2-year Master in Artificial Intelligence

Paolo Torroni Director of the Degree Programme

Department of Computer Science and Engineering

Good reasons to study Artificial Intelligence...

...other good reasons to study Artificial Intelligence

- To be able to choose your career pathway: acquire skills that can be applied almost everywhere
  - Examples: healthcare, automotive, industry 4.0, production, HR recruiting, marketing, customer service, telecommunications, business intelligence, gaming, public administration, education, scientific research, …
- To improve people's well-being and quality of life
- To spend your best years doing something useful and fun
- To make the World a better place

- OK, but **why a master's degree in AI?**
- (and why this particular one?)

why a master's degree in AI?
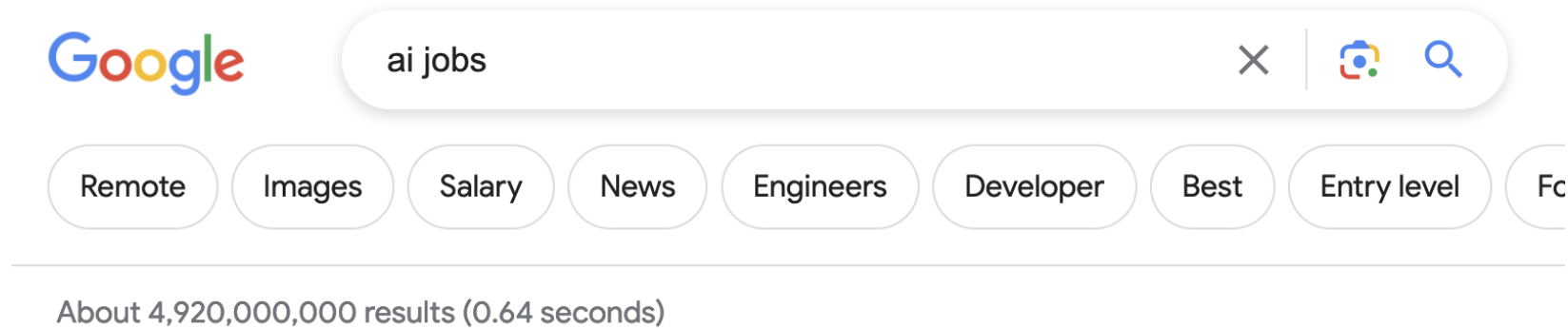
- The job market is in great demand of AI master graduates and PhDs with a solid computer science background
- In the last years, AI has grown incredibly fast, and it keeps growing even faster. A master degree gives you the tools for keeping up to date
- There's a lot to learn, and a lot to do

Why study Artificial Intelligence in Bologna?

- **Education**. AI is interdisciplinary and multidisciplinary by definition; Bologna offers deep and widespread skills in many fields
- **Research**. In the Department of Computer Science and Engineering of the University of Bologna, internationally renowned faculty members have been researching, teaching, applying Artificial Intelligence for many decades
- **Business**. Bologna and Emilia-Romagna offers a unique environment with companies interested in AI and innovation and with significant infrastructures
- **Bologna**.

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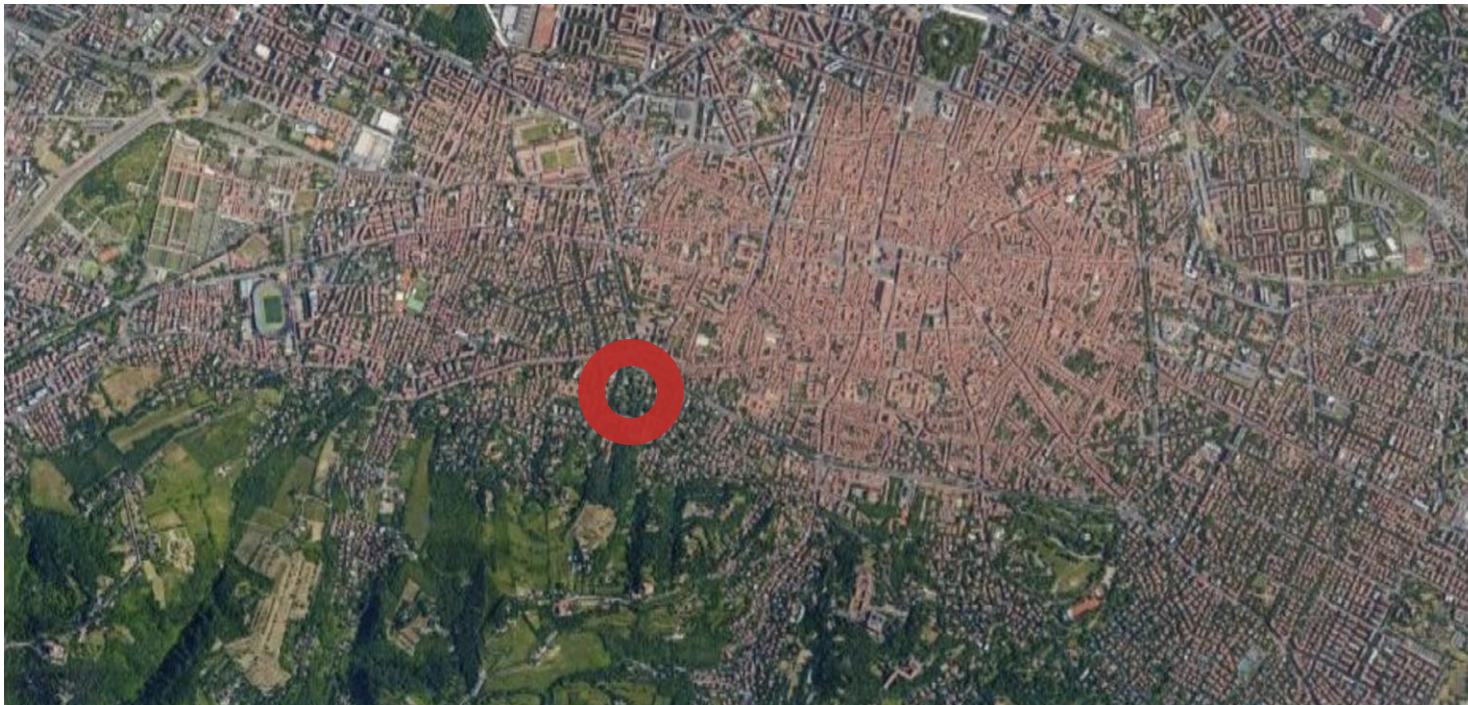
Why study Artificial Intelligence in Bologna?

Professional figure

Huge demand in the job market for a new professional figure: the **specialist in Artificial Intelligence**

- Very good general knowledge of computer science
- Masters a great variety of techniques and methods of AI

A great variety of techniques and methods

descendant(D,A) :- parent(A,D).
descendant(D,A) :- parent(P,D), descendant(P,A).
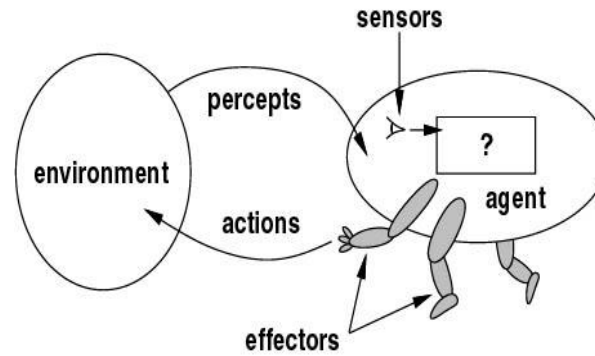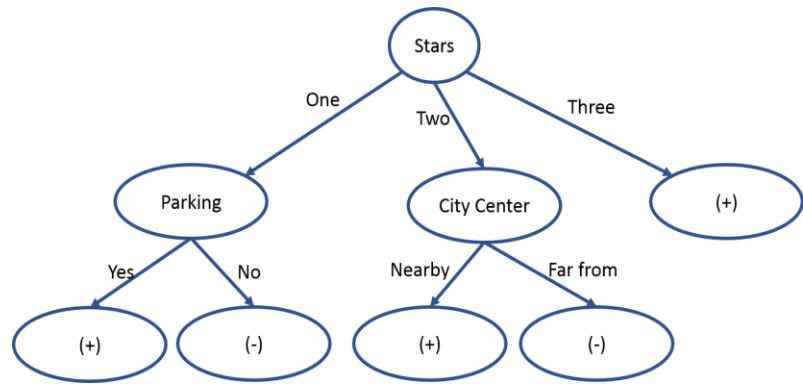
RULE037

IF the organism
  1) stains grampos
  2) has coccus shape
  3) grows in chains

THEN
        There is suggestive evidence (.7)
that the identity of the organism is
streptococcus.
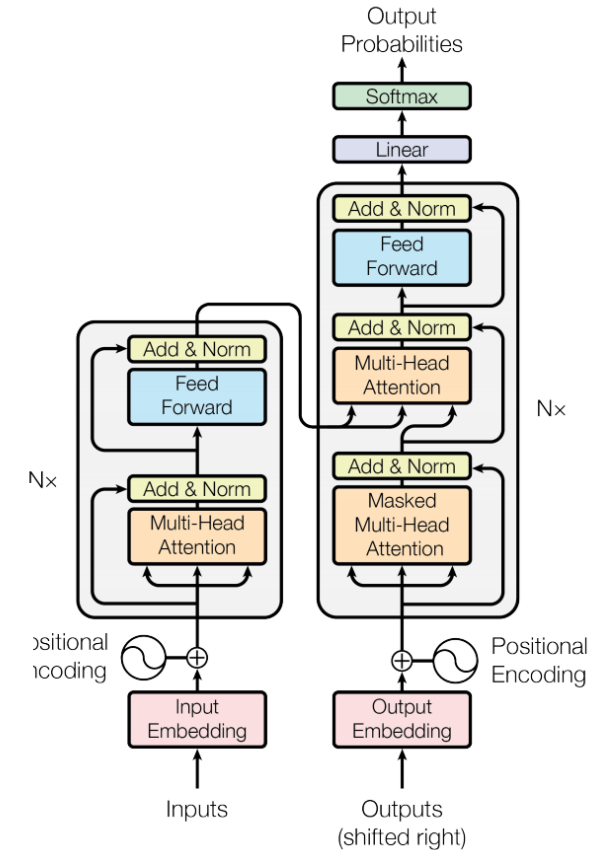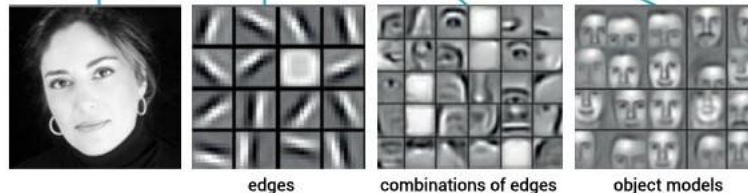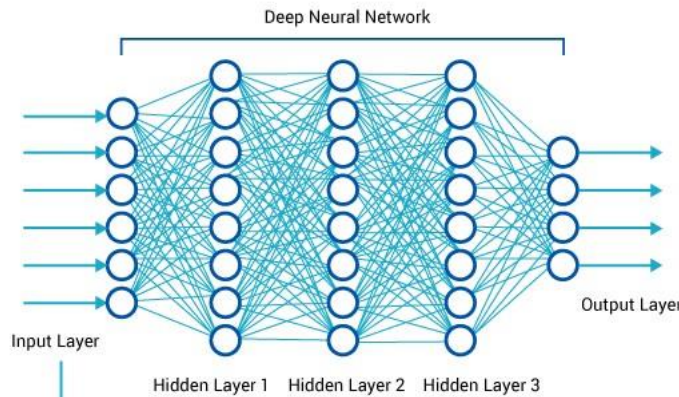
What is the profile of the Artificial Intelligence specialist?

- Has a very good general knowledge of computer science
- Masters a great variety of techniques and methods of AI
- Shows a wide interdisciplinary education: ethics, privacy, neuroscience, …
- Is interested in a global market of job opportunities
- Is willing to follow scientific and technological topics in continuous evolution

Facts and figures

Duration: 2 years (4 semesters, 120 ECTS)

International: all learning activities in English

Type of degree: **MSc** (Computer Science) or **MEng** (Computer Engineering)

Admission: open to holders of a 3-year Bachelor degree in:

- Computer Science
- Computer Engineering
- Applied Informatics

or in

- Information Engineering (Automation, Electronics, Telecommunications, Biomedical Engineering)
- Mathematics
- Physics
- Statistics

with a significant background in computer science/engineering

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Facts and figures

Enrolment statistics

- 2019: 500 applications, 90 enrolled, 13% extra-EU

- 2020: 1000 applications, 130 enrolled, 23% extra-EU

- 2021: 1500 applications, 150 enrolled, 26% extra-EU

- 2022: 2000 applications, 100 enrolled, 18% extra-EU

- 2023: 3300 applications, 130 enrolled, 56% extra-EU

- 2024 so far: 2700 applications (3x from last year same period), 70 admitted

  - Next deadlines:

    - 16th April and 4th June (recommended for extra-EU)

    - Most probably, new intakes from July through November (**NOT recommended** for extra-EU)

- Applications from 123 countries

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Pie chart — nationality distribution:

- Pakistan 38%
- India 16%
- Iran 15%
- Italia 10%
- Cina Repubblica Popolare 4%
- Other 18%

Detail (Other breakdown):
- Bangladesh 3%
- Turchia 1%
- Etiopia 1%
- Afghanistan 1%
- Algeria 1%
- Kazakhstan
- Nigeria
- Russia=federazione Russa
- Egitto
- Libano
- Azerbaigian
- Siria
- Gran Bretagna e Irlanda del Nord
- Sudan
- Malesia
- Stati Uniti D'America
- Somalia

Legend:

Pakistan	India	Iran	Italia	Cina Repubblica Popolare	Bangladesh	Turchia
Etiopia	Afghanistan	Algeria	Kazakhstan	Nigeria	Russia=federazione Russa	Egitto
Libano	Azerbaigian	Siria	Gran Bretagna e Irlanda del Nord	Sudan	Malesia	Stati Uniti D'America
Somalia	Ghana	Tunisia	Germania	Marocco	Uzbekistan	Grecia
Nepal	Sri Lanka	Spagna	Albania	Francia	Cipro	Camerun
Arabia Saudita	Paesi Bassi	Iraq	Romania	Indonesia	Ungheria	Kenya
Ruanda	Tanzania	Ucraina	Colombia	Ecuador	Giordania	Libia
Brasile	Emirati Arabi Uniti	Eritrea	Irlanda=eire	Sudafricana Repubblica	Zimbabwe	Canada
Gambia	Kirghizistan	Polonia	Serbia	Belgio	Bielorussia	Bulgaria
Territori Palestinesi	Armenia	Australia	Benin	Lituania	Messico	Myanmar
Perù	Svezia	Taiwan	Uganda	Austria	Bosnia ed Erzegovina	Cile
Danimarca	Filippine	Islanda	Montenegro	Portogallo	Repubblica Dominicana	Repubblica Slovacca
Senegal	Svizzera	Thailandia	Uruguay	Venezuela	Andorra	Argentina
Bahrein	Corea del Sud	Costa D'Avorio	Costa Rica	Estonia	Finlandia	Georgia
Giappone	Guatemala	Haiti	Kuwait	Lesotho	Lettonia	Lussemburgo
Macedonia	Malawi	Mali	Malta	Mauritius	Mozambico	Niger
Norvegia	Nuova Zelanda	Oman	Panama	Paraguay	Repubblica del Congo	Repubblica Democratica del Congo
Sierra Leone	Togo	Vietnam	Zambia			

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Web site

Attendance

All lectures are **in presence** (**no streaming**)

All exams are **in presence** except for project presentations/discussions

Lessons in two periods

- Mid September to mid December
- Mid February to end of May

Exams are in three periods (4 dates per year per course):

- January through mid February
- June through mid July
- First half of September

Plenty of opportunities for **periods abroad** and **internships**
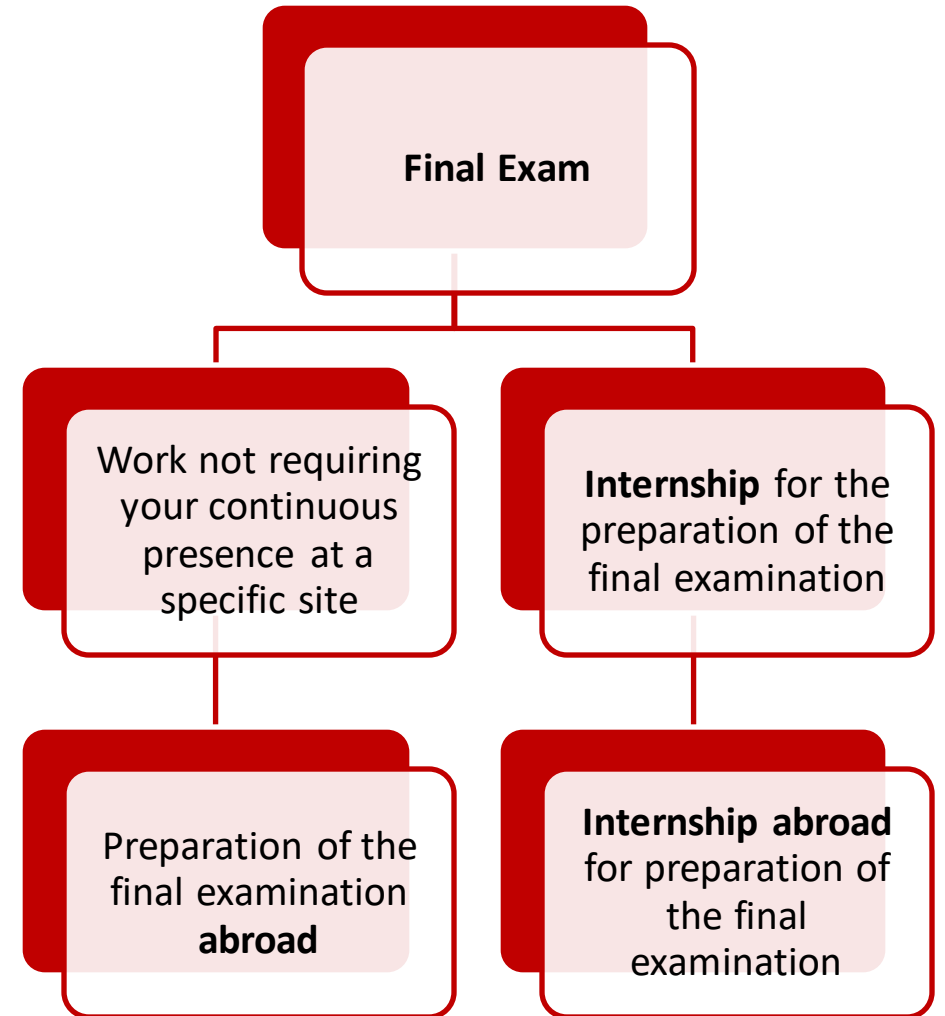
Structure of the curriculum

First year: all mandatory courses

- Statistical and Mathematical Methods for Artificial Intelligence
- Combinatorial Decision Making and Optimization
- Image Processing and Computer Vision
- Cognition and Neuroscience
- Machine Learning and Deep Learning
- Languages and Algorithms for Artificial Intelligence
- Fundamentals of Artificial Intelligence and Knowledge Representation
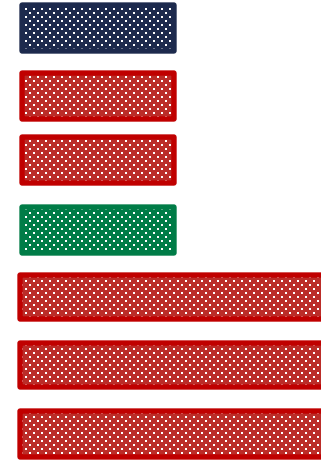
Second year: two mandatory courses

- Natural Language Processing
- Ethics in Artificial Intelligence
- 3-4 elective courses, soft skills and other skills
- Project works
- Final project (master thesis)
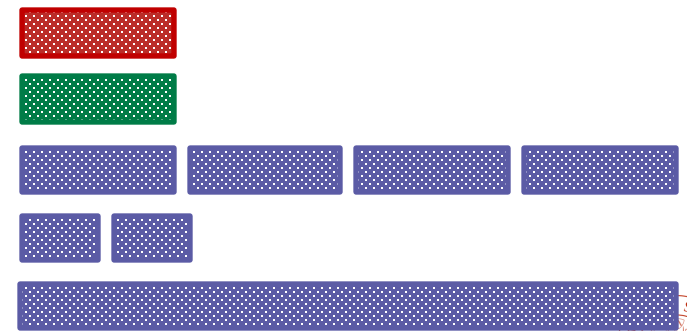
Elective courses

Artificial Intelligence in Industry

- Goal: familiarize with how to tackle industrial problems (in a broad sense).

- Emphasis on looking at the big picture, picking the right tools, and combining them, using both simple and advanced techniques.

- Course delivered as a set of simplified industrial use cases, making extensive use of systems like Jupyter notebooks and Docker containers.

- Outcome: a sort of a cookbook, from which the students can draw ideas when facing real-world problems

- Ability to identify and anticipate anomalous events, dealing with time series, combine optimization and ML methods, build hybrid ML/statistical models, take into account constraints in Machine Learning models

- Project examples: understanding and prediction of epidemic processes, medical diagnosis, packing systems for industrial pallets, detecting anomalies in wind turbines, estimating survival for liver transplants, model industrial equipment using ML and physics

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Elective courses

Artificial Intelligence in Industry

Internet of Things

- Goal: to introduce the enabling technologies, protocols, software architectures and applications for the development of the IoT paradigm and its synergy with AI, Big/Open Data, Digital Twin, etc.

- Covers IoT fundamentals: definitions, applications, enabling technologies

- Project examples: Multiprotocol IoT Bridge Platform (data visualization, storage, bridging), IoT service middleware, toolchain for Industrial IoT and Service Oriented Architectures, WoT and Digital Twin, mobile crowdsensing and crowdsourcing platforms, activity recognition and context awareness, drones and autonomous systems (e.g. drone swarms), …
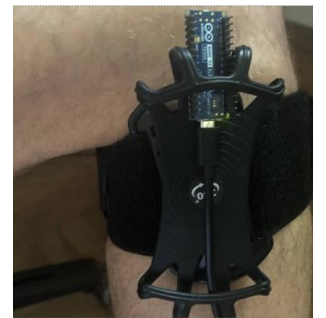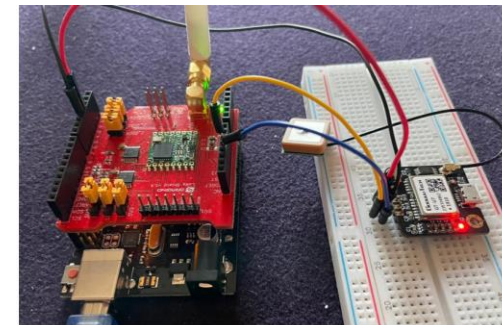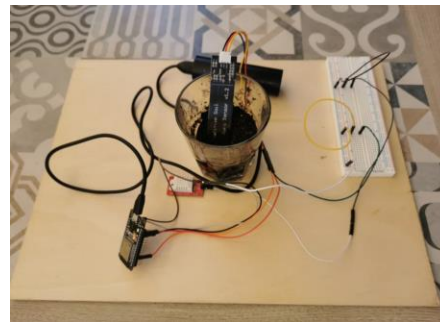
IoT Prism Lab
Research Lab at University of Bologna

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Elective courses

Artificial Intelligence in Industry

Internet of Things

Complex Systems and Network Science

- Goal: to understand the mathematical foundations, goals and methodologies of complexity science and answer a set of questions about the way natural, artificial and technological systems work

- Examples of complex systems: social insects, human brain, immune system, economies, financial markets, cities, traffic data centers, the Internet, peer-to-peer systems, the World Wide Web

- Focus on networks and their fundamental role in the transmission of information, transportation of goods, spread of diseases, diffusion of innovation, formation of opinions, adoption of new technologies

- Understanding the structure and dynamics of these networks is essential for understanding why certain technologies dominate their competitors, or why a certain videos go viral while others don't

Elective courses

Artificial Intelligence in Industry

Internet of Things

Complex Systems and Network Science

Multi-Agent Systems

- Design and engineer intelligent systems as multi-agent systems, by integrating techniques and methods from artificial intelligence in an effective and methodologically-sound way
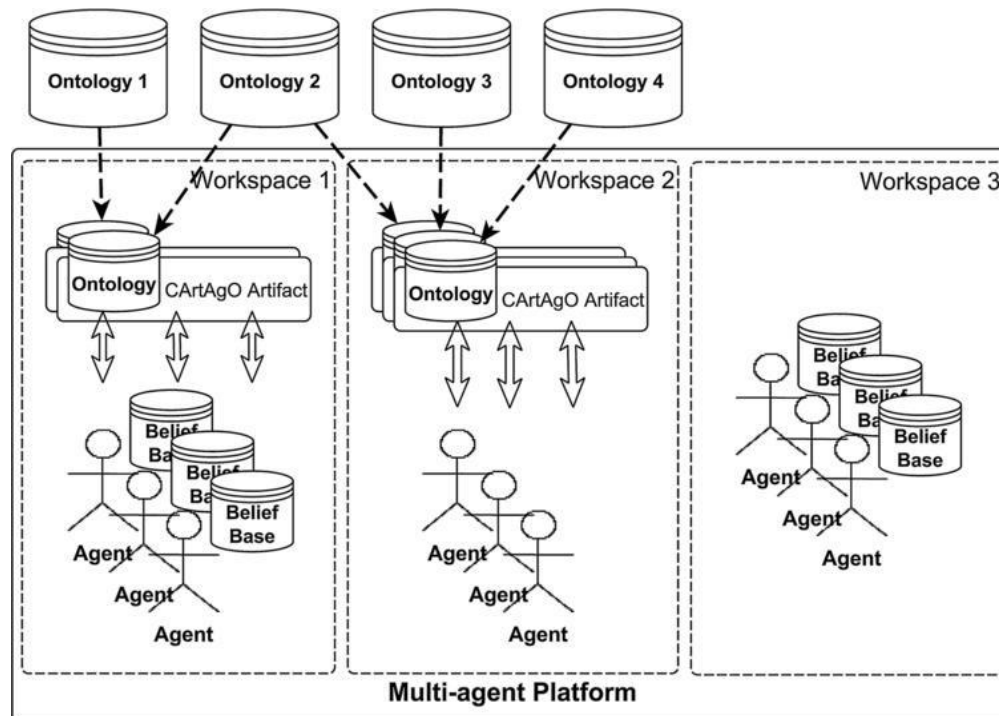
Elective courses

Artificial Intelligence in Industry

Internet of Things

Complex Systems and Network Science

Multi-Agent Systems

Data Mining, Text Mining and Big Data Analytics

- Goal: to understand how a possibly very large set of data can be analysed to derive strategic information and to address "data-driven" decisions.

- Covers data-mining tasks such as data selection, data transformation, analysis and interpretation, with specific reference to unstructured text data, and with the issues related to analysis in "big data" environments.

- Big data distributed processing framework Apache Hadoop, Apache Spark big data analytics engine

- CRISP methodology for the definition of a Data Mining process, Data Warehouses, Data Cube, OLAP

- Knowledge discovery

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Elective courses

Artificial Intelligence in Industry

Internet of Things

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Multi-Agent Systems

Data Mining, Text Mining and Big Data Analytics

Knowledge Engineering

- Goal: to acquire advanced semantic modelling capabilities and a proper knowledge of the state of the art in ontology and knowledge graph engineering. Project and practical sessions to face realistic project scenarios and become expert in using the available methods and tools for knowledge engineering

- Projecet examples: smart music playlist engined by semantic relations between songs; sensory data integration for monitoring the environmental health in Italian seas; creation of multimodal multimodal data knowledge graphs; comparing translations across multiple languages by formal reasoning on their knowledge graph representations

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Elective courses

Artificial Intelligence in Industry

Internet of Things

Complex Systems and Network Science

Multi-Agent Systems

Data Mining, Text Mining and Big Data Analytics

Knowledge Engineering

Blockchain & Cryptocurrencies

- To know all about distributed ledgers, decentralized file systems, smart contracts, cryptocurrencies, fintech and other applications
- At the end of the course, the student is able to develop simple smart contracts that can be deployed on a blockchain

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Elective courses

Artificial Intelligence in Industry

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Architectures and Platforms for Artificial Intelligence

- To understand the requirements of ML workloads for computing systems, the main architectures for accelerating machine learning workloads and heterogeneous architectures for embedded machine learning, the most popular platforms made available by cloud providers to specifically support machine/deep learning applications.

- To know how to assess the computational and memory requirements of modern neep neural network (DNN) topologies, to improve computational efficiency on DNN workloads, to optimize DNN computations for execution on RISC-V cores, to understand parallel programming patterns (embarassingly parallel, decomposition, master/worker, scan, reduce), to gain practical knowledge of Shared-Memory parallel programming with OpenMP, with application examples from the ML field

Elective courses

Artificial Intelligence in Industry

Internet of Things

Complex Systems and Network Science

Multi-Agent Systems

Data Mining, Text Mining and Big Data Analytics

Knowledge Engineering

Blockchain & Cryptocurrencies

Architectures and Platforms for Artificial Intelligence

User Experience Design

- To to design, implement and evaluate software systems in terms of practicality, experience, affection, meaning and value that they may have on the target audience. Characteristics such as ease of use, usefulness and efficiency are fundamental for the positive evaluation of the user experience of the system. To understand explanations and explainability in complex systems and AI systems.

Elective courses

Artificial Intelligence in Industry

Internet of Things

Complex Systems and Network Science

Multi-Agent Systems

Data Mining, Text Mining and Big Data Analytics

Knowledge Engineering

Blockchain & Cryptocurrencies

Architectures and Platforms for Artificial Intelligence

User Experience Design

Autonomous and Adaptive Systems

- Reinforcement Learning; game-theoretic approaches to cooperation and coordination; models of human, artificial and hybrid social systems; bio-inspired learning systems; complex adaptive systems; artificial intelligence and creativity; ethical implications of AI/autonomous systems.

- Examples include the implementation of a Deep Reinforcement Learning agent that is able to play a videogame or a board game like Chess and Go or a simulation of agent societies using Multi-agent Reinforcement Learning.

Elective courses

Artificial Intelligence in Industry

Internet of Things

Complex Systems and Network Science

Multi-Agent Systems

Data Mining, Text Mining and Big Data Analytics

Knowledge Engineering

Blockchain & Cryptocurrencies

Architectures and Platforms for Artificial Intelligence

**User Experience Design**

Autonomous and Adaptive Systems

Artificial Intelligence and Robotics

- Designing systems composed of one or multiple robotic agents. Learn the most popular models, methods, architectures, and tools for programming robotic agents endowed with significant computational and cognitive capabilities.

- Lectures and lab work using ROS and Gazebo

Elective courses

Artificial Intelligence in Industry

Internet of Things

Complex Systems and Network Science

Multi-Agent Systems

Data Mining, Text Mining and Big Data Analytics

Knowledge Engineering

Blockchain & Cryptocurrencies

Architectures and Platforms for Artificial Intelligence

User Experience Design

Autonomous and Adaptive Systems

Artificial Intelligence and Robotics

Cybersecurity

Scalable and Reliable Services

Social Network Analysis

Machine Learning for Computer Vision

Multimedia Data Management
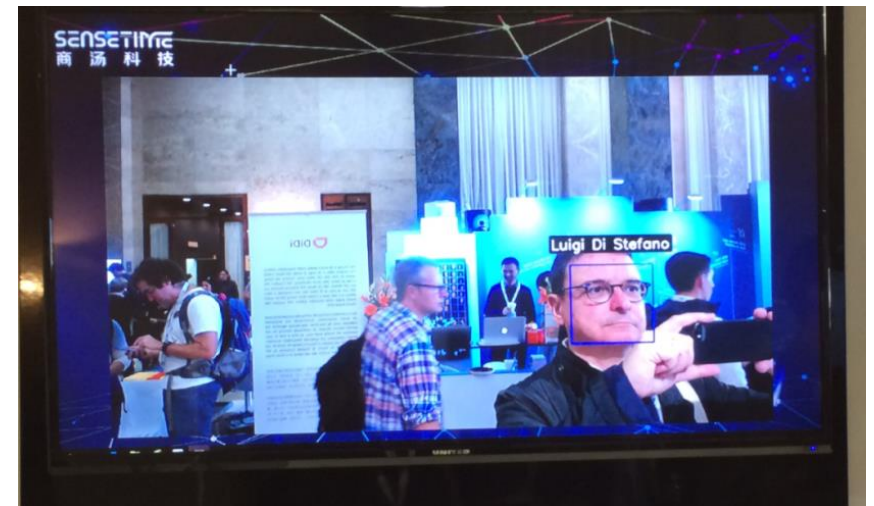
... and more

Job opportunities

Typically, the AI specialist finds employment in roles in highly technological environments:

- Companies and public institutions

- Public or private research institutes

- Research and development departments in big companies or in public institutions

- Universities and schools

- Consulting firms

- Start-ups

- Free-lancing

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Professional activities

Every stage in the **realisation of systems** for/with

- planning and optimisation
- machine learning
- decision support
- computer vision
- language processing
- industrial automation
- …

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… in all sorts of **sectors**

Industry, Transport, Medicine, Smart cities, Home automation, Security, Agriculture, Information systems, Education, Entertainment, …

But also **consulting**, **education**, **research** and **innovation** in AI, machine learning and other areas of computer science

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2. Learn how to enrol

On the degree programme's website, go to "Admission**"** and read the call for applications and other information

3. Learn about scholarships, benefits and services

Go to www.unibo.it/en and browse the "Services and Opportunities" section

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