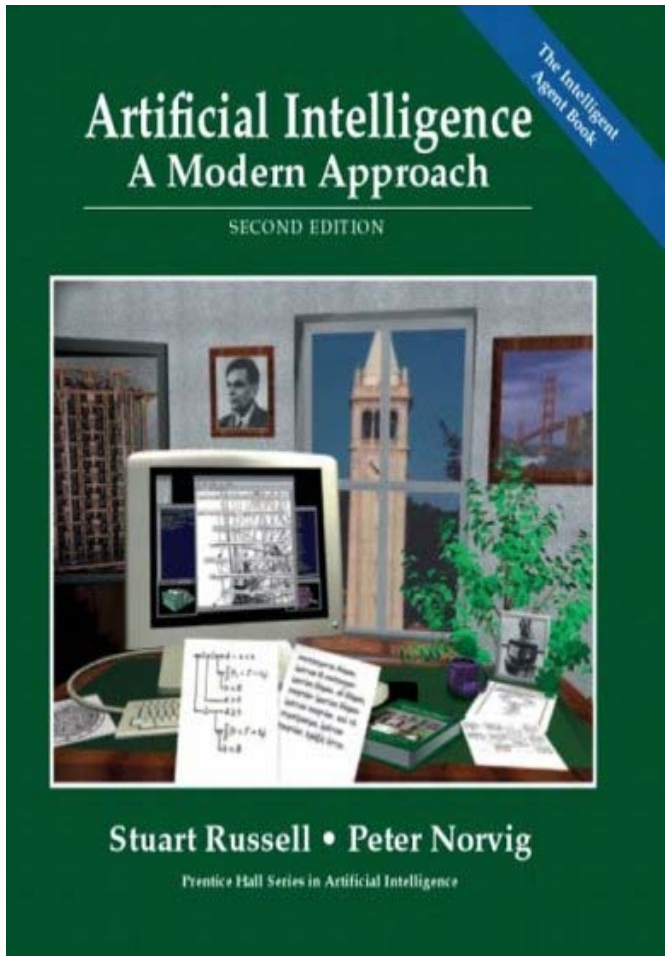
CSC384h: Intro to Artificial Intelligence

- RecommendedText:

  Artificial Intelligence: A Modern Approach by Stuart Russell and Peter Norvig. 2nd Edition, 2003.

  - **This is a good introductory text on AI, well written and with very broad coverage.**
  - **Lecture notes will be posted on line.**
  - **2 copies of are on 24hr reserve in the Engineering and Computer Science Library.**



- Additional Reference:
  - *Computational Intelligence: A Logical Approach* **by David Poole, Alan Mackworth and Randy Goebel.**
- **Both texts have useful websites.**

Lectures

- Outlines of the lectures will be posted to the web, but some examples will be done only in class. **You can print the notes prior to class** so that you can take extra notes to augment the slides in class.
- The text can be used for additional information and some additional background material. It provides a good motivation and context for many of the techniques we will be studying.
- However the material you will be responsible for will all be covered in class or on your assignments.

Web Site

- **http://www.cdf.toronto.edu/~csc384h/[fall/winter]/**

  ←notice "fall or winter dependent on the term."

- The web site will be the primary source of more detailed information, announcements, etc.
  - Check the site often (at least every one or two days).
  - Updates about assignments, clarifications etc. will also be posted on the web site.

E-Mail

- Only e-mail from a UofT account will be answered (other sources are likely to be treated as spam).
- I encourage you to ask your questions in person rather than by e-mail.
- I don't read e-mail during the weekends and during the week it might take a couple of days for me to find the time to respond.
- For e-mail about the assignments see the course WEB page.

News Group

- The course news group will **not be moderated**.
- It can be used to communicate with your fellow students.
- Do not send questions there that you want answered by the instructor.
- Answers that would be important to everyone will be posted to the web site, not to the news group.

Marking Scheme

- Course work
  - 4 Assignments (mostly programming)
  - 4 term tests (1 hour each).
  - No final exam
  - Assignments are worth a total of 40%: [10% each].
  - Term tests are worth a total of 60%: [15% each].
- Late Policy/Missing Test
  - No late assignment will not be accepted.
  - Missed Test/Assignment with a medical excuse will be given a mark based on the student's and the class's performance on all tests/assignments.
- Plagiarism (handing in of work not substantially the student's own) is an academic offense. Please be careful when discussing ideas about assignments.

Important Dates

- On course handout.

Prerequisites

- Prerequisites will not be checked for this course, except for the CGPA (cumulative grade point average) condition.
  - You don't need to request a waiver.
  - You should have a stats course either the standard STA 247/255/257 or at least something like STA 250.
  - You need to have some familiarity with Prolog, CSC324 is the standard prerequisite. We will give some tutorial material on Prolog but you will be required to learn what you need for the assignments.
  - In all cases if you do not have the standard prerequisites you will be responsible for covering any necessary background on your own. We can't provide any assistance with this.

Subareas of AI

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

Course Topics

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

Course Topics

- Knowledge Representation (Chapter 7-10)
  - First order logic for more general knowledge.
  - Knowledge represented in declarative manner.

- Planning (Chapter 11-12)
  - Predicate representation of states.
  - Planning graphs
  - Reachability heuristics.

Course Topics

- Uncertainty (Chapter 13-16)
  - Probabilistic reasoning, Bayes networks
  - Utilities and influence diagrams.

Further Courses in AI

- **CSC321H "Introduction to Neural Networks and Machine Learning"**
- **CSC401H1 "Natural Language Computing"**
- **CSC411H "Machine Learning and Data Mining"**
- **CSC412H1 "Uncertainty and Learning in Artificial Intelligence"**
- **CSC420H1 "Introduction to Image Understanding"**
- **CSC485H1 "Computational Linguistics"**
- **CSC486H1 "Knowledge Representation and Reasoning"**
- **CSC487H1 "Computational Vision"**

What is Artificial Intelligence?

- Chapter 1 & 2 in Russell & Norvig gives a more detailed discussion that touches on many other interesting points and history.
  - Very interesting reading.

What is Artificial Intelligence?

- What is **AI**?
- What is **intelligence**?
- What features/abilities do humans (animals? animate objects?) have that you think are indicative or characteristic of intelligence?

Webster says: a. the capacity to acquire and apply knowledge.
b.the faculty of thought and reason.
...

Alternate Definitions (Russell + Norvig)

	Like humans	Not necessarily like humans
Think	Systems that think like humans	Systems that think rationally
Act	Systems that act like humans	Systems that act rationally

Human intelligence

- Is imitating humans the goal?
- Pros?

- Cons?

Human intelligence

- The Turing Test:
  - A human interrogator. Communicates with a hidden subject that is either a computer system or a human. If the human interrogator cannot reliably decide whether on not the subject is a computer, the computer is said to have passed the Turing test.

- Turing provided some very persuasive arguments that a system passing the Turing test is intelligent.

- However, the test does not provide much traction on the question of how to actually build an intelligent system.

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

	Computer	Human Brain
Computational Units	1 CPU, 10^8 gates	10^{11} neurons
Storage Units	10^{11} bits RAM 10^{12} bits disk	10^{11} neurons 10^{14} synapses
Cycle time	10^{-9} sec	10^{-3} sec
Bandwidth	10^{10} bits/sec	10^{14} bits/sec
Memory updates/sec	10^9	10^{14}

Human intelligence

- But more importantly, we know very little about how the human brain performs its higher level processes. Hence, this point of view provides very little information from which a scientific understanding of these processes can be built.
- Nevertheless, Neuroscience has been very influential in some areas of AI. For example, in robotic sensing, vision processing, etc.

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 behavior we are trying to achieve.
  - A precise benchmark against which we can measure the behavior 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

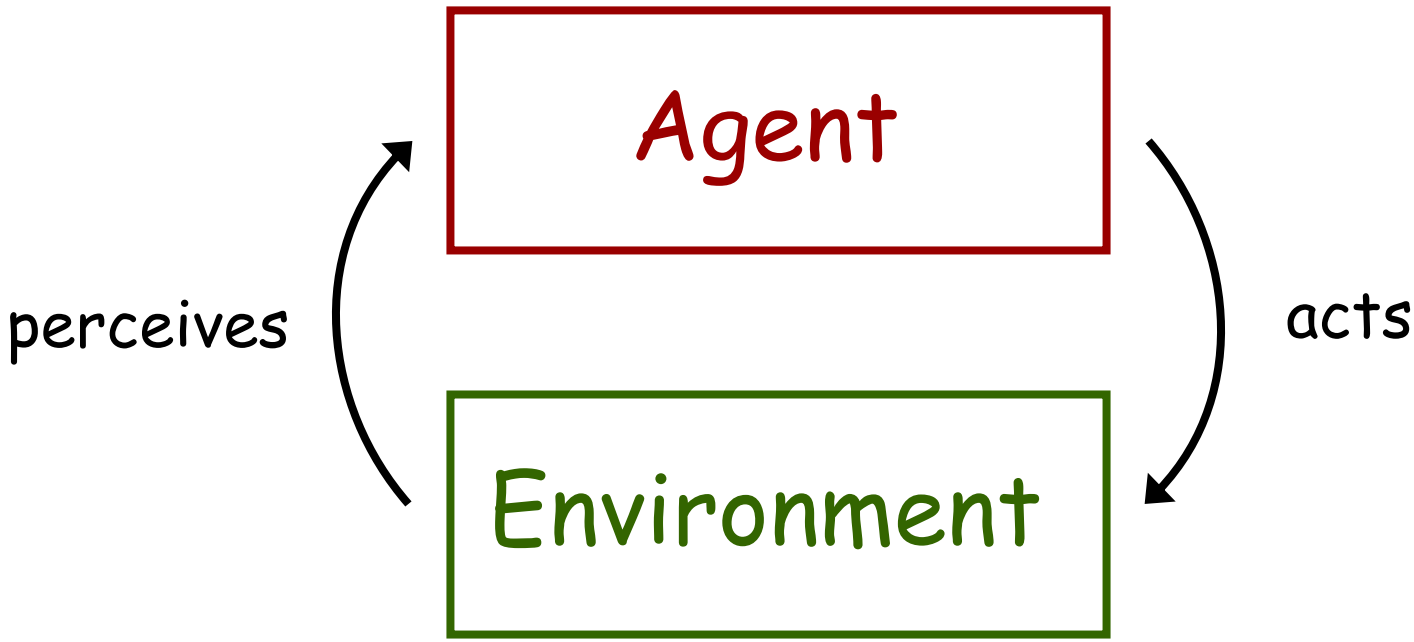
Computational Intelligence

- *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 rationality.
- 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.

Agency

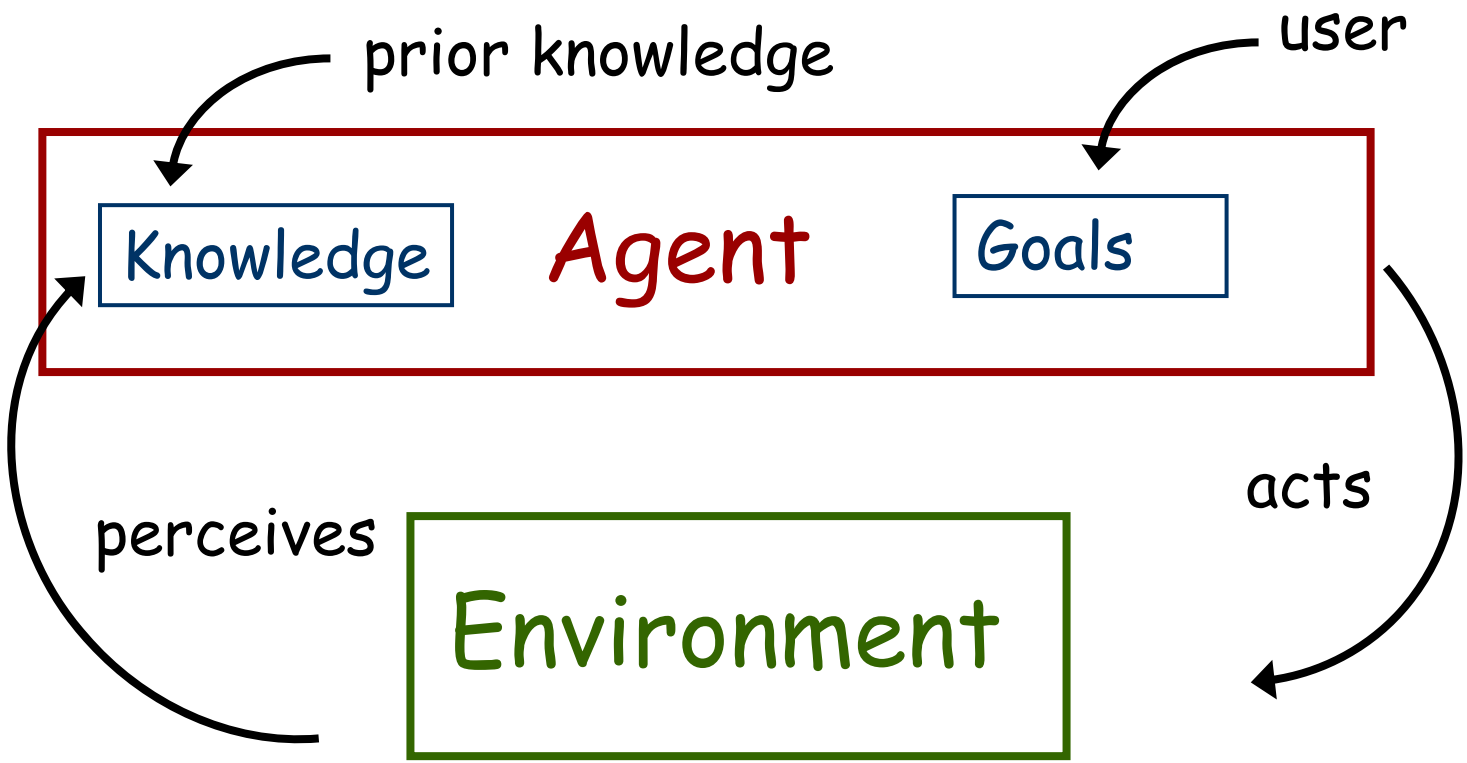
- It is also useful to think of intelligent systems as being **agents**, either:
  - with their own goals
  - or that act on behalf of someone (a "user")
- An *agent* is an entity that exists in an *environment* and that *acts* on that environment based on its *perceptions* of the environment
- An *intelligent agent* acts to further its own interests (or those of a user).

Agent Schematic (I)



- This diagram oversimplifies the internal structure of the agent.

Agent Schematic (II)



- Require more flexible interaction with the environment, the ability to modify one's goals, knowledge that be applied flexibly to different situations.

Degrees of Intelligence

- Building an intelligent system as capable as humans remains an elusive goal.
- However, systems have been built which exhibit various specialized degrees of intelligence.
- Formalisms and algorithmic ideas have been identified as being useful in the construction of these "intelligent" systems.
- Together these formalisms and algorithms form the foundation of our attempt to understand intelligence as a computational process.
- *In this course we will study some of these formalisms and see how they can be used to achieve various degrees of intelligence.*

AI Successes

- In 1997 Deep Blue defeated world chess champion Garry Kasparov in six games.
  - But Deep Blue can still make novice mistakes!
- World champion checkers player Chinook.
- World champion Backgammon player learned how to play.
- In 1999, a NASA AI agent ran a satellite beyond Mars for over a day, without ground control.