



Elementary Probability and Statistics MATH 1530

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Some Graphics by
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Chapter 1 Introduction to Statistics

1-1 Overview

1-2 Types of Data

1-3 Critical Thinking

1-4 Design of Experiments

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1-1 Overview

Statistics

Two Meanings

- ❖ Method of analysis
- ❖ Specific numbers

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Statistics

❖ Method of analysis

a collection of methods for planning experiments, obtaining data, and then organizing, summarizing, presenting, analyzing, interpreting, and drawing conclusions based on the data

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Statistic

❖ Specific number

numerical measurement describing some characteristic of a sample

Example: Twenty-three percent of people polled believed that there are too many polls.

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Definitions

❖ Data

observations (such as measurements, genders, survey responses) that have been collected.

Definitions

❖ Population

the complete collection of all elements (scores, people, measurements, and so on) to be studied. The collection is complete in the sense that it includes all subjects to be studied.

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Definitions

❖ Census

the collection of data from every element in a population

❖ Sample

a subcollection of elements drawn from a population

1-2 Types of Data

Definitions

❖ Parameter

a numerical measurement describing
some characteristic of a population

population



parameter

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Definitions

❖ Statistic

a numerical measurement describing
some characteristic of a sample

sample



statistic

Definitions

❖ Quantitative Data

numbers representing counts or measurements

❖ Qualitative (or categorical or attribute) Data

can be separated into different categories that are distinguished by some nonnumerical characteristic.

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Definitions

❖ Quantitative Data

the incomes of college graduates

❖ Qualitative (or categorical or attribute) Data

the genders (male/female) of college graduates

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Definitions

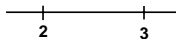
❖ Discrete

data result when the number of possible values is either a finite number or a 'countable' number of possible values

0, 1, 2, 3, . . .

❖ Continuous

(numerical) data result from infinitely many possible values that correspond to some continuous scale that covers a range of values without gaps, interruptions, or jumps



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Definitions

❖ Discrete

The number of eggs that hens lay; for example, 3 eggs a day.

❖ Continuous

The amounts of milk that cows produce; for example, 2.343115 gallons a day.

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Levels of Measurement

❖ Nominal

❖ Ordinal

❖ Interval

❖ Ratio

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Definitions

❖ nominal level of measurement

characterized by data that consist of names, labels, or categories only. The data cannot be arranged in an ordering scheme (such as low to high)

Example: survey responses yes, no, undecided

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Definitions

❖ ordinal level of measurement

involves data that can be arranged in some order, but differences between data values either cannot be determined or are meaningless

Example: Course grades A, B, C, D, or F

Definitions

❖ interval level of measurement

like the ordinal level, with the additional property that the difference between any two data values is meaningful. However, there is no natural zero starting point (where *none* of the quantity is present)

Example: Years 1000, 2000, 1776, and 1492

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Definitions

❖ ratio level of measurement

the interval level modified to include the natural zero starting point (where zero indicates that *none* of the quantity is present). For values at this level, differences and ratios are meaningful.

Example: Prices of college textbooks

Levels of Measurement

- ❖ **Nominal - categories only**
- ❖ **Ordinal - categories with some order**
- ❖ **Interval - differences but no natural starting point**
- ❖ **Ratio - differences and a natural starting point**

Section 1-3 Critical Thinking

- ❖ **Almost all fields of study benefit from the application of statistical methods**

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Critical Thinking

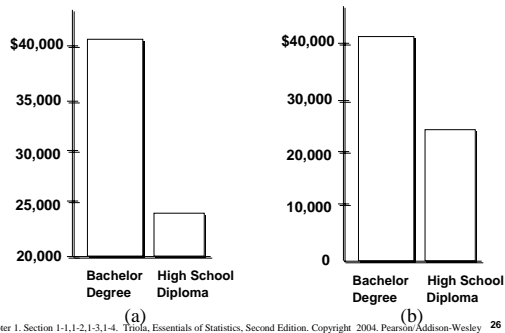
- ❖ **Bad Samples**
self-selected survey
(or voluntary response sample)

one in which the respondents themselves decide whether to be included

Critical Thinking

- ❖ Voluntary Response Samples
- ❖ Small Samples
- ❖ Graphs

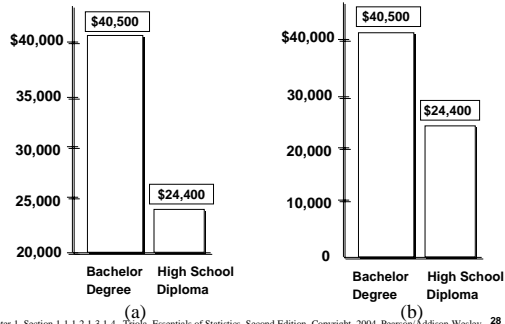
Salaries of People with Bachelor's Degrees and with High School Diplomas



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We should analyze the numerical information given in the graph instead of being misled by its general shape.

Salaries of People with Bachelor's Degrees and with High School Diplomas



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Critical Thinking

- ❖ Voluntary Response Samples
- ❖ Small Samples
- ❖ Graphs
- ❖ Pictographs

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Double the length, width, and height of a cube, and the volume increases by a factor of eight



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Critical Thinking

- ❖ Voluntary Response Samples
- ❖ Small Samples
- ❖ Graphs
- ❖ Pictographs
- ❖ Percentages
- ❖ Loaded Questions
- ❖ Order of Questions
- ❖ Refusals
- ❖ Etc.

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Section 1-4

Design of Experiments

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Two Major Points

- ❖ If sample data are not collected in an appropriate way, the data may be completely useless.
- ❖ *Randomness* typically plays a crucial role in determining which data to collect.

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Definitions

❖ Observational Study

observing and measuring specific characteristics without attempting to *modify* the subjects being studied

Definitions

❖ Experiment

apply some *treatment* and then observe its effects on the subjects

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Designing an Experiment

- ❖ Identify your objective
- ❖ Collect sample data
- ❖ Use a random procedure that avoids bias
- ❖ Analyze the data and form conclusions

Definitions

❖ Confounding

occurs in an experiment when the effects from two or more variables cannot be distinguished from each other

Definitions

❖ Replication

used when an experiment is repeated on a sample of subjects that is large enough so that we can see the true nature of any effects (instead of being misled by erratic behavior of samples that are too small)

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Randomization and Other Sampling Strategies

❖ Random Sample

when members from the population are selected in such a way that each individual member has an equal chance of being selected.

Randomization and Other Sampling Strategies

❖ Simple Random Sample

when size n subjects is selected in such a way that every possible *sample of the same size n* has the same chance of being chosen.

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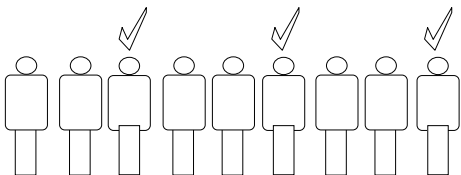
Random Sampling - selection so that each has an equal chance of being selected



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Systematic Sampling - Select some starting point and then select every K^{th} element in the population.



Example: Every third person

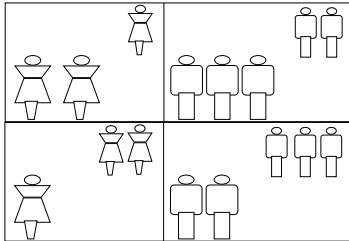
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Convenience Sampling - use results that are readily available



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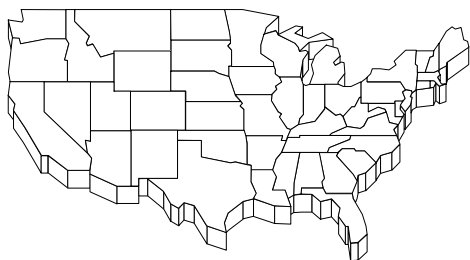
Stratified Sampling - subdivide the population into subgroups that share the same characteristic, then draw a sample from each stratum



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Cluster Sampling - divide the population into sections (or clusters); randomly select some of those clusters; choose all members from selected clusters



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Methods of Sampling

- ❖ Random
- ❖ Systematic
- ❖ Convenience
- ❖ Stratified
- ❖ Cluster

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Definitions

- ❖ **Sampling Error**
the difference between a sample result and the true population result; such an error results from chance sample fluctuations.
- ❖ **Non-sampling Error**
sample data that are incorrectly collected, recorded, or analyzed (such as by selecting a biased sample, using a defective instrument, or copying the data incorrectly).

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