Bayesian Statistics and Data Analysis
Course information

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Section 1

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1. have knowledge in basic concepts, philosophy, and perspectives in Bayesian Statistics,
2. derive posterior distributions in simple situations,
3. derive and use predictive distributions,
4. identify and formulate Bayesian probabilistic models for analysis and predictions,
5. estimate models using contemporary computer-based methods for posterior approximations,
6. understand and use basic principles for decisions under uncertainty,
7. have knowledge about and be able to use Bayesian methods for model comparisons,
8. be able to critically evaluate Bayesian methods,
9. report, orally and in writing, a Bayesian statistical analysis

Pre-requisites

- Basic probability theory
    - probability, probability density, distribution
    - sum, product rule, and Bayes' rule
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  - histogram, density plot, scatter plot
- *Note!* This is a masters course in Statistics.

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First assignment is a recap.

Course Outline

Two main parts:

- Core Content (9 lecture blocks)

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Exact dates and details; see the course page.

Core Content

- Every week: lectures (approx. 2-4h)
  - Online video material and reading assignments (approx. 2-4h, 50-90 pages a week)
  - Lecture(s): present overall theory and content (overview)
  - Assignment(s): Computational and theoretical individual work. *Start monday morning every week!*
- An individual assignment (approx. 12-16h). Deadline Sundays 23.59.

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- An individual assignment (approx. 12-16h). Deadline Sundays 23.59.
- Recommended workflow for each week
    - Do the reading assignments
    - Watch the videos (although, optional)
    - Do self-study exercises
    - Start with the assignment
    - Attend lecture (bring questions!)
    - Attend Zoom datalabs (bring questions! Helps with debugging Stan code)
    - Submit the assignment

Section 2

Assignments

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8. We supply grading information for all assignments. Although, they may change!
9. We have quite strict formatting guidelines. Read carefully!

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- We also supply a knitR LATEX template suitable for Overleaf.

Course Workload

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- Conclusions from 2023
  - More work in Assignment 2
  - Better balance between Assignment 6 and 7
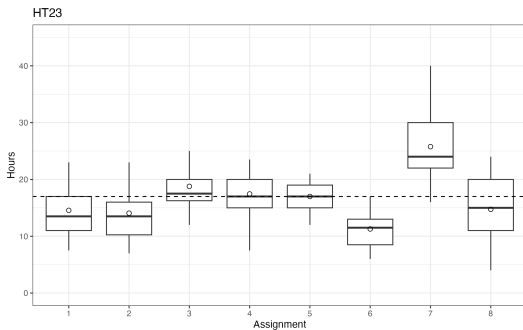
Student course workload

Stan

- Stan is a probabilistic programming framework (PPF) and ecosystem
- 40+ developers, 100+ contributors, 100K+ users
- R, Python, Julia, Scala, Stata, Matlab, command line interfaces
- More than 120 R packages using Stan
- Many packages to support diagnostics and workflow
- Can be used for frequentist inference as well
- Alternative PPF exists, Turing (Julia), Pyro (PyTorch), etc.

mc-stan.org

Section 3

Mini-project

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- Data analysis of choice on real data.
- 2-3 students.

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- Ideally, use a model not presented in this course.
- Project will last two weeks (half time) - but start earlier.
- The project should use Stan.
- Approximate 40 hours of work *per student*.

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- The project should result in a 4 page report (PDF) using the ICML LaTeX template (see course page).
- Project oral presentation (10-15 minutes)

Mini-project

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- Supply a half-page project proposal of data and problem in the middle of the course.
- Ideally, use a model not presented in this course.
- Project will last two weeks (half time) - but start earlier.
- The project should use Stan.
- Approximate 40 hours of work *per student*.
- The project should result in a 4 page report (PDF) using the ICML LaTeX template (see course page).
- Project oral presentation (10-15 minutes)
- The first author is corresponding author

Section 4

Practicalities

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- Course page/content: Github – please do a PR if something is wrong!

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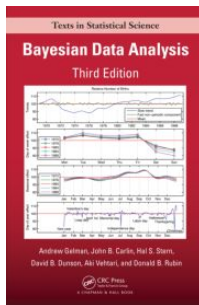- Acknowledgements: Aki Vehtari
- Teaching assistant: Väinö Yrjänäinen

Literature

- Book: Gelman, Carlin, Stern, Dunson, Vehtari & Rubin: Bayesian Data Analysis, Third Edition. (online pdf available)

- Additional articles and blog posts (see reading list per week)

Section 5

Examination

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2. To pass with distinction (VG): 7/10 VG points

3. If everything is correct in an assignment (ξ90%), 1 VG point is awarded *on the first submission deadline*.

4. The mini-project is worth 2 VG-points (if it is passed with distinction).

5. Ph.D. students: I suggest you get VG to pass the course. Make the project a potential paper.

6. Reassesment of grades (supply form to course admin)

7. Failing the course: You will need to redo all assignments and mini-project.

8. Large language models, e.g. chatGPT, are not allowed.

Section 6

Course improvements

Course improvements since last time

- Three step project
- Improving assignment balance

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Course improvements

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- Be ready to put the work in!
- Don't be afraid to ask questions.
- Try complete all the assignment on time.

Questions?

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