BrainWorlds
Interdisciplinary Research Initiative

The interdisciplinary BrainWorlds Research Initiative aims at a better understanding of internal world models for humans, animals, and artificial systems in reaction to a changing environment. These models are crucial for planning and predicting events and are constantly updated through sensory information, experiences, and emotions. However, they are not exact representations but abstract constructs tied to the nervous system's components. Incorrectly constructed models can lead to complex neuro-psychiatric conditions and dysfunctional AI systems.

The objective of the BrainWorlds Research Initiative is to gain integrated mechanistic insights into internal world models in biological and artificial individuals – from deep networks to autonomous robots – thus enabling the development of next-generation AI and AI-based neuromodulation in personalized medicine.

universität freiburg

IMBIT //
Intelligent Machine-Brain Interfacing Technology

Freiburg-Oxford Workshop
November 8-9, 2023

Chairs
Prof. Dr. Ilka Diester, Freiburg
Prof. Dr. Thomas Brox, Freiburg
Prof. David Dupret, Oxford
Prof. Dr. med. Andreas Vlachos, Freiburg

Location
IMBIT BrainLinks-BrainTools
University of Freiburg
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Image
Büro Magenta

UNIVERSITY OF OXFORD

OXFORD NEUROSCIENCE

Internal World Models in Animals, Humans, and AI

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PROGRAM

Wednesday, November 8, 2023

Welcome

09:00 **Ilka Diester**, Freiburg: Welcome address

Session 1 **What is a "good" representation/ internal world model?**

Moderator: David Dupret

09:15 **Joschka Boedecker,** Freiburg: Fantastic representations and how to learn them

09:30 **Matthew Rushworth**, Oxford: Identifying and disrupting internal models in humans and other primates: Extending into the social domain

09:55 **Thomas Brox**, Freiburg: Are learned representations in AI internal world models?

10:10 **Monika Schönauer**, Freiburg: How prior knowledge about the structure of our environment supports new learning and the formation of stable neocortical representations

10:25 **Discussion**

10:50 Coffee break (15')

Moderator: Andreas Vlachos

11:05 **Andrea Vedaldi**, Oxford: A statistical learning perspective on reconstructing the 3D world

11:30 **Tim Behrens**, Oxford: Generalisation and inference in the frontal hippocampal circuitry

11:55 **Marlene Bartos**, Freiburg: Spatial and contextual representation of the virtual world in the mouse hippocampus

12:10 **Andrew Straw**, Freiburg: A diversity of insect species and route learning behaviors but a conserved neural substrate

12:25 **Discussion**

12:55 Lunch (1 h 5')

Session 2 **Formation, maintenance and adaptation of representations and internal world model**

Moderator: Marlene Bartos

14:00 **Helen Barron,** Oxford: Building internal models during periods of rest and sleep

14:25 **Bernhard Staresina**, Oxford & **Andreas Schulze-Bonhage**, Freiburg: Brain rhythms supporting memory consolidation during sleep

15:00 **Andrea Kiesel**, Freiburg: Action control model

15:15 **Christian Leibold**, Freiburg: Hierarchical formation world models: A hypothesis based on the hippocampal space code

15:30 **Discussion**

16:00 Coffee break (20')

Moderator: Thomas Brox

16:20 **Andrew Sharott**, Oxford: Global neuronal population dynamics predicts prospective reward magnitude and goal approach

16:45 **Adam Kortylewski**, Freiburg: General artificial vision with generative worlds models

17:00 **Ingmar Posner**, Oxford: Embodied intelligence – from sensing to collaboration

17:20 **Abhinav Valada**, Freiburg: Robot learning from interactions

17:35 **Discussion**

Dinner

Thursday, November 9, 2023

Session 3 **What is a "maladapted" representation/internal world model?**

Moderator: Monika Schönauer

09:00 **Johannes Letzkus**, Freiburg: Top-down control of neocortical threat memory

09:15 **Matthew Nour**, Oxford: Cognitive and neural map representations in schizophrenia

09:40 **Ludger Tebartz van Elst**, Freiburg: Visual disambiguation deficits as examples of perceptual and cognitive dysfunctional world models in schizophreniform psychosis

09:55 **Andreas Vlachos**, Freiburg: Targeting internal world models with brain stimulation – reverse and horizontal translation

10:10 **Discussion**

10:40 **The Rector's address** to the workshop participants

10:50 Group Picture (10')

11:00 Coffee break (20')

Session 4 **Ethical implications**

Moderator: Nicole Rosskothen-Kuhl

11:20 **Veronika Lipphardt**, Freiburg: Internal world models from a history of science perspective

11:35 **Philipp Kellmeyer**, Freiburg: Ethical implications of epistemic gaps in human-AI interaction

11:50 **Ilina Singh**, Oxford: Ethics of function and dysfunction in models of psychiatric illness

12:15 **Discussion**

12:45 Lunch (1 h 15')

Breakout Session 1 Room 42 – upon invitation

Moderator: Anil Ananthaswamy

14:00 **Summarizing session** (Part 1)

15:00 Coffee break (15')

15:15 **Summarizing session** (Part 2)

Breakout Session 2 Nexus Lab – for all workshop participants

Moderators: Veronika Lipphardt & Sabrina Livanec

14:00 **Science reflection**: How do scientists bridge the gap between data and interpretation? What plays into decision making in research? Reflecting upon science is part of any research endeavour in any discipline.

15:00 Coffee break (15')

Moderators: Nicole Rosskothen-Kuhl & Julia Veit

15:15 **Next generation needs**: How can BrainWorlds better address the needs of the next generation scientists? We want to discuss our supporting measures and learn from you where we might still need to catch up.

Closing Nexus Lab

16:15 **Ilka Diester**, Freiburg: Closing remarks