



UNIVERSITY OF TARTU
Institute of Computer Science



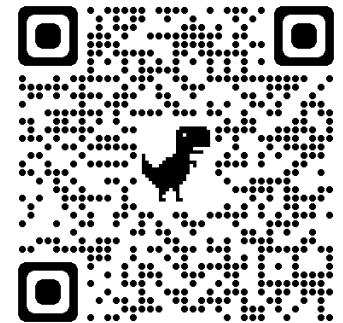
SEA Group: Software Engineering Analytics

University of Tartu
Alumni Day 2024

Dietmar Pfahl

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<https://sep.cs.ut.ee>



My Journey to Tartu /1

1981-2005



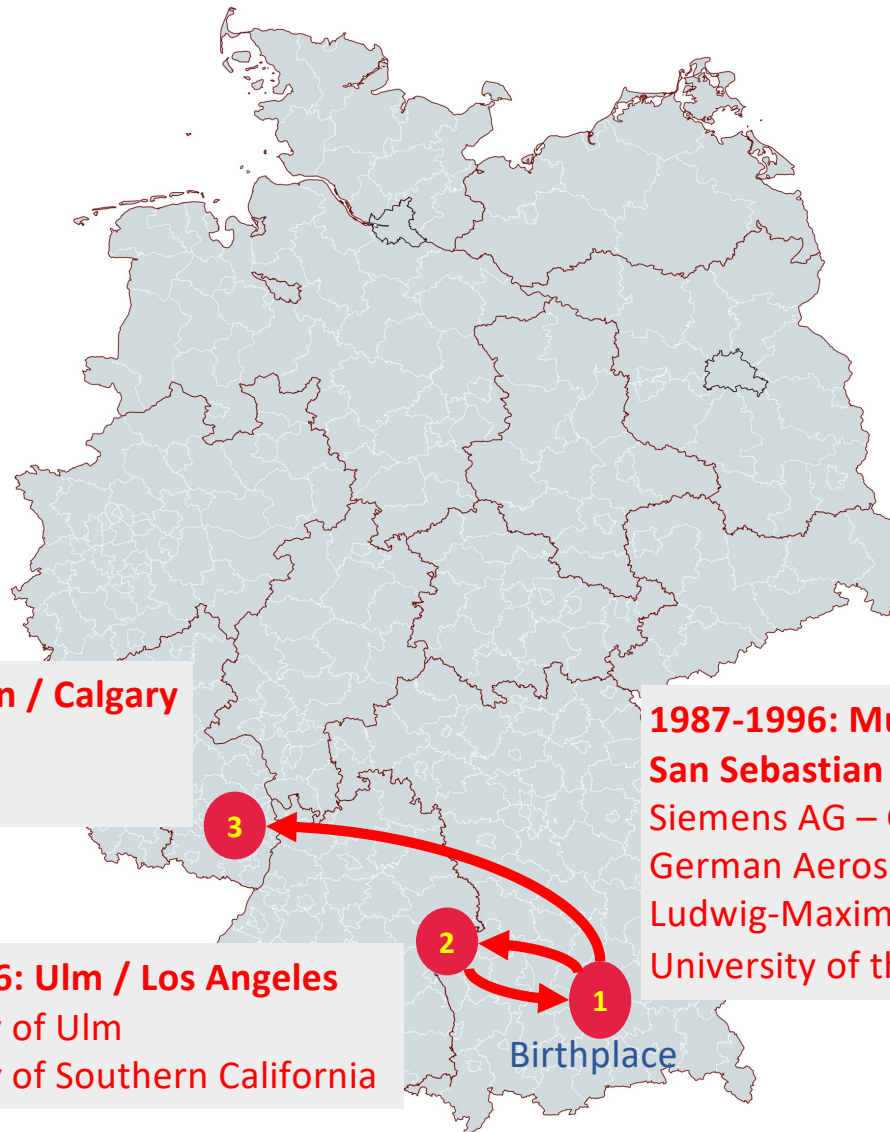
Dietmar Pfahl



1996-2005: Kaiserslautern / Calgary
Fraunhofer IESE
University of Calgary



1981-1986: Ulm / Los Angeles
University of Ulm
University of Southern California



Spain
Basque Country



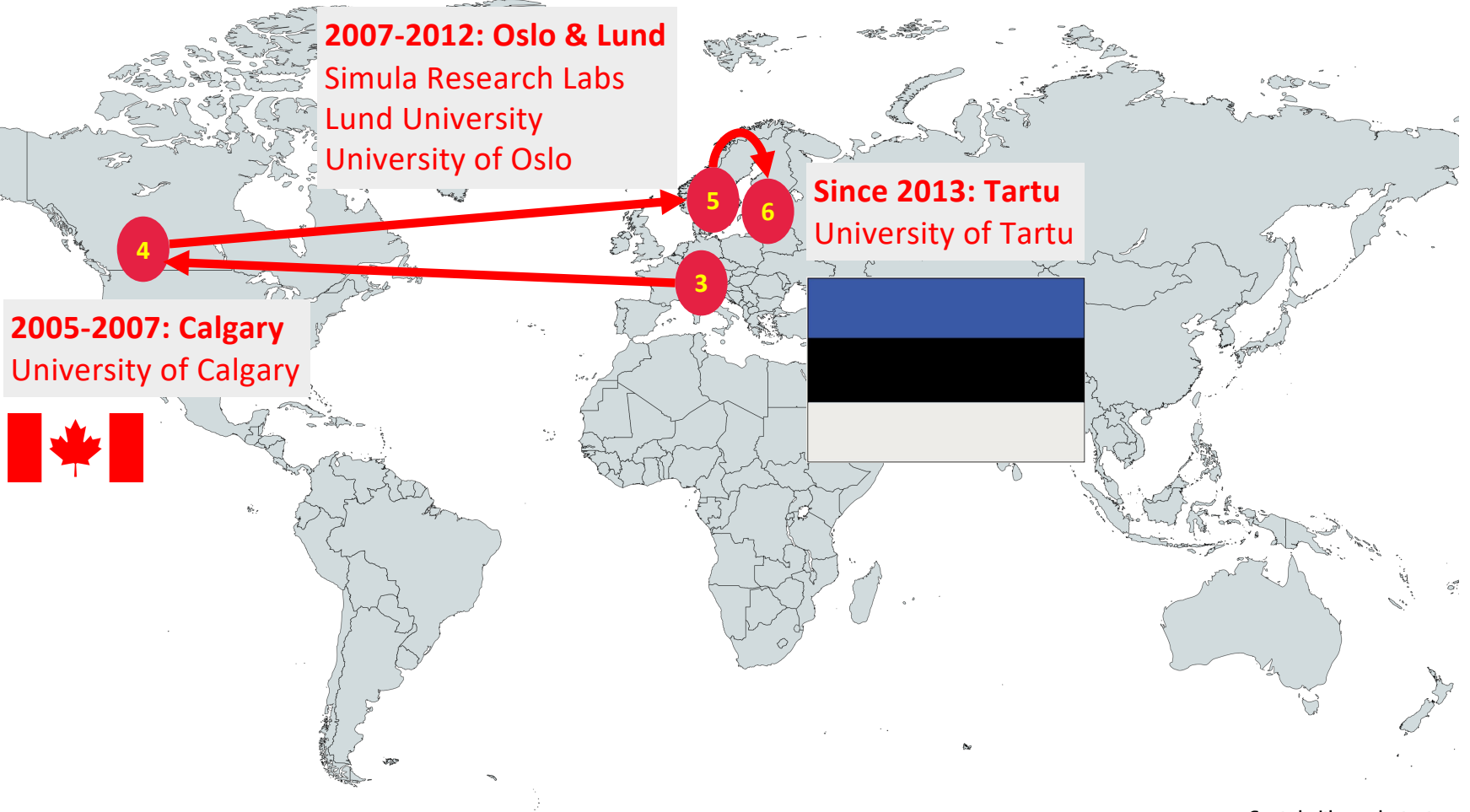
1987-1996: Munich / Oberpfaffenhofen / San Sebastian (Donostia)
Siemens AG – Corporate Research
German Aerospace Research Establishm't
Ludwig-Maximilians University
University of the Basque Country

My Journey to Tartu /2

2005-2024



Dietmar Pfahl



Software Engineering Analytics – The Team

Dietmar Pfahl
(Professor)



Hina Anwar
(Assistant Professor)

Faiz Ali Shah
(Assistant Professor)



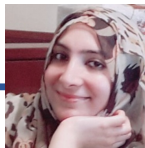
Kristiina Rahkema
(Assistant Professor)

Aleja Duque-Torres
(Junior Researcher, PhD Student)



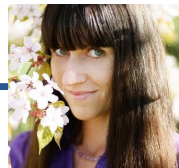
Fauzia Khan
(Junior Researcher, PhD Student)

Maj-Annika Tammisto
(Junior Researcher, PhD Student)



Maria Khan
(Junior Lecturer, PhD Student at TLU)

Laima Anna Dalbina
(Programmer, MSc Student)



Past members of SEA:

- Ezequiel Scott (Assistant Professor)
- Mariana Falco (Visiting Researcher)
- Tarcio Bezerra (Visiting Researcher)
- Huishi Yin (former PhD Student)
- Riivo Kikas (former PhD Student)



Software Engineering Analytics – The Mission

“To collect and analyze software engineering data with the goal to estimate, predict, and improve the quality of software and software-intensive systems”

Notes:

- Software Engineering = A systematic approach to develop software with the expected quality, within a given time and effort budget
- Software quality has many dimensions/facets, e.g., functionality, dependability, maintainability, performance, energy-efficiency, etc.
- The terms “estimate, predict, and improve” imply the development of models and tools (prototypes)

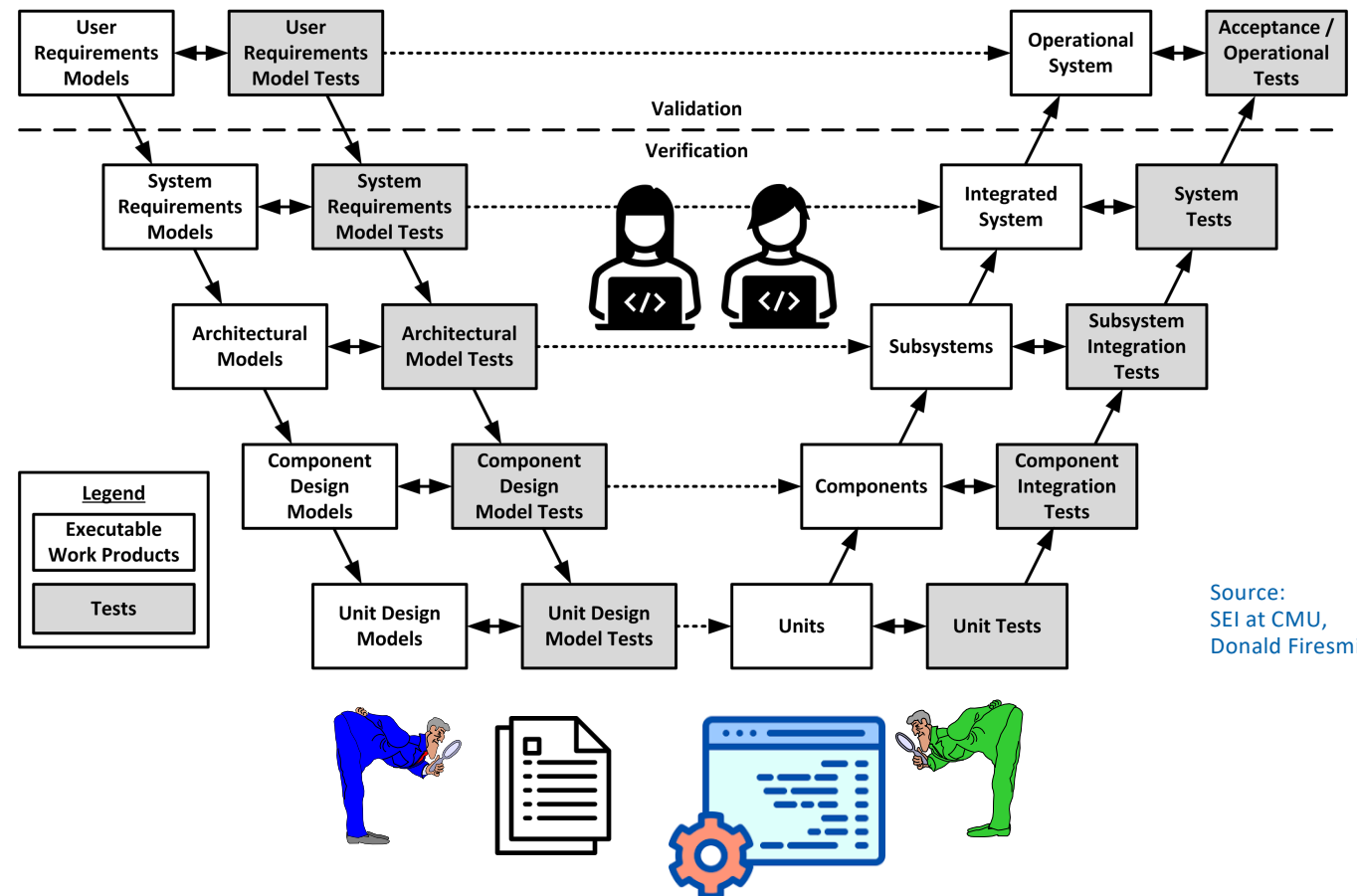
Software Engineering Analytics – The Scope

What we do:

- Methods and tools for static document and code analysis
- Methods and tools for dynamic code analysis (incl. testing)
- Methods and tools for quality estimation and prediction
- Methods and tools for selecting, augmenting, and generating test data, test cases, test oracles, and test code

Note:

- All of this may or may not involve AI



SEA Project Example 1: Mobile App Feature Analysis

Research Topic:

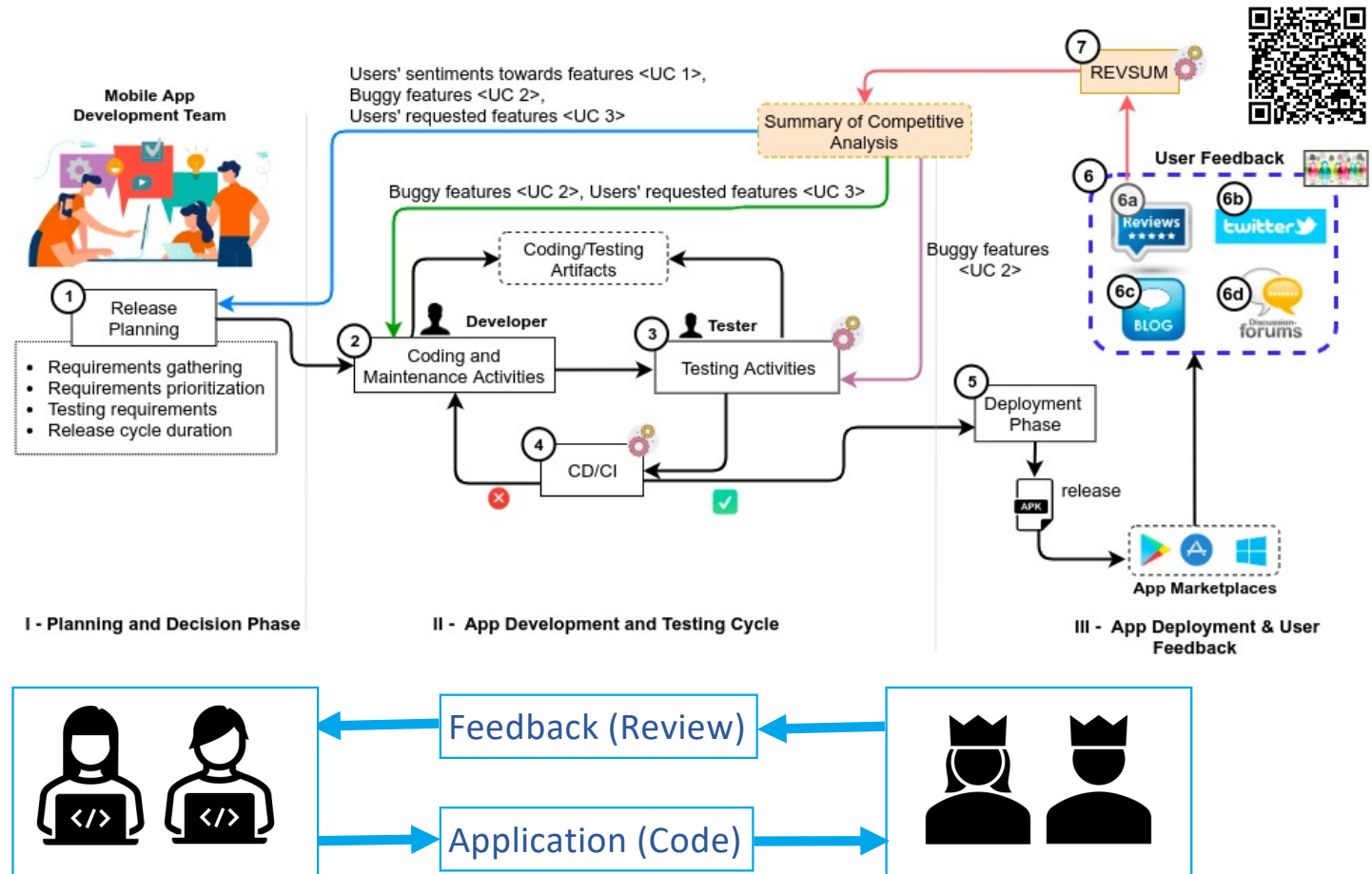
- Automated extraction, selection, and classification of end user reviews (mobile apps) → what features are good/bad/missing?

Why?

- To support app feature maintenance and evolution decision-making

Who benefits?

- App developers and (indirectly) app end users



SEA Project Example 2: Mobile App Energy Efficiency

Research Topic:

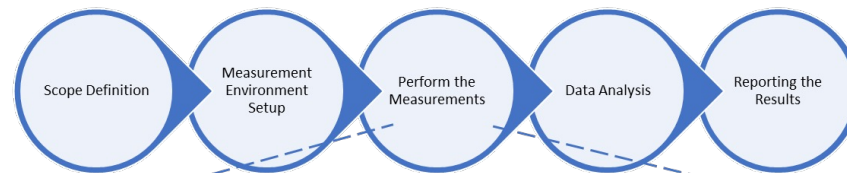
- Analysis of energy efficiency of code refactoring -> trade-off between maintainability and efficiency
- Analysis of energy efficiency of third-party library code -> recommend what library to use for specific tasks, if energy efficiency is important

Why?

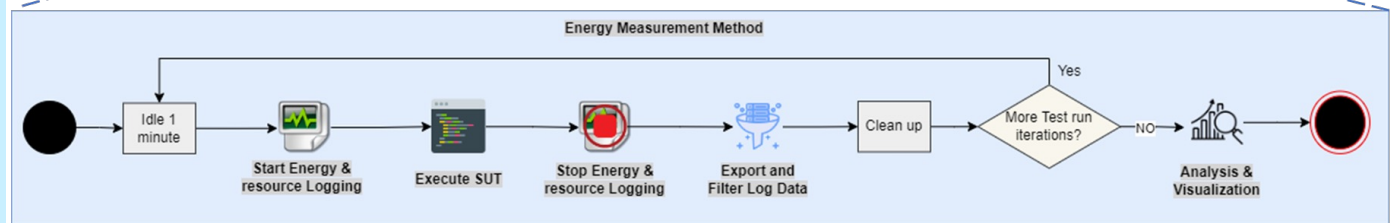
- To recommend energy-efficient refactoring decisions and library choices

Who benefits?

- App developers and (indirectly) app end users



Measured Metrics	Unit
Duration	s
Mean power draw	W
Energy	Wh or J
CPU usage	%
RAM usage	MB or %



Software-Based Energy Measurement Method

SEA Project Example 4: Test Oracle Generation

Research Topic:

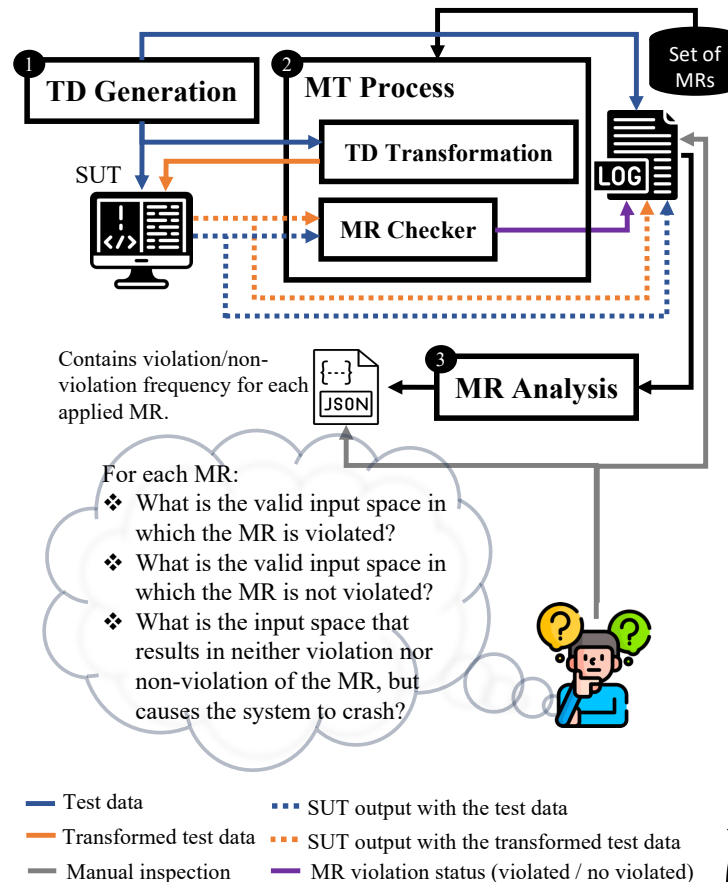
- Combine fuzzing (test data generation) and metamorphic testing to generate effective test oracles

Why?

- To (semi-)automatically select and constrain metamorphic relations for test suite generation and augmentation

Who benefits?

- Testers and (indirectly) software developers and software end users



Property of map search tool:
Should the path change,
if we swap s and d? → **NO**

Metamorphic Relation (MR):
`assertEquals((SUT(s,d) , SUT(d,s))`



SEA Project Example 5: Simulation-Based Safety Test

Research Topic:

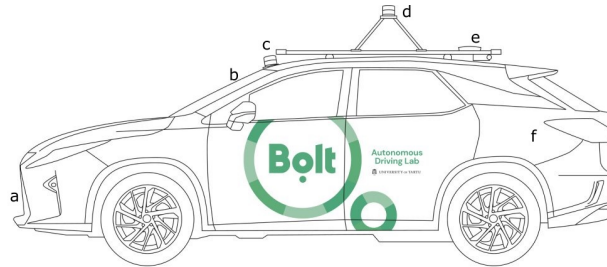
- Methods for simulation-based safety testing of Automated Driving Systems (ADS)

Why?

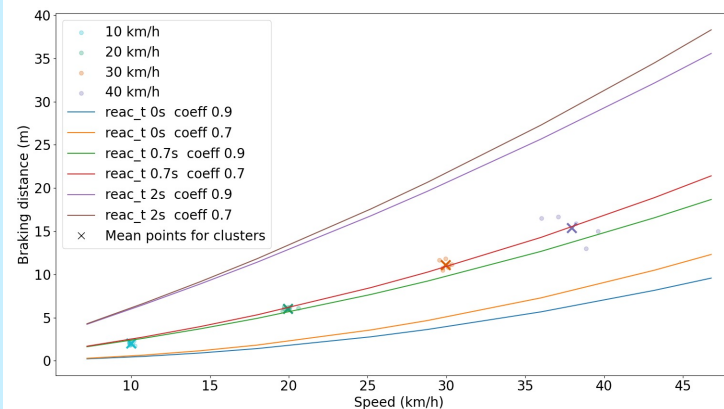
- To help improve the safety of ADS
- To complement on-road testing

Who benefits?

- Testers and developers of ADS and (indirectly) users of ADS and traffic participants where ADS operate



Comparing the emergency braking of simulated ADS versus theoretical reference modes:



SEA Project Example 6: Synthetic Test Data for X-tee

Research Topic:

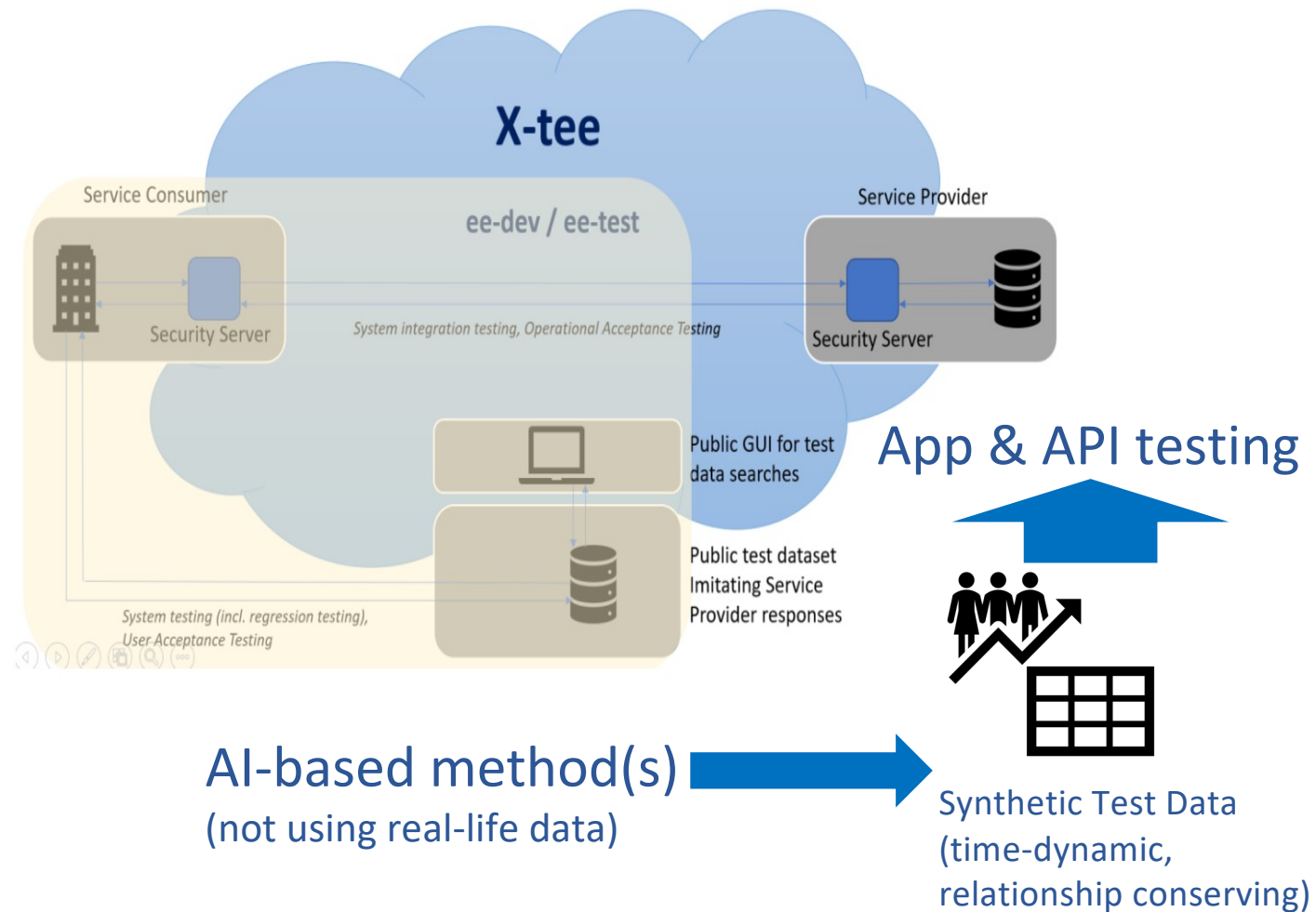
- Methods for automatic generation of relationship-conserving time-dynamic test data sets for the testing of X-tee services

Why?

- To increase test efficiency and effectiveness of X-tee services

Who benefits?

- Testers and developers of X-tee services and (indirectly) end users



SEA Supervision & Teaching

PhD (since 2014):

- 5 PhD theses completed at UT
- 2 PhD theses completed at University of Calgary
- 3 PhD theses ongoing



2 PhD theses to start in sep 2024:

- AI-powered methods for detecting and explaining security vulnerabilities in code
- A method for systematically assessing the safety of automated driving systems via simulation

MSc & BSc (since 2014):

- 50+ MSc theses completed
- 30+ BSc theses completed



Courses and Curricula we are responsible for:

- International MSc Software Engineering (program director)
- 3 MSc-level courses (6 ECTS per term / 35 students per term)
- 3 BSc-level courses (7.5 ECTS per term / 160 students per term)

SEA Collaboration & Service

**PROFES 2024
In Tartu !!!**



Collaboration:

- Within ICS/UT: ADL, Huber Flores' lab, Kairit Sirt's lab, Vesal Voidani's lab (in 4 other chairs)
- Within Estonia: joint MSc/BSc supervisions with companies / RIA
- Within Europe: Several collaborations with Universities and Research Institutes (Fraunhofer, SCCH), several EU project applications with many partners (academia, industry)
- Worldwide: Member of ISERN (International Software Engineering Research Network)

Service:

- Organizer of international conferences (ICSSP 2015 in Tallinn / ESEC/FSE 2019 in Tallinn / PROFES 2024 in Tartu)
- Member of several OCs, PCs, and steering committees worldwide
- Editorial board member of two top-level international journals (ESEM, INFOSOF)
- Volunteering in professional organisations (ACM, IEEE)
- Reviewer of grant application for several public funding agencies in Europe (Austria, Belgium, Finland, Ireland, Sweden, Switzerland, EU)

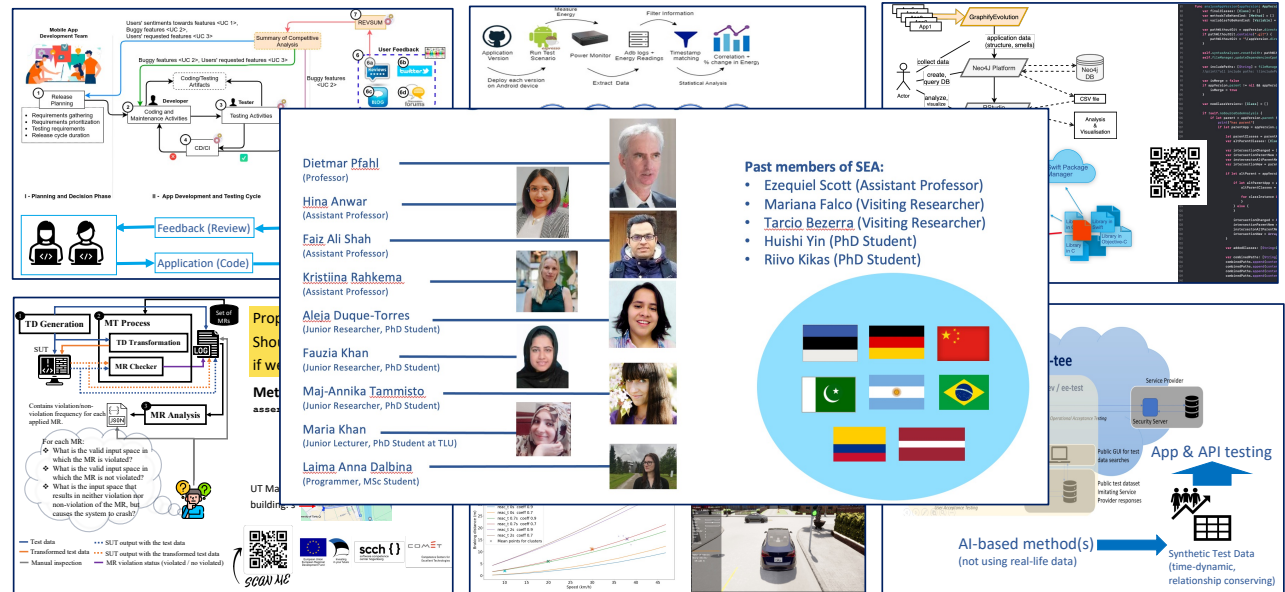
Wrapping it up

We are serving the Research Community, the Industry, the Society

by

- Extending the body of knowledge
- Building models and tools
- Educating the future work force

“To collect and analyze software engineering data with the goal to estimate, predict, and improve the quality of software and software-intensive systems”





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Institute of Computer Science

**Talk to us if you wish to learn
more about our research!**



Hina



Faiz



Kristiina



Dietmar



unitartu



tartuuniversity

