Artificial Intelligence COMPSCI 4004 (H) 2020-2021 Syllabus

Examinable Material:

- Artificial Intelligence – a modern approach, 3ed, Stuart J. Russell and Peter Norvig, ISBN: 978-0-13-604259-4 ("AIMA")
- Lecture notes
- Lab worksheets and solutions.
- ~~Deep Q-learning (DQN) (https://arxiv.org/abs/1312.5602) and Rainbow (https://arxiv.org/abs/1710.02298) papers (corresponding to the lectures)~~ (corrected 22/4 2021; only recommended to read/study the papers)

Note: We assume students have a working knowledge of probability corresponding to AIMA Ch 13

		Lectures and labs (examinable unless indicted in the notes/lecture)	**Textbooks/papers** Refers to chapters in ***AIMA 3ed Chapter*** (material from AIMA presented in the lectures are examinable) unless otherwise specified).	**Important concepts/techniques/topics**
Introduction		Week 2	1	
Intelligent agents		Week 2	2	Agent types (reflex, model-based, goal, utility, learning), rationality, PEAS, task environment.
Deterministic problems	Search	Week 3	3	Discrete vs continuous search space, depth first search, breadth first search, A-star, graph/tree search, informed, uninformed search, heuristic, optimality, completeness, complexity, discrete search space
	Goal, search and optimization	Week 3	4-4.2	Hill climbing/gradient decent, optimality, consistency, complexity, cost/fitness functions.
Stochastic problems	Bayesian Networks	Week 4	14-14.4,14.7-14.8	Knowledge representation, Bayesian networks, exact enumeration, joint distributions, conditional independence, causality, explaining away. Reasoning based on Bayesian networks. Benefits of applying Bayesian networks in knowledge representation and reasoning.
	Utility and decisions	Week 5	16	Decision-making under uncertainty, utility, value of (perfect) information, expected utility, maximum expected utility, rationality.
	Markov Decision Processes	Week 6 Note: Compared to AIMA the lectures/labs contain additional examinable material on Markov processes and Markov reward processes.	17-17.4	Sequential decision-making under uncertainty, Markov processes, Markov reward processes, Markov decision processes, Bellman (optimality) equations, value iteration, policy iteration.
Learning agents	Function approximations / supervised machine learning	Week 8-10 Note: Compared to AIMA lectures/labs contain additional examinable material on RBF models.	18-18.2,18.4,18.6-18.7 (It is recommended to read chapter 18 in full to appreciate the general context of supervised learning)	Linear models (incl. RBF) and neural networks for regression/function approximation, softmax for classification in the policy search/gradient setting (backpropagation for neural networks is not examinable); fully connected neural networks with linear, sigmoid/tanh and ReLU activation functions, Misc. loss functions (MSE, Huber and specialised policy search/gradient losses).

	Reinforcement learning	Week 7-10 Note: Compared to AIMA the lectures/labs include additional examinable material on DQN (replay and double Q-learning), policy search/gradient methods and (basic) actor critic methods.	21, Note: It is only recommended to read the DQN paper, RAINBOW paper (corrected 22/4 2021)	Bellman equations (revisited), model-free vs model-based reinforcement learning, adaptive dynamic programming, temporal difference learning, Q-learning, policy search/gradient methods (including REINFORCE algorithm, function approximation (linear models and neural networks), online learning/stochastic gradient descent and generalization. Deep Q-learning (including replay memory and double Q-learning).
Ethical & Philosophical issues	Ethical & Philosophical issues	Week 11	26,27	Ethical & Philosophical issues