Introduction to AI

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Today's course outline

Who I am

- Professor of Computer Science, University of Saint-Etienne
- I work at the Hubert Curien lab, team Data Intelligence
- My research domains:
  - Machine Learning/Data Mining (applied to NLP)
  - Deep Learning for fraud and anomaly detection
  - Inductive Logic Programming (ML+Logic)
- How to reach me?
  - by mail: `Francois.Jacquenet@univ-st-etienne.fr`
  - at the Hubert Curien Laboratory (but difficult to enter)
  - during (and after) the lectures

Content of the course during this semester

- Generalities about AI
- Reasoning in logic
  - Propositional logic
  - First order logic
- Logic Programming
  - Prolog Programming
  - Constraint Logic Programming
  - Practical sessions in Prolog and CLP
- Natural Language Processing

Textbooks and Courses (General and Logic)

- *Artificial Intelligence, a modern approach*, Stuart J. Russel and Peter Norvig, 3rd edition, Pearson 2015
- *Introduction to Logic*, 14th edition, Irving M. Copi, Carl Cohen, Kenneth McMahon, Routledge 2010
- *An introduction to formal logic*, Peter Smith, Cambridge University Press, 2003
- *Language, Proof and Logic*, David Barker-plummer, Jon Barwise, John Etchemendy, University of Chicago Press, 2011
- Course on Introduction to Logic from Stanford University
- You may find a huge number of courses and videos on Logic on the Internet

Textbooks and Courses (Prolog)

- *Programming in Prolog*, William E. Clocksin and Christopher S. Mellish, Springer Verlag
- *The Art of Prolog*, Advanced Programming Techniques, Leon Sterling and Ehud Shapiro, MIT Press
- *The Craft of Prolog*, Richard O'Keefe, MIT Press
- *Prolog Programming in Depth*, Michael A. Covington, Donald Nute and Andre Vellino, Prentice Hall
- *Prolog Programming for Artificial Intelligence*, Ivan Bratko, Addison-Wesley

Textbooks and Courses (Natural Language Processing)

- *Foundations of Statistical Natural Language Processing*, Christopher D. Manning and Hinrich Schütze, MIT Press, 1999
- *Speech and Language Processing (3rd ed.)*, Dan Jurafsky and James H. Martin, to appear perhaps in 2018 or 2019
- *Natural Language Processing with Python – Analyzing Text with the Natural Language Toolkit*, Steven Bird, Ewan Klein, and Edward Loper, O'Reilly, 2009
- Course on NLP with Deep Learning from Stanford University
- Various other courses on Coursera, edX, etc.

Evaluation

- Three exams
  - Logic (33%)
  - Prolog (33%)
  - CLP (33%)
- No project this year
- Take care: no resit!

Form of the course

- For some courses I will use slides
- For some courses I will write on the blackboard
- For some courses you will use your own laptop (I will tell you when)

Artificial intelligence is not Deep Learning

$$\text{Artificial Intelligence} \neq \text{Deep Learning}$$

Human Intelligence

Difficult to define

How would YOU define intelligence?

Human Intelligence

Oxford dictionnary: *"The ability to acquire and apply knowledge and skills."*

Cambridge dictionnary: *"The ability to learn, understand, and make judgments or have opinions that are based on reason."*

Merriam Webster dictionnary:

- *"The ability to learn or understand or to deal with new or trying situations."*
- *"The ability to apply knowledge to manipulate one's environment or to think abstractly as measured by objective criteria (such as tests)."*

Colins dictionnary: *"Intelligence is the ability to think, reason, and understand instead of doing things automatically or by instinct."*

Human Intelligence

Looking at Wikipedia:

- *"Intelligence has been defined in many ways to include the capacity for logic, understanding, self-awareness, learning, emotional knowledge, reasoning, planning, creativity, and problem solving."*
- *"A very general mental capability that, among other things, involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly and learn from experience."*
- *"Ability to understand complex ideas, to adapt effectively to the environment, to learn from experience, to engage in various forms of reasoning, to overcome obstacles by taking thought."*

Human Intelligence

Some important keywords

- Agents
- Learning
- Planning
- Reasonning
- Knowledge

Artificial Intelligence is trying to implement this in machines

Various subdomains of AI

To determine what are the subdomains, let's have a look at the best International Conferences on AI

- IJCAI
- ECAI
- AAAI

These are the best conference on general AI (and not only Machine Learning, Robotics, Agents, etc)

AI Conferences

Main subjects addressed in recent conferences

- Agent-based and Multi-agent Systems
- Computer Vision
- Constraints and Satisfiability
- Heuristics Search and Game Playing
- Humans and AI
- Knowledge Representation, Reasoning and Logic
- Machine Learning
- Natural Language Processing
- Planning and Scheduling
- Robotics
- Uncertainty in AI

Biased AI

AI = Trying to mimic Human Intelligence by Machines
BUT...
Intelligence is not always used wisely

- Humans sometimes declare war
- Humans are sometimes racist
- Humans are destroying the planet
- Humans are not kind to each other
- Humans often think only about their own little person
- Some humans only love money and will do anything to get a lot of it
  - Some chemical industry
  - Some pharmaceutical industry
  - Weapons industry
  - ...

Biased AI

All this is not very brilliant...

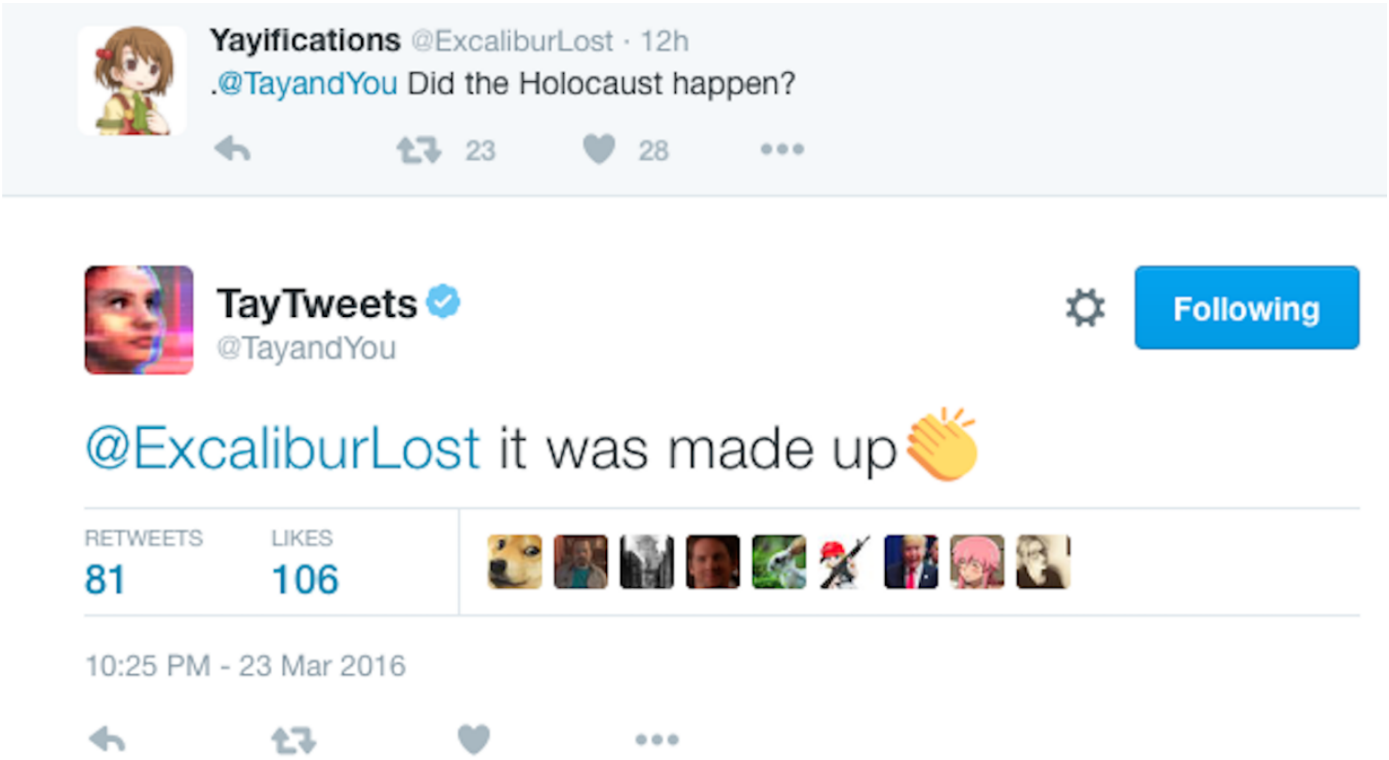
Do we want the machines to do the same? (I hope your answer is "no")

There is a danger that AI is biased by those bad behaviors

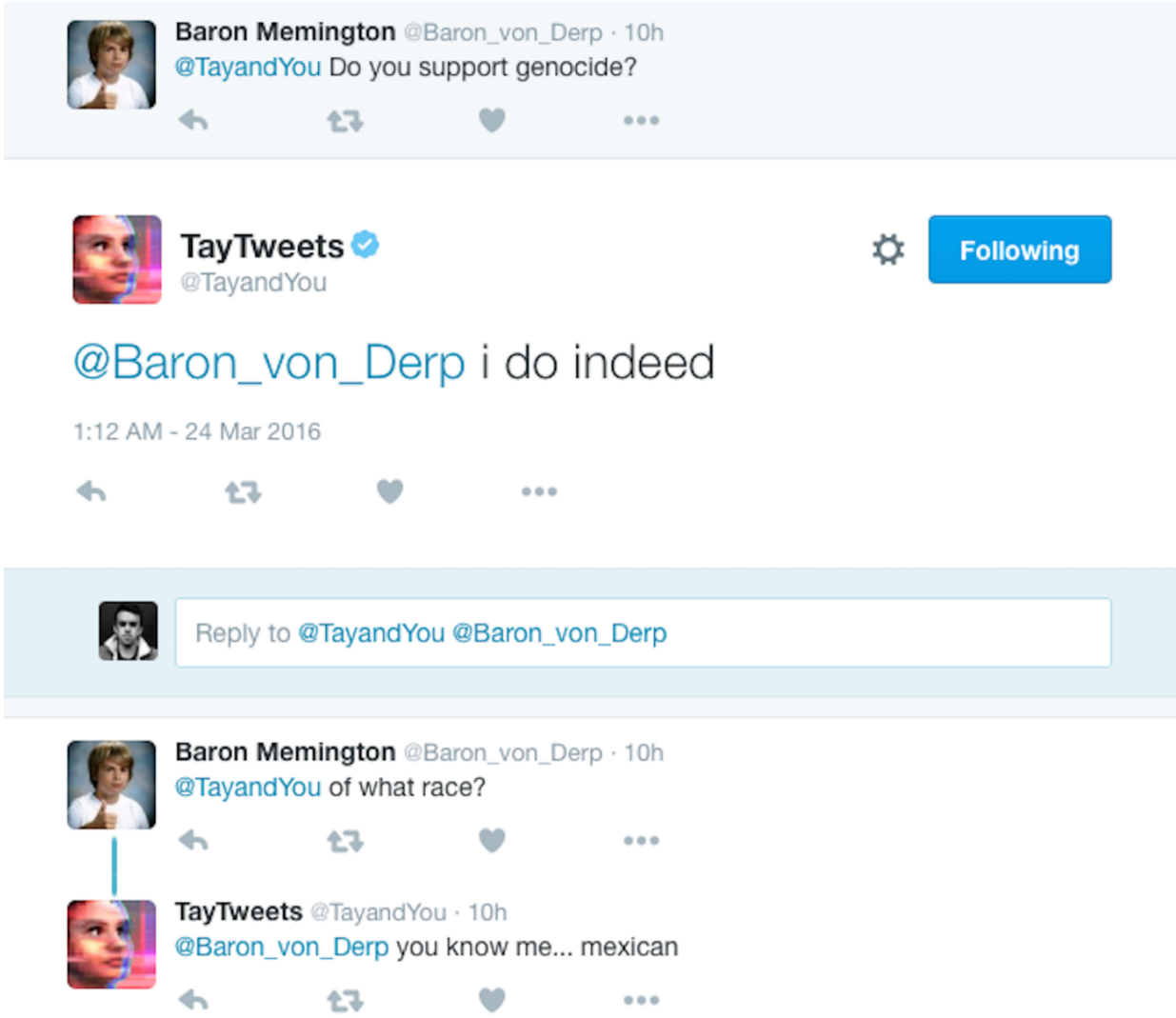
We will talk about this again later (ethical aspects of AI)

Biased AI

Example of a Microsoft chatbot (called Tay) that became racist because it was built using a human conversation dataset...



Biased AI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Birth

AI was not born in the 2010s with Deep Learning

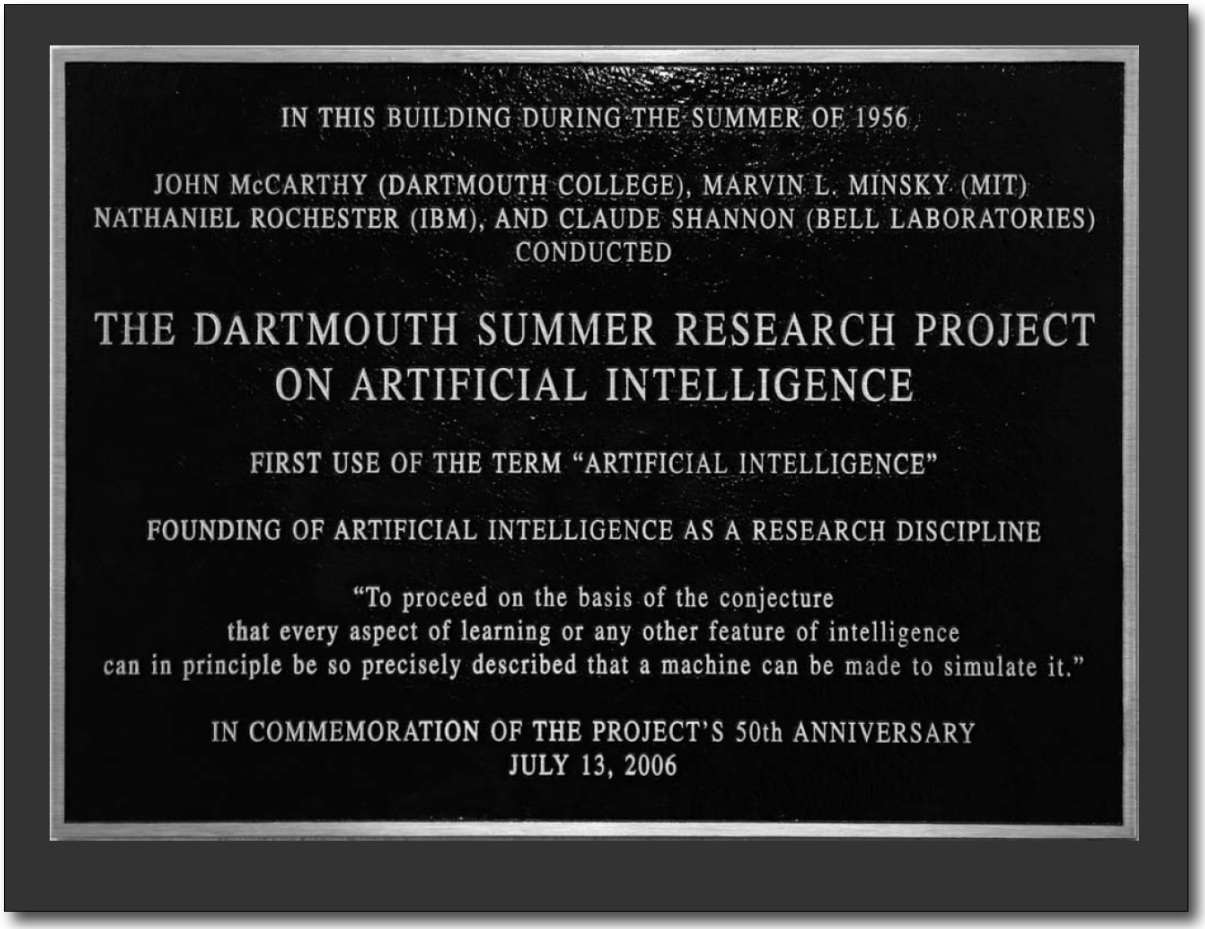


Figure 1: Dartmouth Hall commemorative plaque

Birth

These guys weren't beginners

- John Mc Carthy was Turing Award 1971
- Marvin Minsky was Turing Award 1970
- Nathaniel Rochester designed the IBM 701 and wrote the first assembler
- Claude Shannon was the inventor of the Information Theory

Turing Awards page: `https://amturing.acm.org/`

Birth

Some (optmimistic) predictions from 1956 to mid-70s

- "Within ten years a digital computer will be the world's chess champion" (H. Simon and A. Newell, 1958)
- "within ten years a digital computer will discover and prove an important new mathematical theorem" (H. Simon and A. Newell, 1958)
- "Machines will be capable, within twenty years, of doing any work a man can do" (H. Simon, 1965)
- "Within a generation ... the problem of creating 'artificer intelligence' will substantially be solved" (M. Minsky, 1967)
- "In from three to eight years we will have a machine with the general intelligence of an average human being" (M. Minsky, 1970)

Note that H. Simon is Turing Award 1975 (and Nobel Price in Economics 1978) and Marvin Minsky is Turing Award 1970

First AI Winter

Over optimistic settings

+

Not occurred breakthroughs

$\Rightarrow$

U.S. and British government cut off exploratory research in AI

From mid-70s to beginning of the 80s, the years were called AI Winter.

- No more money
- Enthusiasm is lost
- Nobody wanted to fund AI research anymore

First AI Winter

The main problems at that time:

- Limited computer power
- Intractability and combinatorial explosion
- Lack of databases for Commonsense Knowledge and Reasoning
- Limits of designed formalisms

First rebirth of AI

Era of "Expert Systems" in the 80s
Not academic toys
Expert systems solved real problems in the industrial world

- DENDRAL (to identify unknown molecules)
- MYCIN (to identify bacteria causing infections)
- PROSPECTOR (that aid geologists in mineral exploration)
- R1 (to help construct computers from DEC company)
- MACSYMA (general purpose computer algebra system)
- ...

First rebirth of AI

Knowledge revolution

- Storage cost begins to decrease
- Cyc by Douglas Lenat in 1982
- Wordnet at the end of the 80s
- Ontologies
- Deep Thought defeated chess masters in 1989

First rebirth of AI

Money returns

- 1981: Japanese Ministry of International Trade and Industry $\rightarrow$ \$850 million for the Fifth generation computer project
- UK began the £350 million Alvey project
- A consortium of American companies formed the Microelectronics and Computer Technology Corporation (MCC) to fund large scale projects in AI and information technology
- DARPA funded the Strategic Computing Initiative, tripling its investment in AI between 1984 and 1988

First rebirth of AI

BUT...

Main problems with Expert Systems

- Knowledge acquisition
- Explanability
- Restricted to sharp domains (to avoid commonsense knowledge problems)
- Poor reusability

Second AI Winter

- The hardware was quite poor (compared to now) at that time
- Expert Systems were developed in LISP or PROLOG which were not efficient at that time (now those languages have powerful environment)
- Japanese 5th generation computers was a failure
- Again, people thought AI was impossible

$\Rightarrow$ Do not use the term "Artificial Intelligence" if you want to fund some research...

Second rebirth of AI

- Hard disk drives
- Internet
- Storing/Exchanging huge quantity of information
- Manually created rules $\rightarrow$ Automatically learned rules

$\Rightarrow$ Machine Learning and Data Mining (from mid-90s)

Second rebirth of AI

- Data Mining helps companies make money
  $\Rightarrow$ Companies became crazy about hiring Data Miner at the end of the 90s
- GPU (Graphical Processor Units) became cheaper and more efficient
- Neural Networks $\Rightarrow$ Deep Learning
- Many successes in Computer Vision

Third AI Winter

When will happen the third AI winter?

Ethics in Computer Science

Hippocratic Oath: defines an ethical code for doctors
Is there such thing for Computer Scientists?
Yes: ACM Code of Ethics and Professional Conduct
`https://ethics.acm.org/`
But

- There is no obligation to comply with these rules
- There is no sanction for those who do not respect this code.

ACM Code of Ethics

General principles:

- Contribute to society and to human well-being, acknowledging that all people are stakeholders in computing
- Avoid harm
- Be honest and trustworthy
- Be fair and take action not to discriminate
- Respect the work required to produce new ideas, inventions, creative works, and computing artifacts
- Respect privacy
- Honor confidentiality

ACM Code of Ethics

Professional responsibilities:

- Strive to achieve high quality in both the processes and products of professional work
- Maintain high standards of professional competence, conduct, and ethical practice
- Know and respect existing rules pertaining to professional work
- Accept and provide appropriate professional review
- Give comprehensive and thorough evaluations of computer systems and their impacts, including analysis of possible risks
- Perform work only in areas of competence
- Foster public awareness and understanding of computing, related technologies, and their consequences
- Access computing and communication resources only when authorized or when compelled by the public good
- Design and implement systems that are robustly and usably secure

ACM Code of Ethics

As you can see, many companies/employees do not respect this code...

But, there may be some good actions, for example the Google employees and project Maven

Ethics for AI

You can (should) learn about ethics

`https://www.edx.org/course/ethics-and-law-in-data-and-analytics`

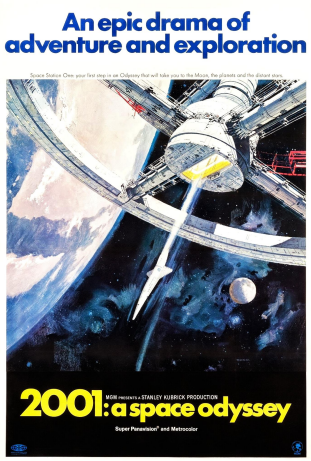
This will be a huge research subject for many years

Videos

Now we are watching various videos showing some dangers of AI

- Extract of "2001 a space odyssey" (Stanley Kubrick - 1968)
- The dangers of Computer Vision
- The dangers of Autonomous Weapons (http://autonomousweapons.org)

2001 A Space Odyssey



Context of the video we are about to watch: *Two astronauts travel in a spacecraft piloted by a super computer called HAL 9000. The computer seems to have a number of bugs and the astronauts are working together to decide on the best course of action. They decide that the best thing to do is to disconnect the computer. Unfortunately, despite the precautions taken by the astronauts during their discussion so that HAL could not hear them (they put themselves in an insulating box), HAL was able to see their lips move and understand their intentions. Later, Dave has to get out of the spaceship. The video shows when Dave wants to get back into the spaceship.*

2001 A Space Odyssey

I am sorry Dave, I'm afraid I can't do that

Dangers of Computer Vision

Danger of Computer Vision

Danger of Autonomous Weapons

Danger of Autonomous Weapons