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Question: The tensile strength of a synthetic fiber was of interest to the ...

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2. (30 points) The tensile strength of a synthetic fiber was of interest to the manufacturer. It is suspected that strength is related to the percentage of cotton in the fiber. Five levels of cotton percentage were used, and five replicates were run in random order, resulting in the following data.

Cotton percentage	1	2	3	4	5
15	7	7	15	11	9
20	12	17	12	18	18
25	14	18	18	19	19
30	19	25	22	19	23
35	7	10	11	15	11

a) Test the hypothesis that the percentage of cotton affect the tensile strength. Use $\alpha=0.05$
 b) Find the p-value for the F-statistic computed in part a)
 c) Estimate σ^2 .

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Expert Answer ⓘ

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Answer:

In the given data, the tensile strength of synthetic fibre under 5 different percentages of cotton are measured.

Test the data whether there is significant difference between the means or not at $\alpha = 0.05$ level of significance.

State the null and alternative hypotheses for the given scenario as below.

$$H_0: \mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$$

$$H_1: \text{At least one } \mu_i \text{ is different} \quad (i = 1, 2, 3, 4, 5)$$

Test the hypothesis at $\alpha = 0.05$ level of significance.

Use the following MINITAB instructions to conduct ANOVA for the given data.

- 1) Import the data into MINITAB worksheet.
- 2) From the menu bar, select **Stat** → **ANOVA** → **One-Way**...
- 3) Select the data columns into **Responses** field.
- 4) Define the **Confidence level** as "95.0".
- 5) Click on **Comparisons**.
- 6) Check the option **Fisher's, individual error rate** and define the value as **5**.
- 7) Click on **Graphs**.
- 8) Check the option **Boxplots of data**.
- 9) Click on **OK** and again on **OK**.

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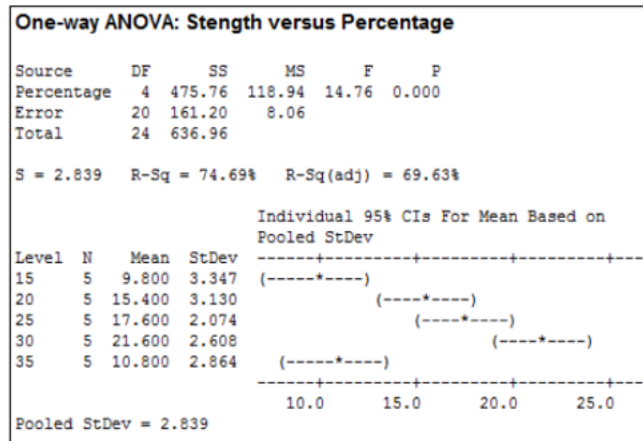
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Thus, the resultant ANOVA is summarized as below.



From the output, the F -statistic is obtained as $F = 14.76$.

The corresponding p -value of the test statistic at $(4, 20)$ degrees of freedom is obtained as $p = 0.000$.

As the p -value is less than $\alpha = 0.05$ level of significance, so reject the null hypothesis.

Therefore, the mean tensile strength of synthetic fibre under 5 different percentages will differ significantly.

(a)

From the results of ANOVA, one can conclude that the mean tensile strength of synthetic fibre under 5 different percentages of cotton will differ significantly.

The Fisher's LSD method is applied when there is significant difference between the means of the treatments.

State the null and alternative hypotheses for pairwise comparisons of means as follows:

$$\begin{array}{ll}
 H_{01} : \mu_1 = \mu_2 & H_{11} : \mu_1 \neq \mu_2 \\
 H_{02} : \mu_1 = \mu_3 & H_{12} : \mu_1 \neq \mu_3 \\
 H_{03} : \mu_1 = \mu_4 & H_{13} : \mu_1 \neq \mu_4 \\
 H_{04} : \mu_1 = \mu_5 & H_{14} : \mu_1 \neq \mu_5 \\
 H_{05} : \mu_2 = \mu_3 & H_{15} : \mu_2 \neq \mu_3 \\
 H_{06} : \mu_2 = \mu_4 & H_{16} : \mu_2 \neq \mu_4 \\
 H_{07} : \mu_2 = \mu_5 & H_{17} : \mu_2 \neq \mu_5 \\
 H_{08} : \mu_3 = \mu_4 & H_{18} : \mu_3 \neq \mu_4 \\
 H_{09} : \mu_3 = \mu_5 & H_{19} : \mu_3 \neq \mu_5 \\
 H_{10} : \mu_4 = \mu_5 & H_{110} : \mu_4 \neq \mu_5
 \end{array}$$

Versus

Test the hypotheses at $\alpha = 0.05$ level of significance.


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Practice



Percentage	N	Mean	Grouping
30	5	21.600	A
25	5	17.600	B
20	5	15.400	B
35	5	10.800	C
15	5	9.800	C

Means that do not share a letter are significantly different.

Fisher 95% Individual Confidence Intervals
All Pairwise Comparisons among Levels of Percentage
Simultaneous confidence level = 73.57%

Percentage = 15 subtracted from:

Percentage	Lower	Center	Upper	
20	1.855	5.600	9.345	(---*---)
25	4.055	7.800	11.545	(---*---)
30	8.055	11.800	15.545	(---*---)
35	-2.745	1.000	4.745	(---*---)

-8.0 0.0 8.0 16.0

Percentage = 20 subtracted from:

Percentage	Lower	Center	Upper	
25	-1.545	2.200	5.945	(---*---)
30	2.455	6.200	9.945	(---*---)
35	-8.345	-4.600	-0.855	(---*---)

-8.0 0.0 8.0 16.0

Percentage = 25 subtracted from:

Percentage	Lower	Center	Upper	
30	0.255	4.000	7.745	(---*---)
35	-10.545	-6.800	-3.055	(---*---)

-8.0 0.0 8.0 16.0

Percentage = 30 subtracted from:

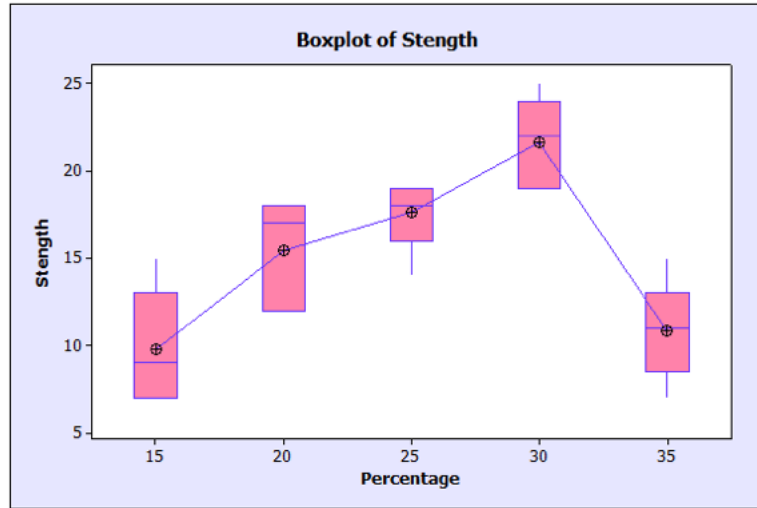
Percentage	Lower	Center	Upper	
35	-14.545	-10.800	-7.055	(---*---)

-8.0 0.0 8.0 16.0

From the above boxplot, it can be observed that the mean tensile strength of synthetic fibre under cotton percentages 15% and 35%, and the mean tensile strength of synthetic fibre under cotton percentages 20% and 25% are not significantly different and the mean tensile strength of synthetic fibre under cotton percentage 30% is significantly different from others.

(b)

The above MINITAB instructions (7) and (8) will plot a comparative boxplots with mean tensile strengths at each level of cotton percentages as follows:



From the above boxplot, it can be observed that the mean tensile strength of synthetic fibre under cotton percentages 15% and 35% are slightly closer, the mean tensile strength of synthetic fibre under cotton percentages 20% and 25% are slightly closer and the mean tensile strength of synthetic fibre under cotton percentage 30% is comparatively more than the others.

Therefore, the comparison through boxplot is similar to the Fisher's LSD method.

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Q: The tensile strength of a synthetic fiber was of interest to the manufacturer. It is suspected that strength is related to the percentage of cotton in the fiber. Five levels of cotton percentage were used, and five replicates were run in random order, resulting in the following data. a) Test the hypothesis that the percentage of cotton affect the tensile strength. Use $\alpha = 0.0$...

A: [See answer](#)

Questions viewed by other students

Q: A manufacturer is interested in testing the tensile strength of a synthetic fiber. We suspect strength is related to the percentage of cotton in the fiber. Five levels of cotton percentage were tested, and five data points were collected at each percentage. Observations cotton % 1 2 3 4 5 15 7 7 15 11 9 20 12 17 12 18 18 25 14 18 18 19 19 30 19 25 22 19 23 35 7 10 1...

A: [See answer](#) 100% (1 rating)

Q: Tensile strength of synthetic fiber, which contains different amount of cotton. It is suspected that strength is related to the percentage of cotton in the fiber. Five levels of cotton percentage were used (denoted as rows in table), and measurements took place in five days (denoted as columns). day cotton percentage 1 2 3 4 5 15 20 25 30 35 7 7 15 11 9 12 17 12 18 18 14 18 18 19 1...

A: [See answer](#)

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