



POWER AHEAD

BUSINESS REPORT

of

Inferential Statistics

PDS Coded Project

PGP – DSBA

Major Analysis Covers : Inferential, Estimation, Hypothesis

And Common Statistical tests

Submitted by : Yash Juneja

INDEX

Problem 1

A physiotherapist with a male football team is interested in studying the relationship between foot injuries and the positions at which the players play from the data collected.

- 1.1 What is the probability that a randomly chosen player would suffer an injury?..4
- 1.2 What is the probability that a player is a forward or a winger?.....4
- 1.3 What is the probability that a randomly chosen player plays in a striker position and has a foot injury?.....4
- 1.4 What is the probability that a randomly chosen injured player is a striker?.....5

Problem 2

The breaking strength of gunny bags used for packaging cement is normally distributed with a mean of 5 kg per sq. centimeter and a standard deviation of 1.5 kg per sq. centimeter. The quality team of the cement company wants to know the following about the packaging material to better understand wastage or pilferage within the supply chain; Answer the questions below based on the given information

- 2.1 What proportion of the gunny bags have a breaking strength of less than 3.17 kg per sq cm?.....5
- 2.2 What proportion of the gunny bags have a breaking strength of at least 3.6 kg per sq cm.?5
- 2.3 What proportion of the gunny bags have a breaking strength between 5 and 5.5 kg per sq cm.?6
- 2.4 What proportion of the gunny bags have a breaking strength NOT between 3 and 7.5 kg per sq cm.?6

Problem 3

Zingaro stone printing is a company that specializes in printing images or patterns on polished or unpolished stones. However, for the optimum level of printing of the image, the stone surface has to have a Brinell's hardness index of at least 150.

Recently, Zingaro has received a batch of polished and unpolished stones from its clients.

- 3.1 Zingaro has reason to believe that the unpolished stones may not be suitable for printing. Do you think Zingaro is justified in thinking so?7
- 3.2 Is the mean hardness of the polished and unpolished stones the same?.....8

Problem 4

Dental implant data: The hardness of metal implants in dental cavities depends on multiple factors, such as the method of implant, the temperature at which the metal is treated, the alloy used as well as the dentists who may favor one method above another and may work better in his/her favorite method. The response is the variable of interest.

4.1 How does the hardness of implants vary depending on dentists?.....	8
4.2 How does the hardness of implants vary depending on methods?.....	9
4.3 What is the interaction effect between the dentist and method on the hardness of dental implants for each type of alloy?.....	10
4.4 How does the hardness of implants vary depending on dentists and methods together?.....	10

Problem 1

A physiotherapist with a male football team is interested in studying the relationship between foot injuries and the positions at which the players play from the data collected.

	Striker	Forward	Attacking Midfielder	Winger	Total
Players Injured	45	56	24	20	145
Players Not Injured	32	38	11	9	90
Total	77	94	35	29	235

1.1 What is the probability that a randomly chosen player would suffer an injury?

Solution : Probability that randomly chosen player would suffer an injury is :-

Total Number of Players Injured/Total Number of players

$$= 145/235$$

$$= 0.62$$

1.2 What is the probability that a player is a forward or a winger?

Solution : Probability that a player is a forward or a winger is :-

(Total number of Forward + Total number of Winger) / Total number of players

$$= (94+29)/235$$

$$= 123/235 = 0.52$$

1.3 What is the probability that a randomly chosen player plays in a striker position and has a foot injury?

Solution : Probability that a randomly chosen player plays in a striker position and has a foot injury is :-

Number of Injured Striker Players / Total number of players

$$= 45/235$$

$$= 0.19$$

1.4 What is the probability that a randomly chosen injured player is a striker?

Solution : Probability that a randomly chosen injured player is a striker is :-

Number of Injured Striker Players / Total number of Injured players

$$= 45/145$$

$$= 0.31$$

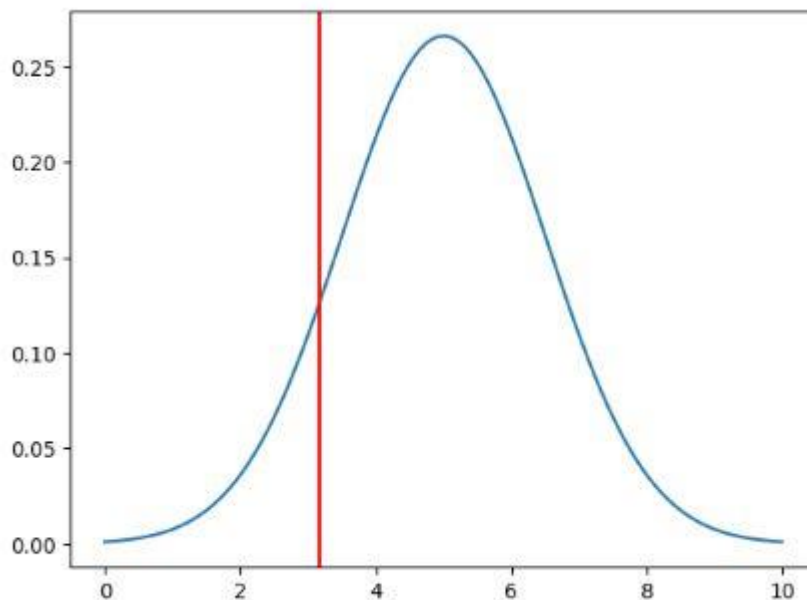
Problem 2

The breaking strength of gunny bags used for packaging cement is normally distributed with a mean of 5 kg per sq. centimeter and a standard deviation of 1.5 kg per sq. centimeter. The quality team of the cement company wants to know the following about the packaging material to better understand wastage or pilferage within the supply chain

Solution : $\mu = 5$, $\sigma = 1.5$

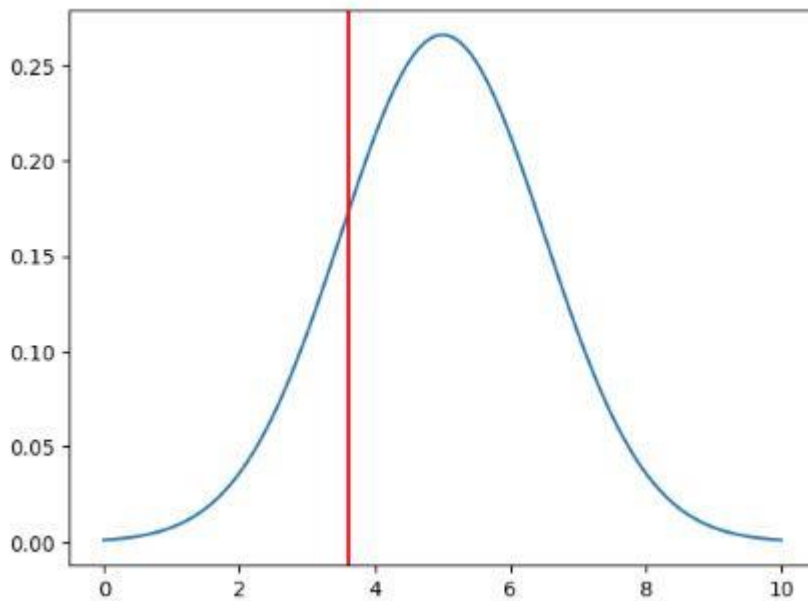
2.1 What proportion of the gunny bags have a breaking strength of less than 3.17 kg per sq cm?

Solution :- $P(X < 3.17) = 0.11$ (11%)



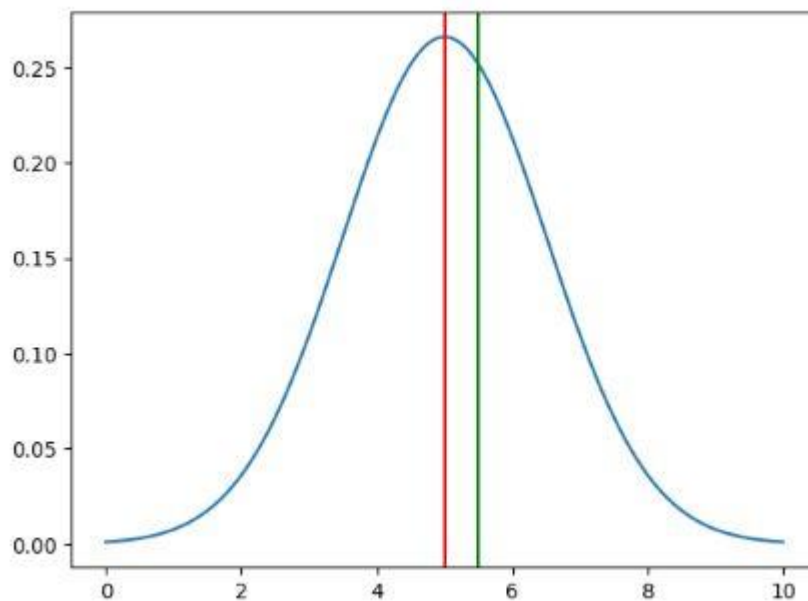
2.2 What proportion of the gunny bags have a breaking strength of at least 3.6 kg per sq cm.?

Solution :- $P(X \geq 3.6) = 1 - P(X < 3.6) = 0.82$ (82%)



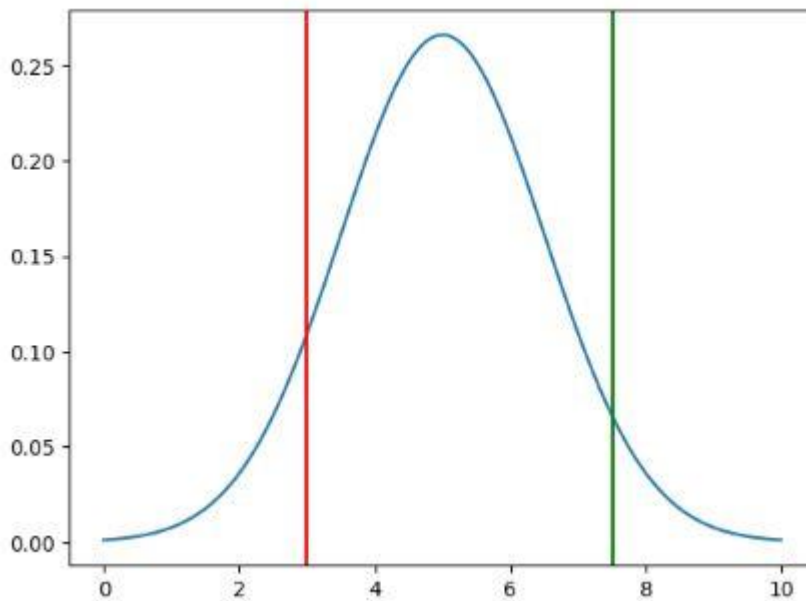
2.3 What proportion of the gunny bags have a breaking strength between 5 and 5.5 kg per sq cm.?

Solution :- $P(5 < X < 5.5) = P(X < 5.5) - (1 - P(X < 5)) = 0.13$ (13%)



2.4 What proportion of the gunny bags have a breaking strength NOT between 3 and 7.5 kg per sq cm.?

Solution :- $P(X < 3 \text{ and } X > 7.5) = P(X < 3) + (1 - P(X < 7.5)) = 0.14$ (14%)



Problem 3

Zingaro stone printing is a company that specializes in printing images or patterns on polished or unpolished stones. However, for the optimum level of printing of the image, the stone surface has to have a Brinell's hardness index of at least 150. Recently, Zingaro has received a batch of polished and unpolished stones from its clients. Use the data provided to answer the following (assuming a 5% significance level);

3.1 Zingaro has reason to believe that the unpolished stones may not be suitable for printing. Do you think Zingaro is justified in thinking so?

Solution :-

H_0 (Null Hypothesis) ≥ 150

H_1 (Alternate Hypothesis) < 150

Given Alpha = 0.05

	Unpolished	Treated and Polished
count	75.000000	75.000000
mean	134.110527	147.788117
std	33.041804	15.587355
min	48.406838	107.524167

Mean hardness of unpolished stones = 134.11
t-statistic = -4.165
p-value = 0.000042

Test Statistic and P-Value of Treated and Polished

```
[158] 1  hyp_mean = 150
      2  t_stat, p_value = stats.ttest_ind(df['Treated and Polished'], hyp_mean,
      alternative='two-sided') # alternative argument is used to specify the tail of
      the test.
      3
      4  print("Test Statistic =",t_stat)
      5  print("p-value =",p_value)

↩ Test Statistic = -0.14096572086923168
  p-value = 0.8882800551824692
```

Since, the P value 0.00004 in case of Unpolished, is less than significant level (0.05), we reject the null hypothesis, So Unpolished stones donot have a hardness effect of atleast 150.

While in case of Treated and Polished P value 0.88 is greater than 0.05, Null Hypothesis cannot be rejected, So Treated and Polished have hardness effect of atleast 150.

3.2 Is the mean hardness of the polished and unpolished stones the same?

Solution :

P-Value of UnPolished & Treated and Polished

```
[ ] 1  #import the required functions
      2  from scipy.stats import ttest_ind
      3
      4  # find the p-value
      5  test_stat, p_value = ttest_ind(Zingaro_Company['Unpolished'], Zingaro_Company
      ['Treated and Polished'], equal_var = True, alternative = 'two-sided')
      6  print('The p-value is ' + str(p_value))

↩ The p-value is 0.0014655150194628353
```

Since the P value 0.001 is less than 0.05, We Reject the Null Hypothesis

This Indicates that there is a Significant Difference between the mean of Polished and Unpolished Stones.

Problem 4

Dental implant data: The hardness of metal implants in dental cavities depends on multiple factors, such as the method of implant, the temperature at which the metal is treated, the alloy used as well as the dentists who may favor one method above another and may work better in his/her favorite method. The response is the variable of interest.

4.1 How does the hardness of implants vary depending on dentists?

Solution :

Ho (Null Hypothesis) = No Difference in the mean hardness of dental implant among all dentists

H1 (Alternate Hypothesis) = There is a Difference in the mean hardness of dental implant among all dentists

```
C(Dentist)
PR(>F)
2.529105e-02
```

Conclusion from the Test Results :-

- The P value for C(dentist) is 2.529105e-02 which is less than 0.05
- This Indicates that there is a significant effect of dentists on the hardness of implants.

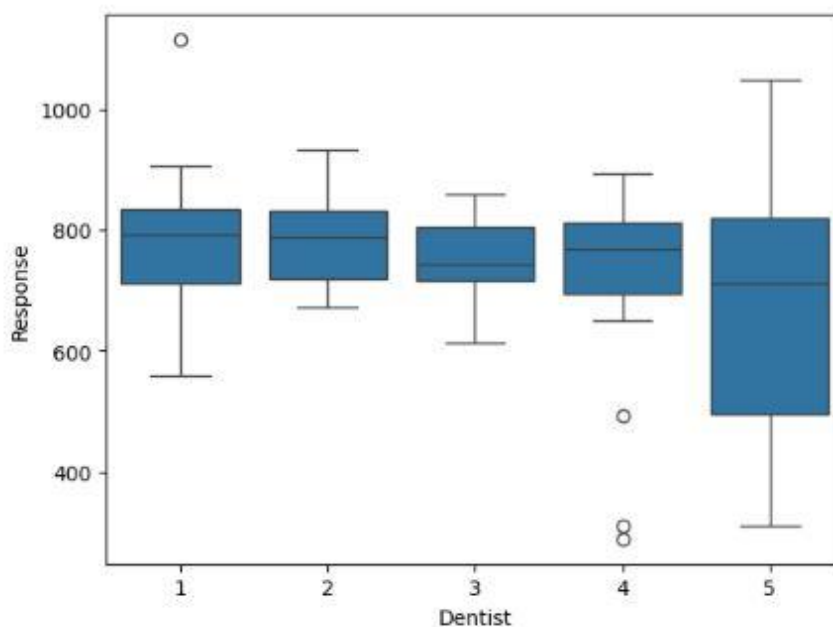


Fig : Hardness of Implant by Dentist

4.2 How does the hardness of implants vary depending on methods?

Solution :

	df	sum_sq	mean_sq	F	PR(>F)
C(Method)	2.0	5.934275e+05	296713.744444	17.610109	3.787606e-07
Residual	87.0	1.465868e+06	16849.058238	NaN	NaN

- The P-value for C(Method) is 3.787606e-07, which is much less than 0.05

- This Indicates that there is a significant effect of dentists on the hardness of implants.

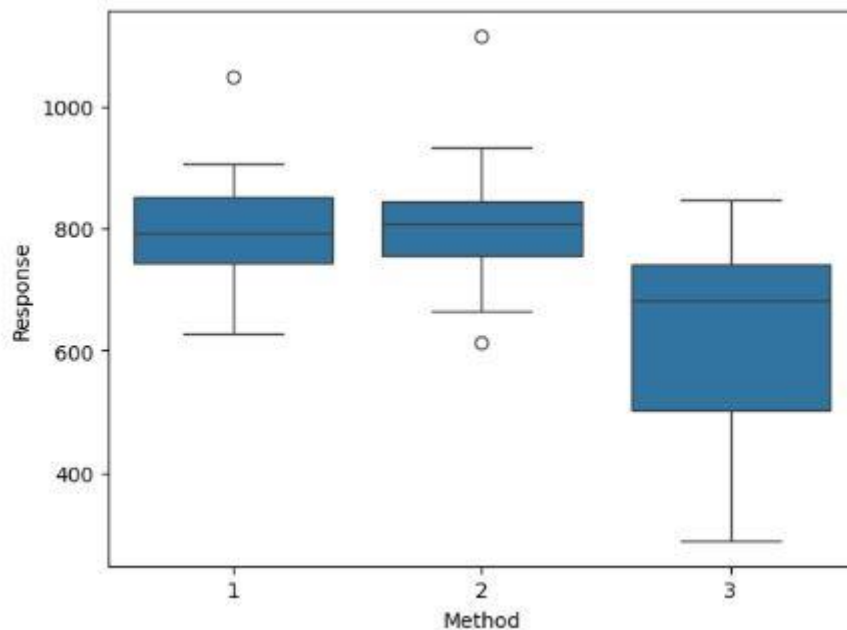


Fig : Hardness of Implant by Method

4.3 What is the interaction effect between the dentist and method on the hardness of dental implants for each type of alloy?

Solution :

```
C(Dentist):C(Method):C(Alloy) 6.382781e-01
Residual                      NaN
```

The P value for C(Dentist):C(Method):C(Alloy) is 6.382781e-01, which is greater than 0.05

This Indicates that there is no significant effect between dentists, method and alloy on the hardness of implants.

4.4 How does the hardness of implants vary depending on dentists and methods together?

Solution :

```
C(Dentist):C(Method) 7.709152e-03
Residual              NaN
```

- The P Value for C(Dentist):C(Method) is 7.709152e-03, which is less than 0.05

- This indicates that there is statically joint effect of Dentist and Method on the hardness of implants.

Conclusion :

- The Hardness of Implants significantly dependent upon Both Dentist and Method.
- There is Significant joint effect of Dentist and Method on the hardness of implants.
- There is no significant interaction between Dentist, Method and alloy on the hardness of implants.
- This Analysis provides insights into how different factors influence the hardness of implants, which is useful in decision making for dental practice.