Statistical tests

Călinici Tudor

2023

OBJECTIVES

- Define what are the statistical tests

- Explain how a statistical test is performed

- Define the types of errors in statistical tests

- Define statistical significance

- Present different types of statistical tests

HYPOTHESIS

- The formulation of new hypotheses (or models or theories) is one of the most important aspects of scientific research. These hypotheses tried to describe or explain real phenomena. In many cases there are earlier hypotheses (descriptions or explanations) that scientists want to replace them with new ones

- To be valid, hypotheses must be tested

Population - Sample

- When a statistic investigation is carried out on a sample, any result obtained has a relative value,
- The results are specific to the sample
- We can not even say with certainty what is the difference between the observed data in the sample and the data in population, since the state of the population is usually unknown.

STATISTICAL HYPOTHESIS

- Therefore, referring to the populations studied starting from the samples, the researchers can not value judgments with certainty, but can express some assumptions which are called **statistical hypotheses**.

- Therefore, **statistical tests** will evaluate the statistical hypotheses. After the test, the statistical hypotheses will be accepted or rejected.

- Example: In the population X the value of a parameter is bigger than the value of the same parameter in the population Y

THE MODEL FOR THE STATISTICAL TESTS

- Statistical hypothesis testing is done by comparing two competing hypotheses :
  - Null hypothesis - the model that the researcher wants to replace
  - Alternative hypothesis - the new model to replace the null hypothesis

THE GOAL OF THE STATISTICAL TEST

- The goal of the statistical test is to reject the null hypothesis

- The result of the test
  - We can not accept the null hypothesis
  - We can reject or we can't reject

THE STEPS OF THE STATISTICAL TEST

- To define the statistical hypotheses
- To choose the right parameter
- To choose the level of significance
- To choose the critical region
- To compute the value of the parameter
- To decide the result of the test

FORMULATION OF PROBLEMS IN TERMS OF STATISTICAL HYPOTHESIS

- Define the null hypothesis - the test is conducted under the assumption that the null hypothesis is true
- Define the alternative hypothesis - also called a working hypothesis – contradicts the null hypothesis

THE PARAMETER

- The statistical parameter of the test expressed in some form the difference between the compared elements

- Is specific for any statistical test

THE LEVEL OF SIGNIFICANCE

- The level of significance is the size of the risk for errors which the researcher is willing to accept and to assume

- Usually the level of significance is between 1 şi 5%

THE CRITICAL REGION

- The critical region is an interval or a union of intervals
- It may vary from test to test
- It depends by the level of the significance

- $(-\infty, -Z_\alpha]$
- $[Z_\alpha, +\infty)$
- $(-\infty, -Z_\alpha] \cup [Z_\alpha, +\infty)$

THE CALCULATION OF THE PARAMETER

- The researchers will compute the value of the parameter

Decision with critical region

- H_0 will be rejected if the value of the parameter is in the critical region. In this situation, alternative hypothesis is accepted, assuming a risk for error $<\alpha$ – type I error

- If the parameter is outside the critical region, the null hypothesis can not be rejected, assuming a risk for error β – type II error

CONCLUSION

- By rejecting the null hypothesis the researcher states that the observed results are not due to chance = the results are significant

- When the null hypothesis is not rejected researcher states that the observed differences are due to chance and the results are not significant

STATISTICAL SIGNIFICANCE

- P – Probability

- Theoretical value for the minimal level of significance for which the null hypotheses can be rejected

- It is specific to statistical software

The meaning of P

- $0.01 \leq p \leq 0.05$ – significant results
- $0.001 \leq p < 0.01$ – high significant results
- $p < 0.001$ – very high significant results
- $p > 0.05$ – non-significant results
- $0.05 < p \leq 0.1$ – tendency

THE RESULT OF THE TEST USING THE STATISTICAL SIGNIFICANCE

- The null hypothesis can be rejected if the results are at least significant

- If the result of the test are not significant the null hypothesis can not be rejected

ERRORS

Result		Truth	
		H_0 True	H_0 False
	H_0 rejected	Type I error (α)	Correct
	H_0 not rejcted	Correct	Type II error (β)

TYPE I ERROR

- $= H_0$ is rejected but is true
- We concluded that there are real differences although they are due to chance
- We conclude that a treatment if effective based on a misinterpretation

Type II Error

- $= H_0$ is not rejected even that it is false
- We concluded that the observed differences are due to chance even when they arise due to differences between samples
- We could abandon a new treatment or a new research direction
- "Power of the test" = 1-**β**

Applying the test– Teoretical

- To apply a statistical test is to compute a specific value (cu z, t, F, chi^2 etc) using research data, this value is then compared with the critical values (known) and then to decide if the null hypothesis is rejected or not.

Applying the test– in practice

- Using a statistical software, choose the appropriate statistical test and interpret results

DESCRIPTIVE STATISTICS PARAMETERS

- Mean
- Median
- Variance, etc.

- Frequency

- Difference
- Relationship
- Independence
- Normality
- Correlation, etc.

QUANTITATIVE PARAMETERS

- We compare the height of people who do performance sports with height of people who do not practice performance sports

- Null hypotheses: there is no difference between the height of people who do performance sports and height of people who do not practice performance sports

ALTERNATIVE HYPOTHESES

- The height of people who practice performance gymnastics is lower than the height of people who do not practice performance sports

- The height of people who practice performance basketball is higher than height of people who do not practice performance sports

- The height of people who practice performance skiing is different than height of people who do not practice performance sports

ONE TAIL TEST VS, TWO TAIL TEST

- When we are interested in a specific direction of the comparation (lower, higher) – one tail test

- When we just want to see difference – no matter in which direction – two tail test

SAMPLE TYPE

- Independent samples – there is no connection between the objects in the samples – tests for independent samples

- Dependent (pair) samples – for each object in first sample we have the corresponding one in the second sample – tests for paired samples

CONCLUSION

- To apply a statistical test, we must know:

- What I want to test

- If it is a quantitative variable -do I use one tail or two tail test

- What kind of samples are involved (independent, pairs)

BE PREPARED FOR THE NEXT LECTURE! SCAN THE QR CODE WITH YOUR MOBILE!

- Sign in using your Microsoft teams account. If the browser ask to remember your user name and password, accept it!