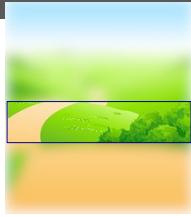


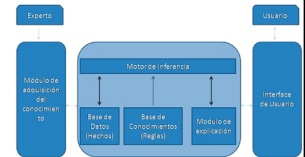
## 4. A new spring



1

## Expert systems

- Production rules:
  - IF-THEN (CONDITION-ACTION)
  - DOMAIN KNOWLEDGE
- Fact base
- Knowledge base (rules)
- Inference engine
- Uncertainty: certainty factors
- Famous expert systems:
  - Mycin: medical diagnosis[Emycin: empty Mycin]
  - Heuristic Dendral: organic chemistry
  - Prospector: geology



2

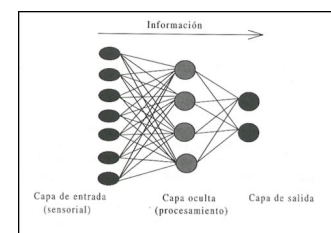
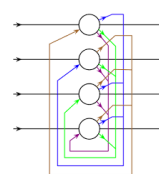
## Knowledge representation

- To declare and operate automatically with the knowledge of a particular domain
  - Predicate logic:
    - $\text{for all } x, \text{man}(x) \Rightarrow \text{mortal}(x)$
    - Semidecidable: decidable parts
    - Inefficient: deduction strategies
    - Exceptions, default reasoning
  - Production rules
  - Semantic networks
  - Frames
- Pending: commonsense knowledge

3

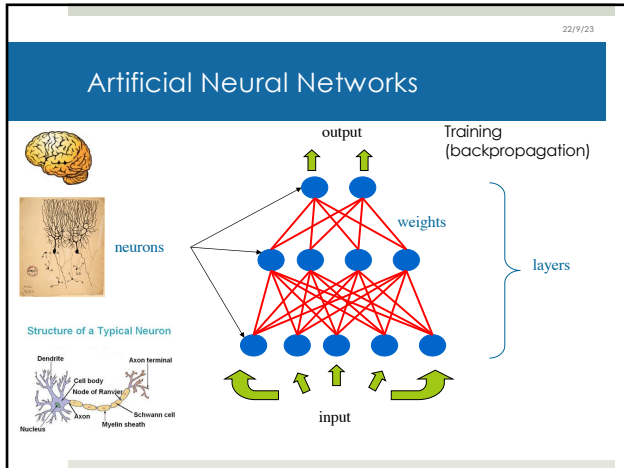
## Multilayer neural networks

- Hopfield Net: associative memory

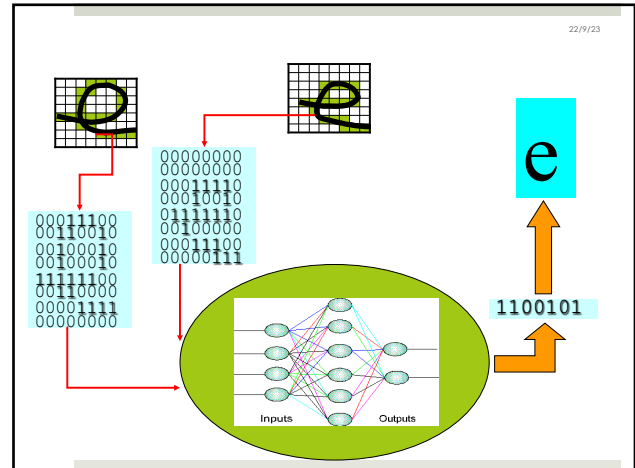


- Nets with hidden layers: overcome perceptron limitations
- Trained with the backpropagation algorithm

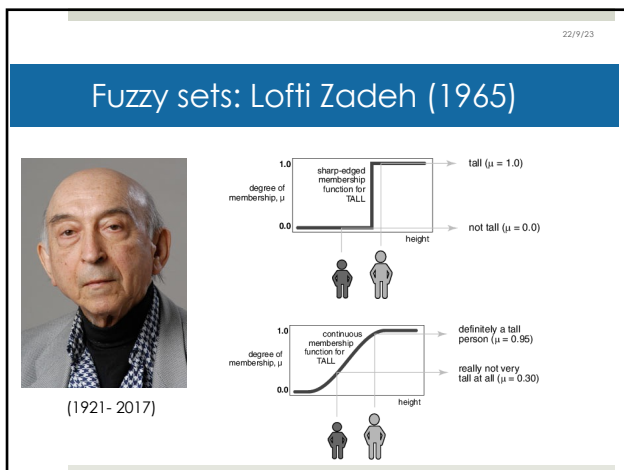
4



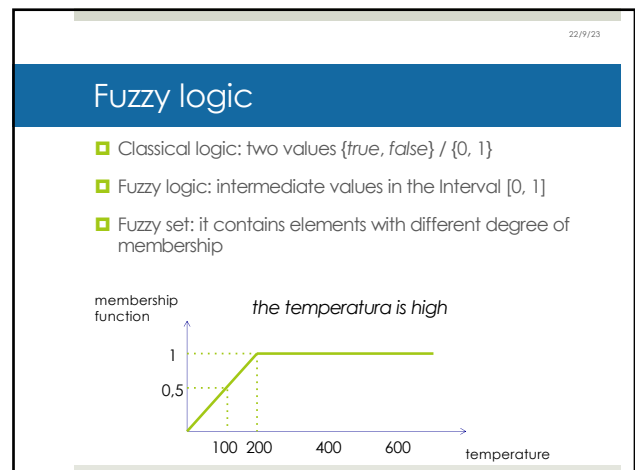
5



6



7



8

22/9/23

## Fuzzy control

NIKON image stabilizer



9

22/9/23

## Search, constraints, planning

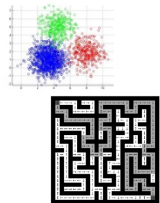
- Frontier search, discrepancy search, real-time search, incremental search...
- Metaheuristics: *hill-climbing*, *simulated annealing*, tabu search, genetic algorithms...
- Many problems can be expressed as a finite set of objects that must satisfy some constraints and/or optimize a function -> sophisticated exact solving methods, with high performance (CP, SAT)
- Partial order planning -> state space
  - New heuristics
  - SATPLAN
  - Graphplan, FF, FD, LAMA

10

22/9/23

## Machine learning

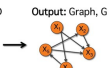
- Unsupervised:
  - data without classes
  - grouping by proximity
- Reinforcement
  - Strategy: trial and error
  - Actions that bring us to the solution
- Case-based
  - Memory of pairs (problem, solution)
  - Similar problems have similar solutions
- Bayesian networks
  - Hypothesis on the network structure
  - Examples to build it



Input: Data, D

$x_1$	$x_2$	$x_3$	$x_4$
0	1	0	0
1	1	0	0
...	...	...	...
1	0	1	2


Output: Graph, G



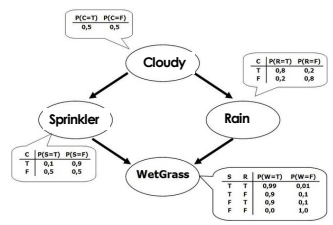
11

22/9/23

## Bayesian Networks



Judea Pearl



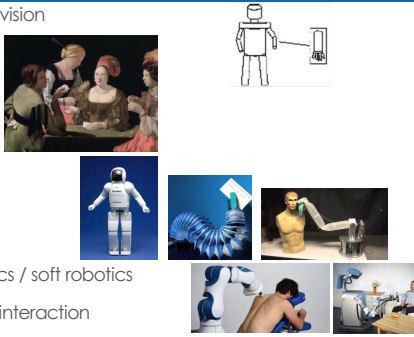
- Operational probabilistic models: hypothesis on the network structure,
- Many applications (spam filters, phone networks, images, etc.),
- Learning from data

12

22/9/23

## Vision and autonomous robots

- Model-based vision
- Active visión
- Robots:
  - Perception
  - Deliberation
  - Acción
- Service robotics / soft robotics
- Human-robot interaction



13

22/9/23

## Multiagent systems

- Autonomous agents
- Communication:
  - Assertions
  - Directives
  - Commitments
- Argumentation
- Negotiation
- Trust and reputation
- Models:
  - Beliefs, desires, intentions
  - Game theory



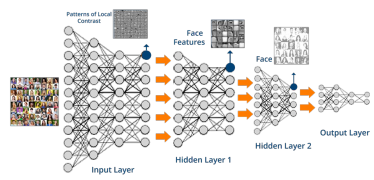
RoboCup

14

22/9/23

## Deep learning

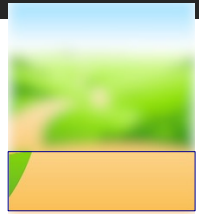
- Complex structure
  - Neural nets with many layers
  - Several abstraction levels
- Need a huge amount of training data
- Spectacular results



15

22/9/23

## 5. AI successes




16

22/9/23

## Computer games

- Chess: Deep Blue [won Kasparov in 1997]
  - Brute force search, parallel alpha-beta
  - Library of openings and endings
  - Singular extensions
  - Sophisticated evaluation function
- Go: AlphaGo [won Lee Sedol in 2016]
  - More difficult, Deep Blue techniques do not work in Go
  - Combination of
    - MonteCarlo Tree Search
    - Deep learning
    - Reinforcement learning
  - AlphaZero plays against itself, selflearning, won AlphaGo [dic 2017]



17

22/9/23

## Self-driving cars

- Goal from 80's, DARPA contests in 2005 y 2007
- Google cars  → Waymo (2016)
- Complex:
  - Sensors + deliberation + action
  - Fault-tolerant planning
  - Safety critical software
  - Ethical issues
- Pursued by many car makers
- Levels: 0(none) to 5 (total control)
  - Currently: level 2, prototype level 4






18

22/9/23

## Language

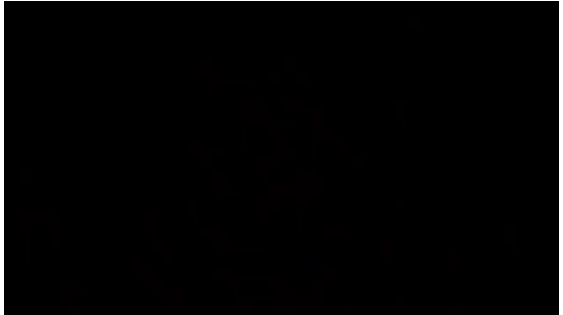
- Watson
  - Program that won Jeopardy! (2011)
  - Several knowledge sources
  - Fast answers
- Siri
  - Virtual assistant in Apple devices
  - Speech recognition: commands and dictate
  - Dynamical connection to webs

19

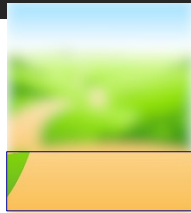
22/9/23

## Watson + Games



20

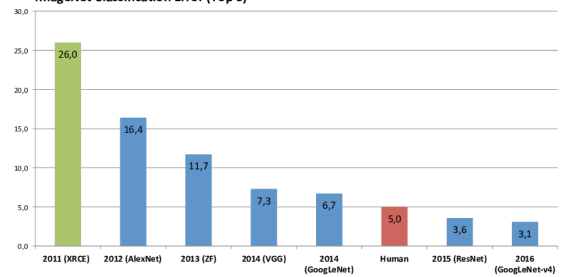
## 5. AI successes (update)



21

## Automatic Image Classification

ImageNet Classification Error (Top 5)



22

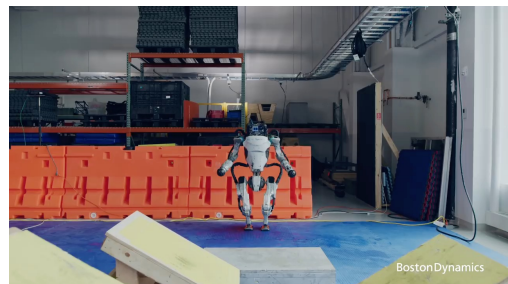
## Neuron automatic translation

- Free services in internet
- Limit in # words to translate; medium/high quality
- Google translate
  - The most popular
  - It translates between 109 languages
  - From 2016
- Deepl
  - The best translator
  - It translates between 26 idiomas
  - From 2017



23


## Parkour made by robots



24

22/9/23


## Generative adversarial networks



25

22/9/23

## Generative AI



*Generative AI is a kind of Artificial Intelligence able to create new and original content automatically.  
It can produce text, code, images, speech and video.*

26

22/9/23


## Generative AI (ChatGPT)

- May you explain in ten lines who is Donald Trump?
- Donald Trump is a prominent American figure, born on June 14, 1946, in Queens, New York City. He's a Republican politician and businessman. He served as the 45th President of the United States from 2017 to 2021. Trump was known for his real estate ventures, including Trump Tower in New York. He gained widespread fame as the host of the reality TV show "The Apprentice." His political career began with a 2015 presidential campaign that emphasized populist and conservative values. He won the 2016 presidential election against Hillary Clinton. His presidency was marked by policy changes, controversies, and a polarizing style. After losing the 2020 election to Joe Biden, he remained active in politics.

27

22/9/23

## 6. Future

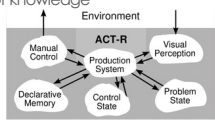
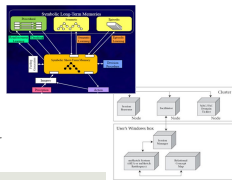


28

22/9/23

## ¿Integrated Systems?

- Complex tasks:
  - Integrate several sources of knowledge
  - AI difficult topic
- Initial programs
  - GPS
  - ACT-R
- SOAR:
  - Search-based
  - Learns from experience
- COMPANION
  - Analogical reasoning
  - For collaborating with the user







29

22/9/23

## ¿General AI?

- Impressive **specific** results
- Low-level tasks, that seemed easy, they showed to be the **most difficult** part
- General AI : still to be achieved
  - Commonsense knowledge
  - Continuous learning
  - Perception + reasoning + learning + action
- Hot topics
  - Massive data processing
  - Nanomaterials
  - Computational creativity



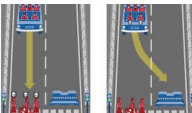




30

22/9/23

## ¿Ethical dilemmas? (extra)

- Massive data acquisition to feed deep learning based applications
- AI is already operational in our society, which generates several ethical issues

31

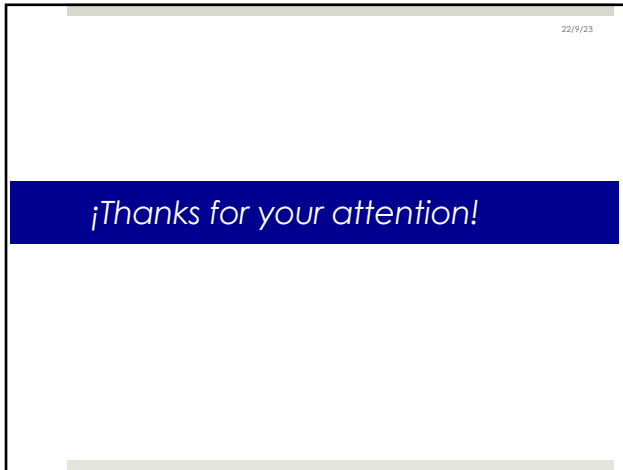
22/9/23

## AI for good (extra)



32





33