2.3 Compare Experimental and Theoretical Probabilities

A Experimental Probability

Experimental probability may be determined at the end of a probability experiment by:

$$P(E) = \frac{\text{number of successful trials (when the event } E \text{ happened)}}{\text{total number of trials}}$$

In order to use this formula:

- ✓ Run several trials for a probability experiment like rolling a die, tossing a coin, drawing a card from a deck
- ✓ Record every outcome
- ✓ Define an event related to the set of outcomes and compute the experimental probability
- ✓ Computers and graphing calculators have random numbers generators that can simulate probability experiments

B Theoretical Probability

Theoretical probability is another measure of the likelihood of an event and is defined by:

$$P(E) = \frac{\text{number of successful outcomes (when the event } E \text{ happened)}}{\text{total number of possible outcomes}}$$

In order to use this formula:

- ✓ Identify all possible outcomes for a probability experiment (just think about it, do not run the experiment)
- ✓ Consider each outcome equally likely
- ✓ Define an event related to the set of outcomes and compute the theoretical probability
- ✓ Use tree diagrams to find the set of all possible outcomes

Example 1. Let toss three coins. Let analyse the event of getting three heads.

a) What is the theoretical probability of getting three heads?

b) Use the Coin Tossing Simulator and run an experiment with 10 trials about tossing three coins. What is the experimental probability of getting three heads?

Example 2. Let roll two dice. Let analyse the event of getting a double.

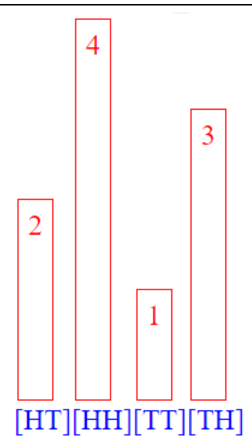
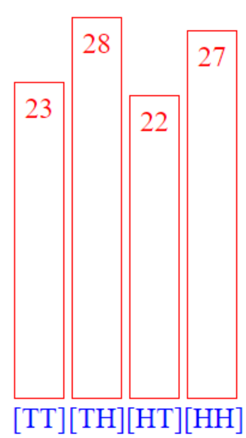
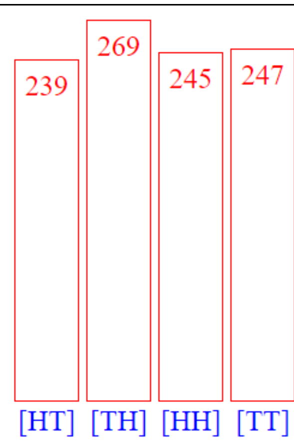
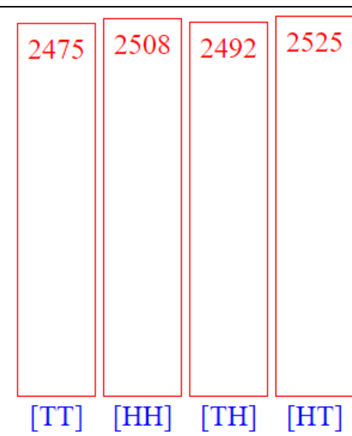
a) What is the theoretical probability of getting a double?

b) Use the Dice Rolling Simulator and run an experiment with 10 trials about rolling two dice. What is the experimental probability of getting a double?

C Link between the Experimental and Theoretical probability

If the number of trials increases, the experimental probabilities get closer to the theoretical probabilities.

Example 3. By using the Coin Tossing Simulator, two coins are tosses. The frequency tables obtained are given below together with the corresponding number of trials. What can be concluded from these diagrams?

10 trials	100 trials	1000 trials	10,000 trials
			

Example 4. In a lottery game, three numbers are drawn from 1, 2, 3, 4, 5, and 6. The numbers may repeat but the order is important. To be a winner of this game, your three numbers should match the winning numbers in that order. Let suppose that you will play the same numbers 1000 times and pay $10 for each trial. If you win the lottery, the price is $1000.

a) Pick you three lucky numbers now. Order is important.

b) Run the Dice Roller Simulator with 3 dice, 1000 trials and count how many times you win the lottery. Can you make a living by playing this game?

c) What is the theoretical probability of winning this game?

d) How much money you have to spend in order to win this game once?

Example 5. In a simple 6-from-49 lotto, a player chooses six numbers from 1 to 49 (no duplicates are allowed). If all six numbers on the player's ticket match those produced in the official drawing (regardless of the order in which the numbers are drawn), then the player is a jackpot winner.
For such a lottery, the probability of being a jackpot winner is 1 in 13,983,816.

a) How is this probability calculated? (this is beyond this course level)

b) If a ticket cost $2, how much money (theoretically) you have to spend in order to win this lotto once?

Reading Pages 76-81
Homework Pages 82-85 # 2, 4, 13