

## Hypothesis test

Questions  
(example)

Does the medicine effective?



How can we  
answer?



literature



experiments

## Hypothesis = assumption

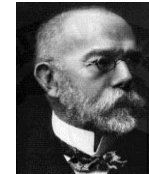
evidence based  
medicine



Not a paradox?

assumption

?



Robert Koch's case with the  
anthrax

Facts, data

anthrax



bacteria



Robert Koch



Question:

Bacteria is the agent or  
not?

## Hypothesis

A. no relationship

B. bacteria is the agent



experiments

Exclusive statements, it is  
enough to test one of them.

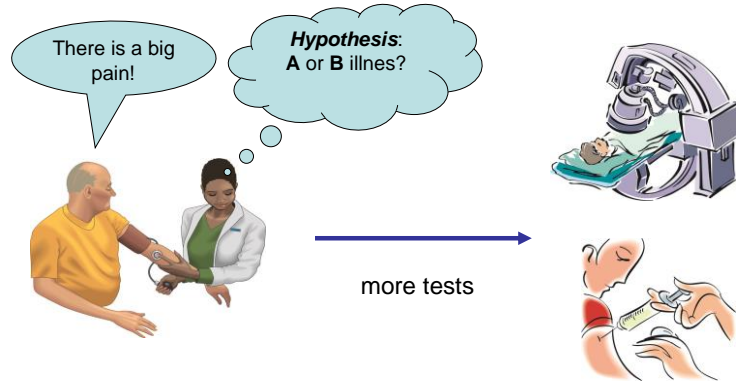


Decision:

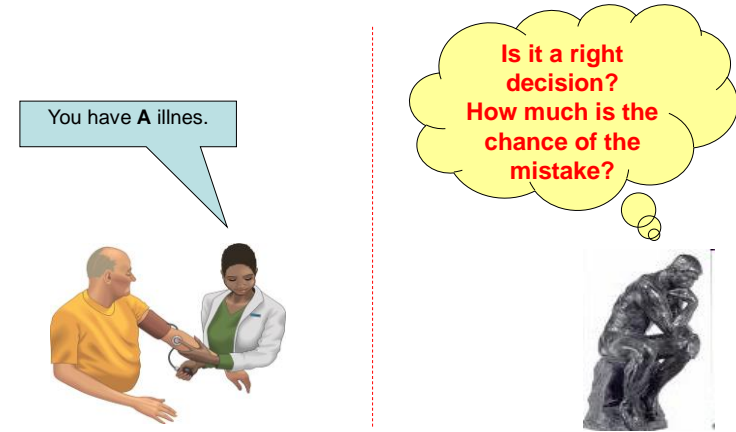
A. is true, so B is false

A. is false, so B is true

## Medical work



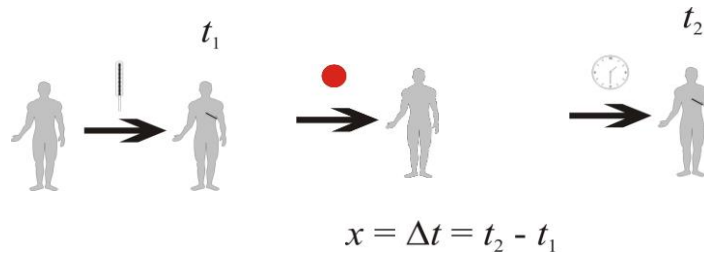
## Decision



## An example

Question: Does the medicine decrease the fever?

experiment



## How many trial is necessary?

Outcome: 1.  $\Delta t > 0$ ; 2.  $\Delta t = 0$ ; 3.  $\Delta t < 0$ .

Is there a right decision?

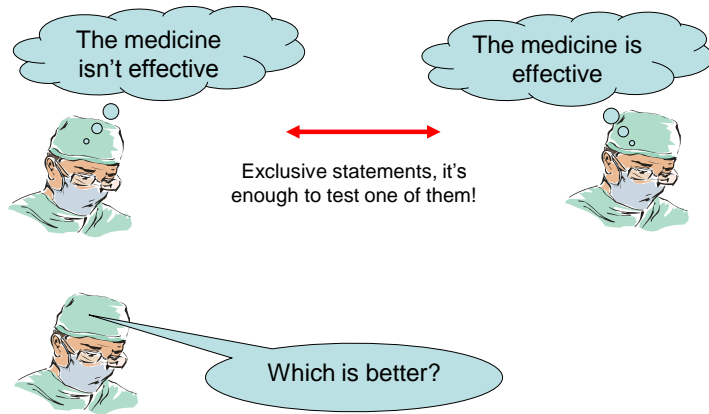
Not only the medicine influences the body temperature!



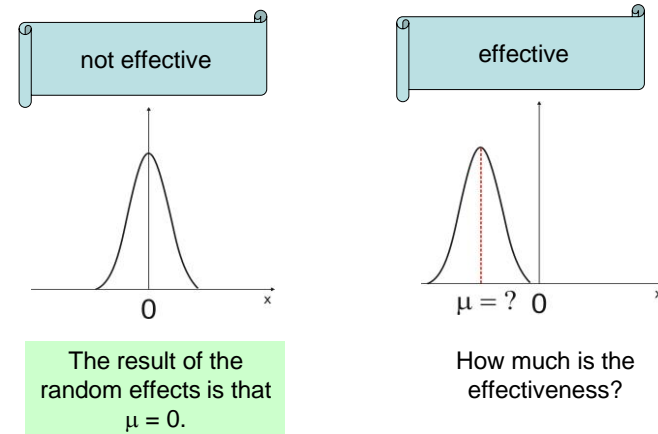
**Assumption!**

The other effects are random!

## Hypotheses



## The distribution of the observed quantity



**If we know the population!!! ( We are able to calculate  $\mu$ !)**

result:

$$\mu = 0$$



conclusion:

The medicine isn't effective.

$$\mu < 0$$



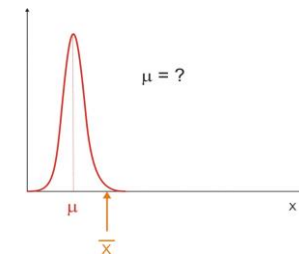
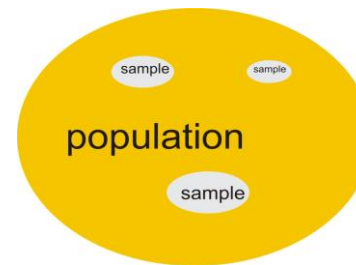
The medicine is effective and  $\mu$  characterizes the effectiveness.

## The situation is more difficult

Normally the population is unknown.

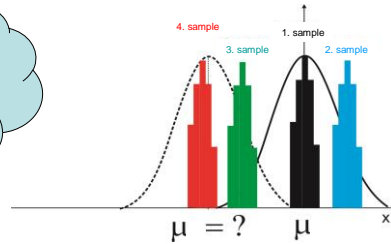
Samples are different from the population!

E.g. the averages fluctuate around the  $\mu$ !



## Select hypothesis!

Which is the right population?



Known distribution!

Usual point of origin: **nullhypothesis**.



## Nullhypothesis: ( $H_0$ )

The deviation of the sample or samples from the population or populations is a **random deviation** due to the sampling error. Frequently it is a negative answer. (e.g.: the medicine is not effective.)



## Alternative hypothesis: ( $H_1$ )

The deviation of the sample or samples from the population or populations is not a **random deviation**. (e.g.: the medicine is effective)

The average is not the mean!  
What is the reason of the deviation?

Sampling error,  
random fluctuation.  
(Our hypothesis is right!)



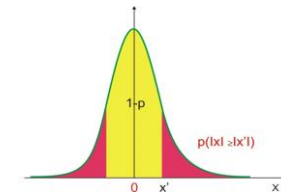
The hypothesis is false (mistake!).  
The deviation is non-random.



## What is the base of the decision?

How much is the chance of the given population?

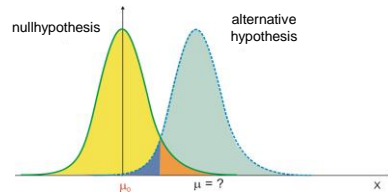
We must know the parameters of the distribution!



## Decision

What is the base of decision?

We must have variables in which case we know the parameters!

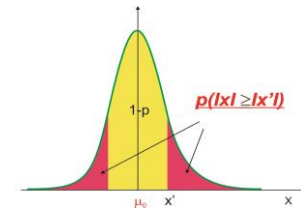


## Null hypothesis

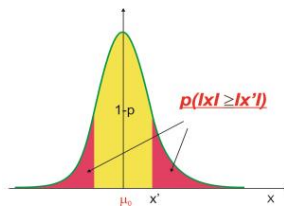
How probable is the random deviation?

In the case of known distribution we are able to determine!

(The shape of the distribution not always gaussian, but it is known!)



## Significant?



If the **p** is enough large, may be random, if the **p** is enough small we say that the difference is significant!

**p** is the probability to be random deviation!



## Significance level

Enough large, enough small?

Select a limit!  
This is the significance level.



Symbol:  $\alpha$ .  
In medical practice this value is frequently 5%.



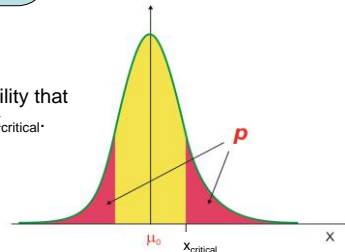
## The base of the decision

If the  $p$  is enough small, there is a big chance, that the nullhypothesis is not true. So the alternative hypothesis is more probable.



$p$  is the probability that  $|x_{\text{calculated}}| \geq x_{\text{critical}}$ .

$x_{\text{critical}}$ : the value belonging to the significance level  
 $x_{\text{calculated}}$ : the value calculated from the sample

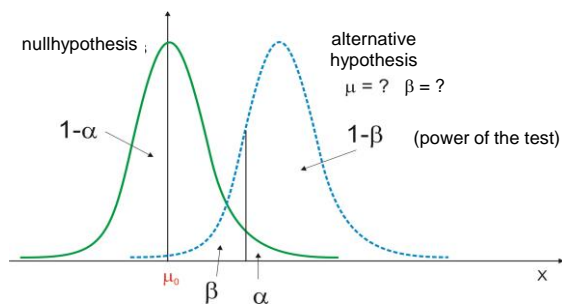


## Decision

- 1. If the probability of the random deviation is small ( $p(|x| \geq |x_{\text{crit}}|) \leq \alpha$ ) – we **reject** the nullhypothesis.
- 2. If the probability of the random deviation is large ( $p(|x| \geq |x_{\text{crit}}|) > \alpha$ ) – we **accept** the nullhypothesis.

The answer is newer yes – no or true - false!!!

## Quantities which characterise the decision



$\alpha$ : **significance level**. (The probability that we reject the nullhypothesis when it is true.)

$\beta$ : the probability that we accept the nullhypothesis when it is false.

## The possibility of the error

		decision: the nullhypothesis is	
		accepted	rejected
reality: the nullhypothesis	true	Right decision	I. Type error ( $\alpha$ )
	false	II. Type error ( $\beta$ )	Right decision

