# AI & Robotics at the IAS-Lab
## (Intelligent Autonomous System Laboratory)

UNIVERSITÀ DEGLI STUDI DI PADOVA

パドヴァ大学

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DIPARTIMENTO
DI INGEGNERIA
DELL'INFORMAZIONE

INTELLIGENT AUTONOMOUS SYSTEMS LAB

# National Lab CINI AIIS (Artificial Intelligence and Intelligence Systems)

**57 nodes on 52 different sites**

**52 universities, 3 national centers**

137 labs

**1128 people**

(931 staff persons: Professors, researchers)

# Artificial Intelligence in Europe

## ARTIFICIAL INTELLIGENCE

Artificial intelligence (AI) refers to systems that display intelligent behaviour by analysing their environment and taking actions – with some degree of autonomy – to achieve specific goals.

Brussels, 25.4.2018
«Artificial Intelligence for

…the strategy places people at the centre of the development of AI — human-centric AI. It is an approach to boost the EU's technological and industrial capacity and AI uptake across the economy, prepare for socio-economic changes, and ensure an appropriate ethical and legal framework.

Rita Cucchiara

EUROPEAN COMMISSION

Brussels, 8.4.2019
«Building Trust in Human-Centric Artificial

# Artificial Intelligence in Europe

*Italy, a driving force behind the European strategy on Artificial*

## ARTIFICIAL INTELLIGENCE

Europe is well placed to benefit from the potential of AI, not only as a user but also as a creator and a producer of this technology. It has excellent research centres, innovative start-ups, a world-leading position in robotics and competitive manufacturing and services sectors, from automotive to healthcare, energy, financial services and agriculture. Europe has developed a strong computing infrastructure (e.g. high-performance computers), essential to the functioning of AI. Europe also holds

Trustworthiness is also a prerequisite for its uptake.

Brussels, 19.2.2020
«White Paper on AI- a European
approach to excellence

EUROPEAN COMMISSION

strategy[3]. On that basis, it can develop an AI ecosystem that brings the benefits of the technology to the whole of European society and economy:

- for **citizens** to reap new benefits for example improved health care, fewer breakdowns of household machinery, safer and cleaner transport systems, better public services;

- for **business** development, for example a new generation of products and services in areas where Europe is particularly strong (machinery, transport, cybersecurity, farming, the green and circular economy, healthcare and high-value added sectors like fashion and tourism); and

- for services of **public interest**, for example by reducing the costs of providing services (transport, education, energy and waste management), by improving the sustainability of products[4] and by equipping law enforcement authorities with appropriate tools to ensure the security of citizens[5], with proper safeguards to respect their rights and freedoms.
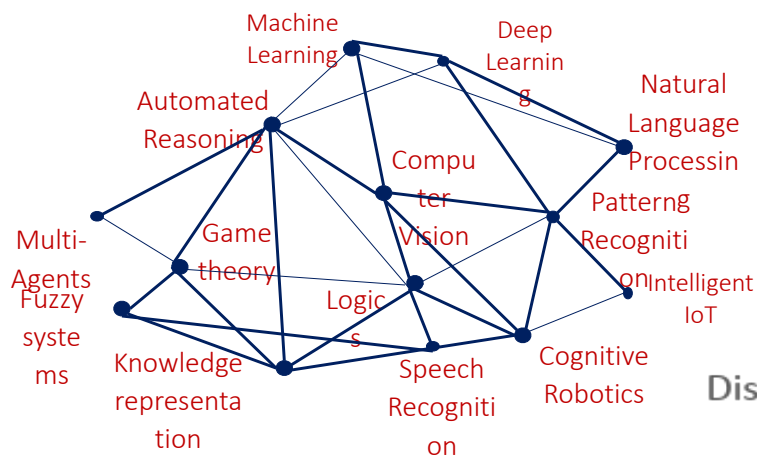
https://ec.europa.eu/info/sites/info/files/commission-white-paper-artificial-intelligence-feb2020_en.pdf

# National Lab CINI AIIS



Machine Learning · Deep Learning · Natural Language Processing · Automated Reasoning · Computer Vision · Patterng Recognition · Multi-Agents · Game theory · Logics · Intelligent IoT · Fuzzy systems · Knowledge representation · Speech Recognition · Cognitive Robotics

Keywords from 2019-2020

**cini** consorzio interuniversitario nazionale per l'informatica

Artificial Intelligence and Intelligent Systems
**cini** National Lab

## Survey Consorzio Cini 2019-2020

http://aiis-survey.consorzio-

Topics

Distribuzione di membri e nodi sui macro argomenti



| | Nodes | Members |
|---|---|---|
| Embodied Artificial Intelligence | | |
| Ontologies | | |
| KR and Logic Programming | | |
| Natural Language Processing | | |
| Agent-Based Systems | | |
| Decision Support Systems | | |
| Human-Computer Interaction | | |
| Computer Vision | | |
| Data Analysis and Mining | | |
| Deep and Machine Learning | | |

0    50   100   150   200   250   300   350   400
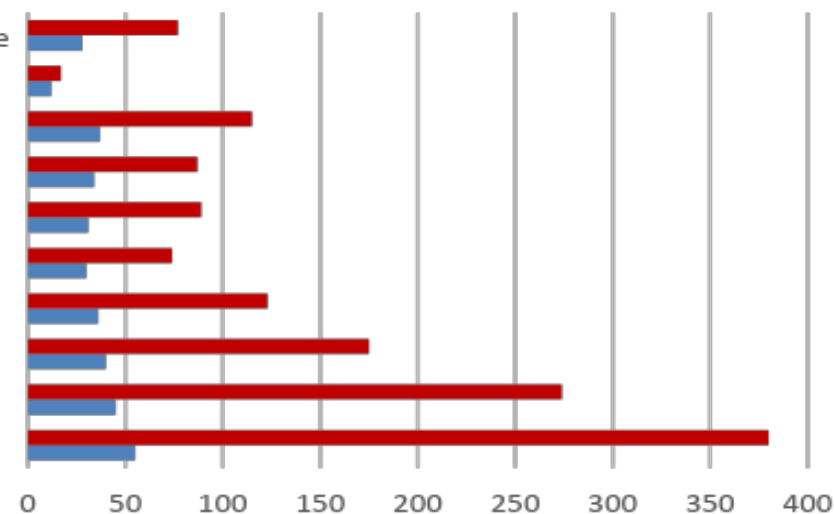
- PoliMI and UniMI (Milano) Machine learning , Game theory, AI in Finance…
- PoliTO and UniTO (Torino) Computer Vision, Machine Learning, Robotics, AI and Health
- UniTN and FBK (Trento) Computer Vision, Multimedia, NLP, Planning, Industrial AI
- UNIVR (Verona) Computer Vision, AI for Health
- UNIPD (Padova) Ai and Robotics, Digital Libraries
- UniBO (Bologna) Logics, Ethics, Edge AI
- UniMORE (Modena) Computer Vision, Deep Learning, Ind CH
- UniPI(Pisa) Big Data, Machine Learning, Robotics, NLP, Ex-A
- UniSI (Siena) Machine Learning
- UniFI (Firenze) Machine learning, Vision, AI and CH
- UniSapienza (Roma) NLP, Robotics, Knowledge Representa
- UniCT (Catania) Computer Vision
- IIT and UniGe (Genova) Machine learning, Vision, Robotics,
- CNR (Pisa, Roma, Bari..) Machine learning, Ontologies, NLP, etc.
- UniCA (Cagliari) Pattern Recognition, Cyber and AI
- UniNA (Napoli) Pattern Recognition, Embedded AI, Transports
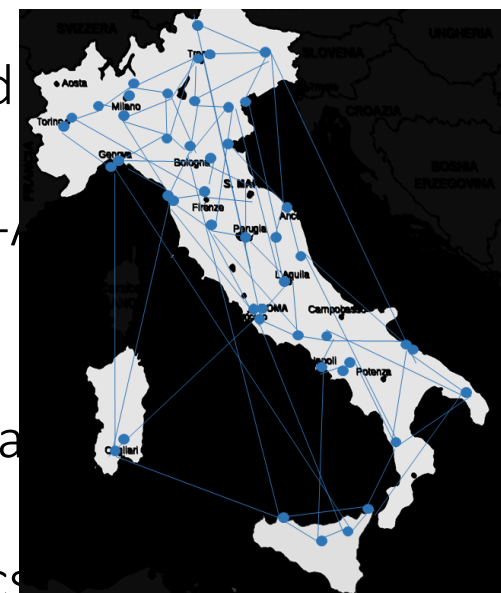
# Final objectives of PNR 2021-2027: Artificial Intelligence

● **To propose AI as the fulcrum of the IT challenge of the new decade**,
i) to maintain Italy's leadership in AI research, both in terms **of foundational and human-centric research** and in terms of multidisciplinary research aspects together with related technologies;
 ii) to give birth to - and strengthen where existing - **the Italian industry** of software, hardware and services in AI, and
iii) to foster **digital transformation** in the short and medium term.


● **To transform Italy into a country that designs and develops "AI for everything"** (AI 4 x) technologies at the service of industrial and social transformation:
-in the short and medium term to **support the conscious adoption of AI technologies**, possibly certifying their reliability;
-in the long term to enable and maintain technological sovereignty in those areas of excellence **typical of the Italian economy**

# Implementation plans …          and final AI Keywords

- **Education**
  - New National Doctoral School in Artificial Intelligence 2021-2025
  - Support to growth to Ai curricula in bachelor and master degree
  - Life-long education in AI

- **Ethics and trustworthy initiatives**

- **Challenges Initiatives**

- **A National long term research project in AI**

- **The National institute of IA and connected centers**

-Human-centric AI in production

-Trusthworthy AI

-ReinaAIssance for made-in-Italy

-Human- AI interaction

- creative and curiosity-driven AI
- AI in generative design

-AI for Goods

-Foundational AI
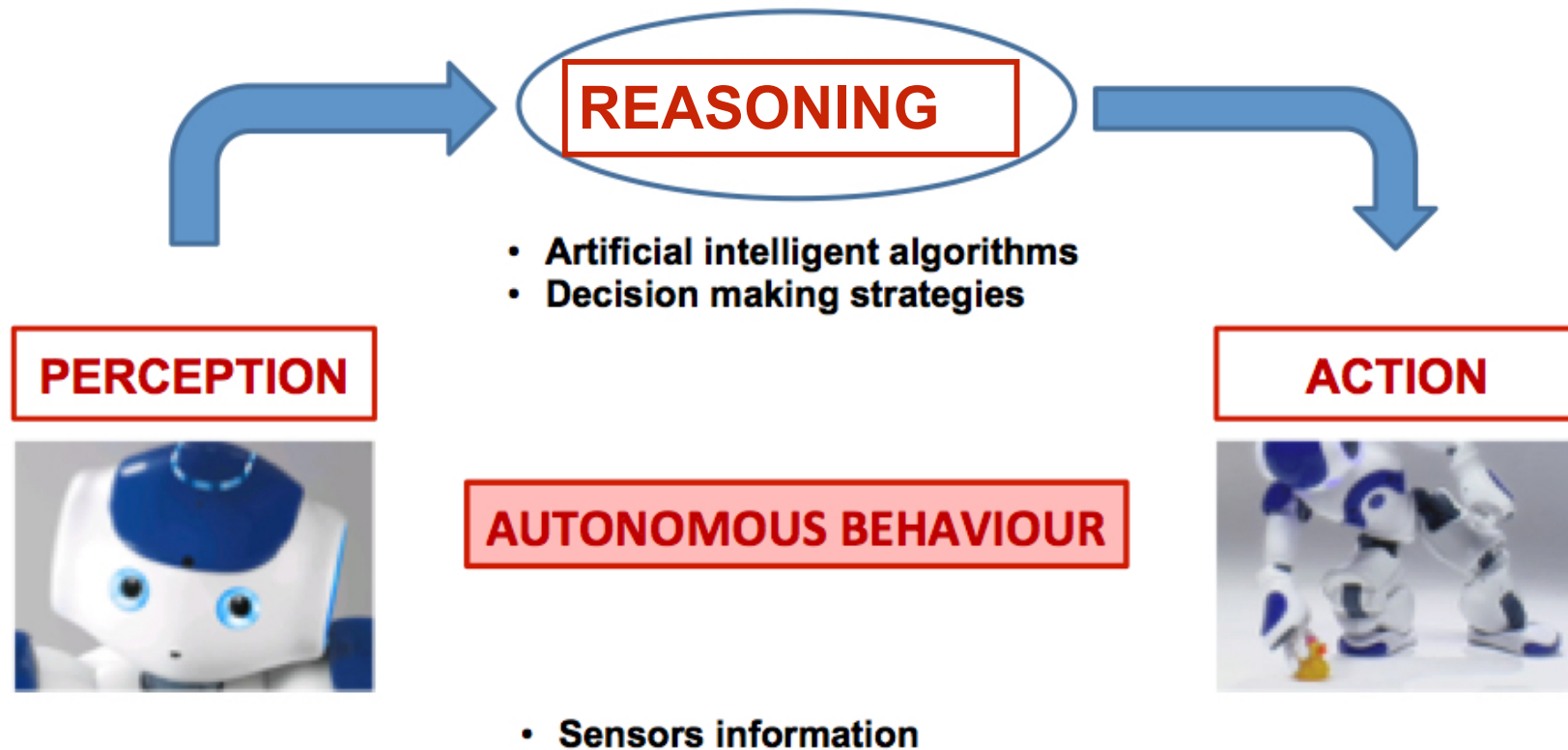
**Programma Nazionale per la Ricerca 2021–2027**
**I GRANDI AMBITI DI RICERCA E INNOVAZIONE**

Ministero dell'Università e della Ricerca

**REASONING**

- Artificial intelligent algorithms
- Decision making strategies

**PERCEPTION**

**ACTION**

**AUTONOMOUS BEHAVIOUR**

- Sensors information

My research goal: to extend perception of robots

...because more (artificial) intelligence is needed by industrial robots

## Research topics

• Autonomous robotics

• Human robot interaction
  • Exoskeleton
  • Muscle & Brain Machine Interface
  • Social robotics

• 3D camera network for people tracking and object tracking

• Educational Robotics

• New vision sensors (2D & 3D)

• Deep Learning for robotic tasks

• Task and motion planning with Force feedback

- EU-H2020 ICT 25 - 2018
  - SPIRIT - A software framework for the efficient setup of industrial inspection robots
- EU-H2020 ICT 22 - 2016
  - eCraft2Learn - Digital Fabrication and Maker Movement in Education
- EU-H2020 FoF 2014
  - FOCUS - Factory of the Future Clusters
- EU-FoF 2012
  - FibreMap - Automatic Mapping of Fibre Orientation for Draping of Carbon Fibre Parts
- EU-FoF 2011
  - Thermobot - Autonomous robotic system for thermo-graphic detection of cracks
- EU-RfSME 2010
  - 3DComplete -  Efficient 3D Completeness Inspection
- EU-FSE 2009:
  - iSP - Innovative Simulation and Programming of robotics workcells
  - iDVS2 - Intelligent Distributed Audio and Video Surveillance System
- EU-FSE 2008:
  - iDVS: Intelligent Distributed Vision System for surveillance and quality inspection
- EU-Comenius2 2006:
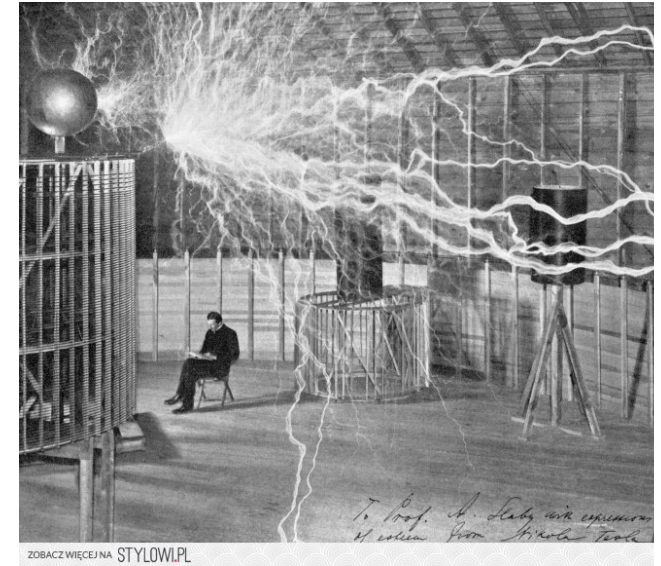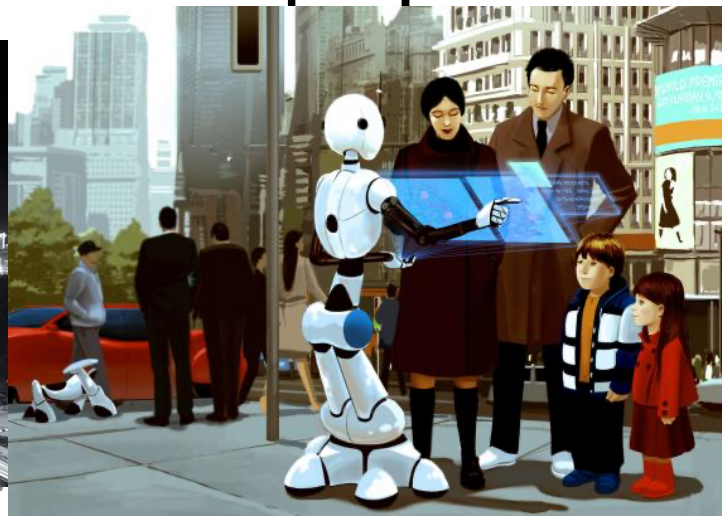  - TERECoP: Teacher Education on Robotics-Enhanced Constructivist Pedagogical Methods
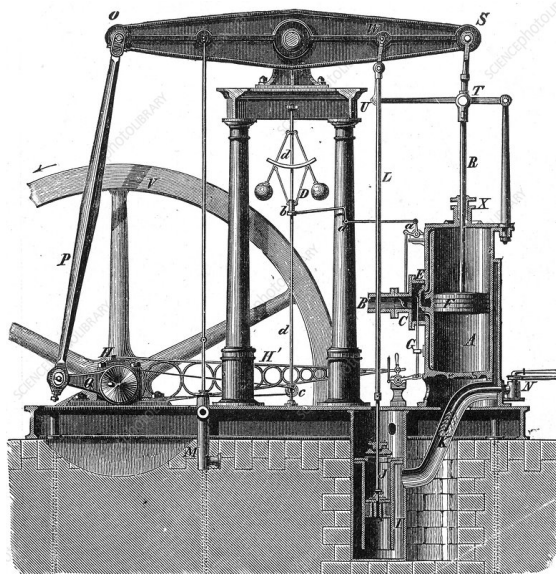
Like the steam-engine or electricity in the past…

## AI and Robotics

are transforming our world, our society and our

# Promuovere la cultura dell'IA

# (Intelligenza Artificiale)

# nel territorio

Due iniziative dell'Università degli Studi di Padova per promuovere la cultura dell'IA e della robotica:

1. Dedicata alle aziende: corso intensivo

2. Dedicata agli studenti: laurea magistrale

# Obiettivo del corso

- Creare un **dialogo** tra UNIPD e imprese del territorio

- **Aggiornare** le aziende sulla più **avanzate tecnologie** in ambito **Intelligenza Artificiale e Robotica** (…sfatando alcune previsioni)

- Presentare le **competenze** di UNIPD nel settore

# Contenuti del corso

Un crash-course sull'Intelligenza Artificiale e la Robotica orientato alle aziende.

- Moduli di 1,5 ore con 30 minuti di domande.
- 3 giornate da 6 ore

## DAY 1

- Intelligent Robotics and Collaborative Robotics (Menegatti)
- AI and learning (Sperduti)
- Industrial Robotics (Rosati)

# Contenuti del corso

## DAY 2

- Industrial computer vision (Pretto)
- AI e social networks (Pini)
- Deep Learning (Ghidoni)

## DAY 3

- Industry 4.0 e Predictive maintenance (Beghi)
- AI and cultural heritage (Orio, Canazza)
- Osservatorio Industria 4.0 (Di Maria)
- Testimonianze, brainstorming and networking

Dal A.A. 2020-21

# Laurea Magistrale in lingua inglese in

# *Computer Engineering*

# Curriculum in AI & Robotics

# Degree Structure

## MANDATORY COURSES

| Course | CFU | Period |
|---|---|---|
| Automata, Languages and Computation | 9 | Y1.1 |
| Machine Learning | 6 | Y1.1 |
| Operations Research 1 | 9 | Y1.1 |

**COMMON TO ALL CURRICULA**

## MANDATORY COURSES

## ELECTIVE COURSES: AT LEAST *X* CFU

## OTHER CHOICES

**CURRICULUM SPECIFIC**

## OTHER ACTIVITIES

| Activity | CFU | |
|---|---|---|
| English Language/Italian Language | 3 | |
| Internship/Research Training | 9 | Y2 |
| Final Project | 21 | Y2 |

**COMMON TO ALL CURRICULA**

UNIVERSITÀ
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# Artificial Intelligence and Robotics

## MANDATORY COURSES

| Course | CFU | Period |
|---|---|---|
| Artificial Intelligence | 6 | Y1.2 |
| Computer Vision | 9 | Y1.2 |
| Intelligent Robotics | 9 | Y2.1 |

## ELECTIVE COURSES: AT LEAST 27 CFU

| Course | CFU | Period |
|---|---|---|
| Deep Learning | 6 | Y1.2 |
| Robotics and Control 1 | 9 | Y1.2 |
| Big Data Computing | 6 | Y1.2 |
| Industrial Robotics | 9 | Y2.1 |
| Learning from Networks | 6 | Y2.1 |
| Natural Language Proc. | 6 | Y2.2 |
| 3D Data Processing | 6 | Y2.2 |

## OTHER CHOICES

| Course | CFU | Period |
|---|---|---|
| Neurorobotics and Neurorehab. | 6 | Y1.1 |
| Quality Engineering | 6 | Y1.1 |
| Game Theory | 6 | Y2.1 |
| Innovation, Entrepreneurship, … | 9 | Y2.2 |
| Operation Research 2 | 6 | Y2.2 |

Key characteristics:

- ☐ Interdisciplinary topics because AI & Robotics is a multi-discipline science
- ☐ Course choices:
  - core competencies in computer engineering
  - Complements from key disciplines: control theory, mechanics, economics, etc.
- ☐ Hands-on experience with laboratories in AI, Robotics, Computer Vision, Industrial Robotics, etc.
- ☐ Soft skills: team work, goal driven productivity, critical thinking, proactiveness, **...**

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