

Techniques of AI

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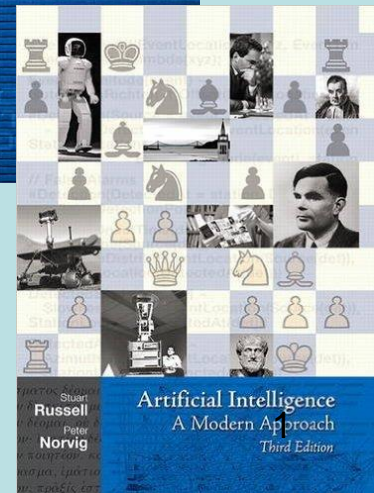
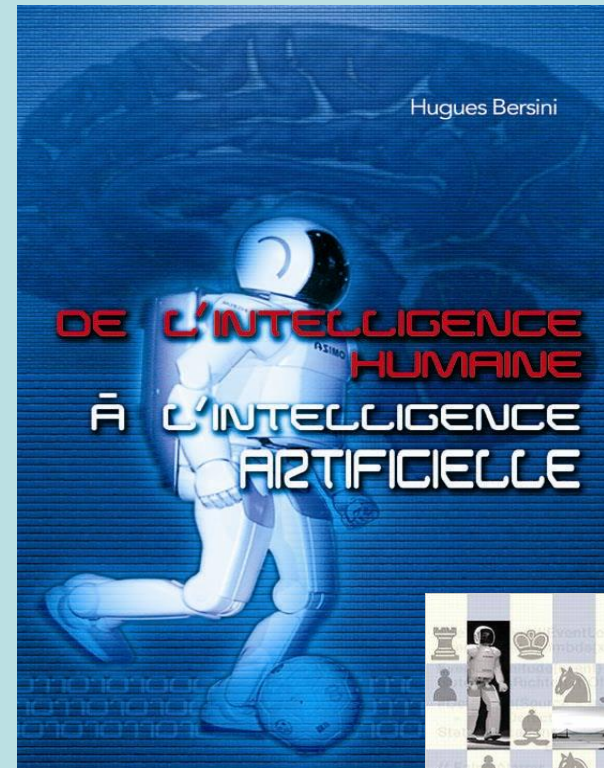
Course material:

De l'Intelligence Humaine à
L'intelligence Artificielle by H. Bersini

Artificial Intelligence, a modern approach
by Russel and Norvig

Prerequisites:

Basic knowlegde of logic, statistics and programming.



What is AI?

Various definitions:

- Building intelligent entities.
- Getting computers to do tasks which require human intelligence.

Simple things turn out to be the hardest to automate:

- Recognising a face.
- Navigating a busy street.
- Understanding what someone says.

AI Pantheon



- Everyday applications

- ▶ cars – cruise control, fuel injection
- ▶ planes – autopilots and lower-level control systems
- ▶ lawnmowers & vacuum cleaners
- ▶ washing machines
- ▶ environmental control – light, thermostats, etc.



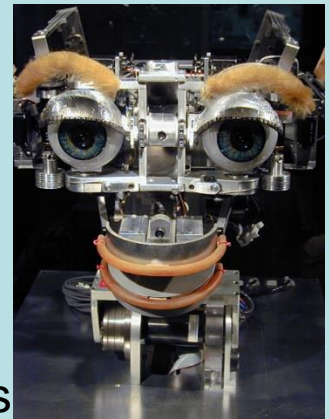
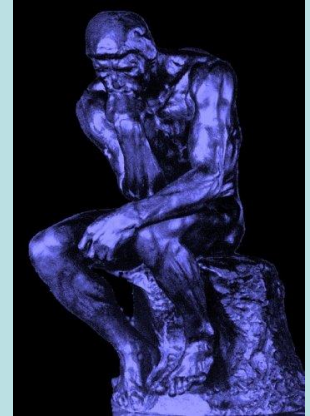
- Large scale applications

- ▶ military strategy planning – Desert Storm
- ▶ prevention of mid-air collisions between planes
- ▶ disaster recovery services – 9/11
- ▶ Deep Space 1 – remote agent experiment



OVERVIEW

- The human side of AI
 - Good old fashioned AI
 - How computers think, resolve, play or discuss of restaurants.
- The animal side of AI
 - New fashioned AI
 - How computers drive, refuse a credit or control a process



Why doing AI?

Two main goals of AI:

- To understand human intelligence better. We test theories of human intelligence by writing programs which emulate it.
- To create useful “smart” programs able to do tasks that would normally require a human (expert).

Who does AI?

Many disciplines contribute to goal of creating/modelling intelligent entities:

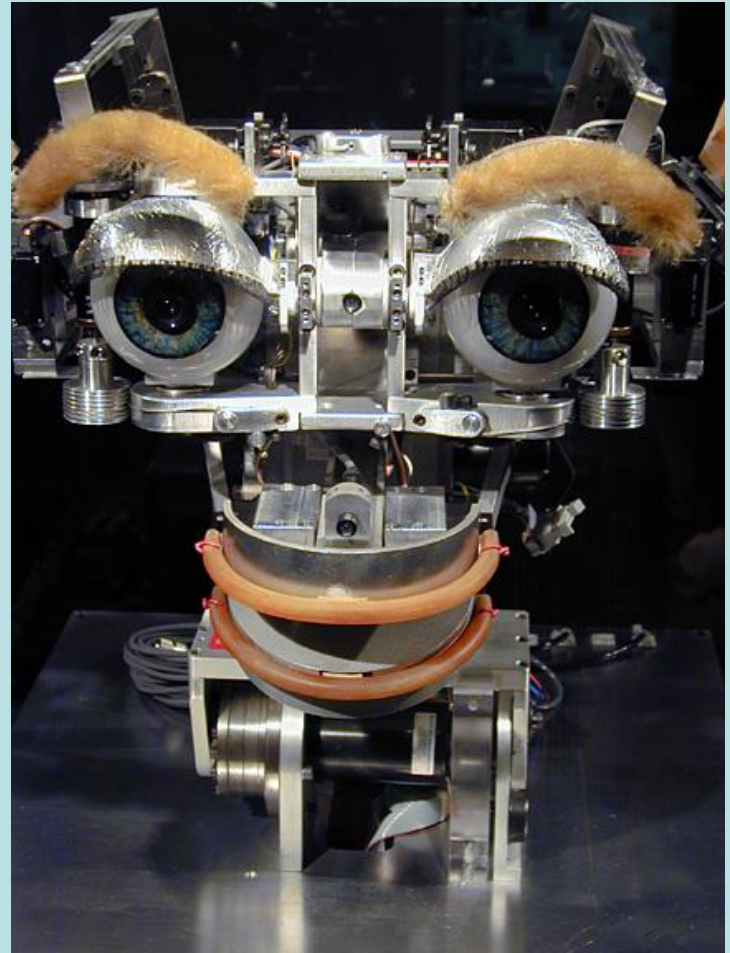
- Computer Science
- Psychology (human reasoning)
- Philosophy (nature of belief, rationality, etc)
- Linguistics (structure and meaning of language)
- Human Biology (how brain works)

Subject draws on ideas from many disciplines.

PLAN

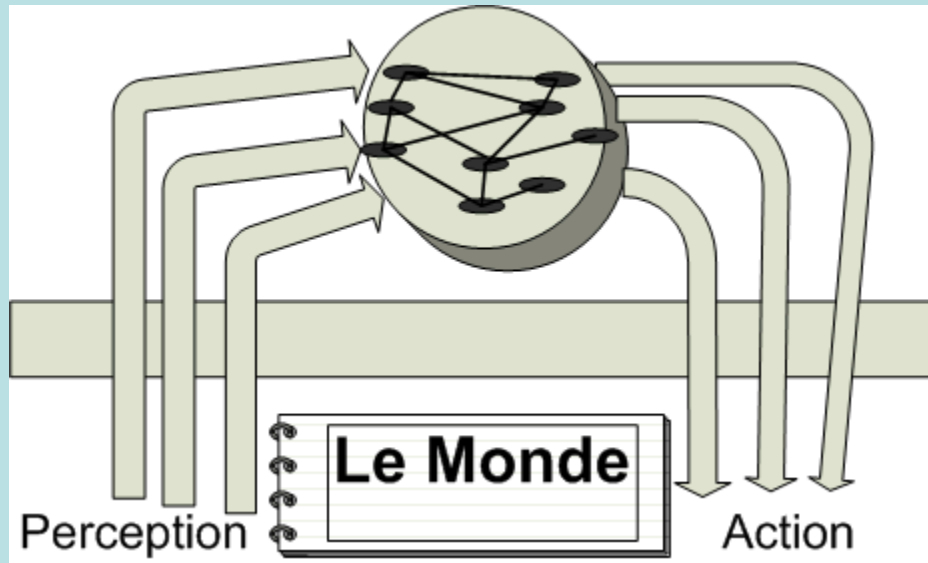
- The human side of IA
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- How computer think, resolve, play or discuss of restaurants.
- The animal side of AI
- New fashioned AI
- How computers drive, refuse a credit or control a process

The human side

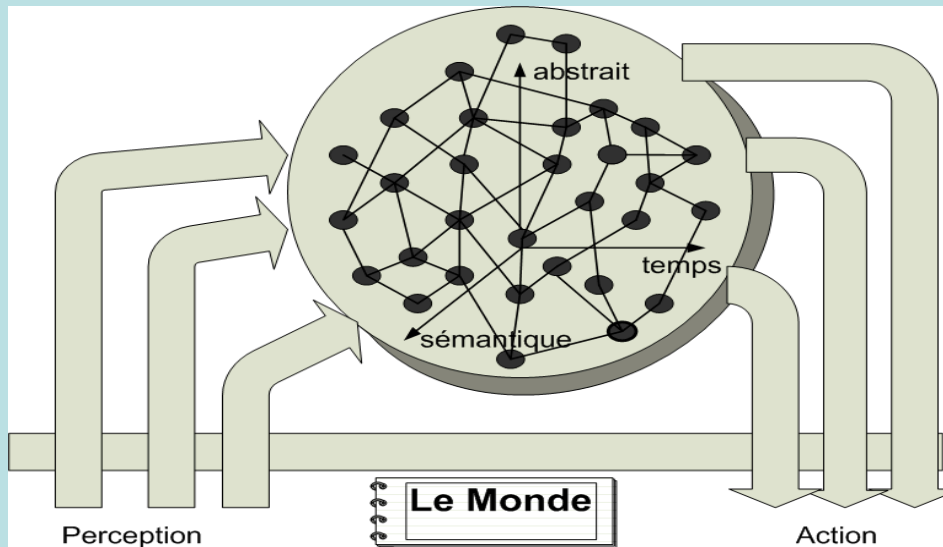


- Intelligence = Mental inferences
- Deductions, planning, mental simulations, reasoning, logics
- Rational intelligence to distinguish from fake intelligences:
 - *Emotional intelligence*
 - *Animal intelligence*
 - *Embodied intelligence*
 - *Collective intelligence*
- Intelligence = IQ, chess, math, logical solving
all the rest is just skills

3 - 0 5 4 - 0 3 3 - 0 3 4



ANIMAL



TAI First Course
Human

Good old fashioned AI

The problem of the water jugs



- There are two jugs of water but with no indication on quantity. One has a maximal capacity of four litres, the other of three litres. How to exactly get two litres in the four litres jug.

Definition of the problem

- The state of the world: (x,y)
- The initial state : $(0,0)$
- The final state: $(2, n)$
- Then a set of operators allowing to evolve the world:

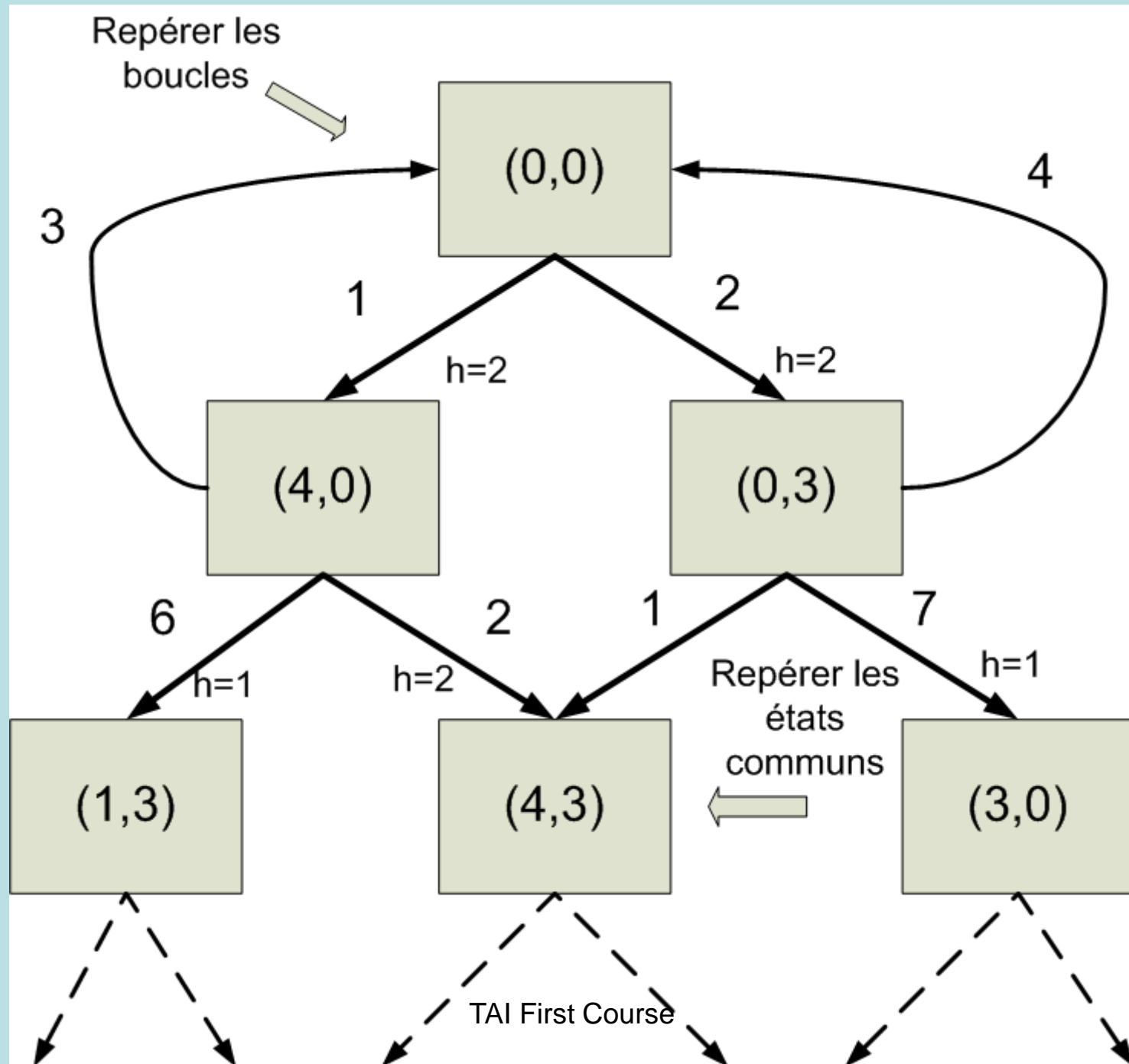
The set of operators



- $(x < 4, y) \rightarrow (4, y)$ fill up the first
- $(x, y < 3) \rightarrow (x, 3)$ fill up the second
- $(x > 0, y) \rightarrow (0, y)$ empty the first
- $(x, y > 0) \rightarrow (x, 0)$ empty the second
- $(x + y > 4, x < 4) \rightarrow (4, y - (4 - x))$ fill x with part of y
- $(x + y > 3, y < 3) \rightarrow (x - (3 - y), 3)$ fill y with part of x
- $(x + y < 4, y > 0) \rightarrow (x + y, 0)$ empty y in x
- $(x + y < 3, x > 0) \rightarrow (0, x + y)$ empty x in y

The inferential engine

- Find the operators that can be applied: their pre-conditions need to match the current state of the world
- Select one → the control strategy:
 - In depth or in width, with heuristics or not
- Avoid looping
- Be able to backtrack
- Do that iteratively until to find the final state
- The solution of a planning problem is the sequence of operators. Often the shortest if you find several solutions.

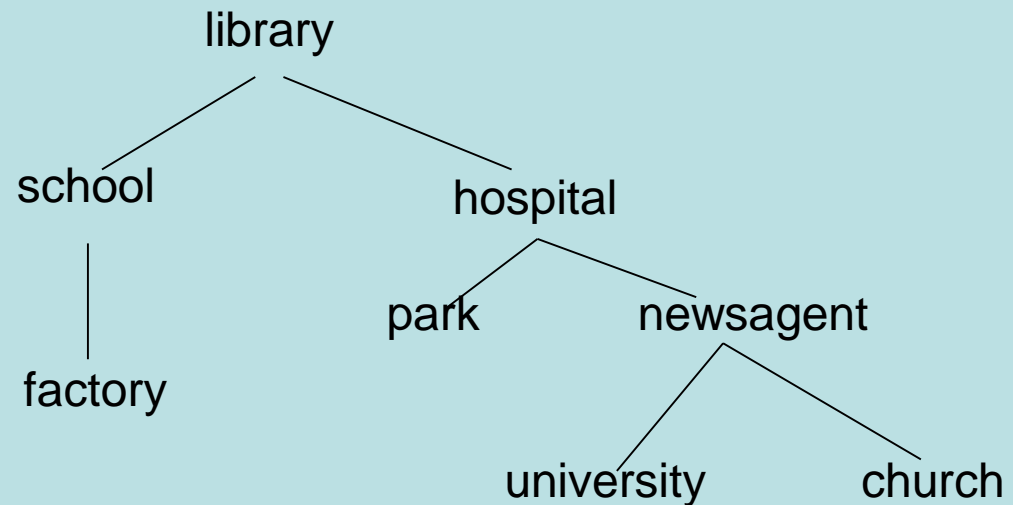
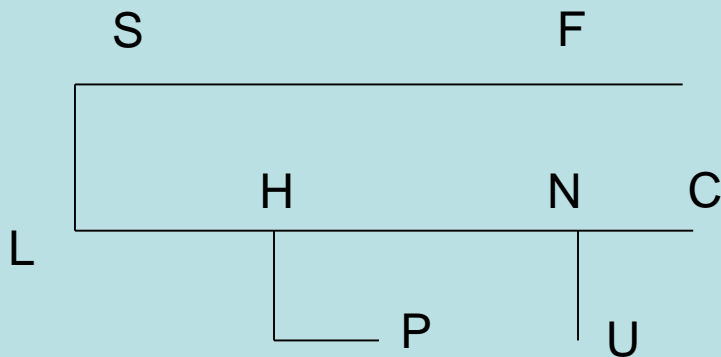


	Operations
(0,0)	
↓	2
(0,3)	
↓	7
(3,0)	
↓	2
(3,3)	
↓	5
(4,2)	
↓	3
(0,2)	
↓	7
(2,0)	

One possible solution

Search Space

- The set of all possible states reachable from the initial state defines the *search space*.
- We can represent the search space as a tree.

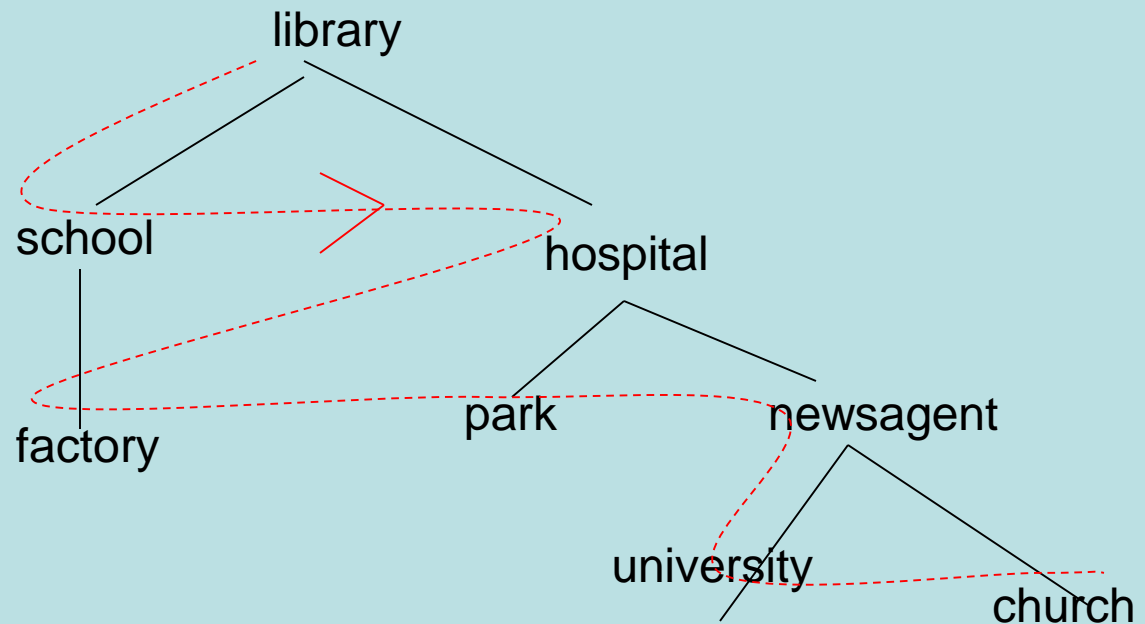


Simple Search Techniques

- How do we search this tree to find a possible route from library to University?
- May use simple systematic search techniques, which try every possibility in systematic way.
- Referred to as **brute force** or **blind** techniques
- Breadth first search
- Depth first search - Follow a path as far as it goes, and when reach dead end, backup and try last encountered alternative.

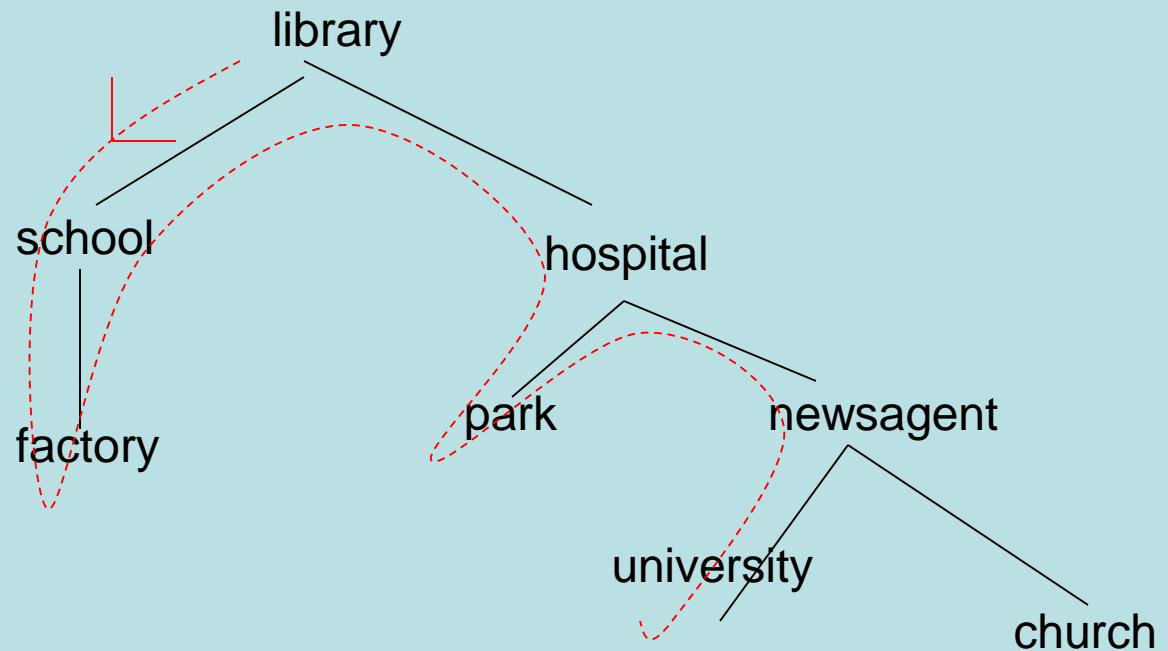
Breadth first search

Explore *nodes* in tree order: library, school, hospital, factory, park, newsagent, university, church.
(conventionally explore left to right at each level)

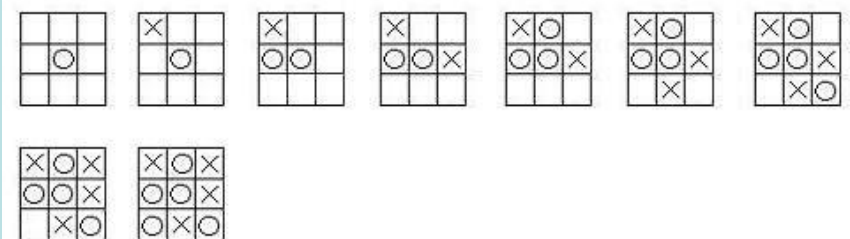
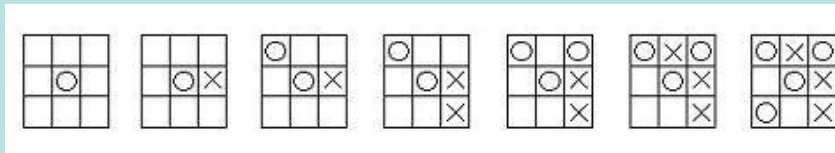


Depth first search

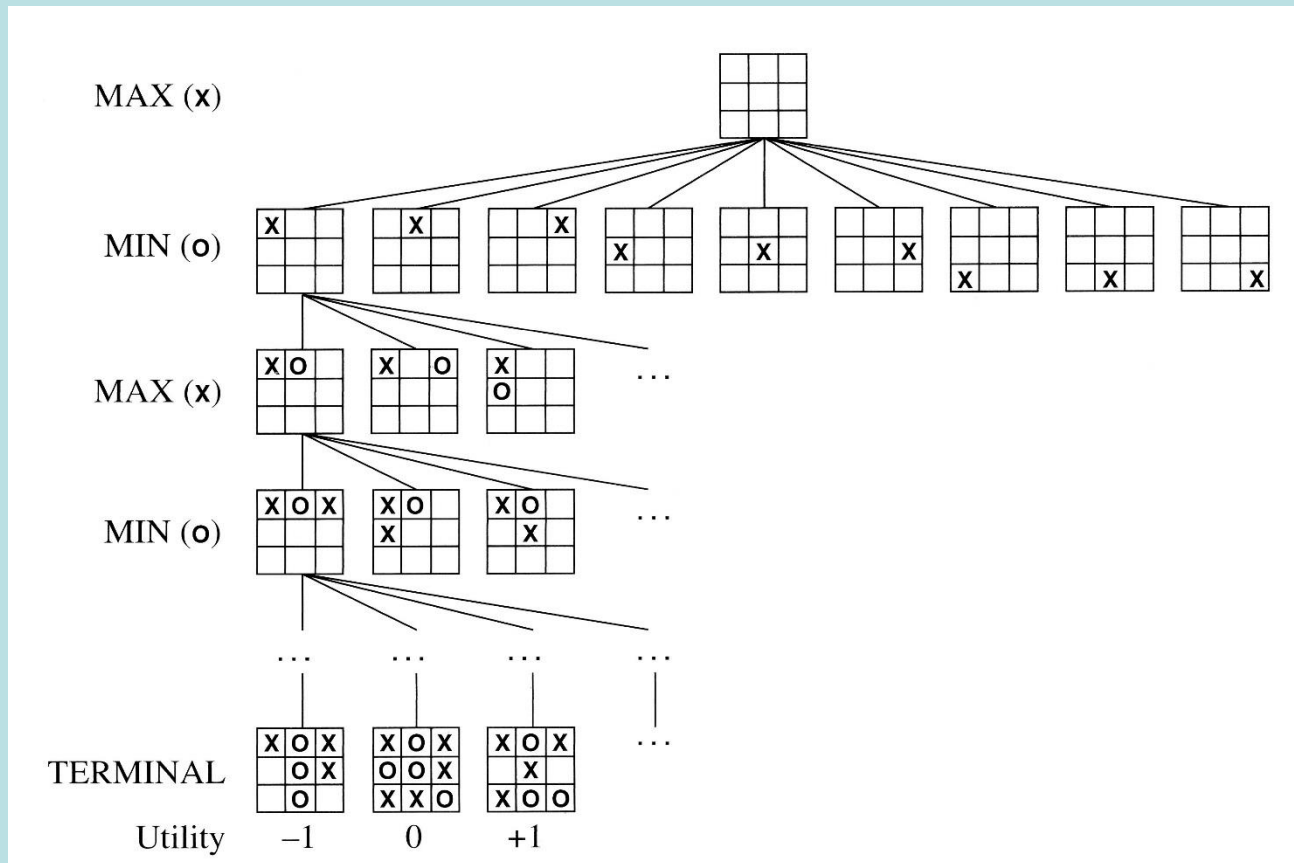
- Nodes explored in order: library, school, factory, hospital, park, newsagent, university.



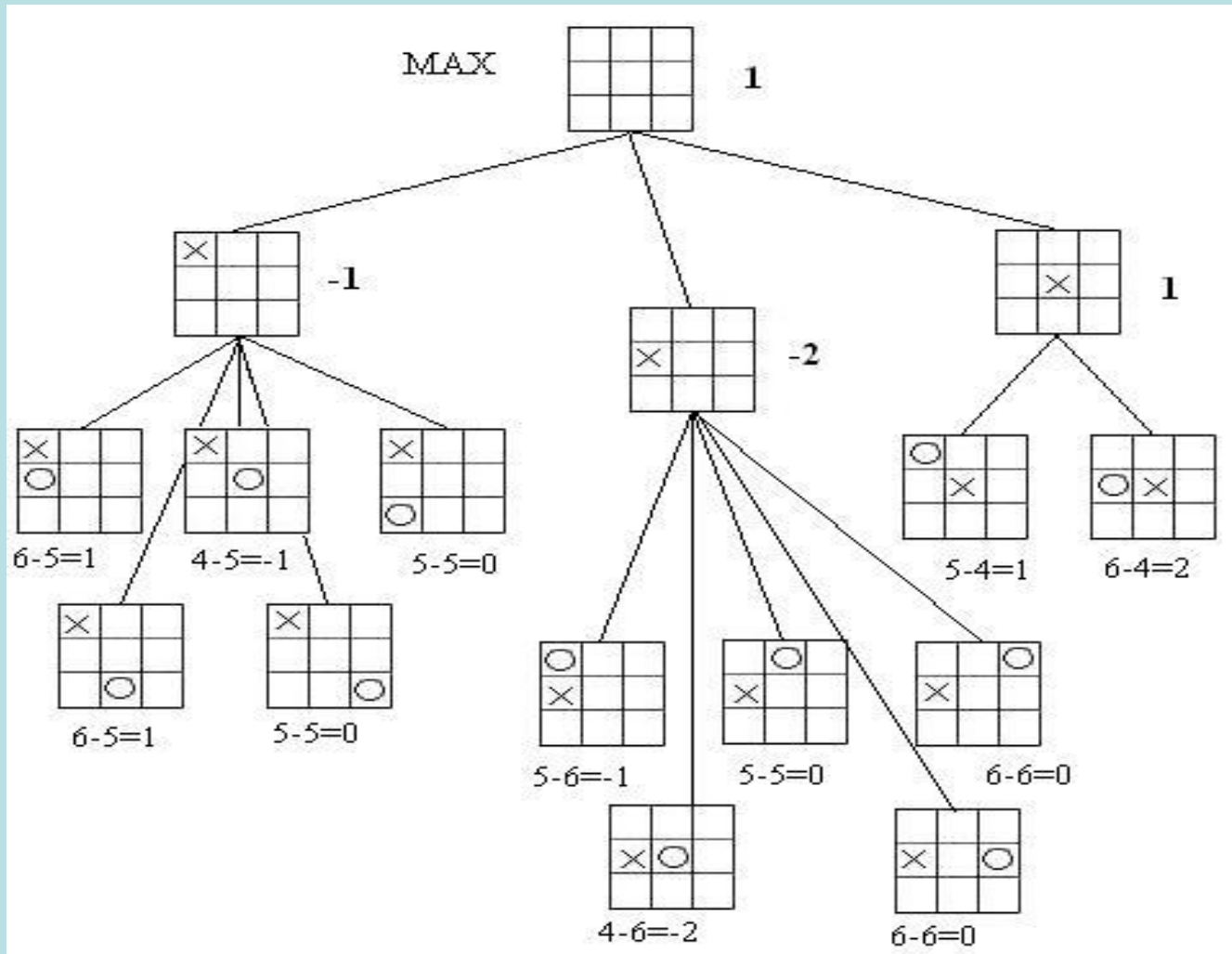
Society games



The Min-Max Strategy



With heuristics

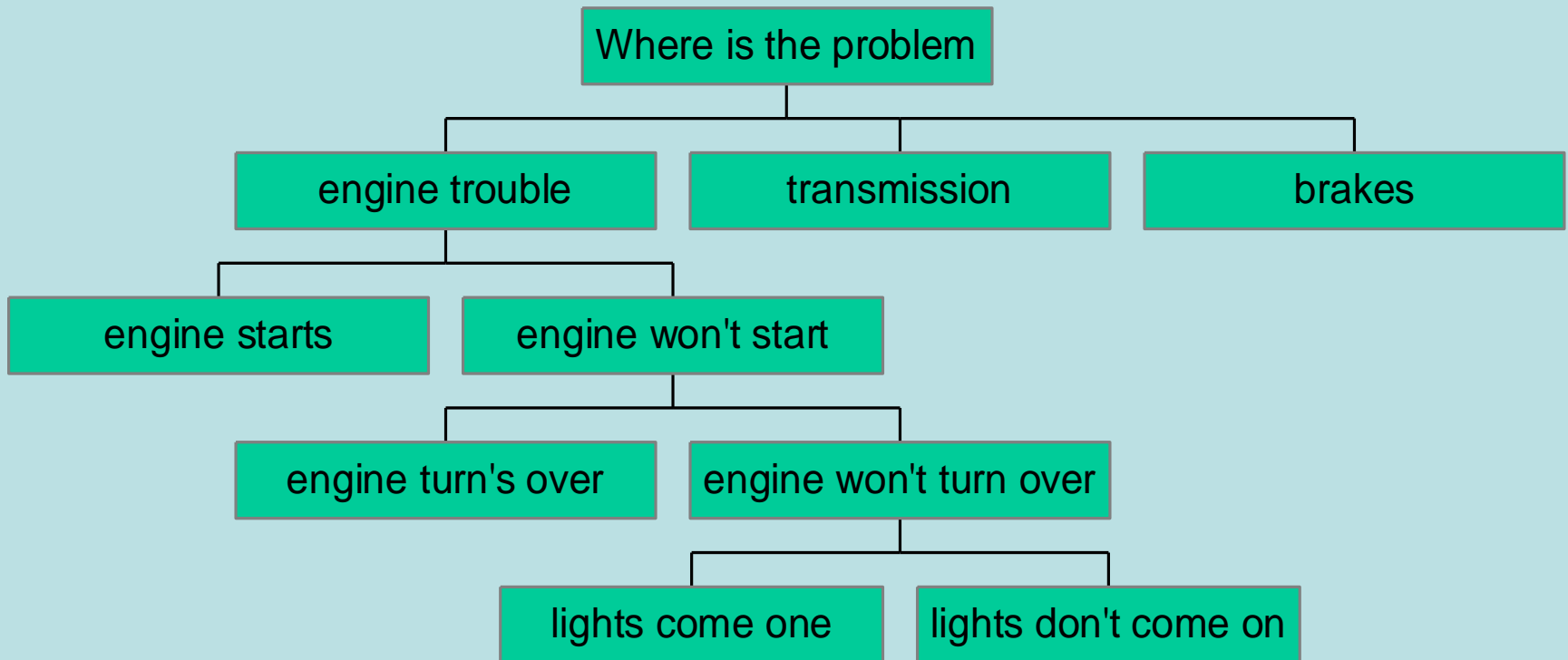


What a software knows about a restaurant

<ul style="list-style-type: none">• Nom: restaurant• Objets: tables menu nourriture addition argent pourboire• Conditions d'entrée:<ul style="list-style-type: none">– Le client a faim– Le client a de l'argent	<ul style="list-style-type: none">• Rôles: client serveuse cuisinier caissier patron• Résultats:<ul style="list-style-type: none">– Le client a moins d'argent– Le patron a plus d'argent– Le client est rassasié– Le client est satisfait
<ul style="list-style-type: none">• Scène 1: entrée<ul style="list-style-type: none">– Le client entre dans le restaurant– Le client cherche une table– Le client choisit une place– Le client va vers la table– Le client s'assoit	<ul style="list-style-type: none">• Scène 3: repas<ul style="list-style-type: none">– Le cuisinier donne la nourriture à la serveuse– La serveuse apporte la nourriture au client– Le client mange la nourriture
<ul style="list-style-type: none">• Scène 2: commande<ul style="list-style-type: none">– Le client prend le menu– Le client regarde le menu– Le client choisit les plats– Le client appelle la serveuse– La serveuse vient à la table– Le client passe la commande– La serveuse va à la cuisine– La serveuse donne la commande– Le cuisinier prépare le plat	<ul style="list-style-type: none">• Scène 4: sortie<ul style="list-style-type: none">– La serveuse prépare l'addition– La serveuse va vers le client– La serveuse donne l'addition au client– Le client paie la serveuse– Le client donne un pourboire à la serveuse– Le client sort du restaurant

Diagnosis of a car problem

Car Problem

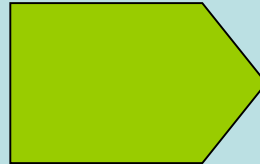


The AI failures

- Man is embodied in his environment
 - Man is a sophisticated sensori-motor process much before any cognitive process takes on.
 - His perception is intrinsically and materially parallel
- The sensori-motor processes essentially depend on their biological grounding: parallel and adaptable
- World outside is complex and requires an interface of a similar complexity.
- But this complexity can be achieved by learning and experience rather than being handcrafted
 - Based on learning and an iterative simplicity. Complex processes emerge from iterating simple mechanisms

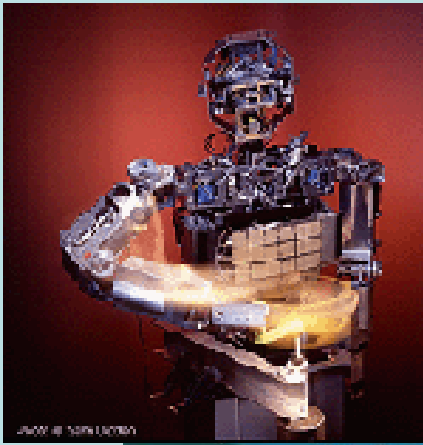
- Man possess 2 cognitive systems
 - 1) Parallel, automatic, unconscious, reflex, adaptable, and very efficient
 - Based on neuronal hardware
 - For playing tennis, piano, becoming an expert
 - 2) Sequential, rigid, conscious and very laborious
 - Based on neuronal software
 - For playing chess, for testing IQ
- Man goes from one to the other in the cases of breakdowns in his automatisms
- Machine intelligence and human intelligence can be of different nature
- For the machines today, recognizing a face is much more difficult than playing chess
- But doesn't Kasparov in part play chess like indeed we recognize a face ?

The animal side



AI
Software
Cognitive Science

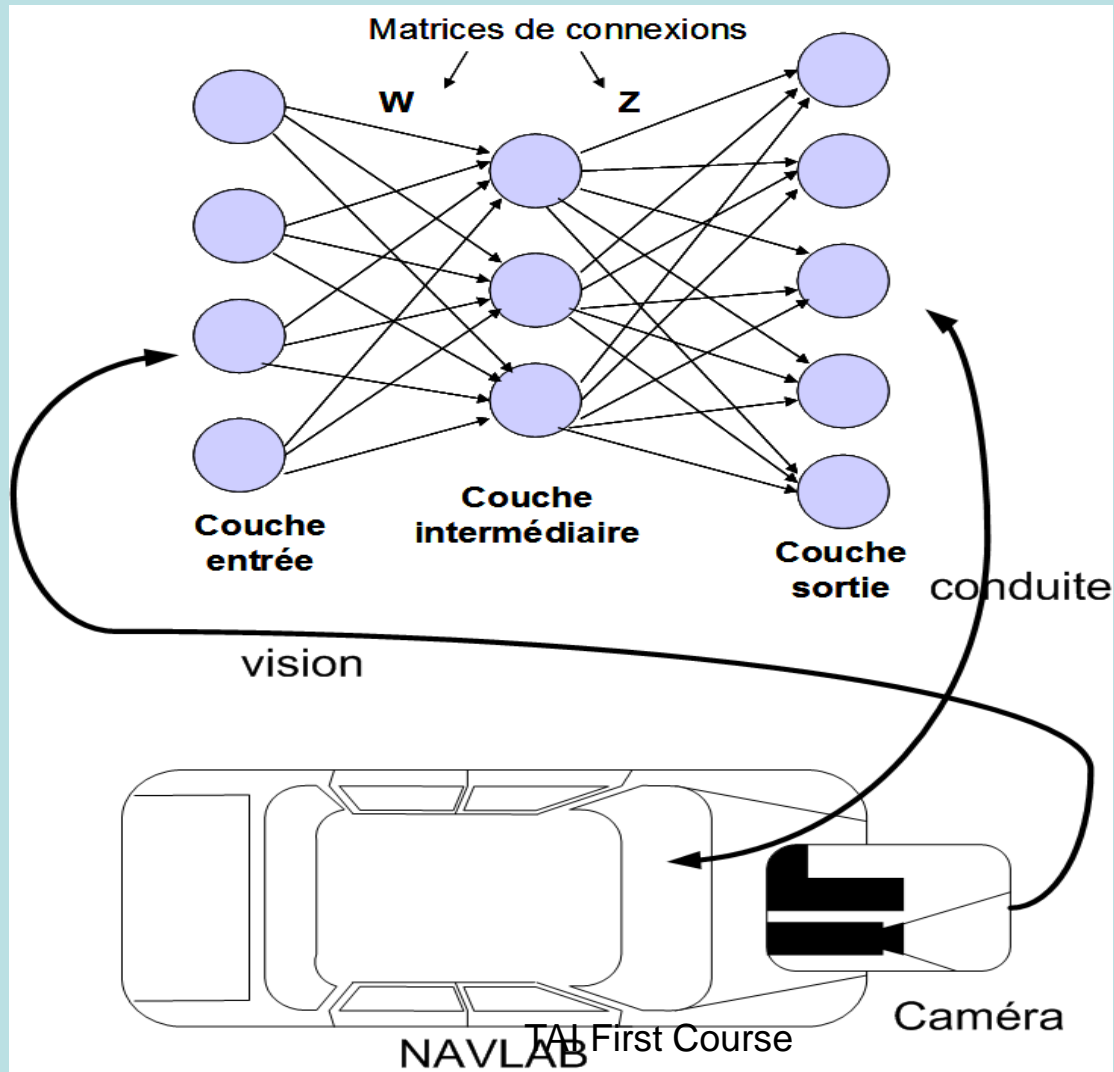
ALife
Hardware
Biology



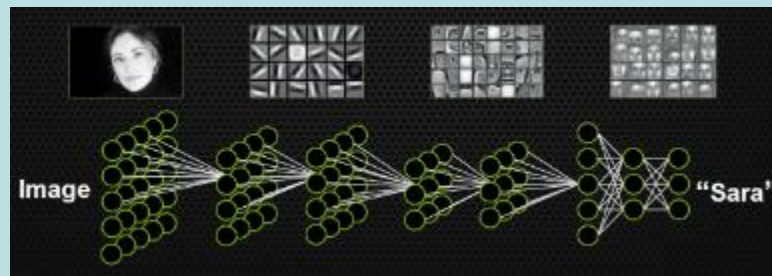
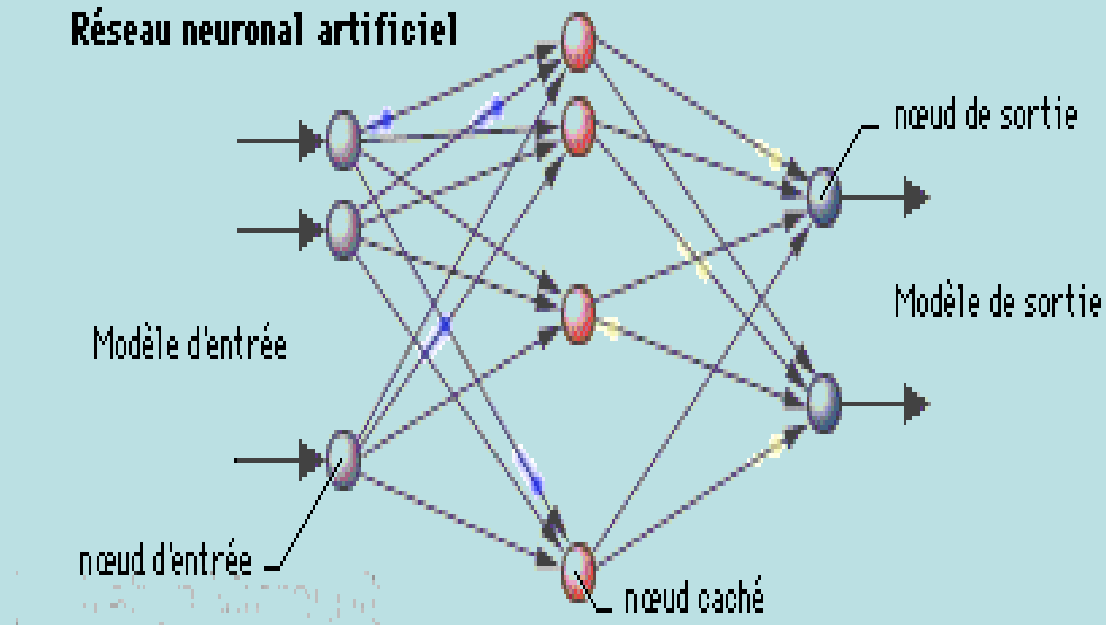
- The animal hidden in each of us might be unavoidable on the road to intelligence
- Our intellectual skill are embodied in our automatisms. They depart from there.
- Don't ever try to fully understand what a chair is without having ever sat in it.
- A turn back is needed towards our biological interface with the outside world.
- Can we as engineer bypass this biology ?
- Do we have to get rid with good old fashioned AI ? NO

Today AI

How does the computer drive



Neural networks

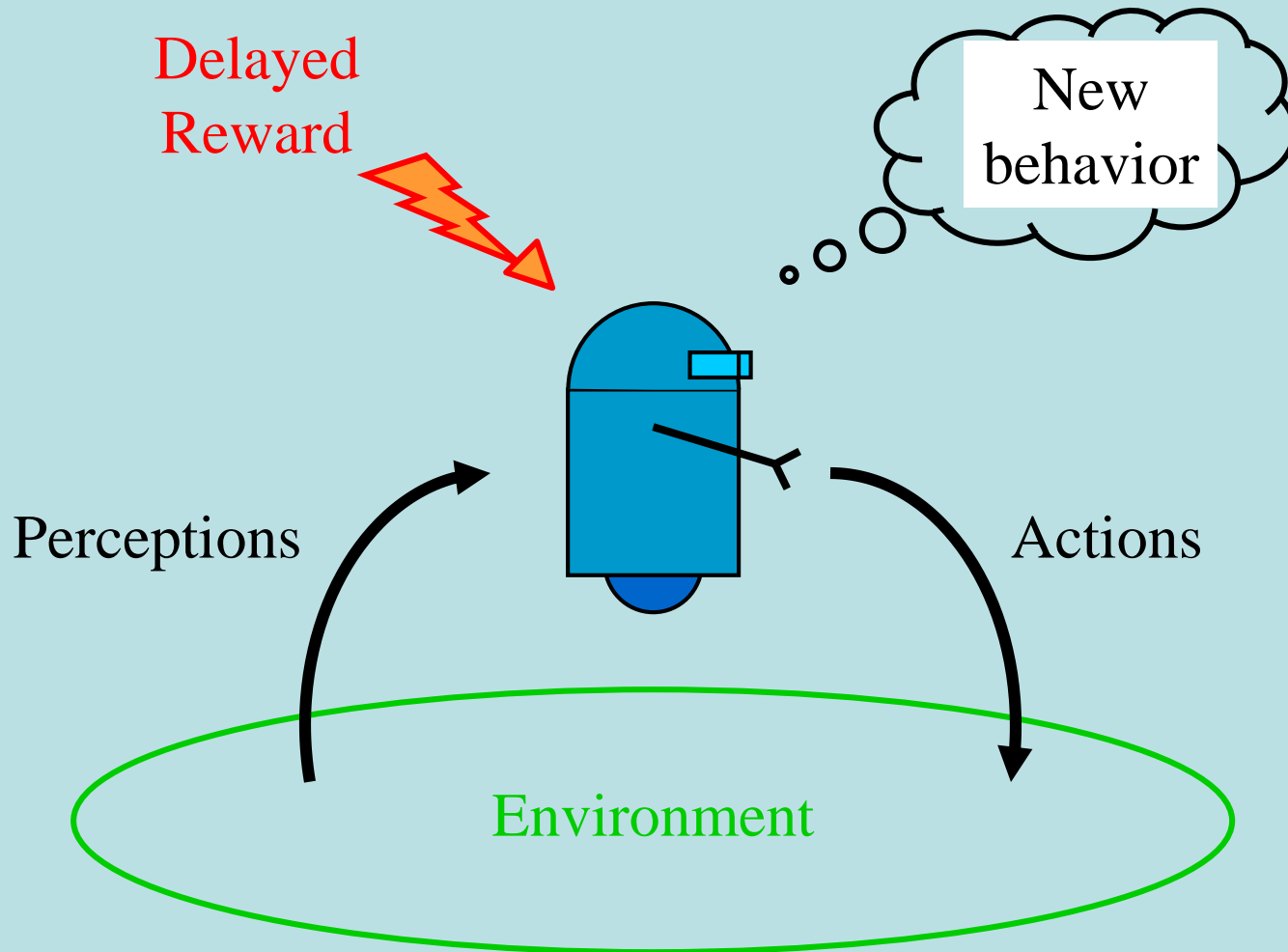


Deep Learning

The Darpa Challenge

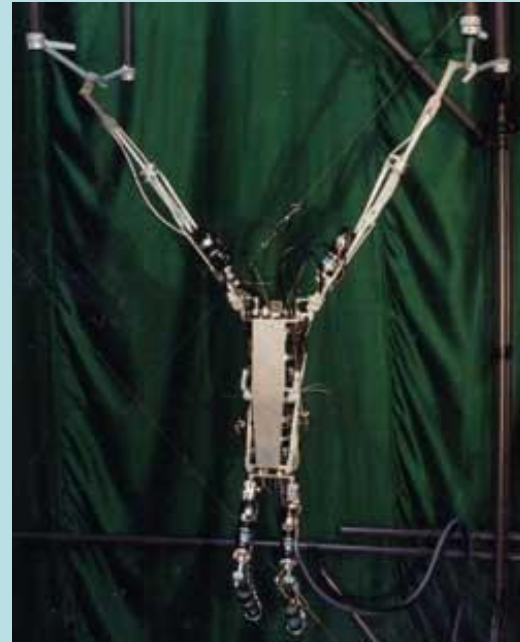


Learning Autonomous Agent



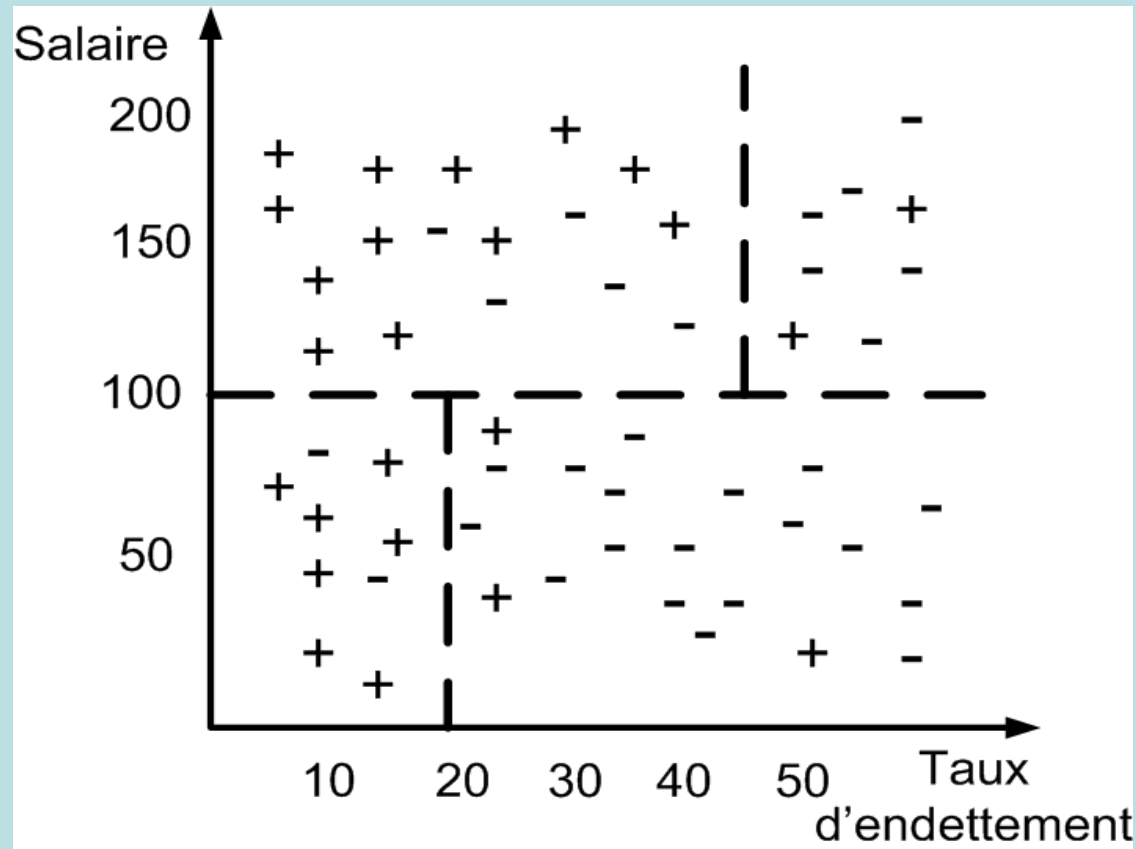
Robotic applications

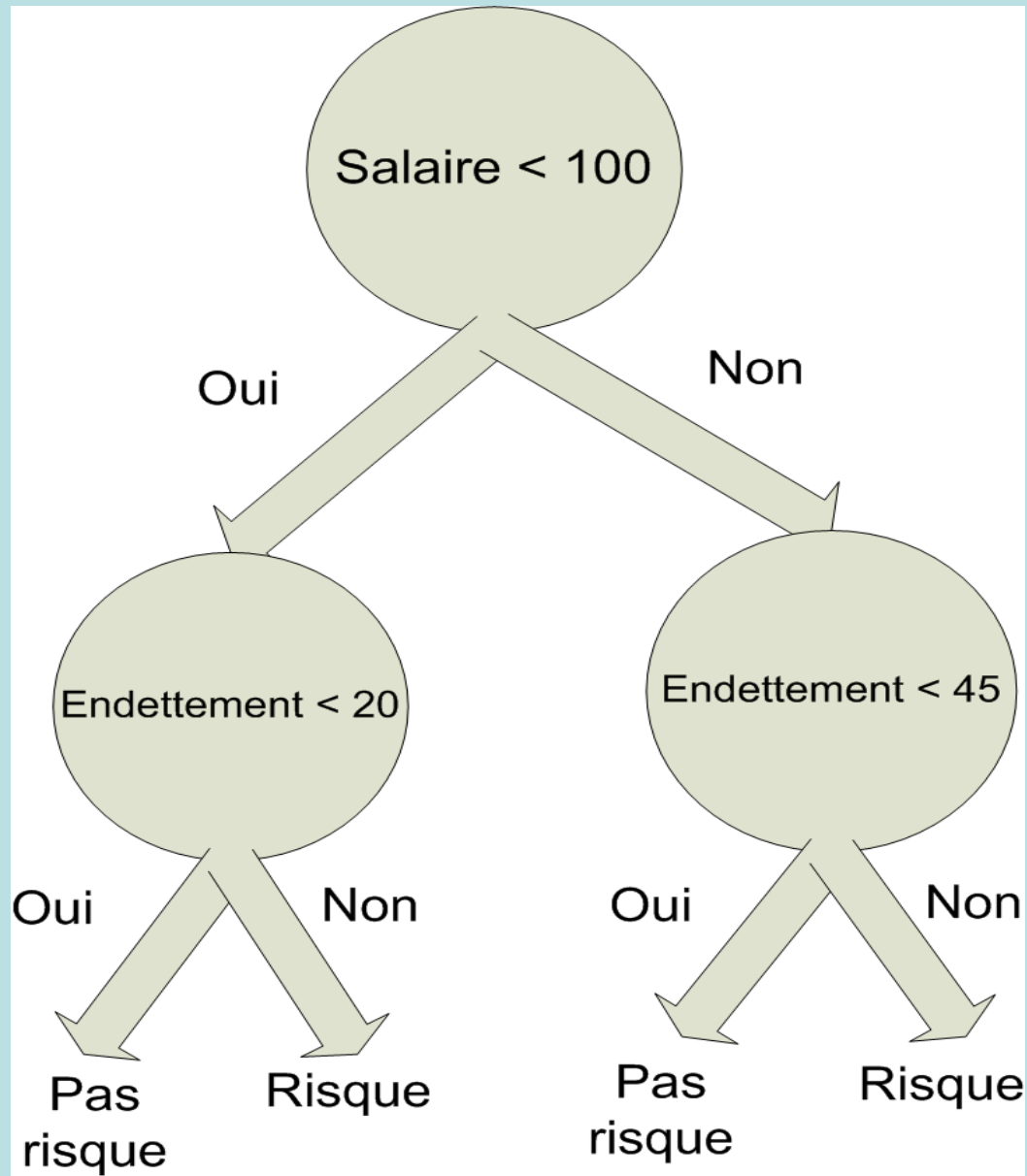
- Autonomous robots:



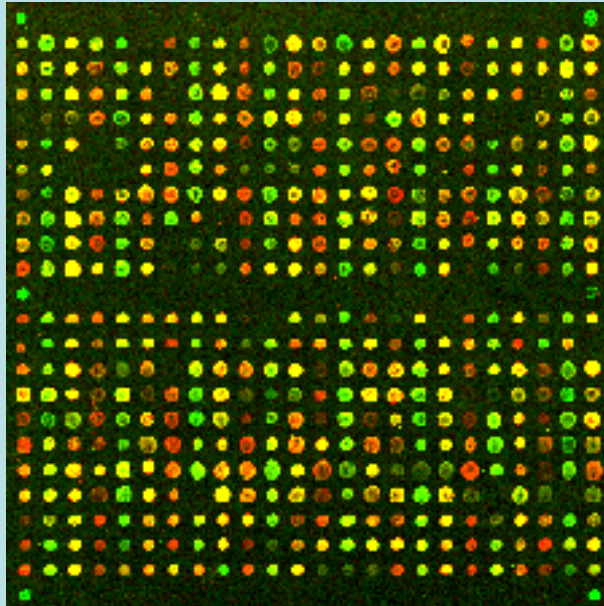
- Softbots: autonomous agents on Internet to profile and help the users.

How does the computer score a credit

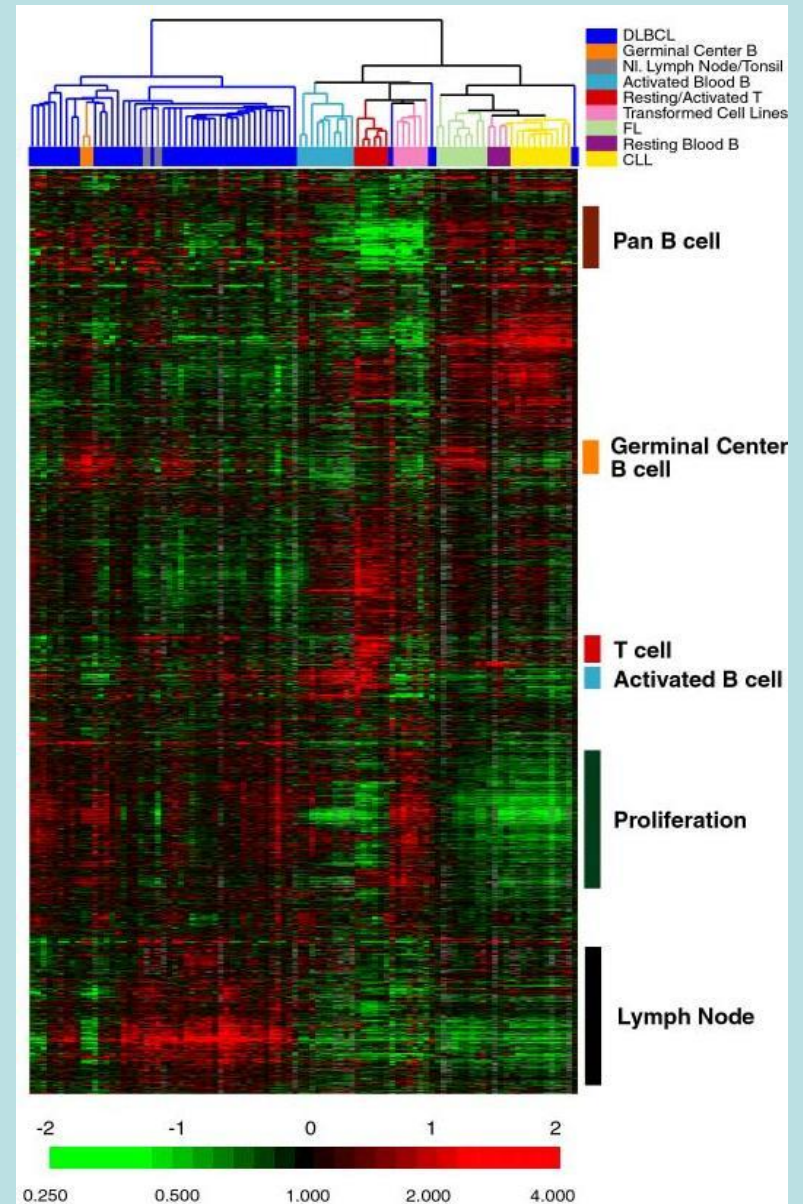


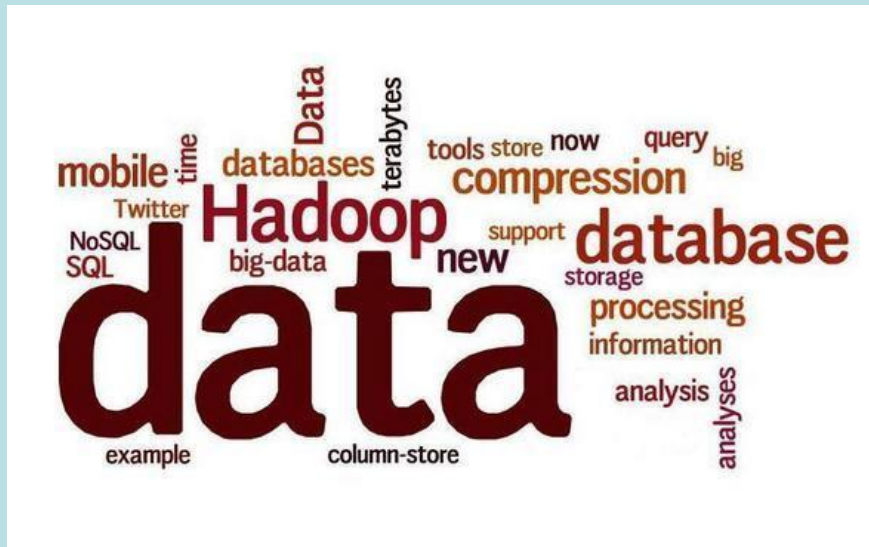


PUCE ADN



Microarray chip



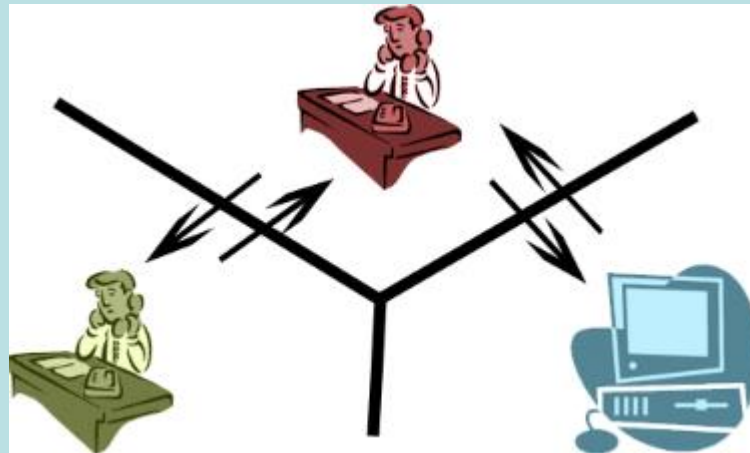


Google's AI

The Big Data trends in AI



Whom I'm talking too?



1965: Eliza -> The software psy



Joseph Weizenbaum

Le patient: "My boyfriend made me come here"

Le psy: Your boyfriend made you come here

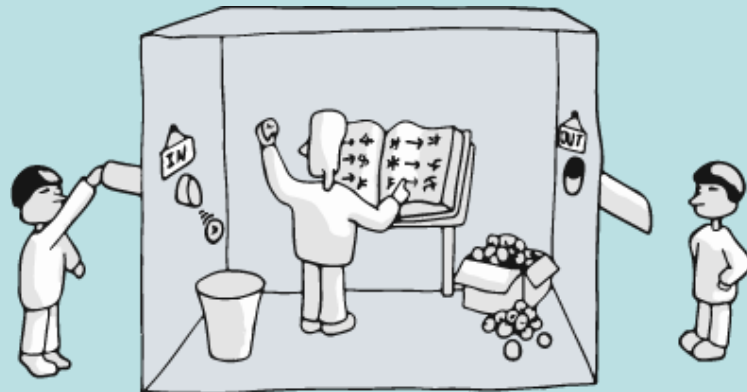
Le patient: He says I'm depressed all the time

Le psy: I am sorry to hear you are depressed

1980: John Searle and the Chinese room

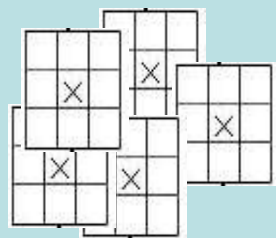


John Searle

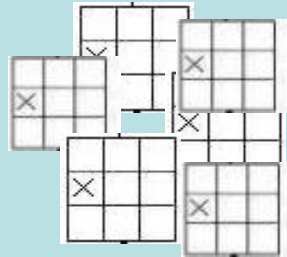


The tic-tac-toe

IA that learns and performs

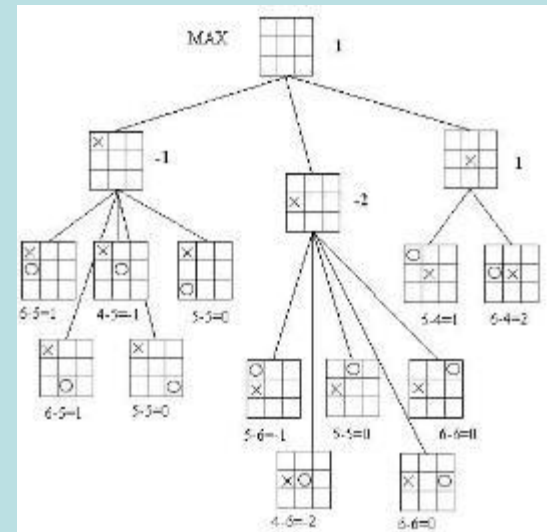


GAGNE !!!



PERDU !!

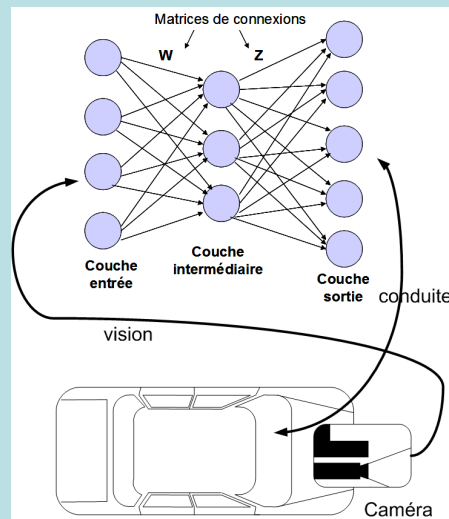
IA that thinks and understands



The automatic car

IA that learns and performs

Control Theory

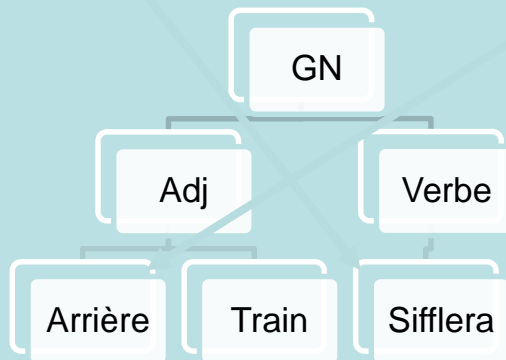


- $\frac{dx}{dt} = F(x, u)$
- $Y = G(x)$
- Objectif: $\min \int_{-\infty}^{\infty} x + u \, dt$
- $u^* = K(x, t)$

Automated translation

IA that understands

- Après ce plat de fayots, mon arrière-train sifflera trois fois



IA that learns and performs

- After this dish of baked beams, my hindquarters whistle three times

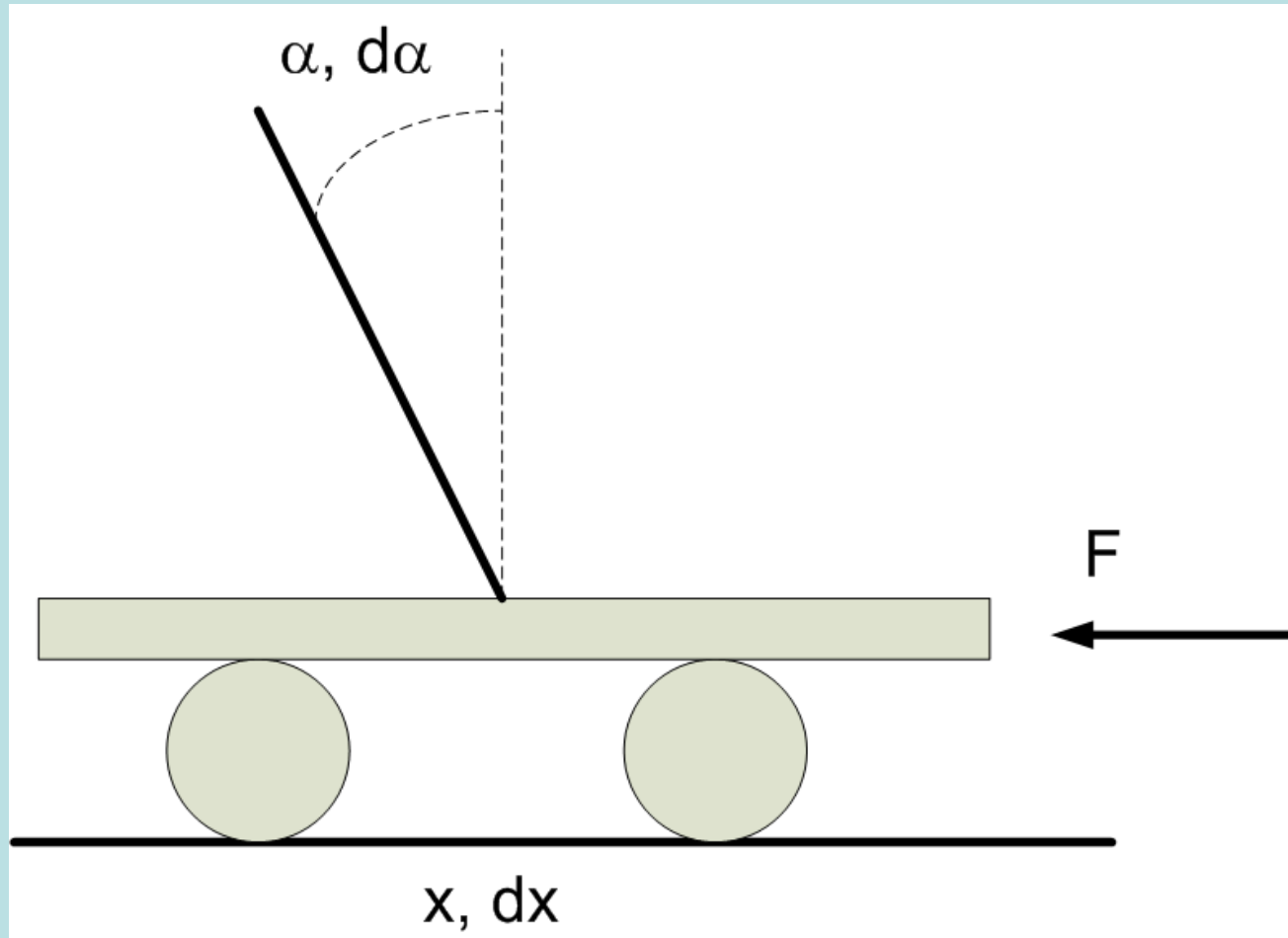


Français



Anglais

How does the computer control



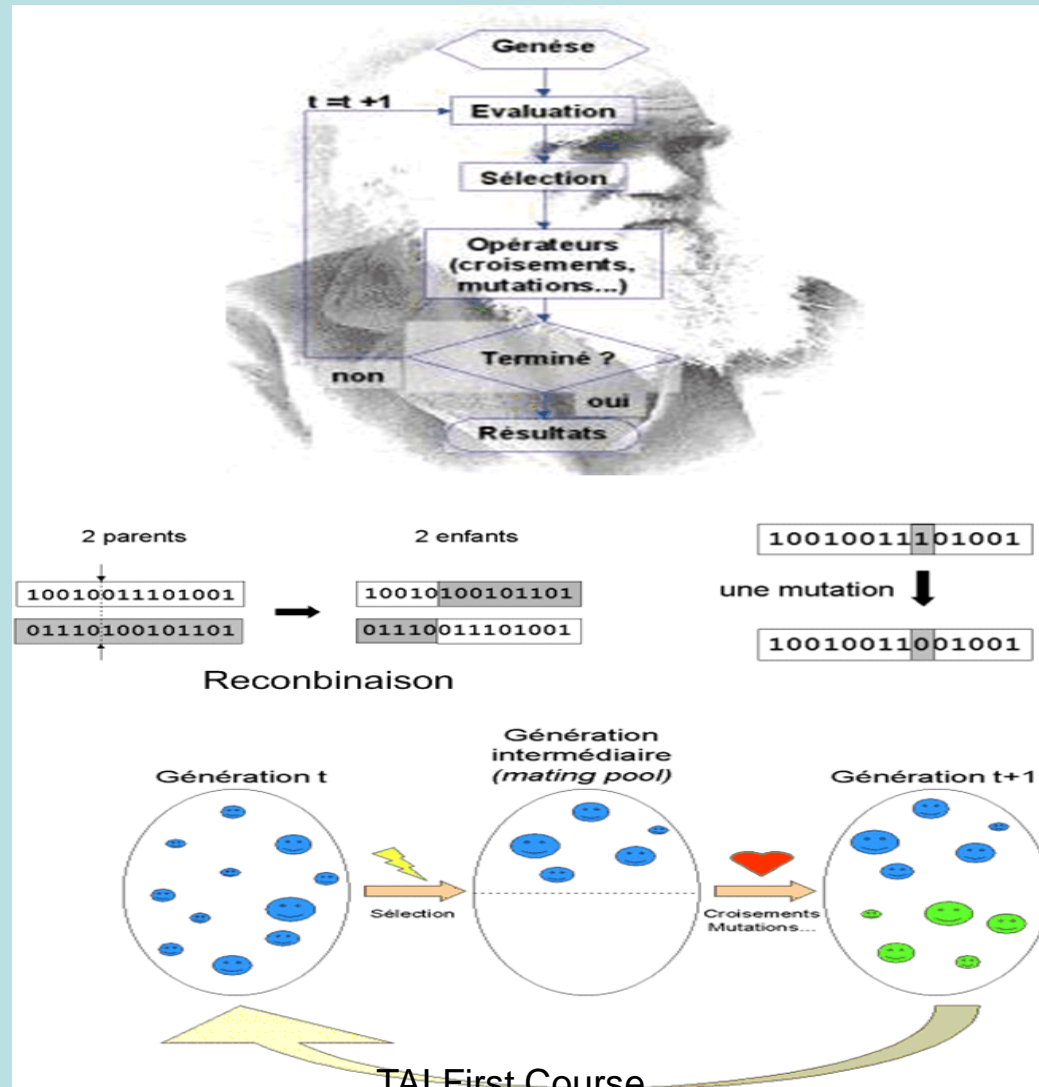
- Si « $-5 \leq \alpha \leq 5$ » ET « $-20 \leq x \leq 20$ » ET « $+2 \leq d\alpha \leq +3$ » ET « $-1 \leq dx \leq +1$ »

Alors « $f = +10$ »

- Si « $-5 \leq \alpha \leq 5$ » ET « $-20 \leq x \leq 20$ » ET « $-5 \leq d\alpha \leq -3$ » ET « $-1 \leq dx \leq +1$ »

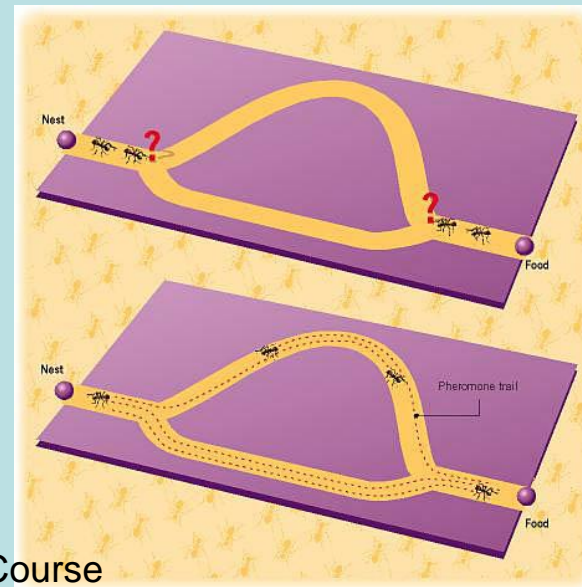
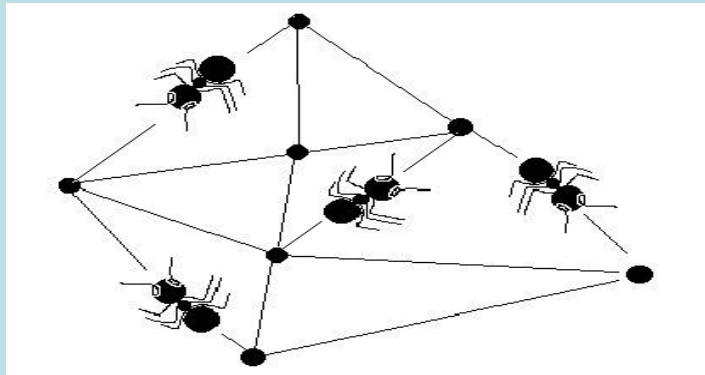
Alors « $f = -10$ »

Genetic algorithms



Ant Colony Optimisation

- Emergence: How new processes (often complex) appear at a higher level from simple underlying rules but iterated infinitely in space and time at a lower level.
- Insect societies are striking examples.
- ACO an excellent optimisation strategy



The Good IA

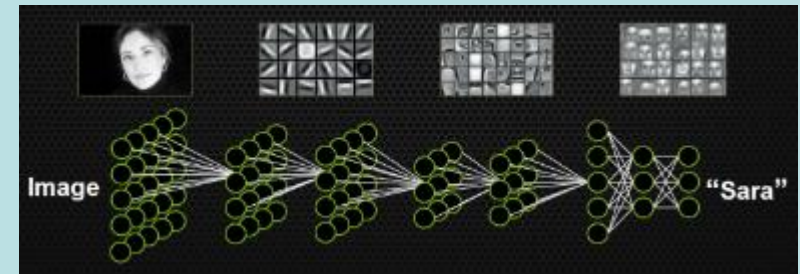


AI that thinks IA that learns



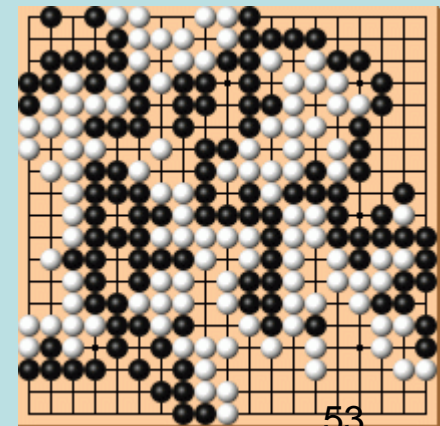
Game
Of Go

Deep Learning



Conclusions

- The best chess player is AI based: Deep Blue
- But the best backgammon player is ALife based: TD-Gammon learning by reinforcement learning
- Jeopardy Watson is just brute force search engine + a bit of inferences
- So ? It is possible that at a certain level of complexity, even for an engineer, learning and adaptation is the only way out.
- To the expense of a “lost of control”. The engineer guides but does not find out.



- AI in Entertainment

- ▶ Movies

- ◉ Metropolis (1927)
 - ◉ 2001: A Space Odyssey (1968)
 - ◉ Bladerunner (1982)
 - ◉ The Terminator (1984)
 - ◉ AI (2001)
 - ◉ I, Robot (2004)



- ▶ TV

- ◉ Star Trek: The Next Generation (Lieutenant Commander Data; 1987-94)
 - ◉ Battlestar Galactica (The Cylons; 1978, 2004-5)



- Books

- ▶ Do Androids Dream of Electric Sheep (1968) by Philip K. Dick
- ▶ Neuromancer (1984) by William Gibson (coined term “cyberspace”)
- ▶ Hyperion (1989) by Dan Simmons
- ▶ Cryptonomicon (1997) by Neal Stephenson (nanotechnology)
- ▶ The Diamond Age (1998) by Neal Stephenson (early wifi, cryptography)
- ▶ Thinks... (2001) by David Lodge

- Robot pets

- ▶ Tamagotchi
- ▶ Aibo

- Video Games

- ▶ Halo

- ◉ Non Player Characters with real time perceptions of their environment
 - ◉ Knowledge of the state of the world, as last perceived
 - ◉ Emotions based on events
 - ◉ Decision making capability

- ▶ Black and White

- ◉ Characters learn from feedback from player
 - ◉ Emergent unscripted behaviour

- ▶ The Sims

- ◉ Toggle 'free will' on and off
 - ◉ Agents climb peaks of a 'happiness landscape'

