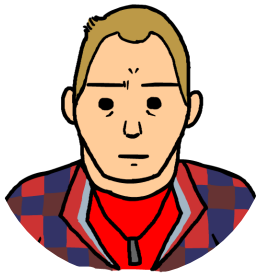

Axel **Faes**

Computer Engineer · PostDoctoral Researcher

Leuven, Belgium

axel.faes@gmail.com | theaxec.github.io | TheAxeC | axelfaes

Abstract

I am a Postdoctoral Researcher in Biomedical Science in Computational Neuroscience at KU Leuven. My main interests include neural computing, big data analysis and brain-computer interfaces. I am also a big supporter of Open Source Software.

Research Interests

Programming Language Theory	Algebraic Effect Handlers, Type Systems and Program Optimization
Artifical Intelligence	Machine Learning, Reinforcement Learning and Virtual Reality
Neuroscience	Neural Computing, Connectomics, Brain Network Analysis and Brain Computer Interfaces

Educational background

Doctoral Programme in Biomedical Science (PhD) in Computational Neuroscience — *Leuven, Belgium*

KU Leuven — *Sep. 2018 - May 2023*

Cognitive and Molecular Neuroscience

Advanced Master of Science in Engineering (M.Sc.) in Artificial Intelligence (76% - Cum Laude) — *Leuven, Belgium*

KU Leuven — *Sep. 2017 - Jul. 2019*

Engineering and Computer Science

Honoursprogramme of the Faculty of Engineering Science — *Leuven, Belgium*

KU Leuven — *Sep. 2016 - Oct. 2018*

Research track - 18 ECTS (2 projects of 9 ECTS) completed in 2016 - 2017.

Master of Science in Engineering (M.Sc.) in Computer Science (Burgelijk Ingenieur - ir.) (76% - Cum Laude) — *Leuven, Belgium*

KU Leuven — *Sep. 2016 - Sep. 2018*

Artificial Intelligence & Theoretical Computer Science

Bachelor of Science (B.Sc.) in Computer Science (79% - Magna Cum Laude) — *Hasselt, Belgium*

UHasselt — *Sep. 2013 - Jul. 2016*

Physics and General courses

Business Summer School: United in Manchester (0739) — *Manchester, UK*

The University of Manchester — *Jul. 2015 - Aug. 2015*

International Business

Honors & Awards

Mar. 2018	**Finalist**, Cyber Security Challenge	*Brussels, Belgium*
Sep. 2017	**3rd place**, ICFP 2017 Student Research Competition	*Oxford, UK*
Jul. 2016	**Bachelor Award**, in Computer Science	*UHasselt, Belgium*
May. 2016	**3rd place**, ACM CHI 2016 Student Design Competition (Interaction Design and User Experience.)	*San Jose, CA, USA*
Feb. 2016	**2nd place**, BeGDC (Belgian Game Development Championship)	*Brussel, Belgium*
Jan. 2016	**IELTS**, Academic Module (8.0/9.0)	*Brussel, Belgium*

Work & Research Experience

Postdoc

Leuven, Belgium

KU Leuven

May 2023 - Current

- Project: ”Sign Language Alphabet decoding from intracranial brain activity”
- Promoter: Prof. Marc van Hulle
- Group: Computational Neuroscience, Laboratory for Neuro-and Psychophysiology, KU Leuven

Phd Candidate (FWO-Aspirant Fellowship)

Leuven, Belgium

KU Leuven

Oct. 2018 - May 2023

- Project: ”Finger Movement Decoding: From Source-Localisation to Tensor Regression Modelling”
- Promoter: Prof. Marc van Hulle
- Group: Computational Neuroscience, Laboratory for Neuro-and Psychophysiology, KU Leuven

Student Job: Creating System Identification course

Leuven, Belgium

KU Leuven

Sep. 2017 - Sep. 2018

- Faculty of Engineering Science: ESAT (Electrical Engineering)
- Research group: STADIUS

Research Assistant: design of type-&-effect system for Eff based on row polymorphism

Leuven, Belgium

KU Leuven

Apr. 2017 - Oct. 2017

- Faculty of Engineering Science: Computer Science
- Research group: DTAI
- Part of the Honoursprogramme of the Faculty of Engineering Science (research track).
- Topic: Development of an row-based type-&-effect system for the Eff programming language

Research Assistent: efficient compilation of algebraic effect handlers

Leuven, Belgium

KU Leuven

Sep. 2016 - Apr. 2017

- Faculty of Engineering Science: Computer Science
- Research group: DTAI
- Part of the Honoursprogramme of the Faculty of Engineering Science (research track). My project is part of the C1 project: Algebraic Effect Handlers: Harnessing the Fundamental Power of Effects. Eff is a functional programming language that uses handlers to handle all kinds of effects. These effects could be I/O, exceptions, user-defined, etc. My task is to design, implement, benchmark and formally proof new optimisations in the Eff compiler. The compiler is written in OCaml.

Web Performance Research Internship

Hasselt, Belgium

Expertise centre for Digital Media (EDM), UHasselt

Jul. 2016 - Sep. 2016

- I worked on the iMinds PRO-FLOW project.
- My work involved creating multiple usecases to measure website performance. The main focus is on the difference between the http versions (http1.1, https, http2).
- During the project, I had to utilise multiple servers, maintain and extend the nodejs framework used to measure website performance, and manually optimize commercial websites using PHP, JS, HTML and CSS.

Summer Research Internship Physical Computing

Hasselt, Belgium

Expertise centre for Digital Media (EDM), UHasselt

Aug. 2015 - Sep. 2015

- Work on a project which focuses on the interaction between a human entity and a drone, aswell as interaction between the drone and virtual objects. This project is written in C++, used the Optitrack motion capture and a custom created drone.

Extracurricular Activities

KU Leuven

Leuven, Belgium

DjangoGirls coach

Mar. 2018 - Current

- We inspire women to fall in love with programming.
- Django Girls organize free Python and Django workshops, create open sourced online tutorials and curate amazing first experiences with technology.

KU Leuven

Leuven, Belgium

Student Representative

Sep. 2017 - Sep. 2018

- POC of Master Computer Science Engineering
- POC of Advanced Master Artificial Intelligence
- Member of Departmental council of Computer Science
- Member of Department board of Computer Science
- Member of Faculty council of Engineering Science

CoderDojo Belgium

Uasselt, PXL

Coach

Sep. 2014 - Current

- Teach children how to program utilising Scratch, Python, Minecraft and Lego mindstorm.

Student Council

UHasselt

Member

Aug. 2015 - Aug. 2016

- Member of Board of Education
- Member of Faculty Council
- Member of Board of Student Facilities
- Member of Diversity Commission
- Temporary representative in VVS (Vlaamse Vereniging van Studenten vzw)

Student Council

UHasselt

Member

Mar. 2015 - Aug. 2015

- Member of Board of Education
- Member of Faculty Council
- Member of Board of Student Facilities

UHAsselt

Hasselt, Belgium

Student Representative

Sep. 2013 - Jul. 2016

- Representing students interests in a Computer Science education context.
- This meant discussing with the university in order to improve teaching, learning, assessment and academic services.
- Representing Computer Science education for high school students

Natural Languages

English Fluent (IELTS: 8.0/9.0)
Dutch Mothertongue
French Basic Knowledge

Projects

Finger Movement Decoding: From Source-Localisation to Tensor Regression Modelling

Leuven, Belgium

PhD

Sep. 2018 - May. 2023

- Brain-Computer Interfaces (BCIs) are hailed for bypassing defective neural pathways by translating brain activity directly into actions that convey the user's intent. How the kinematics of muscular activity relates to the motor- and somatosensory activity in the brain has been the focus of recent advancements. With such motor BCIs, amputees are able to gain control over a prosthesis and stroke patients to regain control over a paralyzed limb via electrical stimulation of their dysfunctional muscles or via an exoskeleton that supports the intended movements. The superior spatio-temporal resolution, bandwidth, and recording stability of electrocorticography (ECoG), a partially invasive brain recording technique, yields a new outlook on motor BCI applications. Despite some stunning successes in arm- and hand movement control from ECoG, the precise decoding of finger movements, which is essential for daily activities, is still lacking. A possible reason is that current decoders rely on conventional one- or two-way regression models, which might not adequately capture the intricate relation between neural activity and intended and unintended (such as coactivations) finger movements. The main objective of this PhD is to develop a robust, accurate, and quick-to-train decoder that predicts single- and coordinated finger trajectories from ECoG recordings. We used multiway decoders as they preserve the multilinear structure of the data while taking advantage of potentially hidden multilinear components. We demonstrated cutting-edge performance with the proposed decoders. As multiway models tend to be slow to train, which may become a significant obstacle for their clinical adoption, we also investigated whether the proposed multiway decoders could be used in a real-time setting. The findings support the relevance of the proposed multiway decoders for real-time ECoG-based finger activity, providing in this way an outlook on achieving hand dexterity.

An Information Theoretical Approach to EEG Source-Reconstructed Connectivity

Leuven, Belgium

Advanced Master's Thesis

Feb. 2018 - Jul. 2018

- This thesis takes an information theoretical approach, which concerns model-free, probability based methods such as Conditional Mutual Information, Directed Information, and Directed feature information. - 17/20

Algebraic Subtyping for Algebraic Effects and Handlers

Leuven, Belgium

Master's Thesis

Feb. 2018 - Jul. 2018

- Extending Algebraic Subtyping to incorperate support for algebraic effects and handlers. Final score - 19/20

Reinforcement Learning Agent in Google Deepmind's StarCraft II Framework - CSAI

Leuven, Belgium

Developer

Feb. 2018 - Jul. 2018

- Implement several learning algorithms in PySC2

Software Architecture course - Project

Leuven, Belgium

Developer

Feb. 2017 - Jul. 2017

- Project made for the course 'Software Architecture'. The goal was to design a software architecture in UML for a IoT-platform concerning plug-gable sensors. The platform allows storage of customer data and the use of third party applications for data analytics. Final score - 18/20

ICAL parser for KU Leuven schedules

Leuven, Belgium

Lead Developer — *Aug. 2016 - Current*

- An nodejs application to create an iCalender file for courses at KU Leuven. Allows the creation of a schedule containing courses from different masters and the option to ignore events.

Machine learning techniques for flow-based network intrusion detection systems

Hasselt, Belgium

Bachelor's Thesis — *Feb. 2016 - Jul. 2016*

- The thesis gives an overview of how machine learning algorithms could be used for intrusion detection using only IP Flows. The system has been used to detect intrusions in Cegeka Hasselt Datacenter network.

Software engineering: Search and Recommendation System

Hasselt, Belgium

Team Member — *Feb. 2016 - Jul. 2016*

- A search and recommendation system for VoD (Video on Demand) for Androme. The system is currently being used in production in the Nebula project. Both Content-Based Recommendations and Collaborative filtering techniques were implemented. Made in a team of 5 (Pieter Teunen, Luuk Raaijmakers, Brent Berghmans, Axel Faes, Matthijs Kaminski, Wouter Bollaert) utilising Java and the Spring framework. Final score - 15/20

TTUI: Household Survival

Hasselt, Belgium

Researcher — *Sep. 2015 - Dec. 2015*

- Project made for the class 'Technologies and Tools for User Interfaces'.
- A tower-defense style game written in Unity utilising Optitrack motion capture. The game combines the virtual world and reality, by allowing users to interact with the virtual world using real-world objects. Made by Brent Berghmans, Axel Faes and Matthijs Kaminski. Final score - 18/20

Cardinal: scripting language

Hasselt, Belgium

Lead Developer — *Jan. 2015 - Sep. 2015*

- Cardinal is a small, fast, class-based, Object Oriented scripting language written in C. It is built upon the skeleton of an existing scripting language and shows how I can modify and improve existing software, as well as design new components to this software.
- New components include a debugger, an embedding API, multiple inheritance and a new module system.

United in Manchester

Manchester, UK

Team Leader — *Jul. 2015 - Aug. 2015*

- A summer school which focuses on teamwork in cross-cultural and multidisciplinary teams, global product development and entrepreneurship. Our team developed a start-up idea on Food Management/Delivery system. Product pitch took place at the end of the course for feedbacks from professionals. Our team consisted of Axel Faes, Linh Chi Evelyn Phan, Reinaert Van de Cruys and Maria Barouh.

PSOPV: Visual Programming IDE

Hasselt, Belgium

Developer — *Feb. 2015 - Jul. 2015*

- A Visual programming IDE created by Axel Faes & Matthijs Kaminski for a course of Hasselt University. The purpose of the IDE is to create 'black boxes' which can send events (signals packed with data) to eachother. We take the idea of using drag-able blocks in a visual IDE and expand on it. Final score - 17/20

Publications

International Journal Papers

[1] **Axel Faes, Marc M. Van Hulle**, "Finger movement and coactivation predicted from intracranial brain activity using extended Block-Term Tensor Regression", Journal of Neural Engineering.

[2] **Axel Faes, Flavio Camarrone, Marc M. Van Hulle**, "Single finger trajectory prediction from intracranial brain activity using Block-Term Tensor Regression with fast and automatic component extraction", IEEE Transactions on Neural Networks and Learning Systems.

[3] **Axel Faes, Aurelie de Borman, Marc M. Van Hulle**, "Source space reduction for eLORETA", Journal of Neural Engineering.

[4] **Axel Faes, Iris Vantieghem, Marc M. Van Hulle**, "Neural Networks for Directed Connectivity Estimation in Source-Reconstructed EEG Data", Applied Sciences.

Conference Papers

[5] **Robin Marx, Maarten Wijnants, Peter Quax, Axel Faes, Wim Lamotte**, "Web Performance Characteristics of HTTP/2 and comparison to HTTP/1.1", International Conference on Web Information Systems and Technologies, pg 87-114.

[6] **Robin Marx, Peter Quax, Axel Faes and Wim Lamotte**, "Concatenation, embedding and sharding: Do HTTP/1 performance best practices make sense in HTTP/2?", WEBIST 2017 - Proceedings of the 13th International Conference on Web Information Systems and Technologies.

Extended Abstracts

[7] **Axel Faes, Mansoureh Fahimi Hnazaee, and Marc M. Van Hulle**, "Causal Graphical Modelling of Functional Connectivity from Reconstructed EEG Sources", 8th International BCI Meeting (2021).

[8] **Axel Faes and Tom Schrijvers**, "Towards a Core Language with Row-Based Effects for Optimised Compilation", International Conference on Functional Programming 2017 Student Research Competition.

[9] **Kashyap Todi, Brent Berghmans, Axel Faes and Matthijs Kaminski**, "Purpose-Centric Appropriation of Everyday Objects as Game Controllers", CHI EA '16: Extended Abstracts of the SIGCHI Conference on Human Factors in Computing Systems. Late Breaking Work.

[10] **Kashyap Todi, Donald Degraen, Brent Berghmans, Axel Faes, Matthijs Kaminski and Kris Luyten**, "Household Survival: Immersive Room-Sized Gaming Using Everyday Objects as Weapons", CHI EA '16: Extended Abstracts of the SIGCHI Conference on Human Factors in Computing Systems. Student Game Competition.

Thesis

[11] **Axel Faes**, "Finger Movement Decoding: From Source-Localisation to Tensor Regression Modelling", PhD Thesis 2023.

[12] **Axel Faes**, "An Information Theoretical Approach to EEG Source-Reconstructed Connectivity", Advanced Master's Thesis 2018.

[13] **Axel Faes**, "Algebraic Subtyping for Algebraic Effects and Handlers", Master's Thesis 2018.

[14] **Axel Faes**, "Machine learning techniques for flow-based network intrusion detection systems", Bachelor's thesis 2016.

Posters

[15] **Axel Faes and Tom Schrijvers**, "Towards a Core Language with Row-Based Effects for Optimised Compilation", International Conference on Functional Programming 2017 Student Research Competition.

Other publication

[16] **Matija Pretnar, Amr Hany Shehata Saleh, Axel Faes and Tom Schrijvers**, "Efficient compilation of algebraic effects and handlers", 2017 - CW Reports, CW708, 32 pp. Leuven, Belgium: Department of Computer Science, KU Leuven..

Talks, presentations and other media

Apr. 25, 2023	"voordracht met als titel "Decoding finger movements from invasive recordings in human motor cortex" ("Decoderen van vingerbewegingen uit invasieve registraties in de motorische cortex van de mens"), Mindseed event Leuven", georganiseerd door NeuroTech Leuven.
May. 11, 2022	"BCI demo op Advanced Engineering, Antwerp Expo,", georganiseerd door AI Vlaanderen, Vlaanderen Industrie 4.0.
Nov. 28, 2021	"BCI demo op de "Dag van de Wetenschap", georganiseerd door Technopolis", georganiseerd door Technopolis (geannuleerd wegens de covid-19 situatie).
Nov. 07, 2019	"voordracht met als titel "'MINDSPELLER' Medical Research Project on Brain Computer Interfaces" \& concert (in samenwerking met Tigran Maytesian en zijn Mind Speller Chamber Orchestra)", Kathedraal van Sint-Michiel en Sint-Goedele, Brussel.
Sep. 19, 2017	"Honours student Axel Faes wins bronze medal in ACM SIGPLAN", KU Leuven, Department of Computer Science.
Sep. 19, 2017	"Student Axel Faes wins bronze medal in the ACM SIGPLAN Student Research Competition in ICFP conference", KU Leuven, Department of Computer Science, DTAI.