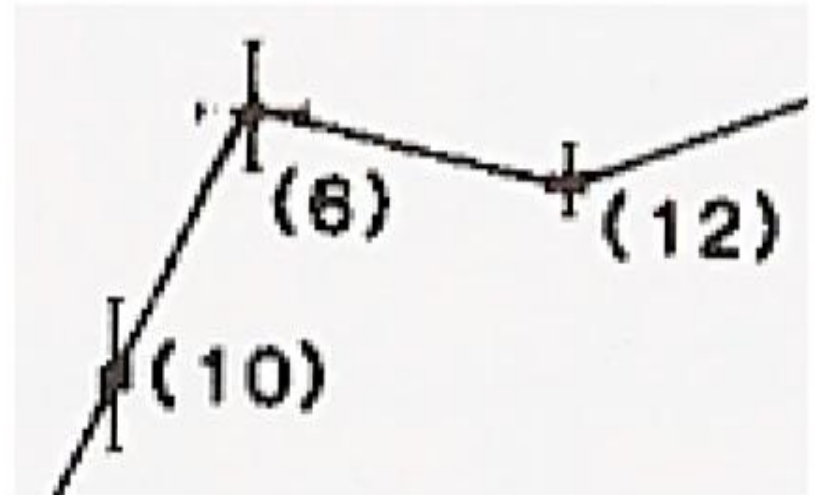
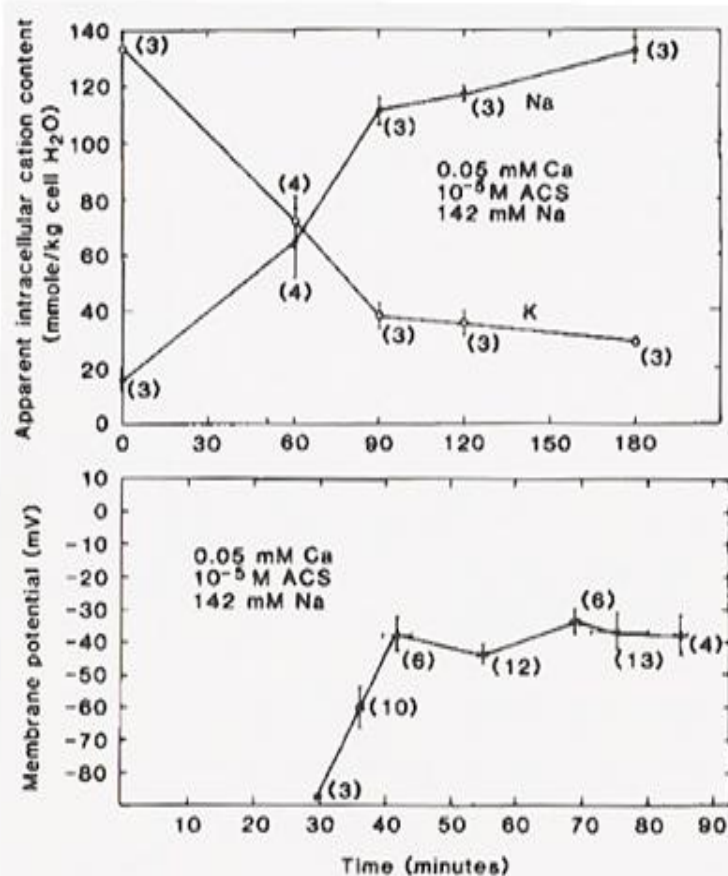
- Use visually prominent graphical elements to show the data.





# Clear Vision

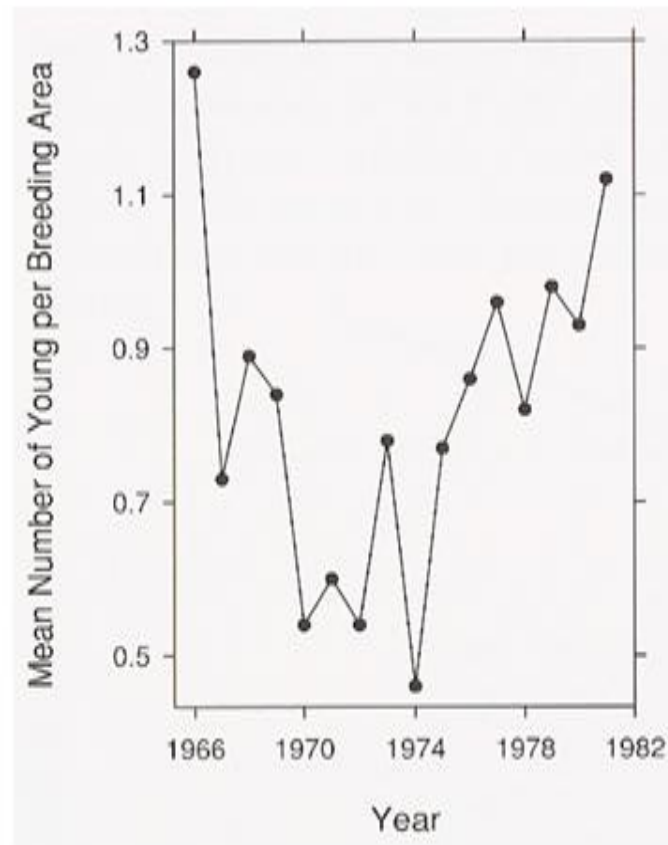
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# Clear Vision

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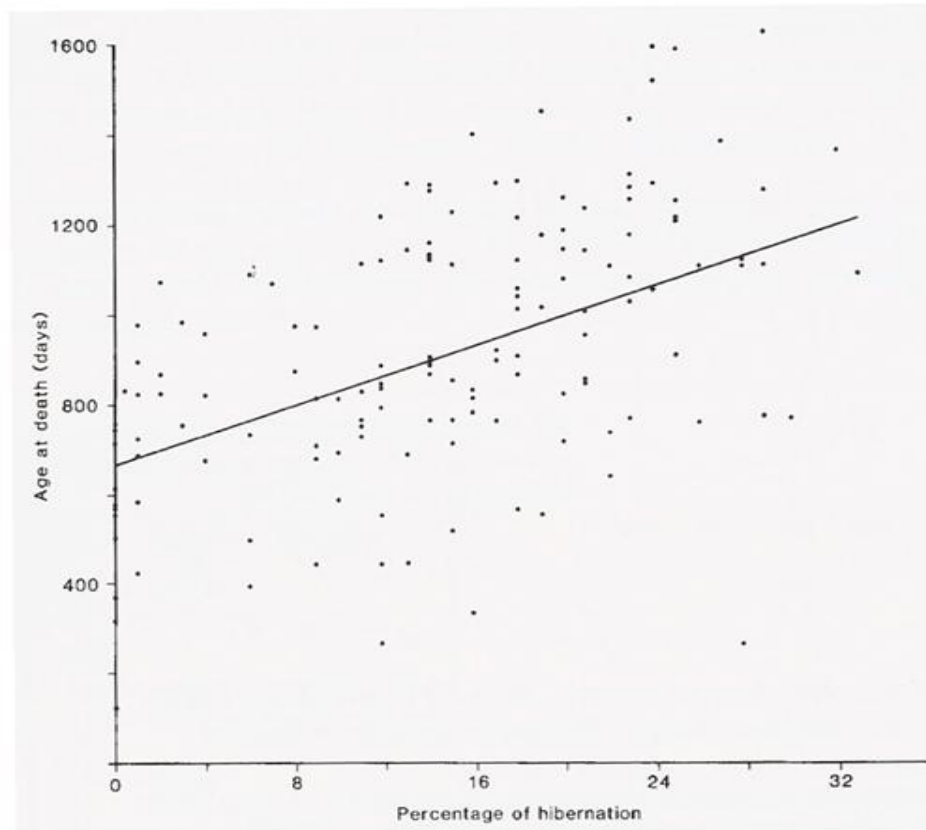
- Principle 2: Visual prominence
  - Use visually prominent graphical elements to show the data.



# Clear Vision

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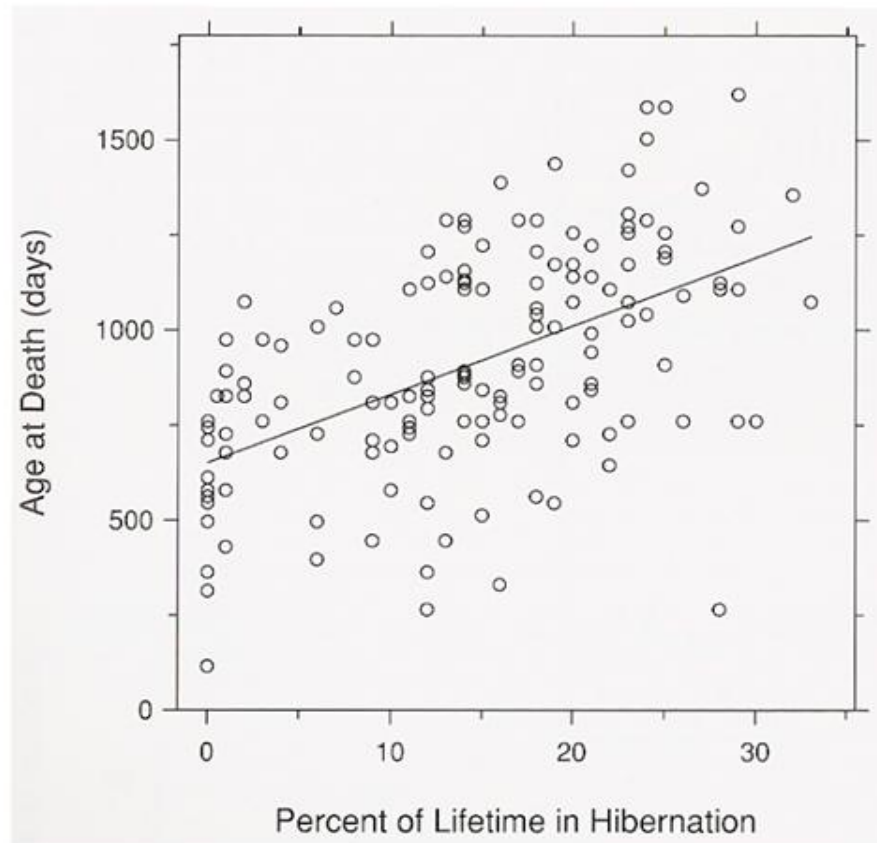
- Principle 3: Scale lines and the data rectangle
  - Use two scale lines (box), add margins for data, tick-marks out, 3-10 tick marks.



# Clear Vision

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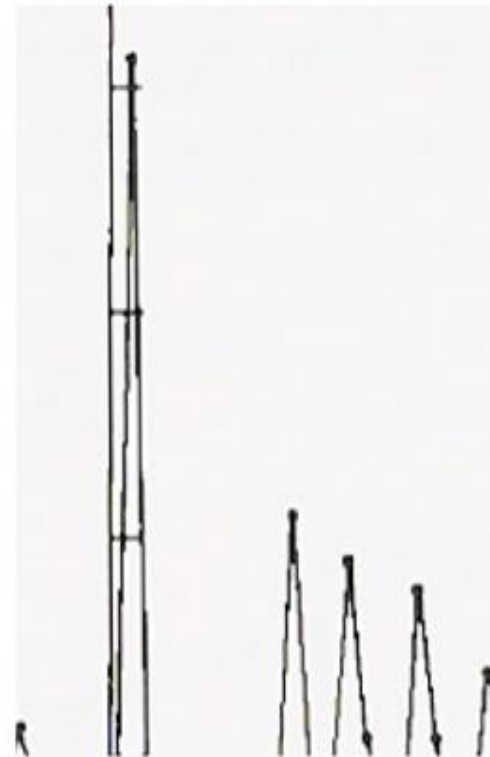
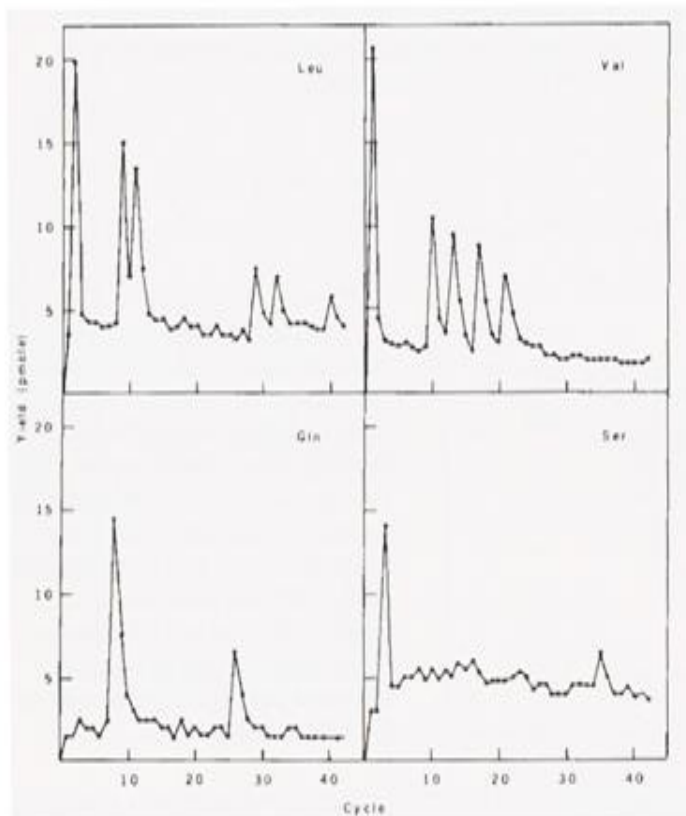
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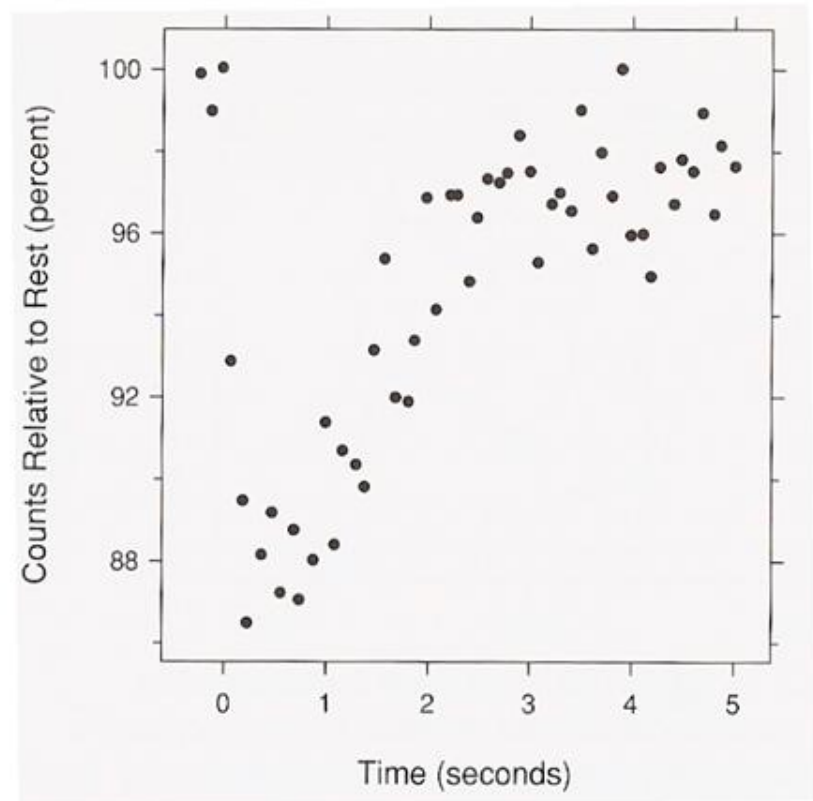
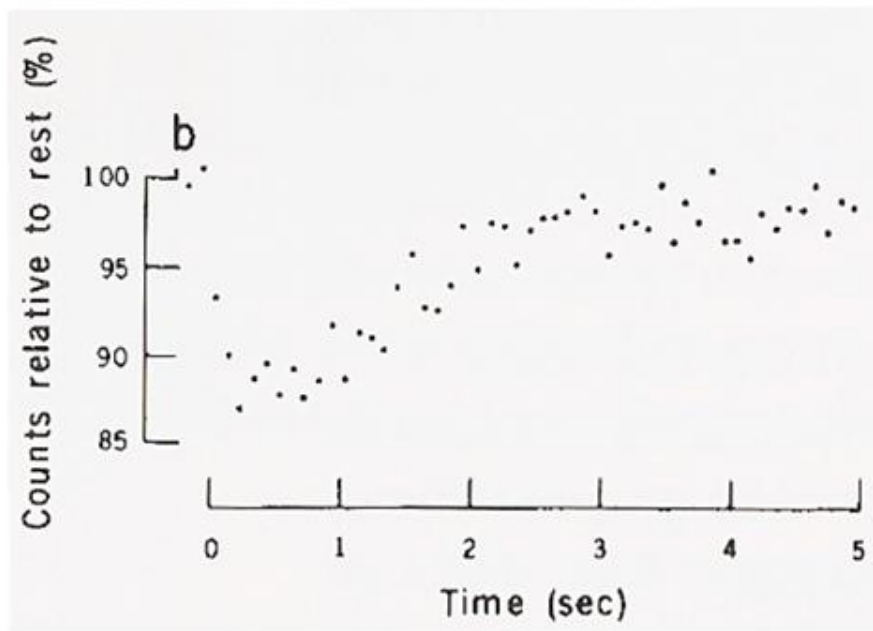
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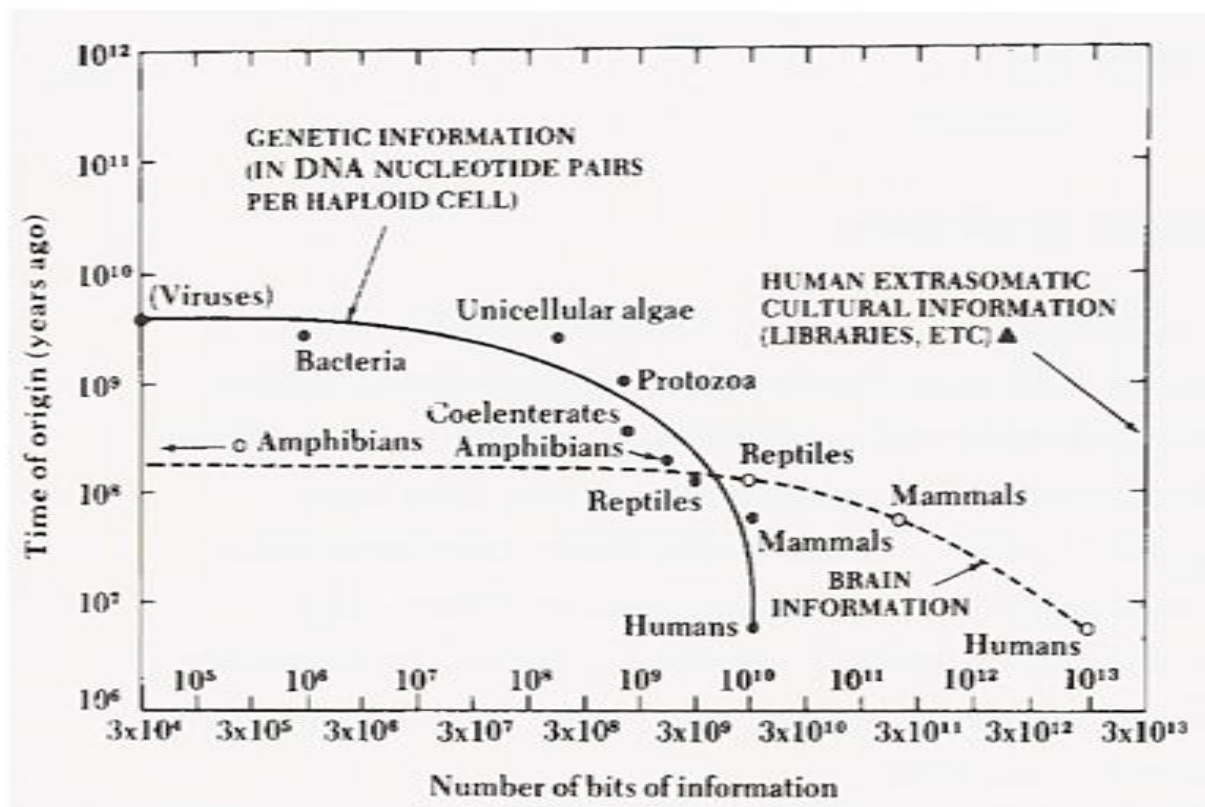
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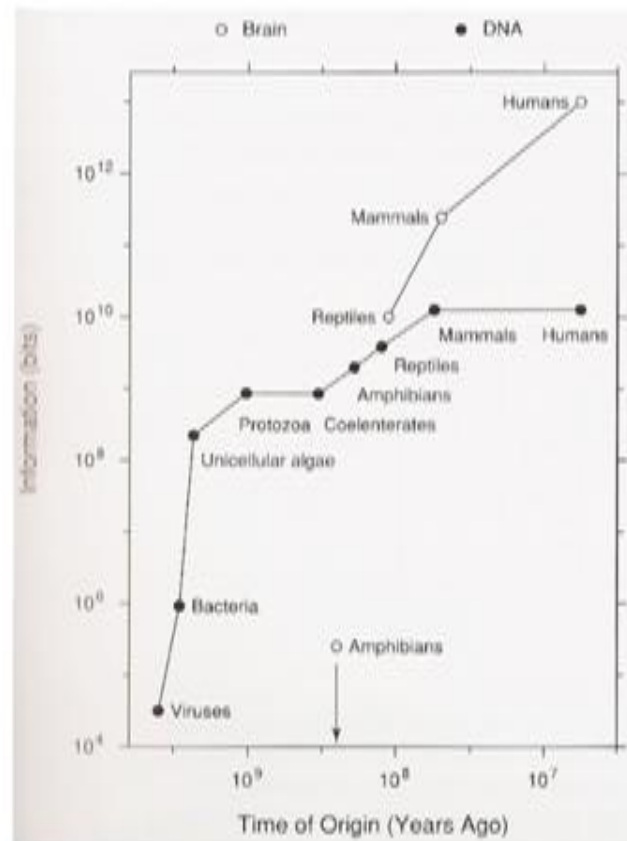
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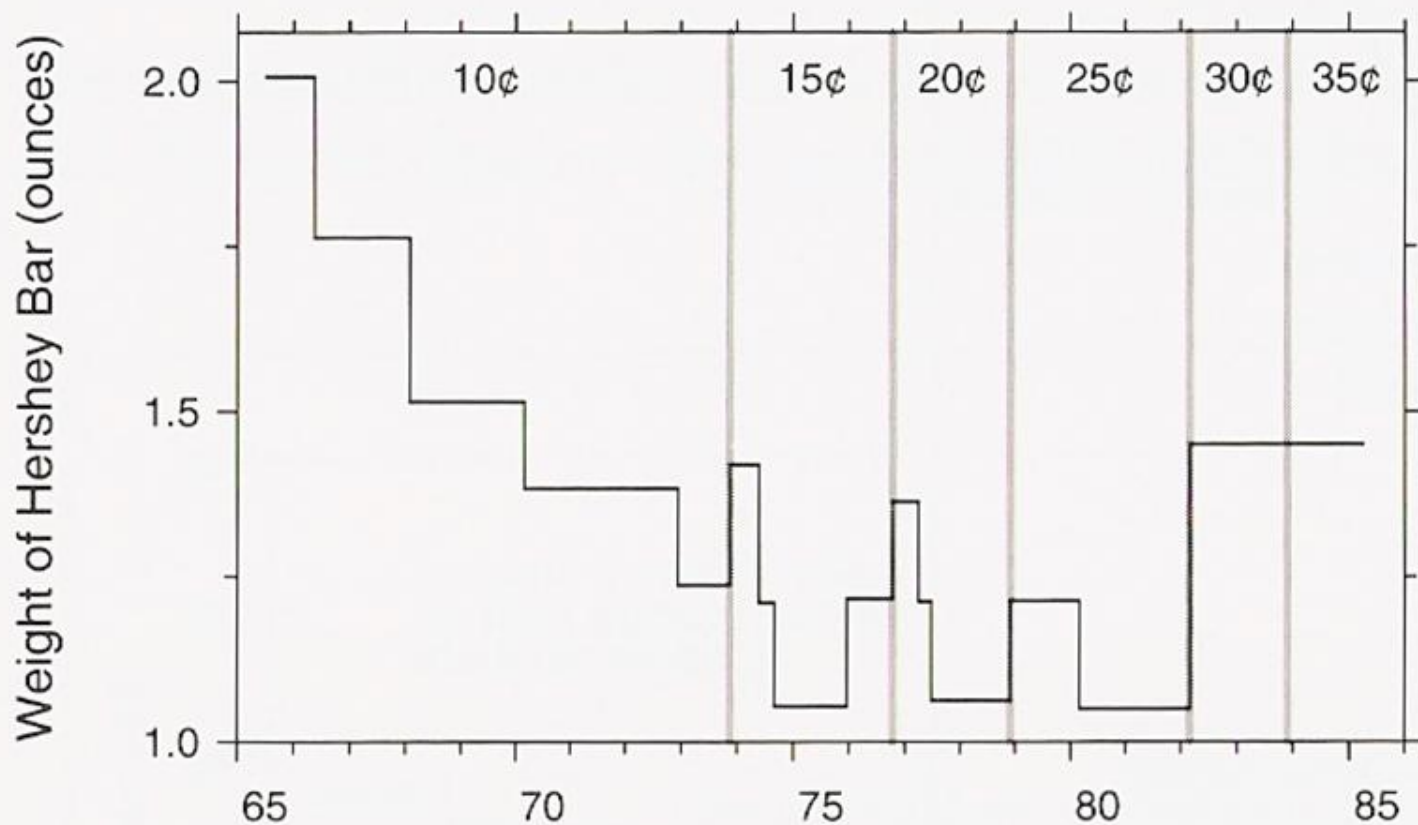




# Clear Vision

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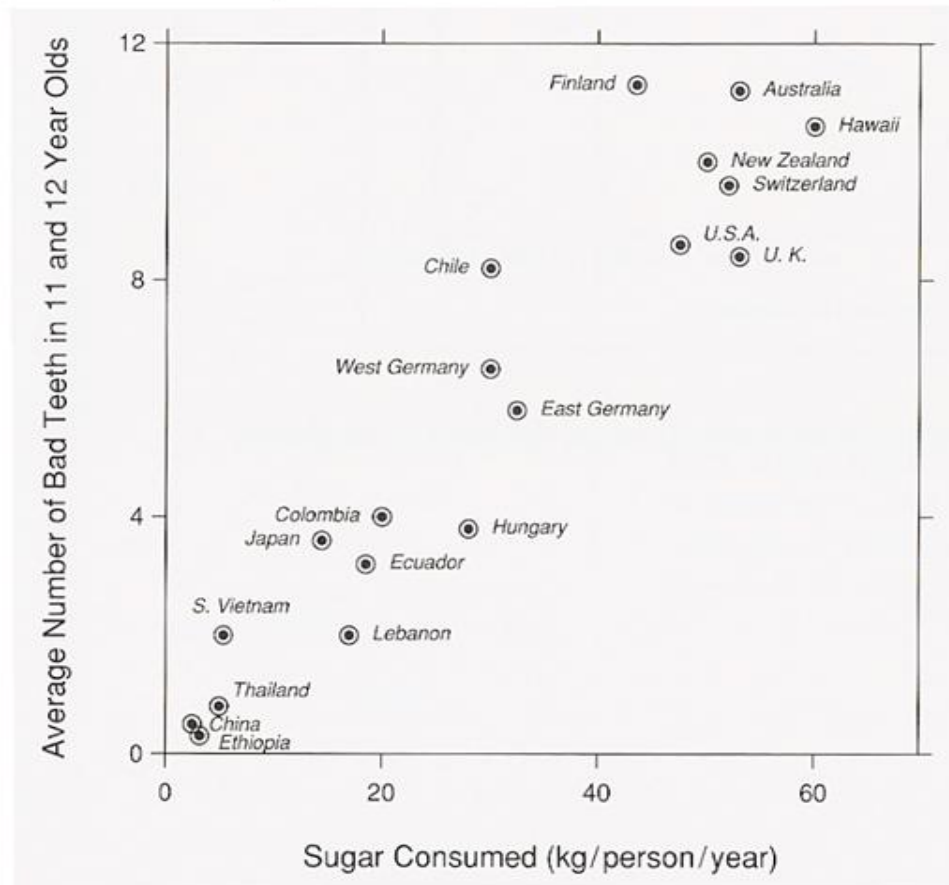
- Principle 4: Reference lines, labels, notes, and keys
  - Only use when necessary and don't let them obscure data.



# Clear Vision

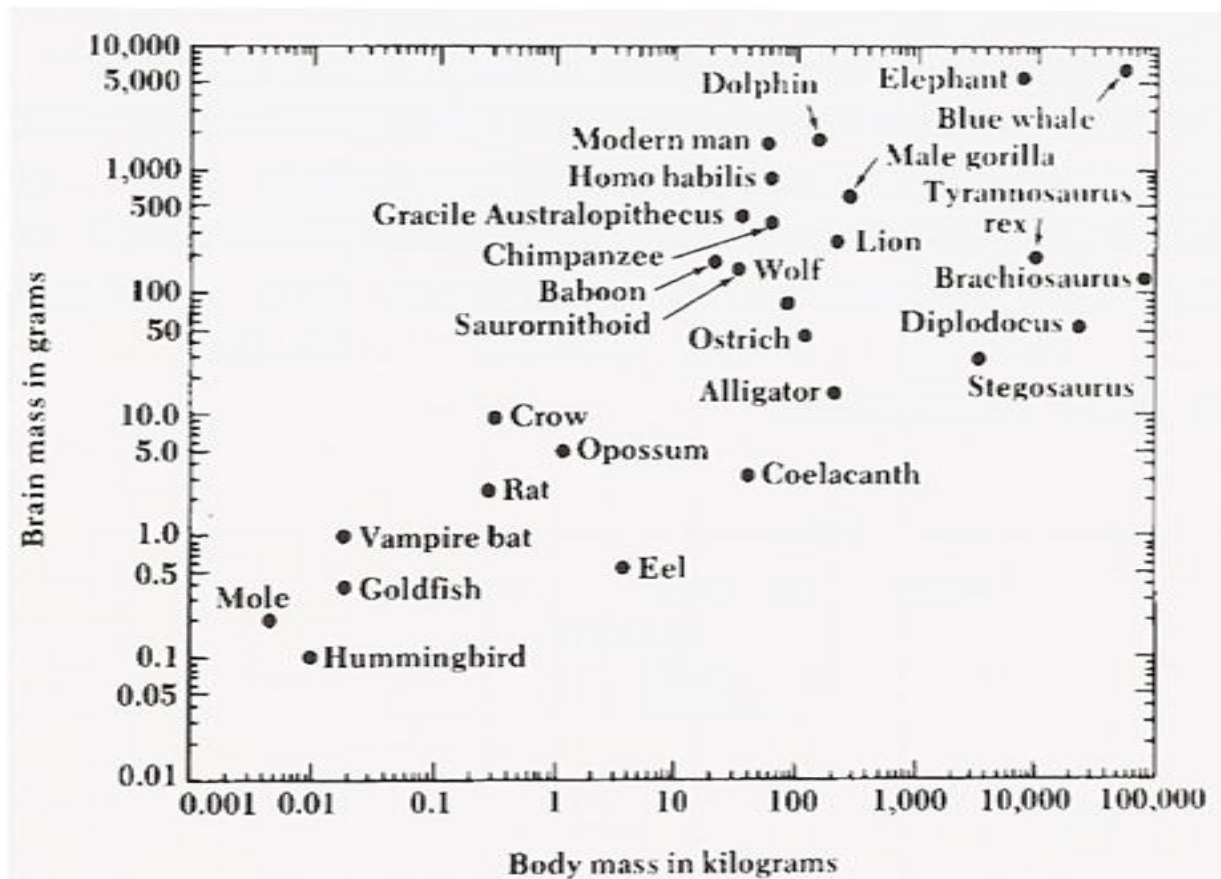
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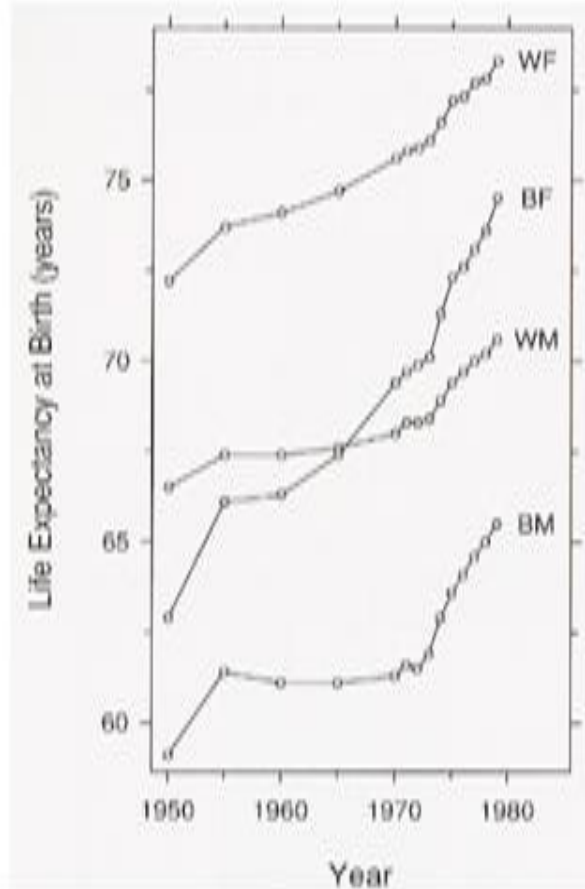
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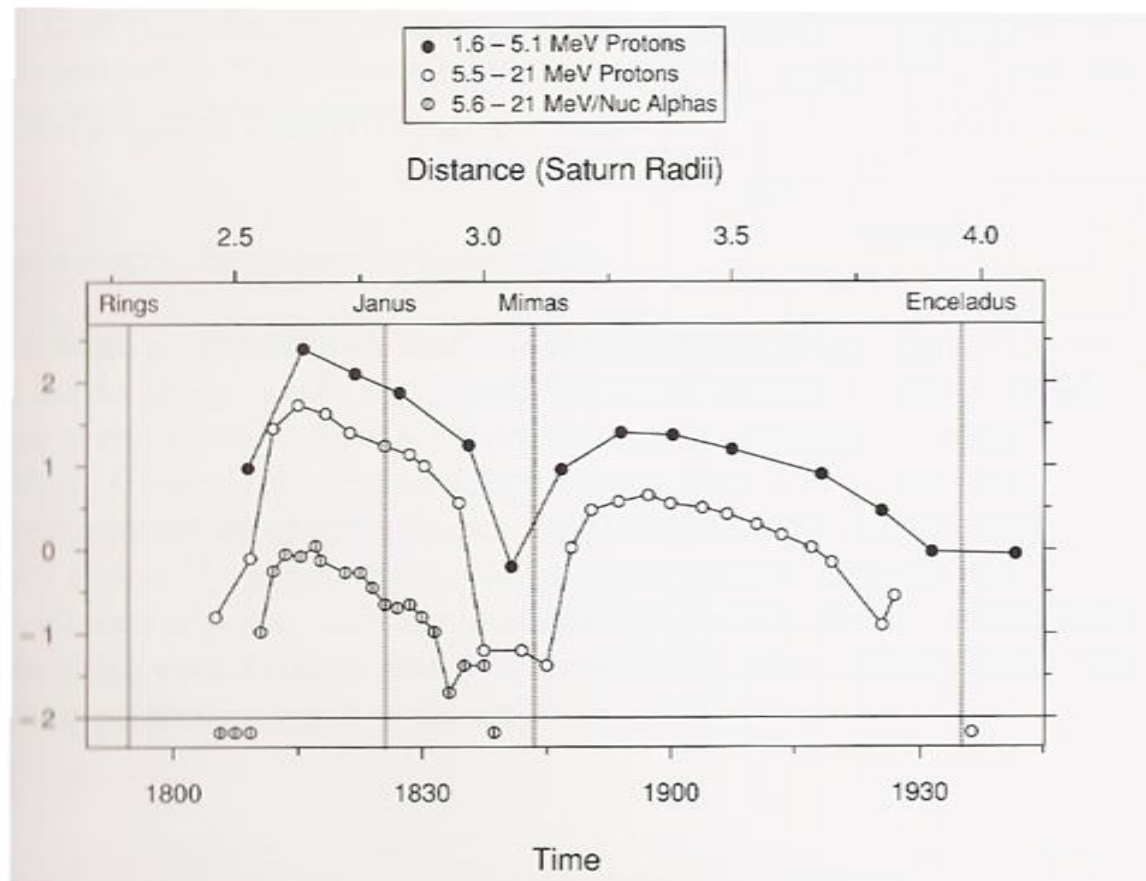
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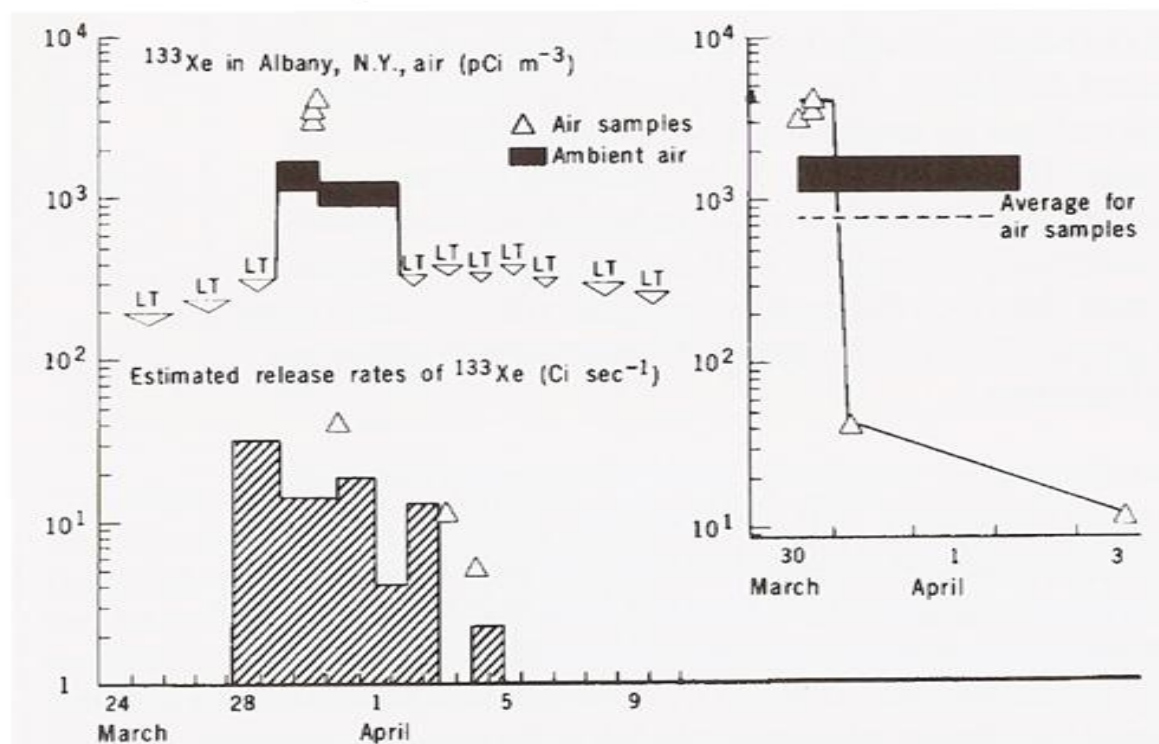
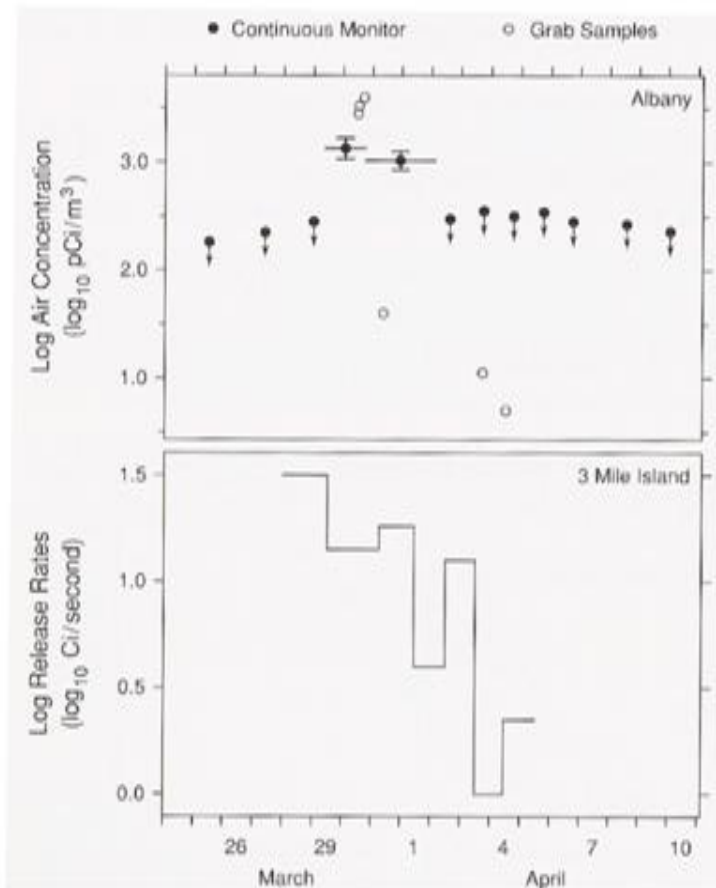


Fig. 1. Xenon-133 activity (picocuries per cubic meter of air) in Albany, New York, for the end of March and early April 1979. The lower trace shows the time-averaged estimates of releases (curies per second) from the Three Mile Island reactor (2). The inset shows detailed values for air samples (gas counting) and concurrent average values for ambient air (Ge diode). Abbreviation: *LT*, less than.

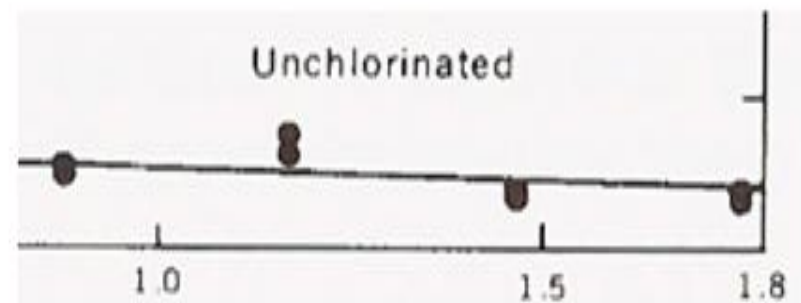
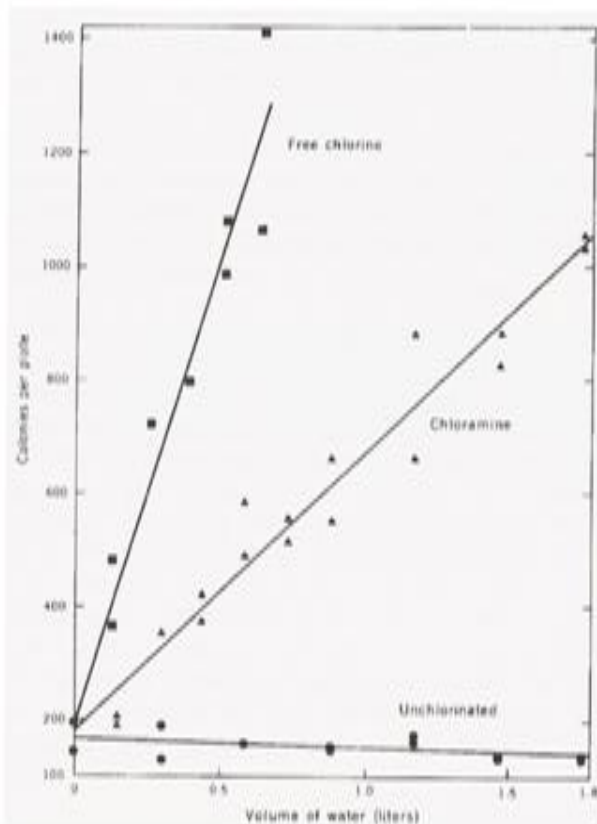
# Clear Vision

- Principle 4: Reference lines, labels, notes, and keys
- Only use when necessary and don't let them obscure data.



# Clear Vision

- Principle 5: Superposed data sets
  - Symbols should be separable and data sets should be easily visually assembled.

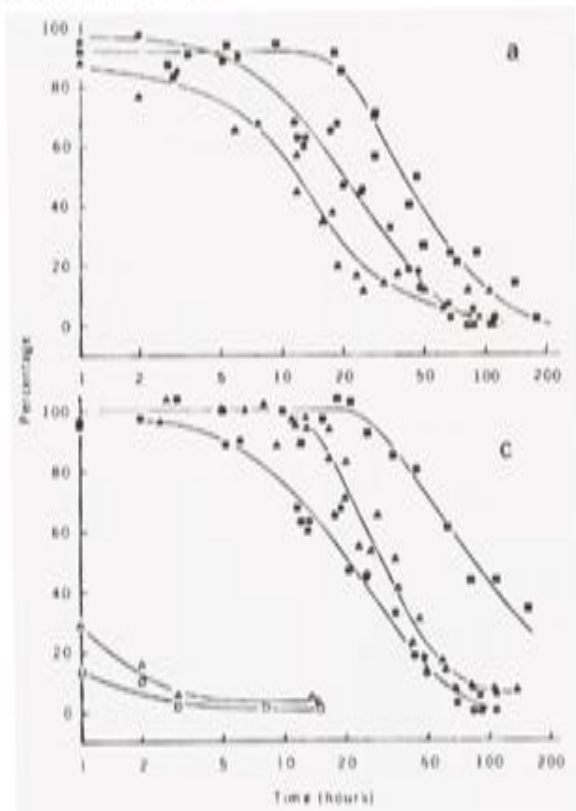




# Clear Vision

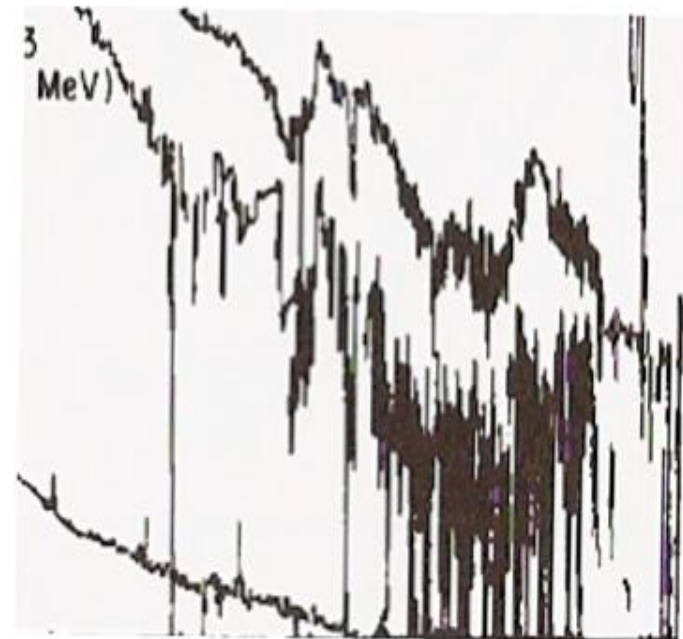
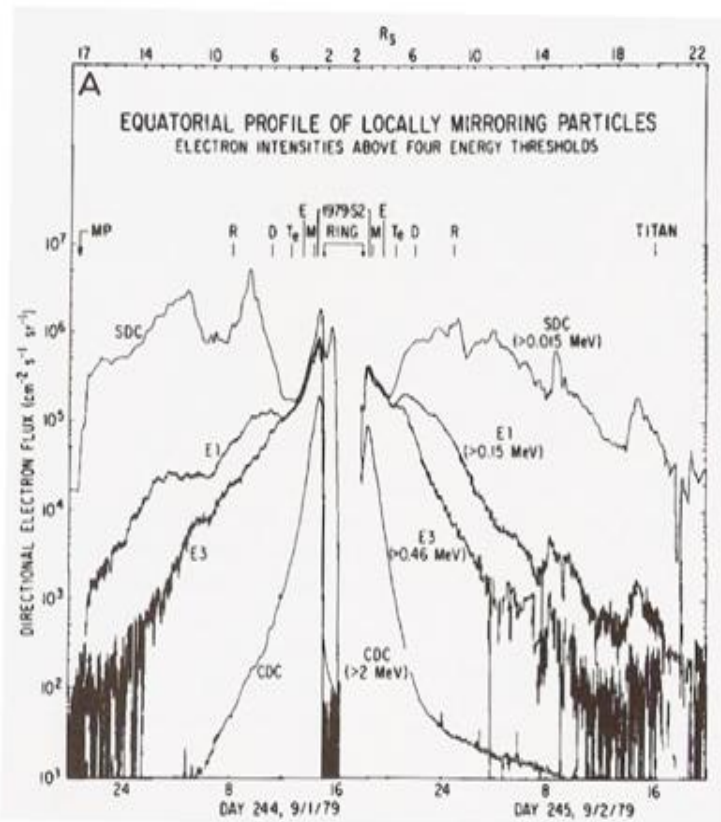
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- Principle 5: Superposed data sets
- Symbols should be separable and data sets should be easily visually assembled.



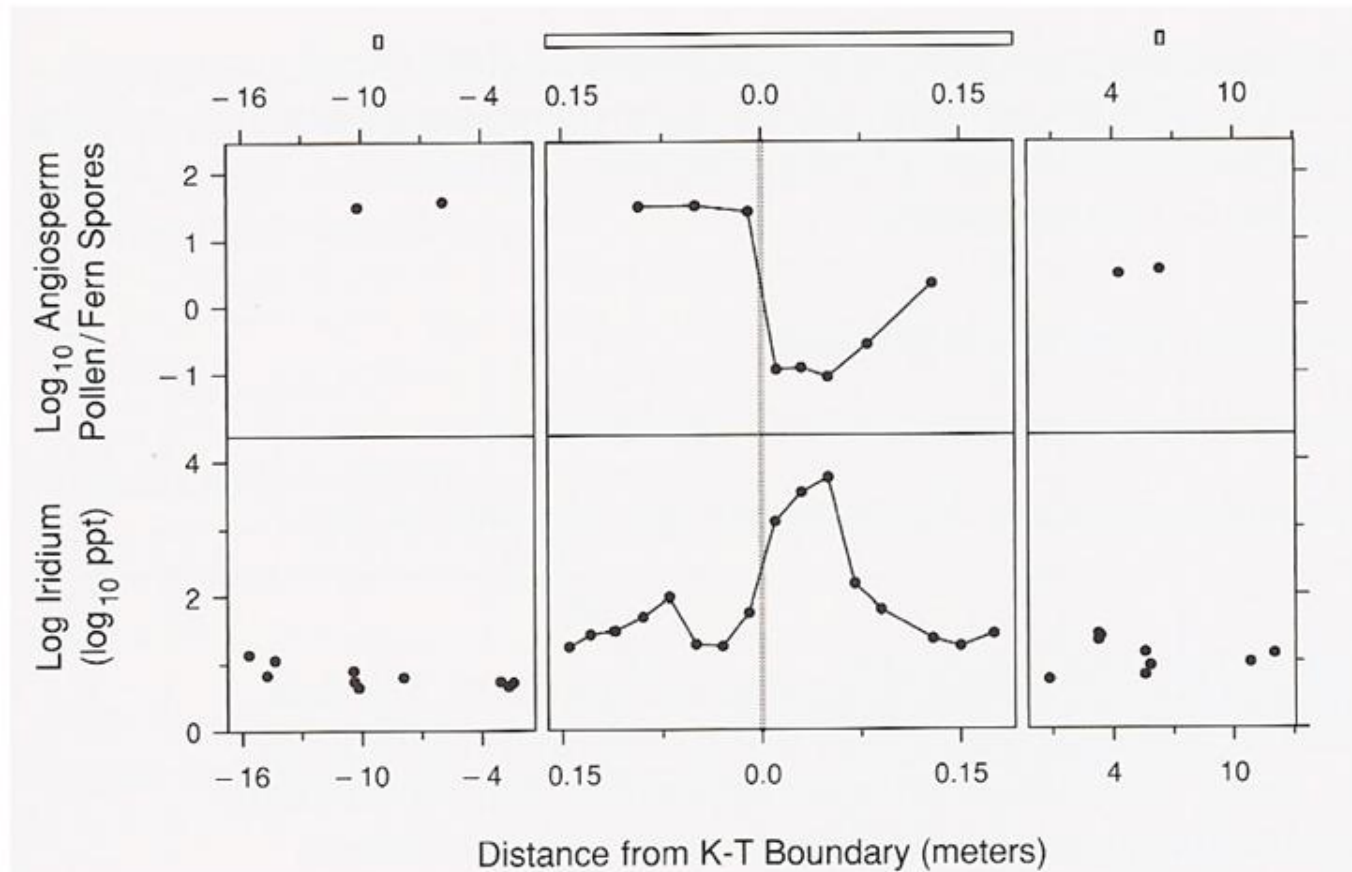
# Clear Vision

- Principle 5: Superposed data sets
  - Symbols should be separable and data sets should be easily visually assembled.



# Clear Understanding

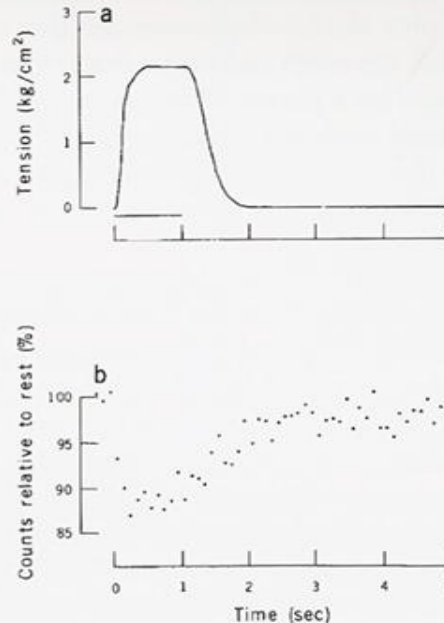
- Principle 1: Explanation and conclusions
  - Describe everything, draw attention to major features, describe conclusions



# Clear Understanding

- Principle 1: Explanation and conclusions
  - Describe everything, draw attention to major features, describe conclusions

Fig. 2. Tension and the intensity of the 42.9-nm layer line during 1-second tetanus at the sarcomere length of 2.2  $\mu\text{m}$ . (a) Tension record averaged over the 40 tetanic contractions required for obtaining the time course of the layer-line intensity. A sartorius muscle was dissected from *Rana catesbeiana* and tetanized for 1 second at 2-minute intervals. The horizontal line represents the period of stimulation. Tension was recorded with an isometric tension transducer (Shinkoh, type UL). (b) Intensity of the first-order myosin layer line at 42.9 nm. The x-ray source was a rotating-anode generator (Rigaku FR) with a fine focus (1.0 by 0.1 mm) on a copper target. This was operated at 50 kV with a tube current of 70 mA; such a high power was possible with an anode of a large diameter (30 cm) rotating at a high speed (9000 rev/min). A bent-crystal monochromator was used at a source-to-crystal distance of 25 cm with a viewing angle of 6°. The intensity of the myosin layer line was measured with a scintillation counter combined with a mask; the mask had apertures at the positions of the off-meridional parts of the first-order layer line. The meridional reflection at 14.3 nm is known to be slightly displaced during contraction, suggesting a minute change in the myosin periodicity (1, 3). It is, therefore, possible that the 42.9-nm layer line is also slightly displaced. However, the possible displacement (14  $\mu\text{m}$  at the position of the mask) would be insignificant compared with the width of each aperture (0.8 mm). The intensity measured at the resting state was 1400 count/sec. The intensities during and after tetanus were expressed as percentages of the resting intensity and plotted against time after the first stimulus of each set of stimuli. Each point represents the intensity averaged over a 100-msec period. The first three points represent the measurements made before stimulation.



# Clear Understanding

- Principle 1: Explanation and conclusions
  - Describe everything, draw attention to major features, describe conclusions

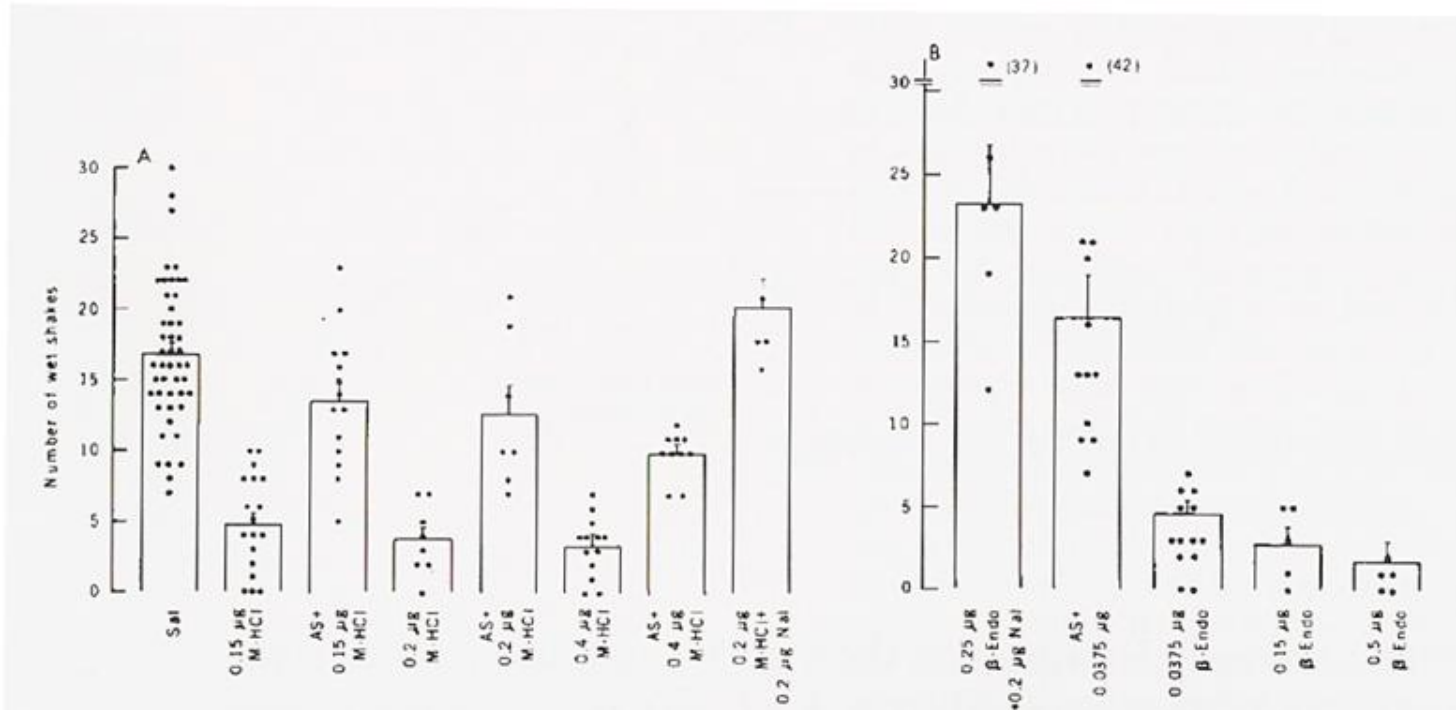
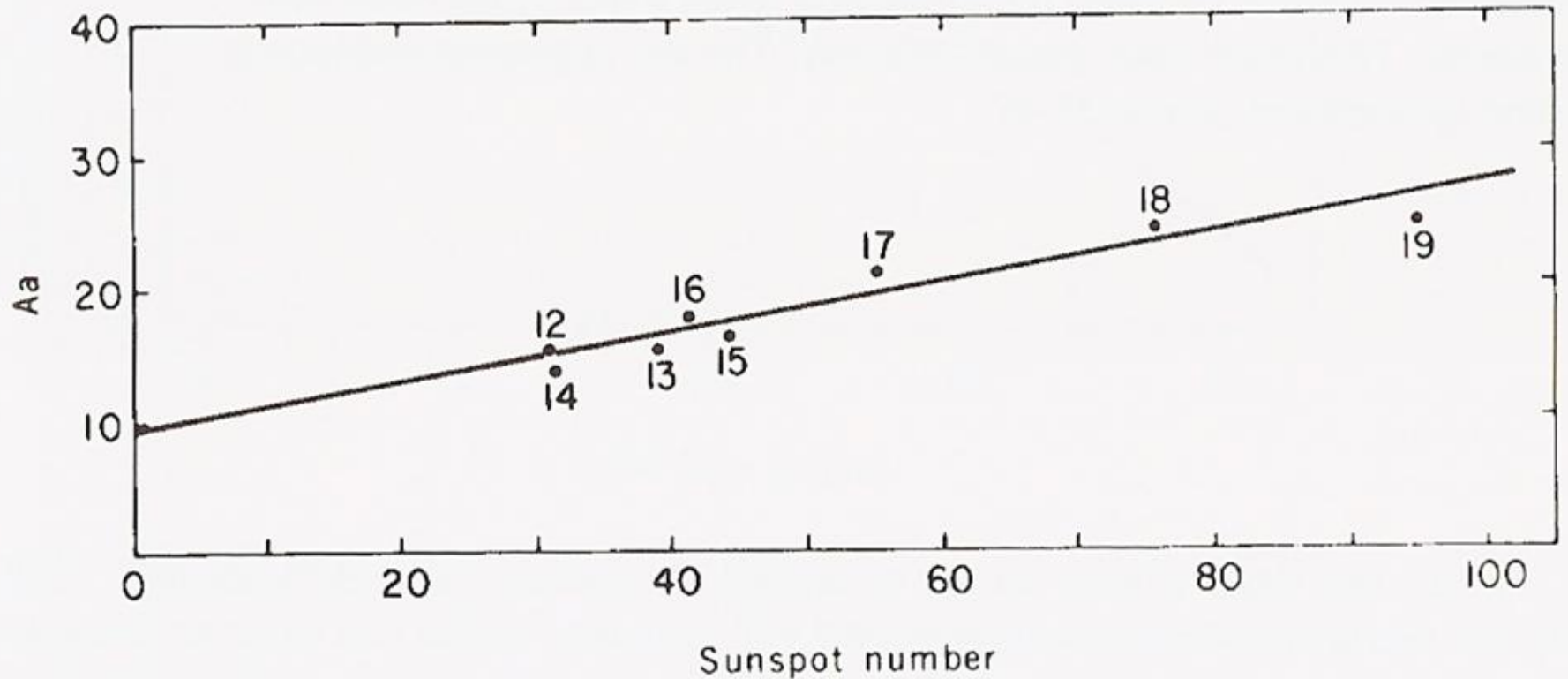


Fig. 1. Inhibitory effect of morphine hydrochloride (A) and  $\beta$ -endorphin (B) on wet-shake behavior in rats. Antagonism was by antibody to cerebroside sulfate (AS). A volume of 2  $\mu$ l was delivered into the PAG in 1- $\mu$ l increments with a 1-minute interval in between. The control consisted of saline (Sal). Morphine HCl (M-HCl) and  $\beta$ -endorphin were preceded by saline, AS, or naloxone (Nal) as indicated. The dose of morphine HCl and naloxone refers to the chloride salt. Each point is the datum for one animal. The AS + morphine HCl groups are all significantly different ( $t$ -test,  $P < .005$ ) from the corresponding morphine HCl groups alone (A). The group receiving AS + 0.0375  $\mu$ g of  $\beta$ -endorphin is also significantly different ( $P < .005$ ) from the group receiving 0.0375  $\mu$ g of  $\beta$ -endorphin (B).

# Clear Understanding

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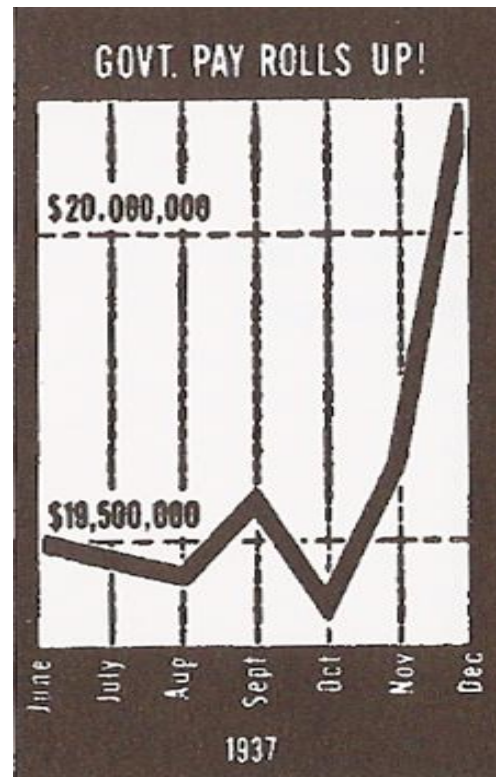
- Principle 2: Use all of the available space
  - Fill the data rectangle, only use zero if you need it



# Clear Understanding

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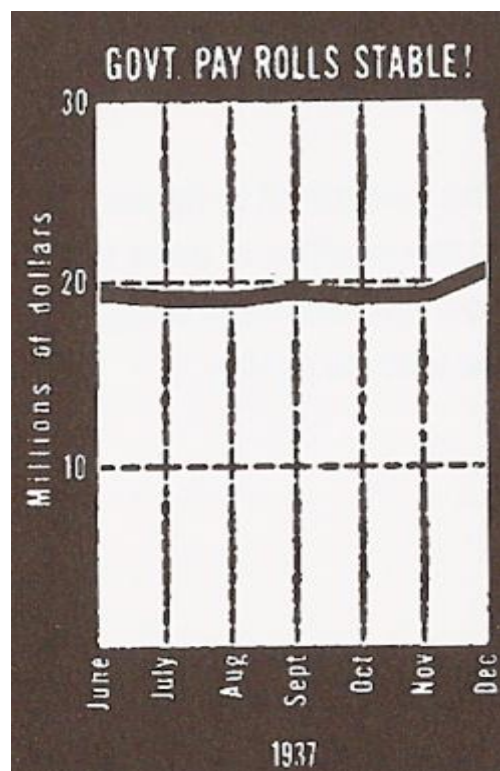
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# Clear Understanding

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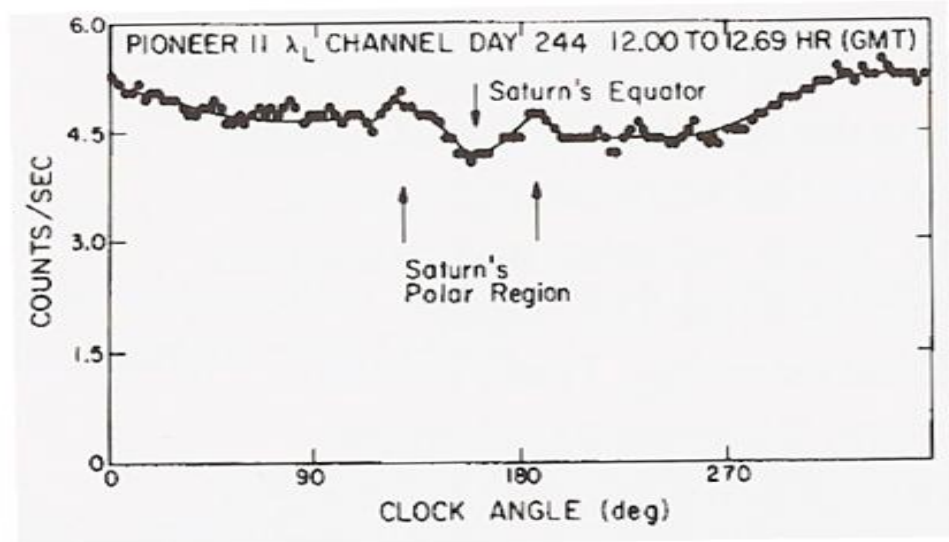
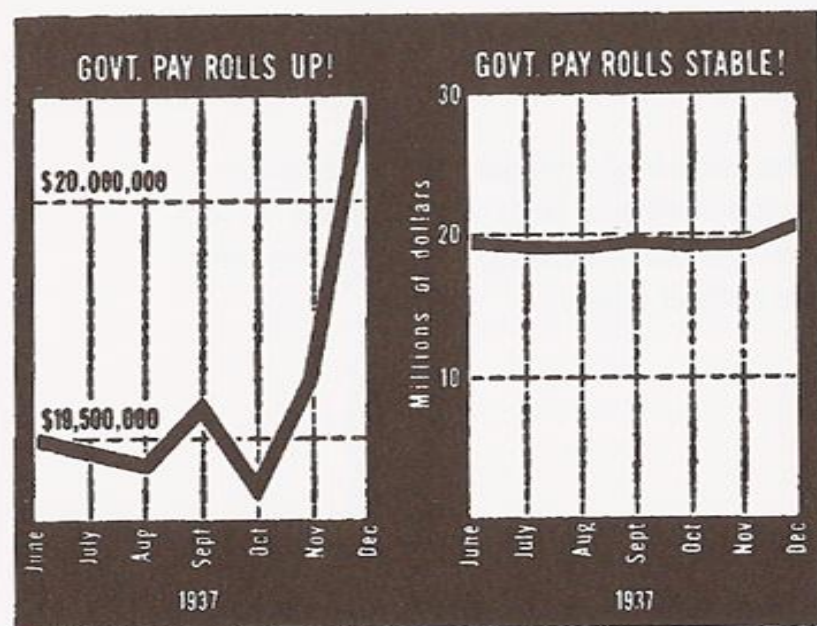
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# Clear Understanding

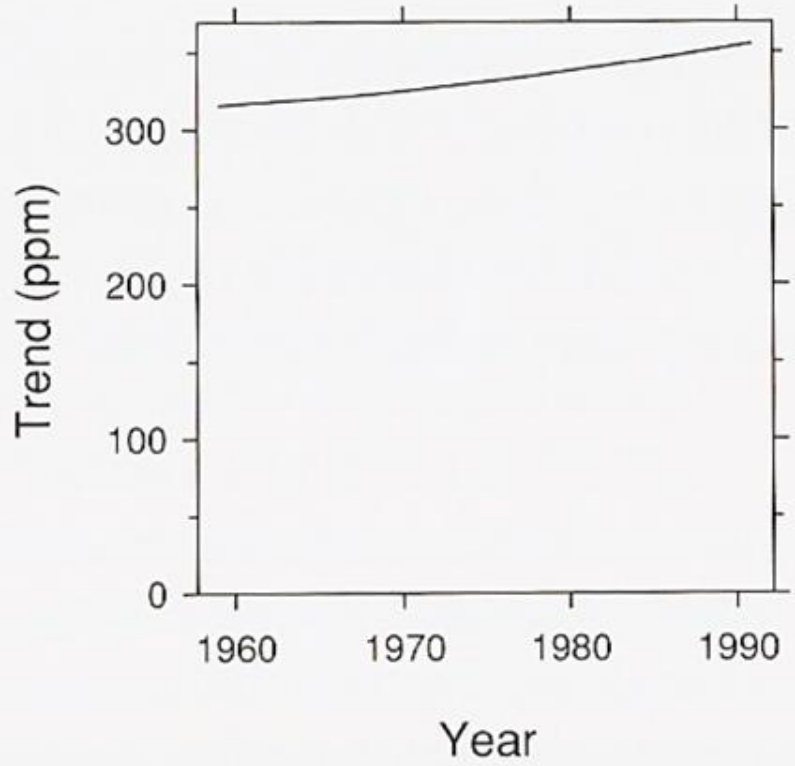
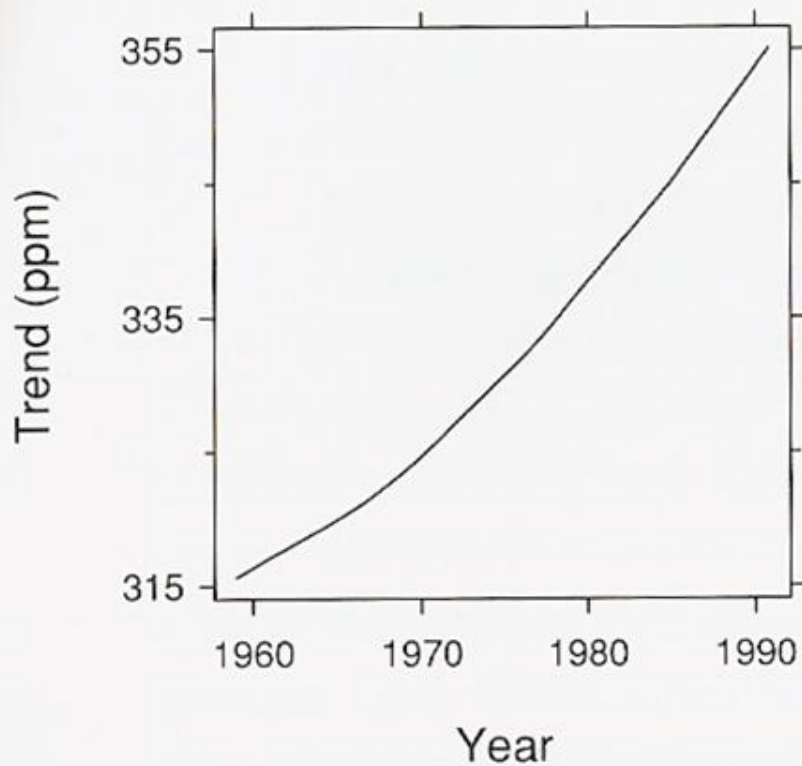
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# Clear Understanding

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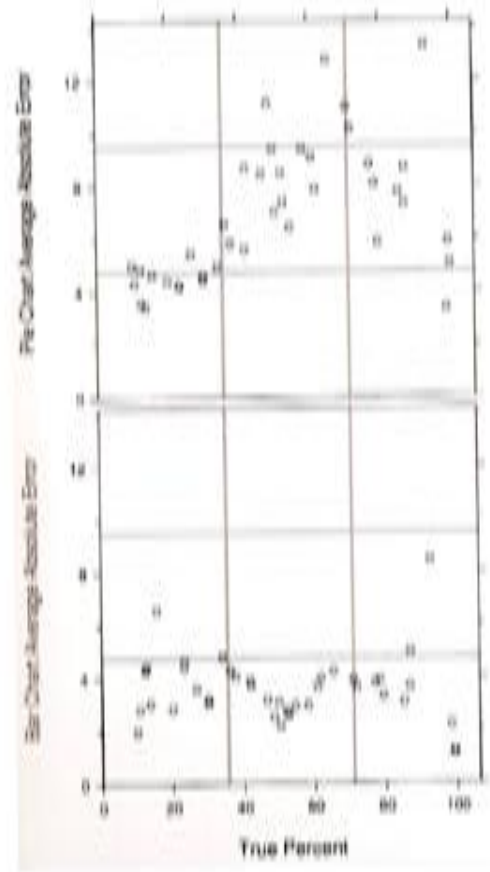


Principle 3: Juxtaposed data sets

# Clear Understanding

Make sure scales match and graphs are aligned

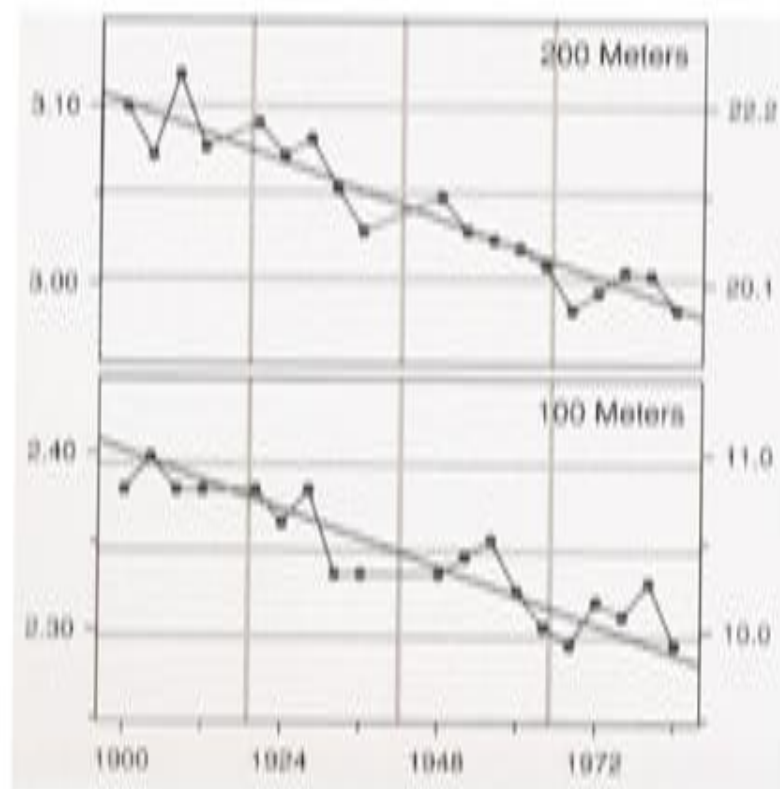
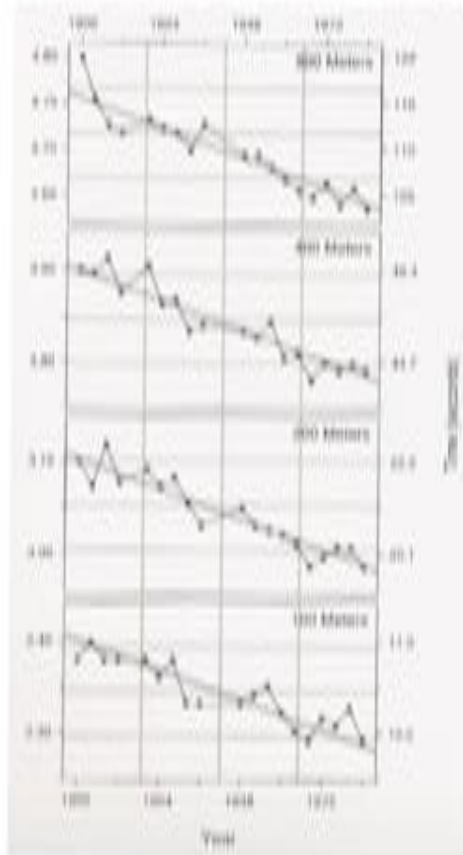
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# Clear Understanding

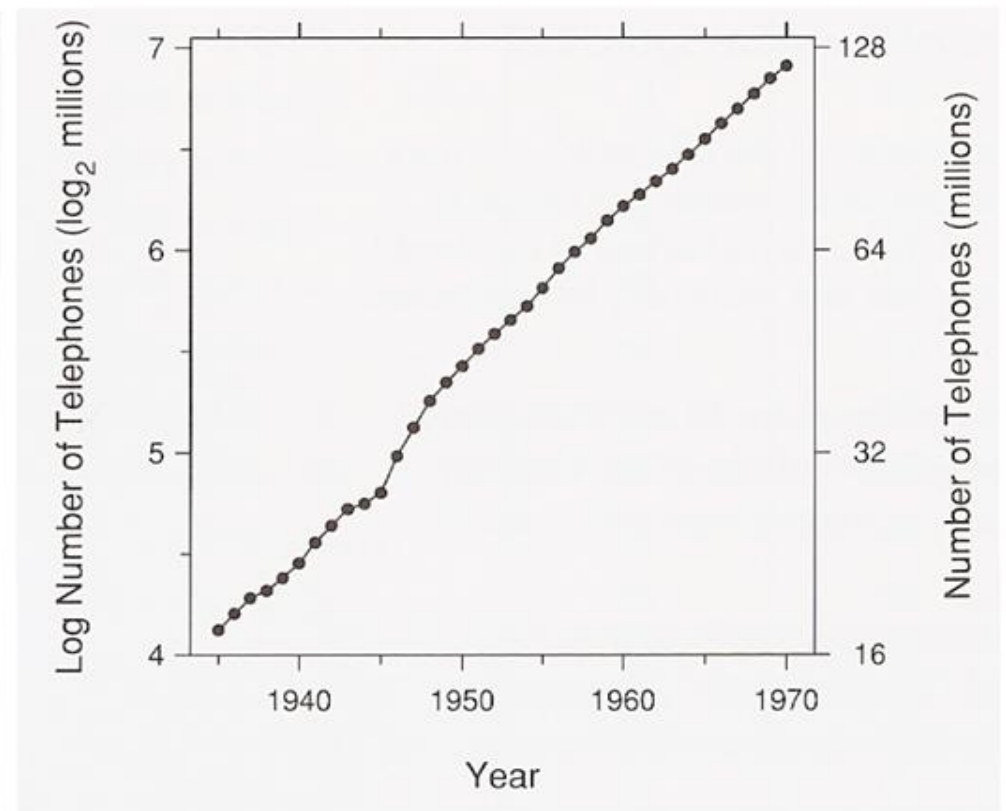
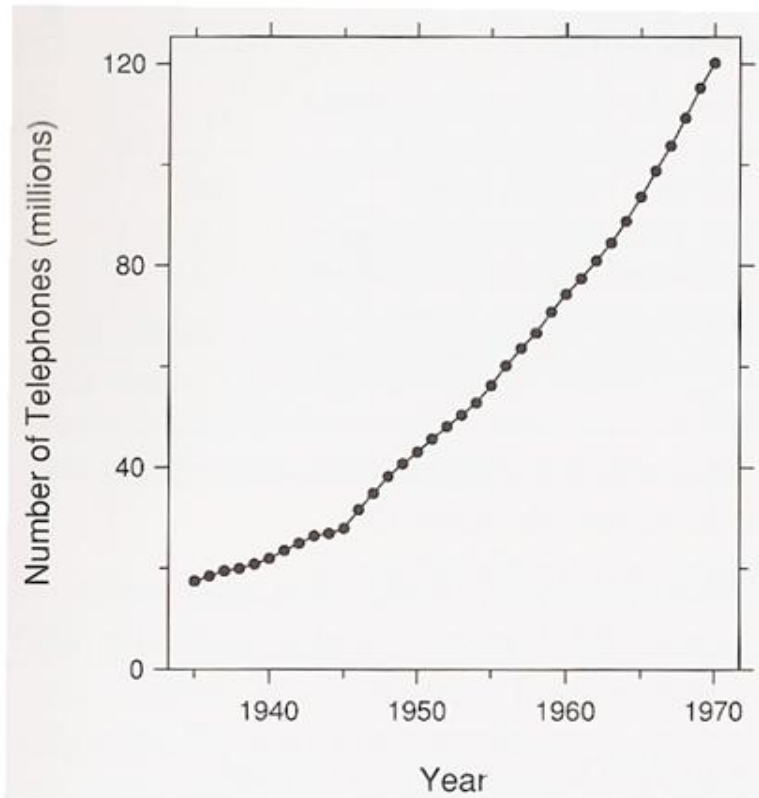
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- Principle 3: Juxtaposed data sets
- Make sure scales match and graphs are aligned



# Clear Understanding

- Principle 4: Log scales
  - Used to show percentage change, multiplicative factors and skewness



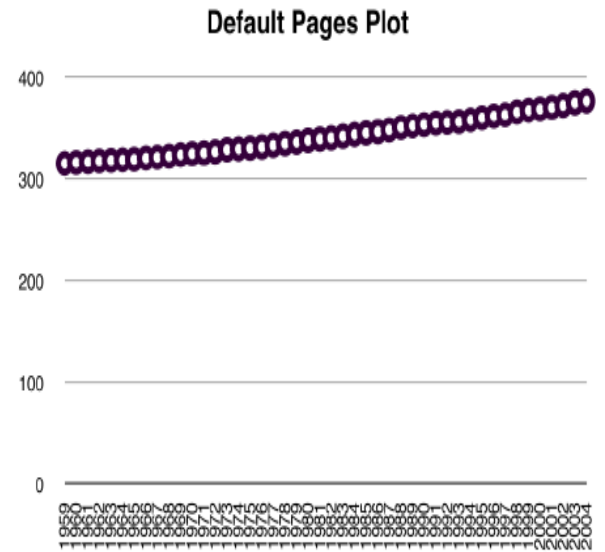
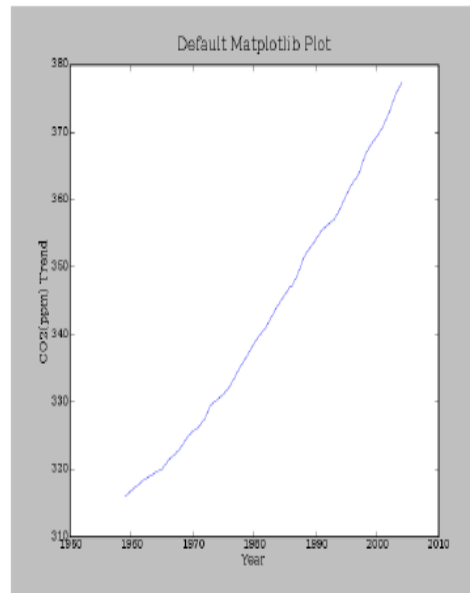
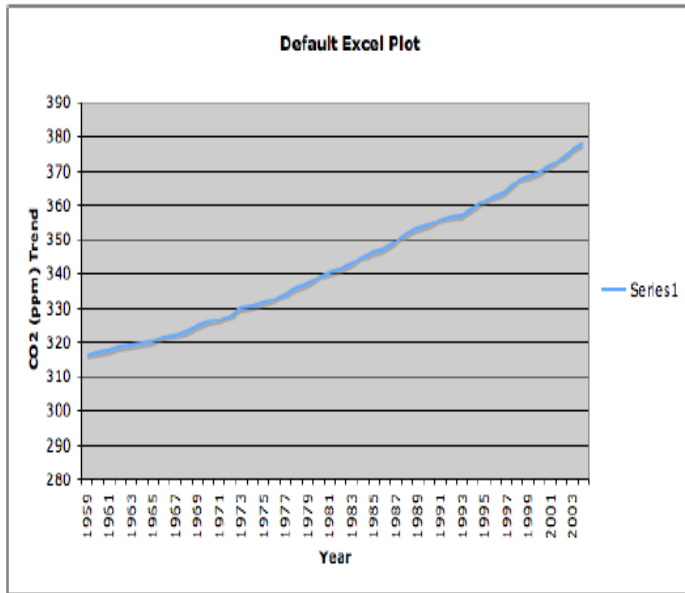
# Summary of Principles

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- Clear Vision
  1. Make data stand out
  2. Visual prominence
  3. Scale lines and data rectangle
  4. Superposed data sets
- Clear Understanding
  1. Explanations and conclusions
  2. Use all available space
  3. Juxtaposed data sets
  4. Log scaling
  5. Banking to 45°

# Summary of Principles

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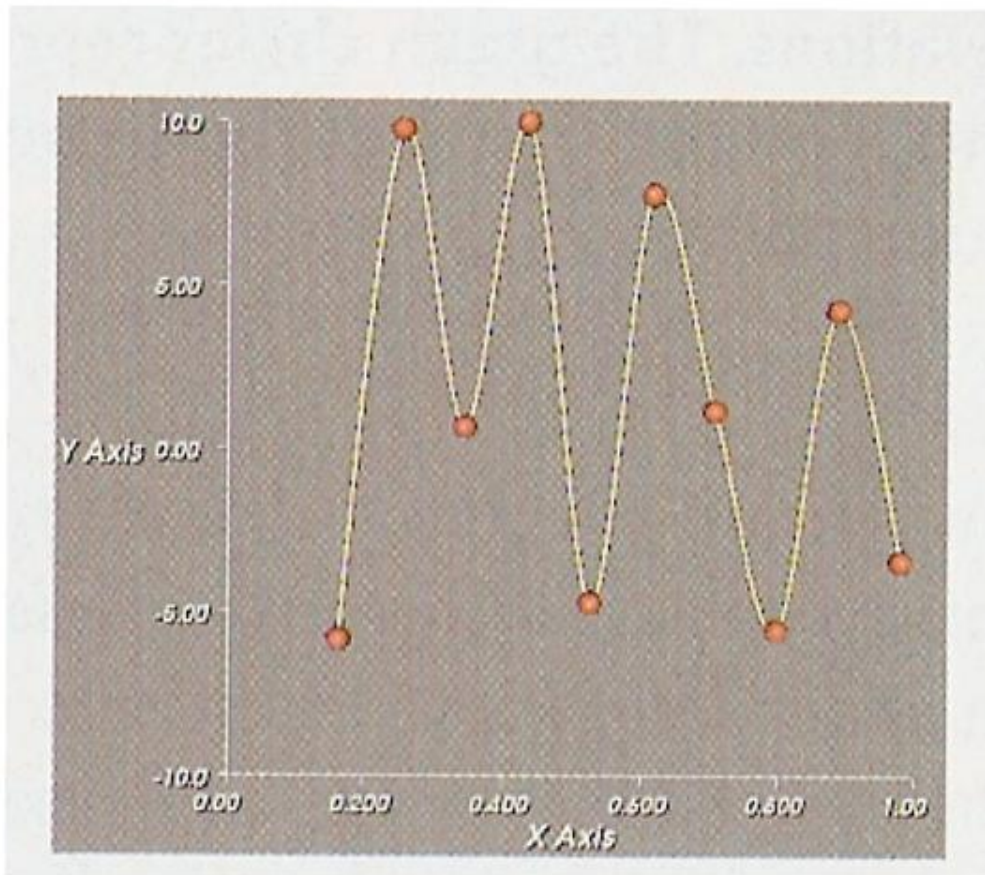


- Why are they all different?
- What is good/bad about each?

# Quiz on Principles

---

- What is wrong with this plot?





# Quiz on Principles

- What is wrong with this plot?

