ESCUELA DE
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Impact Strength Of Insulation Cuts

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PROBLEM

The main premise of the research is that, in the following experimental situation about Impact Strength Of Insulation cuts applies treatment of analysis of the data to be able to compare them. We use this way to get a answer to our problem. For that we using two-way ANOVA model. In order to compare the null hypothesis against the alternative hypothesis. In addition, we use the variables Lot, Cut, and Strength(Figure 1). Moreover, we are going to use the data of the Figure 1 to calculate the points of lot, boxplot of lot, points of cut, boxplot of cut, and analyze the results. Finally we use the ANOVA and we analyze its table.

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Lot	Cut	Strength	Lot	Cut	Strength	Lot	Cut	Strength	Lot	Cut	Strength
L1	Cross	0.46	L2	Cross	1.03	L3	Length	0.59	L4	Length	0.86
L1	Cross	0.67	L2	Cross	1.06	L3	Length	0.63	L4	Length	0.92
L1	Cross	0.69	L2	Cross	1.17	L3	Length	0.64	L4	Length	0.93
L1	Cross	0.73	L2	Cross	1.18	L3	Length	0.64	L4	Length	0.96
L1	Cross	0.77	L2	Cross	1.32	L3	Length	0.65	L4	Length	0.98
L1	Cross	0.78	L2	Length	0.80	L3	Length	0.68	L5	Cross	0.45
L1	Cross	0.79	L2	Length	0.85	L3	Length	0.72	L5	Cross	0.47
L1	Cross	0.80	L2	Length	0.87	L3	Length	0.75	L5	Cross	0.47
L1	Cross	0.85	L2	Length	0.97	L3	Length	0.79	L5	Cross	0.52
L1	Cross	0.89	L2	Length	1.00	L3	Length	0.81	L5	Cross	0.53
L1	Length	0.84	L2	Length	1.01	L4	Cross	0.81	L5	Cross	0.54
L1	Length	0.86	L2	Length	1.08	L4	Cross	0.82	L5	Cross	0.55
L1	Length	0.87	L2	Length	1.09	L4	Cross	0.86	L5	Cross	0.56
L1	Length	0.88	L2	Length	1.14	L4	Cross	0.87	L5	Cross	0.57
L1	Length	0.88	L2	Length	1.16	L4	Cross	0.88	L5	Cross	0.60
L1	Length	0.91	L3	Cross	0.52	L4	Cross	0.89	L5	Length	0.44
L1	Length	0.92	L3	Cross	0.52	L4	Cross	0.90	L5	Length	0.47
L1	Length	0.93	L3	Cross	0.58	L4	Cross	0.93	L5	Length	0.48
L1	Length	0.95	L3	Cross	0.59	L4	Cross	0.97	L5	Length	0.49
L1	Length	1.15	L3	Cross	0.60	L4	Cross	1.06	L5	Length	0.51
L2	Cross	0.84	L3	Cross	0.63	L4	Length	0.79	L5	Length	0.53
L2	Cross	0.84	L3	Cross	0.64	L4	Length	0.79	L5	Length	0.59
L2	Cross	0.86	L3	Cross	0.65	L4	Length	0.81	L5	Length	0.61
L2	Cross	0.89	L3	Cross	0.71	L4	Length	0.82	L5	Length	0.67
L2	Cross	1.03	L3	Cross	0.80	L4	Length	0.84	L5	Length	0.72

Figure 1: Data of the variables of impact strength of insulation cuts in foot-pounds.

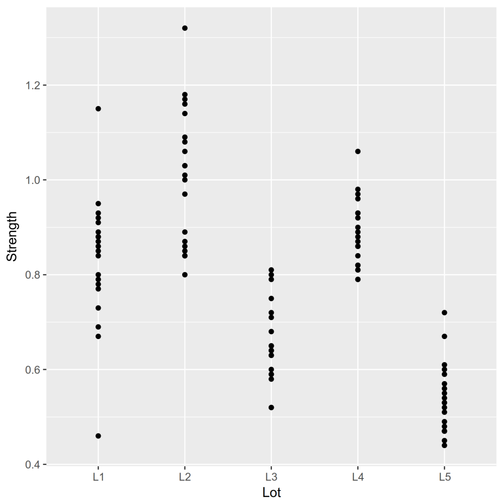

Figure 2: Points of Lot: lot of insulating material vs Strength: impact strength in foot-pounds.

In the figure 2, we could observe more variation in L1 and L2, the other lots are distributed in a determined strength rank.

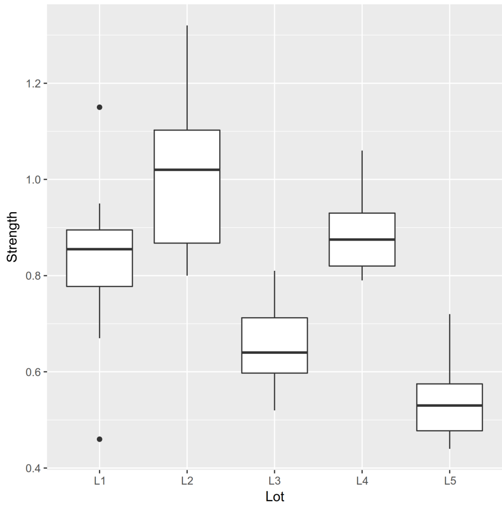

Figure 3: Boxplot of Lot: lot of insulating material vs Strength: impact strength in foot-pounds.

In the figure 3, the lot of insulating material L2, L4 and L5 has more resistance at the impact strength in foot-pounds, while L3 and L5 has the less resistance. Furthermore, in L1 there are two suspected outliers.

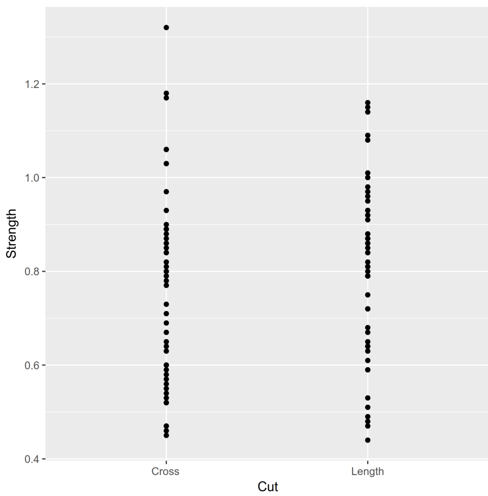

Figure 4: Points of Cut: cut lengthwise (length) or crosswise (cross) vs Strength: impact strength in foot-pounds.

In the figure 4, we could observe more variation of the data in the cut lengthwise (length) than in crosswise (cross).

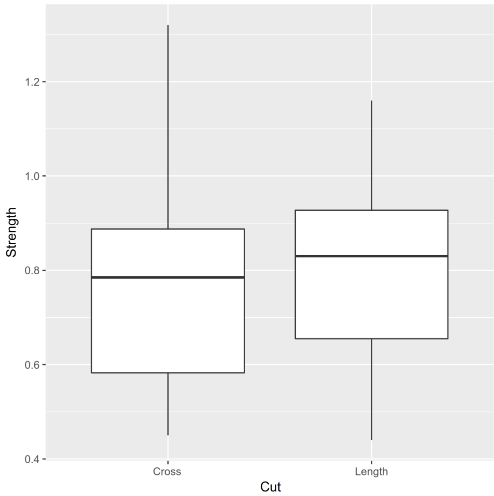

Figure 5: Boxplot of Cut: cut lengthwise (length) or crosswise (cross) vs Strength: impact strength in foot-pounds.

In the figure 5, we could observe that the median of the cut length and cross are similar. Then, the impact strength in foot-pounds almost unchanged.

Now we need to evaluate our model between the response variable Strength with the explanatory variable Lot and Cut, then the model will be $Strength = Lot * Cut$. There are difference between the lots according to the Table 1 because we can reject the null hypothesis, also the interaction between the Lot and Cut is significant because we reject the null hypothesis.

Coefficient	**p-value**
LotL1	<2e-16
LotL2	1.28e-08
LotL3	0.008994
LotL4	0.000725
LotL5	4.76e-06
CutLength	0.000155
LotL2:CutLength	0.001963
LotL3:CutLength	0.084338
LotL4:CutLength	0.001610
LotL5:CutLength	0.018651

Table 1: Model summary evaluated by R.

Using the ANOVA Table 2, the Lot is significant by a significance level very near to 0, and the p value equal to 2.2e-16. While the Cut is important using a 0.01 significance level, and the interaction between the Lot and Cut is significant taking into account the p value 0.009504, so we reject the null hypothesis.

	p-value
Lot	<2e-16
Cut	0.035272
Lot:Cut	0.009504

Table 2: ANOVA table used in our model.

APPENDIX: R CODE

```r
library(ggplot2)
data <- read.table("table142.txt", header=T, sep=";")
data

# Points of  Lot: lot of insulating material
# vs strength: impact strength
ggplot(data, aes(Lot, Strength)) +
   geom_point()

# Boxplot of  Lot: lot of insulating material
#vs strength: impact strength
# in foot-pounds.
ggplot(data, aes( Lot , Strength)) +
   geom_boxplot()

# Points of Cut: cut lengthwise (length) or crosswise (cross)
# vs strength: impact strength in foot-pounds.
ggplot(data, aes(Cut, Strength)) +
   geom_point()

# Boxplot of Cut: cut lengthwise (length) or crosswise (cross)
# vs strength: impact strength in foot-pounds.
ggplot(data, aes(Cut, Strength)) +
   geom_boxplot()

## The model Strength=Lot*Cut
mod1 <- lm(Strength~Lot*Cut, data=data, x=T)
mod1
# Summary of our model
summary(mod1)
# Anova table of our model
anova(mod1)
```