Spicy Level of Ma-Po Tofu

STAT 453 Final Project

Zimeng Ming

V00844078

University of Victoria

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Introduction:

Ma-po tofu is one of the famous Chinese dishes around the world. In Victoria, BC, there is a restaurant named "Hong Kong West Restaurant" has the best Ma-po in the town and always very popular in Victoria natives. It tastes spicy but also numbing. Ma-po Tofu combines seven specific Chinese adjectives: numbing, spicy hot, hot temperature, fresh, tender, aromatic, and flaky in one dish and this dish becoming a representee of chinses traditional dishes around the world. Ma-po tofu is made with tofu and ground beef, in a spicy Chili and bean-based sauce, typically a thin, oily, and bright red suspension. The spicy level of the Ma-po tofu are mainly cause by the Chili, bean-based sauce, and the amount of water add-in. There are lots of different youtuber has posted the tutorial of Ma-po Tofu online, the materials used for those tutorials are quite different. According to the comments below each video, the different types of Chili, different brands of bean-based sauce and different amount of water can make huge difference for the spicy level of a Ma-po tofu.

However, what is the secret to a spicy level of the Ma-po Tofu? Is the different types Chili makes a huge difference in spicy? Is the different brand or price for the bean-based sauce makes a huge difference in spicy? What factors are determining the highest spicy level of Ma-po tofu? How much water should the cooker place in the dish and delicious? In the previous research made by one of the organizations of master chief in China named "Old Meal guy (Lao Fan Gu)", the standard recipe is 1tsp salt, 1tsp sugar, 1tsp "Pi-Xian" bean-based sauce, 1tsp Sichuan pepper and 5 whole Sichuan Chili with 1/4 cup of water mixed with starch. For this recipe, the spicy level will be mild spicy and based on the comment of this recipe, several people have confirmed the spicy level is mild for the recipe. Thus, for this research, the mild spicy are denoted to a score of 3 out of 10. The major focus on this research is how the combination of different Chili, bean-based sauce and amount of water will affect the spicy level of Ma-po tofu.

Methods/procedure:

The procedure of making a Ma-po tofu will follow the tutorial made by "Old Meal guy". 2^3 factorial design is choosing to use in this research where the 3 factors are Chili, bean-based sauce, and the amount of water. There are two types of Chili, one is from Sichuan province, China which denotes to high level and the other is from Mexico which denotes to low level. There are two brand for bean-based sauce, the one is "Pi-Xian" sauce which is $12.99 for one bottle and denotes to high level, the other one is "Lee Kum Kee" which is $4.99 for one bottle and denotes to low level. There are two levels of usage of water, low level will have 1/4 cup and high level will have 1/2 cup of water. The table 1 will show the 2^3 two-level factorial design runs in standard order. There will be 8 combinations and for each combination will make 2 Ma-po tofu therefore total of 16 Ma-po tofu will be produced. There are 5 people will taste the produced dishes and give a score for level of spicy, the score range is 1-10, 1 is not spicy and 10 is the spiciest. To ensure the randomization, the tasters do not know what combination is using for the dish before all the 18 runs are completed. The average will be calculated for each trail and recorded. In order to reduce of the bias of taste, each person participated in the experiment can only taste 2 Ma-po tofu for every 5 hours (basically 2 for lunch and 2 for dinner), so total of 4 Ma-pod can be tasted for each day. The whole experiment is expected to use 8 days to complete.

	FACTORS		
RUN	A: Types of Chili	B: Bean-based Sauce	C: Amount of water
1	-	-	-
2	+	-	-
3	-	+	-
4	+	+	-
5	-	-	+
6	+	-	+
7	-	+	+
8	+	+	+

Table 1: 2^3 Factorial Design for Level of Spicy Effects

The other material for Ma-po tofu are remaining same in each experiment, there will be 2 tsp oil, 1/2 firm tofu in brand "T&T", 1tsp salt, 1tsp sugar, 1tsp Sichuan pepper and 1 tsp of sketch that needs to mix with water added. All the experiment will use same wok and same teaspoon for measuring the materials. Cooking time is also another thing should be restricted and controlled because the cooking time will affect the temperature of wok while cooking.

There are several nuisance factors could appear on during this experiment, such as the tofu used for each experiment. Because each tofu may have different conditions and it is very difficult to cut the tofu to exactly one and half size. Thus, it might have slightly different for the tofu used in the trail, the water remaining in tofu may affect the level of spicy in the end. This could not be controlled well during the experiment. In addition, As the spicy level for each person are really depends on the person self, the acceptance of the spicy level is very unique to each person, the score that the taster given may various, thus the weight may be used in the future study and will be discussed more on the following experiment.

Once the result coming out, the regression model will apply to the result and using ANOVA analysis to determine the significant factors. In addition, the analysis will plot out the normal probability plot and other useful information to help the analysis find the significant factors. The final model will indicate which factor is the significant and answer the question of what can affect the spicy level of Ma-po Tofu.

Data Collection and Result:

As described on the first part, for this experiment, only types of Chili, bean-based sauce and amount of water are changed as variables, the other materials used are remaining same in this experiment. The experiment is designed using 8 days to finishes, 1 run for lunch and 1 for dinner. However, due to the COVID-19 limitation, the experiment is compress to 4 days to finish and it might cause bias on the score.

The Raw data is showing on the Appendix (Raw Data in Standard order), there are 16 runs are randomly running for 8 treatment combinations, each treatment combination contain 2 replicates. The running order is random and is showing on the first column of the run part. The record contains the spicy level score (1-10) given by 5 tasters, average of each single replicate and the total score received for each treatment combination. Also, the average for each taster's score are calculated in order to find out the acceptance of spicy level for different individual taster.

Analysis the Data:

The total score received for each run are used in the analysis, the reason is to minimize the effect about the different acceptance of spicy level for each person. The experiment is running by the run order that shows on the raw data in appendix, using a full factorial model to identify factors that affect the spicy level of Ma-po tofu yielded the following results:

```
Call:
lm(formula = SpicyLevel ~ A * B * C, data = SpicyLevel_Data)

Residuals:
   Min     1Q Median     3Q    Max 
    -3     -2      0      2      3 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept)  23.0625     0.6644  34.713 5.19e-10 ***
A             7.5625     0.6644  11.383 3.20e-06 ***
B             0.1875     0.6644   0.282   0.7849    
C            -5.3125     0.6644  -7.996 4.38e-05 ***
A:B          -1.3125     0.6644  -1.976   0.0836 .  
A:C          -0.3125     0.6644  -0.470   0.6507    
B:C           0.5625     0.6644   0.847   0.4218    
A:B:C         1.5625     0.6644   2.352   0.0466 *  
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 2.658 on 8 degrees of freedom
Multiple R-squared:  0.9623,	Adjusted R-squared:  0.9292 
F-statistic: 29.14 on 7 and 8 DF,  p-value: 4.41e-05
```

Figure 1 Parameter Estimates

From the parameter estimates result, it indicates factor A, C and combination of ABC are significant. Then check the ANOVA Table:

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	
A	1	915.1	915.1	129.566	3.20e-06	***
B	1	0.6	0.6	0.080	0.7849	
C	1	451.6	451.6	63.938	4.38e-05	***
A:B	1	27.6	27.6	3.903	0.0836	.
A:C	1	1.6	1.6	0.221	0.6507	
B:C	1	5.1	5.1	0.717	0.4218	
A:B:C	1	39.1	39.1	5.531	0.0466	*
Residuals	8	56.5	7.1			

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

Figure 2 ANOVA Table

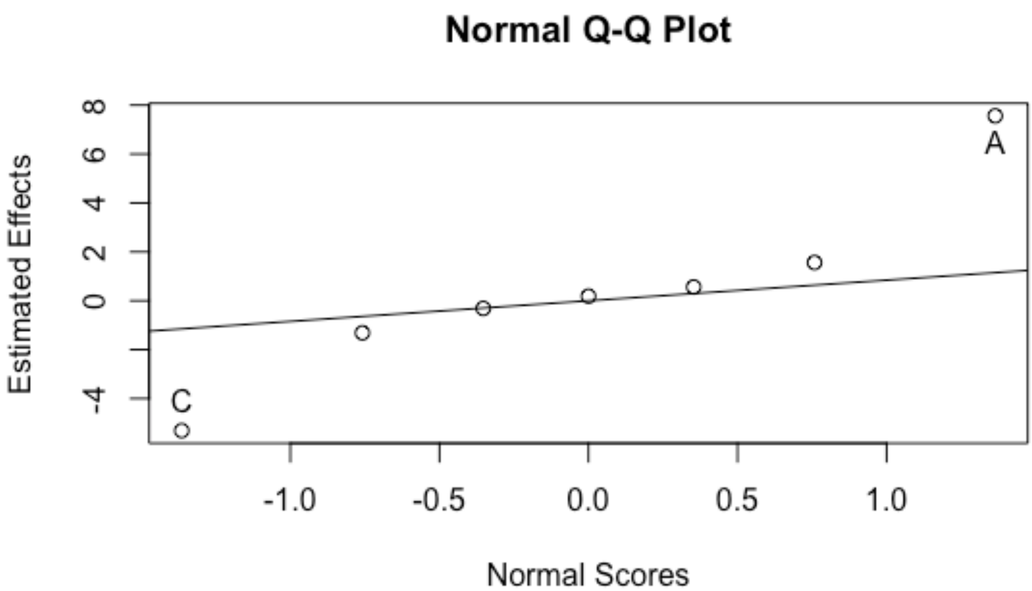

Figure 3 Normal Probability Plot

According to the ANOVA Table and Normal probability plot, they both indicates the factor A and C are significant. The R^2 for fitted model are 0.9632 which is pretty high and as the F-statistic is 29.14 and p-value is extremely small, the model are seems fitted and significant, the full factorial design is worthwhile.

Then we can discard B from the experiment and projecting the 2^3 factorial design to 2^2 factorial design. Then there should be 4 replicates for the new projected model. The analysis result for the new projected model is:

```
> summary(res.aov)
            Df Sum Sq Mean Sq F value   Pr(>F)    
A            1  915.1   915.1  85.287 8.40e-07 ***
C            1  451.6   451.6  42.087 2.99e-05 ***
A:C          1    1.6     1.6   0.146    0.709    
Residuals   12  128.7    10.7                     
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Figure 4 The Projection model ANOVA Table

```
> summary(res.lm)

Call:
lm(formula = SpicyLevel ~ A * C, data = SpicyLevel_Data)

Residuals:
   Min     1Q Median     3Q    Max 
-5.250 -1.625  0.500  1.188  4.750 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept)  23.0625     0.8189  28.163 2.49e-12 ***
A             7.5625     0.8189   9.235 8.40e-07 ***
C            -5.3125     0.8189  -6.487 2.99e-05 ***
A:C          -0.3125     0.8189  -0.382    0.709    
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 3.276 on 12 degrees of freedom
Multiple R-squared:  0.914,	Adjusted R-squared:  0.8925 
F-statistic: 42.51 on 3 and 12 DF,  p-value: 1.143e-06
```

Figure 5 Parameter Estimate for Projected model

From the analysis result above, the interaction of factor A and C are not significant, so the final should drop the interaction and remain the main factor A and C. The analysis result for the final model are presented following:

```
Call:
lm(formula = SpicyLevel ~ A * C - A:C, data = SpicyLevel_Data)

Residuals:
    Min      1Q  Median      3Q     Max 
-4.9375 -1.4688  0.4375  1.1250  5.0625 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept)  23.0625     0.7915  29.137 3.16e-13 ***
A             7.5625     0.7915   9.554 3.05e-07 ***
C            -5.3125     0.7915  -6.712 1.44e-05 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 3.166 on 13 degrees of freedom
Multiple R-squared:  0.9129,	Adjusted R-squared:  0.8996 
F-statistic: 68.17 on 2 and 13 DF,  p-value: 1.284e-07
```

Figure 6 Final Model Parameter Estimates

```
          Df Sum Sq Mean Sq F value   Pr(>F)    
A          1  915.1   915.1   91.29 3.05e-07 ***
C          1  451.6   451.6   45.05 1.44e-05 ***
Residuals 13  130.3    10.0                     
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Figure 7 Final model ANOVA Table

From the result above, the final model should only contain factor A and C. All the terms are using is significant in the final model. Then check the normal probability and residuals. From the result showing on the Appendix, the normal Q-Q plot for residuals (figure 8) are randomly rely on the line, and tend to increase from beginning to the end, the normal probability test (figure 9) has a very high p-value which do not reject null hypothesis and has significant evidence that the residuals are in the normal distribution. The last plot (figure 10) are looks not in a same pattern for variability, it may contain outliers or due to the projection.

Discussion:

Reviewing the parameter estimates for the final linear model, the factor A, the types of chili are using and factor C, the amount water are using in the cooking has significant influence on the spicy level of Ma-po tofu, the bean-based sauce do not have significant effect on the spicy level of Ma-po tofu. The types of chili are using in the Ma-po tofu has positive effect on spicy level since the estimate are positive and the amount of water are using in Ma-po tofu has negative effect on the spicy level of Ma-po tofu since the estimate are negative. Hence if want the Ma-po tofu to be spicy, the high level of Chili (Sichuan Chili) and lower level of amount water are using in the Cooking. The residual analysis also proves the result are significant and in normal distributed. The final model equation should be:

$$Y_{Level\ of\ Spicy} = 7.5625X_{Types\ of\ chilli} - 5.3125X_{amount\ of\ water\ are\ use} + 23.0625$$

However, there are several factor should consider in this experiment. First of all, the spicy score which given by the taster are quiet subjective. The level of acceptance for different people are unique. As for this bias, the experiment is designed to use the total score for each treatment combination which can effectively avoid the bias. In addition, because experiment is narrow down to 4 days, each meal has two runs to taste thus the second run result can be influenced by the previous run. This bias can be running for a block design, so for every run order with even number will be the block 1 and the run order with odd number will be the block 2. Then can apply the block effect -1 to the block 1, the reason for adding the block effect is when the taster tastes the pervious run, the spicy flavour will normally remain in their tongue, Therefore, the subtraction on the block will reduce the bias a little. The ANOVA table (Appendix Figure 11) for the blocking design are showing that the significant factor is remaining factor A and C, but the normal probability plot (Appendix Figure 12) are only label out the factor A is significant. The main result is not change.

There also some errors happened on the fixed variables for cooking an Ma-po tofu, it is very hard to keep the other materials are exactly same. Also for the temperature during the cook are slightly different, those factors are treated as nuisance factor and uncontrollable.

Conclusion:

In conclusion, the final model contributed for this experiment are $Y_{Level\ of\ Spicy} = 7.5625X_{Types\ of\ chilli} - 5.3125X_{amount\ of\ water\ are\ use} + 23.0625$. The types of chilli and amount of water do have significant effect on spicy level of Ma-po tofu but the bean-based sauce does not. The combination with highest level of types of chilli (Sichuan Chilli) combined with lowest level of amount water are using in the cooking (1/4 cups) will make the highest level of the spicy. The statistic model of full 2^3 factorial design are using for basic model and also combined with using the projection design and block design to reduce the residuals in this experiment.

As for the future study, the key point should be focusing on reduce the effect for the nuisance factor and adding more factors to this experiment to form more factor factorial design.

Appendix:

1. *Raw Data in Standard order:*

Treatment Combination	FACTORS			Runs								
	A: Types of Chili	B: Bean-based Sauce	C: Amount of water	Run Order	Replicate 1							
					Allen	Sun	Thea	Jacky	Delun	Average	Total
"(-1)"	-	-	-	1	3	4	5	5	3	4	20
a	+	-	-	14	6	7	9	9	7	7.6	38
b	-	+	-	5	4	4	5	5	3	4.2	21
ab	+	+	-	8	6	6	8	8	7	7	35
c	-	-	+	4	1	2	4	3	1	2.2	11
ac	+	-	+	9	4	5	5	5	3	4.4	22
bc	-	+	+	15	2	2	2	2	3	2.2	11
abc	+	+	+	6	5	4	5	5	4	4.6	23
					Replicate 2						
"(1)"	-	-	-	10	2	4	4	4	2	3.2	16
a	+	-	-	3	7	8	9	9	8	8.2	41
b	-	+	-	7	4	4	6	6	5	5	25
ab	+	+	-	13	6	6	7	6	6	6.2	31
c	-	-	+	12	1	2	3	2	1	1.8	9
ac	+	-	+	2	5	5	6	5	5	5.2	26
bc	-	+	+	11	2	3	3	2	1	2.2	11
abc	+	+	+	16	5	6	7	6	5	5.8	29

2. *Residual Analysis Plot:*

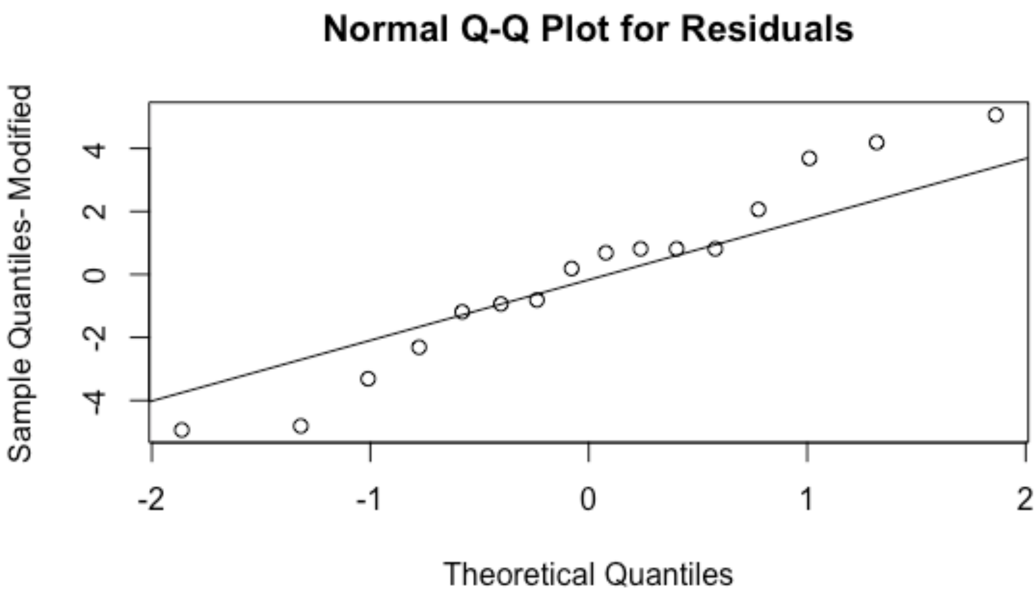

Figure 8 Normal Probability Plot for Final Model

```
        Shapiro-Wilk normality test

data:  SpicyLevel_residuals
W = 0.96287, p-value = 0.714
```

Figure 9 Normal Probability Test for Final Model

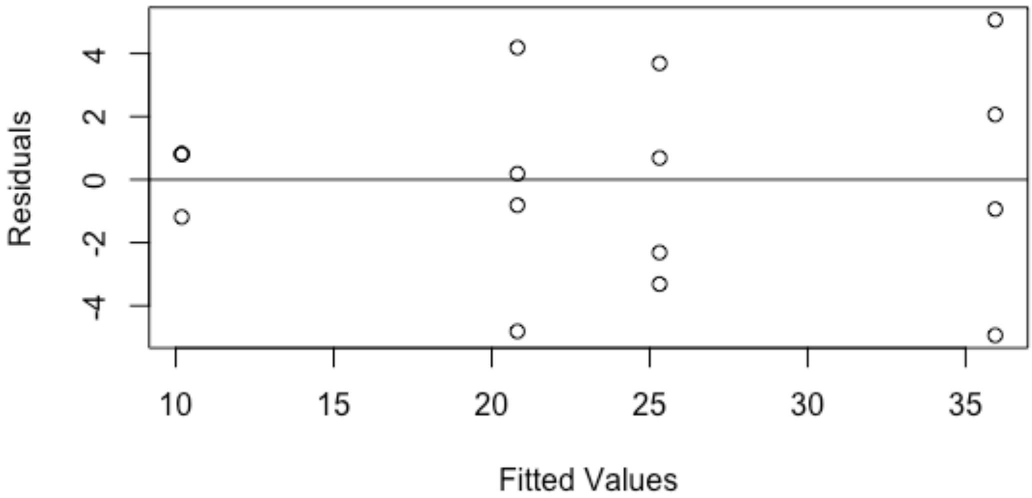

Figure 10 Residuals VS Fitted Values for Final Model

3. *Block Design Result:*

```
             Df Sum Sq Mean Sq F value   Pr(>F)    
A             1  945.6   945.6 117.409 1.26e-05 ***
B             1    0.1     0.1   0.008 0.932269    
C             1  430.6   430.6  53.462 0.000161 ***
Block1        1    0.8     0.8   0.101 0.760033    
A:B           1   32.6    32.6   4.047 0.084162 .  
A:C           1    1.6     1.6   0.194 0.672878    
B:C           1    5.1     5.1   0.629 0.453897    
A:B:C         1   33.3    33.3   4.141 0.081327 .  
Residuals     7   56.4     8.1                     
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Figure 11 Block Design ANOVA Table

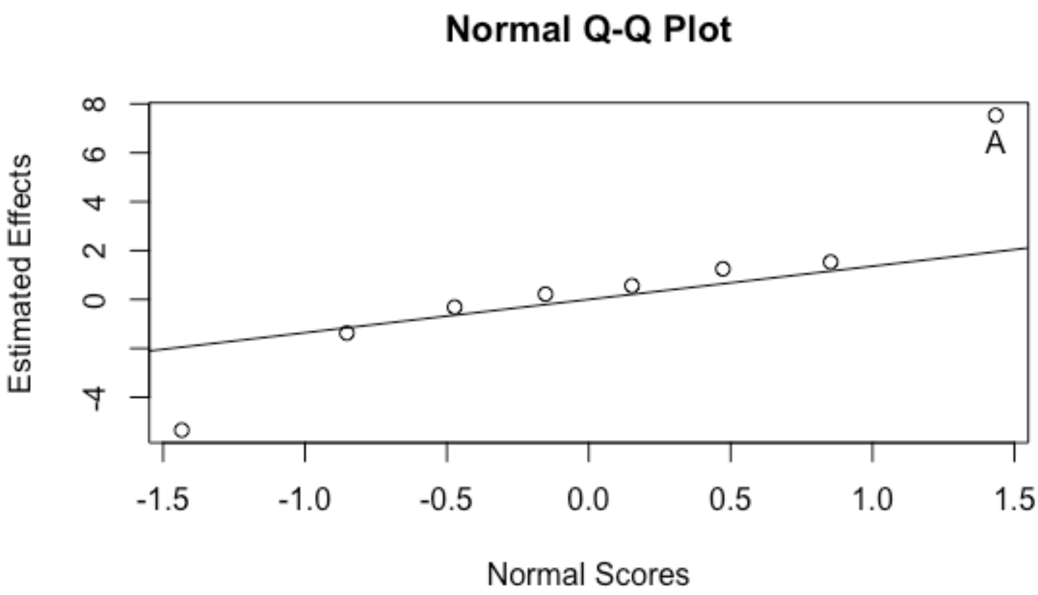

Figure 12 Block Design Normal Probability Design

4. The R Code (only contain test result not the plot):

```
#buliding the data frame
rm(list = ls())
A=rep(c(-1,1),4)
B=rep(c(rep(-1,2),rep(1,2)),2)
C=rep(c(rep(-1,4),rep(1,4)))

#enter the data and complete the data frame.
SpicyLevel=c(20,38,21,35,11,22,11,23,16,41,25,31,9,26,11,29)
SpicyLevel_Data <- data.frame(SpicyLevel, A,B,C)

#analysis the data
res.lm<-lm(SpicyLevel~A*B*C, data=SpicyLevel_Data)
summary(res.lm)

##
## Call:
## lm(formula = SpicyLevel ~ A * B * C, data = SpicyLevel_Data)
##
## Residuals:
##    Min     1Q Median     3Q    Max
##     -3     -2      0      2      3
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  23.0625     0.6644  34.713 5.19e-10 ***
## A             7.5625     0.6644  11.383 3.20e-06 ***
## B             0.1875     0.6644   0.282   0.7849
## C            -5.3125     0.6644  -7.996 4.38e-05 ***
## A:B          -1.3125     0.6644  -1.976   0.0836 .
## A:C          -0.3125     0.6644  -0.470   0.6507
## B:C           0.5625     0.6644   0.847   0.4218
## A:B:C         1.5625     0.6644   2.352   0.0466 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.658 on 8 degrees of freedom
## Multiple R-squared:  0.9623, Adjusted R-squared:  0.9292
## F-statistic: 29.14 on 7 and 8 DF,  p-value: 4.41e-05

res.aov<-aov(SpicyLevel~A*B*C,data=SpicyLevel_Data)
summary(res.aov)
```

```
##             Df Sum Sq Mean Sq F value   Pr(>F)    
## A            1  915.1   915.1 129.566 3.20e-06 ***
## B            1    0.6     0.6   0.080   0.7849    
## C            1  451.6   451.6  63.938 4.38e-05 ***
## A:B          1   27.6    27.6   3.903   0.0836 .  
## A:C          1    1.6     1.6   0.221   0.6507    
## B:C          1    5.1     5.1   0.717   0.4218    
## A:B:C        1   39.1    39.1   5.531   0.0466 *  
## Residuals    8   56.5     7.1                     
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#Normal probability plot
library(daewr)
```

```
## Registered S3 method overwritten by 'DoE.base':
##   method           from       
##   factorize.factor conf.design
```

```
fullnormal(coef(res.lm)[-1],alpha=.025)
```

```
#Projected model
res.aov<-aov(SpicyLevel~A*C,data=SpicyLevel_Data)
summary(res.aov)
```

```
##             Df Sum Sq Mean Sq F value   Pr(>F)    
## A            1  915.1   915.1  85.287 8.40e-07 ***
## C            1  451.6   451.6  42.087 2.99e-05 ***
## A:C          1    1.6     1.6   0.146    0.709    
## Residuals   12  128.7    10.7                     
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
res.lm<-lm(SpicyLevel~A*C, data=SpicyLevel_Data)
summary(res.lm)
```

```
## 
## Call:
## lm(formula = SpicyLevel ~ A * C, data = SpicyLevel_Data)
## 
## Residuals:
##    Min     1Q Median     3Q    Max 
## -5.250 -1.625  0.500  1.188  4.750 
## 
## Coefficients:
```

```
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  23.0625     0.8189  28.163 2.49e-12 ***
## A             7.5625     0.8189   9.235 8.40e-07 ***
## C            -5.3125     0.8189  -6.487 2.99e-05 ***
## A:C          -0.3125     0.8189  -0.382    0.709
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.276 on 12 degrees of freedom
## Multiple R-squared:  0.914,  Adjusted R-squared:  0.8925
## F-statistic: 42.51 on 3 and 12 DF,  p-value: 1.143e-06
```

```r
#Final model - remove non-significant terms
res.lm<-lm(SpicyLevel~A*C-A:C, data=SpicyLevel_Data)
summary(res.lm)
```

```
##
## Call:
## lm(formula = SpicyLevel ~ A * C - A:C, data = SpicyLevel_Data)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -4.9375 -1.4688  0.4375  1.1250  5.0625
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  23.0625     0.7915  29.137 3.16e-13 ***
## A             7.5625     0.7915   9.554 3.05e-07 ***
## C            -5.3125     0.7915  -6.712 1.44e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.166 on 13 degrees of freedom
## Multiple R-squared:  0.9129, Adjusted R-squared:  0.8996
## F-statistic: 68.17 on 2 and 13 DF,  p-value: 1.284e-07
```

```r
res.aov<-aov(SpicyLevel~A*C-A:C,data=SpicyLevel_Data)
summary(res.aov)
```

```
##             Df Sum Sq Mean Sq F value   Pr(>F)
## A            1  915.1   915.1   91.29 3.05e-07 ***
## C            1  451.6   451.6   45.05 1.44e-05 ***
## Residuals   13  130.3    10.0
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#Residual Analysis
#Normality
SpicyLevel_residuals=res.aov$residuals
qqnorm(SpicyLevel_residuals, ylim=c(min(SpicyLevel_residuals),max(Sp
icyLevel_residuals)), main = "Normal Q-Q Plot for Residuals",
      xlab = "Theoretical Quantiles", ylab = "Sample Quantiles- Modif
ied",
      plot.it = TRUE, datax = FALSE)

qqline(SpicyLevel_residuals, datax = FALSE, distribution = qnorm)
```

```
#Test normality using Shapiro Wilks
shapiro.test(SpicyLevel_residuals)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  SpicyLevel_residuals
## W = 0.96287, p-value = 0.714
```

```
#Check Variance
Fitted_values=res.aov$fitted.values
plot(Fitted_values,SpicyLevel_residuals,ylab="Residuals",xlab="Fitte
d Values")
abline(h=0)
```

```
# Block design
#Introducing Block effect
#Modification 1- counfound ABCD with blocks
Block1=c(1,2,1,2,2,1,1,2,2,1,1,1,2,2,1,2)
#Modified response variable
SpicyLevelRate_Mod=SpicyLevel;
SpicyLevelRate_Mod[Block1==1]=SpicyLevelRate_Mod[Block1==1]-1
SpicyLevelRate_Data_Mod <- data.frame(SpicyLevelRate_Mod, A,B,C)
res.aov2<-aov(SpicyLevelRate_Mod~A*B*C+Block1,data=SpicyLevelRate_Da
ta_Mod)
summary(res.aov2)
```

```
##             Df Sum Sq Mean Sq F value   Pr(>F)
## A            1  945.6   945.6 117.409 1.26e-05 ***
## B            1    0.1     0.1   0.008 0.932269
## C            1  430.6   430.6  53.462 0.000161 ***
```

```
## Block1       1    0.8     0.8   0.101 0.760033
## A:B          1   32.6    32.6   4.047 0.084162 .
## A:C          1    1.6     1.6   0.194 0.672878
## B:C          1    5.1     5.1   0.629 0.453897
## A:B:C        1   33.3    33.3   4.141 0.081327 .
## Residuals    7   56.4     8.1
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
res.lm2<-lm(SpicyLevelRate_Mod~A*B*C+Block1, data=SpicyLevelRate_Dat
a_Mod)
fullnormal(coef(res.lm2)[-1],alpha=.025)
```

Reference:

1. The slides are using for STAT 453 (2021 Spring) course at University of Victoria made by Dr. Michelle Miranda.