1 Probability Models

In your group, determine a probability model (i.e., the sample space and probabilities of outcomes) for each random experiment below.

1. Flipping a (fair) quarter

2. Flipping two (fair) quarters

3. Flipping a (weighted) quarter in which heads is twice as likely as tails

4. Rolling two (fair) dice

2 Basic Probability Rules

In your group, discuss the following questions related to the random experiment of rolling two (fair) six-sided dice.

1. What do you think the probability is of rolling two dice that sum to 5? Why?

   Solution (click to open)

2. Make a conjecture for the general rule of the probability of an event of a random experiment happening.
3. What do you think the probability is of rolling two dice that do not sum to 5? Why?

   Solution (click to open)

4. Make a conjecture for the general rule of the probability of an event of a random experiment not happening. This is called the **complement** of an event.
5. What do you think the probability is of rolling two dice that sum to 5 OR multiply to 6? Why?

   Solution (click to open)

6. Make a conjecture for the general rule of the probability of "event A" OR "event B" of a random experiment happening. This is called the **union** of two events.

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3 Using Probability Rules

We will now practice computing probabilites using the rules we've just established. Use the probability models provided to answer each question.

1. The probability models below are for the global mean temperature increase at the end of the century as compared to pre-industrial levels. There are two models: with and without climate policies in place. The probability models are based on the MIT Integrated Global System Modeling (IGSM) Framework.

Global Mean Temp. Change	Probability (no policy)	Global Mean Temp. Change	Probability (with policy)
$< 3^\circ$ C	0.09	$< 1.5^\circ$ C	0.05
$3 - 3.25^\circ$ C	0.14	$1.5 - 1.75^\circ$ C	0.20
$3.25 - 3.5^\circ$ C	0.16	$1.75 - 2^\circ$ C	0.43
$3.5 - 3.75^\circ$ C	0.29	$2 - 2.25^\circ$ C	0.25
$3.75 - 4^\circ$ C	0.20	$> 2.25^\circ$ C	0.07
$> 4^\circ$ C	0.12		

   a. What is the probability that the global mean temperature change is not above 4° C with no policies in place?
   b. What is the probability that the global mean temperature change remains below 2° C with policies in place?
   c. What is the probability that the global mean temperature change is below 3° C OR above 4° C with no policies in place?
   d. What is the probability that the global mean temperature change is below 2.25° C OR above 2° C with policies in place?

2. A city developed an urban planning probability model for the increase in population over the next 3 years.

Population Increase (in thousands)	Probability
< 50	0.12
$50 - 75$	0.23
$75 - 100$	0.36
$100 - 115$	0.25
> 115	0.04

   a. What is the probability that the city increases less than 100 thousand people over the next 3 years?
   b. What is the probability that the city does not increases more than 115 thousand people over the next 3 years?
   c. Suppose that a neighboring city is modeled by the same probability model. What is the probability that both cities increases less than 50 thousand people over the next 3 years? Assume that population growth in the two cities is independent.
   d. Suppose that a neighboring city is modeled by the same probability model. What is the probability that at least one of the two cities increases less than 50 thousand people over the next 3 years? Assume that population growth in the two cities is independent.
   e. In the last two questions, we assume that population growth in the two cities is independent. Discuss in your group to what extent this is a good or bad assumption.

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