CASPER VAN ELTEREN

Computational scientist

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ABOUT ME

I offer a unique profile in artificial intelligence, physics, computer science and neuroscience to study non-linear dynamics in complex dynamical systems. My dream job would entail studying how self-emergent behavior arises from the interaction of simple agents.

EDUCATION

Master of Science

Donders Graduate School for Cognitive Neuroscience

Sept 2016 – May 2019 Nijmegen

Research master in computational science, *cum laude*.
Specialization: Brain networks.
Main subjects: Machine learning, computational neuroscience, information theory, computational cognitive neuroscience, advanced math, electrophysiology, hemodynamics, brain-computer interfacing, complexity analysis, advanced signal analysis.
GPA:8.41

Master thesis: Dynamical importance of nodes in networks is poorly predicted by static network topological features
Supervisor: Dr. Rick Quax
Description:: Complexity is a major problem for the 21st century. A common question for dynamical systems is 'which node is most important?'. A traditional approach is using structure to predict the most important causal node. In this thesis, I show how this approach is volley. Using information theory I provide an alternative approach that is able to predict the largest driver-node with 100% accuracy in real-world networks. The results from this study allow scientists from any fields to reliably estimate causal flows using observations only.

Bachelor of Science

University of Amsterdam

Sept 2011 – June 2014 Amsterdam

Psychobiology, *cum laude*.
Minor in computational science
Main subjects: Systems of neuroscience, programming, statistics and experimental design.
GPA: 8.81

Bachelor's thesis: *Frequency sliding: A novel method to study non-linear dynamics in EEG*
Supervisors: Dr. Mike Cohen & Dr. Andries van der Leij
Description: This thesis explores the relation between motion-coherence and changes in peak frequency using a novel method in EEG analysis.

MY LIFE PHILOSOPHY

"What I cannnot create, I do not understand" - Richard Feynman

MOST PROUD OF

Information impact toolbox
Part of my thesis I wrote a lightning fast general framework for simulating complex dynamical networks. The framework allows scientists from different disciplines to hook their own model and compute information impact with c/c++ level performance.

Created the Zebrafish viewer
A lightning fast 3D data visualizer written in python using OpenGL.

Created a Brain-Computer interface
I designed the stimulus design and the backend for a BCI that allows for the incorporation of error correction signal (ERN) while playing the Brainrunner game.

Best in class
Research proposal and academic poster was elected in top 10% of the Bachelor program

STRENGTHS

Hard-working | Creative | Tenacity | Python | Matlab | R | C++ | Advanced signal analysis | Advanced math | Data visualization | Machine learning | Information theory

LANGUAGES

English ●●●●○

Dutch ●●●●●

INTERESTS

Technology | Music | Art | Gaming

«««< HEAD I play both drums and bass guitar, and I enjoy keeping up with the latest technology and playing the occasional video game. Additionally, I both design and build my own keyboards. ======= I play both

drums and bass guitar, and I enjoy keeping

PUBLICATIONS

The dynamic importance of nodes is poorly predicted by static topological features [https://arxiv.org/abs/1904.06654]

April 2019

Amsterdam

One of the most central questions in network science is: which nodes are most important? Often this question is answered using topological properties such as high connectedness or centrality in the network. However it is unclear whether topological connectedness translates directly to dynamical impact. To this end, we simulate the kinetic Ising spin model on generated and a real-world networks with weighted edges. The extent of the dynamic impact is assessed by causally intervening on a node state and effect on the systemic dynamics. The results show that topological features such as network centrality or connectedness are actually poor predictors of the dynamical impact of a node on the rest of the network. A solution is offered in the form of an information theoretical measure named information impact. The metric is able to accurately reflect dynamic importance of nodes in networks under natural dynamics using observations only, and validated using causal interventions. We conclude that the most dynamically impactful nodes are usually not the most well-connected or central nodes. This implies that the common assumption of topologically central or well-connected nodes being also dynamically important is actually false, and abstracting away the dynamics from a network before analyzing is not advised.

PROJECTS

Data mining in Zebrafish data

Radboud University

November 2016 - September 2017 Nijmegen

Exploring whole-brain dynamics using calcium data using a variety of machine learning techniques. Focus was especially on applying blind source separation to deal with big-data. Furthermore, I developed a QT application to be able to visualize the data in 3D (zebrafish viewer) in python using OpenGL wrappers.

Clustering distribution using CAESAR algorithm in Danio rerio

Radboud University

April 2017 - ongoing Nijmegen

Novel method using light-sheet imaging allow for the recording of large-scale brain activity in the Danio rerio. This thus creates a need for clever data dimensionality reduction methods in order to capture the sparse underlying structure. The CAESAR algorithm has been recently developed to estimate both spatial maps as well as temporal time courses using a Bayesian-like structure. In this lab report I aim to explore whether in spontaneously behaving fish, a sparse structure can be found.
Grade: N\A

Review paper - Optogenetics in primates: A technical assessment

Radboud University

Jan 2017 - March 2017 Nijmegen

In deciphering the relation between mind and brain, a fruitful line of research has been in causal manipulation of neural circuits. Optogenetical methods have been used with great success in rodent research for these purposes. However, applying these methods in primates has suffered a delay. Translating our neuroscientific knowledge from simpler animal

REFEREES

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models to more complex models closer to humans is crucial for our understanding in neural pathalogies as well as more fundamental philosophical issues. In this paper, I will provide a brief overview of the field of optogenetics in primates. Furthermore, I will discuss the different technical difficulties contributing to the slow start of optogenetics in primates.
Grade: 8

Operational Architectonics: An Evaluation

Radboud University

Feb. 2017 - April 2017 Nijmegen

Operational architectonics is a framework that combines ideas from neurocomputational, symbolic, and dynamic approaches to establish an isomorphism between phenomenlogical experience and neural dynamics. In this paper I evaluate the framework with its relevance to neuroscience.
Grade: N\A

Boltzman machine performance on MNIST data

Radboud University

Jan 2017 - Feb 2017 Nijmegen

The Boltzmann Machine is an algorithm that uses an artificial neural network in order to sample from a learned distribution. The sampling distribution is learned unsupervised from example data, making use only of the statistics available in that data. Different learning procedures have been proposed to allow for efficient approximation of the target statistics. As Boltzmann Machines learn a generative model, they can also be used for classification tasks by calculating the probability of a target sample to be generated by the learned sampling distribution. In this report we make use of Boltzmann Machines to classify images of the MNIST dataset. In section 1 we give a brief introduction to the underlying theory. In the following section we report on the results of our experiments. The final section concludes with a general discussion of the findings.

Multi-layered perceptron performance on MNIST

Radboud University

Jan 2017 - Feb 2017 Nijmegen

A multilayer perceptron is a neural network composed of a series of perceptrons used to solve classification or regression tasks. A key drawback of the single perceptron unit is that it cannot compute functions which are not linearly separably, such as e.g. the logical XOR operation. By introducing a hidden layer in the architecture, the machine concatenates perceptron mappings in series - which, in the case of its units having non-linear activation functions, makes the multilayer perceptron a powerful universal approximator. This report will highlight the computational advantages of the multilayer perceptron and how to harness it - shedding a theoretical view on the backpropagation algorithm and gradient descent procedures, but also providing practical tricks that make learning most efficient.

Automatic Error-Correction Using Feedback-Related Negativity

Radboud University

Nov 2016 - Feb 2017 Nijmegen

I designed the backend for a Brain Computer Interface in python. This included expanding the Fieldtrip buffer and designing the experiment, data analysis and online signal processing pipeline.
Grade: 8.5

Data analysis of light-sheet imaging data from Danio rerio.

Computational Analysis of Neuronal Activity & Behavior Lab

Sep 2016 - Dec 2016 Nijmegen

The hard problem of consciousness: A meta-physical remedy for neurophenomenology

Radboud University

Feb 2016 - Jul 2016 Nijmegen

Research in cognitive neuroscience is focused on understanding how physical processes are involved in our mental capacities. The problem of explaining why there is phenomeno- logical experience to physical processing is known as the hard problem of consciousness (HPC). In 1996, Francisco Varela proposed a methodological remedy to the HPC, called neurophenomenology. Instead of minimizing the subjective experience in neurocognitive modeling, neurophenomenology aims to go beyond the HPC by considering phenomeno- logical data on equal footing with objective data. In this paper, I examine whether it is conceptually possible for neurophenomenology to go beyond the HPC. I argue that neurophenomenology as classically formulated by Varela, will not go beyond the HPC in any way. Additionally, I will address the (remaining) relevance of neurophenomenology to cognitive neuroscience.
Grade 8

Transient Dynamics: Closing The Gap Between Consciousness and Sub-consciousness?

University of Amsterdam

Jan 2013 - Feb 2013 Amsterdam

In this paper I will argue in favor of a dynamical approach to the study of brain and cognition. The explanatory gap between brain states and cognitive states is considered one of the most difficult problems for neuroscience to solve. The two most dominant philosophies of the twentieth century that emerged from the cognitive revolution, cognitivism and connectionism, proposed two key concepts concerning cognition, namely that cognitive states could be represented as descriptive states and they are found in the brain as conditions of the network. However, they fail to capture cognitive performance outside domain specific areas. Therefore,

I argue that by using dynamic systems we can significantly reduce the explanatory gap.
Grade: 8

EXPERIENCE

Intern Computational Analysis of Neuronal Activity & Behavior Lab

Radboud University

Sept 2016 - ongoing Nijmegen

Minor computational science

University of Amsterdam

Sep 2013 Dec 2013 Amsterdam

Relevant methods: non-linear dynamics (criticality, chaos, entropy).
GPA: 8.27

Intern brain cognitive center

University of Amsterdam

Feb 2014 - Aug 2014 Amsterdam

Student Response group

University of Amsterdam

2011-2013 Amsterdam

Part in a group focused on improving the communication between educators and students.

Tutor

StudentPlus

2011-2013 Amsterdam

Tutoring mathematics

Hospitality

Various employers

2008-2013 Amsterdam