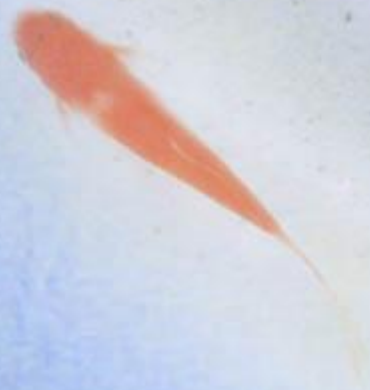# Experimental Probability Vs. Theoretical Probability

Objectives & Standards

- To explore experimental and theoretical probability with experiments and simulations

- To calculate and compare both probabilities

- MA.E.2.3.1
- MA.E.3.3.1

What do you know about probability?

- Probability is a number from 0 to 1 that tells you how likely something is to happen.
- Probability can have two approaches
  -experimental probability
  -theoretical probability

Key Words

- Experimental probability
- Theoretical probability
- Law of Large Numbers
- Outcome
- Event
- Random

Experimental vs.Theoretical

Experimental probability:

P(event) = number of times event occurs

total number of trials

Theoretical probability:

P(E) = number of favorable outcomes

total number of possible outcomes

How can you tell which is experimental and which is theoretical probability?

Experimental:

You tossed a coin 10 times and recorded a head 3 times, a tail 7 times

P(head)= 3/10

P(tail) = 7/10

Theoretical:

Toss a coin and getting a head or a tail is 1/2.

P(head) = 1/2

P(tail) = 1/2

Experimental probability

Experimental probability is found by repeating an **experiment** and observing the **outcomes**.

P(head)= 3/10
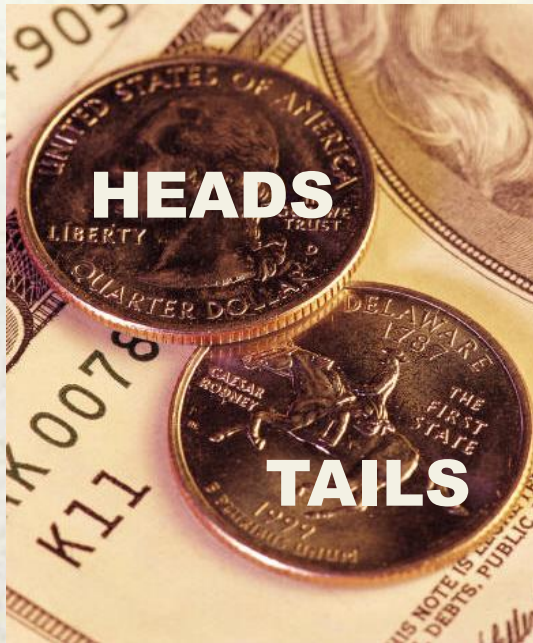
A head shows up 3 times out of 10 trials,

P(tail) = 7/10

A tail shows up 7 times out of 10 trials

Theoretical probability

P(head) = 1/2

P(tail) = 1/2

Since there are only two outcomes, you have 50/50 chance to get a head or a tail.

Compare experimental and theoretical probability

Both probabilities are ratios that compare the number of favorable outcomes to the total number of possible outcomes
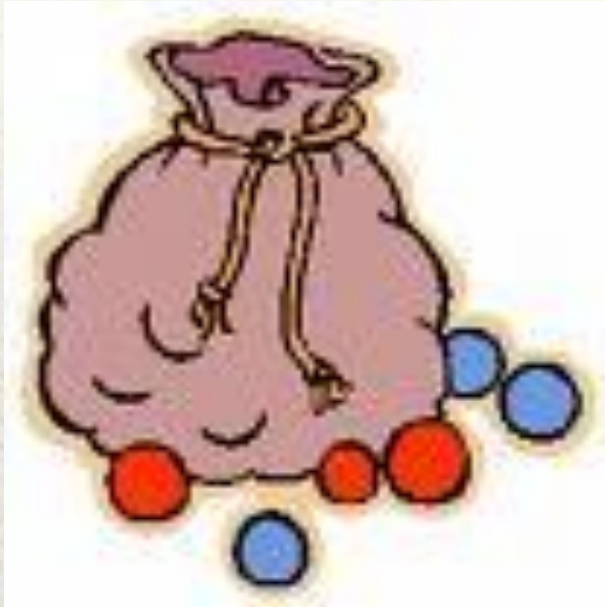
P(head)= 3/10

P(tail) = 7/10

P(head) = 1/2

P(tail) = 1/2

Identifying the Type of Probability

- A bag contains three red marbles and three blue marbles.

P(red) = 3/6 =1/2

✓ Theoretical

(The result is based on the possible outcomes)

Identifying the Type of Probability

Trial	Red	Blue
1		1
2	1	
3		1
4	1	
5		1
6		1
Total	2	4
Exp. Prob	1/3	2/3

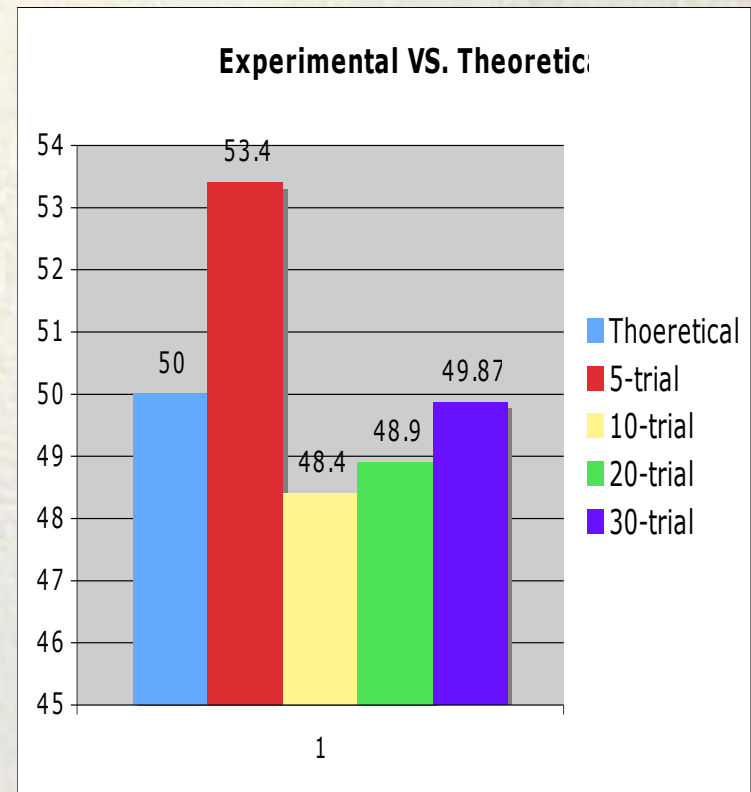- You draw a marble out of the bag, record the color, and replace the marble. After 6 draws, you record 2 red marbles

P(red)= 2/6 = 1/3

✓ Experimental

(The result is found by repeating an experiment.)

How come I never get a theoretical value in both experiments? Tom asked.

- If you repeat the experiment many times, the results will getting closer to the theoretical value.

- Law of the Large Numbers

Experimental VS. Theoretical

Legend:
- Thoeretical
- 5-trial
- 10-trial
- 20-trial
- 30-trial

Values:
- 50
- 53.4
- 48.4
- 48.9
- 49.87

Law of the Large Numbers 101

- The Law of Large Numbers was first published in 1713 by Jocob Bernoulli.
- It is a fundamental concept for probability and statistic.
- This Law states that as the number of trials increase, the experimental probability will get closer and closer to the theoretical probability.

Contrast experimental and theoretical probability

| *Experimental probability* is the result of an experiment.	*Theoretical probability* is what is expected to happen.

Contrast Experimental and theoretical probability

Three students tossed a coin 50 times individually.

- Lisa had a head 20 times. (20/50 = 0.4)
- Tom had a head 26 times. (26/50 = 0.52)
- Al had a head 28 times.   (28/50 = 0.56)
- Please compare their results with the theoretical probability.
- It should be 25 heads. (25/50 = 0.5)

Contrast Experimental and theoretical probability

		Summary of toss up results				
Name	# of Heads	Exp P(H)	P(H)	# of Tails	Exp P(T)	P(T)
Lisa	20	0.4	0.5	30	0.6	0.5
Tom	26	0.52	0.5	24	0.48	0.5
Al	28	0.56	0.5	22	0.44	0.5
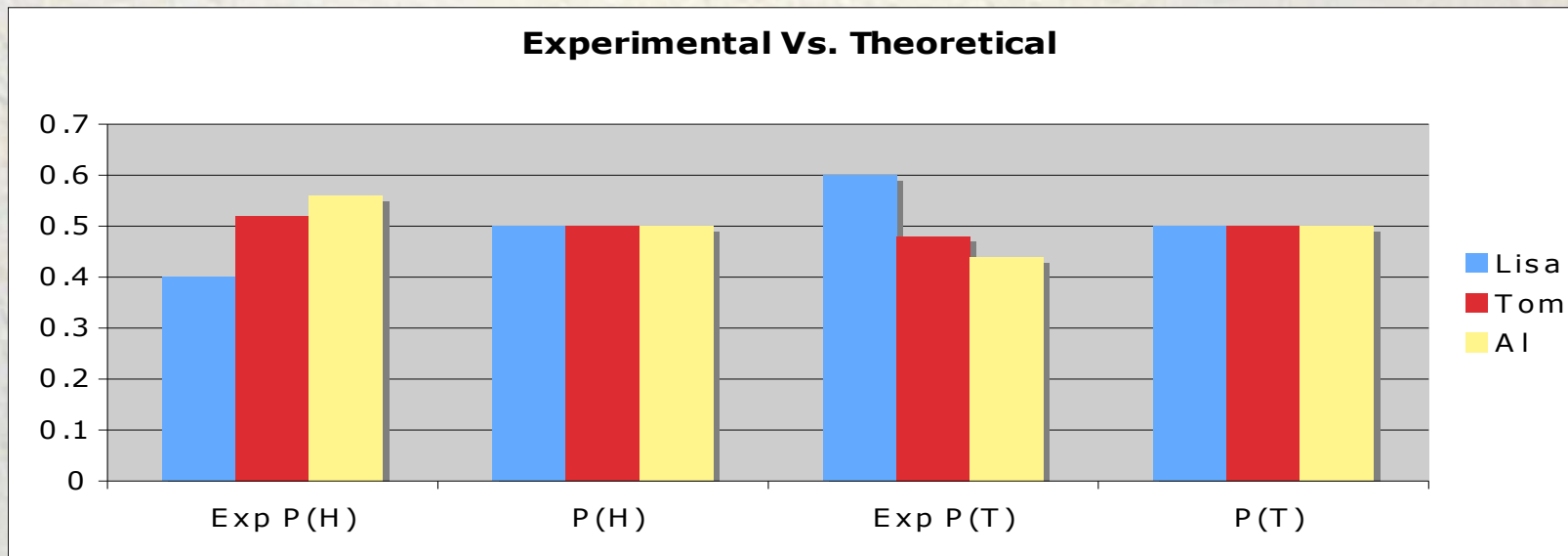
Lesson Review

- Probability as a measure of likelihood
- There are two types of probability
- Theoretical--- theoretical measurement and can be found without experiment
- Experimental--- measurement of a actual experiment and can be found by recording experiment outcomes