

MEDICAL STATISTICS

Physiology

Anatomy

Chemistry

...

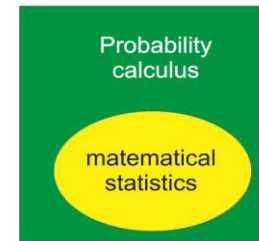
Statistics



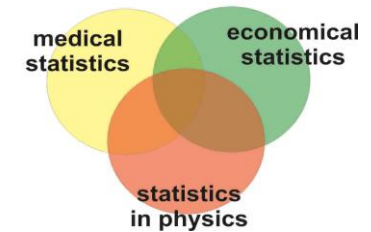
No any doubt

Medical statistics

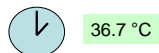
Theory:
matematics



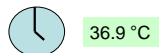
Practice:
applied statistics
(examples)



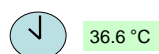
Example: body temperature



36.7 °C



36.9 °C



36.6 °C



36.7 °C



36.9 °C



36.5 °C

1. Inaccuracy of the measurement.

2. Daily fluctuation!!!

3. Biological variability!!!

The measured value is not constant!

Measured value: 37.0 °C.

Is it healthy or not?

Another examples

RBC: $4.5 \times 10^{12} \text{ 1/l}$ ($3.9\text{-}5 \times 10^{12} \text{ 1/l}$) → normal range?

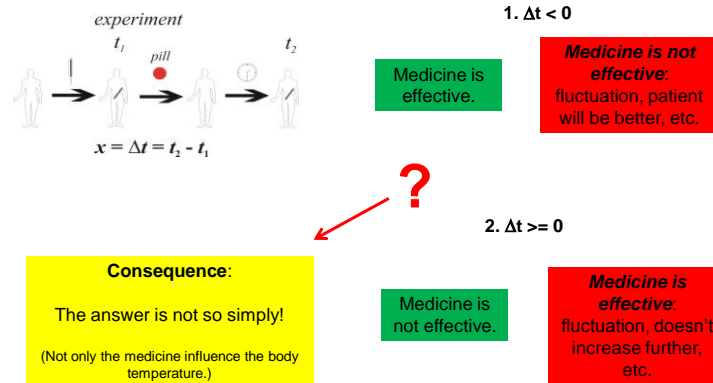
The new method in therapy is better then the old one or not?

How can we prove that a medicine decreases the fewer or not?



Questions!

How can we answer?



Variables

variable	range	type	variable type	
height	~50 cm ... ~250 cm	real number	numerical	continuous
no. of teeth	0 .. 32	integer		discrete
blood type	A, B, AB, 0	letters		nominal
severity of cancer	1 ... 4	integer	categorical	ordinal

Descriptive statistics!

Description of a variable

- Type
- Possible values
- Occurrence of the values

Numerical variables

Name	<i>Continuous</i>	<i>Discrete</i>
Definition	Infinitely large no. of values in a certain range	Only finite number of values
Example	Height, temperature, pressure ...	No. of teeth, no. of children ...

Categorical variables

Name	<i>Nominal</i>	<i>Ordinal</i>
Definition	No order among the values	There is a certain order
Example	Gender, blood-type ...	Severity of the illness, strength of pain ...

Determination of the possible values

- Continuous : giving a possible range.
» e.g.: height from ~50 cm - to ~ 250 cm
- Another : listing the values, if it is possible
» E.g.: blood type: A, B, AB, 0

Occurence

Observation: The occurrence of the values are not the same!



Trial: experiment, observation, data collection.

Deal with only the case, when the trial may be repeated!

Outcome: result of one trial. (e.g.: height of a student)

Population

How many people?



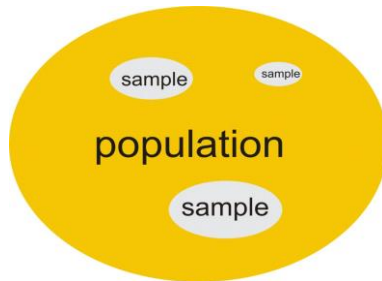
As many as possible.



Ideal case: All of the people → **population**

Sample

A smaller portion of the population.



n : no. of the elements (people) in the sample.

x : the tested variable (quantity)

x_i : i -th element from the sample

Selection of the sample

Main principle: **Random sample**

Medical statistics: if there is no any reason to exclude,
must be random!

Occurrence

Frequency (k): no. of occurrence in the sample.

k_i : no. of occurrence of the i -th value in the sample.

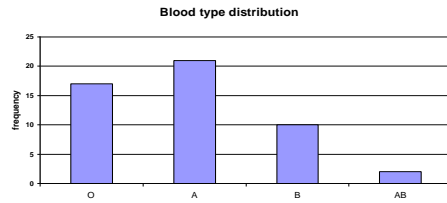
$$n = \sum_i k_i$$

Frequency distribution

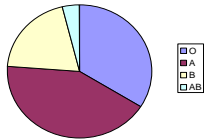
Frequency as the function of the possible values.

Blood-type	0	A	B	AB	total
frequency	17	21	10	2	50

Presentation



Bar-chart



Pie-chart

Relative frequency, proportion

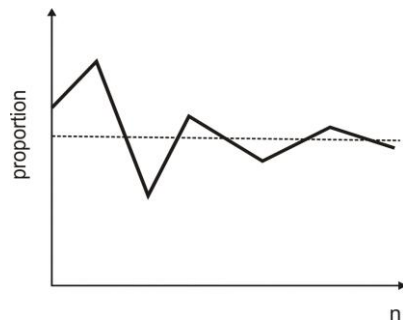
The ratio of the frequency and the total no. of the elements.

$$\sum_i \frac{k_i}{n} = \frac{1}{n} \sum_i k_i = \frac{1}{n} \times n = 1$$

Frequently it is given as percentage:

$$\frac{k_i}{n} \times 100\%$$

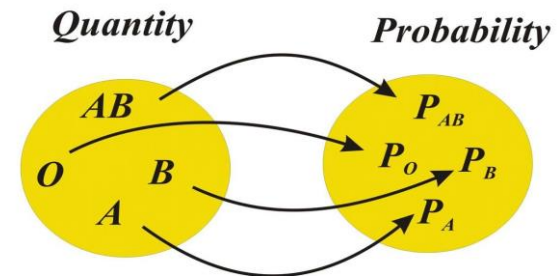
Probability (P)



If n is infinite the name of the proportion is the probability.

Probability (P): proportion in the population.

Probability distribution



Properties of the probability

$$0 \leq P \leq 1$$

$P = 0$ - never occur
 $P = 1$ - always occur

Example: blood- type

$$P_A + P_B + P_{AB} + P_O = 1$$

(exclusive events)

$$\sum_i P_i = 1$$

Probability and proportion

Sample

n is finite

proportion

Population

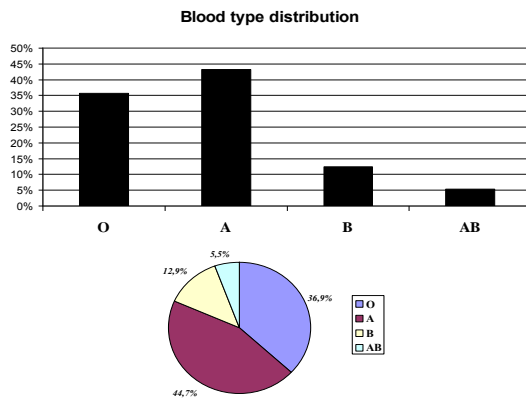
$n = \infty$

probability

Probability very frequently is unknown!

We usually use proportion instead of the probability.

Presentation



Continuous quantity

Infinite no. of possible values!!!

Class: a short interval in the whole range.

Class-width: the length of the class.

Frequency: no. of elements in the given class.

Like a discrete value!

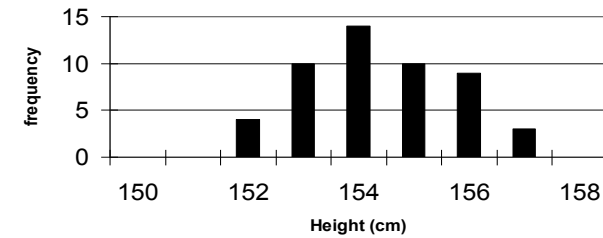
Example

1	160 cm
2	181 cm
3	175 cm
4	163 cm
5	165 cm
6	179 cm
7	164 cm
8	185 cm
9	177 cm
10	168 cm

class	k_i
160-164	3
165-169	2
170-174	0
175-179	3
180-184	1
185-189	1

Presentation

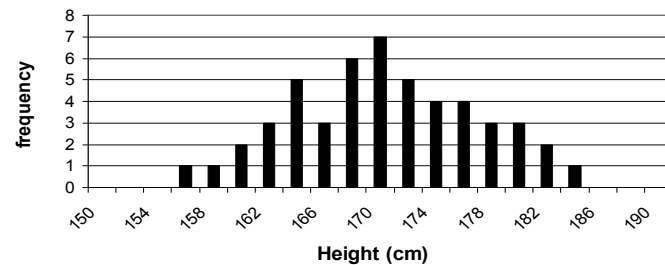
Frequency distribution (class width = 5 cm)



5 cm is too large!

Decrease the width!

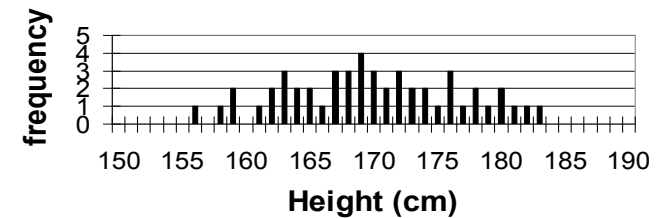
Frequency distribution (width = 2 cm)



Observation: frequency decreases!

Presentation

Frequency distribution (class width = 1 cm)



Reason: n is too small!

Consequence

Class-width



No. of classes



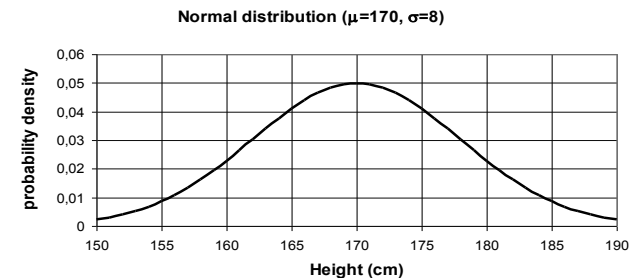
Frequencies



We must increase the no. of the elements!

Normal distribution

If n and no. of classes are infinite!



Theoretical description

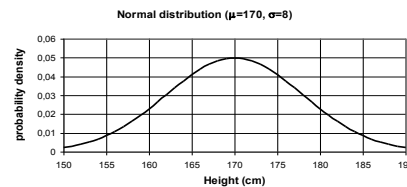
Normal or Gauss-distribution

$$g(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

Parameters:

μ – expected value or mean

σ – theoretical standard deviation

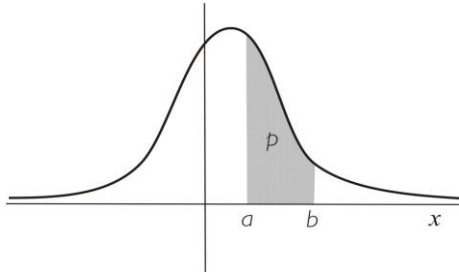


Meaning of the parameters

μ **(mean):**
the value belonging to the maximum of the curve.

σ **(theoretical standard deviation):**
the average deviation of the data from the μ .

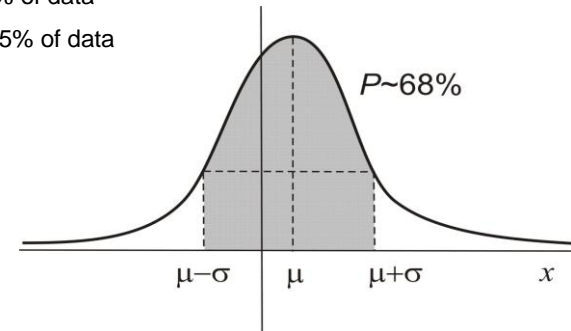
Probability



P is the probability that x is in the (a,b) interval.

Standard deviation

$(\mu \pm \sigma)$ ~ 68% of data
 $(\mu \pm 2\sigma)$ ~ 95% of data
 $(\mu \pm 3\sigma)$ ~ 99.5% of data



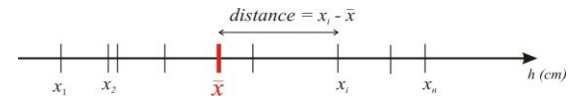
Normal distribution

Theoretical distribution that describes the population. In practice usually we don't know the parameters of this.



We usually have a **random sample** from the population.
 We must estimate the parameters!

Estimation of the μ



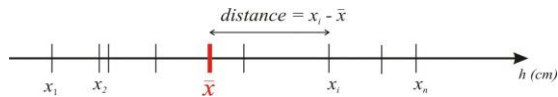
average: must be in the center of the data range.

$$\sum_i (x_i - \bar{x}) = 0 \quad \longrightarrow \quad \bar{x} = \frac{\sum_i x_i}{n}$$

Estimation of the σ

σ = average deviation of the data from the μ .

s (standard deviation) = average deviation of the elements from the average.



$$Q_x = \sum_i (x_i - \bar{x})^2 \geq 0$$

Standard deviation

$$s = \sqrt{\frac{Q_x}{n-1}}$$

s: the average deviation of the elements from the average.

$$(\bar{x} \pm s) \sim 68\%$$

$$(\bar{x} \pm 2s) \sim 95\%$$

$$(\bar{x} \pm 3s) \sim 99.5\%$$

Relation of parameters

Sample	$n \rightarrow \infty$	Population
average	\longrightarrow	μ
s	\longrightarrow	σ

Question of the week!

How can we estimate the μ and the σ ?