

Quantitative Analysis in Geography

Geography 247
Quantitative Analysis in Geography
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Week 2: The Nature of Probability and Statistics

Instructor: Rama Prasada Mohapatra
Department of Geography
University of Wisconsin-Milwaukee
email: rama@uwm.edu

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Quantitative Analysis in Geography

Outline

1. Introduction
2. Observational and Experimental studies
3. Variables and Types of Data
4. Data collection and Sampling Techniques
5. Descriptive and Inferential Statistics
6. Uses and Misuses of Statistics

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1. Introduction
Statistics

- **Meaning**
 - The methodology for collecting, analyzing, and presenting data.
- **Users**
 - Used in various fields: medicine, engineering, natural sciences, biological sciences, business, education, sports, public health, operations research, quality control, social sciences (including geography) etc

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1. Introduction
Statistics: Definition

- **Definition**
 - Statistics is the science of conducting studies to collect, organize, summarize, analyze, and draw conclusions from data.
- **Statistical data collection**
 - Statistical data is collected by individuals, government agencies, non-profit organizations, and businesses

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1. Introduction
Statistics in Geographical Research

- **Example (distance to school versus travel time)**
 - **Data**
 - Distance from living place to school
 - Travel time
 - **Representation of data**
 - Scatter diagram: distance on x axis, time on y axis

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1. Introduction
Why statistical analysis?

- **Summarize the findings of studies**
 - Example: total parking space available on campus
- **Understanding of the phenomenon under study**
 - Example: on campus parking is costly
- **Forecast the state of variables**
 - Example: parking space demand in and around the campus
- **Evaluate performance of certain activity**
 - Example: UPASS ridership
- **Decision making**
 - Example: finding out the best location for a new parking lot

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2. Observational and Experimental studies

There are several ways to classify statistical studies. Here, we will discuss about two type of studies

1. Observational studies
2. Experimental studies

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2. Observational and Experimental studies

- **Observational study**
 - In such studies, the researcher merely observes what is happening or what has happened in the past and tries to draw conclusions based on these observations.
- **Example**
 - Most of the undergraduates majoring in Geography continue their studies to complete Master's degree.

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2. Observational and Experimental studies

- **Experimental study**
 - In such studies, the researcher manipulates one of the variables and tries to determine how the manipulation influences other variables.
- **Example**
 - Knowledge of GIS helps the undergraduates majoring in Geography to secure a job of high beginning salary.

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2. Observational and Experimental studies

Comparing salary (Experimental study)
Geography undergraduate students

Students were divided into two groups by random assignment

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2. Observational and Experimental studies

Comparing salary (Experimental study)

- **Treatment group**
 - In this group the students are subjected to treatment (GIS knowledge)
- **Control Group**
 - The students are not subjected to treatment

It is assumed that all other factors influencing beginning salary of students are same for both the groups.

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2. Observational and Experimental studies

- **Advantages of observational study**
 - It usually occurs in natural settings
 - Helpful when it is dangerous or unethical to conduct an experiment
 - Variables are not controlled by researcher
- **Disadvantages of observational study**
 - Cause-and-effect situation cannot be shown
 - Accuracy of data
 - It may be expensive and time consuming

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2. Observational and Experimental studies

- **Advantages of Experimental study**
 - How to select subjects
 - How to assign them to specific groups
 - Control the independent variable
- **Disadvantages of Experimental study**
 - They occur in laboratories
 - So the result might not apply to natural settings
 - Hawthorne effect (subjects who knew they are participating in an experiment change their behavior)

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3. Variables and Types of Data

Variables

- **In the previous example “students beginning salary” is a variable**
 - It varies from student to student
- **Variable**
 - A variable is a characteristics or attribute that can assume different values
- **Independent**
- **Dependent**

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3. Variables and Types of Data

Variables

- **Independent variable**
 - The independent variable is also called the explanatory variable. In an experimental study this is the one that is being manipulated by the researcher.
- **Dependent variable**
 - The resultant variable is called the dependent variable or the outcome variable.

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3. Variables and Types of Data

Variables

Variables can be classified as qualitative or quantitative

- **Qualitative variable**
 - Variables that can be placed into distinct categories (gender: male/female)
- **Quantitative variable**
 - Quantitative variables are numerical and can be ordered or ranked (age: people can be ranked)
 - Discrete
 - Continuous

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3. Variables and Types of Data

Variables

- **Discrete variables**
 - Values that can be counted (number of children in a family; number of students in a class; income of Professors; 0,1,2,3..)
- **Continuous variables**
 - These variables can assume an infinite number of values between any two specific values. Obtained by measuring, often fractions and decimals (temperature).

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3. Variables and Types of Data

Variables

The classification of variables can be summarized as follows

```

graph TD
    Variables --> Qualitative
    Variables --> Quantitative
    Quantitative --> Discrete
    Quantitative --> Continuous
    
```

Random variables: whose values are determined by chance

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3. Variables and Types of Data

Data

- **Data**
 - Measurement or observation values that the variables can assume
- **Data value or datum**
 - Each value in the data set is called a data value or a datum.
- **Data set**
 - A collection of data value forms a data set.

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3. Variables and Types of Data

Data types

- In addition to being classified as qualitative or quantitative, variables can be classified by how they are categorized, counted or measured.
 - Nominal
 - Ordinal
 - Interval
 - Ratio
- There is no complete agreement about classification of data

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3. Variables and Types of Data

Data types

- **Nominal data**
 - The nominal level of measurement classifies data into mutually exclusive (nonover-lapping), exhausting categories in which no order or ranking can be imposed on the data.
 - Data can not be ranked
 - Example: gender, marital status, zip codes

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3. Variables and Types of Data

Data types

- **Ordinal data**
 - The ordinal level of measurement classifies data into categories that can be ranked; however, precise differences between the ranks do not exist.
 - A large variation exists among the individual subject.
 - Example: 1st, 2nd, 3rd; high, medium, low

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3. Variables and Types of Data

Data types

- **Interval data**
 - The interval level of measurement ranks data, and precise differences between units of measure do exist; however there is no meaningful zero.
 - Unlike ordinal data precise differences exists between units incase of interval data
 - Example: temperature (1^o difference between 72^o F – 73^o F; however 0^o F does not mean no heat)

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3. Variables and Types of Data

Data types

- **Ratio data**
 - The ratio level of measurement possesses all the characteristics of interval measurement, and there exists a true zero.
 - In addition, true ratios exist when the same variable is measured on two different members of the population (example: ratio between weight of one person to another person)
 - Example: height, weight, area

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4. Data collection and sampling techniques

Source of data

- **Already available data**
 - Census, MPROP (land and building data of city of Milwaukee) etc
- **Data creation**
 - Experiment
 - Survey
 - Personal interview
 - Telephone survey
 - Mailed questionnaire

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4. Data collection and sampling techniques

Survey types

- **Personal interview**
 - Advantage of obtaining in-depth responses to questions from person being interviewed
 - Interviewer may be biased
 - Interviewers must be trained
 - Costly and time consuming

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4. Data collection and sampling techniques

Survey types

- **Telephone survey**
 - Less costly than personal interview
 - People may be more candid since there is no face-to-face contact.
 - People may not have access to phones or they may not be available when a call is made
 - Tone of the voice of the interviewer may affect

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4. Data collection and sampling techniques

Survey types

- **Mailed questionnaire**
 - Can be used to cover wider geographical area
 - Less expensive to conduct when compared to other two methods
 - Respondents can remain anonymous if they desire
 - Disadvantage: low turnout, difficulty in understanding questions and inappropriate answers to questions

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4. Data collection and sampling techniques

Sampling

- Researchers use samples to collect data as very often it is not possible to collect data for entire population.
- It saves time and money
- Give each subject in the population an equal likely chance of being selected

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4. Data collection and sampling techniques

Sampling

- **Population**
 - A population consists of all subjects (human or otherwise) that are being studied.
- **Sample**
 - A sample is a group of subjects selected from a population.

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4. Data collection and sampling techniques

Sampling

- **Statisticians use four basic methods for sampling as described below**
 - Random sampling
 - Systematic sampling
 - Stratified sampling
 - Cluster sampling

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4. Data collection and sampling techniques

Sampling

- **Random sampling**
 - Samples are collected by chance methods or random numbers
 - Random numbers could be generated in Microsoft Excel
- **Systematic sampling**
 - By numbering each subject and then selecting the kth subject

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4. Data collection and sampling techniques

Sampling

- **Stratified sampling**
 - The population is divided into groups (strata) at first depending on importance of study
 - Then samples were selected randomly within each strata
- **Cluster sampling**
 - The population is divided into groups (clusters) by some means (geographic area)
 - Then some clusters are randomly selected

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5. Descriptive and inferential statistics

- **Descriptive Statistics**
 - Descriptive statistics consists of the collection, organization, summarization, and presentation of data.
- **Inferential Statistics**
 - Inferential statistics consists of generalizing from samples to populations, performing estimations and hypothesis tests, determining relationships among variables, and making predictions.

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6. Uses and misuses of statistics

- **Suspect samples**
 - Small number of samples
 - How the subjects in the sample are selected (convenience samples)
- **Ambiguous averages**
 - Mean, median, mode for the same data set can differ markedly
 - Any one of these averages could be used to justify the researchers position
- **Detached statistics**
 - "Our brand of crackers has one-third fewer calories."

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6. Uses and misuses of statistics

- **Implied connections**
 - Use of words such as may, suggest, some etc.
 - Example: eating fish may help to reduce your cholesterol
- **Misleading graphs**
 - Inappropriately drawn graphs can misrepresent data and lead to false conclusion

Statistics when used properly, can be beneficial in obtaining much information but when used improperly, can lead to much information

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