**Exercise 3**

In the previous exercise (2) we calculated the artificial columns {Clarity, Politeness, Satisfaction} for each entry in the data.

In the current exercise we filtered the data, leaving in only subjects with the ages of 18-49. We also filtered out the NA rows from the data.

In order to work with R for statistical analysis, we mapped the Hebrew in the given dataset to English identifiers. The relevant mappings to this exercise are as follows:

Comp\_Use\_Know:

|  |  |
| --- | --- |
| **ID** | **ORIGINAL VALUE** |
| **F1** | ידע בינוני (למשל, מסוגל להתקין תוכנות בעצמי) |
| **F2** | ידע בסיסי (למשל, יודע לגלוש באינטרנט ובפייסבוק) |
| **F3** | ידע רב (משתמש בהרבה תוכנות שונות ויכול לפתור בעצמי הרבה בעיות במחשב) |
| **F4** | מומחה (מבין בהרבה תחומים ומסוגל לאבחן ולפתור כמעט כל בעיה) |

Sex:

|  |  |
| --- | --- |
| **ID** | **ORIGINAL VALUE** |
| **C1** | זכר |
| **C2** | נקבה |

**Part 1**:

For this section we split the data in two ways: (1) By System {S, C} (2) By Sex {C1, C2} Where S stands for "Software", C for "Social Systems", C1 for "Male" and C2 for "Female". Then we have conducted two unpaired t-tests for comparing two groups by their Politeness as follows:

Constant variance test (F test) between each pair of the groups (1) and (2) revealed that they have equal variance with high p-values equal to 0.7779 and 0.8602 respectively.

Test 1 for comparing the groups (1):

We performed unpaired t-test with equal variance and got the following results:

*t = 3.8093, df = 275 , p-value = 0.0001719*

As we can see from the results we reject which means that the factor System has a significant impact on Politeness.

Test 2 for comparing the groups (2):

We performed unpaired t-test with equal variance and got the following results:

*t = -0.2531, df = 275, p-value = 0.8004*

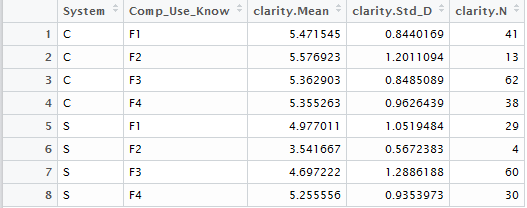
As we can see from the results we cannot reject which means that the factor Sex has no significant impact on Politeness.

**Part 2:**

In this section we conducted a two-way ANOVA with the input:

We have groups according to the possible combinations of the two factors: .

Descriptive statistics:



In order to test if the variance is constant we performed Levene's test and get the following results:

Df Sum Sq Mean Sq F value Pr(>F)

data\_filtered$clarity 1 2.06 2.0592 5.899 0.0158 \*

Residuals 275 95.99 0.3491

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

P-value is less than 0.05 therefore we reject the null hypothesis where we have a constant variance.

Giving this situation we used a significance level of 0.01 instead of 0.05 in the two-way ANOVA. (Theoretically we should be performing here a-parametric test like B-F and Welch ANOVA fixes).

We get the following results from the two-way anova:

Df Sum Sq Mean Sq F value Pr(>F)

System 1 20.4 20.402 19.649 1.36e-05 \*\*\*

Comp\_Use\_Know 3 3.8 1.265 1.219 0.3033

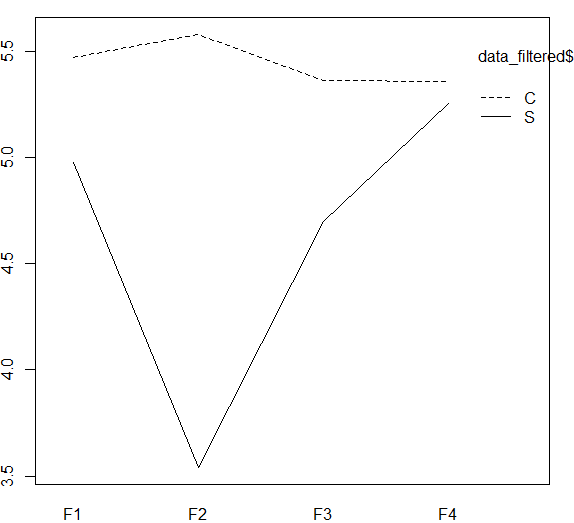
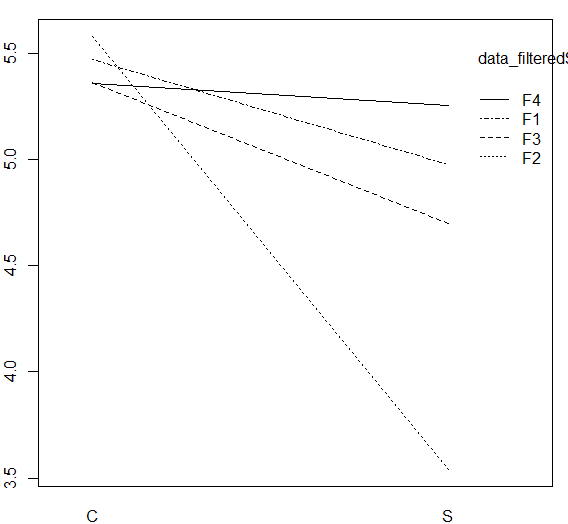
System:Comp\_Use\_Know 3 10.6 3.535 3.404 0.0182 \*

Residuals 269 279.3 1.038

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Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

As it can be seen in the results, the factor System is strongly significant which means that it's impact is very high on Clarity.



**System**

**Comp\_Use\_Know**

**System**

**Comp\_Use\_Know**

We cannot conclude that there is an interaction between System and Comp\_Use\_Know because we use a significant level of 0.01.

According to the interaction plots we see some possible interaction between System and Comp\_Use\_Know. However, the results from the two-way ANOVA show that this is not sufficient for the significance level of 0.01.

Because the p-value of the interaction variable is close to 0.01 we decided to do an interaction effects analysis using the following 6 tests:

1. One-way ANOVA of Clarity~Comp\_Use\_Know where System = "S".

Df Sum Sq Mean Sq F value Pr(>F)

Comp\_Use\_Know 3 13.63 4.544 3.482 0.0181 \*

Residuals 119 155.30 1.305

---

Signif. codes: 0 ‘\*\*\*’ 0.001 ‘\*\*’ 0.01 ‘\*’ 0.05 ‘.’ 0.1 ‘ ’ 1

1. One-way ANOVA of Clarity~Comp\_Use\_Know where System = "C".

Df Sum Sq Mean Sq F value Pr(>F)

Comp\_Use\_Know 3 0.77 0.2561 0.31 0.818

Residuals 150 124.01 0.8267

1. T-test of Clarity~System where Comp\_Use\_Know = "F1".

t = 2.0985, df = 51.788, p-value = 0.04075

95 percent confidence interval:

0.02161104 0.96745540

1. T-test of Clarity~System where Comp\_Use\_Know = "F2".

t = 4.6519, df = 11.51, p-value = 0.0006234

95 percent confidence interval:

1.077491 2.993022

1. T-test of Clarity~System where Comp\_Use\_Know = "F3".

t = 3.3584, df = 101.6, p-value = 0.001104

95 percent confidence interval:

0.2725097 1.0588523

1. T-test of Clarity~System where Comp\_Use\_Know = "F4".

t = 0.43086, df = 63.161, p-value = 0.668

95 percent confidence interval:

-0.3627115 0.5621267

The results we got from the 6 tests match the interaction plots.

From the first two One-way ANOVA tests we conclude the following:

When System = "S" the value of Comp\_Use\_Know effect Clarity significantly with p-value = 0.0181. This result can be seen visually on the left interaction plot where the values of Clarity for each value of Comp\_Use\_Know are highly distinct. When System = "C" those values are more close to each other which means that Comp\_Use\_Know has less effect power on Clarity.

From the later four t-tests we conclude the following:

When Comp\_Use\_Know = F2 the t-test results show that p-value is very small which can be seen on the right interaction plot as the large difference between Clarity values of System = "S" and System = "C". This is also true for F1,F3 but with less effect on Clarity. In fact, the value of the p-values is correlated to the size of the difference of the Clarity values on the interaction plot for each Comp\_Use\_Know value.

When Comp\_Use\_Know = F4 the t-test results are not significant which can be seen on the plot as the smallest difference on Clarity between the two systems.

Finally, we performed three post-hoc Scheffe tests in order to find out if there are differences between each two values of the factor Comp\_Use\_Know as follows:

clarity std r Min Max

F1 5.266667 0.9603240 70 2.166667 7

F2 5.098039 1.3907667 17 2.833333 7

F3 5.035519 1.1332745 122 2.000000 7

F4 5.311275 0.9449633 68 2.666667 7

alpha: 0.05 ; Df Error: 269

Critical Value of F: 2.638161

Means with the same letter are not significantly different.

Groups, Treatments and means

a F4 5.311

a F1 5.267

a F2 5.098

a F3 5.036

clarity std r Min Max

F1 4.977011 1.0519484 29 2.166667 6.166667

F2 3.541667 0.5672383 4 2.833333 4.000000

F3 4.697222 1.2886188 60 2.000000 7.000000

F4 5.255556 0.9353973 30 2.666667 7.000000

alpha: 0.05 ; Df Error: 119

Critical Value of F: 2.680811

Means with the same letter are not significantly different.

Groups, Treatments and means

a F4 5.256

a F1 4.977

a F3 4.697

a F2 3.542

clarity std r Min Max

F1 5.471545 0.8440169 41 3.333333 7

F2 5.576923 1.2011094 13 3.833333 7

F3 5.362903 0.8485089 62 3.000000 7

F4 5.355263 0.9626439 38 3.333333 7

alpha: 0.05 ; Df Error: 150

Critical Value of F: 2.664907

Groups, Treatments and means

a F2 5.577

a F1 5.472

a F3 5.363

a F4 5.355

As we can see there are no significant differences between the factor values according to because each value ended up in the same group a.

**Conclusions:**

From the interaction plots and the two-way ANOVA results we conclude that System=C has significantly higher Clarity from System=S.