Introduction

Unit 1

We Will Know

- What's "intelligence"
- Application of AI
- History of AI
- Components in AI
- The concept of agent
- Three types of designing agents
  - Reflex, goal-based, and utility-based
- Environments of agent

Introduction to AI

- Brief history of AI
- AI domain
  - Rule, knowledge, and expert
  - Solving problems
  - Agents
  - Uncertainty
  - Machine learning
- What is intelligence?
  - What's the difference between you and an animal?
  - What's the difference between you and a robot?

Applications

- Game
  - Deep Blue (in 1997)
  - Koei 三國志
  - Is the game smart or fool?
  - On-line game
- User help system (Microsoft Co.)
  - Knowledge base for troubleshooting
  - Answer wizard: adaptive to individual user

Applications

- Space probe (NASA)
  - Control space-craft and carry out objectives
  - Pilot assistance
  - Automatic planning and execution model
- Automatic control
  - Driving car/air plane
    - "No hand cross American", over 2805 miles, in control for 98%, all different environments
  - Factory
  - Routing in network

Applications

- Natural language processing
  - Control your computer by voice
- Diagnosis assistance
  - X-ray/CT/MRT
  - Anamnesis analysis
- Automatic Control
- Adviser or consultant

What is AI

- The automation of activities that we associate with human-thinking, activities such as decision-making, problem solving, learning, etc. (Bellman, 1978)
- The study of mental faculties through the use of computational models. (Charniak+McDermott, 1985)
- The branch of computer science that is concerned with the automation of intelligent behavior. (Luger+Stubblefield, 1993)

表 1-1 人工智慧和知識工程歷史上的主要事件一覽表

時期	主要事件
人工智慧的誕生 (1943～1956)	McCulloch 和 Pitts，神經活動潛在想法的邏輯運算，1943 Turing，計算機器和智慧，1950 電子數值積分器和計算機計畫(von Neumann) Shannon，西洋棋博弈的電腦程式設計，1950 達特茅斯學院(Dartmouth College)舉行的機器智慧、人工神經網路和自動理論暑期研討會，1956
人工智慧的成長 (1956～20 世紀 60 年代後期)	LISP(McCarthy) 通用問題解算機(GPR)計畫(Newell 和 Simon) Newell 和 Simon，人類問題解決方案，1972 Minsky，知識表達的框架結構，1975
人工智慧的幻想破滅 (20 世紀 60 年代後期～70 年代早期)	Cook，複雜性的理論證明過程，1971 Karp，複合問題的再生性，1972 Lighthill 報告，1971

專家系統的發現 (20 世紀 70 年代早期～80 年代中葉)	DENDRAL(Feigenbaum, Buchanan 和 Lederberg，史丹佛大學) MYCIN(Feigenbaum 和 Shortliffe，史丹佛大學) PROSPECTOR(史丹佛研究院) PROLOG-一種邏輯程式語言(Colmerauer, Roussel 和 Kowalski，法國) EMYCIN(史丹佛大學) Waterman，專家系統指南，1986
人工神經網路的再生 (1965～現在)	Hopfield，神經網路和具有突發整合計算能力的物理系統，1982 Kohonen，拓撲結構的正確特徵圖譜的自組織產生，1982 Rumelhart 和 McClelland，平行分散處理，1986 首屆 IEEE 神經網路國際會議，1987 Haykin，神經網路，1994 神經網路，Matlab 應用工具包(MathWork 公司)
演化計算 (20 世紀 70 年代早期～現在)	Rechenberg，演化策略-基於生物資訊理論的最佳化技術系統，1973 Holland，自然和人工系統的適應性，1975 Koza，遺傳程式設計：透過自然選擇的電腦程式設計，1992 Schwefel，演化和最佳尋找，1995 Fogel，演化計算：面向機器智慧的新哲學，1995

時期	主要事件
用文字計算 (20 世紀 80 年代後期～現在)	Zadeh，模糊集，1965 Zadeh，模糊演算法，1969 Mamdani，使用語言合成法的模糊邏輯在近似論證中的應用，1977 Sugeno，模糊理論，1983 日本的“模糊”消費品(洗碗機、洗衣機、空調、電視機、影印機) 仙台地鐵系統(日立公司，日本)，1986 Negoita，專家系統和模糊系統，1985 首屆 IEEE 模糊系統國際會議，1992 Kosko，神經網路和模糊系統，1992 Kosko，模糊思維，1993 Yager 和 Zadeh，模糊集、神經網路和軟計算，1994 Cox，模糊系統手冊，1994 Kosko，模糊工程，1996 Zadeh，用文字計算一典範轉移，1996 模糊邏輯，Matlab 應用工具包(MathWork 公司)

What's Involved in Intelligence

- Ability to interact with real world
  - image/video/speech
- Knowledge
  - rule and inference
  - expert system
- Reason
  - modeling external world
  - problem solving, decision making
  - uncertainty
- Learning
  - We are continuously learning

Components in AI

- Knowledge representation
  - Intelligent agent
  - Rule and knowledge
  - First-order logic
  - Rule inference
  - Expert system
  - Planning and acting

Components in AI

- √ Problem Solving
  - – Searching
  - – Game playing
- √ Uncertain knowledge and reasoning
  - – Uncertain: probability and fuzzy
  - – Bayesian framework

Components in AI

- Machine Learning
  - √ – Probabilistic model and Bayesian model
  - √ – Neural network
  - – Decision tree
  - – Instance-based learning
  - – Reinforcement learning
  - – Genetic algorithm
  - – SVM: support vector machine
  - – …

Components in AI

- Hybrid application
  - – Intelligent agent
  - – Natural language processing
  - – Robot
  - – Embedded system

Related to Other Courses

- Pattern recognition 圖形辨識
  - – Data classification and recognition
  - – Supervised and unsupervised learning
- Data mining 資料探勘
  - – Data analysis
  - – Associated rule for data mining

Related to Other Courses

- Machine learning 機器學習
  - – Different methods of learning
- Information retrieval 資料查詢
  - – Traditional textual data
  - – Web search
  - – Image
  - – Audio
  - – Video
  - – Multimedia

What is intelligence?

- How do you design a machine to be intelligent?
- How do you be an intelligent human?
- What's your procedure of thinking and making decision

What is intelligence?

- How do you learn something?
  - What day is your birthday?
    - Memory
  - 13+8=?
    - Memory and inference
  - How do you go to Taipei Main Station?
    - Vehicle: by bus? by motorbike? by car?
    - Time: rush or non-rush hour
    - Making different decisions with different cases

What is intelligence?

- Intelligence is the ability of:
  - understanding
  - learning
  - solving problems
  - making decisions

To be or not to be
that is the question

You and Animal

- What's the difference between you and an animal?
  - Eating
  - Sleeping
  - Attack and Defense
  - You can choose a better case in decision
    - Animal can do too

You and Computer

- Who is more intelligent? You or computer?
  - How can we say who is more intelligent?
  - You can think anything
    - You win
  - Computer can find a solution very fast
    - you lose
  - Then, who is more intelligent?

How to Build Intelligence

- How to build a good *FLYING* machine?
  - ~~X~~ Synthesis birds?
  - √ Understand aerodynamic principle
- How to build a good *THINKING* machine?
  - ~~X~~ Synthesis human brains?
  - √ Understand reasoning principle

How to Build Intelligence

- Best *FLYING* machine
  - Airplane
  - Not improved bird
- Best *THINKING* machine
  - ~~?~~ Not improved human brain
  - e.g. Deep Blue

Illustration

- Deep Blue
  - The first machine to win a chess game against a reigning world champion (Garry Kasparov) under regular time controls.
  - http://en.wikipedia.org/wiki/Deep_Blue_%28chess_computer%29
  - 4-2, Feb. 17, 1996
- ASIMO
  - http://asimo.honda.com/asimotv/
- Bill Gates
  - 家家都有機器人,
  - 撰文／比爾・蓋茲（Bill Gates）
  - http://sa.ylib.com/read/readshow.asp?FDocNo=966&CL=4

Illustration

- 通往專家心智之路
  - 撰文／羅斯（Philip E. Ross）翻譯／黃榮棋
  - http://sa.ylib.com/read/readshow.asp?FDocNo=899&CL=4
- 讓電腦說人話
  - 撰文／阿倫（Andy Aaron）、艾德（Ellen Eide）、比崔利（John F. Pitrelli）
  - 翻譯／鍾樹人
  - http://sa.ylib.com/read/readshow.asp?FDocNo=707&CL=19

Intelligence

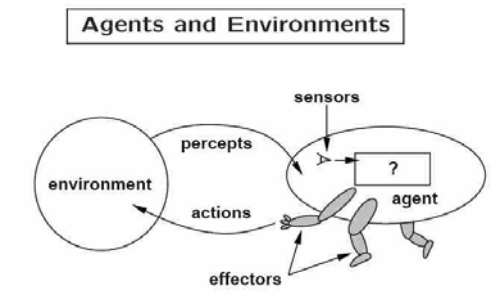
- Human intelligence v.s. machine intelligence
- Goal: machine with rational, not right behavior
  - Right thing
    - Expected to maximize goal achievement, given the available information
    - Not necessary involve thinking
  - Rational thing
    - Inference and reasoning
    - Unit: agent

What is Rational

- What is rational depends on four things
  - Performance measure: defining degree of success
  - Percept sequence: everything that the agent has perceived
  - What the agent knows about the environment
  - The actions that the agent can perform

What's an Agent

- An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through effectors.
- You
  - Environment: wind, stone, light, …
  - Sensor: eyes, ears, skin, other organs
  - Action: hands, legs, other body parts
  - Perception: cold, hot, pain, hungry, …



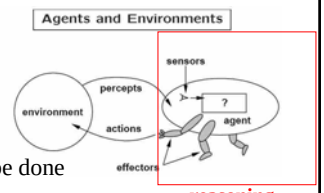
Agent = Architecture + Program

Examples

Properties	Digital camera	Air Condition	Diagnostic Assistance
Environment	lighting	temperature	patient, hospital
Sensor	lens	thermometer	input devices
Action	exposure	on/off	questions, test, treatment
Perception	bright or dark	cold/cool/ warm/hot	symptoms, x-ray/CT/MRT

Common Tasks of Agent

- Given
  - model of world
  - percepts
  - goals
- Determine
  - what actions should be done



reasoning and learning

⇨ **mapping from percepts to actions**

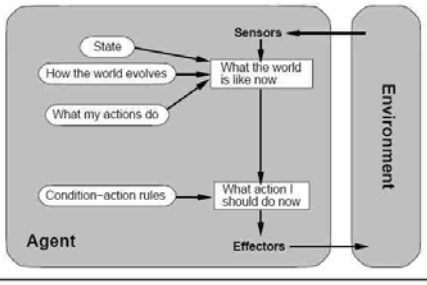
Common Tasks of Agent Examples

- Percept
  - sense (visual, acoustic, ..)
  - communicate
- Action
  - move (arms, legs, chess, …)
  - order
  - explain
- Reasoning
  - answer to query
  - plan
  - deal with trade-off
- Adapting/learning
  - update user model
  - update agent model
  - update world model

Policy

- Policy
  - map from percept sequences to actions
  - Agent programming is to design and implement a good policy
- Types of policies
  - Reflex: response immediately to percepts
  - Goal-based: act to a achieve goal
  - Utility-based: try to maximize “happiness”

Reflex




```
function REFLEX-AGENT-WITH-STATE(percept) returns action
  static: state, a description of the current world state
          rules, a set of condition-action rules
  state ← UPDATE-STATE(state, percept)
  rule ← RULE-MATCH(state, rules)
  action ← RULE-ACTION[rule]
  state ← UPDATE-STATE(state, action)
  return action
```

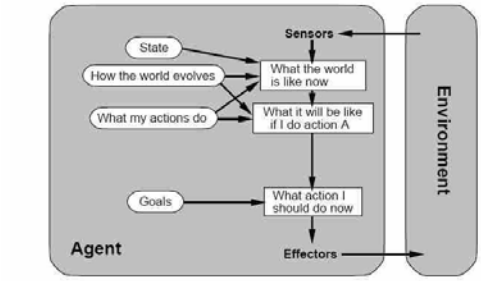

Reflex Agent

- Three types of designing
  - Tables
  - Rules
  - States
- Problems of Reflex
  - Only single reason for each situation, so only for single goal
  - Designer must anticipate all cases of situations

Goal-Based Agent

- Generate possible sequences of actions
- Predict resulting states
- Assess goals in each resulting state
- Choose an action that achieves goal

Goal-Based Agent

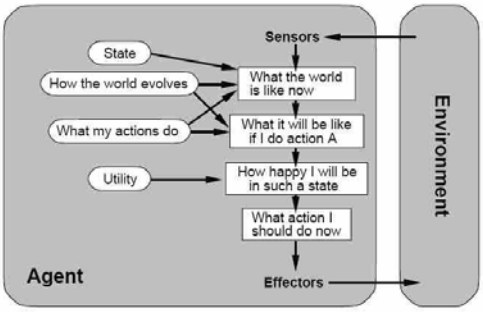


Note: can reprogram agent simply by changing goals!

Utility-Based Agent

- Goals are qualitative
- We want to make quantitative comparisons of actions
- Important for making trade-offs
  - speed v.s. safety
  - likelihood of success v.s. importance of goal

Utility-Based Agent



Environments

- Agent design depends on
  - performance measure (goal, utility, …)
  - complexity of its environment
- Properties of environments
  - Accessible to inaccessible
  - Deterministic to non-deterministic
  - Episodic to non-episodic
  - Static to dynamic
  - Discrete to continuous

Easy to Difficult

Environments

Environment	Accessible	Deterministic	Episodic	Static	Discrete
Chess with a clock	Yes	Yes	No	Semi	Yes
Chess without a clock	Yes	Yes	No	Yes	Yes
Poker	No	No	No	Yes	Yes
Backgammon	Yes	No	No	Yes	Yes
Taxi driving	No	No	No	No	No
Medical diagnosis system	No	No	No	No	No
Image-analysis system	Yes	Yes	Yes	Semi	No
Part-picking robot	No	No	Yes	No	No
Refinery controller	No	No	No	No	No
Interactive English tutor	No	No	No	No	Yes