PSYCHOLOGY 300B
Statistical Methods in Psychology II

• Lectures
  Monday & Thursday, 11:30 a.m. – 12:50 p.m.
  Cornett A221

• 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)
• **Text Book** (optional)


• earlier edition on 2-hr reserve in library

• **Objectives**

• develop understanding of some basic statistical analyses applied in psychological research
• understand logic and theory behind each analysis, its computational procedures, circumstances of its 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 12

• Prerequisites and Registration
  • at least C in PSYC 300A or declared major/honours in Linguistics
  • must register by add deadline (January 21)

• Evaluation
  Examination 1: Thursday, January 29 (25%)
  Examination 2: Thursday, March 5 (25%)
  Final examination: April 7-22 (40%)
  Research proposal: Thursday, February 26 (2%)
  Research report: Monday, March 23 (8%)
Schedule of Topics

Review of essential concepts
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)
Alternative to significance testing
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?

- a bimodal distribution?
Review of Essential Concepts

• Standard normal distribution \[ z = \frac{X - M}{S} \]

![Diagram of standard normal distribution with marked areas: 34%, 14%, 2%]

• 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>
</thead>
<tbody>
<tr>
<td>.73</td>
<td>0.2673</td>
<td>0.7673</td>
<td>0.2327</td>
</tr>
<tr>
<td>.74</td>
<td>0.2704</td>
<td>0.7704</td>
<td>0.2296</td>
</tr>
<tr>
<td><strong>.75</strong></td>
<td><strong>0.2734</strong></td>
<td><strong>0.7734</strong></td>
<td><strong>0.2266</strong></td>
</tr>
<tr>
<td>.76</td>
<td>0.2764</td>
<td>0.7764</td>
<td>0.2236</td>
</tr>
<tr>
<td>.77</td>
<td>0.2794</td>
<td>0.7794</td>
<td>0.2206</td>
</tr>
</tbody>
</table>
Review of Essential Concepts

• Distribution of 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?

\[
\begin{align*}
_8C_4 &= \frac{8!}{(8-4)!4!} \\
&= \frac{8(7)(6)(5)}{4!} = 70
\end{align*}
\]

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?

$$\binom{100}{4} = 3,921,225$$
Review of Essential Concepts

• Distribution of sample means

$\mu_M = \mu$

$\sigma_M = \frac{\sigma}{\sqrt{N}}$

All possible samples of $N = 1$

All possible samples of $N = 50$

Frequency

Frequency

Frequency
Review of Essential Concepts

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

Population of raw scores

\[ \sigma = 15 \]

All samples of \( N = 40 \)

Distribution of sample means

\[ \sigma_M = 2.37 \]

Expected sample mean

Reminder

\[ \sigma_M = \frac{15}{\sqrt{40}} \]

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

Population of raw scores

100
σ = 15

Distribution of sample means

Distribution of sample means

100
σM = 2.37

• If an unlikely sample mean is obtained
  • just a fluke?
  • reason to reject H₀
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
    • $H_0 : \mu = 100 \quad H_1 : \mu > 100$
    • $N = 40 \quad M = 105 \quad s = 18$ (estimate of $\sigma$)

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

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

\[ t \quad df = 39 \quad 0.05 \]
Review of Essential Concepts

• Evolution of the $t$ distribution

<table>
<thead>
<tr>
<th>Normal</th>
<th>$t$ ($df = 40$)</th>
<th>$t$ ($df = 10$)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Graph" /></td>
<td><img src="image2.png" alt="Graph" /></td>
<td><img src="image3.png" alt="Graph" /></td>
</tr>
</tbody>
</table>
Review of Essential Concepts

• \( H_0 : \mu = 100 \) \( H_1 : \mu > 100 \)

• \( N = 40 \) \( M = 105 \) \( s = 18 \) (estimate of \( \sigma \))

Directional (one-tailed) test

\[
t = \frac{105 - 100}{2.85} = 1.75
\]

\( p = .044 \)

Nondirectional (two-tailed) test

\[
t = \frac{105 - 100}{2.85} = 1.75
\]

\( p = .088 \)