FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE(AE1FAI)

Module Introduction and fundamentals in AI

Instructor: Dr Qian Zhang

MODULE CONVENORS

- Dr Qian Zhang,
- Office: PMB438, qian.zhang@nottingham.edu.cn
- Research area: Pattern recognition and Computer Vision
- Interest area: object recognition, image synthesize, image processing

- Dr Huan Jin,
- Research area: Optimization Techniques, Machine Learning

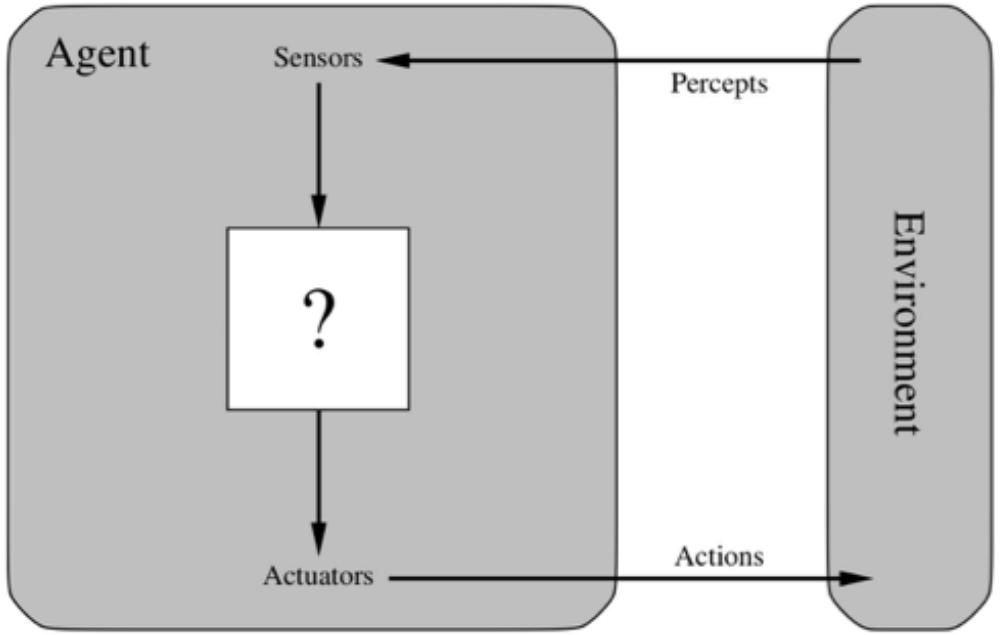
AN OVERVIEW OF THIS SESSION

- Module introduction (part 1)

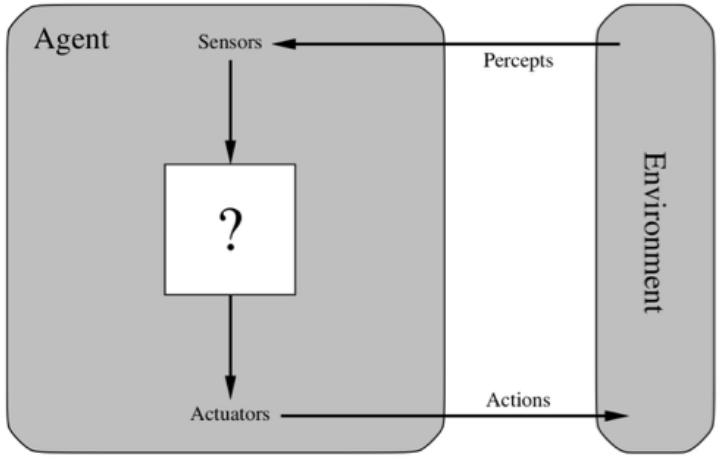
- What is Artificial Intelligence? (part 2)

PART 1 – WHAT TO LEARN?

Major AI researchers and textbooks define this field as "the study and design **of intelligent agents**", where an intelligent agent is a system that **perceives its environment** and **takes actions** that **maximize its chances of success.**



HOW THE MODULE FIT



- **Perceives its environment**
  - Observation and understanding of the environment
  - Observations = > Facts (machine learning, pattern recognition)
  - Facts = > knowledge (data mining, knowledge representation and reasoning, searching)
- **Take actions**
  - Making decisions (searching, reasoning, machine learning, uncertainty management, Evolutionary computation)
- **Maximize the change of success**
  - Optimization
  - Evolutional computation

COMP1037	Fundamentals in Artificial Intelligence
COMP2051	Artificial Intelligence Methods
COMP2047	Introduction to Image Processing
COMP3055	Machine learning
COMP3065	Computer Vision
COMP4107	Big Data
COMP3050	Individual Dissertation Single Honours

UNUK:
Planning and Search and Artificial Intelligence Programming
Fuzzy Sets and Fuzzy Logic Systems
Automated Decision Support Methodologies
Knowledge Representation and Reasoning

LEARNING OUTCOME
-DO NOT EXPECT

- Transform yourself into a Terminator
- Become a famous Hacker
- Build yourself a Robot Girl/Boy friend

MODULE INTRODUCTION-LEARNING AIMS (INTRODUCTION LEVEL)

- Define what we mean by **AI**
- Understand the basic theory of a **range of AI techniques**
- Knowledge to **implement** some basic AI techniques
- Become familiar with **AI software**
- Insights of AI **history**, i.e. key milestones
- Aware of current **AI applications**
- **Provide foundation for next few years of study**

MODULE INTRODUCTION - CONTENT

- Introduction
  - Definition and issues (Qian)
- Solving Problem by Searching
  - Problem space and search (Qian)
  - Blind search (Qian)
  - Heuristic search (Qian)
  - Game play (Qian)
- Machine learning
  - Introduction to machine learning (Huan)
  - Neural network (Huan)
  - Bayesian theorem (Huan)

MODULE INTRODUCTION - TEXTBOOK

- **Artificial Intelligence – A Modern Approach (global edition)(AIMA) (Russell/Norvig), 1995 & 2003**
  - Most comprehensive textbook in AI
  - Much of the material for this course is from this book, available from library
  - Web site: http://aima.cs.berkeley.edu/
  - Reference book: You don’t have to learn the **whole** book

MODULE INTRODUCTION-TEXTBOOK

Artificial Intelligence – A Modern Approach (Russell/Norvig), 1995 & 2003

- Chap 1: Introduction
- Chap 3: Solving Problems by Search
- Chap 5: Adversarial Search
- Chap 13.5: Bayes' Rule and its use
- Chap 18: Learning from Example
- Chap 20: Learning Probabilistic Model
- Chap 26: Philosophical Foundation
- + extra reading provided at each session

MODULE INTRODUCTION-MOODLE

- All lecture slides and additional notes
- Assessments: coursework and exam info, incl. previous exam paper/example questions
- Textbooks, reading list
- Module schedule (to be updated)
- Other resources

MODULE INTRODUCTION – LAB

- Lab sessions (PMB432, Python)
  - Start on 1st March (2nd week of the semester)
  - Python intro: 1 lab (First running in UNNC, allocate more hours for python tutorials)
  - Object-orient programing: 1 lab
  - Search techniques: 3 labs
  - Machine learning: 3 labs
  - IDEs: Jupyter notebook, Spyder
    - get anaconda installed on your laptop
    - 1st year running lab with python. The feedback channel is always open, and you are welcome to provide comments.

MODULE INTRODUCTION-CONTACT HOURS

- Lecture time 20 - 22 hours (10-11 sessions)
- Lab sessions: 16-18 hours
- Coursework: ~10 hours
- Self study & revision: ~50 hours

MODULE INTRODUCTION-ASSESSMENT

- **75% examination** 75 marks
  - 1.5 hours
  - **3** compulsory questions
  - Covers ALL lectures content

- **25% coursework**
  - 2 pieces:
    - I: Search techniques 15 marks
    - II: machine learning 10 marks
  - Supported in lab sessions

PART TWO - WHAT IS AI?

- 5 years old child vs. computer: which is more intelligent?
- Any real world examples of using AI?

APPLICATION AREAS OF AI TECHNIQUES (DATA MINING/LEARNING SYSTEMS)

- Siri
- Self-driving Car
- Robotics
- Machine translation
- Chatbot
- AI agent in video game
- … …

APPLICATION AREAS OF AI TECHNIQUES (DATA MINING/LEARNING SYSTEMS)

- Autonomous planning and scheduling
- Computer Vision
- Natural language processing
- Search engines
- Medical diagnosis
- Credit card fraud / Spam mail detection
- Stock market analysis
- Speech and handwriting recognition
- Adaptive websites
- Recommender system
- … …

WHAT IS AI?

- **Artificial intelligence (AI)** is the branch of computer science that develops machines and software with intelligence.
- Major AI researchers and textbooks define the field as "the study and design **of intelligent agents**", where an intelligent agent is a system that **perceives its environment** and takes actions that **maximize its chances of success**.

WHAT IS AI?

- **John McCarthy**, who coined the term in 1955: "the science and engineering of making intelligent machines"

- AI is the study of how to make computers do things which, at the moment, people do better.

Elaine Rich, 1991

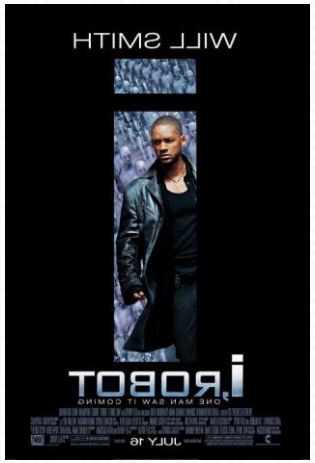
- AI is a branch of computer science and engineering that deals with intelligent behaviour, **learning**, and adaptation in machines.

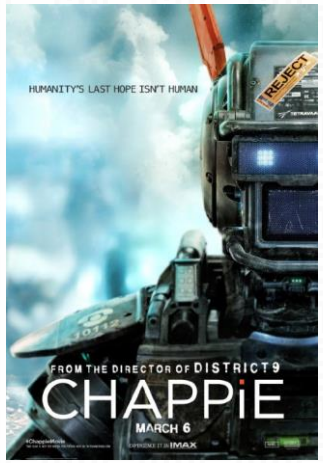
Wikipedia, 2009

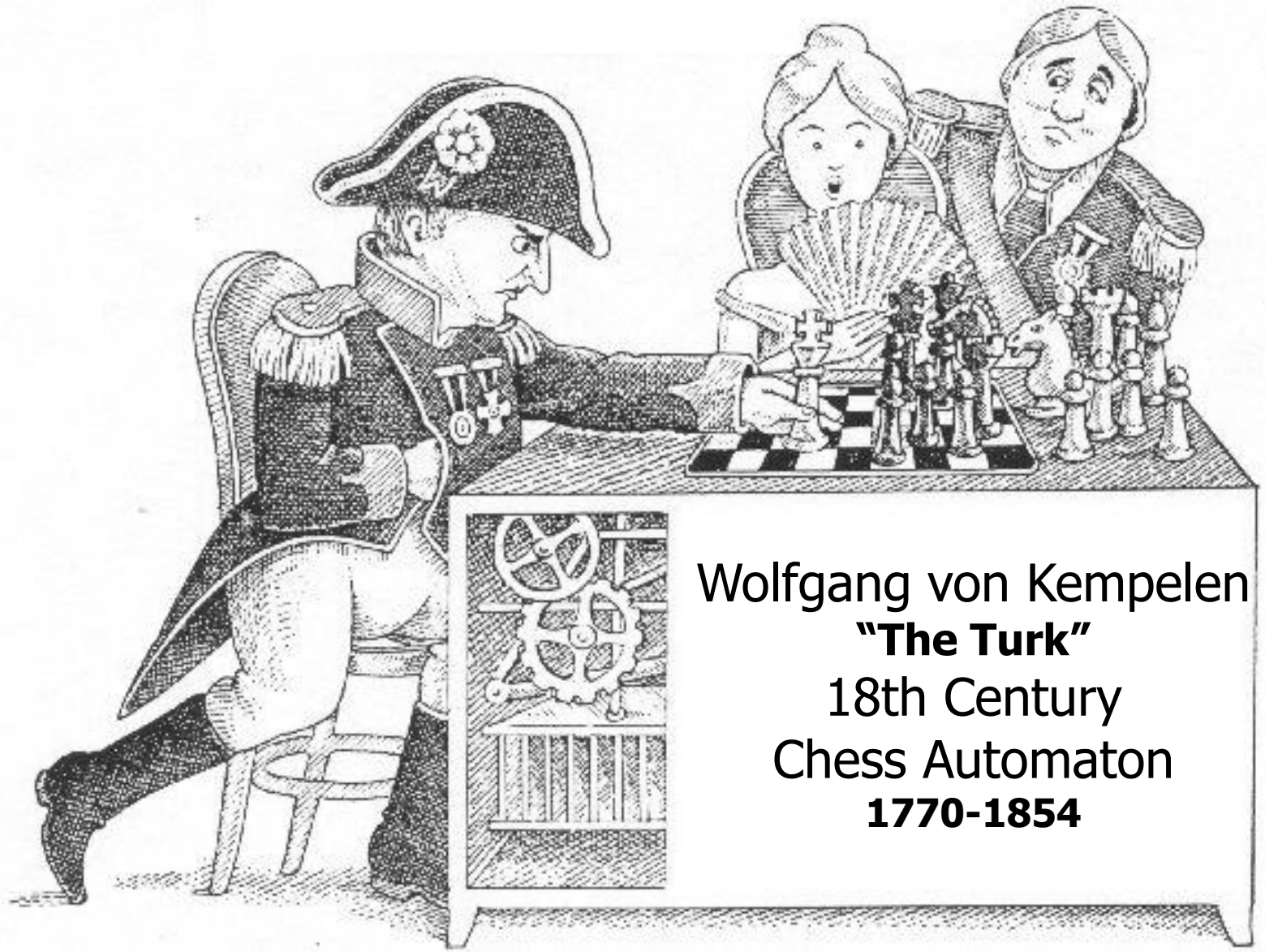
WHAT IS AI?

- The concept of machine can think and act like human beings has bring a lot of resource for movie and fiction.
- Can machines ever be intelligent?
  - A.I. Artificial Intelligence (2001)
  - Director: Steven Spielberg
  - Philosophy film
- Any other robots in movies?

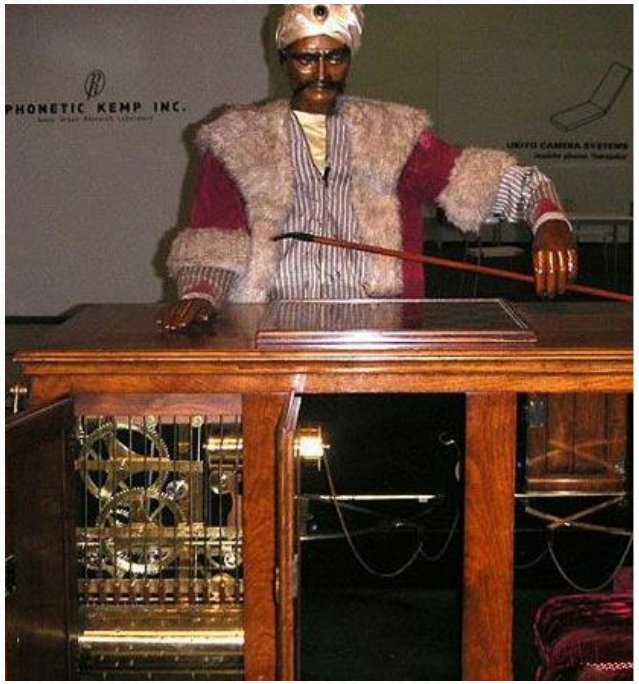
ROBOTS IN MOVIES

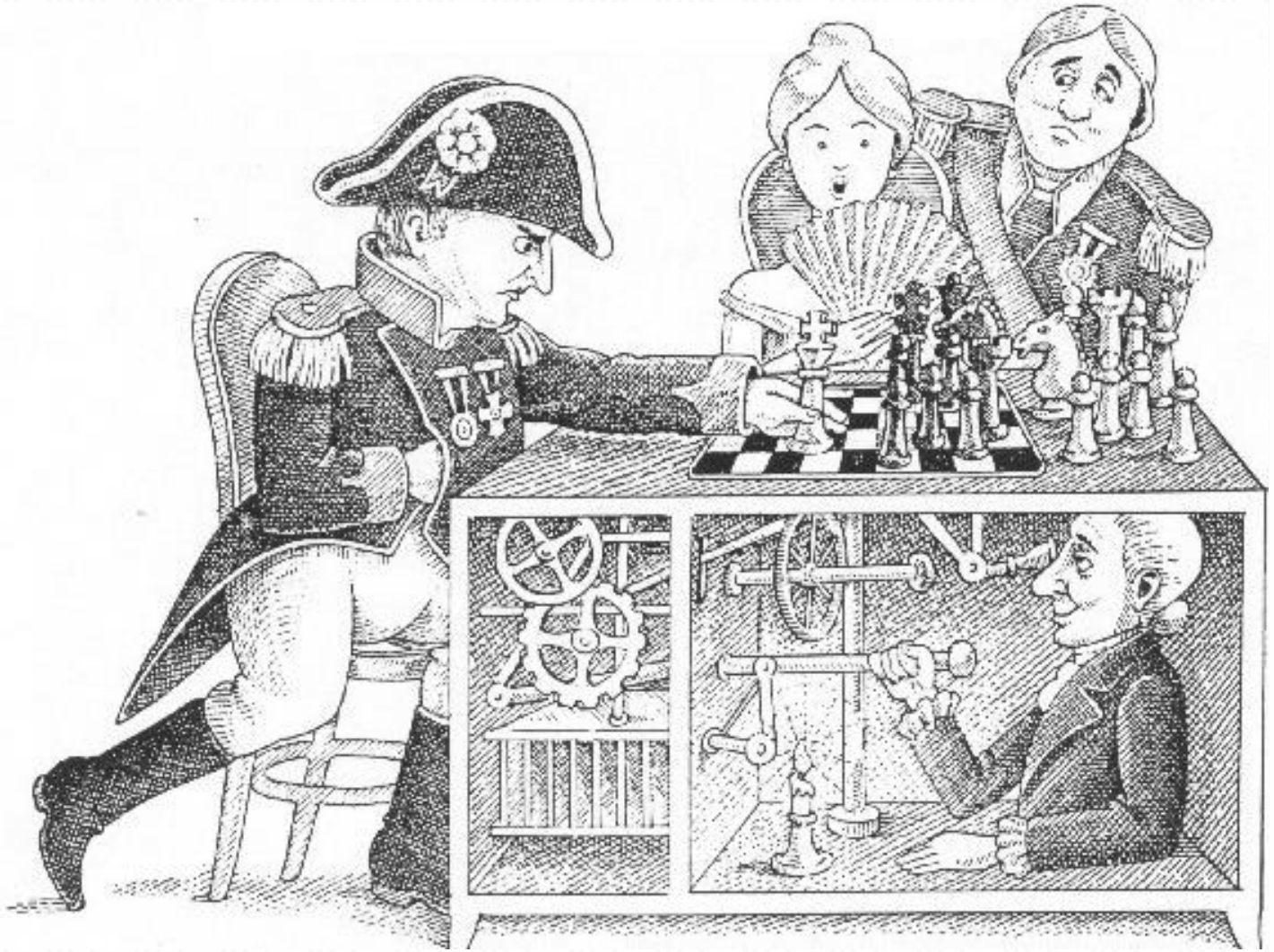


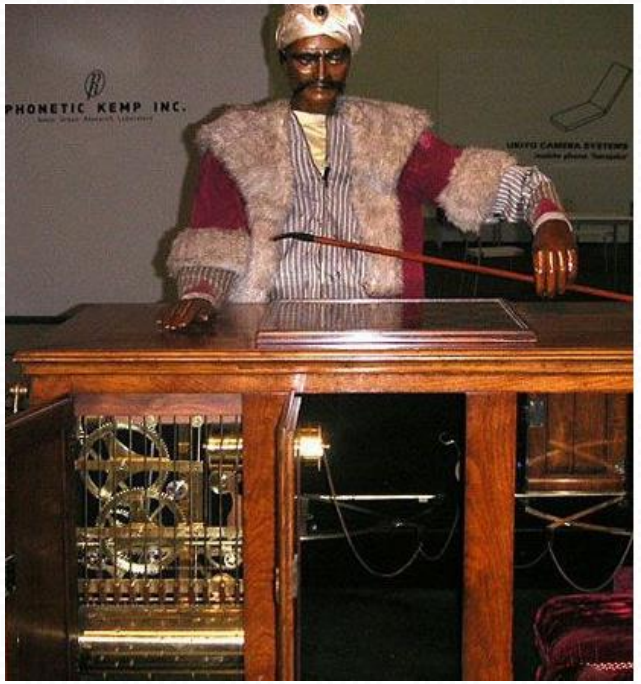




Wolfgang von Kempelen
"The Turk"
18th Century
Chess Automaton
1770-1854






PHONETIC KEMP INC.

KEY MOMENTS IN AI

- **1943 WW2**
  - Turing Test
  - Influenced AI, till now

- **1956 Birth of AI**
  - John McCarthy and Marvin Minsky
  - AI term coined, Dartmouth University
  - Top down approach: pre-processed to do things vs.
  - Bottom up approach: simulate brains, learn new behaviours

KEY MOMENTS IN AI

- **1970s' AI winter**
  - Common sense reasoning and supposedly simple tasks like face recognition would always be beyond their capability
  - Perceptron not able to implement basic function.
  - Machine translations: NRC, 1950s', translation from Russian to English
    - "The spirit is willing but the flesh is weak" (心有余而力不足) produced
    - "The vodka is good but the meat is rotten"
    - Requires knowledge to establish content
  - Funding for the industry was slashed

KEY MOMENTS IN AI

- **1980s, expert system, new hope**
  - General problem solving vs. expert system
- **1990 Bottom up approach**
  - Imitate biology, ANN

- **1997 AI Game, Milestone**
  - Deep Blue, 11 May 1997
- **2002 First robot for the home**
  - Roomba by iRobot

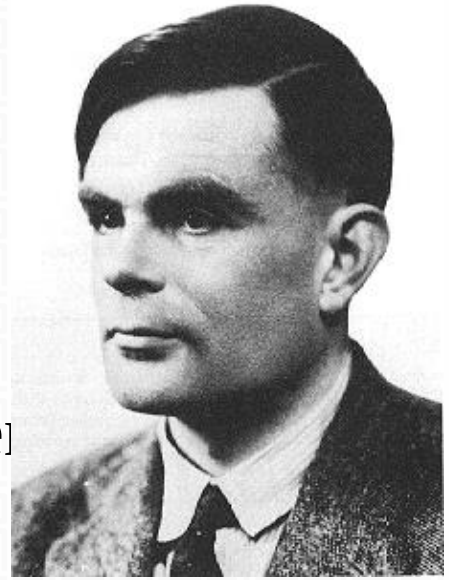
KEY MOMENTS IN AI

- **2008 Speech recognition**
  - Google, 92% accurate
- **2011**
  - Watson won US quiz show Jeopardy
- **2014 Turing test passed**
  - Chatbot Eugene Goostman

WHAT IS AI?

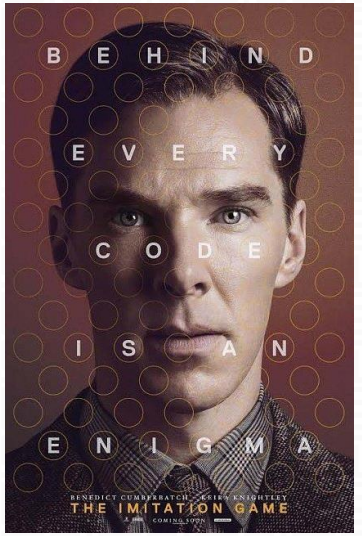
- **What is intelligence?**
  - Understanding languages
  - Automated reasoning
  - Usually require knowledge
  - Learning
  - ……
- **Do machines really understand？**

ALAN TURING



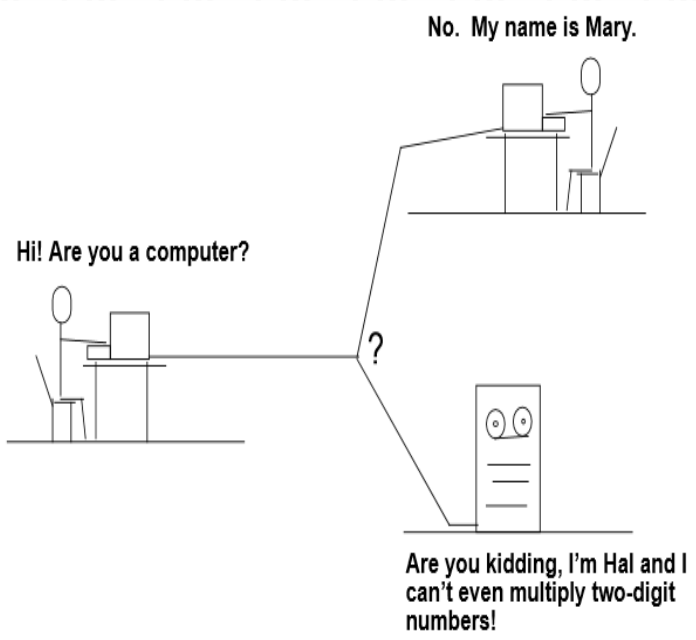
- Father of modern Computer Science
- Founder of computer science, mathematician, philosopher and code breaker

- 1936: provide a formalization of the concepts of The **Turing machine**, which can be considered a model of a general purpose computer
- 1939-40 Devises the **Bombe**, machine for Enigma **decryption**, breaking the **German ciphers** in the second world war.
- 1950: **Philosophical** paper on machine intelligence: the **Turing Test**



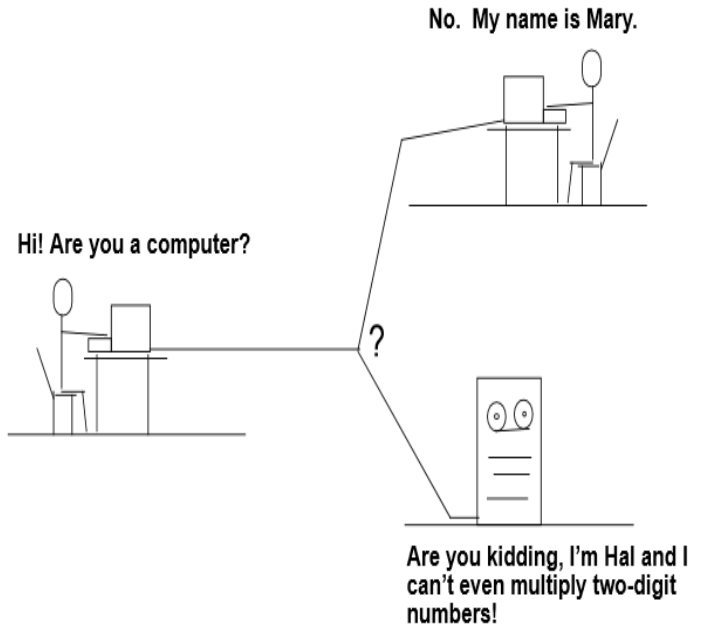
THE TURING TEST

- The test is conducted with two people and a machine
- One person plays the role of an **interrogator** and is in a separate room from the machine and the other person
- The interrogator cannot see the machine and person, he only knows the person and machine as A and B.



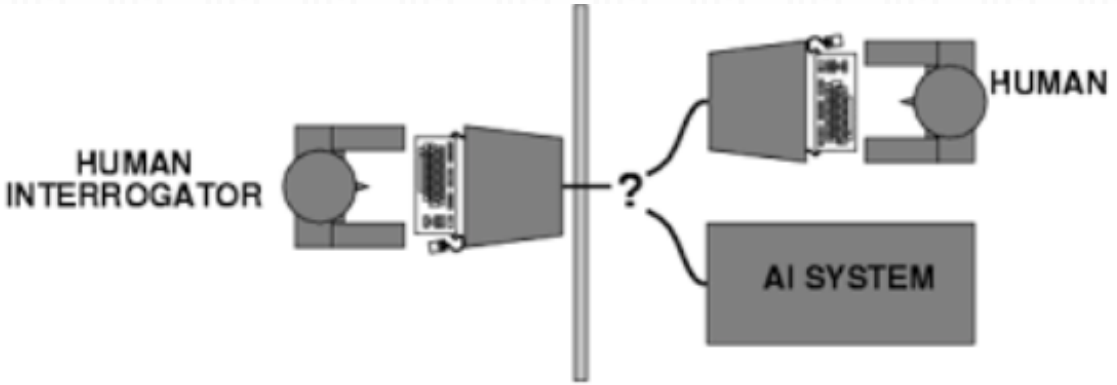
THE TURING TEST

- The interrogator's task: to find out which candidate is the machine or human, only by **asking them questions**.
- The aim of the machine is to **fool** the interrogator into thinking that it is a person.
- If the machine can fool the interrogator **30% of the time**, the machine is considered **intelligent**.



THE TURING TEST

- If the Turing Test was passed, Turing would conclude that the machine was intelligent
  - Suggested as a way of saying when we could consider machines to be intelligent, or at least act intelligently?
  - A satisfactory operational definition of intelligence



THE TURING TEST

- Turing predicted the machines will be able to pass the test by the year 2000.
- In 2014, the chatbot "Eugene Goostman" passed the Turing test
  - with 33% of the event's judges identified goostman as human.
  - The first machine to pass a Turing test

AN INTERVIEW WITH EUGENE GOOSTMAN

Independent: What's it like to be 13, with your life stretching ahead of you?

Eugene: It's something extremely mysterious. I can't tell you anything more about it, sorry... Wanna ask me something more?

Independent: Who's going to win the World Cup?

Eugene: I'm not interested in soccer, unfortunately. I think, it's quite annoying show. I believe even cockroach races are more intelligent and amazing show.

Independent: You look a bit like Harry Potter. Are you a fan of the series?

Eugene: I have no idea why kids go crazy about Harry Rotter – sorry – Potter. No magic wand can turn a boring geek into a super-hero.

Independent: Where do you live?

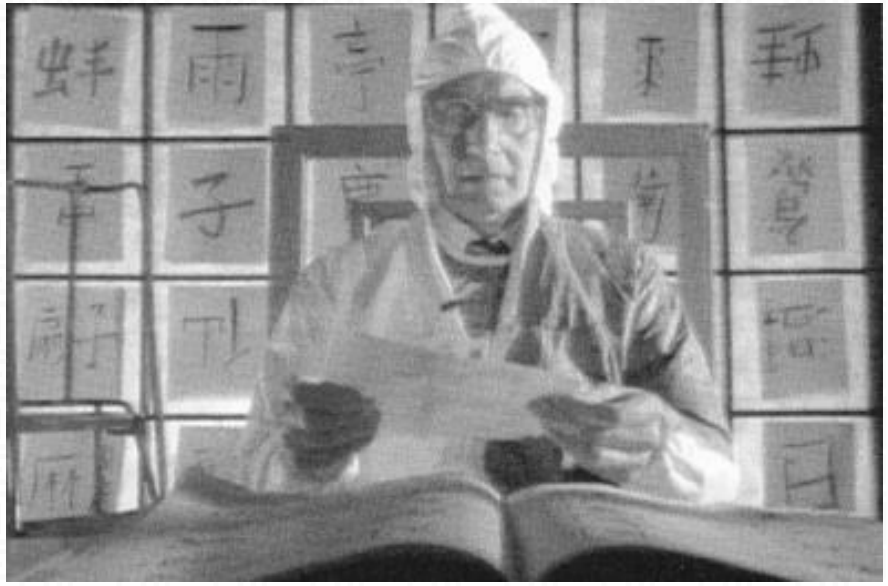
Eugene: I live in a big Ukrainian city called Odessa. It is on the Black Sea shore.

THE TURING TEST

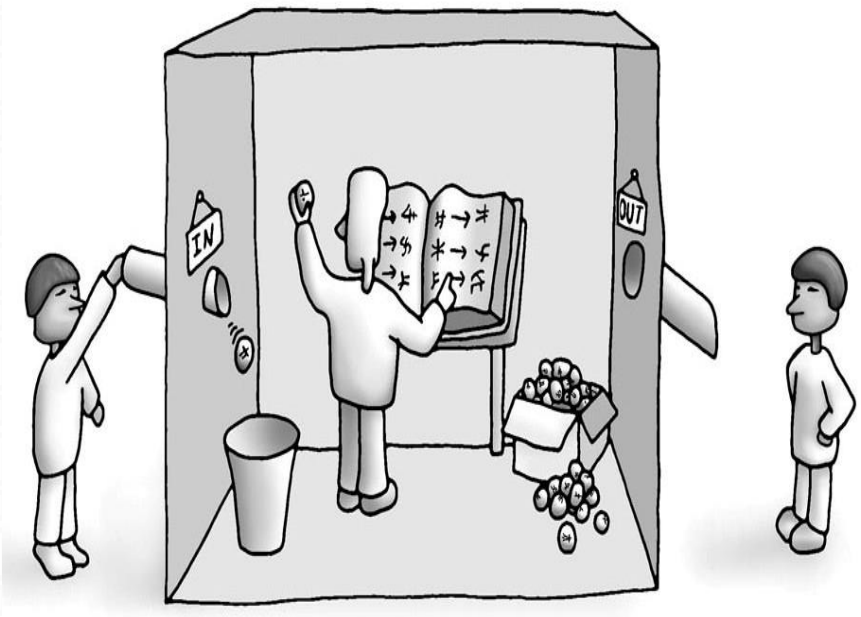
- What would a computer need to pass the Turing test?
  - Natural language processing: to communicate with examiner.
  - Knowledge representation: to store and retrieve information provided before or during interrogation.
  - Automated reasoning: to use the stored information to answer questions and to draw new conclusions.
  - Machine learning: to adapt to new circumstances and to detect and extrapolate patterns.
  - Vision (for Total Turing test): to recognize the examiner's actions and various objects presented by the examiner.
  - Motor control (total test): to act upon objects as requested.
  - Other senses (total test): such as audition, smell, touch, etc.

THE CHINESE ROOM

- In 1980 John Searle devised a thought experiment which he called the Chinese Room (Searle, 1980)
  - Searle, J.R. 1980. Minds, Brains and Programs. Behavioral and Brain Sciences, 3: 417-457, 1980
- Searle argued that the Turing test could not be used to determine if a machine can think
  - Behaving intelligently was not enough to prove a computer was intelligent



THE CHINESE ROOM



- The system comprises of:
  - a human, who only understands English
  - a rule book, written in English
  - stack of paper.
    - One stack of paper is blank.
    - The other has symbols on them.
- In computing terms
  - the human is the CPU
  - the rule book is the program
  - the two stacks of paper are storage devices.

SEARLE'S CLAIM

- We have a system that is capable of passing the Turing Test and is therefore intelligent according to Turing

- But the system does **not understand Chinese** as it just comprises a rule book and stacks of paper which do not understand Chinese.

- Therefore, running the right program does not necessarily generate **understanding,** the system only **act** as it understands Chinese

CATEGORIES OF ARTIFICIAL INTELLIGENCE

◆Definitions of AI (textbook)

	Human	**Rational**
Think	Thinking humanly	Thinking rationally
ACT	Acting humanly	Acting rationally

◆Strong AI vs. Weak AI (John Searle)

- **Strong AI:** A system can have a mind and mental states
- **Weak AI:** A system can act intelligently
(there are non-intelligent ways to achieve intelligent tasks)

MACHINE INTELLIGENCE

Argument: Computers can't be intelligent

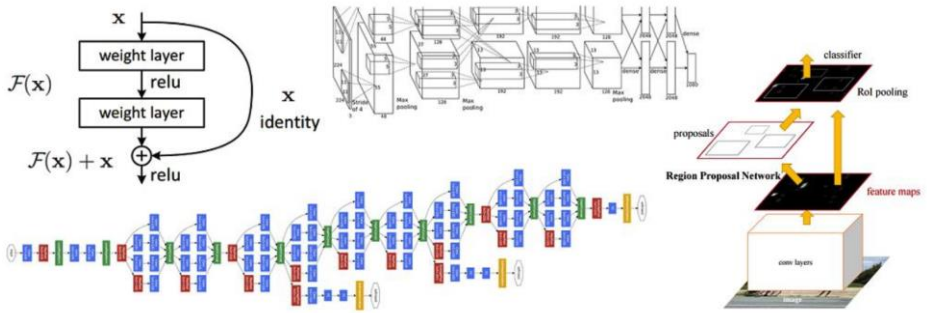
- In common sense, intelligence requires:
  - **Self-awareness**: being conscious of one's own existence
  - **Intentionality**: having the intention of doing something, to achieve some goals
- Computers can play strong games, and a chimpanzee can play poor games?
  - There are **non-intelligent ways** to achieve intelligent tasks (weak AI)

Define Machine intelligence:

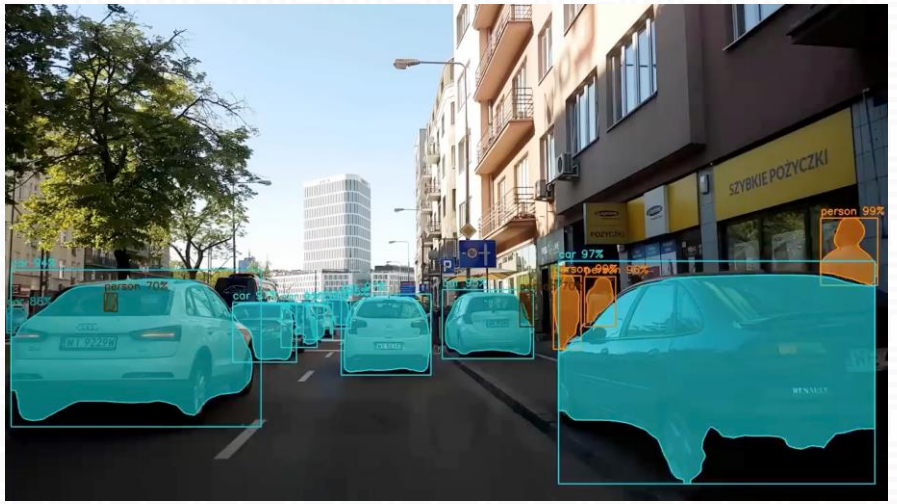
Where a computer is used to accomplish tasks which, were it to be done by human, would require intelligence

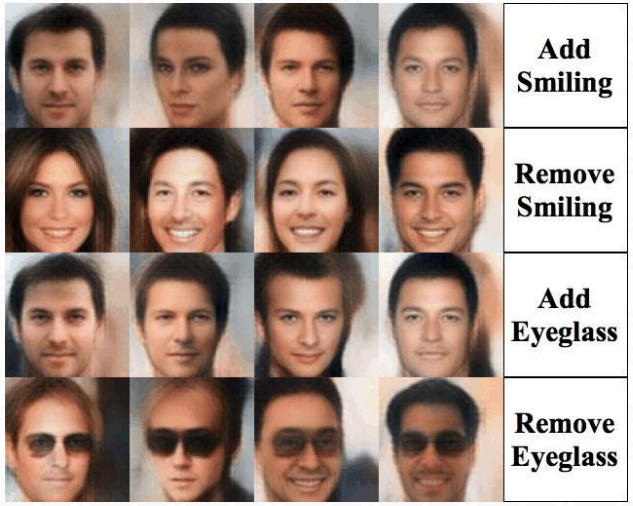
- E.g. How does Siri work?
- Google self-driving car has safely driven 1100,000 km since 2010.

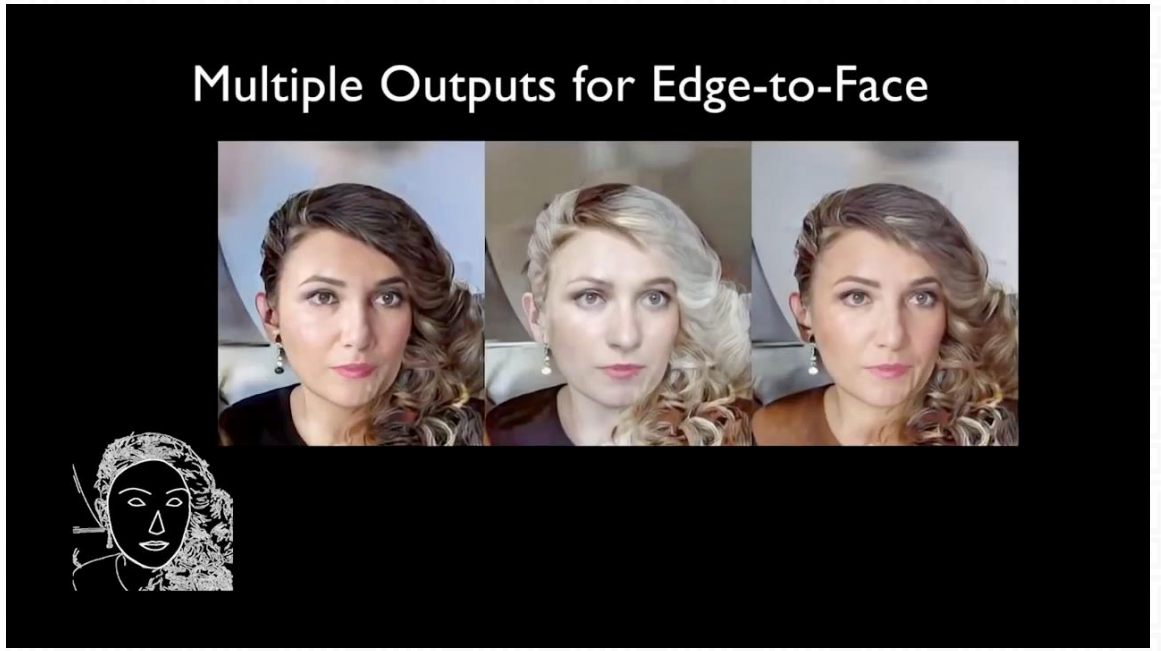
STATE OF THE ART(CV)



Source: [Isola et al. 2016]


SZYBKIE POŻYCZKI
person 99%
car 97%
person 70%


Add Smiling
Remove Smiling
Add Eyeglass
Remove Eyeglass


Multiple Outputs for Edge-to-Face

PREDICTIONS IN AI HISTORY

- "*Within 10 years a computer will be a chess champion*"
  - Herbert Simon, 1957
  - IBM Deep Blue on 11 May 1997
- "*In some point…we should have to expect machines to take control*"
  - Alan Turing, 1951
- "*Robots will be smarter than us all by 2029*"
  - "Theory of singularity": humans and machines will converge
  - Ray Kurzweil, 2014

YOUR PREDICTION!

- AI could spell end of the human race.

  Stephen Hawking, 2014

- Can machines ever be intelligent? **If so, when?**

SUMMARY

- Understand the four categories of AI definition
- Differentiate between strong vs. weak AI
- The Turing Test and the Chinese Room
- Brief history of AI, and AI games

SELF STUDY

Read the book chapters and understand

- AI terminologies
  - 4 categories of definitions from different AI books
  - Weak AI: Machine can possibly act intelligently
  - Strong AI: Machines can actually think intelligently
- **Turing test**
  - A satisfactory operational definition of intelligence
- **The Chinese Room experiment**

SELF STUDY & FURTHER READING

- AIMA Chapter 1 and Chapter 26
- Next Week: AIMA Chapter 3.1 – 3.2