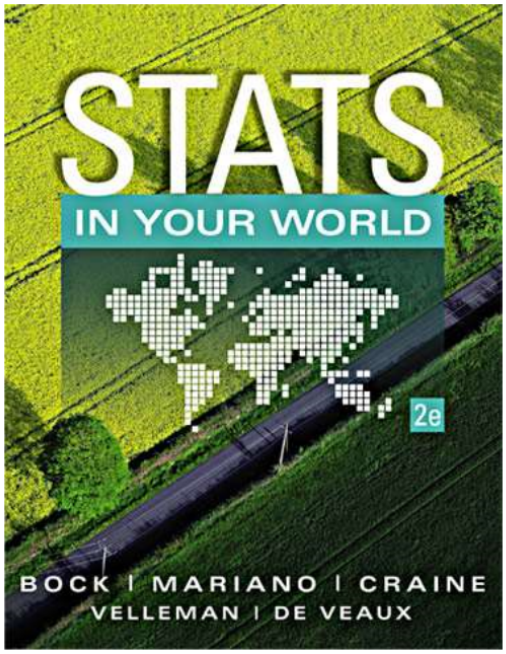
Chapter 13

What Are the Chances?

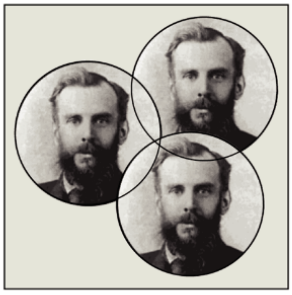


The First Three Rules of Working with Probability

- We are dealing with probabilities now, not data, but the three rules don't change.
  - Make a picture. - Venn Diagrams
  - Make a picture.
  - Make a picture. - Tree Diagrams

The First Three Rules of Working with Probability (cont.)

- The most common kind of picture to make is called a Venn diagram.



- We will see Venn diagrams in practice shortly…

Ch. 14

Formal Probability

1. Two requirements for a probability:
   - A probability is a number between 0 and 1.
   - For any event **A**, $0 \le P(\mathbf{A}) \le 1$.

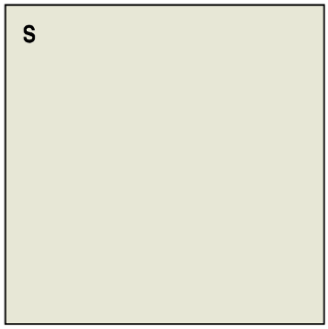
0 = the event is impossible

1 = the event is certain (definite)

Formal Probability (cont.)

2. Probability Assignment Rule:

- The probability of the set of all possible outcomes of a trial must be 1. (all options add up to 1)
- $P(\mathbf{S}) = 1$ (**S** represents the set of all possible outcomes.)



The sample space **S**.

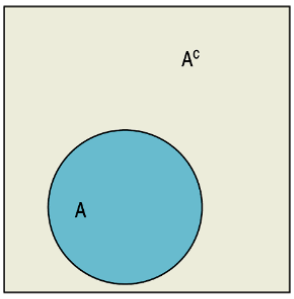
Formal Probability (cont.)

3. Complement Rule: (opposite of A)

- The set of outcomes that are *not* in the event **A** is called the complement of **A**, denoted $\mathbf{A^c}$.
- The probability of an event occurring is 1 minus the probability that it doesn't occur: $P(\mathbf{A}) = 1 - P(\mathbf{A^c})$

P(Rain) = .70

P(No Rain) = .30

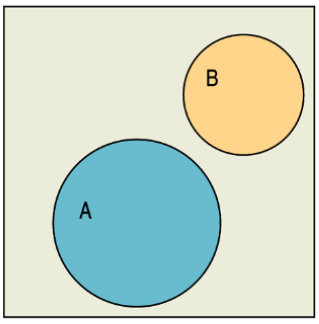


The set **A** and its complement.

Formal Probability (cont.)

4. Addition Rule:

- Events that have no outcomes in common (and, thus, cannot occur together) are called disjoint (or mutually exclusive).



no A and B

Two disjoint sets, **A** and **B**.

Formal Probability (cont.)

4. Addition Rule (cont.):

- For two disjoint events **A** and **B**, the probability that one *or* the other occurs is the sum of the probabilities of the two events.
- $P(\mathbf{A} \cup \mathbf{B}) = P(\mathbf{A}) + P(\mathbf{B})$, provided that **A** and **B** are disjoint. (No both)

Deck of cards. Pick 1 card.

P(6 or 8) = $\underbrace{\frac{4}{52} + \frac{4}{52} = \frac{8}{52}}_{P(6) + P(8)}$ (can't be a 6 and an 8)

Formal Probability (cont.)

5. Multiplication Rule: (And)

- For two independent events **A** and **B**, the probability that *both* **A** and **B** occur is the product of the probabilities of the two events.
- $P(\mathbf{A} \cap \mathbf{B}) = P(\mathbf{A}) \times P(\mathbf{B})$, provided that **A** and **B** are independent.

Independent

Deck of cards. Pick 1. Replace. Pick another 1.

P(6 and 8) = $\frac{4}{52} \times \frac{4}{52} = \frac{16}{2704}$

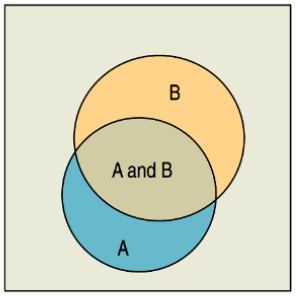
Deck of cards. Pick 1. Don't replace. Pick another 1.

P(6 and 8) = $\frac{4}{52} \times \frac{4}{51} = \frac{16}{2652}$ **Still independent?** No

Formal Probability (cont.)

5. Multiplication Rule (cont.):

- Two independent events **A** and **B** are not disjoint, provided the two events have probabilities greater than zero:



Two sets **A** and **B** that are not disjoint. The event (**A** and **B**) is their intersection.

Formal Probability (cont.)

5. Multiplication Rule:

- Many Statistics methods require an **Independence Assumption**, but *assuming* independence doesn't make it true.
- Always *Think* about whether that assumption is reasonable before using the Multiplication Rule.

Formal Probability - Notation

Notation alert:

- In this text we use the notation $P(\mathbf{A} \cup \mathbf{B})$

- In other situations, you might see the following:
  - *P*(**A** or **B**) instead of $P(\mathbf{A} \cup \mathbf{B})$ "Union"
  - *P*(**A** and **B**) instead of $P(\mathbf{A} \cap \mathbf{B})$

Putting the Rules to Work

- In most situations where we want to find a probability, we'll use the rules in combination.
- A good thing to remember is that it can be easier to work with the *complement* of the event we're really interested in.

Homework:

!!Read!! Chapter 13 and do the

4 Just Checking questions on pg. 317.