PSYCHOLOGY 300B
Statistical Methods in Psychology II

• Professor
  Dr. Michael Masson
  Office: Cornett A183 (enter through A177)
  Office hours: Wednesday 11 AM–12:30 PM, or by appointment
  Phone: 250-721-7536
  e-mail: mmteach@uvic.ca
  web site: web.uvic.ca/psyc/masson
  • lecture slides and audio recordings of lectures
  • web link to text-related resources (e.g., stat tables)

• Teaching Assistant
  Myles Maillet
  e-mail: maillet1@uvic.ca
• Lectures
  Monday & Thursday, 11:30 a.m. – 12:50 p.m.
  Cornett B143

• Tutorials
  • expect 7 or 8 tutorials, announced in class or on web site
  • Tuesday 10:30 – 11:20 AM – Cornett A129
  • Wednesday 1:30 – 2:20 PM – Cornett A125
• **Text Book** (optional)


• copy on 2-hr reserve in library

Suggested on-line text book
http://davidmlane.com/hyperstat/index.html

• **Objectives**

  • develop understanding of some basic statistical analyses applied in psychological research
  • understand logic and theory behind each analysis, its computational procedures, circumstances of it use, and interpretation of its results
  • examinations will test this understanding
  • classroom lectures are the *essential* component
• **Study Groups**
  - formation of study groups is recommended
  - e-mail professor if interested (mmteach@uvic.ca)
    - deadline: January 13

• **Evaluation**
  
  Examination 1: Monday, January 30 (22%)  
  Examination 2: Monday, March 6 (23%)  
  Final examination: April 7-25 (40%)  
  Research proposal: Thursday, February 27 (5%)  
  Research report: Monday, March 23 (10%)
• **Schedule of Topics**

  Review of essential concepts
  Introduction to Bayesian analysis
  Testing hypotheses about two population means
  Power to detect an effect

{Examination 1}
  Analysis of variance: Hypotheses about more than two population means
  Analysis of variance: Two independent variables and the concept of interaction

{Examination 2}
  Analysis of variance: Repeated measurement of subjects
  Analysis of frequencies (nominal measurement scale)
Review of Essential Concepts

• Random sampling and random assignment

• Inferring cause and effect
  • can a correlation imply a causal influence?

• z score transformations
  • what result is obtained when z score transformation is applied to a uniform distribution?

\[ z = \frac{X - M}{S} \]

• a bimodal distribution?
Review of Essential Concepts

• Standard normal distribution

\[ z = \frac{X - M}{s} \]

- Problem: what is the probability of randomly drawing a z-score greater than or equal to 1.0?
- a z-score between –1 and –2, inclusive, or between 0 and 1, inclusive?
- a z-score of 0.75 or greater?
**Review of Essential Concepts**

<table>
<thead>
<tr>
<th>$z$</th>
<th>Mean to $z$</th>
<th>Larger Portion</th>
<th>Smaller Portion</th>
</tr>
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<tr>
<td>.73</td>
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<td>0.7673</td>
<td>0.2327</td>
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<tr>
<td>.74</td>
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<td>0.7704</td>
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<tr>
<td>.77</td>
<td>0.2794</td>
<td>0.7794</td>
<td>0.2206</td>
</tr>
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</table>
Review of Essential Concepts

• Distribution of sample means

  • consider a simple population of 8 scores
    1  2  3  4  5  6  7  8

  • how many different samples of \( N = 4 \) can be drawn (without replacement) from this population?

\[
8 \binom{4}{4} = \frac{8!}{(8-4)!4!} = \frac{8(7)(6)(5)}{4!} = 70
\]

Draw an arbitrary sample of \( N = 4 \) and compute \( M \)
Review of Essential Concepts

• Distribution of sample means
  • consider a population of 100 scores
    • how many different samples of \( N = 4 \) can be drawn (without replacement) from this population?

\[_{100}C_4 = 3,921,225\]
Review of Essential Concepts

• Distribution of sample means

\[ \mu_M = \mu \]
\[ \sigma_M = \frac{\sigma}{\sqrt{N}} \]
Review of Essential Concepts

• Logic of hypothesis testing for a population mean
• construct a model of all possible outcomes

NOTE: If there are 500 scores in this population, then there are $2.24 \times 10^{59}$ possible samples of size 40 (a trillion is only $10^{12}$)
Review of Essential Concepts

• Logic of hypothesis testing for a population mean
  • construct a model of all possible outcomes

- Population of raw scores
  - $\sigma = 15$

- Distribution of sample means
  - $\sigma_m = 2.37$
  - Anomalous sample mean

- If an unlikely sample mean is obtained
  • just a fluke?
  • reason to reject $H_0$
Review of Essential Concepts

• Hypothesis testing: single population mean
  • Headstart program may improve intelligence test scores of young children
    \( \mu = 100 \quad \sigma = 15 \)
  • directional or nondirectional hypothesis?
  • \( H_0: \mu = 100 \quad H_1: \mu > 100 \)
  • use .05 significance level: critical \( z = 1.65 \)

\[ N = 40 \quad M = 105 \]

\[ z = \frac{M - \mu}{\sigma_M} = \frac{105 - 100}{2.37} = 2.11 \]

\[ p = .0174 \quad p < .05 \]
Review of Essential Concepts

- Hypothesis testing: single population mean
- Use of the $t$ distribution when $\sigma$ is not known
  - $H_0 : \mu = 100$    $H_1 : \mu > 100$
  - $N = 40$    $M = 105$    $s = 18$ (estimate of $\sigma$)

$$s_M = \frac{18}{\sqrt{40}} = 2.85 \quad \text{(estimate of} \sigma_M)$$

$$t = \frac{M - \mu}{s_M} = \frac{105 - 100}{2.85} = 1.75$$

$df = 39$
Review of Essential Concepts

• Evolution of the $t$ distribution

Normal

$t$ (df = 40)

$t$ (df = 10)
Review of Essential Concepts

- $H_0: \mu = 100 \quad H_1: \mu > 100$
- $N = 40 \quad M = 105 \quad s = 18$ (estimate of $\sigma$)

Directional (one-tailed) test

$$t = \frac{105 - 100}{2.85} = 1.75$$

$$p = .044$$

Nondirectional (two-tailed) test

$$t = -2.023$$

$$p = .088$$
Review of Essential Concepts

• Related-samples \( t \) test
  • drug expected to reduce symptoms of anxiety
  • \( H_0: \mu_1 = \mu_2 \quad H_1: \mu_1 > \mu_2 \) (1 = placebo, 2 = drug)

<table>
<thead>
<tr>
<th>Subj</th>
<th>Place.</th>
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<th>Diff.</th>
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<tbody>
<tr>
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<td>2</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>5</td>
<td>−1</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>3</td>
<td>2</td>
</tr>
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<td></td>
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</tr>
<tr>
<td>20</td>
<td>7</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

\[ M_D = 3.2 \quad s_D = 5.7 \]

\[ s_{M_D} = \frac{s_D}{\sqrt{N}} = \frac{5.7}{\sqrt{20}} = 1.27 \]

\[ t = \frac{M_D - 0}{s_{M_D}} = \frac{3.2 - 0}{1.27} = 2.52 \]

Critical \( t \) ratio for a one-tailed test:
\[ t_{\text{crit}}(19) = 1.729 \]

Reject \( H_0 \)  \( t(19) = 2.52, p < .05 \)