MATH 3339
Statistics for the Sciences

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Lecture 1

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Outline

1. Types of Data
2. Types of Variables
3. Sets
4. Venn Diagrams

Background

Chapter 1: Overview and Basic Concepts

What is Statistics?

- Statistics is used to make intelligent decisions in a world full of uncertainty. "A knowledge of statistics provides the necessary tool to differentiate between sound statistical conclusions and questionable conclusions." (*Business Statistics Communicating with Numbers*, Jaggia and Kelly, 2013, pg 4)
- Statistics is the science of collecting, organizing, and interpreting numerical facts which we call *data*.

A Data Set: Course Grades From Previous Session

variables

https://www.math.uh.edu/~cathy/Math3339/data/grades.txt

observation

Student	Score	Grade	Tests	Quiz	HW	Session
1	100.707	A	99.233	87.308	101.270	Sp16
2	81.310	B	75	98.231	64.444	Sp16
3	8.194	F	14.667	12.769	3.175	Sp16
4	90.449	A	91.533	77.231	82.222	Sp16
5	68.461	D	65.783	81.769	68.571	Sp16
6	103.955	A	103.32	97.923	101.905	Sp16
7	92.889	A	95.6	85.923	75.556	Sp16
8	84.805	B	83.2	79.385	75.238	Sp16
9	91.640	A	89.967	91.231	85.079	Sp16
10	22.316	F	17.433	40.615	44.444	Sp16
11	98.363	A	94.167	99.231	101.587	Sp16
12	49.250	F	43.917	73.077	78.095	Sp16
13	16.967	F	15.5	20.077	29.841	Sp16
14	50.747	F	45.533	67.385	57.460	Sp16
15	43.184	F	72.983	47.462	38.413	Sp16
16	100.845	A	98.667	96.231	100.317	Sp16
17	84.195	B	77.5	87.154	95.556	Sp16
18	84.400	B	78.733	78.615	82.540	Sp16
19	67.170	D	74.3	68.538	72.063	Fal15
20	87.413	B	92	82.077	77.778	Fal15
21	67.899	D	71.8	71.077	84.127	Fal15
22	74.676	C	70.083	83.308	73.016	Fal15
23	40.054	F	44.133	21.308	33.333	Fal15
24	101.014	A	101.08	98.923	95.873	Fal15
25	11.972	F	17.1	10.385	3.810	Fal15
26	79.831	B	86.233	71.923	46.667	Fal15
27	83.301	B	94.6	69.692	60.317	Fal15
28	72.299	C	64.967	67.615	99.394	Sum16
29	83.821	B	77.2	80.923	83.030	Sum16
30	90.703	A	83.617	87.923	80.000	Sum16

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Types of data

- **Population Data** is everything or everyone we want information about. It is a set of data that consists of all possible values pertaining to a certain set of observations or an investigation.

- **Sample Data** is a subset of the population that we have information from. It is just a small section of the population taken for the purpose of investigation.

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Examples of Types of Data

Identify the population and the sample for each of the following:

- University of Houston is interested in how many students buy used books as opposed to new ones. They randomly choose 100 students at the student center to interview
  - Population - all UH students.
  - Sample - the 100 students interviewed.
- An elementary school is creating a new lunch menu. They send questionnaires to students with last names that begin with the letters M through R.
  - Population - all students in this elementary school
  - Sample - M - R.

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Two Types of Variables

Go back to the example of **grades**. We have several variables, score, grade, tests, quiz, hw, & session.

- The variables **grade, & session** are *categorical variables*. **Categorical variables** place a case into one of several groups or categories.
- The variables **scores, tests, quiz & hw** are **quantitative variables**. **Quantitative Variables** take numerical values for which arithmetic operations such as adding and averaging make sense.

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Two Types of Quantitative Variables

Quantitative variables can be classified as either **discrete** or **continuous**.

- Discrete quantitative variables - a countable set of values.
- Continuous quantitative variables - data that can take on any values within some interval.

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Examples of Variables

Classify the following variables as categorical or quantitative. If quantitative, state whether the variable is discrete or continuous.

- Political preference.

  Categorical

- Number of siblings.

  quantitative — discrete

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Examples of Variables Part 2

Classify the following variables as categorical or quantitative. If quantitative, state whether the variable is discrete or continuous.

- Blood type.

  categorical

- Height of men on a professional basketball team.

  Quantitative — continuous.

- Time it takes to be on hold when calling the IRS at tax time.

  Quantitative $(0, \infty)$

Winning the State Lottery

- Suppose a person won the Jackpot of the State Lottery five times in a row.
- What do you think would happen?
- Is it possible for a person to win the state lottery five consecutive times?

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Randomness and Probability

- We call a phenomenon **random** if individual outcomes are uncertain.
- However, there is a regular distribution of outcomes in a large number of repetitions.
- Chance behaviors unpredictable in the short run but has a regular and predictable pattern in the long run.
- Long-run must be infinitely long to give them frequencies of enough time to even out.

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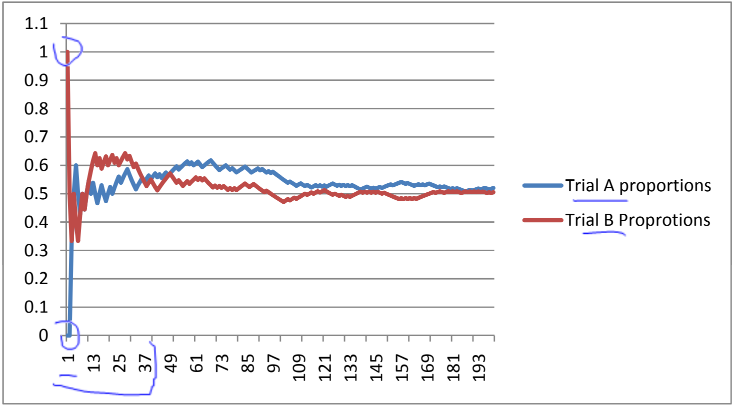
Proportion of Heads in Long Run



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Probability

- "A **probability** is a numerical value that measures the likelihood that an uncertain event occurs." *Business Statistics: Communicating with Numbers, Jaggia and Kelly, pg 96*
- The **probability** of any outcome of a random phenomenon is the proportion of times the outcome would occur in a very long series of repetitions.

Why Study Probability in Statistics?

- Statistical Idea: Rare event rule for inferential statistics
- If, under a given assumption, the probability of a particular observed event is extremely small, we conclude that the assumption is probably not correct.

< 0.0001

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Random Experiments

In order to study probability we need know how random experiments work. Examples of random experiments:

- Flipping a coin
- Asking who is the likely winner of a presidential election.
- Weighing Hershey chocolate bars.

A random experiment has the following two characteristics:

1. The experiment can be replicated an indefinite number of times under essentially the same experimental conditions.
2. There is a degree of uncertainty in the outcome of the experiment. The outcome may vary from replication to replications even though the experimental conditions are the same.

Sample Space

- A **set** is a collection of objects.
- The items that are in a set called **elements**.
- We typically denote a set by capital letters of the English alphabet. Usually, E_i
- Examples: $E_1 = \{knife, spoon, fork\}$, $E_2 = \{2, 4, 6, 8\}$.
- The set E_2 could also be written as
  $E_2 = \{x | x \text{ are even whole numbers between 0 and 10}\}$.
- The **sample space** of a random experiment is the set of all possible outcomes. Ω is used to denote sample space.

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Notations of Sets

Notation	Description
$a \in A$	The object a is an element of the set A.
$A \subseteq B$	Set A is a subset of set B. That is every element in A is also in B.
$A \subset B$	Set A is a proper subset of set B. That is every element that is is in A is also in set B and there is at least one element in set B that is not in set A.
$A \cup B$	A set of all elements that are in "A **or** B." "A union B"
$A \cap B$	A set of all elements that are in "A **and** B." A & B
Ω	Called the **universal set**, all elements we are interested in.
$\sim A$ complement of A	The set of all elements that are in the universal set but are not in set A. $\bar{A}$ A^c A'
$\bigcup_i E_i$	$E_1 \cup E_2 \cup \ldots$, the union of multiple sets
$\bigcap_i E_i$	$E_1 \cap E_2 \cap \ldots$, the intersection of multiple sets

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Examples

The following are sets: $\Omega = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$,
$E_1 = \{1, 2, 3, 4, 5, 6, 9, 10\}$, $E_2 = \{3, 4, 7, 8\}$, and $E_3 = \{2, 3, 9, 10\}$

$$E_3 \subset E_1$$

$$E_1 \cap E_2 = \{3, 4\}$$

$$E_1 \cup E_2 = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$$
$$= \Omega$$

$$\sim E_3 = \overline{E_3} = E_3^c = \{1, 4, 5, 6, 7, 8\}$$

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Examples

The following are sets: $\Omega = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$,
$E_1 = \{1, 2, 3, 4, 5, 6, 9, 10\}$, $E_2 = \{3, 4, 7, 8\}$, and $E_3 = \{2, 3, 9, 10\}$

$$E_2 \sim E_1 = E_2 \cap \sim E_1 = E_2 \cap E_1^c$$

$$= \{3, 4, 7, 8\} \cap \{7, 8\}$$

$$= \{7, 8\}$$

$$E_1 \cap E_2 \cap E_3 = \{3\}$$

More Examples

The following are sets: $\Omega = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$, $E_1 = \{1, 2, 3, 4, 5, 6, 9, 10\}$, $E_2 = \{3, 4, 7, 8\}$, and $E_3 = \{2, 3, 9, 10\}$

1. What elements are in $\sim E_2 \cap \sim E_3$?

$\sim E_2 \cap \sim E_3 = \{1, 2, 5, 6, 9, 10\} \cap \{1, 4, 5, 6, 7, 8\}$

$= \{1, 5, 6\}$

2. What elements are in $E_2 \cap \sim E_1$?

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Definitions

- A **Venn diagram** is a very useful tool for showing the relationships between sets.
- Venn diagrams consist of a rectangle with one or more shapes (usually circles) inside the rectangle.
- The rectangle represents all of the elements that we are interested in for a given situation. This set is the universal set.

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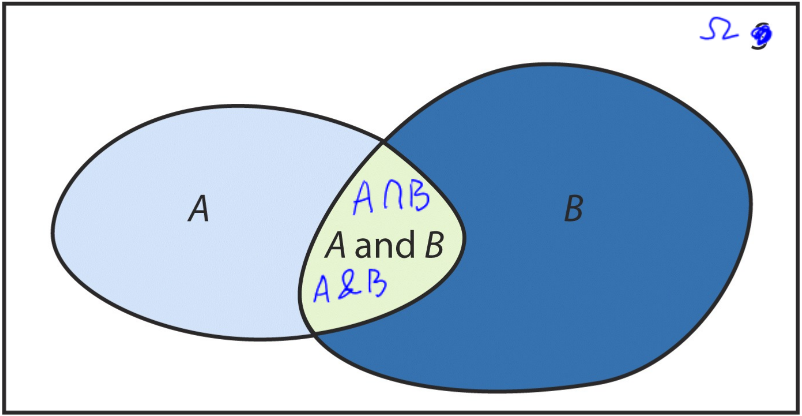
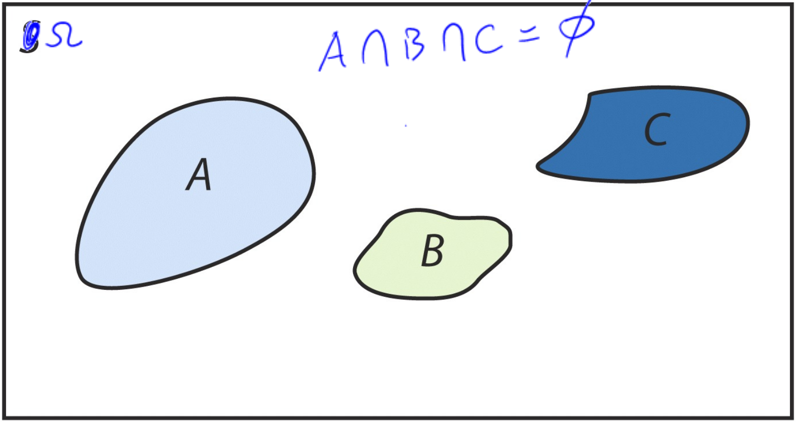
Graph of Venn Diagrams



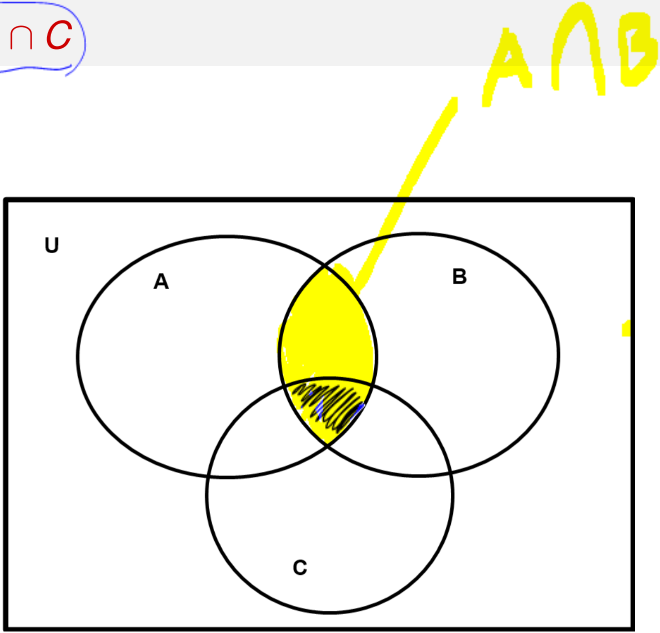
Graph of Disjoint Events

$A \& B = \phi$ $\quad$ $B \& C = \phi$

$A \cap B \cap C = \phi$



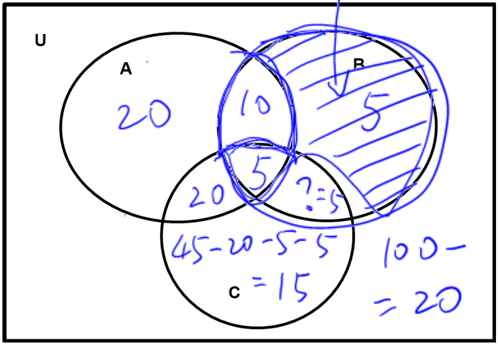
$A \cap B \cap C$



Soft Drink Preference

A group of 100 people are asked about their preference for soft drinks. The results are as follows: 55 like Coke, 25 like Diet Coke, 45 like Pepsi, 15 like Coke and Diet Coke, 5 like all 3 soft drinks, 25 like Coke and Pepsi, 5 only like Diet Coke (nothing else). Fill in the the Venn diagram with these numbers.

A: coke
B: Diet Coke
C: pepsi



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