Minor Cognitive Science and Artificial Intelligence

Offered by: Tilburg University
Language: English
Primarily interesting for: Major Data Science
Prerequisites: n.a.
Contact person: Anne Lafarre

The courses of this minor are in principal only open to Data Science students and you will be allowed to follow these courses on a first come first serve basis. If you would like to take these courses, please send an email to A.J.F.Lafarre@uvt.nl (Anne Lafarre) before June 29 and explicitly indicate which course(s) (including course name and course code) you want to follow in which year (2020-2021 or 2021-2022). If there are sufficient places left, you immediately receive a confirmation.

Students that are not part of the Data Science program are also allowed to follow these courses too, if there is sufficient place for this. If by June 29 there are still sufficient places available, students of other programs are selected to join these courses and will be informed the day after.

What is this package about?
In this minor package from the bachelor Cognitive Science and Artificial Intelligence, you learn about artificial intelligence (the study of computers and software that can perform intelligent behavior). Particularly, you focus on artificial intelligence, human cognition and technological innovation and ask questions like: "Can computers interpret human emotions in a reliable way? How does our brain process all the impulses which it receives and how does it respond to virtual and augmented reality? How does communication between humans and robots work? And what forms of artificial intelligence can we expect in the (near) future?".

Note 1: Please note that this minor takes place in Tilburg and you need to register as follows:
If you are a bachelor Data Science student, and therefore are enrolled at both Eindhoven University of Technology and Tilburg University, you need to register in the way that you are used to register for courses, so by using Osiris. However, if you are enrolled at Eindhoven University of Technology but are not a Data Science student, you need to enroll as an individual minor student at Tilburg University. For the various steps that you need to take to complete this enrollment procedure, please consult this webpage:
https://www.tilburguniversity.edu/students/administration/registration/first-minors

Note 2: select at least three (minimum of 15 ECTS) courses from the following list. There is a maximum of 25 students per course.

Note 3: these courses take place in Tilburg and do not follow the time schedule of the TU/e. They are mainly organized in semesters. Keep this in mind when selecting these courses. Please contact Anne Lafarre in case you experience difficulties with your schedule.
<table>
<thead>
<tr>
<th>Course code</th>
<th>Course name</th>
<th>Timing?</th>
<th>ECTS</th>
<th>Prior knowledge required?</th>
</tr>
</thead>
<tbody>
<tr>
<td>822047</td>
<td>Introduction to Machine Learning</td>
<td>Semester 2</td>
<td>6</td>
<td>Being able to program in Python.</td>
</tr>
<tr>
<td>810031</td>
<td>Autonomous Systems</td>
<td>Semester 2</td>
<td>6</td>
<td>n.a.</td>
</tr>
<tr>
<td>800882</td>
<td>Multi-agent systems</td>
<td>Semester 1</td>
<td>6</td>
<td>n.a.</td>
</tr>
<tr>
<td>800829</td>
<td>Advanced Programming</td>
<td>Semester 2</td>
<td>6</td>
<td>Being able to program in Python.</td>
</tr>
<tr>
<td>800883</td>
<td>Introduction to Deep Learning</td>
<td>Semester 2</td>
<td>6</td>
<td>Course: 822047, and being able to program in Python.</td>
</tr>
</tbody>
</table>
Course descriptions:

822047 Introduction to Machine Learning
This course provides an introduction to machine learning – extracting knowledge from data - using Python and accompanying libraries. Machine learning is applied in all domains of every day life, from music and film recommendations to financial decisions, security, personalized health care, and practical research. At the end of this course, students will be able to:
- implement solutions to real-world machine learning problems;
- describe fundamental concepts in machine learning;
- describe most widely used machine learning algorithms, their advantages and shortcomings;
- use Python libraries for the purposes of model building, evaluation, and parameter learning.

810031 Autonomous Systems
The course offers a review of standard cognitive robotics that provide insights into the mechanisms behind natural and cognitive phenomena, with a focus on how to model these in simulations and robots. The course is organized around three main topics:

I. Autonomous systems:
   - Behavior-based robotics
   - Cognitive robots
   - Perception, action and control

II. Developmental robotics
   - Learning in robots
   - Language learning in robots
   - Symbol grounding

III. Social Robotics
   - Socially assistive robots
   - Human-Robot Interactions

Based on these themes, students will obtain an intuitive understanding of the strengths and weaknesses of autonomous systems and cognitive robotics. Lectures will be alternated with seminars in which students gain hands-on experience with the programming of robots. In addition, students will work on a project in which they develop a cognitive model and implement this on robots. At the end of this project, the result will be demonstrated to the class during one of the seminars.

800882 Multi-agent systems
Multi-agent systems are everywhere: Air traffic controllers landing planes, utility companies distributing energy, travel agents booking trips. In each case, there are various ‘agents’ that are coordinating, negotiating and competing with each other to deliver the required services. The promise of the future is that more, if not all, of the agents in these systems will be artificial. How can we build such agents, and the systems in which they operate? Some of the design challenges are similar to those of any intelligent autonomous system – that is, we need a way to specify the agents’ goals, a strategy for fulfilling them, and an algorithm for learning from experience. But other challenges are specific to the multi-agent setting: How can the agents predict what others will do? What strategies can they use to coordinate? What protocols should they use for communication? These questions are at the core of multi-agent systems research. In this course, we will review the fundamental concepts underpinning the field of multi-agent systems, which are drawn mainly from probability theory, logic, and game theory. In addition, we will read, summarize and critique papers discussing practical applications. Each week, there will be a lecture, a problemset, and assigned
reading, covering the following: What Are Agents? Agent Decisions; Strategic Games; Coordination Games; Agent Negotiation; and Mechanism Design.

800829 Advanced Programming
Advanced computational techniques are necessary for developing complex (large) programs, according to proven design principles and programming best practices. Such techniques are also at the basis of many of the courses taught in the CSAI and Data Science programs. The course "Advanced Programming" builds on the computational knowledge of the courses "Data Structures and Algorithms" and "Basic Programming" in two ways: (1) it teaches the students advanced concepts of the general programming language Python, and (2) it provides the necessary skills to use advanced programming concepts, algorithms and data structures utilizing standard and third-party library tools.

800883 Introduction to Deep Learning
Deep Learning has revolutionized Machine Learning and has emerged as the primary technique for addressing many problems in computer science, natural sciences, linguistics, and engineering. That is so as Deep Learning techniques yield the best performances so far in a large variety of application domains such as computer vision, natural language processing, self-driving cars, drug discovery, and genomics. This course provides students with the fundamentals of Deep Learning needed to understand, build, and apply Deep Neural Networks. Students will learn about the main building blocks of Deep Neural Networks and the primary algorithms used to train them. The course also provides practical skills to apply Deep Learning techniques to a variety of problems through hands-on sessions and project-based assignments.