SALONE DELL'ORIENTAMENTO 2025

#TOMORROW STARTS TODAY

CORSO DI LAUREA MAGISTRALE

INGEGNERIA INFORMATICA

COMPUTER ENGINEERING

Automation and Intelligent Cyber-PhysicalSystems

Politecnico di Torino

1859

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Automation and Intelligent Cyber-Physical Systems

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Cyber-physical systems: looking for a definition

- A **cyber-physical system (CPS)** is a collection of devices interacting through a communication networks to perfom complex cooperative tasks

- Each device can:
  perform computations

  share information over the communication networks

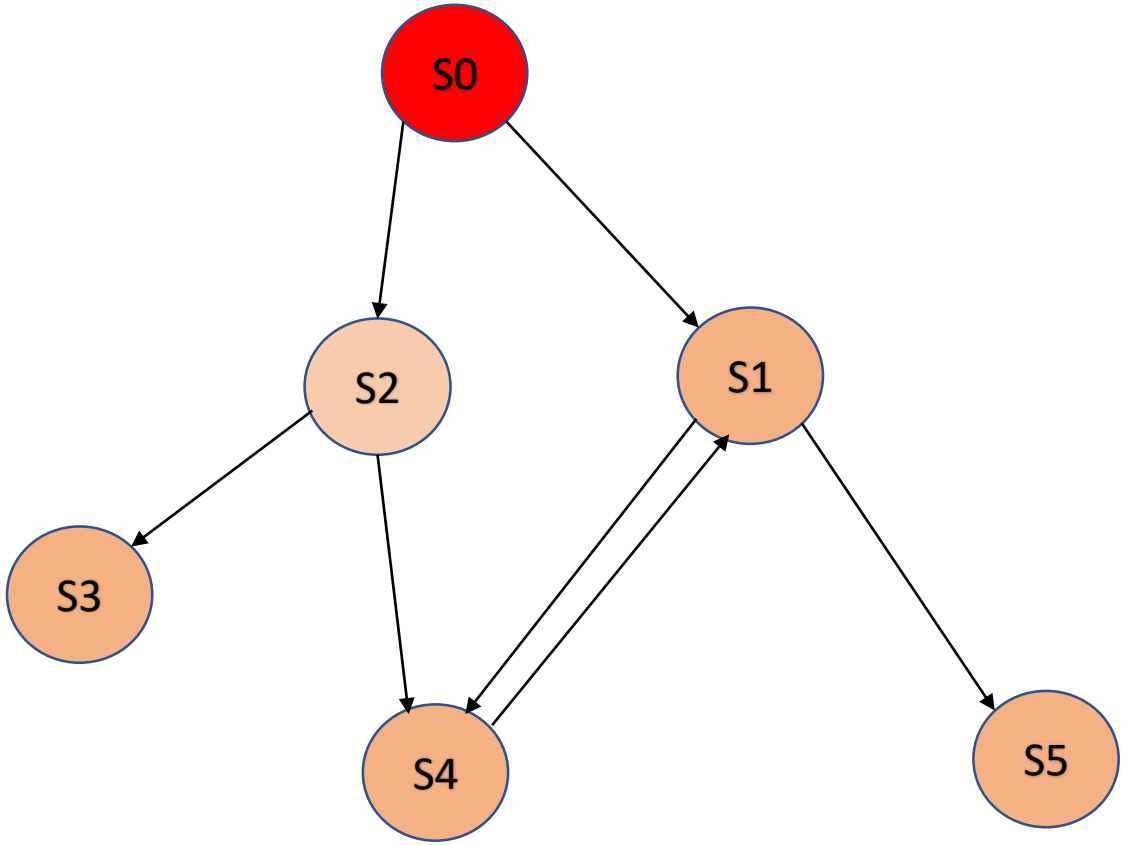
  interact with the physical world

Some examples of CPS

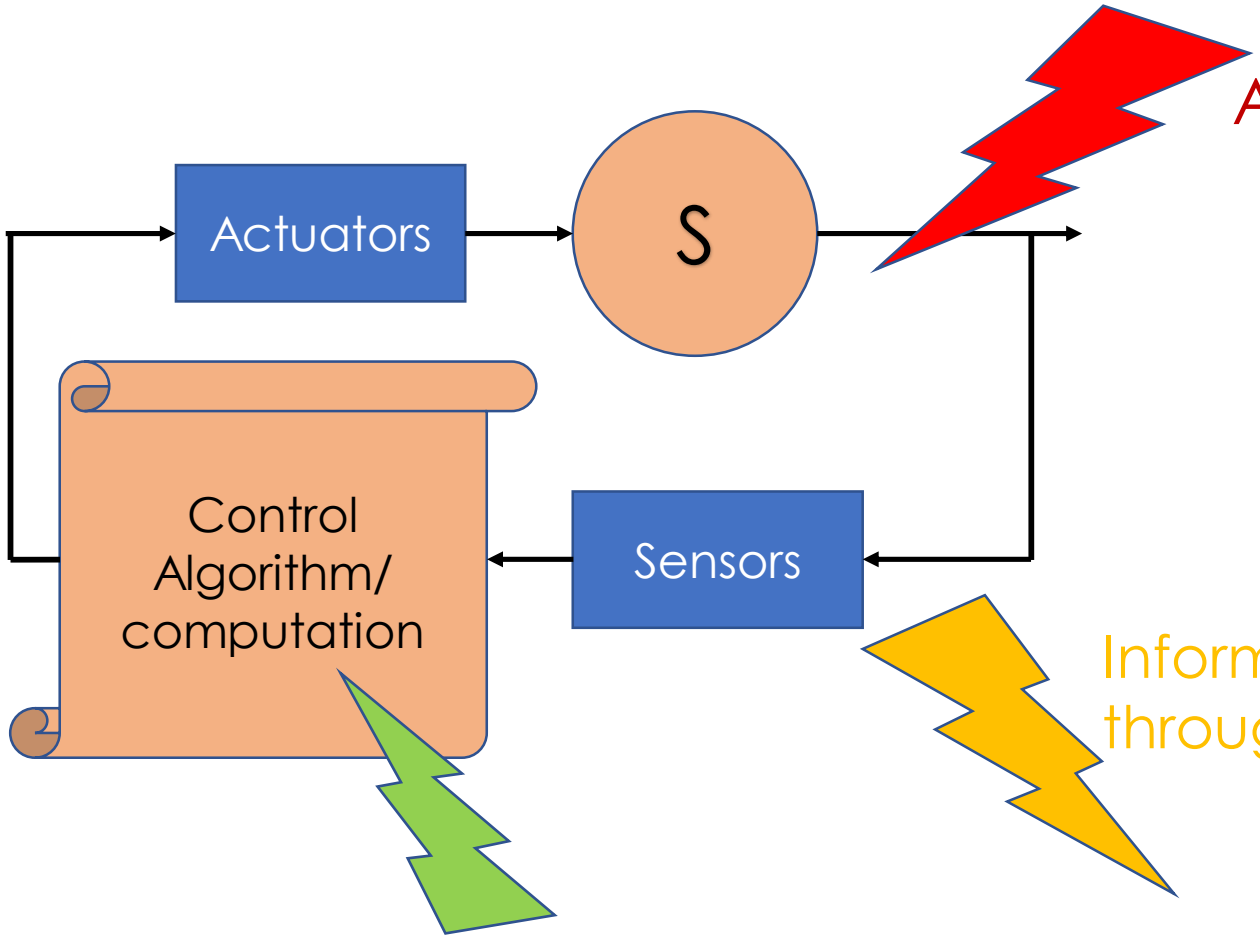
- Mobile multi-robots teams
- Networks of industrial robots
- Smart grids
- Sensor networks
- Formation of autonomous vehicles
- Traffic networks
- Biological networks
- Many more…

Multi agent systems

- A cyber-physical system can be modeled as a multi-agents system
- Multi-Agent systems are (typically) assumed to be spatially distributed
- Complex systems made up of many interacting subsystems can be modeled as CPS as well



General structure of a single agent



Attacks from malicious agents

Information sent to other agents through the networks

Information received from other agents from the networks

Automation and Intelligent CPS

- Automation (generically speaking) deals with the problem of designing machines and algorithms able to replace human action to perform complex task

- Control theory is the key tool of Automation

- Automation of complex systems can be reformulated as the problem of designing intelligent CPSs

- The number of problems that can recasted as the problem of controlling a complex CPS is limiteless….

- **Examples of applications:** Aerospace applications, Industrial robotics, intelligent vehicles, smart grids, control over various kind of networks (communication, vehicles, opinion dynamics, epidemics models,..)

What will you learn (more specifically)?

- Convex optimization and engineering applications

Why you need to study convex optimization?

- Several problems arising in engineering/science can be formulated in terms of mathematical optimization; most of them leads to convex optimization problem
- Modelling, estimation and control algorithms involves (convex) optimization

You will learn:

- How to formulate engineering/science problems in terms of convex optimization
- How to efficiently solve such problem

What will you learn (more specifically)?

- Modelling and control of cyberphysical systems

Why you need to study modeling and control of cyberphysical systems?

- Complex real world systems involves a large number of physical subsystems
- The subsystems interact to perform a cooperative task
- CPSs are subjected to external attacks
- Standard techniques focused on modeling/estimation/control of each single subsystem are not able to optimize the behavior the entire complex system and counteracts the possible attacks

You will learn:

- How to model complex systems as a multi agent systems
- How to design effective estimation/localization algorithms in presence of attacks via sparse optimization
- How to design effective algorithm for cooperative control of CPSs (e.g., synchronization, formation control)

What will you learn (more specifically)?

- Nonlinear control and aerospace applications

Why you need to study nonlinear control?

- The majority of real-world systems are nonlinear dynamical systems
- Effective control of such systems require the knowledge of mathematical tools and practical algorithms explicitly derived to cope with the presence of nonlinear effects

You will learn:

- How to analyze the properties of nonlinear dynamical systems
- How to design effective nonlinear controllers for nonlinear systems
- How to apply such algorithms to real-world problems in the aerospace field

What will you learn (more specifically)?

- Networks dynamics and learning

Why you need to study networks dynamics and learning?

- Complex real world systems involves a large number of (physical) subsystems **sharing information through a (communication) networks**
- The behavior of the overall systems strongly depends on the interactions between subsystems
- Analysis and optimization of complex systems requires the knowledge of advanced mathematical tools (distributed optimization, game theory, Markov chain)

You will learn:

- How to construct and compare mathematical models for interconnected systems arising in information, social, economic, biological, and infrastructure networks
- How to design propose cooperative distributed algorithms on networks
- How to apply theory and algorithms to energy and transportation systems, opinion and epidimics dynamics, social and economic networks

What will you learn (more specifically)?

- Robot learning, Robotics/Sistemi robotici

Why you need to study robot learning and robotics?

- Robotics is nowadays ubiquitous, both in the traditional assembly and automation environments, and in emerging applications like assistance to humans, robotic surgery, health care, space exploration, agriculture

You will learn:

- How to mathematically model the behavior of a robots
- How to design control algorithms for both industrial and mobile robots
- How to apply reinforcement learning techniques to robots and autonomous systems in general

What will you learn (more specifically)?

- Machine learning for vision and multimedia

→ provides fundamental notions on theory and algorithms for machine and deep learning techniques

- Estimation, filtering, and system identification

→ provides fundamental notions on theory and algorithms for estimation, filtering and systems identification of dynamical systems

- Discrete event systems

→ provides fundamental tools for anlyzing the behavior of discrete-events systems arising in the various contexts, such as robotics, factory automation, networks

Suggested optional courses

- Modern design of control systems

→ provides fundamental notions on theory and algorithms for robust control of uncertain systems

- Digital control technologies

→ provides fundamental notions on theory and algorithms for digital control of dynamical systems

- Laboratory of robust identification and control

→ provides fundamental tools for data-based modeling and control of dynamical systems

Politecnico di Torino

COLLEGIO ICM

Aperitivo di benvenuto

Martedì **1 aprile** 2025 H. **17:30**

2° piano Dipartimento **DAUIN**, **Corso Castelfidardo 34/d** (ingresso lato MixTo)

Occasione perfetta per fare nuove conoscenze, scoprire i laboratori del collegio ICM ed incontrare i docenti dei relativi corsi di studio!