SOCI 326
Quantitative Methods in Social Research

Session 6 – Hypothesis Testing: Introduction

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Session Overview

- In this session we turn our attention to the second major tool for transforming sample features into population features. You were introduced to this concept in sessions 1 and 2. We will learn the logic and methods of hypothesis testing or significance testing.

Session Outline

- State the different forms of statistical hypotheses
- Identify the difference between Null and Alternative hypotheses
- Establish the logic of hypothesis testing
- Describe the steps in hypothesis testing

Topic One

INTRODUCTION TO HYPOTHESIS TESTING

What is a hypothesis?

Statement

Guess

Tentative

Yet to be proven

Statistical Hypotheses?

Statistical Hypotheses

Null (Empty/No relationship)

Alternative (there is a relationship)

Why hypothesis testing?

- Hypothesis testing is another way of doing inferential statistics
- Hypothesis testing is also referred to as significance testing
- As researchers we will want to compare a sample mean to a population mean
- Specifically, we want to know if the groups represented by the samples are different from the populations on a **specific trait or variable (age, gender, education…)**

NB: We are not interested in the sample per se but in the larger group from which it was selected

Topic Two

AN EXAMPLE

Appropriate For A Hypothesis Test

- As a researcher, you are interested in finding out whether the average age of third year Sociology Majoring students was significantly different from All sociology students. You randomly sample 170 level 300 sociology majoring students with an average age of 21 and a standard deviation of 1.5years. Is your sample significantly different?
- Are the GPAs of University political leaders different from the GPAs of the student body as a whole? To investigate, the academic performance of a **random sample** of 134 student politicians from University of Ghana are compared with the GPA of all students at the university

Meaning of statement 1

- Is sample same as the population?

- Answer: If answer is yes
  - The population your sample came from and the population you are comparing with are the same meaning there **is no difference (Null Hypothesis** symbolized as **H_0)**
- Answer: If answer is no
  - The population your sample is coming from **is different** from the population you are comparing with (**Alternative Hypothesis** symbolized **H_1**)

Topic Three

STEPS FOR HYPOTHESIS TESTING

Steps For Hypothesis Testing

- Six steps to follow in organizing hypothesis testing:
- ***Step 1:*** Make assumptions
- ***Step 2:*** State the null and alternative hypotheses
- ***Step 3:*** Select the sample distribution and establish the critical region
- ***Step 4:*** Compute the test statistic
- ***Step 5:*** Make a decision and
- **Step 6: I**nterpret the results of the test

References

- Healey, J. F. (2010). ***Statistics: A Tool for Social Research.*** Wadsworth: CA pg 156 - 176

Topic Four

MAKING ASSUMPTIONS

Step 1: Make Assumptions

Three sets of assumptions have to be made when working with single samples

1. The sample must be randomly selected. This applies to all inferential statistics
2. What is the level of measurement for the single variable
3. The sampling distribution of all possible samples is normal in shape

Applying the assumption to a single sample mean variable

1. The sample must be randomly selected.
2. The level of measurement for the single variable must be interval-ratio level (eg. Age, time, distance, performance scale, attitude scale etc.).
3. The sampling distribution of all possible samples is normal in shape. Whether sample size is large or not (if sample size “n”≥ 100: large sample).

Topic Four

STATING THE NULL AND ALTERNATIVE HYPOTHESES

Step 2: State the null hypothesis

- The null hypothesis is represented as (Ho)
- Ho: Is always a statement of no difference

  It is statistically expressed by equating the actual unknown population parameter (eg. μ) to the proposed population parameter (61). Example:

  Ho: μ = 61
- Where μ refers to the population mean of students
- The null hypothesis is central in hypothesis testing because that is where the decision of rejecting or failing to reject a hypothesis is made (reference)

What is a Null Hypothesis?

- A null hypothesis is the hypothesis that is tested
- The null hypothesis is a statement of ***no difference*** or a statement of ***equality***
- In other cases the null hypothesis is a statement of ***no relationship***

NB: The null hypothesis is used to set up a test

...What is a Null Hypothesis?

- The null hypothesis is also a statement of chance
- Chance has to do with probability
- The probability that when a coin is tossed it will be a head or a tail that shows up is ½
- Example of a statement of chance is the normal curve
- There's only a 1% chance that a score would fall *beyond* ±2.58 standard deviations from the mean

Research (Alternative) Hypothesis

- The researcher must always state an alternative hypothesis after stating the null hypothesis
- The claim of the research is that there is a significant difference and thus hopes to reject the null hypothesis
- The researcher's stance is stated as (***H1***)
- ***H1***always contradicts the null hypothesis

Expressing the Alternative Hypothesis

- The research hypothesis can be stated in several ways using the following symbols to express the relationship: ≠, <, or >

Examples:

1. The students test scores in the drug awareness programme are different from their parents test scores (61)
    1. HI: $\mu \neq 61$ (≠: means not equal to)
2. The students test scores in the drug awareness programme are greater than their parents test scores
    1. HI: $\mu > 61$ (>: means more than)
3. The students test scores in the drug awareness programme lesser than their parents test scores
    1. HI: $\mu < 61$ (<: means less than)

Sketch 1

1. The students test scores in the drug awareness programme are different from their parents test scores (61)
    1. HI: $\mu \neq 61$ ($\neq$: means not equal to)

Sketch 2

1. The students test scores in the drug awareness programme are greater than their parents test scores
    1. HI: $\mu > 61$ (>: means more than)

Sketch 3

1. The students test scores in the drug awareness programme lesser than their parents test scores
    1. HI: $\mu < 61$ (<: means less than)

Stating the step 2

- Step 2: State the Null and Alternative Hypothesis
  - H0: U = … (available population data)
  - H1: U ≠ … (available population data) (2-tailed test)

Topic Five

SELECTING THE SAMPLING DISTRIBUTION AND CRITICAL VALUE(S)

Step 3: Select the sampling distribution and establish the critical region

- The rule setting stage
- We develop the basis to decide on our null hypothesis by using the sampling distribution
- The sampling distribution is the standard against which a particular sample outcome is measured
- Examples of sampling distributions include Z or Normal distribution, t distribution etc.
- The critical region is the areas under the sampling distribution that include extreme (unlikely) outcomes (illustrate)
- From our example we were given an alpha level of 0.05, thus Z score of ±1.96 called Z(critical)

Z-critical

- $Z_{(critical)}=\pm 1.96$

Step 4: Compute The Test Statistic

- The sample value must be converted into Z score
- Converting sample values to Z scores is referred to as computing the test statistic
- When the sample values are converted to Z scores we refer to it as Z(obtained)

$$Z_{(obtained)} = \frac{\bar{x} - u}{\frac{\sigma}{\sqrt{n}}}$$

Z from Session 3

- Converting raw scores to Z-score from Session 3

$$Z = \frac{x - \bar{x}}{s}$$

- Where U = Population mean

σ = Population Standard Deviation

$\bar{x}$ = Sample Mean

n = Sample size

Topic Five

MAKING A DECISION AND INTERPRETING THE RESULTS

Step 5: Make a decision

- Compare the test statistic (obtained) with the critical value
- If the test statistic falls into the critical region, we will reject the null hypothesis
- If the test statistic does not fall into the critical region, we fail to reject the null hypothesis
  - Z(critical) and Z(obtained)

Step 6: Interpret the results of the test

- Since Ho has been rejected it implies that …(revert the H1 statement)

- Since we fail to reject H0 it implies that there is no significant difference…

Exercise

- State the Hypotheses for the following statements
- Nationally, the average score on the matured students' university entrance exams (math test) is 355 marks, with a standard deviation of 87. Are AUCC students different?
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- A sample of 105 workers in the Packing Division of the Kenkey Toy Factory earns an average of $24,375 per year. Are workers in the packing division overpaid?

References

- Healey, J. F. (2010). ***Statistics: A Tool for Social Research.*** Wadsworth: CA Chapter 8