



# TEWA 1: Advanced Data Analysis

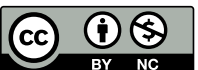
## Lecture 01

Lei Zhang

Social, Cognitive and Affective Neuroscience Unit (SCAN-Unit)  
Department of Cognition, Emotion, and Methods in Psychology

[https://github.com/lei-zhang/tewa1\\_univie](https://github.com/lei-zhang/tewa1_univie)

lei.zhang@univie.ac.at  
lei-zhang.net  
@lei\_zhang\_lz



# Conduct at the University

- Read the current information provided on **u:find** and **u:space**. Information at short notice is sent via e-mail.
- Register for courses and exams.
- Always maintain a distance of **1-metre** from other persons.
- **Wear a face mask** during courses and if the minimum distance of 1 metre cannot be kept.
- **Wash your hands** regularly and thoroughly and **sanitise work areas**.
- Please **do not use lifts**, if possible.
- Do not come to the University when sick. In case of a suspected COVID-19 infection, call the **hotline 1450** immediately.
- For further information, please go to **[studying.univie.ac.at/info](https://studying.univie.ac.at/info)**.

# Taking care of each other

- Please only use **labelled seats** in lecture halls:
- Please **do not change** the labels and/or move furniture.
- If you don't get a labelled seat, please use a **student space** for hybrid learning.
- Recommended: **keep a seat number record**:
  - available online at [studying.univie.ac.at/info](https://studying.univie.ac.at/info)
  - Additionally you can use the **Stopp-Corona-App** by Red Cross.
- For further information, please go to [studying.univie.ac.at/info](https://studying.univie.ac.at/info).

Lehrveranstaltungen/lectures:



Prüfungen / exams:



# Goal of this course

- Practical R programming, with DataCamp
- 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 20 (+5) registered students
- received 22
- 88% return rate, many thanks!

spontaneous feedback are still welcome at any time!

## What is your experience with...

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

## You would like to...

- learn about regression models?
- 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

06.10	L01	Introduction and overview
14.10	L02	Introduction to R/Python/Matlab
21.10	L03	Probability; Bayes' Theorem
28.10	L04	Linking data and parameter & model
04.11	L05	Binomial model with Grid approximation
11.11	L06	Binomial model with MCMC in Stan
18.11	L07	Simple linear model in Stan
25.11	L08	Cognitive Modeling; Rescorla-Wagner model
02.12	L09	Implementing Rescorla-Wagner model
09.12	L10	Hierarchical modeling + Optimizing Stan codes
16.12	L11	PRL task & model comparison
13.01	L12	Stan style tip & debugging + HPC demo
20.01	L13	Summary + Exam
27.01	L14	(optional, in case we are behind schedule)

On-going R tutorials  
& Group programming

Exam

Programming project

# Course structure

## Theoretical part

90 min

80-85 min (intermixed)

Lecture + Programming (live demo)

5-10 min

Discussion &  
feedback

## Practical part

90 min

80-85 min

Group Programming (tutorial and/or datacamp)

5-10 min

Discussion &  
feedback







# Group programming

(Based on some heuristic)

Are cameras and mics on,  
on average?

Is anyone  
sharing screen?

collapsed view
















Breakout room 1	4	1	 	
Breakout room 2	4	0	 	

Students  
(Participants)

TAs  
(Co-hosts)




what's  
going  
on in  
room 2?

Breakout room 1

 		Dave
 		Mak
 		Linda
 		Sura
 		Noel



Breakout room 2

 		Lottie
 		Loriea
 		Peter
 		Hermine

I should  
check in  
on room 2!

# Programming project

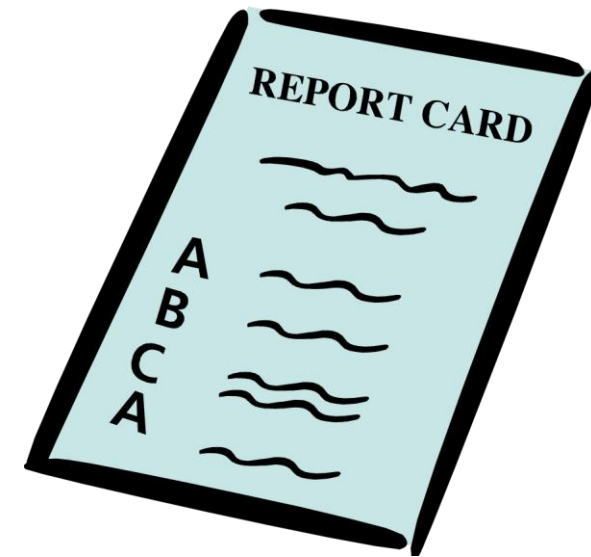
- already on Github
- should be submitted before the end of semester (07.02.2021)
- use R and RStan
- will be a real-world cognitive modeling problem
- hand in the \*.R and \*.stan files in a ZIP file
- name as: lastname\_matriculatenummer\_200149.ZIP
- no need to write a report

## Example exam question: real-world situation

- Your colleague Lisa encountered a term “likelihood” when reading papers, but she has never learned Bayesian statistics. She comes to you and asks which of the following is “likelihood”. (assuming  $\vartheta$  is unknown parameter,  $D$  is observed data)
  - (A)  $p(\vartheta)$
  - (B)  $p(D)$
  - (C)  $p(\vartheta | D)$
  - (D)  $p(D | \vartheta)$

# Gradings

- Regular **participation** (25%; counting from the 14/10)
  - using Google Sheets (later via email); Be honest 😊
- **Regular programming** tutorials (datacamp.com) (35%)
- **Programming project**, 10 (25%), due on [07.02.2021](#)\*
- **Exam** (15%); 10 multiple-choice questions
- Grades: >87% 1, >75% 2, >63% 3, >50% 4, <=50% 5
- At least 51% to obtain **8 ECTS**



\*0.5 point deduction per day for overdue submission



**More survey results.**

# More Qs about the course

NA

What shall i do, If i cant join the lecture? (i anyway will watch it later or does it count as unattended?)

no

Not yet :)

What are the differences to the course you held in the past semester?

not yet

# Q regarding the instructor

NA

Maybe why you have chosen this subject? (Bayesian)

no

Are you as awesome as your description of the course? ;))

not yet

## misc.

NA

Am taking an R introductory class in parallel this semester, which I have faith will help me keeping up with this class! Also excited about finally learning some programming skills!

I started with the `advent_calendaR` today, so I'm far away from finishing the "crash-course" before starting the TEWA unfortunately, so I hope there will be some time, to get used to R

I would love at least some "in person" teaching units

There's no other TEWA 1 course for Geist & Gehirn available this semester. To finish my studies, I can't wait for another semester. I do not have any experiences working with bayesian statistics. I hope that the course is makable for beginners as well.

# About me

- Current: Postdoc @ [SCAN-Unit](#), with [Prof. Claus Lamm](#)
- Ph.D. Cognitive/computational neuroscience, *summa cum laude*
- M.Sc. Cognitive neuroscience
- B.Sc. Psychology
- Office hours: by appointment (online or 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: focusing 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

# My research

SCIENCE ADVANCES | RESEARCH ARTICLE

COGNITIVE NEUROSCIENCE


## A brain network supporting social influences in human decision-making

Lei Zhang<sup>1,2\*</sup> and Jan Gläscher<sup>1\*†</sup>

## Revealing Neurocomputational Mechanisms of Reinforcement Learning and Decision-Making With the hBayesDM Package

Woo-Young Ahn<sup>1</sup>, Nathaniel Haines<sup>1</sup>, and Lei Zhang<sup>2</sup>

## Using reinforcement learning models in social neuroscience: frameworks, pitfalls and suggestions of best practices

Lei Zhang, <sup>1,2</sup> Lukas Lengersdorff<sup>1,2</sup> Nace Mikus,<sup>1</sup> Jan Gläscher,<sup>3</sup> and Claus Lamm<sup>1,2,4</sup>

**Full title:** Modeling cognitive flexibility in autism spectrum disorder and typical development reveals comparable developmental shifts in learning mechanisms

**Authors:** Crawley, Daisy<sup>\*1</sup>; Zhang, Lei<sup>\*2,3,4</sup>; Jones, Emily<sup>5</sup>; Ahmad, Jumana<sup>1</sup>; San José Cáceres, Antonia<sup>1,6</sup>; Oakley, Bethany<sup>1</sup>; Charman, Tony<sup>7</sup>; Buitelaar, Jan<sup>8</sup>; Murphy, Declan<sup>1,9</sup>; Chatham, Christopher<sup>4</sup>; den Ouden, Hanneke<sup>8</sup>; Loth, Eva<sup>1,9</sup> & the EU-AIMS LEAP group

# Further questions

- What knowledge is expected as a prerequisite?
  - some stats, some programming. I'll start from the beginning, and you need to do the exercise.
- How many R skills will we get taught?
  - As much as I could, but fit everything in one semester 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...



# What do other people say?

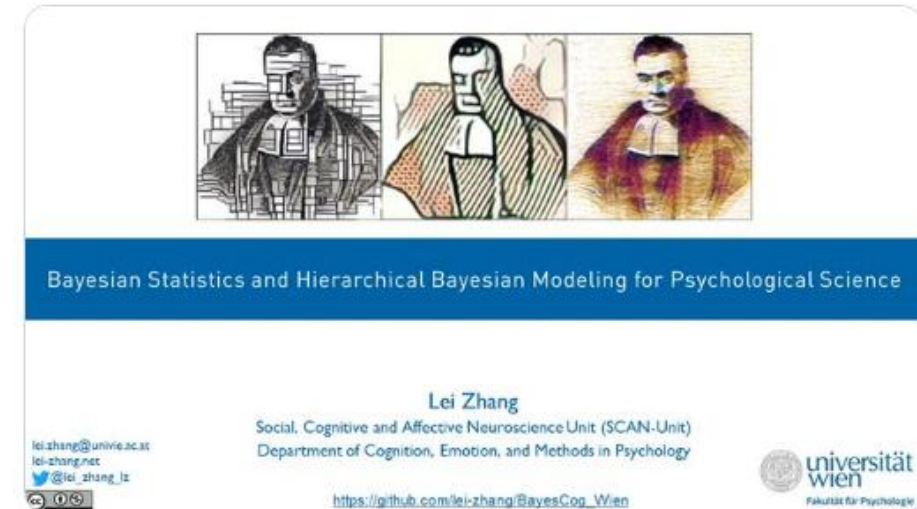


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1/13) This semester's teaching on Bayesian stats and cognitive modeling is over! Thanks to COVID (ironically!), I recorded all my teaching sessions w/ [@zoom\\_us](#), and they are available on [#Youtube](#).

Wondered what have we covered to the cog-neuro audience? A thread.



3:24 PM · Jun 26, 2020 · Twitter Web App

||| View Tweet activity

174 Retweets 14 Quote Tweets 634 Likes





**Richard McElreath**

@r1mcelreath



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



**Anna Jacobson** @AnnaChingChing · Feb 21

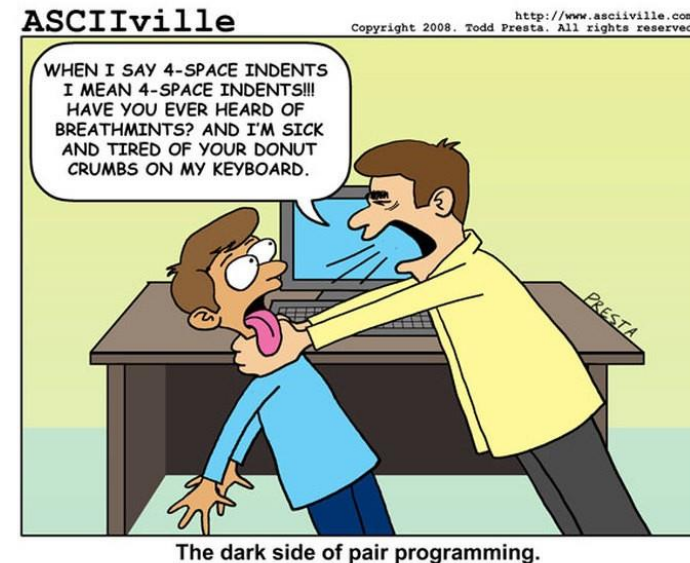
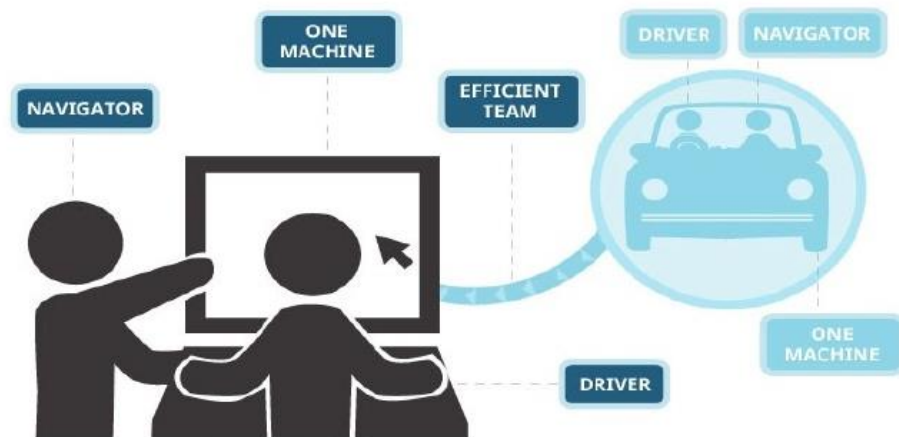
"If you are confused, it is only because you are trying to understand." -  
@r1mcelreath in Statistical Rethinking

**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

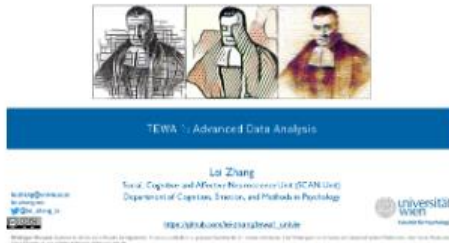
# PAIR PROGRAMMING



# A quick look at GitHub

## TEWA 1

TEWA (Theorie und  
Empirie  
wissenschaftlichen  
Arbeitens) 1 / Theory  
and Empirical  
Research 1



lei-zhang / tewal\_univie

Unwatch 1

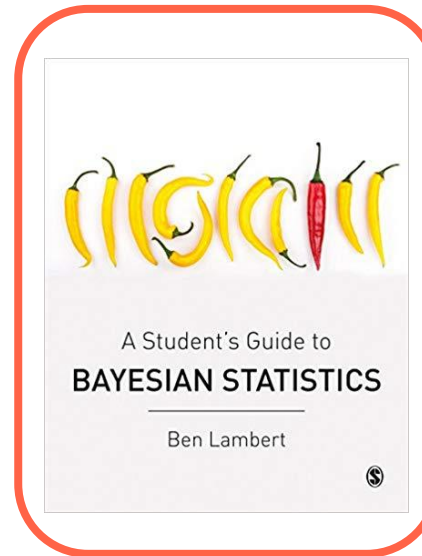
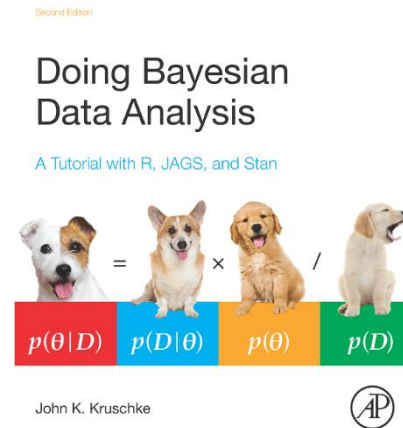
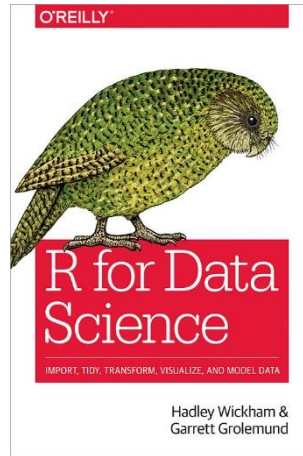
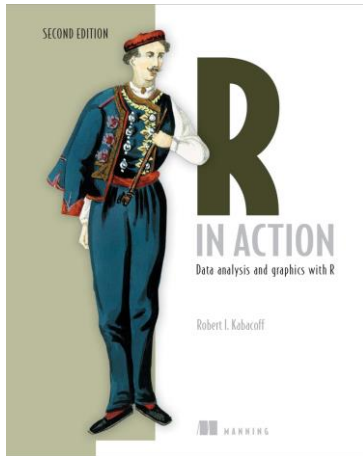
<> Code Issues Pull requests Actions Projects

main Go to file Add file Code

lei-zhang update 4 minutes ago 4

00_R_cheatsheet	update	4 minutes ago
01.R_basics	update	4 minutes ago
02.binomial_glo...	update	4 minutes ago
03.bernoulli_coin	update	4 minutes ago
04.regression_h...	update	4 minutes ago
05.regression_h...	update	4 minutes ago
06.reinforcemen...	update	4 minutes ago
07.optm_rl	update	4 minutes ago
08.compare_mo...	update	4 minutes ago
09.debugging	update	4 minutes ago
Programing_pro...	update	4 minutes ago
LICENSE	update	11 minutes ago
README.md	update	9 minutes ago
Thumbnail_tewa...	update	4 minutes ago

# Resources

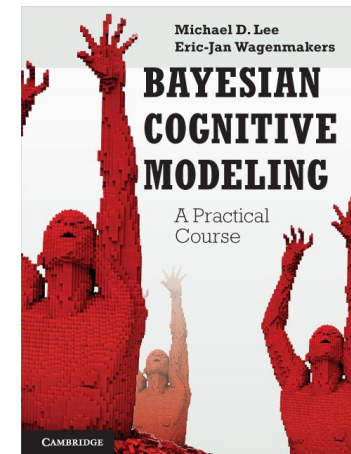
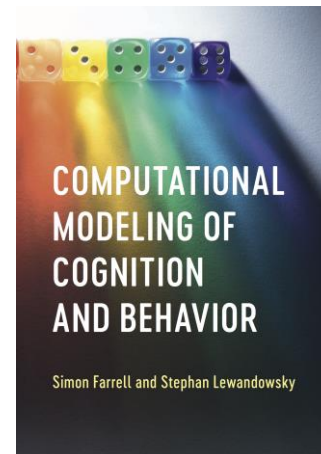
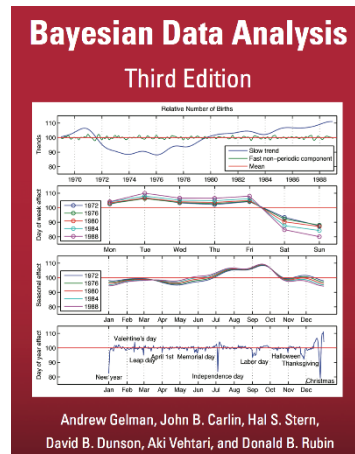
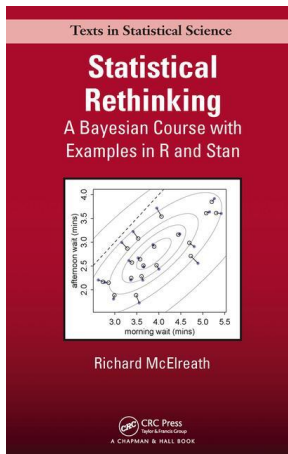


## Statistical Thinking for the 21st Century

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Draft: 2020-03-15

<http://statsthinking21.org/>



DataCamp

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



JASP

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

**Now welcome to TEWA 1!**



ANY  
QUESTIONS  
?



Happy Computing!