Introduction to Artificial Intelligence

Unit # 1

Today's Agenda

- Course Contents
- Grading Policy
- Projects
- Overview of the Main Topics
- Introduction to Artificial Intelligence

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Course Outline

- Overview of Artificial Intelligence
- State Space Representation
- Search Techniques
- Machine Learning/ Data mining
- Propositional and Predicate Logic
- Probabilistic Reasoning
- Evolutionary Algorithms
- Computer Vision
- Robotics

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Useful Information

- Course Website
  http://cse307ai-s2013.wikispaces.com
- **Text Book**
  – Tim Jones, *Artificial Intelligence: A Systems Approach*, 2007.

- **Reference Books**
  – S. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach*, 2009.
  – Ben Coppin, *Artificial Intelligence Illuminated*, 2004.
  – Steven Rabin, *AI Game Programming Wisdom 3*, 2005.
  – Steve Rabin, *AI Game Programming Wisdom 4*, 2008

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Software Tools

- SWI-Prolog   (http://www.swi-prolog.org/)
- GeNIe   (http://genie.sis.pitt.edu/)
- Weka   (http://www.cs.waikato.ac.nz/ml/weka/)
- KNIME   (http://www.knime.org/)

- For programming assignments, you can use any standard programming language (e.g. Java, C#, C++, etc.).

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Acknowledgement

- Lecture slides of CS307 – "Introduction to Artificial Intelligence" by Dr. Sajjad Haider, IBA.
- Lecture slides of CS221 - "Artificial Intelligence: Principles and Techniques " (Autumn 2012), by PercyLiang, Stanford

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Marks Distribution
(Tentative)

- Term Exam – 30 % (15 + 15)
- Final – 40 %
- Assignment - 7.5 %
- Quiz - 7.5 %
- Project – 15%

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Basic Questions
(Taken from http://www-formal.stanford.edu)

- What is artificial intelligence?
- **It is the science and engineering of making intelligent machines**, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence.
- Yes, but what is intelligence?
- Intelligence is the computational part of **the ability to achieve goals** in the world OR "**Ability to make the right decisions** given set of inputs and a variety of possible actions."
  Varying kinds and degrees of intelligence occur in people, many animals and some machines.
- Isn't there a solid definition of intelligence that doesn't depend on relating it to human intelligence?
- Not yet. The problem is that we cannot yet characterize in general what kinds of computational procedures we want to call intelligent. We understand some of the mechanisms of intelligence and not others.

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Basic Questions (Cont'd)

- Isn't AI about simulating human intelligence?
- Sometimes but not always or even usually. On the one hand, we can learn something about how to make machines solve problems by observing other people or just by observing our own methods. On the other hand, most work in AI involves studying the problems the world presents to intelligence rather than studying people or animals. AI researchers are free to use methods that are not observed in people or that involve much more computing than people can do.

- Does AI aim at human-level intelligence?
- Yes. The ultimate effort is to make computer programs that can solve problems and achieve goals in the world as well as humans. However, many people involved in particular research areas are much less ambitious.

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Intelligence in machines vs humans

What has happened over the last 40-50 years - to the disappointment of all those who made breathless predictions about where AI would go - is that things such as playing chess have turned out to be incredibly easy for computers, whereas learning to walk and learning to get around in the world without falling over has proved to be unbelievably difficult.

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History of AI

- **1950s – The Birth of AI**
  - 1950: Alan Turing publishes "Computing Machinery and Intelligence."
  - 1956: John McCarthy coins the term, "Artificial Intelligence" at a Dartmouth computer conference.
  - 1958: John McCarthy invents the Lisp language, an AI programming language, at Massachusetts Institute of Technology (MIT).
- **1960s – The Rise of AI**
  - 1965: Joseph Weizenbaum builds ELIZA, an interactive program that carries on a dialogue in English on any topic (MIT).
  - Arthur's Clark book titled "2001: A Space Odyssey" – HAL, an intelligent computer onboard a Jupiter-bound spacecraft, murdered most of the crew out of paranoia over its own survival.
  - Knowledge representation was a strong theme during the 1960s, as strong AI continued to be a primary theme in AI research.

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History of AI

- Overwhelming Optimism
  - I believe that in about fifty years' time it will be possible to programme computers…to make them play the imitation game so well that an average interrogator will not have more than 70 percent chance of making the right identification after five minutes of questioning.

  - *— Alan Turing, Computing machinery and intelligence, 1950.*

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History of AI

- Overwhelming Optimism(Cont'd)
  - *Machines will be capable, within twenty years, of doing any work a man can do*
    - Herbert Simon, 1956

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History of AI

- Overwhelming Optimism(Cont'd)
  - In from three to eight years, we'll have a machine with the general intelligence of an average human being.

  - — *Marvin Minsky to Life magazine, 1970*

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History of AI

- Overwhelming Optimism
  - We can expect computers to pass the Turing test, indicating intelligence indistinguishable from biological humans, by the end of the 2020s.

  - — *Ray Kurzweil, The Singularity is Near, 2005*

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History of AI

- 1970s – The Fall of AI
  - The 1970s represented the fall of AI after an inability to meet irrational expectations.

- 1990s to Today – AI Rises Again
  - Advancement in probabilistic reasoning, machine learning, intelligence agents, and computational intelligence systems.
  - 1997: IBM computer Deep Blue beats world champion Garry Kasparov in chess match.

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Turing Test

- One or more human judges interview computers and human foils using terminals (so that the judges won't be prejudiced against the computers for lacking a human appearance).
- The nature of the dialog between the human judges and the candidates (i.e., the computers and the human foils) is similar to an online chat using instant messaging.
- The computers as well as the human foils try to convince the human judges of their humanness. If the human judges are unable to reliably unmask the computers (as imposter humans) then the computer is considered to have demonstrated human-level intelligence

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Loebner Prize
http://en.wikipedia.org/wiki/Loebner_Prize

Home Page of The Loebner Prize in Artificial Intelligence

"The First Turing Test"

Loebner Prize Gold Medal
(Solid 18 carat, not *gold-plated* like the Olympic "Gold" medals)

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Critiques on Turing test

- It is widely believed today that even if a computer could pass the Turing test, it would still not truly be conscious or intelligent in the way that humans are.
- It is more important to study the underlying principle of intelligence than to duplicate an exemplar.
- Aeronautical engineering tests do not define the goal of their field as making "machines that fly so exactly like pigeons that they can fool even other pigeons".
- The quest for 'artificial flight' succeeded when the Wright brothers and others stopped imitating birds and started using wind tunnels and learning about aerodynamics.

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Big Milestones

- On May 11, 1997, an IBM computer called IBM ® Deep Blue ® beat the world chess champion after a six-game match: two wins for IBM, one for the champion and three draws. The match lasted several days and received massive media coverage around the world. It was the classic plot line of man vs. machine.

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Big Milestones

- **DARPA Urban Challenge**
- The DARPA Grand Challenge is a prize competition for driverless cars.
- The 2007 Challenge was held in California.
  - 96 KM course
  - 6 hours time duration
  - Rules included obeying all traffic regulations while negotiating with other traffic and obstacles and merging into traffic.
  - The $2 million winner was Tartan Racing, a collaborative effort by CMU and GM.

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Big Milestones

14 February 2011 Last updated at 09:31 GMT

IBM supercomputer challenges humans on TV quiz

By Maggie Shiels
Technology reporter, BBC News, Silicon Valley

A supercomputer, designed by IBM, is to face two human contestants on the US quiz show Jeopardy.

IBM machines have previously taken on chess players

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The Dream
We proposed that the ultimate goal of the RoboCup Initiative to be stated as follows:
"By mid-21st century, a team of fully autonomous humanoid robot soccer players shall win the soccer game, comply with the official rule of the FIFA, against the winner of the most recent World Cup."

Few research areas are:
- Agent architecture in general
-- Computer Vision
– Combining reactive approaches and modeling/planning approaches
– Real-time recognition, planning, and reasoning
– Reasoning and action in a dynamic environment
– Sensor fusion
– Multi-agent systems in general
– Behavior learning for complex tasks
– Strategy acquisition
– Cognitive modeling in general

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Ms Pac-Man Competition

- The aim of this competition is to provide the best software controller for the game of Ms Pac-Man. This is a great challenge for computational intelligence, machine learning, and AI in general.
- The mode of interaction is as follows: about 15 times per second your program will be sent a pixel map of the Ms. Pac-Man window, and it then responds with an integer indicating the direction of the joystick.
- http://www.grappa.univ-lille3.fr/~loth/pacman.mpeg

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Strong vs. Weak AI

- Strong AI refers to the field of research that is interested in making computers think at a level equal to humans

- Weak AI represents the wider domain of AI technologies. Weak AI features can be added to systems to give them intelligent qualities.

- The course focuses on weak AI.

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Strong vs. Weak AI

- The followers of **strong AI** believe that by giving a computer program sufficient processing power, and by providing it with enough intelligence, one can create a computer that can literally think and is conscious in the same way that a human is conscious.
- Many philosophers and Artificial Intelligence researchers consider this view to be false, and even ludicrous.
- **Weak AI**, in contrast, is simply the view that intelligent behavior can be modeled and used by computers to solve complex problems.

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Philosophical vs. Practical AI

- Philosophical:
  - Can machines think, in principle?
  - Will machine thought be different from human thought?

- Practical
  - Collection of techniques to automatically solve particular problems that require "intelligence" (whatever that is)

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Philosophical vs. Practical AI

- Philosophical AI Questions
  - Can we make something that is as intelligent as a human?
  - Can we make something that is as intelligent as a bee?
  - Can we get something that is really evolutionary and self-improving and autonomous and flexible….?

- Practical AI Questions
  - Can we save this plant $20 million a year by improved pattern recognition?
  - Can we save this bank $50 million a year by auto fraud detection?
  - Can we start a new industry of handwriting recognition / automated negotiation / helpdesks/ …..?

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What is Intelligence ?
(http://en.wikipedia.org/wiki/Intelligence)

- How to define intelligence is controversial.
- As stated by "Mainstream Science on Intelligence" (1994), an editorial statement by fifty-two researchers:

  *"A very general mental capability that, among other things, involves the ability to **reason**, **plan**, **solve problems**, **think abstractly**, **comprehend complex ideas**, **learn** quickly and learn from experience. It is not merely book learning, a narrow academic skill, or test-taking smarts. Rather, it reflects a broader and deeper capability for comprehending our surroundings— **"catching on," "making sense" of things, or "figuring out" what to do.**"*

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Intelligence

- Intelligent behavior exhibit some or all of the following characteristics:
  – Problem Solving
  – Reasoning
  – Planning
  – Decision making
  – Inference
  – Learning

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Focused Areas

- Search Techniques
- Machine Learning/ Data mining
- Propositional and Predicate Logic
- Probabilistic Reasoning
- Evolutionary Algorithms
- Computer Vision
- Robotics

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Applications – Search/Planning

Route planning: (e.g., Google maps); search + heuristics

Logistics planning: hospitals organize bed schedules, staff rotations

Fleet Management

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Applications - Prediction

- Medical Diagnosis
- Fraud Detection
- Recommendation Systems
- Loan Defaulter
- Intrusion Detection
- Stock Prediction

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Applications – Computer Vision

- Check reading: automatic tellers widespread
- Face detection/recognition: widespread on digital cameras
- Object recognition: 10 million labeled images, 100,000 object categories
- Scene understanding: partition image and label regions with building, sky, road, etc.
- Activity recognition: infer high level concept from low level data (UIUC)
- Kinect based applications

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Robotics

- Disaster areas: after earthquakes, surveillance robots check for survivors and structural integrity
- Household chores
- Robotic surgery: less invasive, can perform some actions better than humans
- Autonomous vehicles(e.g., Google Car)

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Applications - Natural language processing

- Spam filtering
- Information retrieval: rank web pages based on relevance to query
- Machine translation: Google Translate handles 64 languages
- Speech recognition: personal assistants (Siri, Google Now)

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AI is everywhere

- Fuel injection systems in our cars use learning algorithms. Jet turbines are designed using genetic algorithms, which are both examples of AI, says Dr Rodney Brooks, the director of MIT's artificial intelligence laboratory.

- Every cell phone call and e-mail is routed using artificial intelligence, says Ray Kurzweil, an AI entrepreneur and the author of two books on the subject, The Age of Intelligent Machines and The Age of Spiritual Machines.

- Idea of ubiquitous computing is getting popular. More formally Ubiquitous computing is defined as "machines that fit the human environment instead of forcing humans to enter theirs."

- There are already autonomous lawnmowers that will wander around gardens all afternoon. The next step might be autonomous vacuum cleaners inside the house (though clutter and stairs present immediate problems for wheeled robots).

- These are all sorts of other uses for artificial animals in areas where people find jobs dangerous or tedious - land-mine clearance, toxic waste clearance, farming, mining, demolition, finding objects and robotic exploration, for example. Any jobs done currently or traditionally by animals would be a focus. We are familiar already from the Mars Pathfinder and other examples that we can send autonomous robots not only to inhospitable places, but also send them there on cheap one-way `suicide' missions. (Of course, no machine ever `dies', since we can restore its mind in a new body on earth after the mission.)

- In the future, drunks will be able to use cars, which will take them home like loyal horses. And not just drunks, but children, the old and infirm, the blind, all will be empowered.

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Summary

- Intelligence is difficult to define, and as a result Artificial Intelligence is also hard to define.
- One definition of Artificial Intelligence is:
  - *Artificial intelligence is the study of systems that act in a way that to any observer would appear to be intelligent.*
- We are looking into the practical aspects of AI that focuses on getting inspirations from natural processes to solve real-life complex problems.

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