

# Bayes' theorem

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## Introduction

What makes probability **more intuitive!**

## Description

Steve is very shy and withdrawn, invariably helpful but with very little interest in people or in the world of reality. A meek and tidy soul, he has a need for order and structure, and a passion for detail.

Seems bookish

90% 10%

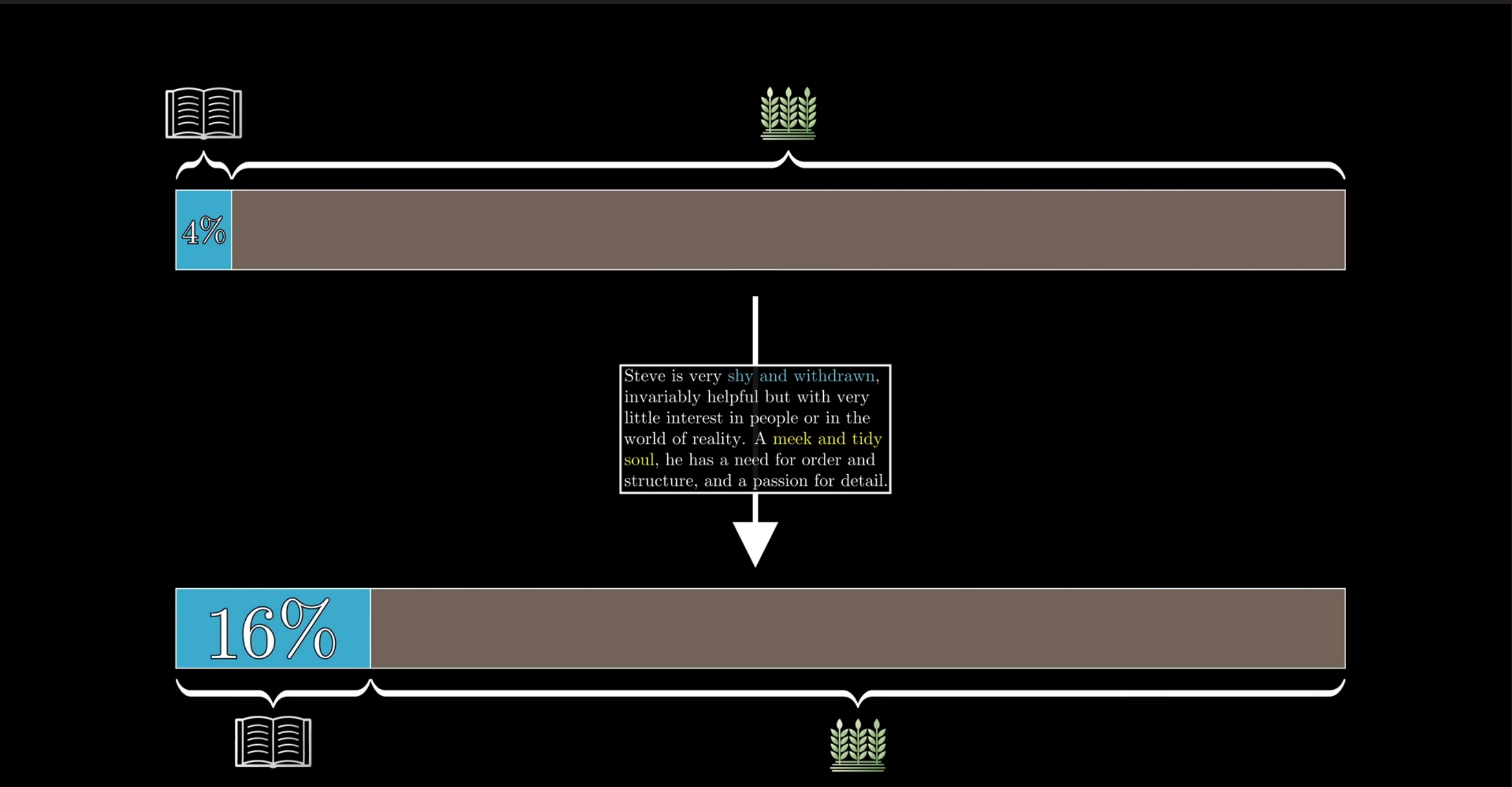
What is more likely?  
1) Steve is a librarian. 2) Steve is a farmer.

## Real Situation

Calculating



Updating



## Heart of Bayes' Theorem

### Heart of Bayes' theorem

All possibilities

All possibilities fitting the evidence

$$P\left(\begin{matrix} \text{Librarian given} \\ \text{the evidence} \end{matrix}\right)$$

When to use Bayes' rule

### When to use Bayes' rule

You have a hypothesis

You've observed some evidence

Steve is very shy and withdrawn, invariably helpful but with very little interest in people or in the world of reality. A meek and tidy soul, he has a need for order and structure, and a passion for detail.

You want  $P(H|E)$

$$P\left(\begin{matrix} \text{Hypothesis} \\ \text{given} \\ \text{the evidence} \end{matrix}\right)$$

## Mathematical Review

$$P(H|E) = \frac{P(H)P(E|H)}{P(H)P(E|H) + P(\neg H)P(E|\neg H)}$$

Bayes' theorem

$$P(H|E) = \frac{P(H)P(E|H)}{P(E)} = \frac{P(H)P(E|H)}{P(H)P(E|H) + P(\neg H)P(E|\neg H)}$$

"Prior"  $\rightarrow P(H) = 1/21$

"Likelihood"  $P(E|H) = 0.4$

$P(E|\neg H) = 0.1$

(a)

(b)

"Posterior"

$$P(H|E) = \frac{P(H)P(E|H)}{P(E)} = \frac{P(H)P(E|H)}{P(H)P(E|H) + P(\neg H)P(E|\neg H)}$$

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