



# Bayesian Statistics and Hierarchical Bayesian Modeling for Psychological Science

## Lecture 01

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Department of Cognition, Emotion, and Methods in Psychology

[https://github.com/lei-zhang/BayesCog\\_Wien](https://github.com/lei-zhang/BayesCog_Wien)

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universität  
wien

Fakultät für Psychologie



# Goal of this course

- Practical **R** programming
- Practical model-building in **Stan**, model diagnostics
- (Enough) theory to ground you
- Be comfortable to use R/Stan for your own work + very basic knowledge of **GitHub**



**What comes to your mind when  
talking about **Statistics**?**

# A clear goal depends on knowledge & expectations

## Pre-course survey

- sent to 16 (+2) registered students
- received 15
- 83.3% return rate, many thanks!

spontaneous feedback are still welcome at any time!

## What is your experience with...

- Statistics?
- R? (and / or Matlab?)
- Cognitive Modeling?

## You would like to...

- gain knowledge of Bayesian stats?
- be able to read “computational modeling” section in papers?
- write your own model?

# Your knowledge of stats



# Your knowledge of programming



# Your expectations





# Schedule of Lectures

18.03	L01	Introduction and overview
27.03	L02	Introduction to R
27.03	L03	Probability; Bayes' Theorem
22.04	L04	Binomial model; MCMC & Stan
29.04	L05	Simple linear model
06.05	L06	Cognitive Modeling; Reinforcement learning model
13.05	L07	More on RL model
20.05	L08	Hierarchical modeling
27.05	L09	More on hierarchical modeling
03.06	L10	Optimizing Stan codes
10.06	L11	PRL task & model comparison
17.06	L12	Stan style tip & debugging
24.06	L13	Programming project + summary + HPC demo

combine

Review a paper #1

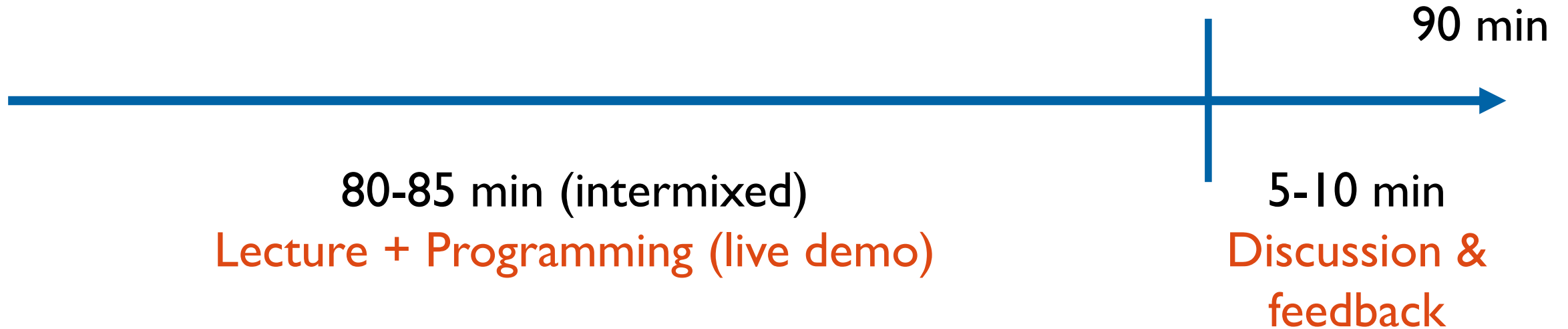
Review a paper #2

Programming project

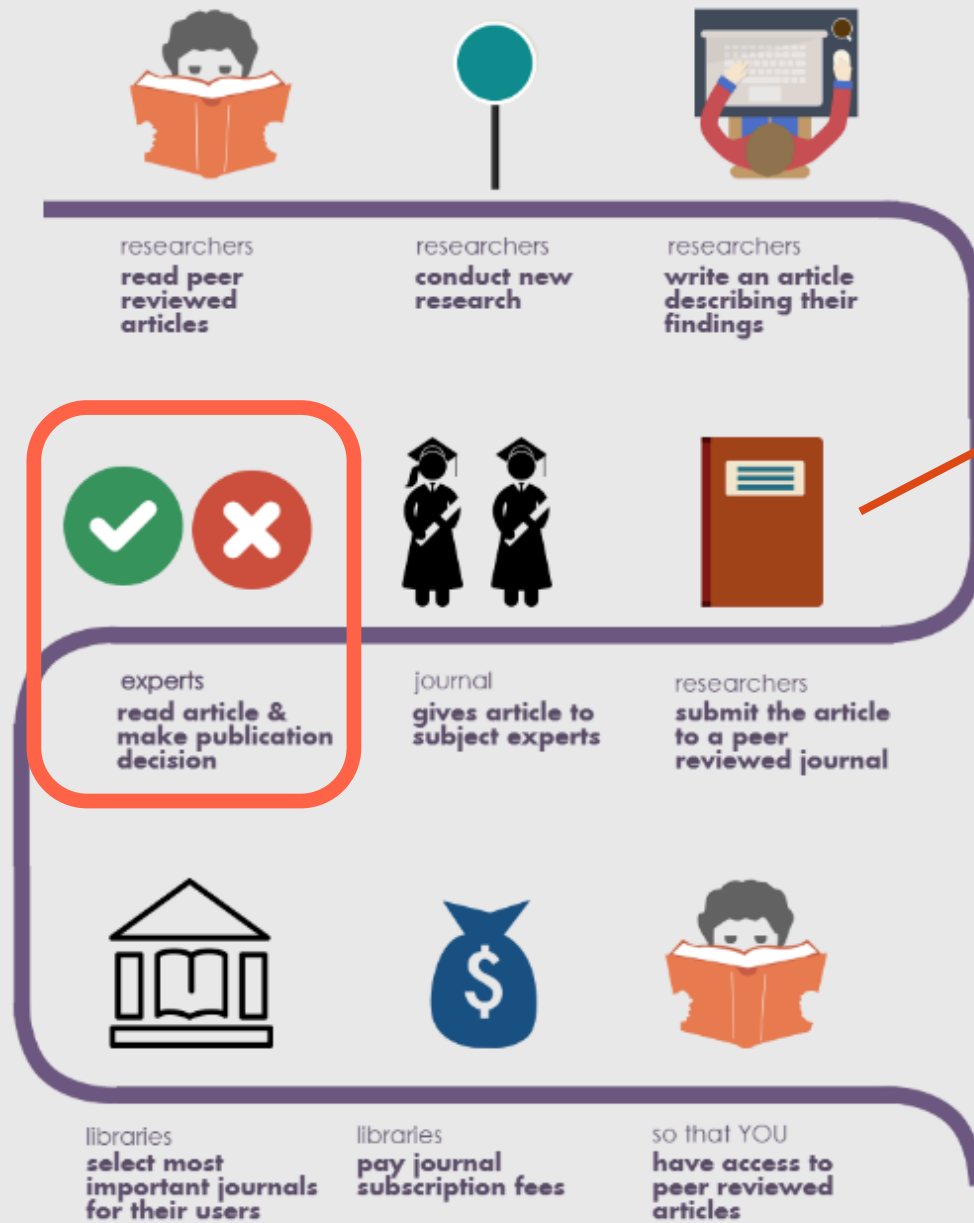
## combined session 03.27

- 03.27
- 09:45 – 13:00, with 15min break in between

# Course structure (from L02)



# Peer Review



preprint

# Review of a paper?

After L06

students 1:18

1

After L11

students 1:18

2

preprint  
bioRxiv<sub>beta</sub>  
THE PREPRINT SERVER FOR BIOLOGY

Ψ  
A X PsyArXiv

# How to review a paper?

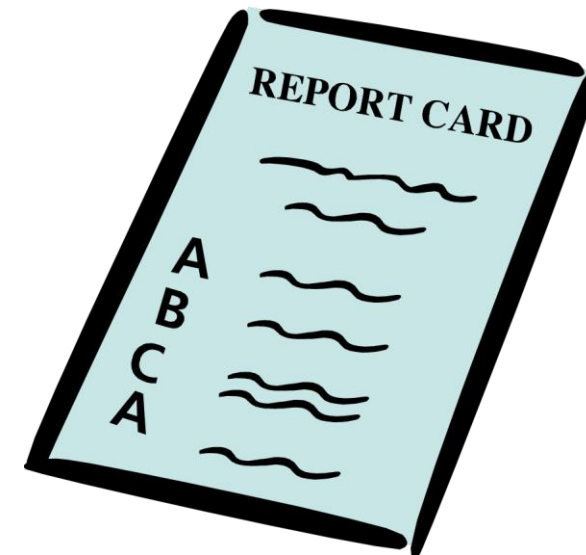
- Suppose you are invited by a journal editor to review a paper
- Of course, you have to read it 😊, carefully and critically
- Then write a review report to the editor
  - (1) Make a summary. What is this paper about? What was done? What was the conclusion?
  - (2) List your concerns. Is the design appropriate? Are the analyses sound? Do their data support the conclusion? What can be done better?
- For this course:
  - up to 3 pages (11pt, 1.5 space)
  - be independent: okay to discuss HOW to review, but do NOT discuss WHAT to review

# Programming project

- already on Github
- should be submitted before the end of semester (31.07.2020)
- use R and RStan
- will be a real-world cognitive modeling problem
- hand in the \*.R and \*.stan files in a ZIP file
- name as: lastname\_matriculatenummer\_200077.ZIP
- no need to write a report

# Gradings

- Regular participation (30%; counting from the 1<sup>st</sup> physical session, if any...)
  - Review of paper#1, 10 (25%), due on [10.05.2020](#)\*
  - Review of paper#2, 10 (25%), due on [14.06.2020](#)\*
  - Programming work, 10 (20%), due on [31.07.2020](#)\*
- 
- Grades: >87% 1, >75% 2, >63% 3, >50% 4, <=50% 5
  - At least 51% to obtain 4 ECTS



\*0.5 point deduction per day for overdue submission



**More survey results.**

# More Qs about the course

NA

na

Not yet

Will there be documentation via a moodle course?

# Q regarding the instructor

NA

na

Not yet

What do you research on

# misc.

NA

na

Sorry in advance for low programming skills, but i am eager to learn, thought of it as an introductory course

My research topic is Sports Analytics, and I would like to apply the learned concepts to it, though I am still unsure how it will come to that

Not yet

Really looking forward to the course! My background is psychology and biokogy(microbiokogy and genetics)

# About me

- Current: Postdoc @ [SCAN-Unit](#), led by [Prof. Claus Lamm](#)
- Ph.D. Cognitive/computational neuroscience, *summa cum laude*
- M.Sc. Cognitive neuroscience
- B.Sc. Psychology
- Office hours: by appointment (Liebiggasse 5, 3. OG)



# My research

- Overarching goal: uncover the **neuro-computational mechanisms underlying social decision-making**
- Methods: behavioral/physiological measurement, cognitive modeling, fMRI
- Previous project: social influence on goal-directed learning
- Current project: in preparation, will focus on the predictive process of pain perception and empathy for pain
- Read more: [www.lei-zhang.net](http://www.lei-zhang.net)
- Potential research assistant / master's thesis opportunity

## Further questions

- What knowledge is expected as a prerequisite?
  - some stats, some programming. I'll start from the beginning, but the pace may be fast
- How many R skills will we get taught?
  - As much as I could, but fit everything in 13 lectures is difficult
- Is this course difficult?
  - this varies from person to person, but from my experience this course is indeed demanding, and can be overwhelming



**Richard McElreath**

@r1mcelreath



I say this a lot, bc I am also confused quite often.



**Anna Jacobson** @AnnaChingChing · Feb 21

"If you are confused, it is only because you are trying to understand." -  
@r1mcelreath in Statistical Rethinking

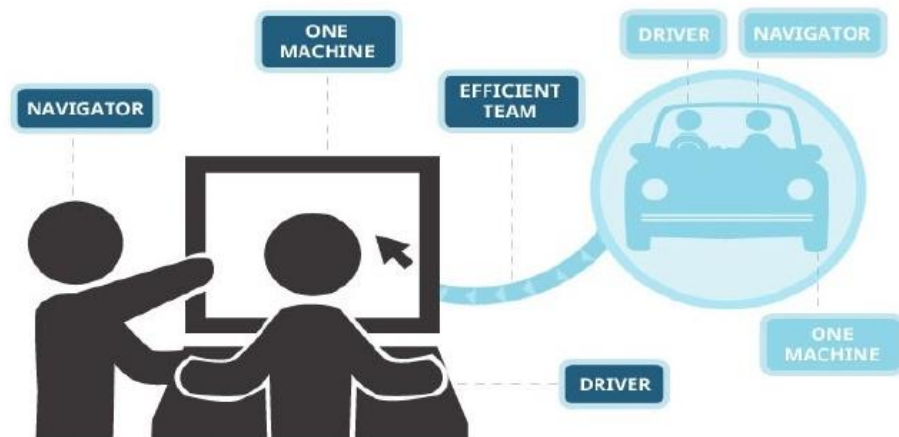


**Anything else?**

# How to Get the Most out of the course

- Lecture structure: 60min theory + demo, 20-30min exercise + discussion
- Work in pairs: Talk to each other & help each other
- Ask questions
- Try the exercises

# PAIR PROGRAMMING



# A quick look at GitHub

lei-zhang / BayesCog\_Wien

Unwatch

9

Star

5

Fork

2

<> Code

Issues0

Pull requests0

Actions

Projects0

Wiki

Security

Insights

Settings

teaching materials univie

Edit

Manage topics

61 commits

1 branch

0 packages

0 releases

1 contributor

MIT

Branch: master

New pull request

Create new file

Upload files

Find file

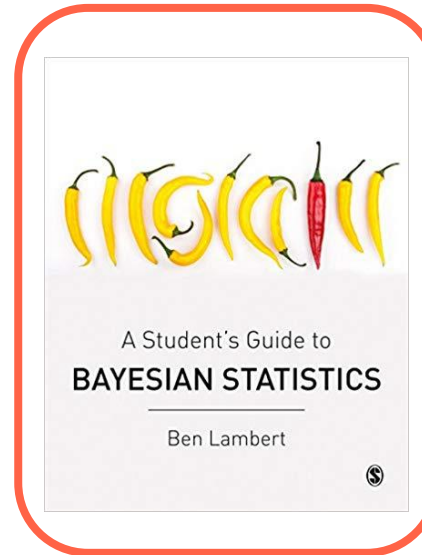
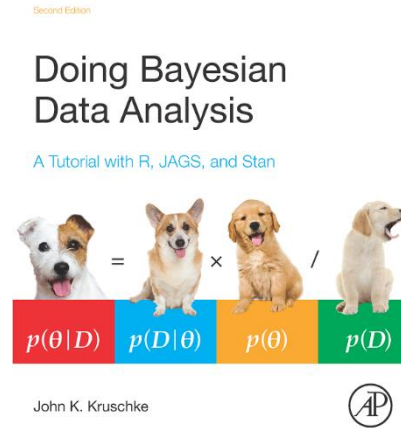
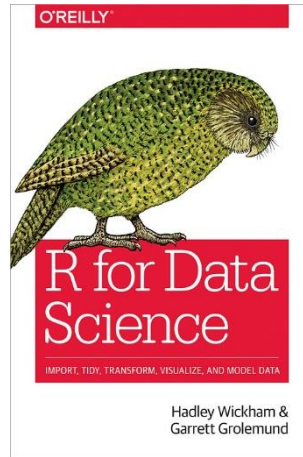
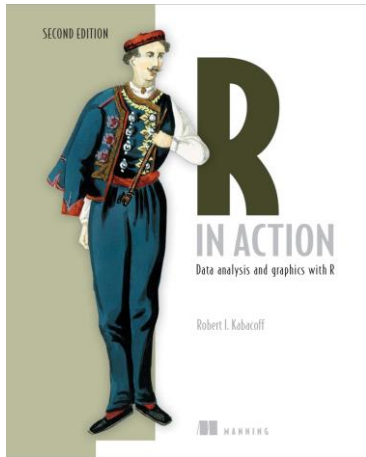
Clone or download

lei-zhang update

Latest commit f02af43 yesterday

00_R_cheatsheet	R	13 months ago
01.R_basics	update	4 months ago
02.binomial_globe	update	4 months ago
03.bernoulli_coin	update	11 months ago
04.regression_height	update	11 months ago
05.regression_height_poly	update	11 months ago
06.reinforcement_learning	update	10 months ago
07.optm_rl	update	2 months ago
08.compare_models	update	10 months ago
09.debugging	update	10 months ago
Programing_project	update	yesterday
review_a_paper	update	yesterday
.gitignore	R	13 months ago
LICENSE	readme & liscence	13 months ago
description.txt	course description	13 months ago
readme.md	update	yesterday

# Resources

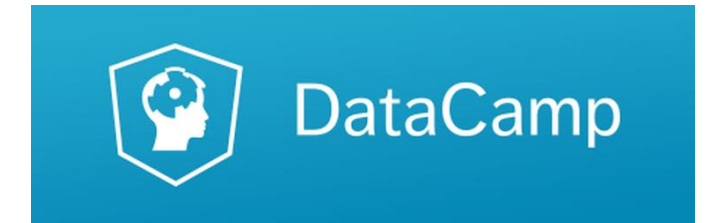


## Statistical Thinking for the 21st Century

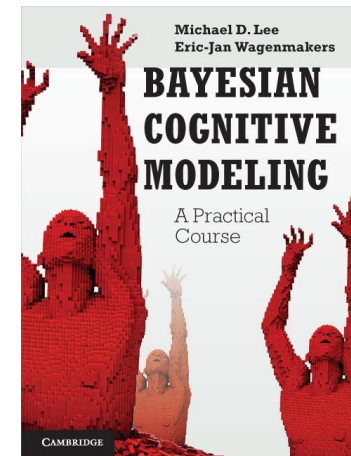
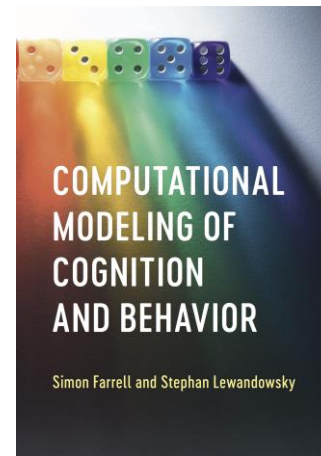
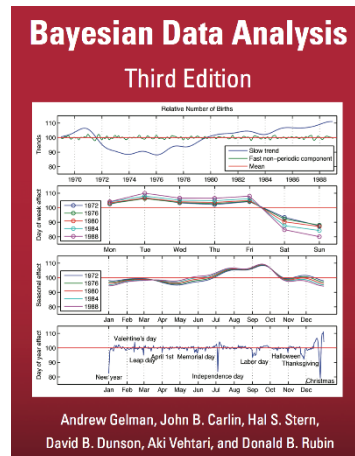
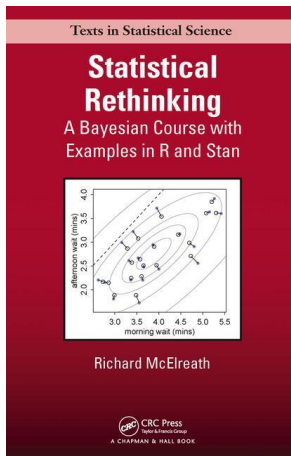
Copyright 2019 Russell A. Poldrack

Draft: 2020-03-15

<http://statsthinking21.org/>



<https://www.datacamp.com/>



<https://jasp-stats.org/>

**Now welcome to Bayesland!**

# Overview

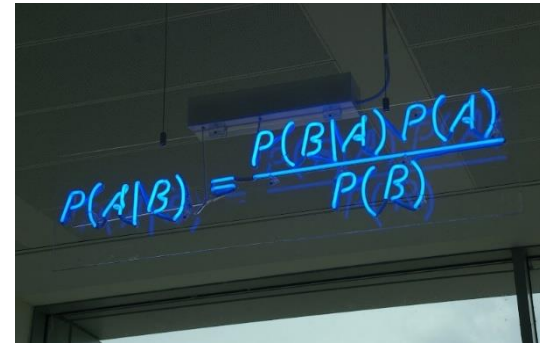
This course is NOT about...

- ... Bayes in the brain (e.g. predictive coding)
- ... Bayesian statistics to supersede classic statistics



However, Bayesian statistics offer great tools to analyze **cognitive processes**!

- Construct cognitive models
- Estimate posterior distributions of parameters
- Compare models: which is the best one, given the data
- Perform model-based analysis, e.g. model-based fMRI/EEG/eye-movement


$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$

ANY  
QUESTIONS  
?

Happy Computing!