**English course title**
Kursnamn på engelska

Reinforcement Learning

**Swedish course title**
Kursnamn på svenska

Förstärkningsinlärning

**Extent (credits)**
Omfattning (högskolepoäng)

5+3

**Language of instruction**
Undervisningsspråk

English

**Recommended prerequisites**
Rekommenderade förkunskaper

Programming experience, basic courses in linear algebra, probability and optimization.

**General course objective/s and learning outcomes (Also specify which PhD examination goals that are addressed/covered. Describe how.)**
Kursens syfte och mål (Beskriv vilka mål för examen på forskarnivå som beaktas och på vilket sätt.)

**General Course Objective:**

Reinforcement learning is a family of modern machine learning techniques which has obtained unprecedented successes in artificial intelligence benchmarks, see for instance Google’s AlphaGo’s successes against humans. Using reinforcement learning techniques, computers can autonomously learn to make decisions using feed-back from real and/or simulated environment/data. This course will give a PhD level introduction to these techniques.

In particular, the general course objective is the following:

- Evaluate the applicability and limitations of reinforcement learning (RL) approaches to a given problem, choose and implement the basic form of a suitable RL method.

**Learning outcomes:**

- understand the basic principles and concepts of reinforcement learning
- evaluate which RL methods are suitable for different types of decision problems

- design and implement model-free and model-based RL methods and evaluate their applicability and limitations for a given problem

- apply function approximation techniques for RL

- interpret exploration-exploitation trade-offs in reinforcement learning

- implement the RL methods introduced in the course using a numerical platform and evaluate the results

PhD examination goals that are most relevant to this course (the abbreviations for the PhD Examination Goals are given according to 2019 TEKNAT study plan):

- C2: Demonstrate specialised insight into the possibilities and limitations of research, its role in society and the responsibility of the individual for how it is used.

Together with the course participants, we will discuss applications, limitations, strength and weaknesses of RL approaches throughout the course. Given the recent successes of artificial intelligence (AI) and machine learning (ML), and the fact that reinforcement learning (RL) is one of the mainstream AI/ML approaches, this course will allow participants to provide specialized insight into this fast evolving paradigm and its role in their research and society.

- B2: Demonstrate the ability to identify and formulate issues with scholarly precision critically, autonomously and creatively, and to plan and use appropriate methods to undertake research and other qualified tasks within predetermined time frames and to review and evaluate such work.

We will critically review the state-of-the-art RL algorithms and actively encourage course participants to form their own ideas to improve the current algorithms.

- B4: Demonstrate the ability in both national and international contexts to present and discuss research and research findings authoritatively in speech and writing and in dialogue with the academic community and society in general.

The mandatory assignments and the optional project will require written or oral presentation and discussion of the results. Hence, we will support this examination goal. Due to the state-of-art nature of the algorithms that will be covered and relatively young nature of the RL field in terms of applications, further opportunities for presentation of the project on a national/international level can also be possible.

- A2. Demonstrate familiarity with research methodology in general and the methods of the specific field of research in particular.
The students will become familiar with the research methodology in the field of reinforcement learning and in general machine learning. Since this research methodology has some unique components compared to more traditional research fields, the students will be able to broaden their perspectives.

- A1. Demonstrate broad knowledge and systematic understanding of the research field as well as advanced and up-to-date specialised knowledge in a limited area of this field and

For course participants whose research topics are related to making decisions over time under unknown environment/system models, this course will provide broad knowledge and some specialized state-of-art knowledge of RL type of methods.

**Course contents**

**Kursinnehåll**


**Instruction (course structure)**

**Undervisning (kursens uppläggning)**

Lectures with in-class exercises (both individual and group exercises), assignments with computational and analytical work, optional project

**Assessment (form of examination)**

**Examination (examinationsformer)**

Assignments that require both computational and analytical work will be used for oral and written assessment (main part of the course, 5 credits). The additional 3 credits can be earned by completing project work. This part will consist of written and oral presentation of the computational work.

**Course examiner (name, e-mail)**

**Examinator (namn, e-post)**
Per Mattsson, per.mattsson@it.uu.se

**Department with main responsibility**

**Huvudansvarig institution**

Department of Information Technology

**Contact person/s (course responsible teacher) (name, e-mail)**

**Kontaktpersoner (kursansvariga lärare) (namn, e-post)**

Per Mattsson, per.mattsson@it.uu.se

**Course dates/period**

**Kurs datum/period**

Spring 2019, Period 4.
Maximum number of participants
Antal platser
50

Submit the application for admission to
Skicka anmälan till kursen till
Per Mattsson, per.mattsson@it.uu.se

Submit the application not later than
Skicka anmälan senast

1 March 2020. In general, the earlier registrations will be prioritized if we get more applicants than the maximum number of participants. In this case, we might also favor a balanced distribution of participants from the different departments instead of the first come, first served principle.