

Proposed Activity Outlines

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About

This document contains high-level draft outlines of the Bayesian concepts introduced and explored during each of our three initial classroom activities. The outlines here are for the *context-free* skeletons that will serve as the underlying framework that the discipline-specific activities will be built on top of.

Activity 1: From the Prior to the Posterior

This activity introduces learners to the notion of the *prior distribution* and the *posterior distribution*. We expect that this may be the learners' first exposure to Bayesian methods, so the following concepts will be introduced and explained.

- The *prior distribution*
- The *posterior distribution*
- The *likelihood function*
- How the *posterior* distribution is obtained by multiplying the *prior* distribution by the *likelihood*

Beyond the initial exposure to the topics/concepts above, learners investigate three major questions in this activity.

1. How can the choice of *prior* influence the resulting *posterior* distribution?
2. How can the amount of data collected influence the resulting *posterior* distribution?
3. How do the choice of *prior* distribution and the *observed data* interact to influence the resulting *posterior* distribution?

Bayesian Thinking Objectives: Upon completion of the activity, learners should be able to:

1. Explain the concept of a *prior distribution* and its significance in Bayesian analysis, highlighting how it reflects initial beliefs before considering the observed data.
2. Explain the role of a *posterior distribution* in Bayesian analysis, and articulate how it results from the combination of the prior distribution and the observed data.
3. Demonstrate how to adjust the strength of a beta-prior, and analyze how varying the strength of the prior influences the posterior distribution.
4. Evaluate how the quantity of observed data impacts the posterior distribution, and explain how more or less data modifies the influence of the prior.
5. Analyze how the interplay between prior strength and data quantity shapes the posterior distribution, focusing on how these elements jointly determine the final Bayesian update.

Activity 2: Estimating a Parameter with Credible Intervals

In this activity, we review the ideas from our first activity. Essential topics are the *prior* distribution and the *posterior* distribution. After a brief review, students are exposed to the notion of the *credible interval*.

The main questions students will explore in this activity are:

1. What effect does the desired containment probability have on the bounds for the credible interval?
2. Is the credible interval symmetric about a point estimate?
3. Must the credible interval contain the point estimate obtained from sample data?

Activity 3: Comparing Two Populations with Tests of Hypotheses

In this activity, we will use Bayesian methods to compare the means of two different populations (similar data situation to the frequentist Independent samples t-test). Concepts such as the *prior* and the *posterior* distributions will be briefly reviewed, as well as *credible intervals*. The focus of this activity will be on how to determine if two populations are different or not, and what pieces of evidence should be examined when drawing conclusions.

The main questions students will explore in this activity are:

1. What pieces of evidence should we use to check for convergence?

2. How would we use *posterior probability* to examine if there is a difference in the means of two populations?
3. How do we use the credibility interval to determine if there is a difference in means?