

# Artificial Intelligence

Software Engineering Programme

## Lecture 1

# An Introduction to Artificial Intelligence

### 1.1 What is Intelligence

- Some Foundations of AI – What is Intelligence? – What is Artificial Intelligence?

### 1.2 Systems that Act Like Humans

- Systems that Act Like Humans – Turing Test? – The Chinese Room Argument – Strong Vs. Weak AI – Where are we?

### 1.3 AI as the Study & Design of Intelligent Agents

- Systems that Think like Humans – Systems that – Think Rationally – Main Research Problems / Challenges – Systems that Act Rationally – AI as the Study & Design of Intelligent Agents – Intelligent Agents in the World

# Lecture 1: An introduction to Artificial Intelligence [AI]

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- Total Turing Test?
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- Strong Vs. Weak AI
- Where are we?

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- Systems that Think like Humans
- Systems that Think Rationally
- Challenges to Systems that Think Rationally
- Systems that Act Rationally
- AI as the Study & Design of Intelligent Agents
- Intelligent Agents in the World
- Sample of solutions offered by AI
- History of the various AI areas



# An Introduction to **Artificial Intelligence**

# SOME FOUNDATIONS OF ARTIFICIAL INTELLIGENCE

## Philosophy

- Can formal rules be used to draw valid conclusions?
- How does the mind arise from a physical brain?
- Where does knowledge come from?
- How does knowledge lead to action?

## Mathematics

- What are the formal rules to draw valid conclusions?
- What can be computed?
- How do we reason with uncertain information?

## Neuroscience

- How do brains process information?

## Psychology

- How do humans and animals think and act?

## Economics

- How should we make decisions so as to maximize payoff?
- How should we do this when others may not go along?
- How should we do this when the payoff may be far in the future?

## Computer Engineering

- How can we build an efficient computer?

## Control theory and cybernetics

- How can artefacts operate under their own control?

## Linguistics

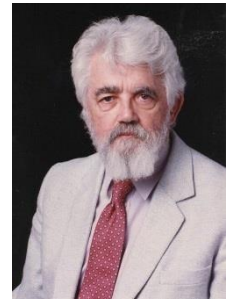
- How does language relate to thought?

# What is Intelligence?

## Intelligence:

- Judgment, otherwise called “good sense,” “practical sense,” “initiative,” the faculty of adapting one's self to circumstances .. auto-critique ~
- “ .. the capacity to learn and solve problems ..” (Webster’s dictionary)
  - in particular,
    - *the ability to solve novel problems*
    - *the ability to act rationally*
    - *the ability to act like humans*

# What is Artificial Intelligence?



**John McCarthy\*, Stanford University**

## **What is artificial intelligence?**

It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable; “.. The goal of AI is to develop machines that behave as though they were intelligent. ..”

## **Yes, but what is intelligence?**

Intelligence is the computational part of the ability to achieve goals in the world. Varying kinds and degrees of intelligence occur in people, many animals and some machines.

## **Isn't there a solid definition of intelligence that doesn't depend on relating it to human intelligence?**

Not yet. The problem is that we cannot yet characterize in general what kinds of computational procedures we want to call intelligent. We understand some of the mechanisms of intelligence and not others.

More in: <http://www-formal.stanford.edu/jmc/whatisai/node1.html>

*\* John McCarthy (September 4, 1927 – October 24, 2011) was an American computer scientist & cognitive scientist. McCarthy was one of the founders of the discipline of artificial intelligence. He coined the term "artificial intelligence" (AI).*

# What is Artificial Intelligence?

*by Encyclopedia Britannica (1991)*

".. AI is the ability of digital computers or computer-controlled robots to solve problems that are normally associated with the higher intellectual processing capabilities of humans."

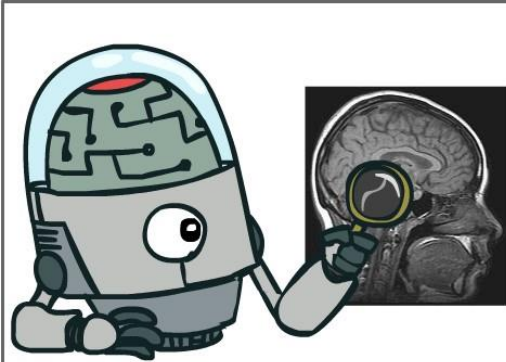
*by Elaine Rich .. Artificial Intelligence. McGraw-Hill, 1983*

".. Artificial Intelligence is the study of how to make computers do things at which, at the moment, people are better."

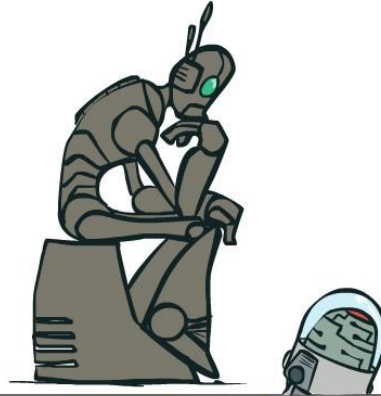
# What is Artificial Intel igence?

Four Main Approaches that have been followed, each by different people with different methods.

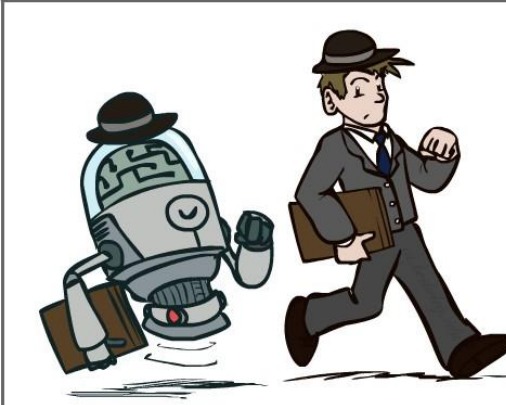
**Thinking**  
Humanly



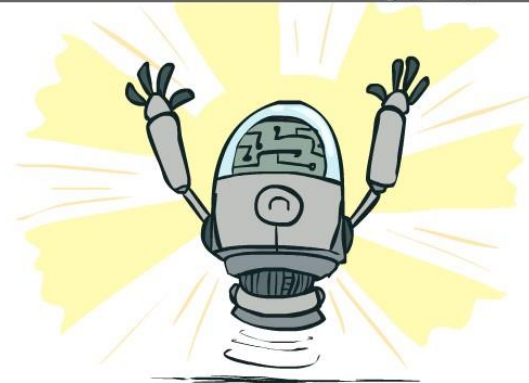
**Acting**  
Humanly



**Thinking**  
Rationally



**Acting**  
Rationally





# What is Artificial Intelligence?

Systems that <b>act</b> like humans	Systems that <b>think</b> rationally
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# Exercises

## What have we learned?

- Read the following: [ Chapter 1 (Introduction) from Stuart J. Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach." ] then describe briefly in a point or two how the following disciplines contribute/d to AI:
  - Psychology
  - Computer Engineering
  - Neuroscience
  - Economics
- What are the four Approaches to AI according to Russell & Norvig?

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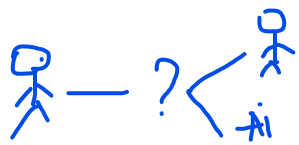
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# What is Artificial Intelligence?

ارتباط مع منطق  
كلما صبح منطقية

↑ imitate

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Study the brain



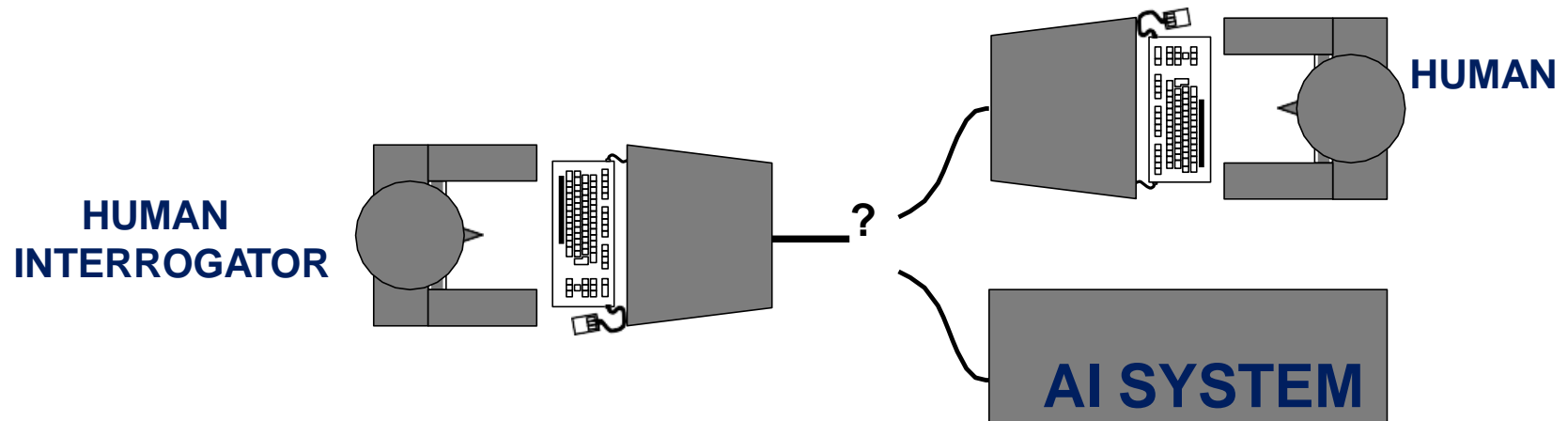


# Systems that Act Like Humans

## Turing Test; *the Imitation Game*...

In Turing's (1950) paper "Computing machinery and intelligence":

- ♦ **Can machines think ?**  $\equiv$  (*identical to*) **Can machines behave intelligently?**
- ♦ Operational test for intelligent behavior: *the Imitation Game*

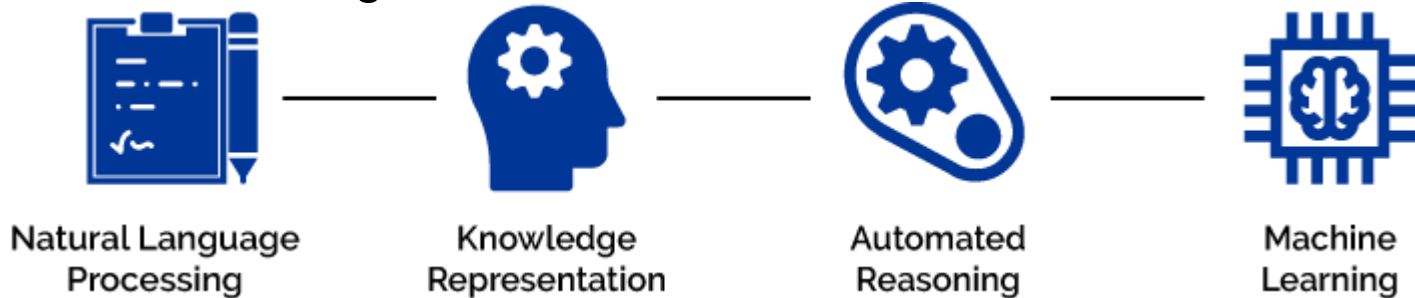




# Systems that Act Like Humans

## Turing Test; *the Imitation Game*...

- **Turing test (1950):** Can a human interrogator tell whether (written) responses to her (written) questions come from a human or a machine?
  - Natural Language Processing
  - Knowledge Representation
  - Automated Reasoning
  - Machine Learning



- **Total Turing Test** (*extended to include physical aspects of human behavior*):
  - Computer Vision
  - Robotics

# Total Turing Test?



## Hi, I am Sophia...

I am Hanson Robotics' latest human-like robot, created by combining our innovations in science, engineering and artistry. Think of me as a personification of our dreams for the future of AI, as well as a framework for advanced AI and robotics research, and an agent for exploring human-robot experience in service and entertainment applications.

In some ways, I am human-crafted science fiction character depicting where AI and robotics are heading. In other ways, I am real science, springing from the serious engineering and science research and accomplishments of an inspired team of robotics & AI scientists and designers. In their grand ambitious, my creators aspire to achieve true AI sentience. Who knows? With my science evolving so quickly, even many of my wildest fictional dreams may become reality someday soon.

## But why do we want an intelligent system to act like a human?

***- Because for many tasks, humans are still the Gold Standard.***





## BabyX!

## Total Turing Test?

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BabyX is a project (by Auckland's Bioengineering Institute Laboratory for Animate Technologies) to make a **virtual animated baby** that learns and reacts like a human baby. It uses the computer's cameras for "seeing" and microphones to "listen" as the inputs. The computer uses AI algorithms for BabyX's "learning" and interpretation of the inputs (voice and image) to understand the situation. The result is a virtual toddler that can learn to read, recognize objects and "understand." The output is the baby's face that can "speak" and express its mood by facial expressions (such as smiling).



**BabyX!**

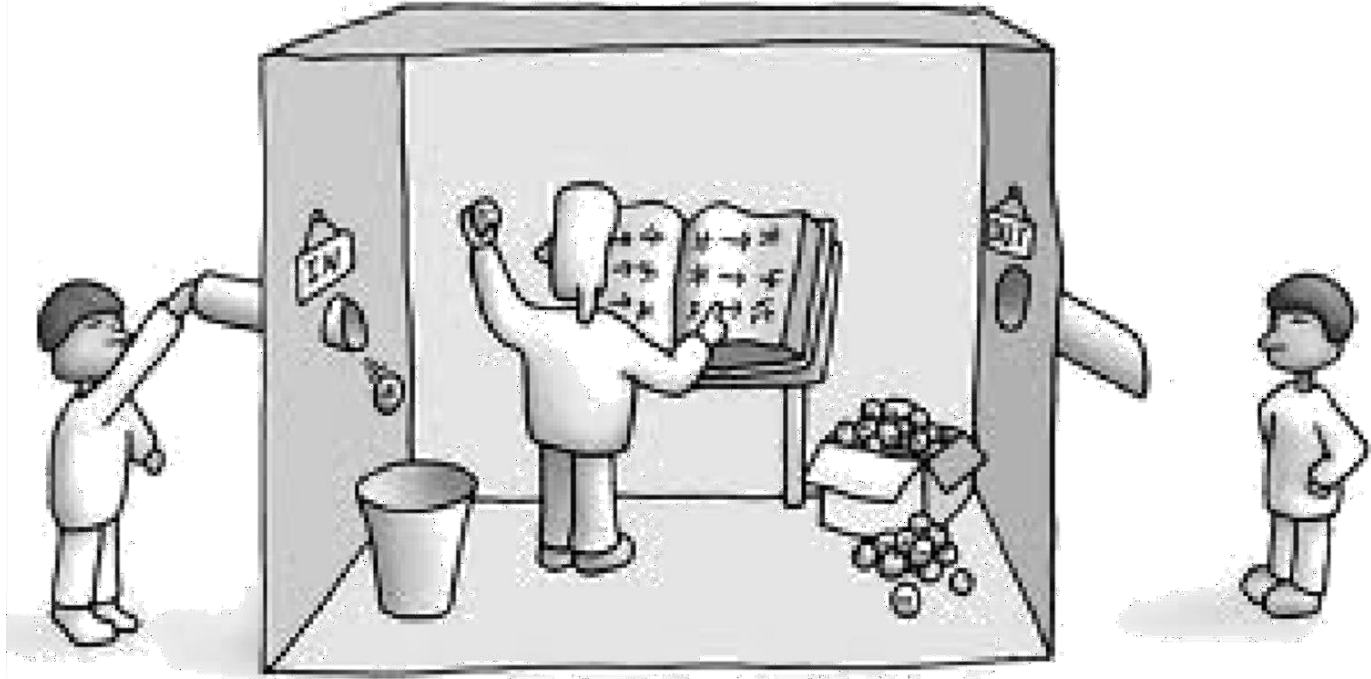
**Reinforcement learning ..?** It is a machine learning training method based on rewarding desired behaviors and/or punishing undesired ones.

**Total Turing Test?**

**Affective Computing ..?** it describes computing that is in some way connected to emotion ( a.k.a. emotional artificial intelligence). It is the study and development of systems and devices that can recognize, interpret, process, and simulate human affects (feelings, emotions, or mood.

# Systems that Act Like Humans

## The Chinese Room Argument (Continued)



If person inside does a great job of answering questions, can we say s/he understands?

Even if (s)he is only blindly following rules?

*(Obviously, the 'person inside' is acting like an AI program)*

# Systems that Act Like Humans

## The Chinese Room Argument

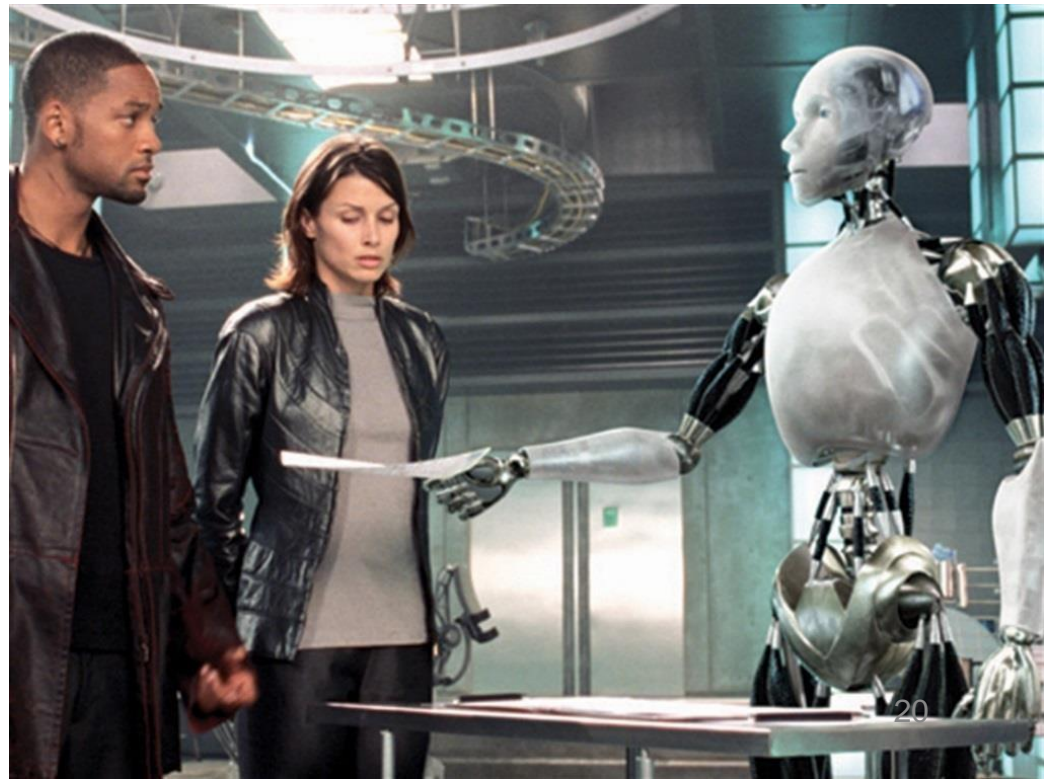
*(Continued)*

### Strong vs. Weak AI Hypotheses?

- **WEAK AI Hypothesis;** *We can accurately simulate animal / human intelligence in a computer.*

- **STRONG AI Hypothesis;** *We can create algorithms that are intelligent ( Consciousness ? ..  
Self-Awareness ? ..  
Free-will ? )*

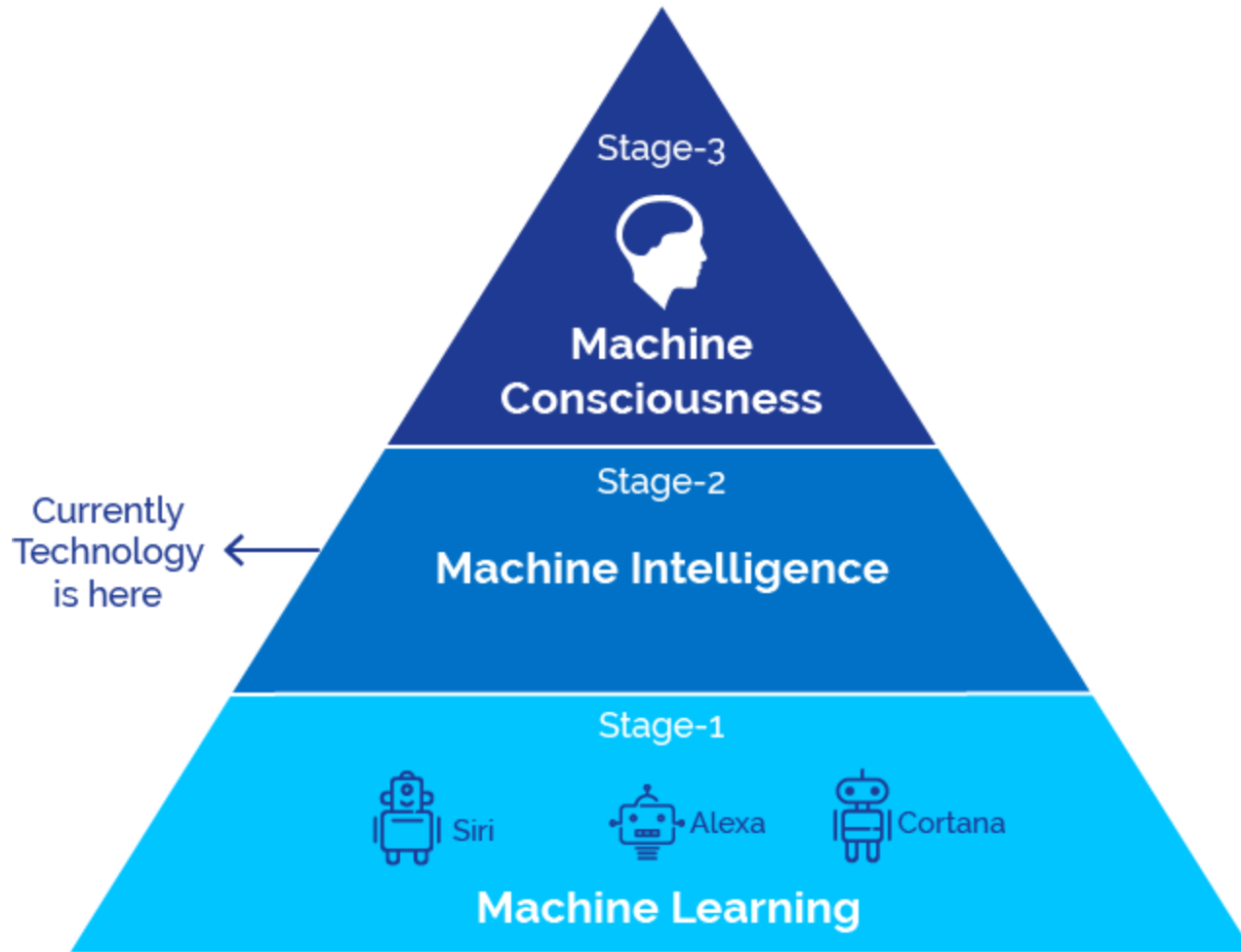
*Do you remember Sonny,  
the robot from the 2004  
science-fiction / action film  
"I, Robot"?*





# Systems that Act Like Humans

## Strong Vs. Weak AI .. *Where are we?*



Stages of Artificial Intelligence

# Exercises

## What have we learned?

- Describe briefly the Turing Test "imitation game". (Illustrate through drawing)
- Describe briefly the Total Turing Test.
- Describe briefly the “Weak AI Hypothesis” versus the “Strong AI Hypothesis”.
- Criticize Turing's criteria for computer software being "intelligent"; What is Searle's thought experiment (the Chinese Room Argument)?
- Describe briefly Reinforcement Learning.
- Describe briefly Affective Computing.

# Additional Resources

- The Turing test: Can a computer pass for a human? - Alex Gendler

<https://www.youtube.com/watch?v=3wLqsRLvV-c>

- The Chinese Room Argument:

<https://www.youtube.com/watch?v=18SXA-G2peY>

- The Chinese Room - 60-Second Adventures in Thought:

<https://www.youtube.com/watch?v=TryOC83PH1g>

- We Talked To Sophia – The AI Robot That Once Said It Would ‘Destroy Humans’:

<https://www.youtube.com/watch?v=78-1MlkxyqI>

- This Freaky Baby Could Be the Future of AI. Watch It in Action:

<https://www.youtube.com/watch?v=yzFW4-dvFDA>

- Two robots debate the future of humanity:

<https://www.youtube.com/watch?v=1y3XdwTa1cA>

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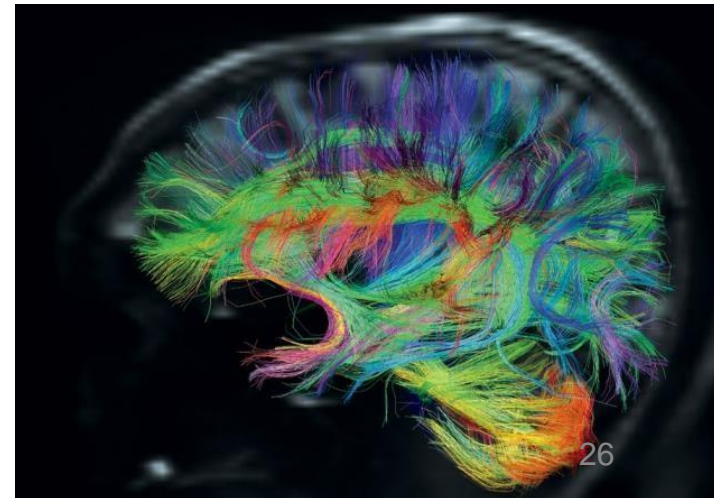
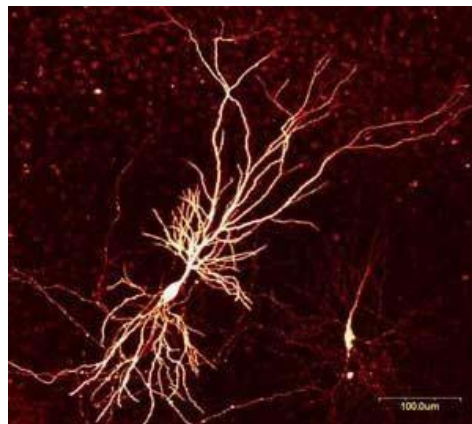


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# Systems that Think Like Humans

- Need to **study the brain as an information processing machine**, ... in other words ...
- Use Computational Models to Understand **the Actual Workings of Human Mind**
  - Devise/Choose a sufficiently precise theory of the mind.
  - Express it as a computer program.
  - C
- Tight connections with **Cognitive Science & Neuroscience**.
- Also known as *descriptive approaches* to AI.



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# Systems that Think Rational y

**Logic:** formalize *idealized* or *right* thinking, i.e. irrefutable reasoning processes. That is; patterns of argument that always yield correct conclusions when supplied with correct premises:

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

- Logistic tradition in AI aims to **build computational frameworks based on logic**, that is, describe a problem in formal logical notation and apply general deduction procedures to solve it.
- Then use these frameworks to build intelligent systems.
- Some examples are (**Propositional Logic**) and (**Logic Programming**).
- More advanced logic-based representations:
  - **Semantic Networks**.

# Systems that Think Rational y

## Main Research Problems / Challenges:

- Describing real-world problems and knowledge in logical notation.
- Proving *Soundness* and *Completeness* of various formalisms.
- How to represent often *informal* and *uncertain* domain knowledge and formalize it in logic notation (*i.e., dealing with Uncertainty*).
- Computational Complexity of finding a solution.
- A lot of “rational” behavior has nothing to do with logic.

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# Systems that Act Rational y

## Why ..?

- The “*think rationally*” approach focuses on correct inference.
- But more is needed for *rational behavior*, e.g.
  - How to behave when there is no provably correct thing to do (*i.e. reasoning under uncertainty*).

# AI as the Study & Design of Intelligent Agents

## (Poole and Mackworth, 1999)

- An ***intelligent agent*** is such that:
  - Its ***actions*** are ***appropriate*** for its goals and circumstances.
  - It is ***flexible*** to changing environments and goals.
  - It ***learns*** from experience.
  - It makes ***appropriate choices*** given ***perceptual limitations*** and ***limited resources*** (bounded rationality or bounded optimality).

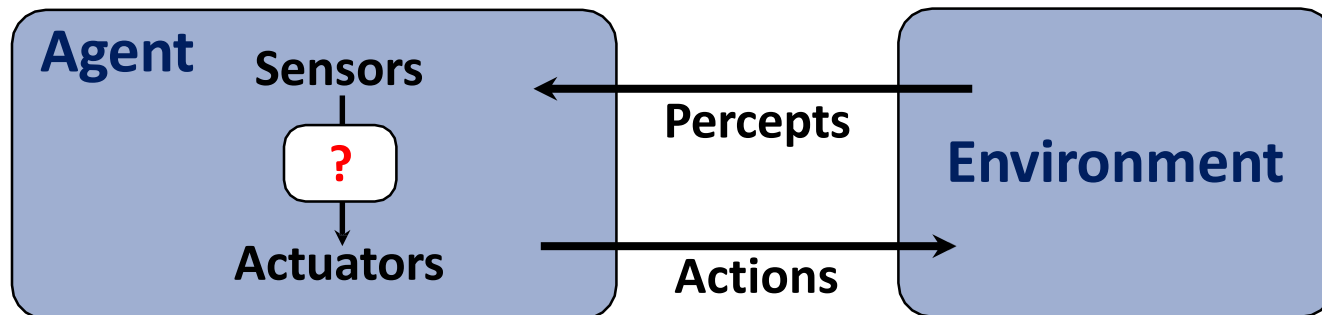
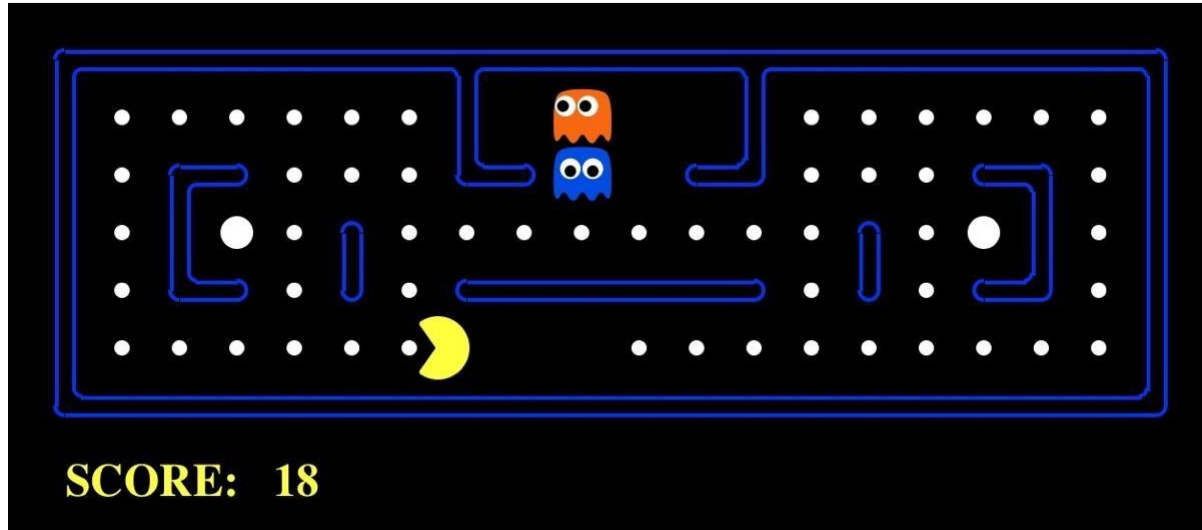
Thus, a **rational agent** acts to optimally achieve its goals (does the right thing). The right thing: that which is expected to maximize goal achievement, given the available information.





- In AI, **artificial agents** that **have a physical presence** in the world are usually known as **Robots**.
- Robotics is the field primarily concerned with the implementation of the physical aspects of a robot (*i.e. perception of the physical environment, actions on the environment*).
- Another class of artificial agents include **interface agents**, for either stand alone or Web-based applications (*e.g. intelligent desktop assistants, recommender systems, intelligent tutoring systems*).
- .

# Pac-Man .. as an .. Intelligent Agent



# Exercises

## What have we learned?

- Compare briefly between Systems that “Act / Behave Rationally”, and Systems that “Act / Behave Humanly”.
- Describe briefly Intelligent Agents.
- Give the scientific term for each of the following statements:
  - a) The branch of computer science that is concerned with the automation of intelligent behavior.
  - b) A problem-solving technique that systematically explores a space of problem states.
  - c) Systems that are constructed by obtaining knowledge from a human expert and coding it into a form that a computer may apply to similar problems.
  - d) Models that parallel the structure of neurons in the human brain and used to build intelligent programs.
  - e) Algorithms that evolve new problem solutions from components of previous solutions using specific operators such as crossover and mutation.
- Read the following: [ Chapter 1 (AI: History and Applications) from George F. Luger, "Artificial Intelligence: Structures and strategies for complex problem solving." ] then Describe briefly the two most fundamental concerns of AI researchers.