Pabna University of Science and Technology

INFORMATION AND COMMUNICATION ENGINEERING

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T-Distribution and F-Distribution

Understanding Key Probability Distributions in Statistics

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Introduction

What are Probability Distributions?

Definition: A function that describes the likelihood of obtaining possible values for a random variable.

Importance: Used in hypothesis testing, confidence intervals, and regression analysis.

Focus of the Presentation: T-Distribution, F-Distribution

T-Distribution

Definition: Estimates population parameters when sample size is small and/or population variance is unknown.

Key Characteristics: Symmetrical and bell-shaped, heavier tails, df determines shape.

Formula:

$$\mathbf{T = (\bar{X} - \mu) / (s / \sqrt{n})}$$

Where:

$\bar{X}$ = sample mean,

μ = population mean,

s = sample std dev,

n = sample size

Applications of T-Distribution

When to Use: Small sample sizes ($n < 30$), unknown population std dev.

Examples: Student's t-test, Confidence intervals for small samples.

F-Distribution

Definition: Used to compare the variances of two populations.

Key Characteristics: Right-skewed, depends on df1 and df2.

Formula:

$$\mathbf{F = (s2^2 / \sigma2^2) / (s1^2 / \sigma1^2)}$$

Where:

$s1^2$ and $s2^2$ = sample variances,

$\sigma1^2$ and $\sigma2^2$ = population variances

Applications of F-Distribution

When to Use: ANOVA, comparing group means, regression significance.

Examples: Variance equality, regression model fit evaluation.

Comparison of T-Distribution and F-Distribution

Feature	T-Distribution	F-Distribution
Shape	Symmetrical, bell-shaped	Right-skewed
Degrees of Freedom	Single parameter (df)	Two parameters (df1, df2)
Use Case	Small samples, unknown variance	Comparing variances, ANOVA
Formula	$T = (\bar{X} - \mu) / (s / \sqrt{n})$	$F = (s2^2 / \sigma2^2) / (s1^2 / \sigma1^2)$

Practical Example

T-Distribution Example:

Scenario:

"A sample of 25 patients has an average blood pressure of 120 mmHg (s=15). Is this different from the population mean (μ=115)?"

Steps:

1) Calculate t-statistic:

$$t=120−11515/25=1.67t=15/25120−115=1.67$$

2) Compare to critical t-value (df=24, α=0.05): ±2.064.

3) Conclusion: "t=1.67 < 2.064 → Fail to reject H_0 (no significant difference)."

Practical Example

F-Distribution Example

Scenario:"Do two factories (A and B) have different product weight variances? Sample A: $s^2=25$ ($n=10$); Sample B: $s^2=16$ ($n=12$)."

Steps:

1) Calculate F-ratio:

$$F=2516=1.56F=1625=1.56$$

1) Compare to critical F-value ($df1=9$, $df2=11$, $\alpha=0.05$): 2.90.
2) Conclusion: "$F=1.56 < 2.90$ → Variances are not significantly different."

Conclusion

Summary

T-Distribution is used for small samples with unknown variance.
F-Distribution is used for comparing variances and ANOVA.

Importance

Both distributions are fundamental in statistical inference and hypothesis testing.

Final Thought

Understanding these distributions is crucial for data analysis and research.