4.1 Probability

**Probability:** the chance of an event occurring

* This is the basis of inferential statistics

**Basic terms:**

**Probability experiment:** a chance process that leads to a well-defined result outcome

**Ex.** roll a die

**Outcome:** the result of a single trial of a probability experiment

**Ex.** 1

**Sample space:** the set of all possible outcomes in a probability experiment

**Ex.** 1, 2, 3, 4, 5, 6

**Event:** a set of outcomes of a probability experiment
Probability of event = P(event)

\[ P(\text{event}) = \frac{\# \text{ of outcomes in which event occurs}}{\# \text{ of outcomes in sample space}} = \frac{n(E)}{n(S)} \]
Ex. I flipped a coin 3 times. What is the sample space?

Tree Diagram:

```
1st flip  2nd flip  3rd flip

H  H  H
H  T  H
H  T  T
T  T  H
T  T  T

Sample Space
HHH
HHT
HTH
HTT
THH
THT
TTT
```

\[ P(HTH) = \frac{1}{8} \]

\[ P(\text{flip at least 1 head}) = \frac{7}{8} \]

\[ P(\text{flip no heads}) = \frac{1}{8} \]
Problems:

A bag of marbles contains ...
3 red, 4 green, 8 blue, and one black.

1. What is the probability of ...... $P(\text{green}) = \frac{4}{16} = 0.25$

2. What is the probability of randomly picking a blue marble?
   $50\% = \frac{1}{2} = \frac{8}{16} = 0.5$

3. $P(\text{green}) = \frac{1}{4}$

4. $P(\text{brown}) = 0\% \quad \text{ impossible}$

5. $P(\text{red or blue}) = \frac{3+8}{16} = \frac{11}{16}$
Types of Probabilities:

*Classical Probability (aka theoretical probability):
  A probability that assumes all outcomes in the sample space are equally likely

*Empirical Probability (aka experimental probability):
  A probability that is based on experience or previous trials

*Subjective Probability
  A probability based on an educated guess or opinion or inexact information
Complementary Events

Two events A and B are complements if and only if all outcomes in the sample space are in A or B

Ex. 5 and not 5

blue and not blue

Notation:

\[ A^c = A' = \bar{A} = \text{the complement of event A} \]
$P(\text{marble}) = 1$

\text{Certain}
Joel has an MP3 player called the Jumble. The Jumble randomly selects a song for the user to listen to. Joel's Jumble has 2 classical songs, 13 rock songs, and 5 rap songs on it.

What is $P(\text{rock song or rap song})$?

\[
P(\text{rock}) + P(\text{rap}) = \frac{13}{20} + \frac{5}{20} = \frac{18}{20}.
\]
The following frequency table summarizes this year's injuries on the Canadian Rounders cricket team.

Based on this data, what is a reasonable estimate of the probability that the Canadian Rounders have 0 players injured for their next match?

<table>
<thead>
<tr>
<th>Number of injured players</th>
<th>Number of matches</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

\[ P(0) = \frac{4}{16} = \frac{25\%}{1} + \frac{2}{16} \]
The following dot plot summarizes the number of vitamins Omar's mom took each day since she started her new health regimen. Each dot represents one day.

Based on this data, what is a reasonable estimate of the probability that Omar's mom takes exactly 6 vitamins tomorrow?
Given that $P(5) = .93$, what is $P(\text{not 5})$?
Hw:

P. 198 # 4-11, 13, 18, 19,
20, 21, 25, 31, 37, 40
p. 198 Answers

18. a. \( P(\text{6 and spade}) = \frac{1}{52} \)
   
   b. \( P(\text{black king}) = \frac{2}{52} = \frac{1}{26} \)
   
   c. \( P(\text{red and 7}) = \frac{2}{52} = \frac{1}{26} \)
   
   d. \( P(\text{diamond or heart}) = \frac{26}{52} = \frac{1}{2} \)
   
   e. \( P(\text{black}) = \frac{26}{52} = \frac{1}{2} \)

20. a. \( P(M) = \frac{8}{30} = \frac{4}{15} \)

   b. \( P(\text{cons}) = \frac{38}{50} = \frac{19}{25} \)