Statistics One

Lecture 8
Null Hypothesis Significance Testing
(NHST)

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Two segments

- Overview
- Problems & Remedies

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Lecture 8 ~ Segment 1

NHST: Overview

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NHST: Overview

- Null Hypothesis Significance Testing (NHST)
  - H_0 = null hypothesis
    - For example, $r = 0$
  - H_A = alternative hypothesis
    - For example, $r > 0$

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NHST: Overview

- Null Hypothesis Significance Testing (NHST)
  - H_0 = null hypothesis
    - For example, B = 0
  - H_A = alternative hypothesis
    - For example, B > 0

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NHST: Overview

- If the alternative hypothesis predicts the direction of the relationship between X & Y (positive vs. negative)
  - Directional test
  - Otherwise it is known as a non-directional test

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NHST: Overview

- Null Hypothesis Significance Testing (NHST)
  - H_0 = null hypothesis
    - For example, B = 0
  - H_A = alternative hypothesis
    - For example, B != 0

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NHST: Overview

- Assume H_0 is true, then calculate the probability of observing data with these characteristics, given that H_0 is true
  - $p = P(D \mid H_0)$
  - If p is very low, then Reject H_0, else Retain H_0

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NHST: Overview

Experimenter Decision

Truth	Retain H_0	Reject H_0
H_0 true	Correct Decision	Type I error (False alarm)
H_0 false	Type II error (Miss)	Correct Decision

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NHST: Overview

- p = P(D | H_0)
- Given that the null hypothesis is true, the probability of these, or more extreme data, is p
  - NOT: The probability of the null hypothesis being true is p
  - In other words, P(D|H_0) != P(H_0|D)

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NHST so far in this course

- *r*
  - Is the correlation significantly different from zero?
- B
  - Is the slope of the regression line for X significantly different from zero?

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NHST for B

- t = B / SE
  - B is the unstandardized regression coefficient
  - SE = standard error
  - SE = SQRT[SS.RESIDUAL / (N – 2)]

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Segment summary

- NHST is a procedure for hypothesis testing
- Requires a binary decision
  - Reject or Retain the Null Hypothesis
- Four possible outcomes
  - Correct retention, correction rejection
  - False alarm (Type 1 error), Miss (Type II error)

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Lecture 8 ~ Segment 2

NHST Problems & Remedies

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NHST Problems

- Biased by sample size
- Arbitrary decision rule
- Yokel local test
- Error prone
- Shady logic

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NHST Problems

- Biased by sample size
  - For example, in regression
    - p-value is based on t-value
    - t = B / SE
    - SE = SQRT(SS.RESIDUAL / (N – 2))

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NHST Problems

- Arbitrary decision rule
  - The cut-off value (alpha) is arbitrary
  - p < .05 is considered standard but still arbitrary
  - Problems arise when p is close to .05 but not less than .05

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NHST Problems

- Yokel local test
  - Many researchers use NHST because it's the only approach they know
  - NHST encourages weak hypothesis testing

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NHST Problems

- Error prone
  - Type I errors
    - Probability of Type I errors increases when researchers conduct multiple NHSTs
  - Type II errors
    - Many fields of research are plagued by a large degree of sampling error, which makes it difficult to detect an effect, even when the effect exists

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NHST Problems

- Shady logic
- Modus tollens
  - If p then q
  - Not q
  - Therefore, not p
  - If the null hypothesis is correct, then these data can not occur
  - The data have occurred
  - Therefore, the null hypothesis is false

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NHST Problems

- Shady logic
- If the null hypothesis is correct, then these data are highly unlikely
- These data have occurred
- Therefore, the null hypothesis is highly unlikely
- If a person plays football, then he or she is probably not a professional player
- This person is a professional player
- Therefore, he or she probably does not play football

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NHST Remedies

- Biased by sample size
  - Supplement all NHSTs with estimates of effect size
    - For example, in regression, report standardized regression coefficients and the model R-squared

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NHST Remedies

- Arbitrary decision rule
  - Again, supplement NHST with estimates of effect size
  - Also, avoid phrases such as “marginally significant” or “highly significant”

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NHST Remedies

- Yokel local test
  - Learn other forms of hypothesis testing
  - Consider multiple alternative hypotheses
    - Model comparison

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NHST Remedies

- Error prone
  - Replicate significant effects to avoid long-term impact of Type 1 errors
  - Obtain large and representative samples to avoid Type II errors

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NHST Remedies

- Shady logic
  - Simply remember, $p = P(D \mid H_0)$
  - OR, avoid NHST, and…
  - Report Confidence Intervals only (see Lecture 10)
  - Apply Bayesian inference

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NHST Problems

- Biased by sample size
- Arbitrary decision rule
- Yokel local test
- Error prone
- Shady logic

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END SEGMENT

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END LECTURE 8

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