P452: Computational Physics

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March 31, 2024

Assignment 3

Answer to Q.3

We have 5 bins in the data; A, B, C, D, and E. C is in the middle. This looks like a standard normal distribution. The total number of students is 600. All the calculations are given in the following table:

Letter grade	x-point	Observed frequency (O_i)	Expected frequency (E_i)	$(O_i - E_i)^2/E_i$
A	2	77	32.3946	61.4190
B	1	150	145.1824	0.1599
C	0	210	239.3654	3.6025
D	1	125	145.1824	2.8056
F	2	38	32.3946	0.9699

Table 1: Calculation

From the table we get: $v = 4$, $N = 600$, Chi-squared, $\chi^2 = 68.9570$
Now the $\chi^2_{critical}$ is 7.779 for 10% significance and 9.488 for 5% significance.
But the chi-square value we obtained is higher than these values.
Thus our initial assumption that the distribution is standard normal is wrong.
That is, our distribution is not standard normal at significance levels of 5% and 10%.

Answer to Q.4

Here, we need to determine whether the lenses in shipments A and B are from the same population using the F-test and t-test.
Welch's t-test:
Given the unequal variances and sample sizes, Welch's t-test was employed to compare the mean focal lengths of shipments A and B. The t-value was calculated using the formula:

$$t = \frac{|\mu_1 - \mu_2|}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

From the calculations presented in Table 2, the obtained t-value was found to be 0.6349. Referring to the t-table for a 5% significance level, the critical t-value (t_{crit}) was determined to be 2.101. Since the computed t-value is less than the critical value, we fail to reject the null

hypothesis (H_0), indicating no significant difference between the means of the two sample sets. This implies that there is no significant difference between the mean focal lengths of shipments A and B, with a confidence level of 95%.

F-test:
The F-value, representing the ratio of variances between shipments A and B, was computed as 1.8106. Utilizing the F-table with degrees of freedom 12 and 6, the critical value ($Q(F|12,6)$) was determined to be 2.905. Since the obtained F-value is notably lower than the critical value, we accept H_0. This indicates no significant difference between the variances of the two sample sets, with a confidence level of 90%.

Tables showing calculation:

Variable	Shipment A	Shipment B	Total
Mean (μ)	4.7146	4.7400	-
Standard Deviation (σ)	0.1013	0.0753	-
Variance (σ^2)	0.0103	0.0057	-
Sample Size (n)	13	7	-
t-value	-	-	0.63486
Degrees of Freedom	-	-	18.0000
F-value	-	-	1.81063

Table 2: Summary of calculations

Test	Result
T-test	No significant difference between mean of two sample sets at 95% confidence
F-test	No significant difference between the variance of the two sample sets at 90% confidence

Table 3: Summary of test results