00 - Course presentation

Bayesian Statistics

Spring 2022-2023

Josep Fortiana

Matemàtiques - Informàtica UB

Monday, February 13, 2023

00 - Presentation

Me

Course organization

Why Bayesian Statistics?

Course goals and teaching blocks

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My coordinates

Josep Fortiana

2nd floor, this building.

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Combined lecture-lab sessions

▶ Lectures & reading:

    ▶ Slides

    ▶ Handouts (lengthy stuff)

▶ Activities:

    ▶ Pen & paper

    ▶ Computations

Programming environments

▶ R 4.2.2 / RStudio.

▶ Anaconda, `jupyter` notebooks with `IRkernel`.

▶ Some Python modules (e.g., Tensorflow).

▶ Other: <u>Stan</u>, JAGS 4.3.1 (WinBUGS, OpenBUGS).

▶ `Greta, Edward2, ...`

Virtual Campus

▶ Course materials

▶ Complementary texts, links, other resources

▶ Discussion forum

Grading

▶ Class attendance & participation

▶ 2 written/coding assignments
  (individual or by groups): (50%)

▶ Course project (50%)

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Bayesian Statistics

▶ Experimental science follows the sequence:

$$\boxed{Hypothesis} \quad \rightarrow \quad \boxed{Experiment} \quad \rightarrow \quad \boxed{New\ knowledge}$$

▶ Bayesian paradigm:

$$\boxed{A\ priori} \quad \rightarrow \quad \boxed{Evidence\ (data)} \quad \rightarrow \quad \boxed{Posterior}$$

The Logic of Science

Edwin T. Jaynes:

Probability theory, as originated by Laplace, is a generalization of Aristotelian logic that reduces to deductive logic in the special case that our hypotheses are either true or false.

Jaynes, Edwin T. (2003). *Probability theory. The Logic of Science,*
Cambridge Univ. Press.

Perception as Bayesian Inference

▶ Bayesian formalism mimics natural perception.

▶ Computer Vision or, more generally, ML.

▶ Consistenly extract information from uncertain data.

Origin of uncertainty

Measurements.

Latent quantities (internal, non observed variables),
including *"parameters".*

Inference from uncertainty

Predictions, inferences, decisions.

Bayesian *vs* Classical (frequentist)

Frequentist

Constants: n,

Variables: $X_1, \ldots, X_n$,

Parameters: θ.

Bayesian

Constants: n,

Variables: $X_1, \ldots, X_n$, and θ.

Bayesian key points

▶ Use any available information, however uncertain.

▶ Blend it with previous knowledge (or lack of it) through objective procedures.

▶ Yield answers comprising a degree of belief (a probability distribution).

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Contents

▶ Vocabulary: probabilities, r.v. 's, distributions,

▶ Experiment: simulate r.v. 's

▶ Easy models (conjugate priors)

▶ Computational methods (MCMC, Approximations)

▶ Models (LM, GLM, Hierarchical,...)