Department of Electronics, Information, and Bioengeneering
Politecnico di Milano

Artificial Intelligence 2019-20

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1. Introduction

1.1 The course

The MSc Program in Computer Science and Engineering of the School of Industrial and Information Engineering, Politecnico di Milano, offers a course on Artificial Intelligence (AI) with two parallel sections:

– students with surname starting A-L: given by Francesco Amigoni (in cooperation with Marcello Restelli and Viola Schiaffonati)

– students with surname starting M-Z (this section): given by Marco Colombetti (also in cooperation with Marcello Restelli and Viola Schiaffonati).

Website, email addresses, and office hours

Relevant information and materials can be found online on the course's website, http://home.deib.polimi.it/colombet/AI/. Prof. Colombetti's office hours are on Thursdays, from 2 to 4 pm. For any problem related to the course feel free to write an email message to the relevant lecturer (marco.colombetti@polimi.it, viola.schiaffonati@polimi.it, marcello.restelli@polimi.it).

Topics

The course concerns *core AI*, that is, the main topics of classical AI as developed starting from the late 1950s. It covers seven topics:

– Brief introduction to AI: aims, research areas, applications

– The concept of a rational agent

– State space search

– Adversarial search

– Constraint satisfaction problems

– Logical inference

– Planning

– History and philosophical problems of AI.

A tentative schedule of the lessons can be downloaded from the course's website.

Integrated course

The two courses Artificial Intelligence and Soft Computing (lectured by Andrea Bonarini) may also be taken as a single, integrated course. I take the liberty of discouraging this practice, because it brings no advantage to the student, at the cost of additional bureaucratic rigidity.

Textbook

The recommended textbook is:

– Stuart Russell, Peter Norvig (2010). *Artificial Intelligence: A modern approach*, 3rd edition, Prentice-Hall/Pearson.

The book consists of more than 1,100 pages, about 300 of which will be covered by the course. The lecturers will also upload some complementary materials (lecture notes, etc.) on the course's website.

Final examination

The final examination consists in a two-hour written test, with conceptual questions and problems to be solved. The structure of the test will be presented before the end of the course. Some past tests with suggested solutions are available on Prof. Amigoni's website,

`http://home.deib.polimi.it/amigoni/ArtificialIntelligence.html`.

AI-related courses at Politecnico di Milano (Leonardo Campus)

A number of AI-related courses are offered at Politecnico di Milano. Here is a list of the courses offered at the Leonardo Campus (further courses are offered at the Como Campus):

– Soft computing (neural networks, fuzzy models, genetic algorithms)
– Knowledge engineering (covering Semantic Web technologies)
– Machine learning
– Autonomous agents and multiagent systems
– Robotics
– Image analysis
– Natural language processing
– Philosophical issues of computer science

1.2 What is AI?

The birth of Artificial Intelligence

Officially, Artificial Intelligence (AI) was born in 1956, during a summer seminar held at Darthmouth College in Hanover (New Hampshire) attended by John McCarthy, Marvin Minsky, Allen Newell, Nathaniel Rochester, Claude Shannon, Herbert Simon (who will later win a Nobel Prize in Economic Sciences), and others.

[More on this in Section 1.1 of the textbook.]

In this course the "acting rationally" approach to AI is taken.

What is intelligence?

Being intelligent is not a clear-cut concept (contrary, for example, to being a metal, or being a neuron). As a consequence, we should not hope to find a simple *theory of intelligence*; maybe "intelligent" cannot even be turned into a rigorous scientific term. Among the typical capacities of intelligent systems are:

– perceiving the environment;
– learning;
– interacting and communicating with others;
– solving problems and acting rationally (mostly in humans, but also present to some degree in many non-human animals);
– using language (humans only).

What is an artificial intelligent system?

We take for granted that an *artificial* intelligent system can only be a system controlled by a suitably programmed digital computer. Why? The answer is that since the 1950s there has been a widespread school of thought that views human intelligence as a computational process. According to this scientific tradition (often called "computational cognitivism" or simply "cognitivism"), to be intelligent means to be a physical system implementing a suitable Turing machine; this presupposes that, at least in principle, it is possible to completely reproduce human intelligence in a computer. Such a radical view is no longer so popular among psychologists and philosophers; however, many researchers in the field of AI probably still endorse it.

1.3 AI today

AI as a research field

As all large research fields, AI articulates into a number of areas. The best way to get an idea of this articulation is to look at the proceedings of the world's largest AI conference, the *International Joint Conference of Artificial Intelligence* (IJCAI). This conference is biennial and it was last held in 2019. in Macao.[1] As one can see from the table of contents, the general topics appear to be (in alphabetical order):

1. Agent-based and Multi-agent Systems
2. Computer Vision
3. Constraints and SAT
4. Heuristic Search and Game Playing
5. Humans and AI
6. Knowledge Representation and Reasoning
7. Machine learning (by far the largest section of the proceedings)
8. Machine Learning Applications
9. Multidisciplinary Topics and Applications
10. Natural language processing
11. Planning and Scheduling
12. Robotics
13. Uncertainty in AI

While this course will mainly provide an introduction to topics 3, 4, 6, and 11, most other topics are addressed by other courses offered at the Leonardo Campus (see Section 1.1).

It is more difficult to give a quick idea of the current applications of AI. At least in general, AI-based solutions tend not to constitute complete systems, but are most often embedded, and partially hidden to the end user, in larger software systems; for example, AI methods are exploited in many recommender systems, in Google's search engine, in the control systems of prototype autonomous vehicles, and so on. In any case, some impressive applications are briefly described in the recommended textbook.

[More on this in Section 1.4 of the textbook.]

It is also important to remark that AI has had a large impact on Computer Science in general, mainly on the areas of computer programming, software engineering, and databases. Indeed, many by now common techniques (like for example dynamic data structures, functional and logic programming, and software development environments) have first been invented and developed as parts of AI systems.

To conclude, the interested reader is referred to the important report *Artificial Intelligence and Life in 2030*,[2] written in 2016 by a panel of AI specialists.

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[1] The proceedings are available online at the URL `https://www.ijcai.org/proceedings/2019/`.

[2] Available at `https://ai100.stanford.edu/2016-report`.