Escenari actual I futur de la Intel.ligència Artificial

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Outline

- Introducció
- Marc del concepte
- Els orígens
- Passeig històric
- L'actualitat
- Àrees
- La IA omni-present
- IDEAI
- El futur

Introduction

The annals of Artificial Intelligence

- Darmouth Summer School on AI, McCarthy 1956
  McCarty, Minski, Shannon, More, Samuel...

"Empirical Science. It studies the mechanisms for intelligent actions"
[McCarthy 56]

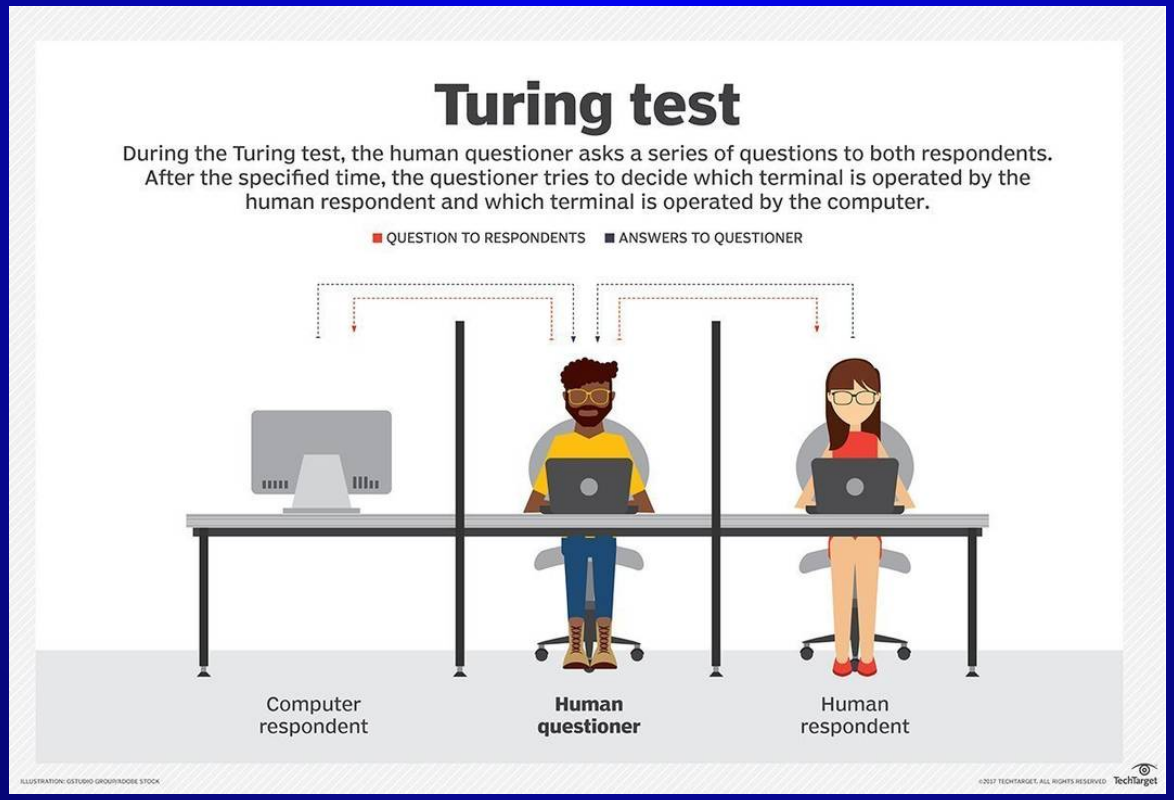
"The science of making machines do what Men do as intelligent beings"
[Minski 56]

"AI can have two purposes. One is to use the power of computers to augment human thinking, just as we use motors to augment human or horse power [...] The other is to use a computer [...] to understand how Humans think [...]. In a humanoid way. If you test your programs not merely by what they can accomplish, but how they accomplish it, [...] you're using Artificial Intelligence to understand the human mind"
[Simon 94]

Artificial Intelligence

- Main goal: **Modeling *intelligent* capacities**
  Building systems which *mimetize* human behaviour
  human mental activity
  rational thinkings

A machine is intelligent if is passes the Turing test



Artificial Intelligence

- **Two basic approaches**
  - **Symbolic AI:**

    cognitive
    reasoning
    focus on process

  - **Connexionist AI:**

    subsymbolic
    computing
    focus on results

Fundamentos filosóficos

¿Son posibles las inteligencias mecánicas?

Aristóteles

Llull

Leyes que gobiernan el pensamiento (lógica)

Descartes

Leibniz

La mente está ligada al mundo físico

El conocimiento es fruto de la percepción (Inducción)

Conocimiento = Teorías lógicas

Las acciones se basan en la conexión entre conocimiento y objetivos

Aristóteles

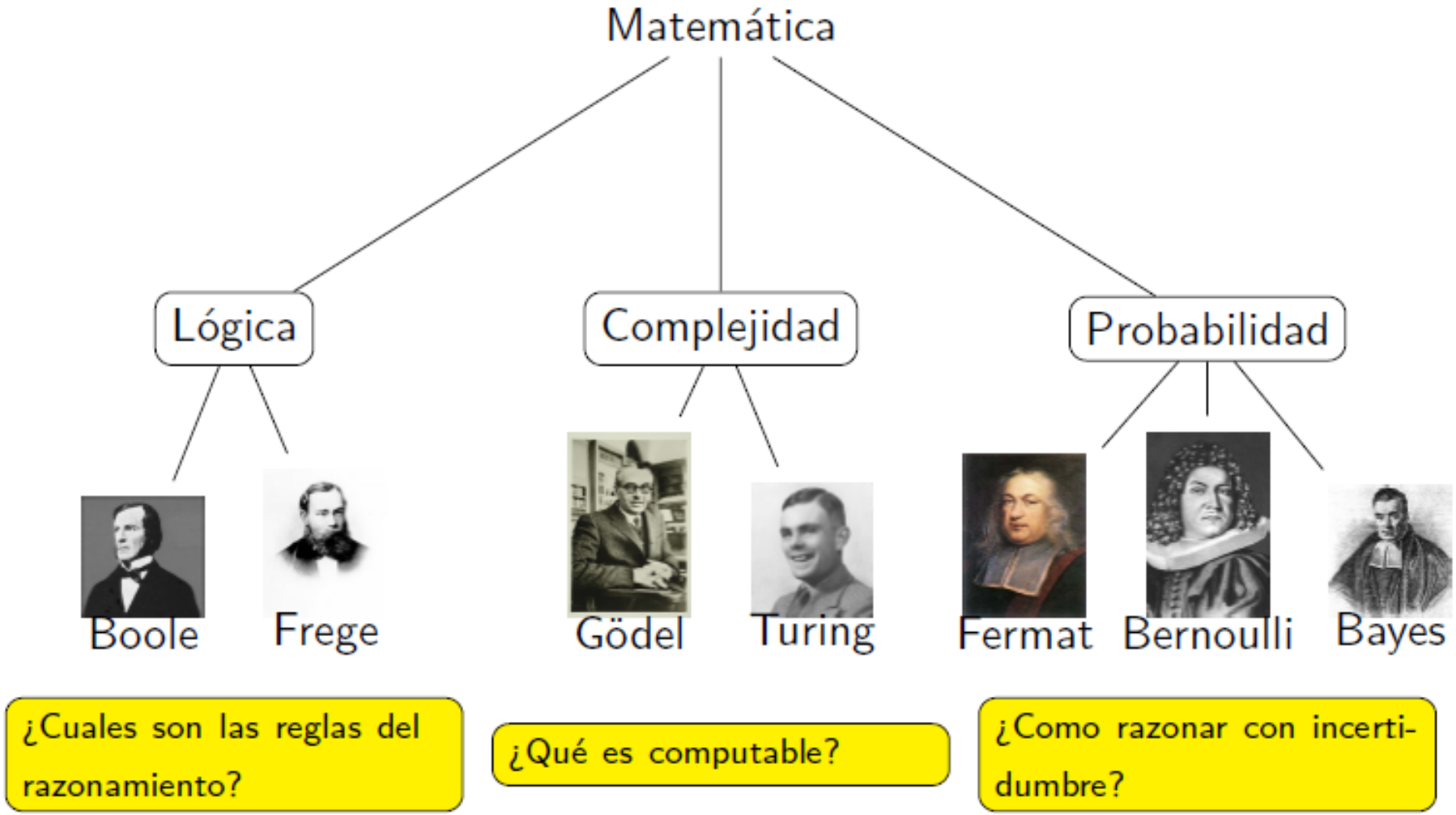
Russell

Hume

Bacon

From slides LSI-FIB-UPC

Fundamentos matemáticos



From slides LSI-FIB-UPC

Artificial Intelligence

- Main goal: **Modeling *intelligent* capacities**
  Building systems which *mimetize* human behaviour
  human mental activity
  rational thinkings

- Methodological basis: Formal logics

- Basic approach:

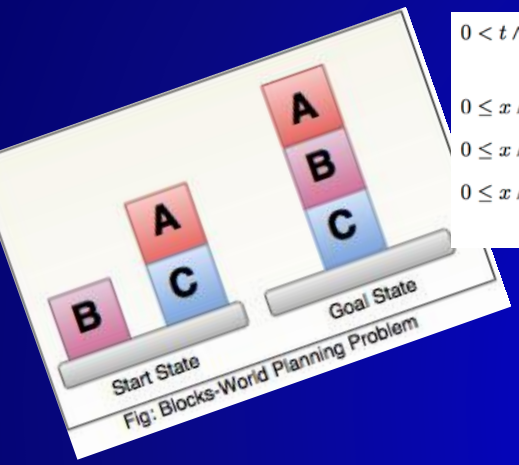
  Use formal logic-based language to model domain knowledge
  Implement the model in a computer to emulate intelligent behaviour

- AI Problems [Russell&Norvig 2003]
  - **Reasoning**
  - **Knowledge representation and management**
  - **Planning**
  - **Learning**
  - **Communication (natural language processing)**
  - **Perception (artificial vision)**
  - **Move-manipulate objects (robotics)**

Artificial Intelligence

1952-1969 Enthusiasm

(problem solving, automatic demonstrators, chess, NLP)



$$0 < t \wedge 0 < v_f \Longrightarrow ((1.565 + .313v_f)\cos(1.16t) + (.01340 + .00268v_f)\sin(1.16t))e^{-1.34t} - (6.55 + 1.31v_f)e^{-.318t} + v_f + 10 \geq 0$$

$$0 \leq x \wedge 0 \leq y \Longrightarrow y\tanh(x) \leq \sinh(yx)$$

$$0 \leq x \wedge x \leq 289 \wedge s^2 + c^2 = 1 \Longrightarrow 1.51 - .023e^{-.019x} - (2.35c + .42s)e^{.00024x} > -2$$

$$0 \leq x \wedge x \leq 1.46 \times 10^{-6} \Longrightarrow (64.42\sin(1.71 \times 10^6 x) - 21.08\cos(1.71 \times 10^6 x))e^{9.05\times 10^5 x} + 24.24e^{-1.86\times 10^6 x} > 0$$

- **Formal foundation: Darmouth School 1956 (McCarthy)**

- Minsky [1963]
  - **Cybernetics**
  - **Neurosciences**
  - **Bionics**
  - **Information and communication theory**
  - **Connexionism (neural nets)**
    [McCullogh 1943]

```
E> Hello. I am ELIZA. How can I help you?
H> i am feeling sad
E> I am sorry to hear you are sad.
H> i had some nightmares tonight
E> You say you had some nightmares tonight
H> yes, my dreams are worrying me
E> What does that dream suggest to you?
H> thrill, scare
E> I am not sure I understand you fully.
H> my dreams annoy me
E> Do you dream often?
H> yes, daily
```

Artificial Intelligence

- 1966-1974: First crisis

  (AI did not succeed on real and big problems)

  * too much quantities of knowledge to transmit to the system (computationally too expensive, non manageable)

  * too difficult to provide complete knowledge (do not forget)

  * too high computational cost, brute force unaffordable

- 1969-1979: Knowledge based systems

  (domain knowledge helps)

  70s MYCIN first expert system (pneumo-infections)

MICYN, Example of dialog (70s)

>What is the patient's name?
John Smith
>Age?
He is 55 **{interpretació LN}**
>Have you obtained positive cultures indicating general
>type? **{Captació evidències}**
Yes
>Let's call the most recent culture CULTURE-1. From
what site was CULTURE-1 taken?
From the blood
>When?
June, 21, 2001
>Let's call the first significant organism from this blood
>culture ORGANISM-1. Do you know the identity of
>ORGANISM-1?
No
>Is ORGANISM-1 a rod or a coccus or something else?
Rod **{Discriminació de causes}**
…

>What is the gramstain of ORGANISM-1?
Gramnegative
> Has John Smith a previous history of alcoholism?
No
> Is there evidence that the infection has hospitalary origin?
Yes
> My therapy recommendations will be based on the
>following possible identities of the organism(s) that seem
>to be significant:
the identity of ORGANISM-1 may be
PSEUDOMONAS
>the identity of ORGANISM-2 may be
KLEBSIELLA
the identity of ORGANISM-3 may be
ENTEROBACTER
>My preferred therapy recommendation is as follows:
>Give the following in combination:
>GENTAMYCIN
>Dose: 1.7 mg/kg Q8H - IV or IM
>Comments: Modify dose in renal >failure
>CARBENICILLIN **{etc.}**

Knowledge based systems

- Specific domain knowledge optimizes the system performance

"Emulation of human problem-solving capacity in a specific domain, using the same knowledge sources as experts"

- Main step: knowledge acquisition

getting domain knowledge to transmit to the system

- Crucial restrictions in AI: domain knowledge must be
  - Correct
  - Complete
  - Consistent

- System quality depends on quality of knowledge acquisition

Knowledge Engineering

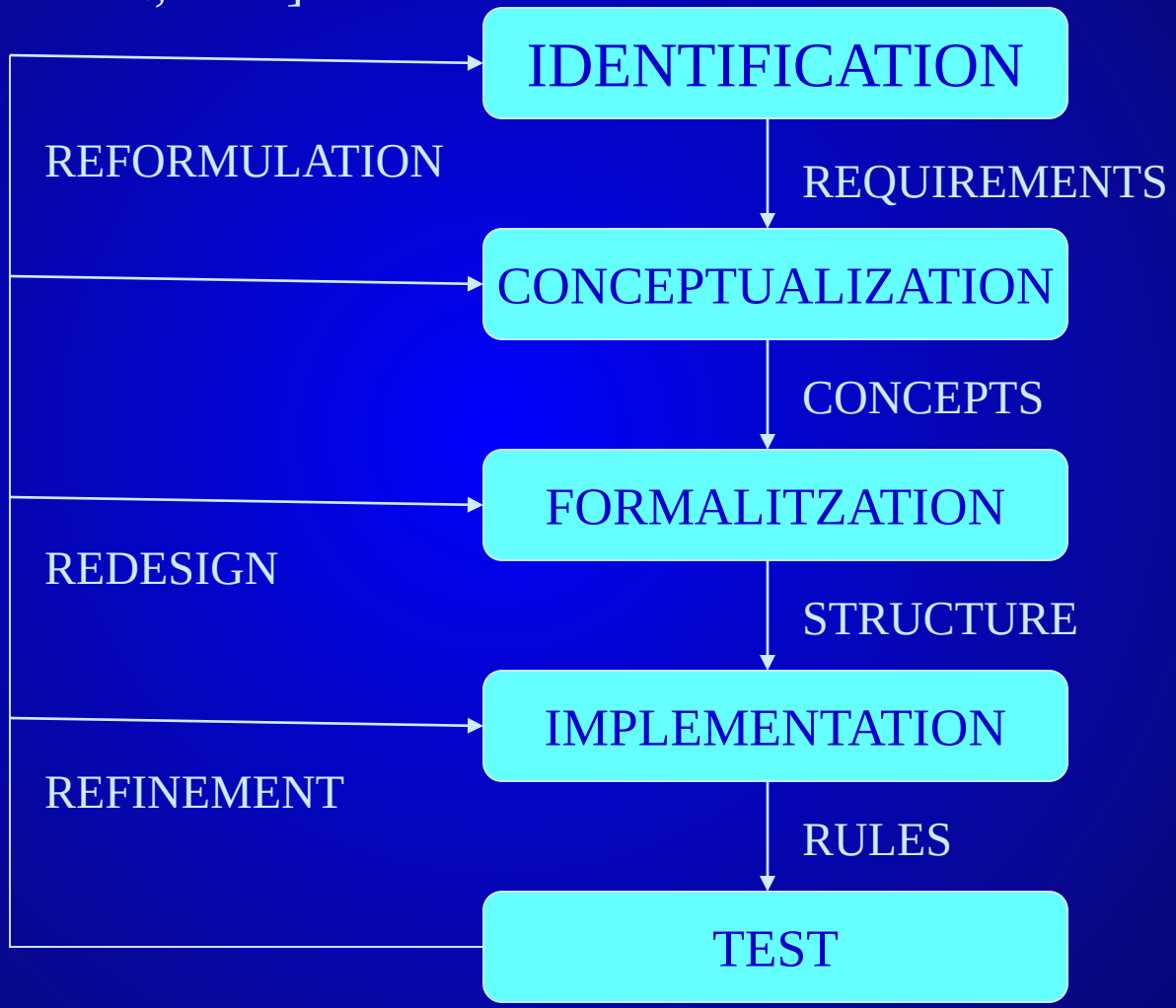
Knowledge Engineering

- Specific field in Artificial Intelligence
  - Since the mid-1980s
  - Improve knowledge acquisition
    - Help experts to formalize their domain knowledge
    - Help experts to elicit implicit knowledge
    - Manage the transfer to the Artificial Intelligent system

- Principles
  - there are different types of knowledge
    (use right approach and technique upon the knowledge required)
  - there are different types of experts and expertise
    (methods should be chosen appropriately)
  - there are different ways of representing knowledge
    (aids on acquisition, validation and re-use of knowledge)
  - there are different ways of using knowledge
    (knowledge acquisition guided by the project aims)

Steps of Knowledge Engineering

[Buchanan *et al.*, 1983]



Knowledge acquisition

- Building a knowledge base
  - Basic domain concepts
  - Relationships between concepts: if-then rules (CP1 logics)

    if <condition> then <consequence>

    <condition>: *proposition, relationship between variables and values*
    <consequence>: *basic concept (fact) or action(s)*

- Very difficult in real non-toy domains
  - Experts have vast amounts of knowledge
  - Experts knowledge is non-structured
  - Most of the knowledge is implicit in experts head
  - Big amounts of implicit knowledge unconsciously used in
    - human reasoning
    - decision-making

- The real bottle neck of knowledge acquisition is

Implicit knowledge

Implicit knowledge

- *Actionable knowledge that is derived from experience of the learner and therefore is pragmatic and valuable*

"*We know more than we can tell*." [Polanyi]

- Knowledge that experts carry in their minds
  - difficult to access
  - difficult to communicate
  - not easily shared
  - highly valuable
    (comes from people, places, ideas, experiencies, habits, culture)
    (not in books)
  - difficult to formalize
  - unconsciously used in human reasoning processes
  - unconsciously active for decision-making

- Experts are not aware of
  - the amount of knowledge they possess
  - the whole set of pieces of knowledge they activate when reasoning or deciding

Implicit knowledge

- *Crucial role in human reasoning and decision making*

  “the key to knowledge creation lies in the mobilization and conversion of tacit knowledge." Nonaka

- Experts have unconcious mechanisms for activating implicit knowledge

- Machines can only work with explicit knowledge
  As implicit knowledge is not transferred to the AI system
  - Inconsistencies in KB
  - Incomplete KB

  - Wrong reasonings
  - Wrong decisions

“Computers are useless, they can only give you answers”
Pablo Picasso

Implicit knowledge

- Frying a couple of eggs:
  1. Heat the oil in a pan
  2. Put eggs inside
  3. Add salt

- Real steps performed
  1. Light the stove
  2. Put the pan on the light
  3. Put the oil in the pan
  4. Heat the oil in a pan
  5. Crack the eggs
  6. Put eggs inside
  7. Add salt
  8. Take out of the pan when cooked

Artificial Intelligence

- **80s: Commercialization of expert systems**
  (simple domains, very specialized)

  Second crisis: There is always more implicit knowledge to formalize!!!!
  Maintenance non affordable

- **Late 80s - :** Replace information source by DATA

  from knowledge acquisition to inductive learning from data

  Machine Learning boom:
  Extract patterns from data
  (clustering, pattern recognition, classifiers)
  (combinatorial computational cost)

  Revisit connexionist methods….. Bioinspired!
  (ANN, evolutionary computation, swarm intelligence)

Artificial Intelligence

- **90s:**

  New paradigm: include/model the unconscious expert's reasonings [Geffner 2002]

  The value of data: KDD-Data Mining: pervasive data [Fayyad 96]

- **2005- : Revival**

  Data Science (decision support, complex domains)
  Big Data (Volume, Velocity, Variety….)
  IOT, Cloud
  real time
  immage, voice, text, signal, web, social networks
  transparency

  (supercomputers, deep learning)

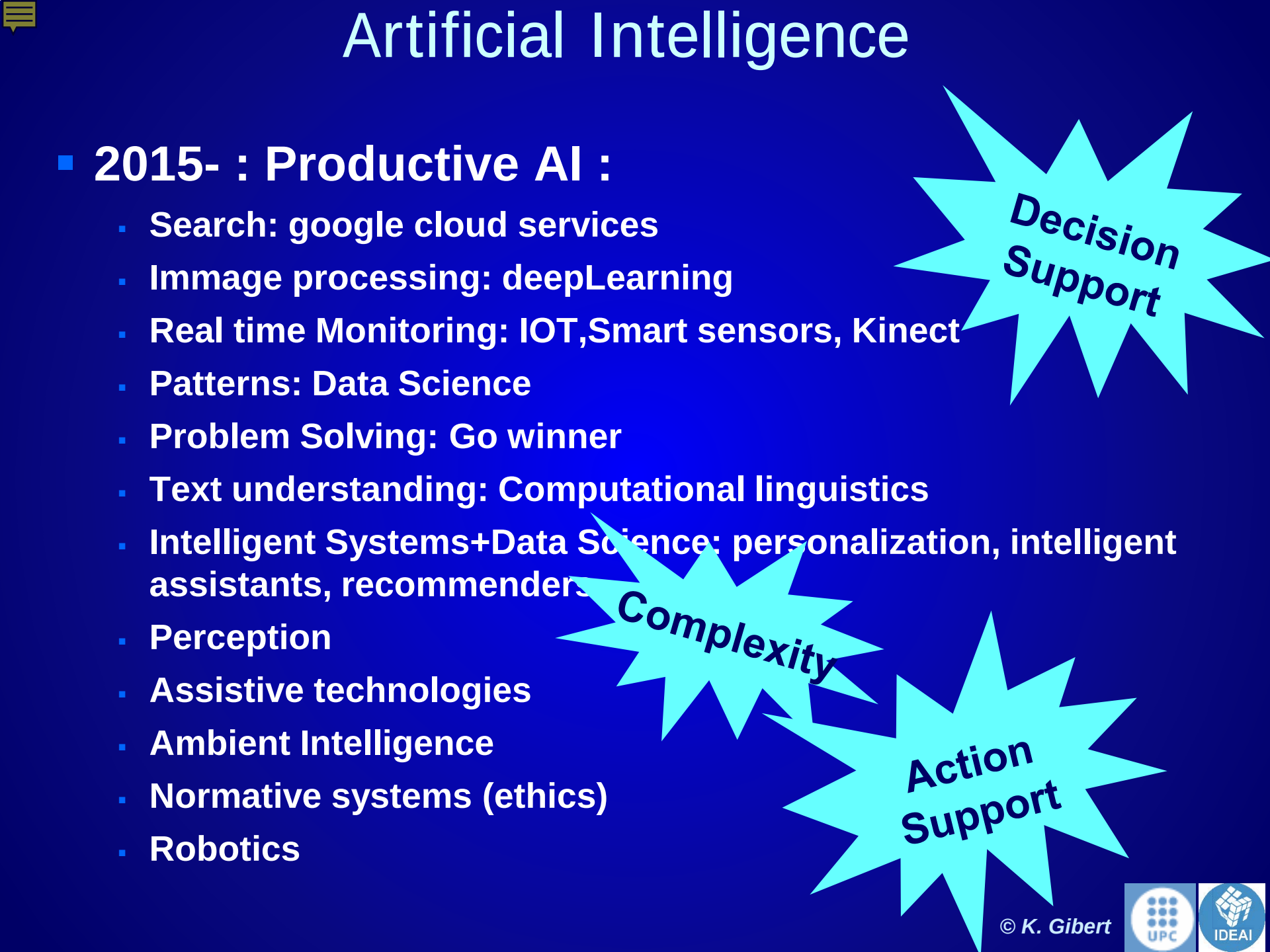
Russell, S. J., & Norvig, P. (2016). *Artificial intelligence: a modern approach*. Malaysia; Pearson Education Limited,.
Nilsson, N. J. (2014). Principles of artificial intelligence. Morgan Kaufmann.
Cohen, P. R., & Feigenbaum, E. A. (Eds.). (2014). The handbook of artificial intelligence (Vol. 3). Butterworth-Heinemann.
Verhagen, W. J., et al. (2012). A critical review of Knowledge-Based Engineering: An identification of research challenges. Advanced Engineering Informatics, 26(1), 5-15.

Artificial Intelligence

- Basic Fields
  - Knowledge representation
  - Problem solving, Search
- Specific Fields
  - Planning
  - Natural Language Processing
  - Automatic Reasoning (normative systems)
  - Knowledge-based Systems (intelligent systems)
  - Perception (sound, immage, touching...)
  - Motion and manipulation
  - Machine Learning (deep learning)
  - Autonomous Agents, social intelligence

Artificial Intelligence

- **2015- : Productive AI :**
  - **Search: google cloud services**
  - **Immage processing: deepLearning**
  - **Real time Monitoring: IOT,Smart sensors, Kinect**
  - **Patterns: Data Science**
  - **Problem Solving: Go winner**
  - **Text understanding: Computational linguistics**
  - **Intelligent Systems+Data Science: personalization, intelligent assistants, recommenders**
  - **Perception**
  - **Assistive technologies**
  - **Ambient Intelligence**
  - **Normative systems (ethics)**
  - **Robotics**



Artificial Intelligence

- self-driving cars gathers 1 Gb/sec of data to predict surrounding events
- Fuel injection systems in cars designed with learning algorithms.
- Jet turbines designed using genetic algorithms
- 10.000 engineers making 2.600 nightly maintenance on Hong Kong's subway, scheduled by an AI system
- AI-powered specialized domestic robots

  (Washing machines, Rumba, Watson, Alexa)
- Computer games (NPCs) use lots of AI
- Call centers are answered by Artificial Intelligences with speech recognition

Artificial Intelligence

- Web search engines use AI techniques (google)
- Automatic detection of credit card fraudulent transactions use relational learning
- Routing of cell phone calls is based on AI
- Personalize marketing is based on consumer habits detected through Data Science (OCEAN model, Cambridge analytics)
- Complex mathematical theorems have been proven by automatic theorem provers (i.e. Robbins conjecture)
- Best Go players are computers (AlphaGo, 2017)
- Computer systems can composing beautiful music and performing it expressively.

Artificial Intelligence

Spacial missions use AI

Mars Science Laboratory

Walks
select relevant rocks
takes some pictures
Vaporizes
and analyses
rocks composition

autonomously

https://elpais.com/elpais/2017/07/05/ciencia/1499252206_200576.html

Artificial Intelligence

Roomba

Domestic assistant

Learns house map:

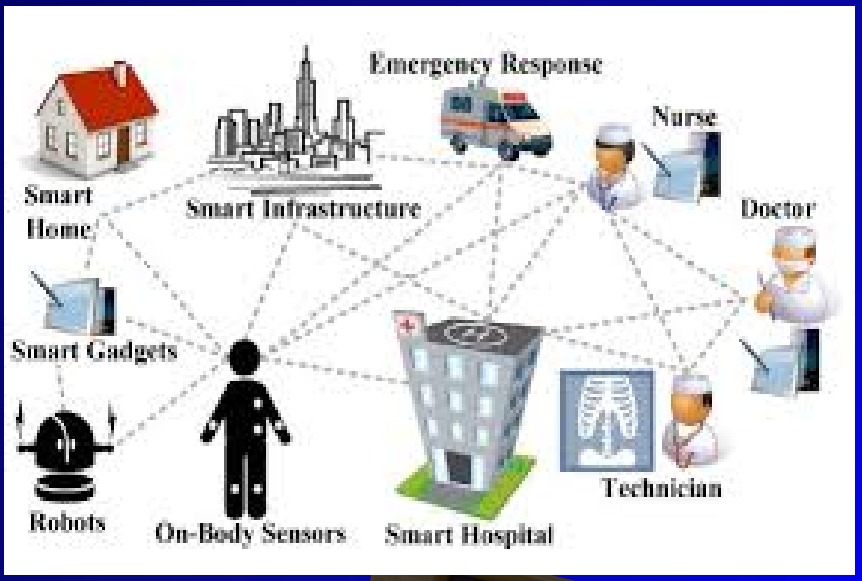
Steps
Doors
Carpets

….detects waste…

Cleans autonomously

http://tech.mit.edu/V123/N2/gadget_review_2.2f.html

Artificial Intelligence



Ambient Intelligence

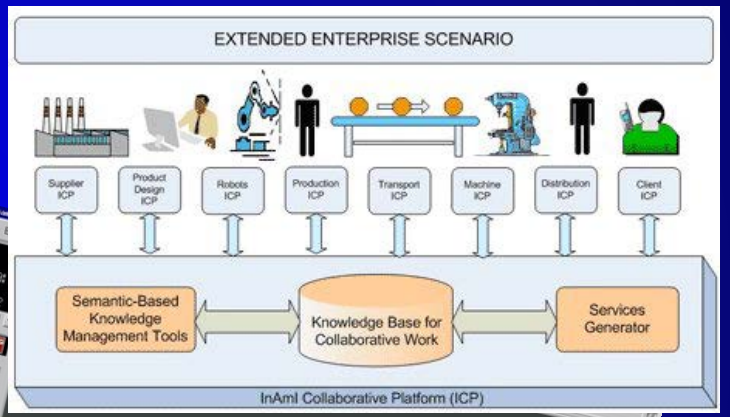
Recommenders
Personalization

Artificial Intelligence

Diagnosis/Control/Planning/Design

Logistics

Intelligent Manufacturing
Industry4.0

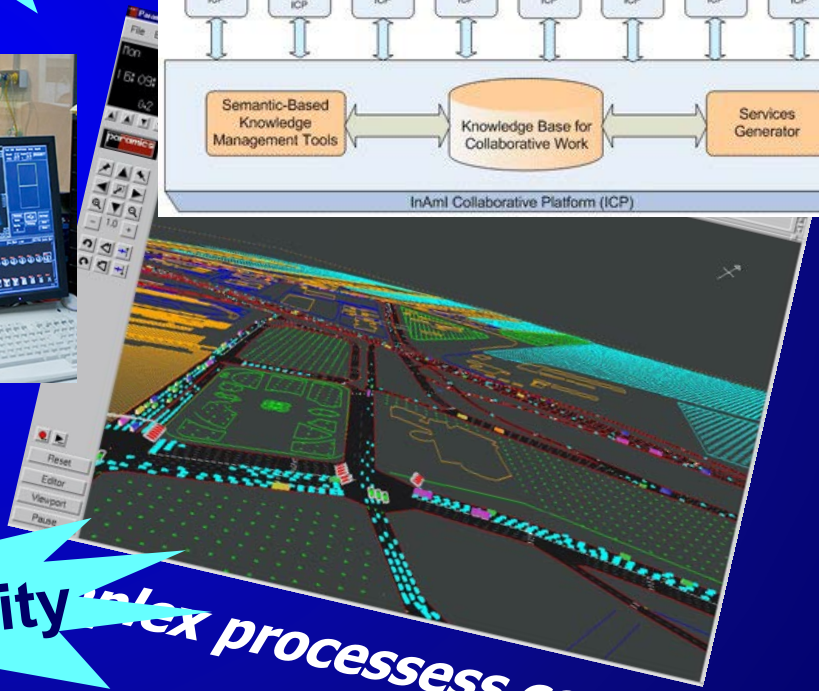


Ethics

Diagnosis

Industrial design

Explainability



Complex processess control

Intelligent Data Science and Artificial Intelligence Research Center IDEAI (UPC)

https://ideai.upc.edu/en

Research group with AGAUR certification SGR-2018/2020

Created oct 2018 (co-founder, current secretary)

6 GR-UPC (KEMLG, GREC, SOCO, GPLN, VEU, GPVI)

56 full time researchers

435 projects in 30 years and 1,185.000€ between 2016-2018

Areas: Efficient resources, Industry 4.0, Economy, Working with talent, Social Inclusion, **Health and Wellness**, Ethics

AI4EU (H2020 project) Jan 2019, > 20millions, 80 partner

K4Care European Project (*IST-2004-026968)*

Proposal for an European Standard for Home Care of elderly and chronic patients using TIC for on-line coordination of all professionals and i ons involved.

Home Care System. The K4Care model

H2020-SPIRE-2015-680843
5.5M€, 4 years
20 partners (Ireland, Spain, UK, Germany, Switzerland, Turkey, Netherlands)

SHAREBOX

industrial symbiosis

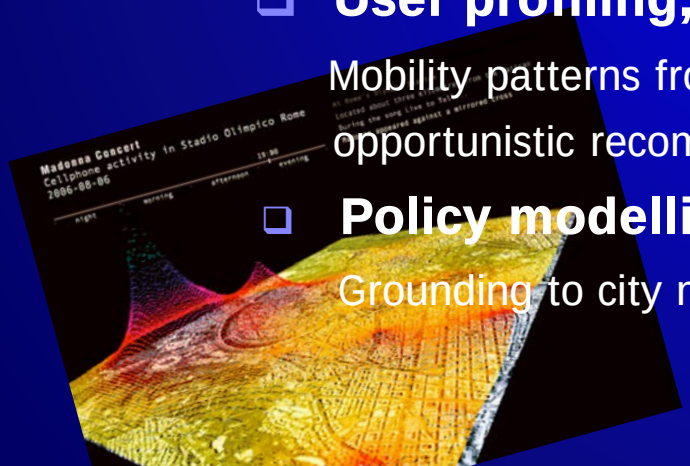
Case based reasoning
Intelligent recommendations of by products sharing
Sustainability

SUPERHUB *(ICT-FP7- 289067)*

SUstainable and PERsuasive Human Users moBility in future cities

- Consortium: 20 Int'l Partners from Belgium, Italy, UK, Txec Rep., Finland
  UPC, ETRA I+D, BCC (Aj. BCN), BDigital, ATM
- 7M €; Duration: 01/10/2011 - 01/10/2014
- Trials in Barcelona Metropolitan Area, Milan and Helsinki

- KEMLg (–at-IDEAI) :
  - **City Event Profile models** for Barcelona, Milan Helsinki
    models connected with: real-time traffic, weather, social networks, etc.
    Detection and identification of unexpected/disruptive events in cities (ML)
  - **User profiling, modelling and recommendation**
    Mobility patterns from social networks, mobility preferences analysis and opportunistic recommendation (data science, bigdata)
  - **Policy modelling and policy making support**
    Grounding to city model: actuations, contextual reality (normative systems)



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BARCELONATECH

i-Walker: The robotic rollator to support mobility

Force sensor

Computing Unit

Motors
Position and orientation sensors

Blocking brakes

- Distributed micro-controller architecture with embedded sensors and actuators
- Reactive control to assist in up and downhill slopes
- Setting parameters for helping and braking forces (mobility support on applications)
  from each sensor
  nation for
  upport to diagnose
  - Walked time and distance
  - Average pushing, leaning and lateral forces applied by user
  - Brake usage
  - Movements in tilts
  - Gait identification and analysis

H2020
Intelligent walker for Parkinson and cognitive impaired patients

Assists walking adatively

Industrialization phase

Artificial Intelligence

grasping wrinkled clothes

Ramisa, A., Alenya, G., Moreno-Noguer, F., & Torras, C. (2012, May). Using depth and appearance features for informed robot grasping of highly wrinkled clothes. In *Robotics and Automation (ICRA), 2012 IEEE International Conference on* (pp. 1703-1708). IEEE.

https://elpais.com/elpais/2017/07/05/ciencia/1499252206_200576.html

Escenari Actual I Futur de la Intel.ligència Artificial

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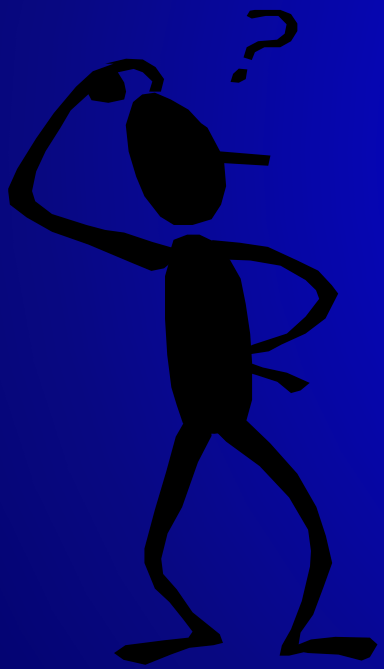

Are there any questions?...

