Open Research Day

9 April 2025

16:00-16:40

Single Session- *lightning talks followed by breakout session*

A108: Smart Society & Digitalized Industry II

Chair: Dr. Bengt Ahlgren, RISE

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- Lightning talk: Session chair: Dr. Bengt Ahlgren, RISE

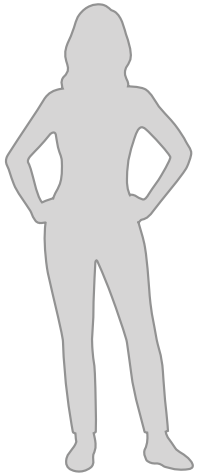
1. Preserving a Rich Legacy of Swedish Engineering Design using Artificial Intelligence - SweDesAI (II)
2. Stockholm EnviroNmental Zone digital Laboratory - SENZ-Lab (Demo)
3. Edge computing for urban traffic monitoring (Demo)
4. Open Sandbox: Automated Verification of Security and Safety for Fast Vehicle Software Development - OSAVSS (II)
5. Analysis and Synergy of Hyper-networked Autonomy at the Societal Scale - ASH-NASS (RP)

Preserving a Rich Legacy of Swedish Engineering Design using Artificial Intelligence - SweDesAI

Digital Futures Faculty Member: Francesco Fuso-Nerini
KTH Climate Action Centre x Nordic Electric Power Technology Company (NEKTAB)

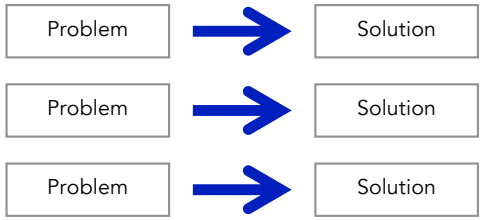
Tremendous achievement by Swedish engineering

Current Methods of Retrieving Knowledge



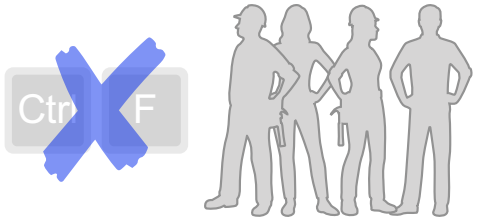
Engineering Expert

Billions of SEK of R&D lost to "document void"



10s Years Experience Problem-Solving

Semi-structured Documentation



Organization relies on keyword searches

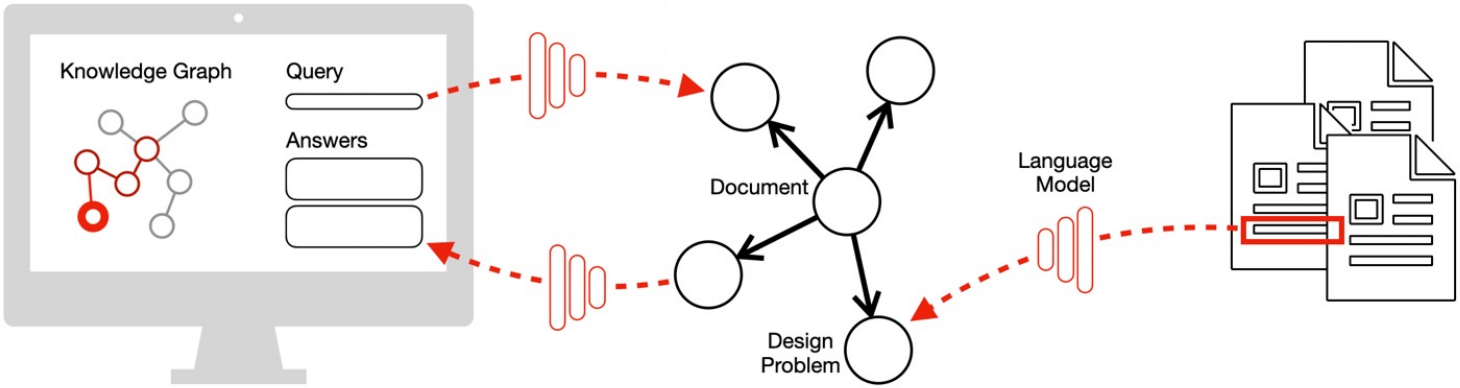
Digital knowledge artifacts from engineering design

Problem → Solution

Textual	User interview transcripts Funding proposals R&D Literature	Online workspace communications Best practice handbooks	User reviews and feedback Regulatory approval docs	Standard operating procedures Production reports
Graphical	Concept sketches Stakeholder recordings System diagrams	CAD models GD&T dimensioning and tolerancing Assembly drawings	Workforce training diagrams Quality assurance charts	Process video capture CAM models Job-shop planning
Expert Knowledge	Intuition for translating needs to requirements	Creativity for generating novel design embodiment	Experience for best methods for product testing	Instinctual awareness of precursors to process variation

Problem identification → *Solution conceptualization* → *Detailed design* → *Manufacturing* → *Operation*

Explainable Knowledge Retrieval



- Store extracted information in a relational database (knowledge graph)
- Transparently show user how questions map to answers for **explainable** retrieval

Theuner et al, *Weaving Knowledge Graphs and Large Language Models: Leveraging Semantics for Contextualized Design Knowledge Retrieval*, CIRP CMS 2024 (Accepted)

Thank you

Stockholm EnviroNmental Zone digital Laboratory (SENZ-Lab)

Romain Rumpler
Engineering Mechanics, SCI, KTH

Who? - The team

Romain Rumpler

Associate Professor
Sound and Vibration

Győző Gidofalvi

Associate Professor
Geoinformatics

Stockholms stad

Anders Broberg

Senior Advisor Smart City
City of Stockholm

Integrated Transport Research Lab

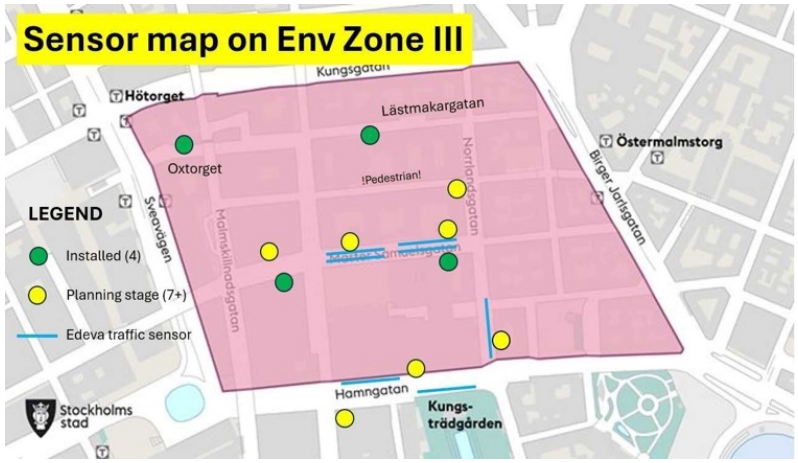
Jonas Mårtensson

Professor
Connected transport systems

What? - Vision & Objectives

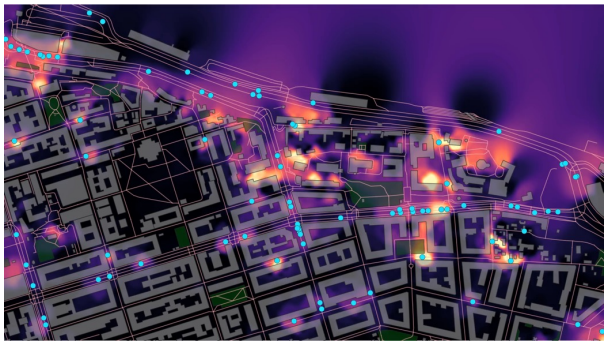
Norrmalm: Environmental Zone class 3

- Access restricted to 0-emission vehicles
- Unique test bed drawing international attention



- ***Vision***: Framework for dynamically optimized traffic control and reduced footprint
- ***Objectives***:
  - ✓ Contribute to quality program of Stockholm City: Smart and connected city
  - ✓ Collect, process, and visualize traffic and emission data
  - ✓ Refine and validate advanced modelling tools
  - ✓ Showcase GIS-based interactive platform with real-time capability

How? - Exp./Modelling chain



Sensing
- Traffic
- Noise
- VOC, PM

Micro-traffic
- Classification
- Distribution (Calibration)

Noise emissions
- Source model
- Propagation

Pollutant emissions
- Microscopic emission model
- Local residence time

Postprocessing
- Indicators
- Aggregation

Visualization
- GIS-based
- Web application

More details in Breakout Session!

Thank you

Edge computing for urban traffic monitoring

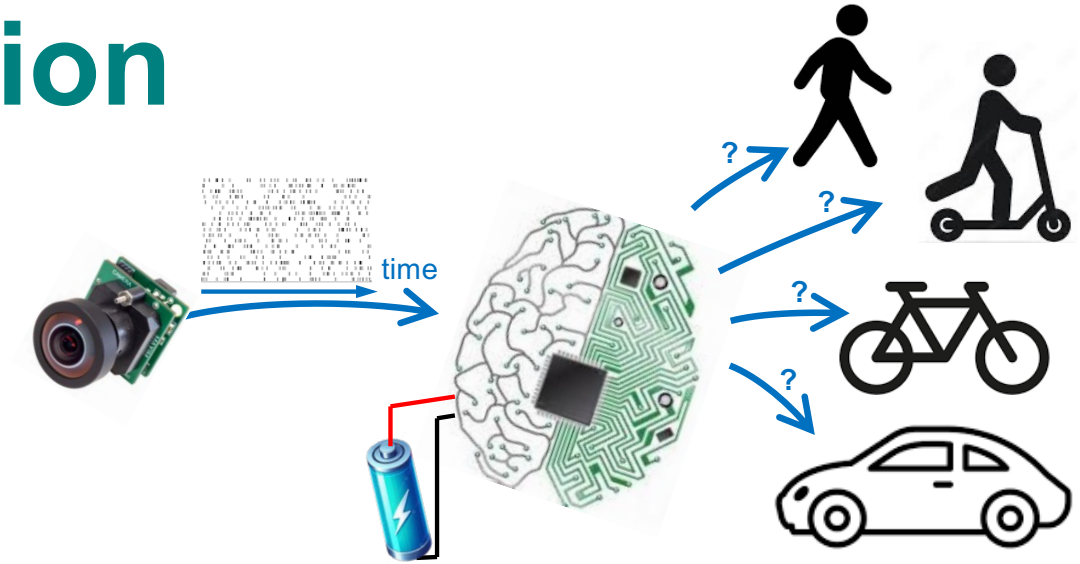
Jörg Conradt
Associate Professor
KTH EECS CST

Wilco Burghout
Associate Professor
KTH ABE CTR

Helry Dias
PostDoc, Centre for Traffic Research, KTH ABE CTR

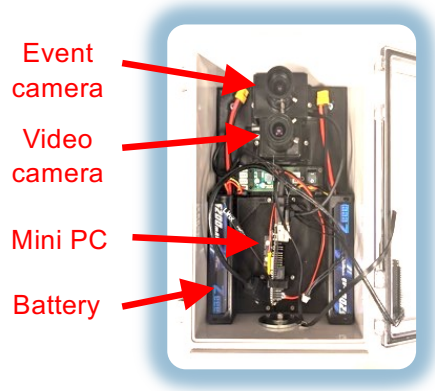
Emma Hagrot
Ms Thesis student,
KTH EECS CST

Project Motivation

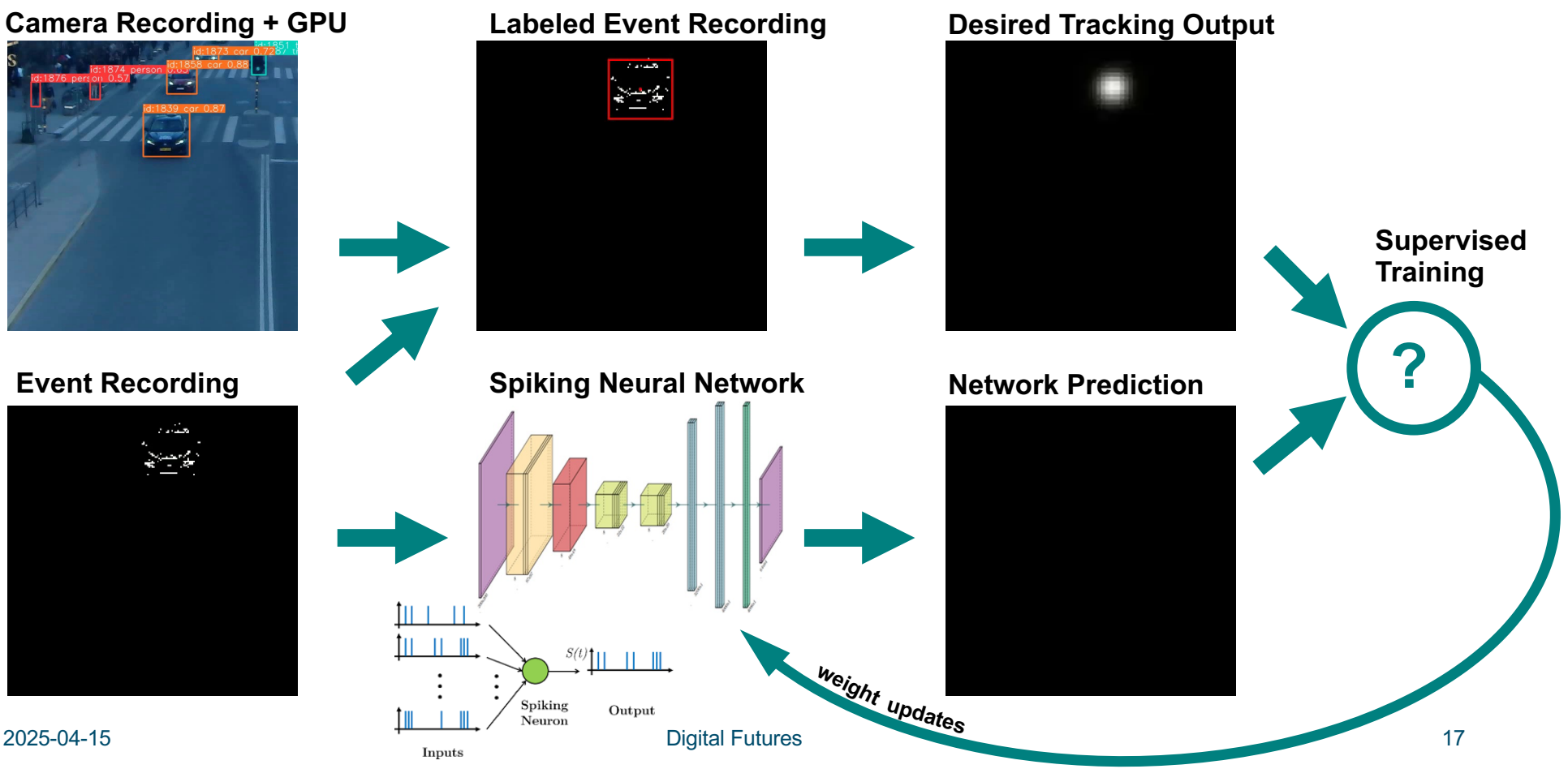


Monitor ALL traffic participants using
event-cameras and neuromorphic processing

- avoids GDPR complications (no camera)
- allows results in real-time (edge computing)
- requires low power budget (neuro networks)

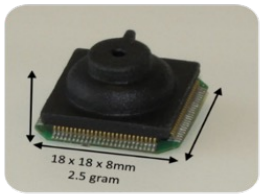


Project Implementation



Demonstrator Project Status

(1) Build hardware (a "box")
- Neuromorphic camera
- Neuromorphic processing



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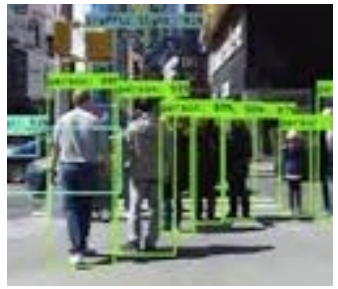
(2) Train a spiking model (on GPU)

Create a training data set (based on existing video sequences, characterized by YOLO or similar)
Note: software / hardware co-design
- Sensor resolution
- Minimum required computing



(3) Integrate low power processors for inference
- Microcontroller with NPU, e.g., STM32N6, Alif E7
- Neuromorphic chips, e.g., Akida, SpiNNaker II, Loihi II

(4) Evaluate
- Characterize tracking quality
- Characterize power consumption

Thank you

Open Sandbox

Automated Verification of Security and Safety for Fast Vehicle Software Deployment

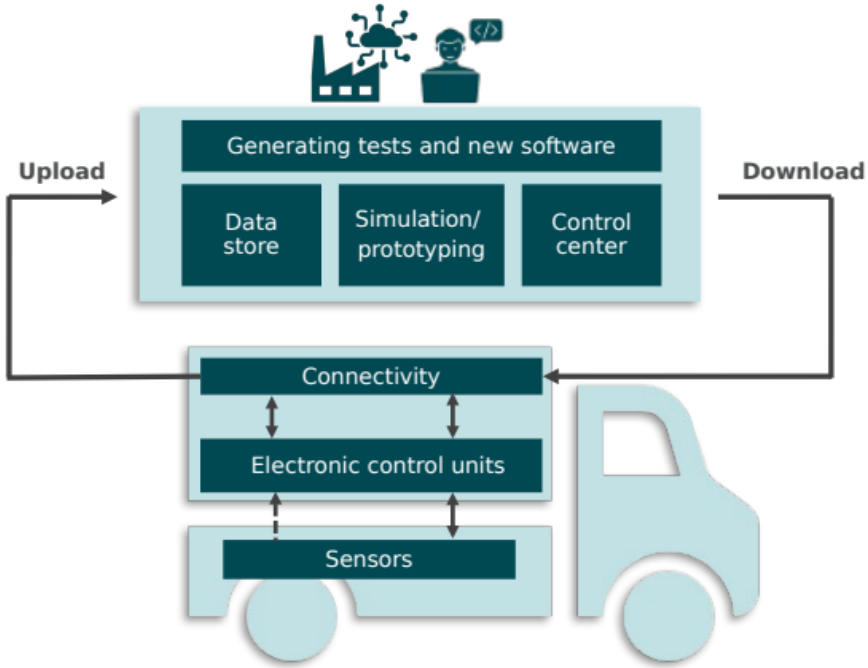
Karl Palmskog
KTH, EECS school

Background and motivation

- Vehicles increasingly depend on software
- Software is continually revised

  (fixing issues, adding features)
- Deployment of new revisions can take

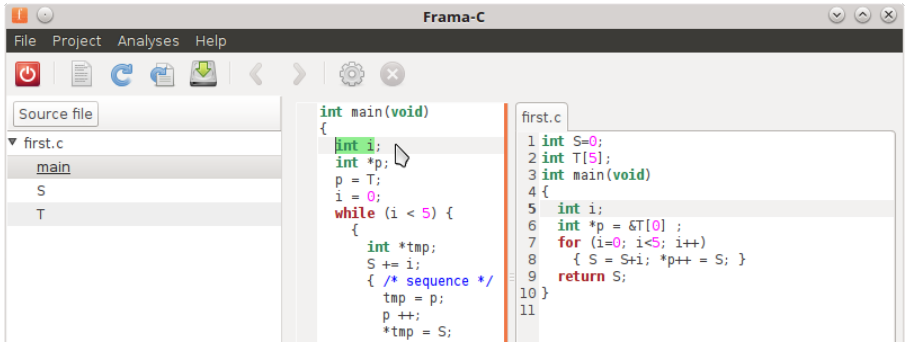
  months to years
- Core problem: testing takes a long time



Project objective: shorten deployment for vehicle software

- Approach: automated, *incremental* formal verification of code
- Safety and security guaranteed using **code contracts**
- Potentially, deployment of new versions could take only hours
- Built on Autodeduct toolchain developed by Scania and KTH

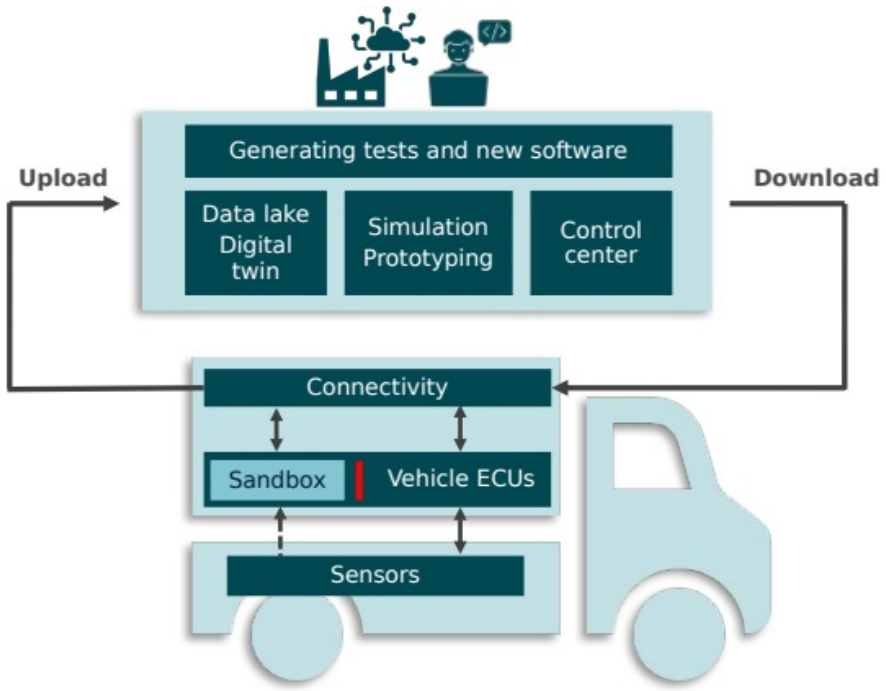
```
/*@
  behavior:
    assumes y != 0;
    ensures \result == \old(x/y);
*/
int div(int x, int y) { /* … */ }
```



Open Sandbox?

Scania's sandbox is an artificial and closed test environment for vehicle software.

If successful, the project can open up the sandbox and allow new software revisions to run in a real environment.



Thank you

Analysis and Synergy of Hyper-networked Autonomy at the Societal Scale (ASH-NASS)

Angela Fontan

Division of Decision and Control Systems (DCS),

EECS, KTH

Silun Zhang

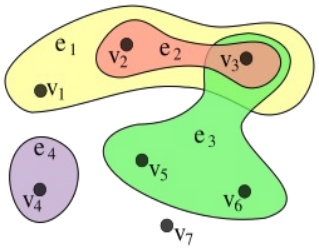
Department of Mathematics,

SCI, KTH

Motivation

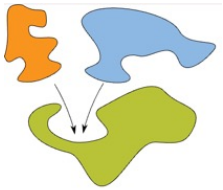
- **Hypergraphs**:

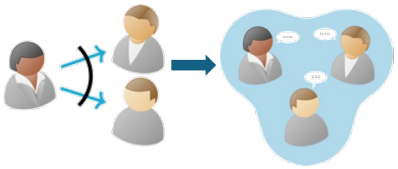
Pairwise Interactions ➡ **High-order Interactions**

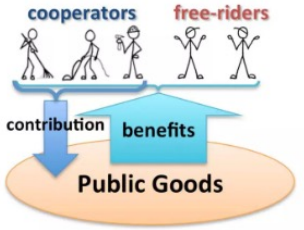


Hypergraphs

- **Examples:**
  - Biological networks
  - Chemical reactions
  - Human interactions


Protein interaction


Group communication

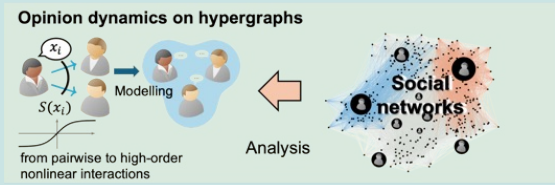
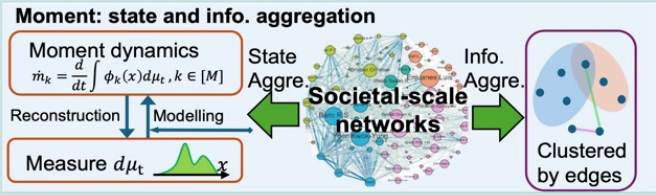
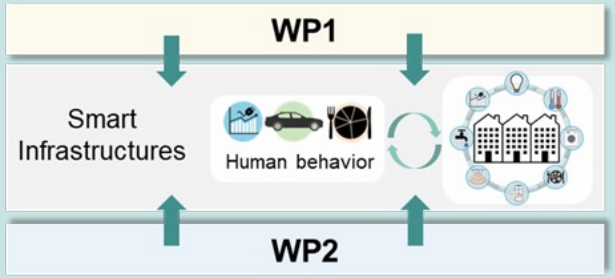


Public goods game

- **Challenges:**
  - Opinion evolution under social influence ➡ Saturation/sigmoidal nonlinearity [1]
  - Number of interactions grows exponentially ➡ Moment modeling [2]

[1] **A. Fontan**, C. Altafini, The role of frustration in collective decision-making dynamical processes on multiagent signed networks, IEEE Transactions on Automatic Control, 2021.
[2] **S. Zhang**, A. Ringh, X. Hu, J. Karlsson, Modeling collective behaviors: A moment-based approach, IEEE Transactions on Automatic Control, 2021.

Project Roadmap

WPs	
WP 1	**Social behavior with high-order interactions:** ▪ Saturated/ sigmoidal nonlinearity ▪ Synchronization and formation of opinion clusters ▪ Synergy 
WP 2	**Model reduction for hypernetworked opinion systems:** ▪ Moment-based modeling ▪ Saturated nonlinearity + state-dependent topology ▪ Synergy 
WP 3	**Demonstration:** ▪ Numerical Simulation ▪ KTH Live-in Lab: - Smart building infrastructure (>300 apartments), sensor networks, CPHS.  

Impact

Design More Efficient and Sustainable Large Infrastructure to Promote Social Wellbeing.

CPS w/ Human

Thank you

digital futures

PARTNERS

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RI. SE

Stockholm University