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Bayesian Statistics

Data Science Immersive

// FLATIRON SCHOOL

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Probability

This morning you got you got a bunch of random coins in change after paying for your breakfast. You start flipping the quarter you have multiple times. After 10 flips, you have 3 heads and 7 tails.

Do you think you have a fair coin, or is your coin possibly weighted to tails?

What do you think is the true probability for flipping heads with this coin?

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Frequentist vs. Bayesian

- Frequentist statisticians rely on the imaginary sampling of an infinite population and derive a probability value that summarizes the result of the experiment
 - Inference made by a frequentist statistician only depends on the frequency of events, or samples observed
- Bayesian statisticians not only rely on actual evidence observed, but also on beliefs

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Bayesian Statistics

Bayesian statistics is a particular approach to applying probability to statistical problems.

We may have a *prior* belief about an event, but our beliefs are likely to change when new evidence is brought to light. Bayesian statistics gives us a solid mathematical means of incorporating our prior beliefs, and evidence, to produce new *posterior* beliefs.

In particular Bayesian inference interprets *probability* as a measure of *believability* or *confidence* that an *individual* may possess about the occurrence of a particular event.

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Frequentist vs. Bayesian

Situation: Determining the probability of seeing a heads come up when flipping a coin.

| Frequentist Interpretation | Bayesian Interpretation |
|--|--|
| The probability of seeing a head when the coin is flipped is the <i>long-run relative frequency</i> of seeing a head when repeated flips of the coin are carried out. That is, as we carry out more coin flips the number of heads obtained as a proportion of the total flips tends to the "true" or "physical" probability of the coin coming up as heads. In particular the individual running the experiment does not incorporate their own beliefs about the fairness of other coins. | Prior to any flips of the coin an <i>individual may</i> believe that the coin is fair. After a few flips the coin continually comes up heads. Thus the prior belief about fairness of the coin is modified to account for the fact that three heads have come up in a row and thus the coin might not be fair. After 400 flips, with 400 heads, the individual believes that the coin is very unlikely to be fair. The <i>posterior</i> belief is heavily modified from the prior belief of a fair coin. |

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Frequentist vs. Bayesian

Situation: Election of a candidate

| Frequentist Interpretation | Bayesian Interpretation |
|--|---|
| The candidate only ever stands once for this particular election and so we cannot perform... | An individual has a prior belief of a candidate's chances of winning an election and their... |

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