8.2: Union, Intersecion, and Complement of Events; Odds

Unions and Intersections:

Example 1: Roll a single die.

a. What is the probability of rolling a number that is even and divisible by 3?
b. What is the probability of rolling a number that is even or divisible by 3?

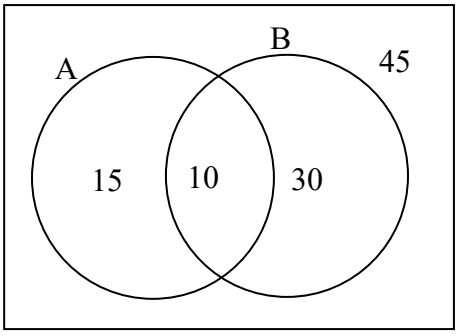
Probability of a Union of Two Events:

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

If the two events are mutually exclusive (disjoint):

$$P(A \cup B) = P(A) + P(B)$$

Example 2: Assume that an equally likely sample space is described by the Venn diagram below.



Complements:

Probability of a complement:

$$P(E') = 1 - P(E)$$

$$P(E) = 1 - P(E')$$

Example 3: Suppose that the probability of someone voting for a certain candidate is 0.46. What is the probability of not voting for the candidate?

Example 4: Roll a pair of dice. What is the probability of rolling a sum of 4 or more?

Odds:

Sometimes the likelihood (or unlikelihood) of an event is described using *odds* instead of probabilities.

Summary:

Probability: The event is contrasted against the whole.

Odds: The event is contrasted against the complement.

Converting from probability to odds:

From Probability to Odds:

- Odds for $E = \dfrac{P(E)}{P(E')}$
- Odds against $E = \dfrac{P(E')}{P(E)}$

When possible, express odds as ratios of whole numbers.

Example 5: Roll a pair of dice. What are the odds for rolling a sum of 3? What are the odds against rolling a sum of 3?

Example 6: What are the odds against rolling an ace when drawing a single card from a standard deck?

Example 7: Suppose that, based upon genetics, a child has a 0.08 probability of developing a certain disease. What are the odds against the child developing the disease?

Converting odds to probability:

From Odds to Probability:

If odds for an event E are $\frac{m}{n}$, (i.e. m:n) then $P(E) = \frac{m}{m+n}$.

Example 8: If the odds against a horse winning a race are 7:1, what is the probability that the horse will win?

Example 9: Suppose an insurance company has used past flood data to determine that determined that the odds against a particular house flooding are 150:1. What is the probability that the house floods?