Artificial Intelligence

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Learning Outputs of Lecture 01

- **Artificial Intelligence**
  - Is concerned with the design of intelligence in an artificial device

- **Acting humanly**
  - Can machines behave intelligently as the human
  - The Turing test

- **Thinking humanly**
  - Scientific theories of internal activities of the brain
  - Cognitive science and Neuroscience

- **Thinking rationally**
  - Correct argument/thought processes
  - Little widely accepted conclusion has been made

- **Acting rationally**
  - Doing the right thing
  - Which is expected to maximize goal achievement, given the available information
The History of Artificial Intelligence

- Artificial Intelligence
  - Term coined by McCarthy in 1956
- 1956 – 1974
  - Search technology
  - Natural language processing
  - Computer vision
- 1980 – 1987
  - Artificial neural networks
  - Expert systems
  - Industry robots
- 1993 – 2003
  - Support vector machine
  - Machine learning
  - Automatic cars
- 2012 –
Feedback of Questionnaire

- Why choose this course?
  - Be interested in this course
  - Useful for further study

- Expectation of this course
  - Learn solid theory of artificial intelligence
  - Learn some useful skills of developing intelligent system
  - More chance to discuss and practice

- Please choose the course you have taken
  - Data structure

- Please choose the techniques you want to learned
  - Various requirements

- How many courses do you have this semester
  - 5 – 6
  - I have final year project
  - My final year project is related with artificial intelligence
General Information

- Course web page

- Text book
  - Stuart Russell and Peter Norvig, “Artificial Intelligence A Modern Approach”

- Lecture of our class
  - Tue. 15:30 – 17:20
  - Y410
  - Contact with Fiona csyliu@comp.polyu.edu.hk

- Lab of our class
  - Tue. 17:30 – 18:20
  - QT402
  - Contact with Songtao Wu csstwu@comp.polyu.edu.hk

Sept. 8, 2015

Intelligent Agent
Course Presentation

- Introduction to a movie related with artificial intelligence
  - Group work with 1 – 4 person(s) each group
  - Every group should work on different movies

- 10 minutes presentation
  - No requirement of report

- Send email to TA including the following information
  - Group member name and student ID
  - Movie name
  - Before Oct. 13 2015

- Presentation date
  - Oct. 27 2015 at 15:30
  - The confirmed presentation order is announced on Oct. 20

- 100 points and 10% for the final grading
  - For detail information, check notes of lecture 01
A Room Clean Job

- The human perceives the environment
  - which room, clean or dirty
- Decides what to do
  - move right or left, suck the dust
- And then acts
A Vacuum-Cleaner Agent

- How to perceive the environment
  - which room, clean or dirty
- How to make the decision
  - move right or left, suck the dust
- How to make the action
Agents

- An agent is an entity that perceives and acts
  - Perceiving its environment through sensors
  - Acting upon that environment through actuators

![Diagram of agent with actuators and sensors interacting with environment](image)
Rational Agent

- Rational Agent
  - An agent is an entity that perceives and acts
  - An agent function is to determine actions from percept histories:
    \[ f: \mathcal{P}^* \rightarrow A \]
  - For any given class of environments and tasks, we seek the agent (or class of agents) with the best performance

- Characteristics of rational agent
  - Distinct from omniscience
  - Agents can perform actions in order to modify future percepts so as to obtain useful information
  - An agent is autonomous if its behavior is determined by its own experience
PEAS of Intelligent Agent Design

- Intelligent agent design
  - Under the assumption that there exists rational agent
  - Aim: find a way to implement the rational agent
- PEAS must first specify the setting for intelligent agent design
  - Performance measure
  - Environment
  - Actuators
  - Sensors
- Design an automated taxi driver
  - Performance measure
    - Safe, fast, legal, comfortable trip, maximize profits
  - Environment
    - Roads, other traffic, customers
  - Actuators
    - Steering wheel, accelerator, brake, signal, horn
  - Sensors
    - Cameras, sonar, speedometer, GPS
Intelligent Agent Types

- Simple reflex agents
- Model-based reflex agents
- Goal-based agents
- Utility-based agents

![Diagram showing actuators, sensors, and environment]
Simple Reflex Agents

- Select actions only based on current perception
  - Infinite loops are often unavoidable
Model-based Reflex Agents

- Maintain internal states
  - A model of the world
Goal-based Agents

- Future is taken into account
  - The agent can choose one from among multiple possible solutions
Utility-based Agents

- Cost will be considered to achieve the goal
  - If save the cost is a kind of goal, it can be classified to a kind of goal-based agent
Example of An Intelligent Agent

- Drive from Arad to Bucharest
- Find the best way
Solve the Problem by Search Agent

- Formulate the perception
  - Initial state: In(Arad)
- Formulate goal
  - Be in Bucharest
  - In(Bucharest)
- Formulate the environment
  - States: various cities with known distances
  - Path cost: The sum of the costs of the individual actions along the path
- Formulate the actions
  - Drive between cities
  - Actions: Go(Sibiu), Go(Timisoara), Go(Zerind)
- Find solution
  - Sequence of cities
  - Transition model: RESULT(In(Arad), Go(Sibiu)) = In(Sibiu)
Searching for Solution

- Solution
  - An action sequence
- Search algorithm
  - Considering various possible action sequences
- Search tree
  - Nodes: states in the state space
  - Root: initial state
  - Branches: actions
- Expanding the current state
  - Apply each legal action to the current state, thereby generating a new set of states
  - Add branches from the parent node leading to child nodes
- Essence of search
  - Following up one option now and putting the others aside for later
  - In case the first choice does not lead to a solution
Example of Tree Search
Loopy Path

- Redundant Paths
  - Loopy Path
Search Strategy

Search strategy
- Pick the order of node expansion

Strategies are evaluated along the following dimensions:
- completeness: does it always find a solution if one exists?
- time complexity: number of nodes generated
- space complexity: maximum number of nodes in memory
- optimality: does it always find a least-cost solution?

Time and space complexity are measured in terms of
- $b$: maximum branching factor of the search tree
- $d$: depth of the least-cost solution
- $m$: maximum depth of the state space (may be $\infty$)
Uninformed Search

- Breadth-first search
  - Expand the shallowest unexpanded node
- Depth-first search
  - Expand the deepest unexpanded node
- Uniform-cost search
  - Expand least-cost unexpanded node
- Uninformed search
  - Also called blind search
  - The strategies have no additional information about states beyond that provided in the problem definition

Sept. 8, 2015
Intelligent Agent
Informed Search
Informed Search

- Informed search
  - Also called heuristic search
  - The strategies know whether one non-goal node is “more promising” than another
  - The “desirability” of a node is estimated by an evaluation function $f(n)$

- Greedy best-first search
  - Expands the node that is closest to the goal, which is evaluated by the heuristic function $h(n)$

- A* search
  - Avoid expanding paths that are already expensive
  - Evaluation function: $f(n) = g(n) + h(n)$.
    - $g(n)$: the cost so far to reach the node $n$
    - $h(n)$: the estimated cost to goal from the node $n$
    - $f(n)$: the estimated total cost of path through the node $n$ to goal