

# 206neutrinos-bootstrap

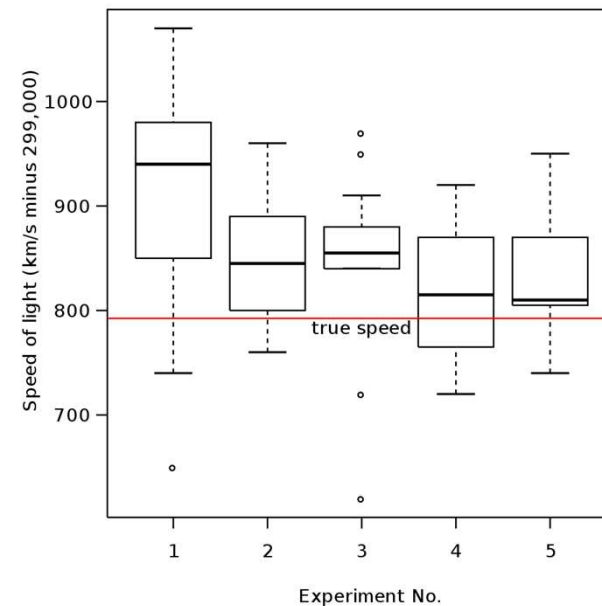
B-MAT-400

# Descriptive statistics

- Science that quantitatively describes and analyses features of a collection of data points
- The goal is to summarize a sample, rather than inferring information on a larger population it may represent
- Applications everywhere
  - Industry (reliability, projections...)
  - Social sciences (census, polls...)
  - Economy (market analysis...)

# Descriptive statistics

- Given a data set  $(x_0, x_1, \dots, x_n)$ , we can describe the observations using measures such as:
  - Central tendency (ex: mean)
  - Dispersion (ex: variance)



# Central tendency measures

- Arithmetic mean

$$\bar{x} = \frac{1}{n}(x_1 + x_2 + \cdots + x_n) = \frac{1}{n} \sum_{i=0}^n x_i$$

- Root mean square

$$x_{rms} = \sqrt{\frac{1}{n}(x_1^2 + x_2^2 + \cdots + x_n^2)} = \sqrt{\frac{1}{n} \sum_{i=0}^n x_i^2}$$

- Harmonic mean (if  $x_i > 0$ )

$$H = \frac{n}{\frac{1}{x_0} + \frac{1}{x_1} + \cdots + \frac{1}{x_n}} = \frac{n}{\sum_{i=0}^n \frac{1}{x_i}} = \left( \frac{1}{n} \sum_{i=0}^n \frac{1}{x_i} \right)^{-1}$$

# Dispersion measures

- Indicate how close are the values to the central tendency
- Variance

$$\begin{aligned}Var(x) &= \frac{1}{n} \sum_{i=0}^n (x_i - \bar{x})^2 \\&= \left( \frac{1}{n} \sum_{i=0}^n x_i^2 \right) - \bar{x}^2 \\&= x_{rms}^2 - \bar{x}^2\end{aligned}$$

- Standard deviation

$$\sigma = \sqrt{Var(x)}$$

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- Goal: Compute central tendency and dispersion measures for a data set evolving with time
- Inputs: n a h sd
  - n: number of values already in the set
  - a: current arithmetic mean
  - h: current harmonic mean
  - sd: current standard deviation
- When started, the program asks the user to enter a new value

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- If a new value is entered:
  - Display the number of recorded values
  - Display the arithmetic mean
  - Display the root mean square
  - Display the harmonic mean
  - Display the standard deviation
  - Asks the user for another value
- If the keyword 'END' is entered, the program stops

## Exercise: Arithmetic mean

- Create a function that takes a number of recorded values, an arithmetic mean, and a new value as parameters, and returns the updated arithmetic mean.

$$\bar{x} = \frac{1}{n} (x_1 + x_2 + \cdots + x_n) = \frac{1}{n} \sum_{i=0}^n x_i$$



## Exercise: Root mean square

- Create a function that takes a number of recorded values, a root mean square, and a new value as parameters, and returns the updated root mean square.

$$x_{rms} = \sqrt{\frac{1}{n} (x_1^2 + x_2^2 + \cdots + x_n^2)} = \sqrt{\frac{1}{n} \sum_{i=0}^n x_i^2}$$

## Exercise: Harmonic mean

- Create a function that takes a number of recorded values, an harmonic mean and a new value as parameters, and returns the updated harmonic mean.

$$H = \frac{n}{\frac{1}{x_0} + \frac{1}{x_1} + \dots + \frac{1}{x_n}} = \frac{n}{\sum_{i=0}^n \frac{1}{x_i}} = \left( \frac{1}{n} \sum_{i=0}^n \frac{1}{x_i} \right)^{-1}$$

(with  $x_i > 0$ )

## Exercise: Wrapping up

- The root mean square is not passed as a parameter. Create a function that computes it from the parameters of 206neutrinos
- Can you find an efficient way to update the standard deviation?