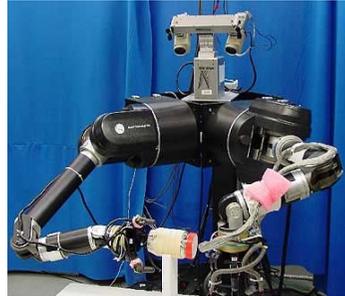


# COMPSCI 111 / 111G

*Mastering Cyberspace:  
An introduction to practical computing*

**Artificial Intelligence**



## Learning Outcomes

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**Outline the difference between strong and weak AI**

**Describe the Turing Test for Artificial Intelligence**

**Describe one of the philosophical objections to strong AI.**

**Describe some of the applications of AI**

## Contents

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**What is AI?**

**Philosophical approaches and thought experiments**

**Historical development and issues**

**Practical applications**

**Summary**

## Exercise

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# Definition of intelligence - OED

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## Intelligence

- The intellect, the understanding

## Intellect

- Faculty of reasoning, knowing, thinking as distinct from feeling

## Thinking

- Using thought or rational judgement

## Thought

- Faculty of reason, process of thinking

<http://en.wikipedia.org/wiki/Intelligence>

# Definition of Artificial Intelligence

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## Systems that *think* like humans

- "...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)

## Computational models of thinking

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

# Strong vs Weak AI

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## Strong AI

- The view that a computer could become self-aware and exhibit intelligent behaviour

## Weak AI

- The view that computers could not become self-aware and reason, but that they could solve specific problems in a well-defined domain (e.g. play chess)

# Philosophy

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## Behaviourist / Functionalist approach

- External behaviour matters
- If it behaves intelligently, then it is intelligent
- Turing test

## Cognitive approach

- What happens internally matters
- We must consider how it thinks, not just look at the behaviour
- Chinese room
- Blockhead



# The Turing Test

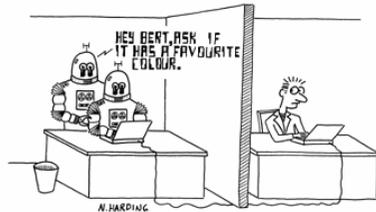
## Professor Alan Turing

- *Computing machinery and intelligence* (1950)
- His view belongs to category of Strong AI



## Defines criteria for determining AI

- Human judge converses with two other entities
- One is a machine
- One is a human
- If the judge cannot tell them apart, then the machine is intelligent.



[http://en.wikipedia.org/wiki/Turing\\_test](http://en.wikipedia.org/wiki/Turing_test)

# The Chinese Room

## John Searle

- *Minds, Brains and Programs* (1980)
- Counter argument against Strong AI



## Chinese Room

- Imagine a computer that can speak fluent Chinese
  - Strong AI would claim the computer is intelligent
- Imagine John Searle sitting in a room full of books
- He receives a set of Chinese symbols, looks them up in a book and writes down the symbols in response
- John Searle does not understand Chinese, but can converse in Chinese
- Computers do the same thing.
- The internal processes do matter.

[http://en.wikipedia.org/wiki/Chinese\\_room](http://en.wikipedia.org/wiki/Chinese_room)

# Chinese Room Rulebook

If you see this shape, "什麼" followed by this shape, "帶來" followed by this shape, "快樂"	then produce this shape, "爲天" followed by this shape, "下式".
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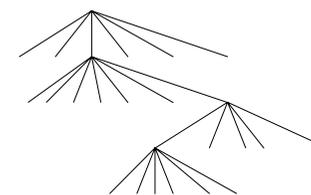
# Blockhead

## Ned Block

- *Psychologism and Behaviourism* (1981)

## Blockhead

- Similar to Searle
- Finite number of syntactically and grammatically correct sentences
- For each starting sentence, a finite number of syntactically and grammatically correct responses exist.
- A complex tree structure results, but not intelligence.



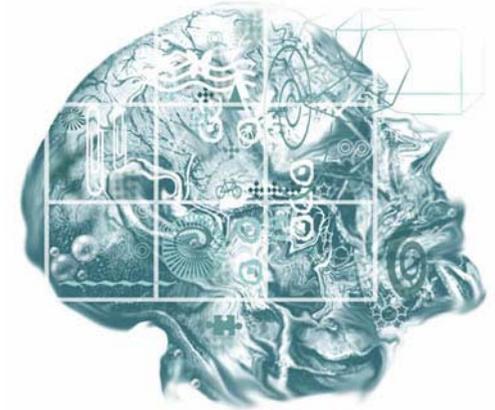
<http://en.wikipedia.org/wiki/Blockhead>

## Exercise

## The study of Artificial Intelligence

### Inherited ideas from many other disciplines

- Philosophy
- Mathematics
- Statistics
- Biological Sciences
- Neuroscience
- Psychology
- Computer Engineering
- Linguistics



[http://en.wikipedia.org/wiki/Artificial\\_intelligence](http://en.wikipedia.org/wiki/Artificial_intelligence)

## Historical success

### McCulloch, W. and Pitts, W.

- *A logical calculus of the ideas immanent in nervous activity (1943).*
- A network of neurons can compute any computable function
- An appropriately defined network can learn

### Newell, A. and Simon, H.

- *The logic theory machine (1956)*
- Software that finds proofs for theorems in symbolic logic

1	$B(x) \vee C(x)$
1	$\exists x (B(x) \vee C(x)) \rightarrow \exists x (B(x) \vee C(x))$
3	$\exists x (B(x) \vee C(x)) \rightarrow \exists x (B(x) \vee C(x))$
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### Samuel, Arthur L.

- *Some Studies in Machine Learning Using the Game of Checkers (1959)*
- Checkers program written in 1952 able to beat good amateur players



## Failure to meet expectations

### Many AI problems are intractable

- Combinatorial explosion
- General knowledge problem

### Combinatorial Explosion

- Exponential growth
- One grain of rice on the first square
- Two grains of rice on the second square
- Double the rice on each subsequent square



### General Knowledge problem

- Knowledge about the world
- If my hand is in the room, then so are my fingers, and my arm and...
- "The flesh is willing but the spirit is weak"
- "The vodka is good but the meat is rotten"

## Fragmented discipline

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### No longer focused on creating a thinking machine

- Strong AI

### Instead, focus on specialised aspects of cognition

- Weak AI

### Moore's Law

- Increasing computing power enables many AI applications that were impractical previously

[http://en.wikipedia.org/wiki/Strong\\_AI](http://en.wikipedia.org/wiki/Strong_AI)

## Exercise

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## Applications of AI

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### Tasks that improve human computer interaction

- Recognition of Faces, Emotions, Handwriting, Speech, Objects
- Speech production, Natural language queries, Conversation

### Tasks that help humans interact with the world

- Wheeled/Bipedal movement, Robotic limbs
- Knowledge databases, Subject Experts
- Reading comprehension

### Tasks that allow robots to act independently

- Coordination of teams, Robot Soccer, Navigation
- Reasoning about the physical world, planning

## Surpassing Humans

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### Chinook

- Written by Jonathan Schaeffer
- Checkers program (Chinook) came second in world in 1992
- It won man-machine world champs in 1994

### IBM Deep Blue

- Won a game against Kasparov in 1996, lost the match
- Won the match against Kasparov in 1997 (3 1/2 vs 2 1/2)
- Deep blue was programmed with history of Kasparov's previous games
- Programming modified between games to avoid traps
- Kasparov was not permitted to study Deep Blue's previous games

[http://en.wikipedia.org/wiki/Deep\\_blue](http://en.wikipedia.org/wiki/Deep_blue)

[http://en.wikipedia.org/wiki/Chinook\\_Checkers\\_Program](http://en.wikipedia.org/wiki/Chinook_Checkers_Program)

# Kasparov vs Deep Blue



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# Expert Systems

## Expert Systems

- Database of facts
- Inference Rules used to combine facts
- Input new facts and derive new information

## MYCIN

- World class Medical Expert System
- Enter symptoms and get diagnosis

## CYC

- Universal expert system (database of human knowledge)
- Facts entered since 1984
- Aim to eventually have CYC read and understand books.

[http://en.wikipedia.org/wiki/Expert\\_systems](http://en.wikipedia.org/wiki/Expert_systems)

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# Natural Language Processing

## Natural language understanding

- Linguistics (sentence trees, syntax, grammar)
- Using storyboards/ scripts for context
- Telephone customer service, voice recognition

## Examples

- Intelligent database query
- Text-based adventure games
- Self-help web sites

## Natural Language Generation

- Speech Production
- ELIZA
- Loebner Prize (beating the Turing Test).

[http://en.wikipedia.org/wiki/Natural\\_language\\_processing](http://en.wikipedia.org/wiki/Natural_language_processing)

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# Loebner Prize 2003 Winner

**JUDGE:** i think i would like to talk about the weather today. what is it like with you?

**JABBERWOCK:** Much the same as it would be for you.

**JUDGE:** which is what?

**JABBERWOCK:** That's a good question - but perhaps a little bit too short in words

**JUDGE:** what is the weather like with you? Is it sunny or raining?

**JABBERWOCK:** Cool, at least here in my room

**JUDGE:** does that then mean it is hot outside?

**JABBERWOCK:** The weather in here is dry and well tempered

**JUDGE:** that's nice. have you ever been to Australia?

**JABBERWOCK:** Thank you

**JUDGE:** you seem as though you are half asleep! what do you think about the rugby world cup at the moment? who do you think will win?

**JABBERWOCK:** How would I know who will win?

**JUDGE:** well maybe you have started watching the games? what about the match today. I think south Africa will win, and you?

**JABBERWOCK:** Never mind, it's not important



<http://www.loebner.net/Prizef/loebner-prize.html>

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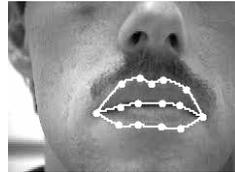
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# Computer Vision

## Handwriting Recognition

- Training to recognise handwriting from an individual



## Edge detection

- Medical imagery, object recognition

## Object Recognition

- Fingerprints
- Faces
- Animals



[http://en.wikipedia.org/wiki/Computer\\_vision](http://en.wikipedia.org/wiki/Computer_vision)

# Autonomous Agents

## Agents

- Programs which work in a defined environment
- Normally Autonomous
- Often cooperative



## Mission to Mars

- Communications between Earth and Mars take too long
- Robot has limited resources – e.g. battery
- Robot must make its own schedule
- Spaceship that can fix its own malfunctions



## RoboCup Soccer

- Robots play each other in soccer
- Estimated that by 2050, robot team will beat world's best soccer team

[http://en.wikipedia.org/wiki/Autonomous\\_agent](http://en.wikipedia.org/wiki/Autonomous_agent)

# DARPA Grand Challenge

## Autonomous vehicle to complete an off-road course in the Mojave Desert within a specified time limit (10 hours)

- 2004 (142 miles) No vehicle came close
- 2005 (135 miles) Stanford team completed course and won US \$2 million



<http://www.darpa.mil/grandchallenge/index.asp>

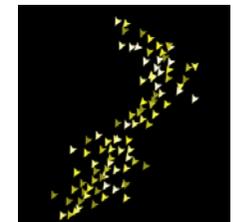
# Artificial Life

## Artificial Life

- Study of systems related to life
- Genetic algorithms
- Genetic programming
- Simulations
- Evolutionary processes

## Emergent behaviour

- Carl Reynolds - Boids (1986)
- Flocking simulation
- <http://ccl.northwestern.edu/netlogo/models/Flocking>



[http://en.wikipedia.org/wiki/Artificial\\_Life](http://en.wikipedia.org/wiki/Artificial_Life)

# Summary

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**AI draws inspiration from many other fields of study**

**Began as a promising discipline with much early success**

**Prompted philosophical debate about the nature of thinking and the possibility of a thinking machine**

**Few people today are focused on Strong AI**

**The study of Weak AI (specialised aspects of intelligent behaviour) has produced many useful applications**