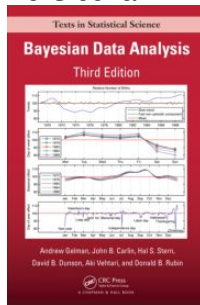


Bayesian data analysis (Aalto fall 2022)

- Book: Gelman, Carlin, Stern, Dunson, Vehtari & Rubin: Bayesian Data Analysis, Third Edition. (online pdf available)
- The course website has more detailed information than these slides
https://avehtari.github.io/BDA_course_Aalto/Aalto2022.html
- Timetable: see the course website
- TAs: Anna Riha, Elena Shaw, Kunal Ghosh, Andrew Johnson, Noa Kallioinen, David Kohns, Leevi Lindgren, Teemu Sailynoja, Niko Siccha



Bayesian data analysis

Pre-requisites

- Basic terms of probability theory
 - probability, probability density, distribution
 - sum, product rule, and Bayes' rule
 - expectation, mean, variance, median
- Some algebra and calculus
- Basic visualisation techniques (R or Python)
 - histogram, density plot, scatter plot

These will be tested with the first assignment round

Bayesian data analysis

Pre-requisites

- What to do if the course seems to be too difficult
 - refresh your memory on pre-requisites (see the course web site for some links)
 - ask for help
 - consider reading Regression and Other Stories
<https://avehtari.github.io/ROS-Examples/>
 - consider reading Statistical rethinking + watching videos
<https://xcelab.net/rm/statistical-rethinking/>

Bayesian data analysis

Different learning styles

- Reading
- Listening lectures
- Solving problems
 - mathematical derivations
 - programming

Bayesian data analysis

Example analyses

- Treatment/control
 - randomize patients to treatment or control
 - is the treatment effective?

Bayesian data analysis

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Bayesian data analysis

Example analyses

- Treatment/control
 - randomize patients to treatment or control
 - is the treatment effective?
- Continuous valued treatment
 - randomize patients with different dosages
 - which dosage is sufficient without too many side effects?
- Different effects for different patients?
 - Is the treatment effect different for male/female, child/adult, light/heavy, ...

Bayesian data analysis

Computer exercises

- Basic visualisation techniques
- Binomial distribution – Algae
- Normal distribution – Windshield
- Difference between binomials – Treatment/control
- Difference between normals – Windshield
- Generalized linear model (GLM) + importance sampling – Bioassay
- GLM + Metropolis + convergence diagnostics – Bioassay
- GLM + Bioassay + Stan
- Linear model + Stan
- Hierarchical model + Stan
- Model selection + Stan

Stan is a probabilistic programming framework and ecosystem

40+ developers, 100+ contributors, 100K+ users

R, Python, Julia, Scala, Stata, Matlab, command line interfaces

More than 140 R packages using Stan

Many packages to support diagnostics and workflow



mc-stan.org

- Exercises 2/3, and project work and presentation 1/3
 - Minimum of 50% of points must be obtained from both the project work and the exercises.

Bayesian data analysis

- Lectures describe basics and give broader overview (recorded and made available)
 - written material has all the details and self-study is possible
- Supporting material and assignments in https://avehtari.github.io/BDA_course_Aalto/Aalto2022.html
 - reading instructions and chapter notes
 - demos (very useful for assignments)
 - slides (not very useful without the lectures)
 - video clips
 - links to additional material
- R demos https://avehtari.github.io/BDA_course_Aalto/demos.html#BDA_R_demos
- (Python demos https://avehtari.github.io/BDA_course_Aalto/demos.html#BDA_Python_demos)
- Aalto Zulip chat instance (link in MyCourses)

Bayesian data analysis

Assignments

- Weekly assignments (some have two weeks time)
 - R (Python) simulation exercises
 - Stan probabilistic programming exercises (via R (Python))
- Related R (Python) demos available (see the course web site)
- TAs available: see Oodi for exercise sessions
- Exercise deadlines on Sunday (see detailed info in the course web page)
 - we recommend to submit before Friday 3pm as TAs are not available during the weekend
 - we allow the late submission on Sunday as some students are working on weekdays
- After the exercise deadline, the grading period Monday–Tuesday
- Students grade 3 other exercises using peergrade.io

Bayesian data analysis

R vs Python

- We strongly recommend using R in the course as there are more packages for Stan and statistical analysis in general in R
- If you are already fluent in Python, but not in R, then using Python may be easier, but it can still be more useful to learn also R

Bayesian data analysis

Assignments

- Assignments are given on PeerGrade (also available in the course website)
- Assignments are returned and graded on Peergrade

- Peergrading used in BDA course since 2016
- Each student grades 3 exercises (randomly distributed)
- Detailed grading instructions – rubric (available also on the course website)
- Also text feedback
- Possible to flag inappropriate grading (please, be polite!)
- TAs check flagged gradings
- Possible to give thumb up for great feedback
 - those who give good feedback will get bonus points
- See more at https://avehtari.github.io/BDA_course_Aalto/assignments.html

Assignments

peergrade.io

- Combined score: 70% submission performance, 30% feedback performance

Assignments

peergrade.io

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- Hand-in score:
 - averaging the scores from peers
 - after flagging, teacher may overrule the score
 - different exercises have different weights

See details at

<http://help.peergrade.io/interfaces-and-features/grading-and-scores/the-hand-in-score>

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- Feedback score:
 - When students receive a review, they are asked to react to it using a scale ranging from “Not useful at all” to “Extremely useful”.
 - These ratings each correspond to a score between 0% and 100%.
 - The feedback score is the average of the reaction scores.
 - “Somewhat useful. Could be more elaborate.” is the baseline reaction.

- Go to BDA MyCourses page
- Click Peergrade and login with Aalto account

Assignments

Plagiarism and empty reports

- It's ok to discuss assignments with others
- It's ok to use code from the demos (good to mention the source)
- Don't copy reports from others or from internet
- Don't submit empty, almost empty or nonsense report
 - these will be problematic for other students
 - if you see such, you can mark it as problematic and get another one for grading

- Project work in groups of 1–3
 - combines all the pieces learned in one project work
 - R or Python notebook report
 - project report peer graded
 - oral presentation graded by me and TAs
- More about projects later

