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Saturday, August 28, 2021 12:04 PM

Section 1

MANE 6313

Subsection 1

Week 2, Module B

Student Learning Outcome

Analyze simple comparative experiments and experiments with a single factor.

Module Learning Outcome

Review of (statistical) hypothesis testing.

Hypothesis Testing

H_0: accused ~~is~~ is innocent

H_1: accused is Not innocent

- A Statistical Hypothesis is a statement about the values of the parameters of a probability distribution. For example:

Decision
1) accept H_0 / fail to reject H_0
2) Reject H_0

$$H_0 : \mu = 1.500$$
$$H_A : \mu \neq 1.500$$

(two-tailed)

$H_0: p = .5$

$H_1: p \neq .5$

- The Null Hypothesis is given by H_0 and is assumed to be true
- The Alternative Hypothesis is given by H_A. We are trying to gather evidence to support the claim of the alternative hypothesis (H_1)
- Hypotheses may be either two-sided or one-sided

$H_1: N < 1.5$

$H_1: N > 1.5$

Hypothesis Testing

- You should be familiar with hypothesis testing.
- You are responsible for the following material:
  - Tests on means with variance known (Table 2-4)
  - Tests on means of normal distribution with variance unknown(Table 2-4)
  - Paired comparison test (section 2-5)
  - Tests on variances of normal distribution (Table 2-8)

Overview: Conducting a Test of Hypothesis

1. Take a random sample from the population under study
2. Compute the appropriate test statistic
3. Decide to either reject or fail to reject H_0

The set of values of the test statistic leading to the rejection of H_0 is called the rejection region or critical region.

Errors in Hypothesis Testing

- A Type I error occurs when the null hypothesis is true but the decision is made to reject H_0

typically $\alpha = .05$

$$\alpha = P\{\text{type I error}\} = P\{\text{reject } H_0 | H_0 \text{ is true}\}$$

experimentor controls α

- A Type II error occurs when the null hypothesis is false but the decision is made not to reject H_0

$$\beta = P\{\text{type II error}\} = P\{\text{ fail to reject } H_0 | H_0 \text{ is false}\}$$

better

$\beta = f(\alpha, n, \Delta)$

H_0: part is good
H_1: part is bad

Decision	Part is good	Part is bad
Good part	✓	type I error, Consumer's risk
Bad part	type I error, Producer's risk	✓

TABLE 4.1 Decision Errors in Hypothesis Testing

Decision	True H_0	False H_0
H_0 not rejected	No error with probability $1 - \alpha$	Type II error with probability β
H_0 rejected	Type I error with probability α	No error with probability $1 - \beta$

power

Source[1]

H_0: person is healthy
H_1: person is sick

Decision	healthy	Sick
healthy	✓	type II error, sick but told healthy
Sick	type I error, healthy but told sick	✓

[1] DeVor, Chang, Sutherland (2007). *Statistical Quality Design and Control: Contemporary Concepts and Methods, 2nd edition.* Pearson: Prentice-Hall.

Questions

1. Which type of error is the producer's risk?
2. Which type of error is the consumer's risk?

Classical Approach

Steps taken from [2]

1. Find parameter of interest
2. State null hypothesis, H_0
3. State alternative hypothesis, H_1
4. Calculate test statistic
5. Construct rejection region
6. State conclusion(s)

[2] Montgomery and Runger (2014). *Applied Statistics and Probability for Engineers, 6th edition*. John Wiley & Sons.

P-value Approach

- Similar in structure to classical approach

1. Find parameter of interest
2. State null hypothesis, H_0
3. State alternative hypothesis, H_1
4. Calculate p-value
5. State conclusion(s)

- Decision rule
  - If p-value $<$ ~~alpha~~ α reject H_0
  - else (p-value $>$ ~~alpha~~ α) fail to reject H_0