

# **CS 461**

# **Artificial Intelligence**

Dr. Hashim Yasin

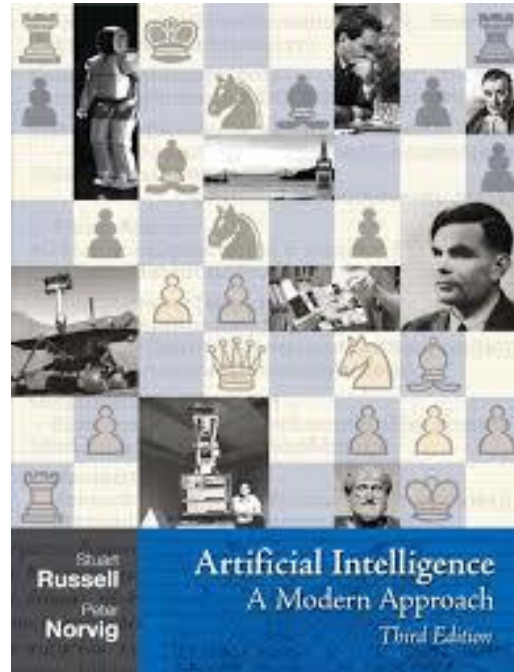
# The Course Details

- ▶ Course # = CS 461
- ▶ Credit Hours: 3+1
- ▶ Focus on **general AI techniques** that have been useful in many applications
- ▶ This course is about designing/implementation of the **rational/intelligent agents**.

# Tentative Marks Distribution

Items	Marks (%)
Quizzes	10-15
Assignments / Project	10-15
Mid Exam I	15
Mid Exam II	15
Final Exam	40-50

## Recommended Books

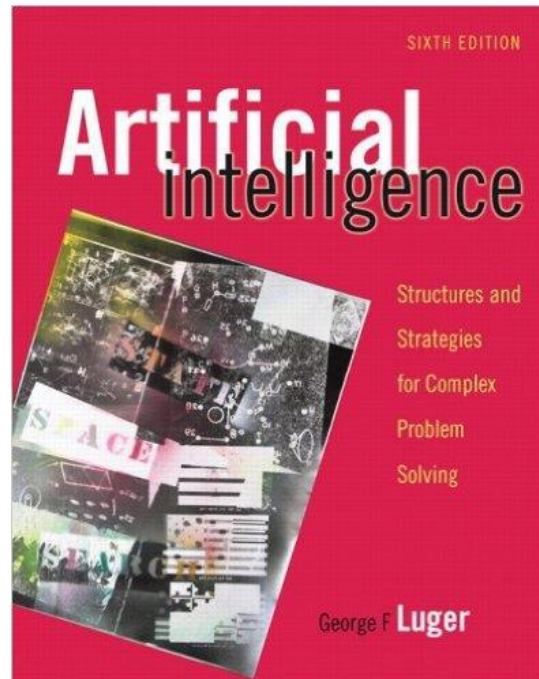


# Artificial Intelligence

## A Modern Approach

# Stuart J. Russell and Peter Norvig

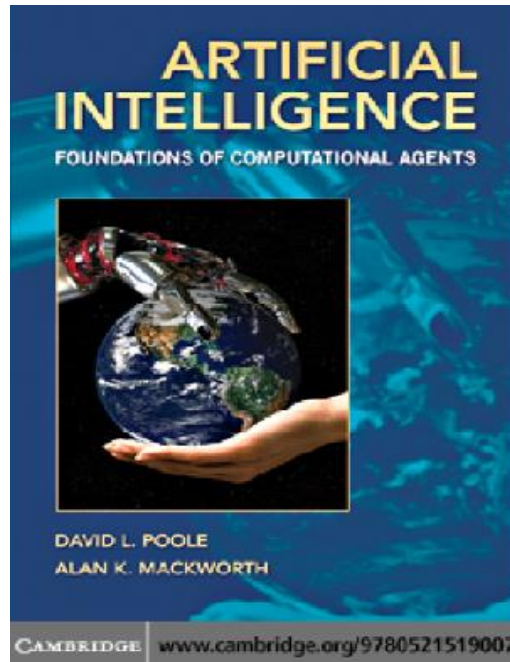
# Recommended Books



## Artificial Intelligence

George F. Luger

# Recommended Books



## Artificial Intelligence

Foundation of Computational Agents

David L. Poole

Alan K. Mackworth

# Contents

- ▶ Agents and its Types
- ▶ Problem Solving using Searching Methodologies
  - Uninformed search
  - Informed search
  - Search with Optimization
  - Adversarial search (Game Theory)
- ▶ Constraint Satisfaction Problems
  - CSP as standard search
- ▶ Constraint Propagation
- ▶ Knowledge Representation

# Contents

- ▶ Reasoning and Logic
  - Propositional Logic
  - First Order Logic
  - Inference in First Order Logic
- ▶ Probability in AI
- ▶ Learning
  - Unsupervised Learning (clustering)
  - Supervised Learning (ANN)
- ▶ Genetic Algorithm
- ▶ Classifiers ...

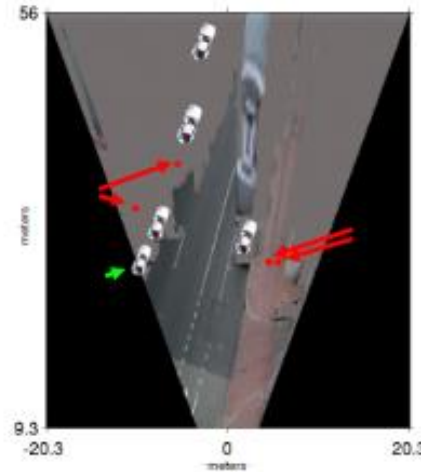
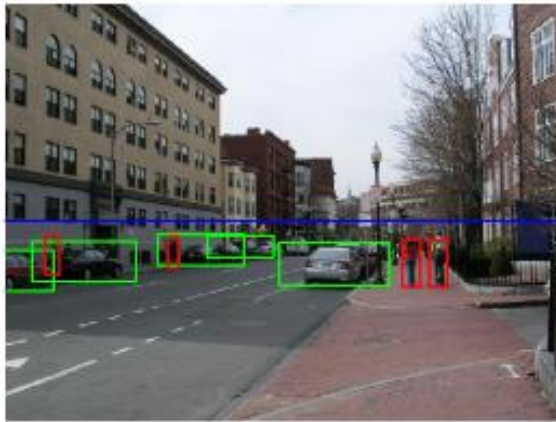


# AI Applications

# AI Applications

## Assisted driving

Pedestrian and car detection



Lane detection



- Collision warning systems with adaptive cruise control,
- Lane departure warning systems
- Rear object detection systems

# AI Applications

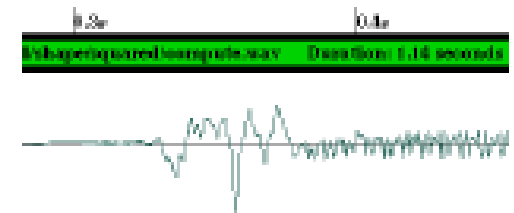
## ▶ Self-drive Cars:

- In 2005, a driverless robotic car named **STANLEY** sped through the rough terrain of the Mojave desert at 22 mph, finishing the 132-mile.
- Google self-driving car project **WAYMO**, stands for a *new way forward in mobility*.



## ▶ Speech recognition:

- A traveler calling United Airlines to book a flight can have the *entire conversation guided by an automated speech recognition and dialog management system*.



Speech Recognition

# AI Applications

## ▶ Autonomous Planning and Scheduling:

- NASA's Remote Agent program became the first on-board autonomous planning program to control the scheduling of operations for a spacecraft.

## ▶ Text Analysis and NLP

- A computer program automatically translates from Arabic to English.
- A program analysis the text and execute the summary of the text.

### Text analysis

Peter H. van Oppen , Chairman of the Board & Chief Executive Officer  
Mr. van Oppen has served as chairman of the board and chief executive officer of ADIC since its acquisition by Interpoint in 1994 and a director of ADIC since 1996. Until its acquisition by Crane Co. in October 1996, Mr. van Oppen served as chairman of the board of directors, president and chief executive officer of Interpoint. Prior to 1985, Mr. van Oppen worked as a consulting manager at Price Waterhouse LLP and at Bain & Company in Boston and London. He has additional experience in medical electronics and venture capital. Mr. van Oppen also serves as a director of Seattle FilmWorks, Inc. and Spacekbs Medical, Inc.. He holds a B.A. from Whitman College and an M.B.A. from Harvard Business School, where he was a Baker Scholar.

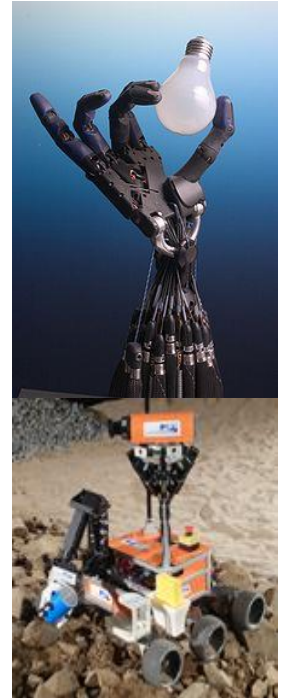
# AI Applications

## ▶ Robotics:

- **PackBot** it is used to handle hazardous materials, clear explosives, and identify the location of snipers.

## ▶ Spam Detection

- Various AI anti-spam techniques
- Each day, learning algorithms classify over a billion messages as spam, saving the recipient from having to waste time deleting
- For many users, could comprise 80% or 90% of all messages, if not classified away by algorithms.





# AI Applications

## ► Computer Vision

### Action Recognition



riding  
sitting  
horse  
grass



riding  
sitting  
horse  
grass



using  
monitor  
keyboard



using  
monitor  
keyboard  
sitting



sitting  
grass  
riding  
bike

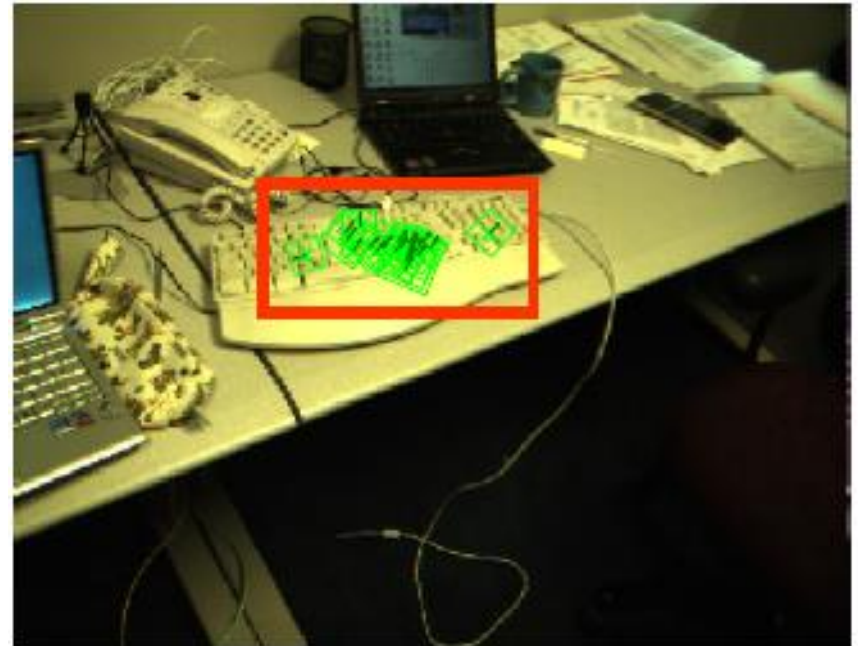
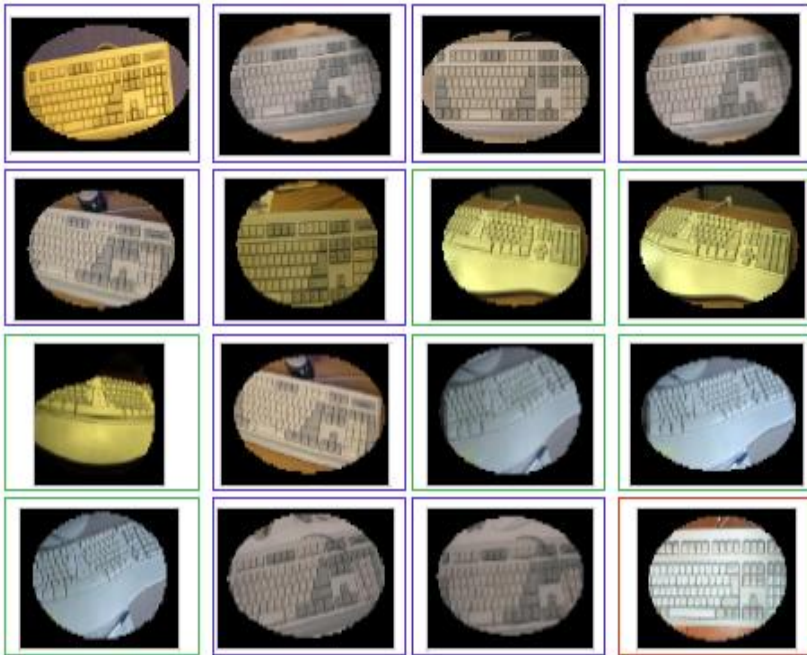


bike  
sitting  
riding  
skyscraper

# AI Applications

## ► Computer Vision

Object detection



# **What is Artificial Intelligence?**





# What is an Intelligence?

“The **ability to learn or understand** things or to deal with new or difficult situations.” **(Merriam Webster)**

“The ability to learn, understand and make **judgments or have opinions** that are based on reason.” **(Cambridge Advance Learner’s Dictionary, 2006)**

“The ability to **acquire and apply knowledge** and skills.” **(Compact Oxford Dictionary, 2006)**

# What is Artificial Intelligence?

- ▶ AI can be defined with four different perspectives
  - Systems that **think like humans**
  - Systems that **act like humans**
  - Systems that **think rationally**
  - Systems that **act rationally**

Think like people



Think rationally



Act like people



Act rationally



# What is Artificial Intelligence?

## Systems that think like humans

"The exciting new effort to make computers think . . .  
**machines with minds**, *in the* full and literal sense."  
(Haugeland, 1985)

## Systems that act like humans

"The art of creating **machines that perform functions that require intelligence** when performed by people"  
(Kurzweil, 1990).

# What is Artificial Intelligence?





## Systems that think rationally

“The **study of the computations** that make it possible to **perceive, reason, and act.**” (Winston, 1992)

## Systems that act rationally

"Computational Intelligence is the study of the **design of intelligent agents.**" (Poole *et al.*, 1998)

# What is Artificial Intelligence?

Think like people			Think rationally
Act like people			Act rationally

- ▶ These definitions --- **two main dimensions**
  - *thought processes and reasoning,*
  - *behaviour.*

# Act Humanly: Turing Test

"Can machines think?"

"Can machines behave intelligently?"

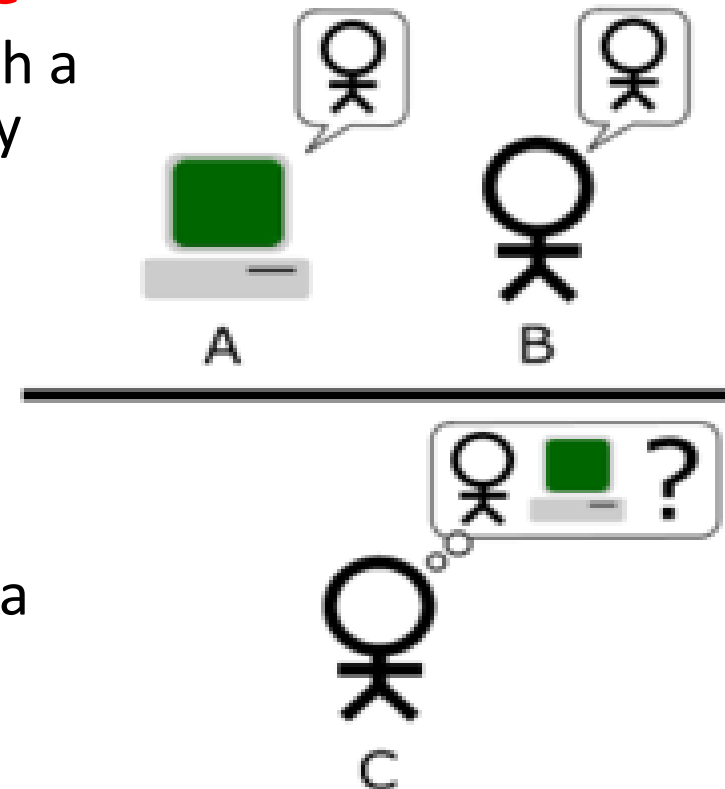
## Turing Test (1950)

- ▶ proposed by **Alan Turing**
- ▶ An attempt to provide a satisfactory **operational test for intelligent behavior**

# Act Humanly: Turing Test

## ► Turing Test --- An Imitation Game

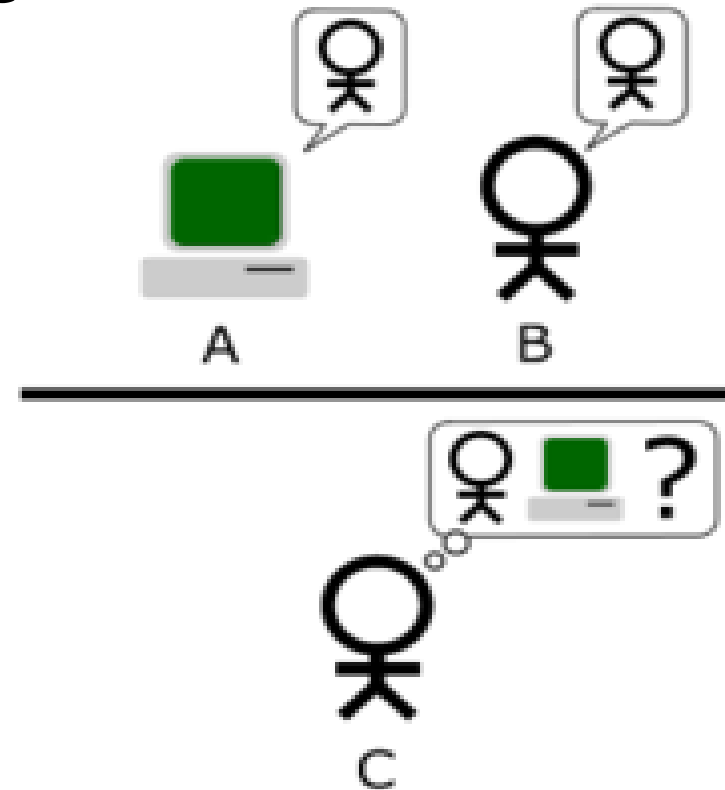
- A (Human) judge communicates with a human and a machine over text-only channel,
- Both human and machine try to act like a human,
- Judge tries to tell which is which.
- Predicted that by 2000, a machine might have a 30% chance of fooling a lay person for 5 minutes.



# Act Humanly: Turing Test

## ► Turing Test --- An Imitation Game

- Natural Language Processing
  - To recognize language
- Knowledge representation
  - To store knowledge
- Automated reasoning
  - To give answer

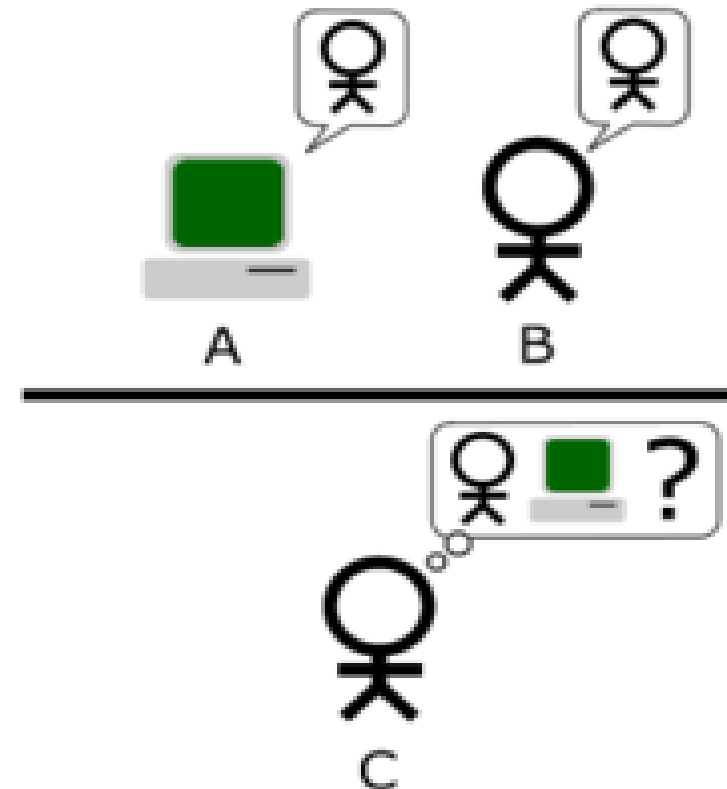




# Act Humanly: Turing Test

## ► Turing Test --- An Imitation Game

- Machine learning
  - adapt to new circumstances
- Computer vision
  - perceive objects
- Robotics
  - manipulate objects

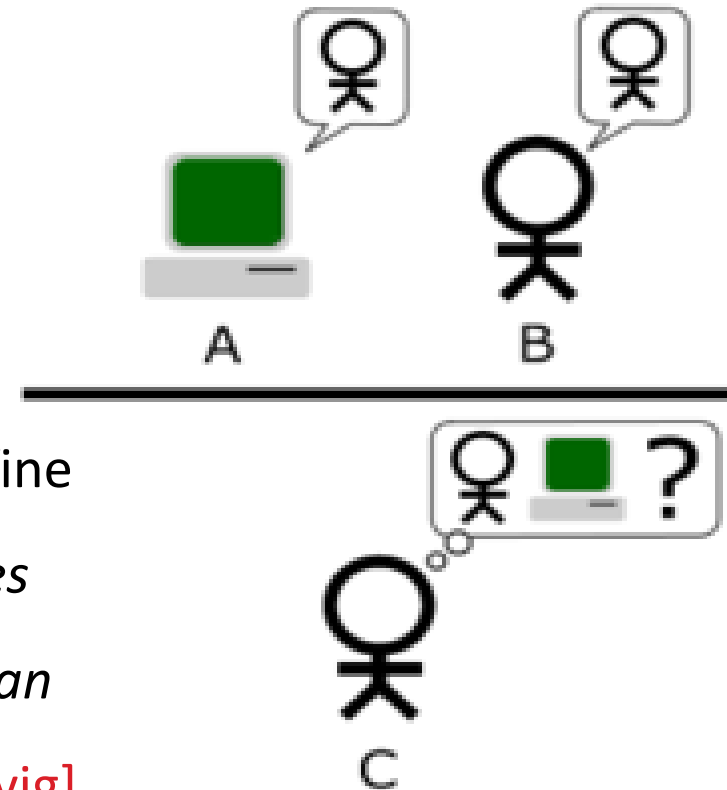


# Act Humanly: Turing Test

- ▶ **Turing Test** --- An Imitation Game

**Is Turing Test the right goal?**

**Aeronautical engineering** texts do not define the goal of their field as: *making machines that fly so exactly like pigeons that they can fool even other pigeons.* [Russell and Norvig]



# Think Humanly

**Cognitive Approach:** Three ways to do this:

- ▶ Through introspection
  - trying to catch our own thoughts
- ▶ Through psychological experiments
- ▶ Through brain imaging

**Cognitive Science:**

- ▶ It brings together **computer models from Artificial Intelligence** and **experimental techniques from Psychology**
  - to construct precise and testable theories of the workings of the human mind.

# Think Rationally

## The “Laws of Thought” approach

- ▶ Aristotle was one of the first to attempt to codify “right thinking”
- ▶ Initiated the field called **logic**

**Socrates is a man; all men are mortal;  
therefore, Socrates is mortal.**

# Think Rationally

## The “Laws of thought” approach

### Two main obstacles:

- ▶ Hard to state informal knowledge in the formal terms -  
-- required for logic
- ▶ A big difference between problem solving in principle  
and in practice.

# Act Rationally

Think like people



Think rationally



Act like people



Act rationally



- ▶ **Act rationally/like a human** presumably requires (some sort of) **thinking rationally/like a human**
- ▶ Humans much more rational in complex domains

# Act Rationally

## The rational agent approach

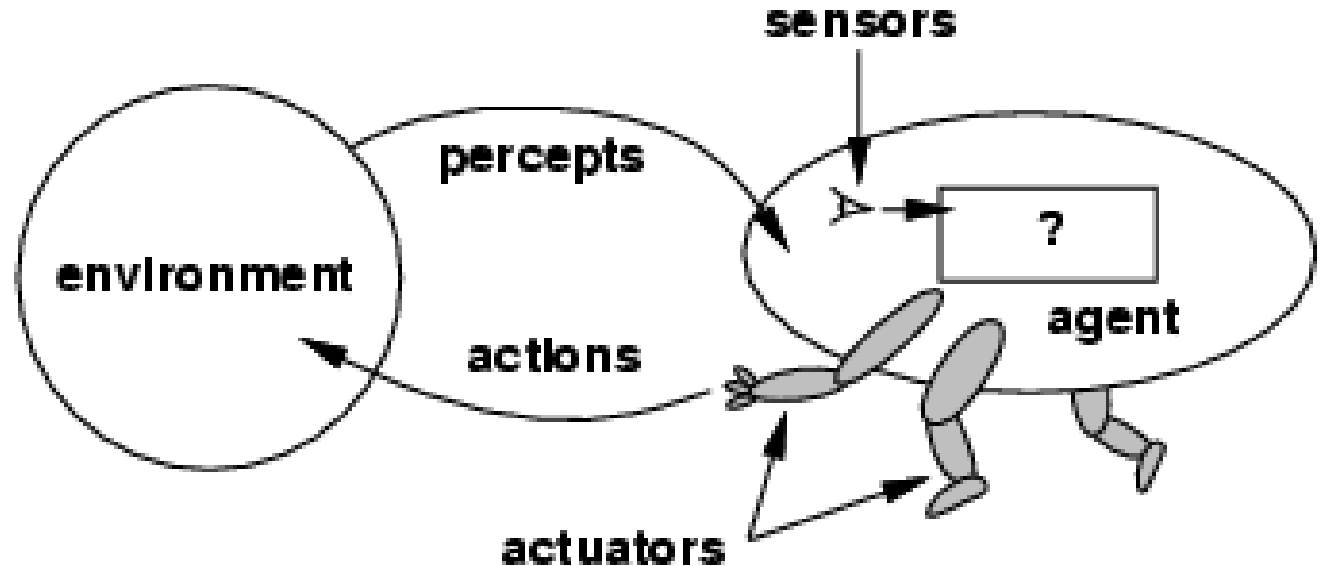
- ▶ **Rational behavior**: doing the *right* thing
- ▶ System is rational if it does the right thing.
- ▶ The right thing
  - to **maximize goal achievement**, given the available information
- ▶ Doesn't necessarily involve thinking – but thinking should be in the service of rational action

**Agent**



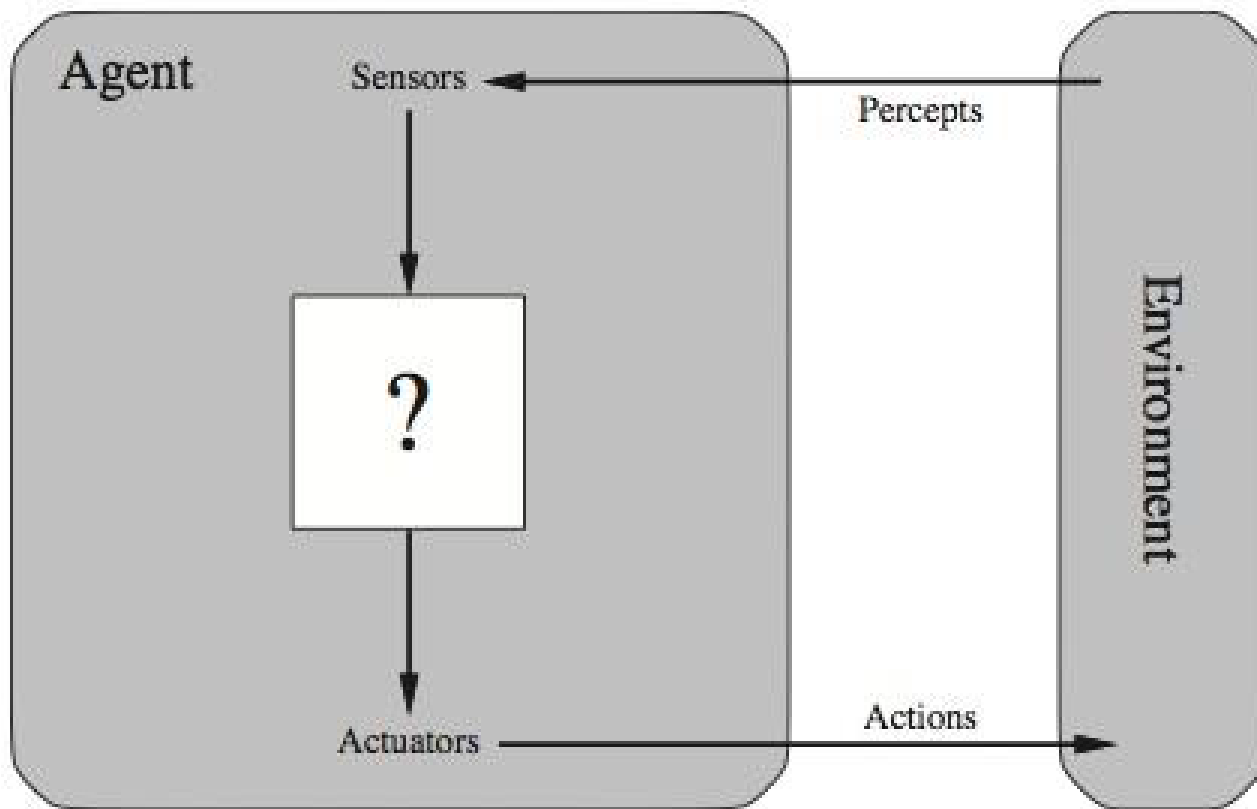
# Agent

- ▶ An **Agent** is an entity which
  - perceives its environment through **sensors** and
  - acts upon that environment through **actuators**
  - **Assumption:** Every agent can perceive its own actions (but not always the effects)



# Agent

## Agent with an Environment



# Agent

- ▶ Abstractly, an agent is **a function which maps percept histories to actions**:

$$[f: \mathcal{P}^* \rightarrow \mathcal{A}]$$

- ▶ Internally, the agent function will be implemented by **an agent program** which runs on the **physical architecture** to produce  $f$
- ▶ agent = **architecture** + **program**

# Acting Rationally

## Agent Examples:

### **Human agent:**

- ▶ Sensors --- eyes, ears, and other organs
- ▶ Actuators --- hands, legs, mouth, and other body parts

### **Robotic agent:**

- ▶ Sensors --- cameras and infrared range finders
- ▶ Actuators --- various motors for actuators

### **A software agent:**

- ▶ Sensors --- Keystrokes, file contents, received network packages
- ▶ Actuators --- Displays on the screen, files, sent network packets

# Agent Example

# Vacuum-cleaner world

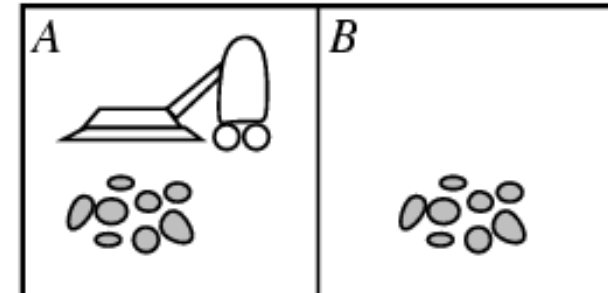
- ▶ Two locations: A and B

- ▶ **Precepts**

- location
- contents
- [A, Dirty]

- ▶ **Actions**

- *Left*
- *Right*
- *Suck*
- *NoOp*



Percept sequence	Actions
[A,Clean]	Right
[A, Dirty]	Suck
[B,Clean]	Left
[B,Dirty]	Suck
[A,Clean],[A,Clean]	Right
[A,Clean],[A,Dirty]	Suck
...	...
[A,Clean],[A.Clean],[A,Clean]	Right
[A,Clean],[A,Clean],[A, Dirty]	Suck

# Rational Agent

- ▶ A rational agent is one that does the right thing.

## How agent should behave?

- ▶ **Performance Measure:** As a general rule, it is better to *design performance measures* according to what one actually wants in the environment.
- ▶ 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.
- ▶ Reward the agent for having a clean floor

# Acting Rationally

## Rationality

**What is rational at any given time?**

It depends on four things:

- ▶ The **performance measure** that defines the criterion of success.
- ▶ The **agent's prior knowledge** of the environment.
- ▶ The **actions** that the agent can perform.
- ▶ The agent's **percept sequence** to date.



# Reading Material

- ▶ **Artificial Intelligence, A Modern Approach**  
**Stuart J. Russell and Peter Norvig**
  - Chapter 1 & 2.

