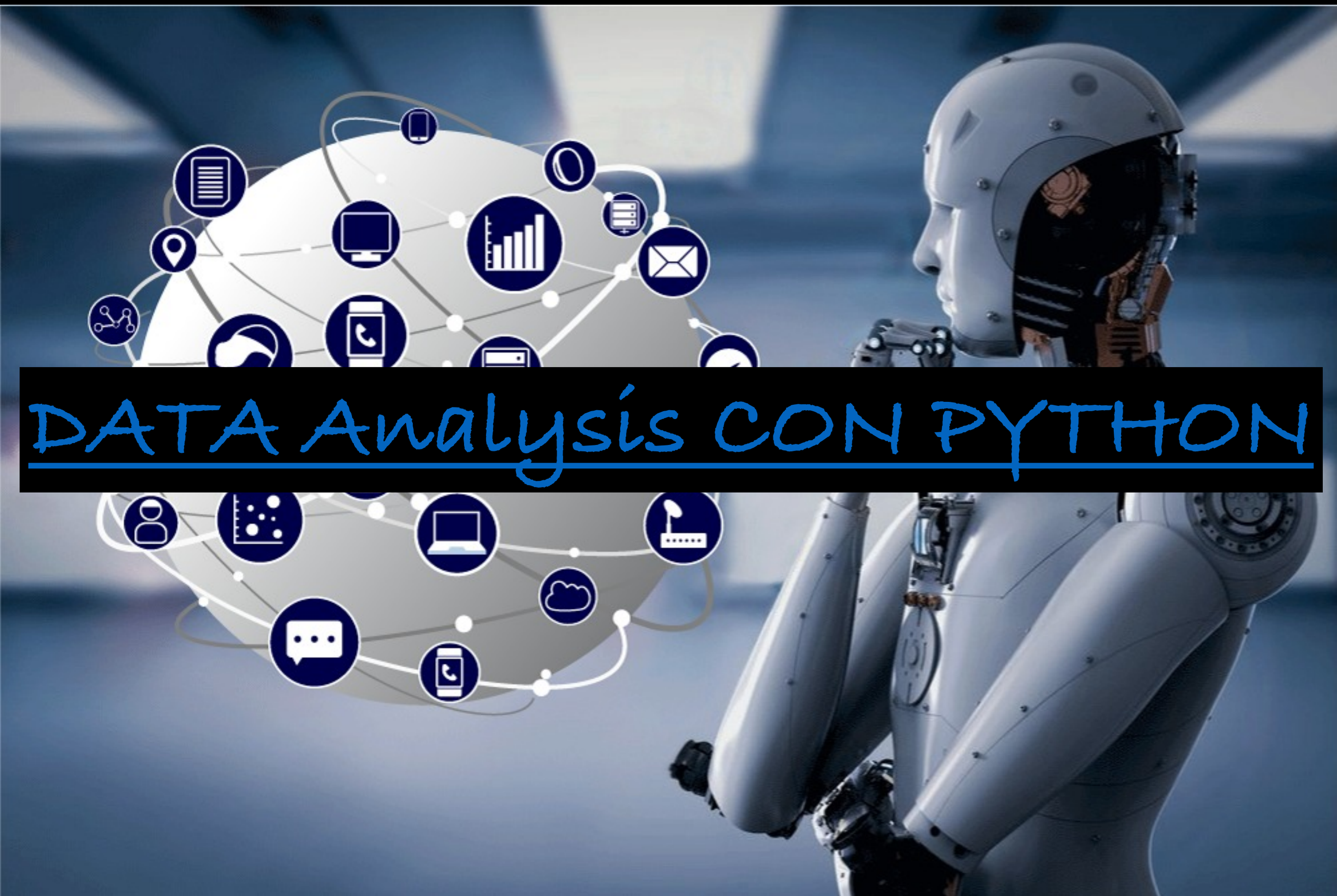
DEDUCE

Santander, 14-24 Mayo 2019

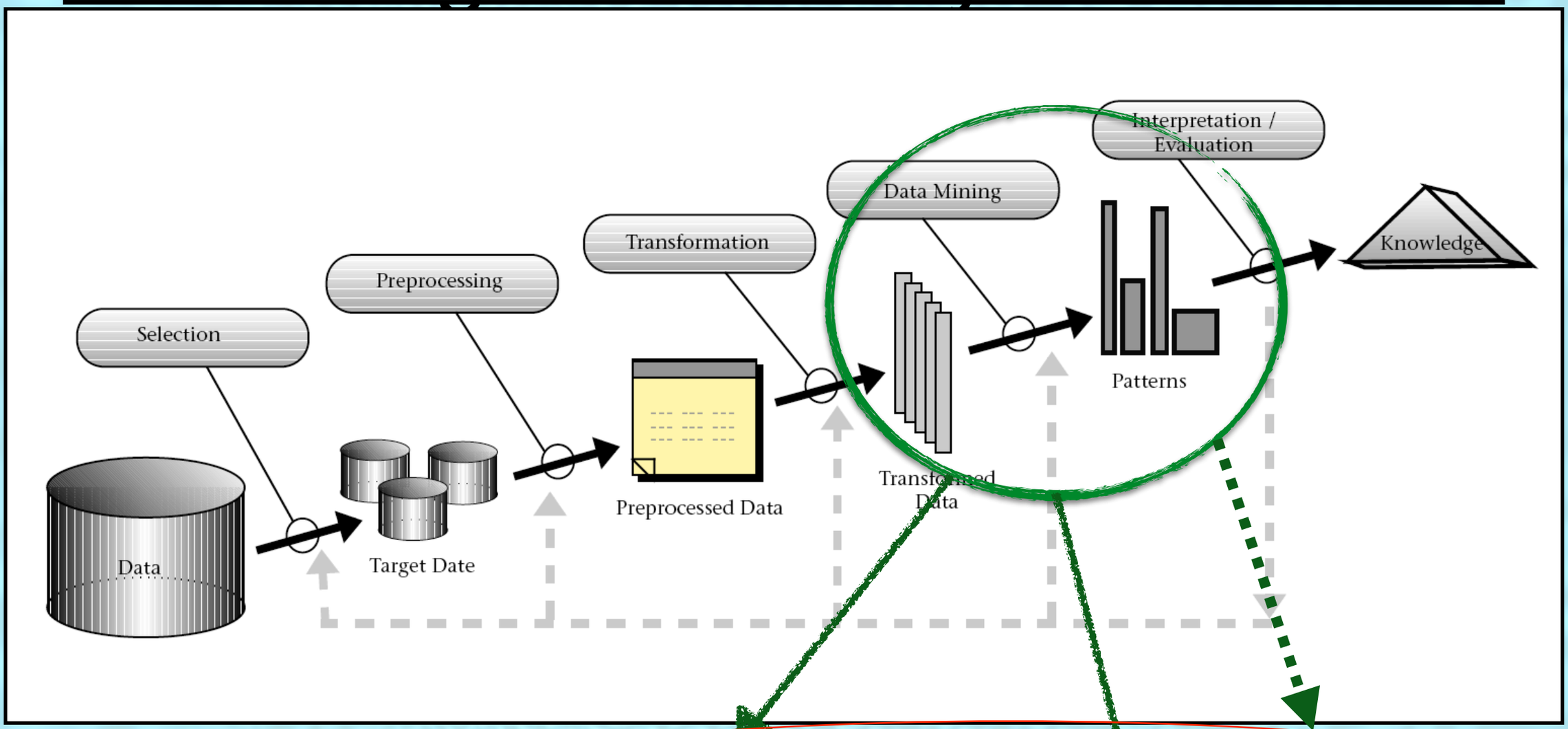


DATA Analysis CON PYTHON

Exploratory Data Analysis

Exploratory Data Analysis

Knowledge Discovery in Datasets



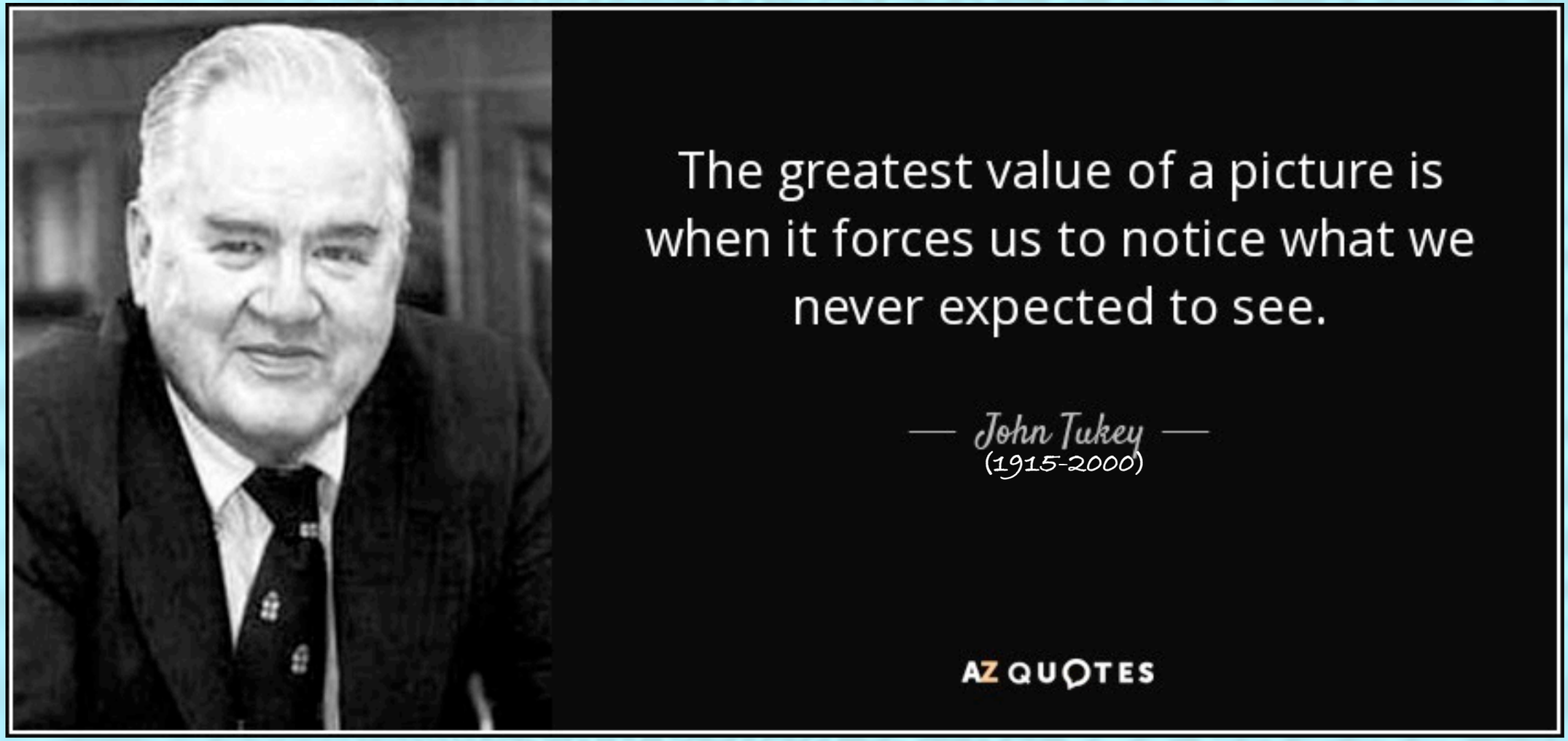
Visualization

Models

Statistics

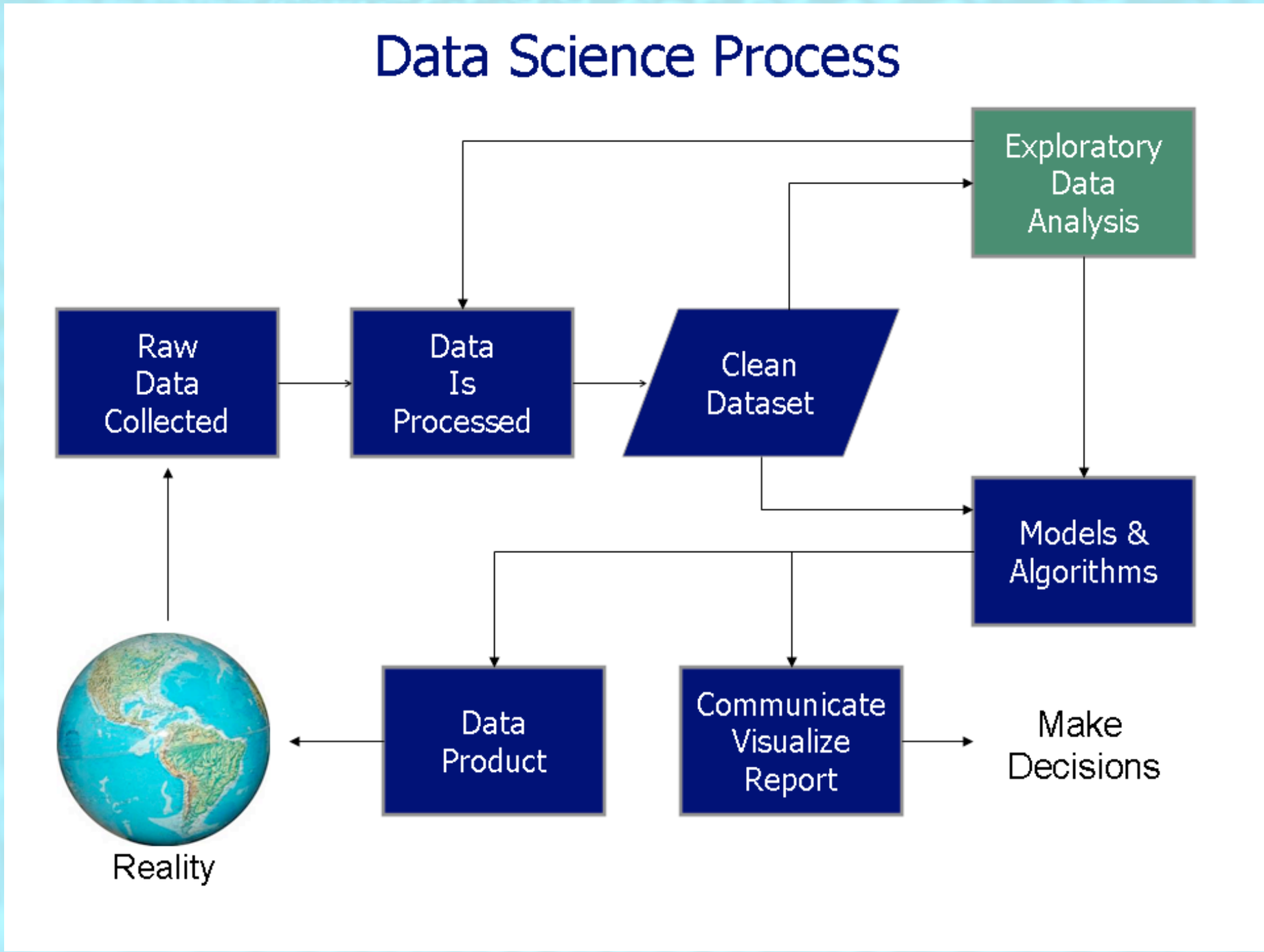
Exploratory Data Analysis

Exploratory Data Analysis (EDA)



Tukey, John (1977), Exploratory Data Analysis, Addison-Wesley.

EDA Definition: *an approach of analysing data that summarise their main characteristics without using a statistical model or having formulated a prior hypothesis [wikipedia]*



EDA Definition: *an approach of analyzing data that summarize their main characteristics without using a statistical model or having formulated a prior hypothesis [wikipedia]*

Main motivations and tasks

maximise insight into a data set

extract important variables

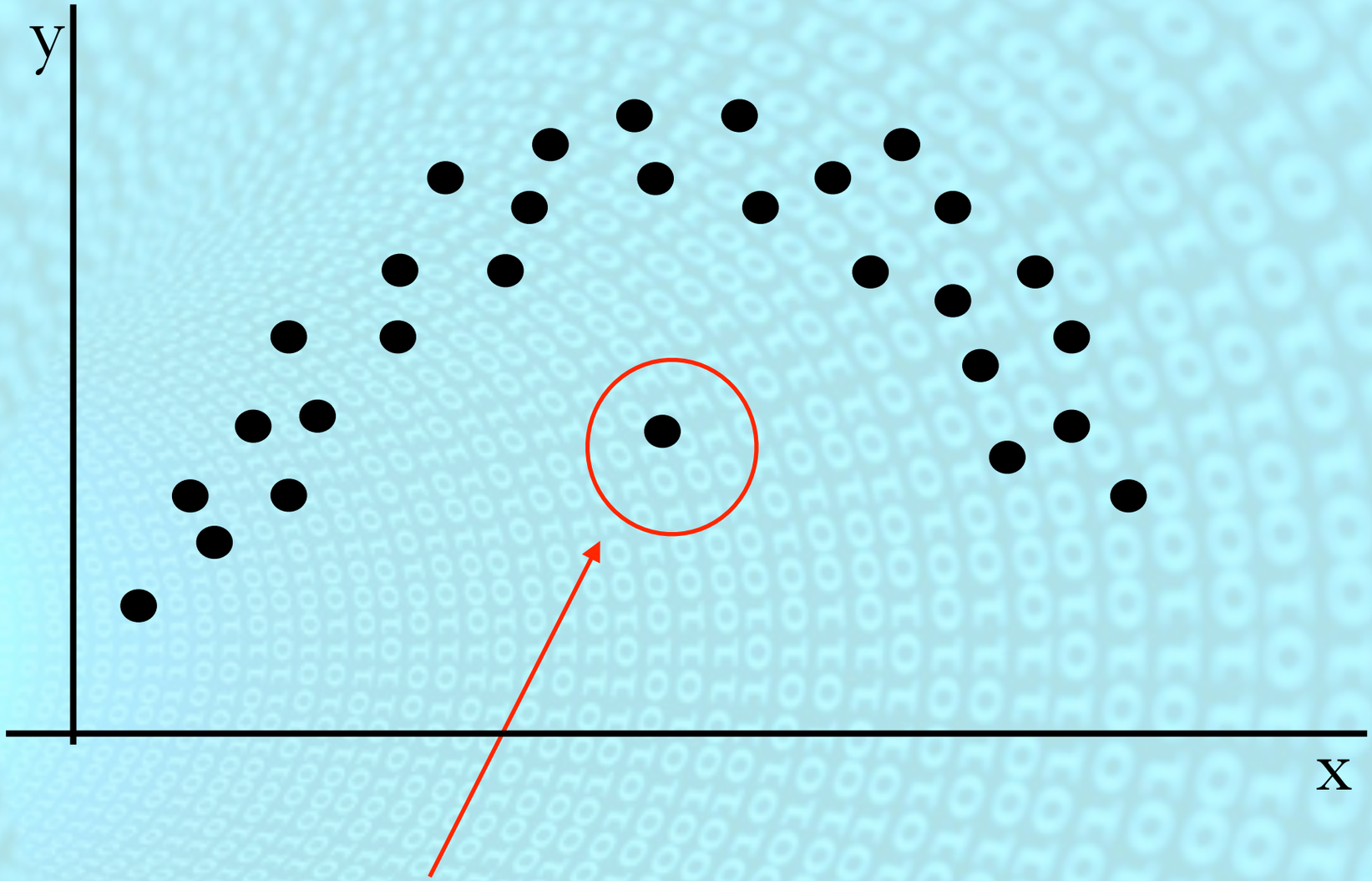
uncover underlying structure

detect outliers and anomalies

test underlying assumptions

address appropriate models of analysis

Example: detect outliers and anomalies

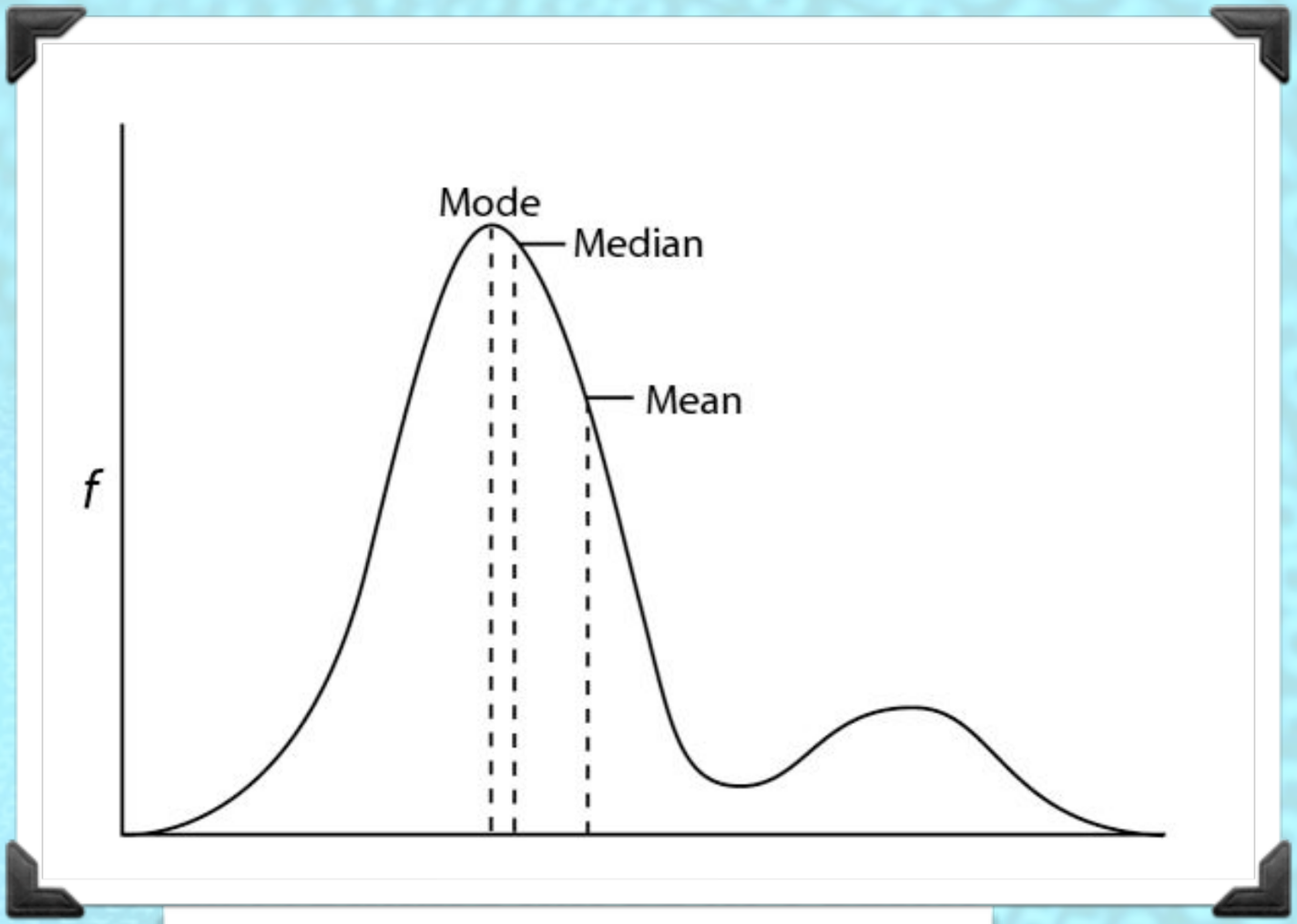


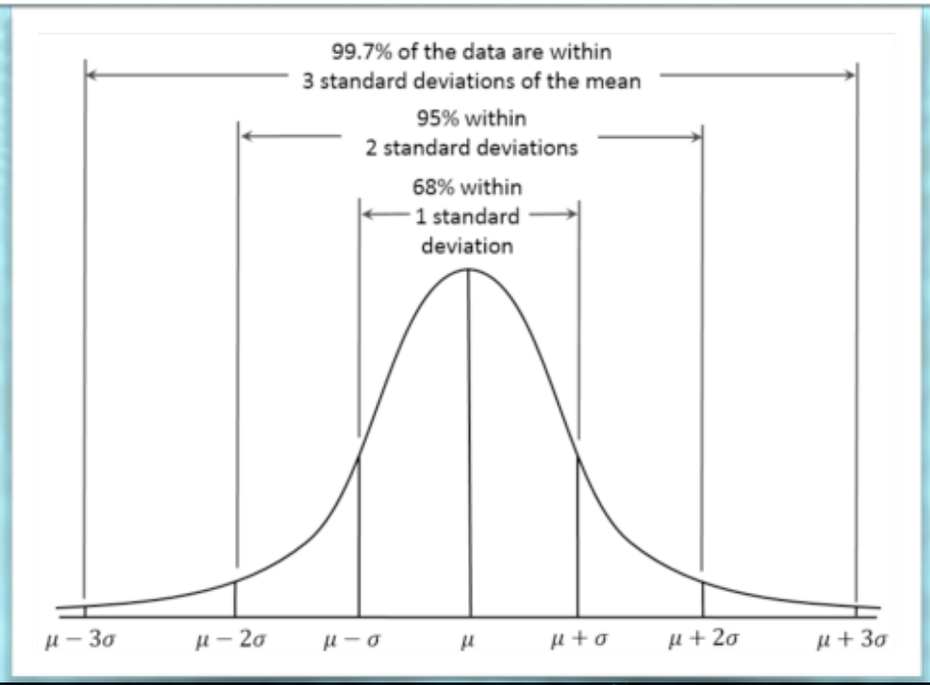
What are anomalies/outliers?

The set of data points that are considerably different than the remainder of the data

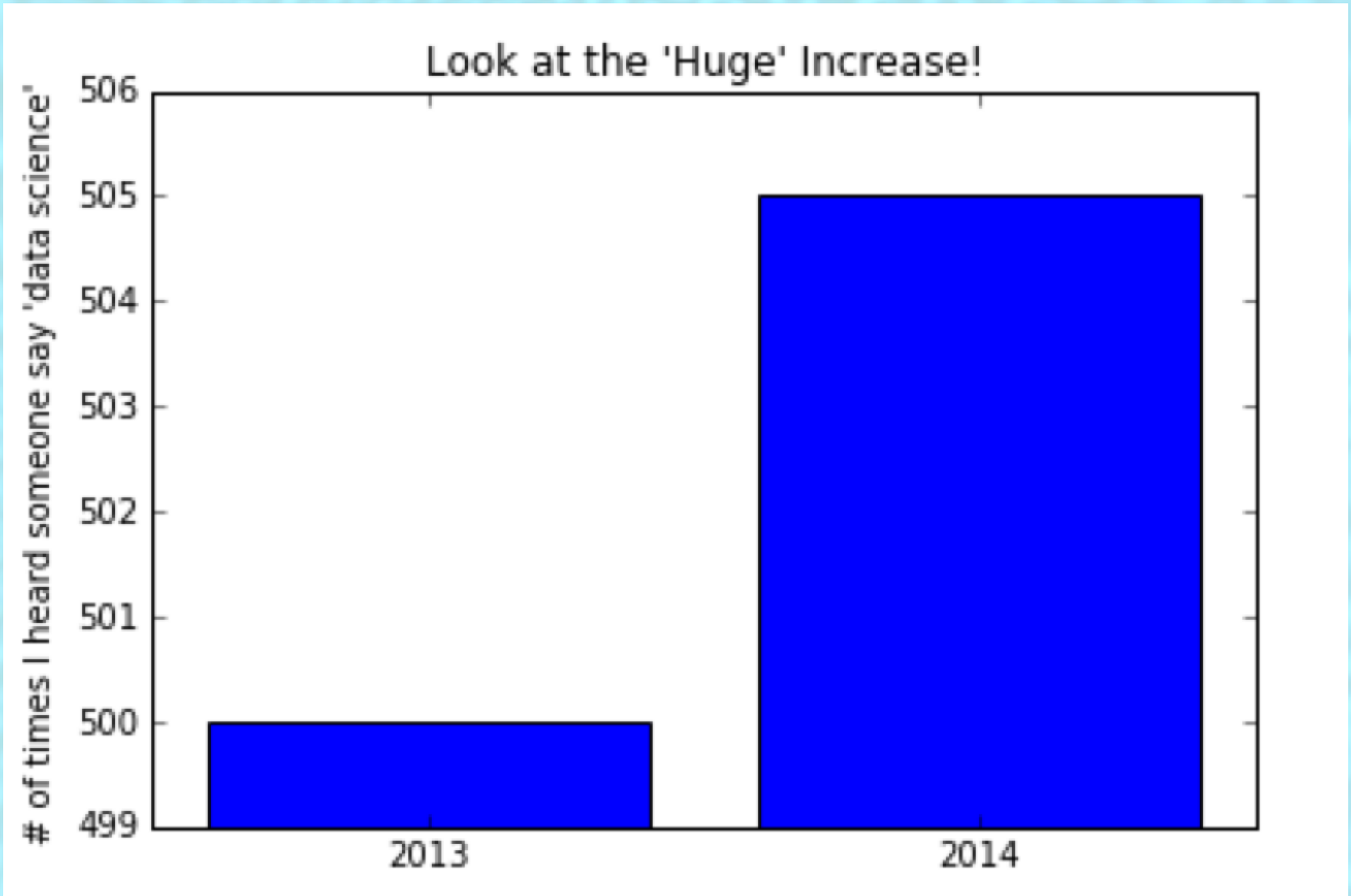
Applications: credit card fraud detection, telecommunication fraud detection, network intrusion detection, fault detection

Example: test underlying assumptions



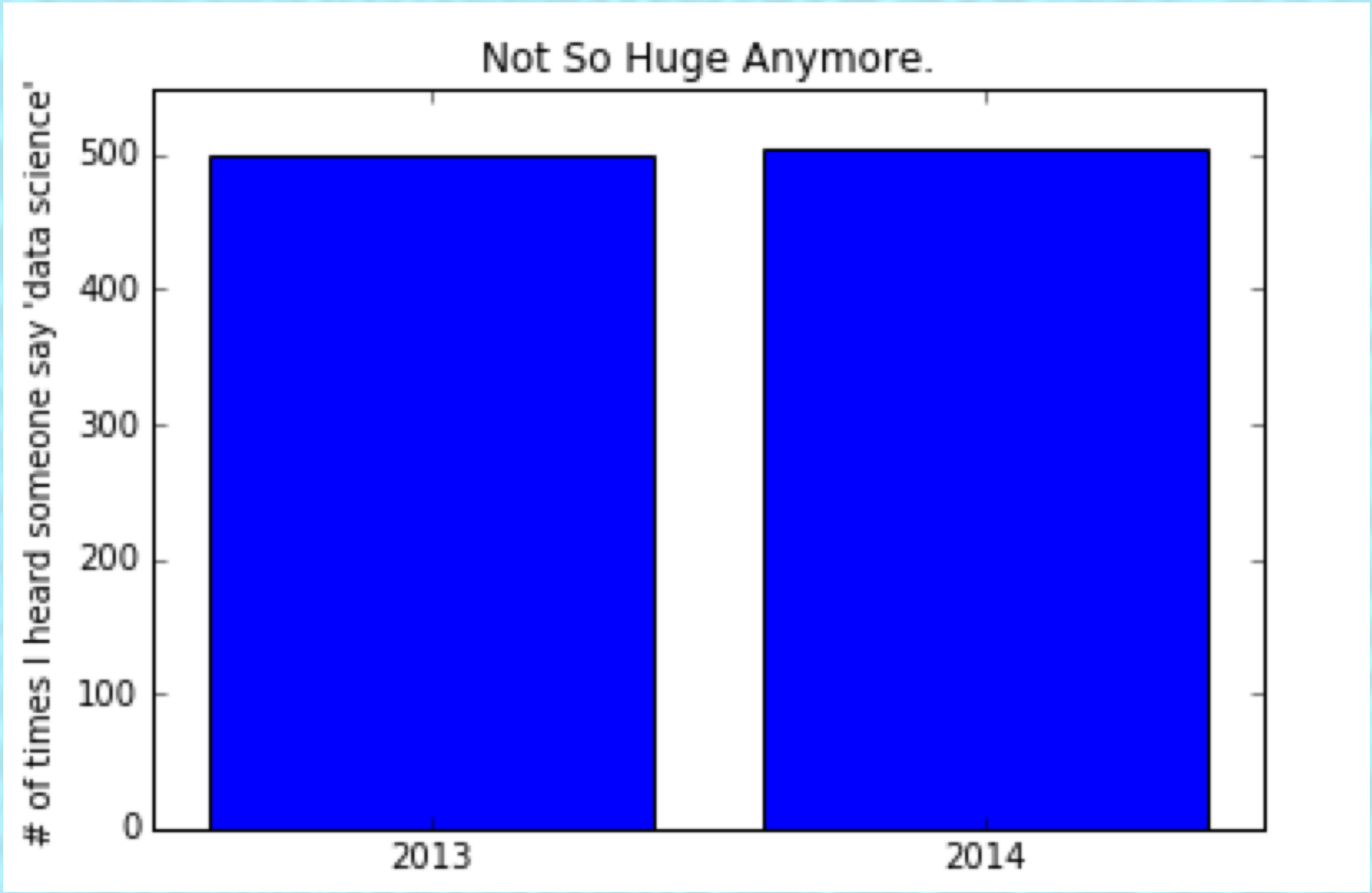


Few recommendations: 1) be fair



misleading bar-charts

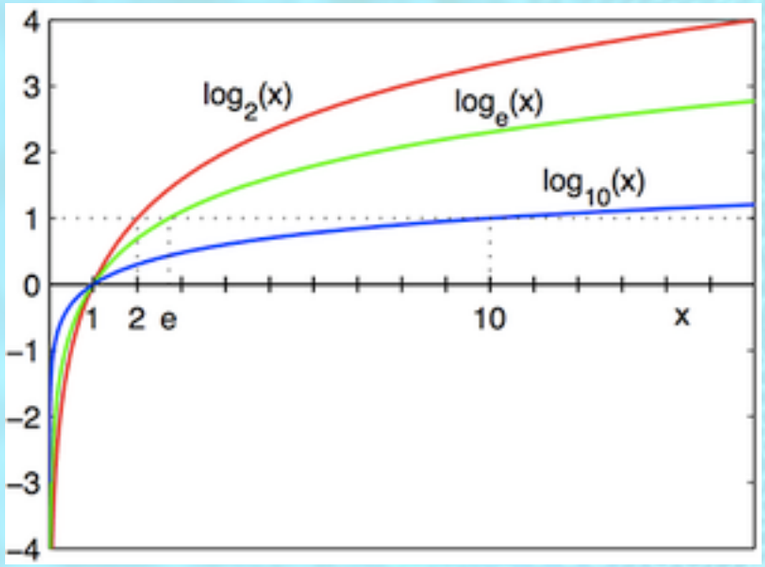
Few recommendations: 1) be fair



misleading bar-charts

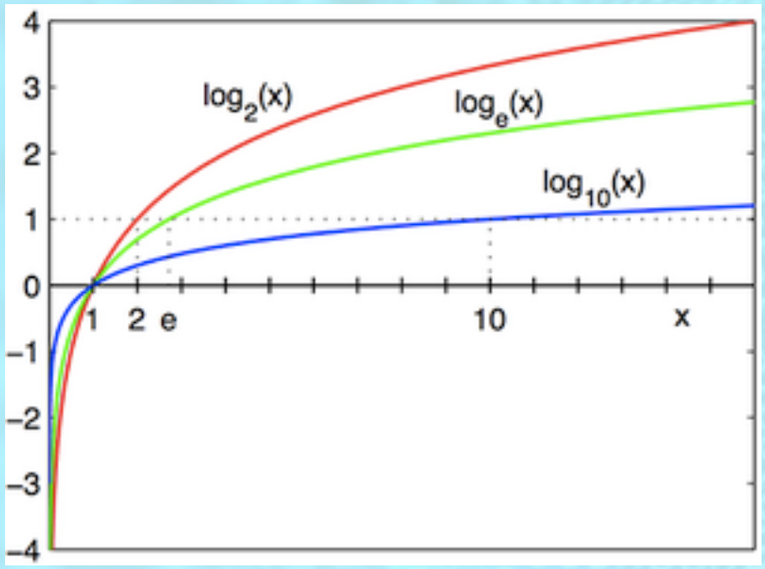
Facts are stubborn, but statistics are more pliable (Mark Twain)

Linear scale not always good

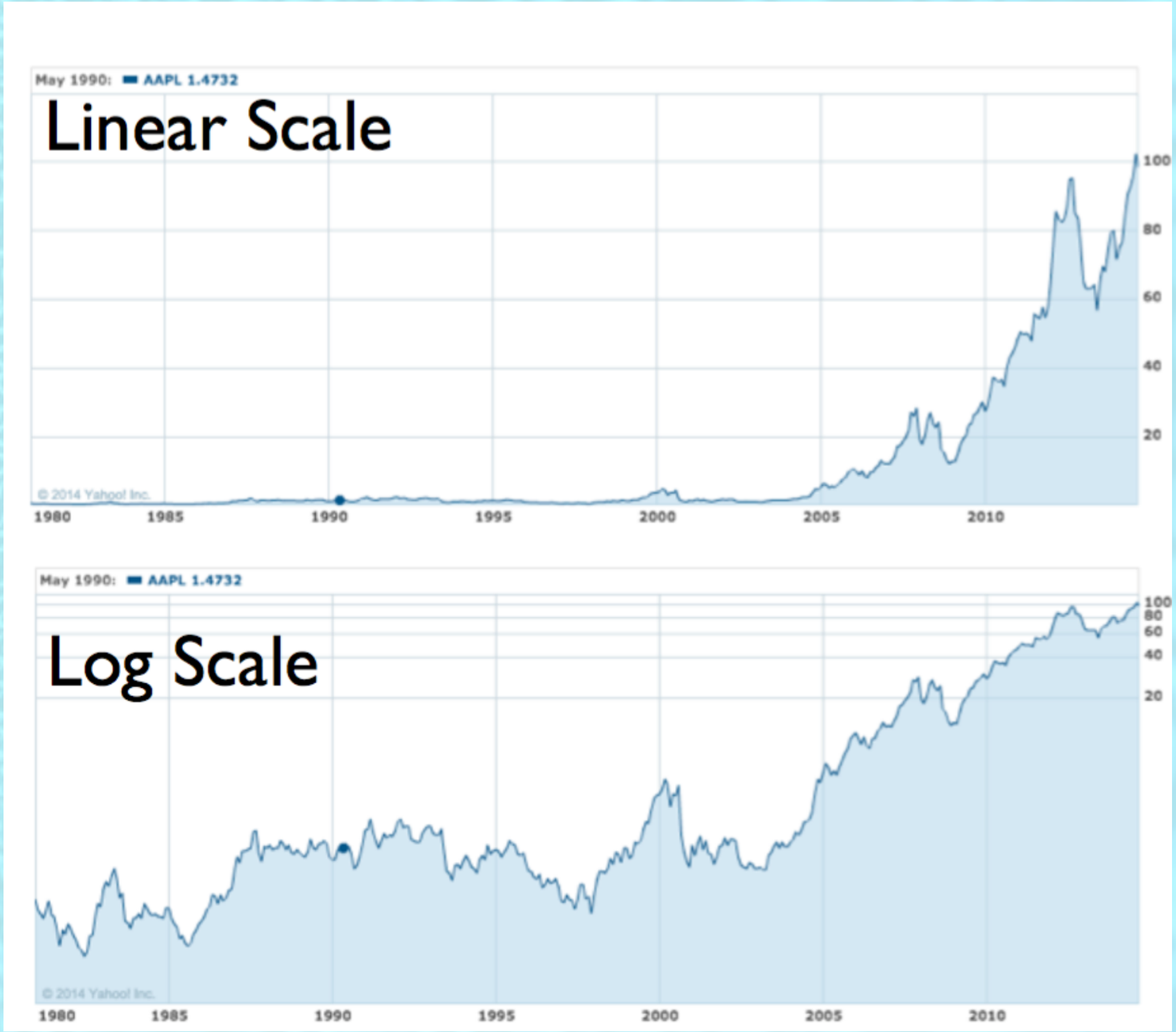


$$x' = log_n(x)$$

Linear scale not always good



$$x' = log_n(x)$$

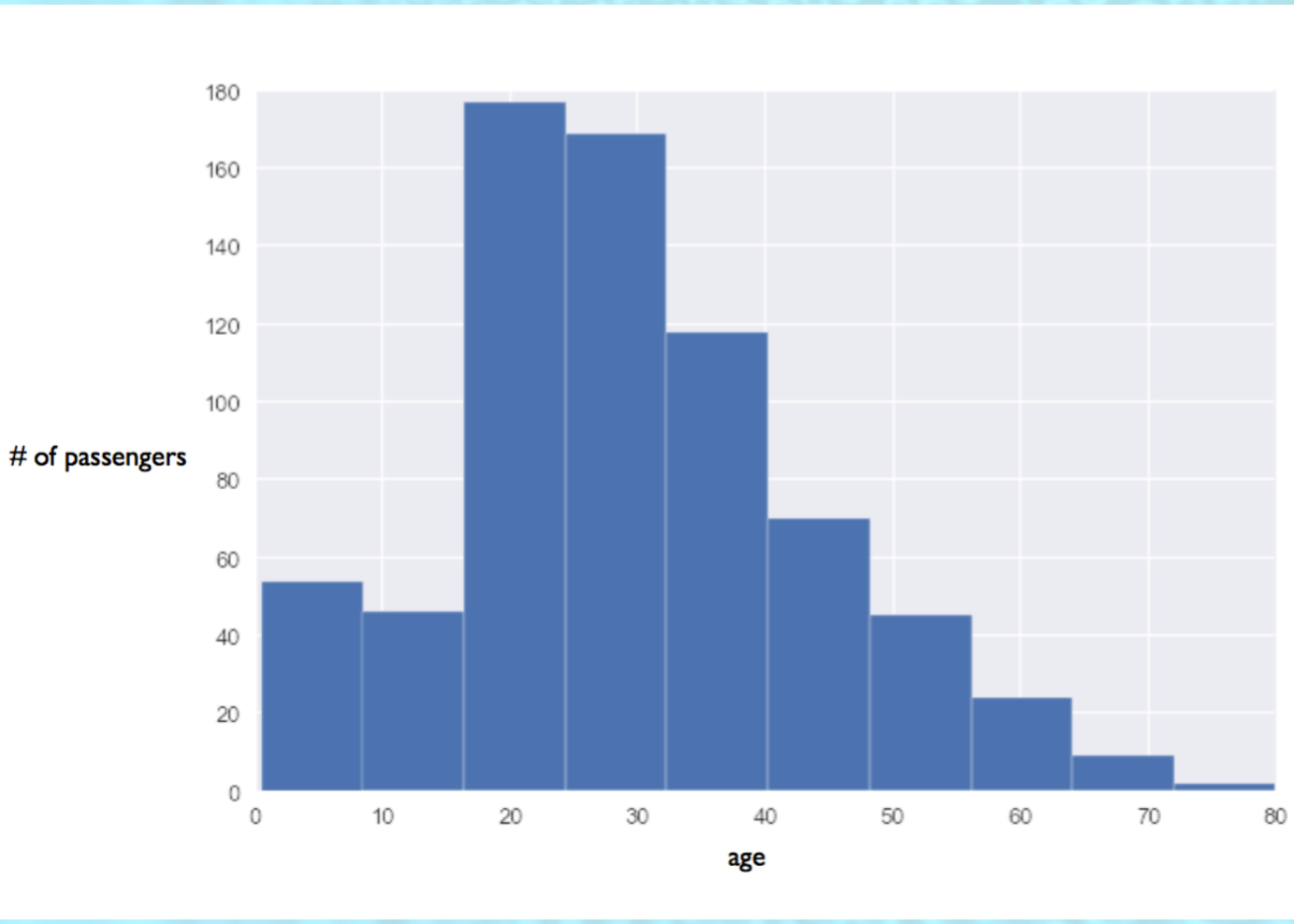


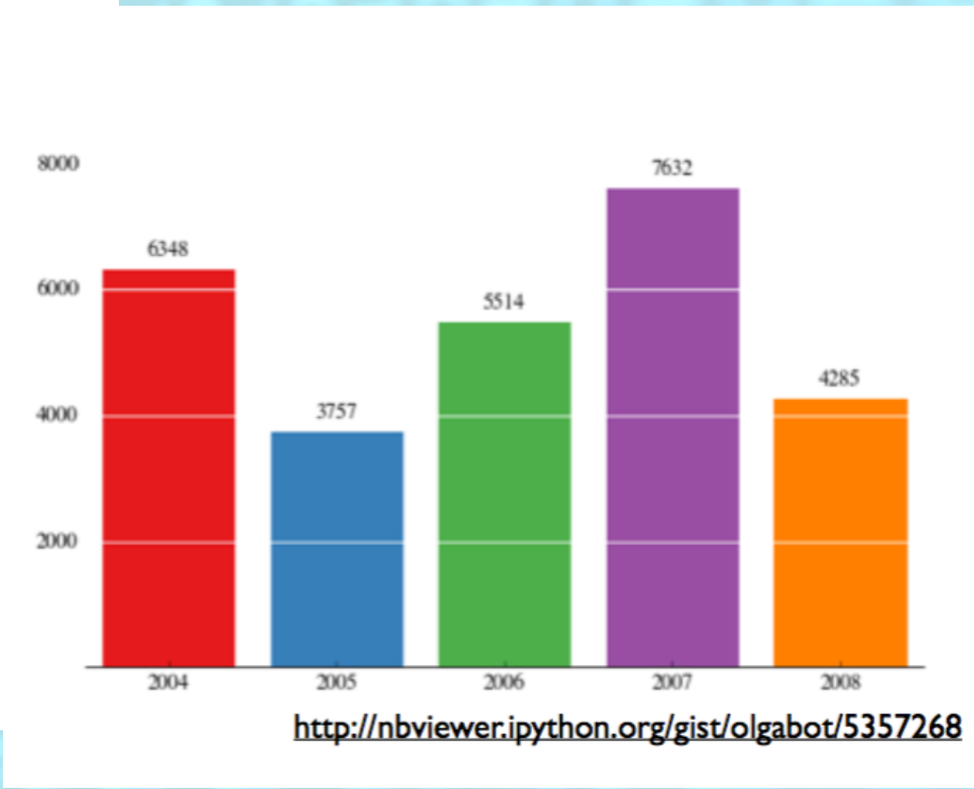
Kind of plots

Bar - charts

1) when you want to show how some quantities varies among a set of items

2) also good to explore how the values are distributed

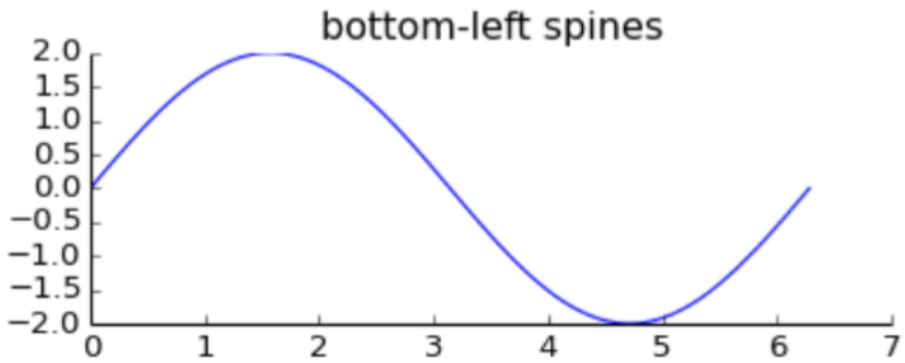


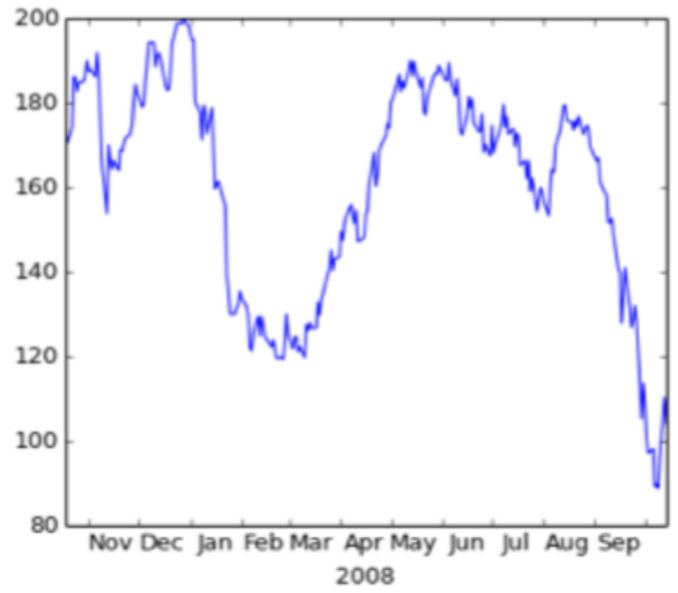


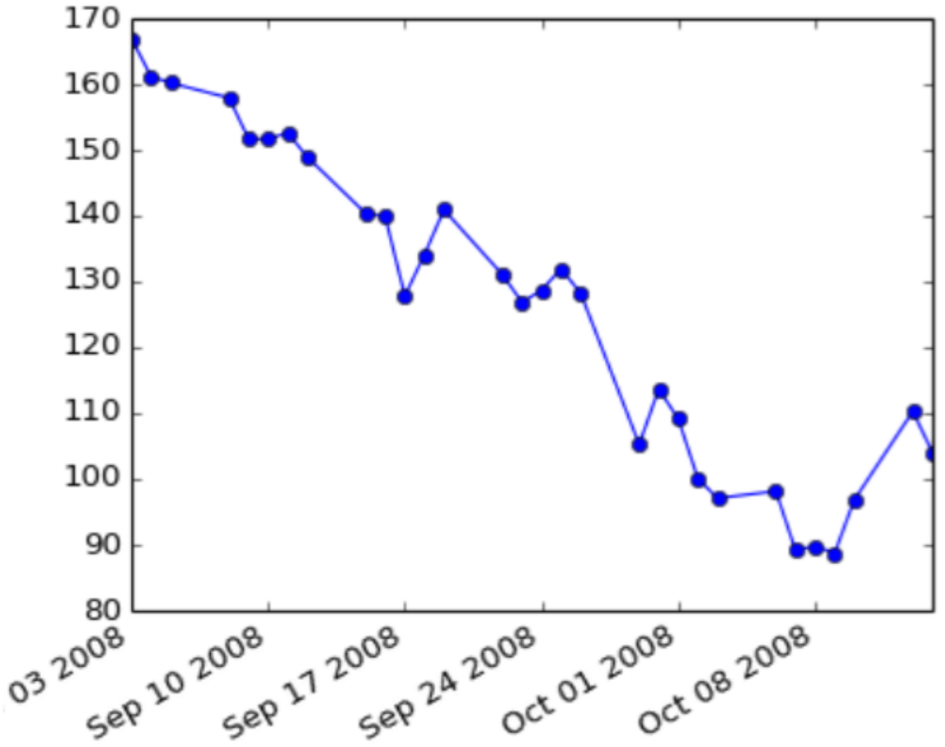
http://nbviewer.ipython.org/gist/olgabot/5357268

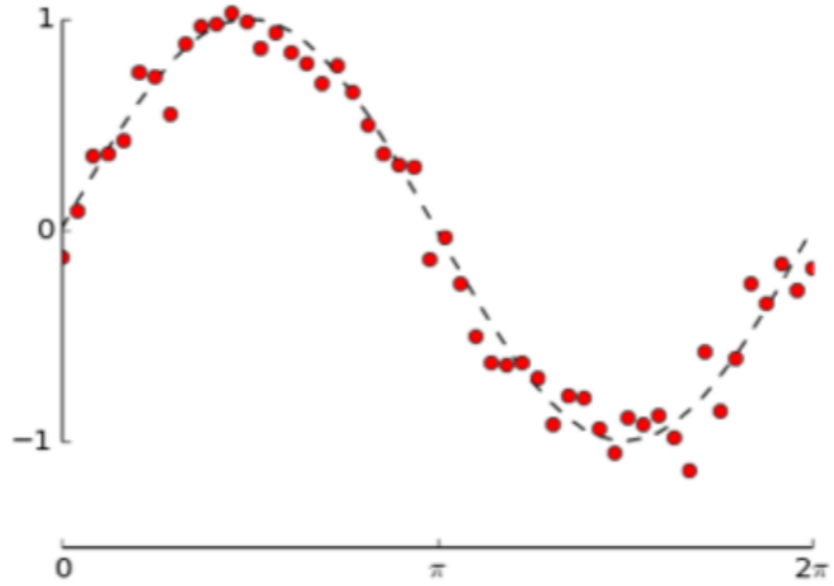
Line-charts

line chart: good choice for showing *trends*





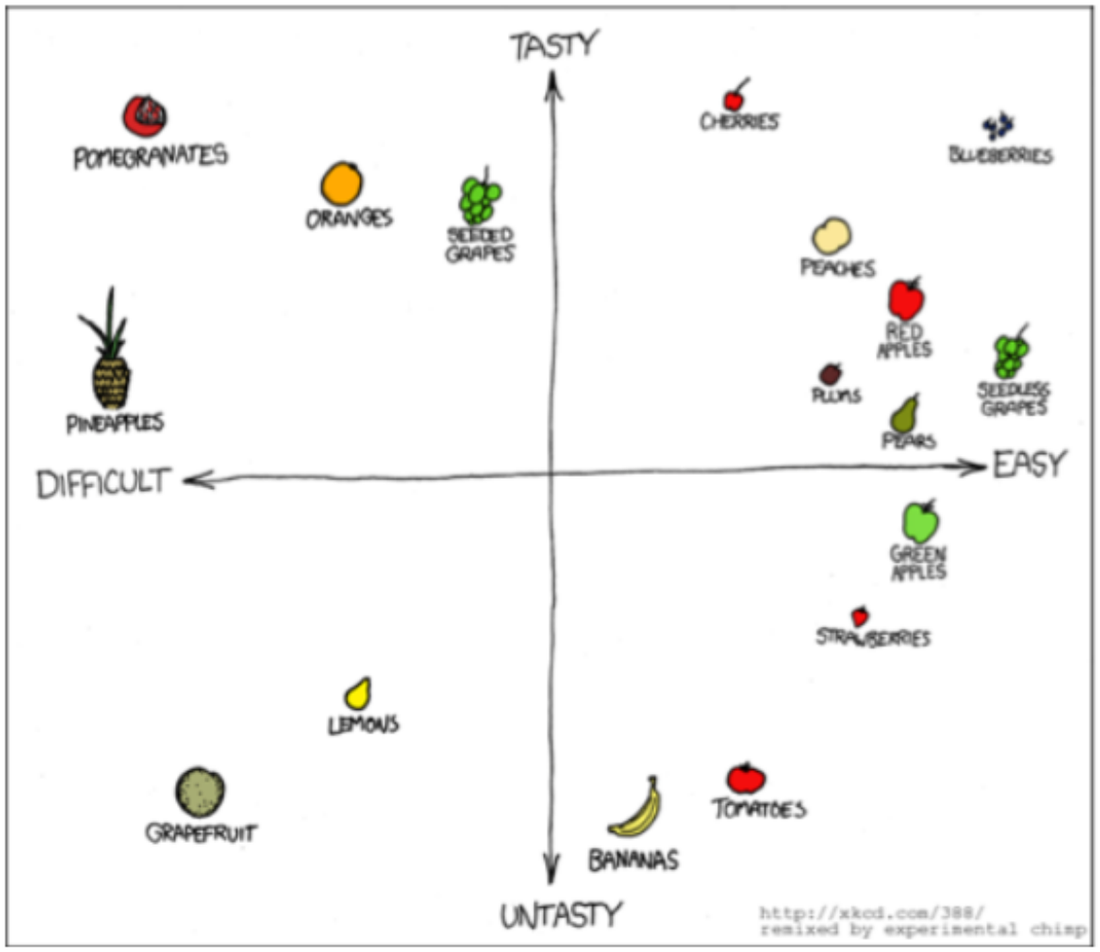


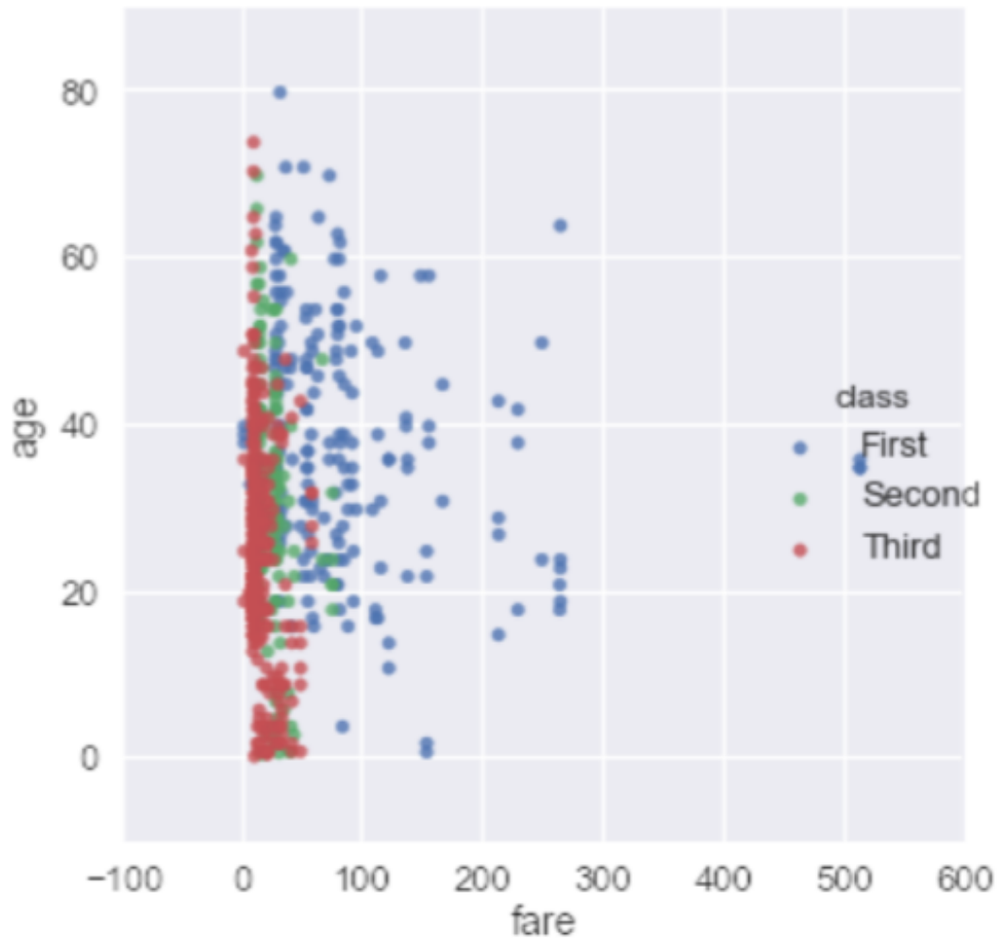


matplotlib gallery

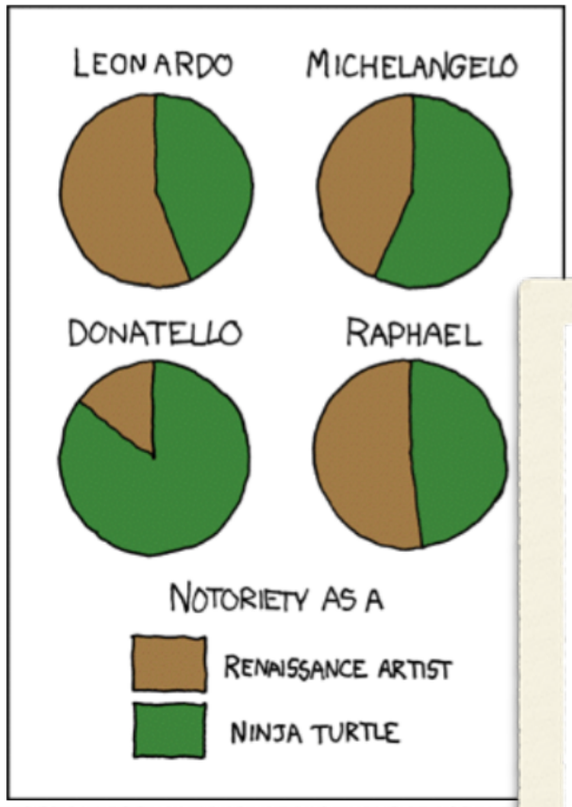
Scatterplots

scatter plot: good choice for showing *relationship* between two paired seats of data



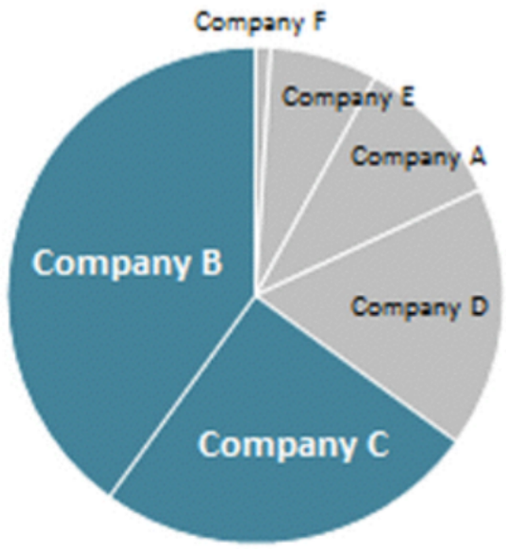


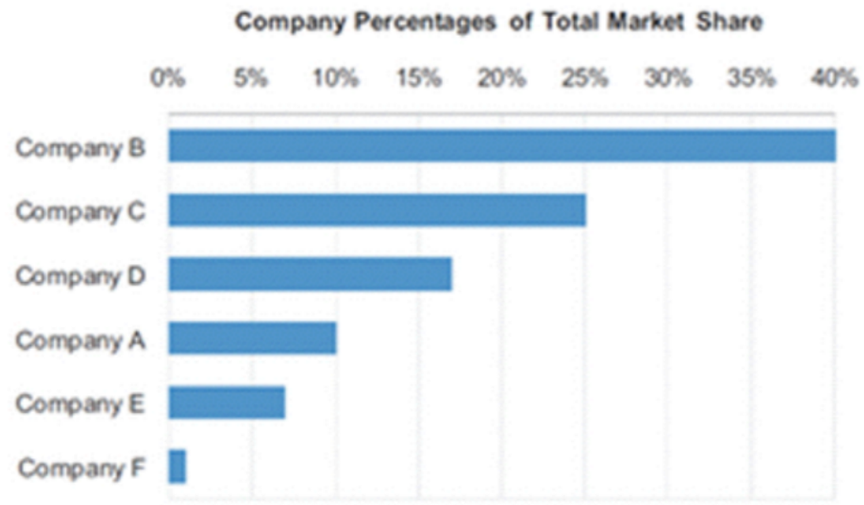
Pie Charts



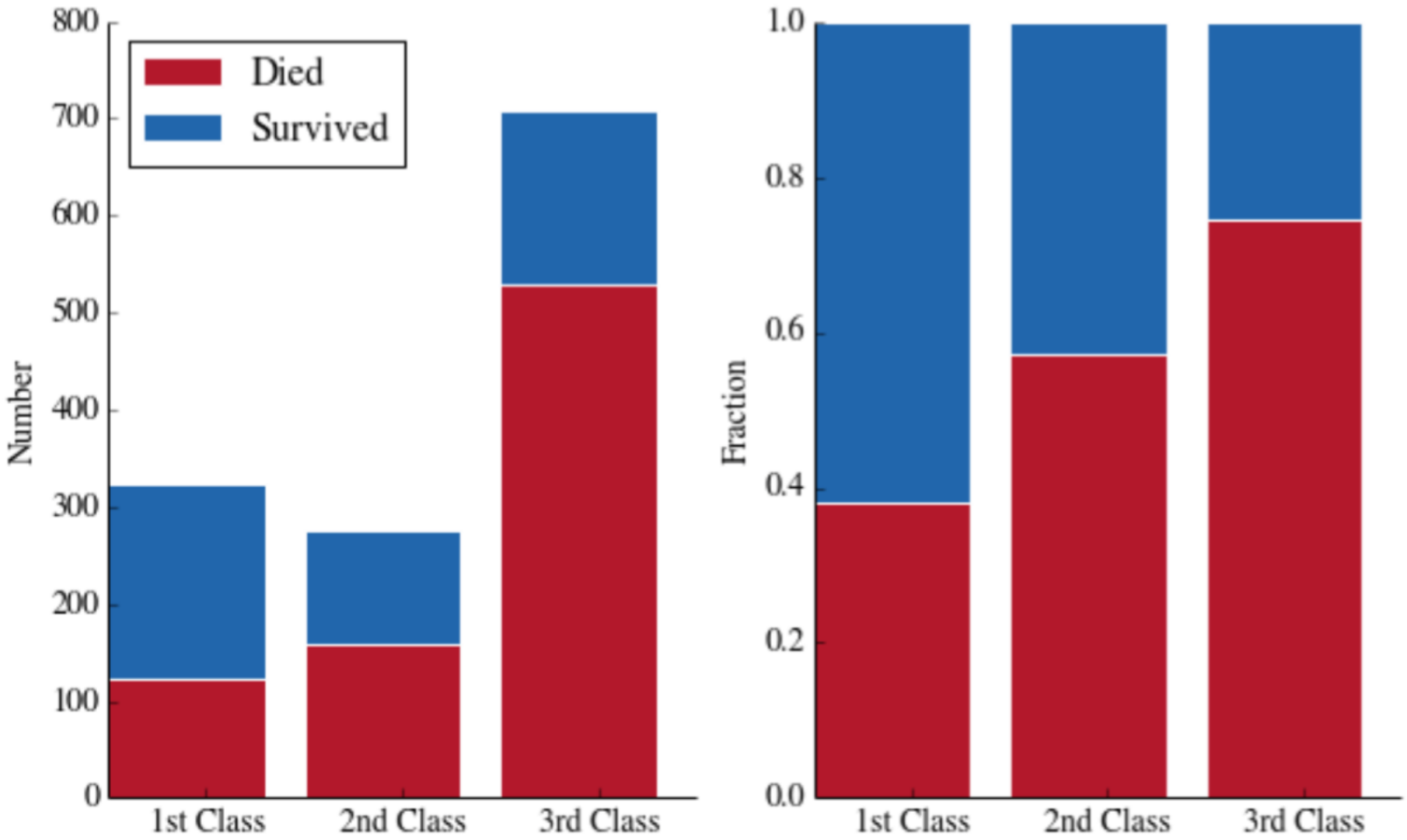
Pie vs. Bar Charts

65% of the market is controlled by companies B and C





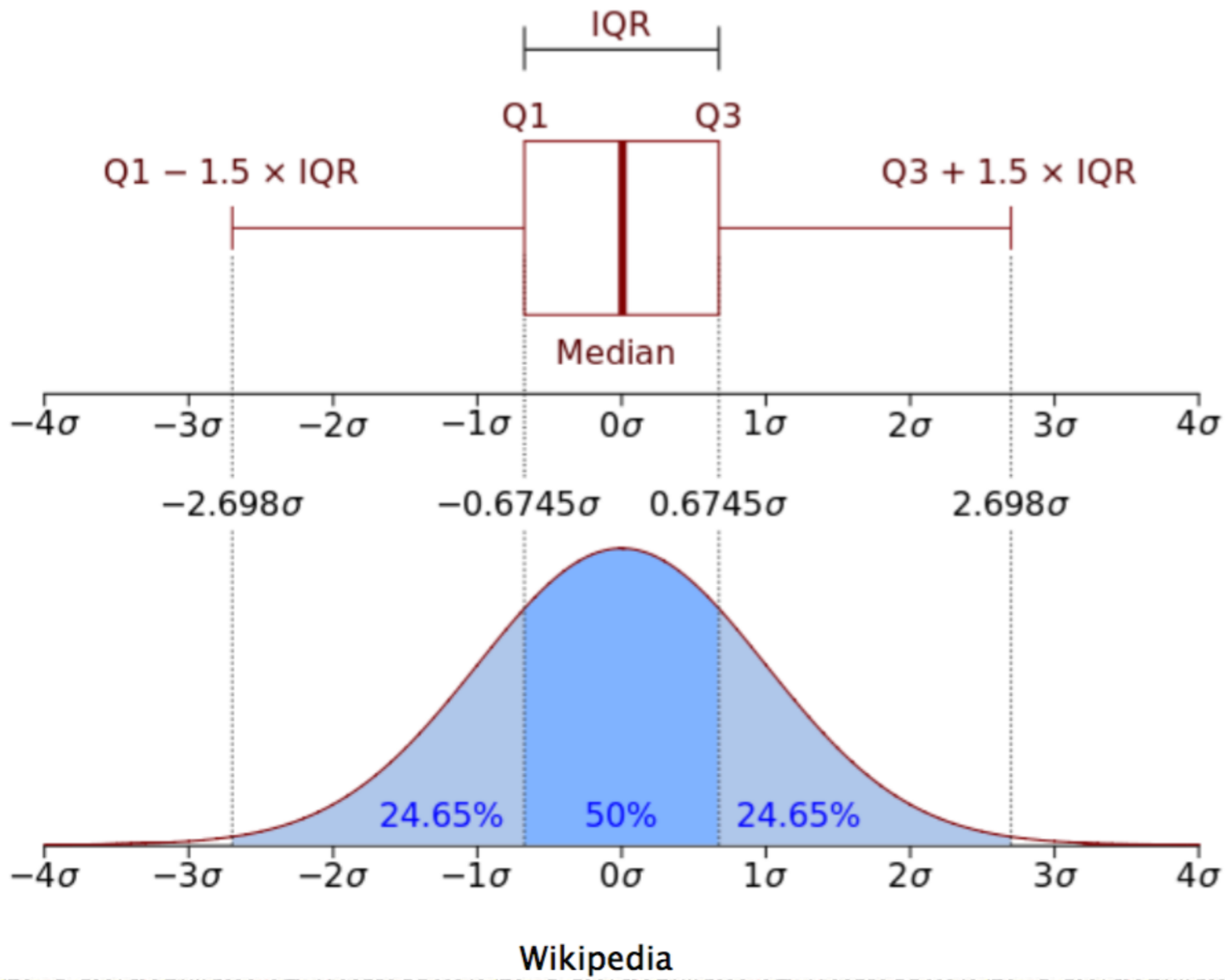
Stacked Bar Chart



Box plots...

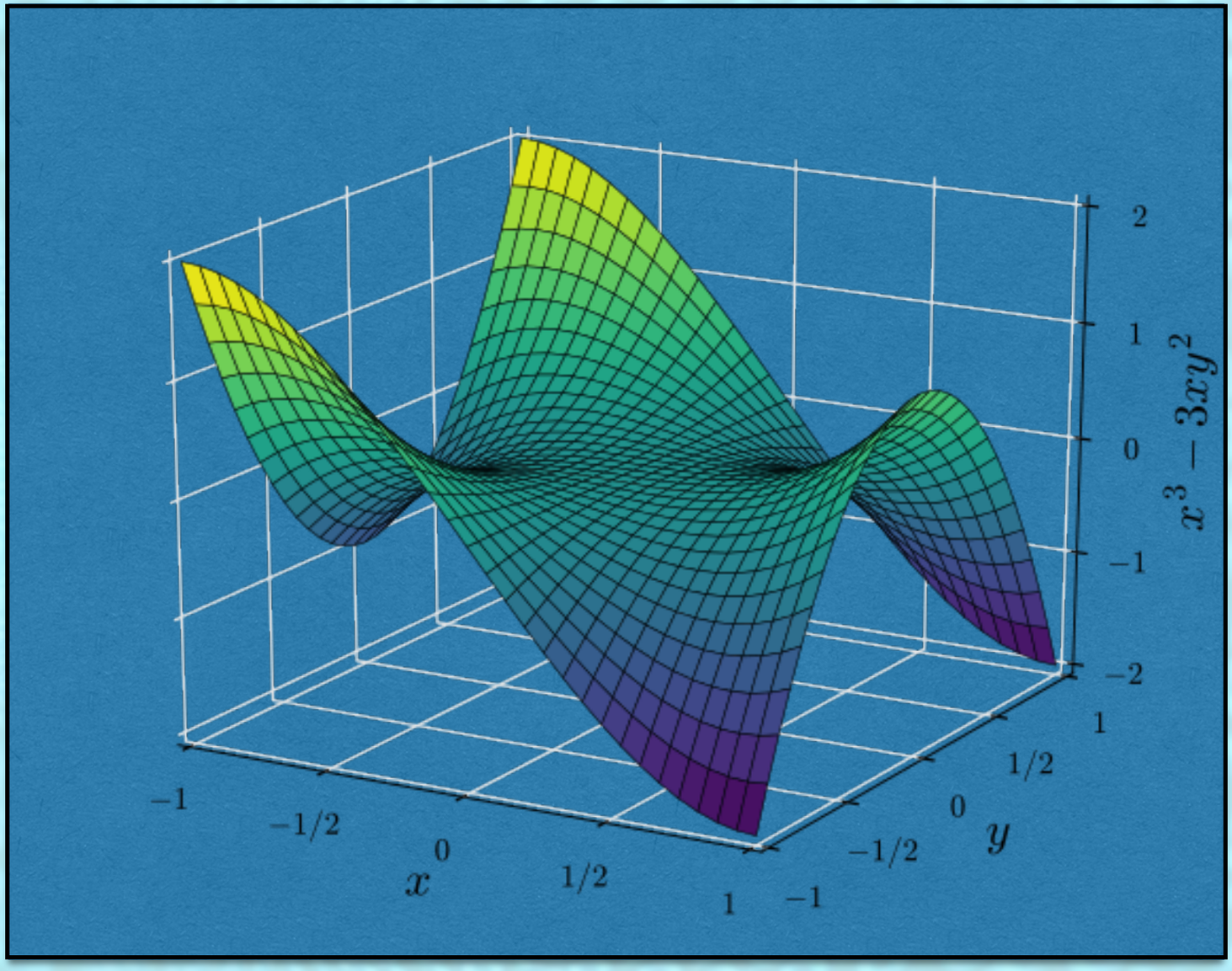
Box Plots

aka Box-and-Whisker Plot

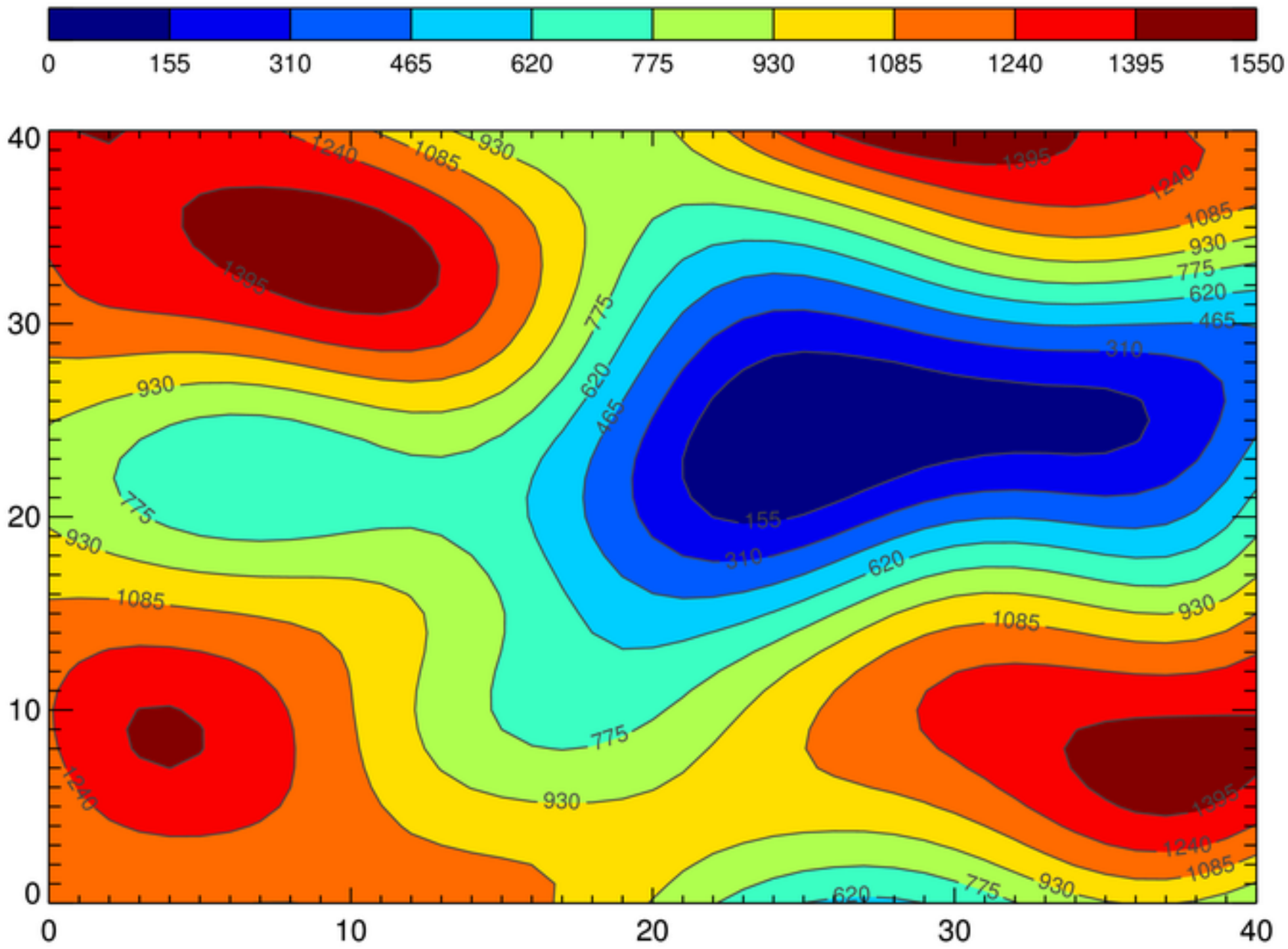


Wikipedia

3-D Data

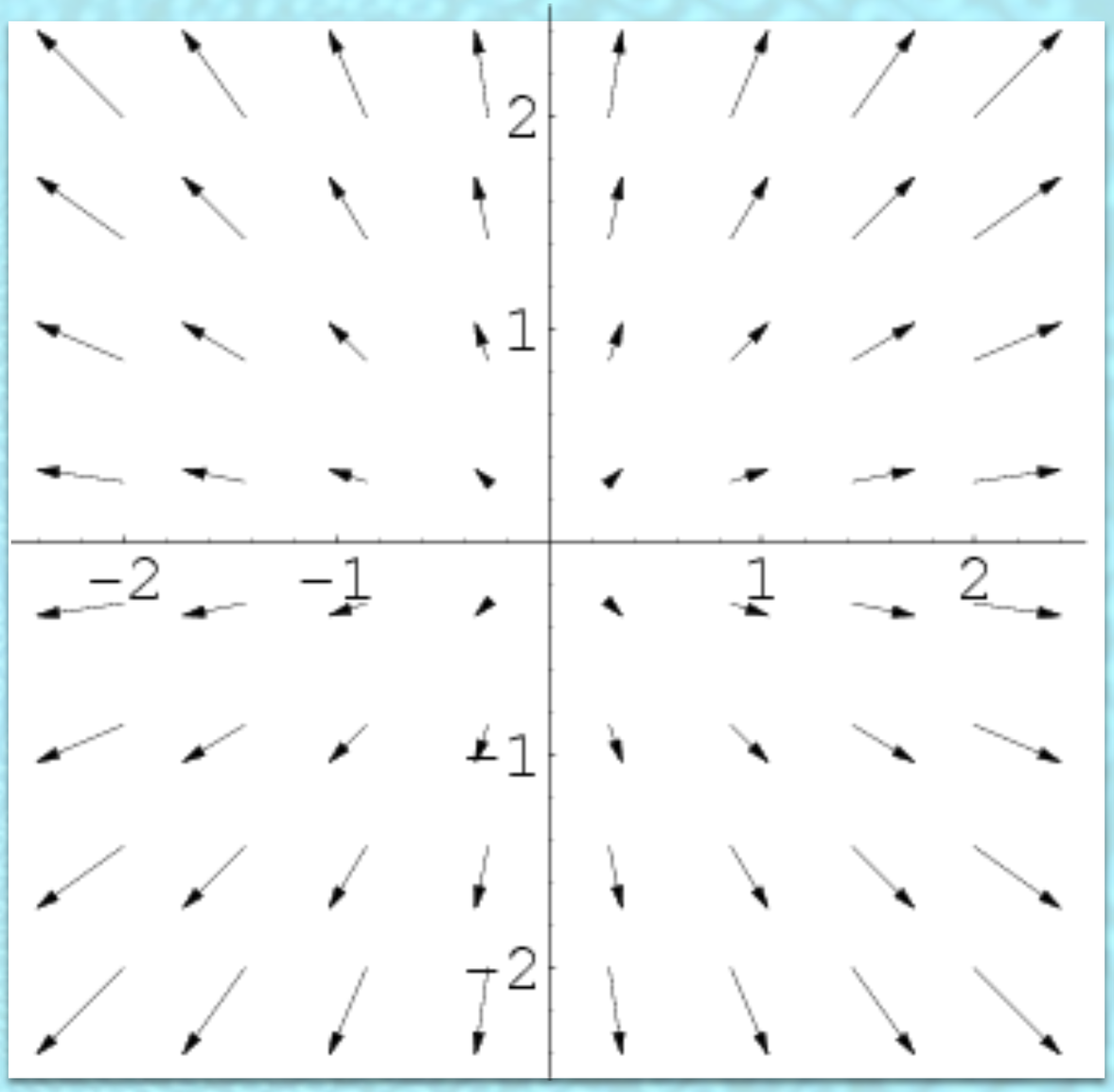


Contour Plots



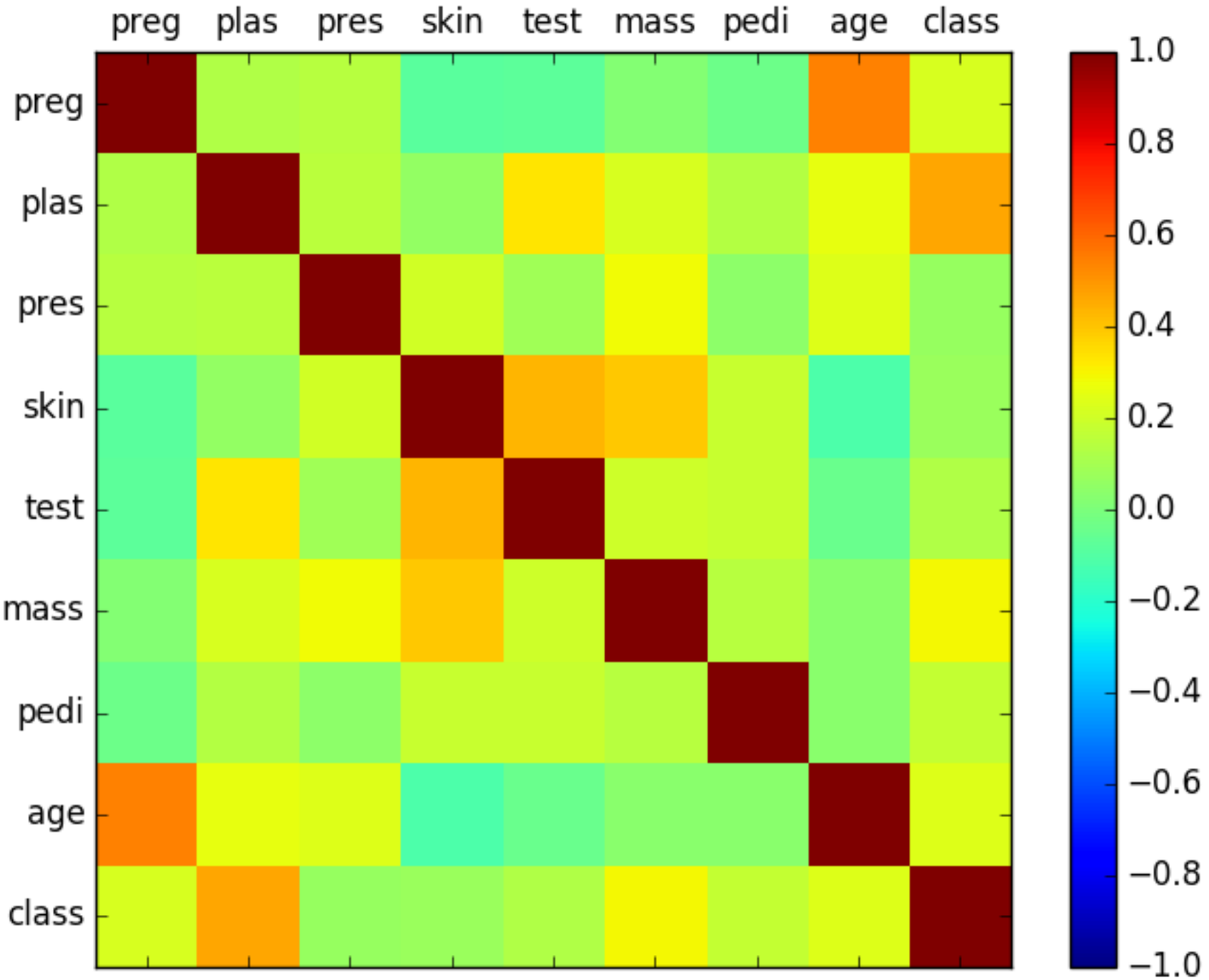
Breaks the plane into separate regions where the value of the 3rd attribute are roughly the same

Vector field plots



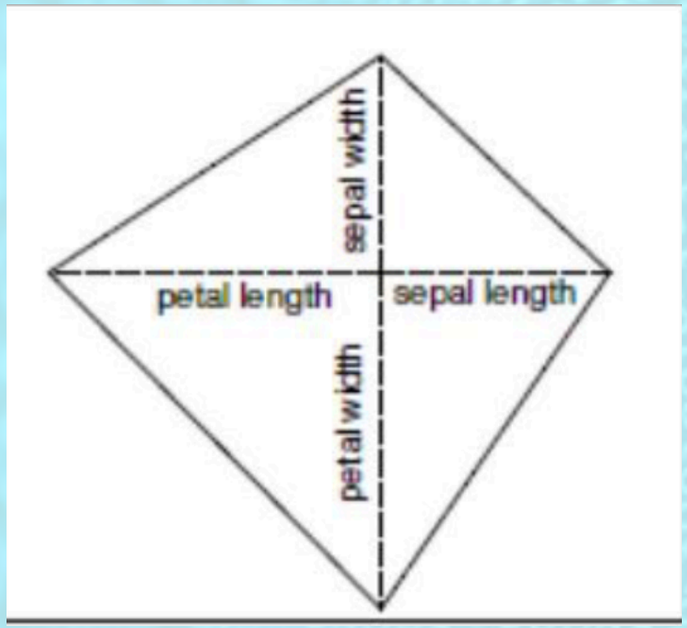
To represent both direction and magnitude associated to a given feature

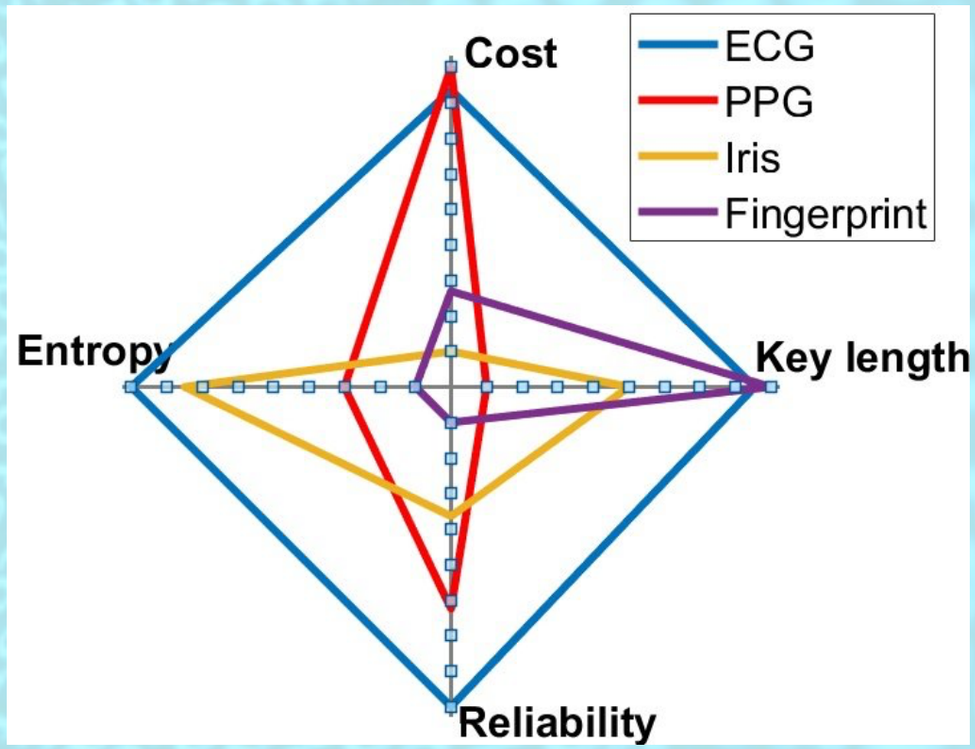
Visualising higher dimensional data



Star coordinates and Chernoff faces

Another way to display multidimensional data is to encode them as symbols, **glyphs** or **icons**

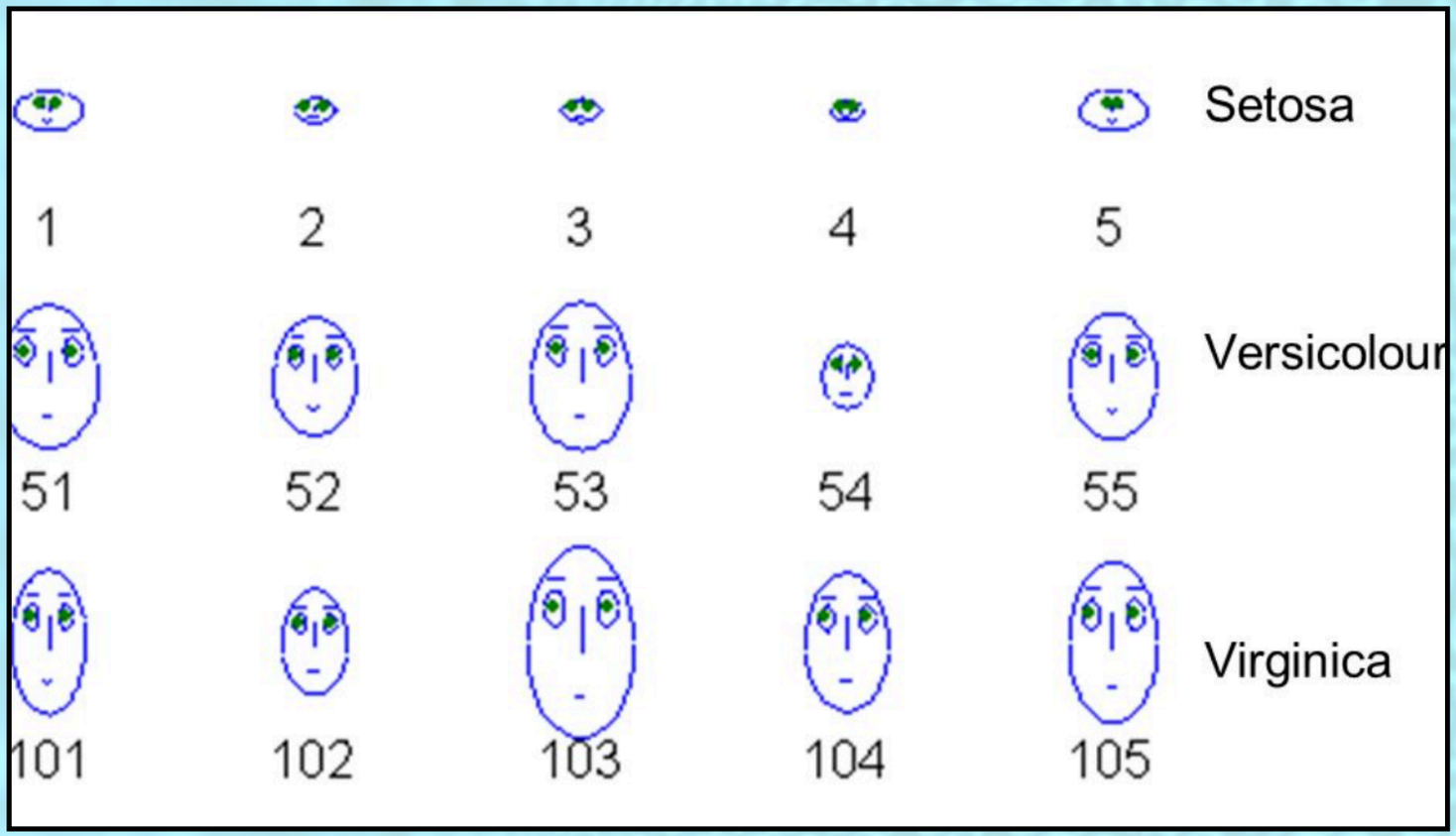




Star graph: one axis for each attribute. All radiating from the center

Star coordinates and Chernoff faces

Another way to display multidimensional data is to encode them as symbols, **glyphs** or **icons**



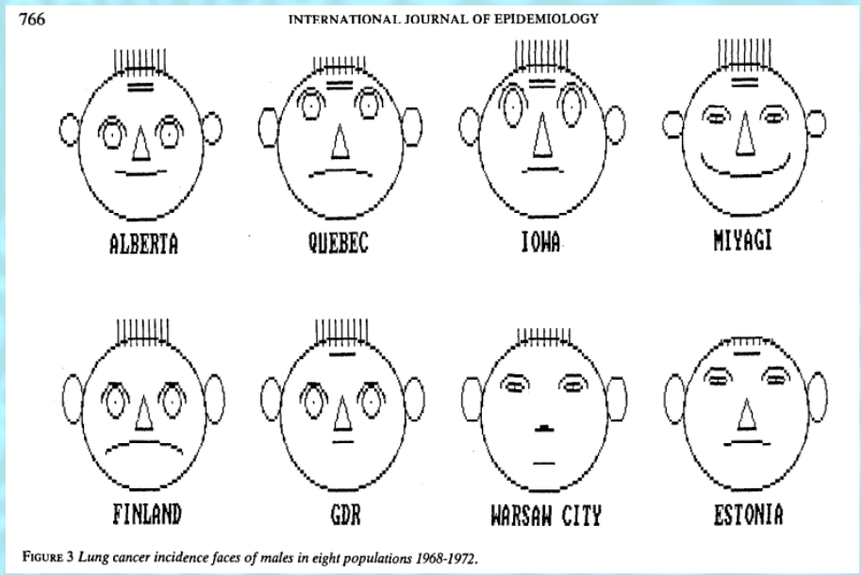
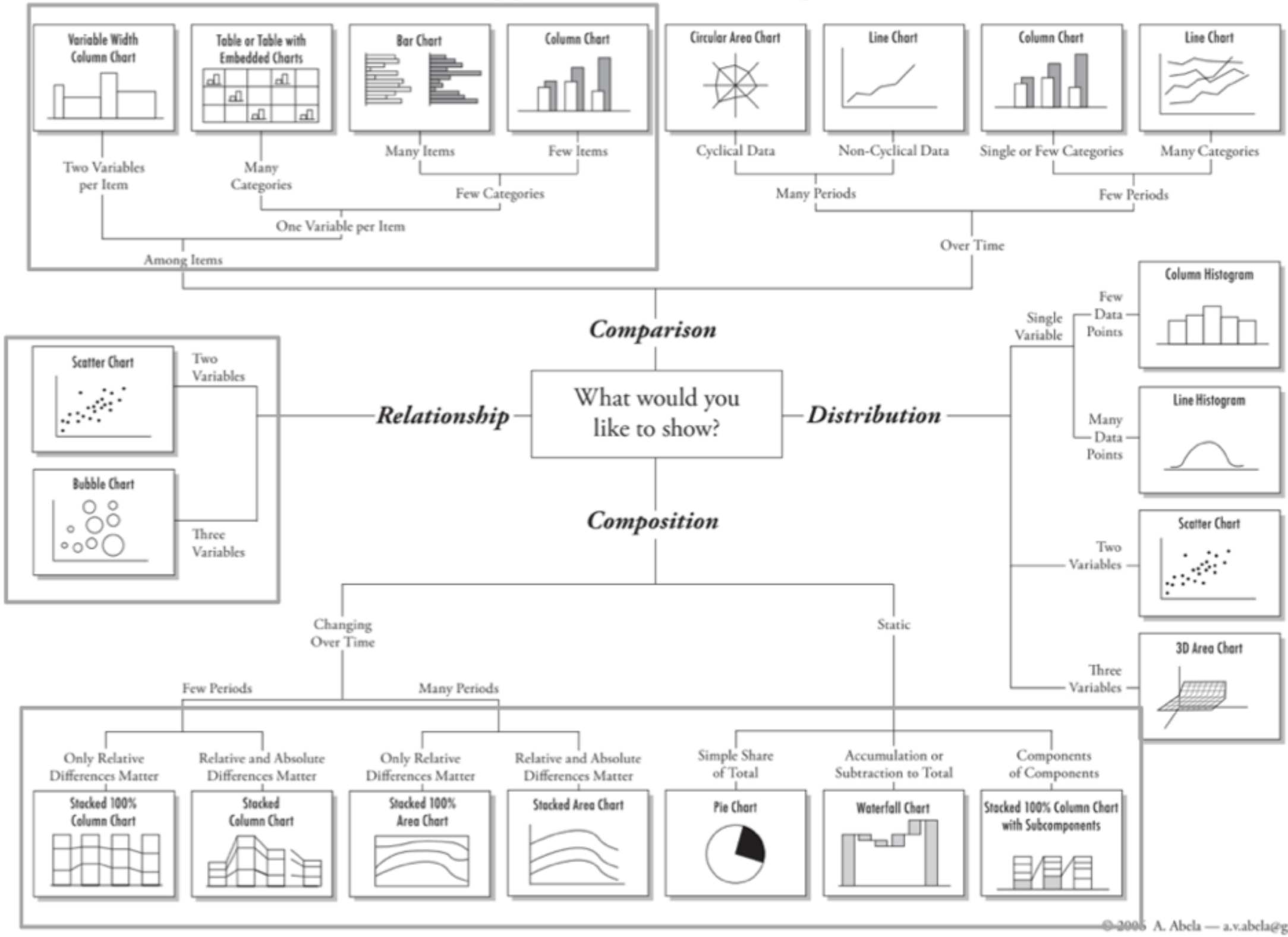


FIGURE 3 *Lung cancer incidence faces of males in eight populations 1968-1972.*

Chernoff faces: each attribute associated with a specific feature of a face

Chart Suggestions—A Thought-Starter



http://extremepresentation.typepad.com/blog/files/choosing_a_good_chart.pdf

MATPLOTLIB

https://matplotlib.org

SEABORN library is written ON Matplotlib and produce more complex visualisations in an easy way

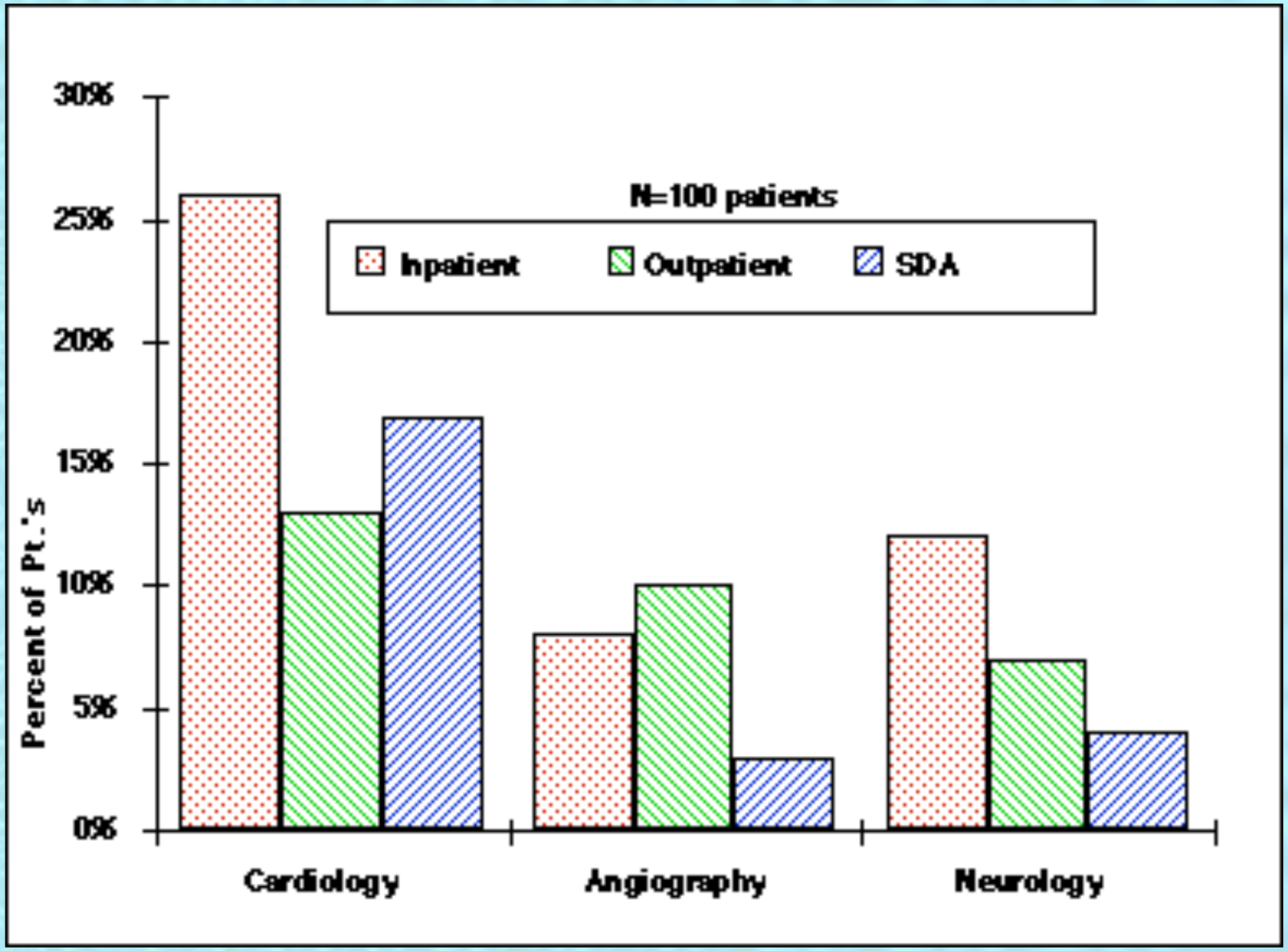
https://seaborn.pydata.org

BOKEH allow WEB plots and 3D visualizations in Python

http://bokeh.pydata.org/en/latest/

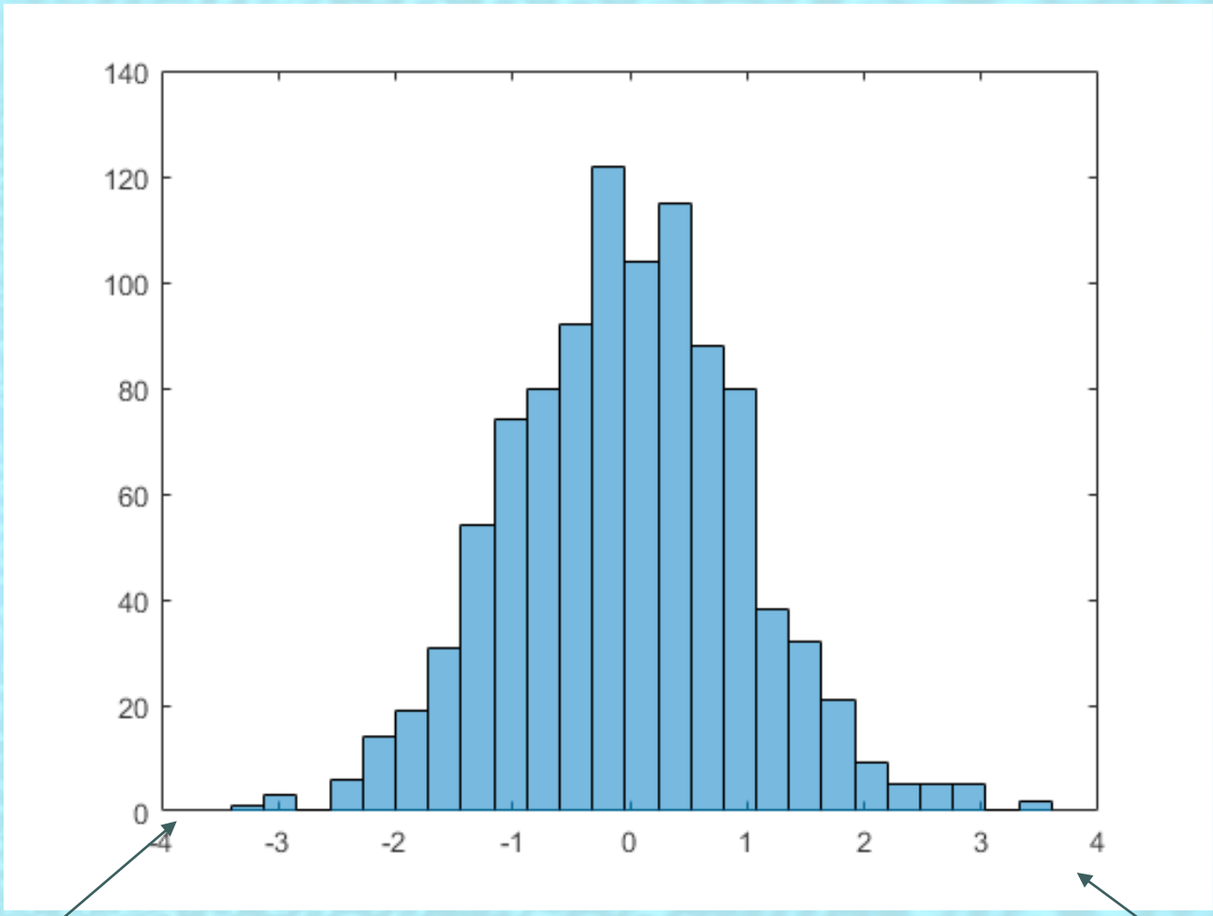
Summary statistics

*) In the worse case of a 1-D set of o unordered categorical(1) values, the best we an do is calculate ***frequency:***



$$frequency(\nu_i) = \frac{number\ objects\ with\ attribute\ \nu_i}{m}$$

*) In the happier case of a *numerical-set* of data,
we can start playing with numbers



total size

min

max

where is centered…?

Measure of location: central tendency

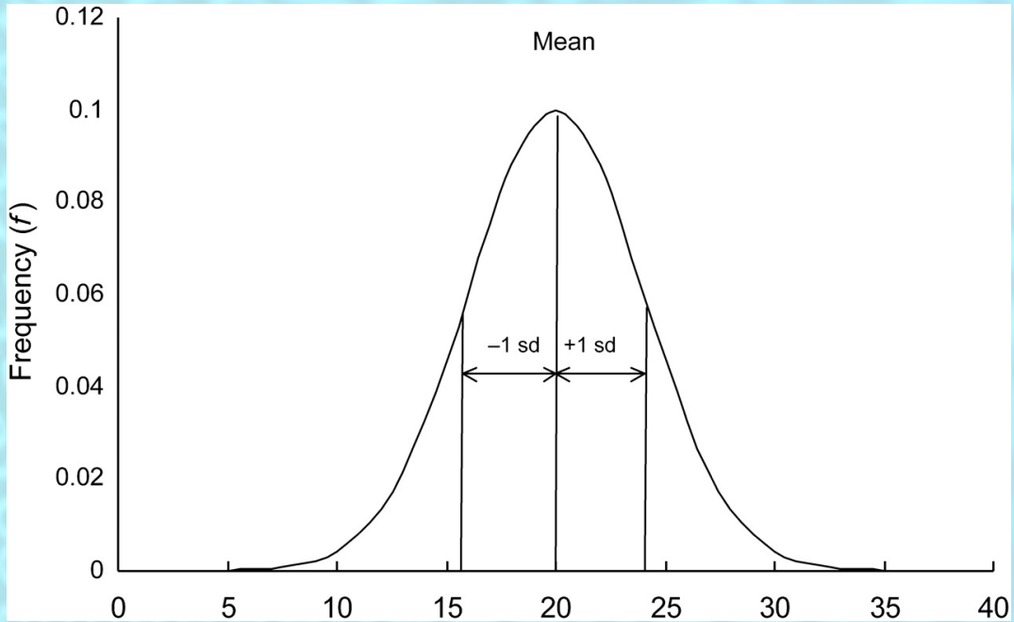
1) Mean

A = 2,6,7,8,9,6,4,6,2,5,8

↓

Mean = (2+6+7+8+9+6+4+6+2+5+8) / 11 ~ **5.7**

$$\mu = \bar{x} = \frac{x_1 + x_2 + x_3 \ldots}{n} = \sum_i^n \frac{x_i}{n}$$



2) Median

A = 2,6,7,8,9,6,4,6,2,5,8 ⟶ central value

sort(A) = 2,2,4,5,6,**6**,6,7,8,8,9

↑

Central tendency

Differences Mean and Median?

A = 2,6,7,8,9,6,4,6,2,5,**8000**

Outliers

Mean = 732.27

Median = 6

3) Mode

A = 2,6,7,8,9,6,4,6,2,5,8 → Most common value

sort(A) = 2,2,4,5,6,6,6,7,8,8,9 mode = median = 6

B = 2,2,4,5,6,6,7,8,8,8,9 → median = 6

mode = 8

NB "mode" is a special kind of frequency (the most frequent), so it can be applied to categorical

*) Generalization of median = **quantile = $x_{y\%}$**

The value less than which a certain percentile of data lies

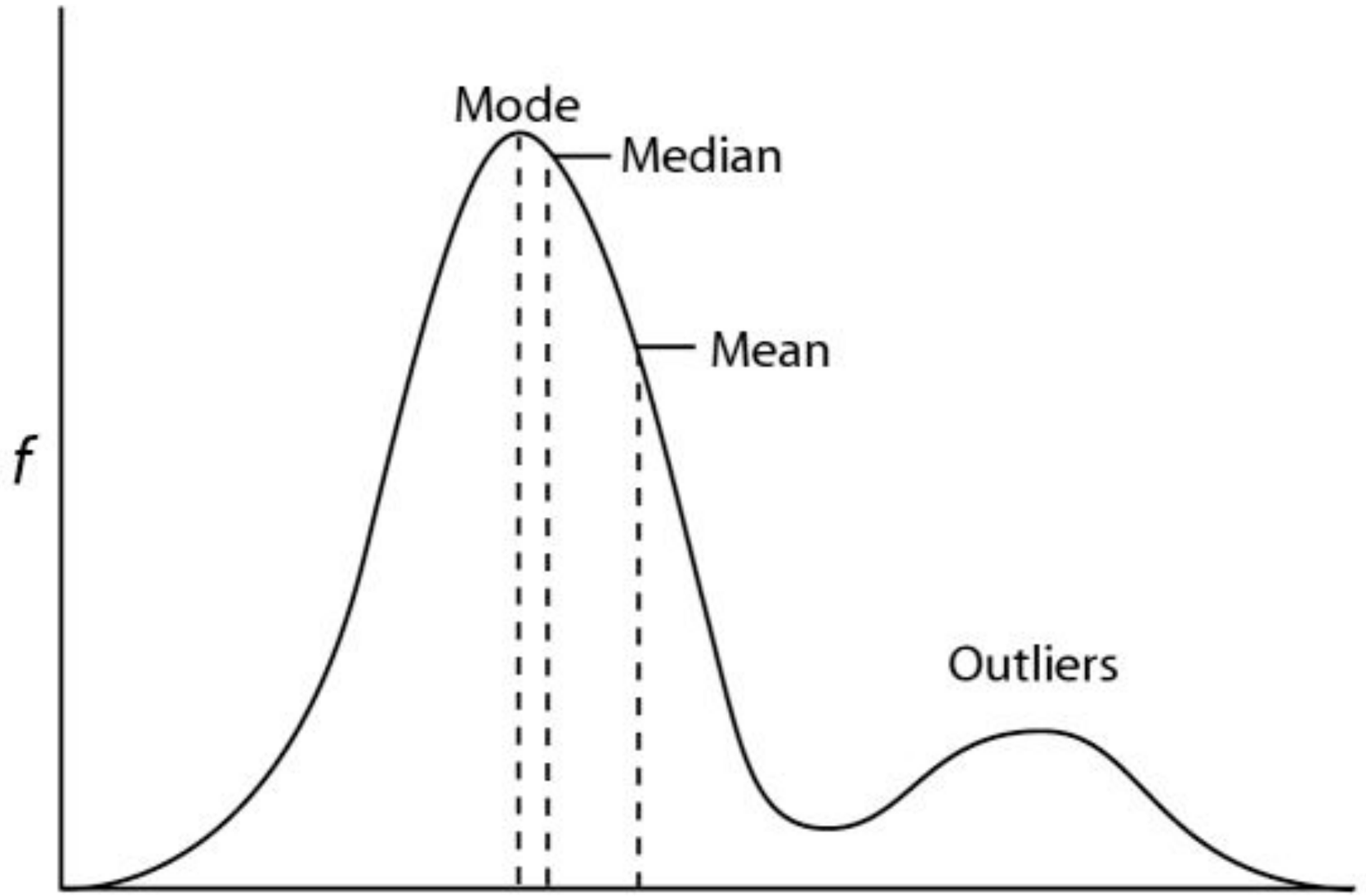
sort(A) = 2,2,4,5,6,6,6,7,8,8,9

50%

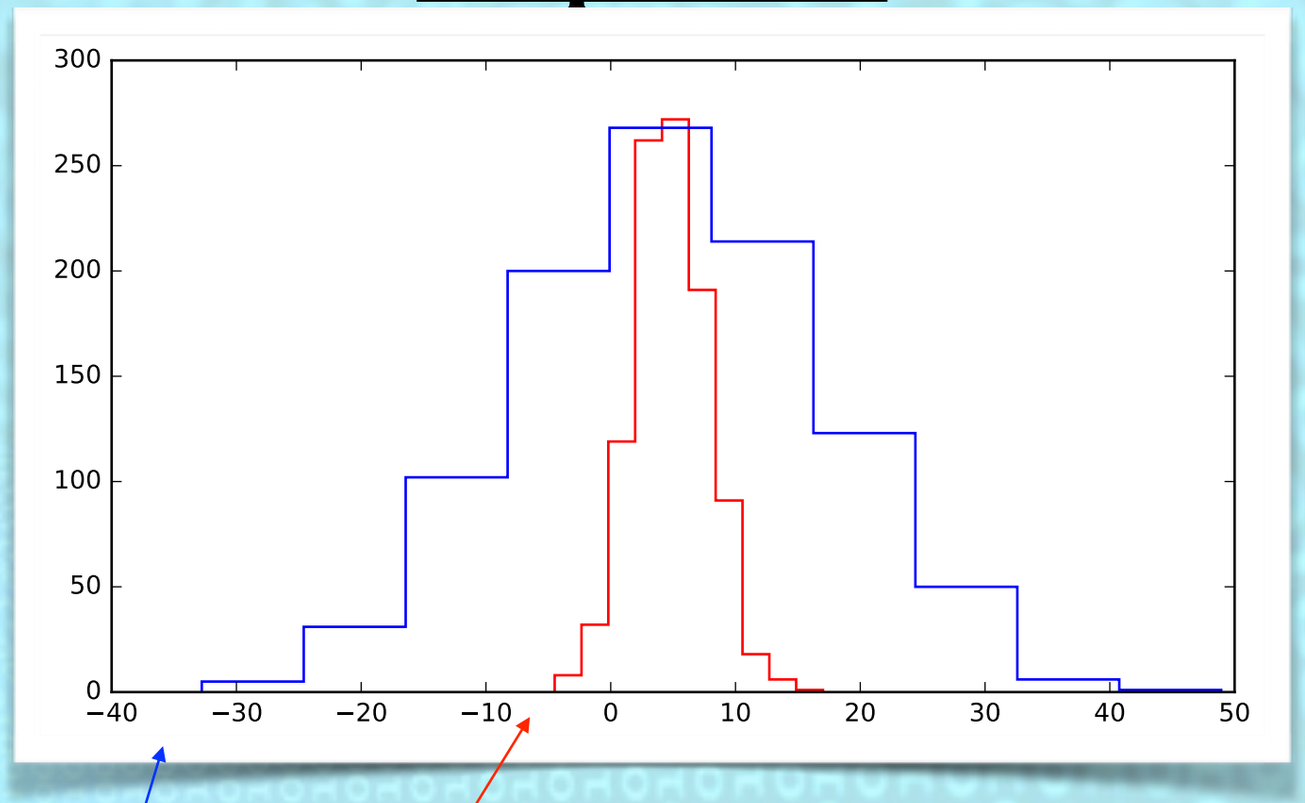
median= quantile of 50%

quantile of 30% ?

Behavior of mode, median and mean respect to outlier



Dispersion



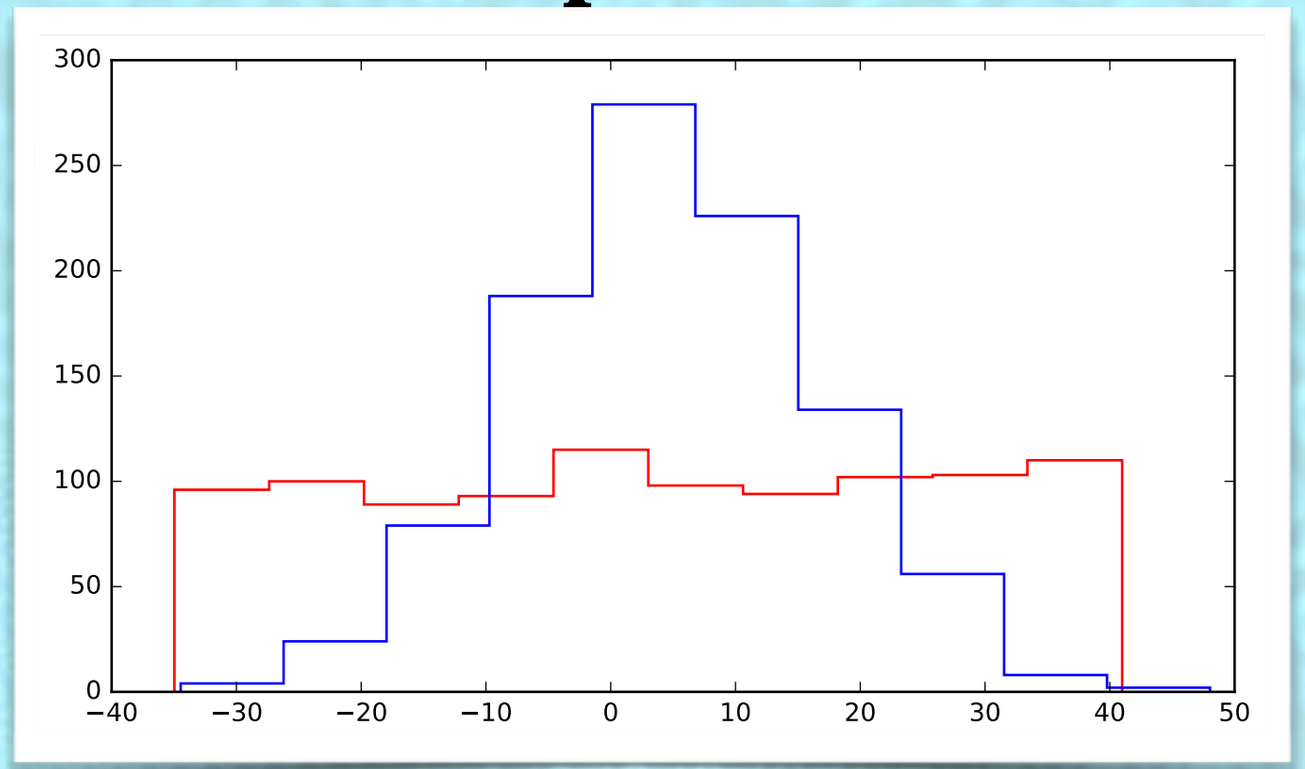
A measure of how spread the data is

1) Range

$$\max(A) - \min(A)$$

same mean different range

Dispersion



A measure of how spread the data is

1) Range

$$\max(A) - \min(A)$$

$$Var(x) = \sigma^2 = \frac{\sum_{i=1}^{n}(x - \bar{x})^2}{n}$$ ***variance***

$$\sigma = \sqrt{(Var(x))}$$ ***standard deviation***

$$Var_s(x) = \frac{\sum_{i}^{n}(x - \bar{x})^2}{n - 1}$$ ***variance from sample***

$$\sigma_s = \sqrt{(Var_s(x))}$$ ***standard deviation from sample***

3) More Robust estimators of spread

Both range and variance are quite affected by **outliers**

1) ***interquartile range (IQR)***

$$IQR(x) = x_{75\%} - x_{25\%}$$

2) ***Absolute average deviation (AAD)***

$$AAD(x) = \frac{1}{n}\sum_{i}^{n} |x_i - \bar{x}|$$

3) ***Median absolute deviation (AAD)***

$$MAD(x) = median\left(|x_i - \bar{x}|, ..., |x_n - \bar{x}|\right)$$

Multivariate Summary statistics

**) measure of the location of data consisting of several attributes can be obtained by computing the mean and median separately*

$$\bar{\boldsymbol{x}} = (\bar{x_1}, ..., \bar{x_n})$$

**) however the spread of the data it is most commonly measured by the*

covariance matrix S

Multivariate Summary statistics

1) ***covariance matrix***

$$S = \begin{pmatrix} x_{1,1} & x_{1,2} & \cdots & x_{1,n} \\ x_{2,1} & x_{2,2} & \cdots & x_{2,n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{n,1} & x_{n,2} & \cdots & x_{n,n} \end{pmatrix}$$

$$x_{i,j} = \frac{1}{n-1}\sum_{k}^{n}(x_{k,i} - \bar{x}_i)(x_{k,j} - \bar{x}_j)$$

measure the degree to which two attributes vary together

if ~0 do not have a (linear) relation

but not direct measure degree of relationship

2 *Correlation (or correlation coefficient r) matrix*

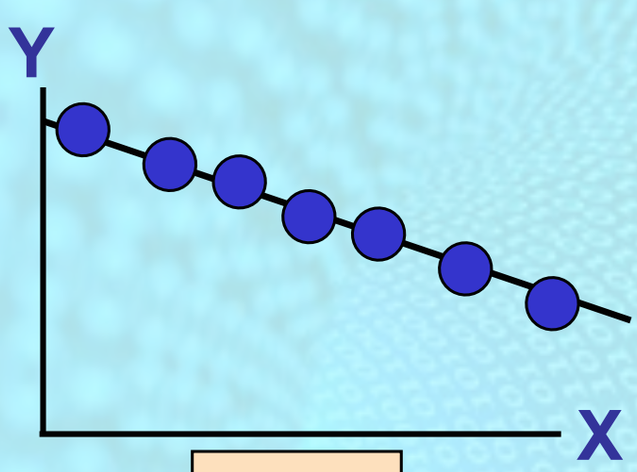
$$r_{i,j} = \frac{x_{i,j}}{\sigma_i \sigma_j}$$

gives immediate indication on how strongly two variables are (linearly) related

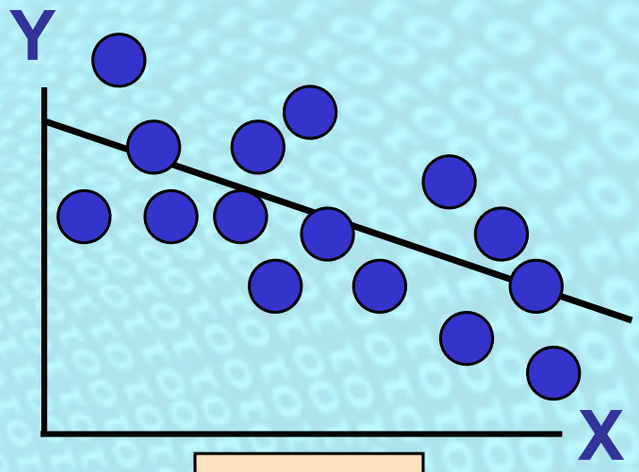
$$R = \begin{pmatrix} r_{1,1} & r_{1,2} & \cdots & r_{1,n} \\ r_{2,1} & r_{2,2} & \cdots & r_{2,n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{n,1} & r_{n,2} & \cdots & r_{n,n} \end{pmatrix} \Rightarrow \begin{pmatrix} 1 & r_{1,2} & \cdots & r_{1,n} \\ r_{2,1} & 1 & \cdots & r_{2,n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{n,1} & r_{n,2} & \cdots & \end{pmatrix}$$

$$\boldsymbol{-1 < r_{ij} < 1}$$

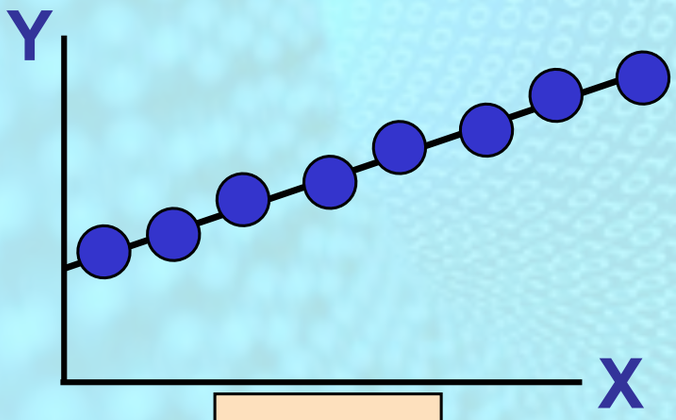
Correlation (*r*):



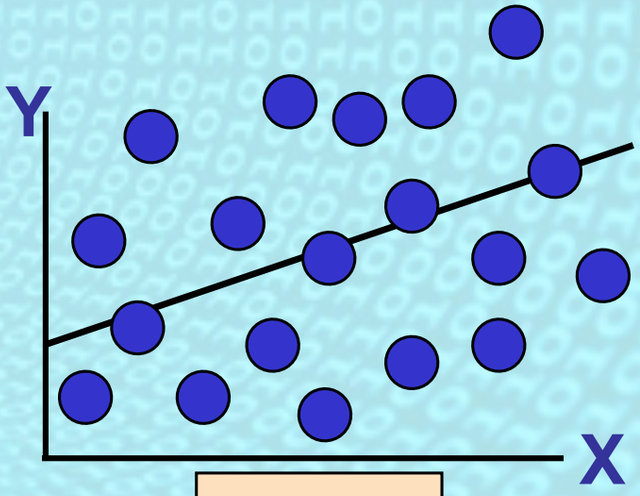
r = -1



r = -.6



r = +1

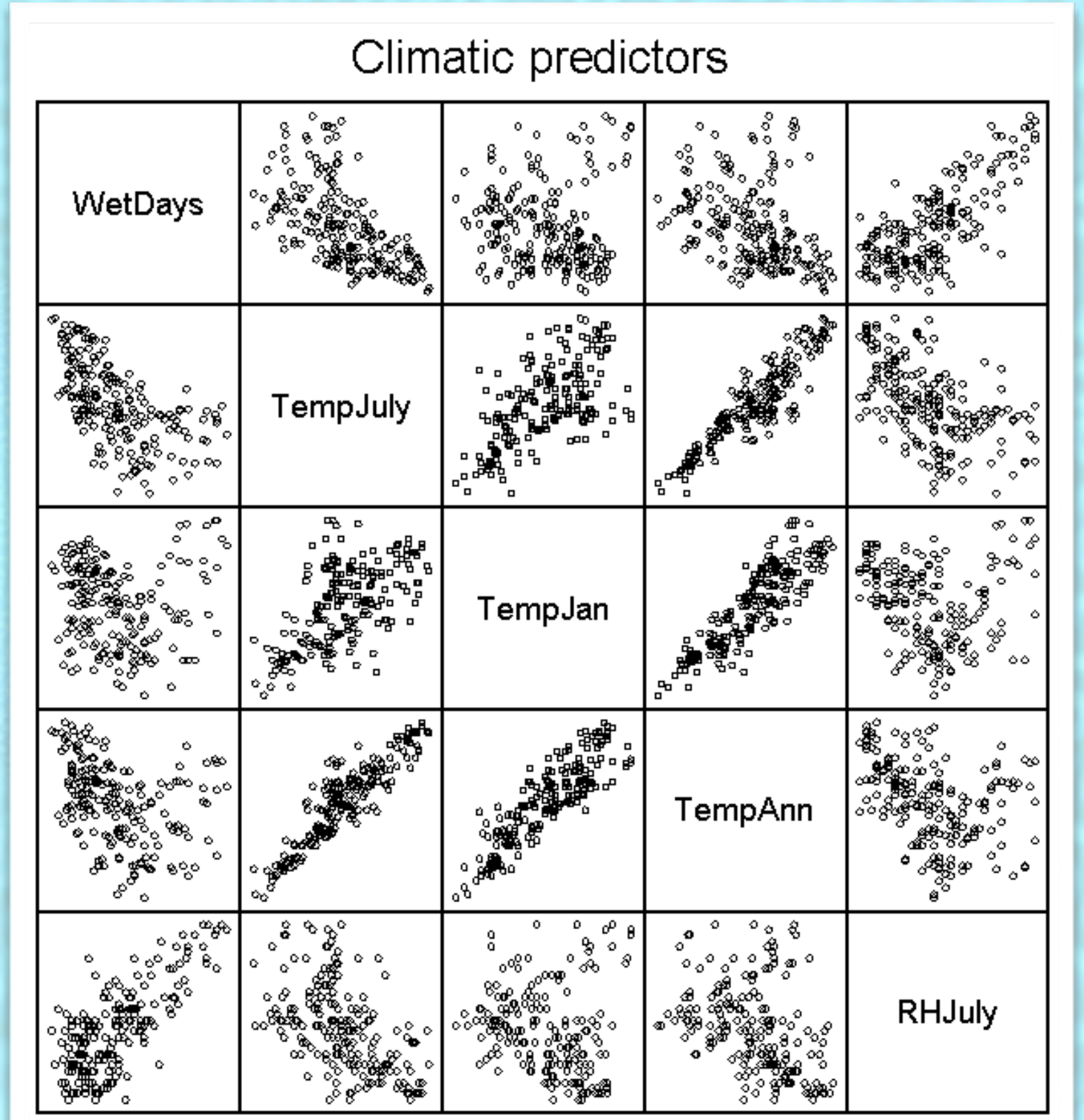


r = +.3

r=0 no correlation

r=1,-1 max correlation

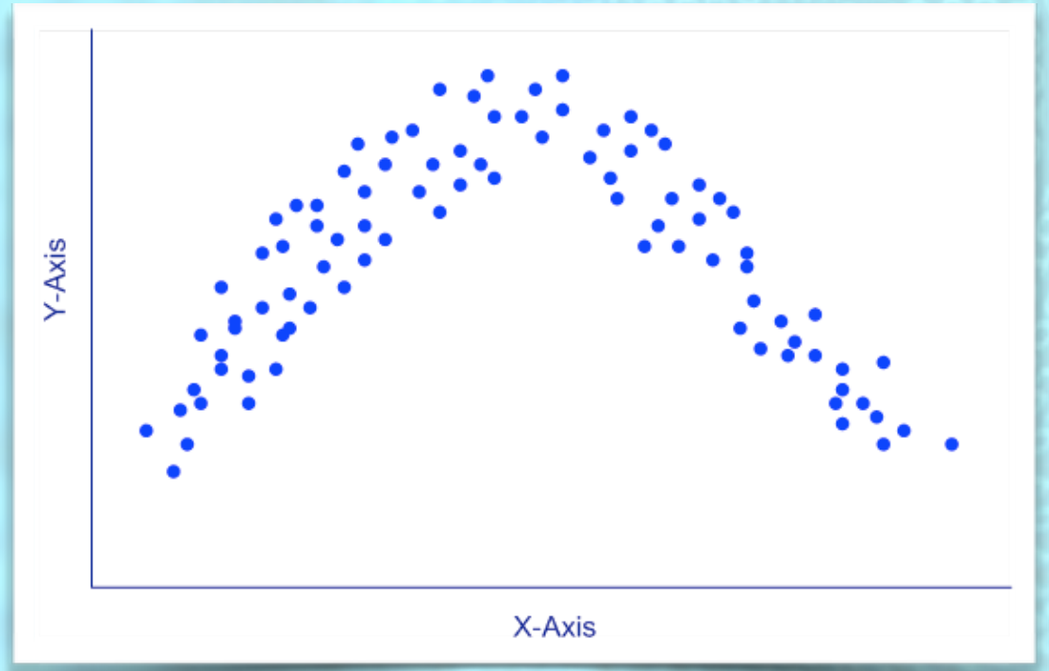
Multivariate analysis : correlation matrix

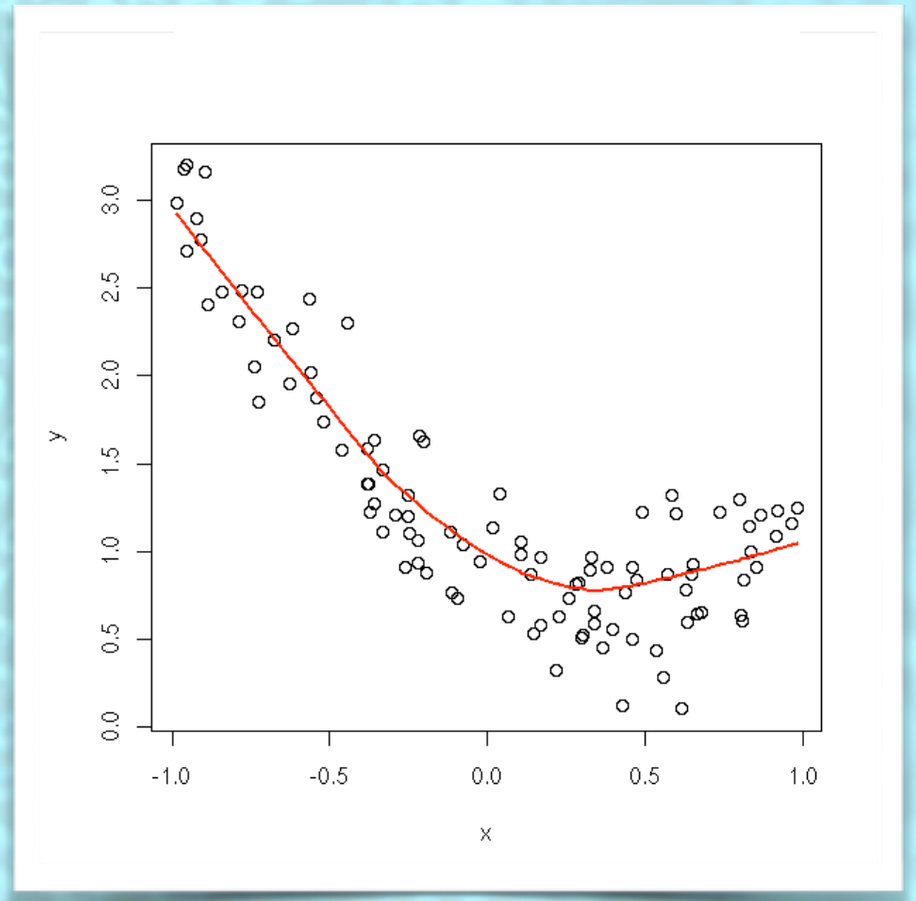


Pay attention:

correlation = 0 → 1) no linear correlation
2) does not imply causation

but you can have non-linear correlations…



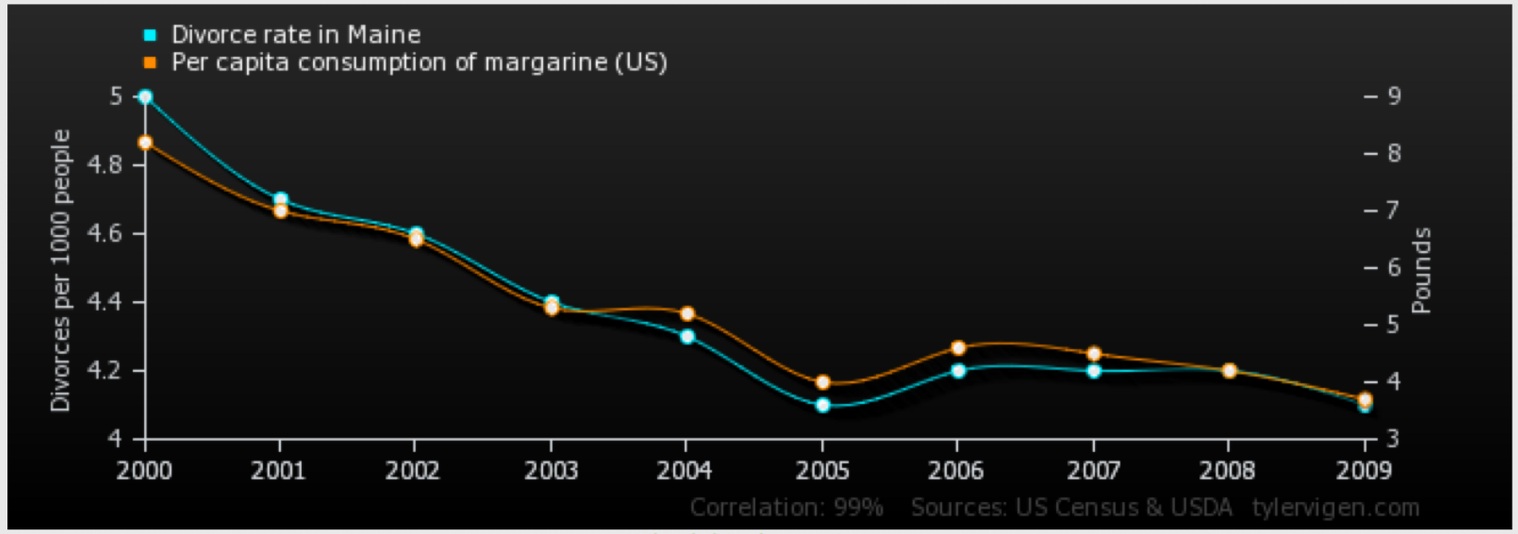


Correlation and causation

Divorce rate in Maine

correlates with

Per capita consumption of margarine (US)



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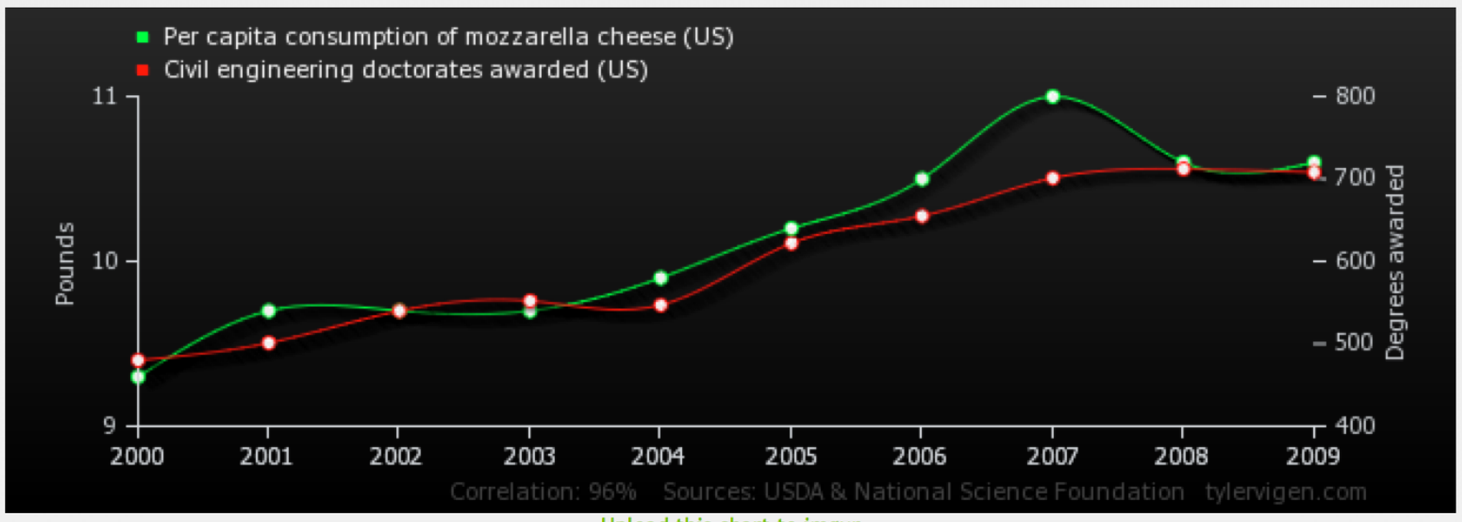
Per capita consumption of mozzarella cheese (US)

correlates with

Civil engineering doctorates awarded (US)



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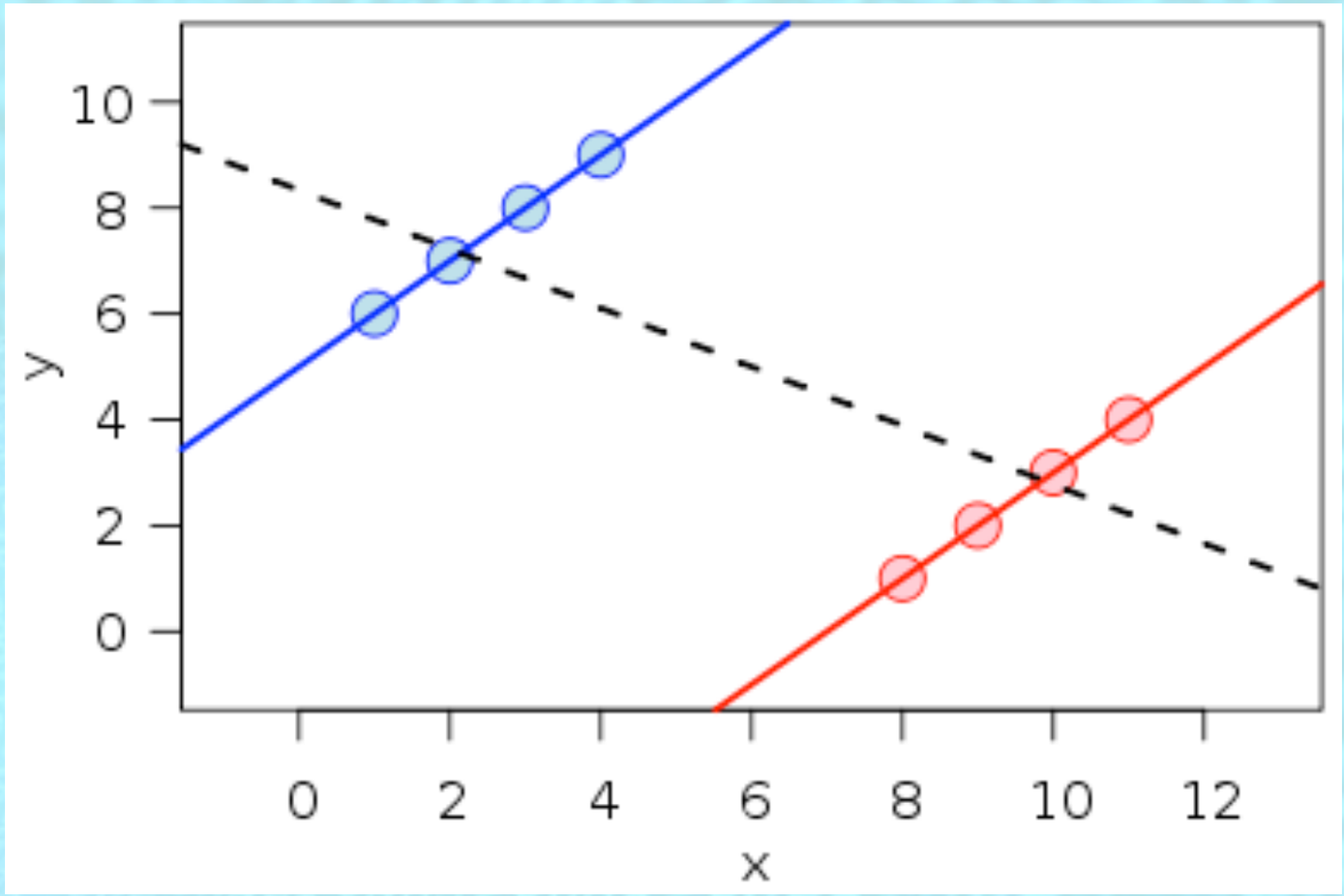
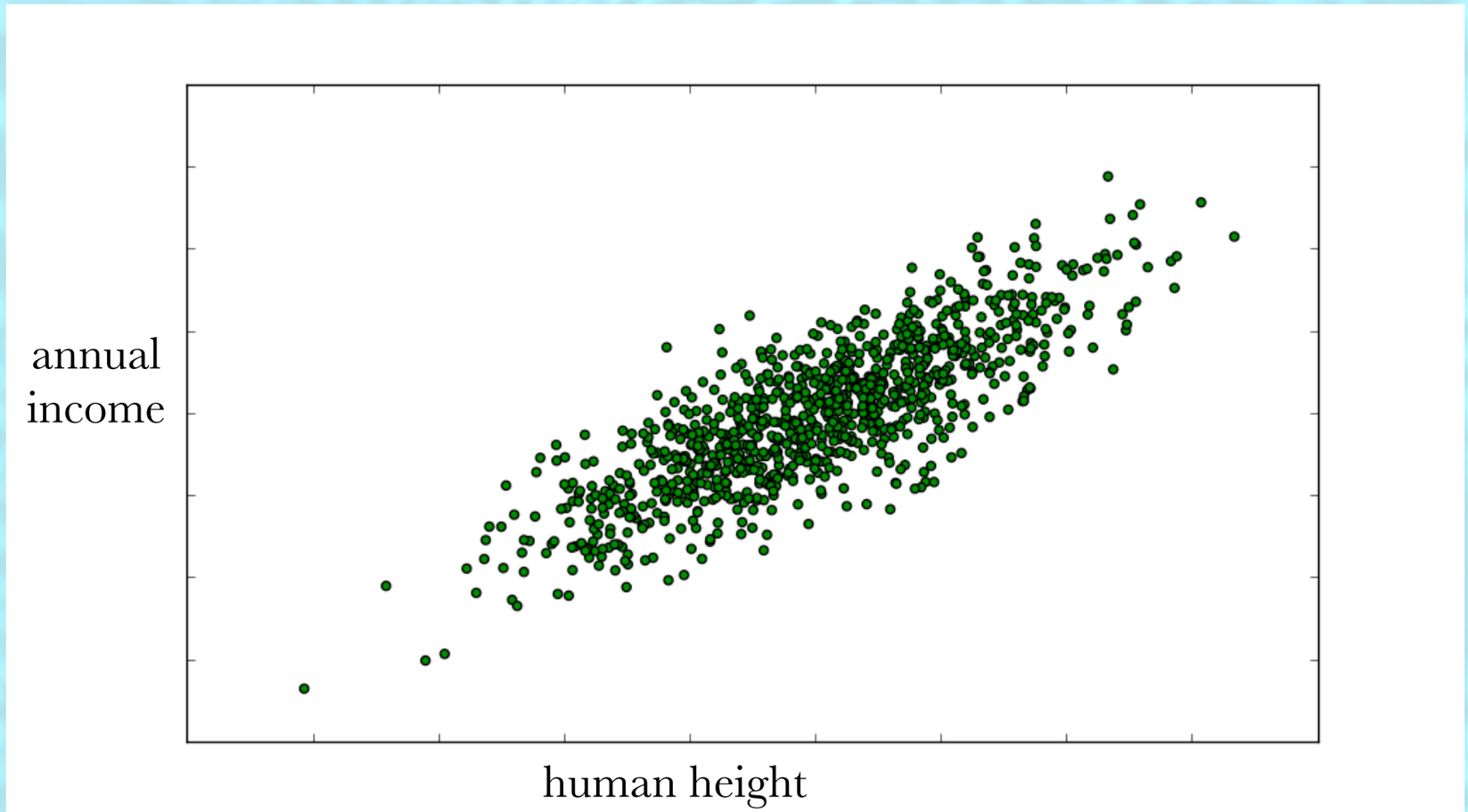
Simpson paradox

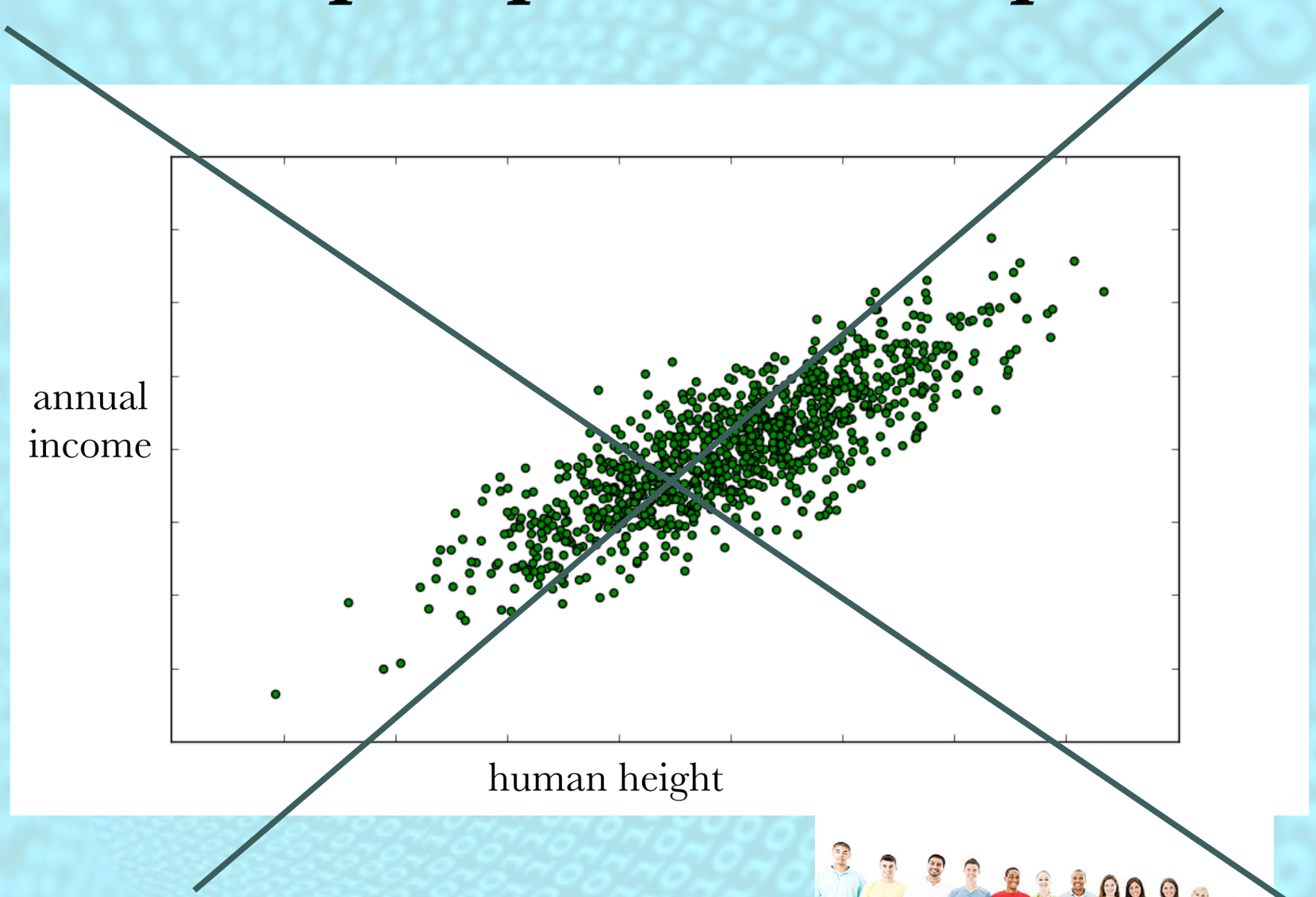


a trend appears in different groups of data but disappears or reverses when these groups are combined.

Simpson paradox: example

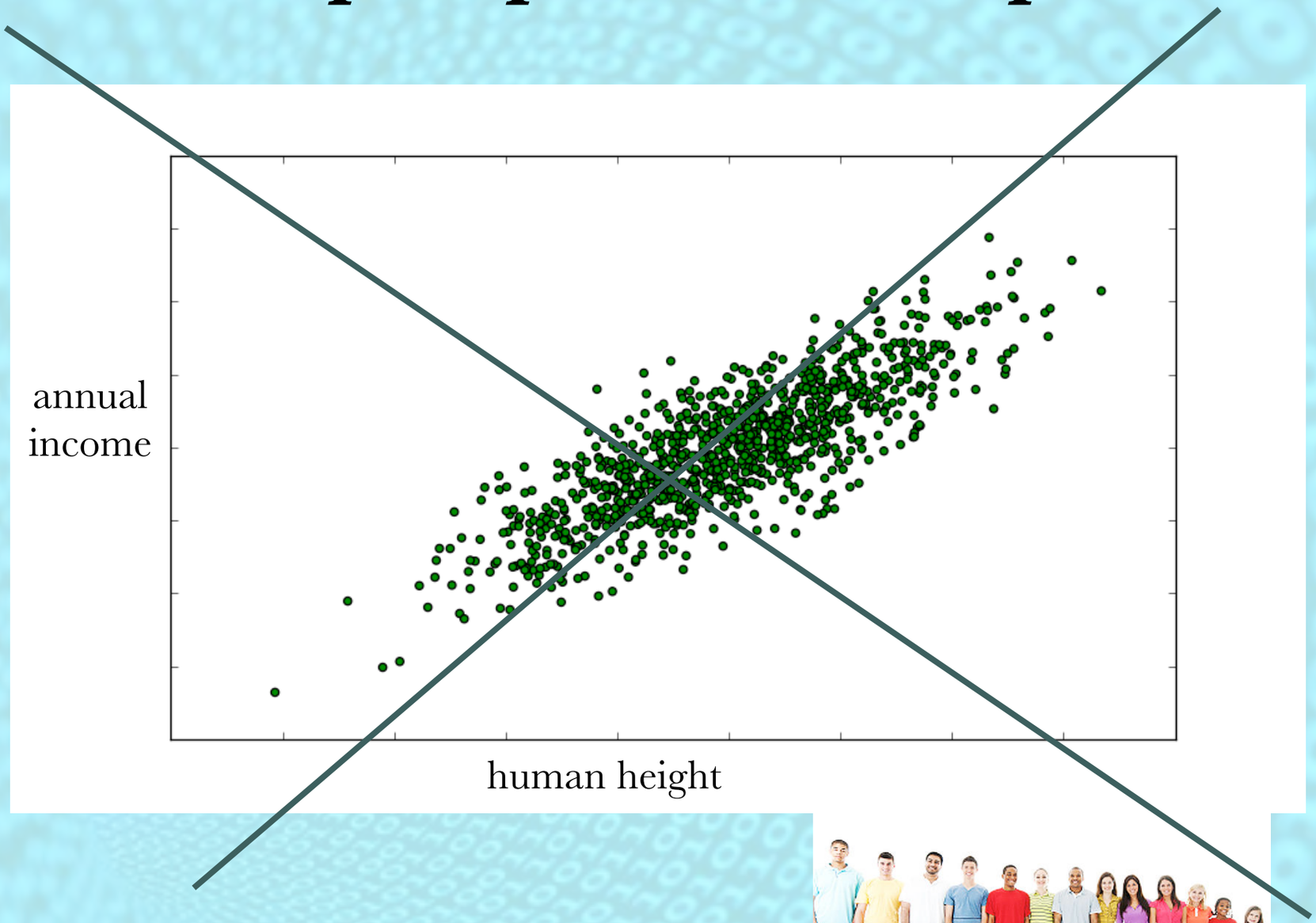


Simpson paradox: example



if I separate samples for country

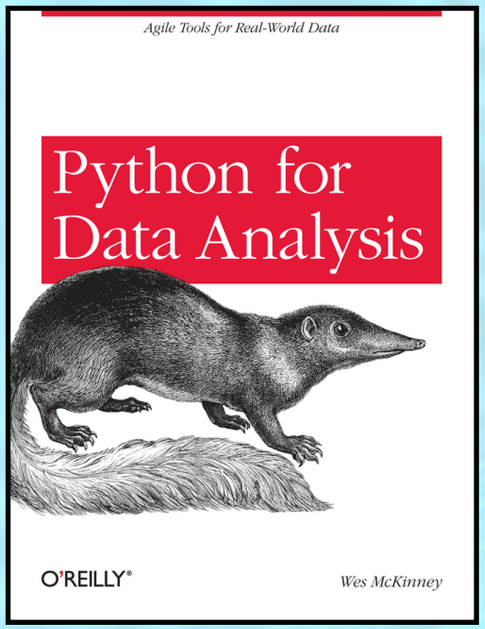
Simpson paradox: example



key issue: assumption in correlation of 2-variables, all the others being equal

solution? know your data

References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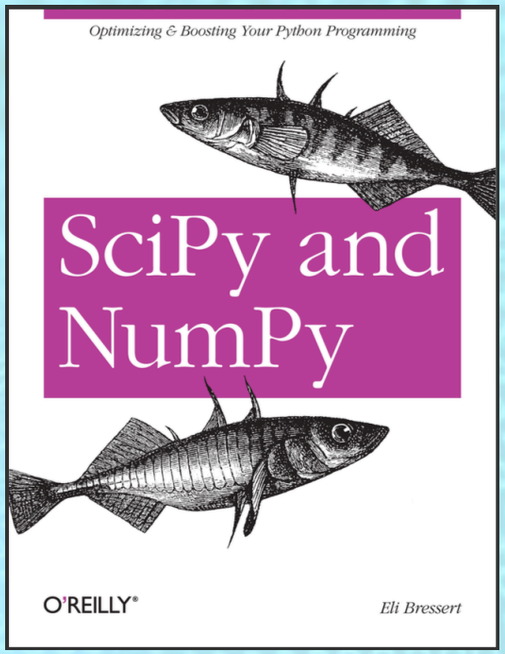
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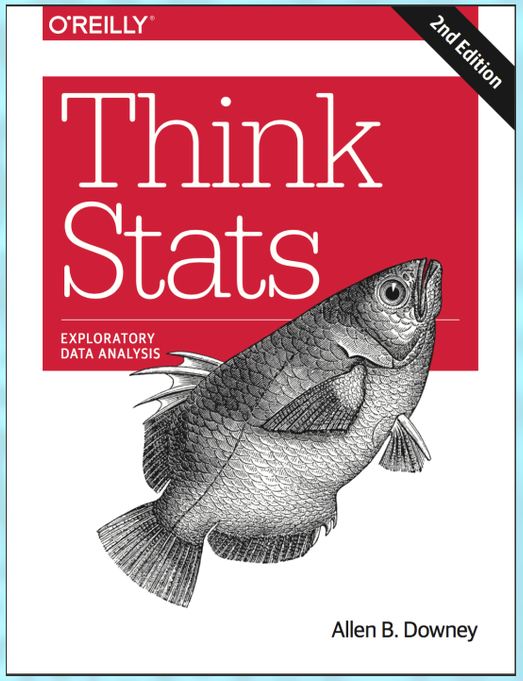
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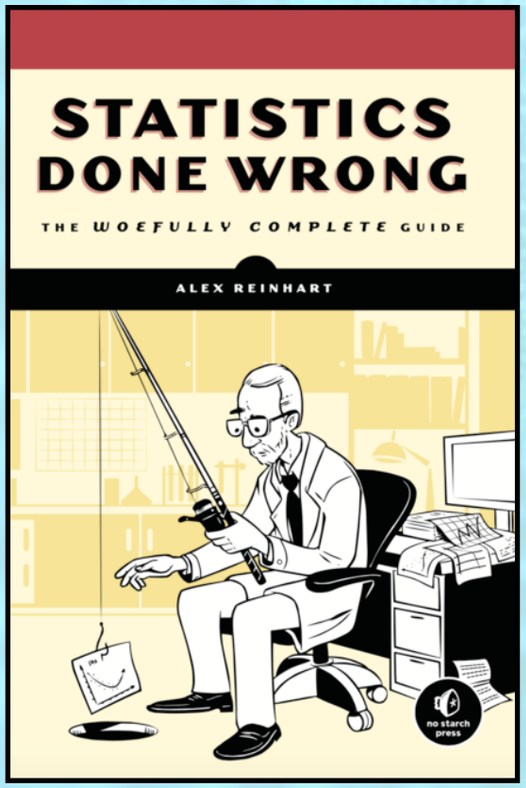
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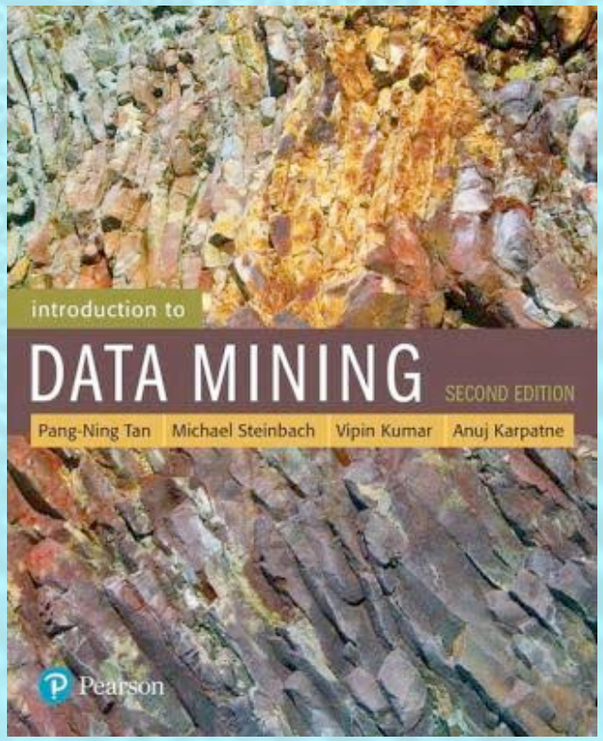
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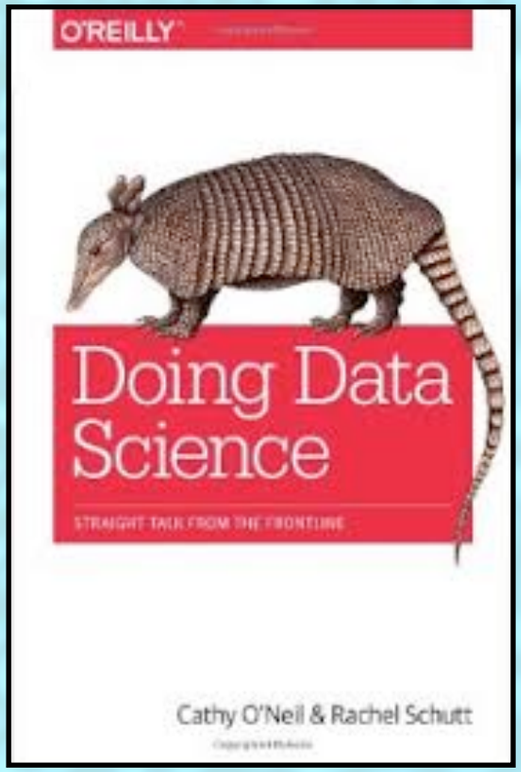
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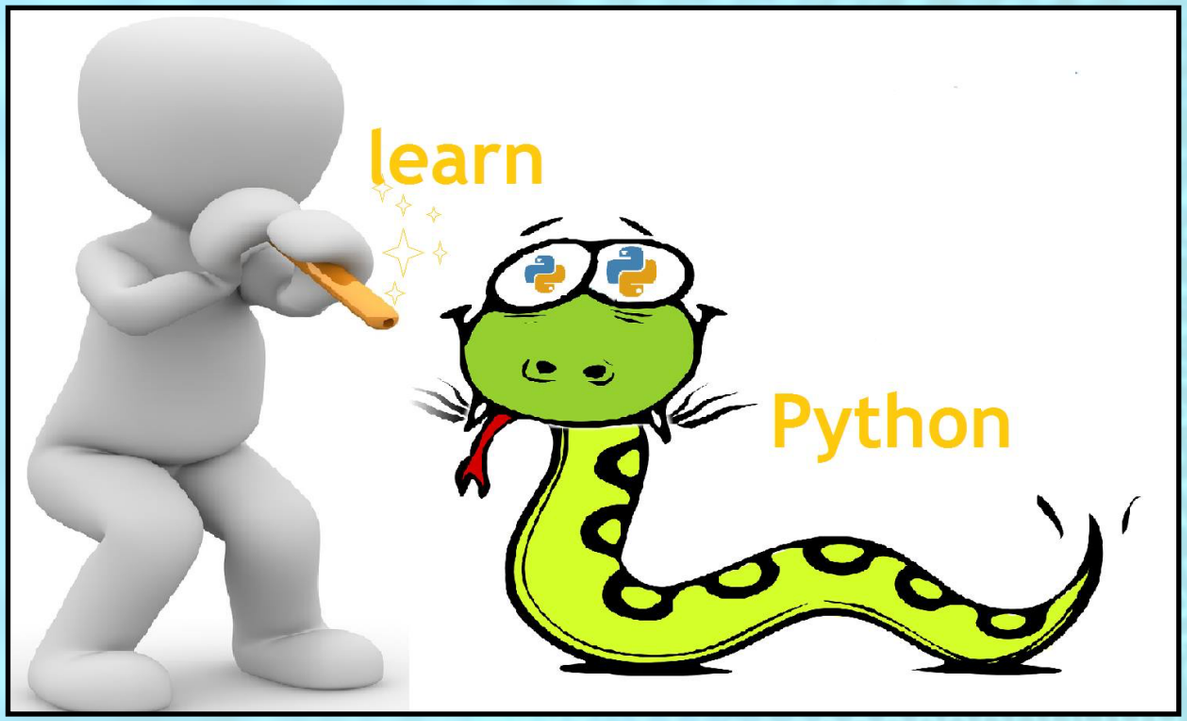
Let's go to the Lab!



https://github.com/Simmetria0/CursoLiberBank_0519

Exercise!

- Importar los datos.
- Dibujar los histogramas.
- Calcular media, mediana, desviación estándar para cada una de las variables con tus módulos y con los de numpy. ¿Existen diferencias?
- ¿Algunas variables se distribuyen como una gaussiana? (Valóralo sólo cualitativamente sobreponiendo una gaussiana en los plots)
- ¿Hay outliers en algunas de las variables?
- Dibuja scatter de una variable contra otra, ¿parece que algunas están correladas?
- Utiliza el coeficiente de correlación para evaluar si realmente están correladas.