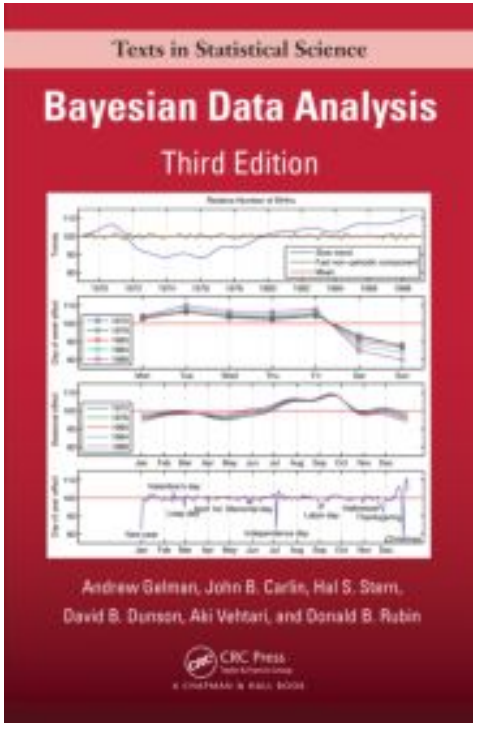
Bayesian data analysis (Aalto fall 2018)

- Book: Gelman, Carlin, Stern, Dunson, Vehtari & Rubin: Bayesian Data Analysis, Third Edition.
- Timetable: Lectures on Mondays at 14-16, TAs available Thursdays 12-16, Fridays 10-12



- 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
Course contents

- Background (Ch 1)
- Single-parameter models (Ch 2)
- Multiparameter models (Ch 3)
- Computational methods (Ch 10)
- Markov chain Monte Carlo (Ch 11–12)
- Stan and probabilistic programming
- Hierarchical models (Ch 5)
- Model checking (Ch 6)
- Evaluating and comparing models (Ch 7)
- Decision analysis (Ch 9)
- Large sample properties and Laplace approximation (Ch 4)
- In addition you learn workflow for Bayesian data analysis

Bayesian data analysis

- Lectures describe basics and give broader overview
  - part of lecture time for questions
  - written material has all the details and self-study is possible
- Supporting material, assignments and news in MyCourses
- Supporting material and assignments in https://github.com/avehtari/BDA_course_Aalto
  - reading instructions and chapter notes
  - demos
  - slides
  - links to additional material
- R demos https://github.com/avehtari/BDA_R_demos/
- Python demos https://github.com/avehtari/BDA_py_demos/

- Exercises are given on PeerGrade (also available in git repo)
- Exercises are returend and graded on Peergrade
- R/Python simulation exercises
- Stan exercises (via R/Python)
  - Stan is a probabilistic programming language implementing full Bayesian statistical inference

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

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  - 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, ...

- Exercises (48p) and project work (24p%)
  - Minimum of 50% of points must be obtained from both the exam and the exercises.
  - Preliminary grade boundaries
    <50%=0, 50%-60%=1, 60%-70%=2, 70%-80%=3,
    80%-90%=4, >90%=5

- Weekly exercises introduced on Monday lecture
- Related R/Python demos available
- TAs available on Thursday 12–16 and Friday 10–12
- Exercise deadlines on Sunday
- After exercise deadline grading period Monday–Tuesday
- Students grade 4 other exercises using peergrade.io

Exercises
peergrade.io

- Used in BDA course since 2016
- Each student grades 4 exercises (randomly distributed)
- Detailed grading instructions
- Also text feedback
- Possible to flag inappropriate grading
- TAs check flagged gradings and strongly coflicting gradings
- Possible to give thumb up for great feedback
  - those who give good feedback will get bonus points

Exercises
peergrade.io

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- Feedback score:
  - The constructive score
  - The hand-in evaluation accuracy score
  - The feedback evaluation accuracy score
  - The feedback completeness score
  - The feedback evaluation completeness score

  See details at
  http://help.peergrade.io/interfaces-and-features/grading-and-scores/the-feedback-score

Project work

- Project work in groups of 2–3
  - combines all the pieces in one project work
  - R or Python notebook report
  - project report peer graded
  - oral presentation