# AI FLANDERS

## Use Cases - Illustrations

Sabine Demey, Program Director

June 12th 2020

# 3 Domains in Focus of the AI Research Program




# Domains and Applications

**HEALTH**

PRECISION MEDICINE

CLINICAL DECISION SUPPORT

HOSPITAL DECISION SUPPORT

…

**INDUSTRY 4.0**

SMART MACHINES

SMART FACTORIES

SMART ENERGY

…

**GOVERNMENT**

**CITIZENS**

PUBLIC EMPLOYMENT SERVICES

PERSONAL DATA

…

…

SMART SPACES

# Selected Applications in Health

## PRECISION MEDICINE

| | |
|---|---|
| Single Cell Technologies | Multiple Sclerosis |
| Visualisation of single cell data & Segmentation of 3D electron microscopy images | Improve MS treatment |

## CLINICAL DECISION SUPPORT

| | |
|---|---|
| Epilepsy | Medical Imaging *Radiation Oncology and Radiology* |
| Automated detection of epileptic seizures | Segmentation & classification for radiation oncology and radiology |

## HOSPITAL DECISION SUPPORT

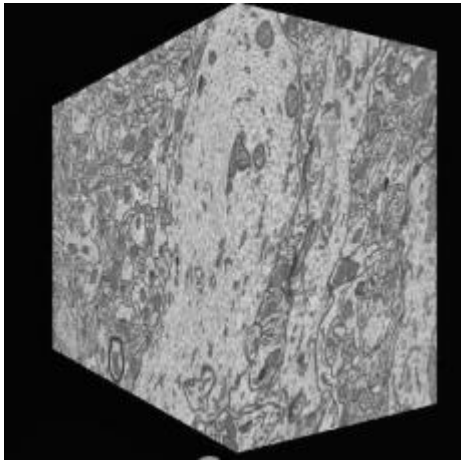
| |
|---|
| Hospital Treatment Decisions |
| Prediction of length of stay in hospitals |

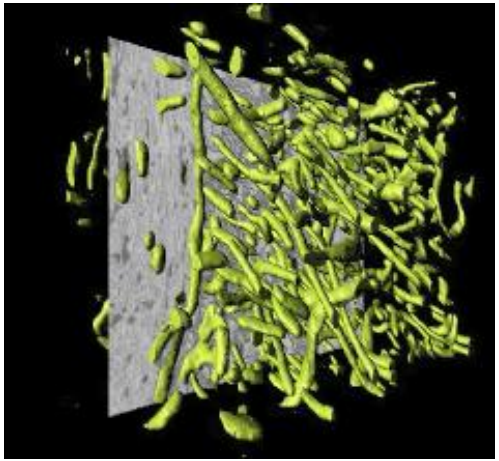
# Single-Cell Technologies

## Visualisation of single cell data

## Segmentation of 3D electron microscopy images

### 3D Electron Microscopy data

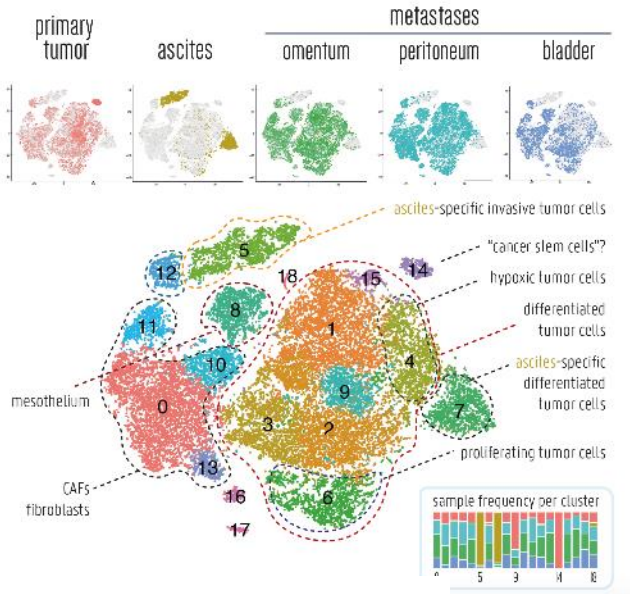




1 Image : 5000x5000 to 10000x10000 pixels (50 to 190 MB)
1 Dataset: 100 to 2000 slides (5 to 380 GB )
1 week : 10 datasets (50GB to 1 TB )



### Single-cell omics data




- Interactive visual analytics
- Structure learning
  - Clusters
  - Trajectories
- Incorporation of prior biological background knowledge

VIB
Yvan Saeys

# Multiple Sclerosis

## Together, we will transform the care of people with MS through better use of data

**MS is an incurable disease, but initiating the proper treatment as soon as possible can slow down progression. BUT many people with MS miss their window of opportunity.**

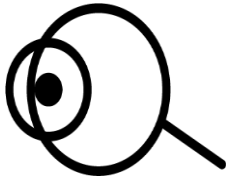
**OUR TARGET: SPEED-UP IDENTIFICATION OF RIGHT TREATMENT FOR THE RIGHT PATIENT AT THE RIGHT TIME**

HEALTH

THREE MAIN **CLINICAL CHALLENGES** ARE DEFINED

**WHICH TREATMENT IS THE BEST?**

Develop decision-support systems for relative treatment effectiveness in a real-world setting
(using RWD: Real World Data)



**DOES THE TREATMENT WORK?**

Identification of new biomarkers for disease activities

**HOW CAN WE IMPROVE PERFORMANCES TO REACH THE LEVEL OF THE INDIVIDUAL PATIENT?**

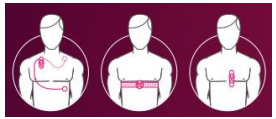
Develop tools and methodologies to support scaling-up real-world MS data research



UHASSELT
Liesbet Peeters

# Epilepsy Monitoring

## Automated real-time seizure detection @ home



ECG/PPG

EEG

Accelerometer

Feature extraction

Seizure classification

Supervised personalization through patient feedback

Unsupervised personalization

Real-time alarm to relatives


Offline seizure diary

| | Data | Time | Description |
|---|---|---|---|
| 1 | 22/01/18 | 22:37:16 | CLONIC seizure |
| 2 | 24/01/18 | 23:13:36 | TONIC seizure |
| 3 | ... | | |

Logging of detected seizures

Inform neurologist

Alter treatment/ medication

HEALTH



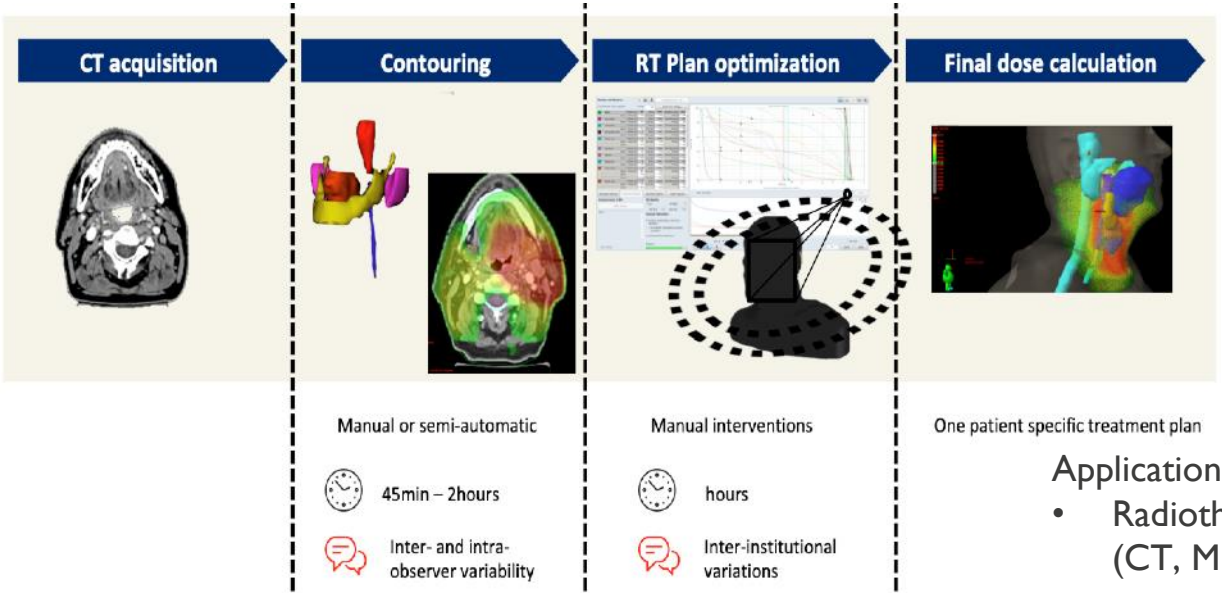
KU LEUVEN

Sabine Van Huffel

# Medical Imaging

## Automated assessment and quantification of medical imaging data for clinical decision support

## Segmentation and classification for radiation oncology and radiology




Applications:

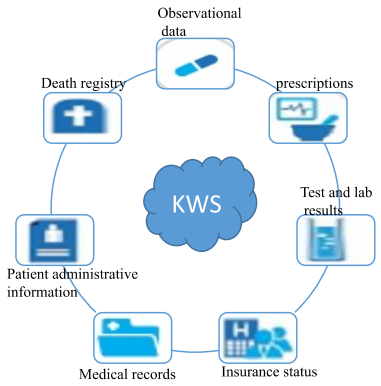
- Radiotherapy planning (CT, MRI, PET), identifying organs at risk
- Chest X-ray images (5000 annotated samples)

HEALTH

# Hospital Decision Support

## Length of stay prediction

Using medical data




For Length of Stay prediction

**Predictive Modelling of:**

- No Hospitalization
- Readmission
- Discharge
- Discharge with continuous care from home by medical personnel

**Risk Modelling**

- Identification of risk factors associated with prolonged length of stay

**Anomaly detection**

- Identification of sudden changes in length of stay

**Challenges**

- Exploit medical acronyms
- Handle extreme LOS across/ within medical units
- Consider medical faults/ incidences while modelling

and automation

Automated Clinical Decision support system

HEALTH



KU LEUVEN
Bart De Moor

# Selected Applications in Industry 4.0

SMART MACHINES

SMART FACTORIES

SMART ENERGY

Smart Monitoring

Smart Control

Smart Industrial Spaces

Smart Energy Distribution

INDUSTRY 4.0

Individual Machines & Robots

Machine Fleets

Flexible Production Cells

Flexible Production Lines

Smart Grids

Windturbine Parks

# Smart Energy Use Case

## Forecasting congestions in low voltage distribution grids

Historic digital meter data (P, Q)

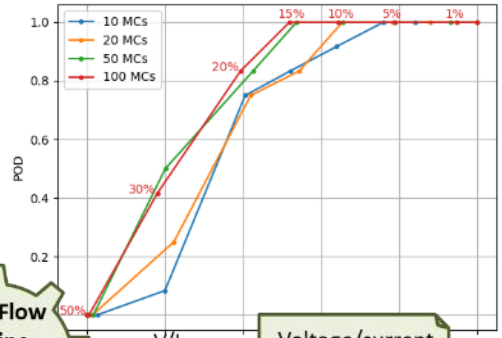
Weather forecasts, holidays, traffic jam info

Grid layout

Profile selector/ forecaster

N profiles

Load Flow Engine




Voltage/current threshold

congestion forecast

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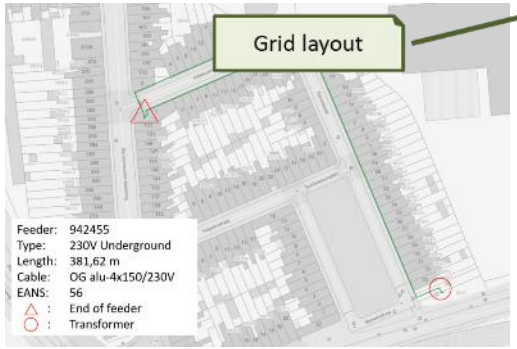
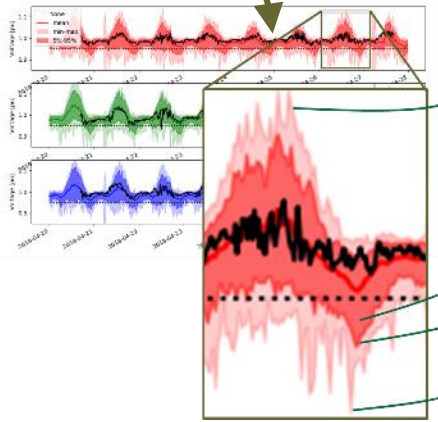


100% percentile

Als 15% percentiel < V threshold
→ Congestie

15% percentiel

5% percentiel

0% percentiel

# Smart Machines Use Cases

**Smart Monitoring**

Monitoring the condition of industrial machines for health management, ...

- Prognostic Health Management
- Power-efficient anomaly detection on high-frequency sensor data

**Smart Control**

Control and optimization of industrial machines and processes

- Closed-loop robotic control
- Machine fleet control
- Optimisation of manufacturing processes


| Individual Machines & Robots | Machine Fleets |
|---|---|

# Smart Factories Use Cases

## Smart Control

Control of multiple agents and/or complex production line

- Control of cooperating robots/arms – reduce programming and execution time
- Optimisation of flexible production lines

## Smart Industrial Spaces

Humans and embodied agents collaborating seamlessly in complex environments

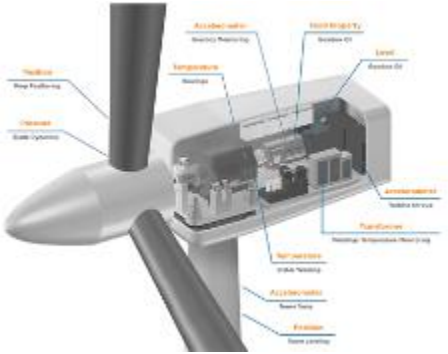
- AI-assisted operator
- Intelligent and instructable AGV
- People detection and tracking

Flexible Production Cells

Flexible Production Lines

# Smart Monitoring – Prognostic Health Management

## for facilitating the maintenance of industrial machines



Wind turbines

Bearings in Machines

Data-driven model

Knowledge-based model

Hybrid model

Diagnostics

+

Prognostics

+

Decision Support

INDUSTRY 4.0

Extend Lifetime

Facilitate Maintenance

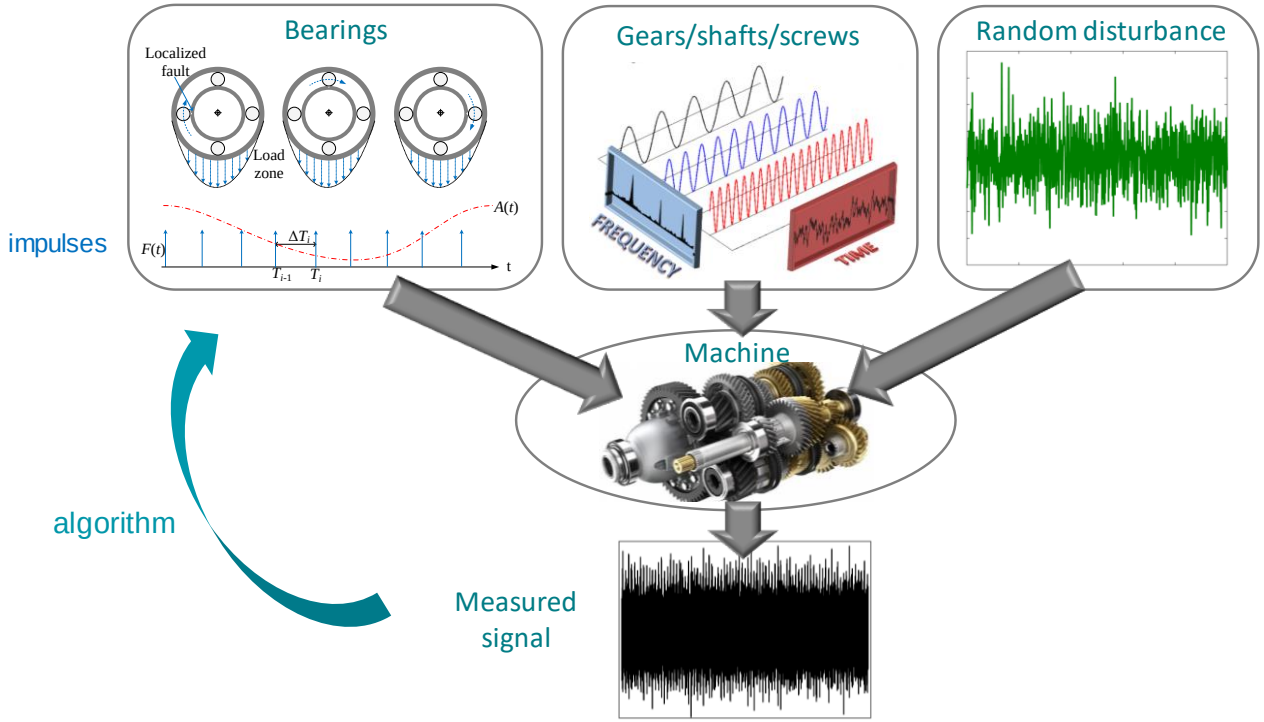

sirris

FLANDERS MAKE

VUB VRIJE UNIVERSITEIT BRUSSEL

# Smart Monitoring - Power-Efficient Anomaly Detection

## for industrial machines, on high-frequency sensor data

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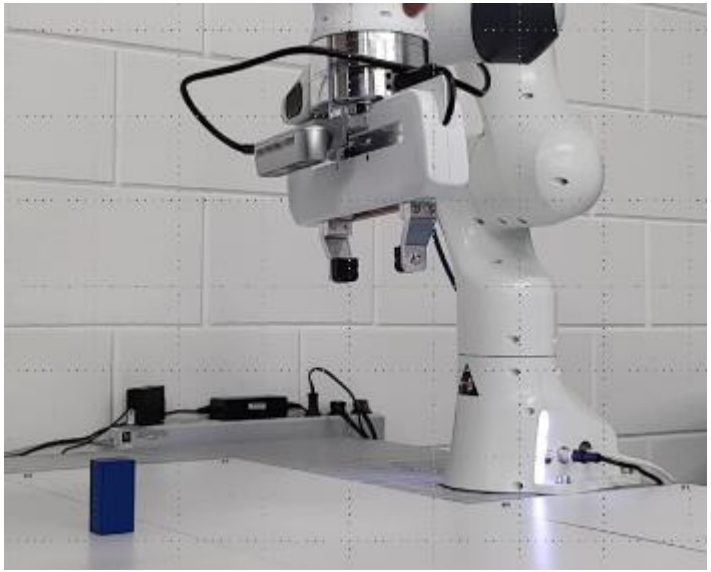
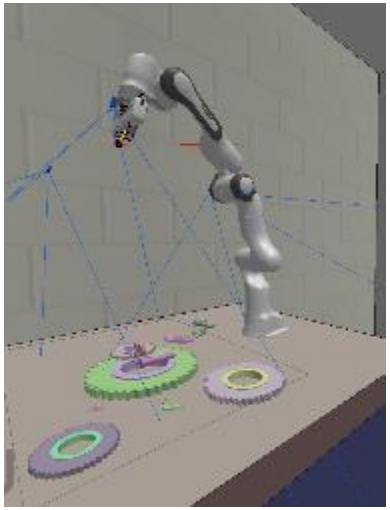
Ted Ooijevaar

# Closed-loop Robot Control

## Low-latency control of robots based on rich sensor input



Single camera to multiple cameras
Learn from single demonstration
Generalize to similar obejcts





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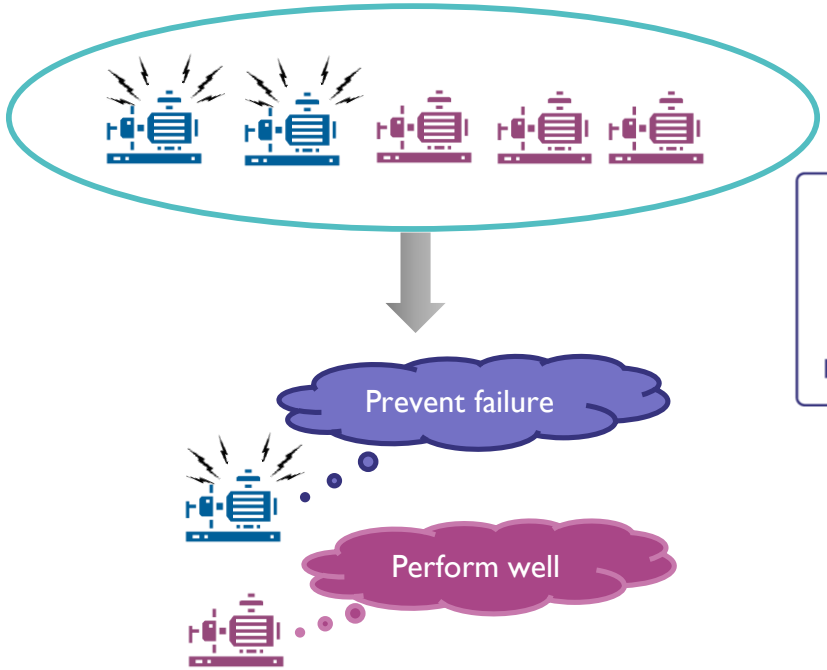
imec

Tim Verbelen

# Smart Control of Machine Fleet

## Towards smarter health-aware control that guarantees machines are continuously online at optimized output performance

Fleet learning aims at **exploiting similarities** between machines in order to optimally use the provided data for control optimization and detection of underperforming assets

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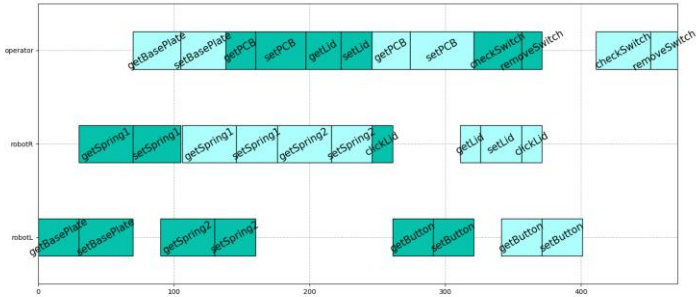
Jan Helsen

# Smart Control of Cooperating Robots / Robot Arms

## We want the next generation of robots to think (compute) and speak (communicate) effectively in cooperative teams

- Robots are getting more autonomous
- Many real-world tasks are impossible to perform by one single robot
- Complex, dynamic, 3D environments
  - Rely on local information to solve global complex problems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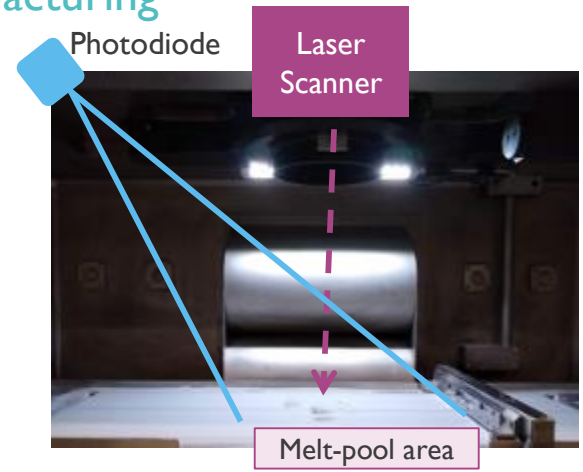
Maarten Witters

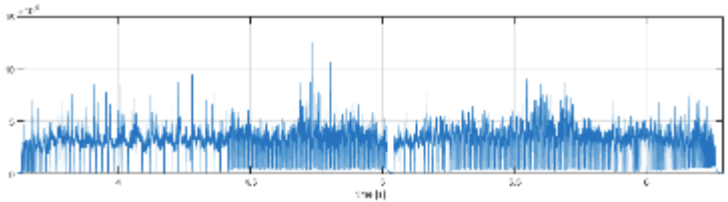
# Smart Control: Optimisation of Manufacturing Processes

## Identify microscopic defects in additive manufacturing

"Additive manufacturing" or "3D printing" is about growing 3-dimensional objects one superfine layer at a time. Each successive layer bonds to the preceding layer of melted or partially melted material.

CT - scan highlighting pores/defects



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# Smart Control: Optimisation of Flexible Production Lines

## Adhesive bonding process

substrates preparation

Acclimatisation → Part preparation → Surface preparation → Surface treatment

product assembly

Adhesive application → Parts assembly → Adhesive curing → Finishing

adhesive preparation

Conditioning → Mixing → Dosing

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Maarten Witters

# Smart Industrial Spaces – People Detection and Tracking

## Multi-sensor collaboration in industrial spaces


- Demonstrate people detection and tracking at an industrial railway crossing in “hot zone”
- Increase safety
  - Elimination of blind zones
  - Collaborative sensor processing

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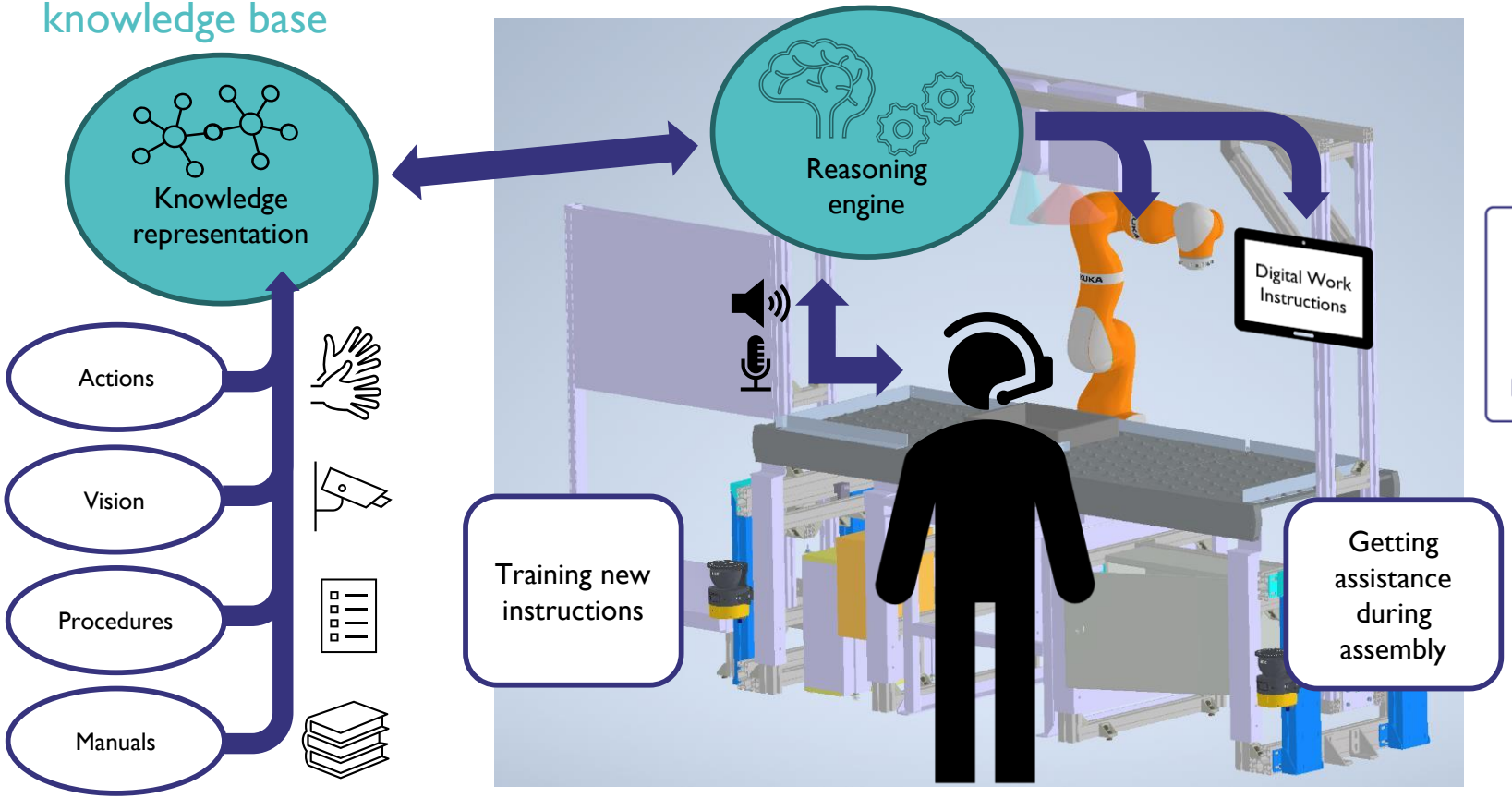
Wilfried Philips

# AI-Assisted Operator

## Towards an enhanced operator through seamless interaction with a smart knowledge base

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Maarten Witters

# Intelligent and Instructable AGV

## Increasing the autonomy of AGVs to address more complex tasks


"Pick up the red pallet and put it on the truck"

- Speech interpretation
- Object recognition and referral
- Learning of tasks, actions, and navigating
- Understanding object relations and context

INDUSTRY 4.0

Increasing the autonomy of AGVs to address new and more complex tasks and allowing adoption in a larger number of agricultural, industrial and logistic settings.

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Chris Ganseman

# Government & Citizens Applications and Use Cases

**PUBLIC EMPLOYMENT SERVICES**

Employment services for citizens, employers and government (public advice)

**PERSONAL DATA**

Exchanging data and knowledge in a healthcare setting


Services for civil clients

Services for employers

Policy Advice



VDAB

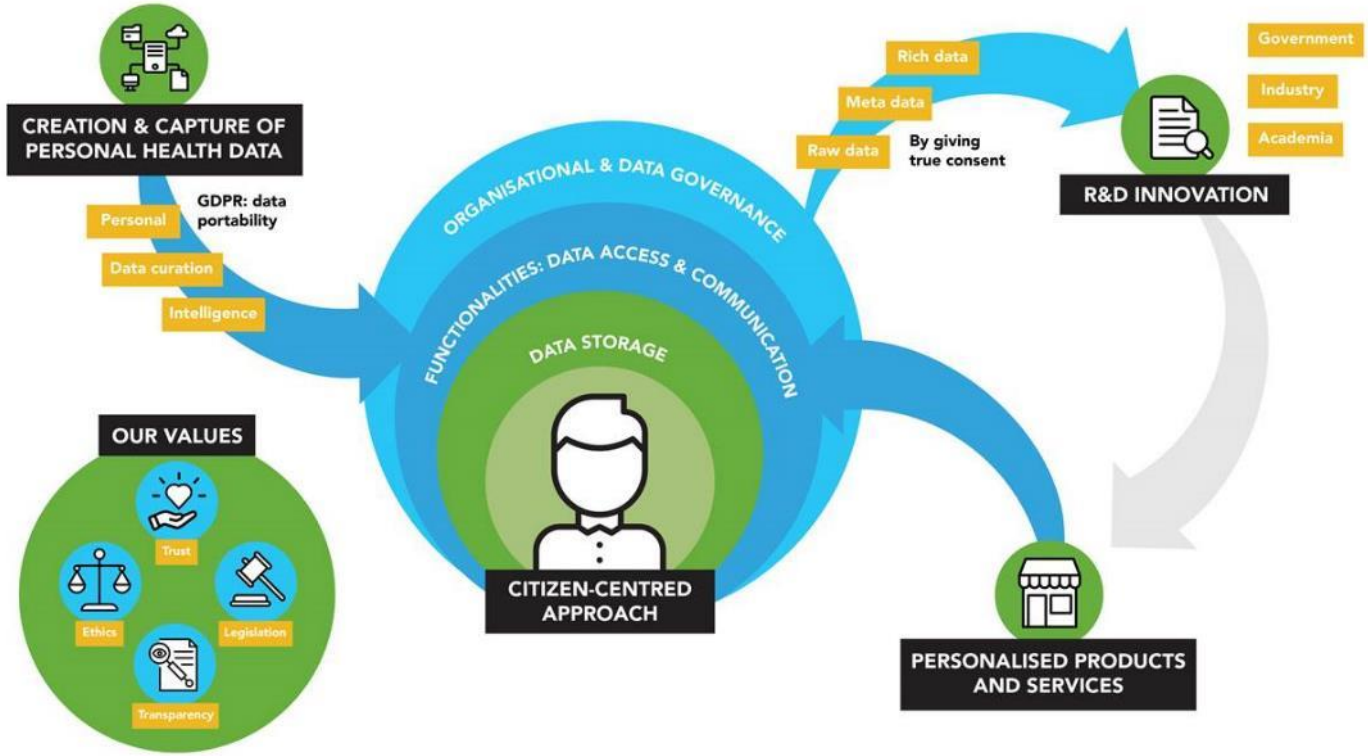


UNIVERSITEIT GENT

Tijl De Bie

# Exchanging Data and Knowledge in a Healthcare Setting

## Distributed data intelligence with decentralized personal data vaults






vito
Bart Buelens

# Common Concept: Smart Spaces

CONVERSATIONAL AGENTS

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RECOMMENDER SYSTEMS

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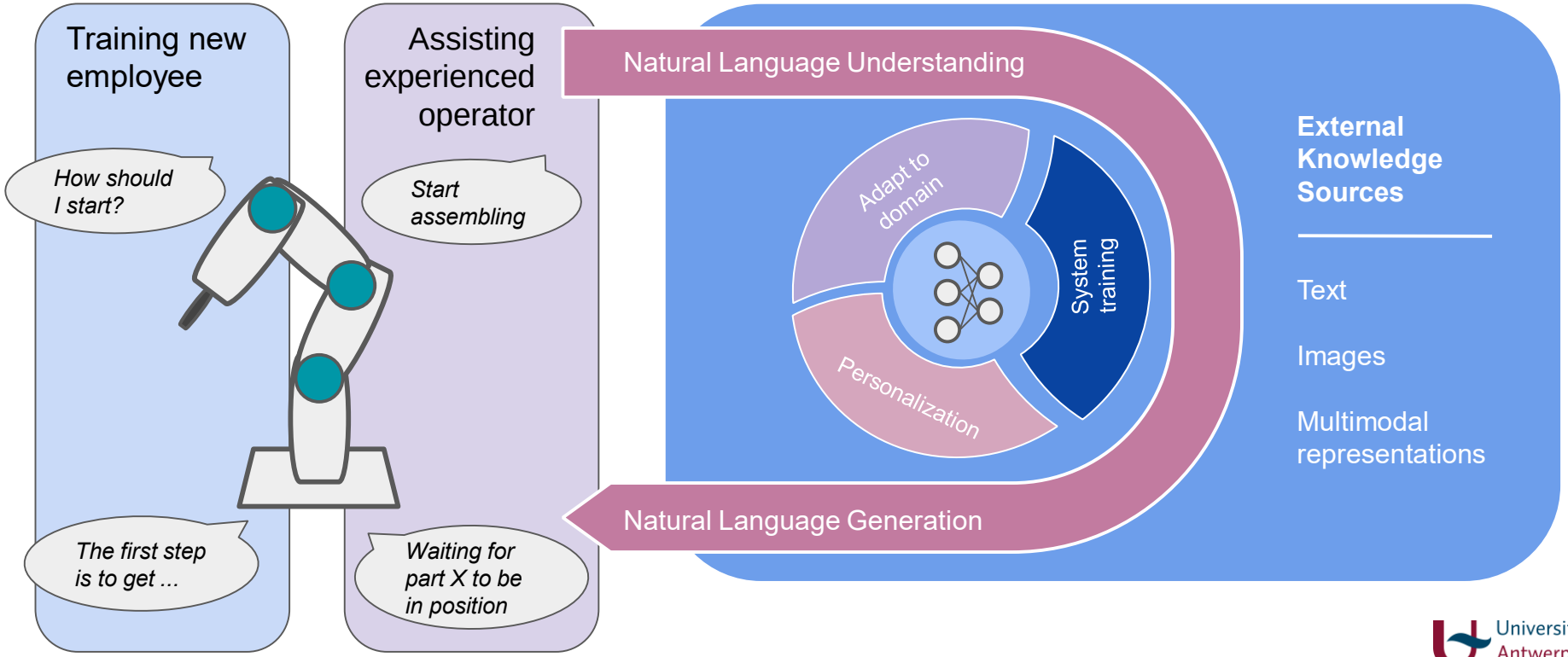
# Conversational Agents

## Cooperative Robot-Arm Example



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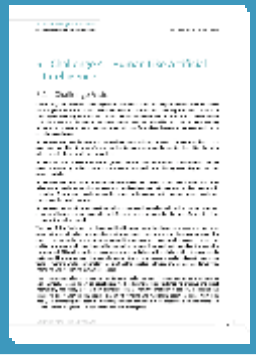
Walter Daelemans

# Recommender Systems

## Cultural Event Example

**GC4 vision**
for interacting with user-centered AI systems



**Use case focus**
making human-AI interactions...

**Intuitive**
low effort
**context**☆ & **intent**☆☆-aware

**Personalized**
system **elicits**☆☆☆ & remembers☆ preferences

**Transparent**
actions are exposed☆ (what) and **explained**☆☆ (why)

☆☆ ~ difficulty

**Demonstrator**
GASTON [provisional name]
recommends local cultural events

I want to take my **niece** to the **theater**. We live in **Hasselt**

How old is she? **What does she like?**

She's 9. She likes **music**.
I would also like to support **independent** theater.

Hm. You may like Chasse Patate (8+) by Studio Orka on August 31st in C-Mine, Genk at 14.00.
They are **family-run** and make children's theater on original locations, with **live music**



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Bart Goethals

# Domains, Applications, Use Cases and 4 Research Challenges

| 3 domains | Applications | | Use Cases |
|---|---|---|---|
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| | | | Smart Monitoring: Power-Efficient Anomaly Detection on High-Frequency Sensor Data |
| | | Smart Control | Smart Control: Closed-Loop Robotic Control |
| | | | Smart Control of Machine Fleet |
| | | | Smart Control: Optimisation of Manufacturing Processes |
| | Smart Factories | | Smart Control of Cooperating Robots/Robot Arms |
| | | | Smart Control: Optimisation of Flexible Production Lines |
| | | Smart Industrial Spaces | Smart Spaces: AI-Assisted Operator |
| | | | Smart Spaces: People Detection and Tracking |
| | | | Smart Spaces: Embodied Agent (Industrial AGV) Performing Tasks Assisted by Operator |
| | Smart Energy | Smart Energy Distribution | Smart Energy Distribution |
| | | | Self-Sustainable Micro-Grids |
| Government &Citizens | Public Employment Services | Public Employment Services | Employment services for Citizens and for Employers and Policy Advice |
| | Medical & Personal Data | Personal Data | Exchanging Data and Knowledge in a Healthcare Setting |
| Smart Spaces | | Conversational Agents & Recommender Systems | Conversational Agents |
| | | | Recommender Systems |

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