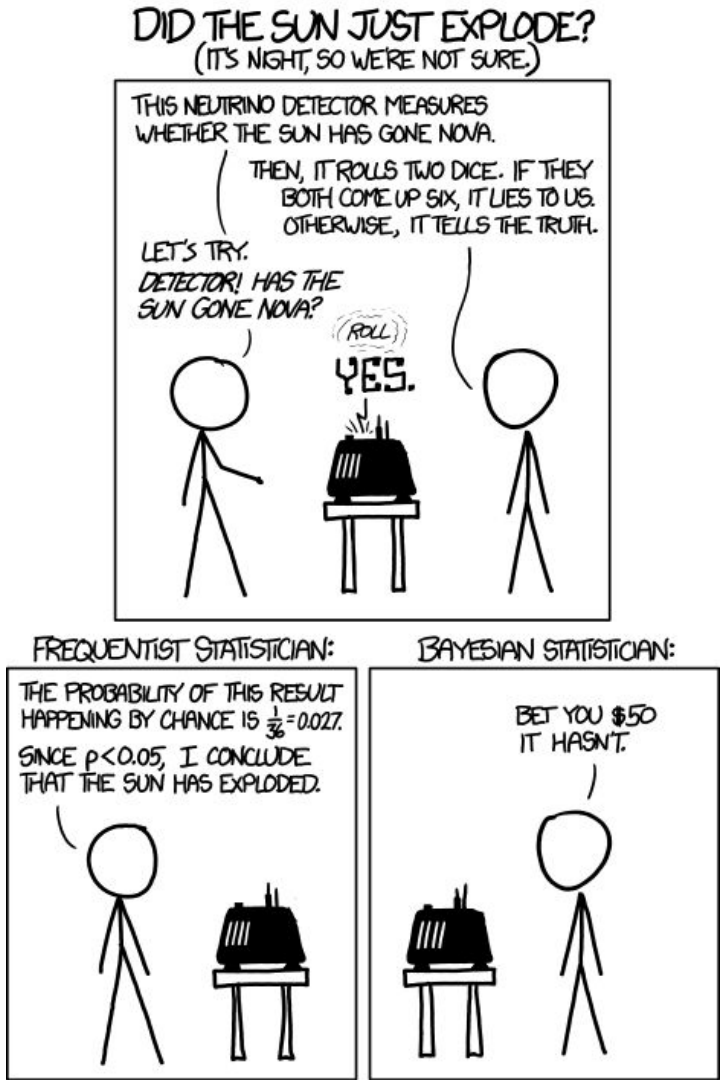
Review on Frequentist (vs. Bayesian?) Statistics

20200614

Frequentist vs. Bayesian

Titan: I think it helps to think about these two side-by-side, to understand how/why they are different.



Side-by-side comparison, source: 18.05 MIT

Frequentist

- **Only uses conditional distributions of data given specific hypotheses.**
  Presumption: some hypothesis is true and observed data is sampled from that distribution.
- **Doesn't depend on a subjective prior** that may vary from 1 investigator to another.

Bayesian

- **Models uncertainty by a probability distribution over hypotheses.**
- To make inferences, **depends on one's degree of confidence in the chosen prior,** and the **robustness of the findings to alternate prior distributions may be relevant & important.**

More contrasts between them, source: 18.05 MIT

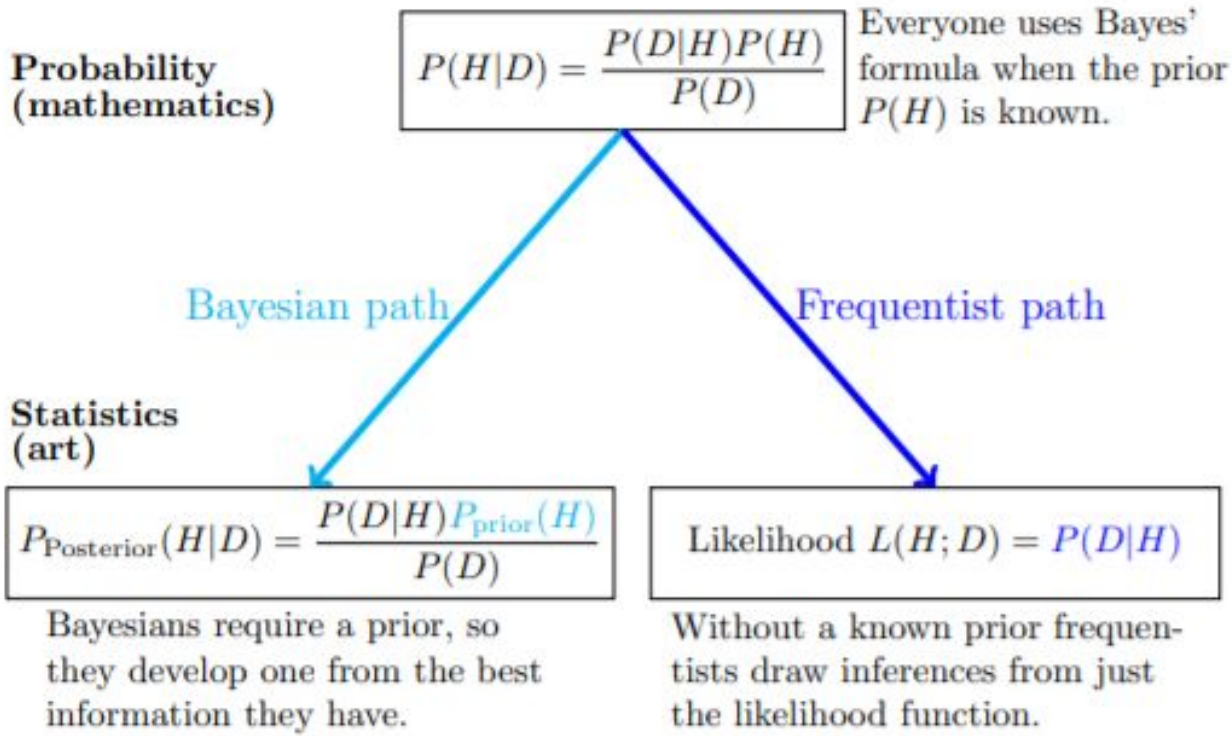
Frequentist

- Never uses/ gives the probability of a hypothesis (no prior or posterior)
- Depends on the likelihood for both observed & unobserved data
- Doesn’t require a prior
- Tends to be less computationally intensive
- Dominated statistical practice in 20th century

Bayesian

- Uses probabilities for both hypotheses & data
- Depends on the prior & likelihood of observed data
- Requires one to know or construct a ‘subjective prior’
- May be computationally intensive
- Dominated statistical practice before 20th century

In short...


Probability
(mathematics)
$P(H|D) = \frac{P(D|H)P(H)}{P(D)}$
Everyone uses Bayes' formula when the prior $P(H)$ is known.
Bayesian path
Frequentist path
Statistics
(art)
$P_{\text{Posterior}}(H|D) = \frac{P(D|H)P_{\text{prior}}(H)}{P(D)}$
Likelihood $L(H;D) = P(D|H)$
Bayesians require a prior, so they develop one from the best information they have.
Without a known prior frequentists draw inferences from just the likelihood function.

Side notes (unrelated)

Types of error

		True state of nature	
		H_0	H_A
Our decision	Reject H_0	Type I error	correct decision
	'Don't reject' H_0	correct decision	Type II error

Type I: false rejection of H_0
Type II: false non-rejection ('acceptance') of H_0