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| **Course Outline**  Department of Computing Science  Faculty of Science |

**COMP 3710 - 3**

**Applied Artificial Intelligence (3,1,0)**

**Winter 2019**

**Instructor:** Mahnhoon Lee **Phone/Voice Mail**: (250) 377-6022

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Office Hour: 10:30 – 11:20 @ Tue, Wed, Thur, Fri

## Course Description

Students investigate non-deterministic computer algorithms that are used in wide application areas but cannot be written in pseudo programming languages. Non-deterministic algorithms have been known as topics of machine learning or artificial intelligence. The topics covered in this course include mainly classical artificial intelligence techniques and soft computing techniques. Classical artificial intelligence techniques include knowledge representation, heuristic algorithms, rule based systems, and probabilistic reasoning. Soft computing techniques include fuzzy systems, neural networks, and genetic algorithms.

## Educational Objectives/Outcomes

* Understand the major areas and challenges of AI.
* Identify problems that are amenable to solution by AI methods, and which AI methods may be suited to solving a given problem.
* Formalize a given problem in the language/framework of different AI methods.
* Implement basic AI algorithms.
* Apply basic AI knowledge and algorithms to solve problems.
* Design simple software to experiment with various AI concepts and analyse results.

#### Prerequisites

* COMP 2230 Data Structures, Algorithm Analysis, and Program Design
* MATH 1650 Mathematics for Computing Science

**Recommended Texts/Materials**

* Artificial Intelligence Illuminated, Ben Coppin, Jones and Bartlett Illuminated Series.

Other Available/Recommended Resources

* Norvig P. Russell S., Artificial Intelligence: A Modern Approach, Prentice Hall.

#### Student Evaluation

* Project 20%
* Assignments 20%
* 2 midterm exams 40% (each 20%)
* Final exam 20%

**Course Schedule**

* Total 13 weeks
* 3 lectures per week (50 Minutes each)
* 1 seminar per week (50 minutes each)
* The last 3-4 weeks will be used for individual projects.

### Other Points to Note

1. **Attendance**

Since this is a programming course, there is a lot of programming involved. Attendance in every class is expected and very important for success in this course. The material presented in class will highlight important concepts and your Labs and Assignments will build on those concepts to demonstrate practical applications of the material covered in class. Students who repeatedly miss lectures or labs will be required to withdraw from the course.

Minimum **80%** of attendance is required.

* **Class Conduct**

During lectures, the student is expected to act in a professional and respectful manner towards other students and instructors; students not conducting themselves in such a manner may be asked to leave. This courtesy is also expected during lab/seminar times, which are allotted only for course work.In particular, private conversations during lectures or labs are NOT allowed. Anyone doing so will be asked to leave the lecture or lab immediately.

1. **Late Homework Policy**

Homework that is late shall receive a mark of zero (0).

1. **Missed work**

All exams and quizzes must be written at the designated time. Missed exams, and assignments will count as zero unless medical reasons supported by a medical doctor’s note are provided.

1. **Academic Honesty Policy**

All work submitted must be your own. TRU's academic honesty is followed in this course. Copied work will result in an automatic F for the course. The student is expected to be familiar with these policies. See the TRU Calendar.

#### Syllabus – Lecture Topics:

(Note: Not necessarily in this exact order and duration, but very close)

* Part I – Introduction to Artificial Intelligence 1 week
* A Brief History of Artificial Intelligence Chapter 1
* Uses and Limitations Chapter 2
* Problem characteristics Lecture note
* Nature of agents Lecture note
* Part II – Classical Artificial Intelligence 4 weeks
* Knowledge Representation Chapter 3
* Searching Chapter 4, 5, 14

Search Methodologies

Advanced Search

Genetic Algorithms (not much classical)

* Knowledge Representation and Automated Reasoning Chapter 7, 8, 9

Propositional and Predicate Logic

Inference and Resolution for Problem Solving

Rules and Expert Systems

* Part III – Machine Learning 3 weeks
* Introduction Chapter 10
* Neural Networks Chapter 11
* Probabilistic Reasoning Chapter 12
* Artificial Life Chapter 13
* Part IV – Advanced Topics 1-2 weeks
* Fuzzy Reasoning Chapter 18

Lecture note

* Intelligent Agents Chapter 19
* Introduction to Understanding Language (when time permits) Chapter 20
* Introduction to Machine Vision (when time permits) Chapter 21

#### Syllabus – Seminar/Lab Topics :

* Solving the problems regarding to the concept of artificial intelligence
* Solving problems using A\* and advanced heuristics
* Solving a problem using a generic algorithm
* Solving the problems regarding to formal languages
* Solving problems using backward chaining and forward chaining
* Implementation of a fuzzy control system
* Solving a problem using a decision tree
* Solving problems using neural networks
* Solving problems using probabilistic reasoning

## Use of Technology

* Programming languages – JavaScript, Java

**ACM / IEEE Knowledge Area Coverage**

**Knowledge Areas**

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| **Knowledge Area (core)** | **Total Hours of Coverage** |
| IS-Intelligent Systems | Total 10 |
| IS/Fundamental Issues | 1 |
| IS/Basic Search Strategies | 4 |
| IS/Basic Knowledge Representation and Reasoning | 3 |
| IS/Basic Machine Learning | 2 |
| DS-Discrete Structures | Total 4 |
| DS/Basic Logic | 4 |
| **Knowledge Area (elective)** | **Total Hours of Coverage** |
| IS-Intelligent Systems | Total 3 |
| IS/Advanced Search | 1 |
| IS/Advanced Representation and Reasoning | 0.5 |
| IS/Reasoning Under Uncertainty | 1 |
| IS/Advanced Machine Learning | 0.5 |

**Body of Knowledge coverage**

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| **KA** | **Knowledge Unit** | **Topics Covered** | **Hours** |
| IS | Fundamental Issues (Core-Tier2) | Overview of AI problems, examples of successful recent AI applications | 1 |
| What is intelligent behavior?   * The Turing test * Rational versus non-rational reasoning |
| Problem characteristics   * Fully versus partially observable * Single versus multi-agent * Deterministic versus stochastic * Static versus dynamic * Discrete versus continuous |
| Nature of agents   * Autonomous versus semi-autonomous * Reflexive, goal-based, and utility-based * The importance of perception and environmental interactions |
| IS | Basic Search Strategies (Core-Tier2) | Problem spaces, problem solving by search | 4 |
| Factored representation (factoring state in variables) |
| Uninformed search (breadth-first, depth-first with interactive deepening) |
| Heuristics and informed search (hill-climbing, generic best-first, A\*) |
| Space and time efficiency of search |
| Two-player games (introduction to minimax search) |
| Constraint satisfaction (backtracking and local search methods) |
| IS | Basic Knowledge Representation and Reasoning (Core-Tier2) | Review of propositional and predicate logic | 3 |
| Resolution and theorem proving (propositional logic only) |
| Forward chaining, backward chaining |
| Review of probabilistic reasoning, Bayes theorem |
| IS | Basic Machine Learning (Core-Tier2) | Definition and examples of broad variety of machine learning tasks, including classification | 2 |
| Inductive learning |
| Simple statistical-based learning, such as Naïve Bayesian Classifier, decision trees |
| The over-fitting problem |
| Measuring classifier accuracy |
| IS | Advanced Search (Elective) | Stochastic search – Simulated annealing; Genetic algorithm |  |
| Implementation of A\* search |
| IS | Advanced Representation and Reasoning (Elective) | Rule-based Expert systems |  |
| IS | Reasoning Under Uncertainty (Elective) | Review of basic probability |  |
| Random variables and probability distributions   * Probabilistic inference * Bayes’ rule |
| Knowledge representations   * Bayesian Networks |
| IS | Advanced Machine Learning (Elective) | Definition and examples of broad variety of machine learning tasks |  |
| Nearest-neighbor algorithms |
| DS | Basic Logic (Core-Tier1) | Review of propositional and predicate logic | 4 |
| Normal forms (conjunctive and disjunctive) |
| Validity of well-formed formula |
| Propositional inference rules (concepts of modus ponens and modus tollens) |
| Predicate logic – universal and existential quantification |
| Limitations of propositional and predicate logic (e.g., expressiveness issues) |