Wednesday September 13

9:30 - 10:30 Tutorial - Deep Active Inference

Noor Sajid

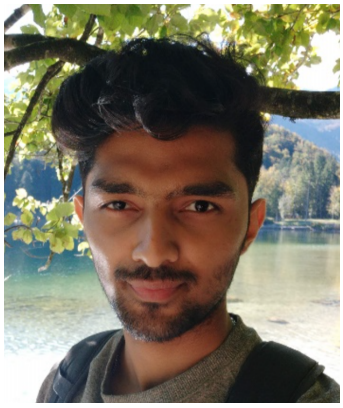
Active inference is a Bayesian framework for understanding biological intelligence. The underlying theory brings together perception and action under one single imperative: minimizing free energy (Friston, 2010). I will present a neural architecture for building deep active inference agents operating in complex, continuous state-spaces using multiple forms of Monte-Carlo (MC) sampling. For this, I will introduce several techniques, novel to active inference. These include: i) selecting free-energy-optimal policies via MC tree search, ii) approximating this optimal policy distribution via a feed-forward `habitual' network, iii) predicting future parameter belief updates using MC dropouts and, finally, iv) optimizing state transition precision (a high-end form of attention). Our approach enables agents to learn environmental dynamics efficiently, while maintaining task performance. I will illustrate this in a toy environment and demonstrate that these agents can automatically create disentangled representations that are apt for modeling state transitions. In a more complex Animal-AI environment, our agents can simulate future state transitions and actions, to evince reward-directed navigation – despite temporary suspension of visual input. Our results show that deep active inference - equipped with MC methods - provides a flexible framework to develop biologically inspired intelligent agents, with applications in both machine learning and cognitive science.

Noor Sajid is a theoretical neuroscience PhD candidate at University College London with Prof. Karl Friston. Her research is aimed at understanding the algorithms of the brain – with a particular interest in mechanisms that support biological adaptation. She investigates how artificial and biological agents adapt when interacting with their environments. Noor hopes that this work will provide insight into how neural networks of wathe brain implement and adapt computations after perturbations. Her work is funded by the UK Medical Research Council's AI and Neuroscience PhD award, 2021 Microsoft PhD Research fellowship and G-Research PhD award.

11:00 - 12:00 Tutorial - Design of Active Inference controllers for dynamic systems

Ajith Anil Meera

Have you ever wondered how the roboticists and control engineers model and control robots? Have you been working with active inference and wanted to put it into robot? In this tutorial, the participants will gain an insight into the modelling and control of dynamic systems using active inference, from a robotics perspective. At the end, the participants will learn to i) model a dynamic system, ii) transform the model to the state space form and, iii) derive the equations for the Active Inference controller. The tutorial will follow a step by step guidance in MATLAB, to control a simple dynamic system (spring mass damper system) towards a desired goal state or goal state velocity, using the Active Inference controller. After this tutorial, the participants will be able to derive the equations of motion of a dynamic system, and design an active inference controller to control it. The same methodology will be followed to demonstrate the simulation results for i) controlling a 2DOF robot arm, ii) control a group of drones to fly in formation towards the goal by avoiding obstacles – all using the active inference controller. This tutorial is not only targeted for beginners, but also for researchers with control knowledge.



Ajith Anil Meera is a post-doctoral researcher with Dr. Pablo Lanillos, working on the EU project METATOOL at Radboud University, The Netherlands, where he investigates robotic control and tool invention with Active Inference. He obtained his PhD from the Department of Cognitive Robotics, TU Delft, on the thesis, "Free Energy Principle Based Precision Modulation for Robot Attention". His research focuses on robot cognition, path planning, estimation and control.

13:30 - 14:00 Welcome

chair: Tim Verbelen

14:00 - 15:00 Keynote - Embodied AI with the Concept of Active Inference

Tetsuya Ogata

Tetsuya Ogata is a Professor with the Faculty of Science and Engineering, at Waseda University, and a Joint-appointed Fellow with the Artificial Intelligence Research Center, National Institute of Advanced Industrial Science and Technology, Tokyo. He is currently a member of the director board of the Japan Deep Learning Association (JDLA) since 2017, and a director of the Institute of AI and Robotics, at Waseda University since 2020.

15:00 - 15:40 Session 1 - Active Inference and Robotics

chair: Hideaki Shimazaki

Contextual Qualitative Deterministic Models for Self-Learning Embodied Agents
Jan Lemeire, Nick Wouters, Marco Van Cleemput

Dynamical Perception-Action Loop Formation with Developmental Embodiment for Hierarchical Active Inference
Kanako Esaki, Tadayuki Matsumura, Shunsuke Minusa, Yang Shao, Chihiro Yoshimura, Hiroyuki Mizuno

16:00 - 17:00 Session 2 - Active Inference and Psychology

chair: Noor Sajid

Towards Understanding Persons and their Personalities with Cybernetic Big 5 Theory and the Free Energy Principle and Active Inference (FEP-AI) Framework
Adam Safron, Zahra Sheikhbahaee

On Embedded Normativity - An Active Inference account of agency beyond flesh
Avel Guénin Carlut, Mahault Albarracin

A Model of Agential Learning Using Active Inference
Riddhi Jain Pitliya, Robin A. Murphy

Thursday September 14

9:30 - 10:30 Keynote - Not only intentional: an Active Inference account of Human Motor Behavior

Antonella Maselli

Antonella Maselli currently works at the Institute of Cognitive Sciences and Technology, at the Italia National Research Council of Italy (CNR). Antonella does research in multisensory perception, cognitive sciences and motor control.

11:00 - 12:00 Session 3 - From theory to implementation

chair: Martijn Wisse

Designing explainable artificial intelligence with active inference: A framework for transparent introspection and decision-making
Mahault Albarracin, Ines Hipolito, Safae Essafi-Tremblay, Jason Fox, Gabriel Rene, Maxwell Ramstead, Karl Friston

An analytical model of active inference in the Iterated Prisoner's Dilemma
Daphne Demekas, Conor Heins, Brennan Klein

Toward Design of Synthetic Active Inference Agents by Mere Mortals
Bert de Vries

13:30 - 14:30 Session 4 - Learning Representations for Active Inference

chair: Tim Verbelen

Exploring Action-Centric Representations Through the Lens of Rate-Distortion Theory
Miguel De Llanza Varona, Christopher Buckley, Beren Millidge

Integrating cognitive map learning and active inference for planning in ambiguous environments
Toon Van de Maele, Bart Dhoedt, Tim Verbelen, Giovanni Pezzulo

Relative representations for cognitive graphs
Alex B Kiefer, Christopher Buckley

14:30 - 15:30 Poster spotlights

chair: Martijn Wisse

Core Active Inference

1. A Neural Network Implementation for Free Energy Principle
   Jingwei Liu
2. Active Inference in Human-Computer Interaction
   Roderick Murray-Smith, Sebastian Stein, John H Williamson
3. Generalized Notation Notation for Active Inference Models
   Jakub Smekal, Daniel Friedman

Active Inference and Neuroscience

4. An Actively Inferential Neuro-AI Interface
   Charles Wan
5. An active inference perspective for the amygdala complex
   Ronald Sladky, Dominic Kargl, Wulf Haubensak, Claus Lamm
6. Spike coding active inference
   André Rodrigues Urbano, Sander Wessel Keemink, Pablo Lanillos, Ajith Anil Meera, Mahyar Shahsavari
7. A model of hippocampal-prefrontal interactions to solve spatial memory-guided tasks
   Toon Van de Maele, Bart Dhoedt, Tim Verbelen, Giovanni Pezzulo
8. Predictive Coding Account of Bipolar Disorder
   Theodoros Sechopoulos

Active Inference for simulated and real robots

9. Hierarchical Active Inference for Exploration and Navigation in Structured Maze Environments
   Daria de Tinguy, Toon Van de Maele, Tim Verbelen, Bart Dhoedt
10. Objects as perceptually grounded neurosymbols for reasoning and behavior
    Ruben S. van Bergen, Pablo Lanillos
11. Real-World Robot Control Based on Contrastive Active Inference with Learning from Demonstration
    Kentaro Fujii, Takuya Isomura, Shingo Murata

Modeling Humans with Active Inference

12. Inventory Decision by Active Inference
    Wanshan Zhu
13. Intra-Active Inference I: Fundamentals
    Ali Rahmjoo, Mahault Albarracin
14. Synthesising Idiographic Computational Models of Human Biometric Data With Virtually Embodied Active-Inference Agents and Their Affordances When Embedded in a Computational Ecology
    Casper Hesp, Richard K Ridderinkhof
15. An Active Inference Approach to Attachment Theory
    Erica Santaguida, Giuseppe Pagnoni

Friday September 15

9:30 - 10:30 Session 5 - Decision-making and Control

chair: Pablo Lanillos

Towards Metacognitive Robot Decision Making for Tool Selection
Ajith Anil Meera, Pablo Lanillos

Understanding Tool Discovery and Tool Innovation Using Active Inference
Poppy Collis, Paul Kinghorn, Christopher Buckley

Efficient motor learning through action-perception cycles in deep kinematic inference
Matteo Priorelli, Ivilin Peev Stoianov

11:00 - 12:00 Session 6 - Theory of Learning and Inference

chair: Chris Buckley

Active Inference in Hebbian Learning Networks
Ali Safa, Tim Verbelen, Lars Keuninckx, Ilja Ocket, André Bourdoux, Francky Catthoor, Georges Gielen, Gert Cauwenberghs

Learning One Abstract Bit at a Time Through Self-Invented Experiments Encoded as Neural Networks
Vincent Herrmann, Louis Kirsch, Jürgen Schmidhuber

Probabilistic Majorization of Partially Observable Markov Decision Processes
Tom Lefebvre

13:30 - 15:00 Keynote - Directions of travel in active inference

Karl Friston

Karl Friston is a British neuroscientist and theoretician at University College London. He is a key architect of the free energy principle and active inference. In October 2022, he joined VERSES Inc, a California-based cognitive computing company focusing on artificial intelligence designed using the principles of active inference, as Chief Scientist.

15:00 - 15:30 Awards ceremony and closing