1.1 Why study probability?

Unit 1: Probability and Counting

Adapted from Blitzstein-Hwang Chapter 1.

Mathematics is the logic of certainty; probability is the logic of uncertainty. Probability is extremely useful in a wide variety of fields, since it provides tools for understanding and explaining variation, separating signal from noise, and modeling complex phenomena. For example, probability is needed in:

1. *Statistics*: Probability is the foundation and language for statistics, enabling many powerful methods for using data to learn about the world.
2. *Physics*: Einstein famously said "God does not play dice with the universe", but current understanding of quantum physics heavily involves probability at the most fundamental level of nature.
3. *Biology*: Genetics is deeply intertwined with probability, both in the inheritance of genes and in modeling random mutations.
4. *Computer science*: Probability also plays an essential role in studying randomized algorithms, machine learning, and artificial intelligence.
5. *Finance*: Probability is central in quantitative finance. Modeling stock prices over time and determining "fair" prices for financial instruments are based heavily on probability.
6. *Political science*: In recent years, political science has become more and more quantitative and statistical, e.g., in predicting and understanding election results.
7. *Medicine*: The development of randomized clinical trials, in which patients are randomly assigned to receive treatment or placebo, has transformed medical research in recent years.
8. *Life*: Life is uncertain, and probability is the logic of uncertainty. While it isn't practical to carry out a formal probability calculation for every decision made in life, thinking hard about probability can help us avert some common fallacies, shed light on coincidences, and make better predictions.