- In your own words, compare and contrast **parametric** and **nonparametric** statistics.

former we Assume the parameters and dist of population is known

Latter doesnt require any dist known beforehand nor Parameters And there is no Assumption

- What are two reasons why researchers might choose a nonparametric test over its parametric equivalent?

1. Analyzed data is nominal or ordinal
2. underlying data doesn't meet the assumption about the population Sample

What are two reasons why researchers might choose a nonparametric test over its param

- List the nonparametric tests we've discussed that are appropriate for **paired** samples.

Sign Test

Wilcoxon Signed Rank Test

List the nonparametric tests we've discussed that are appropriate for **independent** samples.

Mann-Whitney test

kruskal-wallis Test

What assumptions do most nonparametric tests appear to make?

Randomness and independence, Random Sampling

1. The following data record the number of ear infections each of 7 swimmers had before (X_i) taking a medication designed to prevent infections and after (Y_i) taking the medication. Using the data provided, answer the following questions:

Swimmer	X_i	Y_i	D_i	**Sign**
A	3	2	1	+
B	0	1	-1	-
C	5	4	1	+
D	4	0	4	+
E	2	1	1	+
F	4	3	1	+
G	3	1	2	+

a. Consider $D_i = X_i - Y_i$. Fill in the D_i column. Then fill in the "Sign" column with the sign of the differences.

b. Use the **sign test** to conduct a hypothesis test assessing whether there is a difference between the population distributions of X and Y.

i. Write the null and alternative hypotheses in words and in symbols;
ii. Calculate a test statistic M;
iii. Calculate the relevant binomial probability;
iv. Can you reject the null hypothesis, assuming $\alpha = .05$?

i) $P(D_i > 0) = P$

$H_0: P = 0.5$ $\quad H_A: P \neq 0.5$ $\quad M = 6$

P-value $= P(Z \geq 6 \mid Z \sim Bin(7, \frac{1}{2})) + P(Z \leq 1 \mid Z \sim Bin(7, \frac{1}{2}))$

$= 2\left(\binom{7}{6}(0.5)^{14}\right) = \frac{1}{8} > 0.05$

Fail to Reject Ho.

T^+ = Sum of Ranks of Positive D_i's $= 3+3+3+3+6+7$

$= 25$

T^- = Sum of Ranks of negative D_i's $= \min\{T^+, T^-\} = 3$

Critical value is 2 for $\alpha = 0.05$

Either T is greater than α, Fail to Reject Ho

d) Fail to Reject H_0 with both test

2. The coded values for a measure of brightness in paper (light reflectivity), prepared by two different processes, are as shown in the accompanying table for samples of size 9 drawn randomly from each of the two processes. Do the data present sufficient evidence to indicate a difference in locations of brightness measurements for the two processes? Give the attained significance level.

Process A	**Process B**
6.1	9.1
9.2	8.2
8.7	8.6
8.9	6.9
7.6	7.5
7.1	7.9
9.5	8.3
8.3	7.8
9.0	8.9

a. Answer the question by using the **Mann-Whitney U test**.
b. Answer the question by using the **independent samples *t*-test**.
c. Provide the null and alternative hypotheses for parts *a* and *b*, along with any assumptions made for each test.

a) $U_A = n_1 n_2 + \frac{n_1(n_1+1)}{2} - W = 81 + \frac{90}{2} - 94 = 32$

$U_B = 81 + \frac{9 \cdot 10}{2} - 77 = 49$

So $U = 32$ and p-value is $2P(U \leq 32) = 2 \cdot 0.2447 = 0.4894$

The critical value of u @ $\alpha = 0.05$ is $17 < 32$

which is saying the result is NOT Significant

$\boxed{\text{We Can not Reject } H_0.}$

b) By using two sample Test, we get $H_0 : \mu_1 - \mu_2 = 0$

Vs $H_a = \mu_1 - \mu_2 \neq 0$

$\bar{y}_1 \approx 8.27$, $\bar{y}_2 \approx 8.13$, $S_p^2 \approx 0.868$

$$|t| = \frac{|8.27 - 8.13|}{\sqrt{0.868\left(\frac{2}{9}\right)}} = 0.319$$

P-value > 0.2 (from table 5) $\boxed{H_0 \text{ Accepted}}$

c) For a. H_0 : The distributions of populations I and II are identical

H_a : The distribution of populations I and II differs locationally.

Sample was selected Randomly and indepdently from population

For b. $H_0 : \mu_1 - \mu_2 = 0$

$H_a : \mu_1 - \mu_2 \neq 0$

Independence / normality / homogeneity of variance, Random Sampling

3. Consider the Friedman statistic

$$F_r = \frac{12b}{k(k+1)} \sum_{i=1} k \left(\bar{R}_i - \bar{R}\right)^2.$$

Square each term in the sum, and show that an alternative form of F_r is

$$F_r = \frac{12}{bk(k+1)} \sum_{i=1}^{k} R_i^2 - 3b(k+1).$$

Hint: Recall that $\bar{R}_i = \frac{R_i}{b}$ and $\bar{R} = \frac{k+1}{2}$, and note that $\sum_{i=1}^{k} R_i = \text{sum of all the ranks} = \frac{bk(k+1)}{2}$.

$$F_r = \frac{12\cdot b}{k(k+1)} \sum \left(\bar{R}_i^2 - 2\bar{R}_i\bar{R} + \bar{R}^2 \right)$$

$$= \frac{12\cdot b}{k(k+1)} \sum \left(\frac{R_i^2}{b^2} - \frac{(k+1)R_i}{b} + \frac{(k+1)^2}{4} \right)$$

$$= \frac{12\cdot b}{k\cdot(k+1)} \sum \frac{R_i^2}{b^2} - \frac{12\cdot b - b\cdot k\cdot(k+1)}{k\cdot b\cdot \cancel{2}} + \frac{12\cdot b(k+1)\cdot k}{4k}$$

$$= \frac{12}{b\cdot k(k+1)} \sum R_i^2 - 3\cdot b(k+1)$$

4. A quality control chart has been maintained for a measurable characteristic of items taken from a conveyor belt at a fixed point in a production line. The measurements obtained today, in order of time from top left to bottom right (68.2 the earliest recorded and 70.1 the latest), are as follows:

68.2	71.6	69.3	71.6	70.4	65.0	63.6	64.7
65.3	64.2	67.6	68.6	66.8	68.9	66.8	70.1

a. Classify the measurements in this time series according to whether each is above or below the overall sample mean and determine, using the **runs test**, whether there are runs of high or low measurements, suggesting a lack of stability in the production process.

b. Divide the time period into two equal parts and compare the means of each, using the t-test, with $\alpha = .05$. Do the data provide evidence of a shift in the mean level of the quality characteristic? Explain.

a) if A lie above mean

if B fall below mean

AAAAA BBBBBB A B A B A

$R = 7$ $n_1 = n_2 = 8$

Non-Random fluctuation would be implied by small # of Runs

By table 10, p-value $= P(R \leq 7) = 0.217$

Then non-Random fluctuation can't be concluded.

B) Divide data into equal parts

$\bar{y}_1 = 68.05$ (for the 1st Row) w/ $s_p^2 = 7.07$

$\bar{y}_2 = 67.29$ (for 2nd row)

For two-sample Test $|t| = \dfrac{|68.05 - 67.27|}{\sqrt{7.07\left(\frac{2}{8}\right)}} \approx 0.5867$

DF=14, $\alpha = 0.05$ give critical value of $1.761 > 0.5867$

Ho Accepted