Welcome to CSC384 Introduction to Artificial Intelligence Winter 2018

CSC384: Intro to Artificial Intelligence

Instructor: Sheila McIlraith
Office: D.L. Pratt 395D (6 King’s College Road)
Office Hours: TBD – let’s discuss!
Email: sheila@cs.toronto.edu

Instructor: Sonya Allin
Office: Bahen 3219 (for office hours)
Office Hours: Mon: 4:15 – 5:15 PM
Email: sonyaa@teach.cs.toronto.edu

This course is being co-taught. Lectures & evaluation will be identical in the two sections. Profs. Allin & McIlraith will each teach certain topics in both sections.

CSC384: Important Dates in 2018

- Family Day (no class): Monday, February 19
- Winter Break (no classes): February 19 - 23
- Drop Deadline: Wednesday, March 14
- Good Friday (no class): Friday, March 30
- Last day of classes: Thursday, April 5 *
- Final exam period: April 9 – 30

* We have an extra class on this day to make up for classes missed on the Good Friday stat holiday.

CSC384: Textbook

Recommended Text:
Artificial Intelligence: A Modern Approach
- 2 copies of are on 24hr reserve in the Engineering and Computer Science Library.
- Recommended but not required.
- Lecture notes cover much of the course material and will be available online before class.
- Electronic version available online at a reduced price.
  http://aima.cs.berkeley.edu

Additional References:
- Computational Intelligence: A Logical Approach
  Poole, Mackworth & Goebel, 1998.
- Artificial Intelligence Foundations of Computational Agents, Poole & Mackworth, 2010: Text and more available online.
  http://aima.cs.berkeley.edu

CSC384: Other Resources

Online Courses:
Various materials and lectures are available online, e.g.,

Udacity
  https://www.udacity.com/courses
  Introduction to Artificial Intelligence

Berkeley
  http://ai.berkeley.edu/home.html
  We will be using some of their software

Sheila McIlraith & Sonya Allin, University of Toronto, Winter 2018
CSC384: Prerequisites

- Some probability (STA 247/STA255/STA257H).
- Good knowledge of python (assignments involve python programming).
- Knowledge of basic data structures (stacks, queues, priority queues), graphs, familiarity with Big O notation and run time complexity (CSC263, 265).
- If you don’t have these prerequisites or don’t feel fully comfortable with these ideas you will be responsible for learning any needed background material.

CSC384: Website

- Course web site:
  http://www.teach.cs.toronto.edu/~csc384h/winter/
- Primary source of more detailed information, course slides, announcements, etc.
- Course Communication:
  Piazza: https://piazza.com/utoronto.ca/winter2018/csc384
- Course Assignment Submission and Administration:
  MarkUs: https://markus.teach.cs.toronto.edu/csc384-2018-01

All announcements will be made on piazza and the course web page. You are responsible for monitoring these regularly.

CSC384: E-mail/board policies

All discussion and communication should be via Piazza unless it's of a personal nature in which case you should email your course instructor.

Piazza is a third-party discussion forum with many features that are designed specifically for use with courses. We encourage you to post questions (and answers!) on Piazza, and read what other questions your classmates have posted. However, since Piazza is run by another company, we also encourage you to read the privacy policy carefully and only sign up if you are comfortable with it. However, if you are not comfortable signing up with your U of T email address, you can access read-only mode. Feel free to discuss further with your instructor.

- For each assignment, a TA(s) will be assigned to answer questions and to monitor Piazza.
- Answers that are important to everyone will be posted to the web site.
- For personal email, subject header should start “[CSC384]”.
- A silent period will take effect 24 hours before each assignment is due. No question related to the assignment that is posed within this 24 hour period will be answered.

CSC384: Where to get help

- Piazza
- Office hours
- Help sessions: we’ll be running extensive assignment-specific help sessions so that you can get personalized help from TAs

CSC384: How you will be graded

- 4 Assignments (3 programming & 1 take home) (40 %)
- 1 term tests (15% )
- 1 in-class quiz (5%)
- 1 final exam (40%)

You must receive a passing grade on the final exam to pass the course.

Late Policy/Missing Test:
- You will have 3 grace days. Use them wisely!
- After that, you will be penalized 10% per day for late assignments.
- For some assignments there may be a cut-off date after which assignments will no longer be accepted.

Plagiarism: submission of work not substantially the student’s own

CSC384: How you will be graded

Course work:
- 4 Assignments (3 programming & 1 take home) (40 %)
- 1 term tests (15% )
- 1 in-class quiz (5%)
- 1 final exam (40%)

Tentative Schedule:

<table>
<thead>
<tr>
<th>Item</th>
<th>Topic</th>
<th>%</th>
<th>Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Search</td>
<td>10%</td>
<td>Jan 19</td>
</tr>
<tr>
<td>A2</td>
<td>Constraint Satisfaction</td>
<td>10%</td>
<td>Feb 5</td>
</tr>
<tr>
<td>Test</td>
<td></td>
<td>15%</td>
<td>Feb 28</td>
</tr>
<tr>
<td>A3</td>
<td>Game Tree</td>
<td>15%</td>
<td>Mar 7</td>
</tr>
<tr>
<td>A4</td>
<td>Uncertainty (take home)</td>
<td>5%</td>
<td>Mar 14</td>
</tr>
<tr>
<td>In-class Quiz (on A4)</td>
<td>5%</td>
<td>Apr 4</td>
<td></td>
</tr>
<tr>
<td>Final Exam</td>
<td>40%</td>
<td>Exam Period</td>
<td></td>
</tr>
</tbody>
</table>

McIlraith & Allin, CSC384 Winter 2018
WHAT IS AI?

Artificial Intelligence (AI)
How to achieve intelligent behaviour through computational means

For most people AI evokes:

...but are these "intelligent"?

Are these intelligent?

What about these?
Huge Acceleration

In the last 5 years the number of technologies and devices embodying some form of “machine intelligence” have exploded

…even surpassing the expectation of those developing the enabling technologies and the basic research

A BRIEF LOOK BACK

Alan Turing (1912 – 1954)

“Computing machinery and intelligence”
Mind, 59, 433-460, 1950

The Imitation Game

“Can machines think?” I believe to be too meaningless to deserve discussion. Nevertheless I believe that at the end of the century the use of words and general educated opinion will have altered so much that one will be able to speak of machines thinking without expecting to be contradicted.

1956-1997

1956: John McCarthy - Dartmouth Artificial Intelligence Conference
1957: Herbert Simon - “within 10 years a digital computer will be the world’s chess champion”
1967: Marvin Minsky - “within a generation , the problem of creating ‘artificial intelligence’ will substantially be solved.
1974-80: Slow progress, relative to expectations “AI Winter”
Early 1980’s: Expert Systems boom
1997-1993: 2nd AI Winter

1997: Chess

IBM’s Deep Blue beats chess grandmaster Garry Kasparov

2011: Watson

IBM’s Watson defeats the Jeopardy champions Brad Rutter and Ken Jennings by a significant margin.

❄

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2011: Watson

IBM’s Watson defeats the Jeopardy champions Brad Rutter and Ken Jennings by a significant margin.
**Autonomous Driving**

**2005:** DARPA Grand Challenge – Stanford autonomous vehicle drives 131 miles along an unrehearsed desert trail.

**2007:** DARPA Urban Challenge – CMU autonomous vehicle drives 55 miles in an urban environment while adhering to traffic hazards and traffic laws.

**Now:** Google Car and efforts by all the major car manufacturers, Mobileye, Uber, ...

Watch for autonomous wheelchairs, boats, ...

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**AlphaGo & DeepMind**

**2016:** AlphaGo beats 9-Dan pro Go player Lee Sedol
**2017:** AlphaGo Zero – learns by playing with itself

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**TODAY**

**AI adoption is “insidious”**

Many applications of machine intelligence are not advertised as such. They’re just devices, technologies, that seem
…a little smarter,
…a little more intuitive,
…a little easier to use,
…and that know you a little better than they used to.

There will be no “ah ha” moment in which we say now we have “achieved artificial intelligence”. It will creep up on us. Systems will adapt to users in the most natural and subtle ways.

And society will adapt to the “new normal”.

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Computational Linguistics
- Siri, Cortana, Google Now
- Language Translation
- Sentiment Analysis of Social Media
- Natural Language and Social Science
  - Dementia detection
  - Deception detection
  - Identity detection...

Knowledge Representation
- Beyond Cognitive Systems like Watson,
  - Automated Planning and Optimization
  - Automated Synthesis of Controllers
  - Smart Web Search
  - The Semantic Web and Linked (Open) Data
  - Biomedical Ontologies
  -...

Robotics
- Kiva Robots (Amazon Robotics)
  - https://www.youtube.com/watch?v=6KRjuuEVEZs

Robotics
- Paro Therapeutic Robot

Robotics
- Geminoid Robot
  - Hiroshi Ishiguro, ATR, Osaka University, Japan
Robotics

Beyond the burgeoning autonomous car industry:
- Surveillance & Security
- Visual authentication
- Detecting drowning people in pools
- Digital photography
- TV/Sports (e.g., was the shot in or out; drawing the 10 yard line)
- Shopping — trying on virtual clothing, recognizing products
- Analyzing behaviour — traffic, people shopping, …

Computer Vision

Again, a myriad of diverse data applications including:
- Language Translation (Google Translate – 100+ languages)
- Recommender Systems (e.g., Netflix, …)
- Advertising
- Word completion in editors
- Image Classification/Matching
- …and at the core of a number of the previous apps

...AND LOTS OF IT IS HAPPENING IN TORONTO!

ADVANCES IN AI WILL HAVE A SIGNIFICANT IMPACT ON SOCIETY

McIlraith & Allin, CSC384 Winter 2018
**Artificial Intelligence (AI)**

How to achieve intelligent behaviour through computational means

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**Broad View of AI**

- Perception: vision, speech understanding, etc.
- Machine Learning, Neural network
- Natural language understanding
- Robotics
- Reasoning and decision making [OUR FOCUS]
  - Knowledge representation
  - Reasoning (logical, probabilistic)
  - Decision making (search, planning, decision theory)

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**Daniel Kahneman**  
(Nobel Prize in Economics)

Two modes of thought:
- System 1 is fast, instinctive and emotional;
- System 2 is slower, more deliberative, and more logical.

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**Computational Intelligence**

- AI tries to understand and model intelligence as a computational process.
- Thus we try to construct systems whose computation achieves or approximates the desired notion of intelligence.
- Hence AI is part of Computer Science.
- Other areas interested in the study of intelligence lie in other areas or study, e.g., cognitive science which focuses on human intelligence. Such areas are very related, but their central focus tends to be different.

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**How do we build artificial intelligences?**
Human Intelligence

- In general there are various reasons why trying to mimic humans might not be the best approach to AI:
  - Computers and Humans have a very different architecture with quite different abilities.
  - Numerical computations
  - Visual and sensory processing
  - Massively and slow parallel vs. fast serial

<table>
<thead>
<tr>
<th>Think</th>
<th>Human Intelligence</th>
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<tbody>
<tr>
<td>Like humans</td>
<td>Systems that think like humans</td>
</tr>
<tr>
<td>Not necessarily like humans</td>
<td>Systems that think rationally</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Act</th>
<th>Human Intelligence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systems that act like humans</td>
<td>Systems that act rationally</td>
</tr>
</tbody>
</table>

Rationality

- The alternative approach relies on the notion of **rationality**.
- Typically this is a precise mathematical notion of what it means to *do the right thing* in any particular circumstance. Provides
  - A precise mechanism for analyzing and understanding the properties of this ideal behaviour we are trying to achieve.
  - A precise benchmark against which we can measure the behaviour the systems we build.

Rationality

- Mathematical characterizations of rationality have come from diverse areas like logic (laws of thought) and economics (utility theory how best to act under uncertainty, game theory how self-interested agents interact).
- There is no universal agreement about which notion of rationality is best, but since these notions are precise we can study them and give exact characterizations of their properties, good and bad.
- We'll focus on acting rationally
  - this has implications for thinking/ reasoning
What We Cover in CSC384

- Search
  - Heuristic Search. (Chapter 3,4)
  - Search spaces
  - Heuristic guidance
- Backtracking Search (Chapter 6)
  - “Vector of features” representation
  - Case analysis search
- Game tree search (Chapter 5)
  - Working against an opponent

What We Cover in CSC384 (cont.)

- Knowledge Representation (Chapter 7-9,12)
  - First order logic for more general knowledge
  - Knowledge represented in declarative manner
- Planning (Chapter 10-11)
  - Predicate representation of states
  - Plan generation via heuristic search
- Uncertainty (Chapter 13-14, a bit of 15)
  - Probabilistic reasoning, Bayes networks
  - In passing: Utilities and influence diagrams (Chapter 16, 17)

Further Courses in AI

- CSC320H “Introduction to Visual Computing”
- CSC321H “Introduction to Neural Networks and Machine Learning”
- CSC401H “Natural Language Computing”
- CSC411H “Machine Learning and Data Mining”
- CSC412H “Probabilistic Learning and Reasoning”
- CSC420H “Introduction to Image Understanding”
- CSC485H “Computational Linguistics”
- CSC486H “Knowledge Representation and Reasoning”

For Next Day

- Readings: Russell & Norvig.
  - Chapters 1 & 2 – optional but interesting!
  - Chapter 3 – topic to be covered over the next week+ and Assignment 1
- See you on Wednesday (not here)
- Friday’s class will be a regular lecture

Get Involved!

- Undergraduate AI Group (UAIG)
- Undergraduate Summer Research Assistantships (USRAs)
- UofT Self-driving Car Team
- …