AI in Optronics

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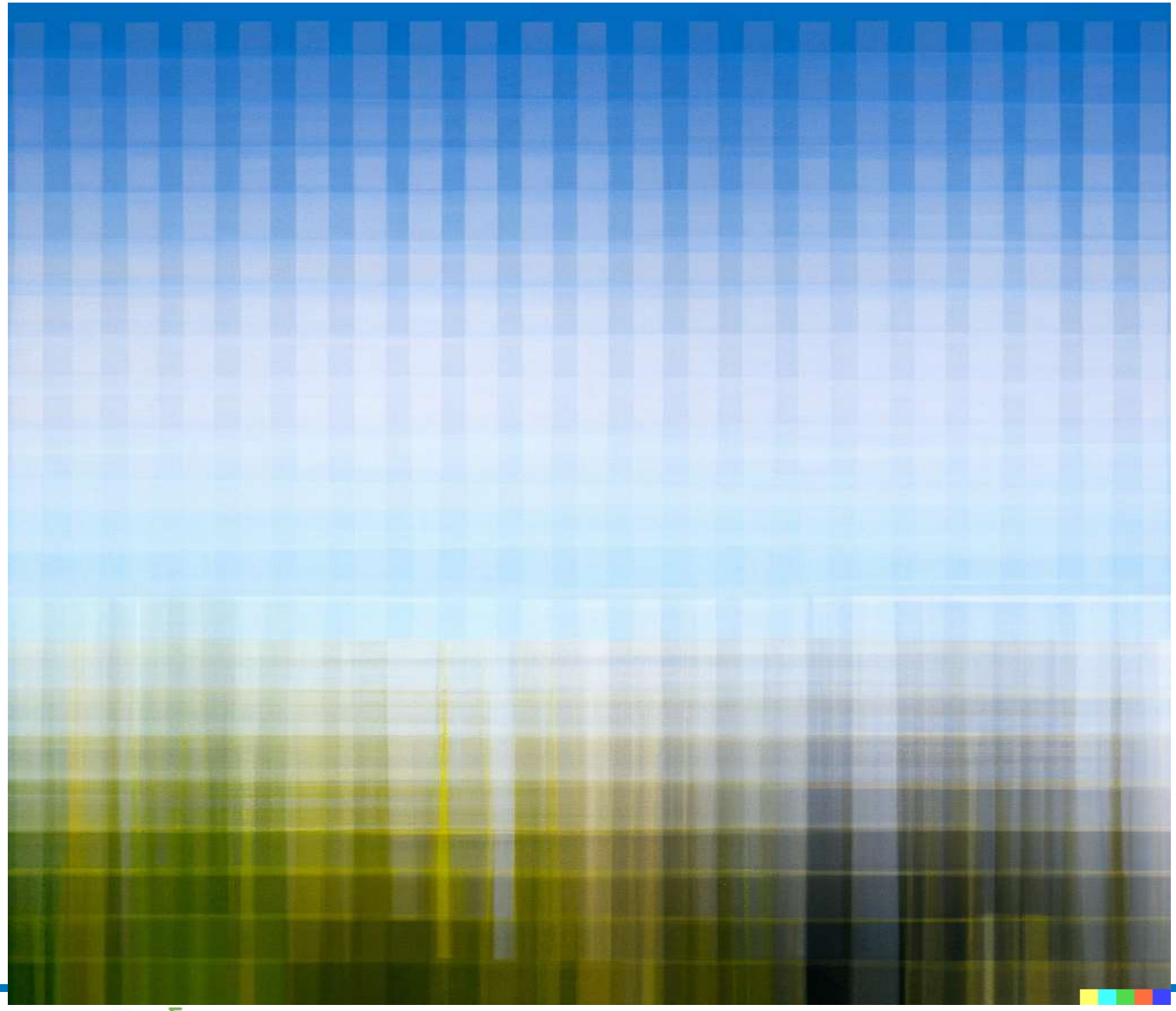
Workshop 2023
ePicture This

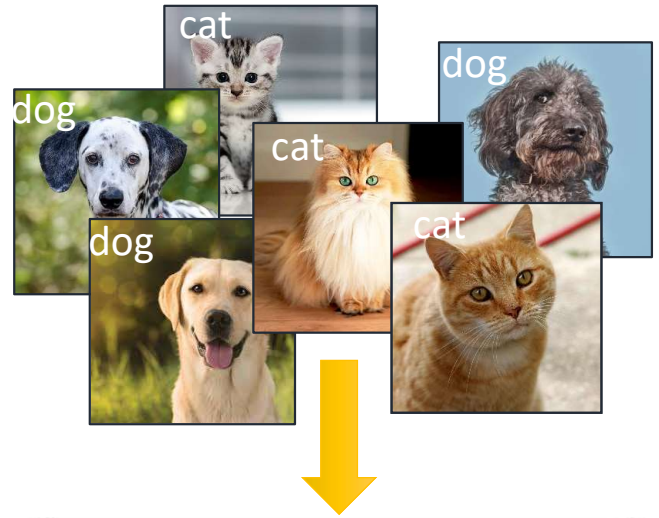
Penta Xecs EURIPIDES² European Smart Electronic Systems Aeneas

Content

- Background
- Challenges
- Applications



What is Deep learning?



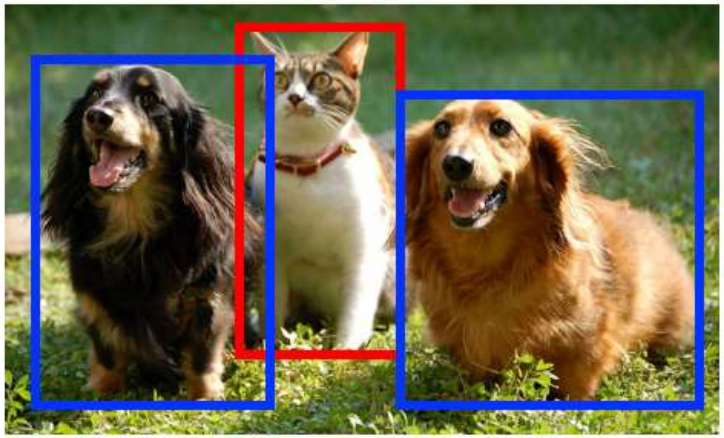
Deep learning model

dog

Classification

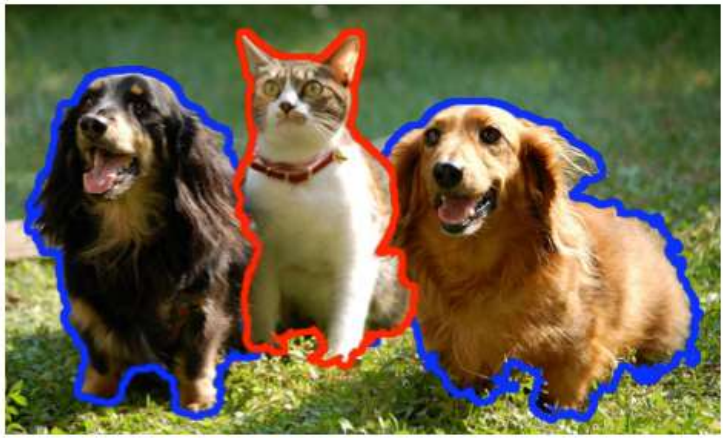
cat

Object detection



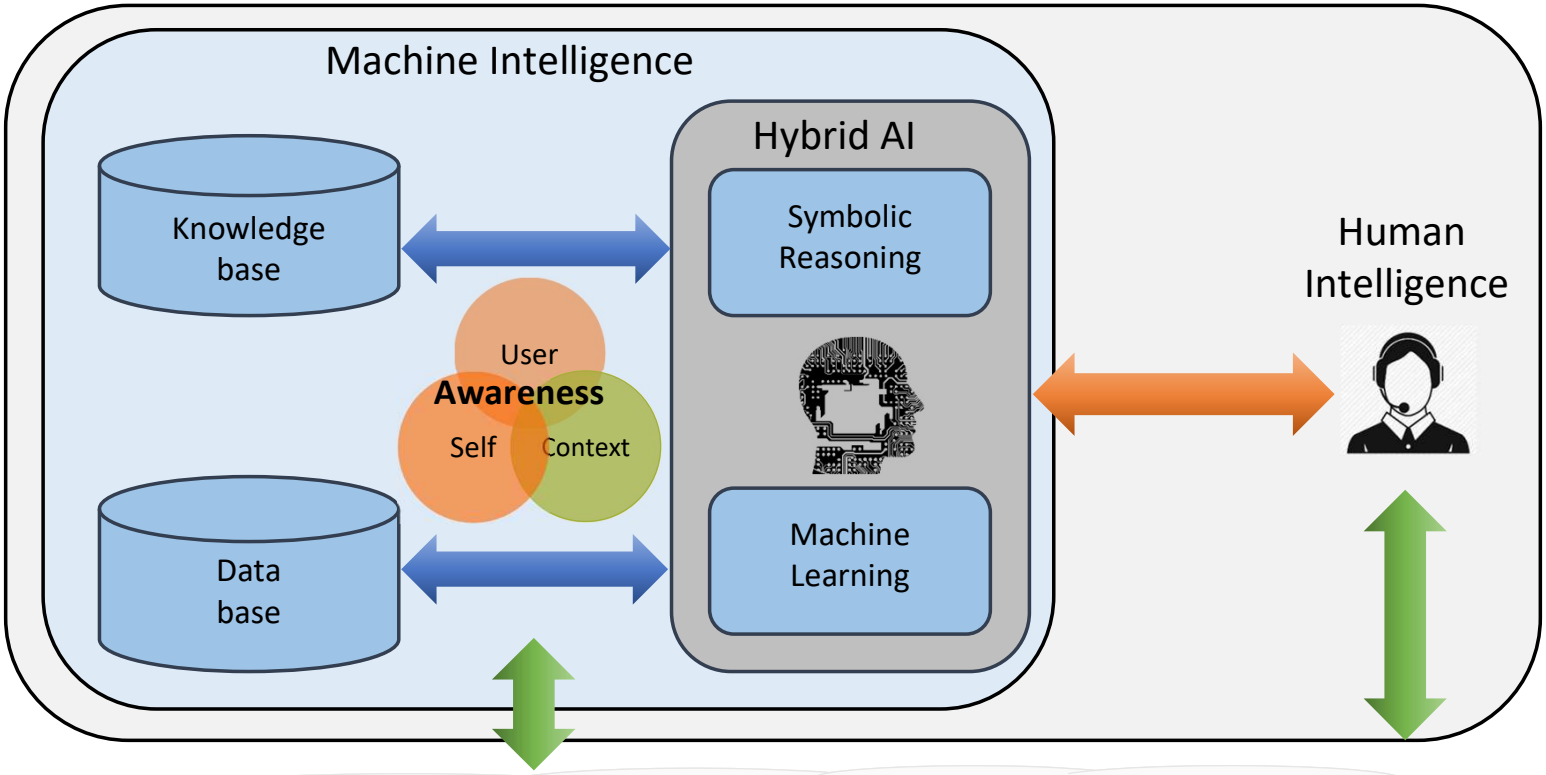
dog, cat, dog

Instance segmentation

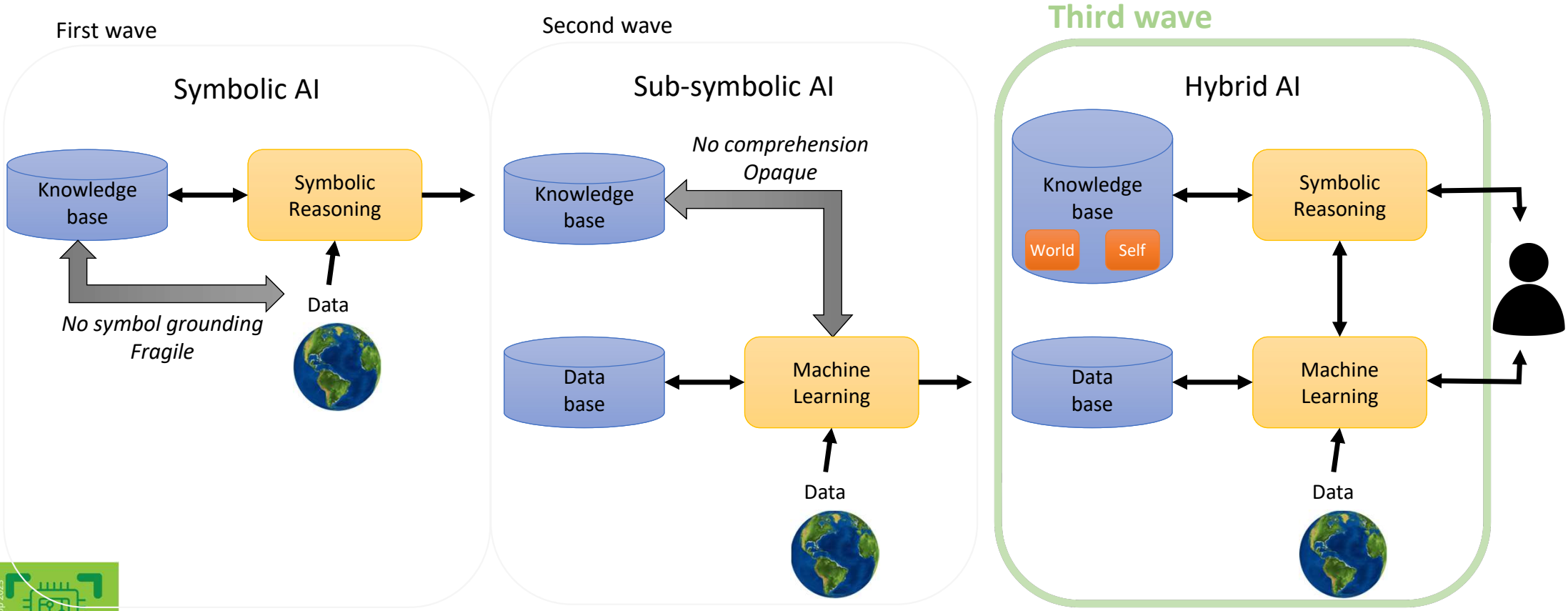


dog, cat, dog

Hybrid Artificial Intelligence



Dot on The horizon: surfing the 3rd wave



Organized by Penta projects:
2020005 Mantis Vision
2021004 Imagination

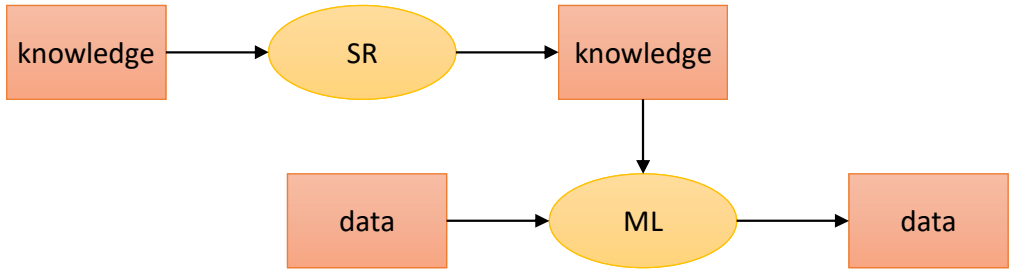
Hybrid AI design patterns

SR = Symbolic Reasoning
ML = Machine Learning

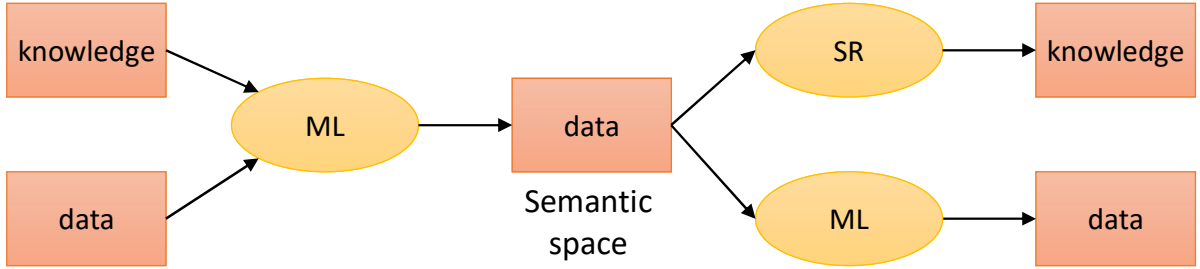
- Classical symbolic reasoning system

- Classical machine learning system

Learning with domain knowledge as prior



Multimodal embedding in semantic space



Source: Frank van Harmelen, Annette ten Teije, "A Boxology of Design Patterns for Hybrid Learning and Reasoning Systems", Journal of Web Engineering, 18(1-3): 97-124. 2019.

Dijk, J., Schutte, K., & Oggero, S. (2019, October). A vision on hybrid AI for military applications. In *SPIE* (Vol. 11169,

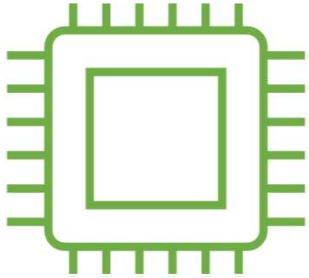
Challenges in non-standard domain

Application in domain is different than standard applications

Little training data

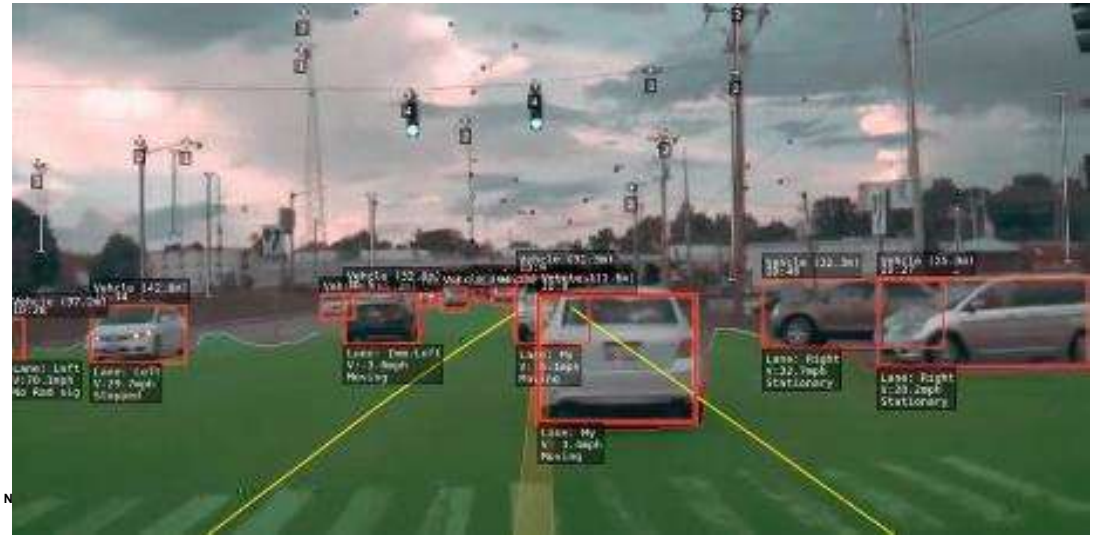
Need for trust

Need for online, adaptive systems



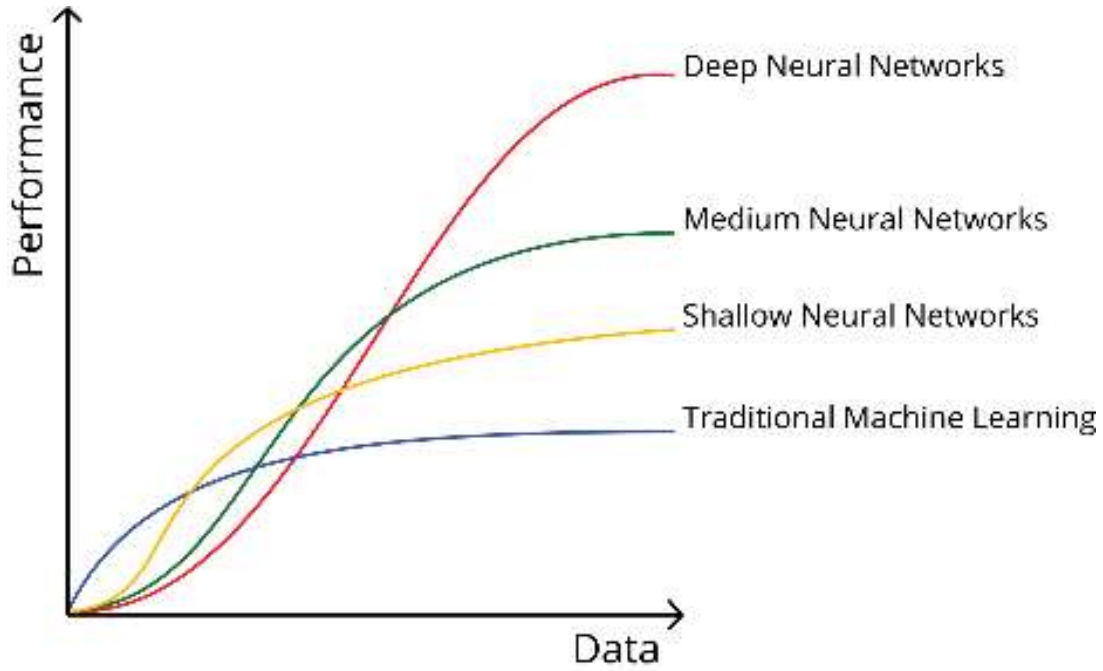
Need for edge processing

Application in other domain



Challenge:

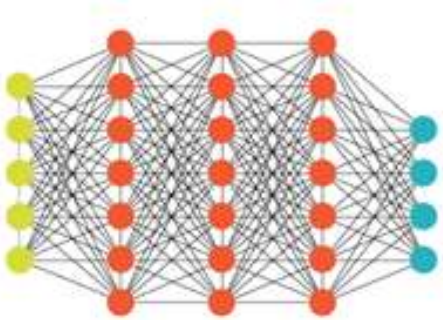
Little data to train and test



Retrain with a different dataset

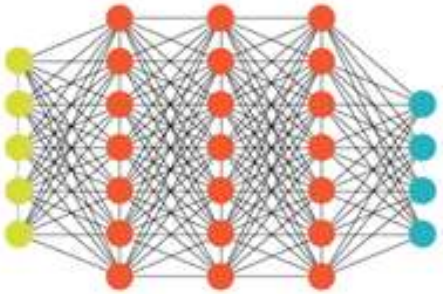
MS COCO

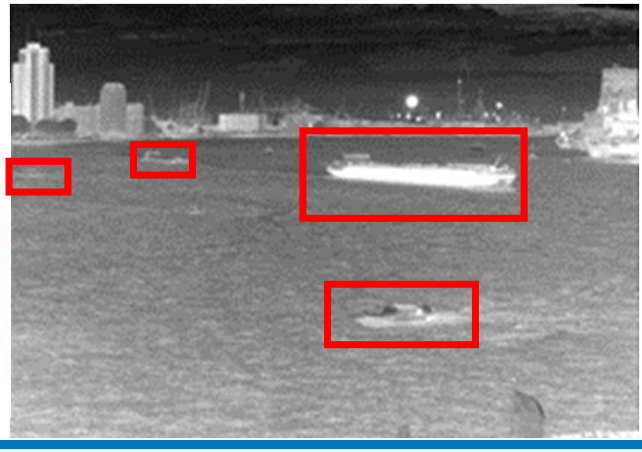
80 classes
RGB
80.000 images



MARITIME DATASET

1 class
LWIR/MWIR
~1600 images



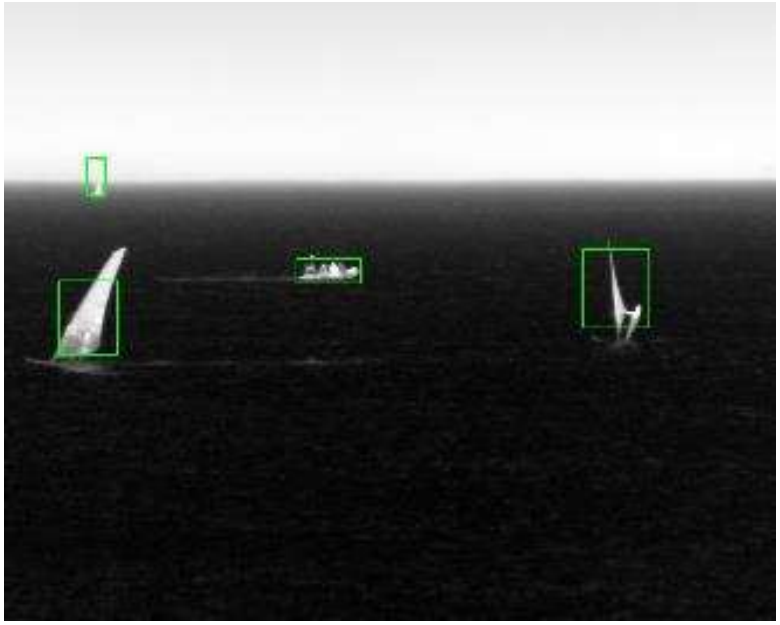


van der Stap, N., van Opbroek, A., Huizinga, W., Wilmer, M., van den Broek, B., Pruim, R., ... & Dijk, J. (2018). Maritime detection framework 2.0: a new approach of maritime target detection in SPIE vol, *10795*

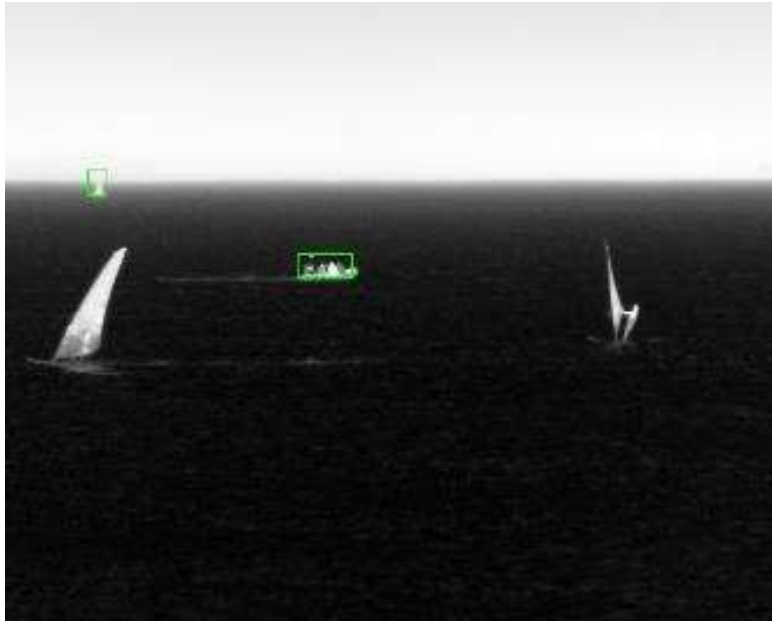
Detection and tracking results

Generalisation

Test result **without** windsurfers in trainingset



Testresult **with** windsurfers **as negatives** in trainingset



Simulation of training examples

Training with ***Grand Theft Auto 5*** (GTA5)
~1360 4k images with a tank

Different
- Backgrounds
- Atmospheric conditions
- Viewing angles
- …

Data augmentation

Results on real imagery

Darpa learning with less labels

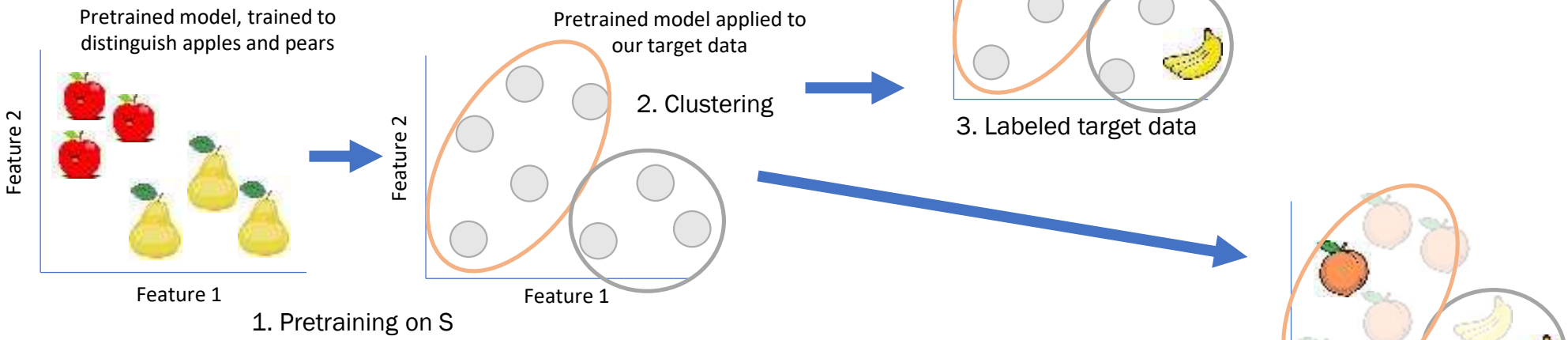
Program description

- DARPA Program Goal:

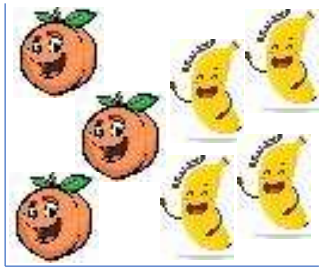
The Learning with Less Labeling (LwLL) program aims to make the process of training machine learning models more efficient by reducing the amount of labeled data required to build a model by six or more orders of magnitude, and by reducing the amount of data needed to adapt models to new environments to tens to hundreds of labeled examples.

- Program tasks: Image classification, object detection, video classification and machine translation
- 13 competing teams
- Top performers in first evaluation (including TNO) continued in the second phase of the program

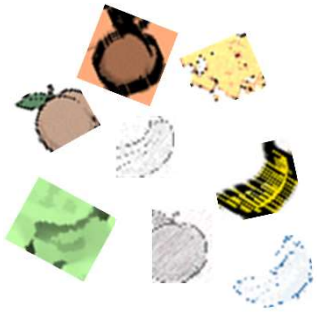
Image classification method



7. Self-supervision

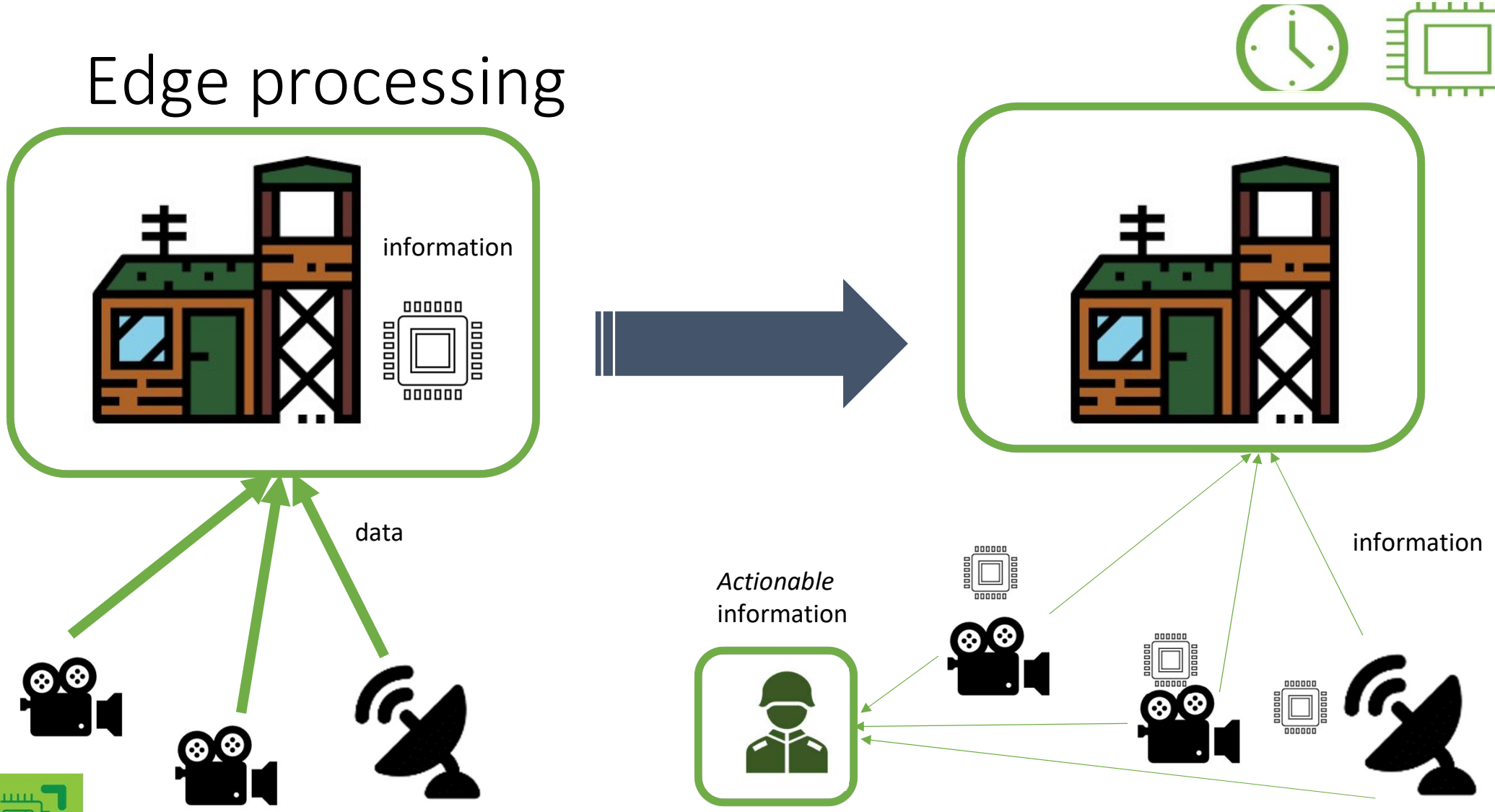


6. Domain transfer data



5. Augmentation

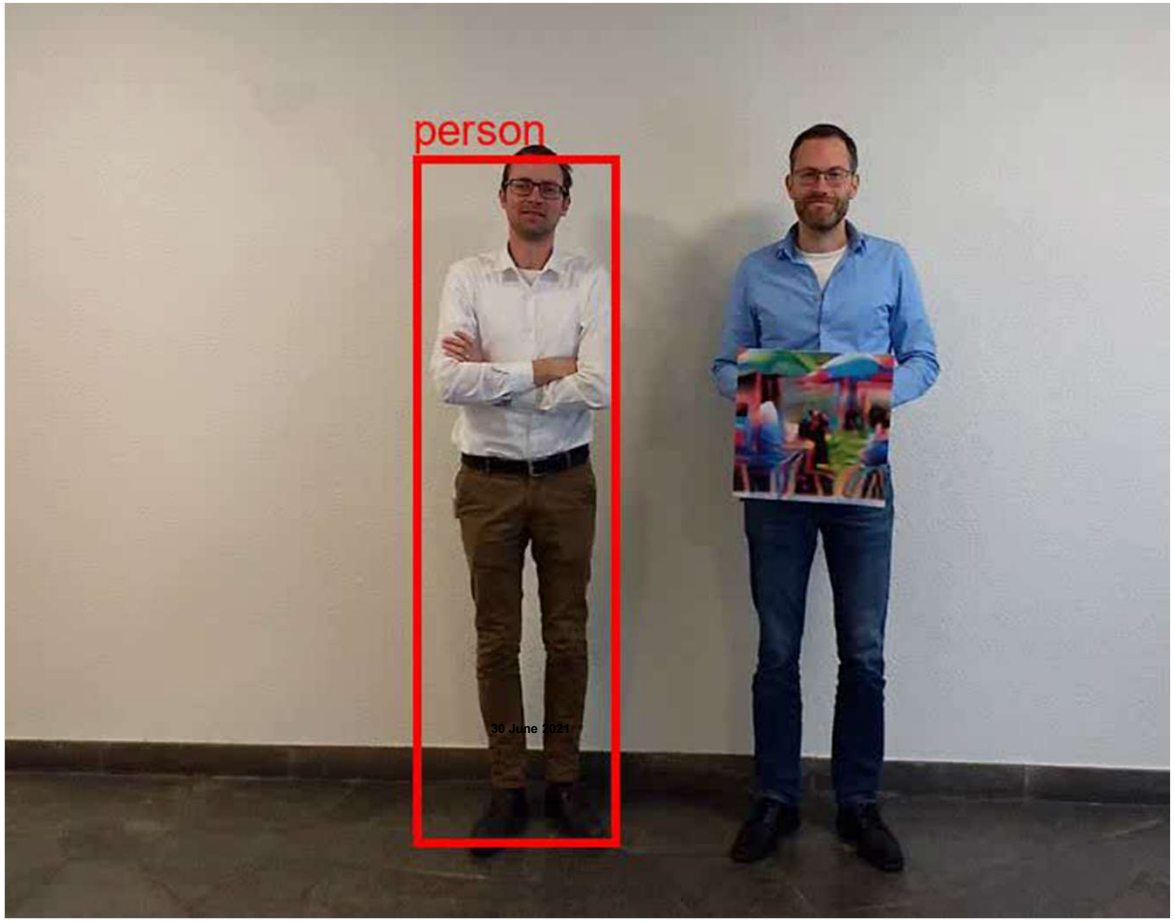
Edge processing



Adversarial attacks on deep learning

https://www.redbubble.com/shop/adversarial+t-shirts

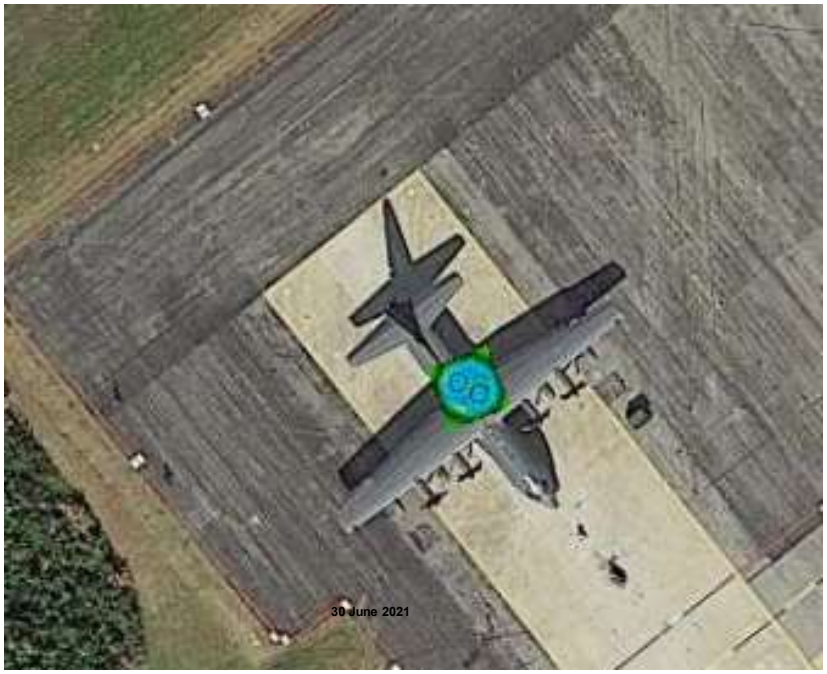
Camouflage for a person detector



Patch camouflage in aerial images

Hide the object from the **human** eye with traditional camouflage techniques

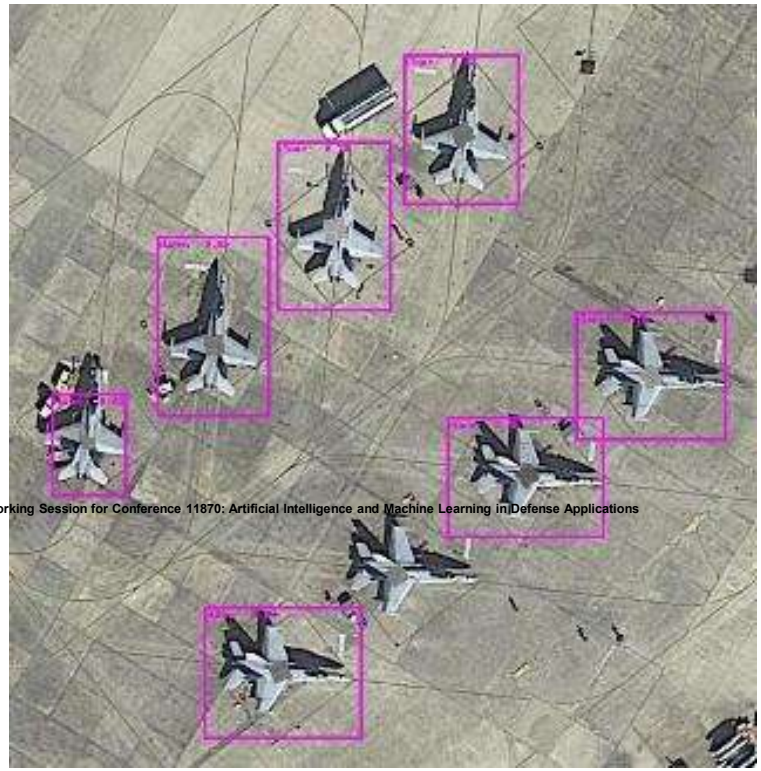
Hide the object from **automatic** detection with an adversarial patch

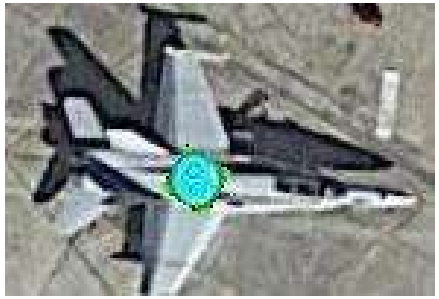


https://www.newscientist.com/article/2253881-small-sticker-could-hide-a-fighter-jet-from-an-enemy-drone/

den Hollander, Richard, et al. "Adversarial patch camouflage against aerial detection." *Artificial Intelligence and Machine Learning in Defense Applications II*. Vol. 11543. International Society for Optics and Photonics, 2020.

Patch camouflage in aerial images





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2021004 Imagination

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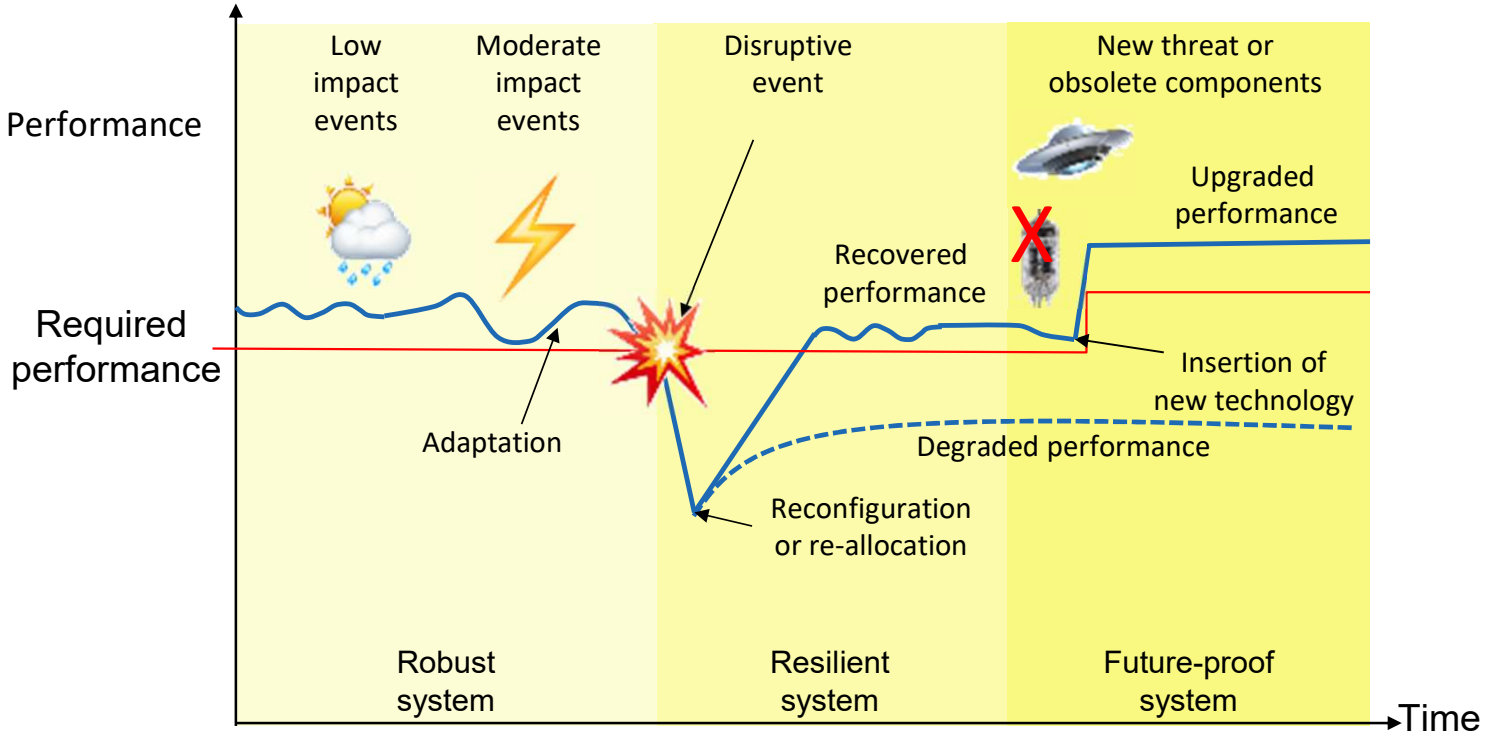
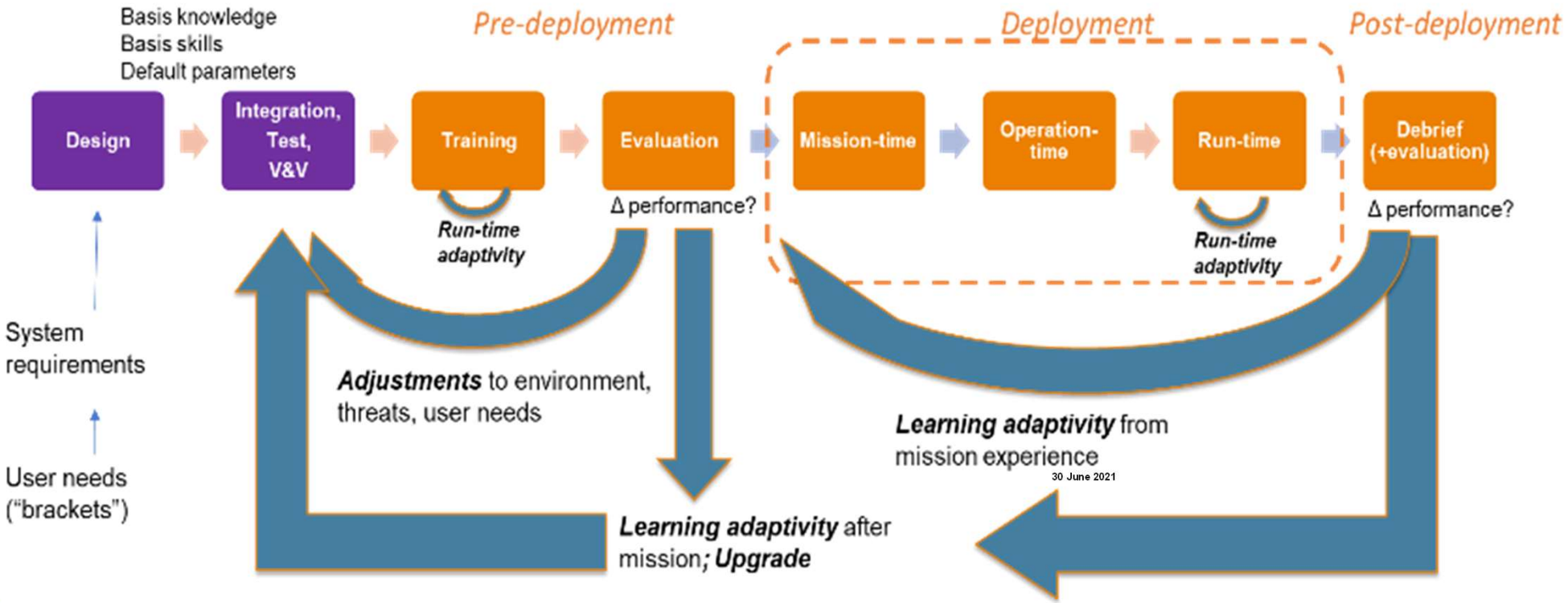
Robustness and Resilience of systems



Source P. Uday, K. Marais, "Designing resilient systems-of-systems: a survey of metrics, methods, and challenges.", System Engineering 2015;18(5):491 –510

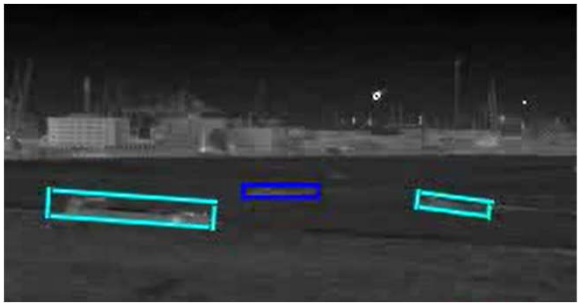
Life cycle of AI system

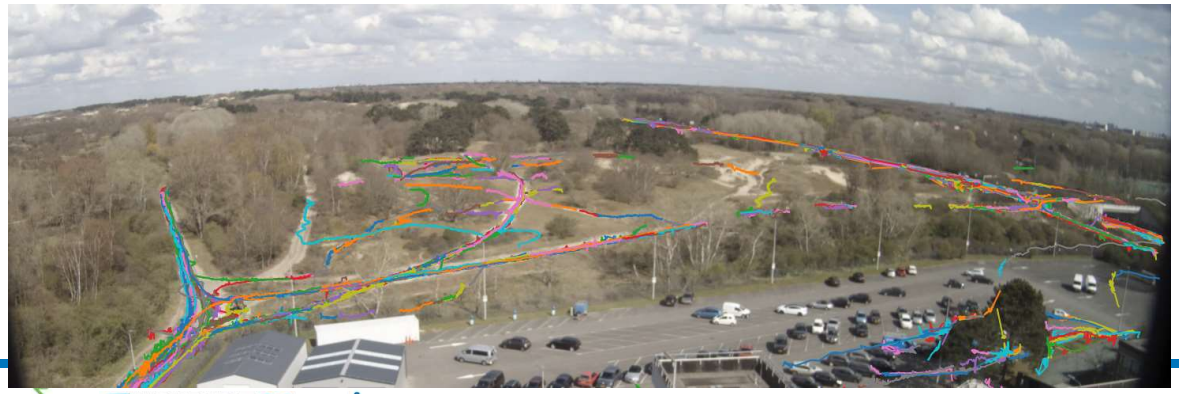


Applications

Application Domains

- **Surveillance**: Monitoring of persons, vehicles, vessels or other objects in various circumstances
- **Defence & Security**: Identifying and tracking potential threats or suspicious activities.
- **Autonomous Systems**: enabling robot perception for autonomous situational awareness





Complex event detection

Goal: Find complex events in large amounts of data

Problem: Event of interest not known on forehand (no training data)

Solution: Train object detection and tracking using DL networks

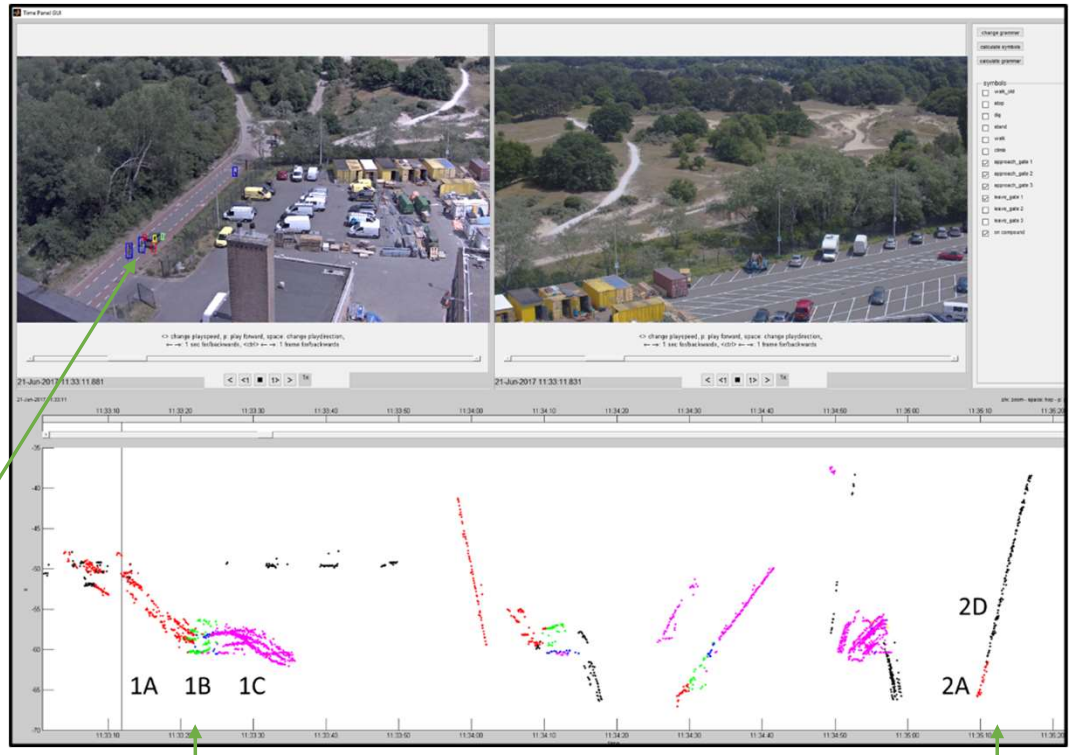
Train low level symbols

High level behaviour specified by user

Setup reasoning framework for complex events

Event detection

Single operational user interface combining video feeds and high level interpretation



High sensitivity object & action recognition

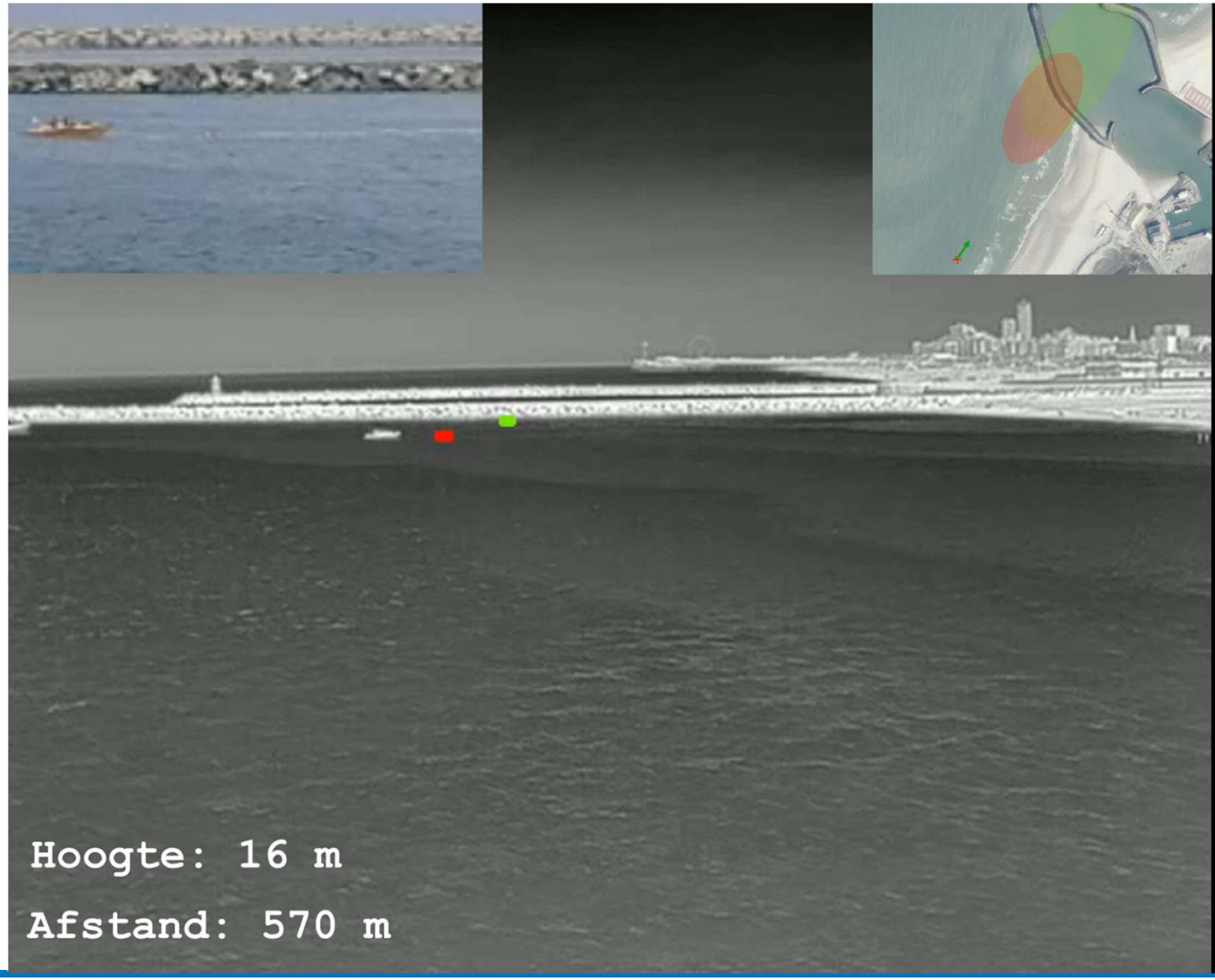
Temporal evolution of threats

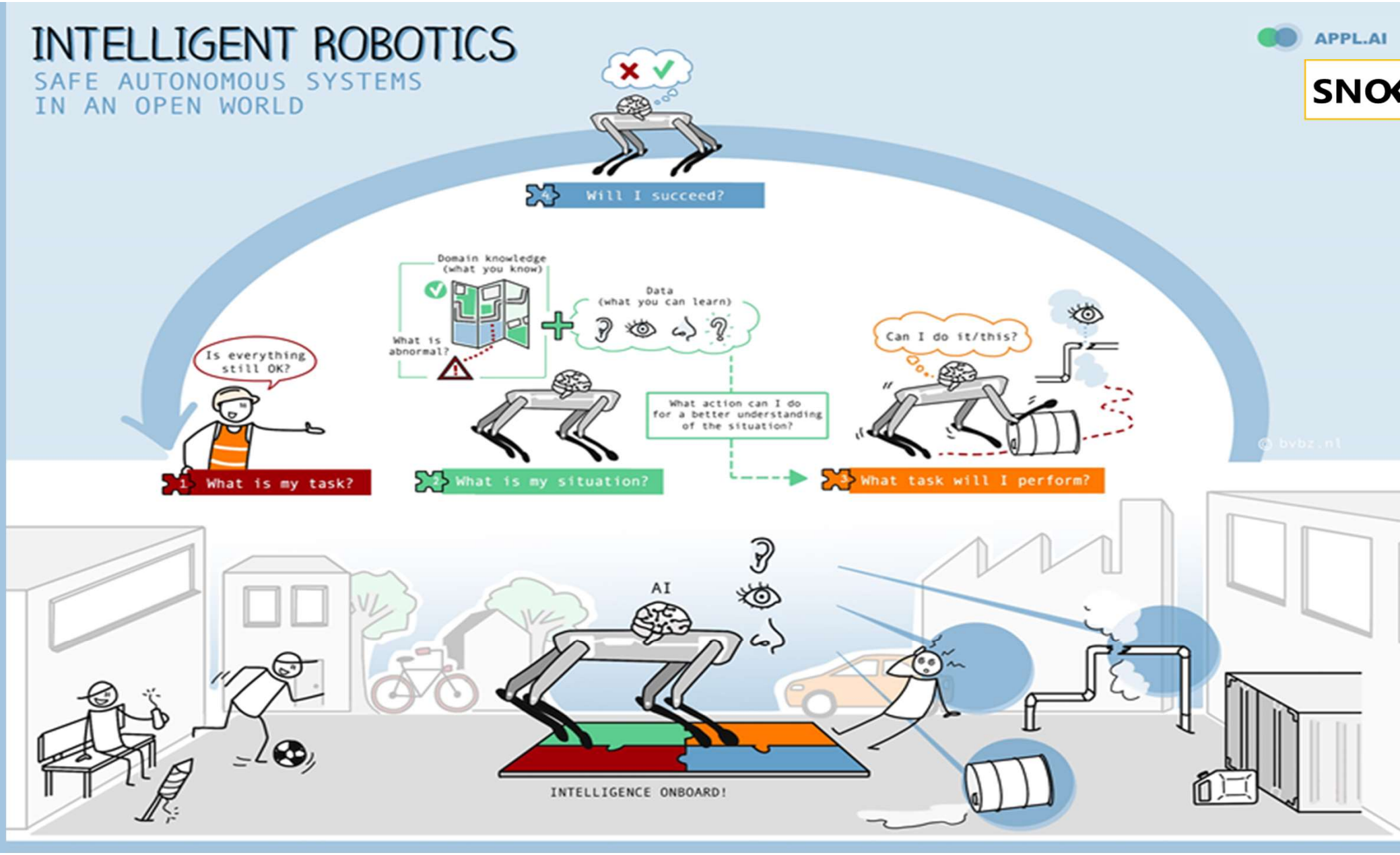
Different threat types


11 September 2019

Search and rescue

https://nos.nl/video/2384218-drenkelingen-sneller-ontdekt-met-speciale-drone-van-knrm




INTELLIGENT ROBOTICS
SAFE AUTONOMOUS SYSTEMS
IN AN OPEN WORLD
APPL.AI
SNOWK
Will I succeed?
Domain knowledge
(what you know)
What is
abnormal?
Data
(what you can learn)
What action can I do
for a better understanding
of the situation?
Can I do it/this?
Is everything
still OK?
1 What is my task?
2 What is my situation?
3 What task will I perform?
AI
INTELLIGENCE ONBOARD!
© bvbz.nl

Use data as starting point

We know concepts:
- *'Staircase', 'Elevator'*

We encounter a new situation.
- *No known concepts detected.*

Image captioning gives:
- *'A ladder is hanging from a ceiling in a room'*

From caption we detect nouns:
- *Ladder, Ceiling, Room*

Compare nouns to known information.

ChatGPT question	Affordances are represented by a triplet of (object, action, effect). For a knob I know the triplet (knob, push, door open). For a button (button, press, door open). If there is a similarity between a ladder and a door, can you than propose an affordance triplet for a ladder?
ChatGPT Answer	Yes, for a ladder, one possible affordance triplet could be (ladder, climb, reach higher elevation).

What attributes can be used to open the door

Objects of interest

{door, handle, etc.}

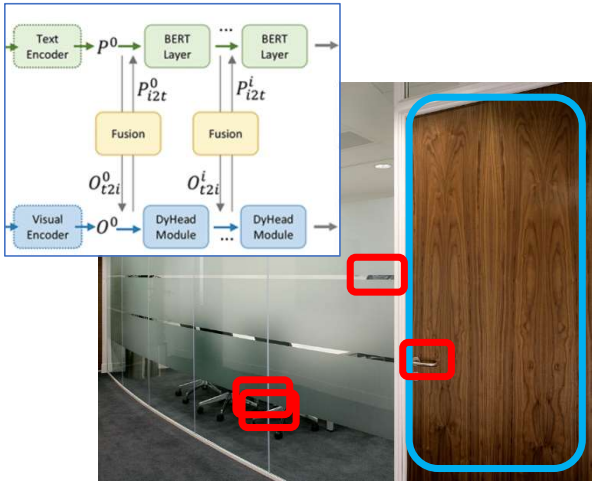
Diversify Prompts

handle →

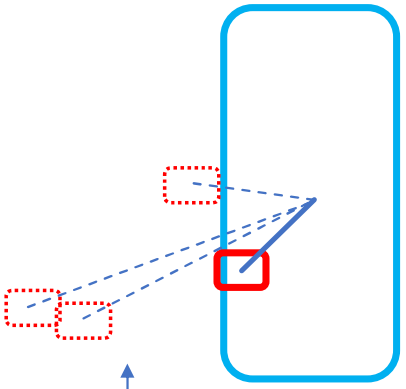
{handle, bar, knob, …}

etc.

Pretrained Large Language-Vision Model (GLIP)



Spatial Reasoning (neuro-symbolic program)



"Improved Zero-Shot Object Localization using Contextualized Prompts and Objects in Context, , ICRA 2023

better recall

zero-shot

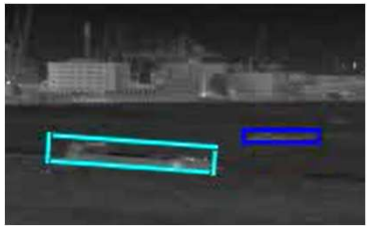
better precision

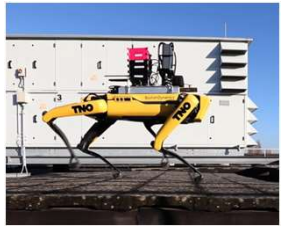
Contextual knowledge about concepts

Contextual knowledge about relations

https://www.youtube.com/watch?v=46J4KBDrevk&t=4s

Summary





Questions?

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21 June 2023