Cosmina Bondor

Review

A ALWAYS

S SEEK

K KNOWLEDGE

Outline

About the theoretical test

About the final mark

30 Examples of questions for the theoretical test

- Recapitulation

period December - 15.January
The evaluation of the didactic activity - sem I

- student receives **a link** in the institutional e-mail box (**...@elearn.umfcluj.ro**),

Complete two forms to evaluate:

- (1) course
- (2) practical work

To access the institutional e-mail box (@elearn.umfcluj.ro) use the Outlook e-mail service (https://outlook.office.com/mail/) and enter the data used for Microsoft Teams.

- The evaluations are confidential, the answers provided cannot be associated with the students' personal data.
- If you encounter difficulties in carrying out the evaluations, or you want to send us aspects that need changes or additions, please send a message to prorectoratevaluare@umfcluj.ro

Theoretical exam

26.01.2025

11 o’clock

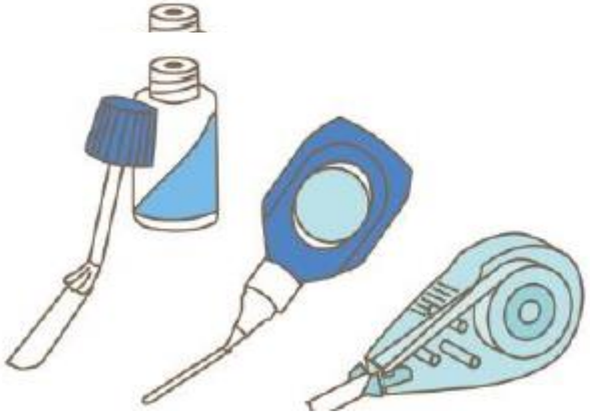
Recommendation: arrive at the location 15 minutes before the exam starts

Bilascu

Must have at the theoretical/practical exam

- ID or Passport
- Student ID
- without phone (in the bag, close)
- without smart watch, tablet, laptop, etc. (in the bag, close)
- pen

Optional to have at the theoretical/practical exam



- office calculator
- white paste

Article 78. Students are allowed to attend the examination for a specific discipline only once per each examination session.

Article 79. (1) Students are allowed to attend the examination for a specific discipline no more than three times during an academic year.

(5) Absence or non-admission to an examination until the end of the semester or module, results in the loss of one possibility of taking that exam.

(8) Students who have an excuse for their absence from the examination, approved by the Council Board of the Faculty, benefit from all the possibilities to submit that examination.

Article 100. Students come to the exam with their student report card (or temporary certificate from the Dean's Office) and their ID (or passport). On entering the examination classroom, the examiners identify the students based on these documents.

Article 102. (1) Bags, outdoor clothes and mobile phones are stored in the locations specified by the supervising teachers and not near to the students.

(2) Cell phones must be turned off when entering the examination classroom and stay that way throughout the examination; they can only be turned on again after leaving the examination classroom.

(3) During the exam, students are not allowed to carry cell phones or other electronic devices enabling interpersonal communication and information access.

Bring calculator
and white pen

Article 103. (1) Students must carry a pen or pencil and other admissive stationery necessary for exam submission.

(2) Any request or question can only be addressed with a loud voice only to the supervising teachers.

Article 105. During the examination, communication between students is forbidden.

Article 108. (1) On leaving the classroom, students must hand the written papers and all their signed sheets.

(2) Upon completion of the written exam, students must sign for the delivering of their written paper.

(2) A discipline is promoted when the final mark, from both theoretical and practical exam, is at least 5.

(5) If the student takes the first task of the exam but is absent from the second, he/she gets the minimum score and is declared failed.

- Students who didn’t took the practical exam cannot enter to the theoretical exam.
- The students, who pass practical exams, are not obliged to take that part of the exam once again in the same academic year.
- The students who have **difference exams (transfer from another faculty)** should plan the exam with the teacher and also pay the university fee for the exam.

Variant 1

1) The cholesterol level on a sample of 600 patients was tested for normality. Chi-Square goodness of fit test was used and a p-value of 0.0004 was obtained. The following is correct:

a) The comparison of the sample mean among a population mean is proper

b) Data are not normally distributed

c) Kolmogorov-Smirnov is the proper test

d) The Chi-Square goodness of fit is not the proper test to be used

e) Data are normally distributed

4) The values of systolic blood pressure measured in mmHg for a sample of 10 patients are as follows: 120, 100, 110, 120, 130, 160, 130, 120, 140, and 160. The arithmetic mean is equal to:

a) 110

b) 130

c) 129

d) 135

e) 120

Universitatea de Medicină şi Farmacie "Iuliu Haţieganu" Cluj-Napoca

Catedra de Informatică Medicală

Facultate, an, grupă: ______________________

____

Numele: ______________________

Prenumele: ______________________

Data examenului: ______ (completati cu majuscule) ______

	A	B	C	D	E		A	B	C	D	E		A	B	C	D	E
1						51						101					
2						52						102					
3						53						103					
4						54						104					
5						55						105					
6						56						106					
7						57						107					
8						58						108					
9						59						109					
10						60						110					
11						61						111					
12						62						112					
13						63						113					
14						64						114					
15						65						115					
16						66						116					
17						67						117					
18						68						118					
19						69						119					
20						70						120					
21						71						121					
22						72						122					
23						73						123					
24						74						124					
25						75						125					
26						76						126					

Varianta 1

ssure measured in mmHg
llows: 120, 100, 110, 120,
e arithmetic mean is equal

Varianta chestionar de examinare

1 ○
2 ○
3 ○
4 ○

ABOUT theoretical test

- Theoretical test (90 minutes):
- 35 questions each worth 1 point
    - Multiple choice questions
    - Five possible response (A, B, C, D & E);

About Exam - Exam Policy

Question with * - only one correct answer

- Questions with one correct answer:
  - 5 concordances = 1 point
  - < 5 concordances = 0 point
- Questions with 2 correct answers :
  - 5 concordances = 1 point
  - 4 concordances = 0.8 point
  - < 4 concordances = 0 point

17.* The 99% confidence interval ($Z_\alpha = 2.579$) associated to systolic blood pressure for a sample of 169 persons with an arithmetic mean of 135 mg/dl and a standard deviation of 20 mg/dl is:

A. [132 - 138]
B. [132 - 138]
C. [83 - 187]
D. [131 - 139]
E. Could not be determined based on provided data

Only one correct !

16) Let be a statistical series with the following data: 40, 60, 20, 20, 60, 80, 80, 40, 60, and 80. The relative frequency of 0.3 corresponds to:

a) 20
b) 40
c) 60
d) 80
e) None is correct

Two correct answers !

About Exam - Exam Policy

- Questions with > 2 correct answers:
  - 5 concordances = 1 point
  - 4 concordances = 0.8 point
  - 3 concordances = 0.3 point
  - < 3 concordances = 0 point

7) The following data represent the age of first episode of myocardial infarction on a series of male patients: 38, 50, 23, 45, 70, 33, 25, 40, 50, 62, and 59. The values of quartiles are as follows: Q1 = 35.5, Q2 = 45 and Q3 = 54.5. The following statements are true:

a) Q2 - Q1 = 9.5
b) Q3 - Q2 = 9.5
c) Data are asymmetrical distributed
d) Data are symmetrical distributed
e) Data are approximately symmetrical distributed

>2 answers correct !

Type of activity	Evaluation criteria	Type	Mark	Weight in final mark
Lecture	**Theoretical exam**	Compulsory	1-10	70%
Practical activity	**Practical exam**	Compulsory	1-10	30%
Class activity	Optional		0.6	

Exam – 35 questions with multiple choice

Maximum points 35 = Maximum mark 10.

If the obtained **points** ≥ 13.7 then

- Mark at theoretical test = 1+ Obtained point*9/35

- If the obtained points < 13.7 then
    - Mark at theoretical test = 4

If theoretical test **mark** ≥ 5 and practical test **mark** ≥5 than

- weighted average = 0.70* theoretical test mark + 0.30 * practical test mark
- Final mark = weighted average + 0.2*no. of Homework with mark higher than 5

Example

- 10 mark at practical test
- 18 points → 1+ 18*9/35=5.63 mark at theoretical test
- Weighted average = 0.7 * 5.63 + 10 * 0.3 = 6.94
- 3 homeworks with marks>5 meaning +0.6 at final mark

- Final mark 6.94 + 3 * 0.2 = 7.54 = 8

Example

- 10 at practical test
- less than 13.7 points → 4 at theoretical test

- Final mark 4 (have to give only theoretical test in re-taken)

Example

- 4 at Practical test
- cannot enter to theoretical test
    - final mark 4 (have to give both tests in re-taken)

If you do not pass, no problem you can come

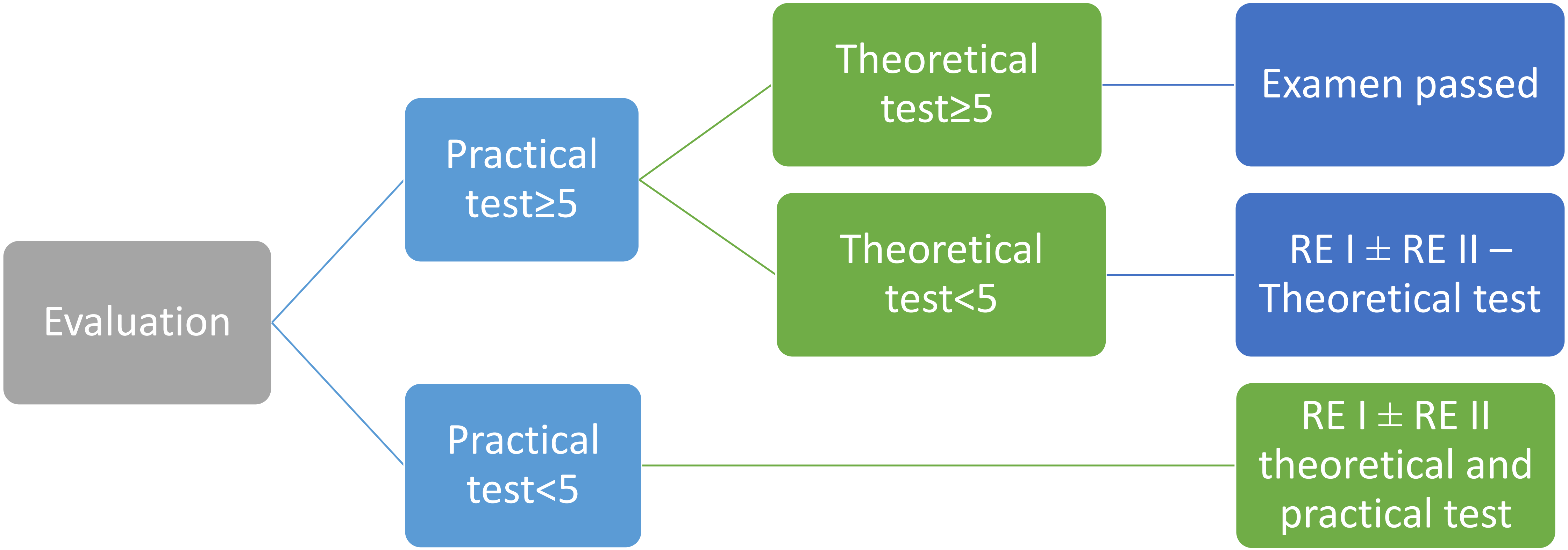
1st Re-taken:

2026 July 13th-17th

2nd Re-taken:

2026 September 14th -18th

Practical tests in the same day as theoretical test after the theoretical test


Evaluation
Practical test≥5
Practical test<5
Theoretical test≥5
Theoretical test<5
Examen passed
RE I ± RE II – Theoretical test
RE I ± RE II theoretical and practical test

Results - Where?

- practical test – in the same day after the test
- theoretical test – 2-3 days after the theoretical test

final mark – 2-3 days after the theoretical test

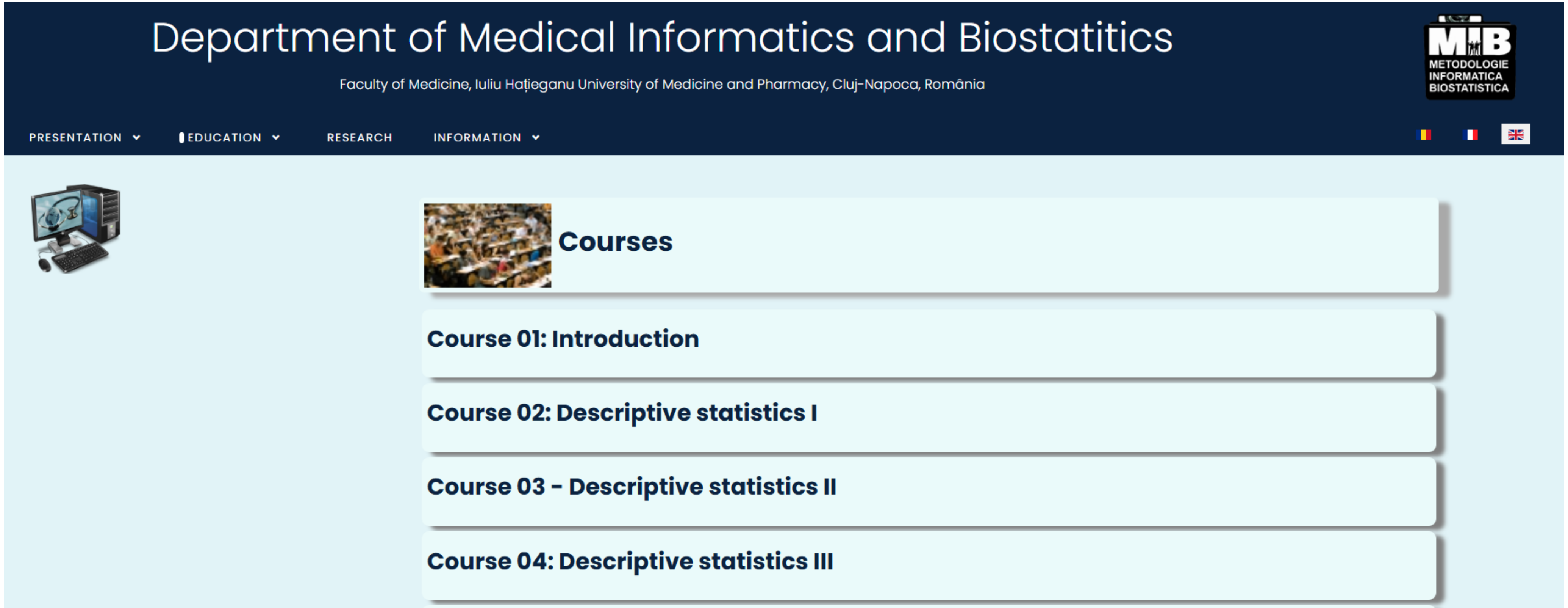
Consultations

- 25th January 2026
- 12 o’clock
- online on Teams

Where are the presentations from courses?

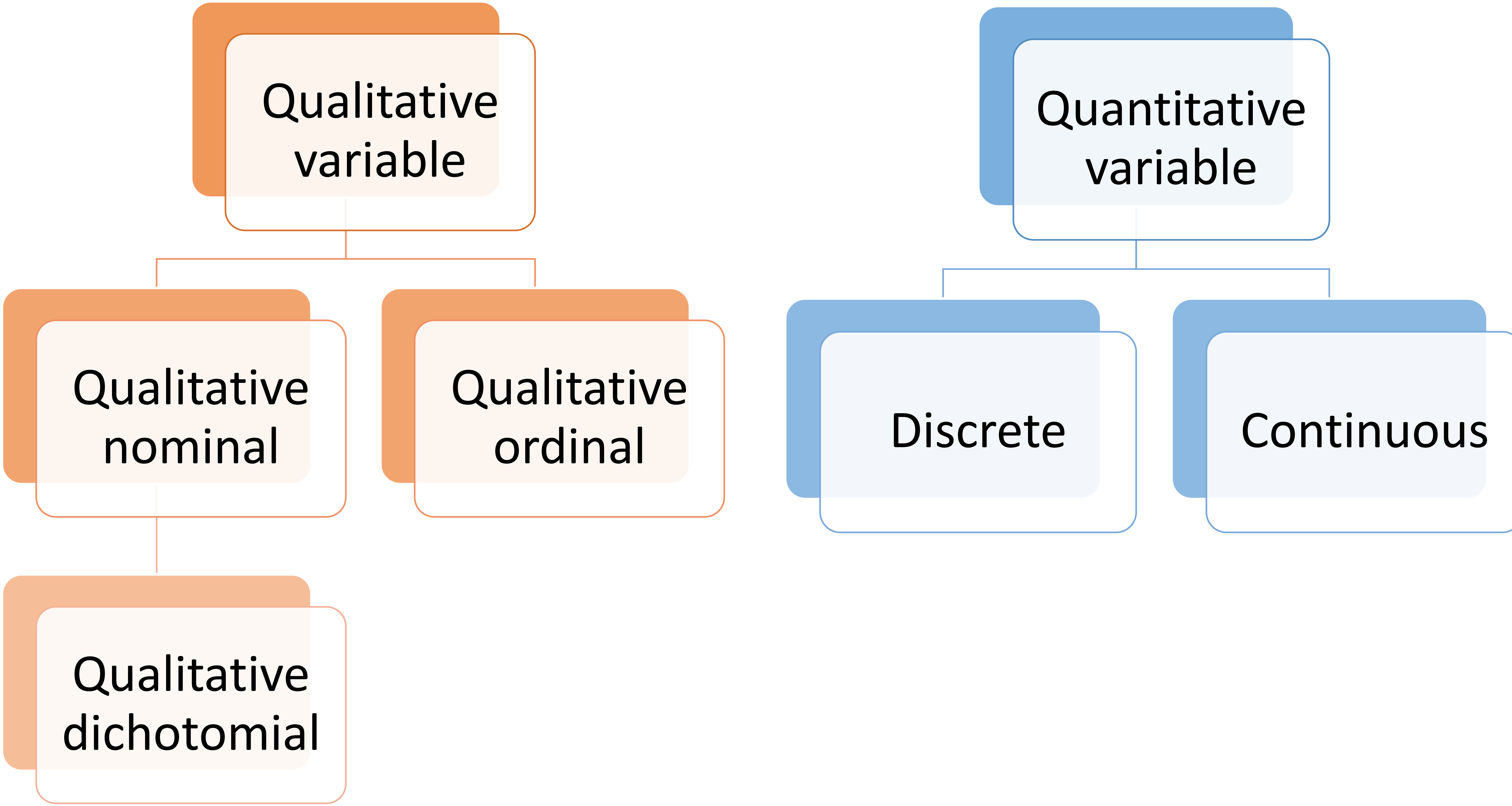
Contact: cbondor@umfcluj.ro

www.info.umfcluj.ro



Review

Variables type


Qualitative variable
Qualitative nominal
Qualitative ordinal
Qualitative dichotomial
Quantitative variable
Discrete
Continuous

Example Question: Variables type

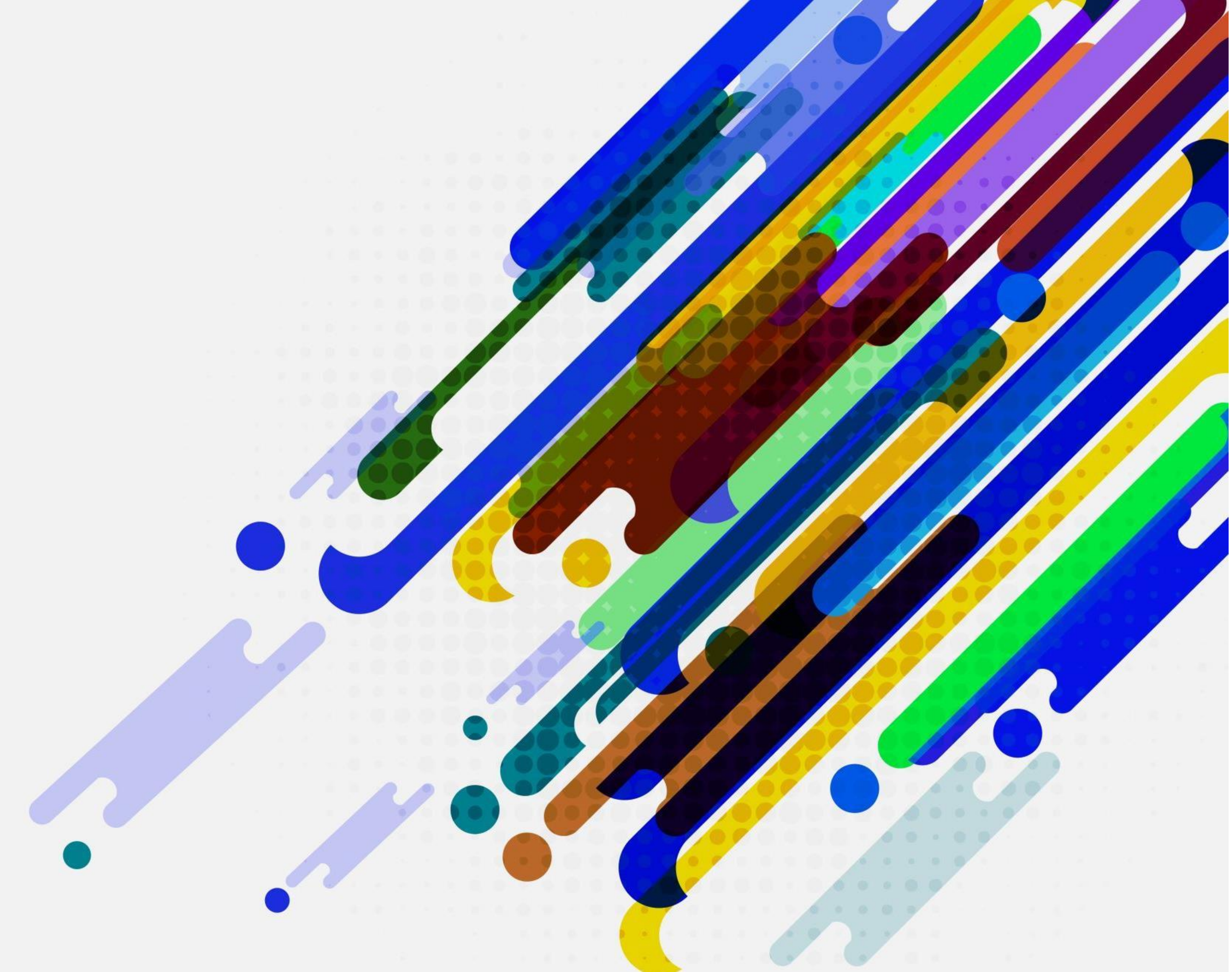
The variable Diabetes (Yes/No) is a

A. Discrete quantitative variable
B. Continuous quantitative variable
C. Nominal qualitative variable
D. Dichotomous qualitative variable
E. Ordinal qualitative variable

Exemple Question: Variables type

The variable Diabetes (Yes/No) is a

A. Discrete quantitative variable
B. Continuous quantitative variable
C. Nominal qualitative variable
D. Dichotomous qualitative variable
E. Ordinal qualitative variable



Descriptive statistics

What can we do?

Count/calculate

Frequencies (absolute/relative)

Frequencies table

Contingency table

Relative risk, risk difference

Simple and compose probabilities

Conditional probabilities: Sensitivity, Specificity, Positive predictive value, Negative predictive value

Qualitative variables

Calculate

Arithmetic mean

Median

Mode

Standard deviation

Coefficient of variation

Range

Minimum /Minimum

Quartiles

Coeficient of determination

Quantitative variables

One qualitative variable

20 cases in intensive therapy

30 cases not in intensive therapy

We count the cases in each category

Frequencies

Frequencies table

	A	B	C
1	Id	Treatment	Intensive therapy
2	1	Methylprednisolone	Yes
3	2	Dexamethasone	No
4	3	Methylprednisolone	No
5	4	Dexamethasone	No
6	5	Methylprednisolone	No
7	6	Dexamethasone	No
8	7	Methylprednisolone	No
9	8	Dexamethasone	Yes
10	9	Methylprednisolone	No
11	10	Dexamethasone	No
12	11	Methylprednisolone	Yes
13	12	Dexamethasone	No
14	13	Methylprednisolone	No
15	14	Dexamethasone	No
16	15	Methylprednisolone	Yes

One qualitative variable

20 cases in intensive therapy = 40%

30 cases not in intensive therapy = 60%

Intensive therapy	Absolute frequency	Relative frequency (%)
Yes	20	40
No	30	60
Total	50	100

We count the cases in each category

Frequencies

Frequencies table

Example:

Into the study were included 10 patients. The following data were collected on the variable Diabetes: Yes, No, No, No, No, Yes, No, No, No, No, where Yes means that the patient has diabetes, No – the patient does not have diabetes. Which of the following statements are true?

A. The relative frequency of people with diabetes in the studied sample is 20%

B. The absolute frequency of people without diabetes in the studied sample is 8

C. The empirical probability that a person suffers from diabetes is 0.2

D. The empirical probability that a person does not suffer from diabetes is 0.8

E. The relative frequency of people with diabetes in the studied sample is 2

Diabetes: Yes, No, No, No, No, Yes, No, No, No, No

B. The absolute frequency of people without diabetes in the studied sample is 8

2 patients with diabetes
8 patients without diabetes

Absotute frequency F_a – count cases on each category

Diabetes: Yes, No, No, No, No, Yes, No, No, No, No

A. The relative frequency of people with diabetes in the studied sample is 20%

=2/10*100=20, 20% from the patients have diabetes
=8/10*100=20, 80% from the patients did not have diabetes

Relative frequency – Divide the frequency with the total number of patients and multiply with 100
$=F_a/n*100$

C. The empirical probability that a person suffers from diabetes is 0.2

D. The empirical probability that a person does not suffer from diabetes is 0.8

Diabetes: Yes, No, No, No, No, Yes, No, No, No, No

=2/10=0.2 the empirical probability that a person suffers from diabetes

=8/10=0.8 the empirical probability that a person does not suffer from diabetes

Empirical probability – Divide the frequency with the total number of patients = $F_a/10$

Example:

Into the study were included 10 patients. The following data were collected on the variable Diabetes: Yes, No, No, No, No, Yes, No, No, No, No, where Yes means that the patient has diabetes, No – the patient does not have diabetes. Which of the following statements are true?

A. The relative frequency of people with diabetes in the studied sample is 20%

B. The absolute frequency of people without diabetes in the studied sample is 8

C. The empirical probability that a person suffers from diabetes is 0.2

D. The empirical probability that a person does not suffer from diabetes is 0.8

E. The relative frequency of people with diabetes in the studied sample is 2

Two qualitative variables ex. Risk factor and disease

	With disease	Without disease	Total
Factor +	a	b	a+b
Factor -	c	d	c+d
Total	a+c	b+d	n=a+b+c+d

	Intensive therapy = Yes	Intensive therapy = No	Total
Methylprednisolone	15	5	20
Dexamethazone	25	5	30
Total	40	10	50

V
cases in each category

Frequencies

Frequencies table

Contingency table

Example:

600 patients were included in the study. 190 had diabetes, of whom 150 were obese. Of those who did not have diabetes, 50 were obese. Which of the following statements is true?

A. The risk of obese people having diabetes is 75%

B. The risk of normal-weight people having diabetes is 10%

C. The relative risk of obese people having diabetes compared to those of normal weight is 7.5

D. The probability that a person does not have diabetes and is of normal weight is 0.6

E. The probability that a person has diabetes and is of normal weight is 0.08

600 patients were included in the study. 190 had diabetes, of whom 150 were obese. Of those who did not have diabetes, 50 were obese.

190 had diabetes

Of those who did not have diabetes, 50 were obese

Of those with diabetes 150 were obese

	Diabetes= Yes	Diabetes= No	Total
Obese=Yes	150	50	
Obese=No			
Total	190		600

600 patients were included in the study.

190-150=40

410-50=360

150+50=200

	Diabetes= Yes	Diabetes= No	Total
Obese=Yes	150	50	200
Obese=No	40	360	400
Total	190	410	600

600+200=400

600-190 = 410

	Diabetes=Yes	Diabetes=No	Total
Obese=Yes	150	50	200
Obese=No	40	360	400
Total	190	410	600

A. The risk of obese people having diabetes is 75%

B. The risk of normal-weight people having diabetes is 10%

RIE=frequency of obese people with diabetes /frequency of obese = a/(a+b)

=150/200=0.75,
75% of obese people have diabetes

RIN=frequency of non-obese people with diabetes /frequency of non-obese = c/(c+d)

=40/400=0.10,
10% of non-obese people have diabetes

	Diabetes=Yes	Diabetes=No	Total
Obese=Yes	150	50	200
Obese=No	40	360	400
Total	190	410	600

A. The risk of obese people having diabetes is 75%

B. The risk of normal-weight people having diabetes is 10%

C. The relative risk of obese people having diabetes compared to those of normal weight is 7.5

Relativ risk

RR = RIE/RIN

→ =75/10=7.5 or 0.75/0.10=7.5

Obese people have a 7.5 times higher risk of diabetes than people who are not obese

	Diabetes=Yes	Diabetes=No	Total
Obese=Yes	150	50	200
Obese=No	40	360	400
Total	190	410	600

D. The probability that a person does not have diabetes and is of normal weight is 0.6

~~E. The probability that a person has diabetes and is of normal weight is 0.08~~

P (no diabetes/non obese) = devide frequency of the person without diabetes and non-obese to the total of the patients=d/600

→ =360/600=0.6

the empirical probability that a person does not have diabetes and is of normal weight

P (diabetes/non obese) = devide frequency of the person with diabetes and non-obese to the total of the patients=c/600

→ =40/600=0.07

the empirical probability that a person have diabetes and is of normal weight

Example:

600 patients were included in the study. 190 had diabetes, of whom 150 were obese. Of those who did not have diabetes, 50 were obese. Which of the following statements is true?

A. The risk of obese people having diabetes is 75%

B. The risk of normal-weight people having diabetes is 10%

C. The relative risk of obese people having diabetes compared to those of normal weight is 7.5

D. The probability that a person does not have diabetes and is of normal weight is 0.6

E. The probability that a person has diabetes and is of normal weight is 0.08

What we can do?

Calculate

Arithmetic mean	Median	Mode
Standard deviation	Coefficient of variation	Range
Minimum /Maximum	Quartiles	Coefficient of determination

if we know the coefficient of correlation r, coefficient of determination is $d=r^2$, ex. r=0.33, $d=0.33^2=0.11$

	A	B
1	Id_pac	Age (years)
2	1	75
3	2	50
4	3	60
5	4	75
6	5	74
7	6	81
8	7	44
9	8	34
10	9	54
11	10	63

- Arithmetic mean for age = (75+50+60+75+74+81+44+34+54 +63)/10 = 610/10 = 61
- sort 34, 44, 50, 54, 60, 63, 74, 75, 75, 81
- median = (60+63)/2 = 61.5
- quartile 1 = 50
- quartile 3 = 75
- mode = 75
- minimum = 34
- maximum = 81
- range = 81-34 = 47

- variation = $[(75-61)^2+(50-61)^2+(60-61)^2+(75-61)^2+(74-61)^2+(81-61)^2+(44-61)^2+(34-61)^2+(54-61)^2+(63-61)^2]/(10-1)=$ $[14^2+(-11)^2+(-1)^2+14^2+13^2+20^2+(-17)^2+(-27)^2+(-7)^2+2^2]/9=$ (196+121+1+192+163+411+ 289+729+49+4)/9= 2155/9= 239.47
- standard deviation = $\sqrt{239.47}$ = 15.47
- coefficient of variation = standard deviation/arithmetic mean = 15.47/61 = 0.25

Example:

10 patients were included in the study. The following data were collected on the variable Age: 100, 10, 90, 20, 40, 60, 50, 50, 50, 60. Which of the following statements is true?

A. The arithmetic mean of age on the studied sample is 53
B. The mode of the age variable on the studied sample is 50
C. The median of the age variable on the studied sample is 50
D. The standard deviation of the age variable on the studied sample is 27.5
E. The range of the age variable on the studied sample is 80

Age: 100, 10, 90, 20, 40, 60, 50, 50, 50, 60

A. The arithmetic mean of age on the studied sample is 53

=(100+10+90+20+40+60+50+50+50+60)/10=530/10=53

$\bar{X}$ – sum of values divided by the total number of values

Age: 100, 10, 90, 20, 40, 60, 50, 50, 50, 60

B. The mode of the age variable on the studied sample is 50

100, 10, 90, 20, 40 once

60 twice

50 3 times

The most frequent value

Age: 100, 10, 90, 20, 40, 60, 50, 50, 50, 60

C. The median of the age variable on the studied sample is 50

10, 20, 40, 50, 50, 50, 60, 60, 90, 100

median = (50+50)/2=50

The value in the middle of the series
We sort the data in ascending order
We made the average of the two values in the middle or the median is the value in the middle

Age: 100, 10, 90, 20, 40, 60, 50, 50, 50, 60

A. D. The standard deviation of the age variable on the studied sample is 27.5

$$s=\sqrt{\frac{\sum_{i=1}^{n}(x_i-\bar{X})^2}{n-1}}$$

$= (100-53)^2+(10-53)^2+(90-53)^2+(20-53)^2+(40-53)^2+ (60-53)^2+$
$+(50-53)^2+(50-53)^2+(50-53)^2+(60-53)^2 =$
$= (47)^2+(-43)^2 +(37)^2+(-33)^2+(-13)^2+(7)^2+(-3)^2+(-3)^2+(-3)^2+(7)^2 =$
$=2209+1849+1369+1089+169+49+9+9+9+49 = 6810$

$s=\sqrt{6810/(10-1)}=\sqrt{756{,}667}=27{,}5$

Age: 100, 10, 90, 20, 40, 60, 50, 50, 50, 60

~~E. The range of the age variable on the studied sample is 80~~

= 100-10 =90

Range = maximum-minimum

Example:

10 patients were included in the study. The following data were collected on the variable Age: 100, 10, 90, 20, 40, 60, 50, 50, 50, 60. Which of the following statements is true?

A. The arithmetic mean of age on the studied sample is 53
B. The mode of the age variable on the studied sample is 50
C. The median of the age variable on the studied sample is 50
D. The standard deviation of the age variable on the studied sample is 27.5
E. The range of the age variable on the studied sample is 80

Interpretations

Relative risk

Risk difference

Coefficient of variation

Skewness

Normal distribution

Kurtosis

Correlation coefficient

The coefficient of variation (CV=s/$\bar{X} * 100$)

interpretation for positive values

- 0% ≤ CV < 10% data are homogene
- 10% ≤ CV < 20% data are relative homogene
- 20% ≤ CV < 30% data are relative heterogene
- 30% ≤ CV data are heterogene

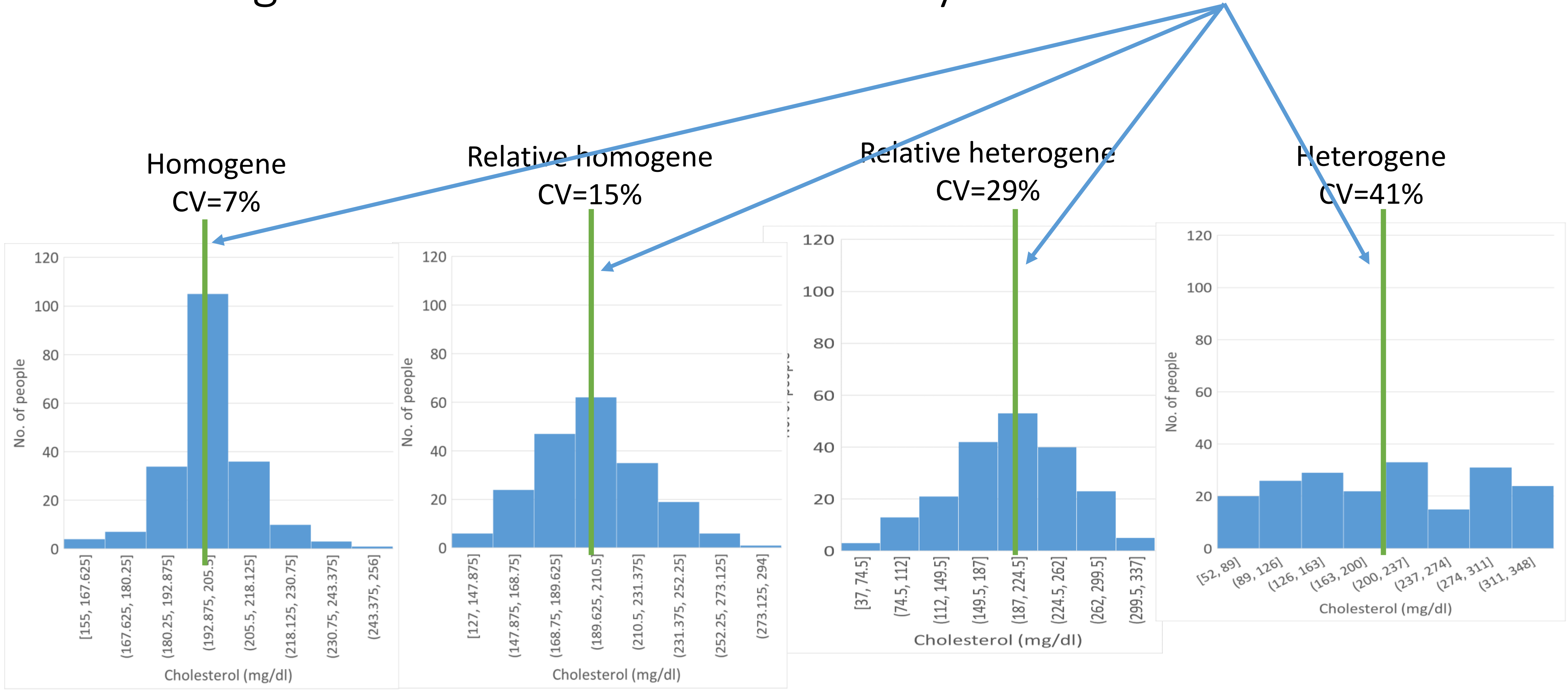
- where s=standard deviation, $\bar{X}$=arithmetic mean

Evaluate which of the following statements are true

A. A coefficient of variation of 0.96 shows that the data is heterogene
B. A coefficient of variation of 0.26 shows that the data is relative heterogene
C. A coefficient of variation of 4 shows that the data is heterogene
D. A coefficient of variation of 24% shows that the data is relative heterogene
E. A coefficient of variation of 4% shows that the data is relative homogene

homogene = values are in vicinity of the arithmetic mean

heterogene = values are not in vicinity of the arithmetic mean



100 patients

100 patients

The coefficient of variation (CV=s/$\bar{X} * 100$)

interpretation for positive values

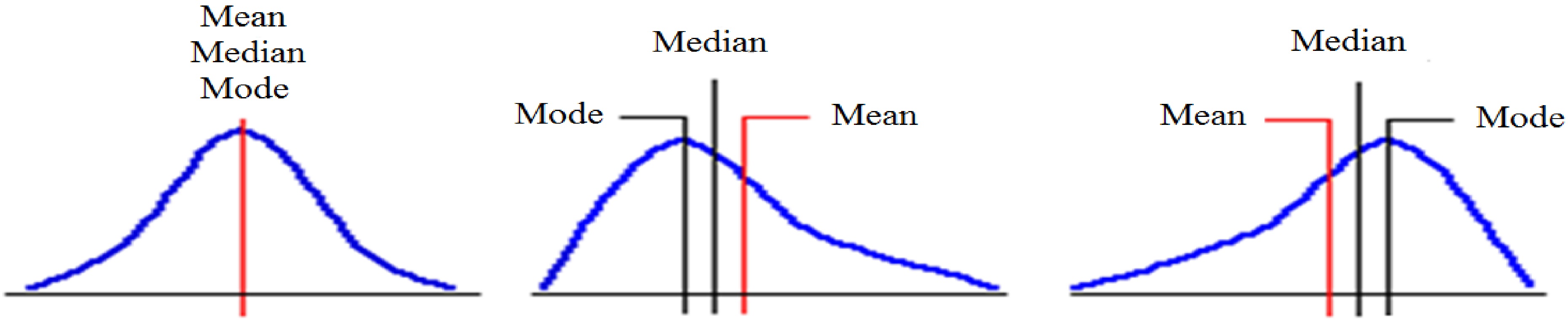
- 0% ≤ CV < 10% data are homogene
- 10% ≤ CV < 20% data are relative homogene
- 20% ≤ CV < 30% data are relative heterogene
- 30% ≤ CV data are heterogene

- where s=standard deviation, $\bar{X}$=arithmetic mean

Evaluate which of the following statements are true

A. A coefficient of variation of 0.96 shows that the data is heterogene
B. A coefficient of variation of 0.26 shows that the data is relative heterogene
C. A coefficient of variation of 4 shows that the data is heterogene
D. A coefficient of variation of 24% shows that the data is relative heterogene
E. A coefficient of variation of 4% shows that the data is relative homogene

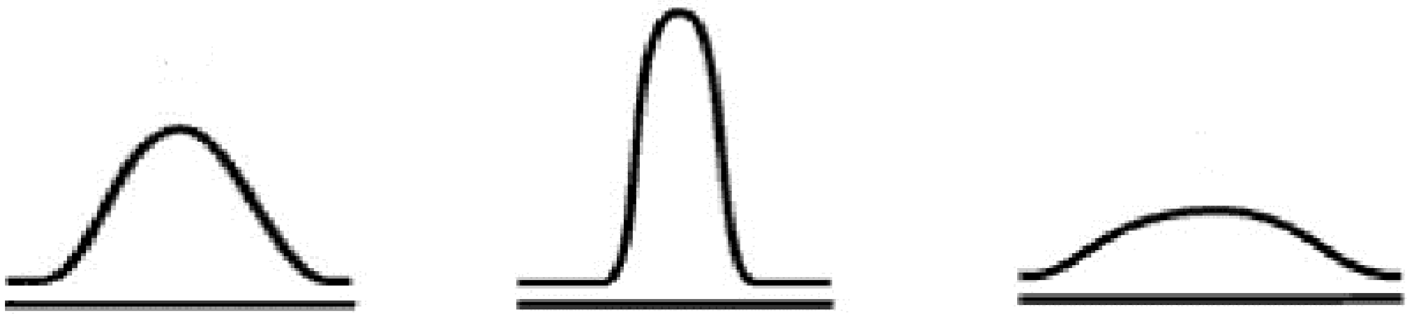
Normal distribution



Symmetric
Skewness=0
symmetrical distribution

Positive asymmetry
Skewness>0
asymmetry to the right

Negative asymmetry
Skewness<0
asymmetry to the left



Mesokurtic
kurtosis=0

Leptokurtic
kurtosis>0

Platykurtic
kurtosis<0

Rule: A serie of numbers is normal distributed if

- ✓ Arithmetic mean ≈ Median ≈ Mode
- ✓ Quartile 1, Quartile 3 are simetrical with the mean/median
- ✓ Skewness ≈ 0 (between -1 to 1)
- ✓ Kurtosis ≈ 0 (between -1 to 1)

Example:

Evaluate which of the following statements are true

A. if the skewness is -3 then the data does not follow a normal distribution
B. if the skewness is 5 then the data does not follow a normal distribution
C. if the kurtosis is -2 then the data does not follow a normal distribution
D. if the arithmetic mean, median and mode are equal then the data follow a normal distribution
E. if the arithmetic mean is 10, quartile 1 is 5 and quartile 2 is 15 then the data does not follow a normal distribution

r/rho correlation coefficient

- r between -1 și 1
- r < -0,25
  - inversely proportional correlation
- r > 0,25
  - directly proportional correlation

COLTON'S EMPIRICAL RULES (1974)

a correlation coefficient

from -0.25 to 0.25

means a weak or null correlation

from 0.25 to 0.50 (or from -0.25 to -0.50)

an acceptable degree of association

from 0.5 to 0.75 (or from -0.5 to -0.75)

a moderate to good correlation

greater than 0.75 (or less than -0.75)

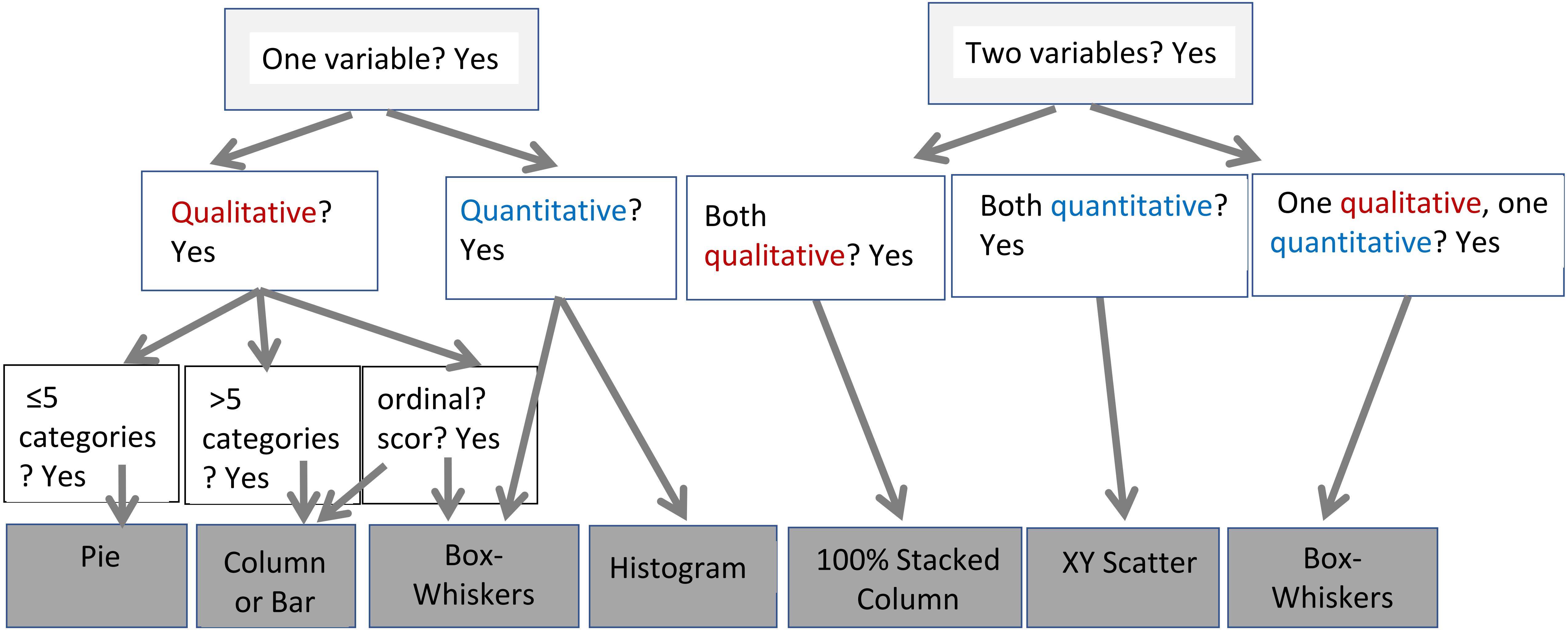
a very good association or correlation

Example:

Evaluate which of the following statements are true

A. A correlation coefficient of -0.96 shows an inversely proportional correlation between the considered series of values
B. A correlation coefficient of 0.26 shows an acceptable correlation
C. A correlation coefficient of -12 shows an inversely proportional correlation between the considered series of values
D. The values of the correlation coefficient vary between -1 and 1
E. A correlation coefficient of 1 shows an inversely proportional correlation between the considered series of values

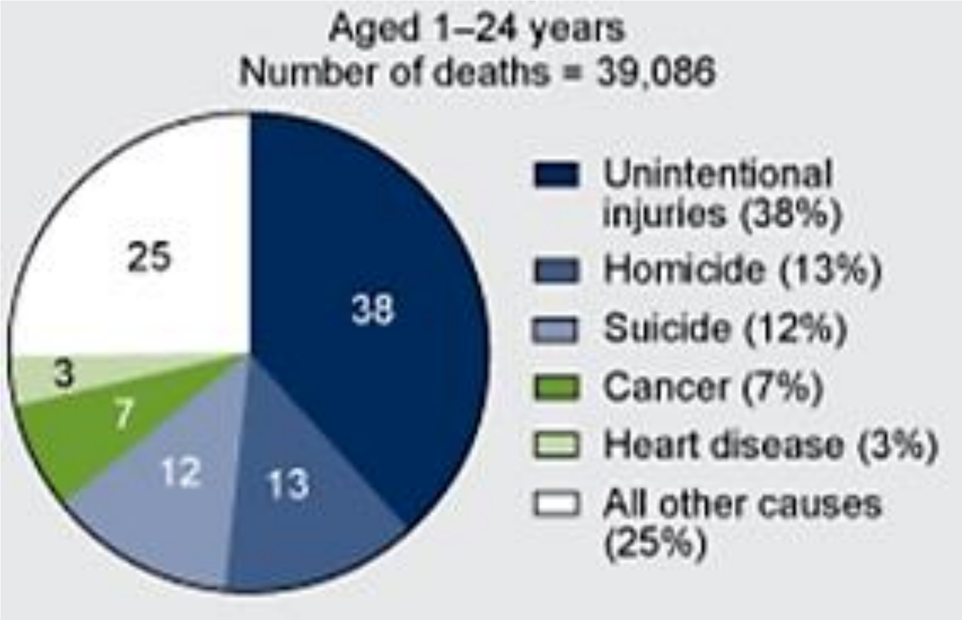
How to choose the right chart?



Choose the right chart

- One qualitative
  - nominal
  - dichotomial
  - ordinal

- **Chart**
  - **Pie (we preffer it when is possible)**
  - Column
  - Bar



Minino Am, Murphy SL. Death in United States, 2010. NCHS Data Brief. 2012:99.

One variables

- One qualitative
  - nominal
  - dichotomial
  - ordinal

Column (when >6 categories or ordinal variable)   or Bar chart

https://www.dreamstime.com/

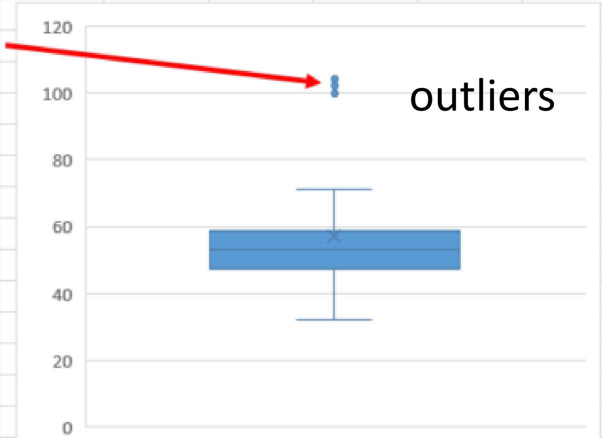
https://www.shutterstock.com/

One quantitative variable

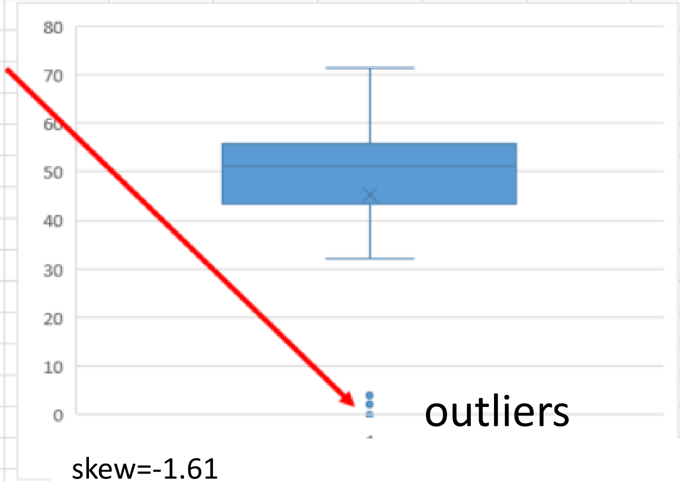
	A	B	H	I	O	P
1	36.72649	Seria 1	100	Seria 2	0	Seria 3
2	35.57328		105		1	
3	59.60017		101		2	
4	58.91328		102		3	
5	50.3623		103		4	
6	56.83134		104		5	
7	54.32939		54.32939		54.32939	
8	51.99329		51.99329		51.99329	
9	56.5538		56.5538		56.5538	
10	48.75946		48.75946		48.75946	
11	50.66565		50.66565		50.66565	
12	58.7618		58.7618		58.7618	
13	53.3491		53.3491		53.3491	
14	33.19699		33.19699		33.19699	
15	71.34057		71.34057		71.34057	
16	53.90801		53.90801		53.90801	
17	53.08085		53.08085		53.08085	
18	33.5888		33.5888		33.5888	
19	49.38341		49.38341		49.38341	
20	47.31551		47.31551		47.31551	
21	51.40647		51.40647		51.40647	
22	45.26709		45.26709		45.26709	
23	57.90226		57.90226		57.90226	
24	39.01349		39.01349		39.01349	
25	44.37459		44.37459		44.37459	
26	45.98524		45.98524		45.98524	
27	57.96515		57.96515		57.96515	
28	54.73206		54.73206		54.73206	
29	53.09208		53.09208		53.09208	
30	51.05496		51.05496		51.05496	
31	42.63723		42.63723		42.63723	
32	45.05121		45.05121		45.05121	
33	53.62224		53.62224		53.62224	
34	47.90595		47.90595		47.90595	
35	60.34871		60.34871		60.34871	
36	51.90284		51.90284		51.90284	
37	64.09885		64.09885		64.09885	
38	32.1287		32.1287		32.1287	
39	51.80323		51.80323		51.80323	
40	58.39705		58.39705		58.39705	

Box-whiskers plot

skew=-0.42
mean=50.91
median=51.94
near normal distribution

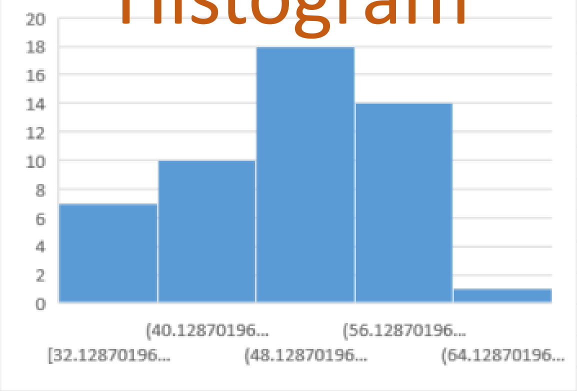


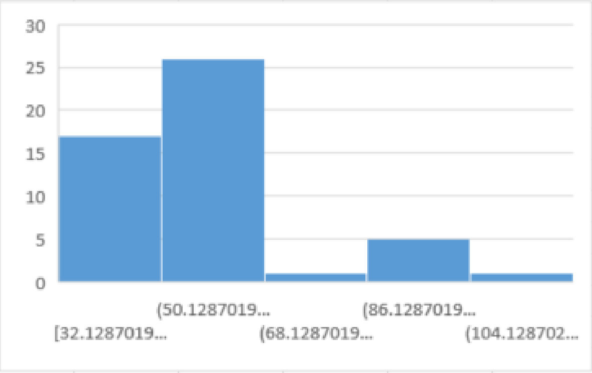
skew=1.62
mean=57.25
median=53.22
non-normal distribution
positive assimetry
outliers in the right part of the distribution
arithmetic mean is drawn to the outliers

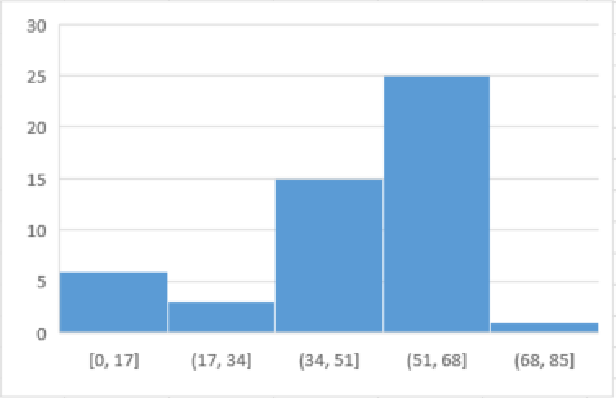


skew=-1.61
mean=45.25
median=51.23
non-normal distribution
negative assimetry
outliers in the left part of the distribution
arithmetic mean is drawn to the outliers

Histogram

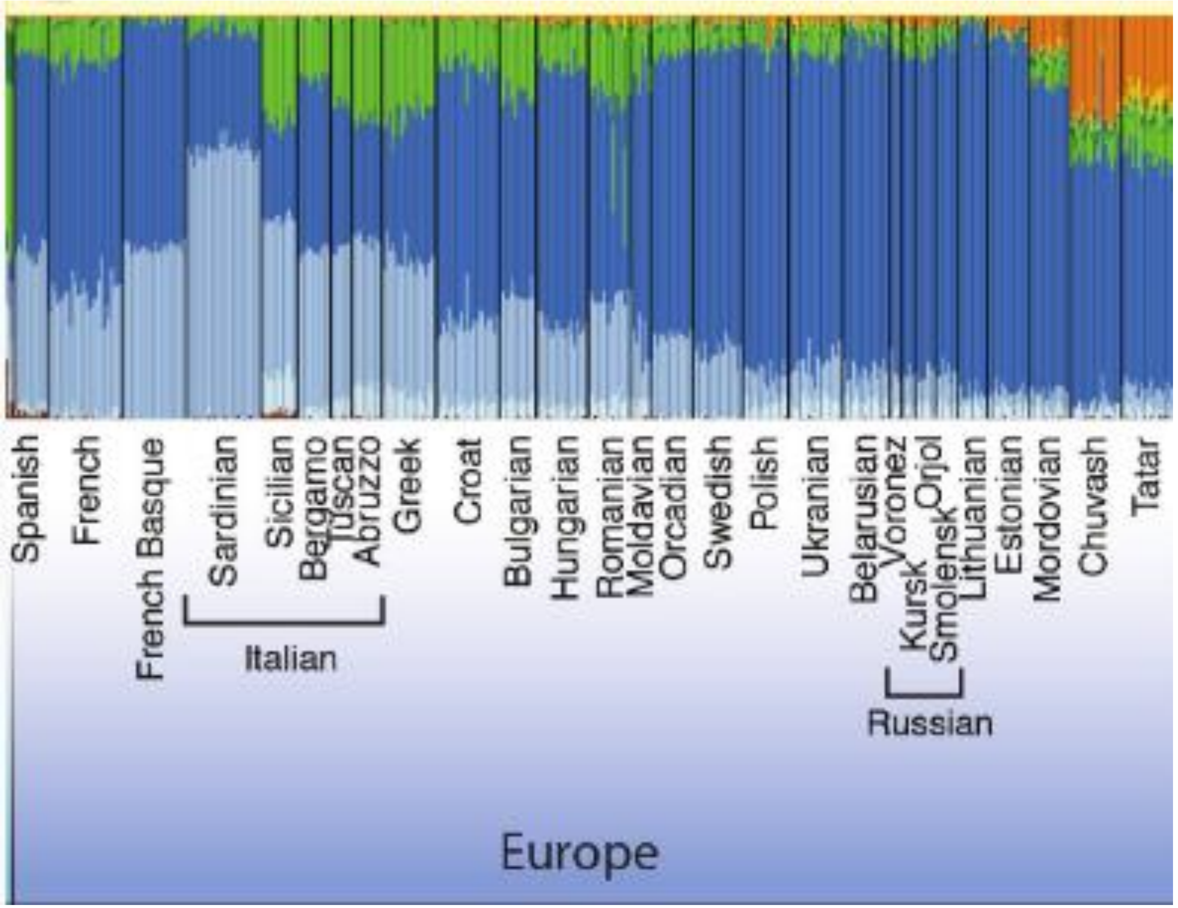




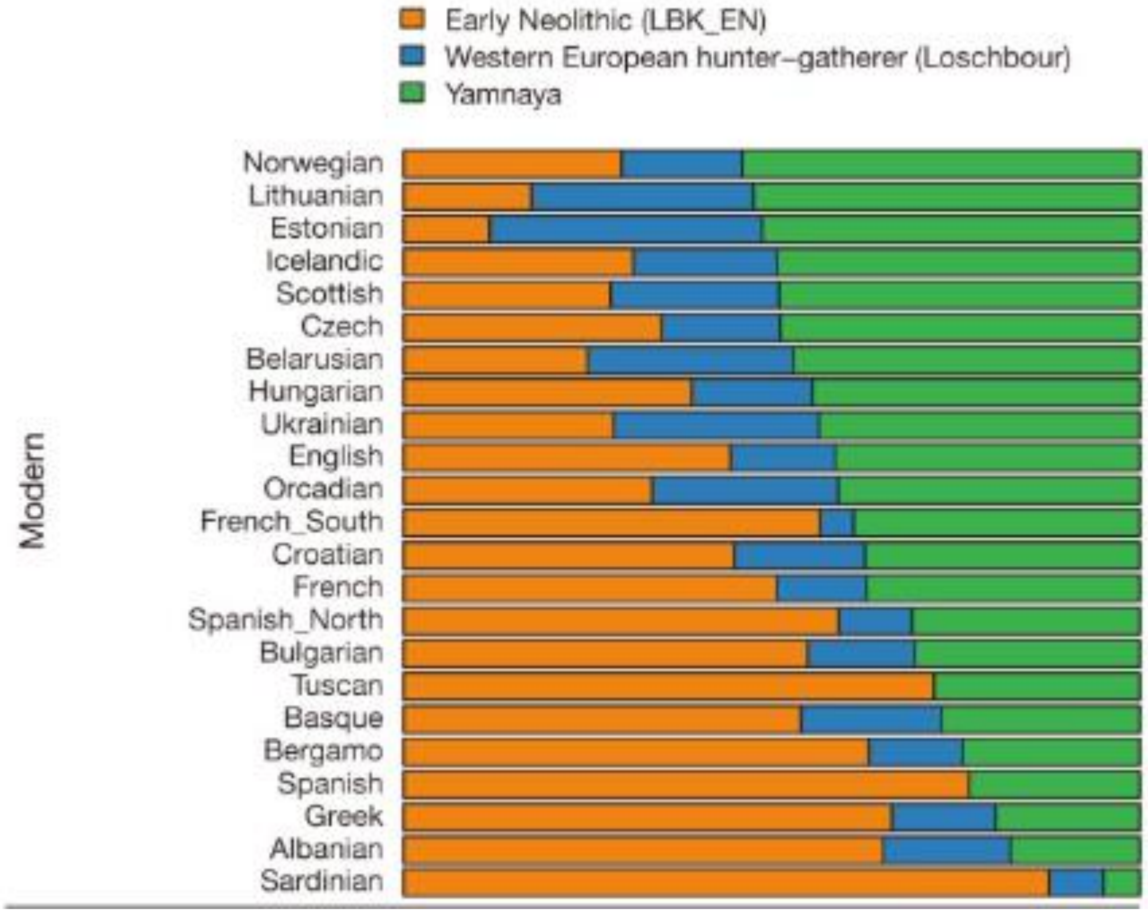


Two qualitative variables

Column or Bar chart – preferably 100% Stacked column/bar chart



Kovacevic L et al. Standing at the gateway to Europe--the genetic structure of Western balkan populations based on autosomal and haploid markers. PLoS One. 2014



Haak W et al . Massive migration from the steppe was a source for Indo-European languages in Europe. Nature. 2015.

- XY Scatter
  - two quantitative variables
  - or ordinal variables with many scores

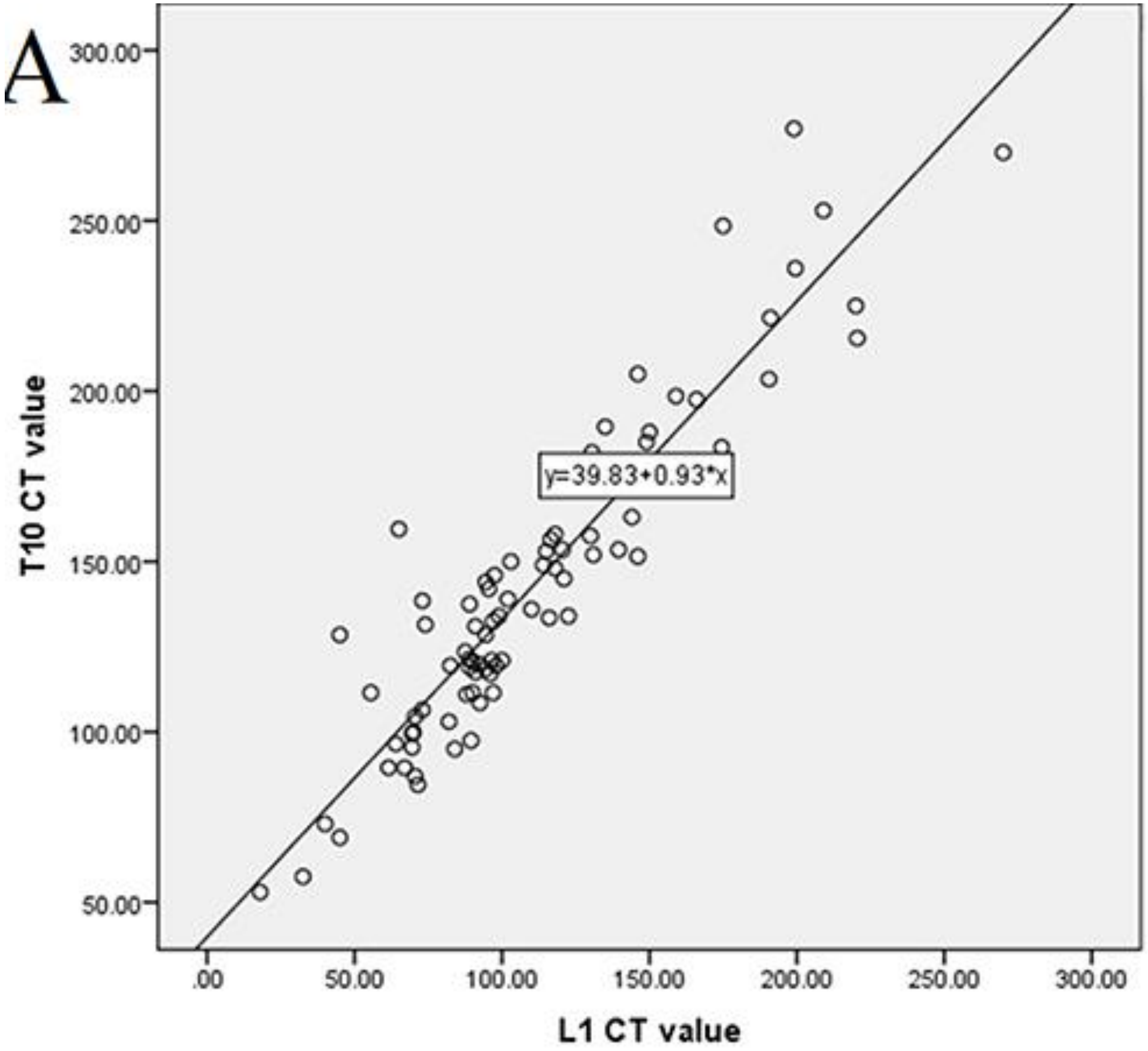
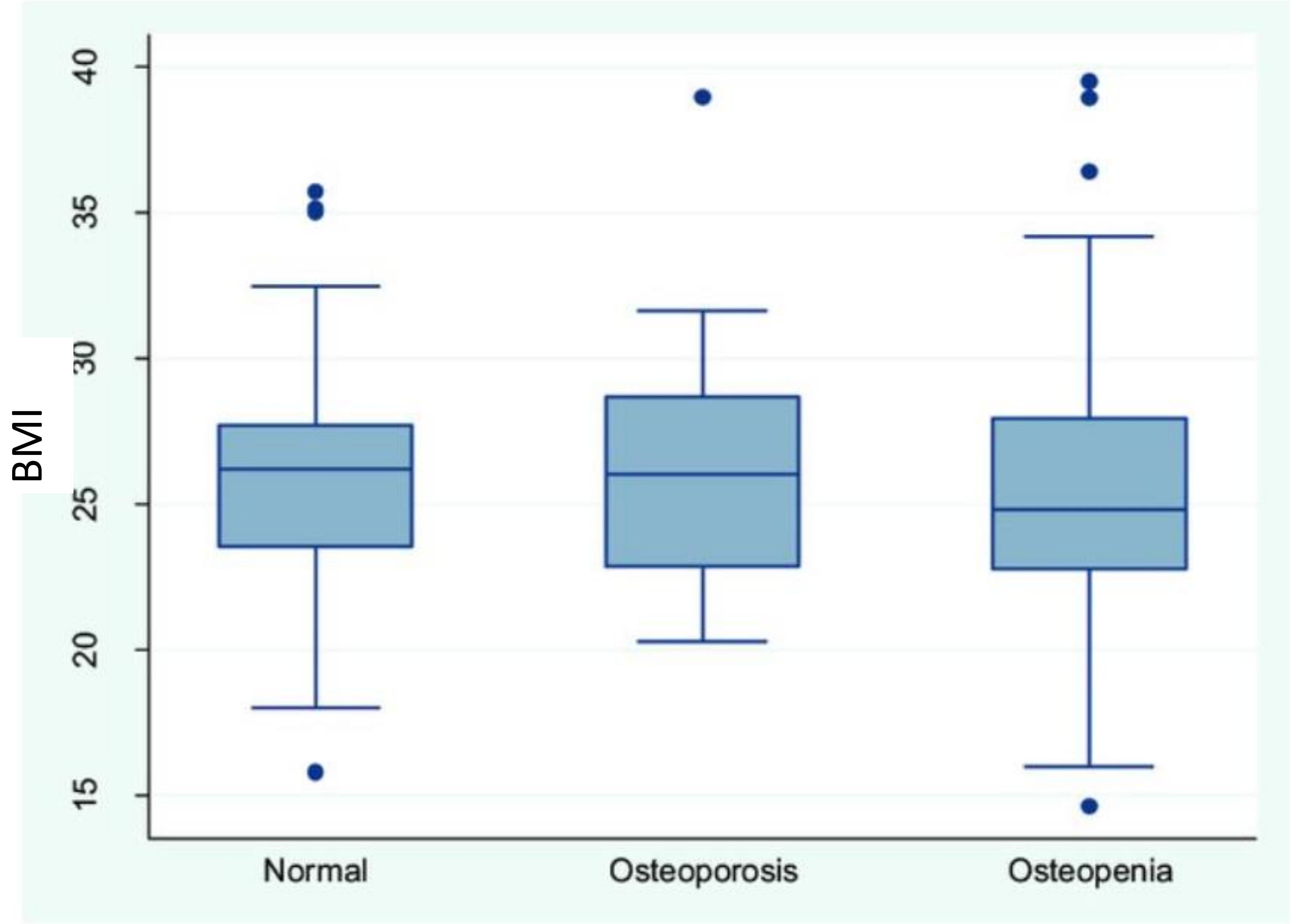


Figure 1 Correlation analysis of CT values of cancellous bone of vertebral bodies T10-T12 and L1. Statistics scatter diagrams and fitting lines of correlation analysis of CT values between (**A**) T10 vs L1

Hu T, Dai S, Yang L, Zhu B. Potential Predictive of Thoracic CT Value and Bone Mineral Density T-Value in COPD Complicated with Osteoporosis. *Int J Gen Med*. 2024;17:3027-3038

- Box-whiskers plot
    - one quantitative variable (or ordinal with many scores) and one qualitative variable (groups, repeated measurements)



Hiremath RN, Yadav AK, Ghodke S, Yadav J, Latwal S, Kotwal A. Osteoporosis among household women: A growing but neglected phenomenon. Med J Armed Forces India. 2018 Jan;74(1):5-10.

Interpretations

Histogram

Box-whiskers plot

100% Column/Bar chart

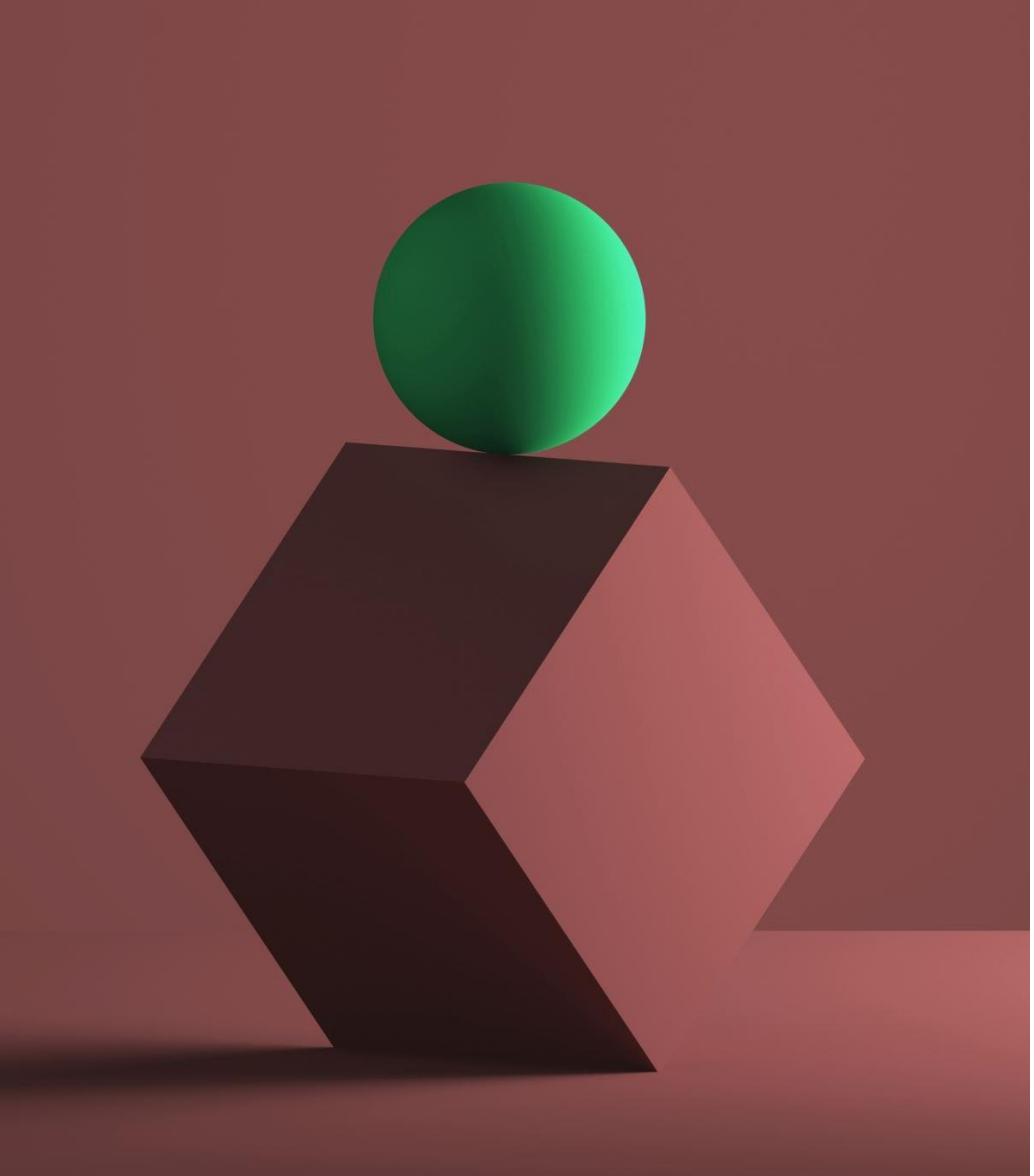
XY Scatter

- about
  - assimetry
  - outliers cases
  - diferencies between groups
  - dependency
    - asceding/descending trend
    - graduality

Example

*A histogram is a suitable graphical representation for:

A. Discrete quantitative
B. Continuous quantitative
C. Nominal qualitative
D. Dichotomous qualitative
E. Ordinal qualitative



Statistical inference

Generalization to the population

Population P

Ex. Frequency of hipertension in the population ϕ

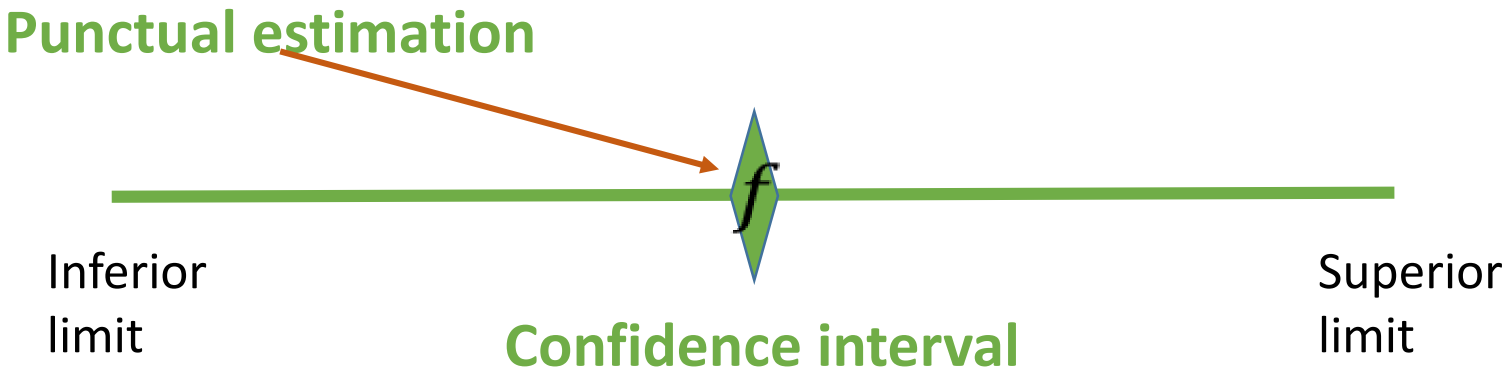
Objective:

- Frequency ϕ, proportion, relative risk, arithmetic mean μ ...

How?

1.
   - Extract randomly a representative sample
2.
   - Calculate the statistics
     - Frequency f
3.
   - with inferencial statistics methods make a generalization to the population
   - **frequency** ϕ is the same as the sample frequency f
   - **frequency** ϕ can be found in the confidence interval

95% confidence interval for a frequency

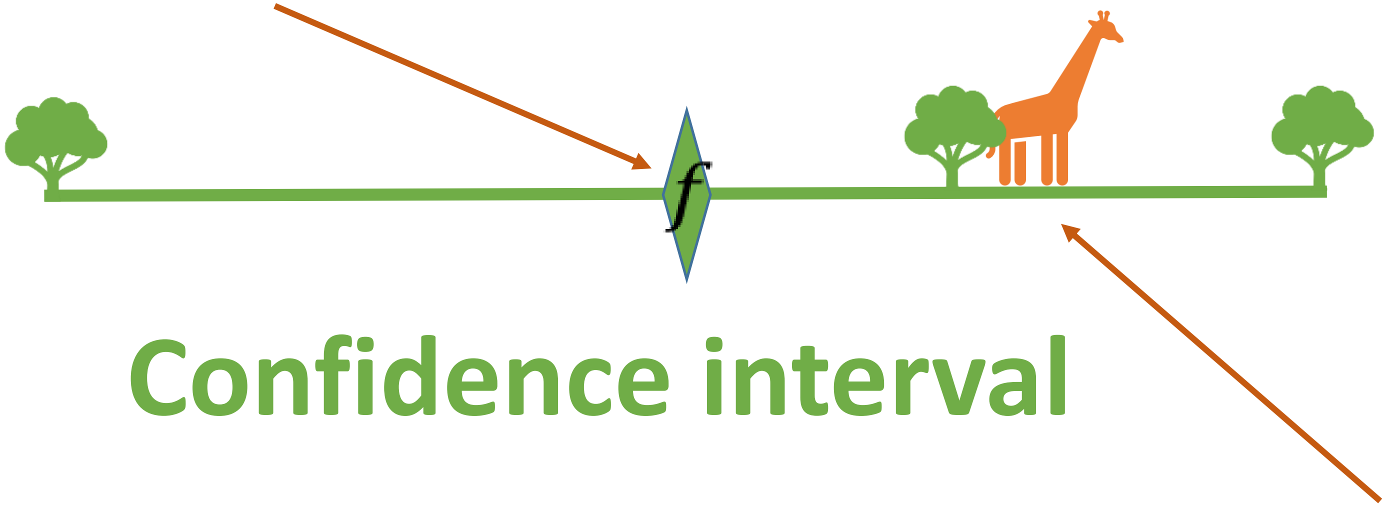


$$f - 1.96\sqrt{\frac{f(1-f)}{n}}$$

$$f + 1.96\sqrt{\frac{f(1-f)}{n}}$$

95% confidence interval for a frequency

Punctual estimation= Frequency calculated on the sample



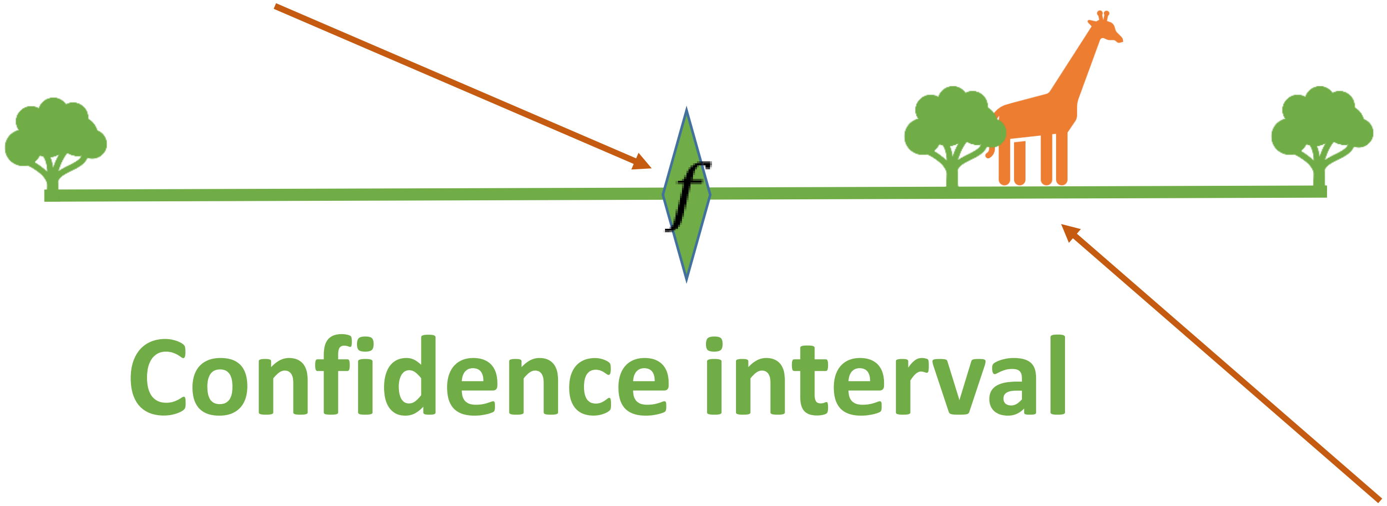
Confidence interval

Frequency of the disease in the population ϕ

- included in the confidence interval with a 95% probability

95% confidence interval for a frequency

Punctual estimation= Frequency calculated on the sample



Confidence interval

Frequency of the disease/risk factor in the population ϕ

can be anywhere in the estimated interval

- We have a 95% chance of extracting a sample from where the estimated confidence interval will contain the population parameter

Ex. Arithmetic mean of cholesterol in population μ 

Population P

Objective:

- arithmetic mean μ  ...

How?

1.
   - Extract randomly a representative sample

2.
   - Calculate the statistics
     - arithmetic mean $\bar{X}$

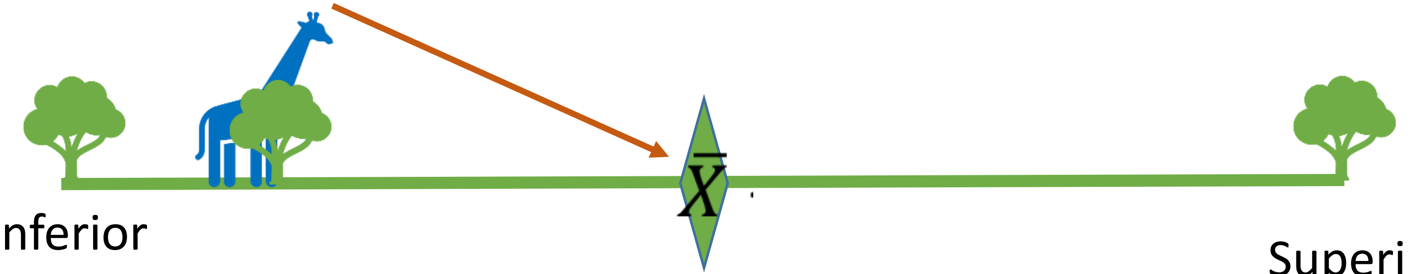
3.
   - with inferencial statistics methods make a generalization to the population
     - **arithmetic mean μ** is the same as the sample arithmetic mean $\bar{X}$
   - **arithmetic mean μ** can be found in the confidence interval

95% confidence interval for an arithmetic mean

arithmetic mean of the population µ

Punctual estimation

- included in the confidence interval with a 95% probability



Inferior limit

Superior limit

Confidence interval

$\bar{X} - 1.96 \frac{s}{\sqrt{n-1}}$

$\bar{X} + 1.96 \frac{s}{\sqrt{n-1}}$

- arithmetic mean of the population µ  - **can be anywhere in the estimated interval**

- We have a 95% chance of extracting a sample from where the estimated confidence interval will contain the population parameter 

Example

For a sample of 82 hospitalized patients, the mean length of stay for patients working in a toxic environment was found to be 25 days/year, with a standard deviation of 9 days. Determine the 95% confidence interval for the mean length of stay for patients working in a toxic environment. (Z_α=1.96, α=0.05).

A. (19; 31)

B. (23.04; 26.96)

C. (24.72; 29.51)

D. (23.23; 26.83)

E. (22.71; 28.51)

$(\bar{X} - 1.96 \frac{s}{\sqrt{n-1}}, \bar{X} + 1.96 \frac{s}{\sqrt{n-1}})$

(25-1.96*9/$\sqrt{82-1}$; 25+1.96*9/$\sqrt{82-1}$)

(25-1.96*9/9; 25+1.96*9/9)

(25-1.96*1; 25+1.96*1)

(25-1.96; 25+1.96)

(23.04; 26.96)

Example

For a sample of 5000 people, the frequency of HPV infection was 15.3%. Determine the 95% confidence interval for the frequency of HPV infection. (Z_α=1.96, α=0.05).

A. (13; 17)

B. (14.3%; 16.3%)

C. (0.143; 0.163)

D. (14.1; 16.5)

E. (10.3; 20.3)

$$\left(f - 1.96\sqrt{\frac{f(1-f)}{n}}; f + 1.96\sqrt{\frac{f(1-f)}{n}}\right)$$

$$\left(0.153-1.96*\sqrt{\frac{0.153*(1-0.153)}{5000}}; 0.153+1.96*\sqrt{\frac{0.153*(1-0.153)}{5000}}\right)$$

$$\left(0.153-1.96*\sqrt{\frac{0.153*0.847}{5000}}; 0.153+1.96*\sqrt{\frac{0.153*0.847}{5000}}\right)$$

$$\left(0.153-1.96*\sqrt{\frac{0.129591}{5000}}; 0.153+1.96*\sqrt{\frac{0.129591}{5000}}\right)$$

$$\left(0.153-1.96*\sqrt{0.0000259182}; 0.153+1.96*\sqrt{0.0000259182}\right)$$

(0.153-1.96*0.005; 0.153+1.96*0.005)

(0.153-0.0099; 0.153+0.0099)

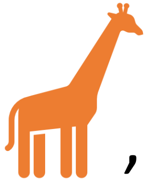
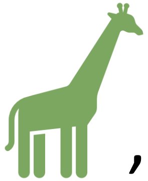
(0.143; 0.163)

(14.3%; 16.3%)

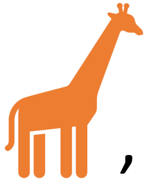
Statistical tests

X, Y – qualitative variables

- Populations P1, P2,...
- Objective: study if there is differences between two frequencies in two/more populations (categories of the grouping variable)

- Frequencies $\phi 1$  , $\phi 2$  , ...

X, Y – qualitative variables

- Populations P1, P2,...
- Objective: study if there is differences between two frequencies in two/more populations (categories of the grouping variable)
- Frequencies ϕ1  , ϕ2  , ...

1.
- Extract randomly representative samples

2.
- Calculate the statistics on the samples
  - Frequencies f1, f2

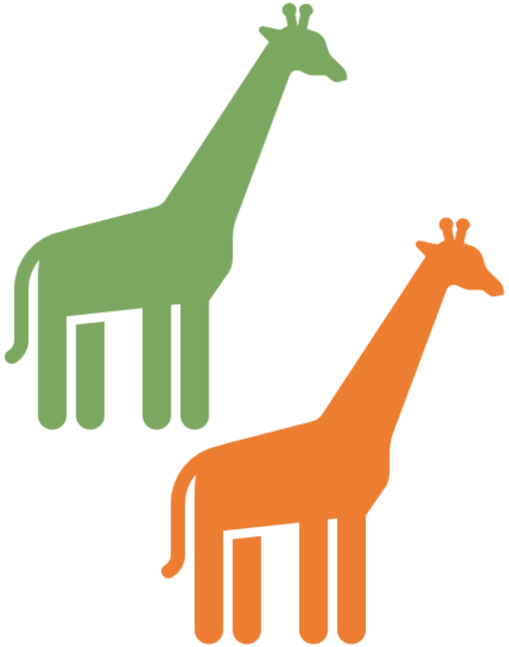
How?

3.

Study objective

Alternative hyphotesis H1:

Different populations $\varphi 1 \neq \varphi 2$

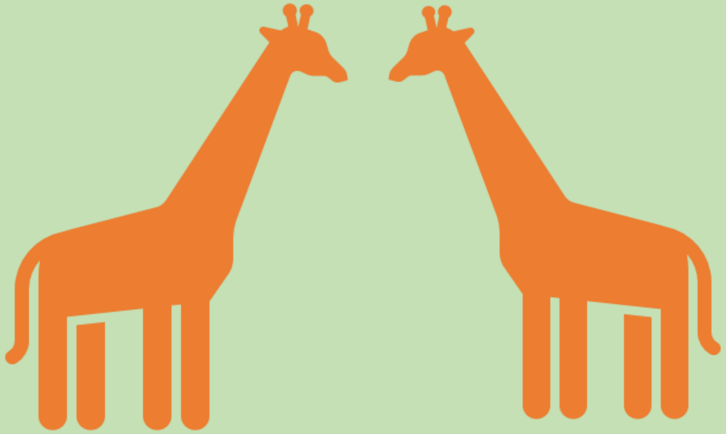


?

Null hyphotesis H0:

The same population: $\varphi 1 = \varphi 2$

we want to prove that this is false



Reductio ad absurdum - proof by contradiction,
a proposition is proved true by proving that it is impossible for it to be false.

What is happening at the population level?

Test the **null hypothesis** that we do not have two different populations, but the same population from the p. of v. of the frequencies of the tested variable

Null hypothesis H0 -implies the denial of the objective we want to investigate

Possible formulations:

- There is no statistically significant difference between groups in terms of frequency
- There is no statistically significant association between 2 variables:Risk factor – disease
- The two variables are independent

Test the **null hypothesis** that we do not have two different populations, but the same population from the p. of v. of the frequencies of the tested variable

Null hypothesis H0 -implies the denial of the objective we want to investigate:

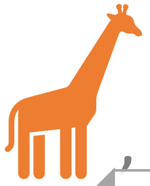
- There is no statistically significant difference between groups in terms of frequency
- There is no statistically significant association between 2 variables:Risk factor – disease
- The two variables are independent

Alternative hypothesis H1 (negation of H0): refers to the objective we want to investigate

- There is a statistically significant difference between groups in terms of frequency
- There is a statistically significant association between 2 variables:Risk factor – disease
- The two variables are dependent

Apply the statistical test --> find which of the hyphotese is true: H0 or H1

X, Y – qualitative variables

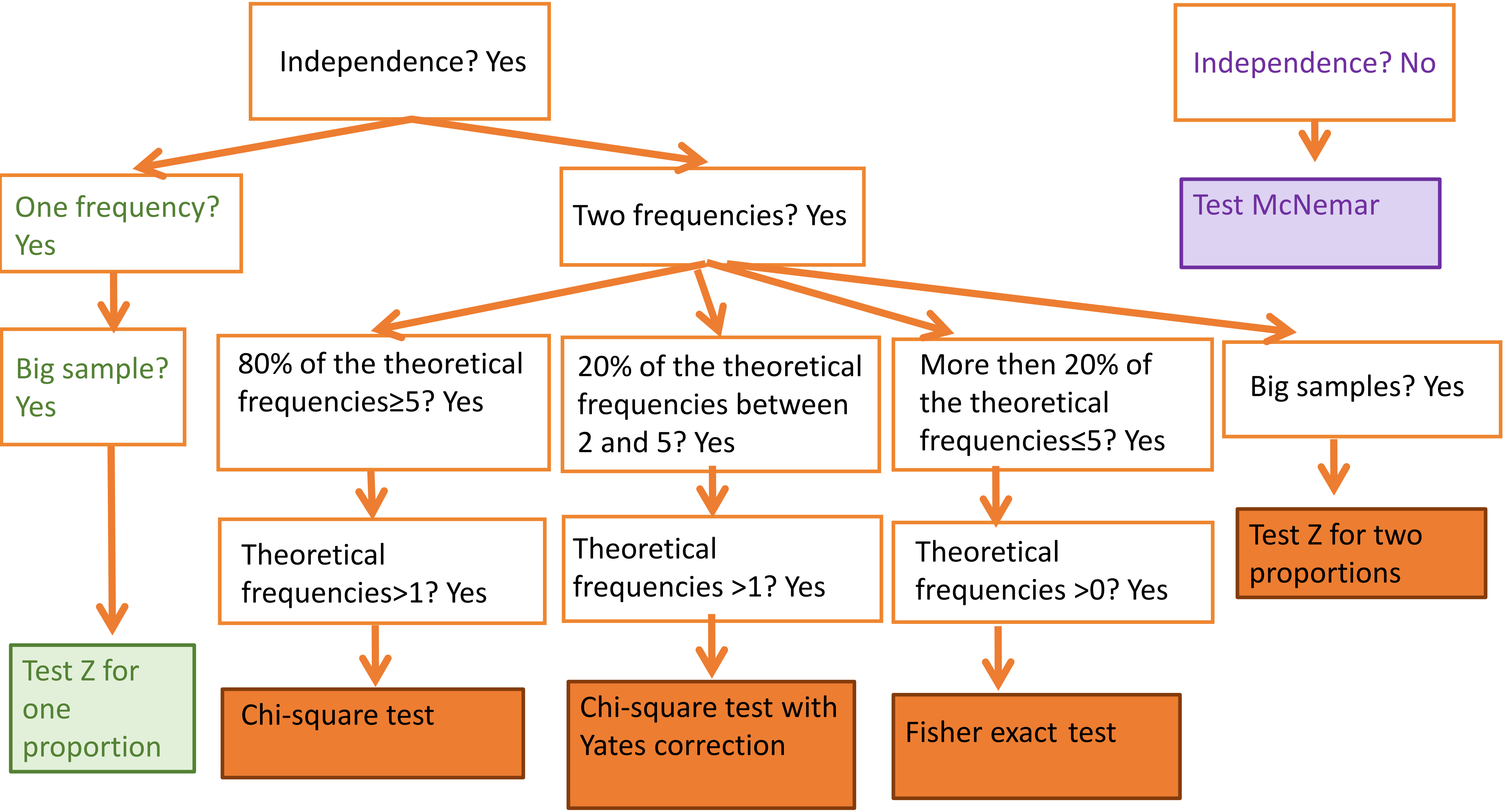
- Populations P1, P2,...
- Objective: study if there is differences between two frequencies in two/more populations (categories of the grouping variable)
- Frequencies ϕ1  , ϕ2  , ...

1.
- Extract randomly representative samples

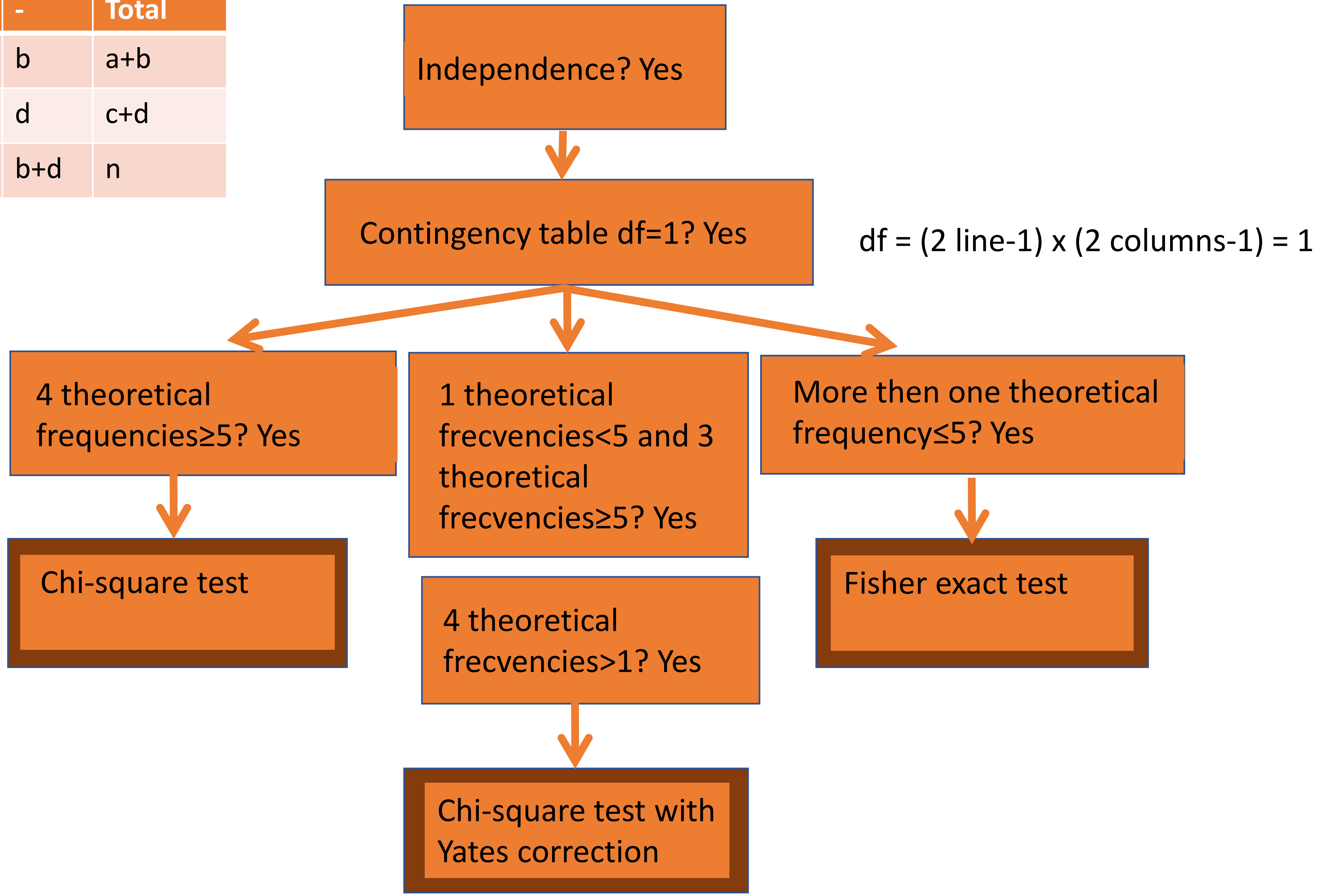
2.
- Calculate the statistics on the samples
  - Frequencies f1, f2

How?

3.
- Through a statistical test
- test the hypothesis that we do not have two different populations, but the same population from the p. of v. of the frequencies of the tested variable
- result: the probability p – the probability of finding differences equal to or greater than the one found on the sample if we repeat the study


Independence? Yes
Independence? No
Test McNemar
One frequency? Yes
Two frequencies? Yes
Big sample? Yes
80% of the theoretical frequencies≥5? Yes
20% of the theoretical frequencies between 2 and 5? Yes
More then 20% of the theoretical frequencies≤5? Yes
Big samples? Yes
Theoretical frequencies>1? Yes
Theoretical frequencies >1? Yes
Theoretical frequencies >0? Yes
Test Z for two proportions
Test Z for one proportion
Chi-square test
Chi-square test with Yates correction
Fisher exact test

	+	-	Total
+	a	b	a+b
-	c	d	c+d
Total	a+c	b+d	n



	With dental implant failure	Without dental implant failure	Total
Smokers	50	1350	1400
Non-smokers	75	1525	1600
Total	125	2875	3000

Observed contingency table

	With dental implant failure	Without dental implant failure	Total
Smokers	$=\frac{125*1400}{3000}=58$	$=\frac{2875*1400}{3000}=1342$	1400
Non-smokers	$=\frac{125*1600}{3000}=67$	$=\frac{2875*1600}{3000}=1533$	1600
Total	125	2875	3000

Theoretical contingency table (null table)

Example

Example - Theoretical contingency table (null table)

	With dental implant failure	Without dental implant failure	Total
Smokers	**58**	**1342**	
Non-smokers	**67**	**1533**	
Total			

4 theoretical frequencies≥5? Yes

→Chi square test

	With dental implant failure	Without dental implant failure	Total
Smokers	**3**	**1397**	
Non-smokers	**67**	**1533**	
Total			

- 1 theoretical frecvencies<5 and 3 theoretical frecvencies≥5? Yes
- 4 theoretical frecvencies>1? Yes

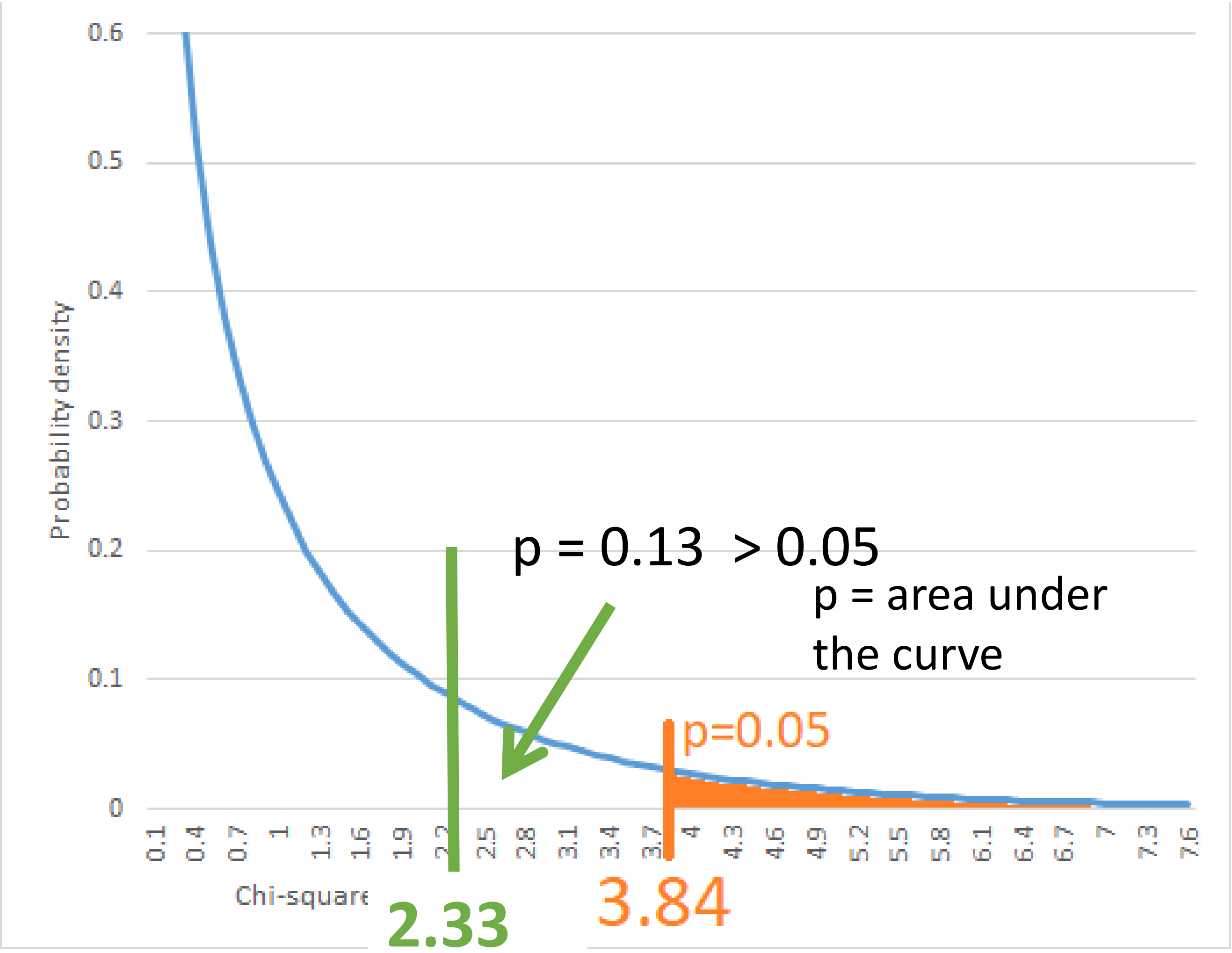
→Chi-square test with Yates correction

	With dental implant failure	Without dental implant failure	Total
Smokers	**3**	**1397**	
Non-smokers	**4**	**1596**	
Total			

- More then one theoretical frequency≤5? Yes

→Fisher-exact test

Test results – Chi-square test



$\chi 2 = 1.33$ is not $(3.84, +\infty)$

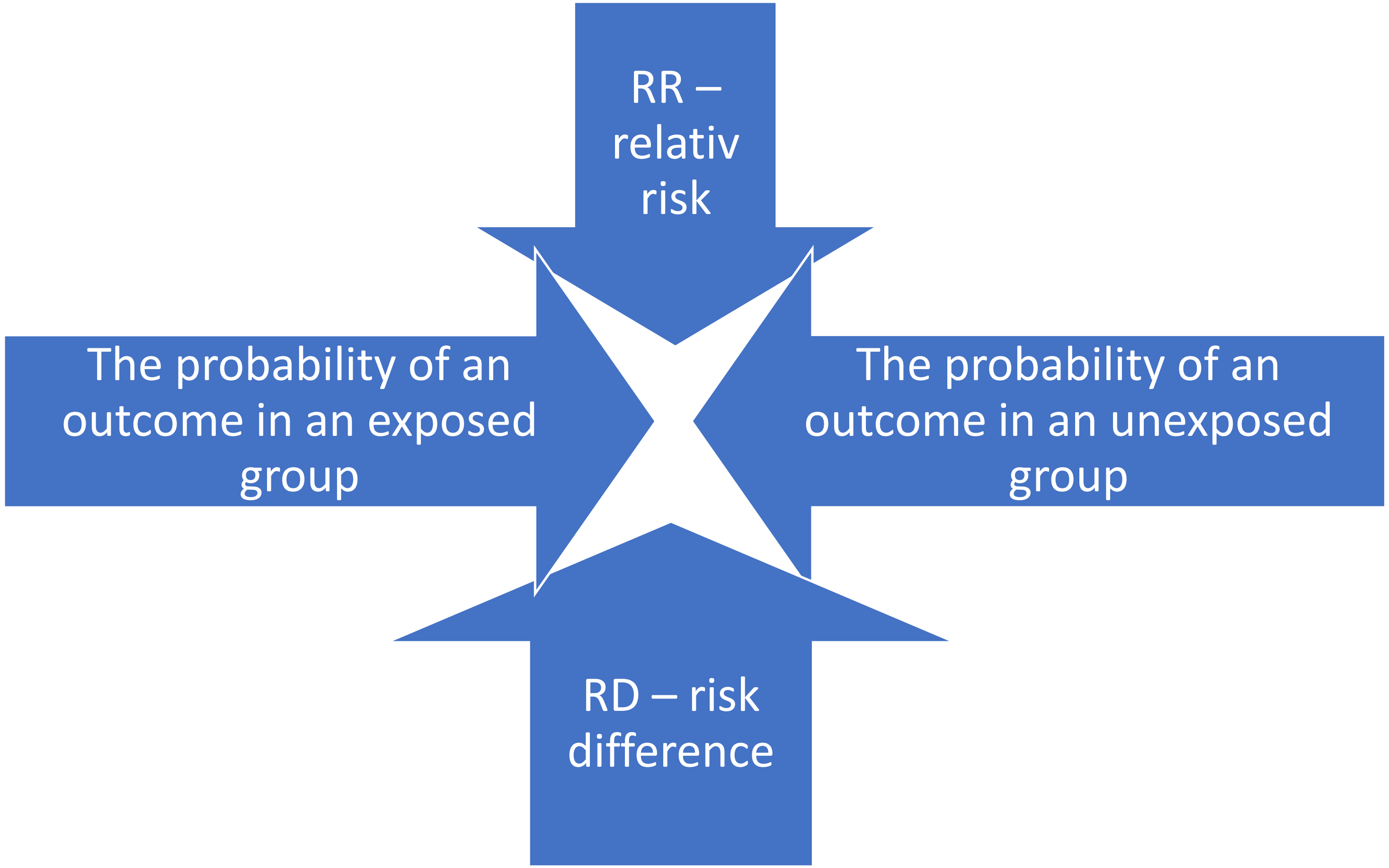
Results interpretations

$\boldsymbol{\chi^2 = 2.33 \notin [3.84, \infty)}$ fail to reject null hypothesis: smoking and dental implant are independent

Or

$p=0.13>0.05$ fail to reject null hypothesis: smoking and dental implant are independent

We measure the effect of the risk factor by calculating



- Calculate the confidence interval of 95%

When applying a statistical test, we do not measure the effect of the risk factor.

A study was conducted to evaluate the association between the women age groups (20–30 and 31–40 years) and whether they have iron deficiency. Which of the following options would be the most appropriate method of analysing these data?

A. Correlation analysis

B. ANOVA test

C. Chi-square test

D. Student t test

E. none of the above

To apply a Chi-Square test

A. one theoretical frequencies can be less than 5

B. more than one theoretical frequencies can be less than 5

C. no theoretical frequencies should be 0

D. no theoretical frequencies should be less than 5

E. all theoretical frequencies should be higher than 1

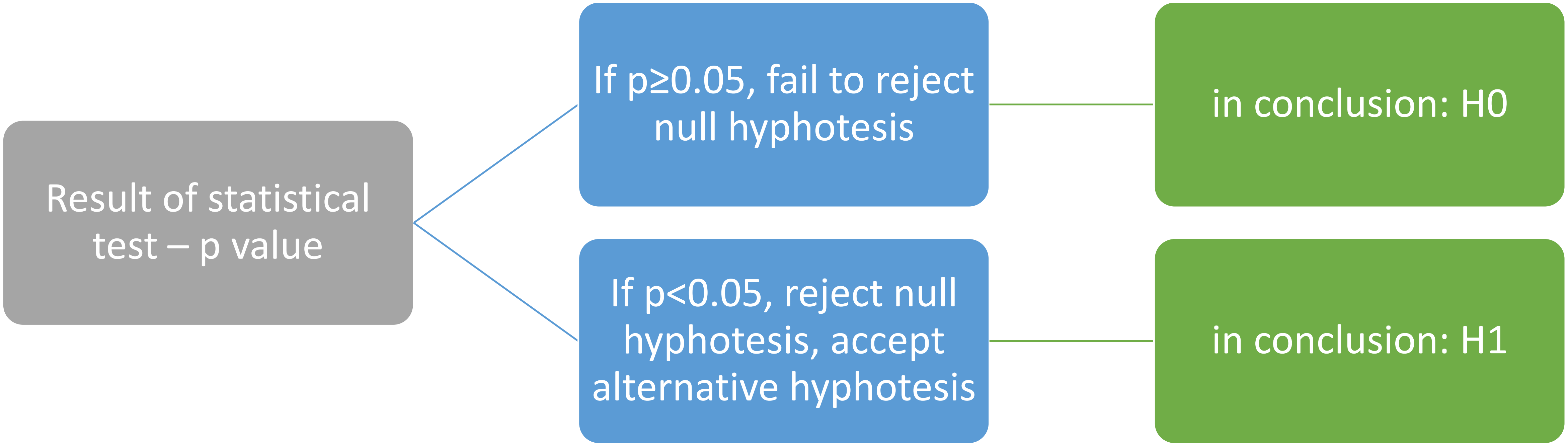
- From 3000 patients with dental implants 125 experienced early implant loss. From 125 with early implant loss 50 are smokers. From 3000 patients 1600 are non-smokers. Question: People who smoke are more likely to have dental implant failure?
- A. the parameter of the test is 1.33
- B. the parameter of the test is 2.33
- C. we reject null hyphotess and accept alternative hyphotesis
- D. there was an association between smoking and dental implant failure
- E. fail to reject null hypothesis: smoking and dental implant are independent

3. Drinking coca cola (daily) is suspected to be associated with apparition of tooth caries. A sample of 500 persons was studied: 220 presented at least one caries and from these 100 reported to be coca-cola drinkers. A number of 210 patients without caries and no coca-cola drinkers were identified. The alternative hypothesis of the test could be:

A. No answer is correct
B. Daily coca-cola drinking and tooth caries are dependent
C. There is an association between tooth caries and daily coca-cola drinking
D. Daily coca-cola drinking and tooth caries are independent
E. Tooth caries and daily coca-cola dinking are not associated

p value interpretation

- H0 – null hyphotesis
- H1 – alternative hyphotesis



24) *Suppose that the p-value in a hypothesis test is 0.08. If the significance level for the test is $\alpha = 0.05$, which of the following is the appropriate decision?

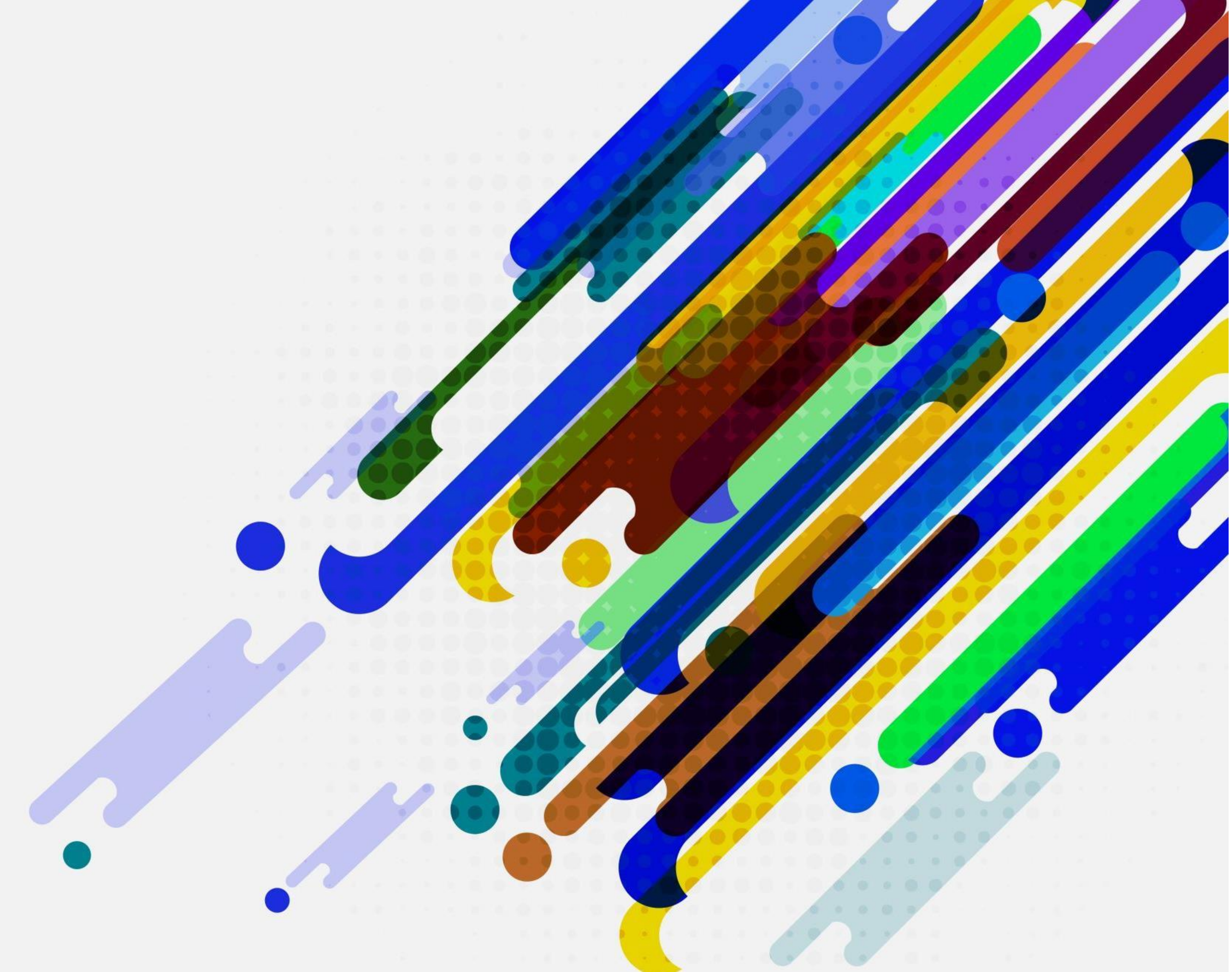
a) Fail to reject H_0

b) Reject H_0

c) There is not enough information given to know whether or not H_0 should be rejected

d) Fail to reject H_a

e) Reject H_a



Statistical test for arithmetic means

- Populations P1, P2,...
- Objective: study of the differences of the parameters of a QUANTITATIVE variable X in two/more populations (categories of the grouping variable Y)

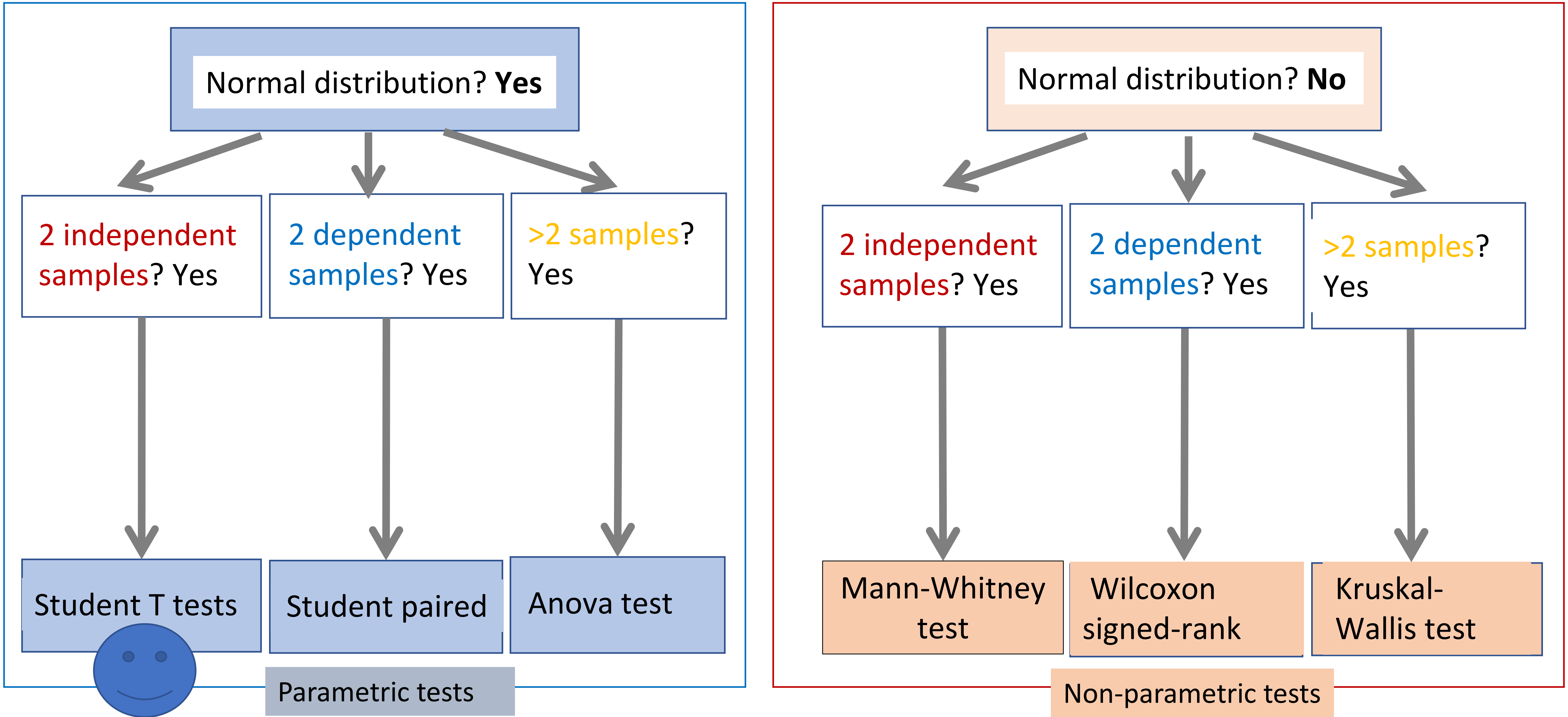
  - Arithmetic means μ1  , μ2  , ...

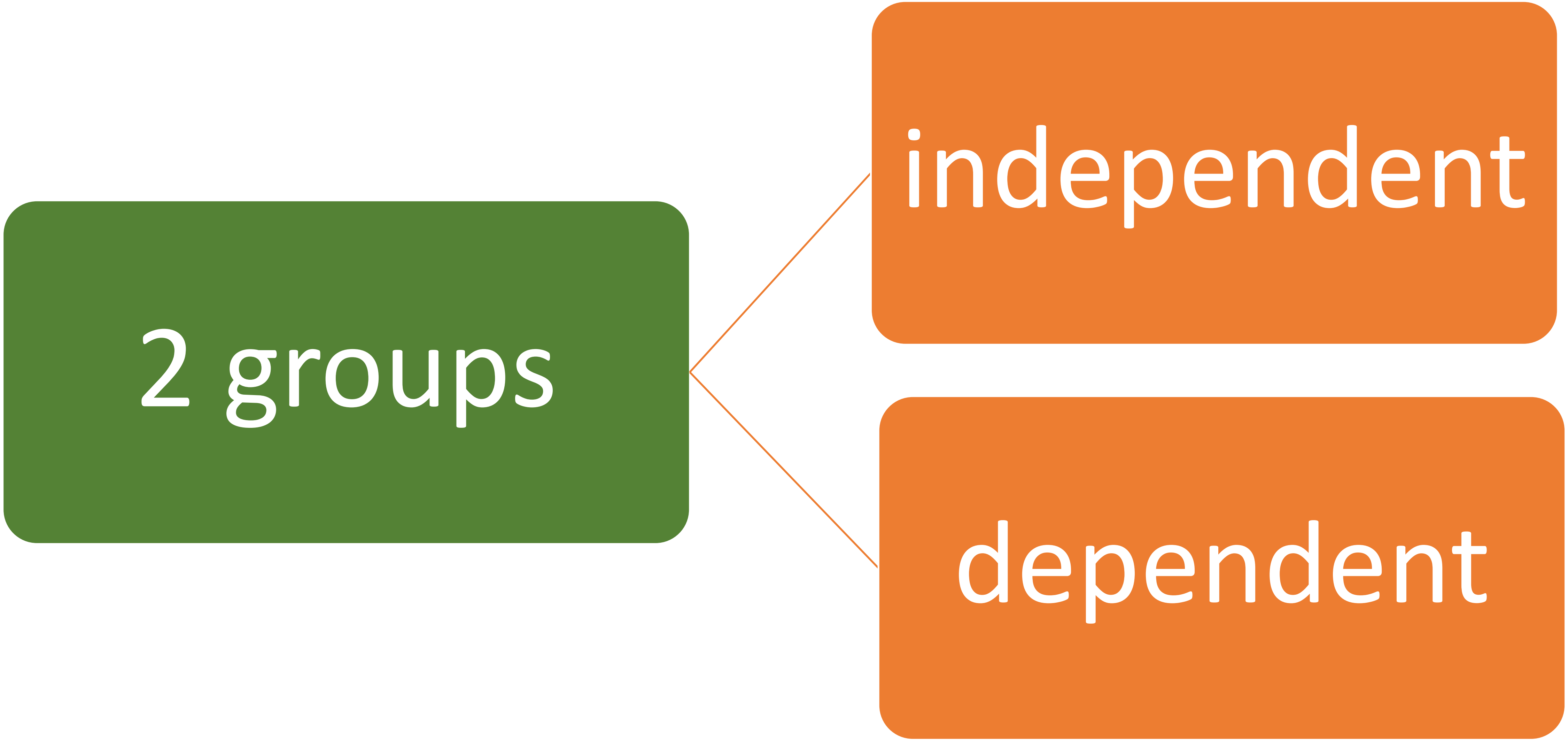
How?

1.
   - Randomly select representative samples from the two populations
2.
   - Calculate the statistics
     - Arithmetic means $\bar{X}1$, $\bar{X}2$
3.
   - By statistical test
   - is tested the hypothesis that we do not have two different populations, but the same population from the p. of v. of the AVERAGES of the tested variable
   - obtain the probability p – the probability of finding differences equal to or greater than the one found if we repeat the study on other samples

simplified to:

Comparing quantitative variables grouped by a qualitative variable. How to choose the right statistical test?




2 groups
independent
dependent

Dependent or independent samples?

- Dependent samples
  - the same patients tested two times
  - after/ before treatments, procedure etc.
  - data are in paires
  - a pair – from the same patient
- Ex. Compare the weight after and before the diet
  - each patient are tested after and before diet
  - patient one: John
    - before 95kg
    - after 65kg
  - etc.

a pair of correspondent data

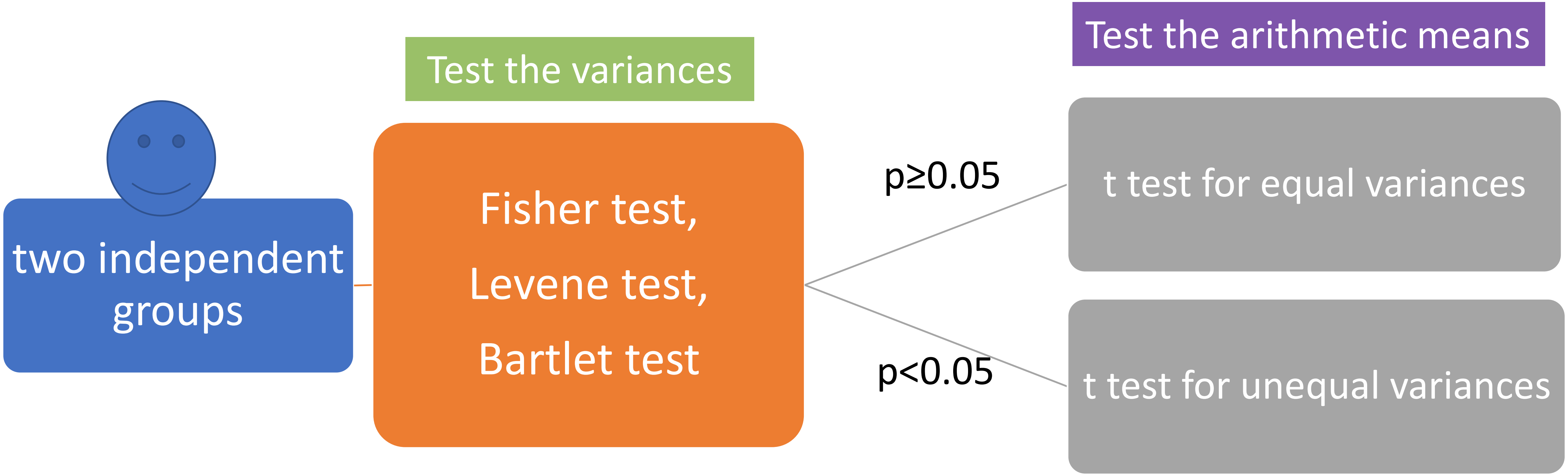
- Independent samples
  - patients are not the same
  - different groups
  - data cannot be put in paires
- Ex. Compare the weight on people who take diet with those without any diet
  - we have 2 different groups

60 patients follow a diet
80 patients do not follow a diet

no correspondence between data

- A study was conducted to compare 23 patients who drink Coca-Cola daily with 36 patients woh do not. They were evaluated to assess the level of advanced glycation end products in their skin with autofluorescence (SAF) (%). Data were normally distributed. The following can be used to compare the SAF in these two groups:
- A. a nonparametric test
- B. a parametric test
- C. the Wilcoxon test
- D. the t-test for independent samples
- E. the Mann-Whitney test

Comparing quantitative variables grouped by a qualitative variable – two independent groups with normal distributions



Variances = standard deviation square = s^2

The hypothesis that we do not have two different populations, but the same population in terms of the distribution of the means of the variable under study

Null hypothesis H0 - assumes the denial of the objective we want to investigate

- There is no statistically significant difference between the groups in terms of the mean

Alternative hypothesis H1 (denial of H0): refers to the objective we want to investigate

- There is a statistically significant difference between the groups in terms of the mean

Statistical test --> we choose between the two possibilities H0 or H1

Example

	Obese (n=15)	Non-obese (n=15)
Glycemia (mg/dl) Arithmetic mean±Standard deviation	160±20	95±10

Normal distribution? → Shapiro-Wilk test for both samples taken separatelly

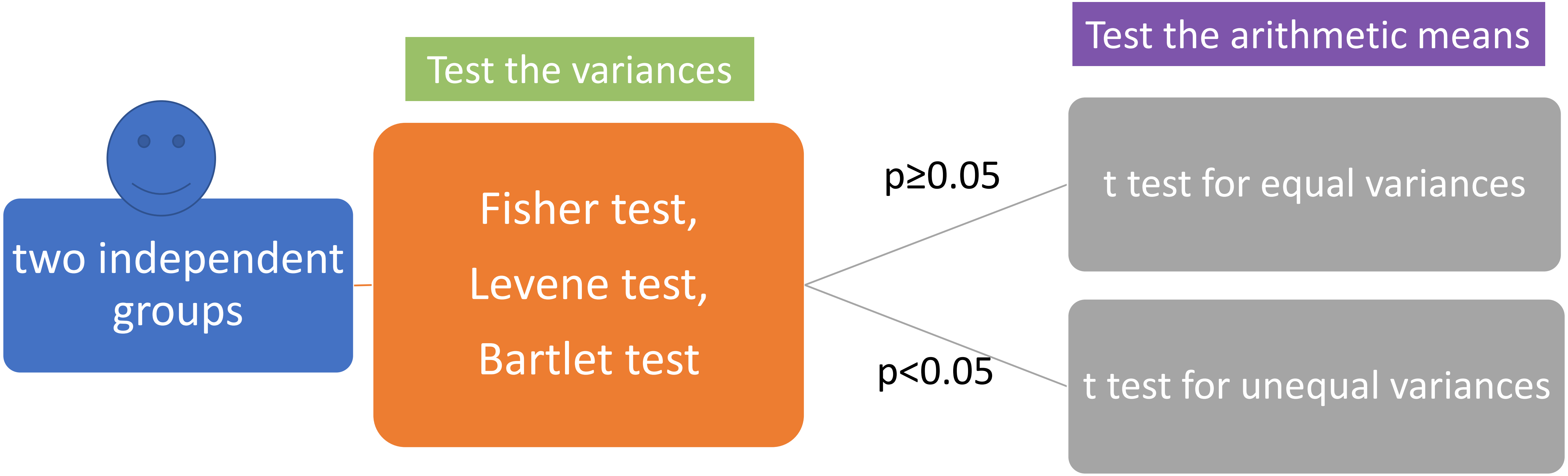
	p value for normal distribution of glycemia		Normal distribution Obese/Non-obese	Test the arithmetic mean differences with
	Obese (n=15)	**Non-obese (n=15)**		
Example 1	0.25	0.43	Yes/Yes	Student t test
Example 2	0.03	0.06	No/Yes	Mann-Whitney test
Example 3	0.15	0.001	Yes/No	
Example 4	0.02	0.001	No/No	

If data are normally distributed, how are the variances?

- **Null hypothesis H0**: There is no significant statistical difference between the variances of glycemia in obese versus non-obese individuals
- **Alternative hypothesis Ha**: There is significant statistical difference between the variances of glycemia in obese versus non-obese individuals

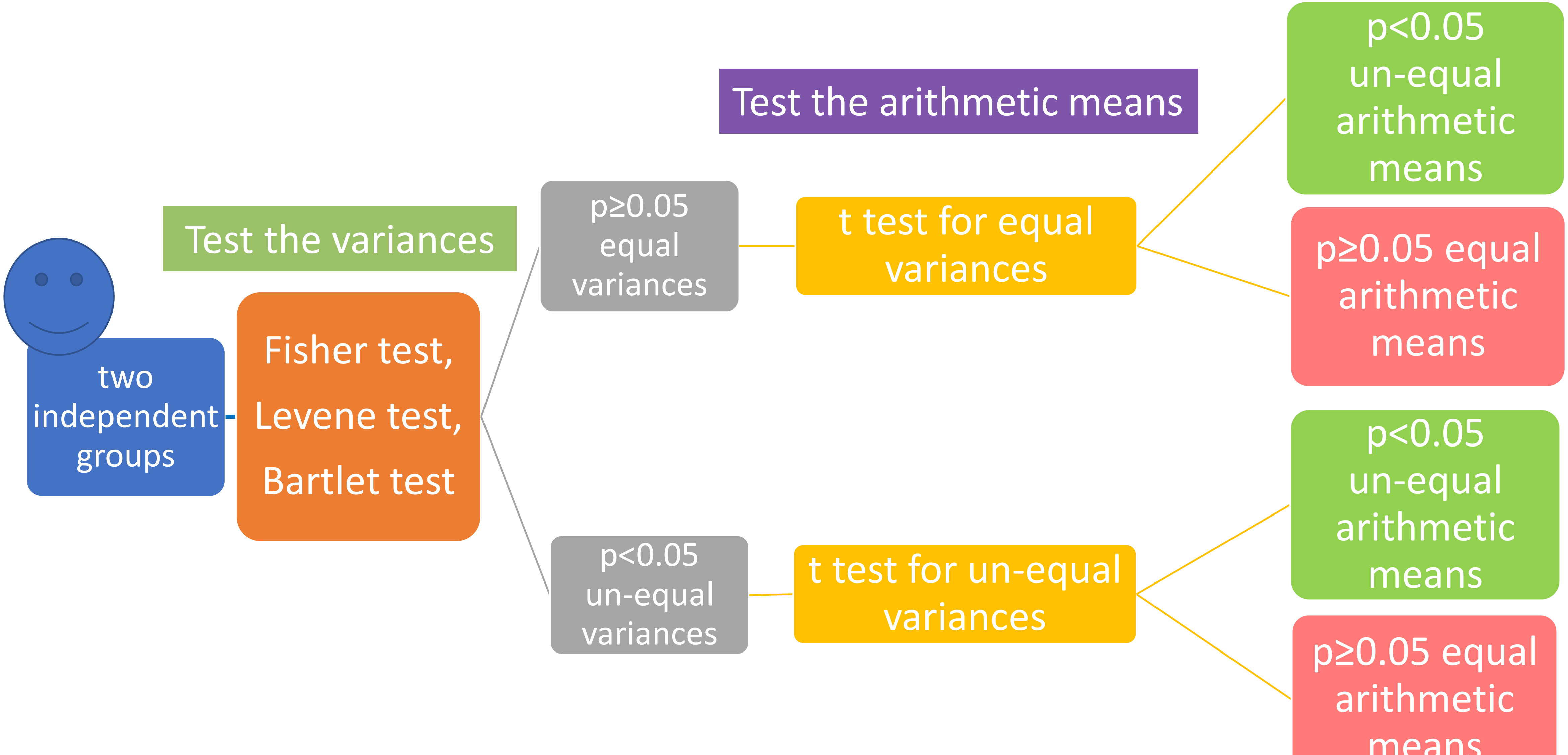
		Obese (n=15)	Non-obese (n=15)	How are the variances?
Example 1	Glycemia (mg/dl) Arith.mean±St.dev.	160±20	95±10	20^2 compare with 10^2

Comparing quantitative variables grouped by a qualitative variable – two independent groups with normal distributions



Variances = standard deviation square = s^2

Comparing quantitative variables grouped by a qualitative variable – two independent groups with normal distributions



Variances = standard deviation square = s^2

- Two independent samples
- Two **variances** to compare
- Data are **normally distributed**

→ Levene Test for variances

		Obese (n=15)	Non-obese (n=15)	p Levene test for variances	
Example 1	Glycemia (mg/dl) Arith.mean±St.dev.	20^2	10^2	0.04	un-equal variances

		Obese (n=15)	Non-obese (n=15)	p Levene test for variances	
Example 1	Glycemia (mg/dl) Arith.mean±St.dev.	20^2	suppose is 15^2	0.12	equal variances

- *A study was conducted to compare 23 patients who drink Coca-Cola daily with 36 patients who do not. They were evaluated to assess the level of advanced glycation end products in their skin with autofluorescence (SAF) (%). Data were normally distributed. The p value for the Levene test was p=0.09. The following test can be used to compare the SAF in these two groups:
- A. the t-test for dependent samples
- B. the t-test for independent samples for equal variances
- C. the Wilcoxon test
- D. the t-test for independent samples for un-equal variances
- E. the Mann-Whitney test

If variances are un-equal, how are the means?

- Two independent samples
- Two means to compare
- **Un-equal** variances
- Normal distributions (n_1 or n_2<30)

T test (Student) for independent samples for un-equal variances

H0: There is no statistical significant difference between the arithmetic means of glycemia in obese versus non-obese individuals
Ha: There is statistical significant difference between the arithmetic means of glycemia in obese versus non-obese individuals

		Obese (n=15)	Non-obese (n=15)	p T test (Student) for un-equal variances
Example 1	Glycemia (mg/dl) Arith.mean±St.dev	160±20	95±10	0.01

p=0.01<0.05 we reject null hypothesis, accept alternative hyphotesis: There is statistical significant difference between the arithmetic means of glycemia in obese versus non-obese individuals

If variances are un-equal, how are the means?

- Two independent samples
- Two means to compare
- **Un-equal** variances
- Normal distributions (n_1 or n_2<30)

T test (Student) for independent samples for un-equal variances (Welch test)

H0: There is no statistical significant difference between the arithmetic means of glycemia in obese versus non-obese individuals
Ha: There is statistical significant difference between the arithmetic means of glycemia in obese versus non-obese individuals

		Obese (n=15)	Non-obese (n=15)	p T test (Student) for un-equal variances
Example 1	Glycemia (mg/dl) Arith.mean±St.dev	160±20	suppose 120±10	0.08

p=0.08>0.05 we fail to reject null hypothesis: There is no statistical significant difference between the arithmetic means of glycemia in obese versus non-obese individuals

If variances are equal, how are the means?

- Two independent samples
- Two means to compare
- **Equal** variances
- Normal distributions (n_1 or n_2<30)

T test (Student) for independent samples for equal variances

H0: There is no statistical significant difference between the arithmetic means of glycemia in obese versus non-obese individuals
Ha: There is statistical significant difference between the arithmetic means of glycemia in obese versus non-obese individuals

		Obese (n=15)	Non-obese (n=15)	p T test (Student) for equal variances
Example 1	Glycemia (mg/dl) Arith.mean±St.dev	160±20	95±15	0.02

p=0.02<0.05 we reject null hypothesis, accept alternative hyphotesis: There is statistical significant difference between the arithmetic means of glycemia in obese versus non-obese individuals

If variances are equal, how are the means?

- Two independent samples
- Two means to compare
- **Equal** variances
- Normal distributions (n_1 or n_2<30)

T test (Student) for independent samples for equal variances

H0: There is no statistical significant difference between the arithmetic means of glycemia in obese versus non-obese individuals
Ha: There is statistical significant difference between the arithmetic means of glycemia in obese versus non-obese individuals

		Obese (n=15)	**Non-obese (n=15)**	**p T test (Student) for equal variances**
Example 1	Glycemia (mg/dl) Arith.mean±St.dev	160±20	suppose 150±15	0.32

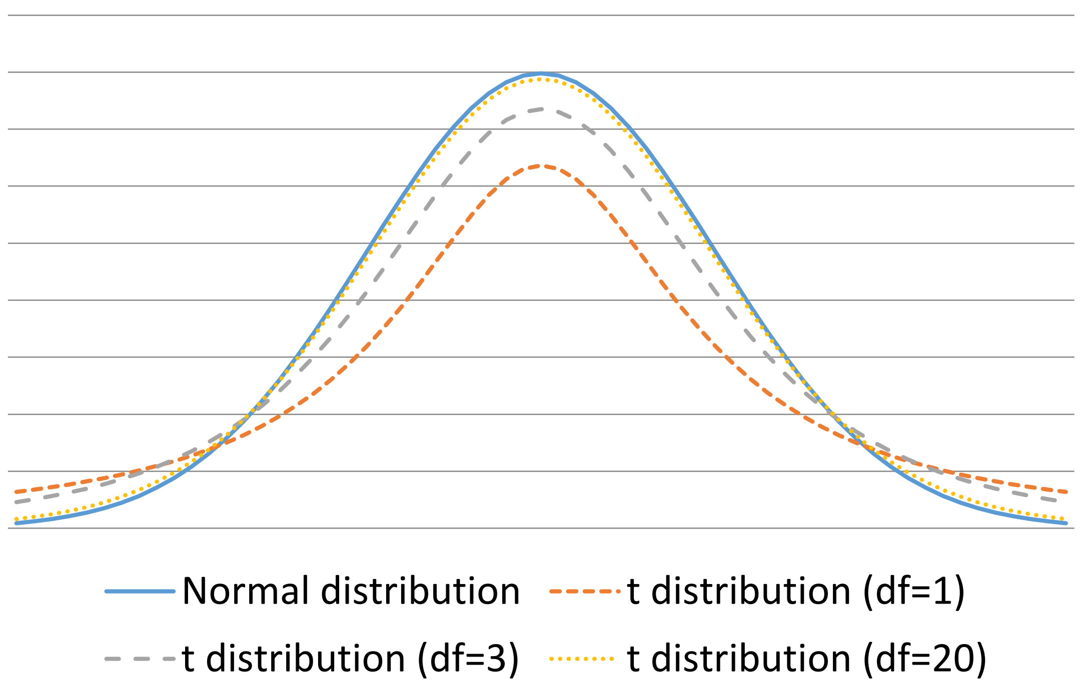
p=0.32>0.05 we fail to reject null hypothesis: There is no statistical significant difference between the arithmetic means of glycemia in obese versus non-obese individuals

- A study was conducted to compare 23 patients who drink Coca-Cola daily with 36 patients who do not. They were evaluated to assess the level of advanced glycation end products in their skin with autofluorescence (SAF) (%). Data were normally distributed. The p value for the Levene test was p=0.04. The p value for the test for the means was p=0.003. The following are true:
- A. We reject the null hypothesis and accept the alternative hypothesis; there is a statistically significant difference in SAF between the group that drinks Coca-Cola daily and the group that does not.
- B. the t-test for independent samples for equal variances was used to compare the arithmetic means
- C. We fail to reject the null hypothesis; there is no statistically significant difference in SAF between the group that drinks Coca-Cola daily and the group that does not.
- D. the t-test for independent samples for un-equal variances was used to compare the arithmetic means
- E. none of the above

How we decide if we know the parameter of the test?

Student t distribution depend on the degree of freedom df

- df=n1+n2-2
- ex. df=15+15-2=28
- If n>30 student distribution is near the same with normal distribution



Choosing the significance level and establishing the critical region

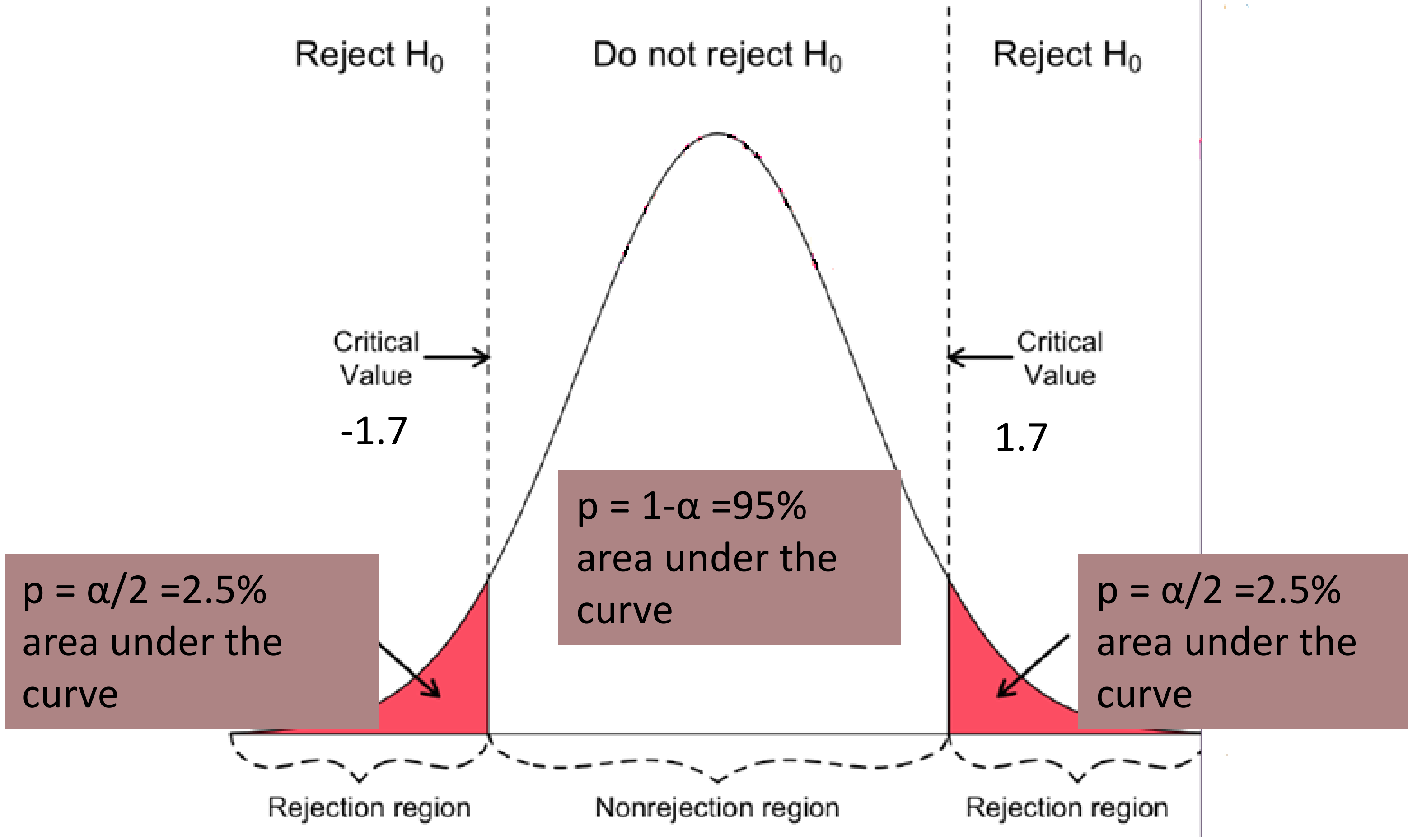
Two tail test

Rejection area

$(-\infty,-1.7] \cup [1.7; +\infty)$

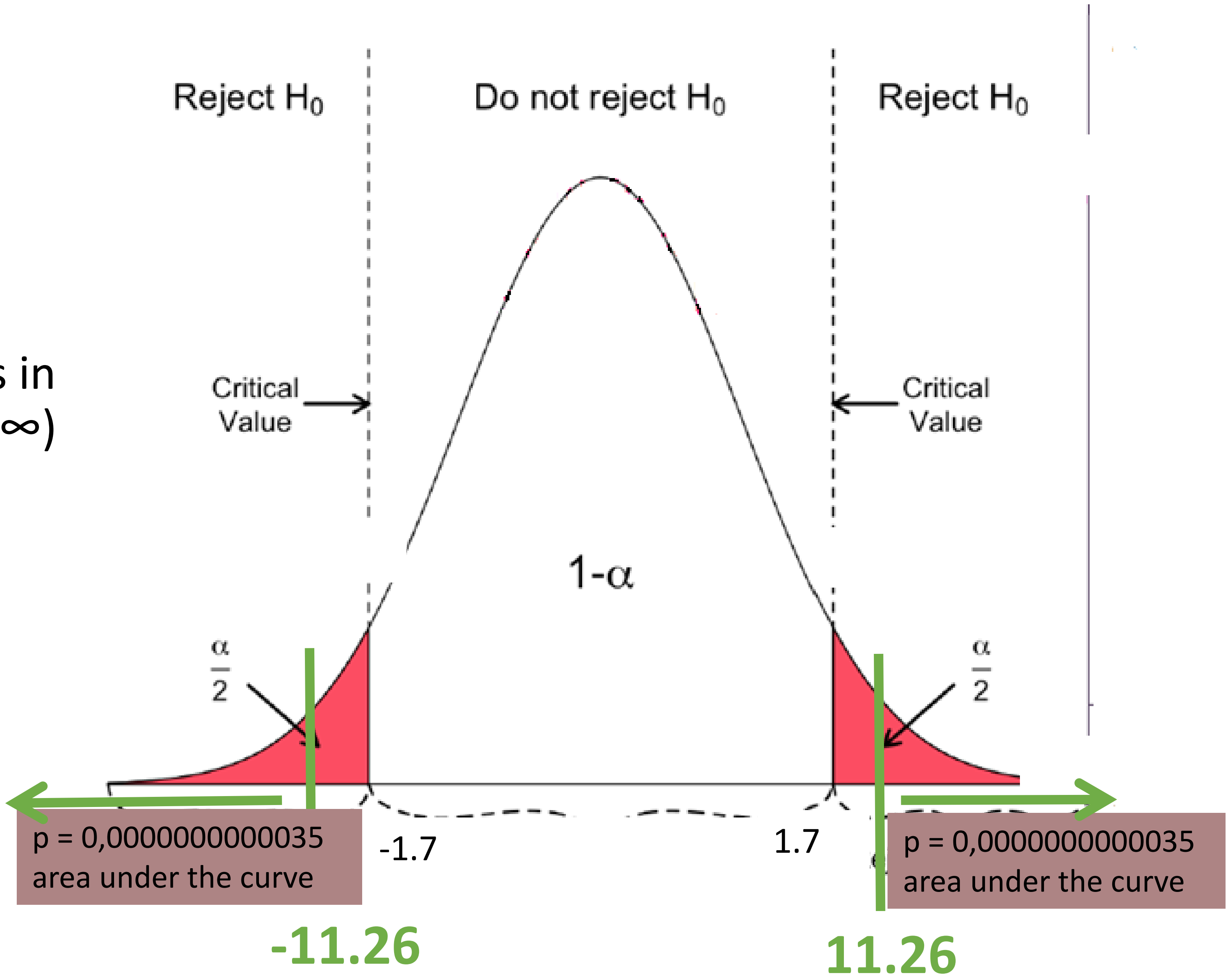
Acceptance area

$(-1.7; 1.7)$



Two-tail test = we sum right and left area the parameter of the test t =11.26 is in the rejection area (-∞,-1.7] ∪[1.7; +∞)

we reject H0, accept H1



If variances are equal, how are the means?

- Two independent samples
- Two means to compare
- **Equal** variances
- Normal distributions (n_1 or n_2<30)

T test (Student) for independent samples for equal variances

H0: There is no statistical significant difference between the arithmetic means of glycemia in obese versus non-obese individuals
Ha: There is statistical significant difference between the arithmetic means of glycemia in obese versus non-obese individuals

		Obese (n=15)	Non-obese (n=15)	parameter of the T-test (Student) for equal variances
Example 1	Glycemia (mg/dl) Arith.mean±St.dev	160±20	95±15	11.26

t=11.26 is in the rejection area $(-\infty,-1.7] \cup [1.7; +\infty)$ we reject null hypothesis, accept alternative hyphotesis: There is statistical significant difference between the arithmetic means of glycemia in obese versus non-obese individuals

If variances are equal, how are the means?

- Two independent samples
- Two means to compare
- **Equal** variances
- Normal distributions (n_1 or n_2<30)

→ T test (Student) for independent samples for equal variances

H0: There is no statistical significant difference between the arithmetic means of glycemia in obese versus non-obese individuals
Ha: There is statistical significant difference between the arithmetic means of glycemia in obese versus non-obese individuals

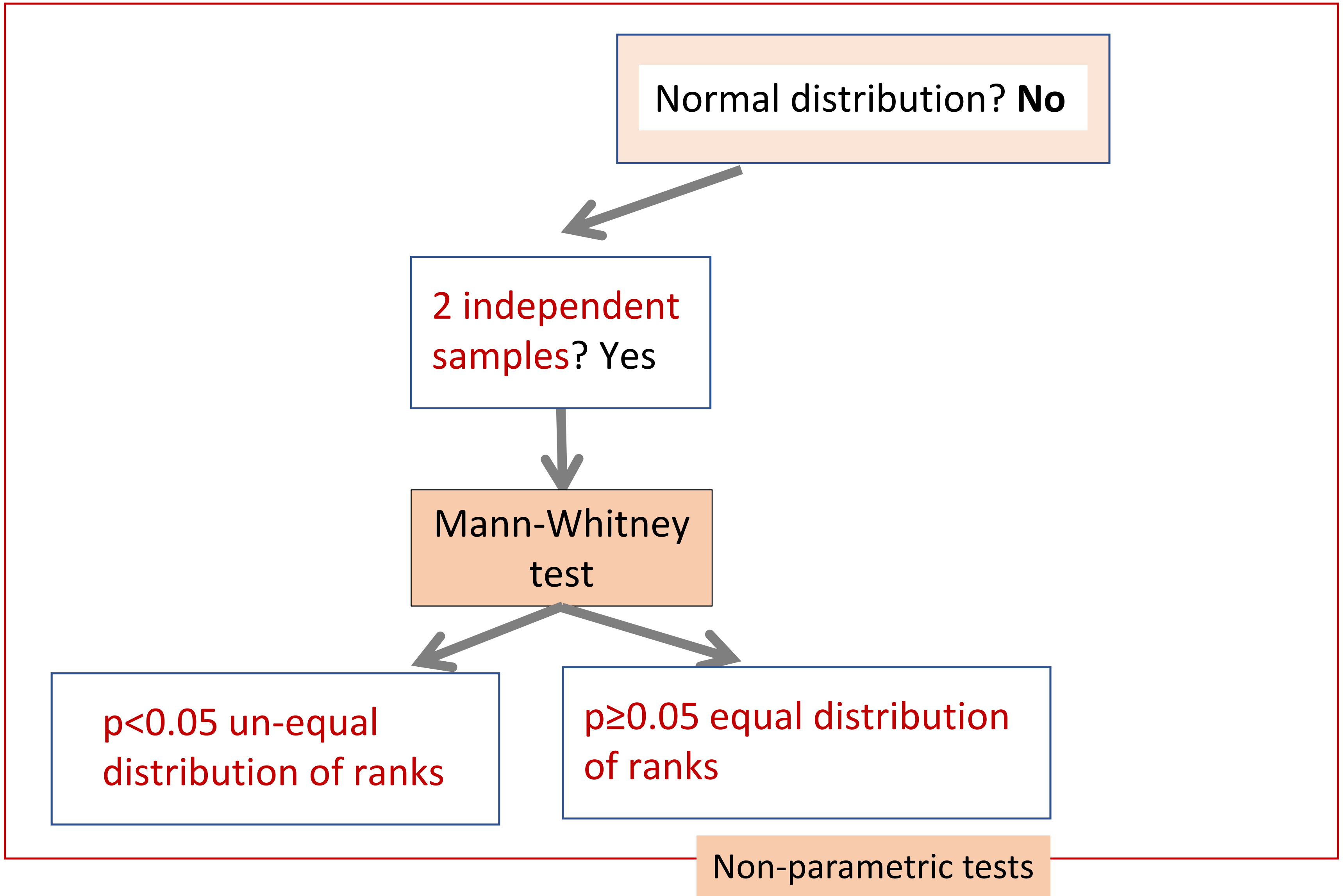
		Obese (n=15)	Non-obese (n=15)	parameter of the T-test (Student) for equal variances
Example 1	Glycemia (mg/dl) Arith.mean±St.dev	160±20	suppose 150±15	1.3

t=1.3 is in not in the rejection area (-∞,-1.7] ∪[1.7; +∞) we fail to reject null hypothesis: There is no statistical significant difference between the arithmetic means of glycemia in obese versus non-obese individuals

- A study was conducted to compare 23 patients who drink Coca-Cola daily with 36 patients who do not. They were evaluated to assess the level of advanced glycation end products in their skin with autofluorescence (SAF) (%). Data were normally distributed. The p value for the Levene test was p=0.46. The parameter of the test was 0.13 (t critical 1.91). The following are true:
- A. We reject the null hypothesis and accept the alternative hypothesis; there is a statistically significant difference in SAF between the group that drinks Coca-Cola daily and the group that does not.
- B. the t-test for independent samples for equal variances was used to compare the arithmetic means
- C. We fail to reject the null hypothesis; there is no statistically significant difference in SAF between the group that drinks Coca-Cola daily and the group that does not.
- D. the t-test for independent samples for un-equal variances was used to compare the arithmetic means
- E. the Mann-Whitney test was used to compare the ranks

non normal distribution

Comparing quantitative variables grouped by a qualitative variable.



- **Null hypothesis H0**: There is no significant statistical difference between the distributions of ranks of glycemia in obese versus non-obese individuals
- **Alternative hypothesis Ha**: There is significant statistical difference between the distributions of ranks of glycemia in obese versus non-obese individuals

		Obese (n=15)	**Non-obese (n=15)**	**p (Mann-Whitney test)**
Example 2, 3, 4 no normal distribution	Glycemia (mg/dl) Arith.mean±St.dev	160±20	95±10	0.02

p=0.02<0.05 reject H0, accept Ha: There is significant statistical difference between the distributions of ranks of glycemia in obese versus non-obese individuals

- **Null hypothesis H0**: There is no significant statistical difference between the distributions of ranks of glycemia in obese versus non-obese individuals
- **Alternative hypothesis Ha**: There is significant statistical difference between the distributions of ranks of glycemia in obese versus non-obese individuals

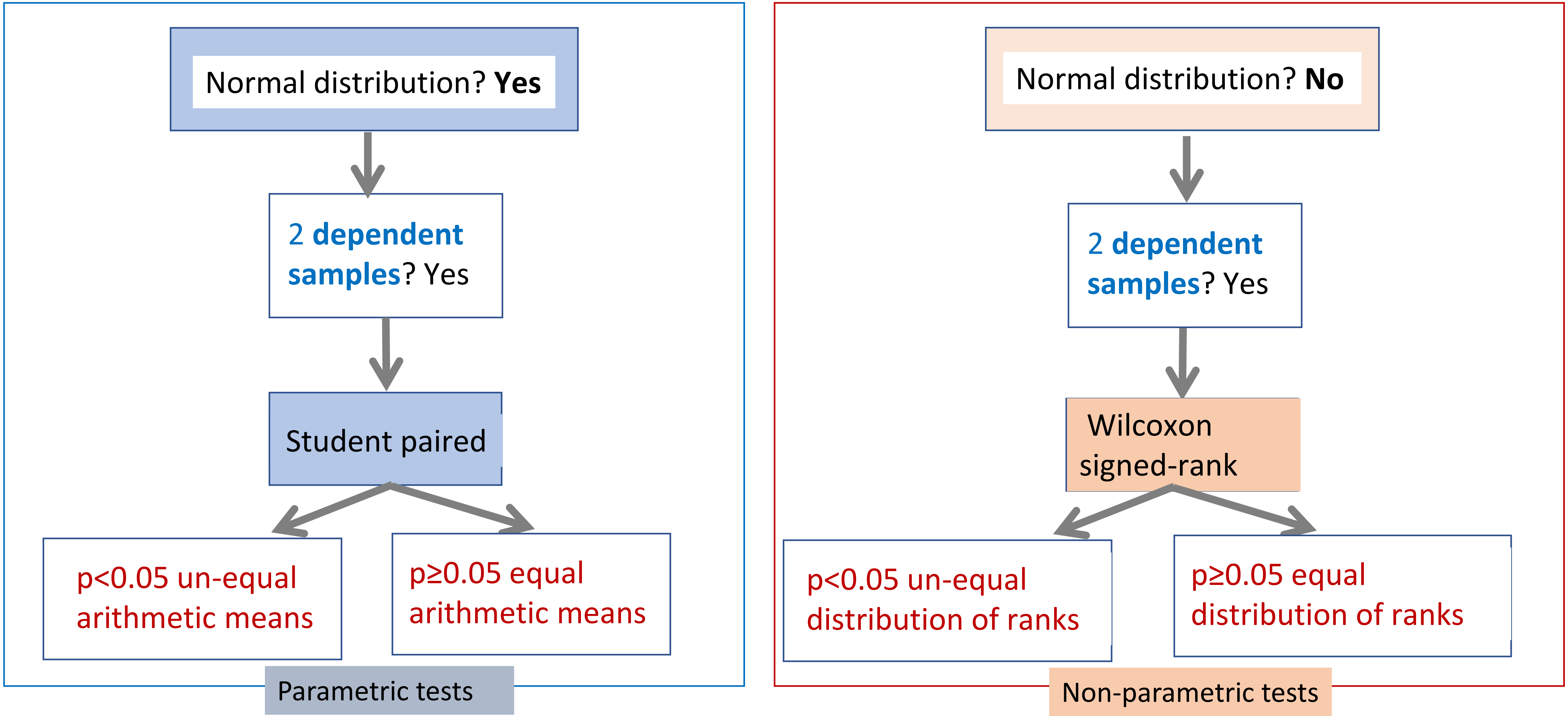
		Obese (n=15)	Non-obese (n=15)	p (Mann-Whitney test)
Example 2, 3, 4 no normal distribution	Glycemia (mg/dl) Arith.mean±St.dev	160±20	95±10	0.15

p=0.15>0.05 fail to reject H0: There is no significant statistical difference between the distributions of ranks of glycemia in obese versus non-obese individuals

- A study was conducted to compare 65 students taking a neurology course. They were tested to assess their ability to recognize Bell's palsy by looking at 10 images of patients with varying degrees of the condition. The students were tested before and after the course. A score was created with grades from 1 to 10 based on how well they recognized the 10 images. To test the scores obtained before and after the course, the following can be used:
- A. a nonparametric test
- B. a parametric test
- C. the Wilcoxon test
- D. the t-test for dependent samples
- E. the Mann-Whitney test

Dependent samples

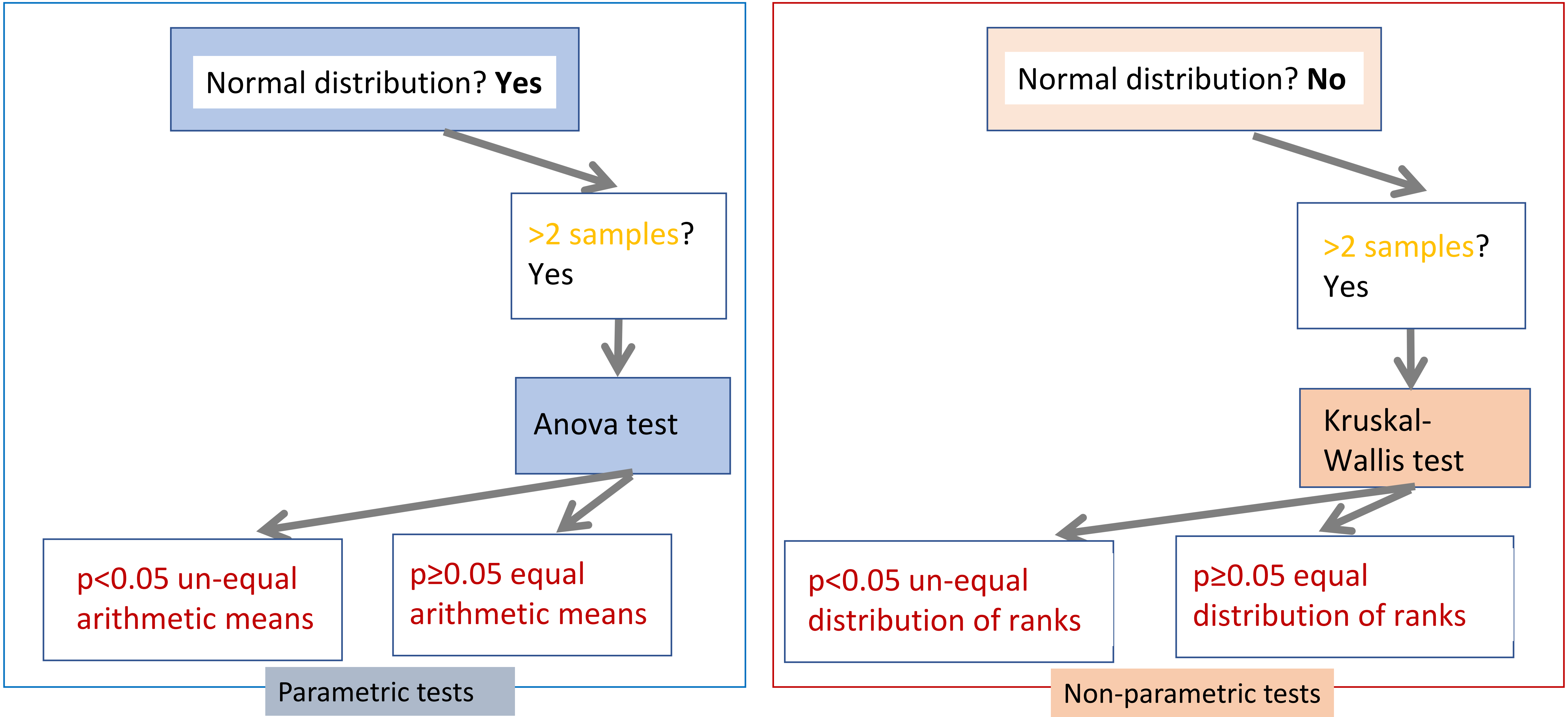
Comparing quantitative variables grouped by a qualitative variable.



- A study was conducted to compare 55 patients with diabetes before and after a new treatment. They were evaluated to assess the level of glycemia. Data were normally distributed. The p value for the test was p=0.67. The following are true:
- A. We reject the null hypothesis and accept the alternative hypothesis; there is a statistically significant difference in glycemia before and after the treatment.
- B. the t-test for independent samples was used
- C. We fail to reject the null hypothesis; there is no statistically significant difference in glycemia before and after the treatment.
- D. the t-test for dependent samples was used
- E. the Mann-Whitney test was used

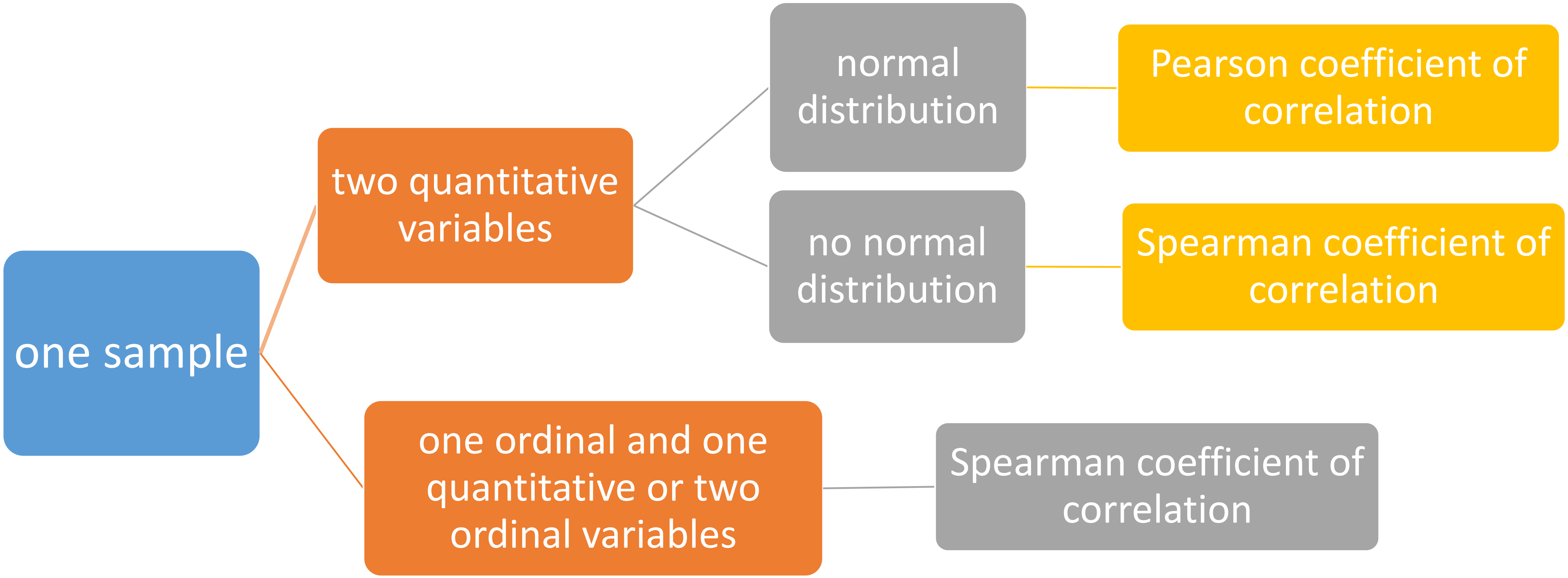
Multiple arithmetic means

Comparing quantitative variables grouped by a qualitative variable.



- A study was conducted to compare 23 patients who drink Coca-Cola daily with, 33 patients who drink Coca-Cola occasionally and with 36 patients who do not drink Coca-Cola. They were evaluated to assess the level of advanced glycation end products in their skin with autofluorescence (SAF) (%). Data were normally distributed. The p value for the Levene test was p=0.46. The p value for the test for the means was p=0.009. The following are true:
- A. We reject the null hypothesis and accept the alternative hypothesis; there is a statistically significant difference in SAF between the tested groups.
- B. the t-test for independent samples for equal variances was used to compare the arithmetic means
- C. We fail to reject the null hypothesis; there is no statistically significant difference in SAF between the tested groups.
- D. the t-test for independent samples for un-equal variances was used to compare the arithmetic means
- E. the Anova test was used to compare the arithmetic means

Correlation


one sample
two quantitative variables
normal distribution
Pearson coefficient of correlation
no normal distribution
Spearman coefficient of correlation
one ordinal and one quantitative or two ordinal variables
Spearman coefficient of correlation

Statistical significance test for the correlation coefficient

- Significance of the correlation coefficient - did the observed value in the sample occur by chance?
- if the statistical test is significant, the probability $p < 0.05$
- Interpretation at the population level - given by the values of r/rho according to Colton's rules
- We can calculate a confidence interval for r/rho
- if $p \geq 0.05$
  - interpretation - the experimental data do not allow us to assert the existence of a relationship at the population level between the variables under study
- if $p < 0.05$
  - interpretation - the experimental data allow us to assert the existence of a relationship at the population level between the variables under study

r/rho	p≥0.05	p<0.05
-0.25 to 0.25	without statistical significance	no correlation, significant statistically
0.25 to 0.5 or -0.5 to -0.25	without statistical significance	acceptable correlation, significant statistically
0. 5 to 0.75 or -0.75 to -0.5	without statistical significance	good correlation, significant statistically
0.75 to 1 or -1 to -0.75	without statistical significance	very good correlation, significant statistically

Interpretation r/rho and p

Important

- $p \geq 0.05$ the coefficient only describes the sample from which it was drawn

- The correlated variables must be quantitative or ordinal
  - Contra example. Height and gender
- There must be a causal relationship between the variables for which correlation is calculated (the association must make sense)
- Contra example. Environmental temperature and IQ

We compute Pearson coefficient of correlation between stomach carcinoma surface of cancer and alcohol intake $r=0.49$, $p=0.03$. The following statements are true:

A. We reject alternative hypothesis and we conclude: there were no correlation between stomach carcinoma surface and alcohol intake

B. Quantity of intake alcohol significantly correlate with stomach carcinoma surface

C. We reject null hypothesis: there were correlation between stomach carcinoma surface and alcohol intake

D. Colton rules indicate a weak correlation between stomach carcinoma surface and alcohol intake

E. The correlation was direct

We compute Pearson coefficient of correlation between the BMI (body mass index) (kg/m^2) of the patients and the duration of long Covid-19 in days r=0.14, p=0.03. The following statements are true:

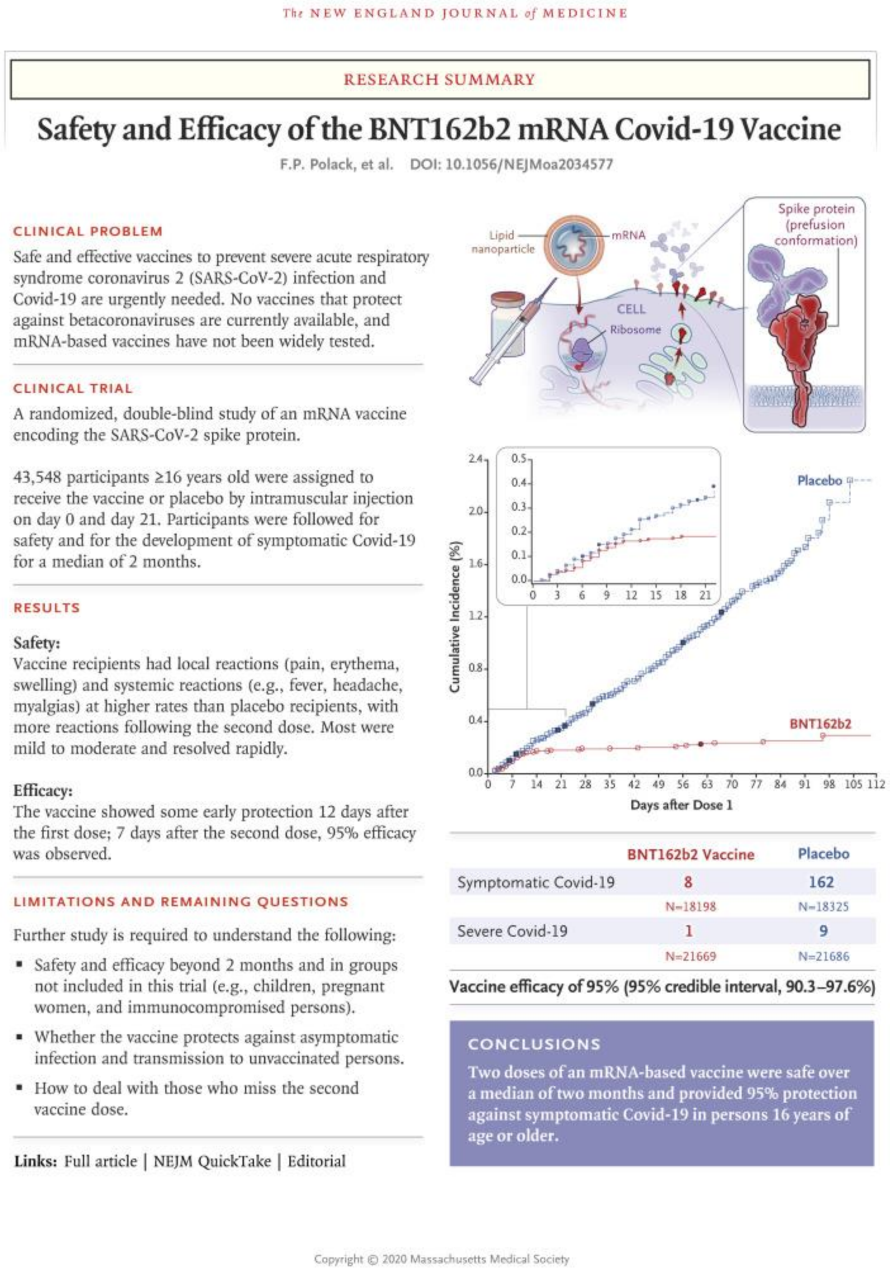
A. We reject null hypothesis and accept alternative hyphotesis; we conclude: there were significant statistically correlation between BMI and the duration of long Covid-19
B. This association cannot be calculated because it make no sense
C. We reject null hypothesis: there were no significant statistically correlation between BMI and the duration of long Covid-19
D. Colton rules indicate no correlation between BMI and the duration of long Covid-19
E. This association cannot be calculated because the assumptions are not met

*We compute Pearson coefficient of correlation between the height (m) of the patients and the duration of long Covid-19 in days r=0.14, p=0.03. The following statements are true:

A. We reject null hypothesis and accept alternative hyphotesis; we conclude: there were significant statistically correlation between BMI and the duration of long Covid-19
B. This association cannot be calculated because it make no sense
C. We reject null hypothesis: there were no significant statistically correlation between BMI and the duration of long Covid-19
D. Colton rules indicate no correlation between BMI and the duration of long Covid-19
E. This association cannot be calculated because the assumptions are not met

*We compute Pearson coefficient of correlation between the gender and the duration of long Covid-19 in days r=0.14, p=0.03. The following statements are true:

A. We reject null hypothesis and accept alternative hyphotesis; we conclude: there were significant statistically correlation between BMI and the duration of long Covid-19
B. This association cannot be calculated because it make no sense
C. We reject null hypothesis: there were no significant statistically correlation between BMI and the duration of long Covid-19
D. Colton rules indicate no correlation between BMI and the duration of long Covid-19
E. This association cannot be calculated because the assumptions are not met



The NEW ENGLAND JOURNAL of MEDICINE

RESEARCH SUMMARY

Safety and Efficacy of the BNT162b2 mRNA Covid-19 Vaccine

F.P. Polack, et al. DOI: 10.1056/NEJMoa2034577

CLINICAL PROBLEM

Safe and effective vaccines to prevent severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection and Covid-19 are urgently needed. No vaccines that protect against betacoronaviruses are currently available, and mRNA-based vaccines have not been widely tested.

CLINICAL TRIAL

A randomized, double-blind study of an mRNA vaccine encoding the SARS-CoV-2 spike protein.

43,548 participants ≥16 years old were assigned to receive the vaccine or placebo by intramuscular injection on day 0 and day 21. Participants were followed for safety and for the development of symptomatic Covid-19 for a median of 2 months.

RESULTS

Safety:
Vaccine recipients had local reactions (pain, erythema, swelling) and systemic reactions (e.g., fever, headache, myalgias) at higher rates than placebo recipients, with more reactions following the second dose. Most were mild to moderate and resolved rapidly.

Efficacy:
The vaccine showed some early protection 12 days after the first dose; 7 days after the second dose, 95% efficacy was observed.

LIMITATIONS AND REMAINING QUESTIONS

Further study is required to understand the following:

- Safety and efficacy beyond 2 months and in groups not included in this trial (e.g., children, pregnant women, and immunocompromised persons).
- Whether the vaccine protects against asymptomatic infection and transmission to unvaccinated persons.
- How to deal with those who miss the second vaccine dose.

Links: Full article | NEJM QuickTake | Editorial

	BNT162b2 Vaccine	Placebo
Symptomatic Covid-19	8 (N=18198)	162 (N=18325)
Severe Covid-19	1 (N=21669)	9 (N=21686)

Vaccine efficacy of 95% (95% credible interval, 90.3–97.6%)

CONCLUSIONS

Two doses of an mRNA-based vaccine were safe over a median of two months and provided 95% protection against symptomatic Covid-19 in persons 16 years of age or older.

Vaccinul Pfizer anti – Covid-19

- First published article
- Clinical trial on 43,548 participants
- Conducted before approval and marketing of the vaccine

Vaccine Pfizer anti – Covid-19

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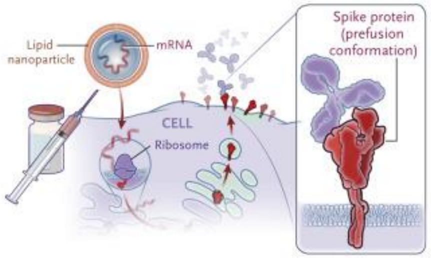

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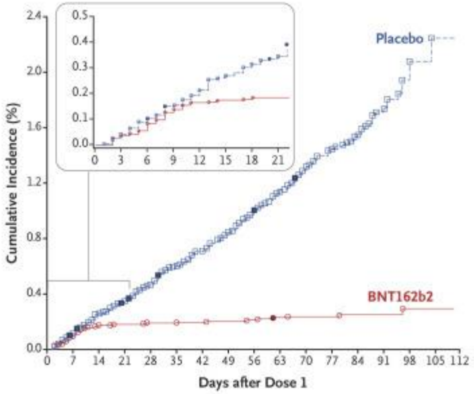

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	N=18198	N=18325
Severe Covid-19	1	9
	N=21669	N=21686

Vaccine efficacy of 95% (95% credible interval, 90.3–97.6%)

LIMITATIONS AND REMAINING QUESTIONS

Further study is required to understand the following:

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- Whether the vaccine protects against asymptomatic infection and transmission to unvaccinated persons.
- How to deal with those who miss the second vaccine dose.

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Vaccine efficacy of 95% (95% credible interval, 90.3–97.6%)

- What is the meaning?

Now you know!!!

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Symptomatic Covid-19	8	162
	N=18198	N=18325
Severe Covid-19	1	9
	N=21669	N=21686

Vaccine efficacy of 95% (95% credible interval, 90.3–97.6%)

- They have COVID-19:
  - 8 from 18. 198 on vaccinated sample = 0.0437%
  - 162 from 18. 325 on non-vaccinated sample = 0.88%
    - RR = 20.13

Efficacity

(162-8=154) from 162

- 152/162=95%
- 95% confidence interval 90.3 % – 97.6%

Vaccine efficacy at population level between 90.3% and 97.6 with a 5% error

If you still not understand the learning objectives please

A **ALWAYS**

S **SEEK**

K **KNOWLEDGE**

TEAMS - CHAT
Bondor Cosmina Ioana

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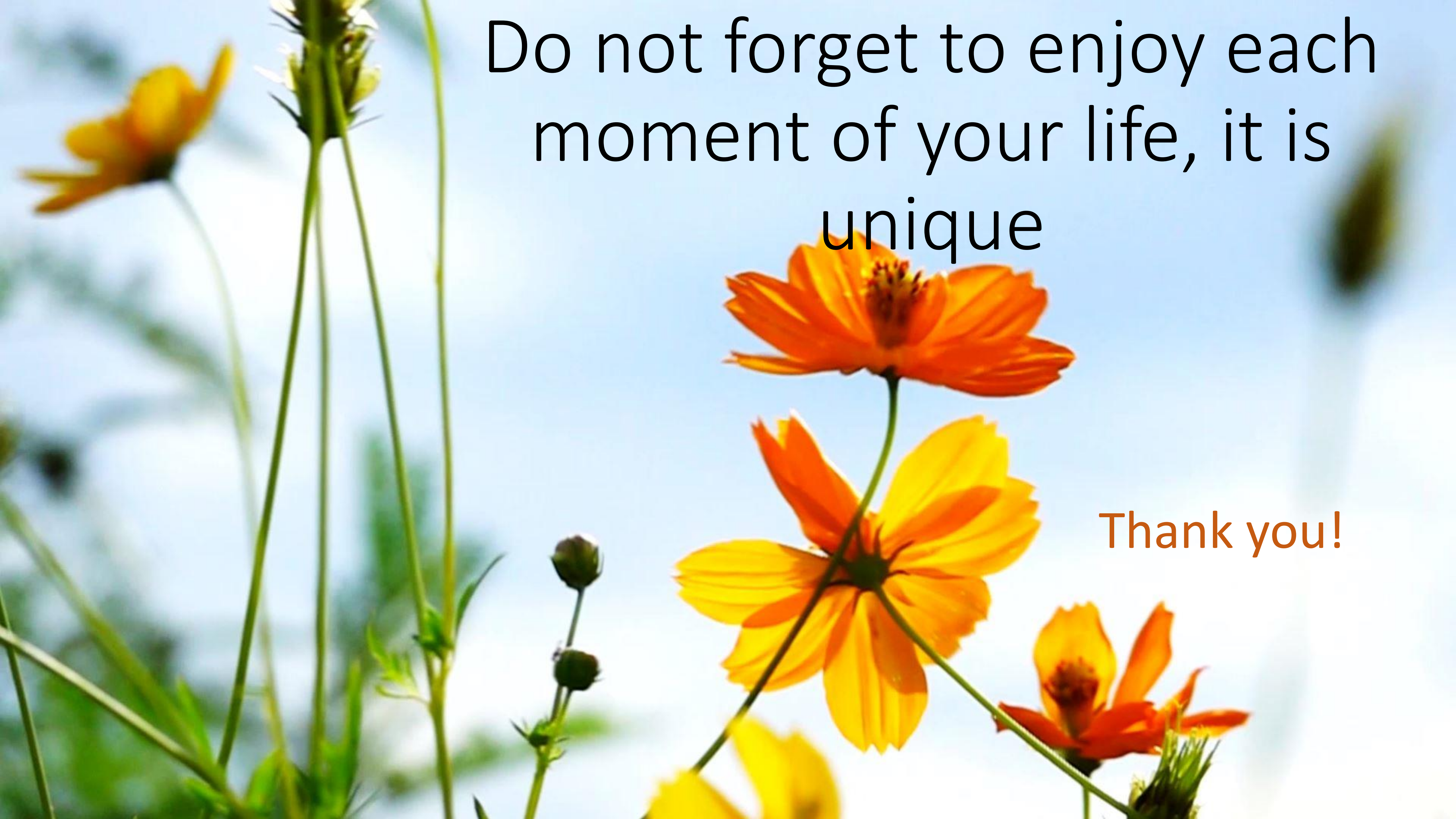
Do not forget to enjoy each moment of your life, it is unique
Thank you!