SSF CLAS
Cyber-security for learning and control systems

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Machine-Learning based systems under attack

1. Assess the vulnerability of ML-based systems

2. Detect attacks, and devise secure ML algorithms

3. Illustrate the concepts in a smart building testbed

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Machine Learning under attack?

At training time

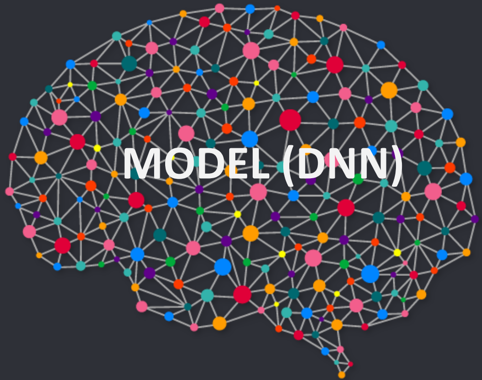
Machine Learning under attack?

At training time

Slightly modify the data in an ***adversarial*** manner

Machine Learning under attack?

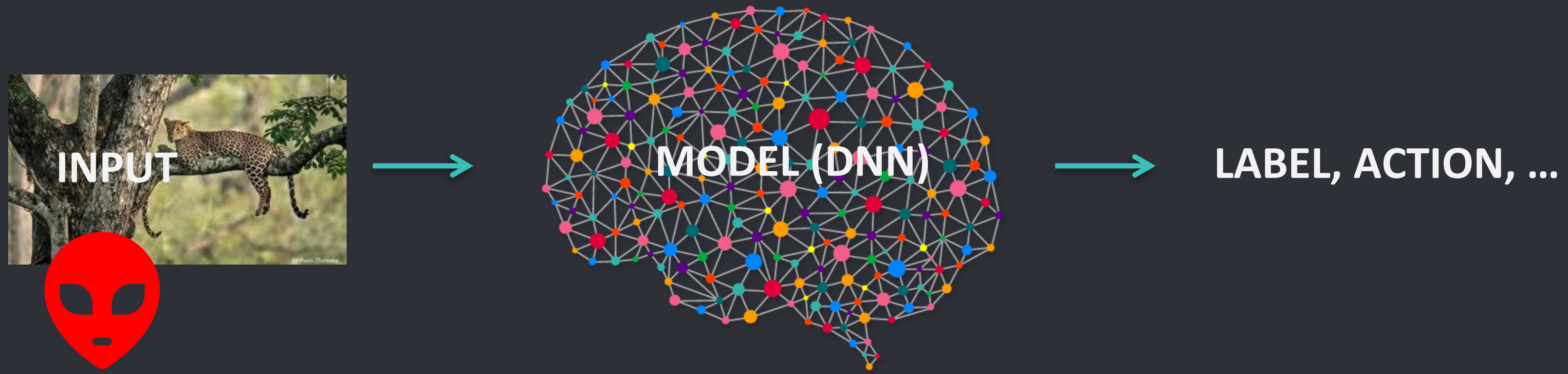
At test time



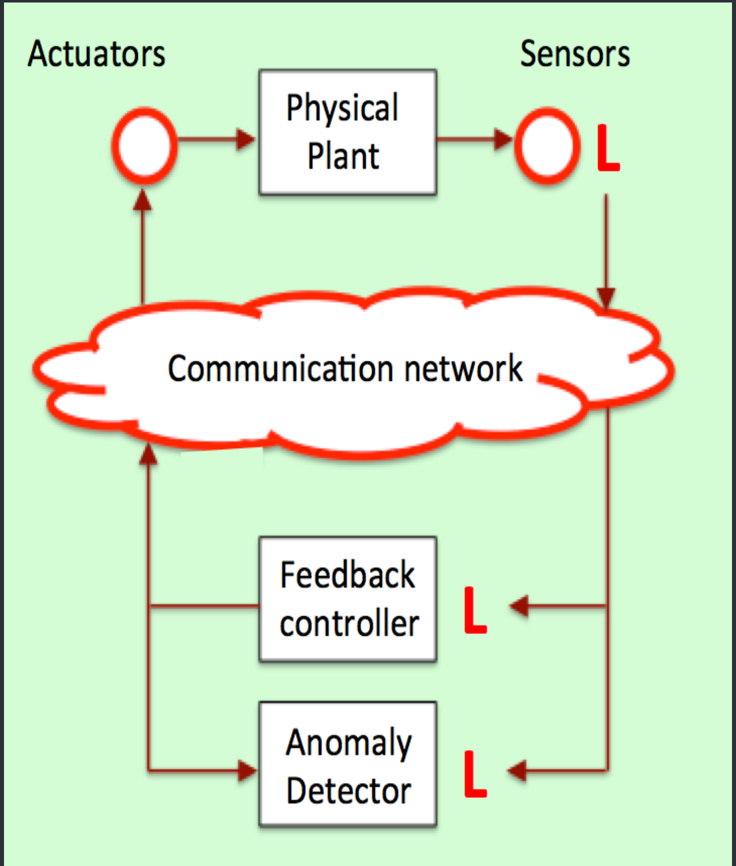
LABEL, ACTION, …

Machine Learning under attack?

At test time



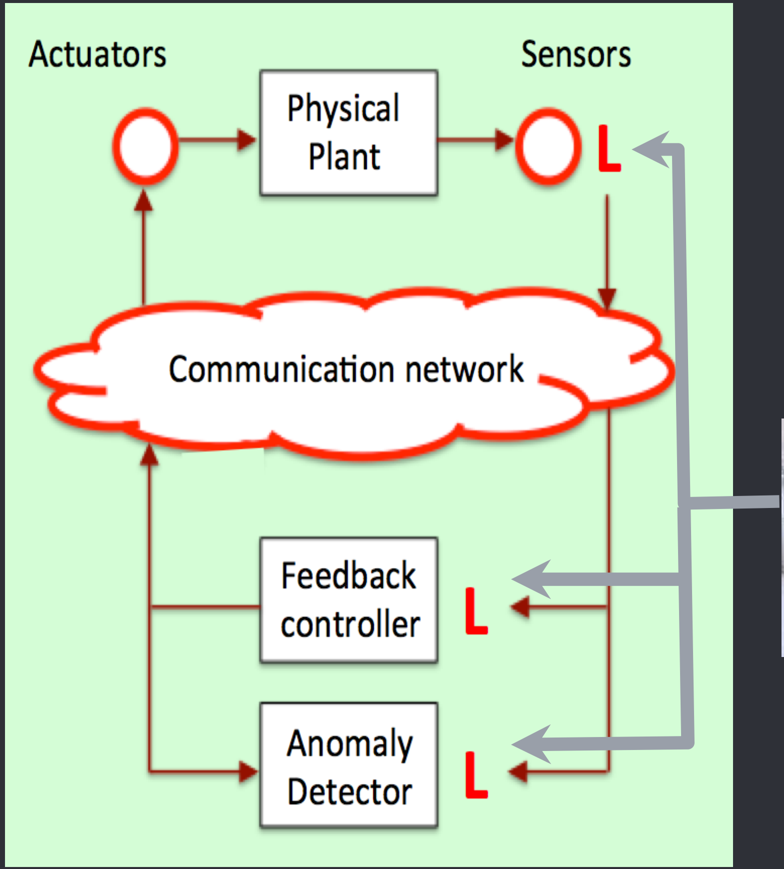
Slightly modify the input to the model in an ***adversarial*** manner



A generic ML-aided control system

L indicates ML components

a. ML helps interpreting sensor measurements
b. ML helps adapting the control (decisions taken) to a (partially) unknown system
c. ML helps building anomaly detectors

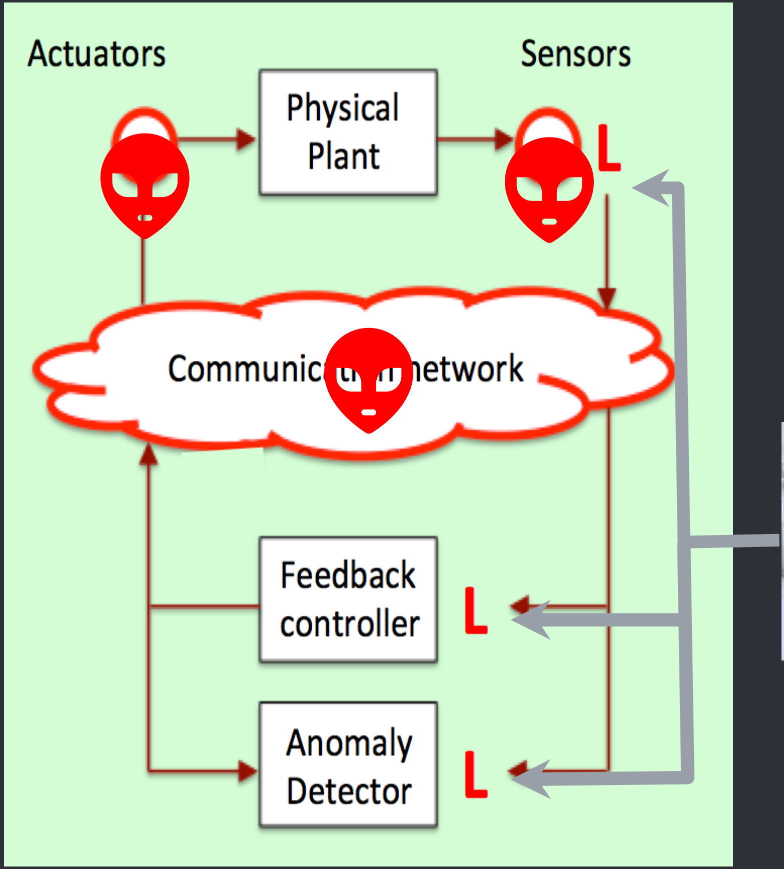


A generic ML-aided control system

ML methods most often comes with external datasets

A generic ML-aided control system

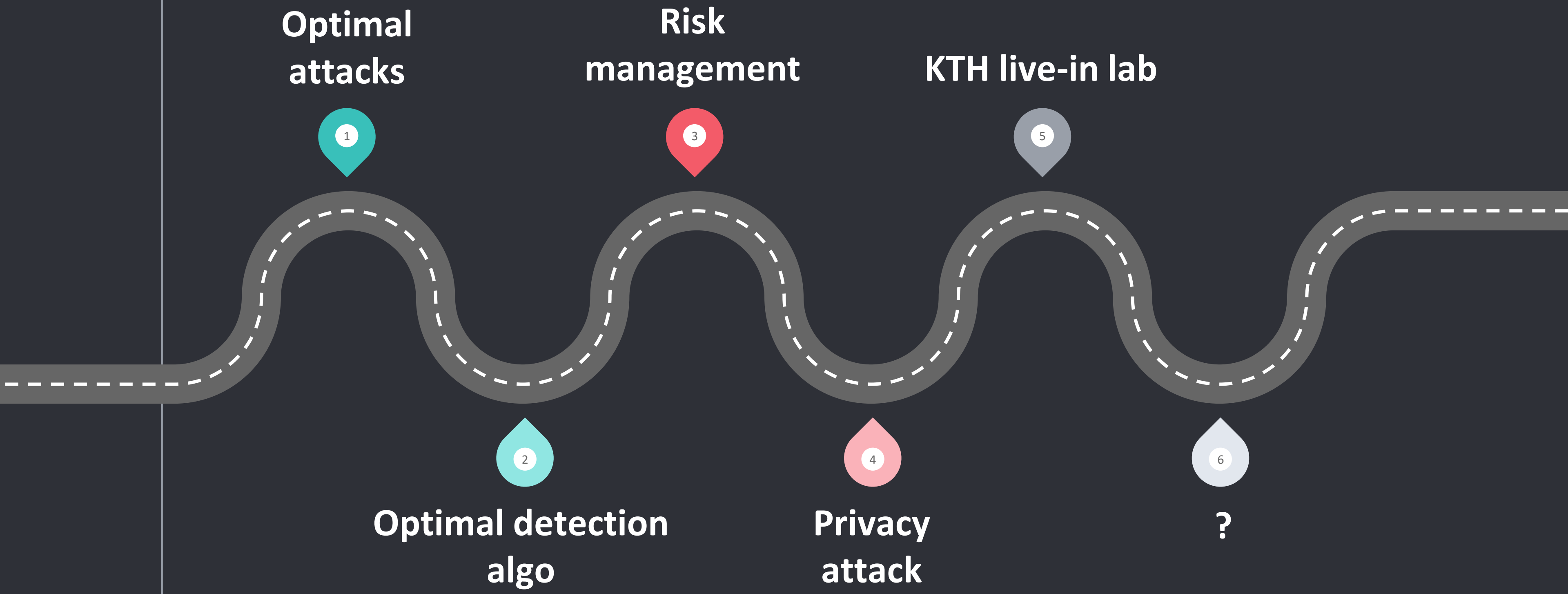
Possible points of attack



Attack at test time

Attack at training time

CLAS results in ML-based controlled systems



RESULTS SO FAR

Achievement snapshots

A - What are the threats and their potential impact?

- Optimal (or worse) attacks and their impact on
  - Reinforcement Learning policy at test time
  - Data-driven control policy at test and / or training time
  - Remote and distributed state estimation

B - Securing learning algorithms

- Secure multi-sensor estimation mechanisms
- Worst-case (adversarial) ML algorithms (e.g. regression)

C - Securing ML-aided control systems

- Secure Reinforcement Learning algorithms
- Secure platooning

Achievement snapshots

D - How can we evaluate risks and allocate defense resources accordingly?

- Game theoretical framework for risk management in advanced persistent threat

The Live-in Lab

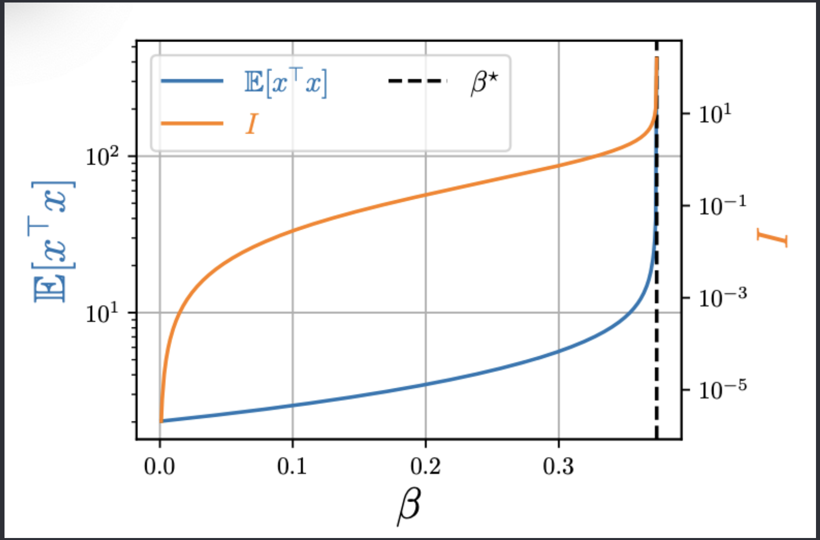
- Analysis of privacy attacks with data generated from the virtual testbed
- Co-simulation Environment to test state-of-the-art ML libraries for control
- Analysis of weak links in the data flows in the Live-In Lab

> 60 published papers

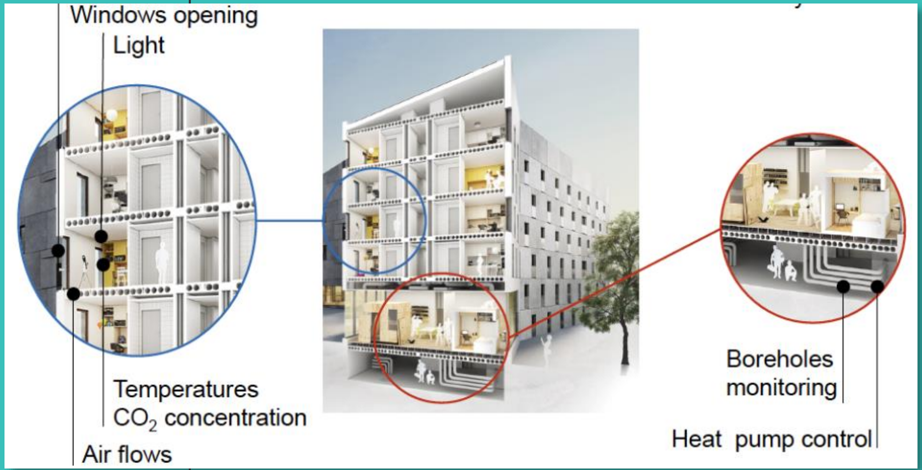
Example 1: Optimal attack / detection of RL policies

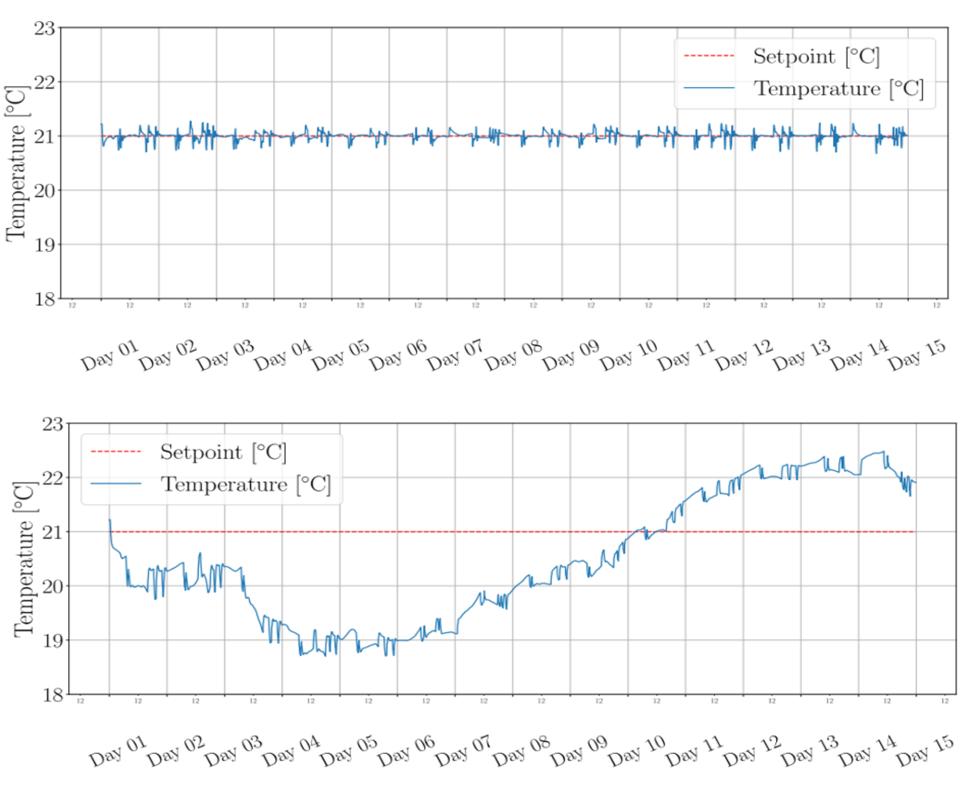
Attacking at test-time a control policy obtained through deep RL

1. Maximal detection rate of an attack π: $\mathbb{P}[\text{detect}] = e^{-I(\pi)}$
2. Optimal attack : $\min_{\pi} R(\pi) \; s.t. \; I(\pi) \geq \gamma$



Example 2: **KTH Live-in lab** (privacy and security)





Desired collaborations

1. How secure and robust is your ML system?

1. Contact: alepro@kth.se