

From Theory to Practice

Artificial Intelligence in Waste Sorting: Selected Examples

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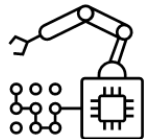
Overview



Introduction



AI in waste sorting



recAIcle project / system



recAIcle selected results



Conclusion and Outlook

Introduction

- AI is everywhere
 - ChatGPT
 - Dall-E 3
 - Adobe Firefly
 -
- AI revolutionises many industries and applications
- AI the solution for all problems?
- Is AI stealing our jobs ?

Introduction

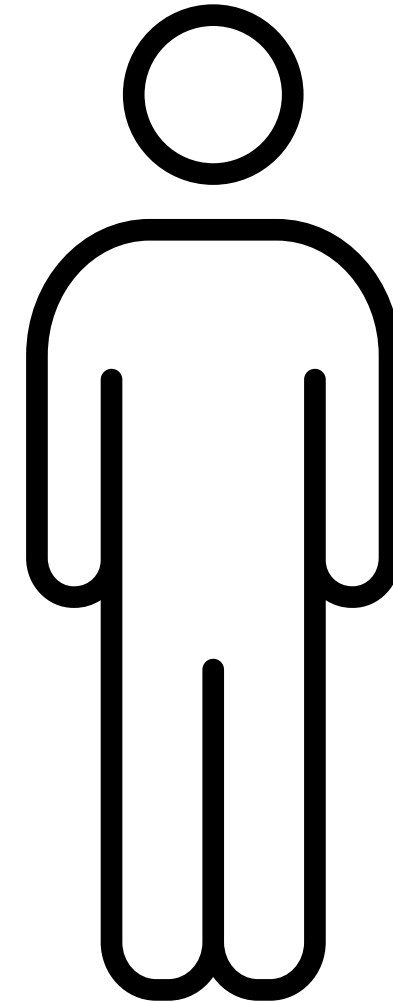
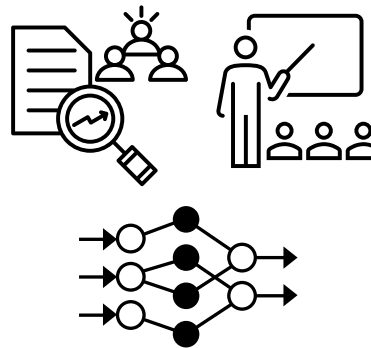
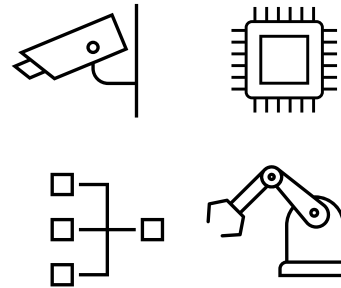
- They can only perform a trained task
 - AI-Models must be trained for a specific use case
 - Most models are static

Example:

- Model: yolov8n
- Mode
 - Detect
 - Predict
- Publicly available:
Github/ultratytics

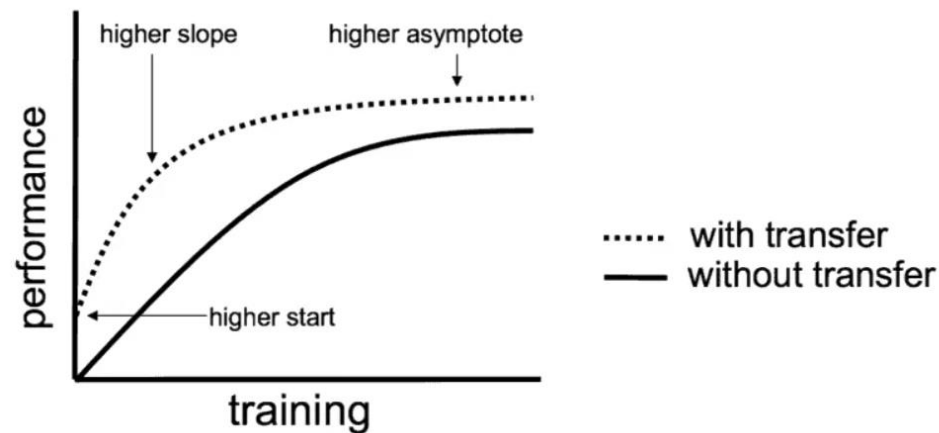
AI-Requirements

- Hardware
 - Sensor
 - Data processing Unit
 - Network
 - Actuators
- Software
 - Preprocessing
 - Trainings data
 - Model

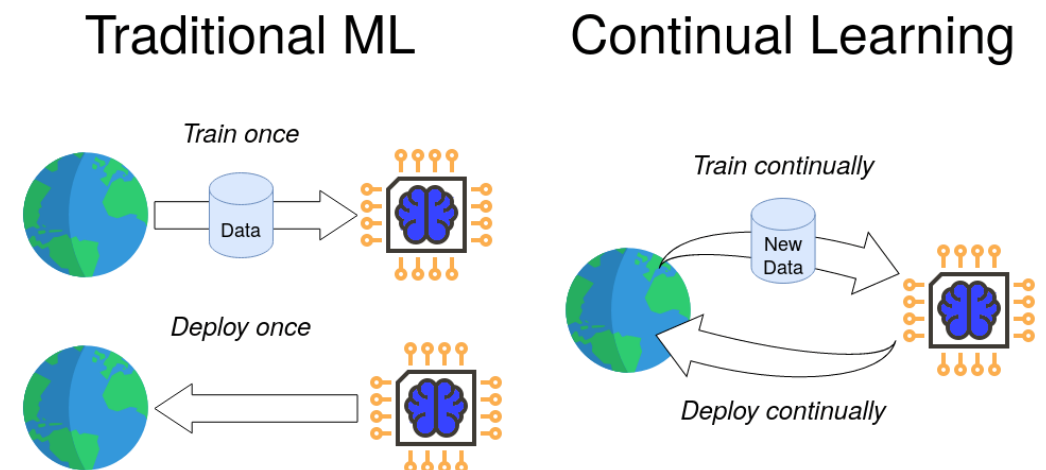


AI - Trends

- Transfer Learning
 - Use of an already trained model
 - Advantages
 - Less Data needed
 - Higher precision



- Continual Learning
 - Model develops memory
 - Ability to adapt
 - Feedback loop necessary



Source: Laurenz Wuttke 2023, Online available: <https://datasolut.com/was-ist-transfer-learning/>

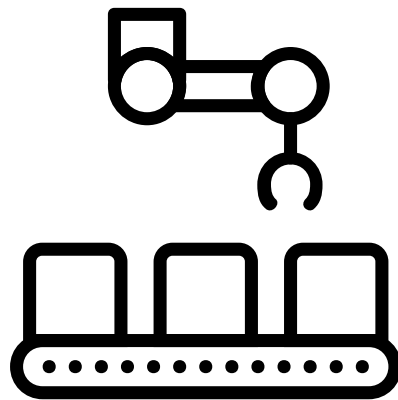
AI-Applications in the waste sector

- Waste sorting
- Monitoring
- Route optimisation
- Impurity detection
- Smart waste bin

AI- Waste Sorting

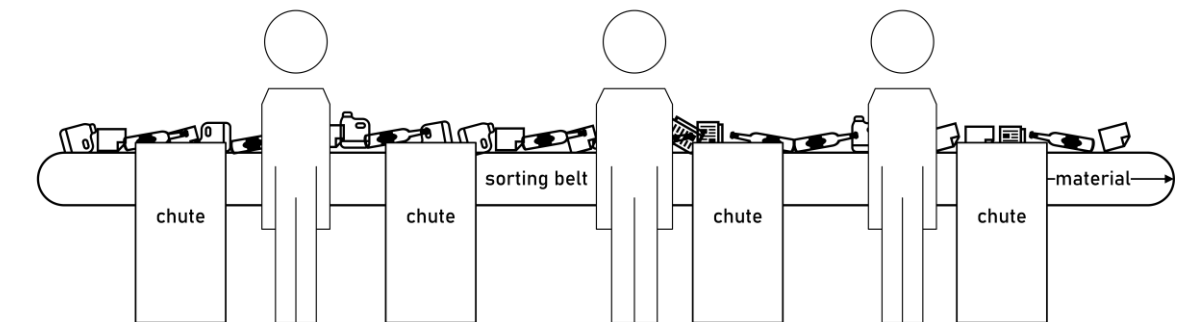
Automatic sensor-based sorters

- Not usable for every material
- Limited in their design range.



Hand sorting

- Very flexible
- Difficult for the sorting workers
- Hard sorting decision



recAicle - Manual Sorting

- Mode of operation
 - negative sorting
 - positive sorting

- Use cases
 - Quality Insurance
 - Interfering material removal
 - Heavy sortable material streams
 - ...

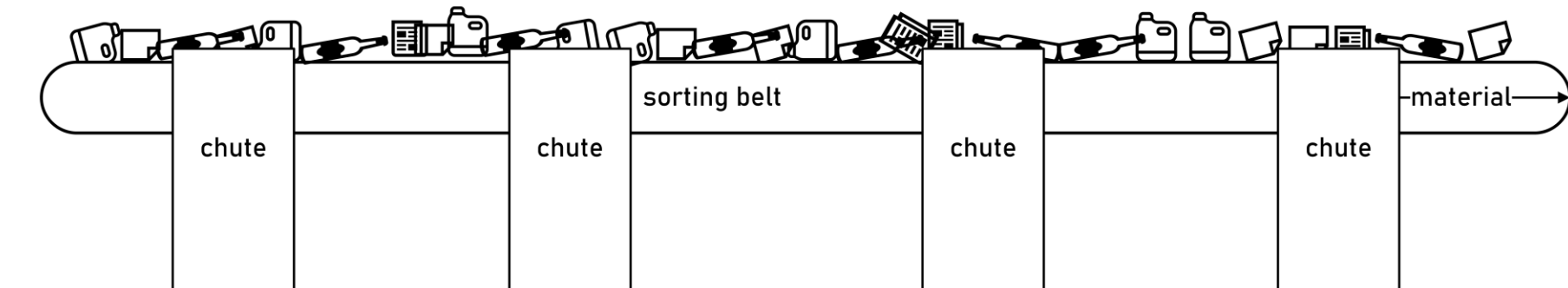


Source: Mayer Recycling GmbH

recAicle-System

State-of-the-art sorting cabine

- Sorting belt
- Chute

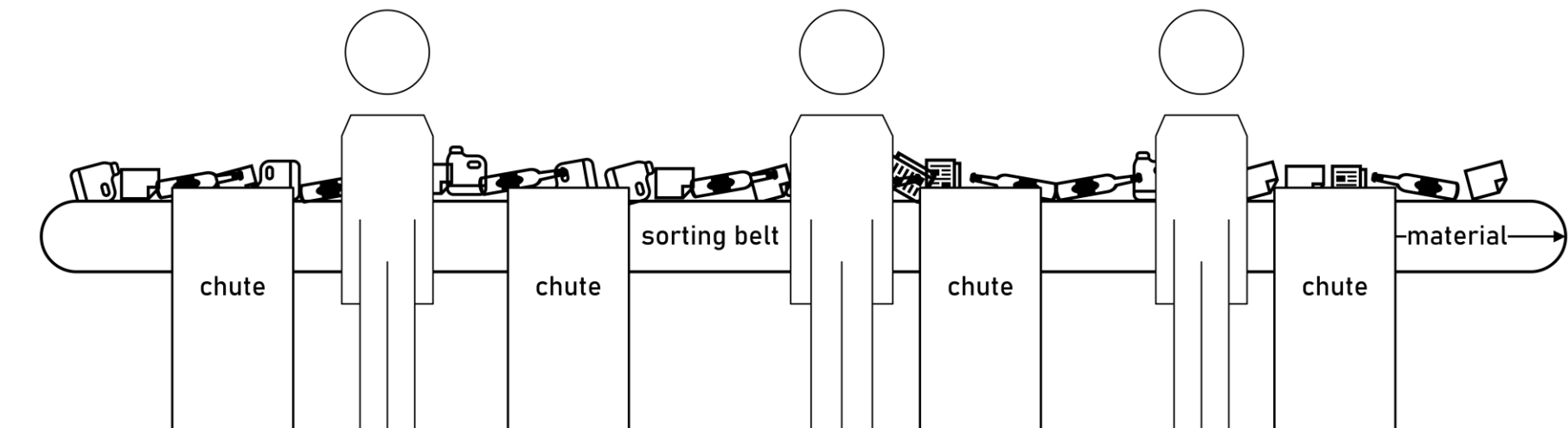


recAicle-System

State-of-the-art sorting carbine

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- Chute
- Sorting workers

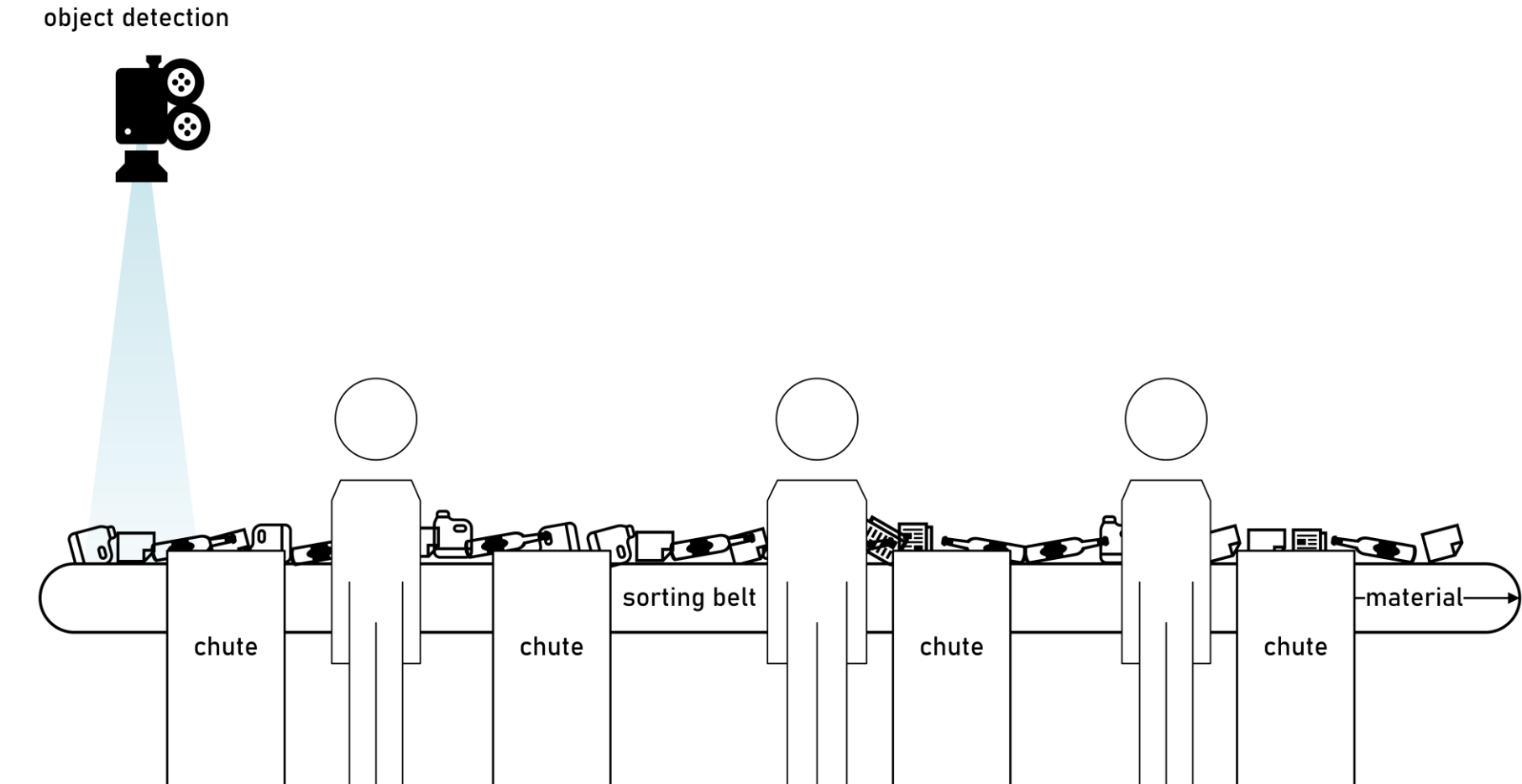
→ Introduction of digital assistance



recAIcle-System

recAIcle System

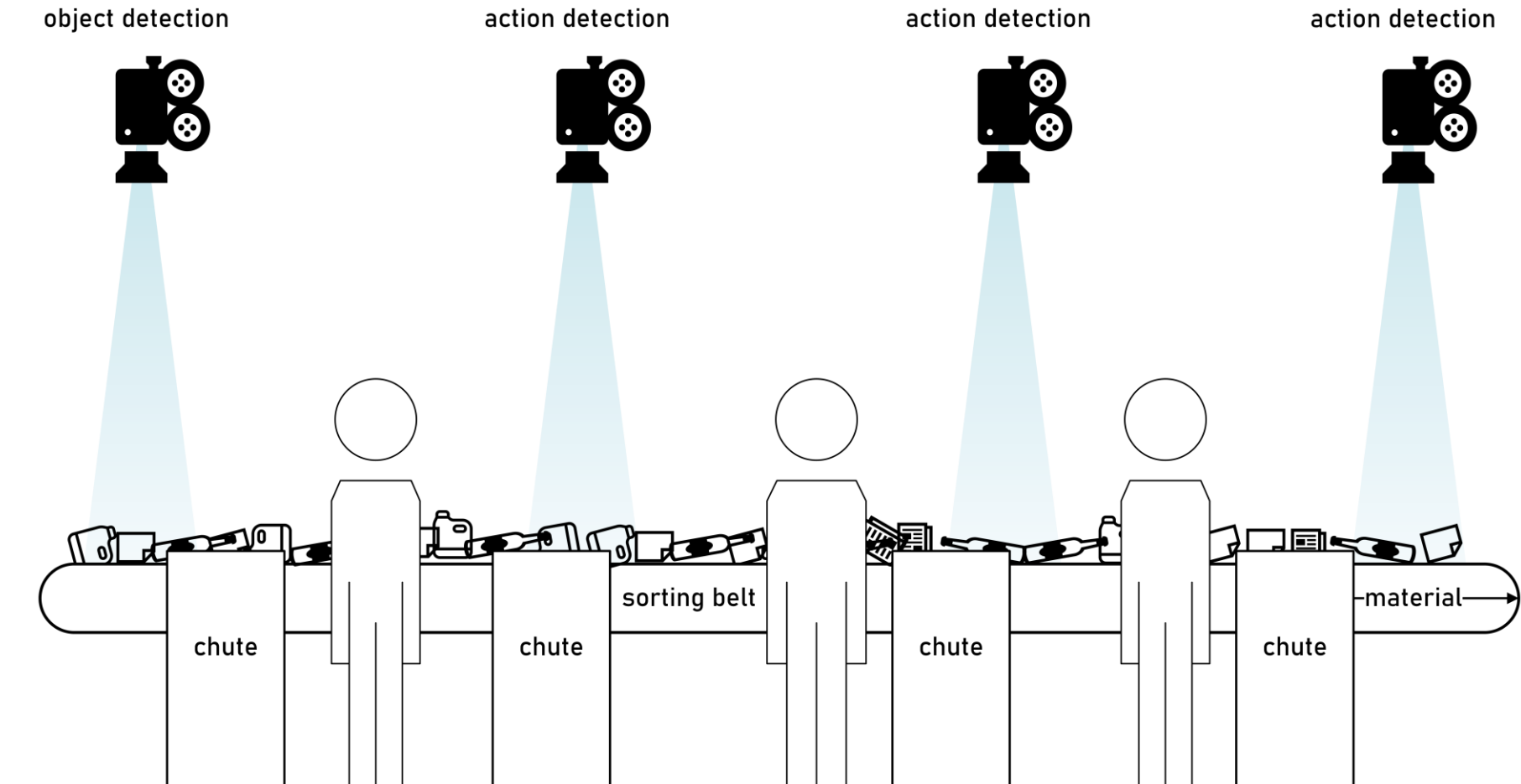
- Object detection



recAIcle-System

recAIcle System

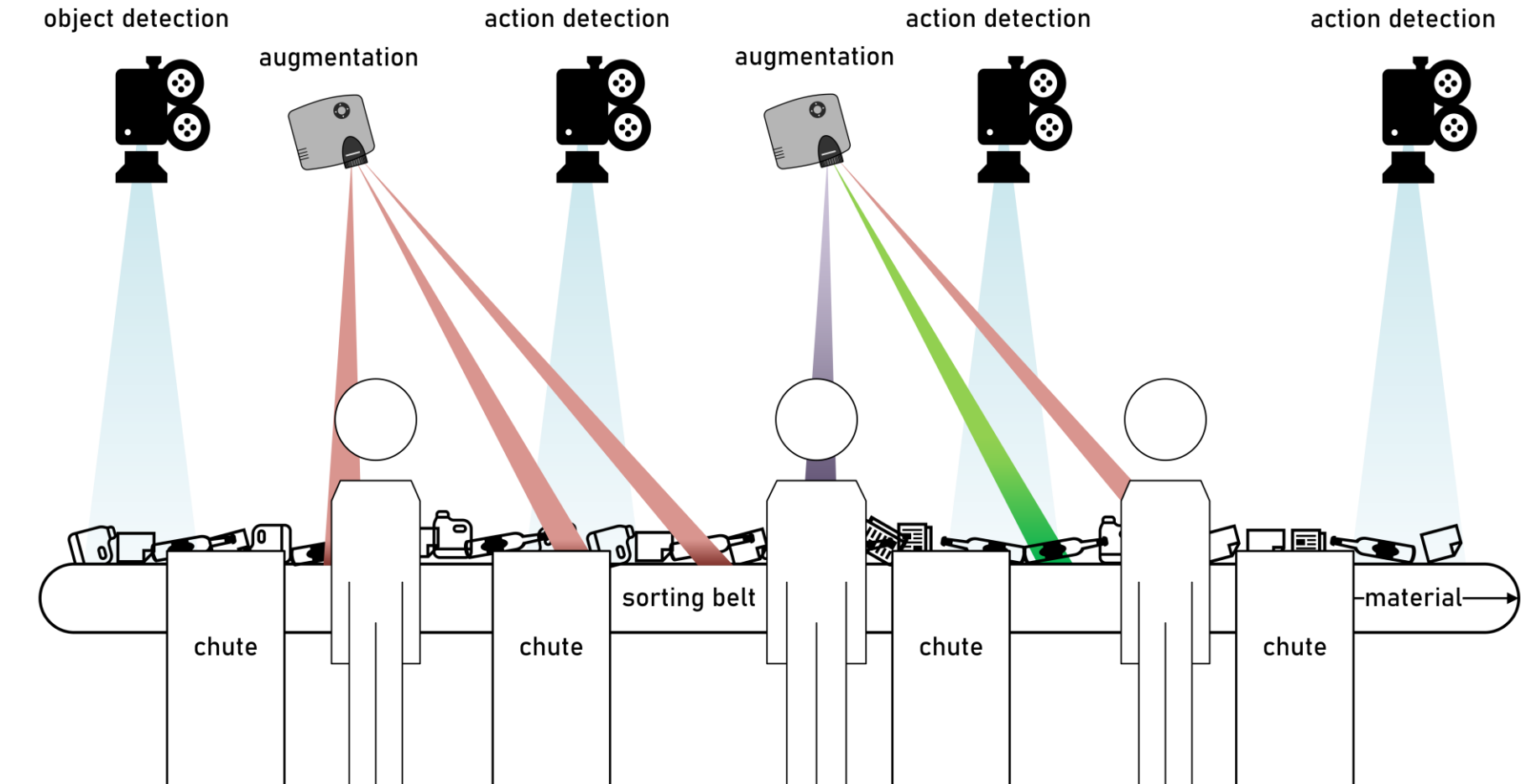
- Object detection
- Classification
- Action detection



recAIcle-System

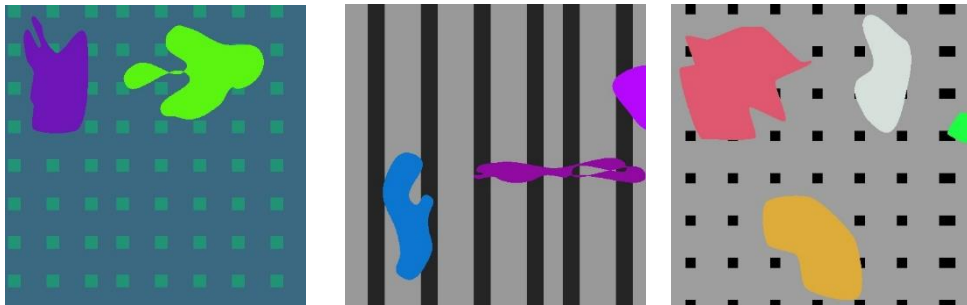
recAIcle System

- Object detection
- Classification
- Action detection
- Object tracking
- Augmentation



recAIcle - Object recognition

- Single Shot MultiBox Detector (SSD) framework
First training with synthetic data set (4000 images) generated by an AI

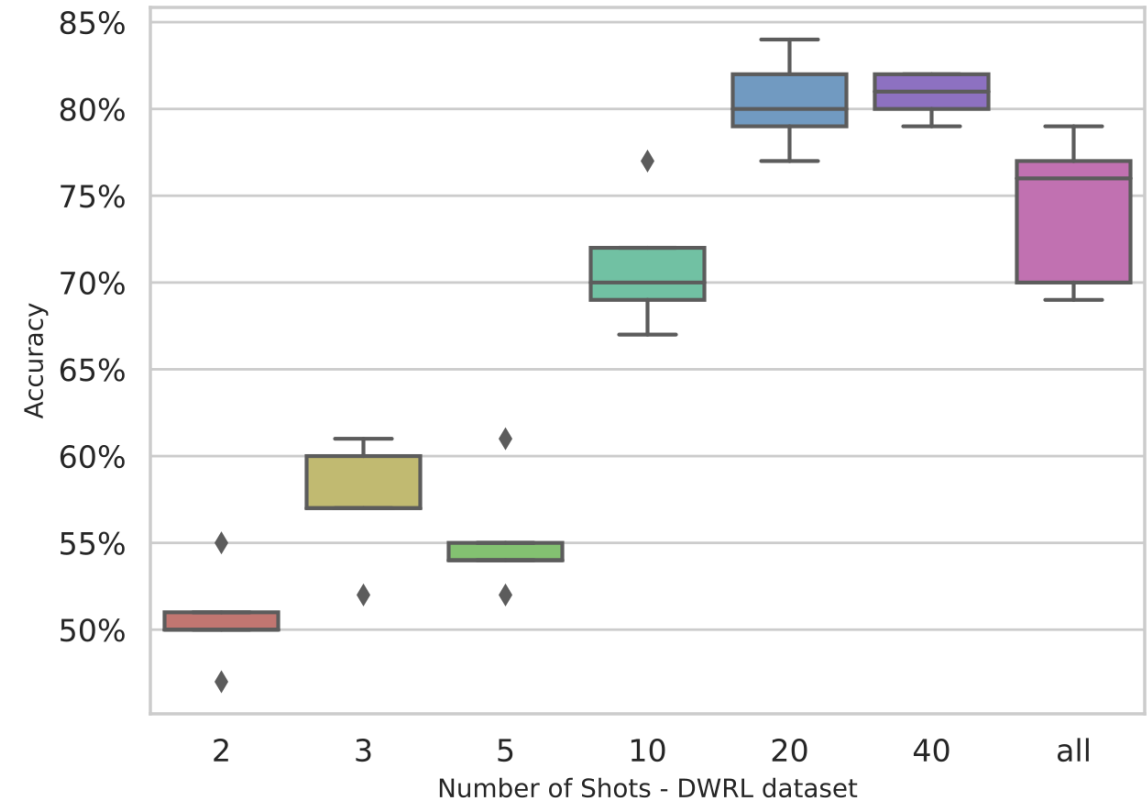


Source: Somayeh Shami, Benedikt Haecker, Bernhard Prangl, Julian Aberger, Jesus Pestana, Michael Krisper, A Vision-Based Trash Particle Classification System for Sorting Facilities, Deutsche Gesellschaft für Abfallwirtschaft e.V.; Fakultät für Bau- und Umweltingenieurwesen der Technischen Universität Wien (Hg.) (2024): 13. Wissenschaftskongress Kreislauf- und Ressourcenwirtschaft am 15. und 16. Februar 2024 an der Technischen Universität Wien. Innsbruck university press..

recAIcle - classification

- pre-trained MobileNet model
 - Use of transfer learning and few-shot learning
 - Integration of lifelong learning

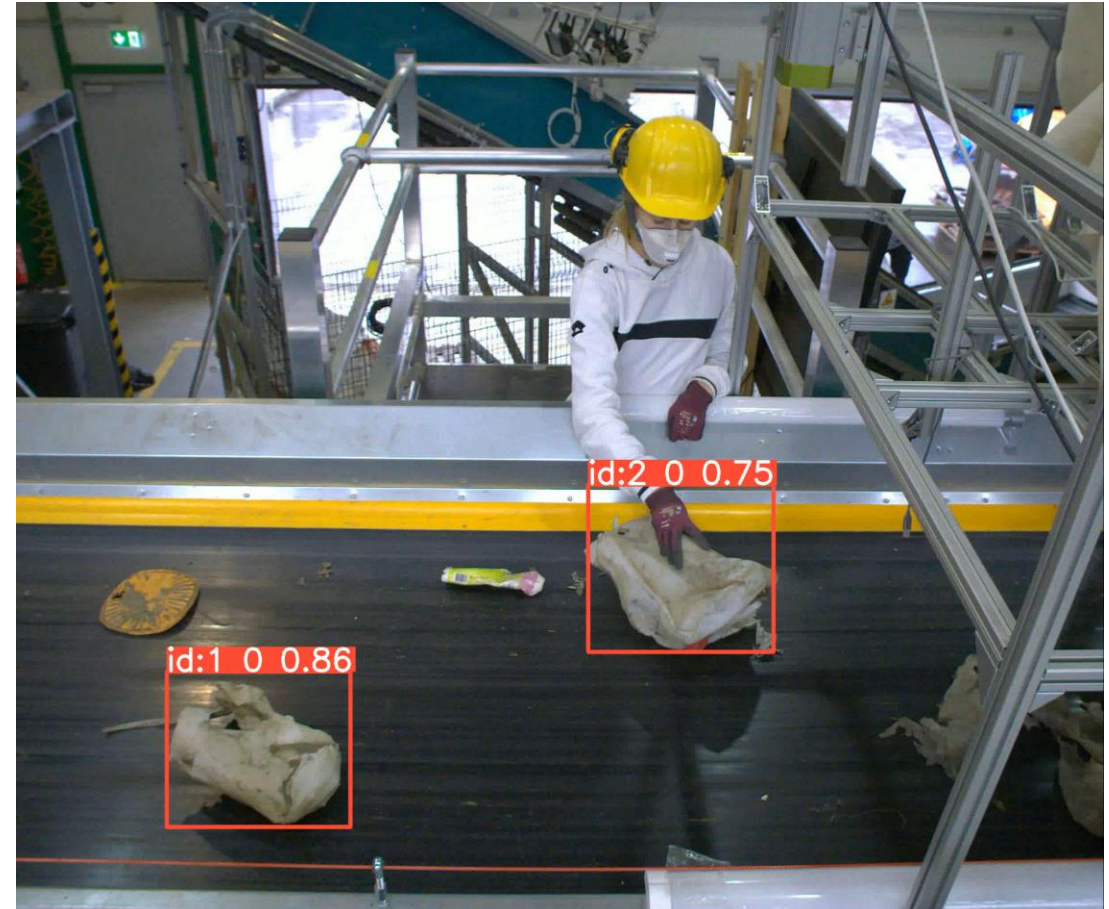
Material type	train	test
GVK	40	10
PE	80	20
PET	80	20
PS	80	20
PVC	40	10



Source: Somayeh Shami, Benedikt Haecker, Bernhard Prangl, Julian Aberger, Jesus Pestana, Michael Krisper, A Vision-Based Trash Particle Classification System for Sorting Facilities, Deutsche Gesellschaft für Abfallwirtschaft e.V.; Fakultät für Bau- und Umweltingenieurwesen der Technischen Universität Wien (Hg.) (2024): 13. Wissenschaftskongress Kreislauf- und Ressourcenwirtschaft am 15. und 16. Februar 2024 an der Technischen Universität Wien. Innsbruck university press..

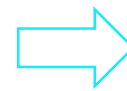
recAIcle - Object tracking



- Object tracking in the scene
 - First step for augmentation
 - Real time



Source: Pro2 Future GmbH

recAIcle - Augmentation

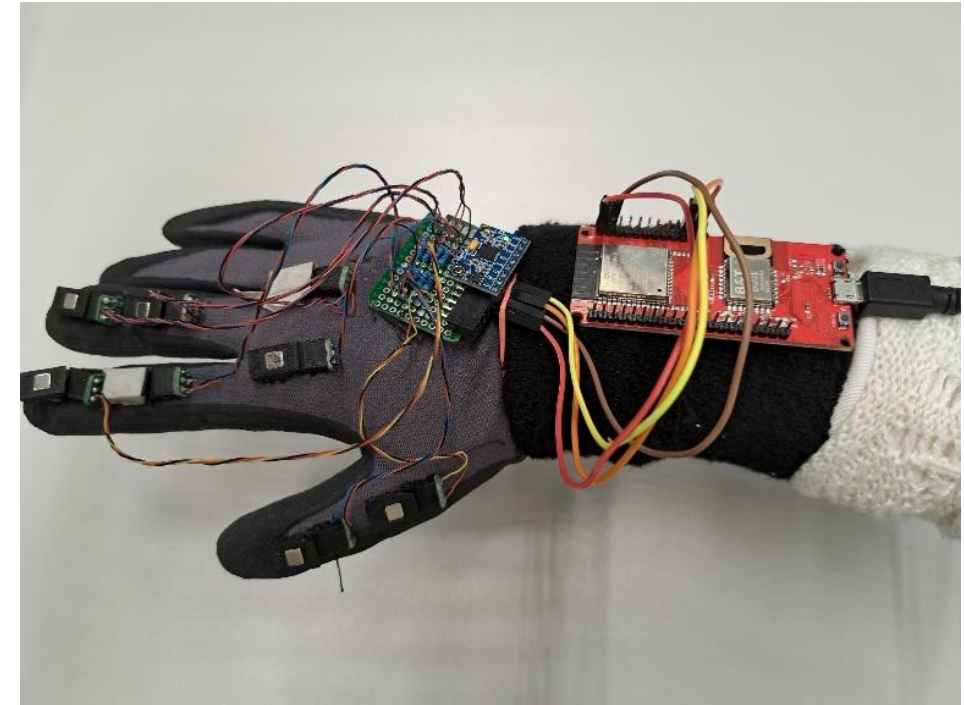


-  Allow
-  Remove



Conclusion and Outlook

- AI is not going to replace us
 - AI is a powerful tool
 - Use case specific limitations
- recAIcle prototype system is ready
 - Test of the assistance system with sorters
 - Integration of the UBW glove
 - Comparison between AI classification and NIR classification




Source: Michael Siegl, Iris Unterkircher, Julian Aberger, Jesus Pestana, Michael Krisper, Action recognition support system for recycling and sorting facilities, Deutsche Gesellschaft für Abfallwirtschaft e.V.; Fakultät für Bau- und Umweltingenieurwesen der Technischen Universität Wien (Hg.) (2024): 13. Wissenschaftskongress Kreislauf- und Ressourcenwirtschaft am 15. und 16. Februar 2024 an der Technischen Universität Wien. Innsbruck university press


Thank you for your
attention



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