EC-350 AI and Decision Support Systems

Week 1
Introduction

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NUST

Acknowledgement: Lecture slides material from Stuart Russell

Faculty Introduction

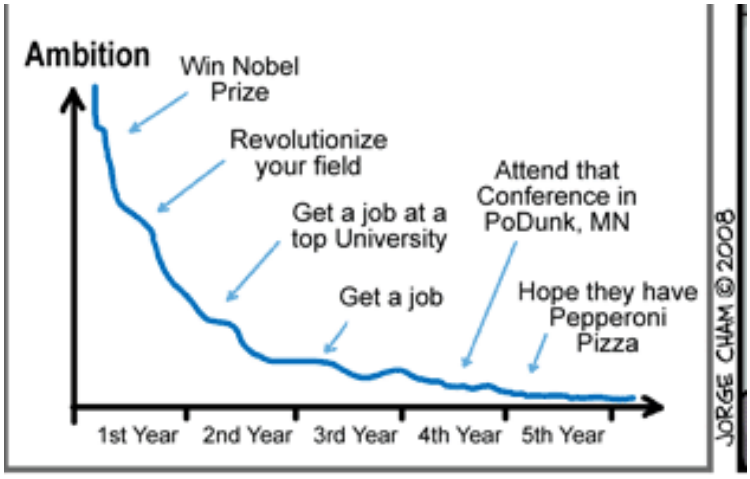
- Education
  - *BE and MS Computer System Engineering*
    - College of EME, NUST
  - *PhD Computer Science (Machine Learning)*
    - The University of Manchester, U. K.
- Experience
  - *More than 7 years*

Areas of Interest

- Machine Learning & Pattern Recognition
- Digital Image & Speech Processing
- Facial and Speech Emotion Recognition

Introduction – (Yours)

– *Aims and goals for life?*



Introduction – (Yours)

- Name
- Previous institution/City
- Area/Subject of interest
- Where you see yourself in future

Course Information

- Course Title: AI and Decision Support Systems
- Course Code: EC-350
- Credit Hours: 3-1
- Semester: Fall 2017
- Email: arslan.shaukat@ce.ceme.edu.pk
- Class: Tue & Wed

Books

- Textbook:
  - *S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 3rd Edition 2010*
- Reference:
  - *Artificial Intelligence: Structures and Strategies for Complex Problem Solving, 6th ed. G. Luger, Addison Wesley, 2009*
  - *Artificial Intelligence: A Systems Approach. M. Tim Jones, Infinity Science Press, 2008*
  - *Pattern Classification (2nd edition 2006), by Richard O. Duda, Peter E. Hart and David G. Stork, Wiley Inter-science.*
  - *Pattern Recognition and Machine Learning by Christopher Bishop, Springer 2006.*

Course Contents

- Introduction to Artificial Intelligence
- Agents, PEAS model, Rationality, Nature & properties of environment
- Structures of agents
- Problem solving by searching, Uninformed search strategies, Breadth first search (BFS)
- Depth first search (DFS) , Depth limited search, Iterative deepening DFS
- Informed search strategies, Greedy best first search, A* search
- Genetic algorithms
- Games, Minimax algorithm, Alpha beta pruning

Course Contents

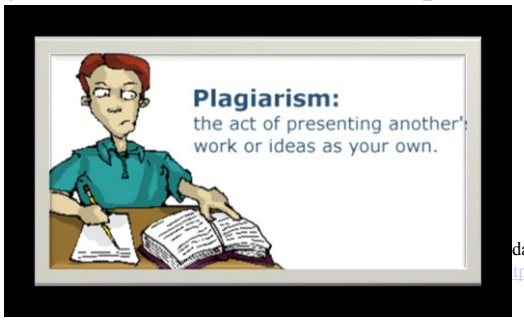
- Introduction to Machine Learning and basic types of classifiers, Performance parameters for evaluation
- K-Nearest Neighbor (KNN), ROC Analysis
- Bayesian Decision Theory
- Naïve Bayes Classifier
- Neural networks and single layer Perceptron
- Introduction to decision trees

Marks Distribution

- Written Exams
  - *2 Sessional Exams* *25%*
  - *Final Exam* *35-40%*
- Quizzes 10%
- Assignments 5%
- Lab 15%
- Lab project 5-10%

Policies

- No extensions in assignment deadlines.
- Quizzes will be unannounced.
- Never cheat.
  - *"Better fail NOW or else will fail somewhere LATER in life"*
- Plagiarism will also have strict penalties.



dapted from *What is Plagiarism* PowerPoint
tp://mciu.org/~spjvweb/plagiarism.ppt

Course Learning Outcomes

Course Learning Outcomes (CLOs)	Level of Learning	PLO
1. Solving problems using various uninformed and informed search strategies.	C3	2
2. Apply local search algorithms like Genetic Algorithm (GA) on optimization problems and perform Minimax search on games such as tic-tac-toe.	C3	2
3. Design machine learning systems, demonstrating understanding of machine learning concepts including feature extraction and classification.	C6	3
4. Implement projects in the lab work that use Python and MATLAB for execution of the theoretical knowledge gained during class lectures, requiring some independent reading, programming and simulations.	P2	3

Artificial Intelligence (AI)

What is Intelligence?

- A machine is intelligent if it has:
  - *Ability to learn and adapt from environment*
  - *Ability to acquire knowledge*
  - *Ability to memorize and proceed*
  - *Ability to plan and schedule*
  - *Ability to recognize voice, patterns, faces*
  - *Ability to understand and perceive*
  - *Ability to solve complex problems*

What is Artificial Intelligence

- If a machine could do all or most of the previously mentioned tasks, we can call that machine an intelligent machine
- The 'intelligence' in the machine is NOT natural but artificial

What is Artificial Intelligence

- Concerned with *building* intelligence in artificial – man made devices
- Making machines to behave like humans – if we consider humans to be intelligent
- Making machines to behave in most rational manner
  - *Thinking/reasoning intelligently*
  - *Acting/behaving intelligently*

Main Branches of AI

- Strong AI
  - *Systems that "think" like humans*
  - *Systems that "think" rationally*
- Weak AI
  - *Systems that "act" like humans*
  - *Systems that "act" rationally*

Strong AI

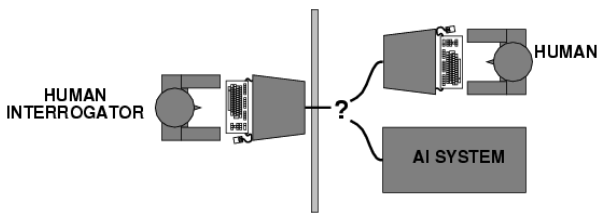
- Make machines to think intelligently [like human beings] as if they have real conscious minds
- Deals with "How brain works"
- Actually tries to recreate the functions of the inside of the brain
- Advocates Machine can replace a human being
- Many researchers believe it is NOT possible to attain

Weak AI

- Machines can be made to act as if they are intelligent
- Treats brain as a black box which creates output after it receives input
- Is NOT concerned with inner functionality of brain
- Most of the research in done in this field

Acting Humanly – Turing Test

- Alan Turing (1950) "Computing Machinery and intelligence"
- Can Machine behave intelligently?
- Operational test for intelligent behavior



Turing Test

- Suggested major components of AI
  - *natural language processing*
    - to enable it to communicate successfully in English
  - *knowledge representation*
    - to store what it knows or hears
  - *automated reasoning*
    - to use the stored information to answer questions and to draw new conclusions
  - *machine learning*
    - to adapt to new circumstances and to detect and extrapolate patterns.
  - *computer vision*
    - to perceive objects
  - *robotics*
    - to manipulate objects and move about.

Thinking Humanly – Cognitive Science

- A system is intelligent if it *thinks* like a human.
- If a system uses the same reasoning processes as a human, then it is intelligent
- Requires scientific theories of internal working of brain
- Two ways:
  - *Try to catch our own thoughts as they go by*
  - *Through psychological experiments*
- Cognitive Science brings together computer models from AI and experimental techniques from psychology
- To construct theories of the workings of human mind

Thinking Rationally – Laws of Thought

- A system is intelligent if it thinks *rationally.*
- An intelligent system is one that follows sound reasoning processes that always lead to correct outcomes.
- Logicians in the 19th century developed a precise notation for statements about all kinds of objects in the world and the relations among them.
- This leads to the study of logic and formal reasoning
- However, logic has its problems.
  - *Formalizing common-sense knowledge*
  - *Computational issues*

Acting Rationally

- A system is intelligent if it *acts rationally.*
- A *rational agent* is one that acts so as to achieve the best possible (expected) outcome, given its knowledge and ability.
- We can build agents that do certain tasks intelligently without having human-level intelligence.
- All the skills needed for Turing Test also allow an agent to act rationally.

Foundation of AI

- Many disciplines provided the foundation for Artificial Intelligence. Few to mention are as follows:

- Philosophy (428 BC – Present)
- Mathematics (800 – Present)
- Economics (1776 – Present)
- Neuroscience (1861 – Present)
- Psychology (1879 – Present)
- Computer Engineering (1940 – Present)
- Control theory & Cybernetics (1948 – Present)
- Linguistics (1957 – Present)

Few applications using AI

- Games
- Robotics
- Tutoring systems
- Medicine
- Biometrics
- Natural Language Processing
- etc…

Few applications using AI

- Deep Blue
  - http://www-03.ibm.com/ibm/history/ibm100/us/en/icons/deepblue/
- Mars pathfinder
  - http://www.nasa.gov/mission_pages/mars-pathfinder/
- Aaron the Robot as an Artist
  - http://www.scinetphotos.com/aaron.html
- Speech recognition
  - http://www.nuance.com/

Few applications using AI

- Honda Humanoid Robot
  - http://world.honda.com/ASIMO/
- Mars rover curiosity
  - http://mars.jpl.nasa.gov/msl/mission/overview/
- Association for the Advancement of AI
  - http://www.aaai.org
- AI Book
  - http://aima.cs.berkeley.edu/

Intelligent Agents

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Intelligent Agent

- An *agent* is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators.
- Agent Examples
  - *A human agent has eyes, ears, and other organs for sensors and hands, legs, mouth and other body parts for actuators*
  - *A robotic agent substitutes cameras and infrared range finders for the sensors and various motors for the actuators.*
  - *A software agent receives keystrokes, network packets, file contents as sensory input and acts upon the environment by displaying on screen, sending network packets and writing files.*

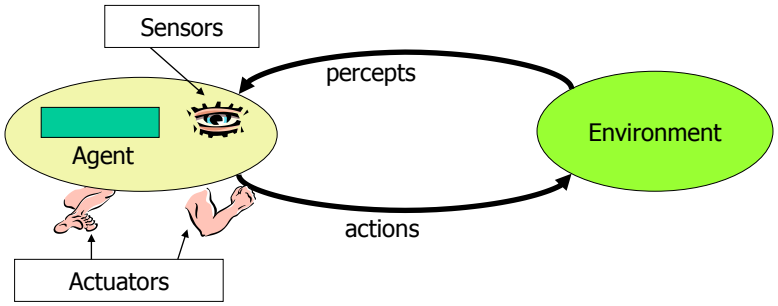
Percept & Percept Sequence

- Percept refers to agent's perceptual input at any given instance
- Percept sequence is the complete history of everything agent has ever perceived
  - *An agent's choice of action at any given instance can depend on the entire percept sequence observed to-date*

Agent Function

- Mathematically, an agent's behavior is described by the agent function that maps any given percept sequence to an action
  - *For most agent this would become a very large table. May be of infinite size*
  - *Have to put a bound on the length of the percept sequence we want to consider*
  - *This table is an external characterization of an agent*
  - *Internally, agent function for an artificial agent shall be an agent program*
  - *Agent Function is a mathematical description*
  - *Agent Program is a concrete implementation*

An Intelligent Agent



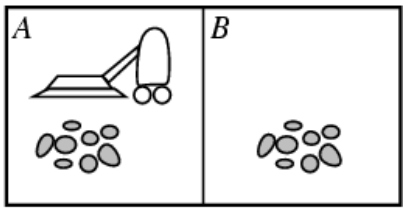
The agent function maps from percept histories to actions:

$$f : P^* \rightarrow A$$

P* = Percept History
A = Actions

The agent program runs on the physical architecture to produce *f*

Vacuum-Cleaner Agent



- Locations: square A, square B
- Percepts: location and contents, e.g., [A, Dirty]
- Actions: Left, Right, Suck, NoOp

Vacuum-Cleaner Agent

Percept Sequence	Action
[A, Clean]	Right
[A, Dirty]	Suck
[B, Clean]	Left
[B, Dirty]	Suck

Good Behavior - Rationality

- *Rational Agent* is the one which does the "right thing" based on what it perceives and the actions it performs.
- Every entry in the table for the agent function is filled out correctly
- The right action is the one that will cause the agent to be most successful
- How can we say an agent is successful?
- We need some criterion to measure its success

Performance Measure

- An objective criterion for success of an agent's behavior
- e.g., performance measure of a vacuum-cleaner agent could be amount of dirt cleaned up, amount of time taken, amount of electricity consumed, amount of noise generated, etc
- No single universal criterion for every agent
- As a general rule, it is better to design a performance measure according to what one actually wants in the environment rather than according to how one thinks the agent should behave
- The selection of performance measure is not always easy

Rationality

- What is rational at given time depends upon four things
  - *The performance measure that defines criterion for success*
  - *The agent's prior knowledge of the environment*
  - *The actions that agent can perform*
  - *The agent's percept sequence to-date*

Rational Agent

- For each possible *percept sequence*, a rational agent should select an *action* that is expected to maximize its *performance measure*, given the evidence provided by the percept sequence and whatever *built-in knowledge* the agent has.
- Vacuum-cleaner agent?

Vacuum-Cleaner Agent

- The performance measure awards one point for each clean square at each time step, over a "lifetime" of 1000 time steps.
- The "geography" of the environment is known a priori but the dirt distribution and the initial location of the agent are not.
- The only available actions are Left, Right, and Suck.
- The agent correctly perceives its location and whether that location contains dirt.