COURSE OUTLINE **SCS 3547 – Intelligent Agents & Reinforcement Learning**

INSTRUCTOR:

Larry Simon
Phone: 416-427-1950
E-mail: larry.simon@utoronto.ca

DATE/TIME:

Live Webinar: 6:00 PM – 7:30 PM
Tuesdays Jan 19 – Mar 23, 2021
Project Presentations: 6:00 PM – 9:00 PM
Tuesdays Mar 30 and Apr 6, 2021

REQUIRED TEXT(S):

1. **[PM]** Artificial Intelligence, Foundations of Computational Agents, Poole & Mackworth (available free online at https://artint.info/2e/html/ArtInt2e.html) or **[RN]** Artificial Intelligence, A Modern Approach, 3rd Edition, by Russell & Norvig
2. **[RL]** Reinforcement Learning, An Introduction, 2nd Edition, by Sutton & Barto
3. **[GO]** Deep Learning ad the Game of Go by Pumperla & Ferguson

COURSE DESCRIPTION:

Modern Artificial Intelligence (AI) systems often combine techniques from many sub-disciplines: Machine Learning, Deep Learning, Reinforcement Learning, Planning, Intelligent Agents, etc. In this course, you'll build your knowledge of techniques that can be built into AI's that allow them to reason about their current situation and plan their next move. You'll build AIs that can learn to play games and need to trade off exploiting strategies they already know are useful vs. exploring new strategies that may be even better. You'll be ready to apply these techniques to solve real world problems such as finding adaptive strategies for dealing with difficult customers or optimizing use of parking spaces.

PREREQUISITE(S):

SCS 3253 Machine Learning

RECOMMENDATIONS:

COMPUTER REQUIREMENTS:
Laptop Computer with the following Specifications:
System Type: 64 bit operating system, X64-based processor; Windows 7/8/10, Mac OS X or Linux; Processor: Intel ® i5-3230M CPU @ 2.6 GHz or better; Installed Memory (RAM): 8 GB or more

CERTIFICATE(S): Certificate in Artificial Intelligence

LEARNING OUTCOMES: By the end of this course, learners will be able to:

- Create your own system of intelligent software agents
- Use increasingly rich forms of logical inference to enable the agents to make decisions that will help them achieve the goals you've set out for them
- Use probabilistic reasoning to allow them to make decisions with incomplete information
- Use Reinforcement Learning to enable the agents to learn winning strategies for themselves while exploring the environment they find themselves in
- Combine these techniques with those of Machine Learning and Deep Learning to enable your agent to use pretrained models or accelerate their learning

COURSE PLAN

Week	Module Topics	Readings/Assignments/ Activities Prior to Class
1 – Intro to Intelligent Agents	• Course logistics • Agents & environments • Exploration & exploitation • Learning Agents • Problem solving as a searching	• PM Chaps. 1 & 2 or RN Chap. 2 • GO Chaps. 2-3 • Assignment 1 assigned
2 – Search	• Searching trees and graphs efficiently • Simulated Annealing • Linear Optimization • Genetic Algorithms • Constraint Satisfaction	• PM Chap. 3-4 or RN Chaps. 3-6 • GO Chap. 4
3/4 – Logical Inference & Knowledge Representation	• Knowledge-based Agents • Propositional Logic • Knowledge Bases • Inference • Multiagent Planning • Ontologies • Modelling Categories, Objects & Events	• PM Chap. 5-6 or RN Chaps. 7-12 • GO Chaps. 6-7 • Assignment 1 due • Assignment 2 assigned
5 – Probabilistic Reasoning	• Bayesian Graphical Models • Probabilistic Programming	• PM Chaps. 8-10 or RN Chap. 14 • GO Chap. 8 • https://www.manning.com/books/practical-probabilistic-

		programming?query=figaro#toc Chap 1 • Assignment 2 due • Assignment 3 assigned
6 – Intro to Reinforcement Learning & Finite Markov Decision Processes	• Intro to Reinforcement Learning • Goals & Rewards • Returns & Episodes • Policies & Value Functions • Optimality • Multi-Armed Bandits	• RL Chaps. 1 & 3 • GO Chap. 9
7 – Dynamic Programming & Monte Carlo Methods	• Policy Evaluation • Policy Iteration • Value Iteration • Monte Carlo Prediction & Control	• RL Chaps. 2 & 4
8 – Temporal Difference Learning	• Temporal Difference Methods • Sarsa • Q-Learning • n-Step Learning • Integrated Planning & Learning	• RL Chaps. 5 & 6 • Assignment 3 due • Assignment 4 assigned
9 – Function Approximation for RL	• Value-function Approximation • Linear Methods • Gradient Descent • Eligibility Traces	• RL Chaps. 9-11
10 – Deep Reinforcement Learning & Policy Gradient Methods	• Deep Q Networks • Policy Gradient Methods • Actor-Critic Methods • Alpha Go & Alpha Go Zero	• RL Chap. 13 • GO Chap. 10-12
11 – Introduction to Advanced DRL	• Recent Examples • Advanced Methods	
12 – Term Project Presentations	• Term project presentations	• Term project due
12 – Term Project Presentations	• Term project presentations	• Assignment 4 due

DELIVERY FORMAT

The following provides a high level description of the main course delivery formats provided by the School.

Please note that your instructor will provide you with a detailed overview of the course venue, learning materials, learning activities and group interaction at the start of your course. If you have any questions about this course, please contact the School at 416-978-2400 or email learn@utoronto.ca to discuss the course delivery format for the course you're interested in.

DELIVERY FORMAT	DESCRIPTION

Online	● **Location of Instruction:** All classes are online via recorded videos and live webinars. ● **Course Administration and Learning Materials:** Course materials are provided in paper-based format (text, readings) and/or as digital online resources through the Quercus Learning Management System. ● **Communication & Interactivity:** Interactions between learners and instructor and between learners directly are conducted primarily via webinar. Some learning activities, ad hoc or project-based interaction may be conducted on the Quercus Learning Management System. E-mail is typically used for ad hoc or project-based interaction outside of class. Occasionally other social media and communication applications may be used for interaction outside class.

GRADING AND EVALUATION:

Assignments	60%
Term Project	30%
Class Participation	10%

There will be 4 assignments during the term worth 15 marks each for a total of 60. The assignments will primarily be programming tasks in Python to complete models for various applications of intelligent agents. The project will be to develop your own special-purpose AI using techniques you learn during the term.

Learners can expect to receive feedback and marks, if applicable, before the course end date, for all their submitted assignment(s) and term test(s) other than the final exam, project or course paper. However, it is the sole responsibility of learners to make sure that they do get these marks from their Instructor and have all related questions answered before the course ends.

If you are unable to write the final exam/project for whatever reason (e.g. medical, work conflicts, family emergencies) you can write an Alternate Examination at the next exam sitting. The Alternate Examination Application form can be downloaded from our website: http://learn.utoronto.ca/how-to-register/forms-applications. Please complete the form, and along with the fee of $150.00, submit it to the Registration Office.

SCS GRADING SCALE:

A	80% to 100%	Excellent
B	70% to 79%	Good
C	60% to 69%	Adequate
D	50% to 59%	Marginal
FX	Less than 50%	Inadequate/Incomplete

FINAL GRADE: To view your final grade, please log into the "My Access – Student Login" located on our website,

www.learn.utoronto.ca/login. Please note that your final grade will not be posted on Quercus.

Once your exam has been written or the course has finished, if you have any questions concerning your grades or final mark, please contact the School directly at scs.business@utoronto.ca or 416-978-2412

CERTIFICATE:

To receive your certificate upon completion of all requirements, please complete the Certificate Request Form available at http://learn.utoronto.ca/how-to-register/certificate-request-form

ACADEMIC CONSULTATION:

Most issues and questions can be addressed during class or by e-mail. Unless urgent information is required, the instructor will respond to your e-mail questions during the next class. If confidentiality is required, a learner and the instructor can arrange a mutually convenient time to address questions – either before or after class, or by telephone.

NOTE(S):

In the event that we have to cancel your class at the last moment due to weather, the illness of the instructor, etc., please ensure that you have provided a daytime phone number or email in your student profile, so that we are able to notify you immediately.

CODE OF CONDUCT:

All School of Continuing Studies learners are required to comply with the University of Toronto Code of Student Conduct available at http://www.governingcouncil.utoronto.ca/Assets/Governing+Council+Digital+Assets/Policies/PDF/ppjul012002.pdf
Learners are also required to comply with the Code of Behaviour on Academic Matters, available at http://www.governingcouncil.utoronto.ca/Assets/Governing+Council+Digital+Assets/Policies/PDF/ppjun011995.pdf

ACADEMIC HONESTY:

If you are using the ideas of others in your written work please see information regarding:

Guidelines for properly citing your sources:
'Writing at the University of Toronto' website at http://www.writing.utoronto.ca/advice/using-sources/documentation

Plagiarism:
http://www.writing.utoronto.ca/advice/using-sources/how-not-to-plagiarize

AUDIO/VIDEO RECORDINGS: You are not permitted to record lectures without the written consent of your instructor(s).

ACCOMMODATION FOR A DISABILITY: If you require accommodation for a disability, please contact Student Services at 416-978-2400 or email learn@utoronto.ca to arrange this service.