

# Day 2 - The ubiquitous bell-shaped curve

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## Learning Objective 2

Judge a distribution by its standard deviation or variance. Know what information is lost with summary statistics. Apply central limit theorem in the context of experiments. Scientifically interpret linear regression results.

## 1 Discrete Probability Distribution

### 1.1 Binomial Distribution

#### The problem of false positives

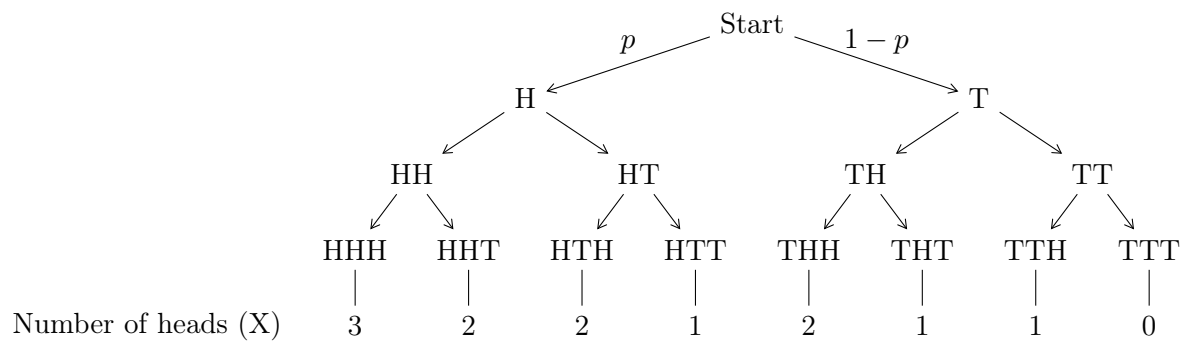
No diagnostic test is perfect in the real world. For example, in a flow cytometry test, we may have issues with unspecific binding and specific cross-reactivity with off targets resulting in false positives, as well as lack of reactivity with the stated target antigen resulting in false negatives. Mathematically, these can be described using **sensitivity** and **specificity**.

- Sensitivity is the probability of a positive test result, conditioned on the individual truly being positive.
- Specificity is the probability of a negative test result, conditioned on the individual truly being negative.

Suppose we have a test designed to identify the presence of a pathogen in patient blood samples. The sensitivity of the test is 80% and the specificity is 99%.

1. Suppose that 10% of the population is infected with the pathogen.
  - (a) What is the probability that a randomly selected patient will be tested positive?
  - (b) If a randomly selected patient is tested and the test result is **positive**, what is the probability that the patient, in fact, has the pathogen?
  - (c) If a randomly selected patient is tested and the test result is **negative**, what is the probability that the patient, in fact, has the pathogen?
2. Suppose now that 0.1% of the population is infected with the pathogen. Does the probability above change? If so, how?

## 1.2 Deriving Binomial Distribution



**Homework 1:** Simulate Monty Hall puzzle and answer questions in `day01_activity01_montyhall.ipynb`.

**Homework 2:** Following the instructions in `day01_activity02_twoChildren.ipynb`, complete a code for Two-Children puzzle simulation and answer questions