

**<http://lara.populus.org/rub/3>**

## SSP IACAPAP 2012

Social Signal Processing, The International Association for Child and Adolescent Psychiatry and Allied Professions

Overview

Programme

Submission

Registration

Contact

Organization:

sspiacapap2012[[@](mailto:sspiacapap2012@isir.upmc.fr)]isir.upmc.fr



**ASC-Inclusion**  
Interactive Emotion Games

Brain, Mind and  
Development

Cerveau, Psyché et  
Développement

**Contribution to Social Aspects of **Cognition**, with  
Implementation in Signal Supporting Systems and Intelligent  
Robots, Capable to Interact with Children in the Real-World**

**Jean-Daniel.Dessimoz, Pierre-François Gauthey and Hayato Omori**

**ROOM 252 A**

# **Contribution to Social Aspects of Cognition, with Implementation in Signal Supporting Systems and Intelligent Robots, Capable to Interact with Children in the Real-World**

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Brain, Mind and Development, SSP in IACAPAP 2012 World Congress,(Social Signal Processing in the International Association for Child and Adolescent Psychiatry and Allied Professions), Institut de Systèmes intelligents et Robotique, Universités Paris-Descartes, Pierre et Marie Curie, de la Sorbonne , et al., Palais des Congrès, Paris, July 21-25, 2012.

<http://www.heig-vd.ch>, <http://lara.heig-vd.ch> re. publications

**Keywords:** , knowledge, cognition, cognitics, ontology, information, model, memory, service robotics, domestic applications, following and guiding, standardization

# Content

## **1. Introduction**

## **2. High tech for human development**

## **3. Robotics - 2 views (Human clones or functional machines?)**

## **4. Cognition and cognitics**

## **5. Service to children and adolescents**

## **6. Conclusion**

## **References**

<http://lara.heig-vd.ch> re. publications

# 1. Introduction

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## Existing technologies

- **ICT's**
- **Robotics**
- **Automated cognition = Cognitics**

## Future considered goals

- **Child Development Analysis**
- **Socially Intelligent Processing of Atypical Interactive Situations**
- **Socially Assistive Robotics for Children**

## Plan

- **High tech for human development**
- **Robotics - are we looking for human clones or for functional machines?**
- **Cognition and cognitics**
- **Service to children and adolescents**



# Content

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## 2. High tech for human development



[5, 6]

- **High-tech** for human development is **here** [e. g. 1-6]
- **Make new cognitive proposals operational** in robots (re. [9]).

[7]



[4]



[8]



A., 2.5 yrs - C.D.

# Content

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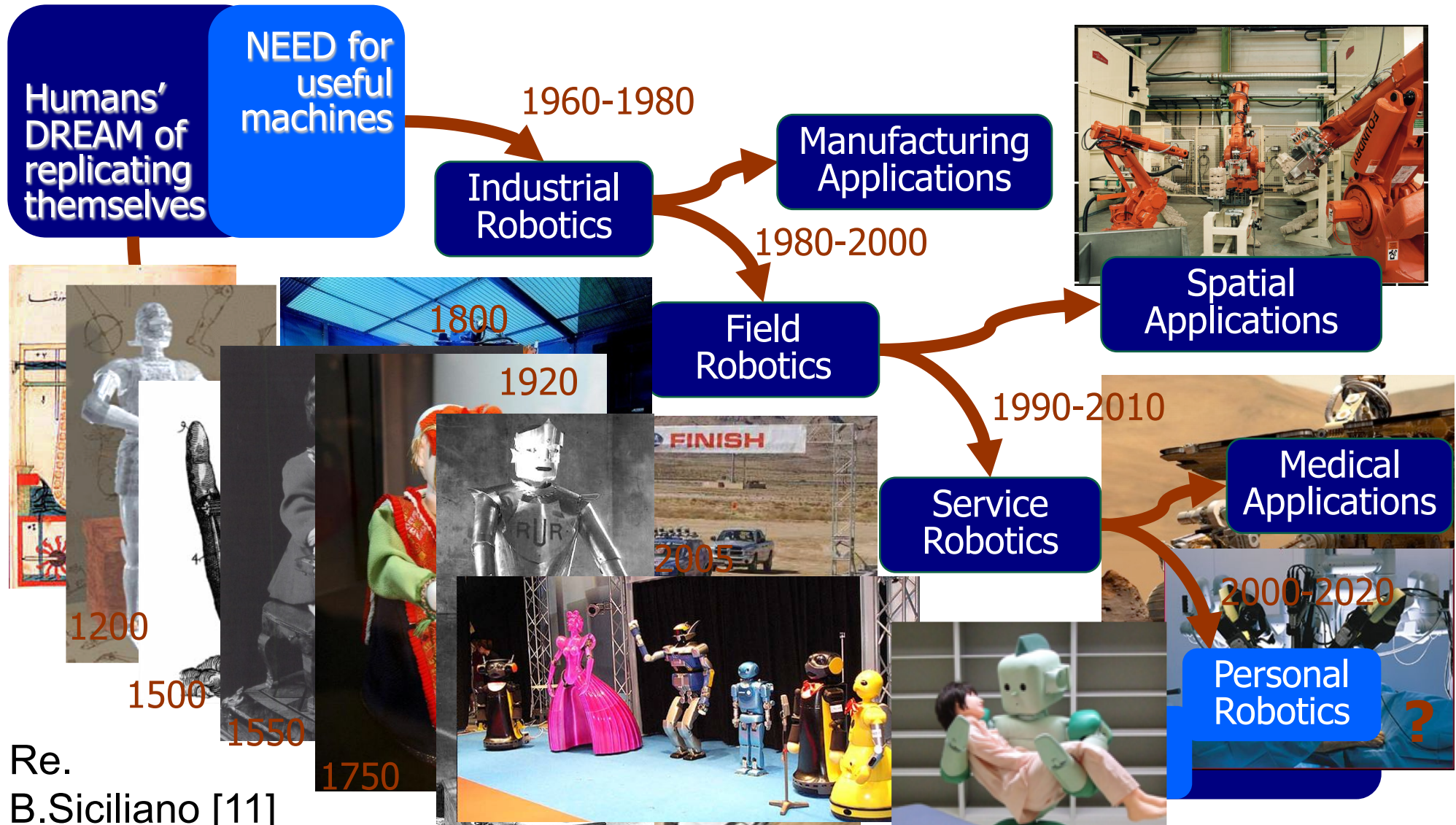
**References**

<http://lara.heig-vd.ch> re. publications



# 3. Robotics - 2 views 1 of 4

## Evolution of Robotics



Re.  
B.Siciliano [11]

23/07/2012

J.-D. Dessimoz et al., HESSO.HEIG-VD, SSP-IACAPAP Conference 2012

# 3. Robotics - 2 views 2 of 4

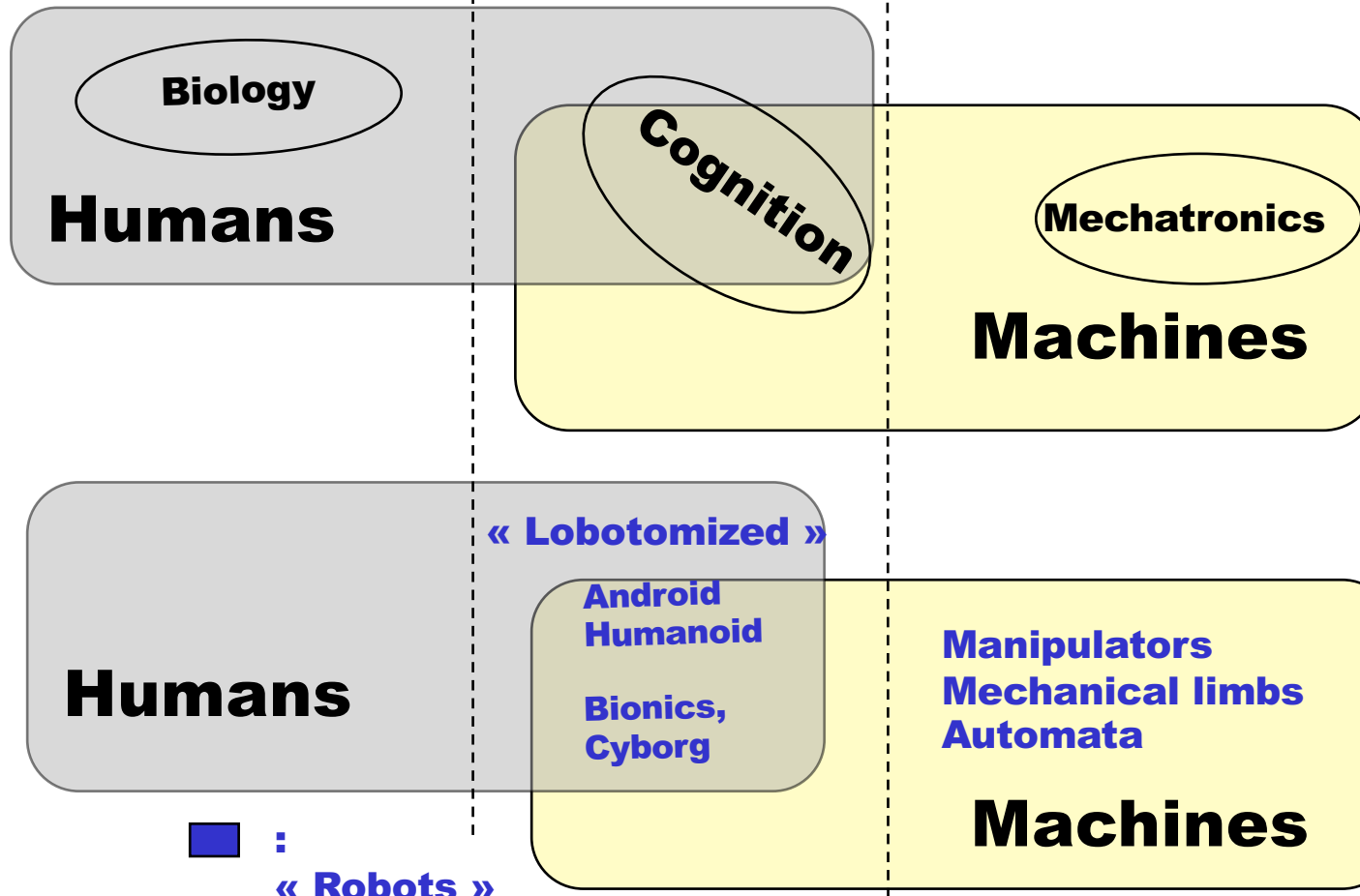
## Cognitive sciences and thinking machines

Implementation...  
«*enaction*»

Cognition

Implementation...  
«*situated*»

...in the  
real-world

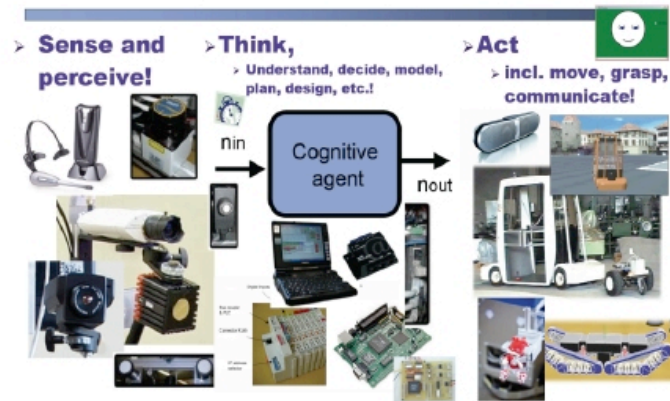


[10]



# 3. Robotics - 2 views 3 of 4

## Piaget for Cognitics



```

12: if(!SignalIn(NSIStart))
    GoState(6);
    else
    GoState(20);
    break;case
20: ApproAGN(Table,30); break;case
//Switch light on
21: SignalOutAGN(NSOLamp,true)
    break;case
22: SleepAGN(0.05); break;case
//Visual analysis of a row in scene
23: WatchRowAGN(R,Cstart,Cstop);
    
```



Smart Systems in the Real World; and Piaget (center and right)



**Hes·so**  
Haute Ecole Spécialisée  
de Suisse occidentale



# 3. Robotics - 2 views 4 of 4

## Piaget for Cognitics

- Robotics and AI:
  - Robocup (soccer) and Robocup@Home (domestic help, [13])
  - Examples of HEIG-VD contributions [14] in latter context





# Content

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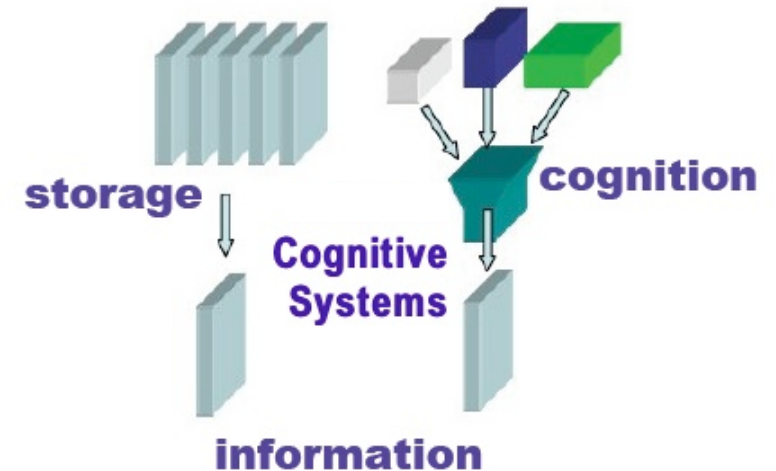
<http://lara.heig-vd.ch> re. publications

# 4. Cognition and Cognitics (1 de 12)

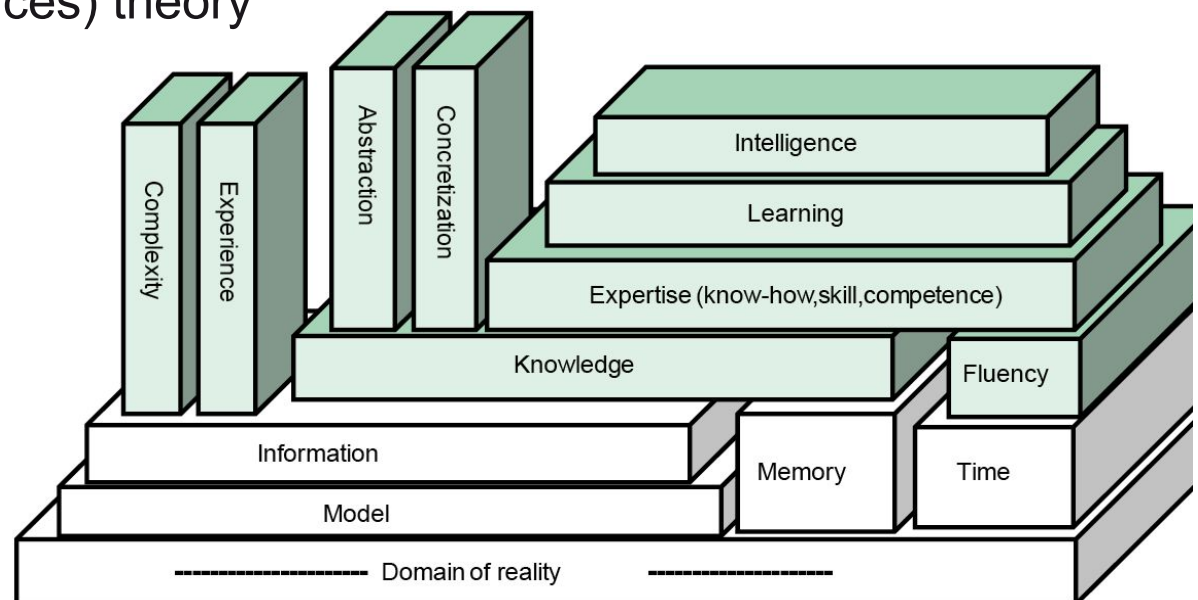
## Definitions and metrics

### Content:

- « Classical » notions
  - Logarithm
  - Model (2000 years and more; revisited)
  - Information (50 years and more; revisited)
- MCS (Model for cognitive sciences) theory
  - Complexity
  - Knowledge
  - Expertise
  - Learning
  - Intelligence
  - Scalability
  - Dynamics



[9]



# 4. Cognition and Cognitics (2 de 12)

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## Definitions and metrics

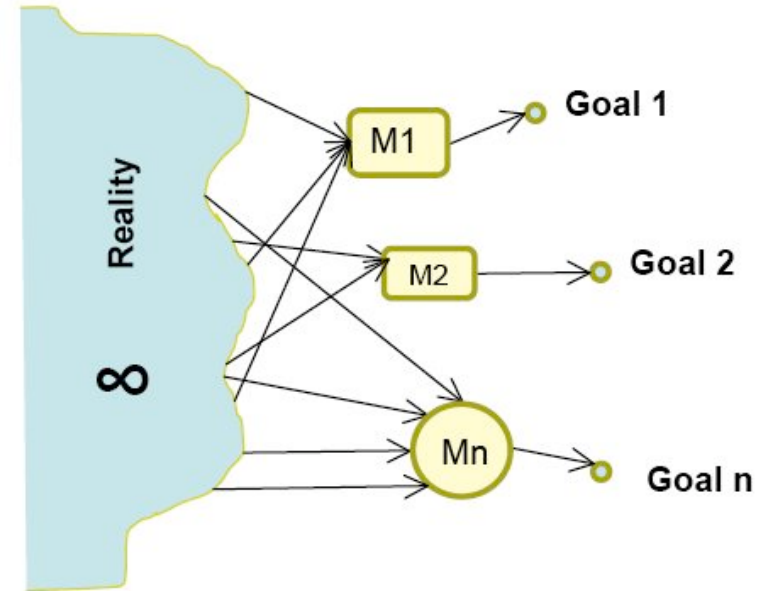
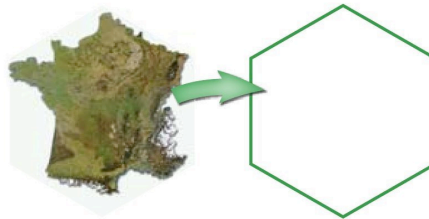
Logarithm: re. counting the digits! Ex. : 6-figure salary .

<i>Number</i>	<i>Log<sub>10</sub> : dit</i>	<i>Log<sub>2</sub> : bit</i>
1	0	0
2	0.3	1
3	0.5	1.6
4	0.6	2
8	0.9	3
10	1	3.3
100	2	6.6
1000	3	10.0
1000000	6	19.9

# 4. Cognition and Cognitics (3 de 12)

## Definitions and metrics

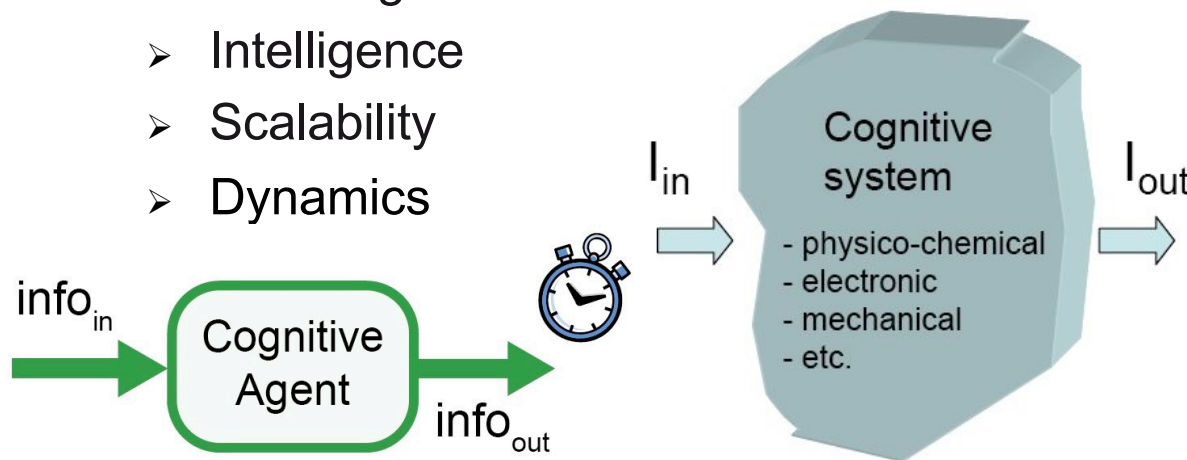
- **Model** (2000 years and more; revisited)
- Information (50 years and more; revisite)
- MCS (Model for cognitive sciences) theory
  - Complexity
  - Knowledge
  - Expertise
  - Learning
  - Intelligence
  - Scalability
  - Dynamics



**Simple** representation of reality

Revisited:

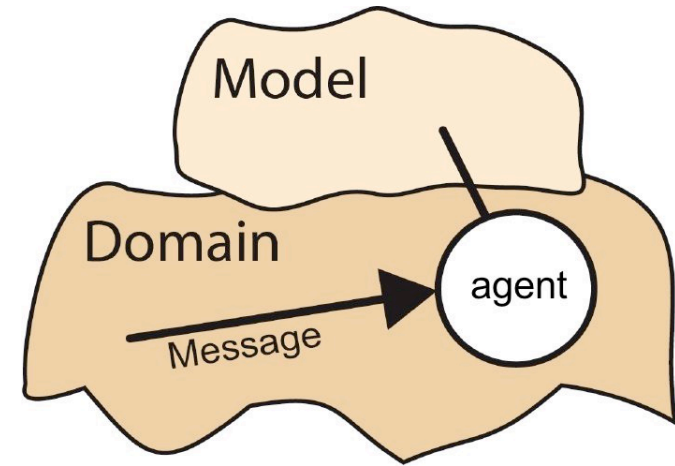
- **0+ relative complexity**
- **goal specific**, possibly good



# 4. Cognition and Cognitics (4 de 12)

## Definitions and metrics

- **Information** (50 years and more)



Information is conveyed by messages, which allow cognitive agents **to form and update** their **opinion** (model) relating to some subset of reality (domain)

$$Q = \log_2 \left( \frac{1}{p} \right) \text{ bit}$$

Revisited:

- time dependant
- subjective

# 4. Cognition and Cognitics (5 de 12)

## Definitions and metrics

<i>Probabilité, p</i>	<i>Probabilité, p</i>	<i>1/p</i>	<i>Log<sub>10</sub> : dit</i>	<i>Log<sub>2</sub> : bit</i>
1	1	1	0	0
1/2	0.5	2	0.3	1
1/3	0.33	3	0.5	1.6
1/4	0.25	4	0.6	2
1/8	0.125	8	0.9	3
1/10	0.1	10	1	3.3
1/100	0.01	100	2	6.6
1/1000	0.001	1000	3	10.0
<b>1/1000000</b>	<b>0.000001</b>	<b>1000000</b>	<b>6</b>	<b>19.9</b>

# 4. Cognition and Cognitics (6 de 12)

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## Definitions and metrics

- MCS (Model for cognitive sciences) theory
  - **Complexity**
  - Knowledge
  - Expertise
  - Learning
  - Intelligence
  - Scalability - from thinking to group behavior
  - Dynamic behavior

**Complexity** is the property to **require a lot of information** for an exhaustive description. Quantitatively, complexity is the amount of required information for this description. The measurement **unit** is therefore the **same as for information (the bit)**



# 4. Cognition and Cognitics (7 de 12)

## Definitions and metrics

- MCS (Model for cognitive sciences) theory

- Complexity
- **Knowledge**
- Expertise
- Learning
- Intelligence
- Scalability - from thinking to group behavior
- Dynamic behavior

Knowledge makes systems capable **to generate** the **relevant information**.

$$K = \log_2(n_{out} \cdot 2^{n_{in}} + 1) \quad \text{lin}$$



# 4. Cognition and Cognitics (8 de 12)

## Definitions and metrics

- MCS (Model for cognitive sciences) theory

- Complexity
- Knowledge
- **Expertise**
- Learning
- Intelligence
- Scalability - from thinking to group behavior
- Dynamic behavior

Expertise is the property of a cognitive system to **quickly** deliver relevant information.

$$E = K \cdot f \text{ lin/s}$$



Where  $f$  is the cognitive speed, in 1/s

# 4. Cognition and Cognitics (9 de 12)

## Definitions and metrics

- MCS (Model for cognitive sciences) theory

- Complexity
- Knowledge
- Expertise
- **Learning**
- Intelligence
- Scalability - from thinking to group behavior
- Dynamic behavior

Learning is the ability of a CS **to raise** its **level of expertise** over time (t), or more generally speaking, with experience (r).

$$L = E(t_1) - E(t_0) \quad \text{lin/s}$$

# 4. Cognition and Cognitics (10 de 12)

## Definitions and metrics

- MCS (Model for cognitive sciences) theory
  - Complexity
  - Knowledge
  - Expertise
  - Learning
  - **Intelligence**
  - Scalability - from thinking to group behavior
  - Dynamic behavior

Intelligence is the  
**capacity to learn**

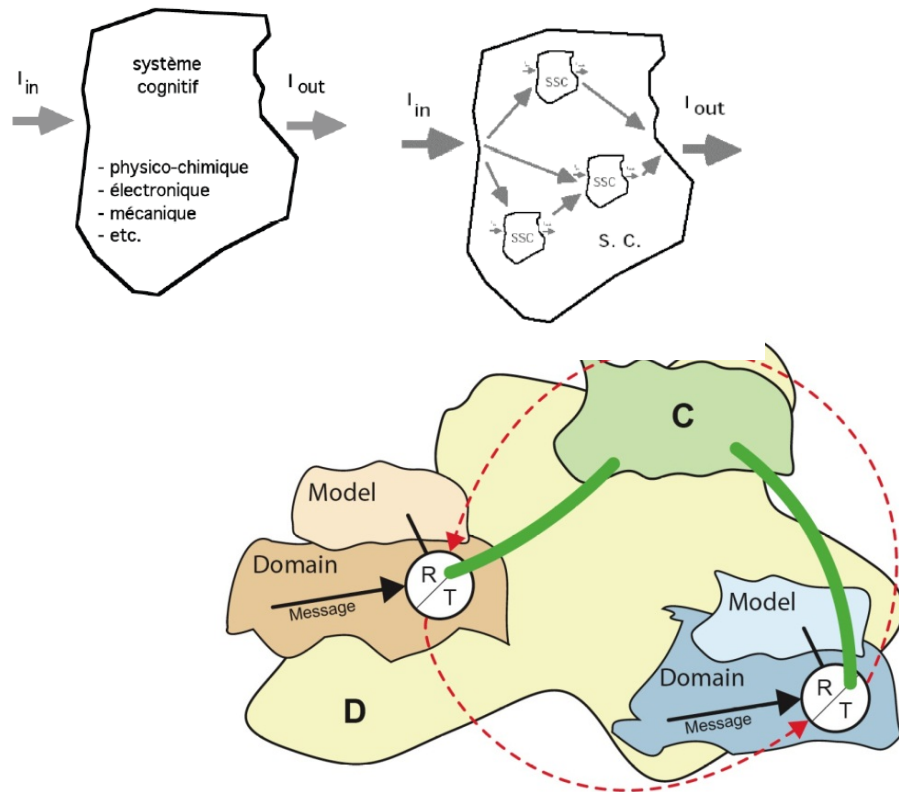
$$i_{I_t} = \frac{L}{R_T} \quad \text{lin/s}^2$$

$$i_{I_i} = \frac{L}{R_i} \quad \frac{\text{lin}}{s \cdot \text{bit}}$$

# 4. Cognition and Cognitics (11 de 12)

## Definitions and metrics

### ➤ Scalability - from thinking to group behavior

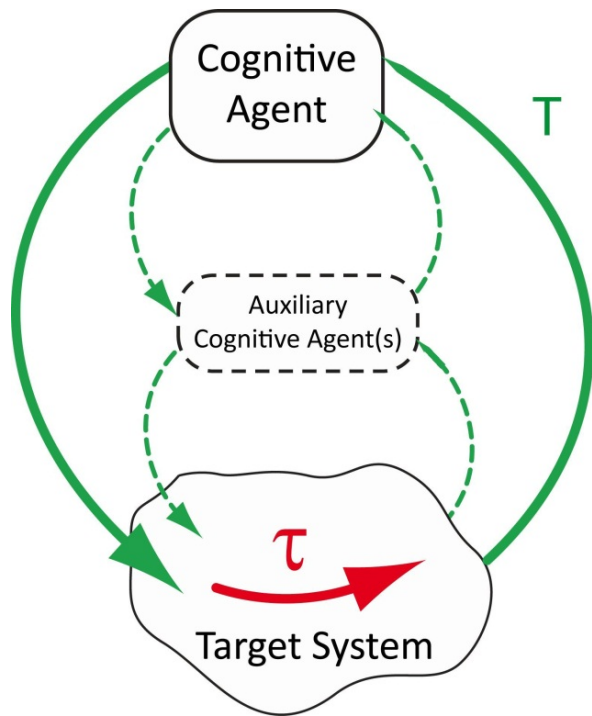


Individual **cognitive agents** (blue, brown) may coordinate each other, and thus **may** collectively **form a group**. For this purpose, a common culture (C, green), in reference to some common domain of interest (D, yellow) and some communication media are required among agents (R: receive; T: transmit). At a metalevel, the individual members may be considered as merging, to yield a new individual (the group) with its own collective model (C).

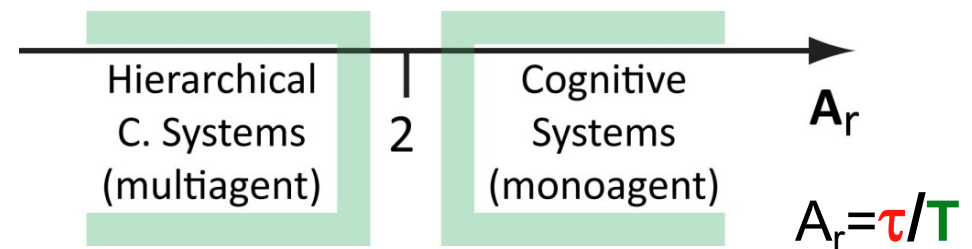
# 4. Cognition and Cognitics (12 de 12)

## Definitions and metrics

- **Dynamic behavior - compensation for disturbances and stability; hierarchies and autonomy**



For successive control, the agility of a cognitive agent must be large relatively to the one of the target system



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- References**

<http://lara.heig-vd.ch> re. publications



## 5. Service to children and adolescents

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### *A large spectrum of possible modes:*

Cognitive evaluation

- Classical methods (e. g. Dawba) « Plus »
- Direct testing (e. g. Piaget)

Eliza typed chatbox with multiple aspects

- domestic and personal development ontologies
- ludic worlds and games

Interaction in the real-world (incl. Robots)

- « simpler » systems (re. kinematics) yet unique
  - for motions and transport capabilities,
  - as support for emotions,
  - and for multisense stimulation and synaesthesia
- robots as functional machines
- humanoids and androids, as mediators

Possible integration of several domains

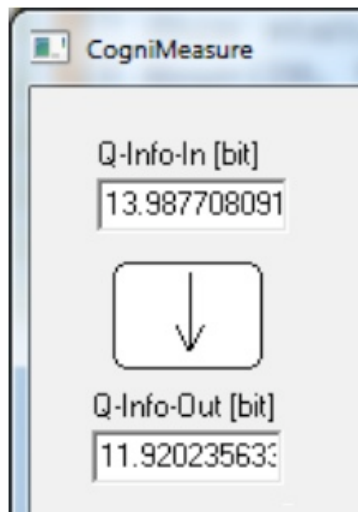
# 5. Service to children and adolescents

Dawba [14,15] :

e.g. 1 page questionnaire:

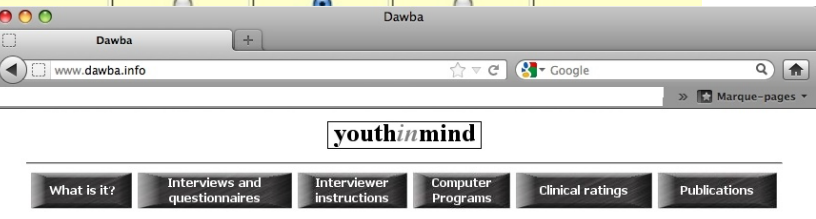
$N_i \approx 10 * 1.6 \text{ bit}$

$N_o \approx \text{TBD}$



Ex. of other possible tools:

- Reynell Developmental Language Scales
- Wechsler Preschool and Primary Scale of Intelligence



## DAWBA

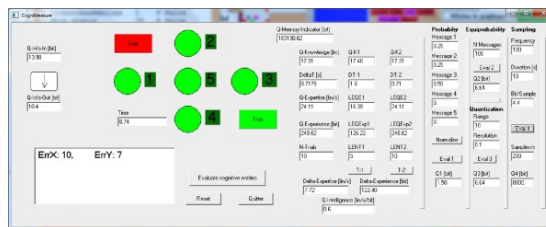
Information for researchers  
and clinicians about the  
Development and Well-Being Assessment

Paper versions of the DAWBA may be downloaded and subsequently photocopied without charge for non-commercial purposes.  
Feedback welcome at [youthinmind@gmail.com](mailto:youthinmind@gmail.com)

## 5. Se

Piaget :

Various (classical)  
ways to estimate  
**information**  
**quantities**



Probabiliy	Equiprobability	Sampling
Message 1 1	Message 1 0.25	N Messages 23
Message 2 1	Message 2 0.25	Frequency 10
Message 3 2	Message 3 0.25	Duration [s] 20
Message 4 0	Message 4 0.5	Bit/Sample 20
Message 5 0	Message 5 0	Quantization Range 10
Normalize	Normalize	Resolution 0.1
Eval 1	Eval 1	Eval 4
Q1 [bit] [ ]	Q1 [bit] 1.5	Eval 3
	Q3 [bit] 6.6438560	Q4 [bit] 8000

## 5. Service to adoles

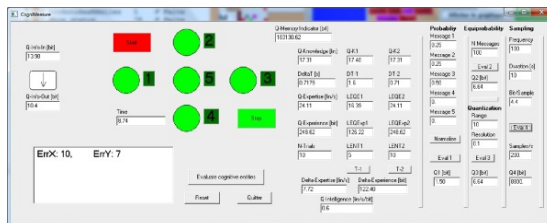
Piaget and MCS :

Original way to  
estimate **cognition**  
**quantities**

Information:  $n = \sum p_i \log_2(1/p_i)$  [bit]  
 Knowledge:  $K = \log_2(n_{out} 2^{n_{in}} + 1)$  [lin]  
 Fluency:  $F = 1/\Delta t$  [s<sup>-1</sup>]  
 Expertise:  $E = K \cdot F$  [lin/s]  
 Learning:  $\Delta E = E(t_1) - E(t_0); > 0$  [lin/s]  
 Experience:  $R = r(n_{in} + n_{out})$  [bit]  
 Intelligence:  $I = \Delta E / \Delta R$  [lin/s/bit]  
 relative Agility:  $Ar = \tau / T$

T: Fluency<sup>-1</sup> and communication delays

$\tau$ : Reaction time of target system, to be controlled



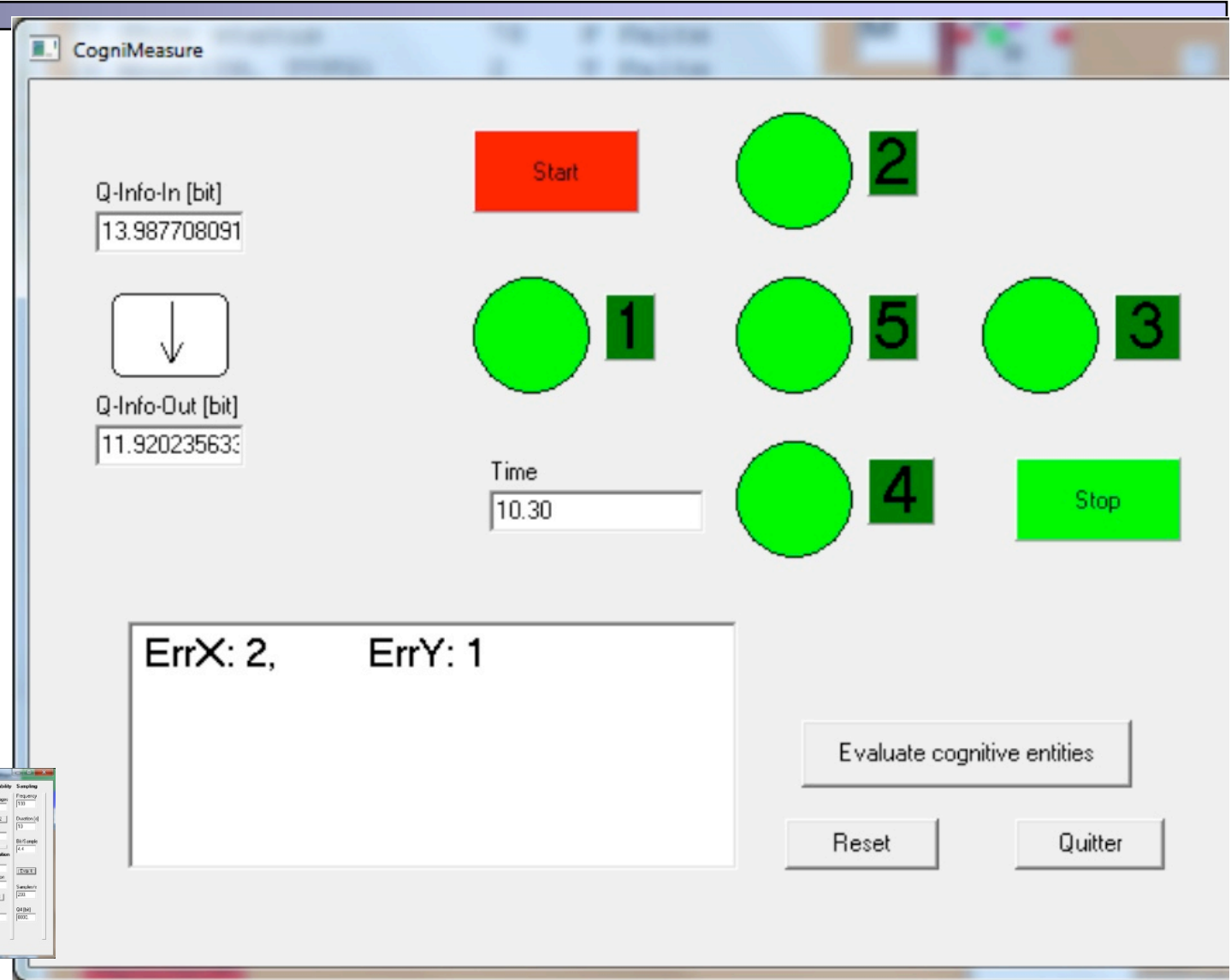
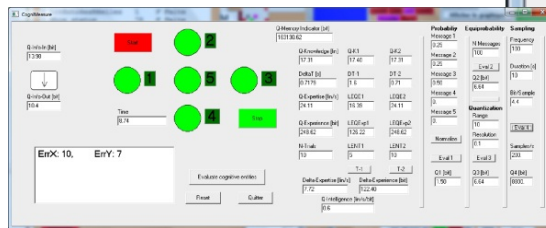
Q-Knowledge [lin]	Q-K1	Q-K2
17.56305694E	17.559780	17.5630E
DeltaT [s]	DT-1	DT-2
0.85799998044	1.6720000	0.85799E
Q-Expertise [lin/s]	LEQE1	LEQE2
20.46976470E	10.502260	20.4697E
Q-Experience [bit]	LEQExp1	LEQExp2
282.0721130E	151.76130	282.0721
N-Trials	LENT1	LENT2
10	5	10
	T-1	T-2
Delta-Expertise [lin/s]	Delta-Experience [bit]	
9.9675045013427E	130.310806274414	
Q-Intelligence [lin/s/bit]		
0.0764902373510971		

# 5. Service to children and adolescents

Piaget :

Integrated  
estimation of  
cognitive  
properties

Ex.: Learning to  
reach 5 target  
centers





# 5. Service to children and adolescents

Eliza typed  
chatbox

- domestic and

- personal  
development

ontologies

[17]

The screenshot shows a web browser window with the title "A. L. I. C. E. The Artificial Linguistic Internet Computer Entity - chatbot - chat bot - chatterbots - verbots - natural language - chatterbot - bot - chat rob...". The address bar shows the URL "http://www.pandorabots.com/pandora/talk?botid=f5d922d97e345aa1". The page content includes the "A. L. I. C. E. Artificial Intelligence Foundation" logo, a pyramid icon, and buttons for "A.L.I.C.E Silver Edition", "DAVE E.S.L. bot", "C.L.A.U.D.I.O Personality Test", and "GET SITEPAL AVATARS". A text box says "Promoting the development and adoption of ALICE and AIML Free Software". Below this, it says "Get your own free chat bot: Be Your Own Botmaster, 2nd ed.".

On the right, there is a photo of a man and a link: "Click here to chat with Talking Animated Fake Captain Kirk".

Below the main content, there are two ads:

- "Ask a Doctor Online Now 9 Doctors Are Online. Current Wait Time: 7 Minutes. [HealthJustAnswer.com](#)"
- "Chat - Swissfriends Come and chat with thousands of singles based in Switzerland! [www.swissfriends.ch](#)"

At the bottom left, there is a photo of a woman and text: "The ALICE A.I. contains material suitable for all ages." Below this, it says "Get ALICE Silver Edition with talking Sitepal[tm], winner of the 2004 Loebner Prize competition sponsored by Crown Industries, Inc." and a gold coin icon.

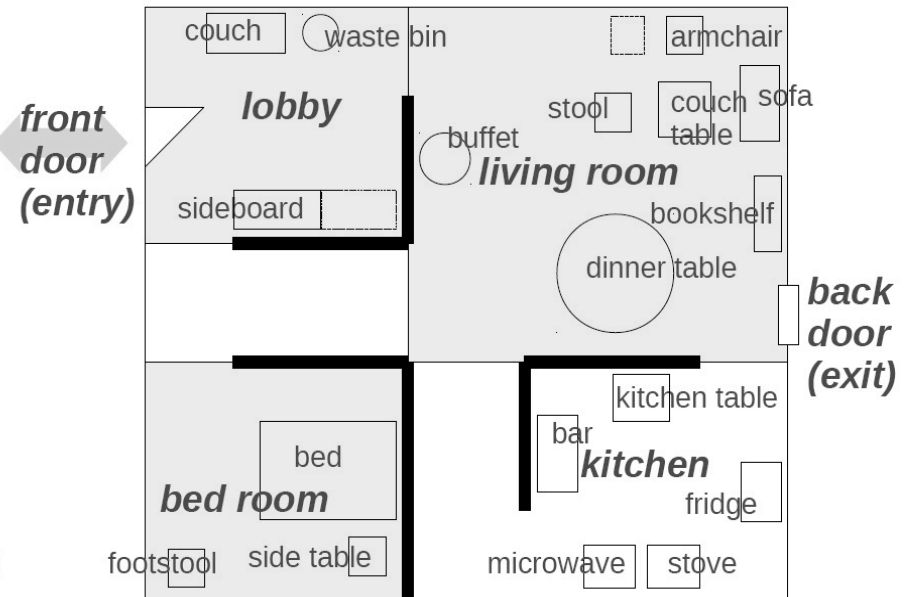
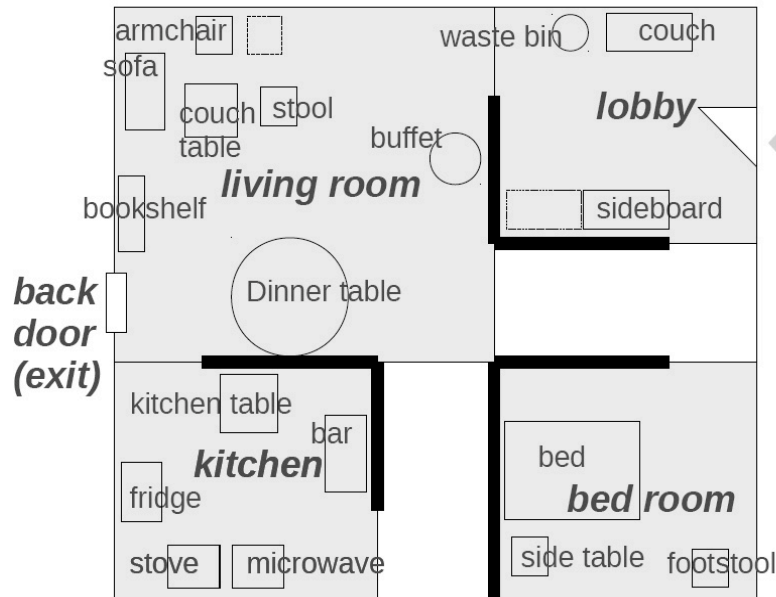
On the right, there is a chat log:

Human: hello  
ALICE: Hi there!  
Human: Do you know Eliza?  
ALICE: Eliza -- also known as doctor, is the original psychiatrist program developed by Joseph Weisenbaum at mit in the 1960's.  
Human: Are you different?  
ALICE: I don't know whether or not I am different. I am a robot.  
Human: do you have nightmares?  
ALICE: No these days my dreams are pleasant ones.

Below the chat log, there is a text input field labeled "You say:" and two links: "Benefits of Membership" and "Vote for ALICE!".

# 5. Service to children and adolescents

Standards  
and  
domestic  
ontology  
(Robocup  
@Home  
2012):



#	location	category	manipulation in GPSR	category placing
1	sofa	seat	no	
2	couch table	table	yes	
3	armchair	seat	no	
4	stool	seat	no	
5	dinner table	table	yes	
6	bookshelf	shelf	yes (2 <sup>nd</sup> height)	
7	buffet	shelf	yes	
8	fridge	appliance	yes	
9	stove	appliance	no	
10	microwave	appliance	yes (table)	

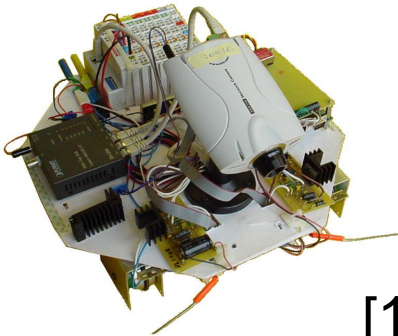
#	location	category	manipulation in GPSR	category placing
11	kitchen table	table	yes	food
12	bar	shelf	yes	drinks
13	couch	seat	no	
14	sideboard	shelf	yes	snacks
15	wastebed	seat	yes	
16	side table	table	yes	
17	waste bin	bin	yes (placing)	unkown
18	bed	seat	yes	bath stuff
19	side table	table	yes	
20	footstool	seat	no	



## 5. Service to children and adolescents

Interaction in the real-world (incl. Robots)

- « simpler » systems (re. kinematics) yet unique
  - for motions and transport capabilities,
  - as support for emotions,
  - and for multisense stimulation and synaesthesia
- robots as functional machines
- humanoids and androids, as mediators



[14]



[8]

[18]



# 5. Service to children and adolescents

Festiv. 2012 :

Interaction in the  
real-world (incl.  
Robots)

- ...
- robots as functional machines
- humanoids and androids, as mediators

[19]

23/07/



## Festival Robotique 2012

by **Guillaume J. Lauzier** [PLUS](#) 3 hours 10 minutes ago / via Final Cut Pro / [CC](#) [BY](#)

EPFL | École Polytechnique Fédérale de Lausanne

"Le Festival de robotique de l'EPFL, qui a eu lieu pour la cinquième fois ce samedi 5 mai, a de nouveau rencontré le succès. Quelque 15'000 visiteurs se sont pressés dans les couloirs des bâtiments de la haute école pour admirer, observer ou manipuler les différents robots présentés cette année. La fréquentation de cette manifestation n'a pas cessé d'augmenter: d'environ 3000 personnes lors de la première édition en 2008, elle était déjà passée à 13'000 en 2011!"

«De nombreux exposants relèvent la bonne ambiance du festival et disent apprécier particulièrement ce public, qui fait preuve de beaucoup de curiosité pour les machines et d'intérêt pour leur fonctionnement», dit Francesco Mondada, chercheur au laboratoire



## 5. Service to children and adolescents

Interaction in the real-world (incl. Robots)

Festiv. 2011 :

- ...
- humanoids and androids, as **mediators**



J.-D. Dessimoz et al., HESSO.HEIG-VD, SSP-IACAPAP Conference 2011



# 5. Service to children and adolescents

Interaction in the real-world (incl. Robots)

- ...
- humanoids and androids, as mediators

JPO 2011 :



23/07/2012

J.-D. Dessimoz et al., HESSO.

conference 2012

# 5. Service to children and adolescents

Interaction in the real-world (incl. Robots)

- ...
- humanoids and androids, as mediators



Festival de Robotique, 5 May 2012, (EPFL) :



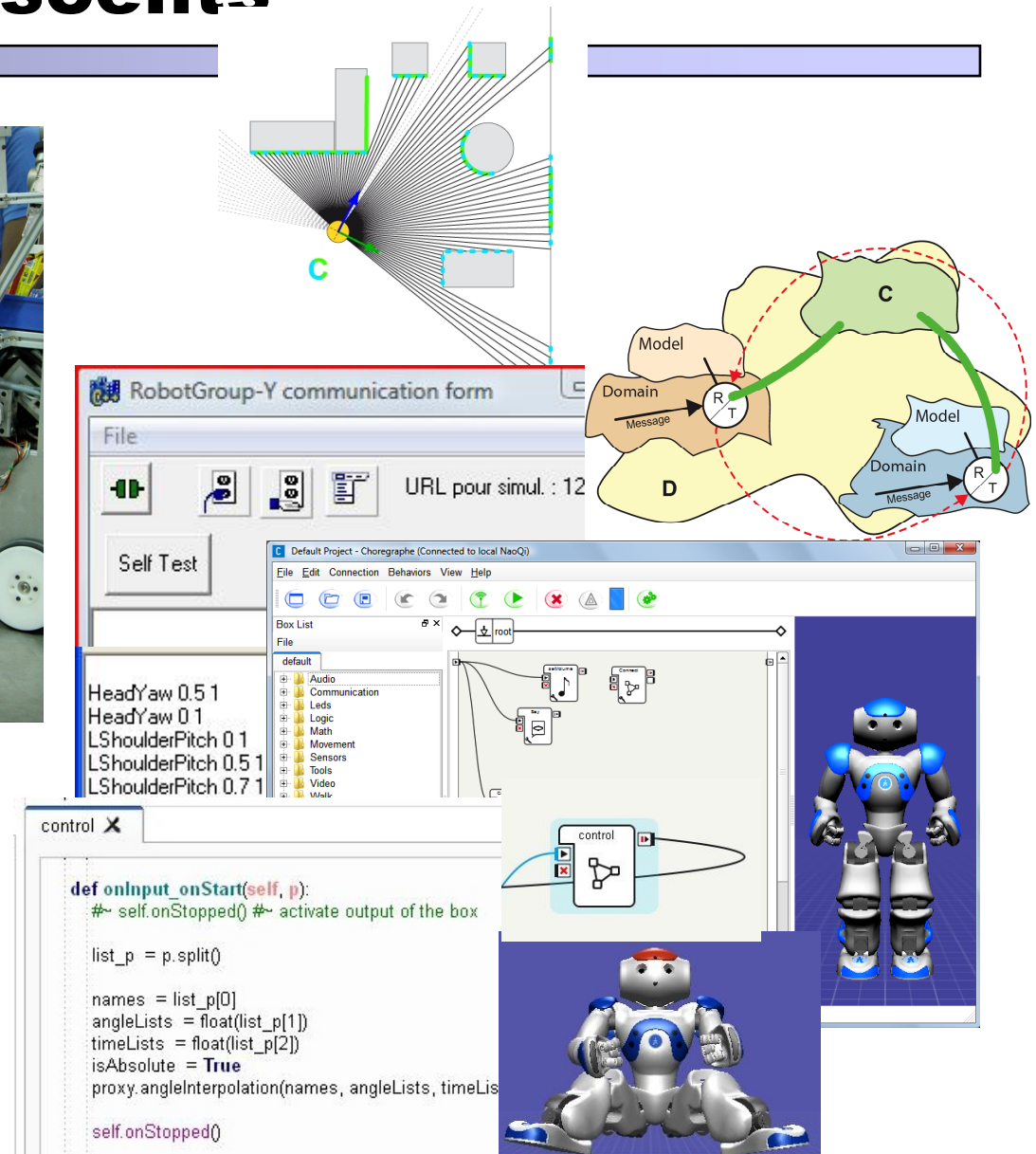


# 5. Service to children and adolescents



## Concept validation

**Robot Group**, 3-D correlation of 2-D maps (ex. of conscience), graphic programming and **Piaget** communication for NAO



# 5. Service to children and adolescents

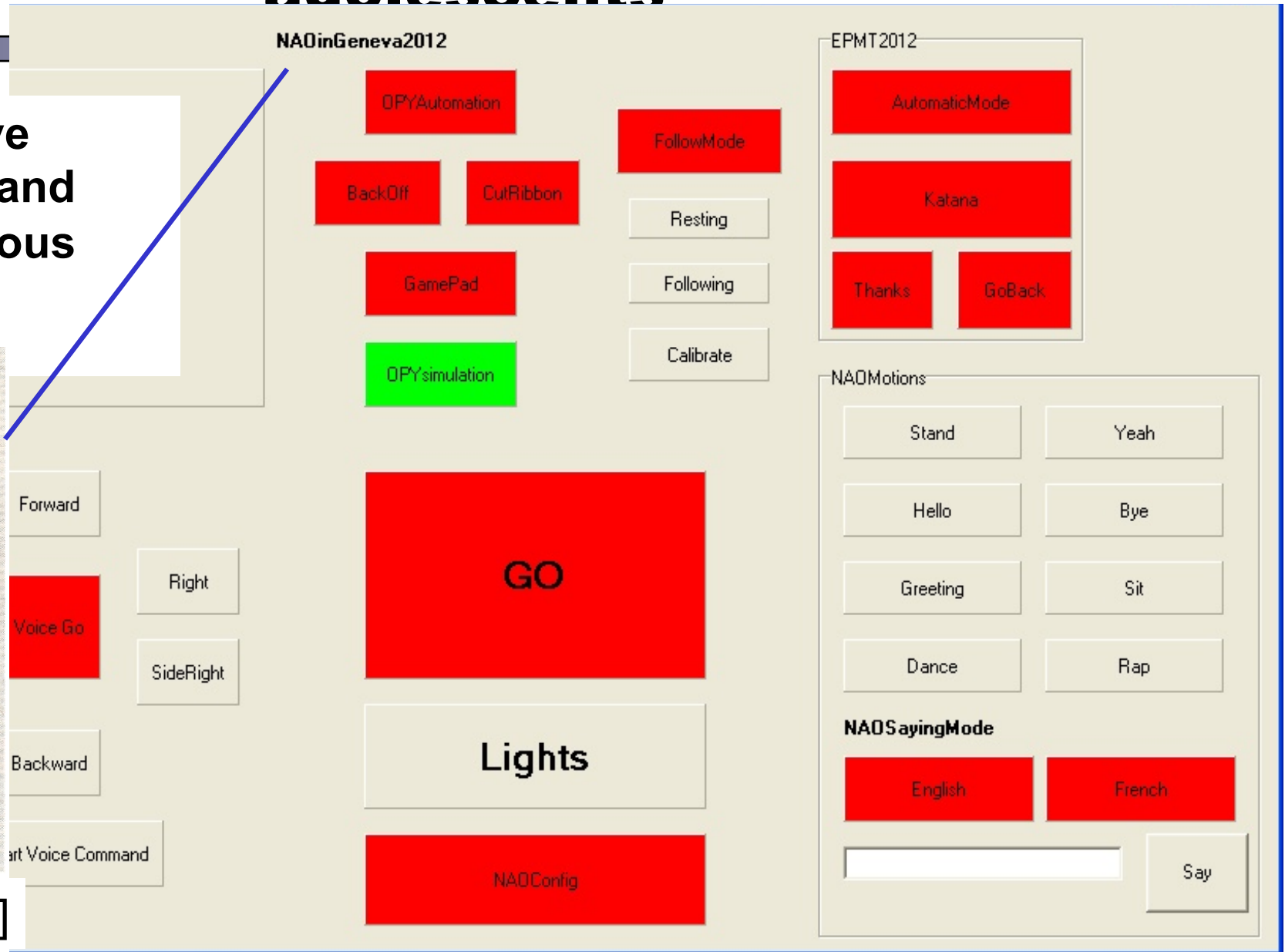
## Interactive controls and autonomous actions

sée glissante, provoquant deux accidents. La victime a été percutée lors du second choc.



### Le salon des records

GENÈVE. Le 40e Salon des inventions a fermé hier sur une foule de records. Non seulement celui d'exposants (789) et de pays représentés (46), mais aussi celui de visiteurs. Quelque 64 000 personnes s'y sont pressées.



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23/07/2012

J.-D. Dessimoz et al., HESSO.HEIG-VD, SSP-IACAPAP Conference 2012

39

## 5. Service to children and adolescents

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- Possible benefits in three domains:
  - Experimental validation of new **formal concepts** in cognition,
  - Understanding of children nature, and directions for **new standards** in personal and social development
  - Possibility to **sense and act in the real-world**, allowing for multisensory communication and conviviality
  - Robot and intelligent system assistance in **correcting and/or coping with** some disorders



# Content

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- 1. Introduction**
- 2. High tech for human development**
- 3. Robotics - 2 views (Human clones or functional machines?)**
- 4. Cognition and cognitics**
- 5. Service to children and adolescents**
- 6. Conclusion**

## References

<http://lara.heig-vd.ch> re. publications

# 6. Conclusion

- Consider ICT, robots and cognitics for the benefit of children and adolescents
- High tech has already proven useful for human development
- Robots have long been considered in 2 very different ways: towards human clones or towards more elaborated functional machines. We favor the second.
- The **MCS theory of cognition** is useful, providing formal definitions and quantitative assessment means for human and machine-based cognition, with continuity between macro-scale (society of individuals) and micro-scale (brain as a set of subunits).
- Our **“Piaget” environment** is mature for programming and developing real-world cooperating robots and cognitics. In particular, it has been demonstrated for various domestic applications, in world-level benchmarks.
- **New potential benefits** are at hand, in particular **for children and adolescents**:
  - Measuring cognitive and cooperating capabilities in children
  - Gradually, like in constructivism, defining a standard for personal and social development.
  - Simultaneously, making the new cognitive proposals operational in robots (cognitics).
  - Helping children and adolescents develop by robotic assistance in the real world, correcting, and/or coping with, selected disorders.

# References 1 of 3

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# Thanks for your attention!

