Cognitive Maps Seminar Syllabus

Instructors
Dr. Charley Wu (charley.wu@uni-tuebingen.de)
Dr. Philipp Schwartenbeck (philipp.schwartenbeck@tuebingen.mpg.de)

Teaching Assistant
Noémi Éltető (noemi.elteto@tuebingen.mpg.de)

Schedule
Location**: 4th floor seminar room, AI building, Maria-von-Linden-Str. 6, D-72076 Tübingen**
Class time: **Wednesdays 16:00-18:00**
Office Hours: Charley (Fridays 14:00-15:00)
Course website: https://hmc-lab.com/Cogmaps.html
Link to submit discussion questions (starting Nov 16th)
List of recommended papers for student-led presentations

Course description and prerequisites:
The aim is to discuss foundational ideas and current research on cognitive maps, which is an area of much current interest across neuroscientific and computational research fields. Originating in rodent navigation tasks, the concept of a "cognitive map" describes the biological and algorithmic mechanisms of storing and generalizing knowledge. Today, cognitive maps are associated with a host of specialized cell types in the hippocampal-entorhinal cortex, observed across a wide range of species, and across different spatial, conceptual, and diverse representational domains. Key open questions are how diverse experiences can be organized into a cognitive map, which then informs behavior in novel and complex settings.

The first half of the semester will be focused on teaching foundational concepts and research on the topic of cognitive maps and reinforcement learning. Then, we will switch to discussing current research trends and state of the art research for the second half of the semester. The instructors (Wu & Schwartenbeck) and guest speakers will lead the first sessions, and then students will be asked to prepare paper presentations for remaining

sessions. Each class will take 2 hrs, and grading will be assigned on the basis of paper presentations and contributions to discussions.

Grading

- [Required] Attendance of at least 80% of sessions
- [30% of grade] Submit 1 engaging discussion question prior to every paper session (16. November onwards)
- [70% of grade] Give one presentation (90-minute session with discussion) on a relevant paper of your choice (recommended papers; other papers are also fine but should be first discussed with the instructors). This can be completed on your own or in a group of 2-3 students, depending on the size of the class

Preliminary Schedule
Wednesdays from 16:00 - 18:00 (see semester schedule)

Date	Host	Topic	Required Readings
19. Oct 2022	Charley	Introduction to cognitive maps	Tolman, E. C. (1948). **Cognitive maps in rats and men.** Psychological review, 55(4), 189.
26. Oct 2022	Philipp	What is a cognitive map? An overview of modern neuroscientific discoveries	Epstein, R. A., Patai, E. Z., Julian, J. B., & Spiers, H. J. (2017). **The cognitive map in humans: spatial navigation and beyond**. Nature neuroscience, 20(11), 1504-1513.
2. Nov 2022	Charley	Introduction to Reinforcement Learning	Niv, Y. (2009). **Reinforcement learning in the brain**. *Journal of Mathematical Psychology, 53*(3), 139–154. [Section 1 only] Dolan, R. J., & Dayan, P. (2013). **Goals and habits in the brain**. *Neuron, 80*(2), 312–325.
9. Nov 2022	Philipp	Neuroscience of RL	Lee, D., Seo, H., & Jung, M. W. (2012). **Neural basis of reinforcement learning and decision making**. Annual review of neuroscience, 35, 287.
16. Nov 2022	Nir Moneta (MPI Berlin)	Cognitive maps beyond spatial stimuli	Doeller, C. F., Barry, C., & Burgess, N. (2010). **Evidence for grid cells in a human memory network**. Nature, 463(7281), 657-661.

Date	Presenter	Title	Paper
23. Nov 2022	Noémi	From Maps to Behavior and Back again	Stachenfeld, K. L., Botvinick, M. M., & Gershman, S. J. (2017). **The hippocampus as a predictive map.** Nature neuroscience, 20(11), 1643-1653.
30. Nov 2022	Georgy Antonov (MPI BC)	Linking memory and navigation	Eichenbaum, H. (2017). **On the integration of space, time, and memory.** Neuron, 95(5), 1007-1018.
7. Dec 2022	Philipp	Student led presentation 1	Recommended papers
14. Dec 2022	Philipp	Student led presentation 2	
11. Jan 2023	Charley	Student led presentation 3	
18. Jan 2023	Charley	Student led presentation 4	
25. Jan 2023	Charley	Student led presentation 5	
1. Feb 2023	Charley	Student led presentation 6	
8. Feb 2023	Charley	Student led presentation 7	

.