I Robot – Isaac Asimov: The three Laws of Robotics and the Robots in the Future

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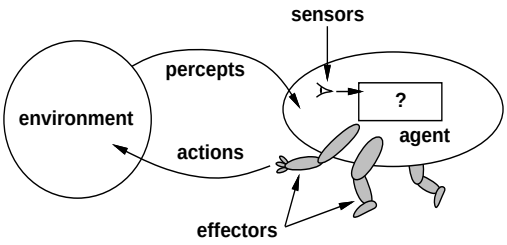
Artificial Intelligence

- **Intelligence**
  - "**Capacity to** solve new problems through the use of knowledge"
- **Artificial Intelligence**
  - "Science concerned with building **intelligent machines**, that is, machines that perform tasks that when performed by humans require intelligence"

Autonomous Agents and Multi-Agent Systems

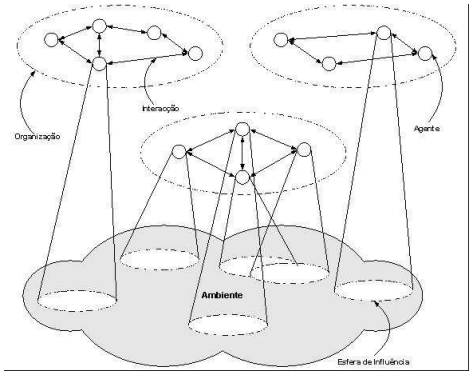
- **Agent Traditional Definition:**

  "Computational System, situated in a given **environment**, that has the ability to **perceive** that environment using **sensors** and **act**, in an **autonomous way**, in that environment using its **actuators** to fulfill a given **function**."



[Russel and Norvig, 1995]

- **Multi-Agent System:**
  - Agents exhibit **autonomous behavior**
  - **Interact** with other agents in the system

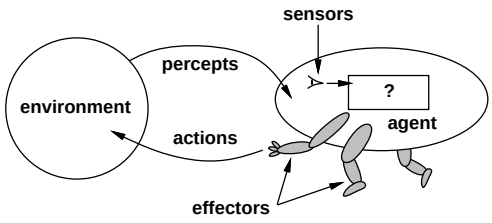


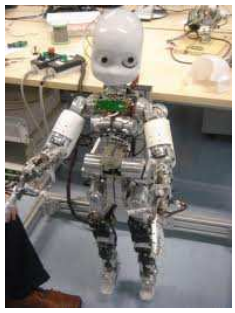
Intelligent Robotics

- **Robotics**
  - Science and technology for **projecting, building, programming and using Robots**
  - Study of **Robotic Agents (with body)**
  - Increased Complexity:
    - **Environments**: Dynamic, Inaccessible, Continuous and Non Deterministic!
    - Perception: Vision, **Sensor Fusion**
    - Action: Robot Control
    - Robot Architecture (Physical / Control)
    - Navigation in unknown environments
    - **Interaction** with other robots/humans
    - Multi-Robot Systems

Robotic and Human Agents

- **Agent:**
  - Perceive its environment using sensors and executes actions using its actuators
- **Human Agent:**
  - Sensors:
    - Eyes, ears, nose, touch, …
  - Actuators:
    - Legs, Arms, hands, vocal cords, …
- **Robotic Agent:**
  - Sensors:
    - Cameras, sonar/infra-red sensors, microphone, …
  - Actuators:
    - Motors, wheels, manipulators, lights, speakers, …





Definition of Robot

- **Notion derives from 2 strands of thought:**
  - Humanoids: human-like
  - Automata: self-moving thing
- **"Robot" --derives from Czech word *robota***
  - "*Robota*": forced work or compulsory service
  - Czech playrighter Karel Capek (1920)
- **Current notion of robot:**
  - Programmable, Mechanically capable and Flexible

Some Definitions of Robot

Robot:

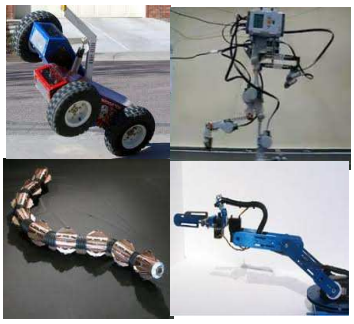
- **" I can't define a robot, but I know one when I see one!" - Joseph Engelberger**
- "Any automatically operated machine that replaces human effort, though it may not resemble human beings in appearance or perform functions in a humanlike manner" - **Encyclopedia Britannica**
- "Machine that looks like a human being and performs various complex acts (as walking or talking) of a human being"
- "Device that automatically performs complicated often repetitive tasks"
- "Mechanism guided by automatic controls" **Merriam-Webster Dictionary**

Good Definitions of Robot:

- "Electromechanical device which can perform tasks on its own, or with guidance"
- "Physical agent (with body) that generates intelligent/autonomous connection between perception and action"
- "Autonomous system in the physical world which may sense its environment and act on it to achieve a set of goals"

Control, Shape, Locomotion of Robots

- **Control:**
  - Directly by a human (ex: space-shuttle robotic arm)
  - Autonomous based on its perceptions and decision methods (ex: soccer playing robot in RoboCup)
- **Locomotion:**
  - Wheels (2, 4, etc.)
  - Legs (Bipeds, quadrupeds, hexapods)
  - Snakes
  - Static (Manipulators)
- **Shapes:**
  - Humanoids (shape and movement similar to humans)
  - Mobile robots (autonomous vehicles)
  - Industrial manipulators (shape depends on function)
  - Reconfigurable (change shape)



Current State of Robotics

- **Used to Perform:**
  - **Dangerous** or difficult **tasks** to be performed directly by humans
  - **Repetitive tasks** that may be performed more efficiently (or cheap) than when performed by humans
- **Robots have moved from manufacturing, industrial applications to:**
  - **Domestic** robots (Pets – AIBO, vacuum cleaners)
  - **Entertainment** robots (social robots)
  - Medical and **personal service** robots
  - **Military** and surveillance robots
  - **Educational** robots
  - Intelligent buildings
  - **Intelligent vehicles** (cars, submarines, airplanes)
  - Other industrial applications (mining, fishing, agriculture)
  - Hazardous applications (space exploration, military apps, toxic cleanup, construction, underwater apps)
  - **Multi-Robot Applications and Human-Robot Teams!**

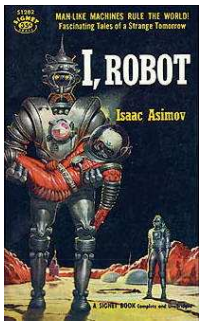
Robots: Hollywood vs. Real-World

- **Hollywood/Asimov Robots:**
  - Human-like capabilities!
  - "Sense all, know all"!
- **Real-World Robots:**
  - Insect or simple animal capabilities!
  - "Sense little, know little"!

based on Lynne E. Parker, 2002

Visions: Dangers and Fears

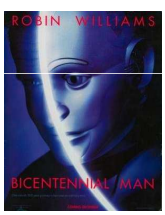
- **Books:**
  - Frankenstein – 1818: Machine (monster) turns against its "creator"…
  - Work of Isaac Asimov about Robots and their interaction with society: IRobot (Asimov's laws of Robotics)
- **Old Movies:**
  - Metropolis (1926)
  - The Day the Earth Stood Still (1951)
  - Forbidden Planet (1956)


Visions: Dangers and Fears

- **Classical Movies:**
  - 2001 Space Odyssey (1968)
  - Star Wars (1977~2005)
  - Star Trek (1979~2002)
  - Blade Runner (1982)
  - Terminator (1984)
  - Short Circuit (1985)
- **Recent Movies:**
  - Matrix (1999)
  - Bicentennial Man (1999)
  - Artificial Intelligence (2001)
  - IRobot (2004)
  - Wall-E (2008)



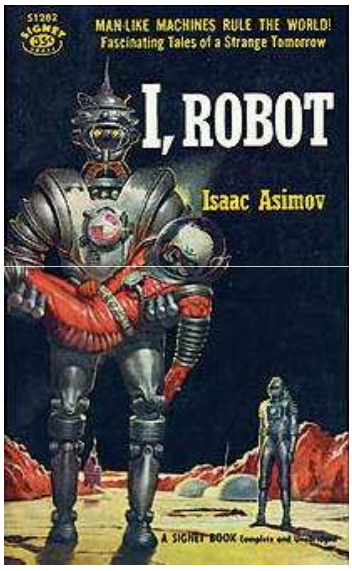



Asimov's Robotic Laws

- The **Three Laws of Robotics** are a set of three rules written by **Isaac Asimov**, which almost all Robots appearing in his fiction must obey. Introduced in his **1942 short story Runaround**, although foreshadowed in a few earlier stories:
  - Law 0) **A robot may not injure humanity** or, through inaction, allow it
  - Law 1) **A robot may not injure a human** being or, through inaction, allow a human being to come to harm
  - Law 2) **A robot must obey orders given** to it **by human** beings, except where such orders would conflict with the First Law
  - Law 3) **A robot must protect its own existence** as long as such protection does not conflict with the First or Second Law

Asimov's Robotic Laws – I Robot

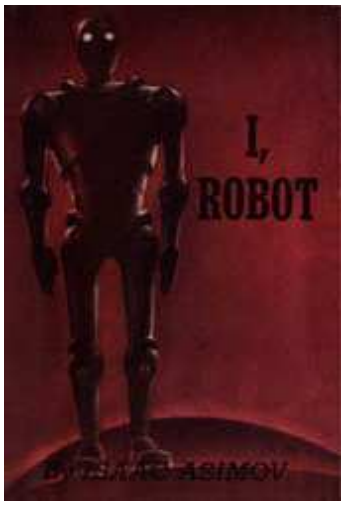
- Collection of nine science fiction short stories first published in 1950 in an edition of 5000 copies
- Stories originally appeared in the American magazines Super Science Stories and Astounding Science Fiction between 1940 and 1950
- Dr. Susan Calvin (chief robopsychologist at U.S. Robots and Mechanical Men, Inc., the major manufacturer of robots) tells them to a reporter (the narrator) in the 21st century
- Stories share the theme of the interaction of humans, robots and morality, and when combined they tell a larger story of Asimov's fictional history of robotics



Asimov's Robotic Laws – I Robot

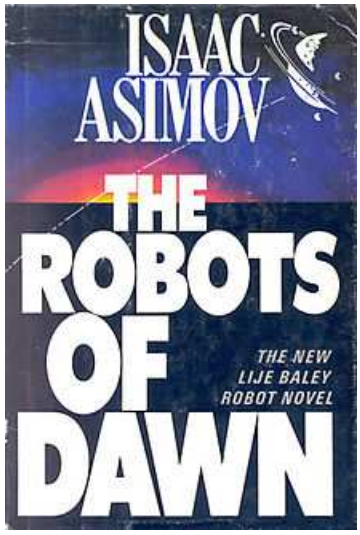
I Robot:

- Introduction
- Robbie
- Runaround
- Reason
- Catch that Rabbit
- Liar!
- Little Lost Robot
- Escape!
- Evidence
- The Evitable Conflict



Asimov's Robotic Laws – I Robot

- Features stories of robots:
  - that are intelligent
  - that get mad
  - mind-reading robots
  - robots with a sense of humor
  - robot politicians and managers
  - robots who secretly run the world
  - robots that replace humans
- Asimov continued discussing these topics in future works…



Conclusions

- Isaac Asimov
  - Three Laws of Robotics
  - Short stories but huge content
  - Huge number of science fiction work about robotics
  - Discusses intelligence, personality, mood, mind-reading, sense of humor, interaction with humans of robots and robots that may be politicians and managers and that eventually will replace humans
- New Challenges for Robotics:
  - Realistic Simulation
  - Robots@Home
  - Heterogeneous Robot Teams
  - Human-Robot Interaction
  - Human-Robot Teams
- Will the Robots be more intelligent than Humans?
- Will the Robots Replace Humans?

Conclusions

- Videos Showing State of the Art in Humanoid Robotics

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