

# LECTURE I: WHY DO I NEED TO LEARN STATISTICS AND PROGRAMMING?

Experimental Methods I, E2019  
BSc in Cognitive Science, Aarhus University  
Wednesday 04/09/2019  
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# SOME PRACTICAL INFORMATION ABOUT THE COURSE

# PRACTICAL STUFF: THE STUDY REGULATIONS (I)

- **Contents:**

- This course introduces the student to basic principles of experimental design, programming and basic statistics based on the general linear model (GLM).

- **Description of qualifications**

- In the assessment of the exam performance, emphasis is placed on the extent to which students can design and execute relevant experimental studies and statistical analyses in response to research questions within cognitive science

# PRACTICAL STUFF: THE STUDY REGULATIONS (2)

- Methods = 40 ETCS, “backbone” of the program!
- Makes the program special compared to related programs (e.g. psychology and linguistics)
- So: make sure to like this subject!

SEMESTER 1	Experimental methods 1  10 ECTS	Introduction to cognitive science  10 ECTS	Cognition and communication  10 ECTS
SEMESTER 2	Experimental methods 2  10 ECTS	Introduction to Cognitive Neuroscience  10 ECTS	Studium Generale  10 ECTS
SEMESTER 3	Experimental methods 3  10 ECTS	Mind and consciousness  10 ECTS	Humanities and International electives (HUM- & IV-fag)  10 ECTS
SEMESTER 4	Computational modeling for cognitive science  10 ECTS	Models of perception and action  10 ECTS	Social and cultural dynamics in cognition  10 ECTS
SEMESTER 5	Bachelor's project  15 ECTS	Elective subject  15 ECTS	
SEMESTER 6	Elective subject  30 ECTS		

# PRACTICAL STUFF: THE STUDY REGULATIONS (3)

- **Exam details:**

- Exam type: Portfolio-based take-home assignment on topic of student's choice
- The portfolio contains five experimental studies identified by the course instructor and submitted to the instructor on the specified date. The portfolio must be handed in at the end of the course on a specified submission date. Assessment: Pass/Fail 
- Grading: Internal co-examination
- Due date for complete portfolio: December 13th, 2019 at 14.00

# PRACTICAL STUFF: THE STUDY REGULATIONS (4)

- **Portfolio topics and deadlines** (may be subject to change):

1. Data mining report on “personality test” data from the intro day  
Deadline Oct. 2nd (individual)
2. PsychoPy script for two-condition reading time experiment  
Deadline Oct. 30th (group)
3. Correlation and t-test analysis of data from reading experiment  
Deadline Nov. 13th (individual)
4. Report on multi-condition group experiment  
Deadline Nov. 27th (group)
5. Logistic regression analysis   
Deadline Dec. 4th (individual)

# ATTENDANCE REGISTRATION



You look at:

Mean = average

Median = middle of the distribution

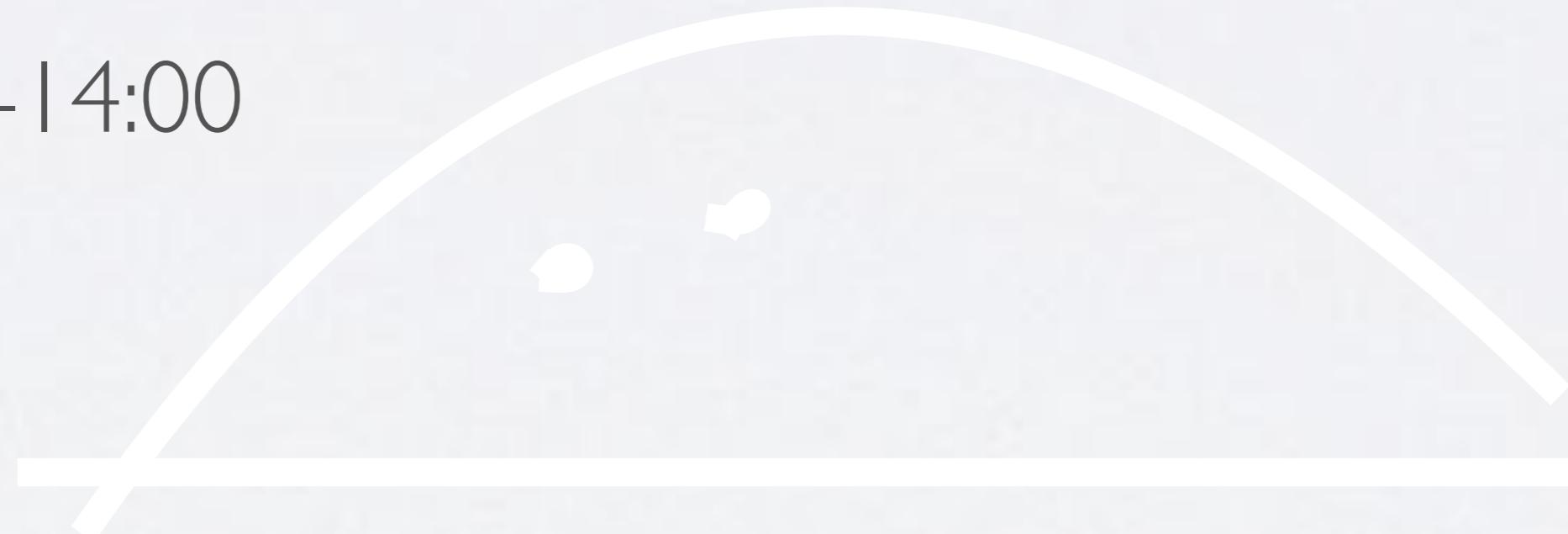
Mode = the value that's most frequent

Plot called:

- Gaussian

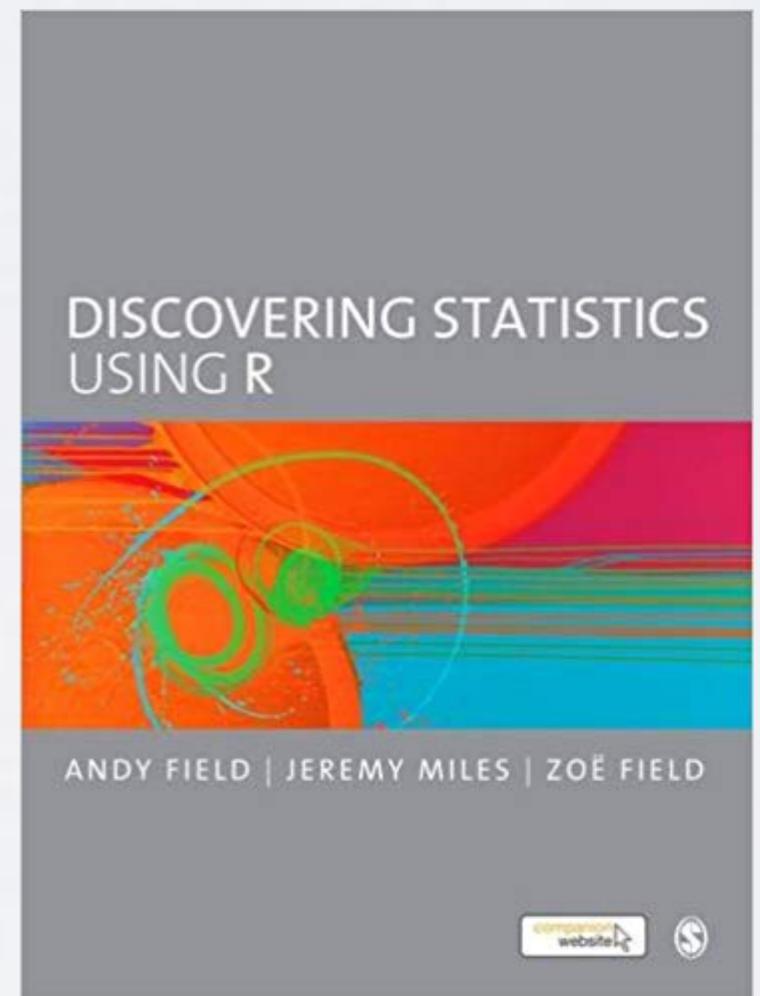
- Normal distr.

- Wednesday
- 13:15-14:00



# LITERATURE

- Textbook: “Discovering Statistics Using R” by Andy Field et al. (Chapters 1-10)
- Selected articles and chapters from other sources (see Course schedule)
- Lecture contents will not be just repetition from the book
- Your responsibility to let me know if there’s something you didn’t understand



# CHAPTER DIFFICULTY

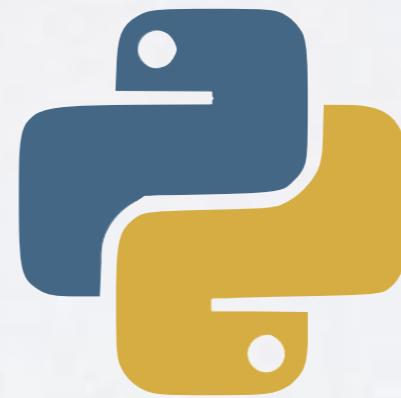
- Chapters are marked with level of difficulty 1-4
- We are only focusing on paragraphs with difficulty 1-2
- You are still welcome to read 3-4

## 2 Everything you ever wanted to know about statistics(well, sort of) (well, sort of)

- 2.1. What will this chapter tell me? <sup>①</sup>
- 2.2. Building statistical models <sup>①</sup>
- 2.3. Populations and samples <sup>①</sup>
- 2.4. Simple statistical models
  - 2.4.1. The mean: a very simple statistical model <sup>①</sup>
  - 2.4.2. Assessing the fit of the mean: sums of squares, variances, standard deviations <sup>①</sup>
  - 2.4.3. Expressing the mean as a model <sup>②</sup>
- 2.5. Going beyond the data <sup>①</sup>
  - 2.5.1. The standard error <sup>①</sup>
  - 2.5.2. Confidence intervals <sup>②</sup>
- 2.6. Using statistical models to test research questions <sup>①</sup>
  - 2.6.1. Test statistics <sup>①</sup>
  - 2.6.2. One- and two-tailed tests <sup>①</sup>

# SOFTWARE

- R + RStudio
- Python + PsychoPy3



# TEACHING FORMAT

- Wednesday 13:00-15:00:
  - Lecture
- Thursday 12:00-14:00 (Class 1) and 14:00-16:00 (Class 2):
  - Practical exercises w/ Anita Kurm
- Wednesday, Dec. 11th, 13-15:
  - Semester recap
- Thursday, Dec. 12th, 12:00-14:00 (Class 1) and 14:00-16:00 (Class 2):
  - Portfolio Q&A

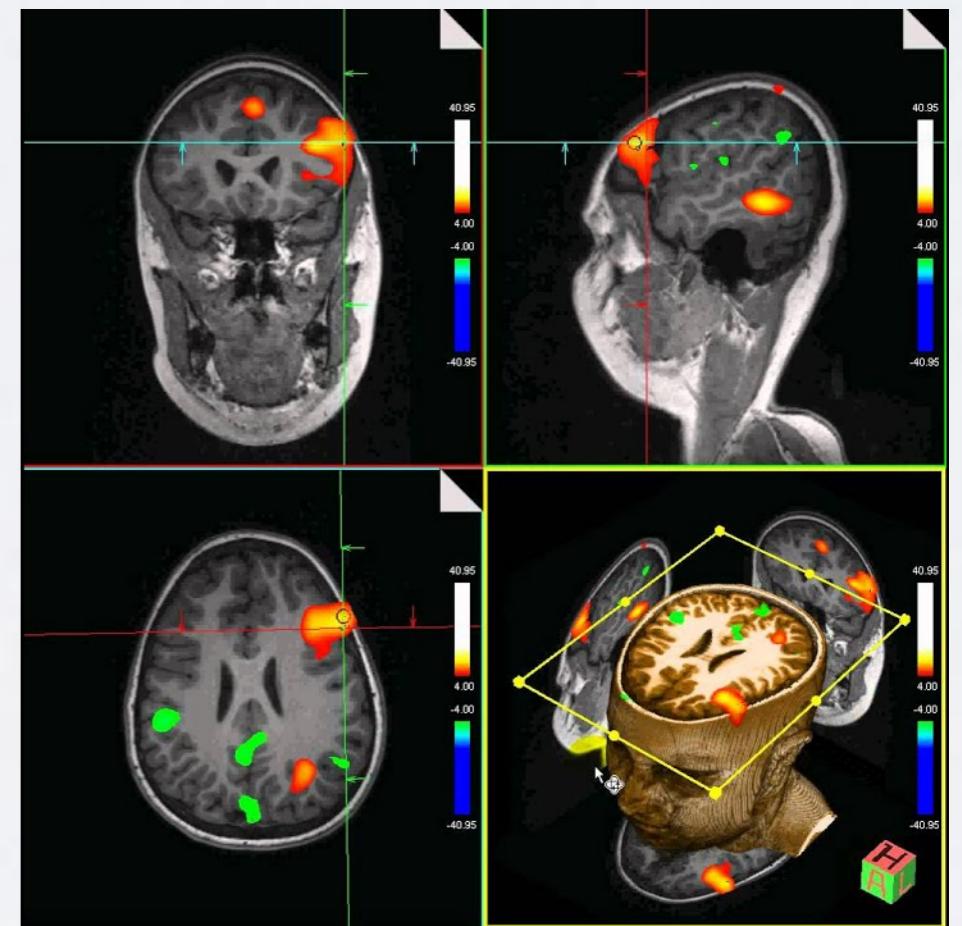
# WHY DO I NEED TO LEARN STATISTICS AND PROGRAMMING?

- I am interested in human thinking and human behavior, not in numbers and graphs:
  - Why so much emphasis on methods?
  - Why don't we concentrate on conceptual investigations and leave the stats to statisticians?



# WHY SO MUCH EMPHASIS ON METHODS?

- Bachelor of Science
- Not methods for methods' sake!
- Experimentation and statistical methods as tools that help us answer questions about the human mind
- We will only work with experimental and statistical methods that we will actually need to answer the questions that interest us!



# WHY DON'T WE CONCENTRATE ON THE CONCEPTUAL?

- In this program, you get both the conceptual side (e.g., Intro to CogSci, CogCom, Mind & Consciousness) and the more methodological side
- Different tools allow us to answer different kinds of questions and give more nuanced answers
- By learning the methods, we are learning to think scientifically:
  - Is this a satisfactory and scientifically sound answer to my research question?
  - Is the evidence I provide enough to prove or disprove a hypothesis?

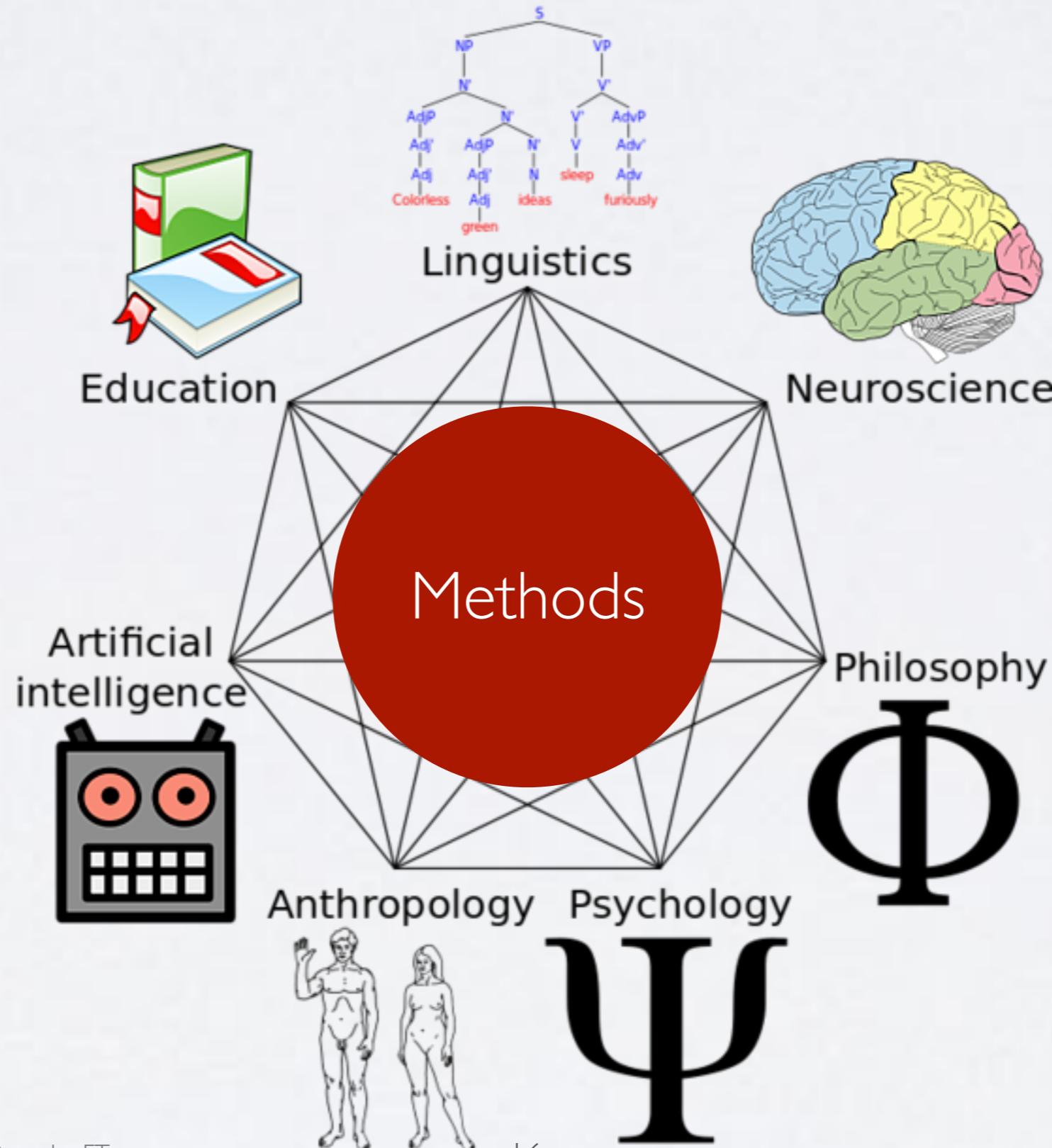


**conclusive or indeclusive answers?**

# APPLIED STATISTICS - NOT MATH!

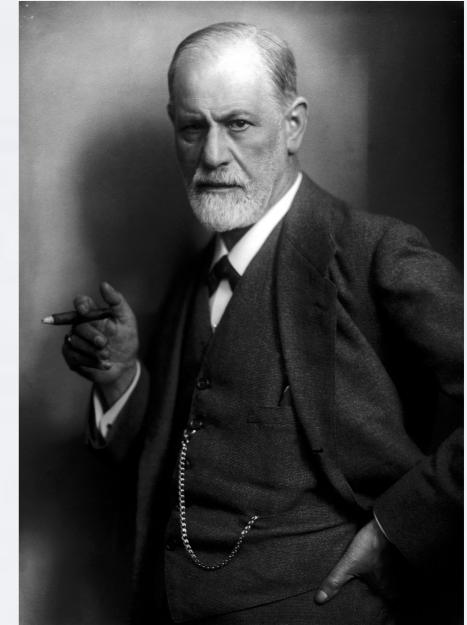
- The most complex math you'll see this semester:
  - $y = a + bx$

# COGNITIVE SCIENCE IS A MULTIDISCIPLINARY AND EMPIRICAL VENTURE (I)



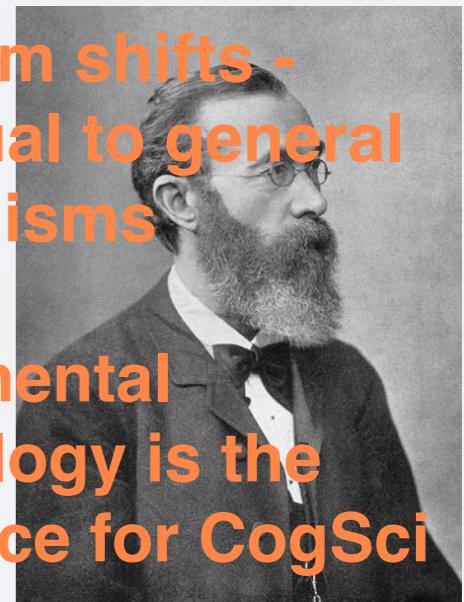
# COGNITIVE SCIENCE IS A MULTIDISCIPLINARY AND EMPIRICAL VENTURE (2)

- Goal of cognitive science: to uncover the general mechanisms underlying human reasoning, emotion, and behavior
- Clinical psychology:
  - concerned about the individual mind/case
  - explains behavior by reference to that individual's personal past/story
  - understand, predict, and influence the individual
- vs. Experimental psychology:
  - 'the mind' as a generalized set of mechanisms: perceptual systems, memory systems, action/overt behavior, emotions, social cognition and interaction, etc.
  - understand, predict, and influence human cognition and behavior



Sigmund Freud (1856-1939)  
Father of psychoanalysis and  
avid cocaine user

**Paradigm shifts -  
individual to general  
mechanisms**



**Experimental  
Psychology is the  
birthplace for CogSci**

Wilhelm Wundt (1832-1920)  
Father of experimental  
psychology

# DIFFERENT METHODOLOGICAL APPROACHES (I)

- 1st person methods (“I”):



Introspective reflection



- 2nd person methods (“You”):

Asking people (e.g., interview)



- 3rd person methods (“He, She”):

Observation



# 1ST PERSON METHODS

## “I THINK MYSELF OUT OF ISSUE X”

- **Introspection**

- How do I as an individual think, experience the world, etc.
- Thought experiments

- **Intuition**

- How do I as representative of a population think, experience the world, etc.
- E.g., grammaticality judgments (*I love you* vs. *\*love I you*)
- Thought experiments

- **Conceptual analysis**

- I break down concepts into their constituent parts to gain a better understanding of a particular issue
- E.g., concept[free will] → constituents[freedom, moral responsibility, determinism, ...] + their interactions

philosophy of mind in  
late 1800 hundred  
- finding solutions or  
problems from the  
retrospect of my  
<- own thought -  
**Thought Experiment**

**But is it  
representative,  
trustworthy or reliable  
to solve the problem,  
from the mind the  
problem occurs of?**

## 2ND PERSON METHODS

“I ASK OTHERS ABOUT HOW THEY RELATE TO ISSUE X”

- **Qualitative interview**

- More or less structured
- Elicits others' introspections



- **Quantitative interview (= questionnaire)**

- Answers to explicitly formulated questions
- Multiple choice vs. open questions



# 3RD PERSON METHODS

## “I OBSERVE SOMEONE DEALING WITH ISSUE X IN EITHER NATURAL OR CONTROLLED SETTINGS”

- **Naturalistic observation**

- Observation/description of human behavior in natural context (no intervention)
- Ethnography, conversation analysis



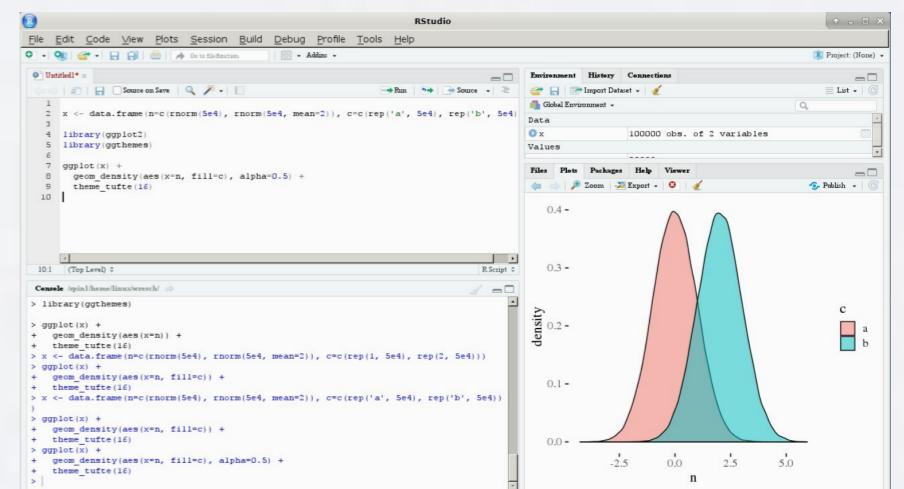
- **Experiment**

- Elicitation of particular responses in a controlled laboratory setting (intervention)
- Experimental psychology

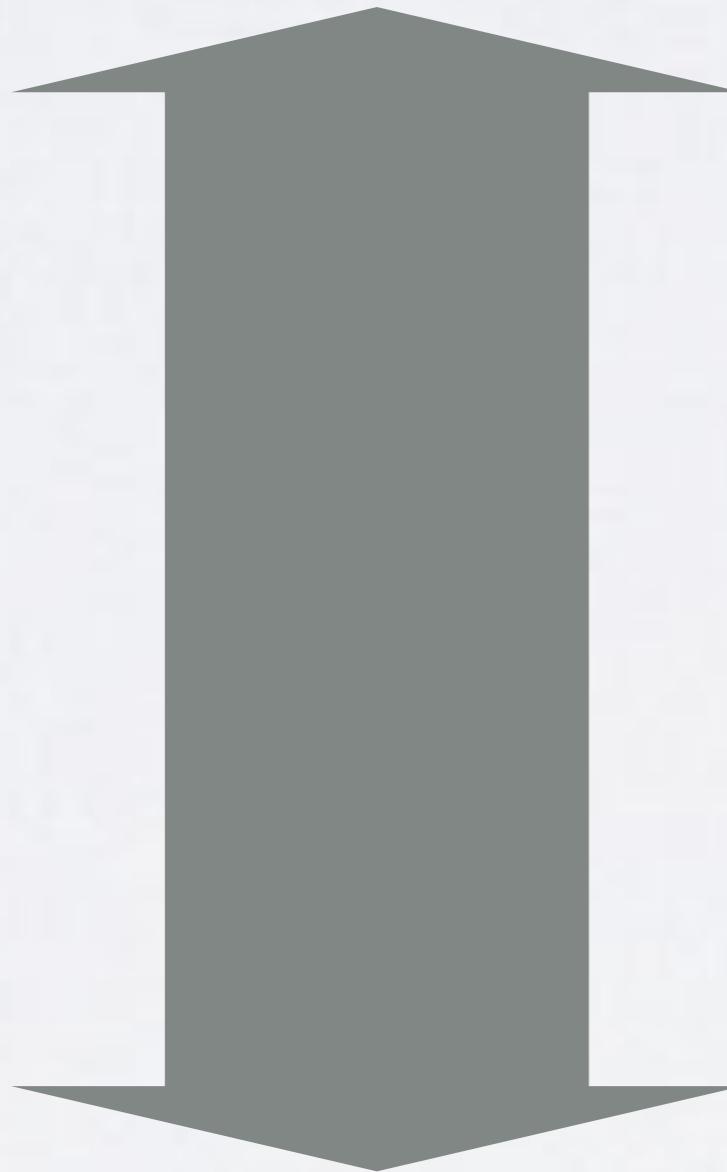


- **Computational modeling**

- Computer simulations of human behavior



# METHODOLOGICAL APPROACHES IN COGNITIVE SCIENCE



## **Observation:**

rich but noisy human behavior

## **Experimentation:**

control, causality, generalisability

## **Modeling:**

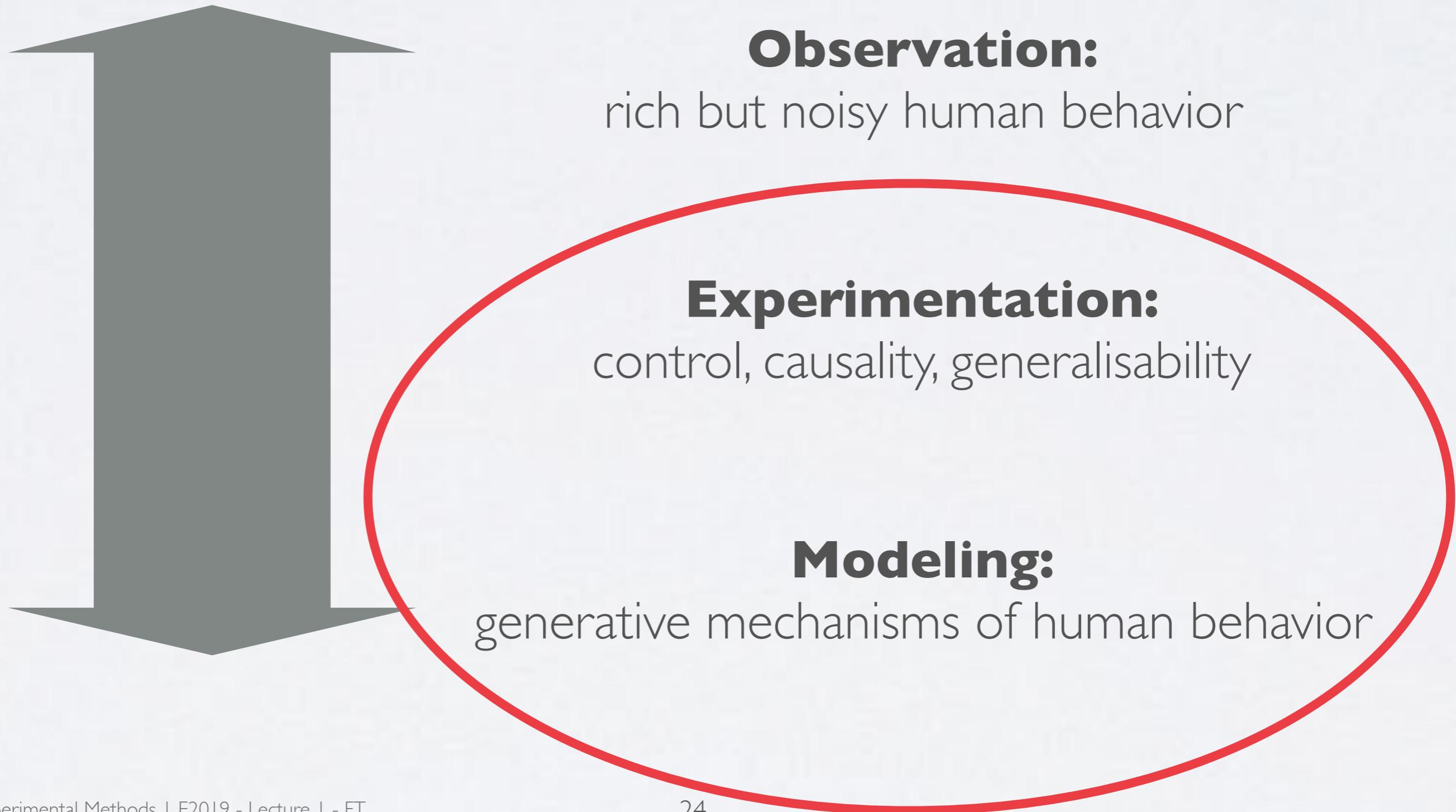
generative mechanisms of human behavior

# DISCUSSION WITH YOUR SIDEMAN/SIDEWOMAN

- What are the advantages of 1st vs. 2nd vs. 3rd person methodological approaches?



# METHODOLOGICAL APPROACHES IN COGNITIVE SCIENCE



# WHY FAVOR EXPERIMENTAL/QUANTITATIVE METHODS?

- They give us well-established objective criteria for what counts as evidence
  - → we can see when we are wrong!
- They help us **minimise** confounding factors, e.g.:
  - **Noise - elements that you don't wanna test**
  - Researcher's influence
  - Confirmation bias - **our own ability to strive for confirmation**
- They allow us to test for causal relationships (cause → effect)
- They give us the power to generalise to “unobserved” cases

# TAKE-HOME MESSAGE

- The study of human cognition is interdisciplinary
- It must relies on insights from many disciplines 
- It combines 1st, 2nd and 3rd person methods
- However, the word “Cognitive **Science**” reflects specifically the use of quantitative/experimental methods that characterize much of the discipline

# TOMORROW

- We'll get acquainted with the R/RStudio environment
- Discuss and try out various basic procedures, such as how to assign various values to variables, lists and data frames and how to access these values again in order to manipulate and use them
- Make sure to install R and RStudio on your computers
- Anita will also help you get started with GitHub — more on that tomorrow

