One factor analysis of variance: Introduction

- We often wish to compare more than two conditions of an independent variable.
- When this is the case we can no longer use the t test but use the analysis of variance (ANOVA).

One factor analysis of variance: Assumption

- Dependent variable is measured in ratio or interval scale.
- Sample mean is normally distributed.
- Respondents are selected randomly.
- Respondents of all the groups are not related.
- Variances of all the groups are equal.

One factor independent analysis of variance: Example

- A research was interested in the effects of hints on a person's ability to solve anagrams (an anagram is a jumbled up word). The time took a participant to solve five eight letter anagrams was measured. The same five anagrams were used in three conditions:
- First letter (where the first letter of the word was given)
- Last letter (where the last letter was given) and
- No letter (where no help was given).
- Thirty participants were chosen and ten were randomly allocated to each condition. The number of minutes it took to solve the five anagrams was recorded.

One factor independent analysis of variance: Example

First letter	Last letter	No letter
15	21	28
20	25	30
14	29	32
13	18	28
18	26	26
16	22	30
13	26	25
12	24	36
18	28	20
11	21	25

One factor independent analysis of variance: Method-1: Post hoc test

- #one way anova
- first_letter = scan()
- 15 20 14 13 18 16 13 12 18 11

- last_letter = scan()
- 21 25 29 18 26 22 26 24 28 21

- no_letter = scan()
- 28 30 32 28 26 30 25 36 20 25

- ex1 = data.frame (first_letter, last_letter, no_letter)

- ex1 #show structure

One factor independent analysis of variance: Method-1: Post hoc test

- final.ex1 = stack(ex1)#arrange data in one column
- names(final.ex1) = c("minutes", "letter.types")#give column title
- final.ex1
- #checking homogeneity of variance
- bartlett.test(minutes ~ letter.types, data = final.ex1)
- #Welch test for equal variance not assume
- #oneway.test (minutes ~ letter.types, data = final.ex1)
- ex1.aov = aov(minutes ~ letter.types, data = final.ex1)
- ex1.aov
- summary (ex1.aov)

One factor independent analysis of variance: Method-1: Post hoc test

- #show pairwise comparison
- TukeyHSD(ex1.aov)
- plot(TukeyHSD(ex1.aov))
- model.tables (ex1.aov, type = "means")
- boxplot(minutes ~ letter.types, data = final.ex1)
- title(xlab = "letter type", ylab = "minutes")

One factor independent analysis of variance: Method-1: Post hoc test

- It can be seen that when participants were not given any help to solve the anagrams (no letter), they took longer to generate the solution (mean time = 28 minutes).
- When given the last letter, participants solved the anagrams quicker than when not given any letter (mean time = 24 minutes) although not as quicker than when not first letter of the solution was given (mean time = 15 minutes).

One factor independent analysis of variance: Method-1: Post hoc test

- Here, we see that the p values is 0.4937, which is greater than 0.05.
- We can therefore assume that variances are approximately equal.
- If less than 0.05, then in this case you need to consider transformation to make your variances more homogenous.
- Here, $p < 0.001$ in **ANOVA** table, this indicates that there is highly significant difference between the three groups.
- There is a lot of variability due to other factor and much less due to error.

One factor independent analysis of variance: Exercise

- A sales manager wishes to determine the optimal number of product training days needed for new employees. He has performance scores for three groups: employees with one, two, or three days of training.
- **The data are in the file *salesperformance.xlsx*.**

- In response to customer requests, an electronics firm is developing a new DVD player. Using a prototype, the marketing team has collected focus group data. ANOVA is being used to discover if consumers of various ages rated the design differently.
- **This example uses the file *dvdplayer.xlsx***

One factor independent analysis of variance: Exercise

- In a class of 30 students, ten students each were randomly assigned to three different methods of memorizing word lists.
- In the first method, the student was instructed to repeat the word silently when it was presented.
- In the second method, the student was instructed to visualize the word and pronounce it silently.
- The third method required the student to associate each word with a strong memory.
- Each student saw the same 10 words flashed on a computer screen for five seconds each. The list was repeated in random order until each word had been presented a total of five times. A week later, students were asked to write down as many of the words as they could recall. For each of the three groups, the number of correctly-recalled words is shown in the following table.

One factor independent analysis of variance: Exercise

Method 1	Method 2	Method 3
1	4	7
2	4	4
0	0	9
0	6	8
4	6	6
3	6	9
1	6	6
0	6	4
3	4	5
3	4	6