Group Presentation

Kruskal-Wallis test

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Purpose of test

To determine whether or not there is a statistically significant difference between independent groups.

Assumption/limitation

- small sample size (non-parametric method)
- the observations are independent of each other
- does not need a normal distribution of the population
- does not need the constant variance of the population

Type of data

- Ordinal
- Continuous

- ordinal:
  - To find out whether the distribution of students' satisfaction with restaurants a, b, and c is the same.

student	1	2	3	4	5	6	7	8	9
Satisfaction of restaurant A	5	7	1	4	4	5	3	6	
Satisfaction of restaurant B	2	6	2	5	4	8	5	8	2
Satisfaction of restaurant C	10	9	3	8	3	9	4		

- continunous
  - determine whether there is any significant difference in catch among the three types of fishing areas.

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022
Offshore	123	237	341	1240	1646	245	103	136	1234
Coastal	256	265	257	533	2404	1338	1325	578	122
Aquaculture	2312	2359	1463	2358	1933	1049	2414	1626	1357

Hypothesis

H_0 : There is no significant difference between the groups

H_1 : There is significant difference between the groups

- The Kruskal-Wallis test can only use to test whether there are differences between multiple groups !
- Use Mann-Whitney U-test to find out which group has the significant difference.

Test Statisitc

1. K groups , $n_1, n_2, \ldots, n_k$ data in group $1, 2, \ldots, k$
    - $n_1 + n_2 + \ldots + n_k = N$
2. Merge all the data and give the rank to each data
    - From the smallest to the largest
3. Get the sum of rank $R_1, R_2, \ldots, R_k$ in each group

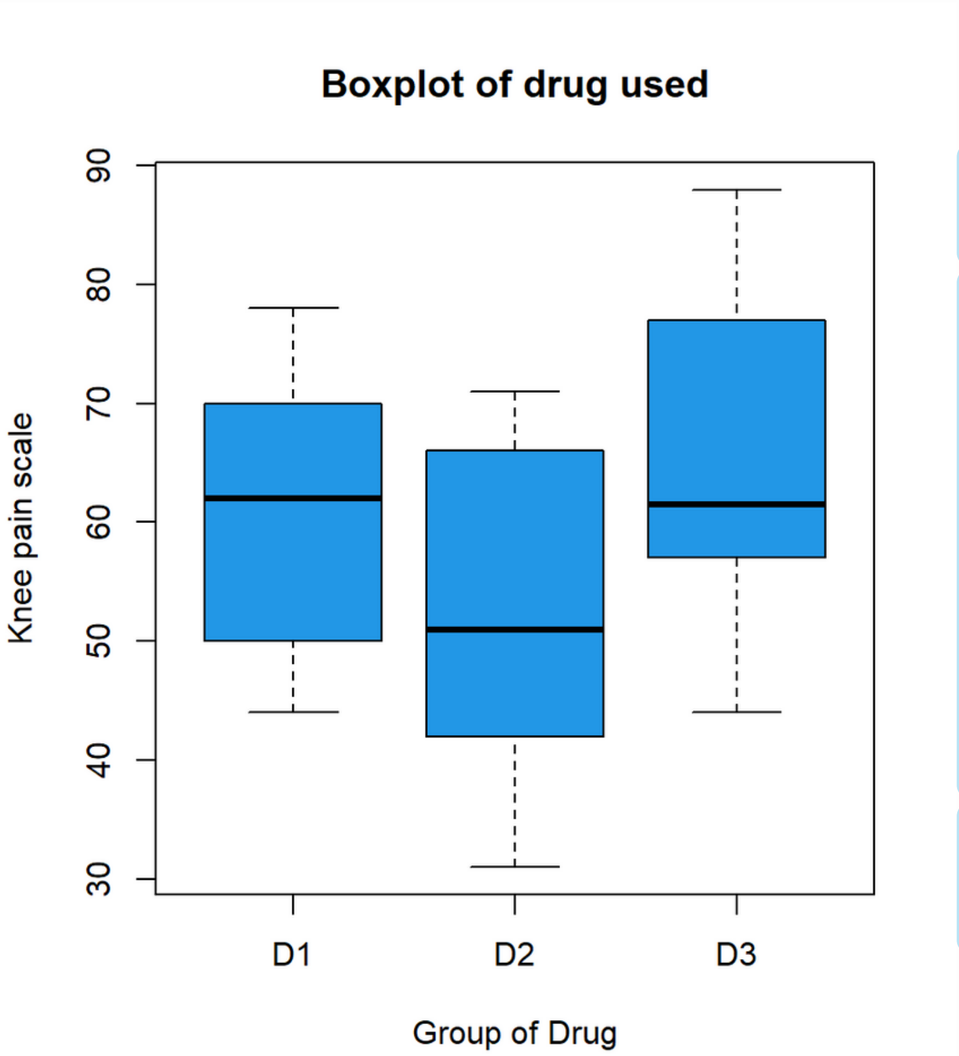
$$H = \frac{12}{N(N+1))} \sum_{i=1}^{k} \frac{R_i^2}{n_i} - 3(N+1) \sim \chi^2(k-1)$$

N：Total number of data
R_i：The sum of rank in group i
n_i：The number of data in group i
k ：The number of groups

Example1:

A researcher wants to know whether or not three drugs have different effects on knee pain, so he recruits 30 individuals who all experience similar knee pain and randomly splits them up into three groups to receive either Drug 1, Drug 2, or Drug 3.

	n	Median	IQR
Drug1	10	62	18.75
Drug2	10	51	20.75
Drug3	10	61.5	16.75



Ho: The knee-pain ratings across the three groups are equal.
Ha: At least one of the knee-pain ratings is different from the others.

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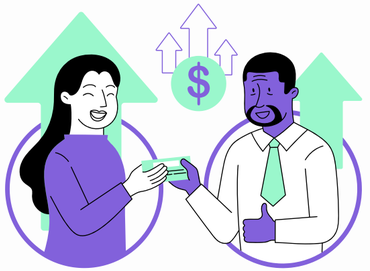
drug1 = c(78, 65, 63, 44, 50, 78, 70, 61, 50, 44)
drug2 = c(71, 66, 56, 40, 55, 31, 45, 66, 47, 42)
drug3 = c(57, 88, 58, 78, 65, 61, 62, 44, 48, 77)
pain.scale = c(drug1, drug2, drug3)
drug.type = factor(rep(1:3, c(10, 10, 10)),
                   labels = c("D1", "D2", "D3"))
kruskal.test(pain.scale, drug.type)
```

```
        Kruskal-Wallis rank sum test

data:  pain.scale and drug.type
Kruskal-Wallis chi-squared = 3.0973, df = 2, p-value = 0.2125
```

Conclusion: Since the p-value of the test (0.2125) is not less than 0.05, we can not reject the null hypothesis. Hence, we claim that there is no sigificant difference between knee pain ratings across these three groups.

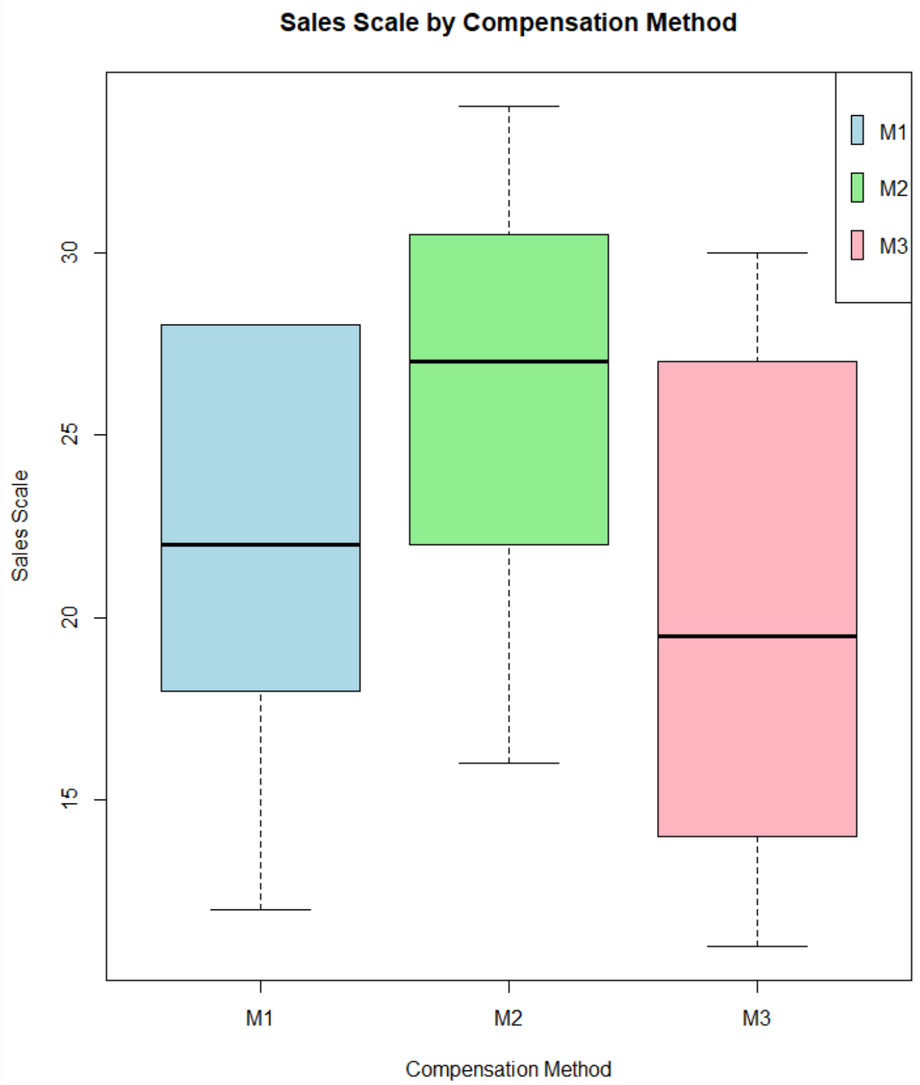
Example2:



Performance records for 18 salespersons are selected to investigate whether compensation methods are a significant motivational factor

A Kruskal-Wallis test is to be performed with $\alpha = 0.01$.

Compensation Method	Sales
Straight Salary	18 12 22 28 28
Straight Commission	27 34 34 27 20 16 24
Salary Plus Commission	11 17 27 14 30 22



Ho: The sales across the three groups are equal.
Ha: At least one of the sales is different from the others.

```
Straight_Salary = c(18, 12, 22, 28, 28)
Straight_Commission = c(27, 34, 34, 27, 20, 16, 24)
Salary_Plus_Commission = c(11, 17, 27, 14, 30, 22)

Sales.scale = c(Straight_Salary, Straight_Commission, Salary_Plus_Commission)
Compensation_Method.type = factor(rep(1:3, c(5, 7, 6)),
                                  label = c("M1", "M2", "M3"))

kruskal.test(Sales.scale, Compensation_Method.type)
```

```
        Kruskal-Wallis rank sum test

data:  Sales.scale and Compensation_Method.type
Kruskal-Wallis chi-squared = 1.7275, df = 2, p-value = 0.4216
```

Conclusion: Since the p-value of the test (0.4216) is not less than 0.01, we do not reject the null hypothesis. Hence, we claim that there is no sigificant difference between sales across these three groups.

Thanks for listening!