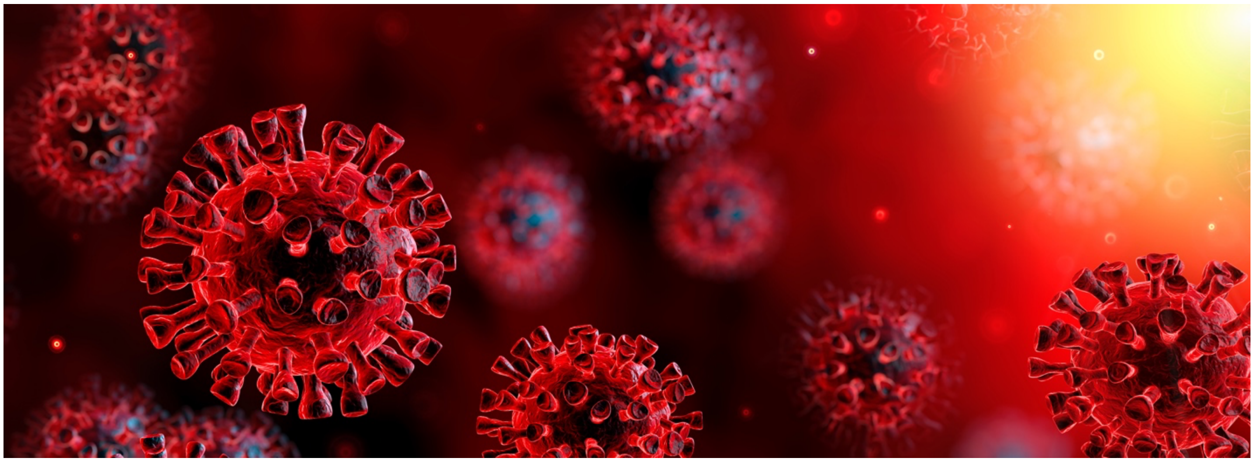
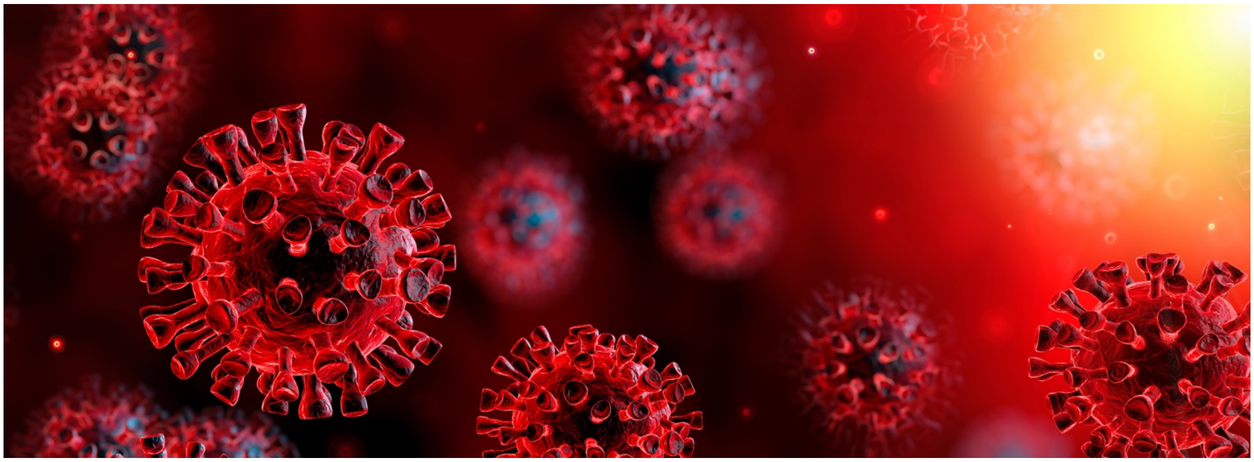
Conditional Probability



What is the Probability of an event given a particular condition? This is explored as a conditional probability when we want to compute the likelihood of events given particular conditions.

The Corona Virus (COVID-19) is a serious matter that is not to be taken lightly. I will be using **fictitious** data to illustrate how the conditional probability definition is used in the Health Industry. This is relevant to all our lives today. This process can be applied to any medical testing we all face and is very interesting.



The following data is a **fictitious** sample of 500 people who were tested for COVID-19.

Covid-19	Test +	Test -	Total
Infected	15	18	33
Not Infected	105	362	467
Total	120	380	500

Using our definition of probability, we can answer some fundamental questions using data from this table. If you select a person at random, what's the probability the person:

1. Is infected ?
2. Is not-infected ?
3. Tests + ?
4. Tests - ?

What is not mentioned to students is that people were actually tested twice to find the errors associated with this particular blood testing procedure. In fact, all medical testing procedures have built in "errors" unique to the test. The errors can be significant or insignificant. In order to compute the "errors" we will need to consider the table and the conditional probability formula.

Def- Probability of A given that B

$$P(A|B) = \frac{n(A \text{ and } B)}{n(B)}$$

B is the condition.

This is known or has happened.

If you select a person at random, what's the probability the person:

Def- False Negative
A test result that incorrectly indicates a person does not have a particular condition.

5. Tests - **given that** the person is infected?

$$P(test - |infected) = \frac{n(test - \ and\ infected)}{n(infected)}$$

Def- False Positive
A test result that incorrectly indicates a person has a particular condition.

6. Tests + given **that** the person not infected?

$$P(test + |not\ infected) = \frac{n(test + \ and\ not\ infected)}{n(not\ infected)}$$

Similarly, we have what is known as true positives and true negatives.

Def- True Positive
A positive test result that correctly indicates a condition is present.

7. Tests + **given that** the person is infected?

$$P(test + \ |\ infected\ ) = \frac{n(test + and\ infected\ )}{n(\ infected\ )}$$

Def- True Negative
A negative test result that correctly indicates that a condition is not present.

8. Tests - **given that** the person is not infected?

$$P(test - \ |\ not\ \ infected\ ) = \frac{n(test - and\ not\ infected\ )}{n(not\ \ infected\ )}$$

Fact- $P(A|B) \neq P(B|A)$
rarely are these probabilities are equal.

Def-Independent Events A and B
A and B are independent, if $P(A) = P(A|B)$

That is the condition B does not change the likelihood of A. B has no effect on A.

Def-Dependent Events A and B
A and B are dependent, if $P(A) \neq P(A|B)$

That is the condition B does change the likelihood of A. B has an effect on A.

These definitions will be of some value when we compute probabilities for multiple selections.