Report Example

Alex Rogers, 29th October 2020

1 Overview

This document provides a template for you to use to write your reports and also an example of the description of a model for the Millikan oil drop experiment. The modelling approaches are described further in the two course books (Davidson-Pilon, 2015; Martin, 2018).

2 Millikan's Oil Drop Experiment

The experimental set-up of Millikan's original oil drop experiment is shown in Figure 1.

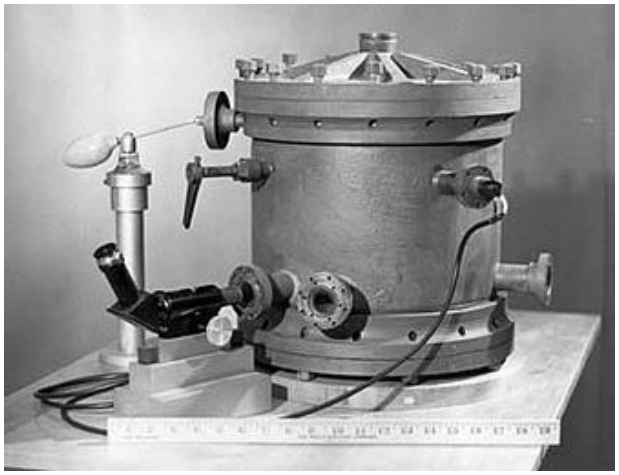

Figure 1: *Millikan's oil drop experiment.*

2.1 Model Description

We assume that we have N measurements of the charge on N individual oil drops. We denote this measurement as c_i for $i \in \{0, \ldots, N\}$. We assume that each measurement is affected by independent Gaussian noise such that:

$$c_i \sim \text{Normal}(n_i \times e, \sigma^2) \tag{1}$$

where n_i is the number of additional electrons on each oil drop and e is the charge on an electron. We do not directly observe n_i and thus we assign it a Poisson prior given by:

$$n_i \sim 1 + \text{Poisson}(1) \tag{2}$$

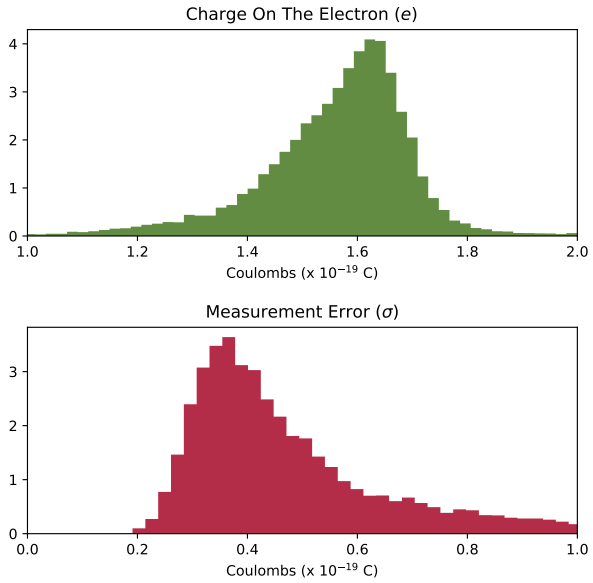

Figure 2: *Posterior probability density functions for the charge on the electron (e) and the measurement error (σ).*

Similarly, we model σ and e with appropriate priors such that:

$$\sigma \sim \text{Exponential}(0.1) \tag{3}$$

$$e \sim \text{Exponential}(1) \tag{4}$$

2.2 Solving the Model

We solve the model using PyMC.[1] Figure 2 shows the posterior probability distribution for the charge on the electron and the accuracy of the experimental measurements.

References

Davidson-Pilon, Cameron (2015). *Bayesian Methods for Hackers: Probabilistic Programming and Bayesian Inference*. Addison-Wesley Professional.

Martin, Osvaldo (2018). *Bayesian Analysis with Python: Introduction to statistical modeling and probabilistic programming using PyMC3 and ArviZ*. Packt Publishing.

[1] `https://docs.pymc.io`