# Bayesian Parameter Estimation

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**Abstract**

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## 1 Introduction

If you needed to estimate parameters – that is to say, fit a model – the first mathematical tool you would likely reach for would be linear regression. In this article, we'll explore an alternative to linear regression called Bayesian Parameter Estimation and consider in what circumstances it might be preferable.

## 2 Background: Bayes' Theorem

Bayes' Theorem is a simple statement about conditional probabilities:

$$P(H|E) = \frac{P(E|H)P(H)}{P(E)} \tag{1}$$

In this notation, $H$ is a hypothesis and $E$ is some evidence we have observed. So Bayes' theorem tells us that we can compute the probability of some hypothesis being true given that we have observed a piece of evidence if we know: * the probability of observing said evidence in a world where the hypothesis is true, * the probability of our hypothesis being true, and * the probability of observing the evidence.

It can be "derived" by considering that we can get the area of region AB below both by considering it either as the fraction of A that AB occupies multiplied by the total area of A *or* as the fraction of B that AB occupies multiplied by the total area of B. (The "Universe" is included to remind us that for A and B to represent probabilities, they have to be normalized!). For a more detailed version of this explanation, check out Oscar Bonilla's blog post on "Visualizing Bayes' Theorem.

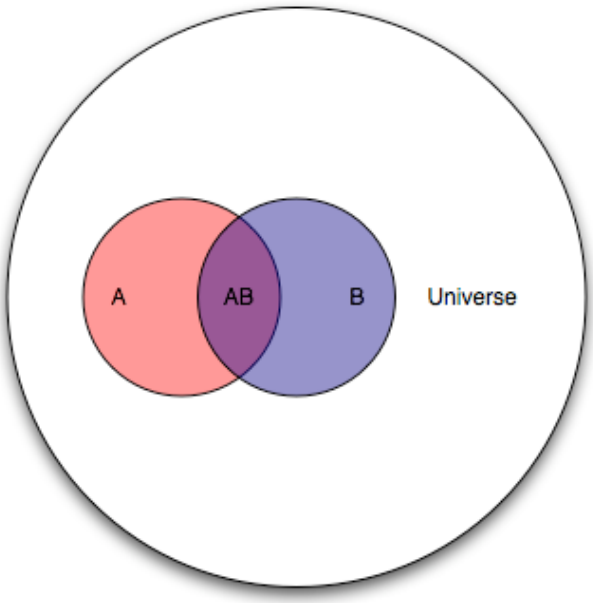


Figure 1: Visualizing the "derivation" of Bayes' theorem, from Bonilla (2009).

Bonilla, O. (2009). Visualizing Bayes Theorem — oscarbonilla.com. https://oscarbonilla.com/2009/05/visualizing-bayes-theorem/.