Type I and Type II Error

Data Science for Quality Management: Two Sample Hypothesis Testing

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Learning objective:

Differentiate between Type I and Type II Error

Type I and Type II Error

- When we are testing hypotheses, we can make errors with respect to our conclusions.
- These errors are referred to as Type I and Type II errors.

Type I Error

- Symbol: α
- The probability of rejecting a true null hypothesis
- Also referred to as a false positive, or producer's risk

Type II Error

- Symbol: β
- The probability of accepting a false null hypothesis
- Also referred to as a false negative, or consumer's risk

Power

- Symbol: 1-β
- The probability of rejecting a false null hypothesis
- The ability of the test to correctly reject a false null hypothesis

Confidence

- Symbol: 1-α
- The probability of accepting a true null hypothesis

Experimental Outcomes

	TRUE	FALSE
Accept H_0	1- α (Confidence)	β (Type II Error)
Reject H_0	α (Type I Error)	1-β (Power)

Example

Decision	Actual Situation or Reality - H_0	
	No Police with Radar	Police with Radar
Find No Police	😊 Confidence (No False Signal)	😢 Type II Error: (Something Missed)
Find Police	😠 Type I Error: (False Signal)	💪 Real Power Ability to Detect

Observations

- $\alpha + \beta$ will never equal 1. They are conditional probabilities based upon different conditions.
- Specifically, α is based upon the premise that H_0 is true, β is predicated on the assumption that H_0 is false.

Observations

- Both α and β represent risk.
- They are an expression of the researcher's willingness to commit an error in their inference.

Observations

- Power, the ability of the test to correctly reject a false H_0, must be “purchased” with sample size and with the selection of an appropriate experimental design.

Observations

- α is not “always more important” than β. For example:
- A drug company wishes to test the safety of a new drug formulation. The hypotheses tested are:

Observations

- H_0: The drug is safe
- H_1: The drug is not safe

- In this case, which type of error is of most concern?

Sources

- Luftig, J. An Introduction to Statistical Process Control & Capability. Luftig & Associates, Inc. Farmington Hills, MI, 1982