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Bayesian Statistics and Data Analysis
Course information

Måns Magnusson
Department of Statistics, Uppsala University

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Section 1

Course information

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Course information

The aims of this course are that, after this course you should:

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Course information

The aims of this course are that, after this course you should:

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

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Pre-requisites

- Basic probability theory
  - probability, probability density, distribution
  - sum, product rule, and Bayes' rule
  - expectation, mean, variance, median

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- Basic visualisation techniques (R or Python)
  - histogram, density plot, scatter plot
- *Note!* This is a masters course in Statistics.

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First assignment is a recap.

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Course Outline

Two main parts:

- Core Content (9 lecture blocks)

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- Assignments (8 individual assignments)

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- Core Content (9 lecture blocks)
- Assignments (8 individual assignments)
- Mini-project: do your own Bayesian data analysis (1-3 students)

Exact dates and details; see the course page.

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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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- 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

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Section 2

Assignments

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1. Core components and concepts and state-of-the-art methods

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   - 3.1 The week of the assignment
   - 3.2 The last day of the course
   - 3.3 2-4 weeks after the course

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7. Three one hour zoom seminars per week with individual help on assignments. *Note!* Don't send us e-mail, instead use the Zoom seminars.

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9. We have quite strict formatting guidelines. Read carefully!

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R vs Python and Colab

- We strongly recommend using R in the course as there are more packages for Stan and statistical analysis in general in R

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- We supply a Google Colab template with everything pre-installed.

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- If you are already fluent in Python, but not in R, then using Python may be easier, but it can still be useful to learn R
- We supply a Google Colab template with everything pre-installed.
- We also supply a knitR LaTeX template suitable for Overleaf.

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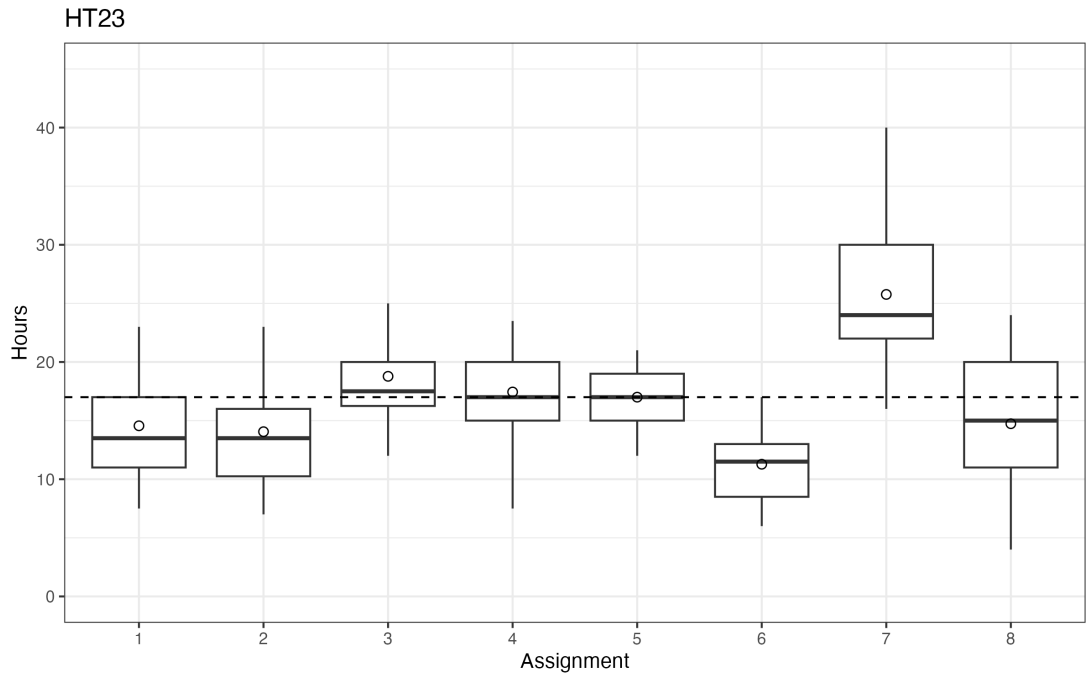
Course Workload

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



Student course workload

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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

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Section 3

Mini-project

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Mini-project

- See project instructions on webpage for details.
- Data analysis of choice on real data.
- 2-3 students.

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- Supply a half-page project proposal of data and problem in the middle of the course.

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- 2-3 students.
- 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*.

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

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Section 4

Practicalities

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Practicalities

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

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- Schedule: Time Edit/Studium
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- Acknowledgements: Aki Vehtari

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Practicalities

- Course page/content: Github – please do a PR if something is wrong!
- Communication: Studium
- Schedule: Time Edit/Studium
- Assignments submissions: Studium
- Acknowledgements: Aki Vehtari
- Teaching assistant: Väinö Yrjänäinen

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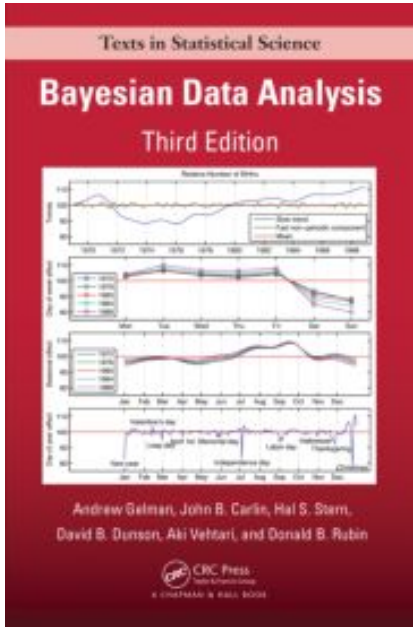
Literature

- 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)

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Section 5

Examination

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3. If everything is correct in an assignment (¿90%), 1 VG point is awarded *on the first submission deadline*.

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Examination

1. To pass (G): All labs, mini-project, and project review need to be passed
2. To pass with distinction (VG): 7/10 VG points
3. If everything is correct in an assignment (¿90%), 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.

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Section 6

Course improvements

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Course improvements since last time

- Three step project
- Improving assignment balance

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Section 6

Course improvements

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Comments from previous students

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

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- Course information
- Assignments
- Mini-project
- Practicalities
- Examination
- Course improvements

Questions?

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