QUANTITATIVE DATA ANALYTICS GROUP

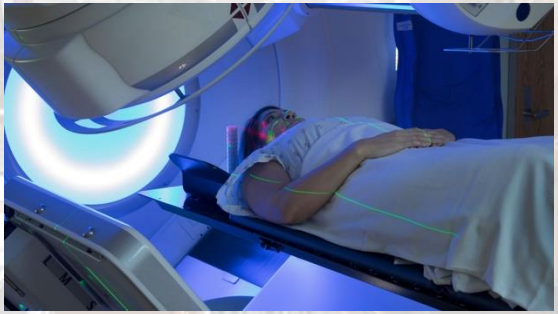
MARK HOOGENDOORN

VRIJE UNIVERSITEIT AMSTERDAM
DEPARTMENT OF COMPUTER SCIENCE

VU VRIJE UNIVERSITEIT AMSTERDAM | Faculty of Science

PREVIOUS THESIS COLLABORATIONS

- AI: Mainly with medical/health researchers
  - Combine methodological innovation with medical application


- Business Analytics: internship required


LESSON LEARNED/BEST PRACTICES

- Make sure data is present from the start
  - Consultancy companies often do not have their own data
  - Medical data is sensitive
- Criteria for theses can vastly differ per discipline, make sure supervisors are aligned and roles are clear
- Have a joint startup meeting
- Value interdisciplinary contributions
  - Might not be a novel AI algorithm, but in healthcare it could be groundbreaking

OPEN INVITATION

- Interested in useful case studies in the domain of healthcare?

- Interested in data-driven projects in companies?
  - Business Analytics offers very well-trained students and good links to companies

Theoretical Computer Science

Mauricio Verano Merino

Examples of Previous Thesis Collaborations

Sports Analytics

Software Language Engineering

ASML

TNO ESI
Powered by industry and academia

LLMs4SE

TNO ESI
Powered by industry and academia

SCHUBERG PHILIS

VAN LANSCHOT KEMPEN

Mauricio Verano Merino
TCS - Sports Intelligence Lab

Things I have learned

👩‍🏫 Be present

📆 Hold regular meetings with partners, not only via students

🥲 Be ready to pivot the project

😐 Companies have different challenges

📣 Use their language

📏 Different disciplines have different metrics

Bioinformatics Group

Zerrin Işik

Previous Thesis Collaborations

Example project: ProteinGLUE
(https://github.com/ibivu/protein-glue)

VU Bioinformatics: Anton Feenstra
Learning and Reasoning: Peter Bloem
Research Student: Henriette Capel

Bioinformatics: ***protein structure prediction***

meets

Computer Science: ***transformer models***

and results in

ProteinGLUE Benchmark Suite

VU

Lessons Learned

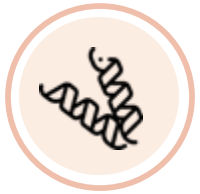
- **Biological data is inherently complex**, demanding extensive preprocessing.
- Bioinformatics tools might **lack standardized documentation.**
- **Rigorous project documentation** is critical for reproducibility and successful implementation.

Best Practices

- **Align Terminology:** Invest time in creating a unified project language.
- **Unify Purpose:** Discover the mutually exciting vision.
- **Define Success:** Establish a clear and realistic timeline.
- **Balance Commitment:** Communicate and balance everyone's commitment level.

"Ten simple rules to ruin a collaborative environment" PloS Comp Bio. 2022

Ideas for Thesis Collaborations

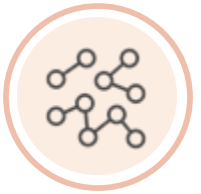


LLM

Protein LLM
for function prediction
(Anton Feenstra)

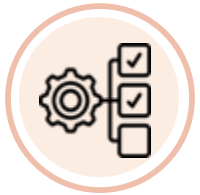
GNN

Comparison of **single-cell/spatial omics** profiling experiments
(Evert Bosdriesz)



Network algorithms

Network-based
patient stratification
(Olga Tsoy)



Multi-task learning

Multi-task learning for
antibody specificity
prediction
(Anton Feenstra)

Neural networks

Deep learning for multi-modal biomarker detection in **dementia** (Zerrin Isik)

VISIT US :)

VU

Research Cocktail
"Piloting Collaborations Through Theses"

Ivano Malavolta

SOFTWARE AND SUSTAINABILITY
S2 RESEARCH GROUP

VU VRIJE UNIVERSITEIT AMSTERDAM

Examples of successful previous thesis collaboration

MSR 2025

The Ecosystem of Open-Source Music Production Software – A Mining Study on the Development Practices of VST Plugins on GitHub

Bogdan Andrei
Informatics Institute
Vrije Universiteit Amsterdam
Amsterdam, the Netherlands
b.m.andrei@uva.nl

Mauricio Verano Merino
Computer Science Department
Vrije Universiteit Amsterdam
Amsterdam, the Netherlands
m.verano.merino@vu.nl

Ivano Malavolta
Computer Science Department
Vrije Universiteit Amsterdam
Amsterdam, the Netherlands
i.malavolta@vu.nl

***Abstract*—In this study we shed light on a unique and interdisciplinary domain, where music, technology, and human creativity intersect: music production software. Today *software* technologies are the predominant means of music production, with a vibrant ecosystem for commercial and open-source products.**

In this work we target VST plugins, the de-facto standard for developing and prototyping music production software. We analyze 15,847 data points over 299 GitHub repositories containing VST plugins. Our results include a systematic quantification of the (i) characteristics of open-source VST projects in terms of, *e.g.*, duration, size, contributors, stars/watchers, licensing, (ii) of the major DAWs are compatible with VST and can act as VST host applications [5].

The technical success of VST is also confirmed by its florid ecosystem of developers, distributors, and publishers. The global audio plugins market, which includes VST plugins, is projected to reach approximately 3.25 billion dollars by 2030 and is growing at a compound annual growth rate (CAGR) of 15.2% from 2023 to 2030 [7]. Prestigious manufacturing companies – *e.g.*, Yamaha, Moog, Korg – which historically

Within VU

With company and other uni

ICWS 2024

Anomaly Detection and Root Cause Analysis of Microservices Energy Consumption

Maximilian Stefan Floroiu[1,3], Stefano Russo[2], Luca Giamattei[2], Antonio Guerriero[2], Ivano Malavolta[1], Roberto Pietrantuono[2]
[1]*Vrije Universiteit Amsterdam, The Netherlands*, [2]*Università di Napoli Federico II, Italy*, [3]*marXact B.V.*
m.floroiu@student.vu.nl, i.malavolta@vu.nl,
{luca.giamattei, antonio.guerriero, roberto.pietrantuono, stefano.russo}@unina.it

***Abstract*—With the expansion of cloud computing and data centers, the need has arisen to tackle their environmental impact. The increasing adoption of microservice architectures, while offering scalability and flexibility, poses new challenges in the effective management of systems' energy consumption.**

This study analyzes experimentally the effectiveness, with respect to energy consumption, of algorithms for Anomaly Detection (AD) and Root Cause Analysis (RCA) for (containerized) microservices systems. The study analyzes five AD and three RCA algorithms. Metrics to assess the effectiveness of AD algorithms are Precision, Recall, and F-Score. For RCA algorithms, the chose metric is Precision at level k. Two subjects of different complexity are used: *Sock Shop* and *UNI-Cloud*. Experiments use a cross-over paired comparison design, involving multiple randomized

Engineers use Anomaly Detection (AD) [2] and Root Cause Analysis (RCA) [3], [4] algorithms to identify deviations from normal behaviors and to ascertain their causes, to then take corrective actions. The main focus is on performance [5], [6], and tools specialized for AD and RCA are today often used for microservices systems too [4], [7]–[9]. Prior studies have investigated both supervised [10]–[12] and unsupervised [13]–[15] machine learning models for AD and RCA, exploiting diverse artifacts like resource consumption data, logs and traces, and investigating deployment configurations. The examination of energy-related indicators is a missing aspect in these research endeavors.

ICSE 2026

Generating Energy-Efficient Code via Large-Language Models – Where are we now?

Radu Apsan[†], Vincenzo Stoico[†], Michel Albonico[⋆], Rudra Dhar[‡], Karthik Vaidhyanathan[‡], Ivano Malavolta[†]
[†] Vrije Universiteit Amsterdam, [⋆] Federal University of Technology of Paraná (UTFPR), [‡] IIIT Hyderabad
r.apsan@vu.nl,v.stoico@vu.nl,michelalbonico@utfpr.edu.br,rudra.dhar@research.iiit.ac.in
karthik.vaidhyanathan@iiit.ac.in,i.malavolta@vu.nl

Abstract

Context. The rise of Large Language Models (LLMs) has led to their widespread adoption in development pipelines.
Goal. We empirically assess the energy efficiency of Python code generated by LLMs against human-written code and code developed by a Green software expert.
Method. We test 363 solutions to 9 coding problems from the EvoEval benchmark using 6 widespread LLMs with 4 prompting techniques, and comparing them to human-developed solutions. Energy consumption is measured on three different hardware platforms: a server, a PC, and a Raspberry Pi for a total of ≈881h (36.7 days).
Results. Human solutions are 16% more energy-efficient on the server and 3% on the Raspberry Pi, while LLMs outperform human

of different AI code assistants like Github Co-Pilot and Cursor. Their ability to streamline development workflows has positioned them as indispensable aids for both novice and expert developers [3, 59, 68].

The rapid integration of LLMs into Software Engineering processes and practices raises critical questions about their long-term implications, particularly on sustainability. While much focus has been given to the performance [18, 40], readability [61, 67], and maintainability of LLM-generated code [11, 21, 75], its energy efficiency is being studied only recently [15, 20, 69]. This oversight is surprising, given the growing importance and relevance of Green AI [73] and software sustainability in general [14, 38]. As LLMs automate more aspects of code generation, their role in propagating or mitigating such inefficiencies becomes a urgent concern.

With company

With other unis

ICSME 2020

From 6.2 to 0.15 seconds – an Industrial Case Study on Mobile Web Performance

Jasper van Riet
Vrije Universiteit Amsterdam
The Netherlands
j.c.a.van.riet@student.vu.nl

Flavia Paganelli
30MHz
The Netherlands
flavia@30mhz.com

Ivano Malavolta
Vrije Universiteit Amsterdam
The Netherlands
i.malavolta@vu.nl

***Abstract*—*Background*. A fast loading web app can be a key success factor in terms of user experience. However, improving the performance of a web app is not trivial and requires a deep understanding of both the browser engine and the specific usage scenarios of the web app under consideration.**
***Aims*. This paper presents an industrial case study targeting a large web-based dashboard, where its performance was improved via 13 distinct interventions over a four-month period.**
***Method*. Firstly, we design a replicable performance engineering plan, where the technical realization of each intervention is reported in details together with its development effort. Secondly, we develop a benchmarking tool which supports 11 widely-used web performance metrics. Finally, we use the benchmarking tool to quantitatively evaluate the performance of the target web app.**
***Results*. We observe a considerable performance improvement over the course of the 13 interventions. Among others, we achieve**

technical backgrounds (*e.g.*, caching, prefetching, image optimization, code bundling) [9]. Assessing how state-of-the-art performance techniques are applied in real industrial projects is fundamental for better understanding their characteristics, gains, and the effort required for their concrete application.

This paper presents an industrial case study performed at 30MHz, a technology company in the agricultural sector. 30MHz is a scale-up of 35 employees that service over 300 customers across 30 countries. The main product of 30MHz is a web dashboard for providing growers insights into geographically-distributed data produced by sensors of humidity, microclimate, wind speed, etc. With most of the data being produced in real-time by a multitude of networked

Lessons learned / best practices

- Be aware of the skills and knowledge you may lack
  - and actively seek out collaborators whose skills complement yours
- Be strategic in choosing students (fit with the company, independence)
  - Reputation of our department at stake
- Chains of projects are good for keeping collaborations warm
  - And make students feel more comfortable
- The company might not be onboard anymore when working on extensions (or major revisions)
  - eg, the internship of the student is over

Ideas for thesis collaborations

- **<Starting>** Evaluation of a set of security-oriented sanitizers to evaluate their energy consumption
  - Energy is often an overlooked aspect when dealing with security
  - This could lead to trade-off analysis and exploration of Pareto frontiers
- **<General> Replication of well-known experiments/studies with an energy flavour**
  - Relevant
  - S2 has already the hardware infrastructure and experiment orchestrators
  - This might unveil non-trivial trade-offs and give a “twist” to what you are already doing
- Areas that I would like to study more:
  - Generative AI
  - Scientific computing
  - Robotics

https://github.com/S2-group/experiment-runner

@Large Research Group (Massivizing Computing Systems)

Apoorva Anand

Jure Antunović

Xiaowei Ouyang

Hexiang Geng

Dante Niewenhuis

Xiaoyu Chu

Zebin Ren

Krijn Doekemeijer

Matthijs Jansen

Jesse Donkervliet

Daniele Bonetta

Tiziano De Matteis

Alexandru Iosup

Successful Collaborations (3 out of N)

He Wen (MSc): “Testing in Kubernetes: A use case study of **JetBrains** CodeCanvas”. Designed and implemented a continuous, orchestration-aware testing framework for Kubernetes-integrated systems

Supervisors: M. Jansen, D. Bonetta (@Large)
and Alexander Chumakin (JetBrains)

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Supervisors: X. Chu, A. Iosup (@Large), J. Pei (SocialAI)

Gideon Pol (MSc): "Towards the Practicality of the Generative Quantum Eigensolver: Constraint-aware Synthesis for Near-term Quantum Computers", in collaboration with the **Quantum Chemistry Group**

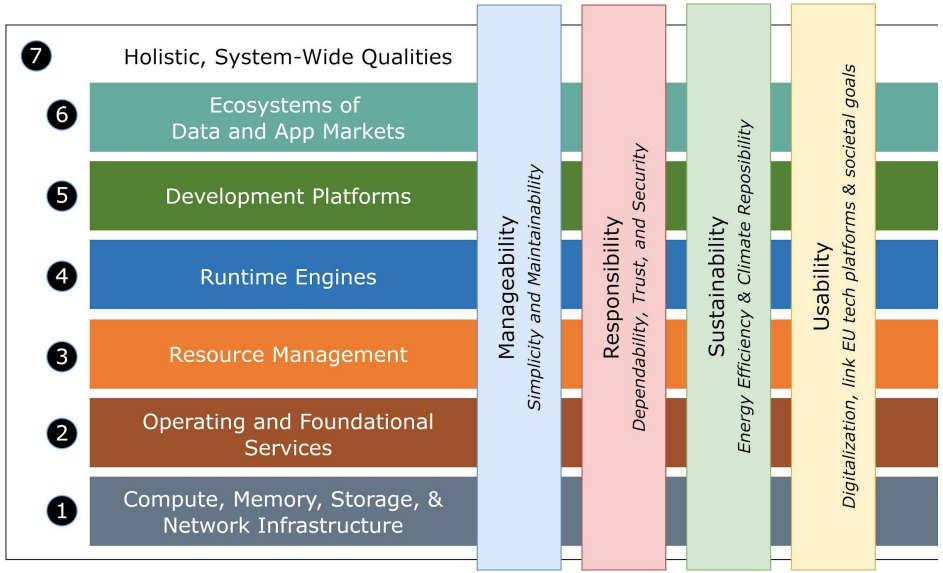
Supervisors: T. De Matteis (@Large), L. Visscher and S. Hariharan (Quantum Chemistry Group)

Best Practices

1. Make sure **expectations are set and clear** for all parties (student, university, receiving partners) **from the very beginning**
    - When dealing with industry, this includes a discussion on IP, open source code / open source thesis report, timeline.
2. Have **regular meetings with the student to ensure progress** and work is going as expected
    - (Especially in the case of internship) The supervisor needs to ensure the scientific work and progress.
3. **Identify unknowns as early as possible, have mitigation plans**. E.g.: “Does the experimental setup require specific datasets, or access to infrastructure?”
    - Theses with external parties require much more future planning (e.g., due to authorizations).

Joint Thesis Ideas

We cover the entire SW stack, and we care about cross disciplinary challenges



www.compsys.science/manifesto/

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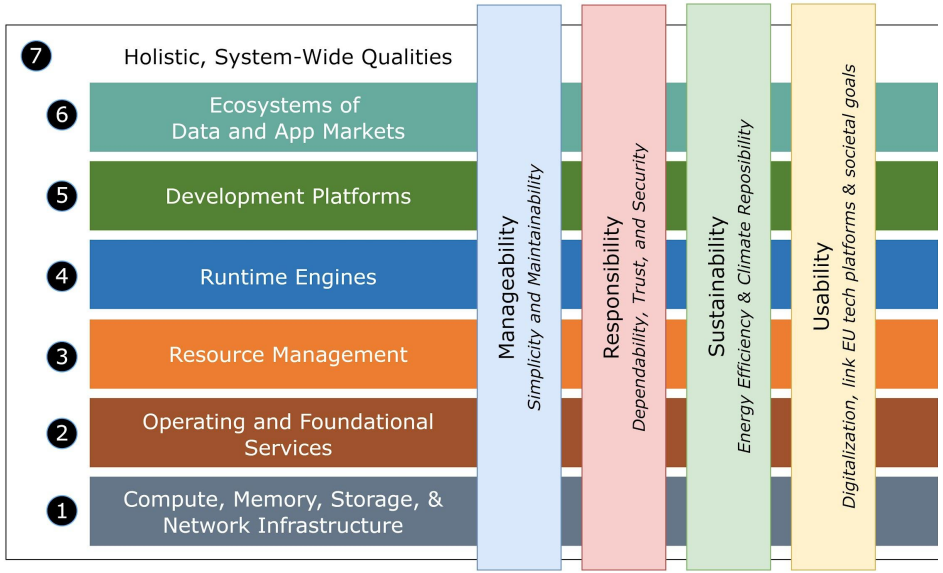
Alexandru Iosup

Distributed systems: cloud, containers (Kubernetes), data center, resource management & scheduling, …



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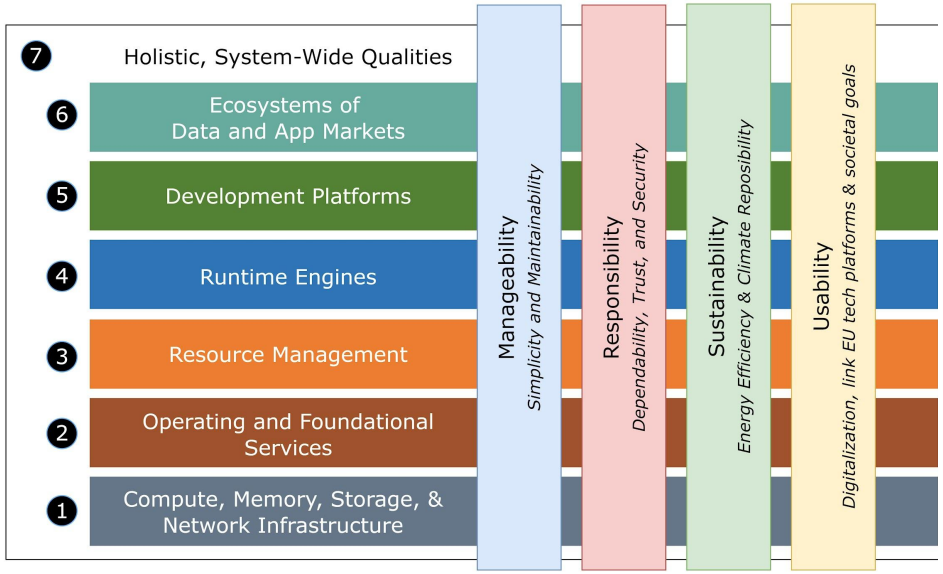
Daniele Bonetta

Programming Languages and System Software: compilers, VMs, runtime performance optimization, data analytics, …



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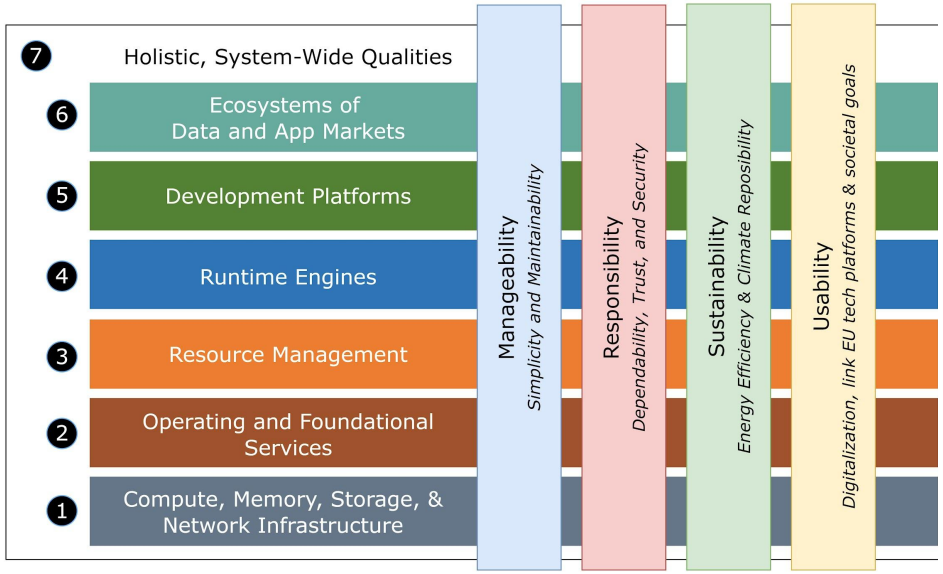
Daniele Bonetta

Programming Languages and System Software: compilers, VMs, runtime performance optimization, data analytics, …

Tiziano De Matteis

HW/Infrastructure: multicore, GPUs, novel accelerators (FPGA), High-Performance/ Parallel Computing, Energy efficiency



www.compsys.science/manifesto/

Decentralized Information Society Engineering

Jaap Gordijn

j.gordijn@vu.nl

Examples of Previous Thesis Collaborations

- Financial sustainability of the Bitcoin
  - Cooperation between SBE (School of Business & Economics / Finance group) and CS
  - Why successful? Very good multi-disciplinary thesis, Journal publication in Electronic Markets Journal,

- Integrating *i** and *e*^{3}*value*
  - Cooperation with the University of Toronto (Prof Eric Yu) and VU CS
  - Why successful? Very good thesis on conceptual modeling, Requirements Engineering conference publication, IEEE Software publication

Lessons Learned / Best Practices

- Preferably, the initiative (and thus commitment) should come from the student first
- Student should be motivated to push things forward
- The student should be able deal with different research traditions (e.g. in case of multi-disciplinary projects)
- Two supervisors needed at both sides, who can cooperate and are willing to step out their own comfort zone

Ideas for Thesis Collaborations

- Using LLM to generate *e*^{3}*value* business models for digital ecosystems and platforms
  - Between a LLM-oriented group and DISE
- A constraint solver for the quantification of *e*^{3}*value* business models
  - Between an operations research group and DISE
- A computational framework on fairness
  - Between a philosophy (ethics) group and DISE

Learning & Reasoning

DiSC - Piloting Collaborations through Theses

Floris den Hengst

Examples

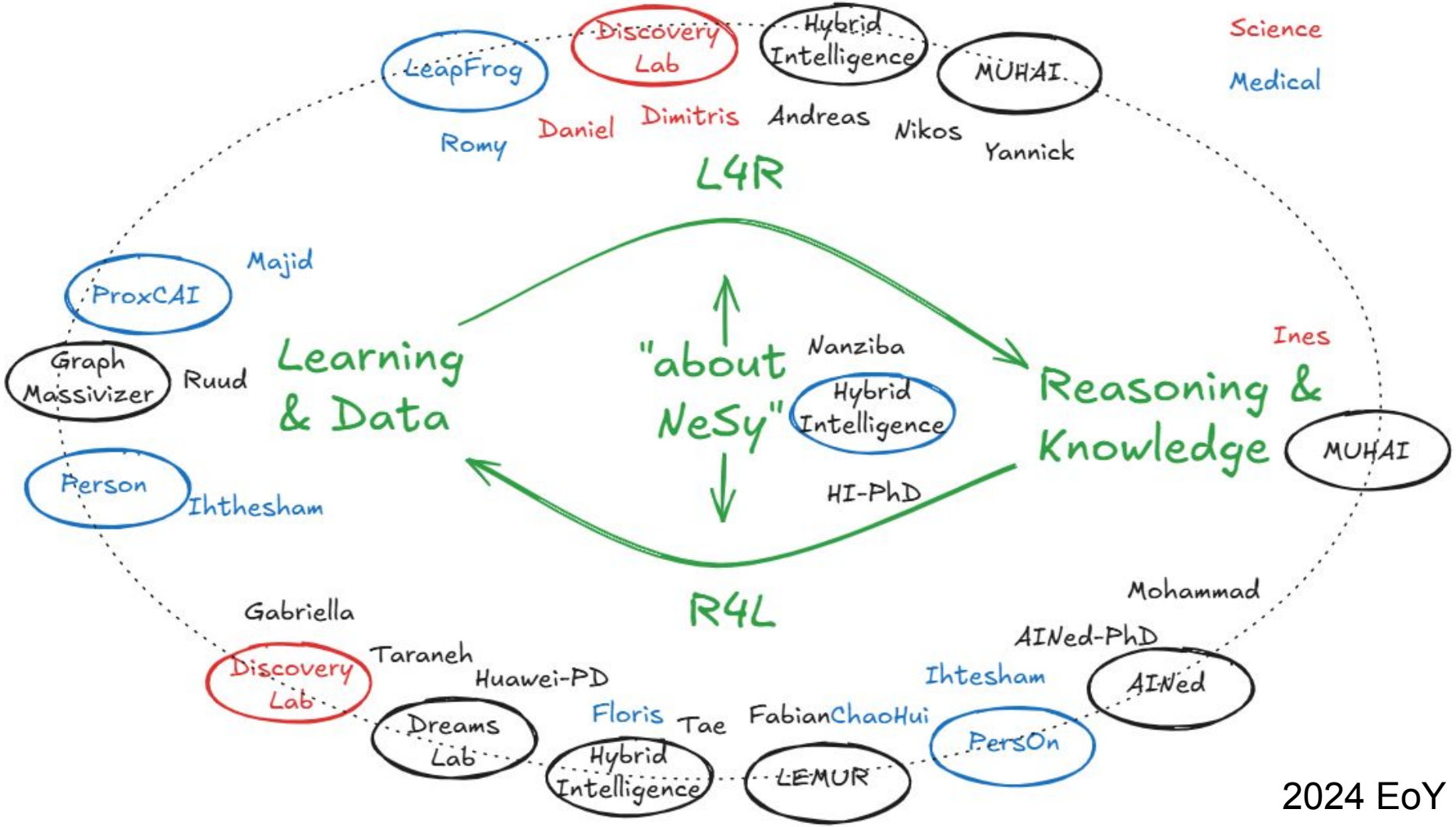
	Year	Partner	Publication
Log parsing with LLMs	2023	Industry	Y
Optimizing mechanical ventilation	2024	Healthcare	Y
Linguistic bias detection	2024	Government	Y
Early HIV detection from doctor's notes	2025	Academic	
Intent classification in chatbots	2025	Industry	Y

Best practices

1. Access to data, systems, expertise, location,… upfront!
    a. Single point of contact. Seniority matters!
    b. Contingency plans
2. Transparency about goals
    a. Align with own expertise
    b. Meet academic standards
    c. Thesis is published, might be follow-up
3. Prepare early for follow-up
    a. Goals of (future) collaboration

Challenges

1. Workload: Depth v.s. Breadth
2. Matching: should everyone be involved?


LeapFrog
Discovery Lab
Hybrid Intelligence
MUHAI
Science
Medical
Romy
Daniel
Dimitris
Andreas
Nikos
Yannick
L4R
ProxCAI
Majid
Graph Massivizer
Ruud
Person
Ihthesham
Learning & Data
"about NeSy"
Nanziba
Hybrid Intelligence
Reasoning & Knowledge
Ines
MUHAI
HI-PhD
R4L
Gabriella
Discovery Lab
Taraneh
Huawei-PD
Dreams Lab
Floris
Tae
Hybrid Intelligence
LEMUR
FabianChaoHui
PersOn
Ihtesham
AINed-PhD
AINed
Mohammad
2024 EoY

Knowledge in AI

[Stefan Schlobach](#)

Full Professor

[Ilaria Tiddi](#)

Assistant Professor

[Patrick Koopmann](#)

Assistant Professor

[Jieying Chen](#)

Assistant Professor

Examples of Successful Thesis Collaborations

Industry collaborations: UWV – thesis on responsible AI in government; Accenture – knowledge graphs and analytics; bias detection in LLMs; Dutch government – bias detection in governmental documents.

Cross-group collaboration: Cooperation Databank with social scientists – translating behavioral data into ontologies and knowledge graphs; worked with L&R on a MSc thesis towards a conference publication

Industry co-supervision with Triply, Lareb, and CFLW – integrating academic insights with real-world data.

Takeaway: Interdisciplinary and industry collaborations strengthen visibility and societal impact of AI research.

Lessons Learned / Best Practices

- ✅ Start with shared vocabulary and align expectations early between academia and industry partners.
- ✅ Hold joint kick-off and regular meetings involving all supervisors to ensure clarity and collaboration.
- ✅ Encourage students to balance academic depth with applied relevance and transparent communication.
- ⚠️ Avoid mismatched expectations or unclear supervision structures that can confuse students.
- 🟢 Honest communication and structured supervision are key to sustainable collaborations.

Ideas for Joint Thesis Topics (2025–2026)

Core focus: Knowledge Graphs and Ontologies – versatile tools applicable across domains.

- Medical AI – structured reasoning for diagnosis and explainability. (Jieying)
- Robotics – semantic representation for perception and action. (Ilaria)
- Combine learning and reasoning with knowledge graphs or symbolic AI. (Ilaria, Patrick, Jieying)
- Data integration with knowledge graphs. (Ilaria, Jieying)
- Responsible AI – explainability, bias detection, and governance frameworks. (Jieying)
- Formal logic (Patrick)

Invitation: Open for cross-group or industry co-supervision opportunities for 2025/2026.

AI & Behaviour

Marcos Oliveira

AI & Behaviour: collaboration experience

Previous thesis collaborations

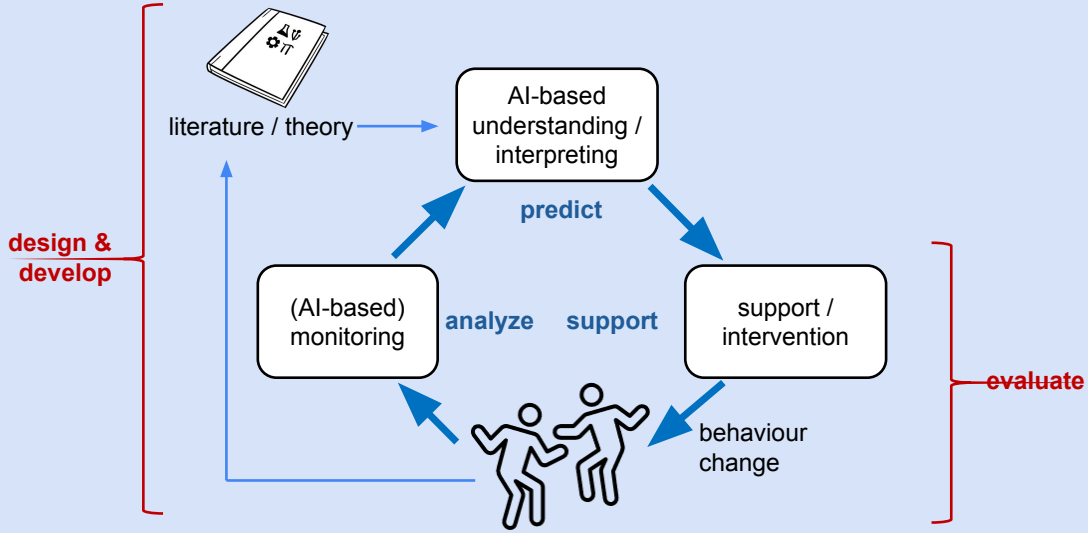
- Mostly internships with companies
- Data collaboration on BSc final project → publication

Lessons learned and challenges

- For BSc projects: minimum-viable-project approach, iterative improvements
  - Careful: too many cooks spoil the broth! 👨‍🍳
- Clear communication and expectation management: define scope beforehand
- Best if there is a clear distribution of responsibilities (e.g., company does daily supervision, VU supervisor discusses academic contribution)
- VU supervisor should have the final say and determine the final grade 🦔

AI & Behaviour: collaboration opportunities

We contribute to society by responsibly advancing Artificial Intelligence that empowers humans to adopt healthy, safe, and sustainable behaviour.



How? Design, **develop**, and **evaluate** AI-based techniques and algorithms to analyze, predict, and support human behaviour, facilitating intentional behaviour change while respecting individual and societal values.

AI & Behaviour: example topics and approaches

- **Identifying societal challenges**
  - staying healthy 🩺
  - safe and just societies ⚖️
  - sustainable use of resources 🥬
- **Designing solutions for supporting change**
  - systemic changes ♻️ (e.g., optimisations in the environment or organisation)
  - behaviour changes 🏃 (e.g., waste reduction, sustainable transport choices, physical activity, activities that foster mental wellbeing)
- **Measuring effects**
  - Mixed-methods evaluation of UX 🔍
  - Measuring brain activity 🧠
  - Tracking online behaviour 📲

Examples of collaboration ideas:

Providing users with real-time insights in energy consumption of software / hardware and use this to support behaviour change

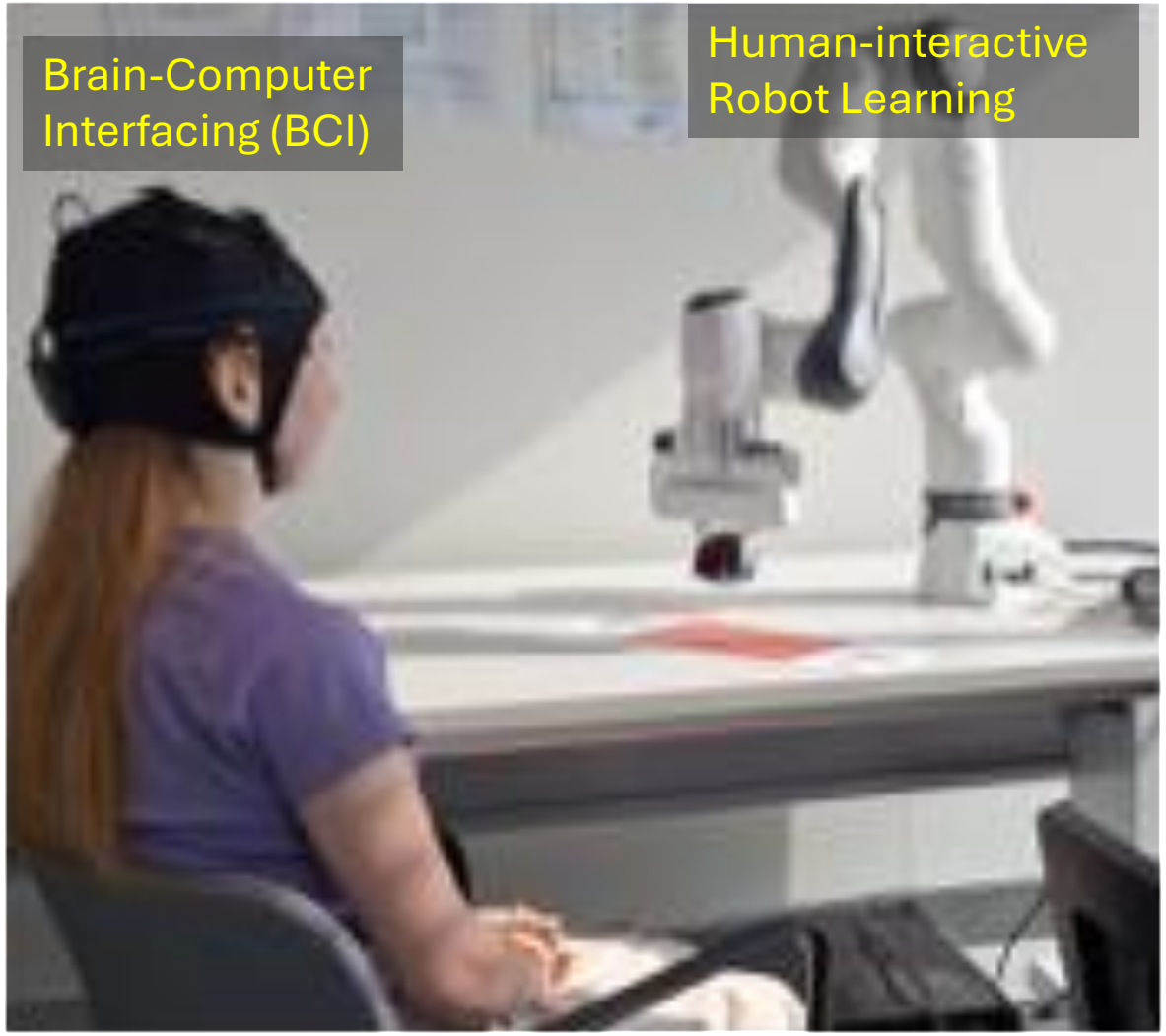
Tracking attention and brain activity

Recommendation algorithms and UX design towards sustainable choices

User-Centric Data Science

Maryam Alimardani

Neuro-adaptive Human-Robot Collaboration



Maryam Alimardani
UCDS

Kim Baraka
Social AI

Thijs Grootjans
Master's AI student

Sandor Potjer
Master's AI student

Classification of Error-related Potentials On Various Tasks in Human-Robot Interaction using a Low-Cost EEG System

Thijs Grootjans - 2676761
Supervisors: M. Alimardani & K. Baraka

Vrije Universiteit, Amsterdam

Master Thesis

ErrP-Augmented TAMER: A Simulation Study on Classification Accuracy Thresholds for Effective Learning

by

Sandor Potjer
(2703665)

Best Practices

Planning

- Set the project **scope and goals** early on.
- Balance **collaboration and individual contribution** (ensures academic independence and flexibility if one student drops out).
- Define **two distinct but related RQs** that can be pursued within a joint project (treat it like a Work Package).

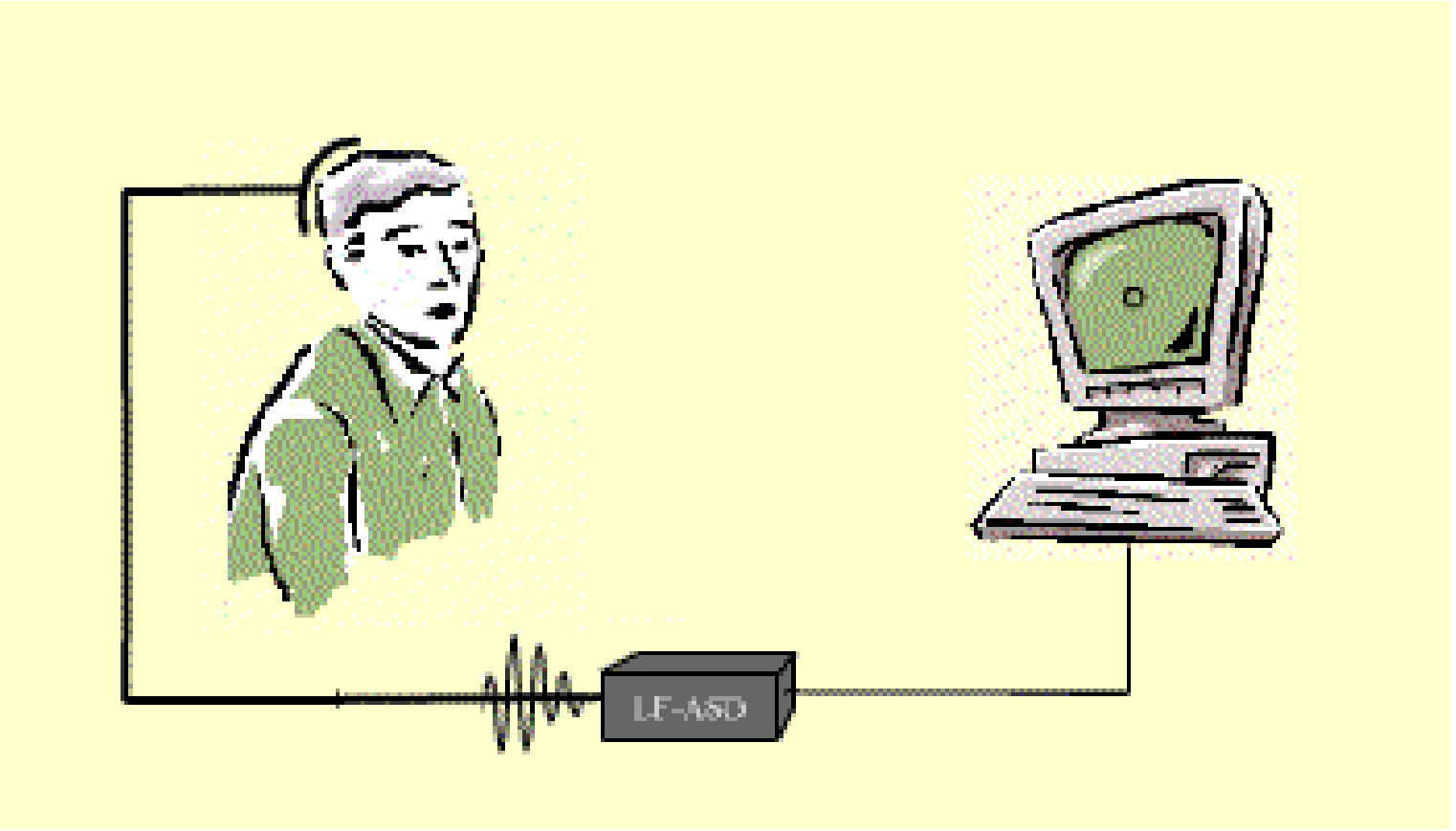
Communication

- Set **clear expectations** with the students about roles, responsibilities, and deliverables.
- Organize **regular meetings**, both for the full team and for each WP.

Long-term considerations

- Agree on **authorship** and credit early if the project leads to publications.
- Keep students at the **center** of the collaboration (their learning, autonomy, and academic progress comes first).

Ideas for Thesis Collaborations



Piloting collaborations through MSc and BSc theses

Jiahuan Pei
Social AI Group

[DiSC] Research Cocktail on October 24th 2025 @ NU-4A67

Mike Ligthart

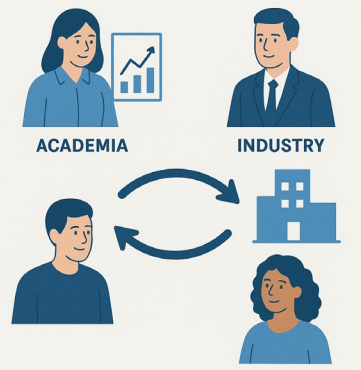
The Robot Bookworm
Stimulating Children's Reading Motivation with a Social Robot
NIAA Collaboration with Educational Sciences

From small to(o) big
From AI a PhD, 2 master thesis and 3 bachelor thesis students were added to the team.
Non-AI / AI went from 1 / 3 to 1 / 9

Heartbreak
External collaborator felt overwhelmed and left the team.

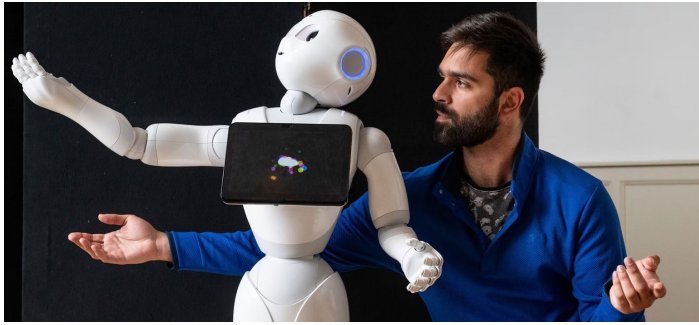
Project was still a success in the end, but collaboration was ended.

Jiahuan Pei



- **Industry internships**
  - 1 MSc student have a fast implementation and basic experiments at the very beginning, but only explored shallow research in the end;
  - 2 MSc students explored internship projects but no use for the thesis; while 1 of them accomplished a pure research project and got a research paper accepted at CIKM within 3 months.
- **Academic staff members** with low risk + broader collaboration
  - Other group (e.g., CLTL Lab, VUSec Group)
  - Universities (e.g., Leiden, WUR)
- **Pairing MSc-BSc students**
  - Benefit for the BSc student but not helpful for the MSc student

Kim Baraka



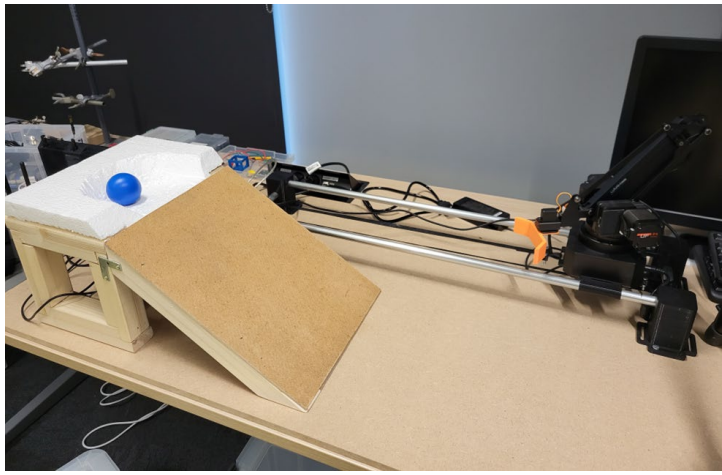
- **Industry internships**
  - Another Kind of Blue (a dance company that does dances with drones) – two students, one of which is writing a short paper about their work there.
  - Others: no continuous collaboration, resource for short-term project
  - Best practice: research interest + NDA + scientific input provided
- **Academic staff members** with low risk + broader collaboration
  - Faculties (e.g., from Comm Sci)
  - Universities (e.g., Leiden)
- **Pairing students**
  - 2 seems to work quite well, but it is VERY important that their personalities match
  - Competitive students will not survive this format typically

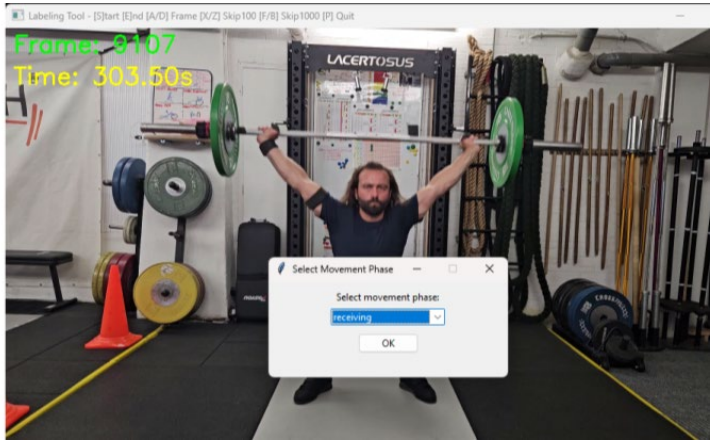
Successful Theses Collaborations Computational Intelligence Group

Anil Yaman

Successful thesis collaborations

- Fungal Faculty (CI group – Art studio)
  - Exhibitions: 2025 - Annual Meeting of the New Champions (by World Economic Forum) Tianjin, China;
    2024 - at MU Gallery, (NL); 2023 - at VU Amsterdam (NL)
  - https://thijsbiersteker.com/fungal-faculty
- Automating the Myth - A Robotic Interpretation of Sisyphus' Eternal Struggle (CI – S2)
  - BSc Thesis: Tahsin Kamil Şimşek
    Supervisors: Ivano Malavolta, Anil Yaman, Guszti Eiben
- Performance Analytics for Olympic Weightlifting (CI and Movement Science)
  - MSc Theses:
    - 2024 - Feek Cool, Accessible Performance Analytics for Olympic Weightlifting based on Computer Vision
    - 2025 – Sam Hartogs, Classification of Movement Phases in Olympic Weightlifting Using Inertial Measurement Units
- AI in Education
  - BSc Theses:
    - 2025 – Ivan Ivanenko, Creating a more AI-resistant environment for assignments completion.
    - 2025 – Peter Mayrany, Automating student behaviour tracking and analysis through a Jupyter Lab extension





Best practices

- **AI applications:** AI applications to other fields made successful projects.
- **Second readership:** Discovering common interests to build on.
- **Persistence:** Keeping the collaboration “alive” with continuation of the projects yearly.

Collaborate with the CI group

- Interdisciplinary nature, involving approaches inspired from (Neuroscience, Psychology, Biology)
- Collective/hybrid intelligence, human-AI/animal collaboration
  - Knowledge representation and reasoning
- Application to robotics
  - Optimization of robot/drone designs
- Application to Art/Education