Turku University of Applied Sciences

Käytännön koulutus ja käyttö AI sovelluksille

Wednesday 19.03.2025

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Dean

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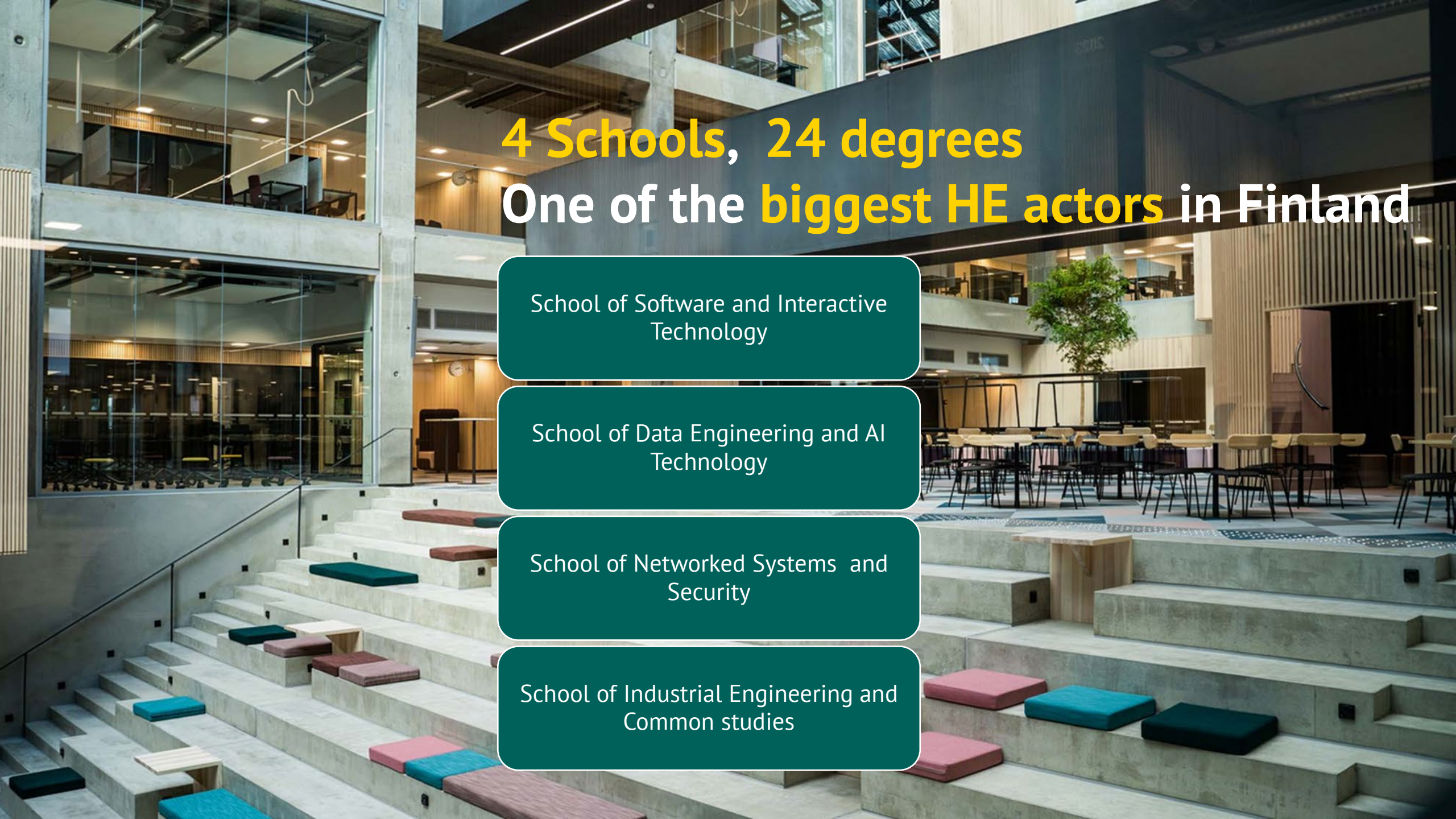
TURKU AMK
Business
Since
1229
Professional Education since 1816.
Creating future for 8∞ years. Now, always, Turku UAS.

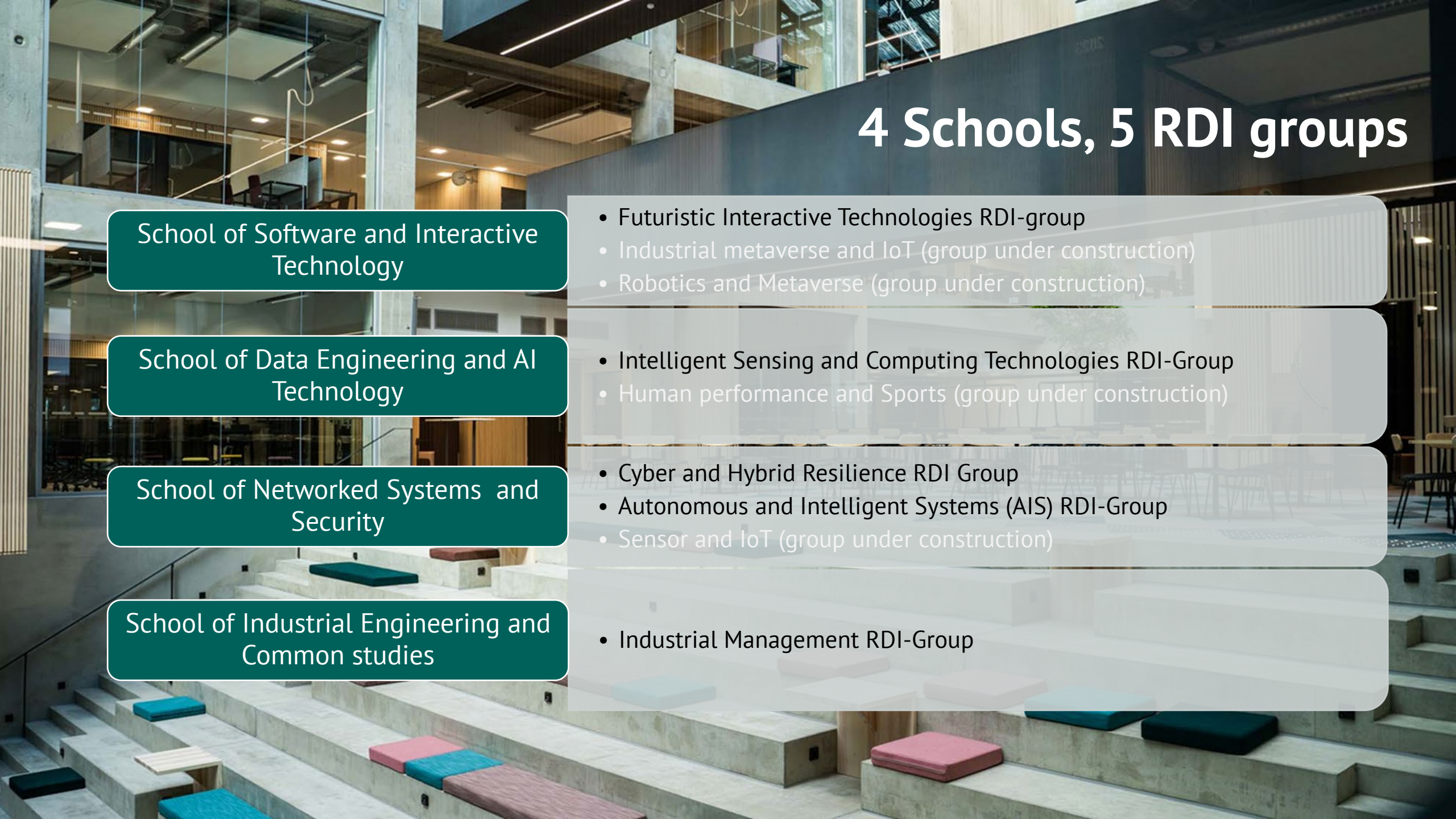

TURKU AMK
Our Mission: We solve the wicked problems of our era and upcoming generations.


TURKU AMK
Our Strategy: To bridge technology, skills and knowledge and stakeholder needs by uncovering benefits that drive real value.



4 Schools, 24 degrees
One of the biggest HE actors in Finland

- School of Software and Interactive Technology
- School of Data Engineering and AI Technology
- School of Networked Systems and Security
- School of Industrial Engineering and Common studies



4 Schools, 5 RDI groups

School of Software and Interactive Technology	• Futuristic Interactive Technologies RDI-group • Industrial metaverse and IoT (group under construction) • Robotics and Metaverse (group under construction)
School of Data Engineering and AI Technology	• Intelligent Sensing and Computing Technologies RDI-Group • Human performance and Sports (group under construction)
School of Networked Systems and Security	• Cyber and Hybrid Resilience RDI Group • Autonomous and Intelligent Systems (AIS) RDI-Group • Sensor and IoT (group under construction)
School of Industrial Engineering and Common studies	• Industrial Management RDI-Group

Data Engineering and AI education

Bachelor level

Data Engineering and AI studies concentrate on designing **data models, data processing and automating data pipelines**, and working with **massive datasets**. AI is accomplished by studying machine learning and the applications of artificial intelligence. The outcome of these studies develops intelligent software and system solutions.

Graduates
work in roles like data engineer, machine learning engineer, AI developer, data architect, and system designer.

Master level

The main themes of the education are **big data management** and the development of **AI-based solutions**.

The themes of the advanced studies are:

- Data Engineering Practices
- Machine Learning Process and Algorithms
- Applications of artificial intelligence

Modules in Bachelor's Data Engineering & AI

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1

Data Engineering & AI Essentials

- Basic skills for Data Management
- Introduction to Data Engineering
- Data Structures and Algorithms

2nd Autumn

2

Basic Processes for Data Engineering & AI

- Data Analytics & Machine Learning
- Big Data Engineering
- Introduction to Artificial Intelligence

2nd Spring

3

Advanced Processes for Data Engineering & AI

- Cloud Services
- Advanced Topics in Data Engineering & AI
- Deep Learning

3rd Autumn

4

Applications of Data Engineering & AI

- Software Development Operations
- Data Engineering Project
- Applications of AI

3rd Spring

5

R&D Project for Data Engineering & AI

- Advanced R&D project

4th Autumn

Modules in Master's Data Engineering & AI

TURKU AMK

Planning for the Future

- Tulevaisuuden toimintaympäristöt (Future Operating Environments)
- Tutkimus- ja kehittämismenetelmät (Research and Development Methods)

Basics of Data Engineering & AI

- Introduction to Data Engineering and AI Technologies
- Introduction to Cloud Technologies and Security

Data Engineering

- MLOps
- Data Engineering project

Artificial Intelligence

- Components and Application of Artificial Intelligence
- AI project

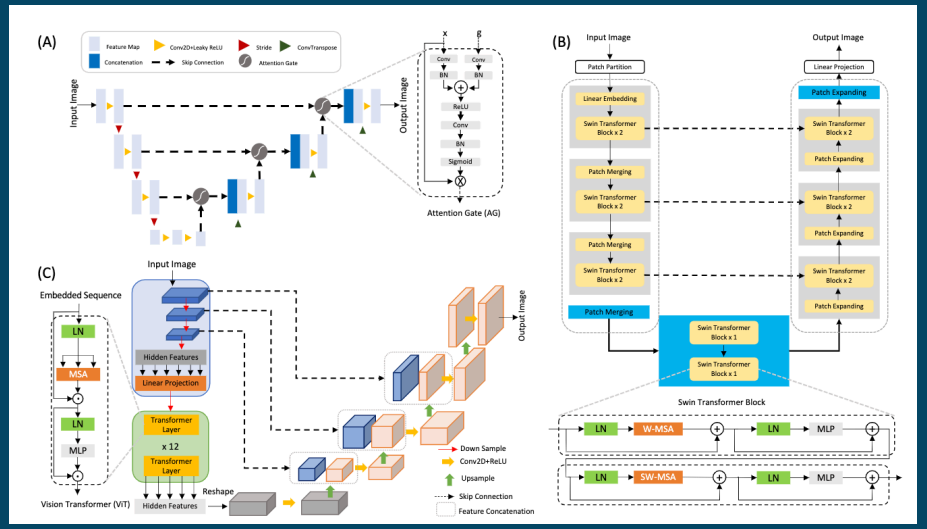
Federated Learning and Differential Privacy

Our team has developed several successful FL frameworks

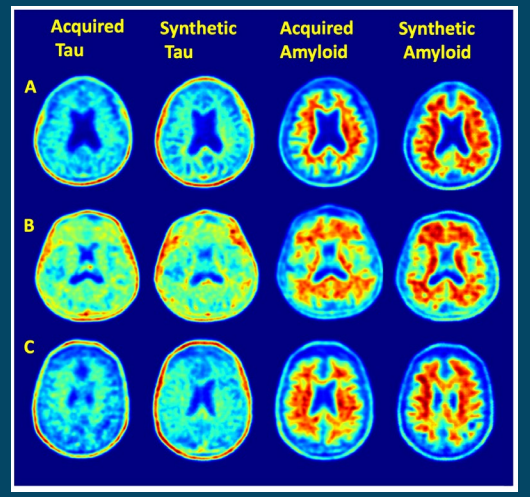
Many of them have been awarded winners in international FeTS Challenges, among others.

International FeTS Challenge
pushes AI boundaries

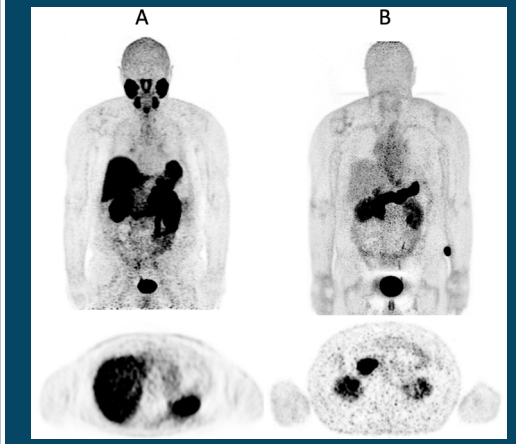
Generative DL models (GANs, Diffusion Models, VAE)



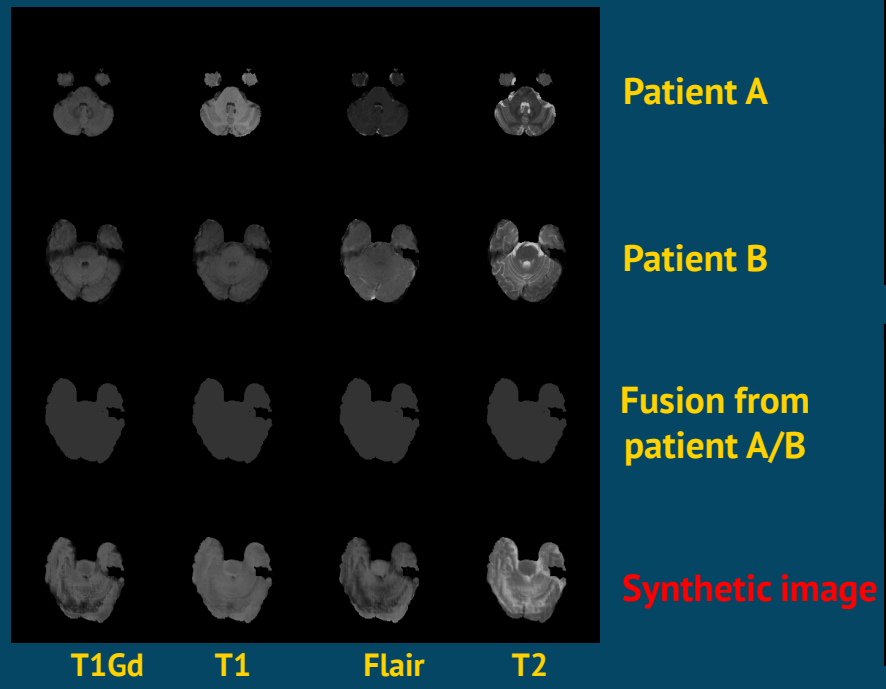
Tracer-to-Tracer PET Image Synthesis in Alzheimer's Disease



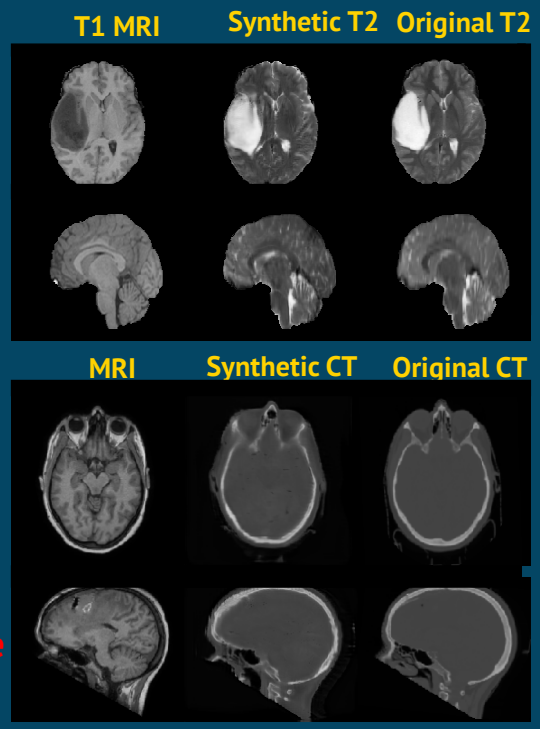
Tracer-to-Tracer PET Image Synthesis in Prostate Cancer



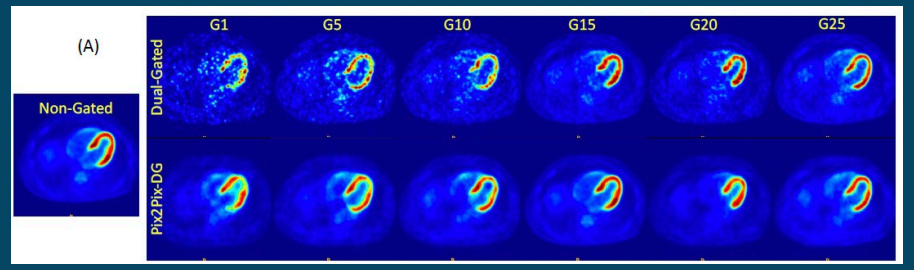
Synthetic Multi-Modal MRI using 3D Pix2Pix



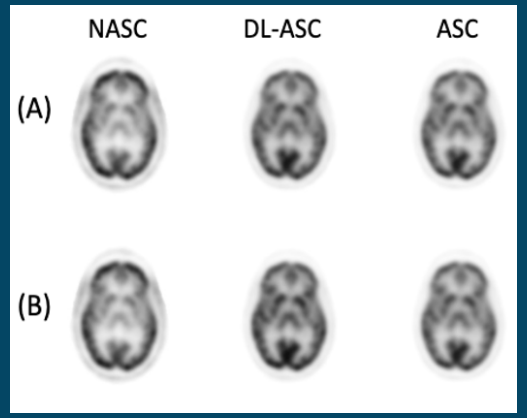
Cross-Modality Image Synthesis using CycleGAN



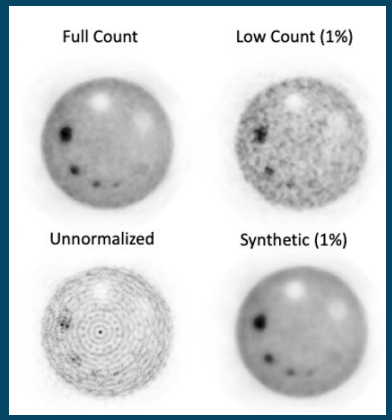
Cardiac PET Image Denoising using DL



Multi-Modal Vision Transformer GAN for Attenuation Correction



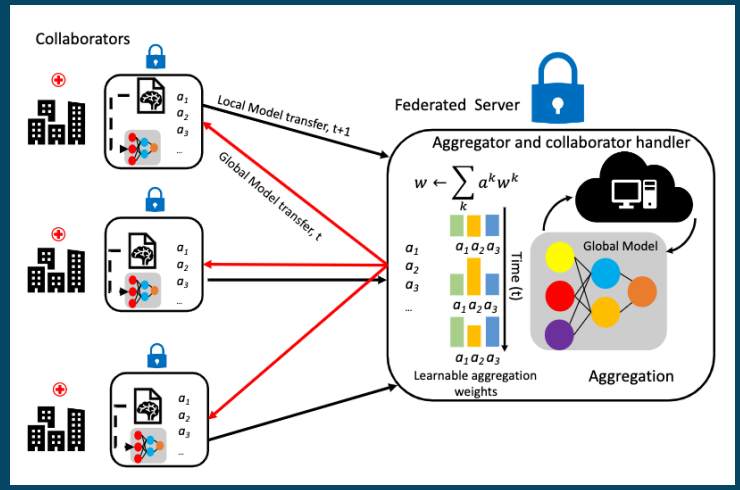
System Calibration and Denoising using DL



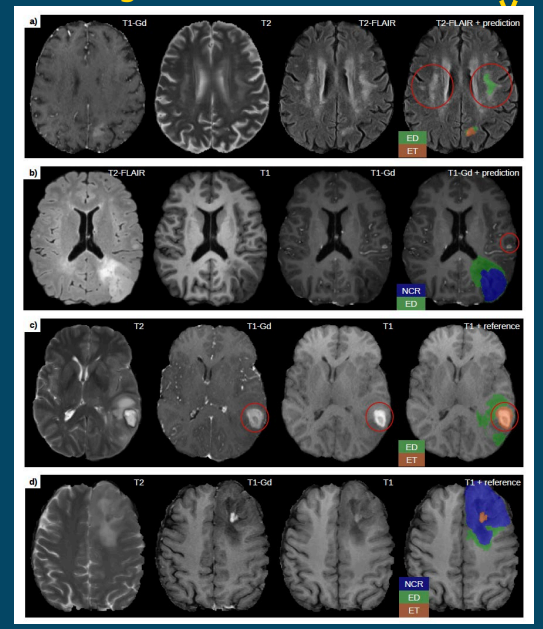
Federated Learning and Differential Privacy

- Our team has developed several FL frameworks so far:
  - **SimAGG** (FeTS 2021 Winner, MICCAI 2021)
  - **RegAGG** (FeTS 2021 Winner, MICCAI 2021)
  - **RegSimAGG** (FeTS 2022 Winner, MICCAI 2022)
  - **DP-SimAGG** (w/ central+ local differential privacy)
  - **RL-SimHAGG** (w/reinforcement learning)
  - **Recommender Engine** Collaborator selection (FeTS 2024, 4th Ranke, MICCAI)
  - **Bayesian SimAGG** (ICONIP 2024-NeurIPS 2024)
- We are constantly developing new FL frameworks and testing the robustness and reliability of our FL algorithms.

Parameter aggregation mechanism



Lesion Segmentation in Brain MRI



Bayesian SimAGG

HSimAGG Algorithm

$$\bar{p} = \frac{1}{|C^r|} \sum_{c \in C^r} p_c, \quad (1)$$

$$\text{sim}_c = \frac{\sum_{j \in C^r} |p_j - \bar{p}|}{|p_c - \bar{p}| + \epsilon}, \quad (2)$$

Similarity factor → $$w_{\text{sim},c} = \frac{\text{sim}_c}{\sum_{j \in C^r} \text{sim}_j}. \quad (3)$$

Data size factor → $$w_{\text{size},c} = \frac{N_c}{\sum_{j \in C^r} N_j}, \quad (4)$$

Averaging factor → $$w_c = \frac{w_{\text{sim},c} + w_{\text{size},c}}{\sum_{j \in C^r} (w_{\text{sim},j} + w_{\text{size},j})}. \quad (5)$$

Harmonic Mean → $$p^m = \frac{1}{\sum_{i \in C^r} \frac{w_i}{p_i}} \cdot \Sigma_{i \in C^r} (w_i \cdot p_i) \quad (6)$$

Bayesian Algorithm

$$p_c \sim \mathcal{N}(\boldsymbol{p_m} \cdot \boldsymbol{b_c}, \lambda) \quad (8)$$

$$b_c \sim \mathcal{N}_+(\mu_c, 0.1) \quad (9)$$

$$p_m \sim \mathcal{N}(0, 1) \quad (10)$$

$$\lambda = 1 \quad (11)$$

$$\mu_c = 1 \quad (12)$$

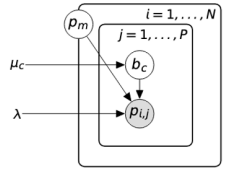


Fig. 3: Plate diagram for the Bayesian model.

– b_c: Bias for each tensor.

The likelihood is modeled as:

$$p[i,j] \sim \mathcal{N}(p_m[j] + b_c[i], \lambda) \quad (13)$$

modeling each element of the tensors as a normal distribution with mean $p_m[j] + b_c[i]$ and variance λ.

NNMF Recommender Engine

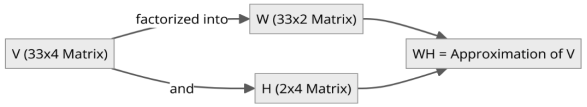
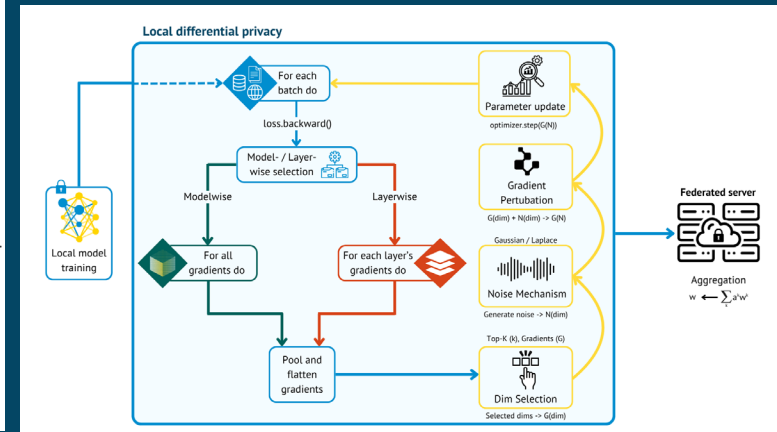


Fig. 1: Non-negative matrix factorization (NNMF) strategy.

Differential Privacy



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Generative AI in Metaverse

Generative AI widely used in our metaverse solutions. With Meyer Turku we have developed collaborative design space where differences annotated using spoken words. With companies such as Kemira, Valmet, Metsä and Lingsoft we have used LLMs to develop AI assistants.

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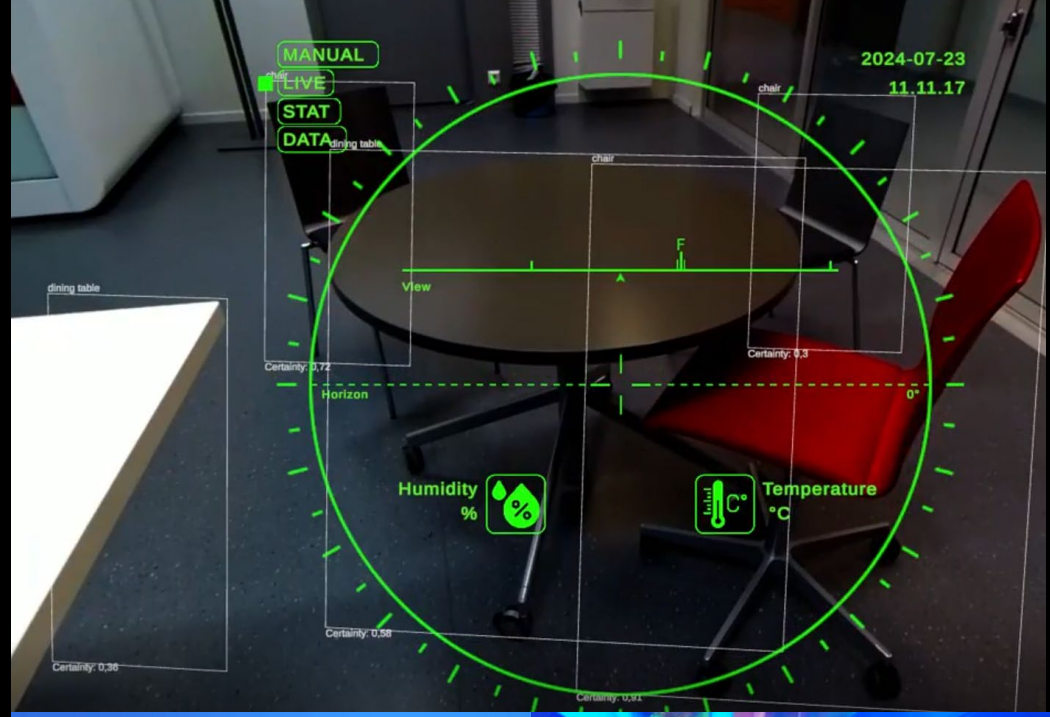
Object Detection

Together with Nokia we have developed next generation remote controlled systems utilizing Nokia's RXRM technology. From real-time 360 video streaming possible to detect objects and visualize augmentation on advanced Uis.



NOKIA

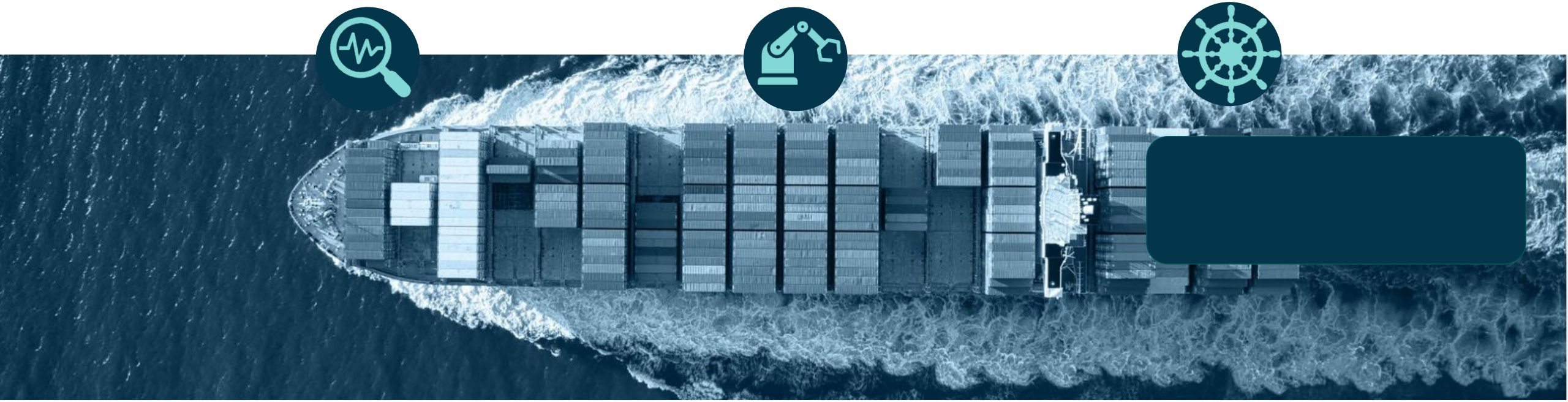
Case study

Turku University of Applied Sciences creates successful teleoperation solution on Nokia RXRM platform

- A new element for collaborative industrial metaverse, building on Nokia's RXRM technology
- Improves remote operations in mobile environments such as the maritime industry
- Users from different locations can work in the same virtual space simultaneously, gaining significant efficiencies

Turku UAS

AI in marine environment



Main Goals & Activities

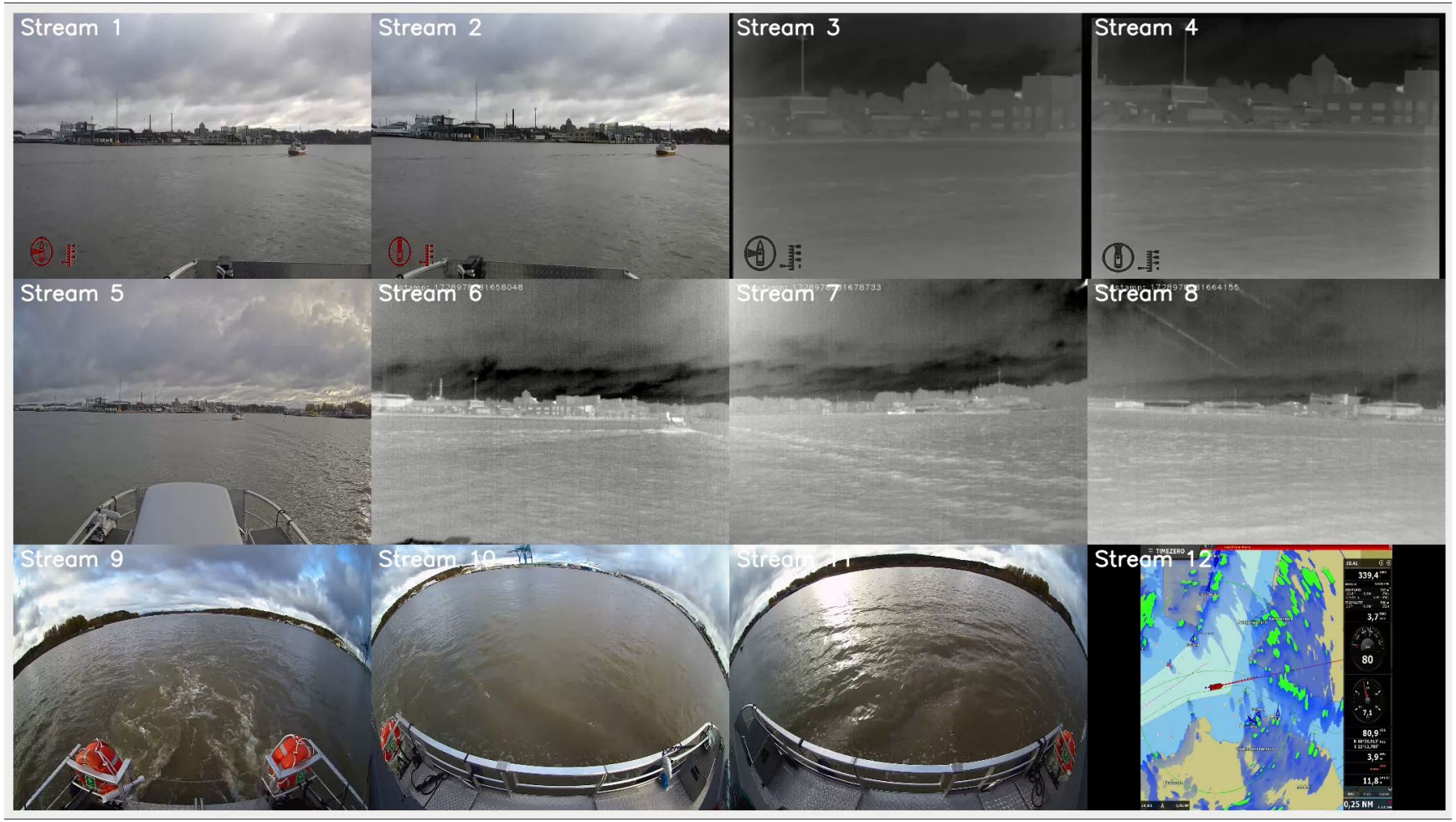
- 1. Multi-Modal and View Sensors Data Collection and Publishing Open Data Set
- 2. AI-Based Auto labeling
- 3. Generating Synthetic Data and Publishing Open Data Sets
- 4. Object Detection & Tracking & Sea Line Detection
- 5. Distance Detection and Cloud Point Creation
- 6. Sensor Fusion
- 7. Human and Robot Interaction
- 8. Monitoring and Object Detection by Drones
- 9. Auto face blurring and Life Jacket Detection
- 10. Lane Detection and Path Planning
- 11. Distributed Navigation for Autonomous Systems
- 12. Federated Learning in Maritime Environments

Multi-Modal and View Sensors Data Collection and Publishing Open Data Set

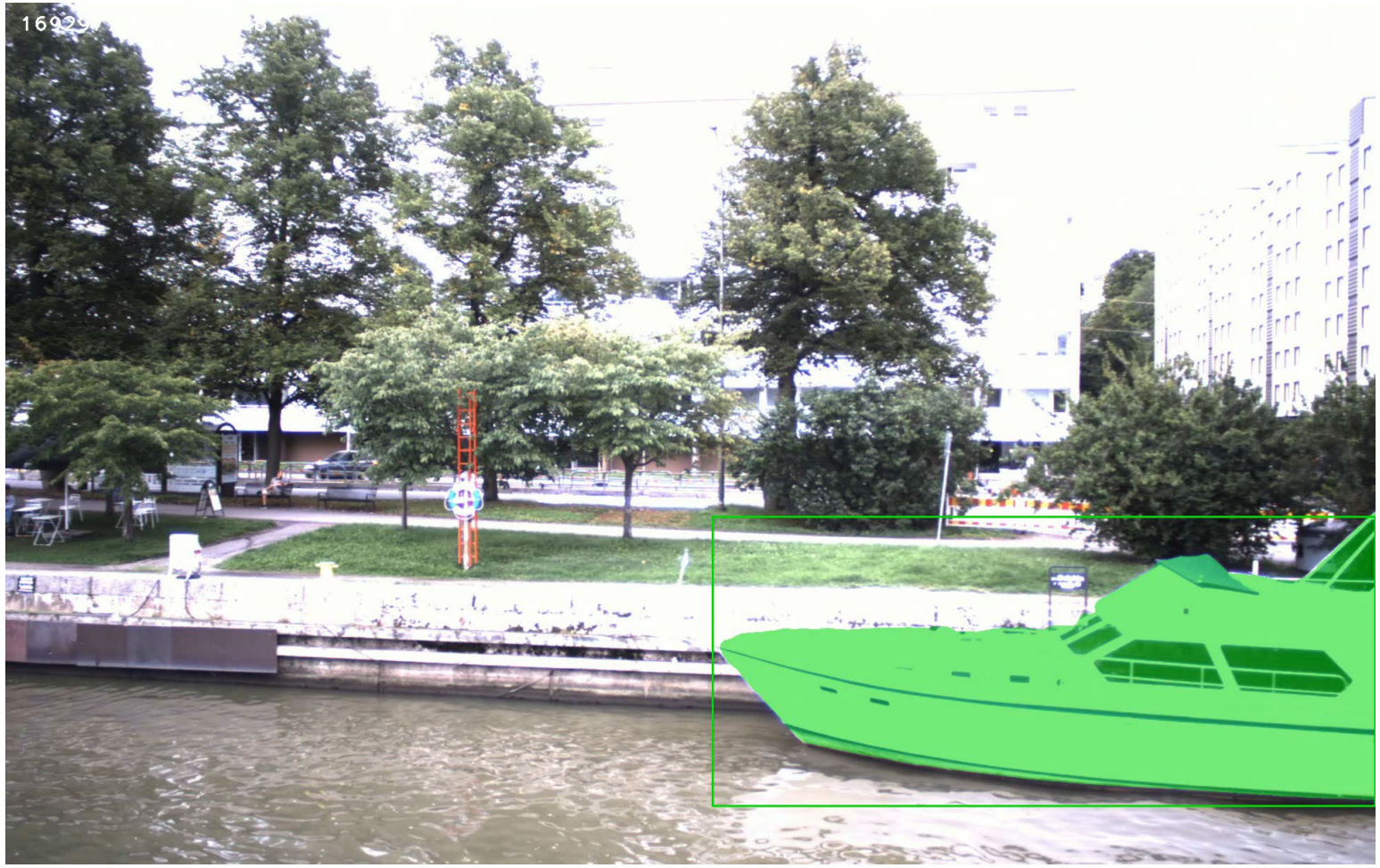
Sensor Setup

Lidar, 2 Stereo vision cameras, 6 RGB cameras, and 5 Thermal cameras, IMU, Radar

Sample Data


Stream 1
Stream 2
Stream 3
Stream 4
Stream 5
Stream 6
Stream 7
Stream 8
Stream 9
Stream 10
Stream 11
Stream 12

Auto Labeling



Synthetic Data

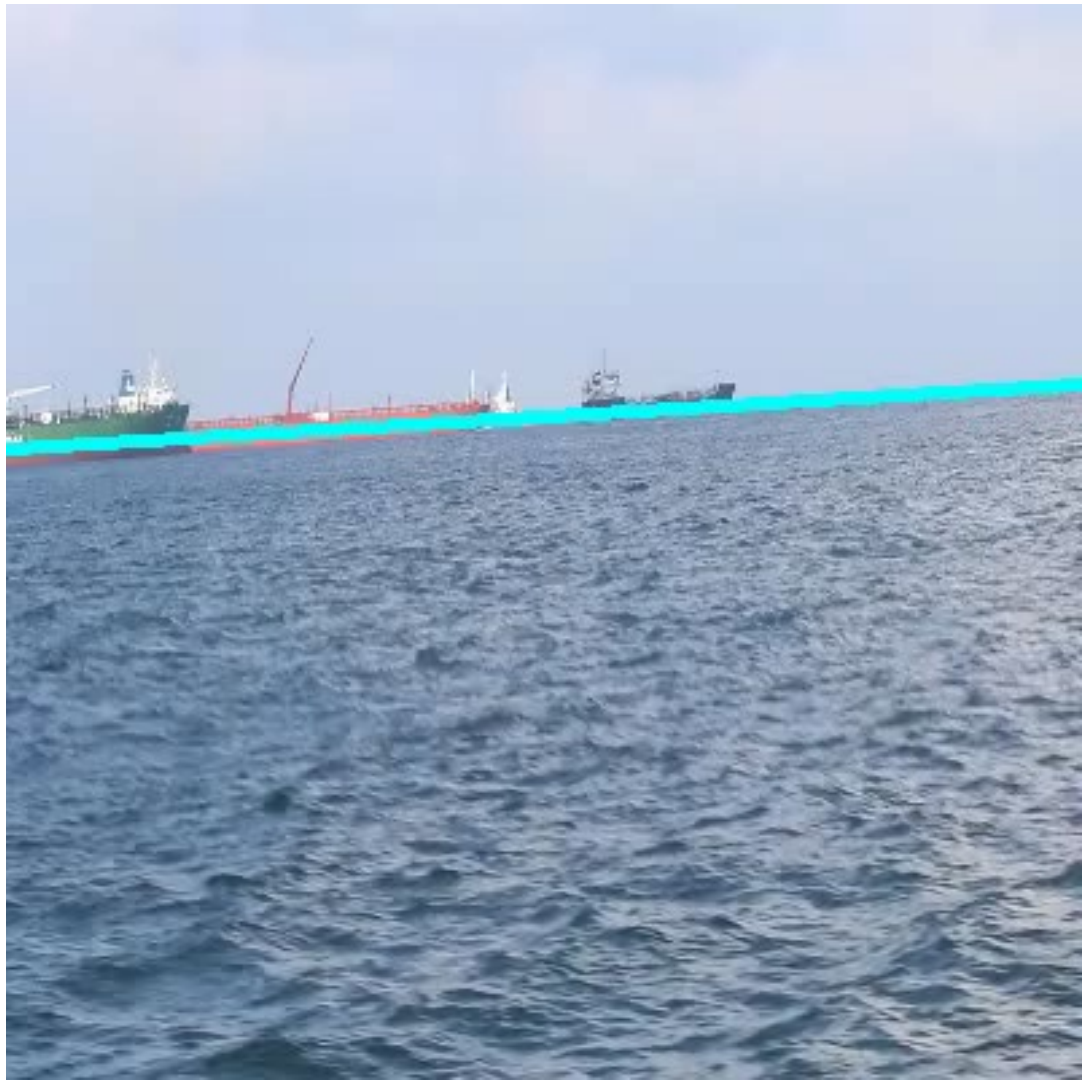
GAN network

Object Detection

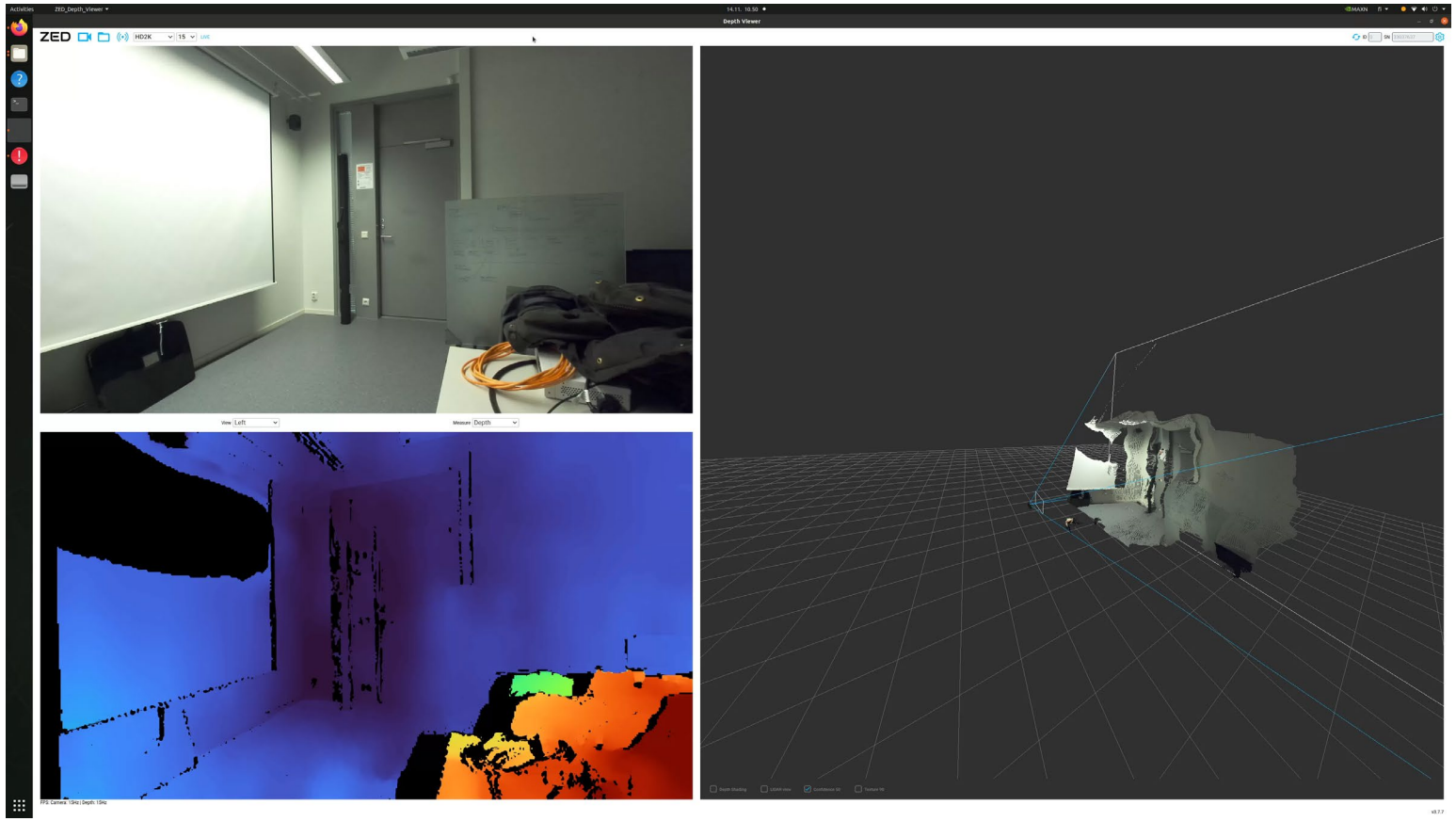
Yolo V7

Object Tracking

Sealine Detection



Distance Detection



Sensor Fusion

Point of view
alignment and timing
synchronization.

Transformer based
IR-RGB fusion

DIANA Dataset

Face Blurring

GDPR

YOLO V7 Face Blur Demonstration

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TURKU UNIVERSITY OF APPLIED SCIENCES

A Sunday Afternoon on the Island of La Grande Jatte

Georg Seurat 1884

Faculty of ICT and Industrial Engineering @ TUAS Board

Tero Reunanen
Dean

ca. 130 experts all together

TURKU AMK

Heads of Education and Research

Jarkko Paavola
School of Networked Systems and Security

Paula Steinby
School of Industrial Engineering and Common studies

Mika Luimula
School of Software and Interactive Technology

Elina Kontio
School of Data Engineering and AI Technology

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Kiitos!

Thank you! Grazie! Tack! Shukran! Merci! Danke!
Dank U! Paldies! Takk! Gracias! Efharisto! спасибо!
Hvala! Dziękuję! Obrigado! Aitäh! Tak! Köszönöm!
Sağol! хвала! Ačiū! Děkuji! Mulțumesc!谢谢!
благодаря! Cảm ơn bạn! 고맙습니다!

Turku UAS, Finland