DIGITAL COGNITIVE TECHNOLOGIES AND USER'S BEHAVIOR

USABILITY AS A BALANCE BETWEEN INTERNAL AND EXTERNAL REPRESENTATIONS

Charles Tijus and François Jouen
LUTIN LIVING LAB
City of Science and of Industry, Paris

SMART COMPOSES

Summer School on
Computational Social and Behavioral Sciences

TODAY'S SPECIAL

1) **SMART** LabEx is about **SMART THINGS**
2) SMART THINGS are based on **SMART INTERACTION TECHNOLOGIES** providing SMART INTERACTION PROCESSES with users Then SMART THINGS are based on **COGNITIVE DIGITAL TECHNOLOGIES**
3) COGNITIVE TECHNOLOGIES come from
    a) Experimental technologies
    b) Then Ergonomics
    c) Then Assistive technologies
4) SMARTNESS (smart usability) is a balance between **INTERNAL AND EXTERNAL REPRESENTATIONS**
5) How to prevent the **EFFECTS OF EXTERNALIZATION**: the development of **IMITATIVE TECHNOLOGIES** as **RESPONSIBLE INNOVATION**.

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MEASURING AND MODELING COMPLEXITY

Poitrenaud, S., Richard, J.-F., & Tijus, C. (2005). Properties, categories and categorization. *Thinking and Reasoning, 11*, 151-208

- independence (presence of one descriptor does not allow us to infer presence of the other),
- equivalence (presence of one brings about the presence of the other and vice-versa),
- exclusion (presence of one precludes the presence of the other),
- implication (presence of one brings about the presence of the other, the reverse being not necessarily true).

Galois Lattices

The O_n x D_m Boolean matrix, which indicates whether each of n objects has or not each of m descriptors, enables the creation of one hierarchy of categories with transitivity, asymmetry and reflexivity.

The maximum number of categories is either 2^{n-1}, or m if $m < 2^{n-1}$, given that each meaningful category should have at least one descriptor, what renders the "combinatorial explosion" relative to the number of descriptors.

1 - **SMART** LabEx is about **SMART THINGS**

EXAMPLES OF SMART THINGS

We may interact with our clothes ....

The interactive clothing and accessories

Prospection of the intelligent dressing of the body

HOMO TEXTILUS

1 - **SMART** LabEx is about **SMART THINGS**

EXAMPLES OF SMART THINGS

1 - **SMART** LabEx is about **SMART THINGS**

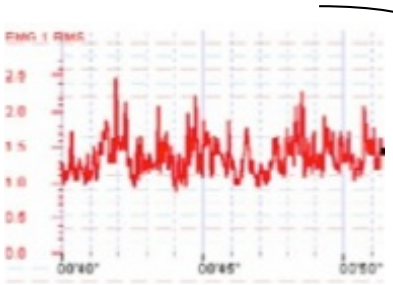
EXAMPLES OF SMART THINGS

SMART CLOTHES

THE PROSPECTIVE ERGONOMICS OF SMART CLOTHING

sensors

Data processing



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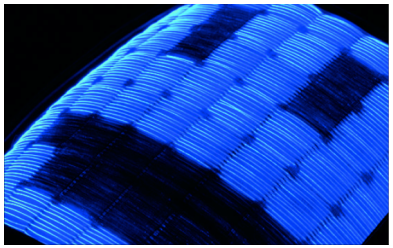
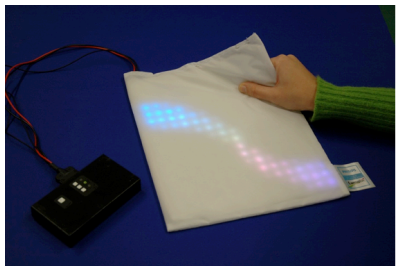
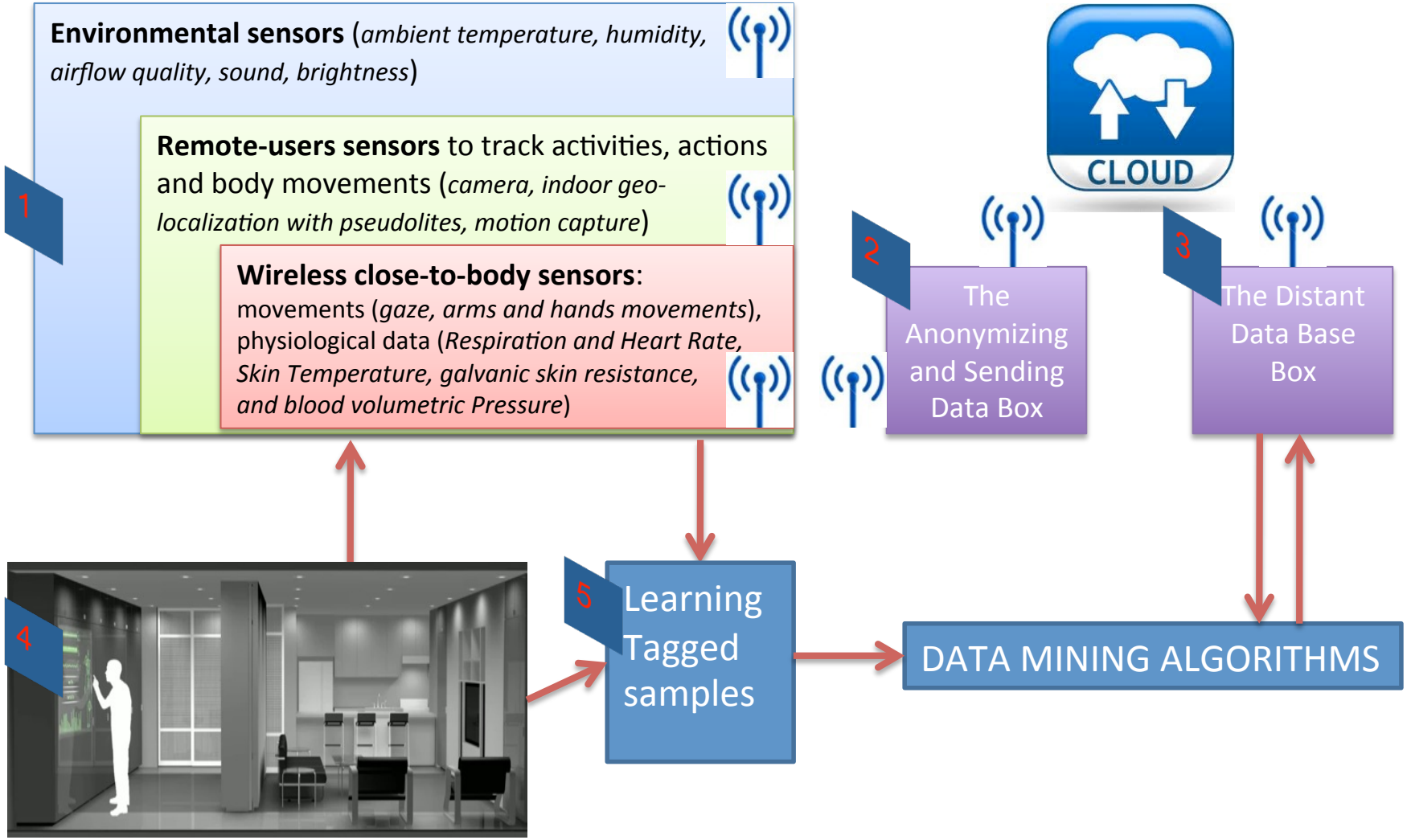




HOMO TEXTILUS

actuators

THE PROSPECTIVE ERGONOMICS OF SMART HOME FOR SENIORS

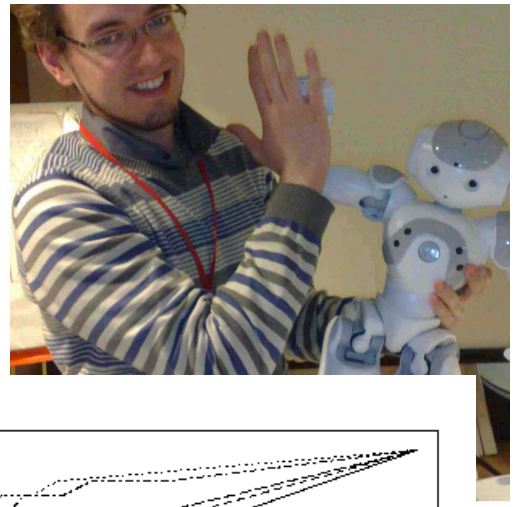


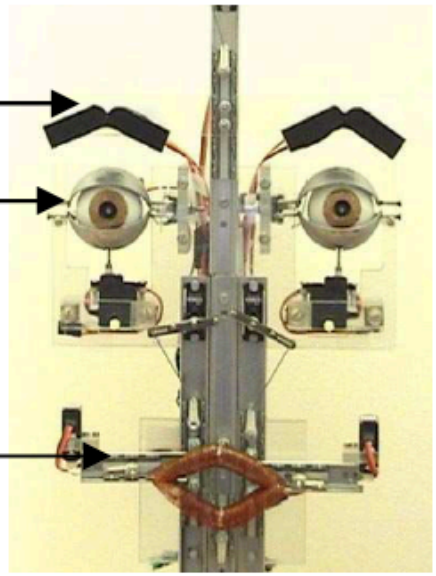
THE PROSPECTIVE ERGONOMICS OF ROBOTICS

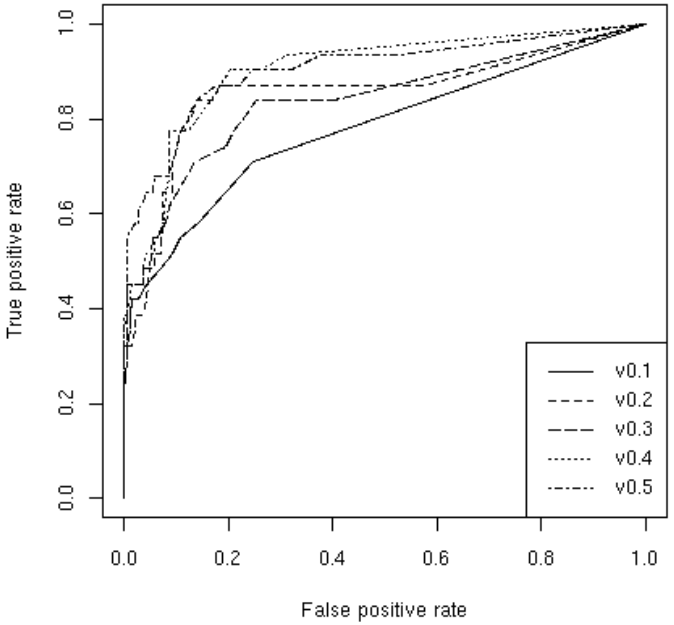
To imitate or being imitate ?

What is more challenging for
Children with autism ?

(J. Nadel)







THE PROSPECTIVE ERGONOMICS OF VIRTUAL AGENTS

VIRTUAL ROBOT

2 - SMART THINGS are based on **SMART INTERACTION TECHNOLOGIES** providing SMART INTERACTION PROCESSES with users Then SMART THINGS are based on **COGNITIVE DIGITAL TECHNOLOGIES**

These Cognitive technologies are technologies based on knowledge of users behavior (emotion, action, reasoning ...)

2.1 – Brain Computing
2.2 – Eye motion Computing
2.3 – Body motion Computing
2.4 – Motion Computing
2.5 – Emotion Computing
2.6 – Action Computing
2.7 – Cognitive Computing

Brain Computing Interaction

Eye Tracking

•Oculométrie et webcam

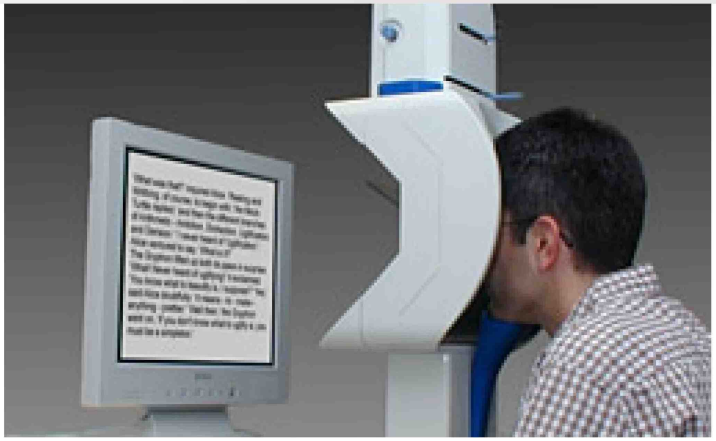
•Plasticité oculomotrice des saccades

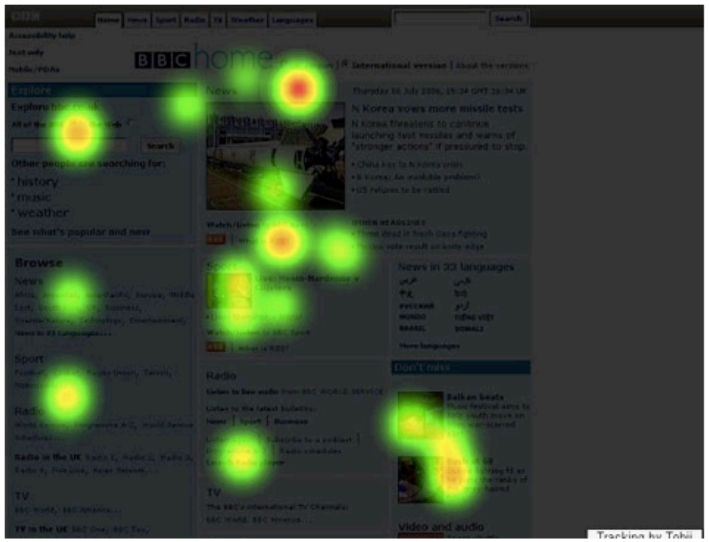
•Etude de la stabilité visuelle

•Modélisation de l'exploration visuelle pour des scènes visuelles dynamiques et statiques

•Dispositifs de commande oculaire

•Indices





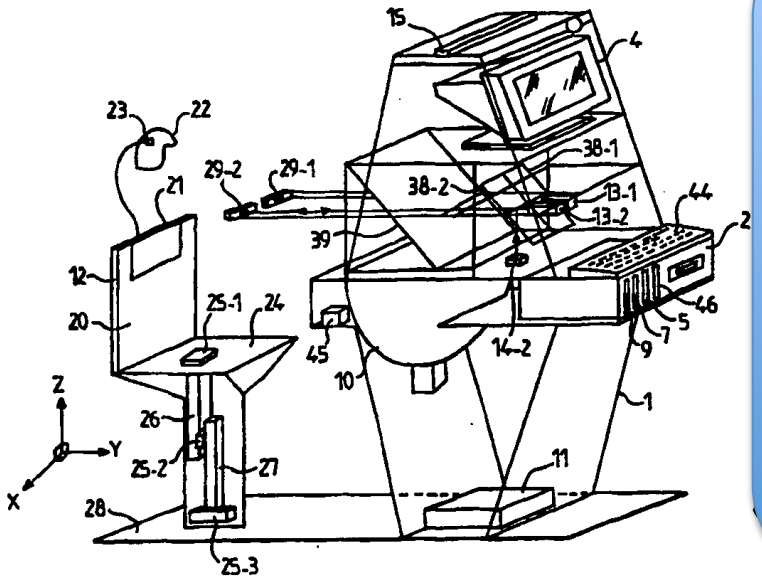
Visualisation Eye-tracking – [confidentiel]
Antoine Visonneau – Laboratoire des Usages en Technologie de l'Information Numérique

(54) Title: DEVICE FOR CONTROLLING EYE MOVEMENT

(54) Titre: DISPOSITIF DE CONTROLE DES MOUVEMENTS OCULAIRES

(57) Abstract

A support (12) for a living being, controllably movable in three directions, defines an area (29-I) for the eyes (30-I). A frame (1) comprises two light sources (14), supplying, at the level of the area (29-I) for the eyes (30-I), two infrared light beams (37-I), two cameras (13-I), each for capturing an image derived from the reflection of said light beam (37-I) on an eye (30-I) and processing means for digitalizing the eye images and processing them in real time to calculate the center coordinates of the corneal point (42-I) with reference to the pupil center (41-I). The processing means further control the movement of the support (12) to position the eyes (30-I) precisely in the axis of the cameras (13-I), according to the coordinates of the pupil contour. A mass memory in the microcomputer (2) stores the data relating to a plurality of basic visual tests comprising a selected sequence of visual stimulation images. The response of the eyes to an image provides a gaze direction which is analyzed by processing means.

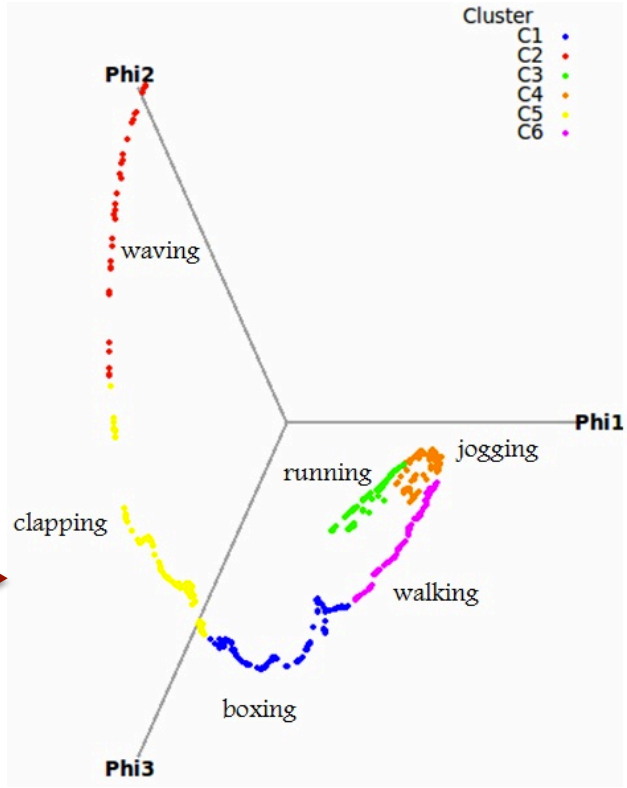


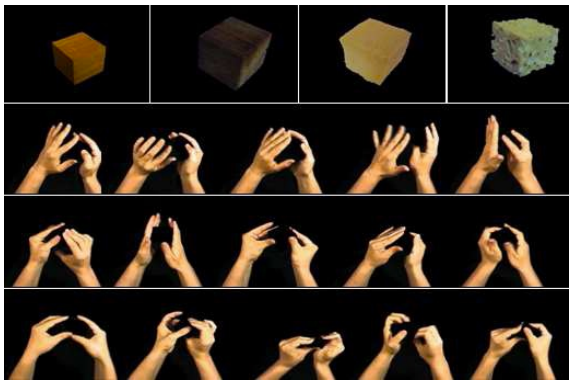
Coupling EyeTracking
(*F. Jouen; P.-M. Baudonnière*)
With EEG
(*EFRP: Eye-Fixation-Related Potentials*)
(T. Baccino)

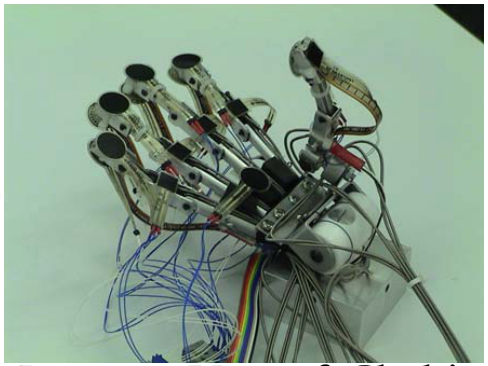
(71) Déposant *(pour tous les Etats désignés sauf US)*: CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE [FR/FR]; 3, rue Michel-Ange, F-75016 Paris (FR).

(72) Inventeurs; et
(75) Inventeurs/Déposants *(US seulement)*: JOUEN, François [FR/FR]; 57, rue Jean-Lecanuet, F-76000 Rouen (FR). BAUDONNIERE, Pierre-Marie [FR/FR]; 83, rue de l'Amiral-Roussin, F-75015 Paris (FR).

MOTION COMPUTING







François Jouen et Youcef Chahir (CHArt-LUTIN & GREYC)

GRASPING MOTION COMPUTING

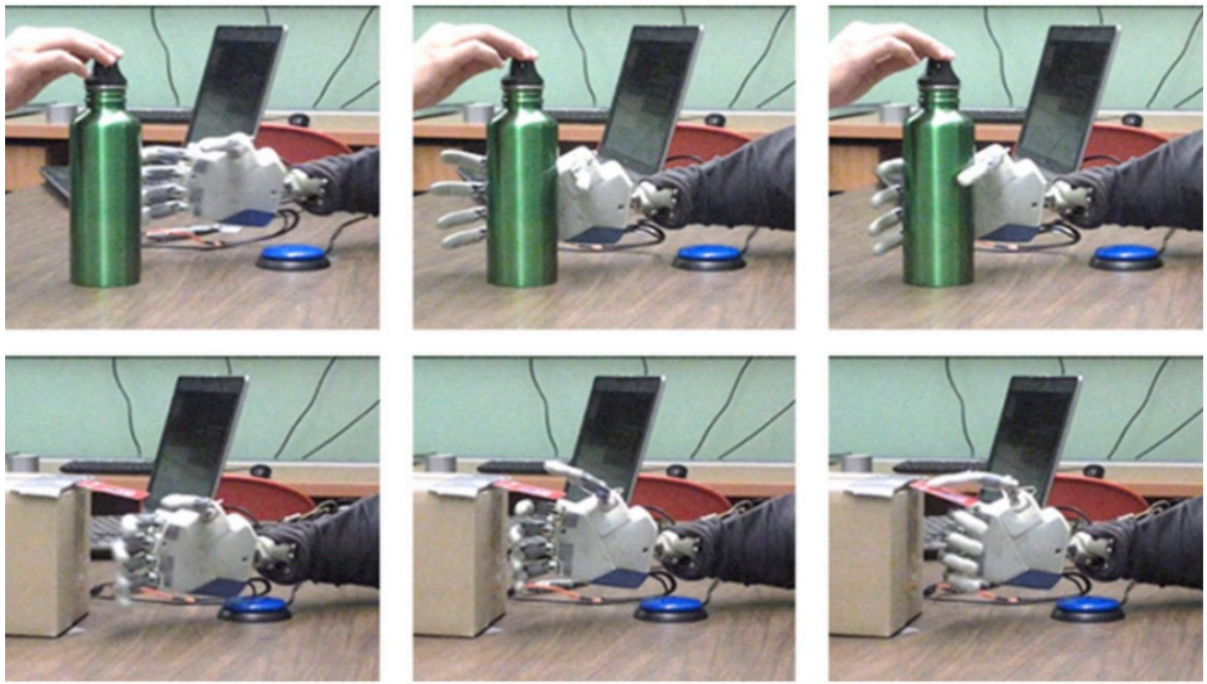
frontiers in Neuroscience

ORIGINAL RESEARCH
published: 09 April 2015
doi: 10.3389/fnins.2015.00121

Global cortical activity predicts shape of hand during grasping

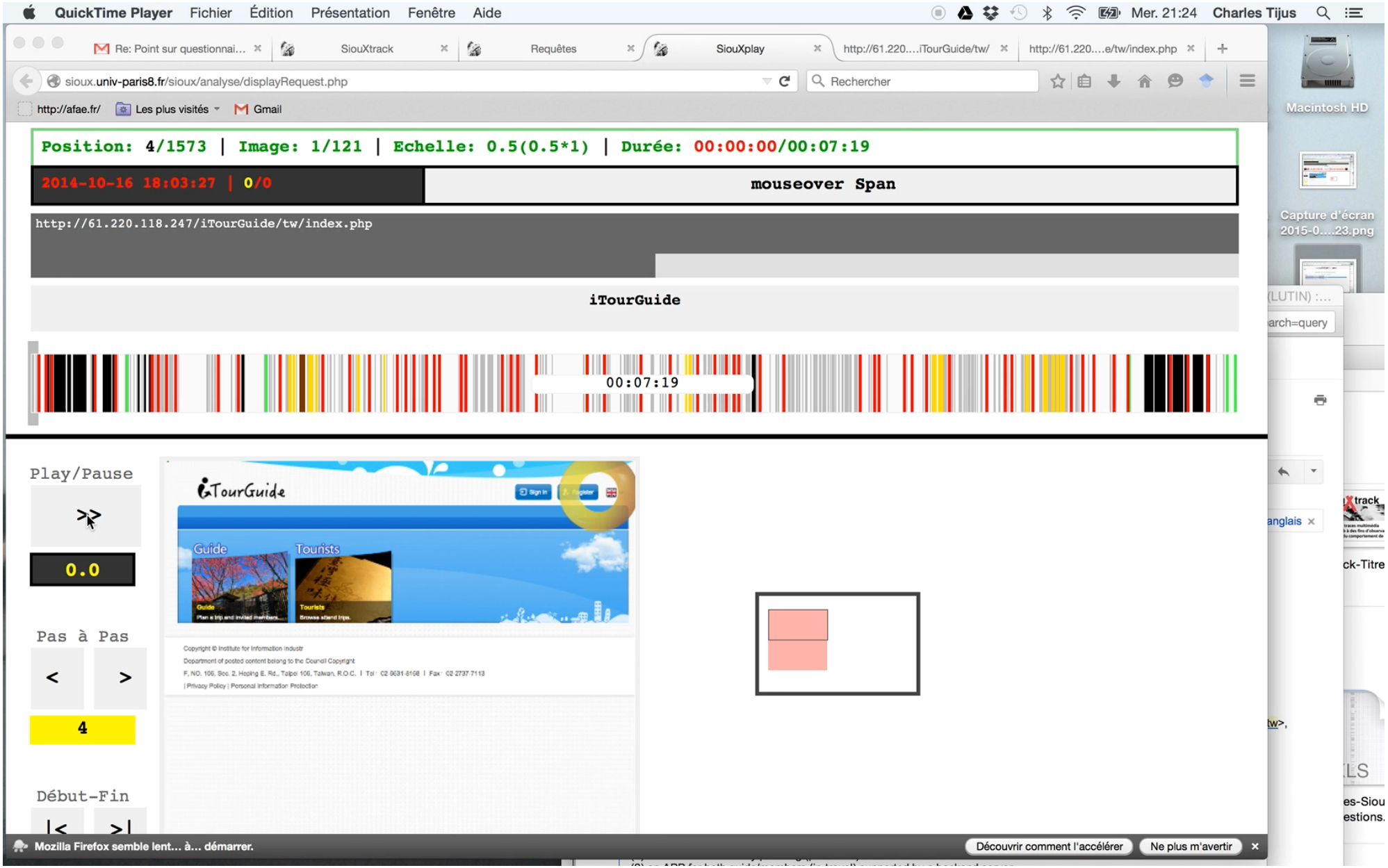
Harshavardhan A. Agashe [1], Andrew Y. Paek [1], Yuhang Zhang [1,2] and José L. Contreras-Vidal [1]*

[1] Noninvasive Brain-Machine Interface Systems Lab, Electrical and Computer Engineering, University of Houston, Houston, TX, USA, [2] Hyperspectral Image Analysis Lab, Department of Electrical and Computer Engineering, University of Houston, Houston, TX, USA



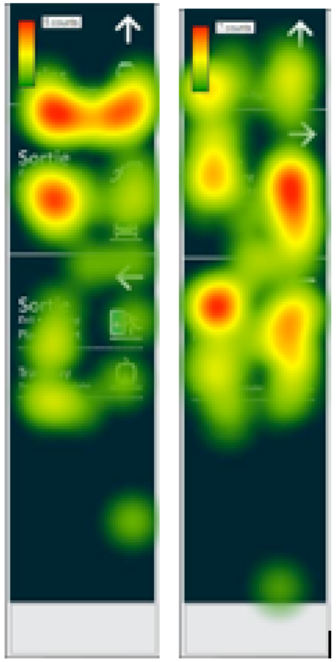
Application for rehabilitation of the gesture in child BMI and motor imagery with BCI (Spruitj et al, 2013 ; Molina, Jouen et al., 2014)

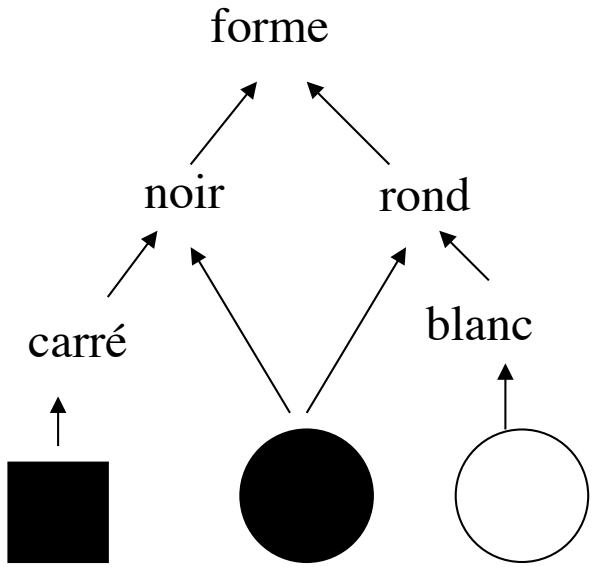
ACTION COMPUTING

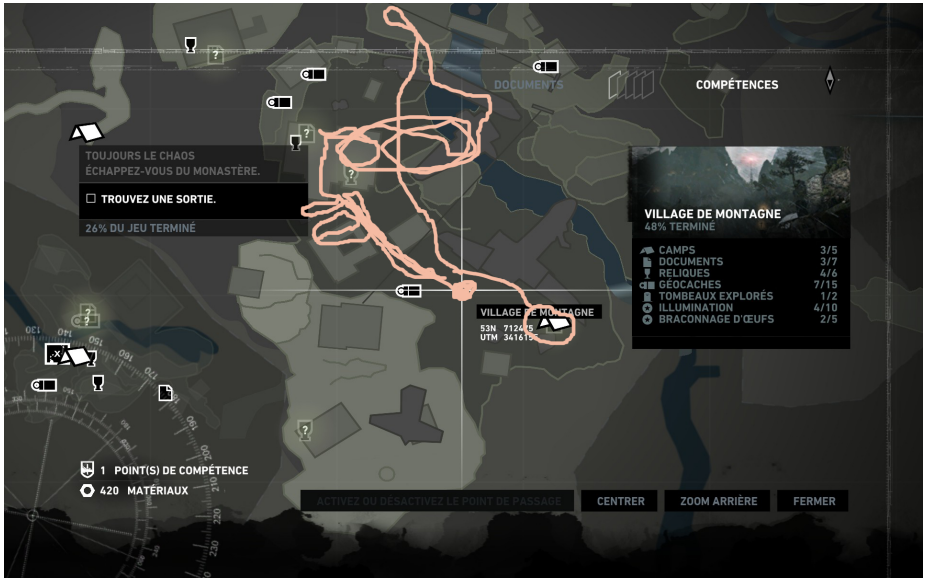


Cognitive Computing

- affordance
- Comprehension
- reasoning
- Decision making
- planning
- strategy
- goals structure
- behavior







A cognitive technology is a technology based on the knowledge of its user behavior (emotion, action, reasoning ...)

3 - COGNITIVE TECHNOLOGIES come from

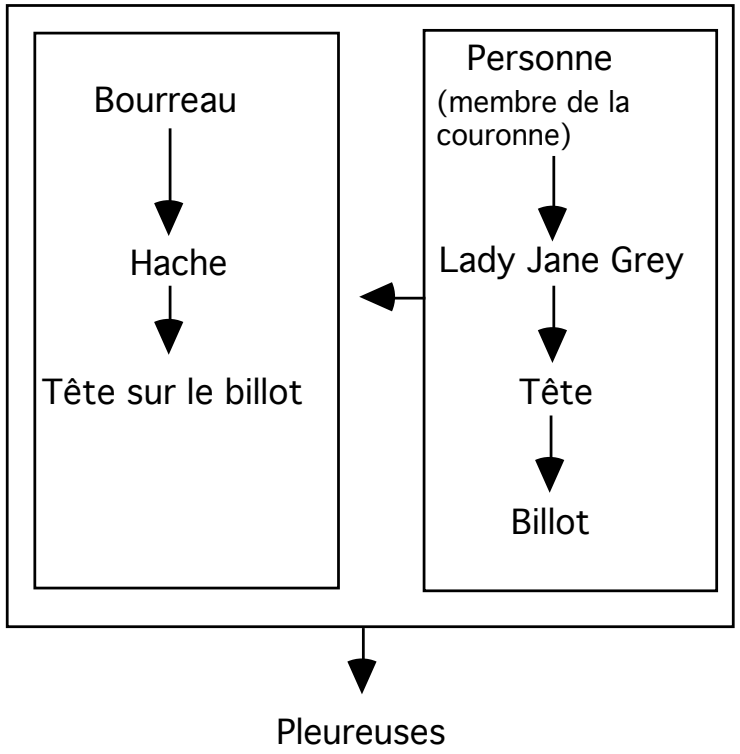
a) Experimental technologies

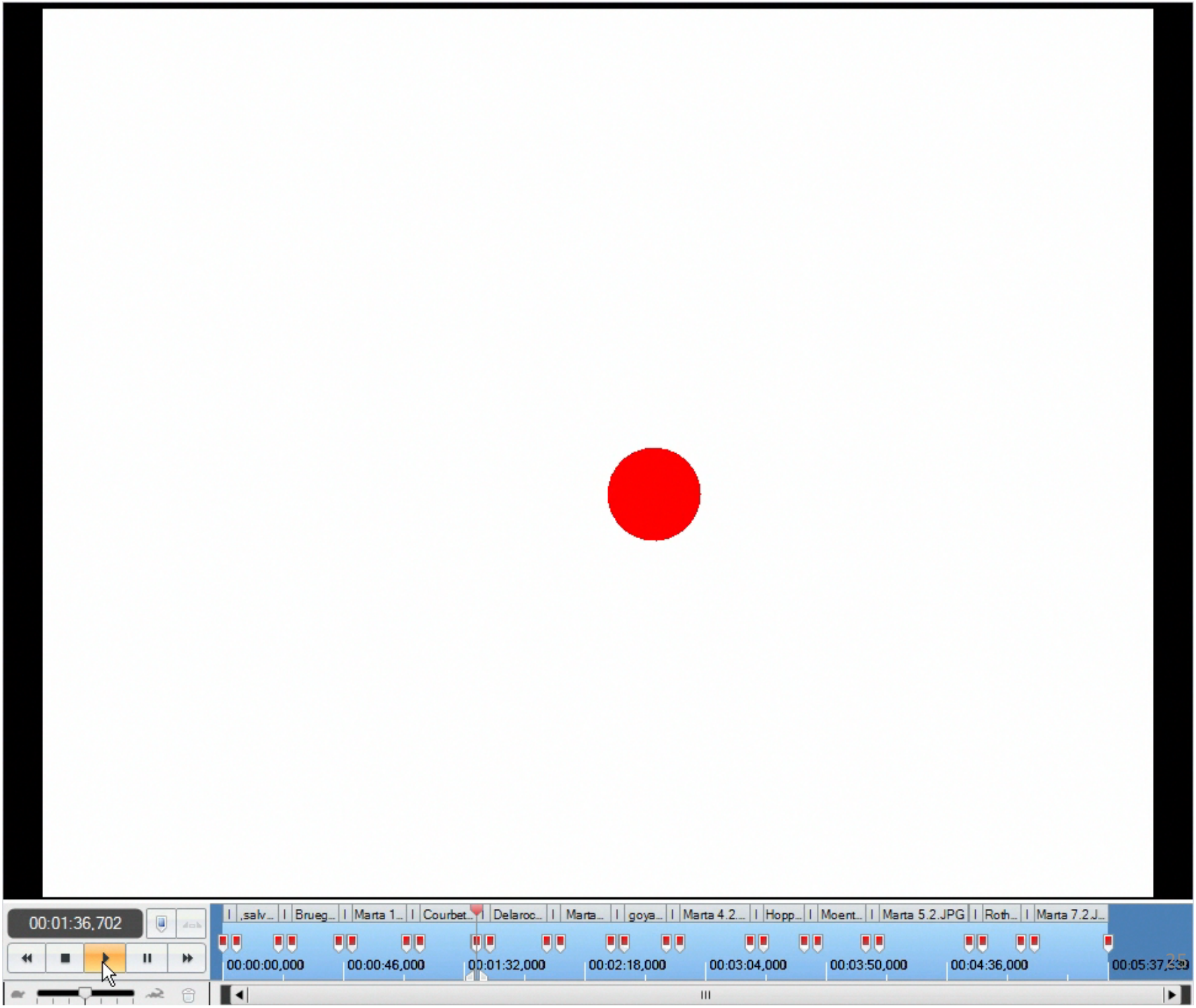
b) Then Ergonomics

c) Then Assistive technologies

The Execution of Lady
Jane Grey
Paul Delaroche
1833

a) Experimental technologies

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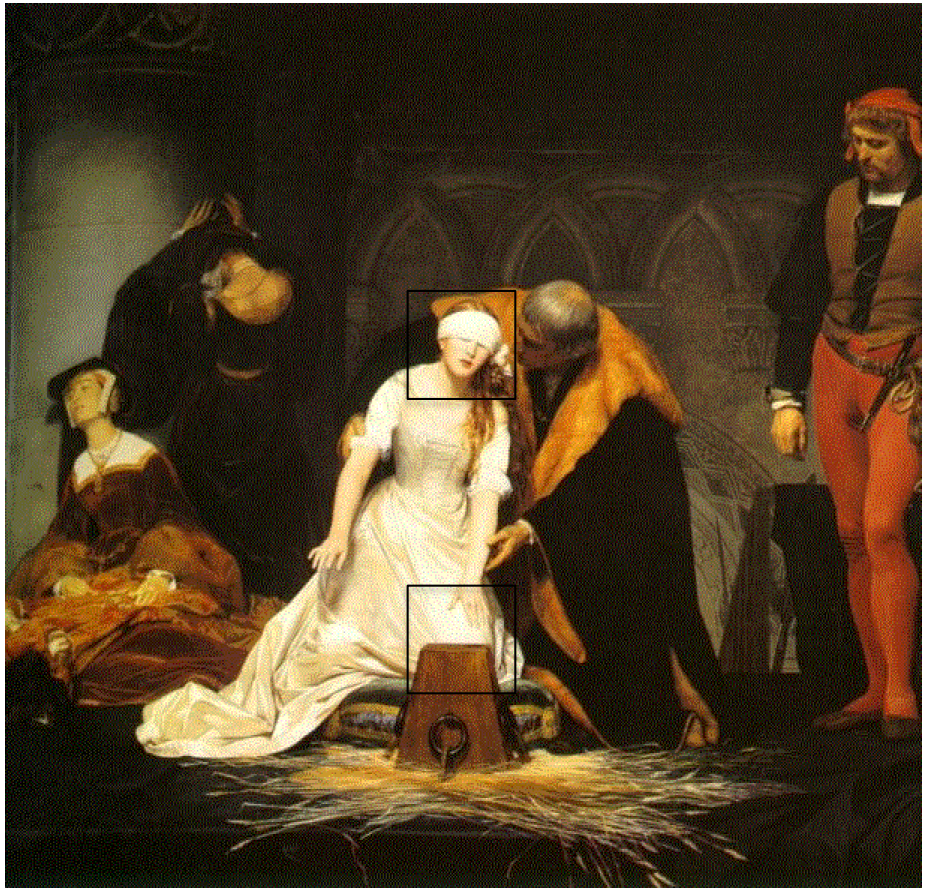
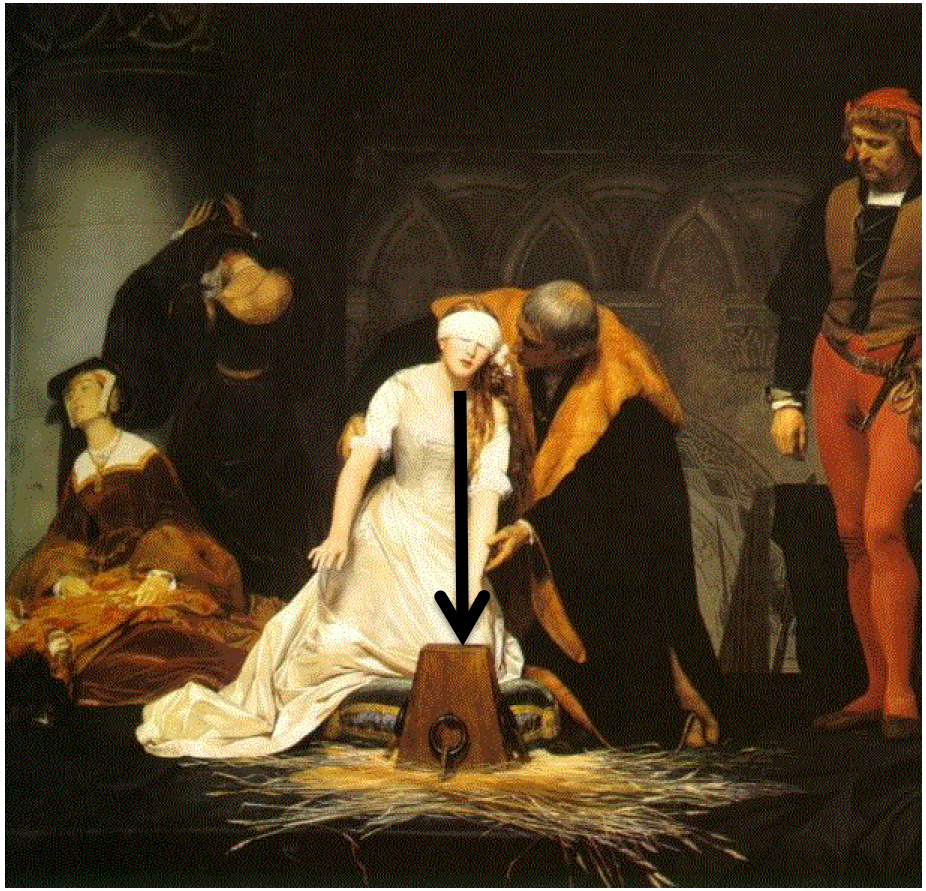
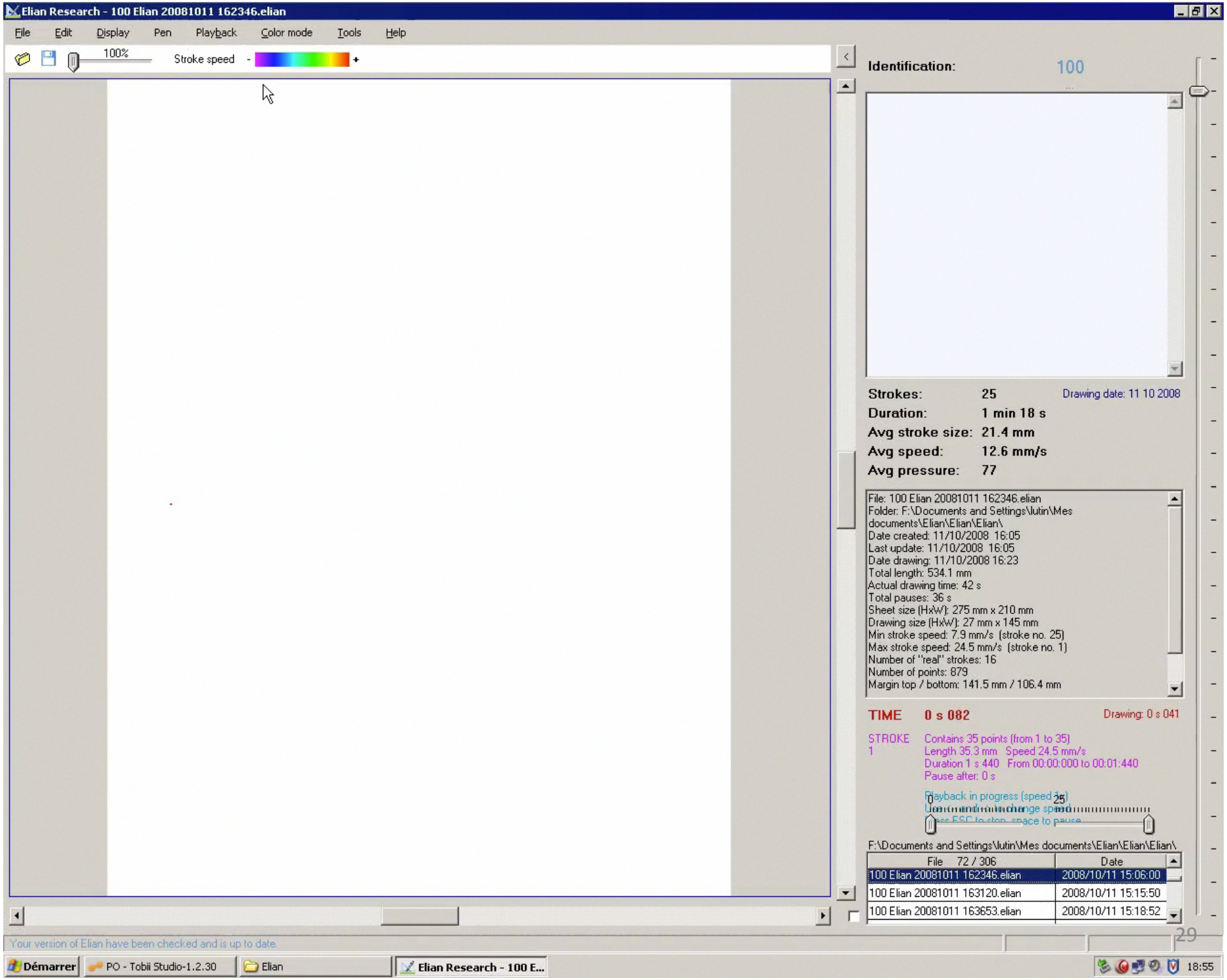
b) Then Ergonomics



c) Then Assistive technologies

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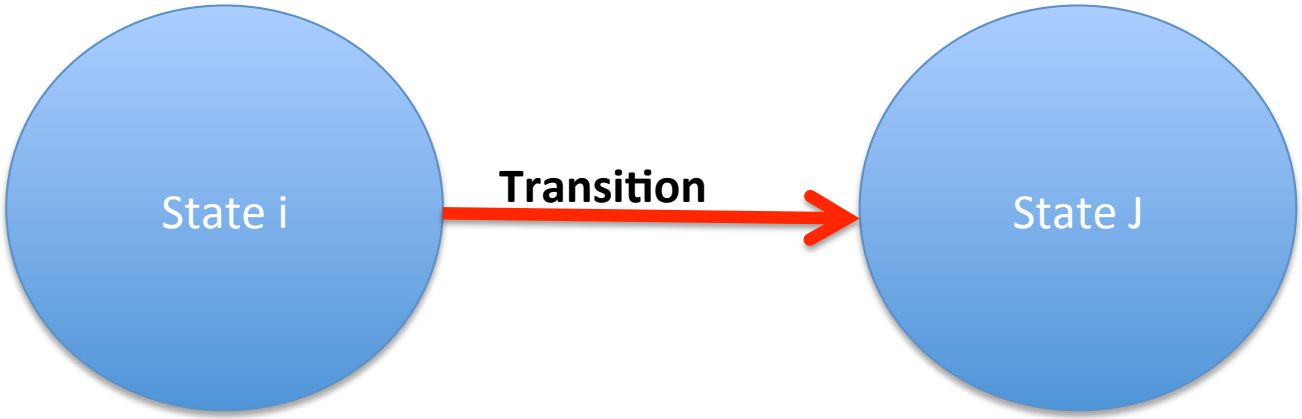
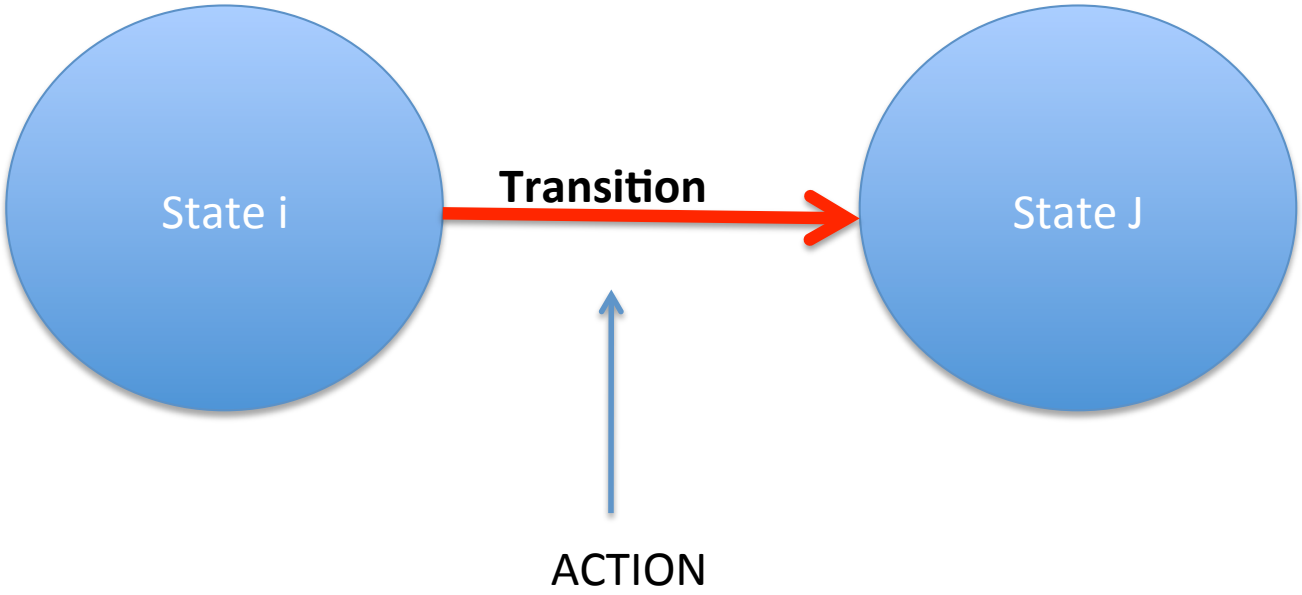
4 - SMARTNESS (smart usability) is a balance between INTERNAL AND EXTERNAL REPRESENTATIONS

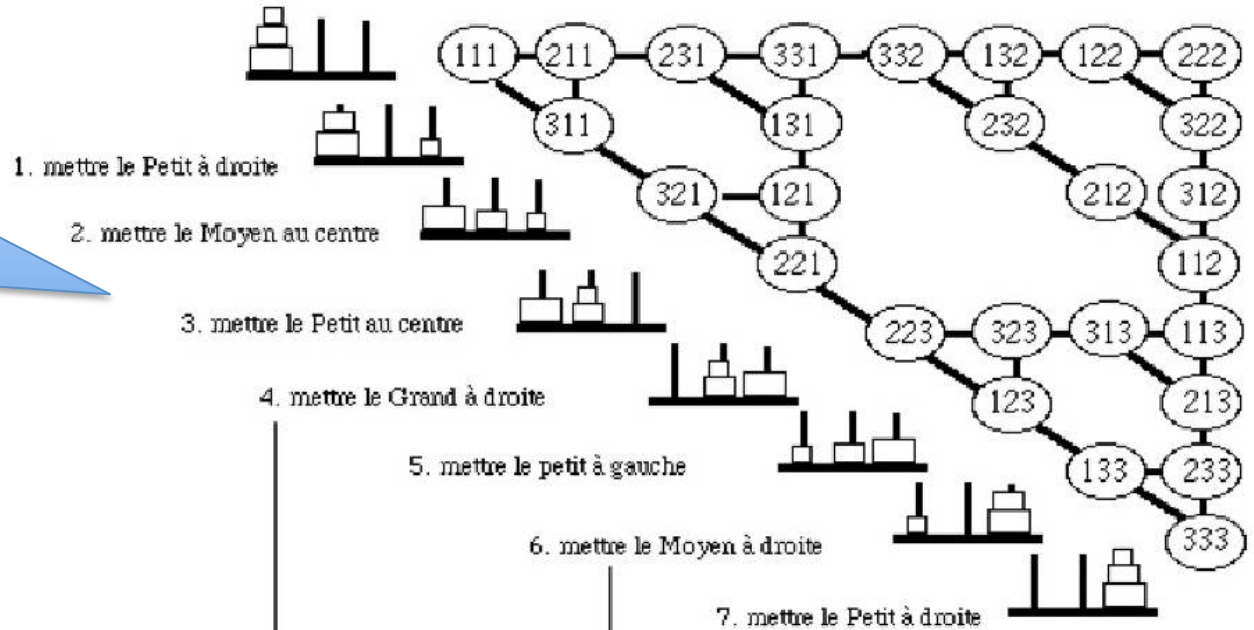


4 - SMARTNESS (smart usability) is a balance between INTERNAL AND EXTERNAL REPRESENTATIONS

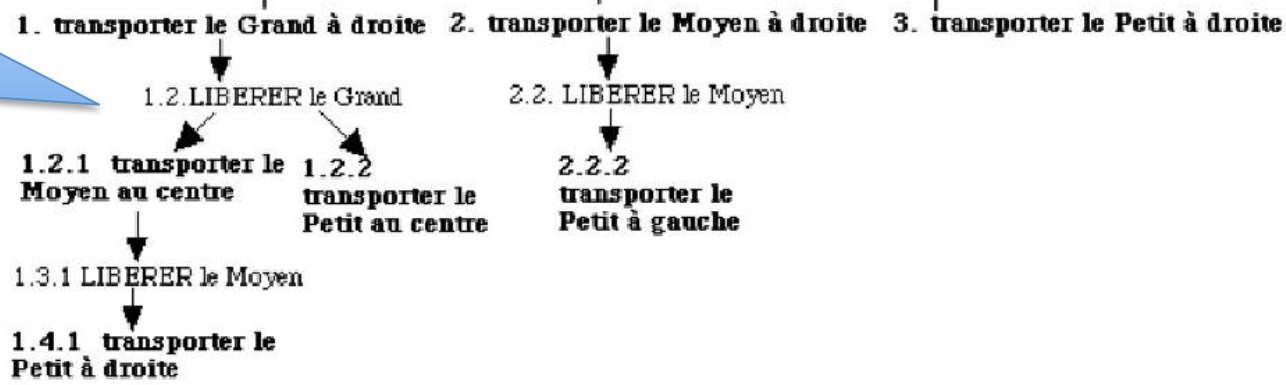


BASIC STANDARD DESCRIPTION OF SITUATION (Augmented Transition Network, ATN)

ACTION PRIMITIVES



GOALS STRUCTURE



CHANGE PLACE

Etat initial

Etat final

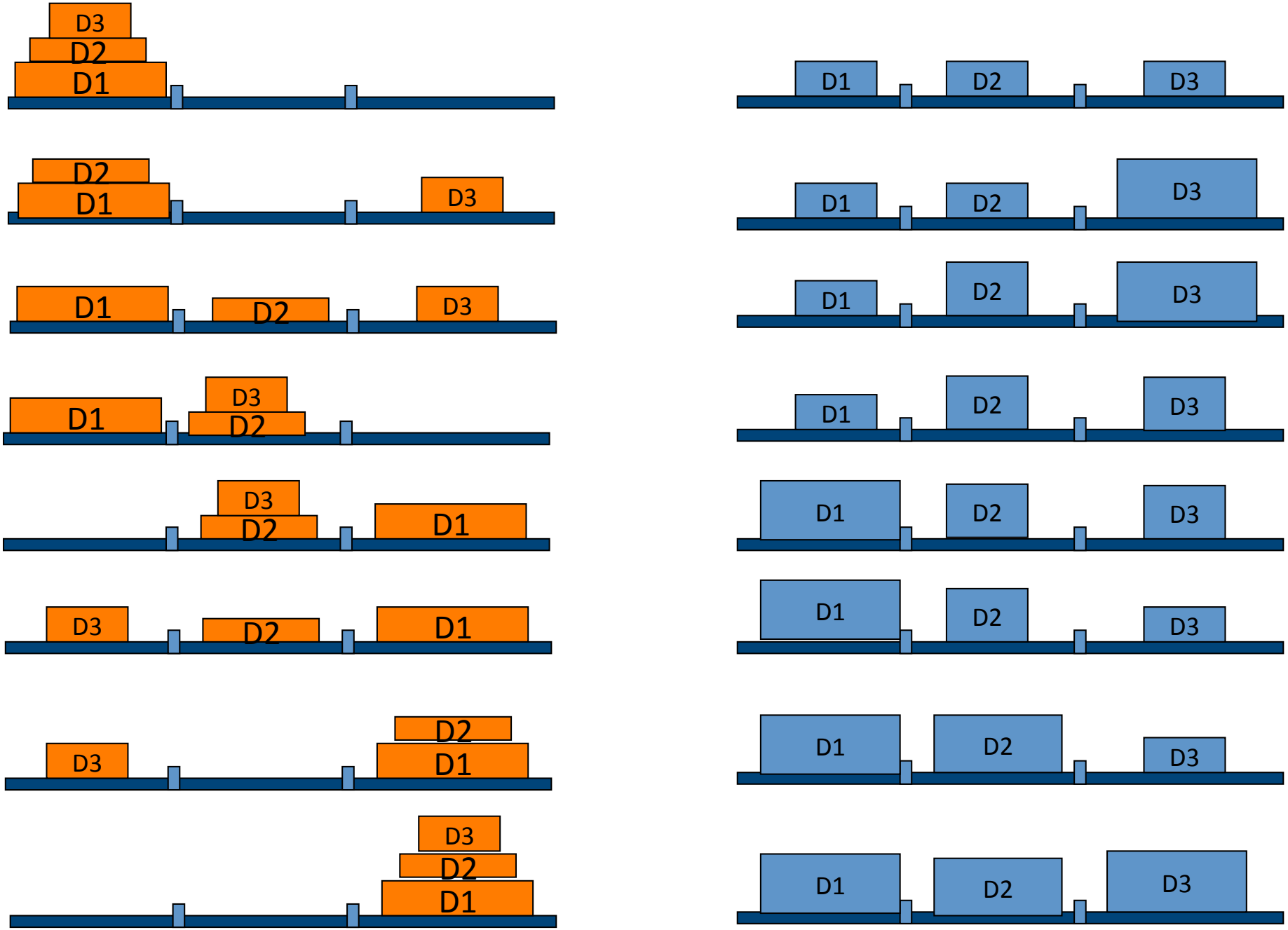
CHANGE SIZE

Etat initial

Etat final

Change place : 11.2 moves
Change size : 67.8 moves

People provide themselves with additional constraints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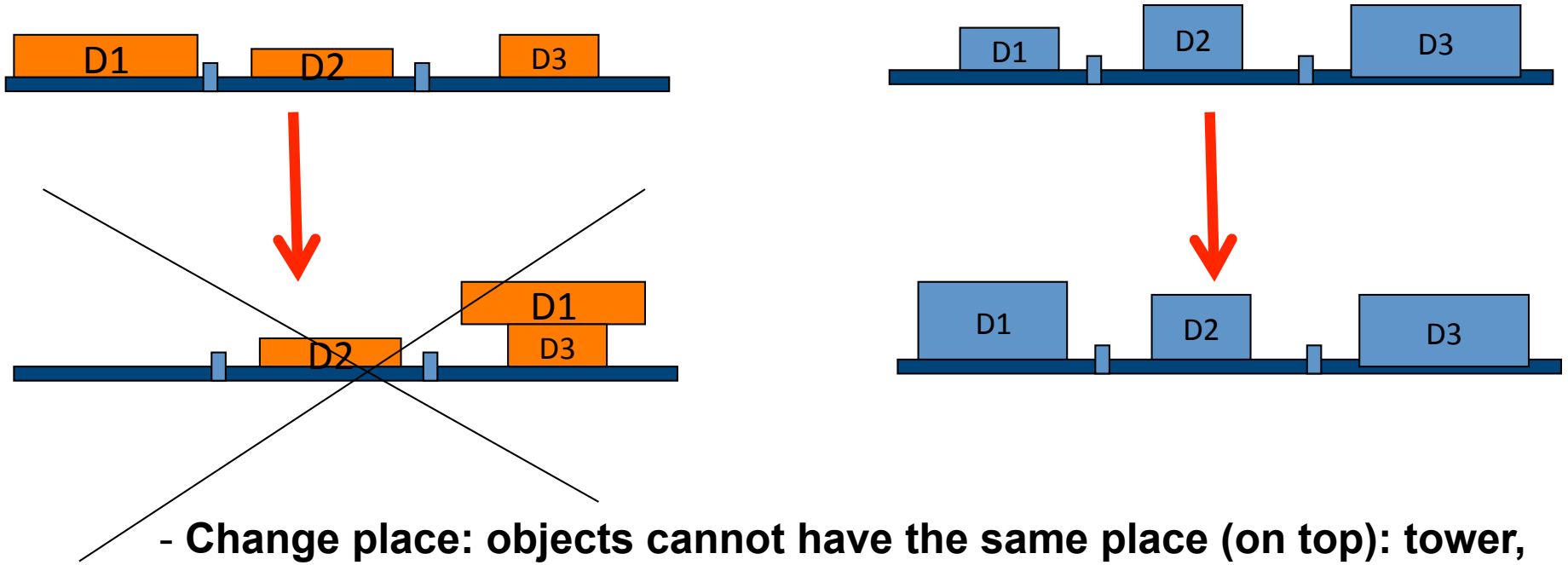
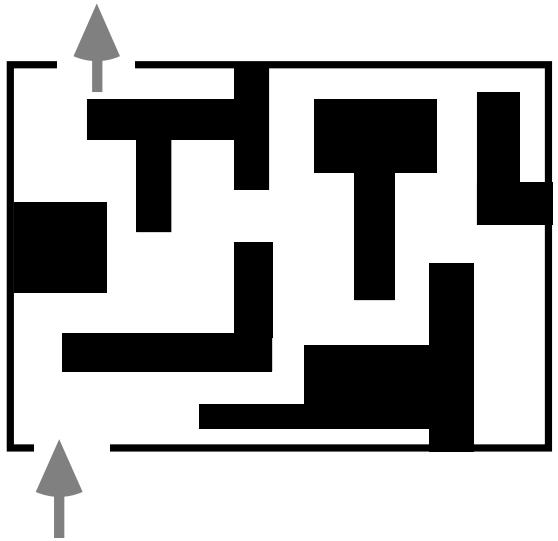
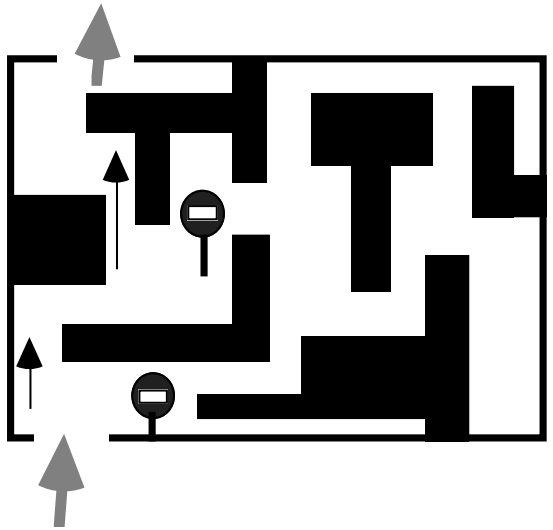
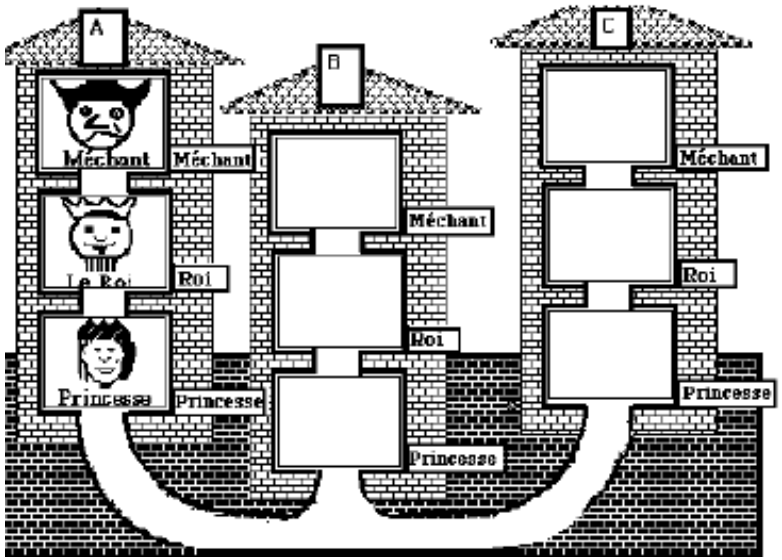
Tour de Hanoi: Smart problem !



- **Change place: objects cannot have the same place (on top): tower,**
- **change Size: objects can have the same size**



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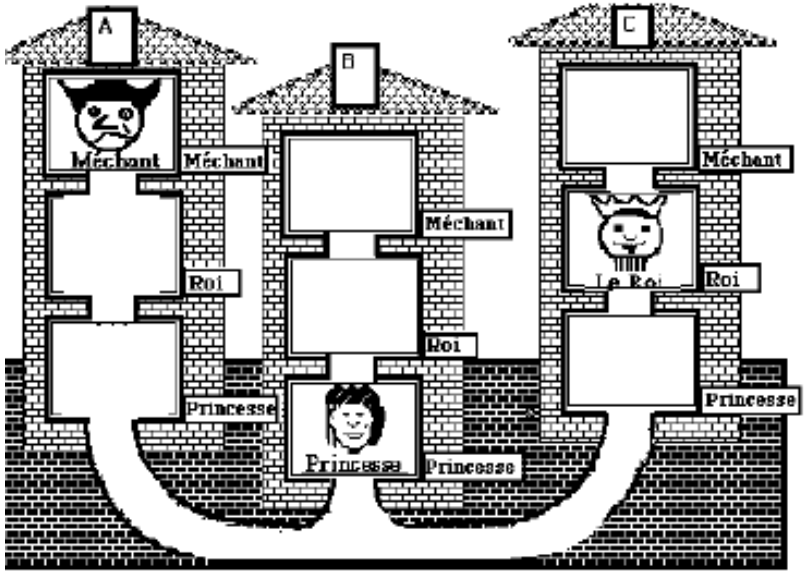
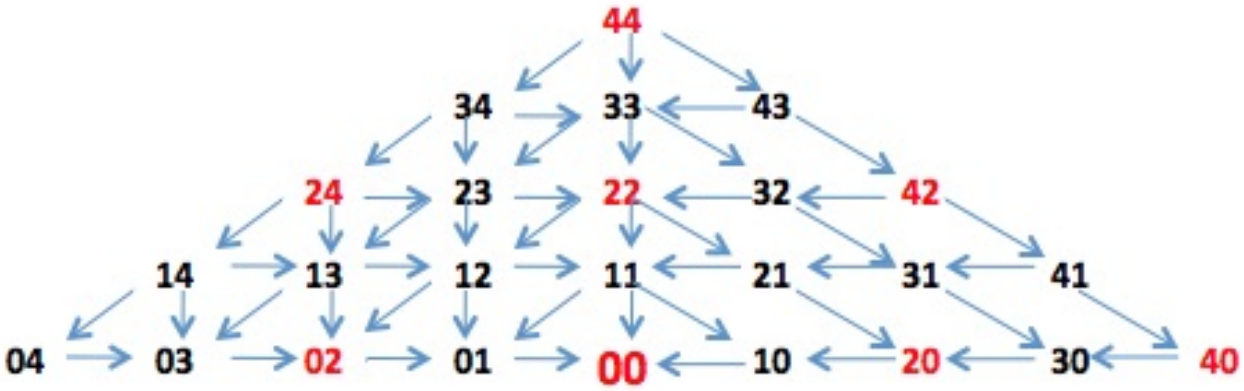

A
B
C
Méchant
Méchant
Méchant
Méchant
Le Roi
Roi
Roi
Roi
Princesse
Princesse
Princesse
Princesse

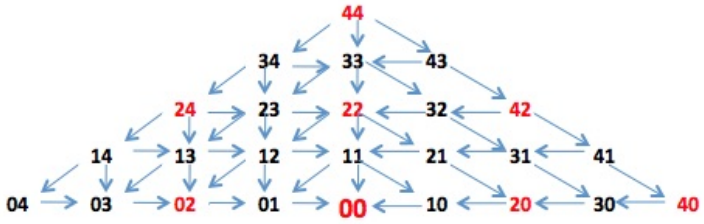
Rules Discovery:
Transfer and Generalization

Problem space for the versions 44

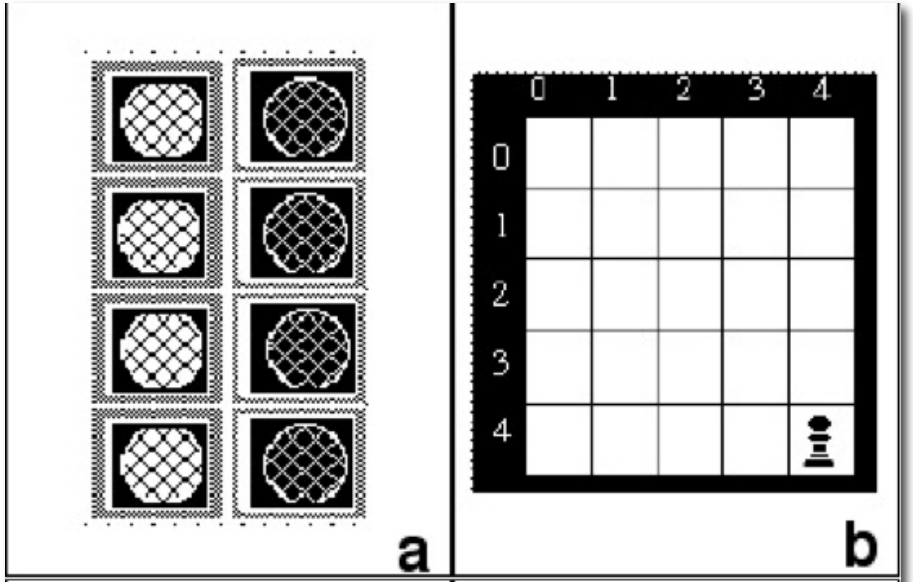
start state: 44

in red are the positive goals and winning state (state 00)



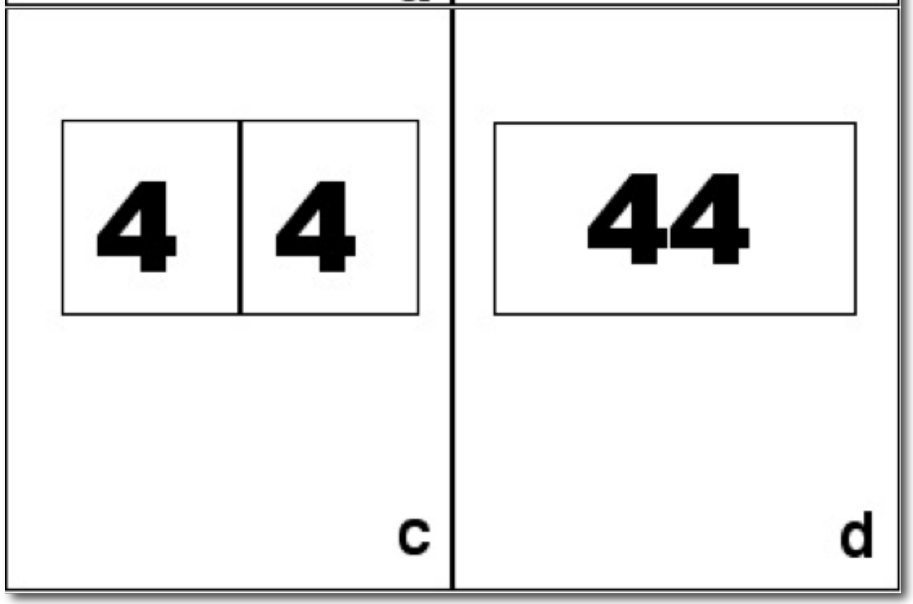


Token44:
-remove a token from the left pile;
-remove a token from the right pile;
-remove a token from both piles.

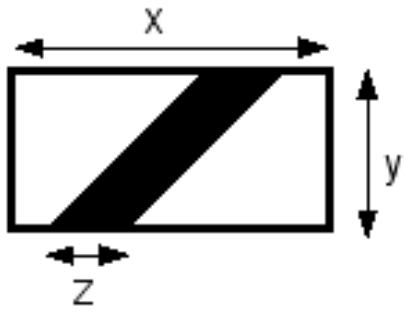


Board44:
the arrows show the three allowed operators.

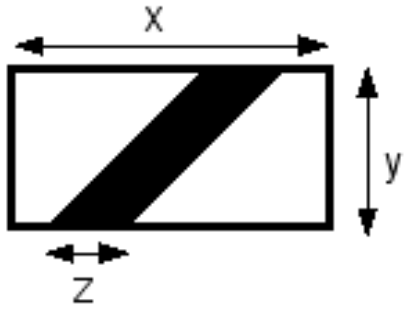
2Digit44:
-subtract 1 on the left box;
-subtract 1 on the right box;
-subtract 1 from both boxes.



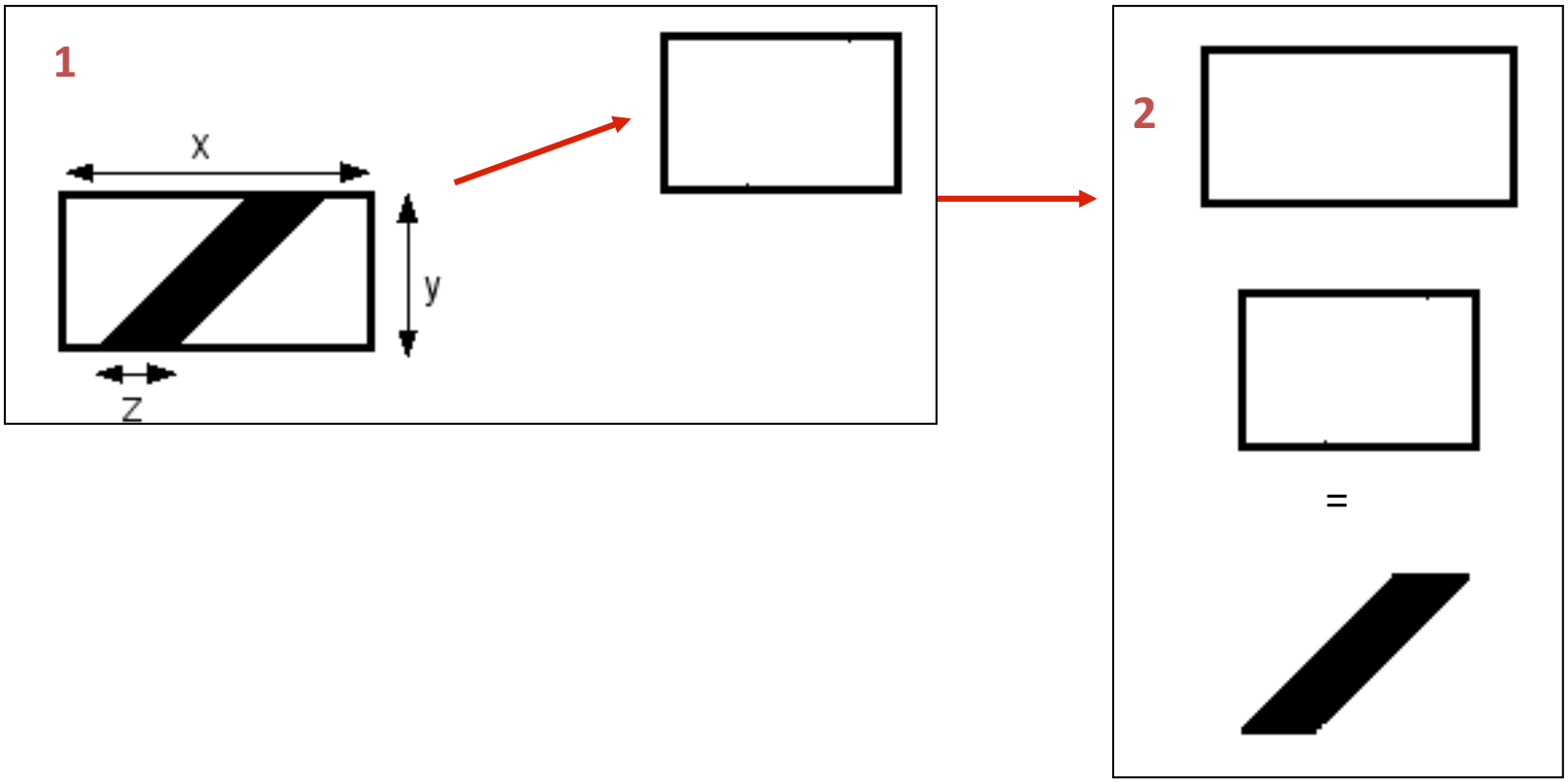
Number44:
-subtract 1;
-subtract 10;
-subtract 11.



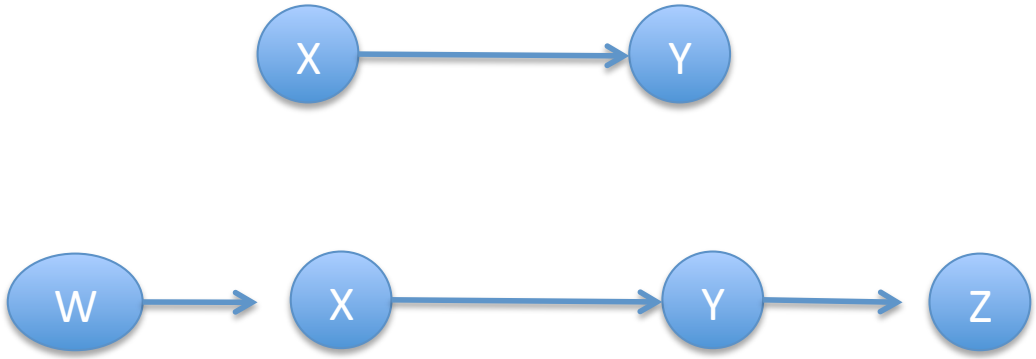
Given X, Y and Z, find the surface of the black part of the rectangle

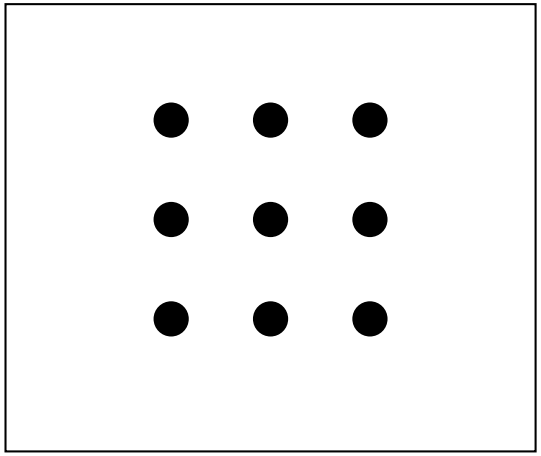


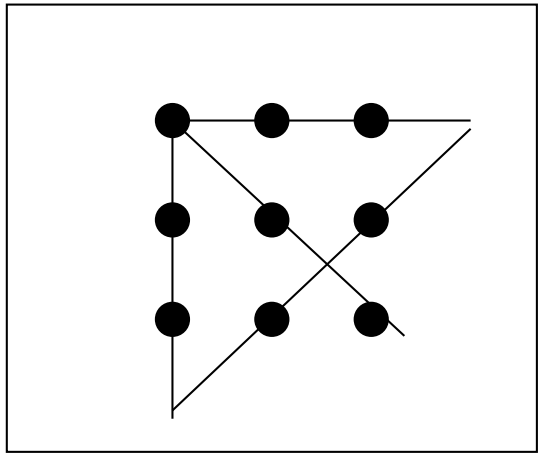
Given X, Y and Z, find the surface of the black part of the rectangle

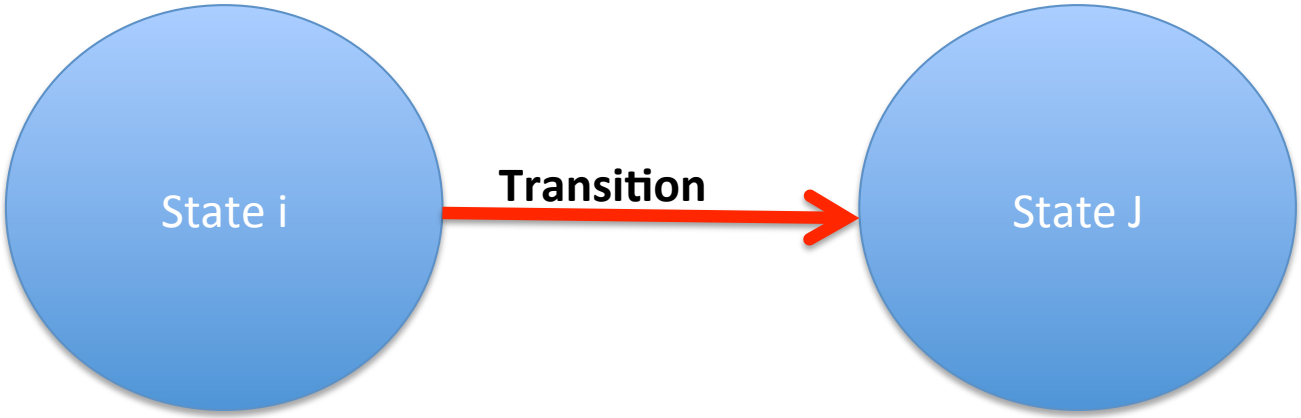


Jean Gabriel Ganascia: "*how to prevent programmers making algorithms to find the cheapest airplane ticket from X to Y, to check only for airplanes starting from A and ending to B, but not from airplanes having other starting and final towns*".

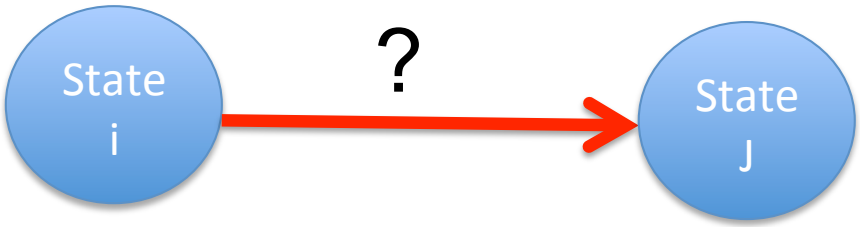


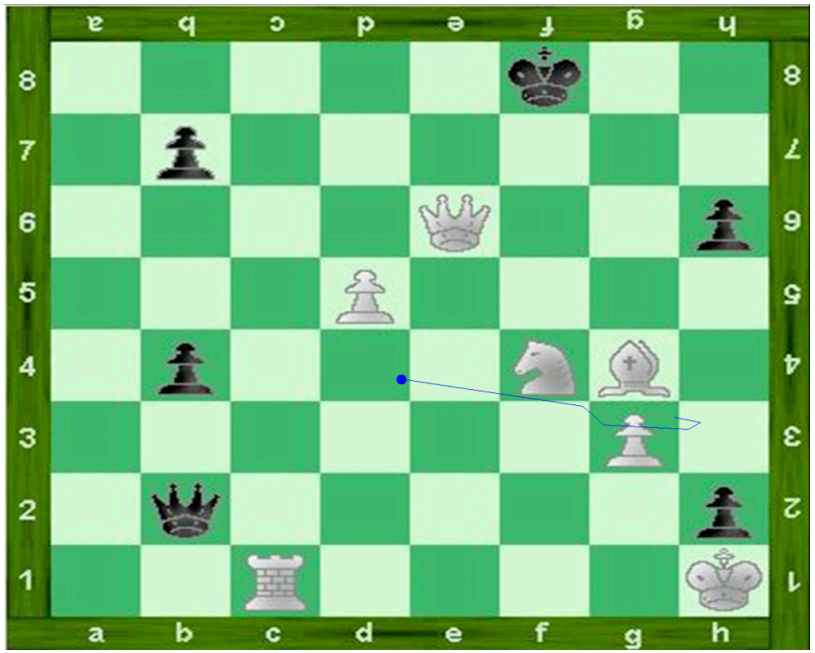


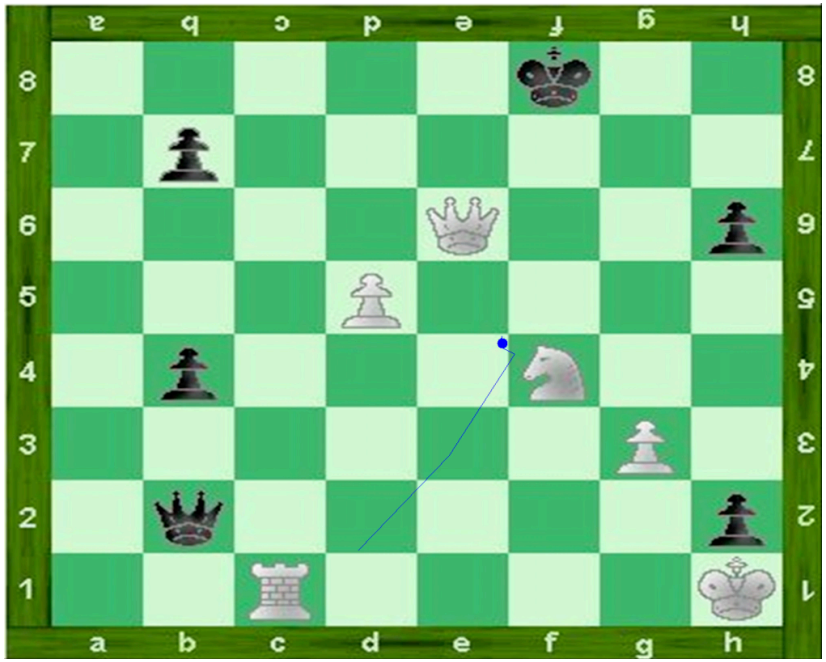




SMART SYSTEMS HELPS SOLVING SITUATED PLANNING, THINKING AND ACTION (decision making) with Cognitive Computing







QuickTime Player Fichier Édition Présentation Fenêtre Aide
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Google Drive
Tous mes fichiers
iCloud Drive
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MacBook Pro No...
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Nulle
Abandonner
Annuler

5 - How to prevent the EFFECTS OF EXTERNALIZATION: the development of IMITATIVE TECHNOLOGIES as RESPONSIBLE INNOVATION.

- **Computers are outsourcing our brains,**
- **Integrated circuits are outsourcing our memory,**
- **Algorithms are outsourcing our mental functions.**

This affects the time and space, but also the ego cogito itself because of
• ***the multiplication of screens and objects connected to the Internet***,
• ***the external ambient intelligence capable of extending and compensating or even replace our mental functions***.

We now have digital technologies that perform cognitive functions: recognition, selecting and memorizing, reasoning, decision making, problem solving ...

(*Michel Serres communication in the meeting of Thursday, January 17, 2013 of the French Academy*)

Cognitive technologies (because non autonomous) are for help : externalizing our cognitive functions

For example, having to calculate the area of a rectangle of 12 by 4 meters,

the result of the operation "12x4" is simply and quickly obtained with the internet search engine that will provide "48" in 260 milliseconds,
specifying also it is the first of more than 21 billion results.

For comparison, psychomotor delay set to press a key is 150 milliseconds.

Solutions from the NADEL's Perspective: IMITATION

Until the conception of autonomous intelligent technologies, given that we can not prevent them outsourcing our cognitive functions, the solution is to base the interaction on the process of imitation

The most beneficial cognitive stimulations are not provided by smart environments which would do for you the thinking job: processing the information, memorizing, making inferences and making decision for you, - except when needed -, but the one that will trigger your attention, your understanding, your reasoning processes, your learning from errors, and will help you succeed : **the machine to imitate** (Danis, Santolini & Tijus, 2000).

For instance, the ideal teacher, or ideal caregiver, for a senior with cognitive decline, is the virtual agent that can interact at your capacity level (**Zone of proximal stimulation**): **thus the one that will invite you to imitate**

Neither Interactive, nor assistive but Imitative technologies that are technologies of simulation

Not Interactive technologies

- *NAO: Hello Sam*
- **SAM: Hello Nao**
- *NAO: What are you doing today Sam ?*
- **SAM: Will go to my class and, you Nao, what are you doing today Nao ?**
- **....**

Not Assistive technologies

- *NAO: Hello Sam*
- **SAM: Hello Nao**
- *NAO: What are you doing today Sam ?*
- **SAM: Will go to my class**
- *NAO: Today is Monday, you will have poetry class*
- **SAM: I was trying to remember, you did the job for me**

But Imitative technologies

- *NAO: Hello Sam, Imitate me: Hello Sam*
- **SAM: Hello ... Sam or Nao ?**
- *NAO: Nao .... I am asking myself what I will be doing today ? (...)*
- **SAM: I Will go to my class, *Today is Monday, I will have poetry...***

Beyond the intrinsic power of Synchronic imitation to develop social interaction and basic social cognition

Imitation offers a robust and reliable experimental procedure allowing to take a two-person perspective in cognitive and neuro-cognitive sciences… and may also be useful for developing intelligent agents.

Imitation and learning

SMART LEARNING

Imitation => Comparison
Analogy
Metaphor

Guttman Scale (Tijus, Danis & Santolini, 1997)

1. One looks at the other.
2. One addresses the other (verbal or motor).
3. One addresses the other (verbal and motor).
4. One pays attention to what the other is doing. A watches what B is doing.
5. One intervenes in what the other is doing. A gets involved in B's activity.
6. One replies to the other. A lasting cognitive interaction is achieved.
7. Both work together. A and B are involved in a shared task.
8. One acts as a model for the other. A gets B to imitate him.
9. One helps the other (verbal or motor) with a difficult task.
10. One helps the other (verbal and motor).
11. Both work together and one helps the other (verbal or motor assistance). When B is having difficulty executing a task on which A and B are working together, A provides him with verbal or motor assistance. The interaction is not incidental; it is supported by an explicit, shared objective that both partners are trying to accomplish together.
12. Both work together and one helps the other (verbal and motor assistance). The participation here is stronger and more explicit.
13. Both work together at the child's level and one helps the other. The adult is implicitly saying 'We're doing this at your level' (cf. for example, an adult's references to the child's personal experience during a reading session).
14. Metacognitive assistance. A provides B with assistance aimed at getting him to think about his actions and thoughts. 'Do you think that's the way to do it?', 'Do you see what will happen if you do that?'. This type of assistance is based on a solid understanding of what the child is actually doing.
15. Metapedagogical assistance. A provides B with suitable assistance for his level of comprehension. This presupposes the tutor's metacognition of her assistance practices (e.g. when the tutor changes her assistance technique when her first intervention proves ineffective).

THANKS FOR YOUR ATTENTION

Cognitive technologies (because non autonomous) are for help : externalizing our cognitive functions

George Dyson: "**What if the cost of machines that think is people who do not think?**"

Nicholas Carr: "**We have failed to take into account the hidden costs of automation**"

What are the effects at the neuronal level of outsourcing of cognitive functions that are no more internalized ?

Are there changes in the temporal organization of neuronal activation of prefrontal brain?

With multitasking situations, there is a synchronization of areas dedicated to tasks carried out in parallel (*which reflects an attention synchronization but also a full activation of multitasking that is below the sum of the activations of each task performed individually*)

(Just, MA, & Buchweitz, A. "What Brain Imaging Reveals about the kind of multitasking" In S. Chipman (Ed) The Oxford Handbook of Cognitive Science New York... Oxford University Press)

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