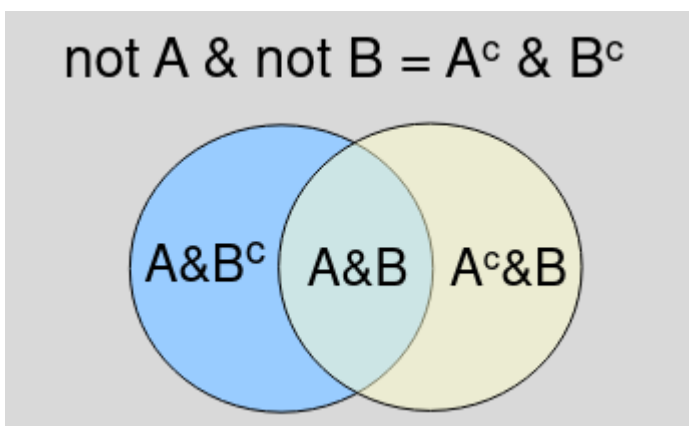


Module 2: Probability

Probability is the study of uncertainty and randomness in the world. It measures chance.

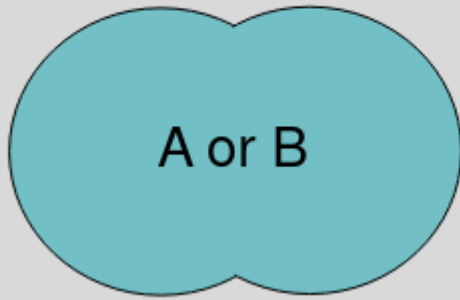
Proportion is a summary statistic. Proportion measures size (i.e. how many patients have optional blood pressure).

- We show the probability of Event A as $P(A)$
- The compliment of an event, or chance of event not occurring is A^C
 - $P(A) + P(A^C) = 1$
- Two events are mutually exclusive (or "disjoint") if when one event occurs the other cannot
- Two events are independent if the probability of one has no impact on the occurrence of the other
 - Events are independent if:
 - $P(A|B) = P(A)$
 - $P(A|B) = P(A | \text{not } B)$
 - Odds ratio = 1 (binary outcome)
- If two events are not independent they are said to be statistically associated
- Joint Probability = $P(A \& B) = P(A, B) = P(A \cap B)$
 - If A and B are independent events: $P(A \& B) = P(A) * P(B)$



- $P(A \text{ or } B) = P(A \cup B)$
 - When A and B are non-mutually exclusive $P(A \text{ or } B) = P(A) + P(B) - P(A \& B)$
 - When A and B are mutually exclusive events $P(A \text{ or } B) = P(A) + P(B)$ since $P(A \& B) = 0$

not A & not B = $A^c \& B^c$



- Conditional probability is the chance of an event occurring given that another event occurred, written as $P(A|B)$ = The probability of A given B.
 - $P(A|B) = P(A \& B) / P(B)$
 - $P(A|B) * P(B) = P(A \& B)$

Bayes' Theorem

Because $P(A \& B) = P(B \& A)$,
 $P(A \& B) = P(B \& A) = P(B|A) \times P(A)$
=
 $P(A|B) \times P(B) = P(B|A) \times P(A)$

$$P(B|A) = P(A|B) * P(B) / P(A)$$

Sensitivity

Sensitivity of a screening test = Probability of positive test given the person has the disease. If X is the test result and Y represents if the person actually has the disease, this can be expressed as $P(X = + | Y = +)$ = the probability of a disease given the test was positive.

Sensitivity = True Positive Fraction = $P(\text{Test}+ | \text{Disease})$

Specificity = True Negative Fraction = $P(\text{Test} - | \text{No Disease})$

False Positive = $P(\text{Test} + | \text{No Disease})$

False negative = $P(\text{Test} - | \text{Disease})$

Positive Predictive Value = $P(\text{Disease} | \text{Test} +)$

Negative Predictive Value = $P(\text{No Disease} | \text{Test} -)$

Odds Ratio

Odds ratio can be used to check independence, events are independent when $OR=1$.

$$OR = (P(X = + | Y = +) / P(X = - | Y = +)) / (P(X = + | Y = -) / P(X = - | Y = -))$$

$$= (P(X = + | Y = +) * P(X = - | Y = -)) / (P(X = + | Y = -) * P(X = - | Y = +))$$

Symmetry of Odds Ratio

$$OR = \frac{P(D | E)}{P(\text{not } D | E)} \div \frac{P(D | \text{not } E)}{P(\text{not } D | \text{not } E)} = \frac{P(E | D)}{P(\text{not } E | D)} \div \frac{P(E | \text{not } D)}{P(\text{not } E | \text{not } D)}$$

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