

## Section 5.1

### Probability Rules

### Definition

- Probability deals with experiments that yield random short-term results or outcomes yet reveal long-term predictability.
- The long-term proportion in which a certain outcome is observed is the probability of that outcome
- Probability is how likely it is that some event will happen

### The Law of Larger Numbers

- As the number of repetitions of a probability experiment increases, the proportion with which a certain outcome is observed gets closer to the probability of the outcome.

### Definitions

- Sample Space: For a probability experiment, sample space is the collection of all possible outcomes (denoted with S)
- Event: Any collection of outcomes from a probability experiment (denoted with E)

### 1. List the sample space of the following

- You are picking two people from the following group (order doesn't matter and you cannot pick the same person twice):

Bill, Sally, Mary, David

### Notation

- $P$  = a probability
- A, B, C, E = specific events
- $P(E)$  = the probability of event E occurring

## Rules of Probabilities

1.  $0 \leq P(E) \leq 1$
2. The sum of all probabilities of all outcomes must equal 1

## Definition

- Probability Model: Lists the possible outcomes of a probability experiment and each outcome's probability

2. Determine if the following is a probability model

Color	Probability
Red	0.2
Blue	0.1
White	0.3
Yellow	0.3
Black	0.1

3. Determine if the following is a probability model

Color	Probability
Bill	-0.3
Sally	0.5
Henry	0.8

4. Construct a Probability Model

How Many Times You Break the Law in a Week	Frequency
0 – 100	2
101 – 200	10
201 – 400	15
Over 400	25

## What Does Probability Mean?

- Impossible Event = 0
- Certain Event = 1
- Any Event is between and including 0 and 1
- 0.5 means 50/50 chance
- An unusual event is an event that has a low probability of occurring (5% cutoff point)

Rule 1: Empirical Approach  
(Real Life)

$$P(E) = \frac{\text{frequency of } E}{\text{number of trials of experiment}}$$

5. Find the probability

A survey of 700 randomly selected students showed that 100 of them believe in ghosts. What is the probability that a randomly selected student believes in ghosts?

Rule 2: Classical Method  
(Theory)

$$P(E) = \frac{\text{number of ways } E \text{ can occur}}{\text{number of different simple events}} = \frac{m}{n}$$

6. Find the probability

A box contains 5 blue markers, 3 red markers, 7 green markers and 10 black markers.

- What is the probability that a randomly selected marker is black?
- What is the probability that a randomly selected marker is blue?

7. Find the probability

Excluding leap year and the probability of being born on any particular day is the same as any other day:

- What is the probability that a randomly selected person was born on the 1<sup>st</sup> of the month?
- What is the probability that a randomly selected person was born in January?
- What is the probability that a randomly selected person was born on the 31<sup>st</sup> day of a month?

8. Find the probability

Out of a standard deck of cards, a card is drawn at random:

- Find the probability it is a heart
- Find the probability it is a king
- Find the probability it is a red card

Rule 3: Simulation Method

$$P(E) = \frac{\text{frequency of E}}{\text{number of trials of experiment}}$$

9. Find the probability using simulation

Simulate rolling a die a hundred times and find the probability of getting either a 5 or 6.

Rule 4: Subjective Probabilities

Guessing or Estimating

10. Find the probability

What is the probability of seeing a motorcycle rider who is a woman?

Rounding Off Probability =  
Given exact fraction, exact  
decimal, or round off to 3  
significant digits