Bell Work

1. How are stratified and cluster sampling different?
2. If I control for age and gender, does a questionnaire qualify as an experiment?
3. Is margin of error a decimal or percentage?
4. How many cards are in a standard deck of cards?

Chapter 5
Probability in our Daily Lives

Section 5.1: How can Probability Quantify Randomness?

Learning Objectives

1. Random Phenomena
2. Law of Large Numbers
3. Probability
4. Independent Trials
5. Finding probabilities
6. Types of Probabilities: Relative Frequency and Subjective

PROBABILITY

- May be the single most important math concept used by the general population.
  - Think about ALL the decisions you make where you judge the likelihood you'll succeed.
  - Should I take a Stats class?
    - Was really, "What chance do I have of getting a good grade in a stats class?"
  - It is wrong to speed?
    - Was really, "I don't think I can get away with it."

PROBABILITY

- May be the single most important math concept used by businesses.
  - If I sell my product for $30.00, will people buy it?
  - If I hire a High School student as a manager of my store, will I regret it later?
  - If I send out 1000 flyers in the mail, how many people will that bring in to my store?
  - Chance of rain is 20%

Probability

- Definition
  - –What you expect to happen if the experiment was continued; the way we quantify uncertainty; the likeliness that an event will occur
  - –I expect heads will occur 50 times if I flip a coin 100 times.

Probability

- Definition
  - The likeliness of an event occurring.
  - A number between 0 and 1.
    - Where the closer to 1, the more likely the event will occur.
  - Uses the notation P(A)
    - Said "P of A"
    - A is the Event.

Probability

- Did you know…?
- When a weatherman says the chance of rain is 70%, that means that in past days with atmospheric pressure like today 70% of them have resulted in rain.

An Event

- Definition
  - –Something we are doing.
    - Dealing Cards
    - Rolling Dice
    - Taking Tests
    - Picking Numbers from a Hat

An Outcome

- Definition
  - –The result of the Event.
    - Drawing an Ace
    - Rolling a 4
    - Scoring a 95%
    - Picking the number 17

A Sample Space

- Definition
  - –All possible Outcomes.
    - Drawing an Ace, King, Queen,etc…
    - Rolling a 1, 2, 3, 4, 5, or 6
    - Scoring a 100%, 99%, 98%, etc…
    - Picking the number 1, 2, 3, 4, 5, etc…

Probability

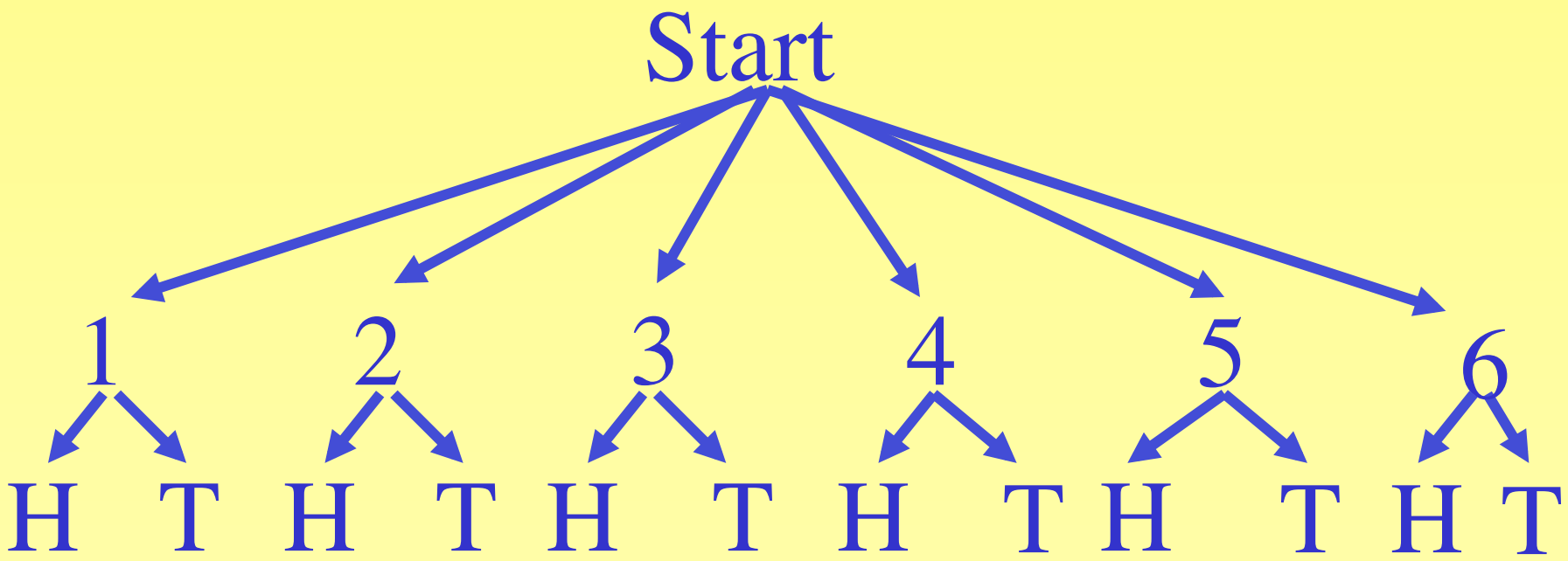
- Examples
  - If you are rolling a fair die…
    - What is the Event?
    - Rolling a die
    - What is the Sample Space?
    - {1,2,3,4,5,6}
    - What is the number of Outcomes in the Sample Space? n(S) =
    - 6

Probability

- Examples
  - –If you are rolling one fair die, and then flipping a coin…
    - What are the Events?
    - What is the Sample Space?
    - What is the number of Outcomes in the Sample Space? n(S) =

Tree Diagram

- Helps to display the outcomes.
- Display the possible outcomes of rolling a die and flipping a coin.



Probability

- Examples
  - –If you are rolling two fair dice,
    - What are the Events?
    - What is the Sample Space?
    - What is the number of Outcomes in the Sample Space? n(S) =

Probability

- Formula: P(A)=

$$\frac{\text{The Number of Ways the Winning Event Can Occur}}{\text{The Number of Ways All Events Can Occur}}$$

Probability

- Examples
  - –What is the probability of getting heads with 1 toss of a coin?
  - –P(heads) =

$$\frac{\text{The Number of Sides with Heads on a Coin}}{\text{The Number of Sides on a Coin}}$$

$$= \frac{1}{2}$$

Probability

- Experiment - Let's use the calculator to simulate flipping a coin 100 times.
  - Generating Random Numbers on a TI-83
  - Choose `MATH > PRB > 5:RandInt(`
  - randInt(lowerbnd, upperbnd, n)
    - randInt(0,1,100)

Is there a way to get the calculator to count for us?

Probability

- Experiment - Let's use the calculator to simulate flipping a coin 100 times.
  - Generating Random Numbers on a TI-83
  - Choose `MATH > PRB > 5:RandInt(`
  - randInt(lowerbnd, upperbnd, n)
    - randInt(0,1,100) -> L_1
    - SortA(L_1)

Probability

- Examples
  - –What is the Probability of drawing an Ace of Spades from a deck of Cards?
  - –P(Ace of Spades) =

$$\frac{\text{The Number of Cards with Ace of Spades in a Deck}}{\text{The Number of Cards in a Deck}}$$

$$= \frac{1}{52}$$

Probability

- Examples
  - What is the Probability of drawing an Ace from a deck of Cards?
  - P(Ace) =

$$\frac{\text{The Number of Cards with Ace in a Deck}}{\text{The Number of Cards in a Deck}}$$

$$\frac{4}{52} = \frac{1}{13}$$

Probability

Examples - We asked 100 students their favorite color. Results:

Red	25
Blue	30
Green	15
Orange	20
Pink	10

What is the probability that a randomly chosen student would say "Blue" is his favorite color?

Probability

Examples - We asked 100 students their favorite color. Results:

Red	25
Blue	30
Green	15
Orange	20
Pink	10

Since we have created a Frequency Chart, we can apply symbols to our probability formula.

Probability

- Formula: P(A)=

$$\frac{\text{The Number of Ways the Winning Event can Occur}}{\text{The Number of Ways All Events can Occur}}$$

$$\frac{\text{The Frequency}}{\text{Total Outcomes}}$$

$$P(A) = \frac{f}{n}$$

Probability

Do couples get engaged or not? If they are engaged, how long did they date before becoming engaged? A poll of 1000 couples gave the following results:

Never Engaged	200
Less than 1 Year	240
1 to 2 Years	210
More than 2 years	350

Probability

- Use the data to estimate the probability that a dating couple chosen at random:
  - Is not engaged
  - Dated less than 1 year before getting engaged
  - Dated between 1 and 2 years before getting engaged
  - Dated more than 2 years before getting engaged

Probability

Do couples get engaged or not? If they are engaged, how long did they date before becoming engaged? A poll of 1000 couples gave the following results:

Never Engaged	200
Less than 1 Year	240
1 to 2 Years	210
More than 2 years	350
Total	1000

The Law of Large Numbers

As the sample size increases, the relative frequency of outcomes gets closer and closer to the actual probability value.

- Flip a coin 10 times. Will 5 of them land on heads?
- But flip a coin 10,000 times. Close to 5,000 of them *will* be heads.

★If you ask 10 people what their dominant hand is and they all say their right, can you conclude that the probability of being right-handed is 1.0 (or 100%)?

Learning Objective 1:
Random Phenomena

- For random phenomena, the outcome is uncertain
  - In the short-run, the proportion of times that something happens is highly random
  - In the long-run, the proportion of times that something happens becomes very predictable

Probability quantifies long-run randomness

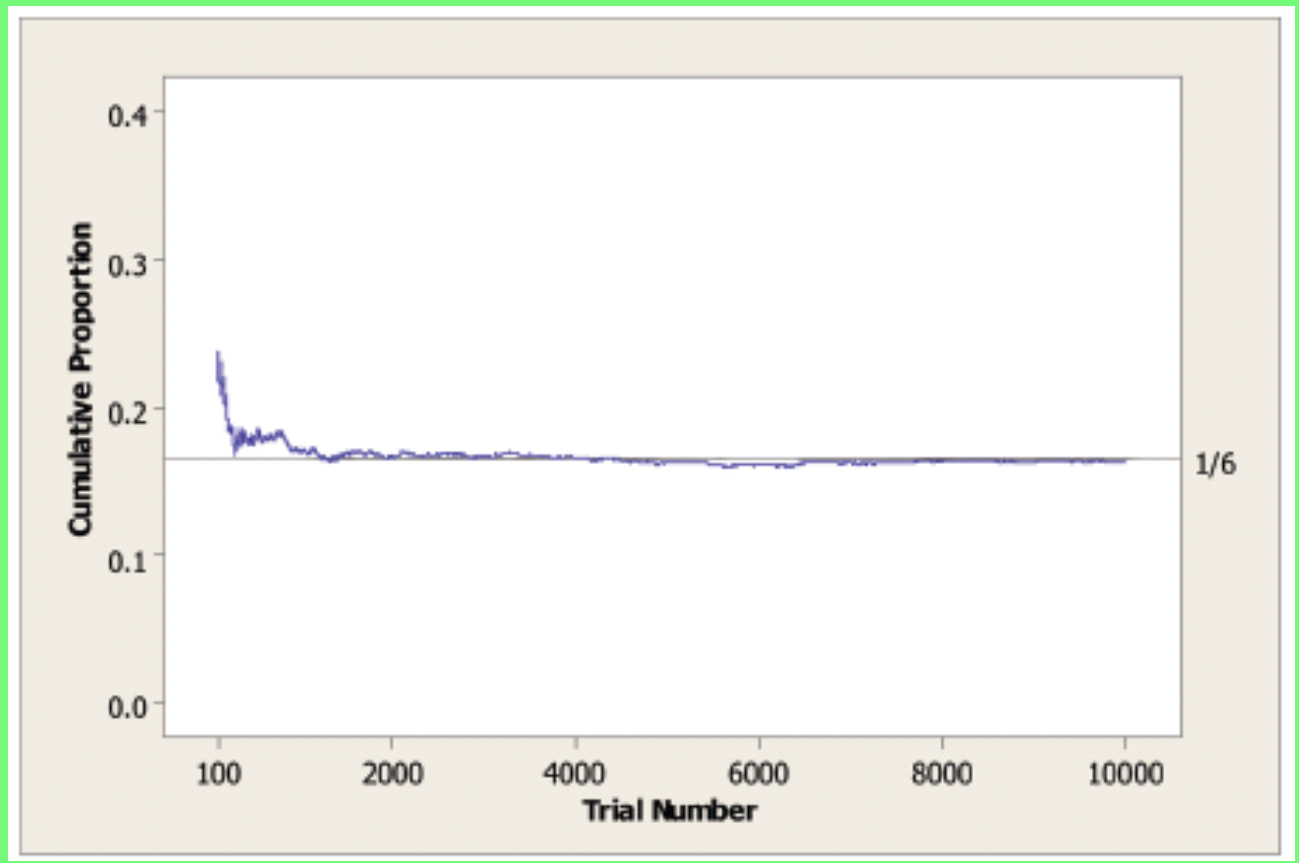
Learning Objective 2:
Law of Large Numbers

- As the number of trials increase, the proportion of occurrences of any given outcome approaches a particular number “in the long run”

Learning Objective 3: Probability

- With random phenomena, the *probability* of a particular outcome is the proportion of times that the outcome would occur in a long run of observations
- Example:
  - When rolling a die, the outcome of "6" has probability = 1/6. In other words, the proportion of times that a 6 would occur in a long run of observations is 1/6.

- As one tosses a die, 1/6 of the observations will be a 6 in the long run.



Learning Objective 3: Probability

- The large of large numbers is what helps casinos to stay in business…you may win for a little while, but they know they will come out ahead.

Learning Objective 3: Probability

- Simulations…

Learning Objective 4: Independent Trials

- Different trials of a random phenomenon are *independent* if the outcome of any one trial is not affected by the outcome of any other trial.
- Example:
  - If you have 20 flips of a coin in a row that are “heads”, you are not “due” a “tail” - the probability of a tail on your next flip is still 1/2. The trial of flipping a coin is independent of previous flips.

- Many people say that if they already have 4 boys, they are due to have a girl, so they will try again.

- It's easy to think this way!

- Playing the lottery anyone?
- Many gamblers go in debt by thinking they are due to win eventually…

Learning Objective 5:
How can we find Probabilities?

- Calculate theoretical probabilities based on assumptions about the random phenomena. For example, it is often reasonable to assume that outcomes are equally likely such as when flipping a coin, or a rolling a die.
- Observe many trials of the random phenomenon and use the sample proportion of the number of times the outcome occurs as its probability. This is merely an estimate of the actual probability.

Learning Objective 6:
Types of Probability: Relative Frequency vs. Subjective

- The ***relative frequency definition of probability*** is the long run proportion of times that the outcome occurs in a very large number of trials - not always helpful/possible.
- When a long run of trials is not feasible, you must rely on subjective information. In this case, the ***subjective definition of the probability*** of an outcome is your degree of belief that the outcome will occur based on the information available.

Learning Objective 6:
Types of Probability: Relative Frequency vs. Subjective

- You can't know what the chances that are that your marriage will succeed, or that there is life after death, or that the defendant in a particular trial really *is* guilty.
- We have to rely on how these things happened for other people and how we believe it will happen for us – **subjective probability**.

- For instance, the first time we send a human to Mars, we will not be able to give the probability of a successful mission. We have to rely on information we have about related events…this is beyond the scope of our class though.
- SO, just be wary of anyone who tells you there is a probability of 0 or 1 for something subjective. They can't be sure!

“Nothing is certain but death and taxes!”

-Benjamin Franklin

Homework

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