PSY104- Statistics in Social Sciences-II

Non-Parametric Tests

Warm-up Questions

About Data Types

1. *"Which type of data is a person's height, weight, or age?"*
2. *"What type of data are letter grades (A, B, C…) in a classroom?"*
3. *"What type of data is gender or marital status?"*

Warm-up Questions

1. *If we want to compare two groups, which statistical tests could we use? Can you give an example?*

2. *If we know the median of a group of students' exam scores, why might we use the median instead of the mean?*

What Are Non-Parametric Tests?

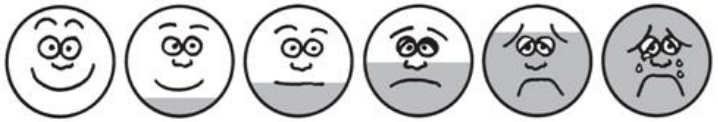
- Non-parametric tests are statistical tests that **do not assume the data follow a normal distribution**.
- Often used when we have:
  - Small sample sizes
  - Ordinal (ranked) data
  - Skewed or non-normal data

NOTE THAT!: Non-parametric tests often **compare medians or ranks** rather than means

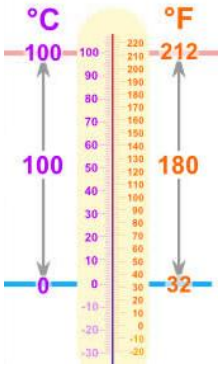
Levels of measurement

Nominal – Gender, race, blood group

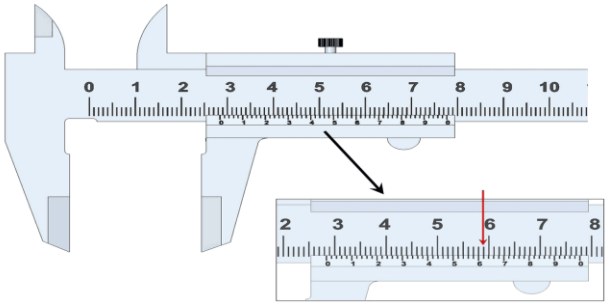
Ordinal – Socio-Economic Status (SES), pain level



Interval – Celsius or Fahrenheit scale



Ratio –Kelvin Scale, Weight, height, pulse rate



Are most variables normally distributed?

NO!

For example,

- Is income distributed normally in the population?
- Incidence rates (rare diseases) are not normally distributed.
- Number of car accidents is also not normally distributed.
- Duration of illness is not normally distributed.

Are most variables normally distributed?

REAL WORLD???

- When the data are not normally distributed.
- When the **sample size is small** and the normality assumption is questionable.
- When the data are measured on an **ordinal (ranked)** scale (e.g., satisfaction ratings).
- When there are outliers, non-parametric tests are more robust than parametric tests.

Difference between Parametric & Non-parametric test

	Parametric test	Non parametric test
1.	Used for ratio or interval data	For ordinal or nominal data
2.	Used for Normal distribution	Any distribution
3.	Mean is usual central measure	Median is usual central measure
4.	Information about population is completely known	No information available
5.	Specific assumptions made regarding population	Assumption free test

- When our data is normally distributed, **the mean is equal to the median!!!**
- **So!** We use the mean as our measure of central tendency.
- However, if our data is skewed, then the median is a much better measure of center.
- Therefore, just like the Z, t and F tests made inferences about the **population mean(s), nonparametric tests make inferences about the population median(s)/distribution.**

Commonly used NP tests

Some of the commonly used non parametric tests are

- ✓ Chi square test
- ✓ Mann-Whitney U test
- ✓ Wilcoxon Signed Rank test
- ✓ Krushkal-Wallis test (H test)
- ✓ Friedman ANOVA
- ✓ Spearman's Rank correlation (did you remember? ☺)

Parametric & Non-parametric tests

AIM	*Parametric t-tests*	*Non parametric equivalent*
Compare one sample to a hypothetical value	One-sample t-test	Sign test
Compare 2 independent sample means	Independent samples t-test	Mann Whitney U test
Compare 2 paired sample means	Paired samples t-test	Wilcoxon Signed rank test
Compare more than 2 sample means	ANOVA	Kruskal-Wallis test
Correlation between 2 variables	Pearson's Correlation	Spearmans Rank Correlation
Compare more than 2 samples - repeated	Repeated measures ANOVA	Friedman test

Commonly used NP tests
Chi-Square Test (Ki-Kare Testi)

- The Chi-Square test is a non-parametric test used to examine relationships between categorical variables.
- It does not require normal distribution.

Types of Chi-Square:

1. **Chi-Square Test of Independence Tests (Bağımsızlık Testi)**

- If two categorical variables are related. (iki kategorik değişken ilişkili mi? sorusu)

Example: Does gender (male/female) relate to preference for therapy type (cognitive/behavioral)?

2. **Chi-Square Goodness-of-Fit Test Tests**

- If observed frequencies match expected frequencies. (gözlenen dağılım beklenen dağılıma uyuyor mu?

Example: Are students' choices among three therapy options equally distributed?

- *Bir zar adil mi? – her yüzün gelme oranı eşit mi?*

Types of Chi-Square

Özellik	**Chi-Square Independence**	**Chi-Square Goodness-of-Fit**
Değişken sayısı	2 kategorik	1 kategorik
Amaç	İki değişkenin ilişkili olup olmadığını test etmek	Bir değişkenin gözlenen dağılımının beklenen dağılıma uyup uymadığını test etmek
Veri tablosu	Contingency table (2 boyutlu)	Tek boyutlu frekans tablosu
Örnek	Cinsiyet ve terapi tercihi	Terapi tercihleri eşit dağılıyor mu?
Serbestlik derecesi (df)	(satır-1)*(sütun-1)	kategori sayısı - 1

Sign test – *alternative to one sample t-test*

- The Sign Test is a nonparametric statistical test used to evaluate whether the median difference between paired observations is equal to zero, based solely on the direction (sign) of the differences rather than their magnitude.
- + or –
- Artanlar mı fazla azalanlar mı?

- **Exmpl**: A teacher wants to see if a training program improved students' scores.
- She records scores **before and after** the training:

Sign test – *alternative to one sample t-test*

Student	**Before**	**After**
1	60	70
2	75	70
3	80	85
4	50	55
5	90	90

- Student 1 → +
- Student 2 → −
- Student 3 → +
- Student 4 → +
- ~~Student 5 → 0~~ (**ignored**)

DECREASE OR INCREASE???

Sign test – *alternative to one sample t-test*

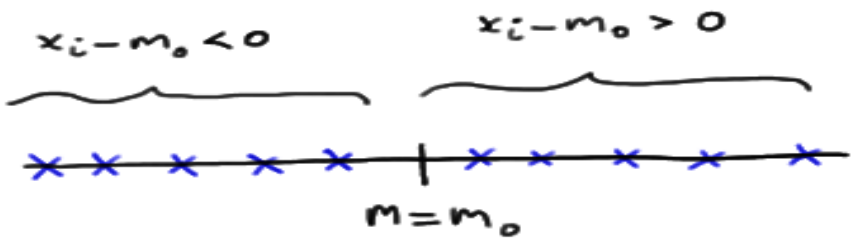
- Can be used as a non-parametric alternative to one sample t test.
- The null hypothesis for the sign test specifies the population median, M_0

  Ho: The **median value** of the population is equal to a stated (Hypothesized) value.

$$H_0 : m = m_0$$

$$H_1 : m \neq m_0 \text{ or } H_1 : m < m_0 \text{ or } H_1 : m < m_0$$

Sign Test



- The data doesn't follow normal distribution
- Mean is not representative of the values since the values are skewed to right or left
- Data transformation doesn't make the values normal
- Tek bir grup verisinin medyanının belirli bir değere eşit olup olmadığı
- Veri: Sürekli (continious) or sıralı (ordinal)

Örnek: Bir grup öğrencinin sınav puanlarının medyanı 70'e eşit mi?

Mann - Whitney U test

- Mann-Whitney U Test is used in place of the two sample t-test when the normality assumption is questionable.
- A non-parametric test used to compare two independent groups when:
- The dependent variable is ordinal (ranked) or continuous, and normality assumption is questionable (data may not be normally distributed).
- It is often called the non-parametric alternative to the independent samples t-test.

IV= Categorical

Mann - Whitney U test

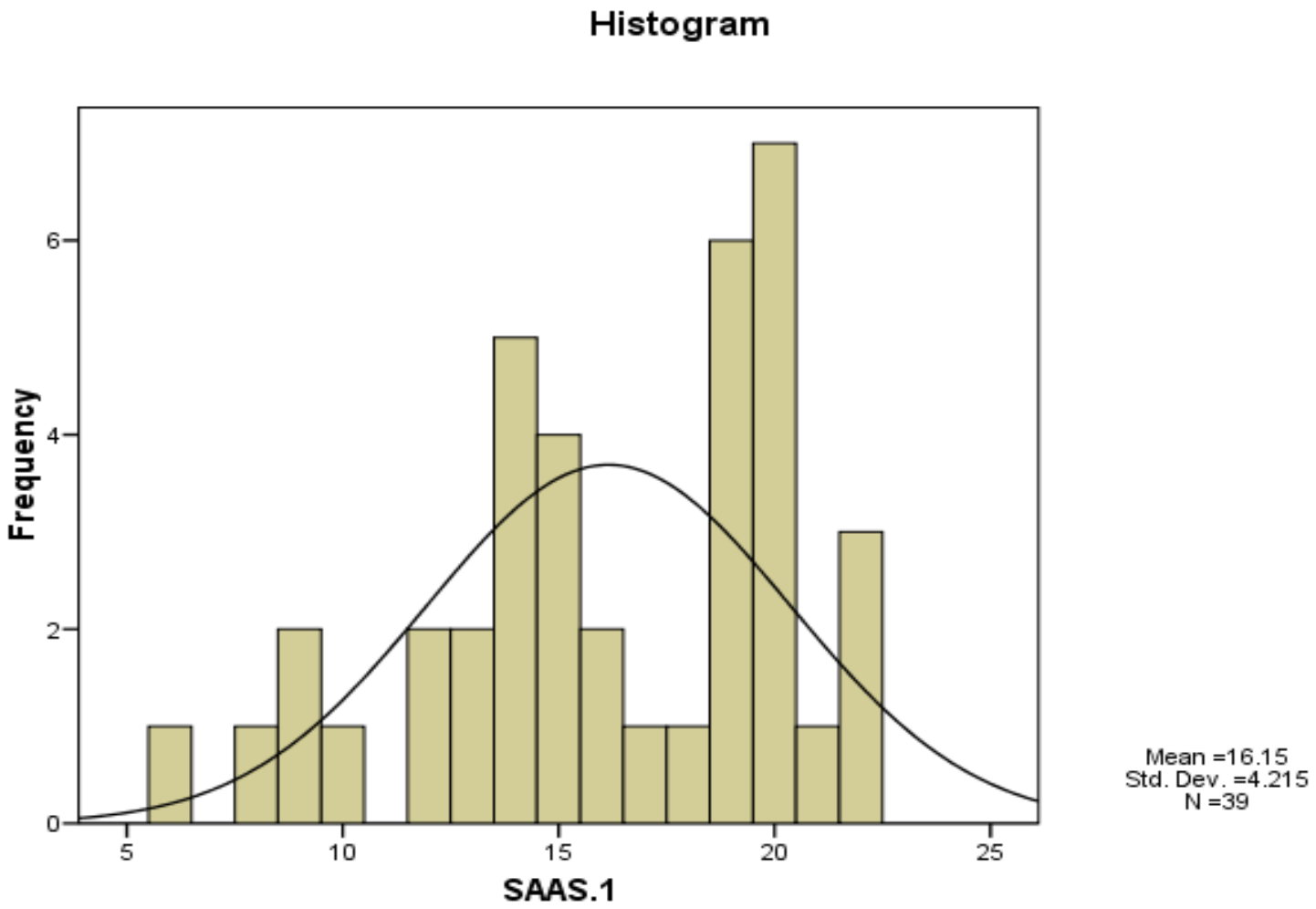
In other words,

- You have two independent groups (e.g., treatment vs control).
- Your dependent variable is: Ordinal (ranked data, e.g., satisfaction levels 1–5) or continuous but non-normal.
- Sample sizes do not have to be equal.

Example:

- Group A: Therapy type 1 (n = 5)
- Group B: Therapy type 2 (n = 6)
- Dependent variable: Anxiety score (0–50), non-normal distribution

SO! You need to check normality, first!



Results of t-test

Group Statistics

	sex	N	Mean	SD
SAAS.1	1 M	11	17.64	5.390
	2 F	28	15.57	3.605

Independent Samples Test

		t-test for Equality of Means		
		t	df	Sig. (2-tailed)
SAAS.1	Equal variances assumed	1.394	37	.172

Results of M W U-test

Ranks

	sex	N	Mean Rank	Sum of Ranks
SAAS.1	1 M	11	26.05	286.50
	2 F	28	17.63	493.50

Test Statistics[b]

	SAAS.1
Mann-Whitney U	87.500
Asymp. Sig. (2-tailed)	.037

b. Grouping Variable: sex

Parametric & non-parametric tests

AIM	*Parametric t-tests*	*Non parametric*
Compare one sample to a hypothetical value	One-sample t-test	Sign test
Compare 2 independent sample means	Student's t-test	Mann Whitney U
Compare 2 paired sample means	Paired t-test	Wilcoxon Signed rank
Compare more than 2 sample means	ANOVA	Kruskal-Wallis test
Compare more than 2 samples - repeated	Repeated measures ANOVA	Friedman test
Assesses the linear relation between two variables.	Pearson's correlation coefficient.	Spearman rank correlation, Kendall Tau

Kruskal-Wallis *H*-Test

- *3 ya da daha fazla bağımsız grup!!!*
- A non-parametric test used to compare three or more independent groups.
- It is the non-parametric alternative to one-way ANOVA.
- Tests whether the distributions of the groups are the same (medians may differ).
- **Three or more independent groups** (e.g., different therapy types).
- Dependent variable is: Ordinal (ranked) or continuous but not normally distributed.
- Sample sizes can be different across groups.
- Example:
- Group 1: Traditional therapy (n=5), group 2: Online therapy (n=6), group 3: Blended therapy (n=4)
- Dependent variable: Anxiety score (0–50)

ANOVA

Descriptives

		N	Mean	SD
Parental. attachment	1	14	207.36	17.248
	2	8	188.13	26.920
	3 +	6	189.83	20.721
	Total	28		
Self. Esteem	1	14	88.57	12.439
	2	8	73.88	13.098
	3 +	6	84.50	13.531
	Total	28		

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Parental. attachment	Between Groups	2405.76	2	1202.9	2.71	.086
	Within Groups	11086.9	25	443.48		
	Total	13492.7	27			
Self.Esteem	Between Groups	1107.20	2	553.60	3.35	.051
	Within Groups	4127.80	25	165.11		
	Total	5235.00	27			

Kruskal Wallis test

Ranks

	sibs. new	N	Mean Rank
Parental.attachment	1	14	17.68
	2	8	11.38
	3 +	6	11.25
	Total	28	
Self.Esteem	1	14	17.43
	2	8	9.25
	3 +	6	14.67
	Total	28	

Test Statistics[a,b]

	Parental. attachment	Self. Esteem
Chi-Square	4.186	5.049
df	2	2
Asymp. Sig.	.123	.080

a. Kruskal Wallis Test

b. Grouping Variable: sibs.new

Spearman's Rank Correlation (r_s)

- This coefficient is used to measure the **relationship between two variables when the data are in ordinal (ranked) form**.
- It is helpful when your data are **not normally distributed** or when you are working with **rank orders instead of exact numerical values**.

It is often used in situations such as:

- When scores are ranked (1st, 2nd, 3rd, etc.)
- When the assumption of normal distribution is not met.
- When you want a **non-parametric** measure of correlation.

Why should we use NP tests?

Non-parametric tests advantages:

- **Normality not required**

Verilerin normal dağılım göstermesi gerekmez.

- **Small sample sizes**

Küçük örneklemler için uygundur.

- **Robust against outliers**

Aykırı değerler (extreme values) test sonucunu çok etkilemez.

- **Ordinal data allowed**

Sıralı (ordinal) veriler ile kullanılabilir.

Why NOT use NP tests all the time?

Non-parametric tests disadvantages:

- **Less powerful**
  Parametrik testlere göre **istatistiksel güçleri genellikle daha düşüktür**, yani farkı tespit etme olasılığı daha azdır. (*p* değeri!!)

- **Cannot estimate parameters**
  Ortalama ve standart sapma gibi **parametre tahminleri yapılmaz**;
  - medyan veya sıra!

- **Less information used**
  Sadece **sıralara veya frekanslara bakar**, tam veri değerleri kullanılmaz → *bilgi kaybı* olabilir.

- **Difficult for complex designs**
  Çok faktörlü veya karmaşık deney tasarımları için uygulanması sınırlıdır.

Any Questions???