Bayesian Statistics & Probabilistic Programming
Spring 2024

Jordi Abante

Department of Biomedical Sciences
Department of Mathematics & Computer Science
Universitat de Barcelona

February 2, 2024

Outline

1. Who am I?
2. Logistics
3. The Bayesian Paradigm
4. Goals and teaching blocks

Who am I?

Jordi Abante

Department of Biomedical Sciences

Department of Mathematics & Computer Science

jordi.abante@ub.edu

Logistics

- Lectures & reading
  - Slides
  - Handouts
- Activities
  - Pen & paper
  - Computational
- Programming environments
  - R 4.X.X / Rstudio
  - Jupyter notebooks with IRkernel
  - Python modules (e.g., Tensorflow)

Logistics

- Virtual Campus
  - Course materials
  - Additional literature
  - Discussion forum
  - Assignments and grades
- Grading
  - Class attendance & participation
  - 2 written/coding assignments (25% each)
  - Final course project (50%)

The Bayesian Paradigm

- Frequentist statistics

$$\textit{Hypothesis} \rightarrow \textit{Experiment} \rightarrow \textit{New knowledge}$$

- Bayesian statistics

$$\textit{A priori belief} \rightarrow \textit{Evidence (data)} \rightarrow \textit{Posterior belief}$$

$$P(A \mid B) = \frac{P(B \mid A)P(A)}{P(B)}$$

The Bayesian Paradigm

- Probability is treated as a measure of belief or confidence
  - Update probabilities based on new evidence
  - Incorporate prior beliefs and likelihood of the data
- One major criticism is the influence of prior information
  - Priors can introduce bias, impacting the conclusions
  - Objectivity might be compromised due to the subjectivity
  - Unbiased priors (Jeffrey's prior)

The Bayesian Paradigm

- Bayesian statistics finds applications in various fields
  - Medical research
  - Finance
  - Machine learning
- What can we do?
  - Parameter estimates with good statistical properties
  - Predictions of missing data and forecasts of future data
  - Framework for model estimation, selection, and validation

Goals and teaching blocks

- Vocabulary: probabilities, RVs, distributions
- Generating simulated data
- Easy models (conjugate priors)
- Computational approaches (MCMC, Approximations)
- Models (e.g., LM, GLM, Hierarchical)