ÖREBRO UNIVERSITET

**Course syllabus**
Third-cycle courses and study programmes

# Artificial Intelligence Search Methods, 4 credits

## *Sökmetoder för Artificiell Intelligens, 4 hp*

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| **Course Code/Codes** | 50DT040 |
| **Subject Area** | Computer Science (Datavetenskap) |
| **School/equivalent** | School of Science and Technology (Institutionen för naturvetenskap och teknik) |
| **Valid from** | 2016-12-151 |
| **Approved** | 2016-12-15 |
| **Revised** | |
| **Approved by** | Head of School Peter Johansson |
| **Translation to English, date and signature** | |

# 1 Course content

This course focuses on two important tenets of Artificial Intelligence, namely Representation and Search. We explore how general uninformed and informed search techniques are used to solve combinatorial problems, and how problem structure can be leveraged to facilitate the search for a solution. The course provides an overview of the following topics:

- Uninformed systematic search (depth-first, breadth-first, uniform cost, iterative deepening search)
- Informed systematic search (greedy best-first, A*, memory-bounded variants of A*)
- Local search (e.g., hill-climbing, simulated annealing)
- Heuristically-guided backtracking search for Constraint Satisfaction Problems (CSP)
- Variable and value ordering heuristics for CSP search
- Constraint propagation
- Specific types of CSPs and specialized search and propagation methods for these (e.g., k-SAT, DPLL and unit propagation, temporal CSPs and path-consistency)

# 2 Outcomes

## 2.1 The course in relation to the doctoral programme

courses and study The course shall primarily refer to the following intended learning outcomes for third-cycle programmes as described in the Higher Education Ordinance, i.e. the doctoral student shall demonstrate:

*Knowledge and understanding*

- broad knowledge and systematic understanding of the research field (part of outcome 1)
- advanced and up-to-date specialised knowledge in a limited area of this field (part of outcome 1)
- familiarity with the methods of the specific field of research in particular (part of outcome 2)

*Competence and skills*

- the capacity for scholarly analysis and synthesis (part of outcome 3)
- the capacity to review and assess new and complex phenomena, issues and situations autonomously and critically (part of outcome 3)
- the ability to identify and formulate issues with scholarly precision critically, autonomously and creatively (part of outcome 4)

The intended learning outcomes are listed in the same order as in the general syllabus for the programme.

### 2.2 Intended course learning outcomes

To obtain a passing grade, the doctoral student shall demonstrate:

Knowledge and Understanding
- an understanding of the computational bottlenecks of different problem solving algorithms
- an understanding of how problem structure relates to the formal properties of the problem
- an understanding of the notions of backtracking, backjumping and clause learning
- an understanding of the notions of k-consistency and strong k-consistency in CPSs, and how they relate to constraint propagation algorithms

Competence and skills
- the ability to formulate real world problems as search problems, and sketch methods to solve them based on uninformed, heuristic and constraint-based search
- the ability to decide the most appropriate algorithm for solving given problems
- the ability to decide whether a given problem is tractable or requires exponential time for automated solving
- skills to use a combination of constraint propagation (inference) and search to solve CSPs

Judgement and Approach
- the ability to choose the most appropriate approach among the several presented during the course for solving a specific problem, and
- an understanding the computational and representational trade-offs of different methods

## 3 Reading list and other teaching material

The following course readings and teaching material will be used on the course:

Overheads/syllabus provided by the instructor and research articles. The following textbooks will be used (recommended, but not in their entirety):

Russell, Stuart and Norvig, Peter (Latest edition)
Artificial Intelligence, A modern Approach
Prentice Hall

Dechter, Rina (Latest edition)
Constraint Processing
The Morgan Kaufmann Series in Artificial Intelligence, Elsevier Science

Biere, Armin, Heule Marijn., Van Maaren, Hans., Walsh Toby. (Latest edition)
Handbook of Satisfiability
IOS Press

Francesca Rossi, Peter van Beek, Toby Walsh (Latest edition)
Handbook of Constraint Programming
Elsevier

# 4 Teaching formats

Teaching on the course takes the following format:

Teaching will occur through seminars. Students will, as part of the examination, also give seminars to the class (see below).

# 5 Examination

The course is assessed through an examination in the format of

A seminar where the student presents and discusses search methods for one or more problems that are relevant to the student's research area.

# 6 Grades

Examinations on third-cycle courses and study programmes are to be assessed according to a two-grade scale with either of the grades 'fail' or 'pass' (local regulations).

The grade shall be determined by a teacher specifically nominated by the higher education institution (the examiner) (Higher Education Ordinance).

To obtain a passing grade on examinations included in the course, the doctoral student is required to demonstrate that he/she attains the intended course learning outcomes as described in section 2.2. Alternatively, if the course consists of multiple examinations generating credit, the doctoral student is required to demonstrate that he/she attains the outcomes that the examination in question refers to in accordance with section 5.

A student who has failed an examination is entitled to a retake.

If an examination consists of several examination components, and a student fails an examination component, the examiner may, as an alternative to a retake, set a make-up assignment with regard to the examination component in question.

A doctoral student who has failed an examination twice for a specific course or course element is entitled, upon his/her request, to have another examiner appointed to determine the grade.

# 7 Admission to the course

## 7.1 Admission requirements

To gain access to the course and complete the examinations included in the course, the applicant must be admitted to a doctoral programme at Örebro University.

## 7.2 Selection

Selection between applicants who have been admitted to doctoral programmes at Örebro University and who otherwise meet the admission requirements as listed above is made according to the following order of precedence:

If no other selection criteria are specified in this section, priority shall be given to applicants with a lower number of course credits left before the award of their degree over applicants with a higher number of remaining course credits. Should two or more students have equal number of credits,

selection will be done through the drawing of lots. This also applies within any selection groups listed unless otherwise stated.

### 7.3 Other applicants than doctoral students admitted at Örebro University

Other applicants than doctoral students admitted at Örebro University may be given access to the course on the grounds of provisions for and/or agreements regarding contracted courses, joint degrees, national graduate schools or cooperation in other respects with other universities.

Any decisions on what such other applicants may be given access to the course are made separately and on the basis of the provisions and/or agreements that occasion the student to apply for the course.

For participation in the course in other respects, the same provisions shall apply as for doctoral students admitted to Örebro University.

## 8 Transfer of credits for courses, study programmes and other experience

Provisions on the transfer of credits can be found in the Higher Education Ordinance and on the university's webpage.

## 9 Other information

The course is given in English.

## Transitional provisions

None.