CS-E577005 : Computational Theories of the Brain

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Course Instructions

Learning Objectives

After completing this course, you will:

- be familiar with some of the prominent computational theories of the brain

- have experience reading and understanding highly technical research from primary source research articles.

- be trained in giving a pedagogical presentation on a technical topic

Teaching team

Andrea

Shamsi

Ray

Steph

- **Lecturer:**
  Stéphane Deny: stephane.deny@aalto.fi

- **Teaching Assistants**
  Raymond Khazoum: raymond.khazoum@aalto.fi
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- *First edition of this course:*
  => feedback welcome (anonymous):
  https://presemo.aalto.fi/braintheory8258

Dates and rooms

Thu 25.04.2024 14:15 - 16:00, R001/M205

Thu 02.05.2024 14:15 - 16:00, R001/M205

(9.5. Ascension Day - no teaching)

Thu 16.05.2024 14:15 - 16:00, R001/M205

Thu 23.05.2024 14:15 - 16:00, R001/M205

Thu 30.05.2024 14:15 - 16:00, R001/M205

Thu 06.06.2024 14:15 - 16:00, R001/M205 (on exam week)

Timeline of the course

25.04.2024 (today): Crash course about the brain and presentation of topics

  <u>Homework</u>: browse the reading material and select 1 to 3 topics. Fill your preferences on MyCourse. Before Friday 26/04 end of day!

02.05.2024 (next week): start reading the material during the class

  <u>Homework</u>: continue reading the material and prepare your presentations

(9.5. Ascension Day - no teaching)

16.05.2024: 2 groups present their topic (Topics T1 – T2?)

23.05.2024: 2 groups present their topic (Topics T2 – T3)

30.05.2024: 2 groups present their topic (Topics T4 – T5)

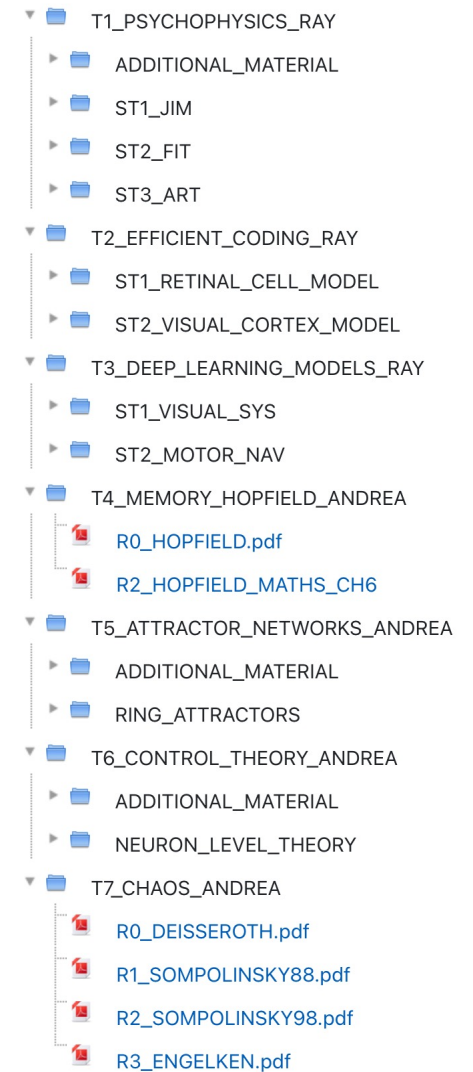06.06.2024: 2 groups present their topic (Topics T6 – T7)

Grading – Pass or Fail

Requirements for passing the class:

1. Attend most lectures (will not be checked) – <u>There is no online option.</u>

2. Present your topic to the class
    - The jury will give detailed feeback on your presentation

3. Organize **two** meetings with your referrent TA ahead of your presentation:
    - Meeting 1: Ask any question you have about the reading material
    - Meeting 2: Give a rehearsal presentation and get feedback (either Shamsi or me will try to also attend that one)

TOPICS

- Topics are found at:
  https://mycourses.aalto.fi/mod/folder/view.php?id=1182868

- Some topics (indicated by T) have subtopics (indicated by ST). In this case, one group will be assigned only one of the subtopics.

- Additional material does not need to be read or presented.

- For Hopfield (T4), there is a book: only chapter 4 to 6 should be studied and presented.

T1_PSYCHOPHYSICS_RAY
  ADDITIONAL_MATERIAL
  ST1_JIM
  ST2_FIT
  ST3_ART
T2_EFFICIENT_CODING_RAY
  ST1_RETINAL_CELL_MODEL
  ST2_VISUAL_CORTEX_MODEL
T3_DEEP_LEARNING_MODELS_RAY
  ST1_VISUAL_SYS
  ST2_MOTOR_NAV
T4_MEMORY_HOPFIELD_ANDREA
  R0_HOPFIELD.pdf
  R2_HOPFIELD_MATHS_CH6
T5_ATTRACTOR_NETWORKS_ANDREA
  ADDITIONAL_MATERIAL
  RING_ATTRACTORS
T6_CONTROL_THEORY_ANDREA
  ADDITIONAL_MATERIAL
  NEURON_LEVEL_THEORY
T7_CHAOS_ANDREA
  R0_DEISSEROTH.pdf
  R1_SOMPOLINSKY88.pdf
  R2_SOMPOLINSKY98.pdf
  R3_ENGELKEN.pdf

Topic assignement mechanism – 8 groups

- For Friday 26/04, each student will have selected 1 to 3 topics/subtopics on MyCourse.

- We will assign each student to a topic/subtopic based on their preferences.

- In case of conflict (too many students interested by the same topic), we will decide based on their motivation and background.

- The groups are formed around the topics chosen. Groups will have 2/3 students each.

Instructions for the presentation

1. Present the facts about the brain that the theory explains

2. Present the theory. Extract the essential technical parts of the theory and explain those as clearly and simply as possible. Use the whiteboard for maths.

3. Present the results of the theory: which facts does it explain well? Which facts remain unaccounted for by the theory?

Tip 1: You may ignore some of the content present in the reading material.
Tip 2: Dive deep into the maths. And then come back to the surface.

Instructions for the presentation

- You will be able to use slides and the whiteboard. Whiteboard is recommended for technical explanations. Practice on a whiteboard before your presentation.

- Upload your slides on MyCourse on the day of your presentation.

- You will have 30 minutes to present (not extremely precise). Then there will be time for questions and feedback.

- You may get questions during your presentation.

Good luck!

How to work together - recommendations

- Each student reads all the reading material.

- Meet once or more to help each other understand the difficult parts.

- Split the presentation in parts, each student responsible for their part.

- Meet a couple of times to put the presentation together such that it is coherent and rehearsed.

Building lecture notes

- Some of you take excellent notes. They could serve as lecture notes for next year. So if you are happy with your notes, please send them to us at the end of the class!

- The lecture notes need to be formatted in LaTeX

- The mathematical derivations seen in class must appear in the lecture notes.

- The name of the students in charge of the topics need to be added to the lecture notes (for credit).

Program: Session 1 (April 4)

- Crash course about the brain
- Presentation of topics of by referent TAs

Program: Session 2 (May 2)

Ray   Andrea

- gather with your group and identify your referrent TA
  - T1-T3: Ray
  - T4-T7: Andrea

- book two meeting dates now with your referrent TA
  - ➤ Meeting 1: Early. Ask any question you have about the reading material.
  - ➤ Meeting 2: One or two weeks before your presentation date. Give a rehearsal presentation and get feedback (either Shamsi or me or both will try to also attend that one)

- Start reading the material in class.

- Ask questions to your referrent TA as they arise.

Program: Sessions 3-4-5-6 (May 16 to June 6)

- 2 groups presents: 30 minutes for each presentation
- 8 minutes for questions
- 8 minutes for feedback
- 10 minutes break
- The second presentation should start no later than 15h07.