Welcome to the Choose Your Track Event

Master Artificial Intelligence & Engineering Systems

Thursday, September 12, 2024

Goals of today

- Overview AI&ES program
- Introduction Tracks AI&ES
- Kick-Off for composing program of examinations
- Introduction Program Committee AI&ES
- AI&ES Info Market

Choose your track – program of the day

13:25 – 13:45	**Intro AI&ES program**	**Mircea Lazar – Program Leader AI&ES**
13:45 – 14:00	**Track presentations:** • **T2 Mobility** • **T1 High-tech systems and robotics** • **T3 Healthcare**	**Tom van der Sande – track coordinator** **Maarten Schoukens – track coordinator** **Fons van der Sommen – track coordinator**
14:00 – 14:15	**Coffee break**	
14:15 – 14:30	**Track presentations** • **T4 Smart cities** • **T5 Science & Discovery** • **T6 Manufacturing systems**	**Ekaterina Petrova – track Coordinator** **Alessandro Corbetta – track Coordinator** **Vinh Dang – track coordinator**
14:30 – 14:45	**Follow up actions**	**Marijke Creusen – Erica academic advisor AI&ES** Procedure submitting Track choice
14:45 – 14:55	**Intro Program committee AI&ES**	**Aditya Ade– student member of PC AI&ES**
14:55 – 16:00/16:30	**Info Market + Drinks**	**Track coordinators /Track mentors/ PHD students / 2nd year MSc AI&ES students**

AI&ES program leader

ASSOCIATE PROFESSOR

MIRCEA LAZAR

RESEARCH PROFILE

Main areas of expertise include measurement and control engineering.

Research interests include stability analysis and control of complex interconnected systems, such as power systems,

- water networks,
- communication networks,
- vehicles platoons
- biological networks.

DEPARTMENT / INSTITUTE
Electrical Engineering
EIRES

GROUP
Constrained Control of Complex Systems
High Tech Systems Center
Control Systems
EAISI
EIRES Research

AI&ES support team

Marijke Creusen-Erica
Academic advisor
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Andriana Marian
Education coordinator
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Mariana van Riel
Policy advisor

AI&ES support team

Open position(s) to join the AI&ES support team!

What you will be doing:

- Promotion of the AI&S program
- Development of the AI&ES LinkedIn page

You are comfortable with the following skills and competencies:

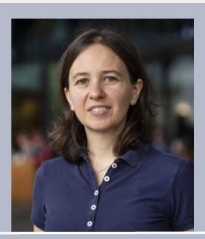
- Spoken and written communication in English
- Taking initiative
- Influencing
- Motivating
- Organization and time management

AI&ES academic support team

Track 1 High-tech Systems and Robotics

Dr. Maarten Schoukens
Control Systems
Electrical Engineering

Dr. Dinesh Krishnamoorthy
Control Systems Technology
Mechanical Engineering



Dr. Elena Torta
Robotics
Mechanical Engineering

Track 2 Mobility

Dr.ir. Mauro Salazar
Control Systems
Technology
Mechanical engineering

Dr. ir. Tom van der Sande
Dynamics and Control
Mechanical Engineering

Track 3 Healthcare

Dr. Fons van der Sommen
Signal Processing Systems
Electrical Engineering

Dr. Federica Eduati
Computational Biology
Biomedical Engineering

Chair Examination Committee

Dr. Sander Struijk
Electronic Systems
Electrical Engineering

Track 4 Smart Cities

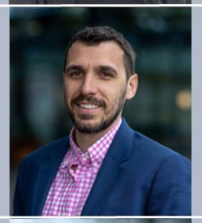
Dr. Ekaterina Petrova
Information Systems in the Built Environment
Built Environment

Dr. Nilufar Neyestani
Electrical Energy Systems
Electrical Engineering

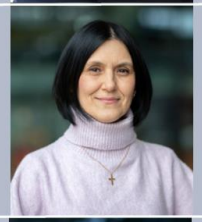
Chair Program Committee

Dr. Ekaterina Petrova
Information Systems in the Built Environment
Built Environment

Track 5 Science and Discovery



Dr. Alessandro Corbetta
Fluids and Flows
Applied Physics and Science Education



Dr. Silvia Gaastra-Nedea
Energy Technology
Mechanical Engineering

Team Internship Coordinator

Jos den Ouden
Signal Processing Systems
Electrical Engineering

Track 6 Manufacturing Systems

Dr. ir. Michel A. Reniers
Control Systems
Technology
Mechanical Engineering

Dr. Vinh Dang
Operations, Planning, Accounting & Control
Industrial Engineering & Innovation Sciences

TU/e

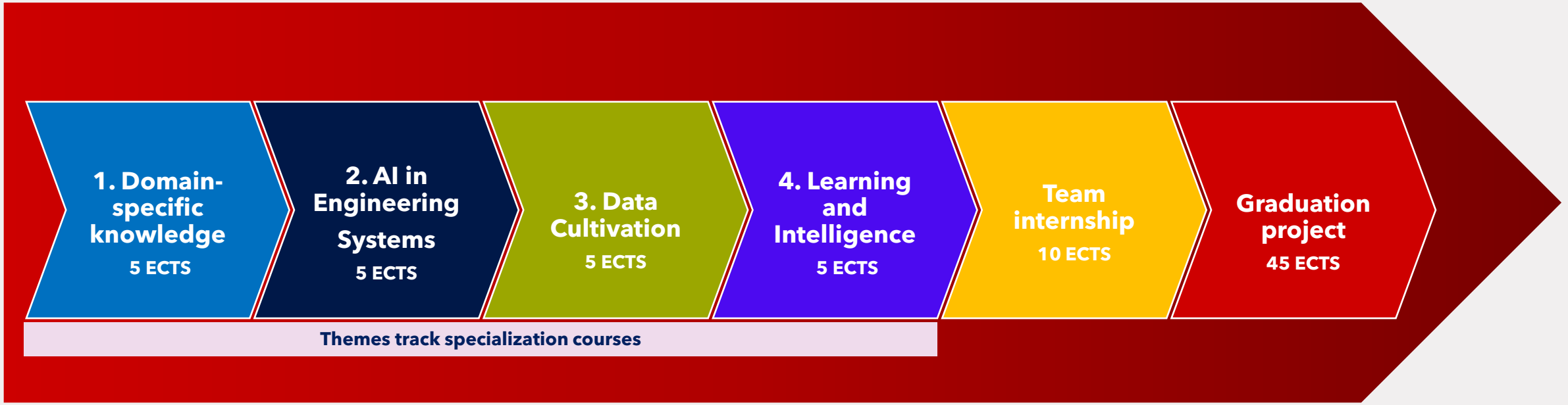
Track coordinators

Track name	Coordinator	Departments involved
1. High-tech systems and robotics	dr.ir. Maarten Schoukens (EE) dr. Dinesh Krishnamoorthy (ME) dr. Elena Torta (ME)	Electrical Engineering Mechanical Engineering
2. Mobility	dr.ir. Tom van der Sande (ME) dr.ir. Mauro Salazar (ME)	Electrical Engineering Mechanical Engineering
3. Healthcare	dr.ir. Fons van der Sommen (EE) dr. Federica Eduati (BmE)	Electrical Engineering Biomedical Engineering
4. Smart cities	dr. Ekaterina Petrova (BE) dr. Nilufar Neyestani (EE)	Built Environment Electrical Engineering
5. Science and Discovery	dr. Alessandro Corbetta (APSE) dr. Silvia Gaastra-Nedea (ME)	Applied Physics and Science Education Mechanical Engineering
6. Manufacturing systems	dr. ir. Michel Reniers (ME) dr. Vinh Dang (IE&IS)	Industrial Engineering and Innovation Sciences Mechanical Engineering

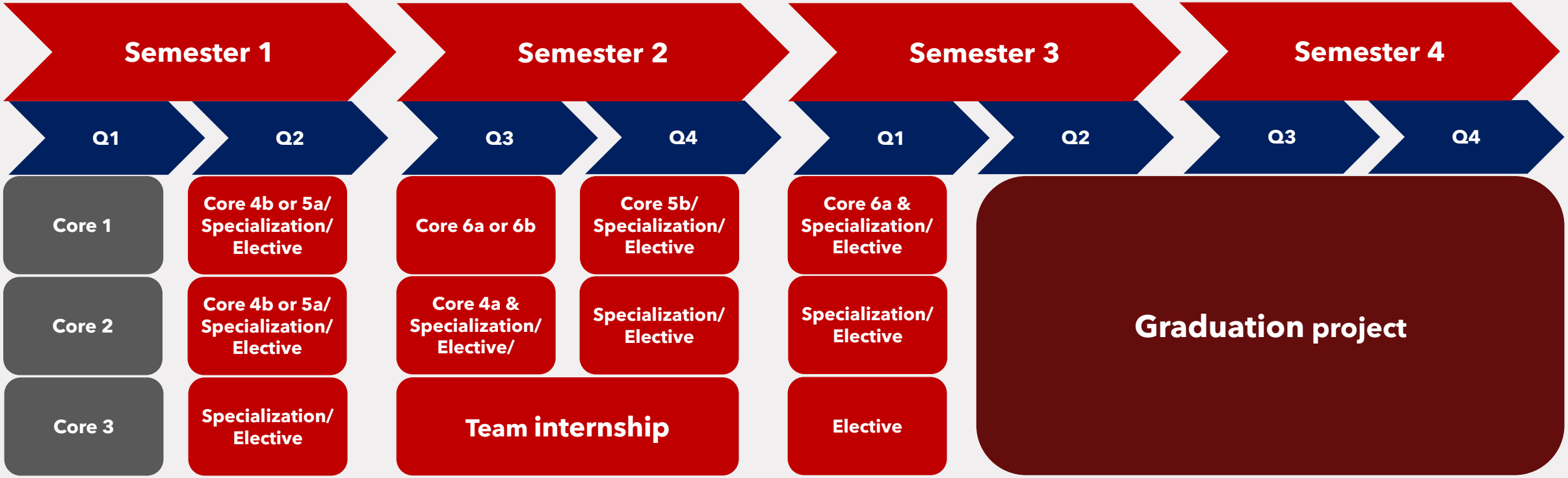
AI&ES program overview

Core courses	30 ECTS	
Specialization courses	20 ECTS	Track!
Team internship project	10 ECTS	
Free elective courses	15 ECTS	
Graduation project	45 ETS	Track!

Track structure



Overview curriculum AI&ES



AI&ES future career

Industry

- AI Engineer
- AI R&D

Academia

- AI EngD
- AI PhD

Startup

- AI driven

… and many more!

Track 2: Mobility

Team Mobility

Track coordinators and mentors:

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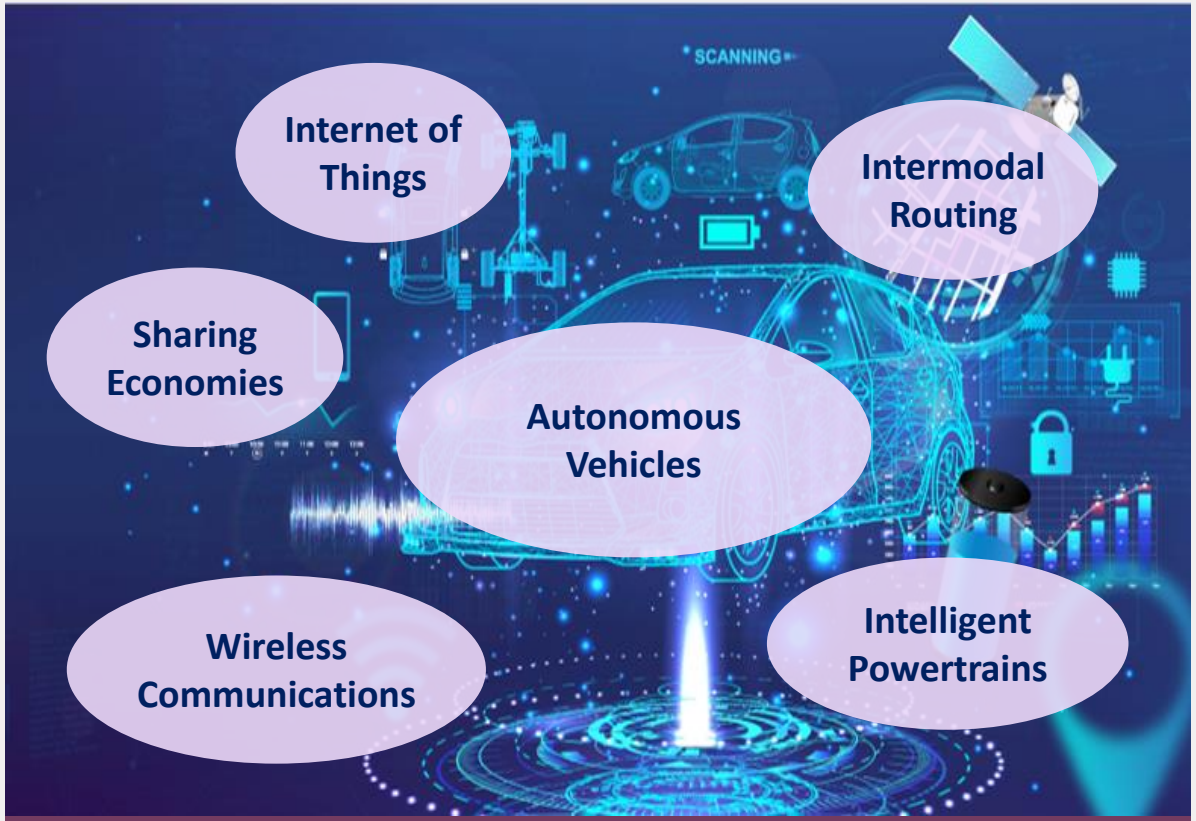
Profile

Dr. ir. Tom van der Sande
Dynamics and Control
Mechanical Engineering
ee.track2.coordinator.aies@tue.nl
Profile

Challenges and Opportunities (1)



AI engineers are needed to tackle mobility-related problems and devise innovative solutions for todays and future mobility challenges.

Challenges and Opportunities (2)

FORBES > INNOVATION > TRANSPORTATION

Waymo Makes A New Safety Case And – Bu

Brad Templ
I cover robo Google's car

0

METROPOLIS

The Self-Driving Cars Wearing a Cone of Shame

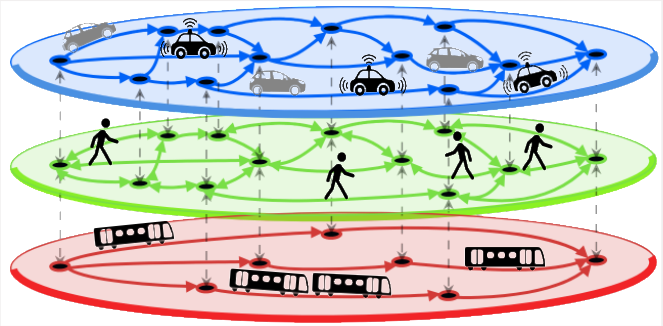
There's a brilliant activist campaign to stop San Francisco's autonomous vehicles in their tracks.

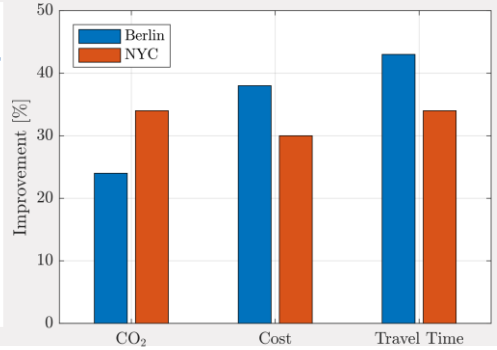
BY ALISON GRISWOLD JULY 11, 2023 • 10:45 AM

A Waymo driv
IMAGES

It looks like a sad unicorn (which, in a way, it is). Screengrab from TikTok/Safe Street Rebel

Autonomy and connectivity can only partially address the spatial inefficiency of cars: Need a **system-level perspective**





Improvements intermodal vs car-only mobility-on-demand

Salazar et al. T-ITS19

TU/e

Challenges and Opportunities (3)

FORBES > INNOVATION > TRANSPORTATION

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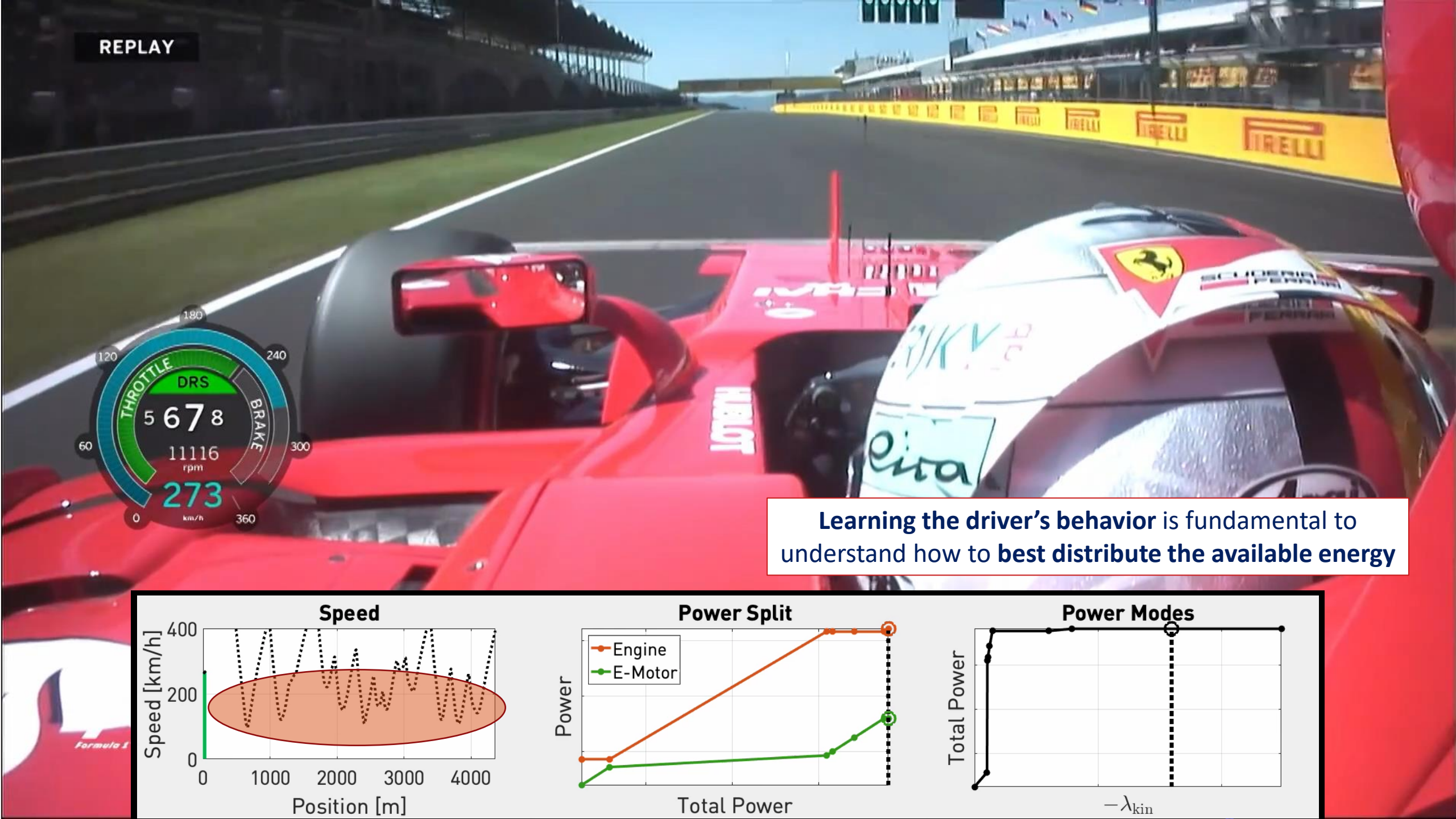
F1 Engineers Spin Up Ultimate Hybrid Controller

Shaving off milliseconds—not notching up mileage—is this smart box's objective

BY MICHELLE HAMPSON | 11 AUG 2023 | 3 MIN READ

» "The estimator would 'guess' the future behavior of the driver and provide the controller with future power requests."

—MARC NEUMANN, ETH ZURICH



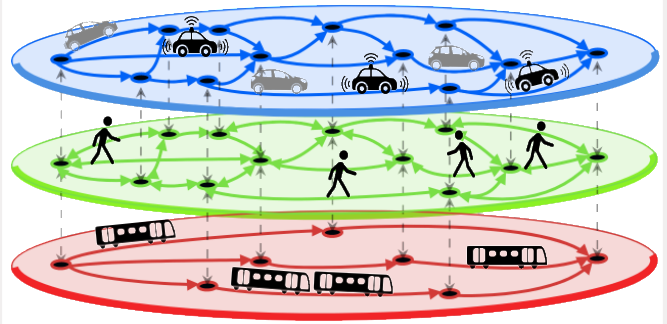
Learning the driver's behavior is fundamental to understand how to **best distribute the available energy**

What will you learn

- **holistic knowledge** on applying **AI methods to mobility systems**
- **design** and **control of individual vehicles** in terms of **autonomous driving** and **powertrain co-design**,
- **macroscopic** perspective encompassing **mobility systems at large**.

Typical topics are:

- Automated driving
- Perception systems
- Cooperative driving
- Intelligent powertrain co-design
- Racing applications
- Smart transportation systems



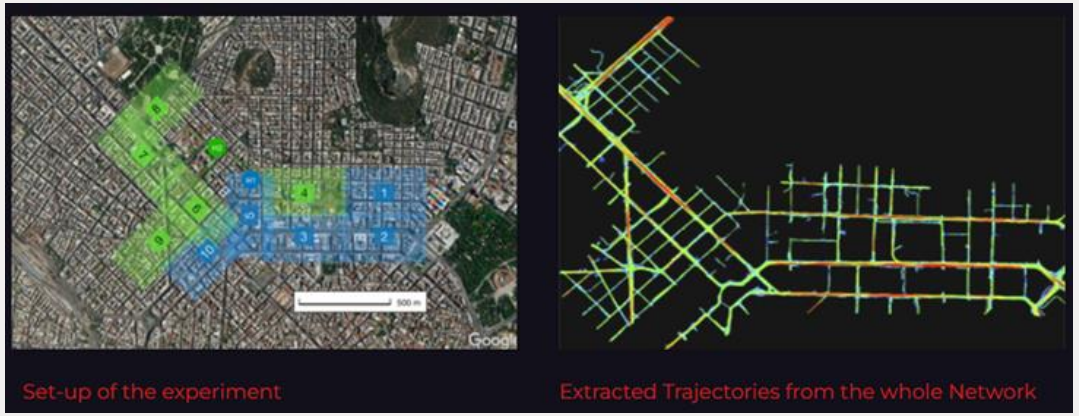
Team internship project example

RC Electric Racing

- Localization and mapping
- Minimum-time trajectory optimization
- Path following and minimum-time maneuvering

Calibration of traffic micro-simulations

- Traffic safety simulation
- Automatically calibrate a traffic micro-simulation using naturalistic driving data (NDD) captured by drones
- Extracting relevant safety-related parameters from NDD



Call for papers for the

11th IFAC Symposium on Advances in Automotive Control

Eindhoven, Netherlands

Conference date 16-18 June 2025

Paper submission 14 November 2024

Conference website www.aac2025.tue.nl

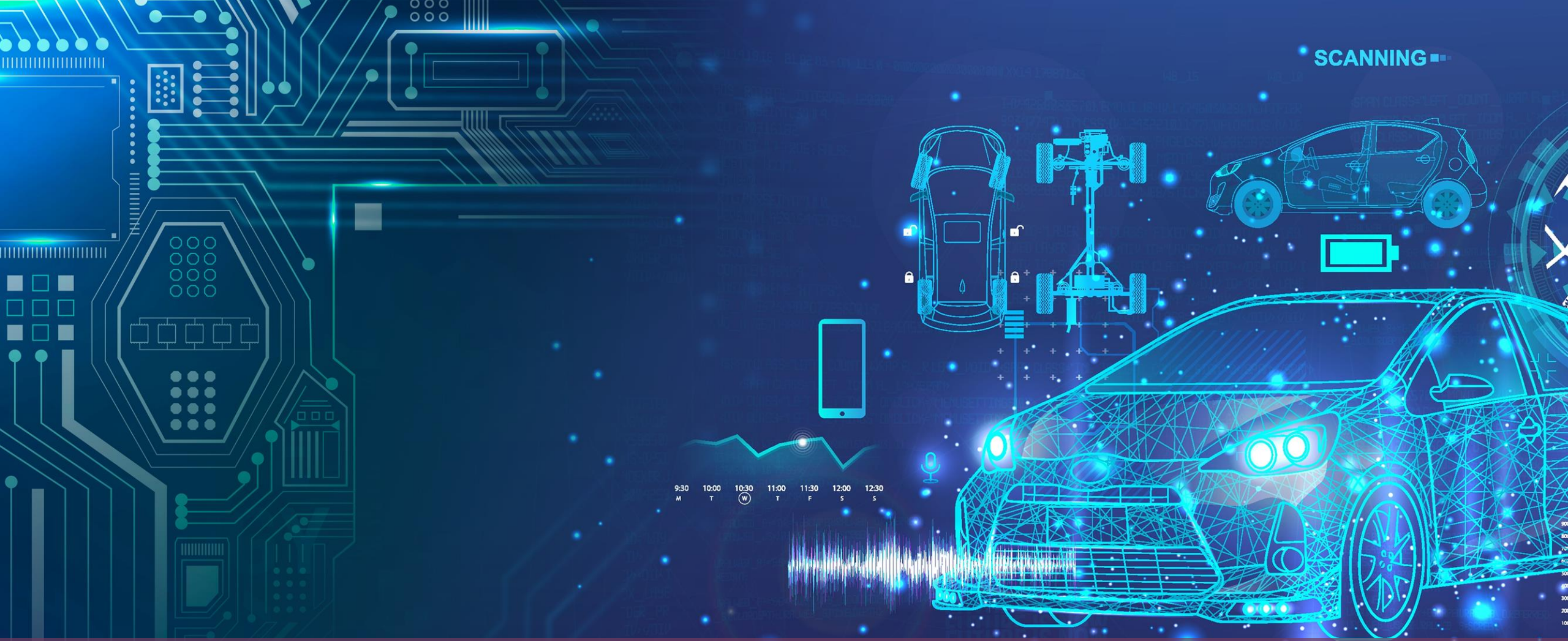
Organizing Committee:

Frank Willems, Emilia Silvas, Mauro Salazar

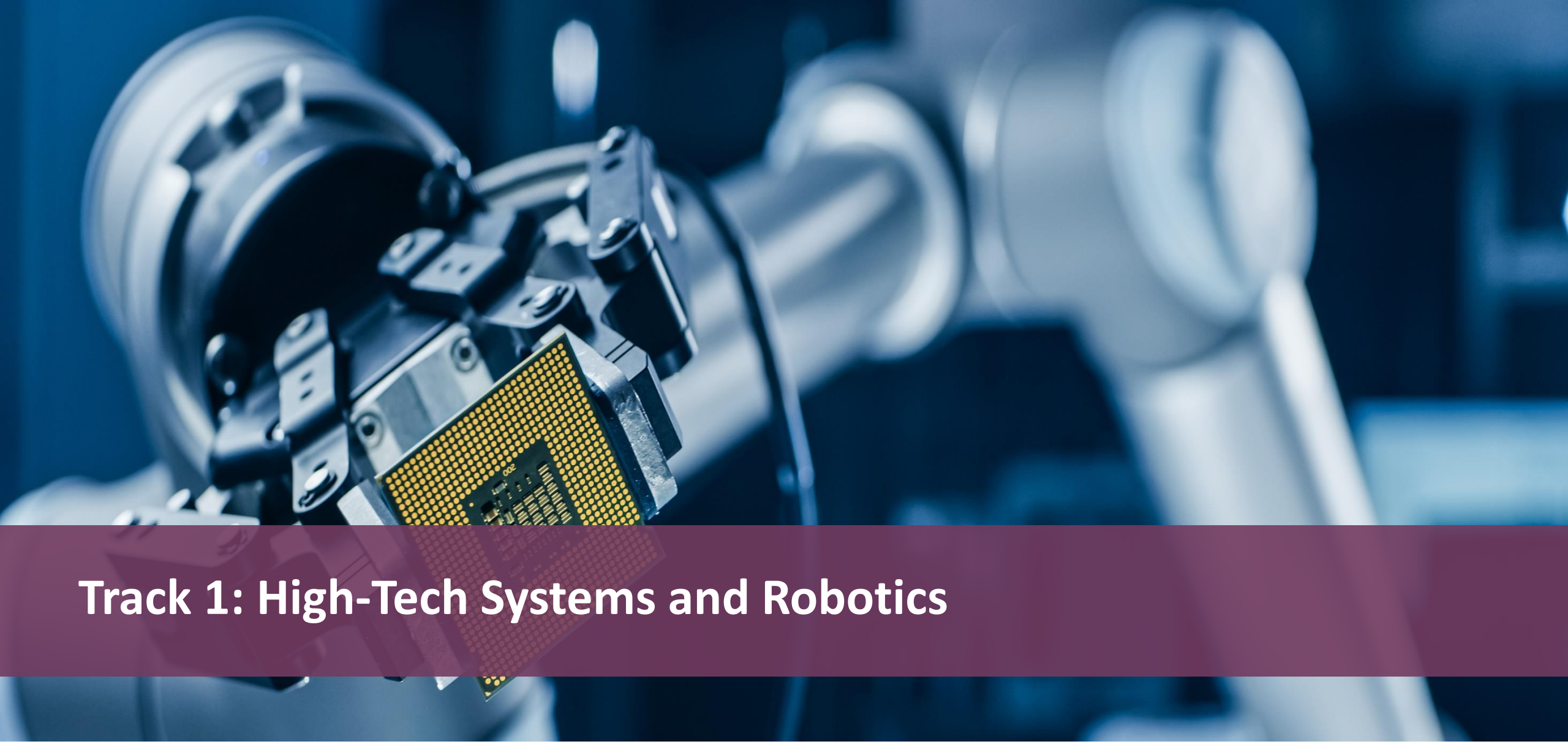
Alexander Katriniok, Theo Hofman, Tijs Donkers, Tom van der Sande

IFAC INTERNATIONAL FEDERATION OF AUTOMATIC CONTROL

TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY



We welcome you in the Mobility track!



Track 1: High-Tech Systems and Robotics

Team High-tech systems and robotics (1)

Track coordinators and mentors:

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Profile

Dr. Elena Torta
Robotics
Mechanical Engineering
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Profile

Team High-tech systems and robotics (2)

Track mentors:

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Dr. Dip Goswami
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Dr. Majid Nabi Najafabadi
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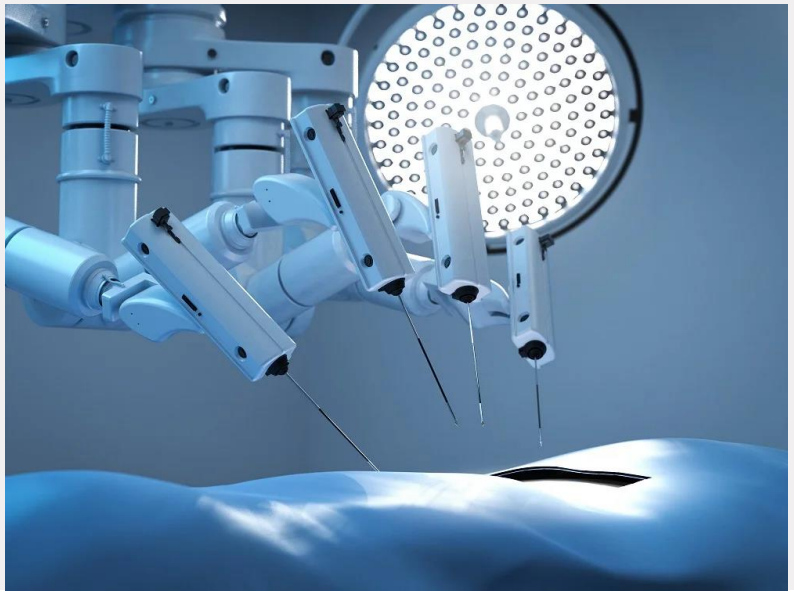
Profile

Overview

Focus on innovative technology for design, development, and control to achieve safe and accurate performance of systems:

- complex systems, multiple physical domains
- environment typically uncertain
- high demands on optimization and computational efficiency
- integration of sensing, control and actuation
- certification on safety, reliability, stability, accuracy and performance of engineering systems

Fundamental questions on learning, computing, data quality, decision-making and handling complex systems



Challenges

Challenges:

- Increased autonomous decision making in design, construction and operation of systems
- Uncertainty and uncertain environments
- Certification of robust performance of machines
- Realization of high-level machine specifications

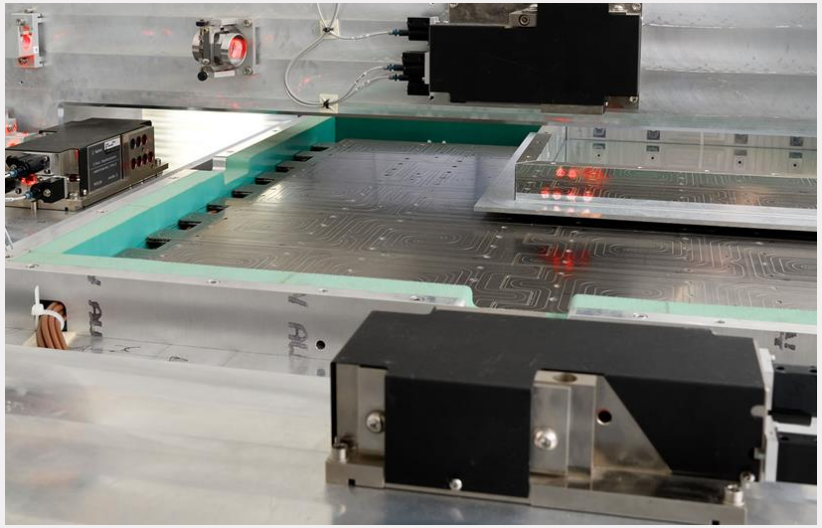
Methods:

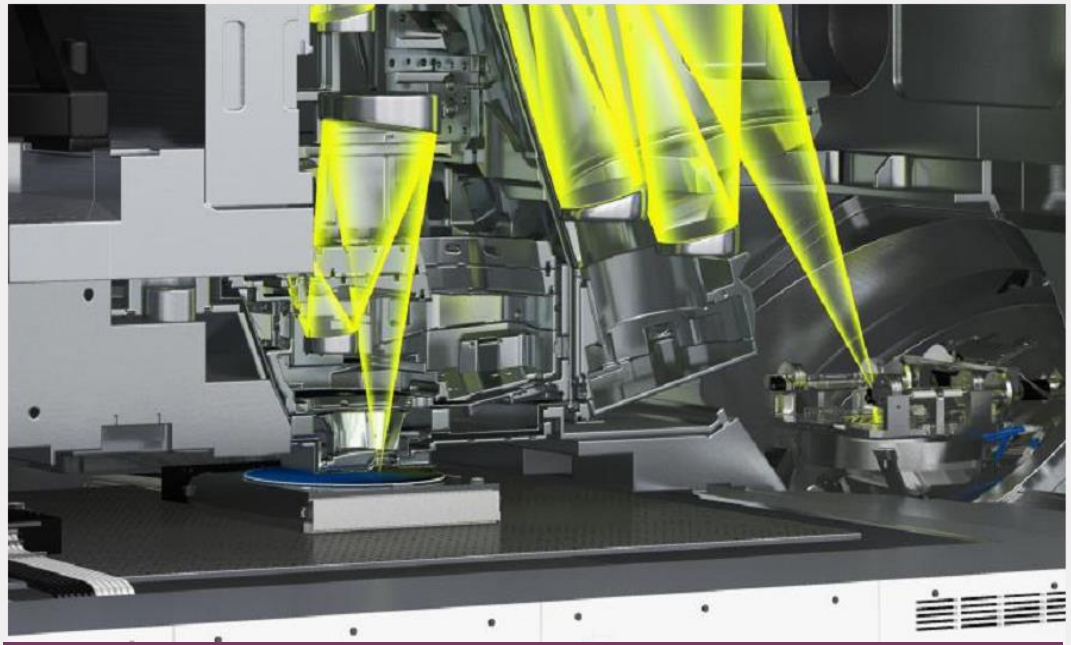
Computer Science | **Systems and Control** | **Data Science** | **Information Technology** | **Life and social sciences**

Opportunities (1)

High-tech in mechatronics and lithography machines

- Improve performance of the most complex machine on the planet
- New principles for control and actuation to achieve nano-precision positioning
- Secure stability, precision, performance, throughput





High-precision mechatronic systems

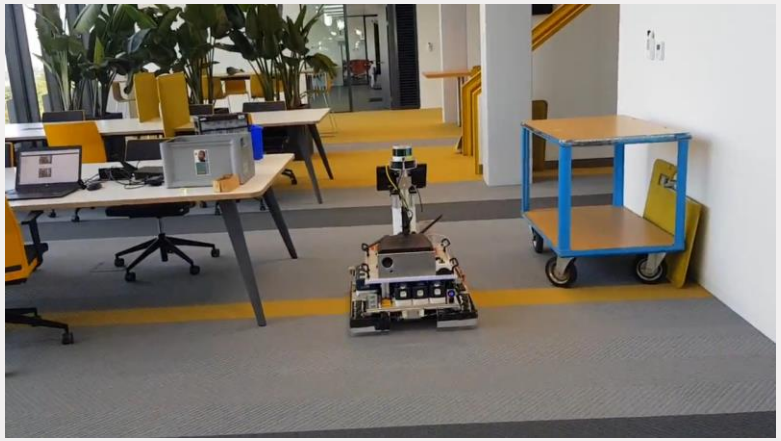
Opportunities (2)

Robotics

- Increase the level of autonomy of robotic systems
- Enable physical interaction between robots and the environment
- Enable robots to learn and adapt to dynamic environments
- Coordinate perception and actions in multi-robots systems

Soft robotics

Semantic navigation (Atlas)



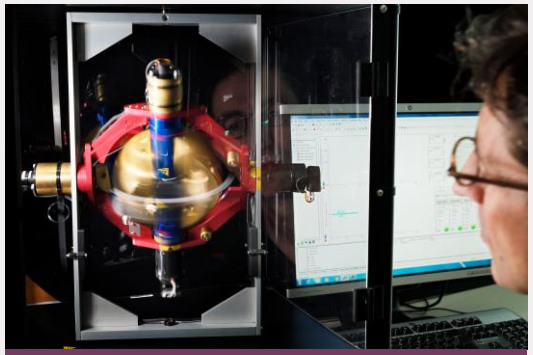
Impact-aware manipulation

Multi-robot coordination

What will you learn and what to expect

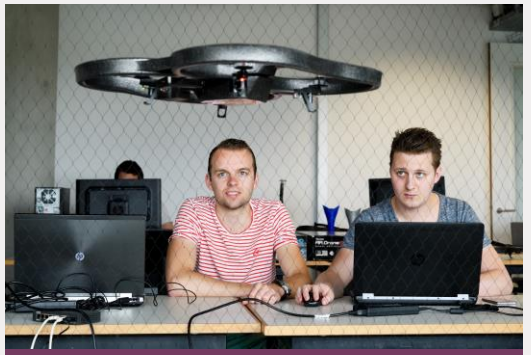
- Learn how AI techniques enhance process optimization, design, control of dynamical systems
- How to learn from process data and reduce uncertainty
- Methods, techniques that lead to verification and performance certification in safety critical situations
- AI solutions to today's engineering problems in high-tech and robotic applications
- To become a valuable engineer for ASML, Avular, Vanderlande, Philips, NXP, Smart Robotics, Thermo-Fisher, Canon, DSM, ….

3D printing and additive manufacturing



Motion control

Humanoid robotic platforms



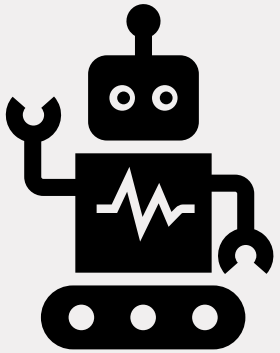
Drones

Team internship project examples

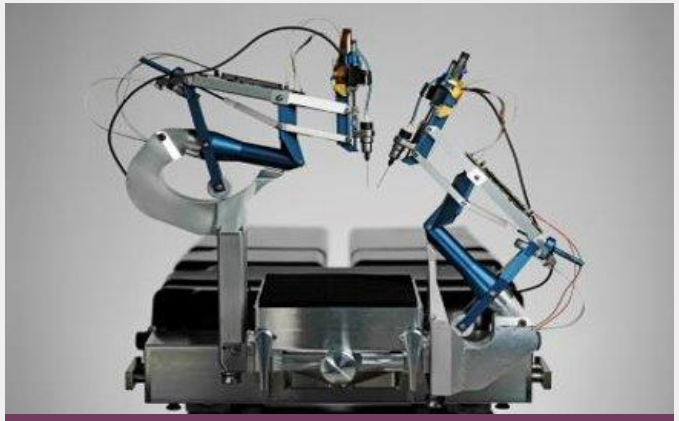
Example projects of last year:

1. AI for autonomous priority vehicles (TU/e)
2. Integrated building information models and robotics (TU/e)
3. Smart building anomaly detection (TU/e)
4. Vision based pressure sensor in a soft object for robotics (TU/e)
5. Alignment marker placement in lithography systems (ASML)
6. Autonomous agriculture robots (Vextronics)
7. Wind turbine blade position monitoring (Tarucca)
8. Hospital robot motion platform (Ambee)

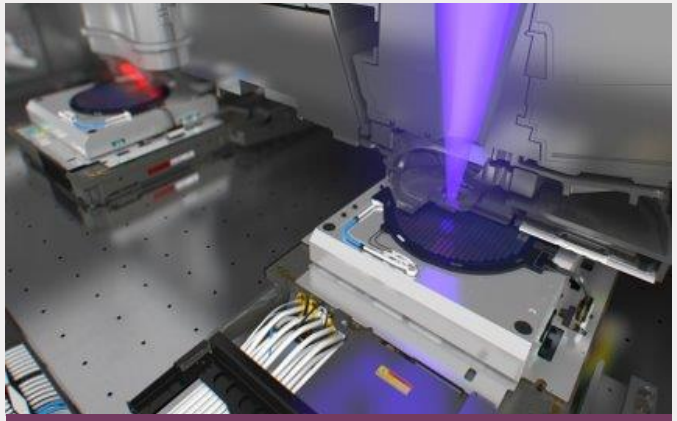
Graduation project examples



AI Fundamentals



Care and cure robotics



Mechatronics & Lithography

Additive manufacturing

Collaborative robots

Battery technology

We welcome you in the High-tech systems and robotics track!

Track 3: Healthcare

Team Healthcare

Track coordinator and mentor

Dr. Fons van der Sommen
Signal Processing Systems
Electrical Engineering
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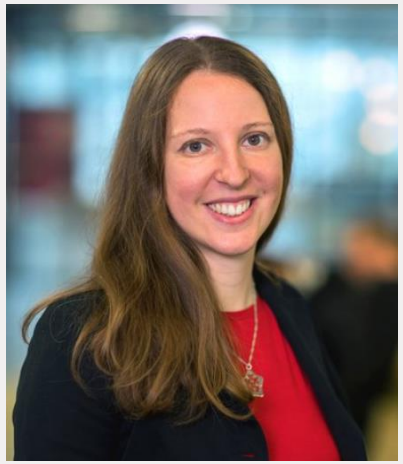
Profile

Track coordinator



Dr. Federica Eduati
Computational Biology
Biomedical Engineering
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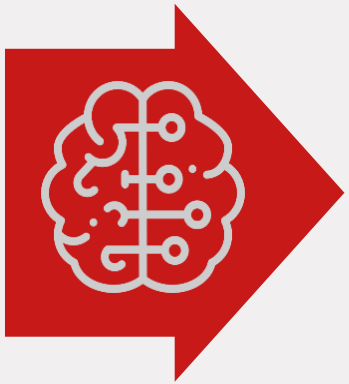
Profile

Overview (1)

Why do we need AI for healthcare applications?

Increasing access to Healthcare

Growing amount of medical data



Artificial intelligence to help with the interpretation and analysis of that data

Rapid sensor development

E.g., with early diagnosis, treatment planning and during interventions

Overview (2)

AI will be an essential and necessary tool for the future medical doctor

However, the opportunities for AI in medicine are not limited to data analysis

- Enable faster and cheaper medical scanners using less radiation
- Expedite the development of artificial organs or other body parts
- Come to a better understanding of diseases
- Provide accurate surgical navigation
- Speed-up drug development
- … beyond the currently imaginable!

AI in healthcare

$\neq$

data science on medical data!

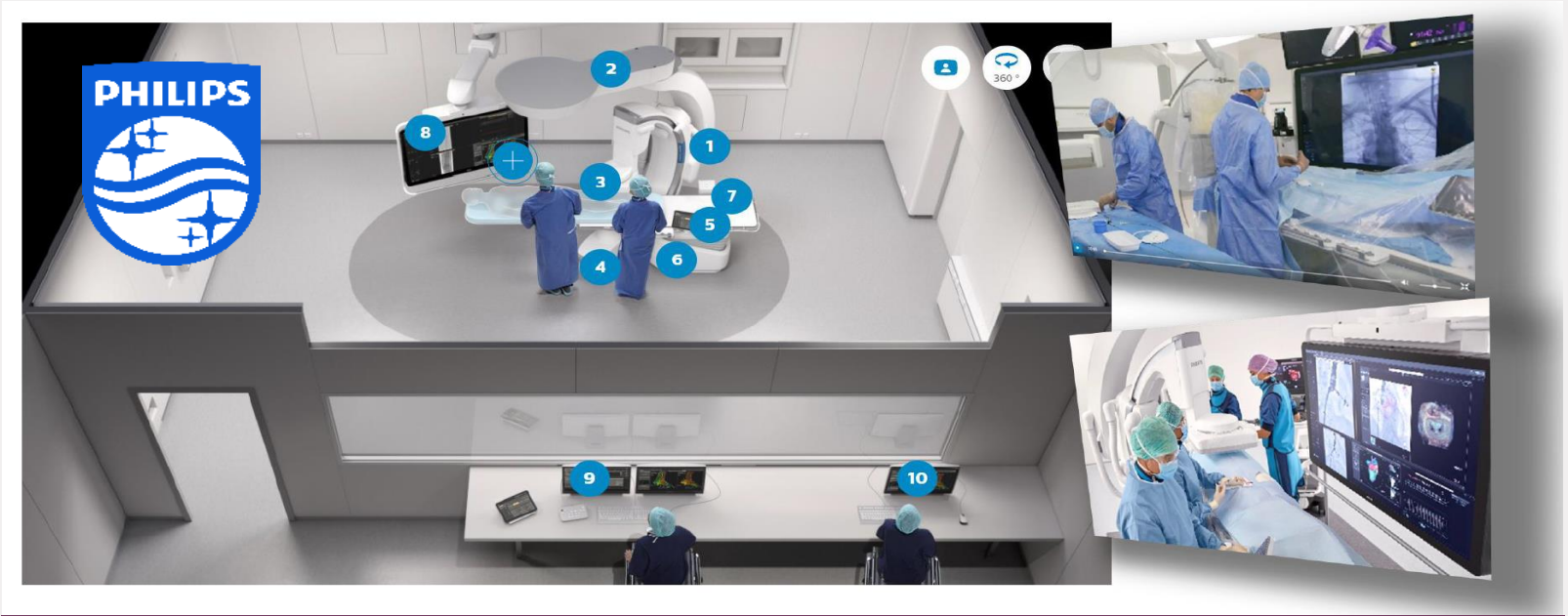
What will you learn

- Automated **medical image analysis** using computer vision and machine learning.
- The basic principles of **medical imaging** methods (MRI, CT, US, …).
- Robotics and AI for **assistive devices** (hearing, speech, rehabilitation).
- AI for **computer-assisted interventions** to support surgical procedures.
- Predictive modelling for **treatment response, patient monitoring and anomaly detection**.
- How to **improve biological models** to enable better understanding of diseases.
- **Explainable** and **trustworthy AI** for communication with medical experts.

Challenges in medical AI

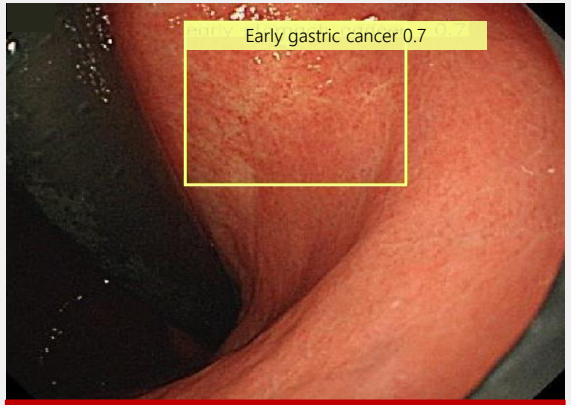
Data	Hard to acquire large, representative, labeled data sets
Uncertainty	Considerable inter-observer variability
Efficiency	Networks are often large, slow and memory-heavy
Robustness	We cannot guarantee stability for all possible input
Interpretability	What is actually happening inside these huge networks?
Explainability	How can these models effectively communicate with humans?

Team internship project example

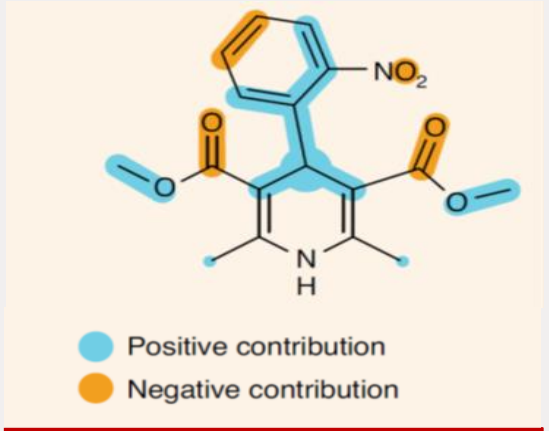


AI application for image-guided therapy

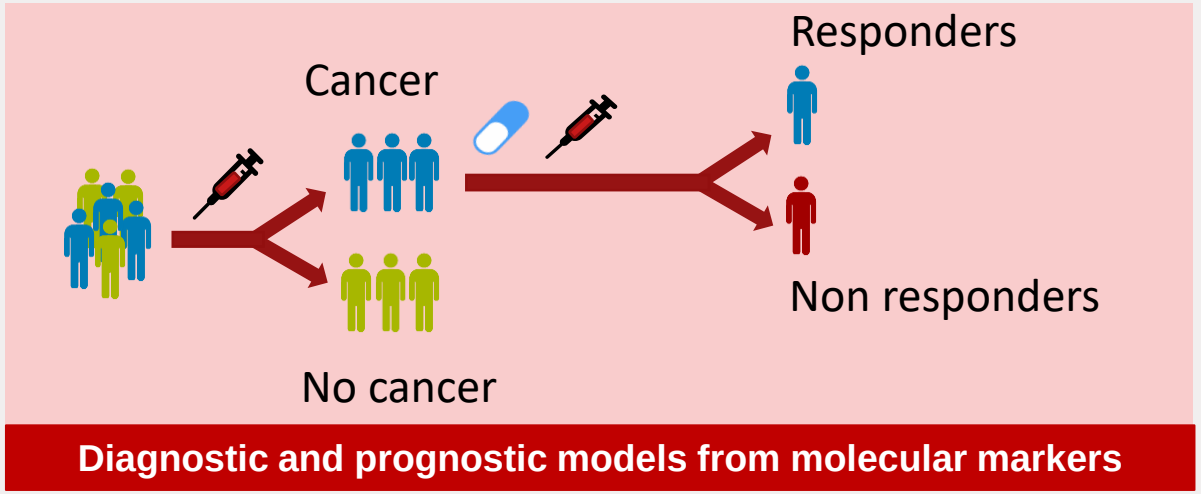
Graduation project examples



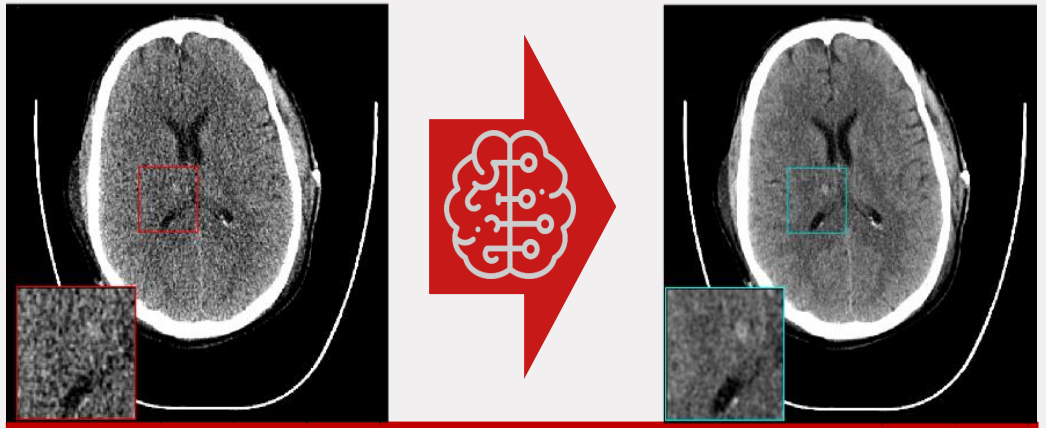
Gastric cancer detection



Drug development



Diagnostic and prognostic models from molecular markers



Denoising CT images

We welcome you in the Healthcare track!

Coffee break – 15 minutes

Track 4: Smart cities

Team Smart cities

Track coordinators:

Dr. Ekaterina Petrova
Information Systems in the Built Environment
Built Environment
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Profile

Dr. Nilufar Neyestani
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Electrical Engineering
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Profile

Track mentor:

Dr. Rob Wolfs
3D Concrete Printing
Built Environment
r.j.m.wolfs@tue.nl

Profile

Challenges and Opportunities

Challenges in the built environment

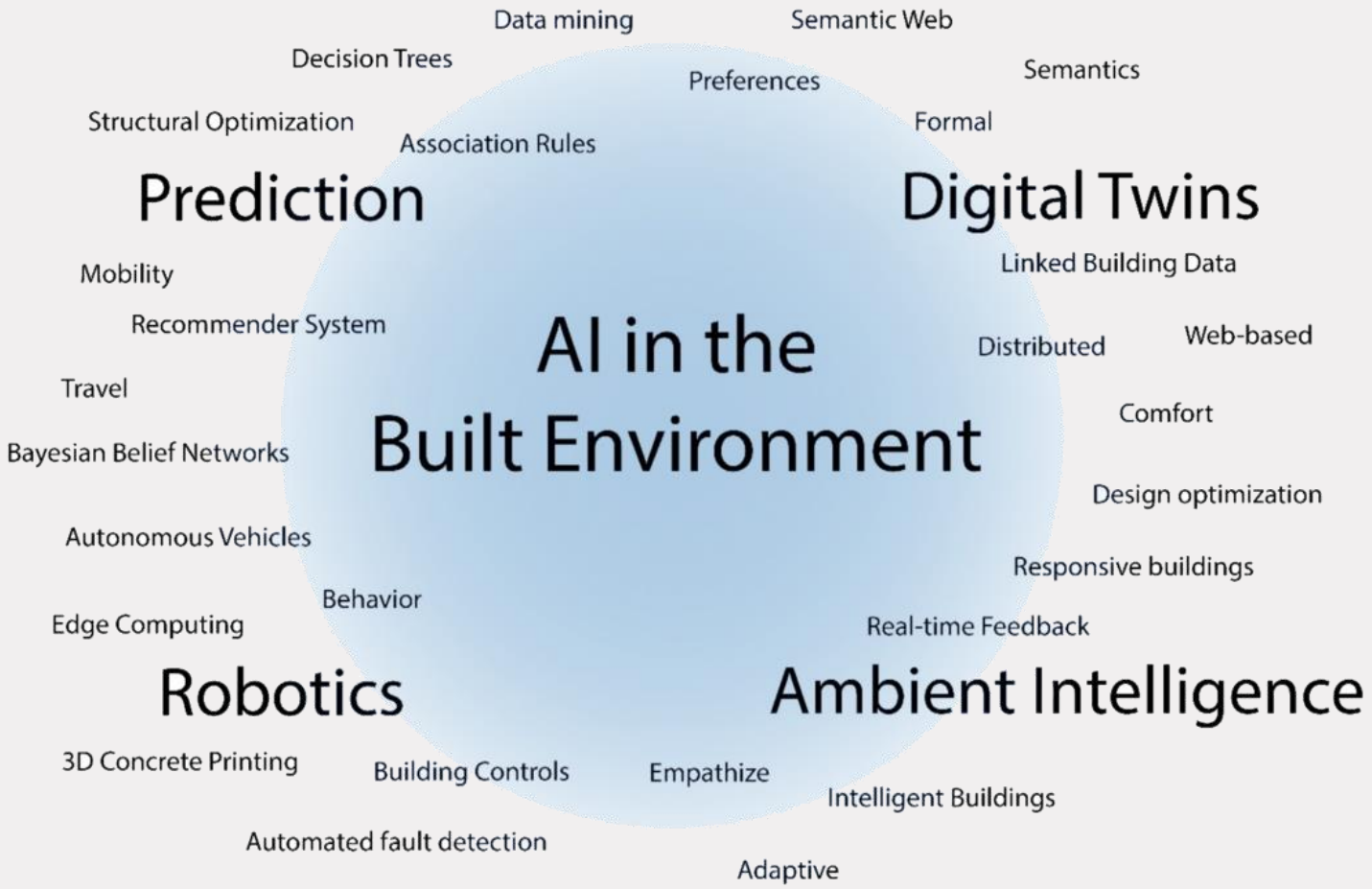
- Decarbonisation
- Energy transition
- Reducing resource use and energy waste
- Sustainability and circularity
- Indoor Environmental Quality
- Occupant health, safety and well-being
- Improved urban mobility
- Demand responsive transportation
- Space utilisation and land use

Buildings, mobility, citizens and complex large-scale systems are key!

Overview

Smart buildings, IoT sensors, actuators, wearables, autonomous vehicles, robots, and Digital Twins transform the built environment from a static medium to an **intelligent medium that interacts with its users and responds to their needs.**

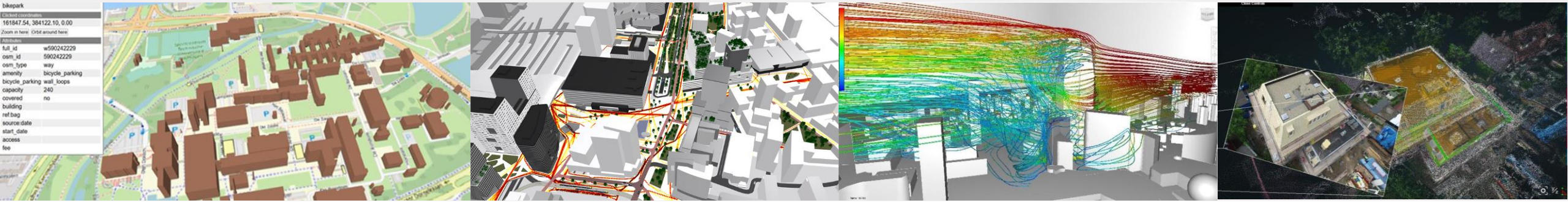
Data generated throughout the life cycle of built assets and **AI enable advanced, technologically sound and tailored engineering solutions to** the challenges.



What will you learn

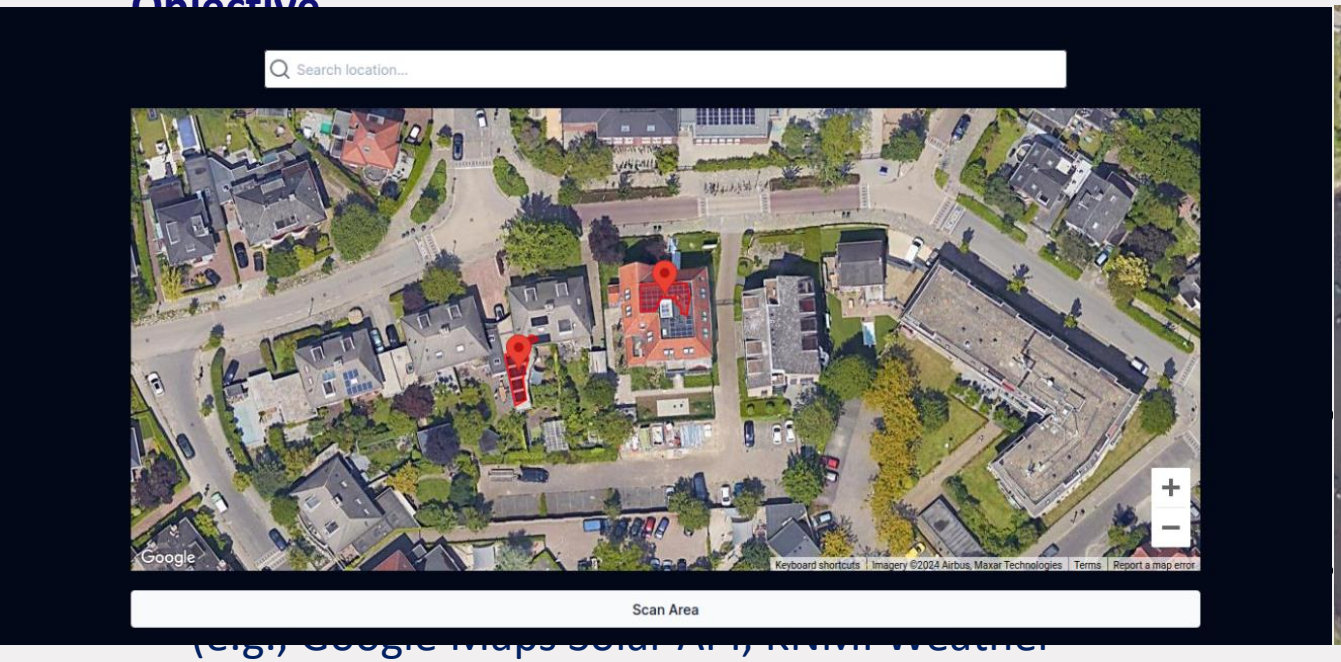
You will learn the fundamentals of:

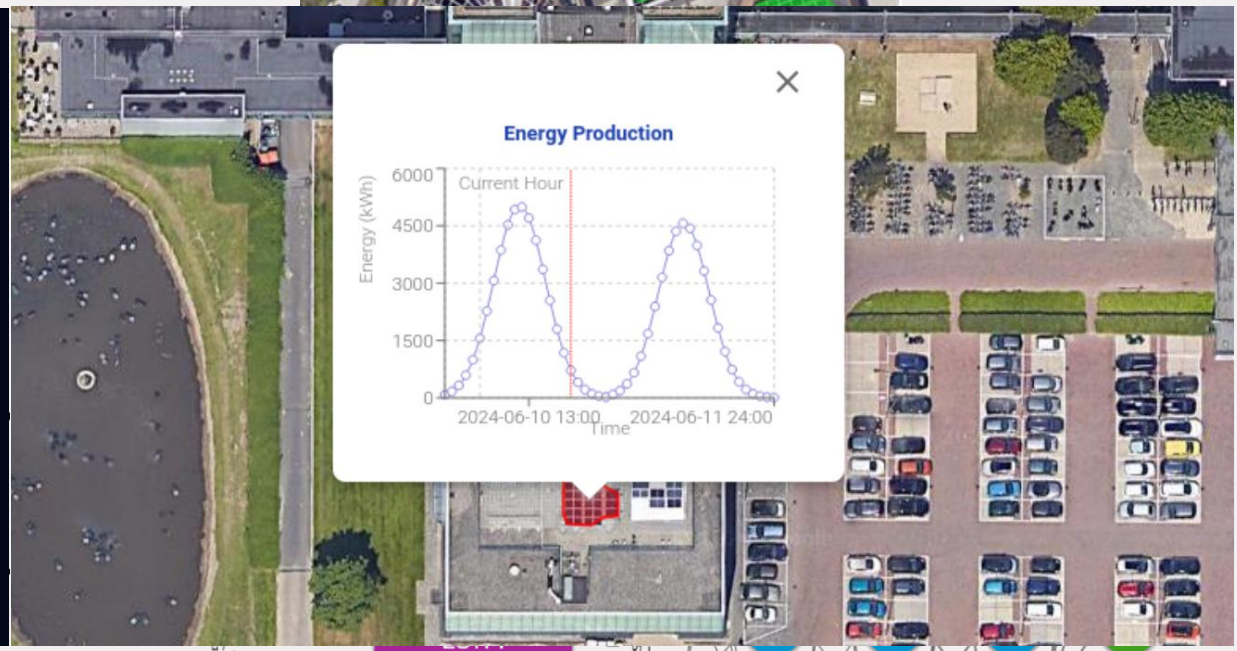
- Building Information Modelling and intelligent buildings
- Robotics and building automation
- Smart Human-Environment and Human-System interaction
- Building performance and energy systems
- Additive manufacturing and 3D printing
- Traffic simulations, MaaS, AV/EV sensing
- Geographic Information Systems
- Smart urban systems and environments



Team internship project example

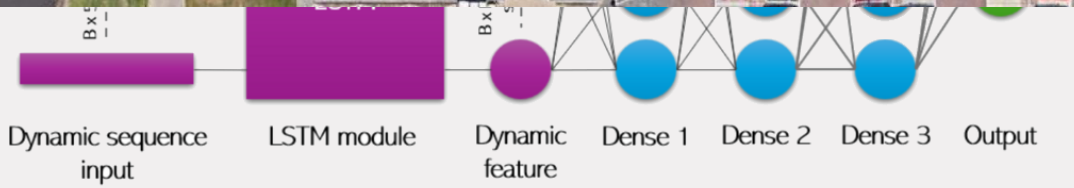
Urban solar energy forecasting



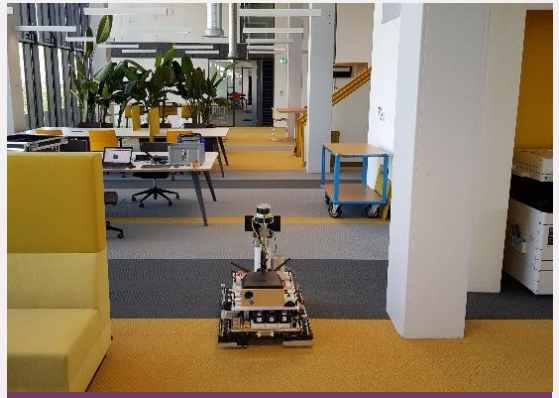


Objective

- Prediction API, Google Maps API, etc.)
- Web application development utilising the above

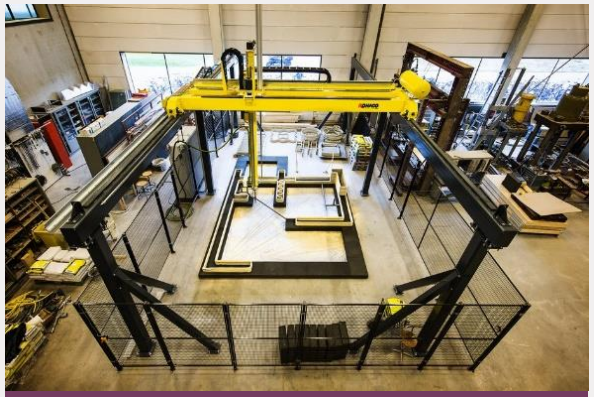


Graduation project examples

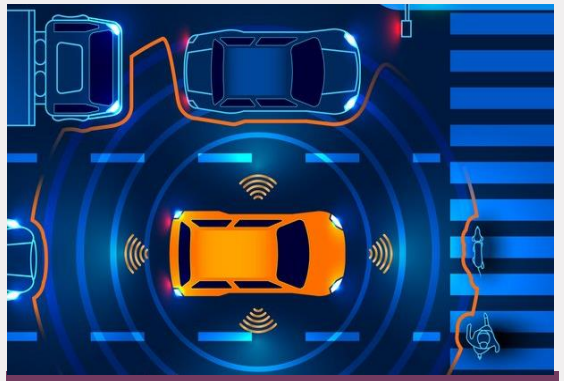


BIM and (construction) robotics

AI and City Digital Twins



AI in 3D Concrete Printing



Autonomous mobility and MaaS

Ambient Intelligence

Smart building control

We welcome you in the Smart Cities track!

Track 5: Science and Discovery

Team Science and Discovery

Track coordinators:

Dr. Silvia Gaastra-Nedea

Energy Technology
Mechanical Engineering
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Profile

Dr. Alessandro Corbetta

Fluids and Flow
Applied Physics and Science Education
ee.track5.coordinator.aies@tue.nl
Profile

Track mentors:

Prof. Federico Toschi

Department of Applied Physics and Science Education
Cascade 2.22
f.toschi@tue.nl
Profile

Dr. Nick Jaensson

Department of Mechanical Engineering

- Gemini South 2.124
- n.o.jaensson@tue.nl

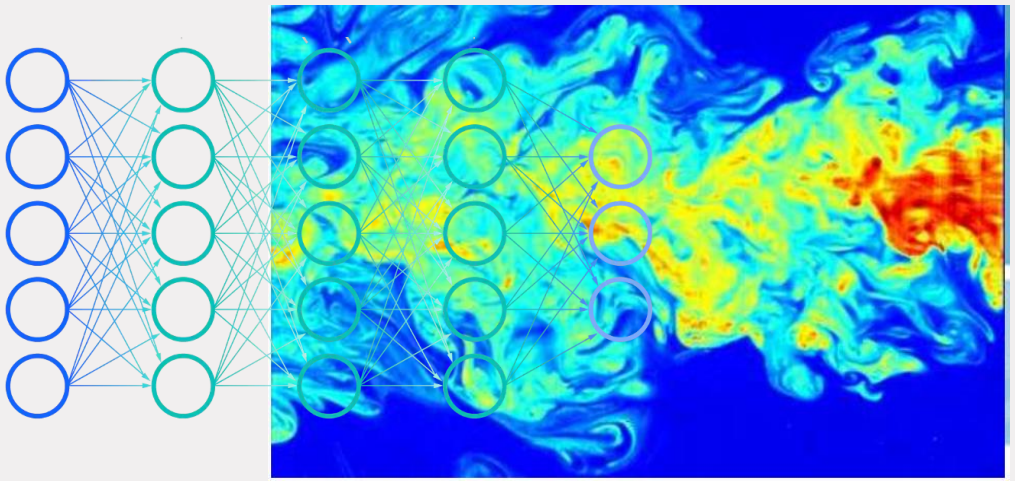
Overview

This decade

AI **key** in technology & society

Next decade

AI **key** in research & science



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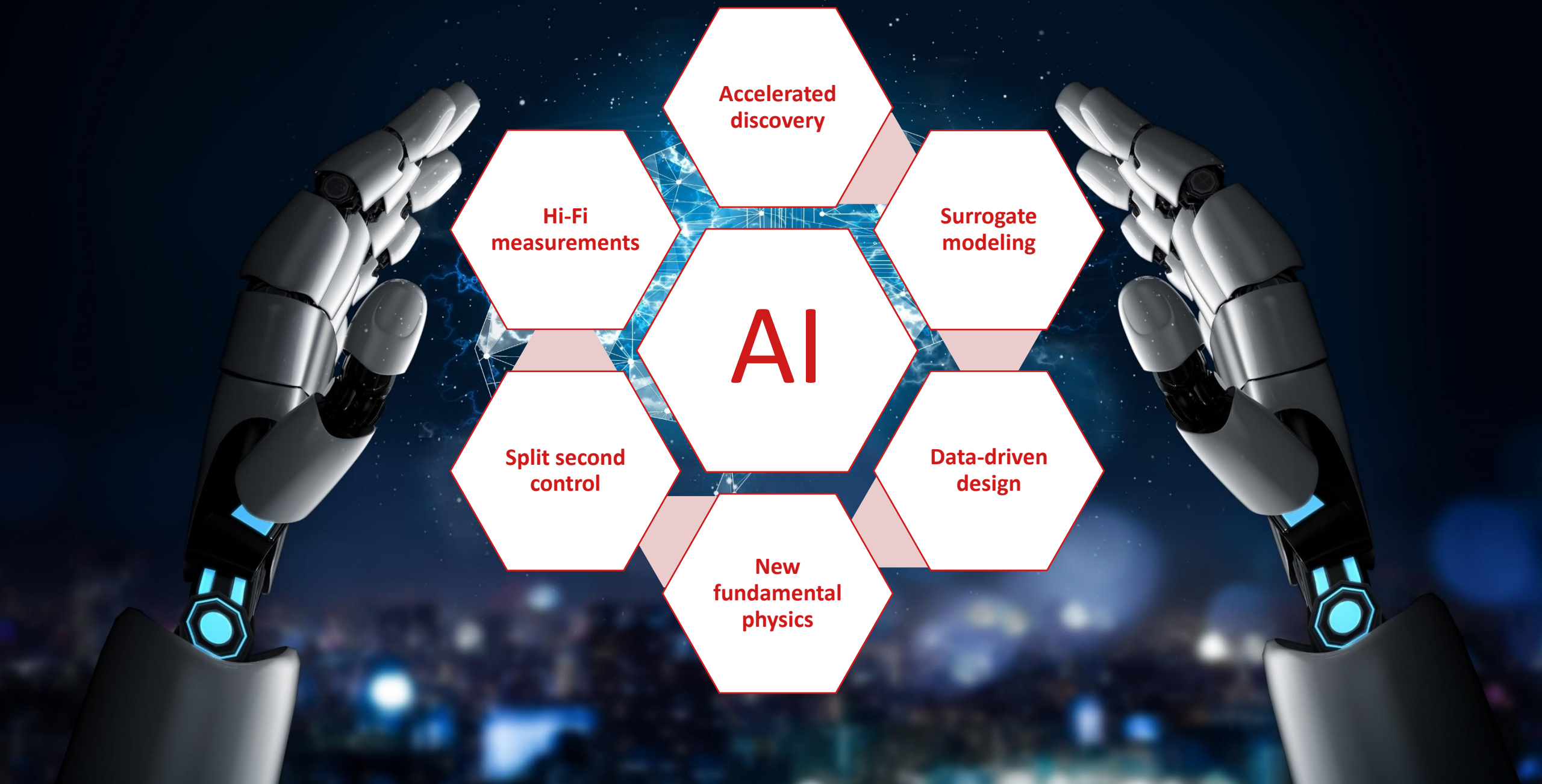
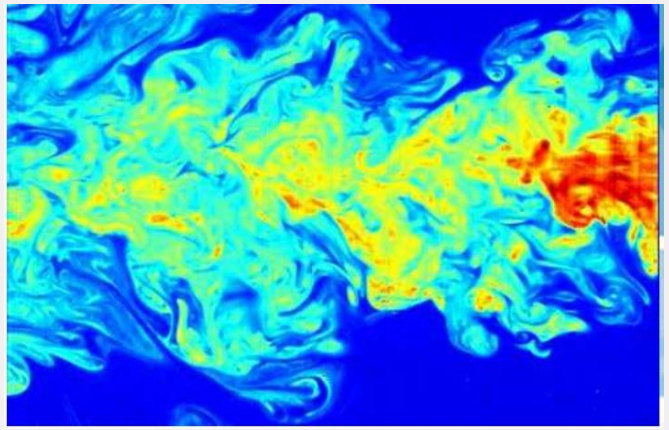
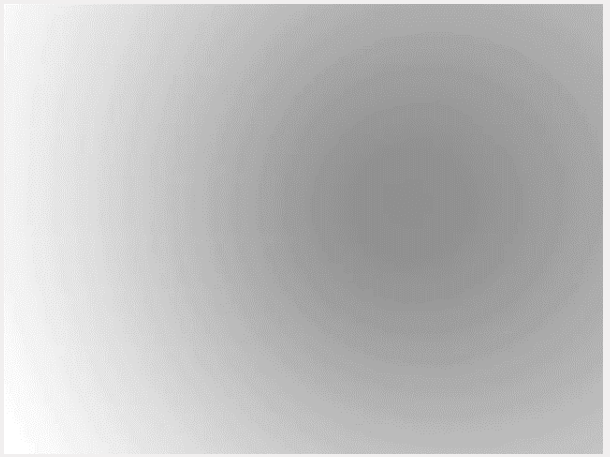
Challenges & Opportunities



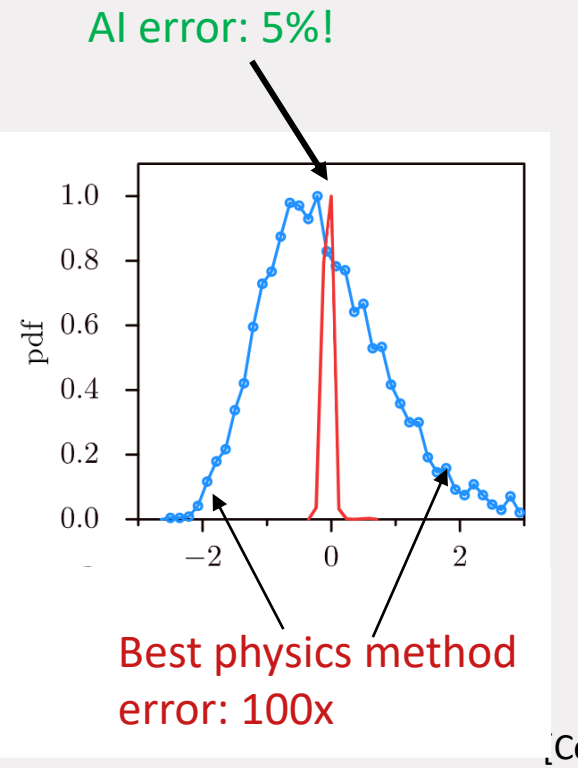
Tackling longstanding scientific challenges now possible with AI!

AI modelling & control of fluid turbulence





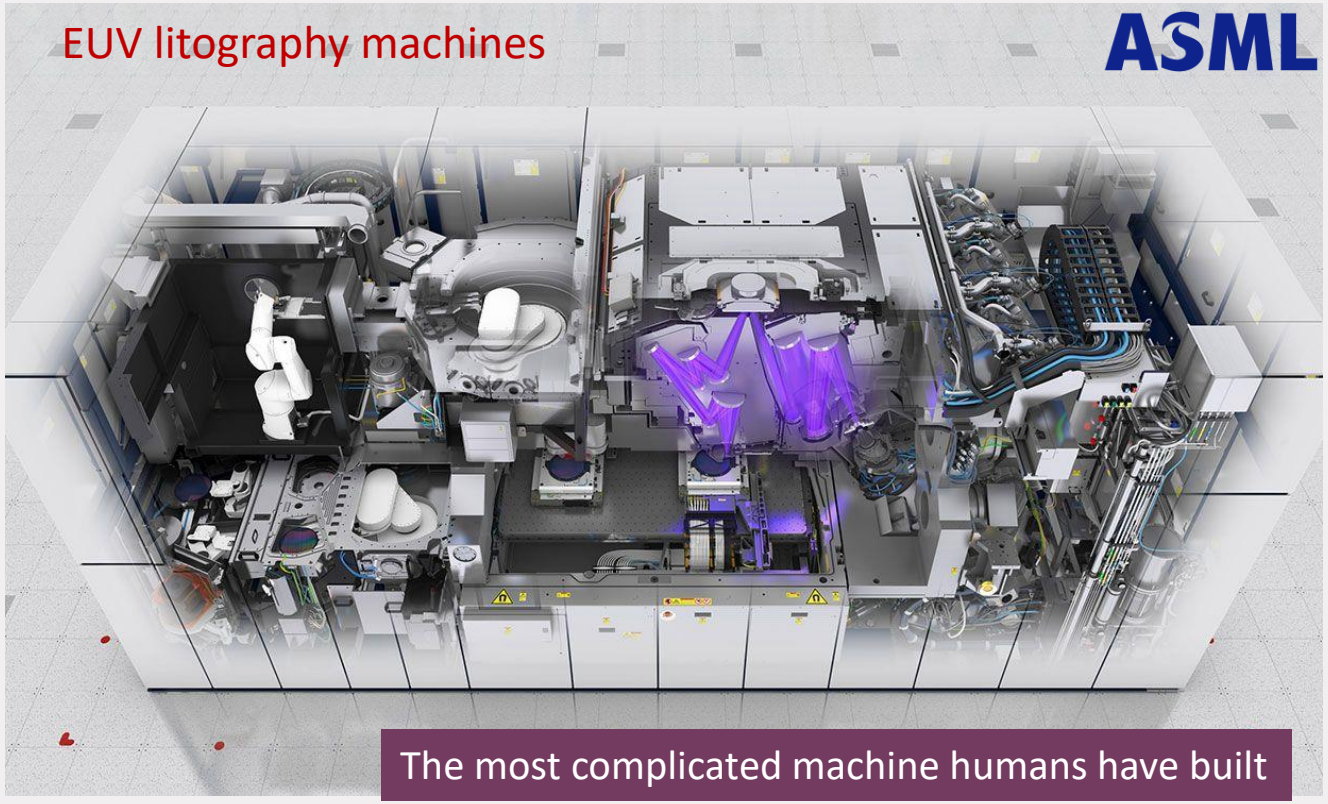
[Toschi et al.]



[Corbetta et al.]

Similarly in nuclear fusion, energy materials, sociophysics…

AI: key in industrial multidisciplinary research



Models complex competing systems:

heat & flow, material science, plasma, optics, chemistry, design, etc...

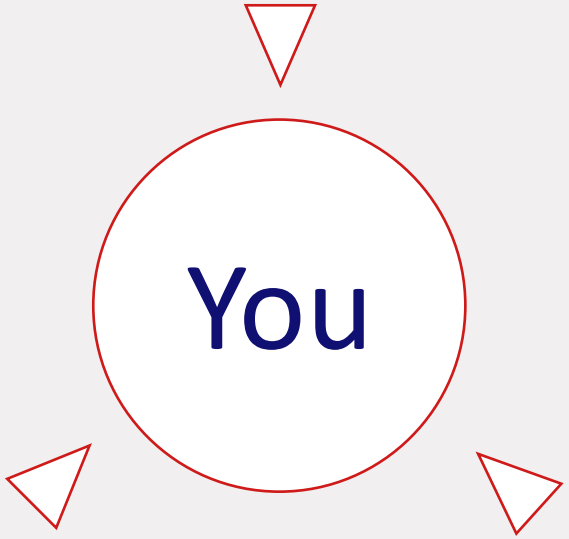
Graduation projects

PLUSS® TECHNOLOGY FOR A BETTER WORLD
SCM Software for Chemistry & Materials
Los Alamos NATIONAL LABORATORY
esa
VDL
ASML
RUBITHERM Phase Change Material
FRITZ-HABER-INSTITUT MAX-PLANCK-GESELLSCHAFT
ProRail
TNO

TU/e

Overview

Acquiring knowledge
AI Foundations + AI for science



Making Impact
in outstanding scientific projects

Establishing new synergies
Transferring AI across different scientific fields

A taylor-made trajectory

Choose master project direction

Define trajectory

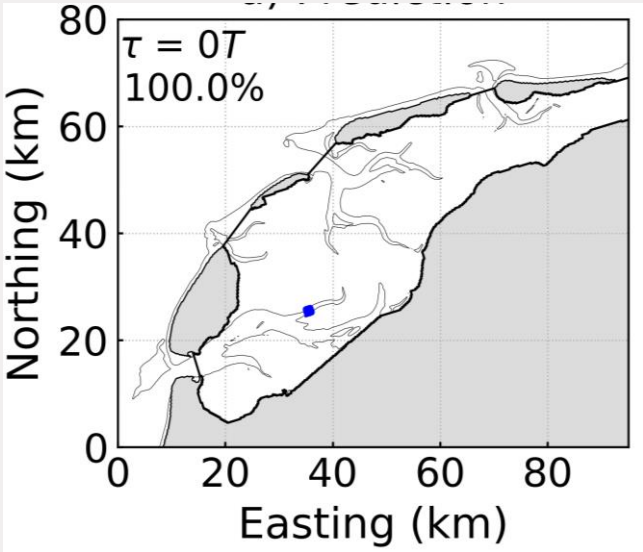
Attend courses
Group project

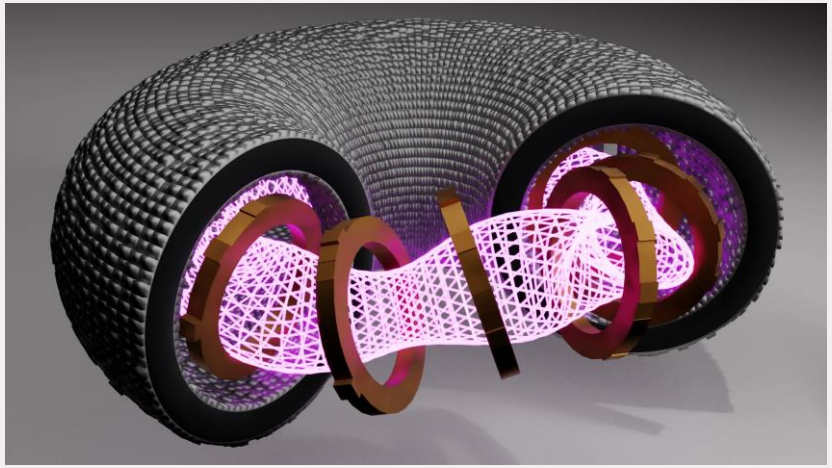
Start final project

Graduate!

Project examples

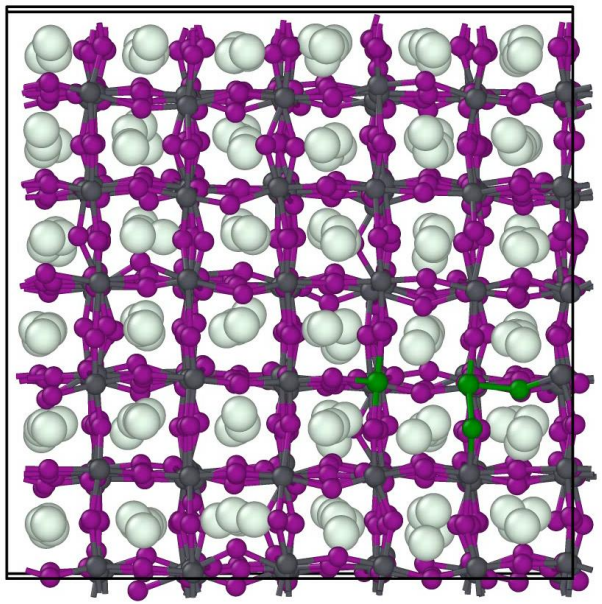
Predicting criticality in our climate





Accelerating the energy transition

Engineering new materials



Managing the largest crowds in the nation

We welcome you in the Science and Discovery track!

Track 6: Manufacturing systems

Team Manufacturing Systems

Track coordinators:

Dr. ir. Michel A. Reniers

Control Systems Technology
Mechanical Engineering

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Profile

Dr. Vinh Dang

Operations, Planning, Accounting & Control
Industrial Engineering & Innovation Sciences,
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Profile

Track mentors:

Dr. Alp Akçay

Industrial Engineering
and Innovation Sciences

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a.e.akcay@tue.nl

Profile

Dr. Mehrdad Mohammadi

Industrial Engineering
and Innovation Sciences

Atlas 4.322

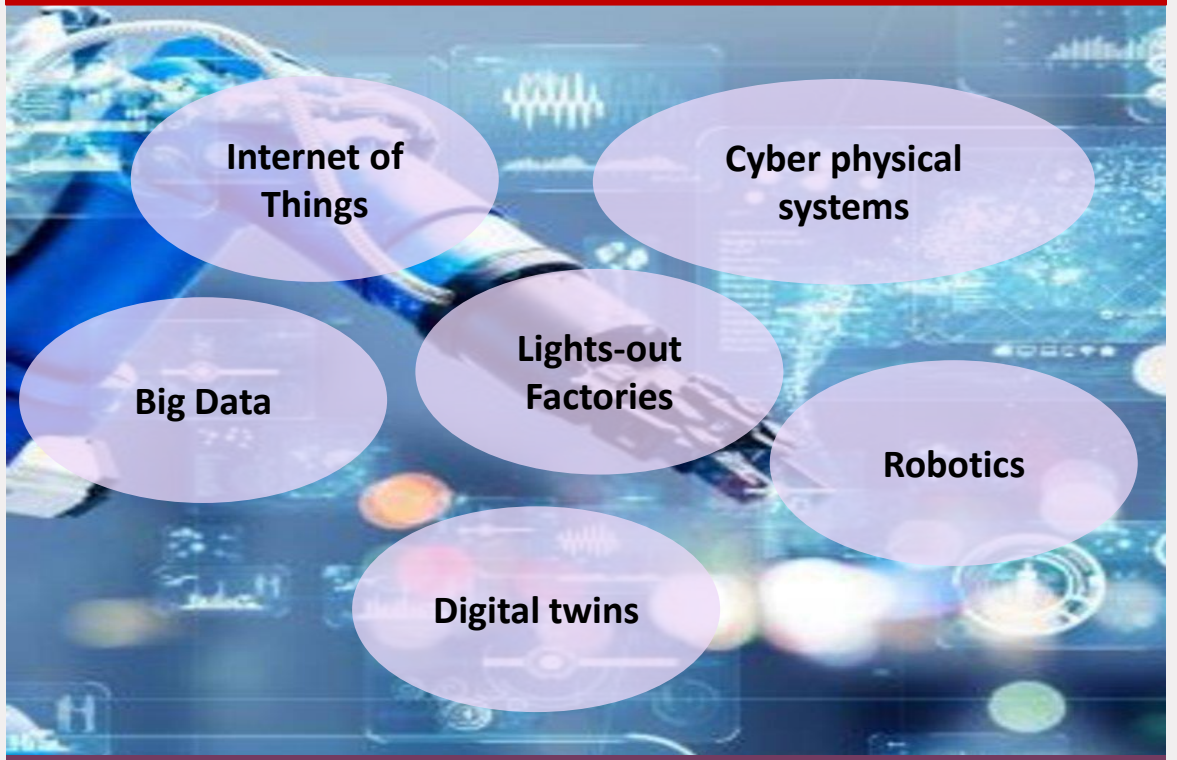
m.mohammadi1@tue.nl

Profile

Challenges and Opportunities

Importance and Challenges in Manufacturing

Opportunities for AI-Enabled manufacturing



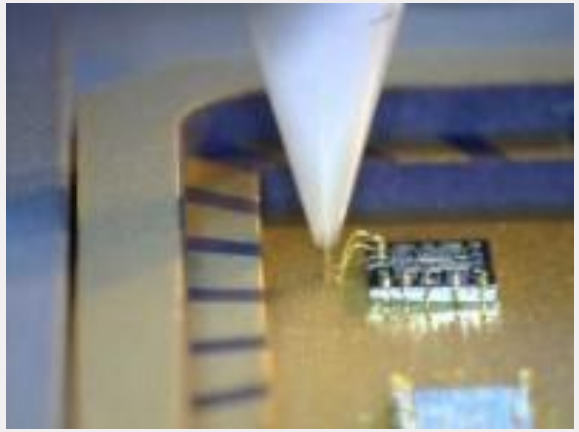
New developments in Digitization, Robotization and Networking need engineers with broad knowledge of AI and manufacturing

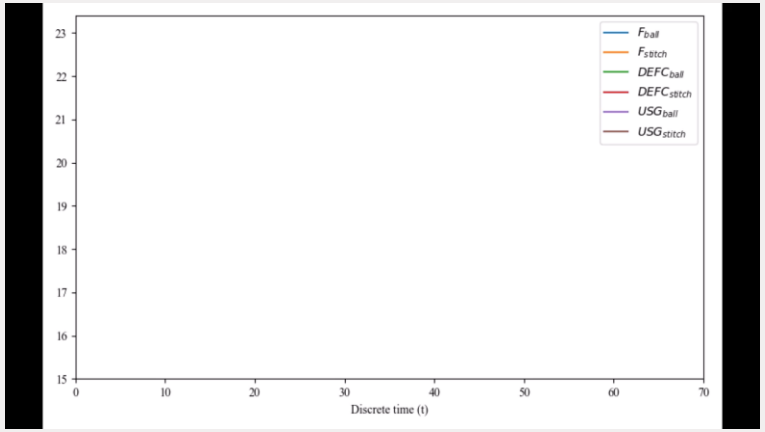
What will you learn

- Manufacturing technology
- Manufacturing system design
- Digital twins
- Cyber physical systems
- Multi-agent systems
- Manufacturing and maintenance logistics
- Planning and scheduling in automated manufacturing systems
- Human-robot interaction

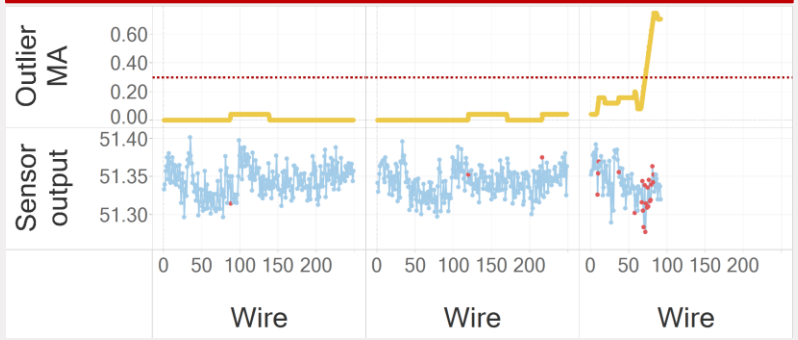
Project example: Data-driven Manufacturing

- Wire bonding process of Integrated Circuits at semi-conductor manufacturer NXP
- Tons of data gathered during 24-7 production
- Make the invisible visible:
  Use data integration and machine learning techniques to extract valuable insights out of the production data
- Machine level and Factory level analysis

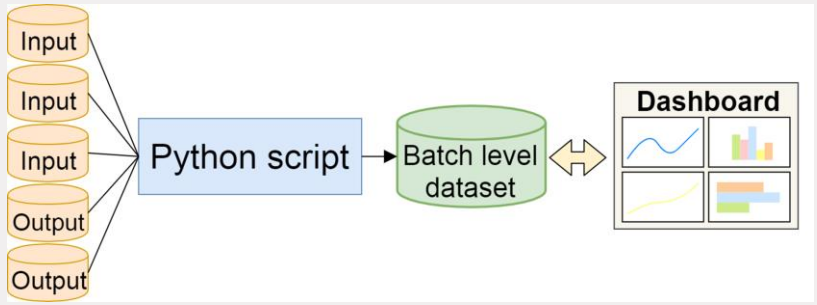


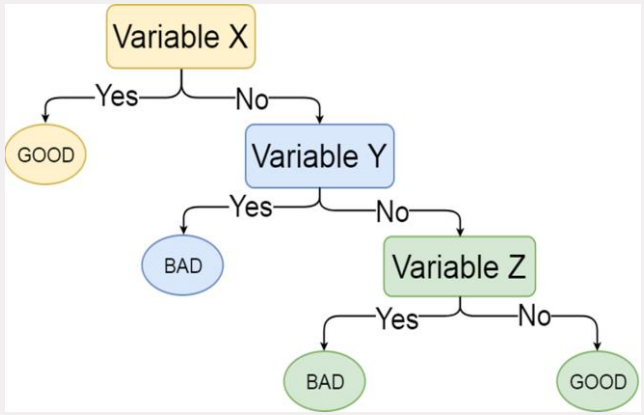


Machine level



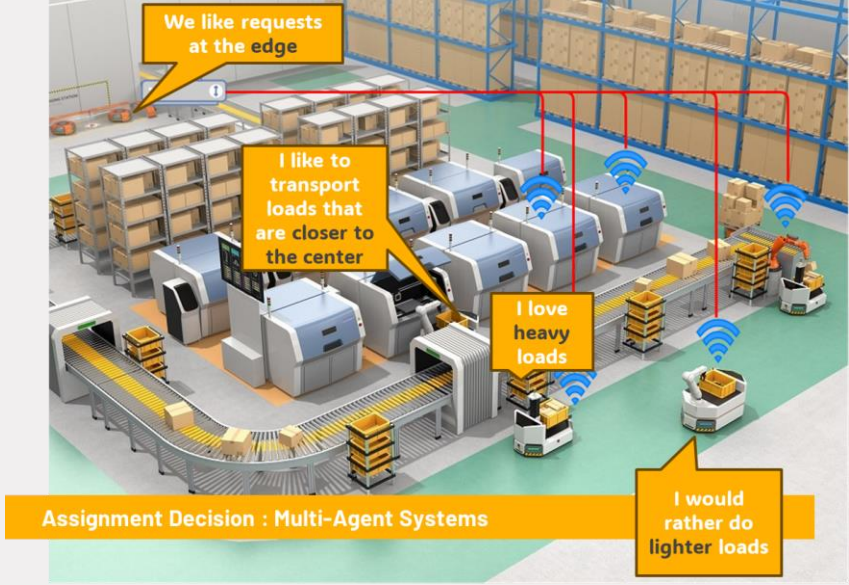
Factory level

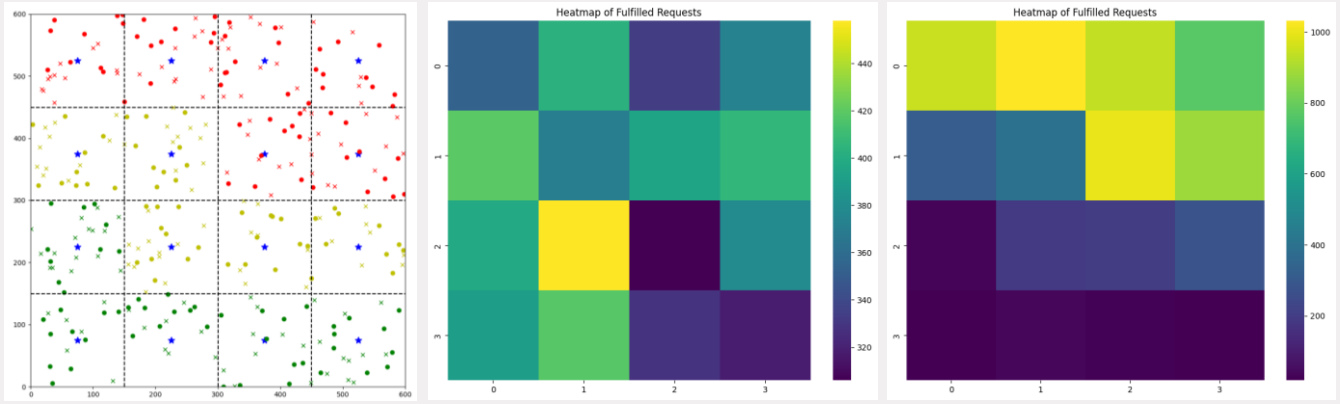




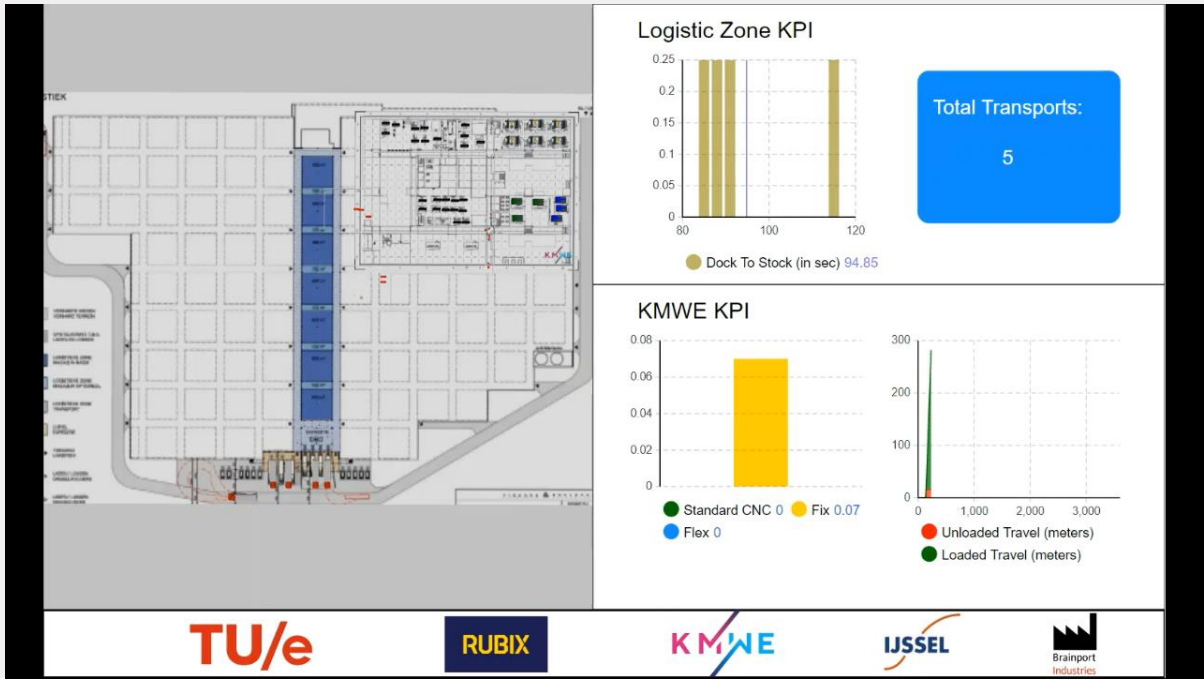
Project example: Smart Intralogistics

- Dispatching heterogeneous fleet of AGVs / AMRs
- Mathematical optimization models and AI-driven algorithms to solve (i) *the assignment of AGVs* to transport tasks, (ii) *scheduling of transport* and charging tasks, and (iii) *repositioning of AGVs*
- Decision-support tool: usable insights from the optimization models





Standard Software AI



TU/e

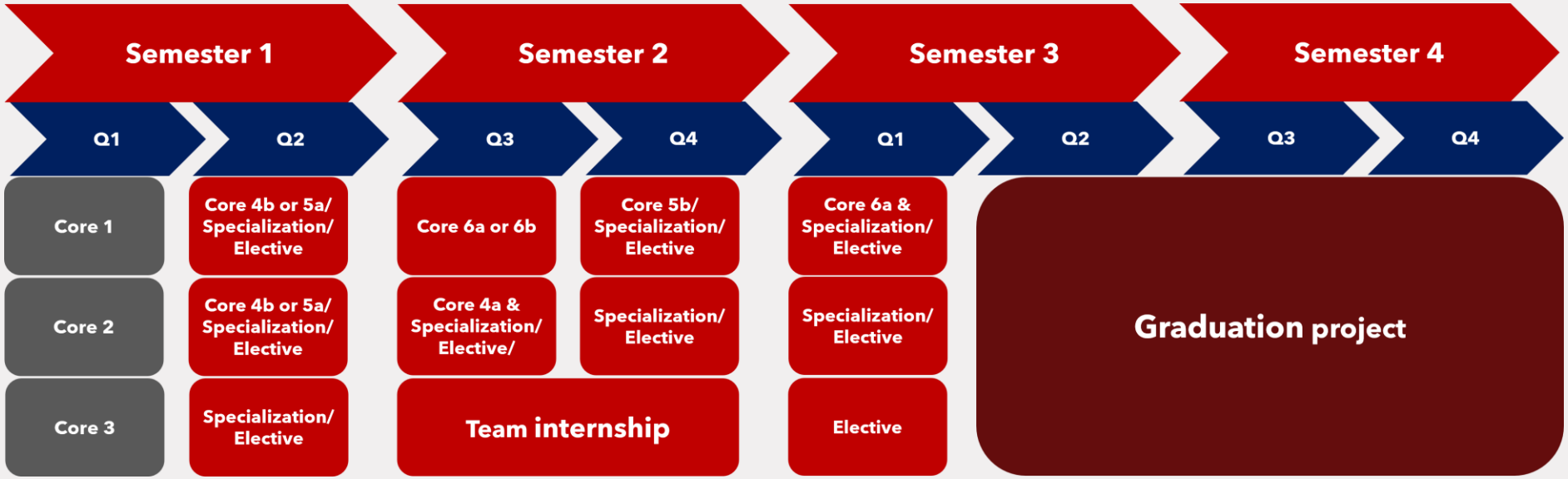
We welcome you in the Manufacturing systems track!

Choose your Track

Academic advisor Marijke Creusen

How to follow-up?

1. Choose your track!
2. Compose a draft program
3. Submit your final program for approval



Procedure track choice- Q1

When	What	Explanation
Sept 12	**'Choose your Track Event'**	Track information See also information and 'track video's' in the online AI&ES education guide.
Sept 19	**Submit your final Track Choice**	Via Canvas form in 5INFO, section 'quizzes'. Please, fill in al required fields.
Sept 20 / Sept 23	**Allocation to a track mentor**	Based on your final choice, you will be allocated to a track mentor. The track mentor will contact you to schedule a first group meeting.

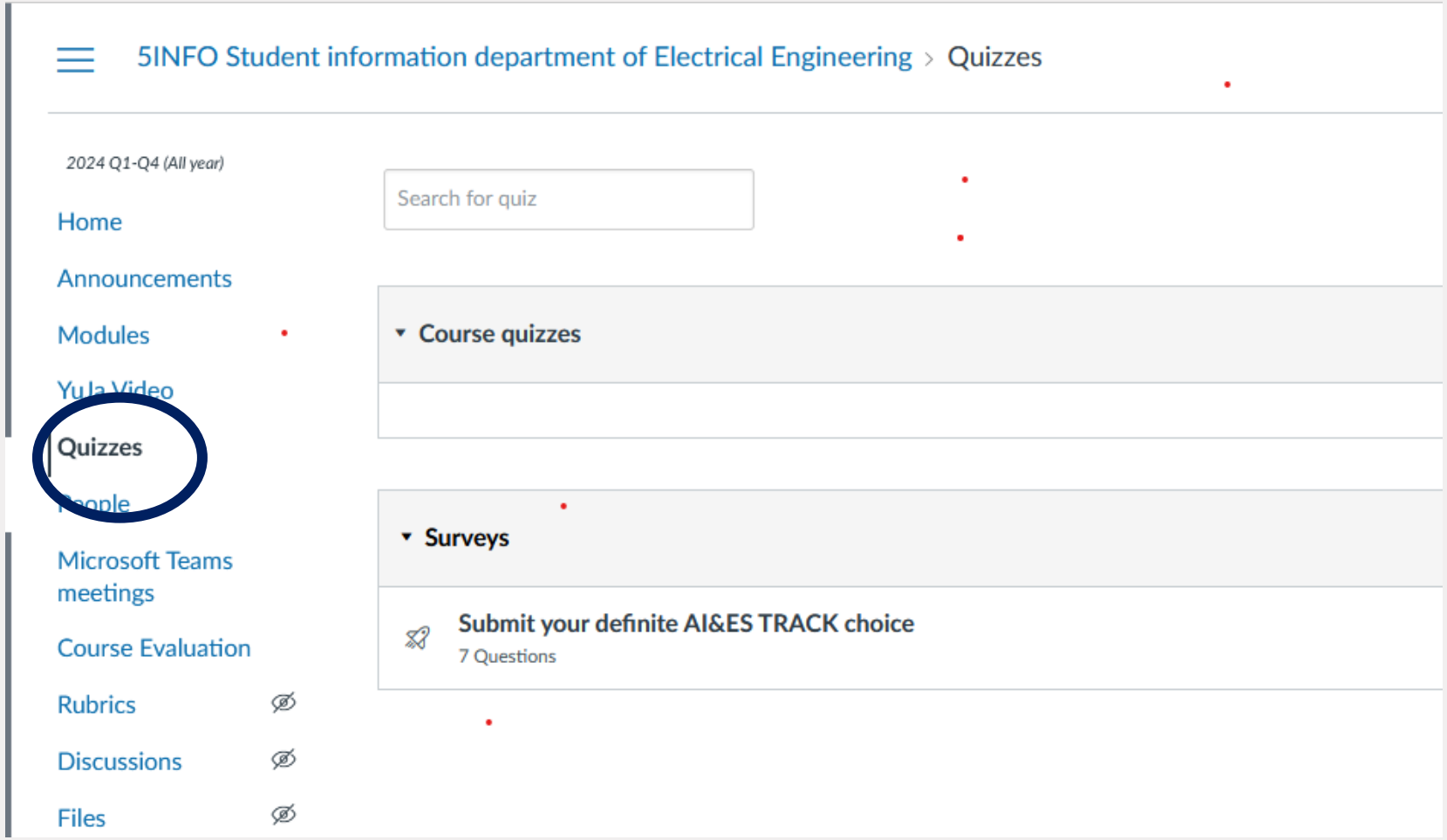
Procedure composing program of examinations - Q1

When	What	Explanation
Before Sept 23	**Prepare the first track mentor meeting**	Think about the following: • Your **motivation** for selecting this track • **Deficiencies** you still might have regarding your track selection • Your first ideas on the **specialization electives** would you like to do • Your preference regarding a **graduation direction** (specific department / research group) • The possibility to have an **international experience**
Between Sept 23 – Oct 4	**First track mentor meeting**	• Course options, including domain specific courses • Start composing a draft course program • Deicide on the courses for Q2
During the track mentor meeting	**Sign 'TU/e Code of Conduct for Scientific Integrity'**	This form must be signed in the presence of your mentor. Afterwards you submit a copy of this form via email to ee.CSA@tue.nl
Before Oct 13	**Registration deadline!** **Courses Q2 and exams Q1**	

Procedure submitting final program of examinations - Q2

When	What	Explanation
To be decided Q2	**Second mentor meeting**	Individual meeting between student and track mentor. Student takes the initiative. To discuss and decide upon your program of examinations.
Strongly recommended **Before the End of Q2**	**Submit your program of examinations to the examination committee for approval.**	Please, follow this procedure:. • You fill in this ***form***: 'program of examinations' • You send the form to your track mentor. • Your mentor signs this form as well: a confirmation that you have discussed the program together. • Your track mentor will e-mail you a PDF version of this final program. • Finally, you submit the PDF version via Osiris –Case, see also this link. Changes to this program can be made later, after consulting the mentor and after approval from the Examination Committee AI&ES. You need to re-submit a second ***'change'*** form via Osiris-Case.
Before Jan 5	**Registration deadline courses and exams semester B**	

Track choice → via Canvas 5INFO (2024)



TU/e Code of Scientific Conduct – via AI&ES online Education Guide

TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

Declaration concerning the TU/e Code of Scientific Conduct

I have read the TU/e Code of Scientific Conduct[1].

In carrying out research, design and educational activities, I shall observe the five central values of scientific integrity, namely: trustworthiness, intellectual honesty, openness, independence and societal responsibility, as well as the norms and principles which follow from them.

Date

.....

Name

.....

ID-number

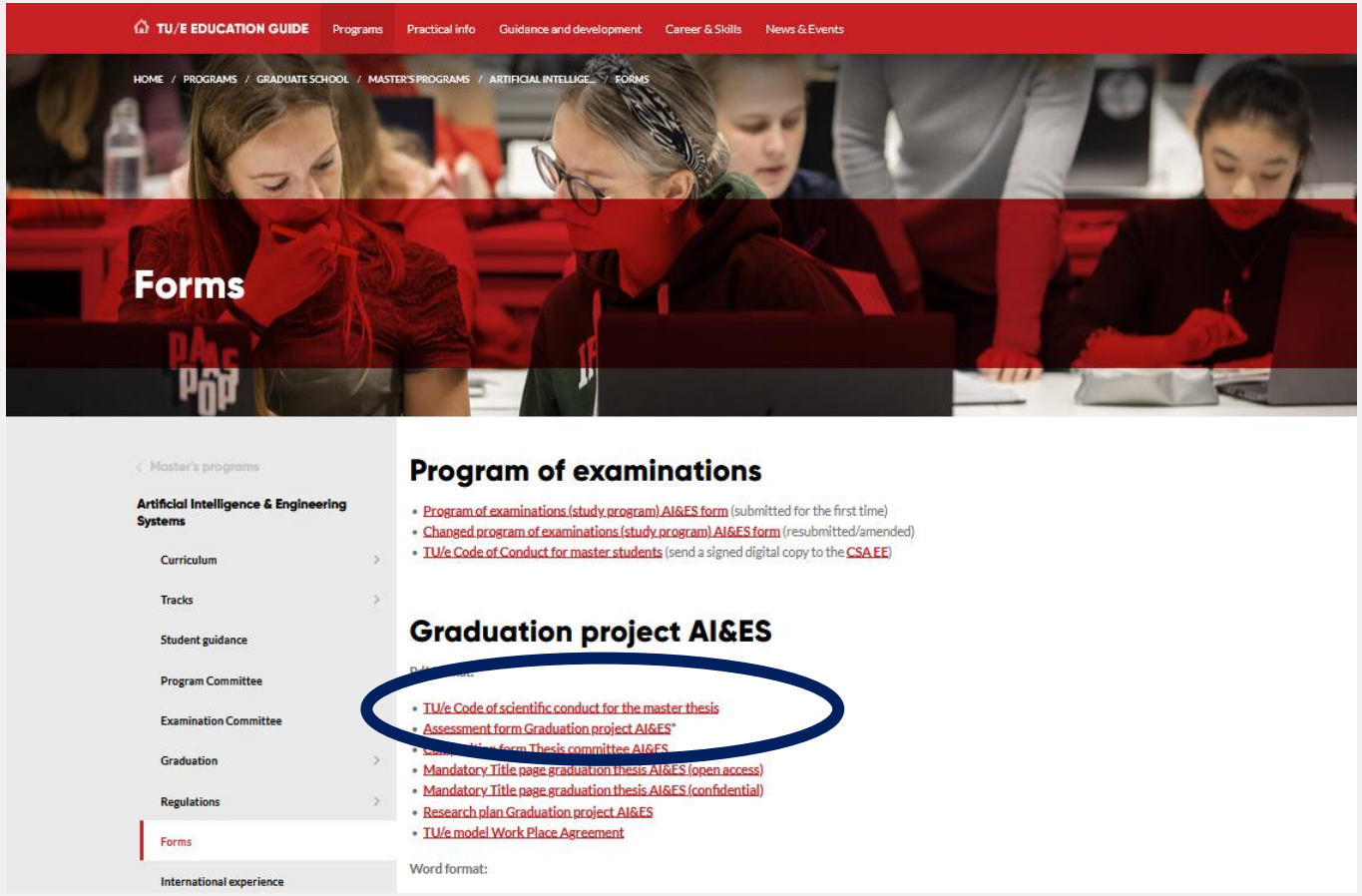
.....

Signature

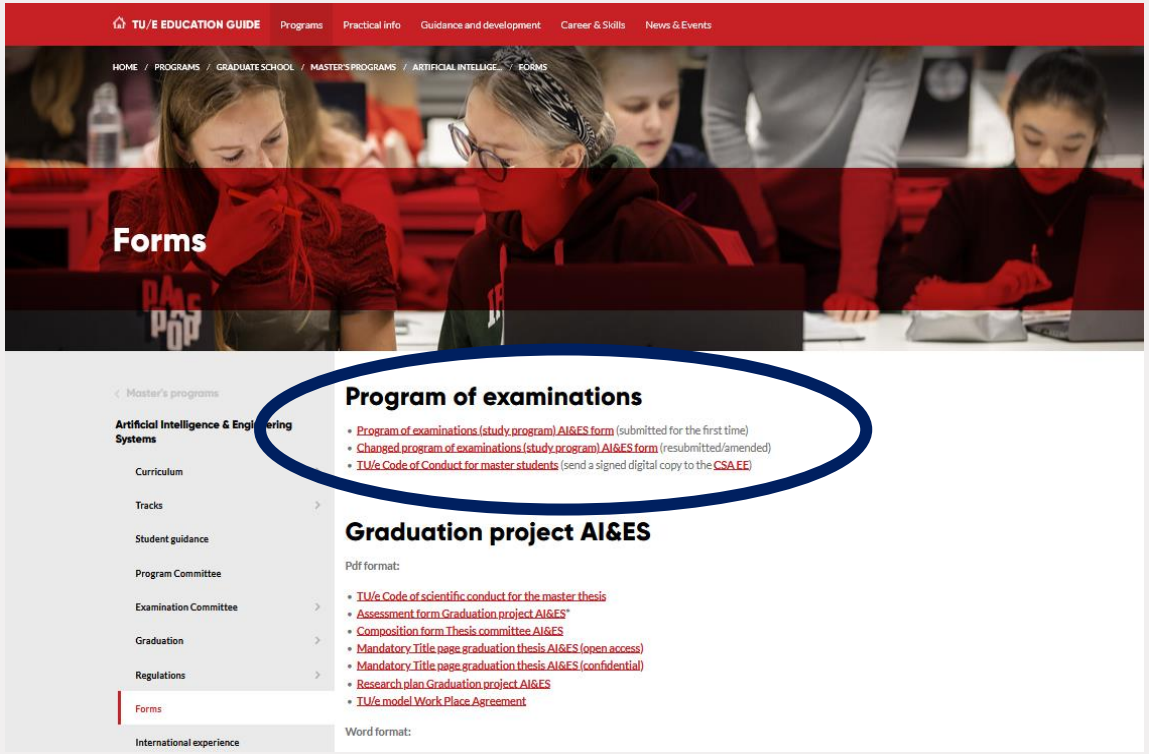
.....

Submit the signed declaration to the student administration of your department.

[1] See: https://www.tue.nl/en/our-university/about-the-university/organization/integrity/scientific-integrity/
The Netherlands Code of Conduct for Scientific Integrity, endorsed by 6 umbrella organizations, including the VSNU, can be found

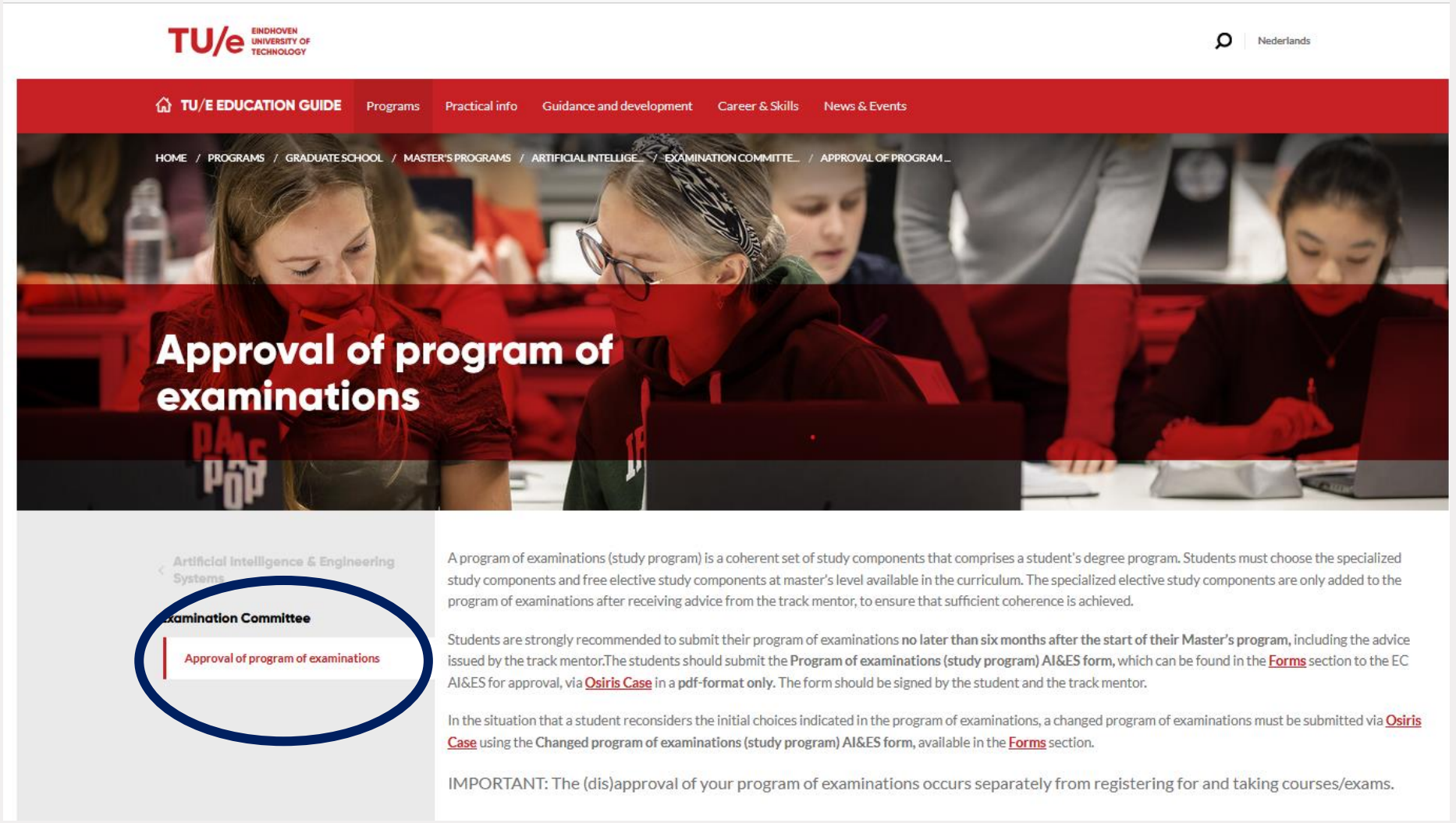


Program of examination form – via AI&ES online Education Guide



	A	B	C	D
	Study Program Form Master Artificial Intelligence & Engineering Systems			
	Personal information		Remarks	
	Student name:			
	Student ID:			
	TU/e email address:			
	Date of master subscription:			
	Prior university bachelor and/or pre-master education:			
	General information		Remarks	
	Submission date:	yyyy/mm/dd		
	First version study program (yes/no):		Is this a new program (yes) or a changed program (no)?	
	Track		Remarks	
	AI&ES track:		1. High-tech systems and robotics, 2. Mobility, 3. Healthcare, 4. Smart cities, 5. AI foundations and science applications, or 6. Manufacturing systems	
	AI&ES track mentor:			
	Exam program discussed with track mentor (yes/no):			
	Graduation project department:		Leave blank if not yet known	
	Graduation project research group:		Leave blank if not yet known	
	Graduation project supervisor:		Leave blank if not yet known	
	Master program			
	Core courses		Remarks	
	1. 5ARB0 Data science: acquisition and analysis	5 EC	Mandatory core course	
	2. 5ARC0 Human and ethical aspects of AI	5 EC	Mandatory core course	
	3. 5ARA0 Software engineering for artificial intelligence	5 EC	Mandatory core course	
	4a. 5SMC0 Control principles for engineered systems or 4b. 4CM40 Physical and data-driven modelling	5 EC	Depending on your choice, leave only course 4a or 4b visible	
	5a. 5SSD0 Bayesian machine learning and information processing or 5b. 1BM120 Decision making with artificial and computational intelligence	5 EC	Depending on your choice, leave only course 5a or 5b visible	
	6a. 5CTA0 Statistical signal processing or 6b. 4DM20 Engineering optimization	5 EC	Depending on your choice, leave only course 6a or 6b visible	
	TOTAL	30 EC		
	Interdisciplinairy team project		Remarks	
	5ARIP0 Interdisciplinairy team project	10 EC		
	TOTAL	10 EC		
	Specialization courses		Remarks	
	Domain-specific knowledge			
	Course code & course name	... EC		
	AI in engineered systems			
	Course code & course name	... EC		
	Data cultivation			

Approval program of examination - via AI&ES online Education Guide



Program Committee AI&ES

Aditya Ade – student member committee

The AI&ES Program committee (PC)

The role of the PC AI&ES:

- To guard and enhance the quality of the educational AI&ES (pre-)master programs.
- To contribute to educational innovation and educational enhancement within the programs.

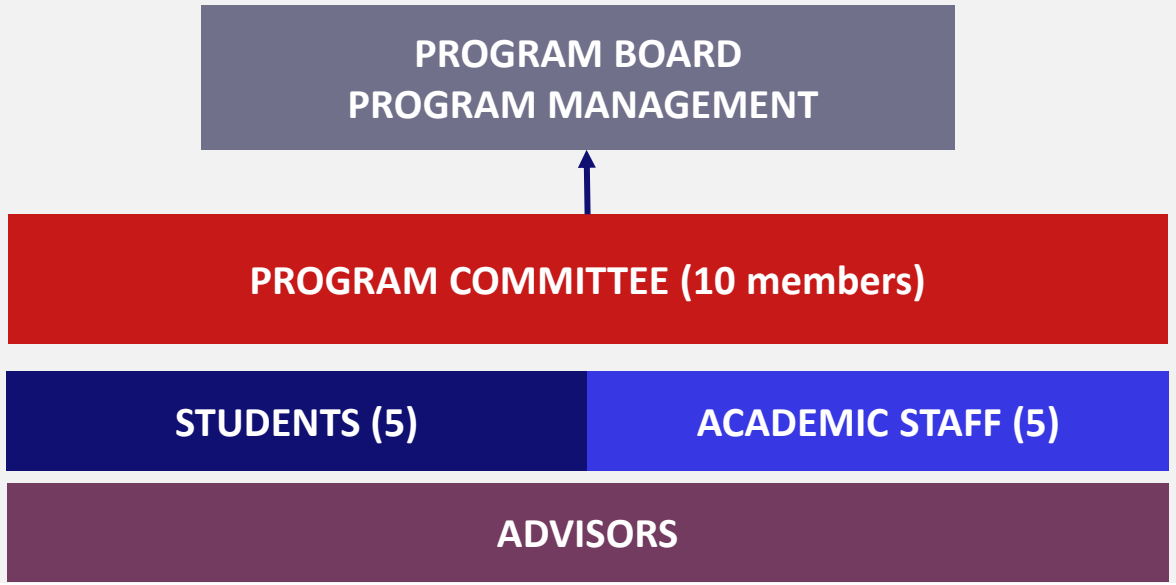
The responsibilities of the PC AI&ES:

- To discuss and advice on the design of the **curricula**, **policy-making** and other **educational related matters** to the program director, the departmental board, and teaching staff.
- To discuss, advise, and approve on **specific sections of the Program and Exam regulations (PER**), and to **assess its implementation.**
- The right of consent regarding the **quality assurance plan** of the department.

The PC is looking for new student-members!!

- Monthly meetings: prepare & participate
- You can put topics on the agenda!
- A one-year term
- You will receive a reimbursement
- You will contribute to the development of the AI&ES programs

Please reach out to academic advisor AI&ES if you're interested.
More information on the application procedure will follow later.



AI&ES Info Market

& Drinks

Track 1 and Track 4 in this room
Track 2, 3, 5 and 6 in the next room