FACULTY OF ENGINEERING

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DEPARTMENT OF INFORMATION AND COMMUNICATION ENGINEERING

Presentation

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Most powerful test

The term most powerful test in engineering statistic usally refers to a hypothesis test that has the higest power among all possible tests of a givensize(significance level).In more technical term:the most powerful test is the one that maximizes the probability of correctly rejecting the null hypothesis when the alternative hypothesis is true

This idea is formalized by the Neyman –Pearson Lemma,which gives a clear answer for the most powerful test when you re testing simple hypothesis.(i.e both the null and alternative hypotheses are fully specified)

Most powerful test (in theory):☞ Likelihood Ratio Test (LRT)Specifically, the Neyman-Pearson Likelihood Ratio Test is the most powerful for comparing two simple hypotheses:$H0$:θ=θ0
H 0 :θ=θ 0
$H1$:θ=θ1H 1 :θ=θ 1

Test	Use Case	Notes
t-test	Compare means (small samples)	Powerful when data is normal
ANOVA	Compare multiple group means	Generalizes t-test to 3+ groups
Chi-squared test	Test categorical data	Used in reliability testing,quality control
F-test	Compare variances	Used in regression, ANOVA
Likelihood Ratio Test (LRT)	Complex model comparisons	Powerful and flexible
Shapiro-Wilk / Anderson-Darling	Test for normality	Powerful for normality checks
Non-parametric tests (e.g., Mann-Whitney U)	For non-normal data	Good alternatives to t-tests

Most Powerful Test:

- A statistical test that has the greatest power of all tests with the same significance level. Suppose that the results of observations are to be used to test a hypothesis H0 against a simple alternative H1; let α be the (given) admissible probability of an error of the first kind — the error arising from the rejection of the hypothesis H0 being tested, according to a statistical test devised to test H0 against H1, when H0 is actually true. In the theory of statistical hypotheses testing, the best test of all those intended for testing H0 against H1 and offering the same probability of an error of the first kind, or, equivalently, having the same significance level α, is the test that has the highest power. In other words, the best test is the one that offers the highest probability of rejecting the hypothesis H0 being tested when the alternative H1 is true. This best test is called the most-powerful test of level α among all tests of leve intended for testing a simple hypothesis H0 against a simple alternative H1. Since the power of a statistical test is one minus the probability of an error of the second kind, the error arising from accepting H0 when it is in fact false, the concept of a most-powerful test is frequently formulated in terms of probabilities of errors of the first and second kinds: A most-powerful test is a test intended for testing a simple hypothesis against a simple alternative and offering the least probability of an error of the second kind among all tests with given probability of the error of the first kind. The problem of constructing most-powerful tests for simple hypotheses is solved by the Neyman–Pearson lemma, according to which the likelihood-ratio test is a most-powerful test.If the competing hypotheses H0 and H1 are compound, the problem of devising most-powerful tests is formulated in terms of a uniformly most-powerful test, if such a test exists.

Standard Errors:

- The standard error (SE) measures the variability or precision of a statistic (like a mean, proportion, regression coefficient, etc.) across different samples.Think of it this way:The standard deviation tells you how spread out individual data points are.The standard error tells you how spread out your estimate (like the mean) would be if you repeated the experiment many times.
- Type of SE Formula What it Measures
- Standard Error of the Mean (SEM) $SE=sn$SE= n s Precision of the sample mean
- Standard Error of a Proportion $SE=p(1-p)n$SE= np(1−p) Precision of a proportion
- SE of Regression Coefficients From matrix algebra in regression Used in hypothesis testing for modelparameters

- Pooled SE (for comparing means) Combines variance from two samples Used in t-tests for independent samples

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Why Are Standard Errors Important in Engineering?

- In engineering stats, SEs play a big role in:
- ✓ Confidence IntervalsE.g., a 95% CI for the mean:$\bar{x} \pm t * \cdot SE$x¯ ±t ∗ ·SE✓ Hypothesis TestingT-tests and Z-tests rely on SEs to compute test statistics.
- ✓ Quality Control & ReliabilitySE helps assess uncertainty in defect rates, lifetimes, etc.
- ✓ Design of Experiments (DOE)SEs tell you how precisely you've estimated effects of factors.🔧
- Quick Example:You measure the strength of 25 samples of a new alloy and get a mean of 100 MPa and standard deviation of 10 MPa.SE=10/root25=10/5=2 SE=2 So the standard error of the mean is 2 MPa. That tells you how much your mean might vary if you took another random sample of 25.