A Sociology of Intelligent, Autonomous Cothinkers and Coagents

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

F3A | Cognitive Systems | Samda A

14:00-15:40

Chair: Oliver Zweigle, University of Stuttgart, Germany
Chair: Jean-Daniel Dessimoz, HESSO, Switzerland

F3A. 4 15:00-15:20

A Sociology of Intelligent, Autonomous Cothinkers and Coagents

Jean-Daniel Dessimoz[1], Jean-François Gauthey[1] and Hayato Omori[2]
[1]*West Switzerland University of Applied Sciences, Switzerland,* [2]*Chuo University, Japan*

Scientific and technological progress has brought robots where machine-based cognition and cooperation abilities start to emerge; not only between robots and humans but also among multiple robots themselves. In order to technically improve performances in latter case, as well as, by analogy, to better understand how humans can interact with one another and grow communities, time as come to further, scientifically and technically develop sociology-related knowledge and ontologies. Critical theoretical bases for cognition have been built and demonstrated, both in the human and machinebased cases, providing valuable contributions in this regard. Now sociable competences are considered, allowing for incrementally binding individuals and small groups into holistic units of increasing scope. Ultimately, what is also considered here is a kind of common, meta-human, secular framework where robots and humans can best co-think and co-act. Concepts have now been complemented and validated by real size implementation and experimentation in the domain of homes, as well as industrial and public environments. This should motivate the reader to get familiar with the proposed formal, quantitative MCS framework, thereby getting better insight in judgment and better ability to quantify requirements.

Hes·so Haute Ecole Spécialisée de Suisse occidentale

heig-vd Haute Ecole d'Ingénieurs et de Gestion du Canton de Vaud

cetT

Institut d'Automatisation Industrielle LaRA Laboratoire de Robotique et Automatisation

A Sociology of Intelligent, Autonomous Cothinkers and Coagents

Jean-Daniel.Dessimoz[1], Pierre-François Gauthey[1] and Hayato Omori

{ Jean-Daniel.Dessimoz or Pierre-Francois.Gauthey } @heig-vd.ch

[1]Hesso // Western Switzerland University of Applied Sciences
Heig-vd // School of Business and Engineering, CH-1400 Yverdon-les-Bains, Switzerland
[2]Chuo University, Tokyo, Japan

12th International Conference on intelligent autonomous systems,
Je-Ju Island, Korea, June 27-27, 2012.

http://www.heig-vd.ch, http://lara.heig-vd.ch

Keywords: Sociology of Robots, Sociology of Automated Systems, Meta-human Secular Sociology, AI, Robotics, Robocup-at-Home, Cooperating Robots, Service Robots, Sociable Robots

Content

1. Introduction 1 of 4

- International initiatives, in particular "RoboCup" [1, 2], => boost to progress in the fields of Robotics and Artificial Intelligence (AI), machine-based cognition.
  - A solid formal basis and a quantitative approach are necessary for cognition.
  - Consider the analogy for a human to jump over a wall: is the wall 30 cm high?, 3 m?
  - Similarly in cognition, appropriate metrics are necessary.
- Complexity of any domain of reality is not within reach.
  - Modeling is always required, and
  - feasible only for specific goals [3].

1. Introduction 2 of 4

- Humans have a particularly strong sense of curiosity and strive to make their lives easier.
- R&D goal: design intelligent robots capable of helping humans in all kinds of situations
- Goal too broad? Focus on artificial soccer players. And domestic helpers [4, 5].
- Concrete examples will be shown in this context, with several levels of multi-agent systems:
  - 1. about 20 agents in the core processing of supervisory Piaget environment;
  - 2. about 20 agents at robot-level, where specialized resources act as specialized agents (computers, servocontrollers, cameras, arms, audio units, PLC, etc.); and
  - 3. at group level where individual robots (RH-Y, OP-Y, Nono-Y) and humans cooperate

1. Introduction 3 of 4

- Interesting shift in paradigm from individual bodies or systems (humans, robots) towards collective entities:
  - including robot-human associations, or
  - including groups of multiple robots .
  - Essence of social systems: re Latin, notions of united, allied, living or liking to live with others (re. Online Etymology Dictionary).
- Some researchers have started to address the topic of a sociology of robots :
  - Re. International Journal of Social Robotics, Springer
  - Re. Interaction Studies journal of John Benjamins Publishing Comp (explores Social Behavior and Communication in Biological and Artificial Systems)

1. Introduction 4 of 4

- New here, connect to two fundamental areas :
  - classical (human-related) sociology corpus of knowledge (ref. follow)
  - formal and quantitative definitions of the Model for Cognitive Sciences (MCS, [6])
    - focus here on new material relating to sociologies
    - more can be found on closely related material in our other publications and online videos, (emotions, validation of concepts in world-level contests, etc. [7]).
- Plan, re TOC

Content

2. Machine-based Cognition and Cooperation 1 de 7

- **Intelligent robots are a kind of "thinking machines", as defined in the middle of 20th century [8].**
  - **Machines have many capabilities, in particular to physically sense and act in the world.**
  - **Cognition is a special capability though, the only one to be explicitly referred to with specific attributes**
    - **"intelligent" or**
    - **"thinking" or**
    - **"with A.I."**

    added to the general notions of machines and robots.

2. Machine-based Cognition and Cooperation 2 de 7

- When machines look like humans, the boundary between these two groups is blurred:
  - Statues
  - Machines and automata (especially next cases)
  - Robots (especially next cases)
  - Humanoids (robots, with limbs similar to humans)
  - Androids (humanoids, moreover looking like humans)

2. Machine-based Cognition and Cooperation 3 de 7

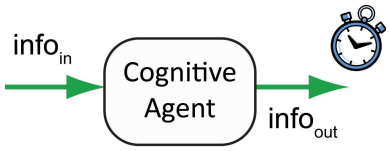
- Yet, cognition is a very controversial area
  - For some people : a faculty continuously extending toward human capabilities (and possibly beyond) from some of the capabilities of very basic existing machines;
  - For other ones: cognition is definitely restricted exclusively to the human domain (notice that for the latter group, AI is essentially impossible).
- This controversy, or
- the related fuzzy state of the situation,

  call for explicit and separate mention of the cognitive properties (”intelligent”, “thinking”), to complement the general words “robot” or “machine”,

2. Machine-based Cognition and Cooperation 4 de 7

- Length and time
  - can be quantified with their specific units (meter, second)
  - relates to a machine in the same way as to a human
- In the same way, cognitive properties can be similarly quantified both for the case of humans and for robots. Re. MCS [6].
- The MCS theory inherits from
  - the advantages as well as from
  - the essential limits of the concepts of
    - model and
    - information
- The MCS theory ("Model for Cognitive Sciences") defines cognitive concepts such as
  - complexity,
  - knowledge,
  - expertise and
  - intelligence
- It is demonstrated, in the case of RoboCup as well as in many other daily applications that machine-based cognition has become pervasive

2. Machine-based Cognition and Cooperation 5 de 7

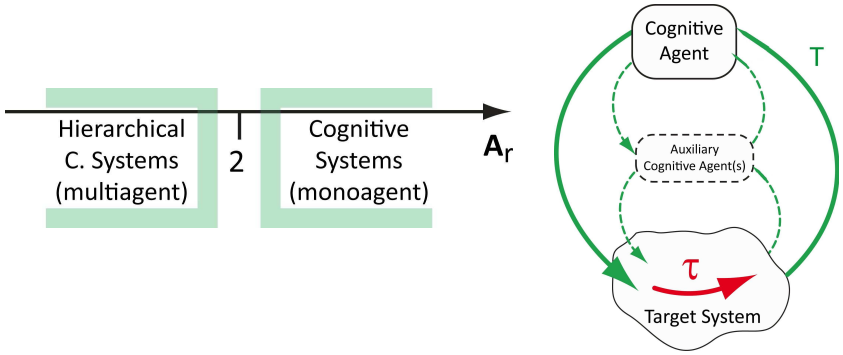


Information:	$n = \sum p_i \log_2(1/p_i)$ [bit]
Knowledge:	$K = \log_2(n_{out}\, 2^{n_{in}}+1)$ [lin]
Fluency:	$F = 1/\Delta t$ [s^{-1}]
Expertise:	$E = K \cdot F$ [lin/s]
Learning:	$\Delta E = E(t_1)-E(t_0)$; >0 [lin/s]
Experience:	$R = r(n_{in}+n_{out})$ [bit]
Intelligence:	$I = \Delta E/\Delta R$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

T: Fluency^{-1} and communication delays
τ: Reaction time of target system, to be controlled
r: number of withnessed experiments

- This is useful for rating requirements and perfomance levels of cognitive tasks and agents
- Just as metric units conveniently allow for describing the height of a wall. Some illustrated elements

2. Machine-based Cognition and Cooperation 6 de 7



- **Other illustrated elements of MCS framework :**
  - **Agility criterion for selecting a structure adapted to system dynamics (*left*)**
  - **Structure and critical dynamic aspects of controlled systems (*right*) . Re. hierarchies, and autonomy.**

2. Machine-based Cognition and Cooperation 7 de 7

- **Life implies more than cognition**
  - **materials, energy, mechanical structures,**
  - **“operations”, some kind of processes.**
  - **cooperative approaches, i.e. some kind of social organization are required.**
- **The role of machines and technologies in the production and processing of materials, energy and mechanical structures is well identified and keeps progressing, as done for centuries.**
- **Cognition has gained a sound theoretical basis, and machine-based cognition is already very significantly operative.**
- **So a critical factor that remains to be addressed now is a scientific and technical delineation of**
  - **(human) sociology, then itself, when required,**
  - **possibly enlarged to accommodate artificial cognitive agents, robots and other systems.**

Content

3. Human and Robotic Arts of Cooperation

3.1 Human - Robot Cooperation 1 de 4

- From an historical and conceptual perspective:
  - robots have been invented for cooperation with humans
  - sorts of slaves serving humans (re. original art and literature context)
- Alan Turing has defined possible intelligence in machines essentially as a capacity of effectively (and with anthropomorphic style) chatting with humans.
- Asimov introduced his famous three laws of robotics with a critical reference to humans.
- The topic of Human-Robot Cooperation has also been concretely addressed for several years (e.g. survey in [9]), even though such robots are not found to be ready yet for large-scale implementations in practice.
- Various degrees of socially relevant interaction have been defined, ranging from relatively passive solutions to more proactive, sociable systems.

3.1 Human - Robot Cooperation 2 de 4

- In RoboCup@Home context,
  - Cooperation is often practiced, with a certain success (to be quantitatively characterized, like for jumping over the wall):
    - vocal and
    - visual communication,
    - ad hoc body presence and
    - motions, as well as
    - close or
    - remote gestures,
  - A humanoid has also been used as mediator between humans and other machines, (e.g. RAH Singapore 2010 - team RH-5, re. Fig. 3)
    - our robot group, PRG-Y, has performed well;
    - it can been developed, programmed, and controlled in real-time with our Piaget environment and language

3.1 Human - Robot Cooperation 3 de 4

- Human and robot share their representations
  - On the left, the robot follows first the human, and then they vocally synchronize their respective English names for describing specific locations, such as the plant in the living room (*"Walk'nTalk", Graz, Austria*).
  - On the right, Nono-Y, our Nao-typed humanoid mediates humans and other machines (OP-Y platform where Nono-Y sits; and RH-Y robot, which has brought drinks and snacks) (*"Open Cgallenge", Singapore*)

21

3.1 Human - Robot Cooperation 4 de 4

- From a scientific and technical point of view,
  - main simplification for machines : the
    - limits of human interaction; communication capacity is relatively small
      - Few perceptive and expressive, physical channels,
      - Very limited signal to noise ratio and bandwidth, i.e. information flows (30 bit/s).
  - on the opposite, main challenge :
    - lack of shared experience between machines and humans (e.g. known objects, names of robots and people, etc.)
    - this latter handicap similarly applies to mutual communication among humans in their huge (life-styled and cultural) diversity (e.g. language mismatch)
  - Robots :
    - limited capability to share human-like emotions
    - but novel specific channels, such as graphic displays and tactile screens, very information-rich and robust against disturbances [7].

29/06/2012 J.-D. Dessimoz et al., HESSO.HEIG-VD, IAS Conference 2012 22

3. Human and Robotic Arts of Cooperation

3.2 Cooperation Among Robots

- **Numerous cases of cooperation of multiple robots have been documented, including extreme cases like swarm robots**
- **Technically, sound bases:**
  - **boom of communication hardware, networks and procedural techniques, useful for inter robot exchange of information**
  - **on the operational side, servoed or compliant techniques allow for the effective cooperation of multiple agents**
- **In "sociology of robots" only robots interact and cooperate. With reference to human-robot interaction case:**
  - **similar paradigm in terms of conventions and shared values**
  - **numerous alternative physical channels and modes possible**
  - **re Section 4 for more on this common paradigm.**
- **Robots are machines**
  - **they do benefit from numerous developments made elsewhere in terms of technologies and standards**
  - **They inherit a common culture (e.g. Ethernet, TCP/IP protocol).**

3. Human and Robotic Arts of Cooperation

3.3 Cooperation Among Humans 1 of 4

- Humans are
  - social beings living in communities
  - communities of various sizes, in particular
    - minimal scope of couples or families,
    - small scale of prehistoric tribes,
    - pan-telluric collective body of modern times.
- Socialization implies
  - mutual help and also
  - mutual control of individuals
  - concepts tightly bounded to the notion of society usually include the ones of
    - common culture,
    - recurrently, religions,
    - stratification of classes and
    - networks of influence.

3.3 Cooperation Among Humans 2 of 4

- About complex social structures
  - especially developed in the context of cities,
  - leading to the notion of political organization,
  - along with secularization
  - finally leading to the dominant, current, world-level, global order - all nations coordinated in UNO

3.3 Cooperation Among Humans 3 of 4

- Sociology
  - core discipline for studying cooperation among humans
  - established to apply scientific rationalism to human behavior (Comte, Durkheim),
  - integrated the progressing power of conflicts (Marx),
  - soon attempted to interpret the causal and goal-oriented properties (meaning) of social action (Weber)
  - language has been considered as a rich repository of social references and constraints (de Saussure)
  - Nowadays, multiple dimensions are considered in sociology, although one is the most significant, extending between two extremes (e.g. Giddens) :
    - individuals (agency) and
    - collective norms (structure)

3.3 Cooperation Among Humans 4 of 4

- As history shows
  - social structures have their own life cycle
  - from time to time human communities adapt themselves to new situations,
    - sometimes with small, gradual changes, and
    - sometimes with brisk discontinuities (revolutions),
  - always in search for a better world.

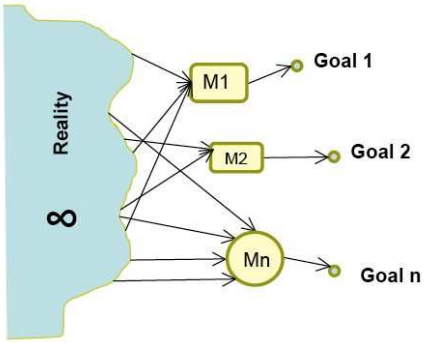
Content

4. Principles of Sociology from a Cognitic and Robotic Perspective 1 de 17

- Science endeavors
  - to acquire from reality experimental, qualitative and quantitative evidence of phenomena, and on this basis,
  - to create coherent and concise theories.
- Success
  - particularly evident for physical processes and properties
  - probably as significant In "soft" sciences (incl. human sciences, sociology), even though much doubt is often expressed, in numerous domains
- It is our goal to (contribute to) bridge the gap
- Top priority as machines get closer to humans
- Cognitive sciences provide a path to a scientific, well-grounded sociology. Especially for a sociology applied to automated, non-human individuals and collectivities

4. Principles of Sociology from a Cognitic and Robotic Perspective 2 de 17

- The MCS theory relies with great benefits on the concept of information
- Even though
  - There are also extremely strong limits, associated with the concept of information
    - time-variation
    - subjectivity
  - And there is still especially another limit, inherited from a more fundamental notion yet, the one of modeling (domain-dependant, infinitesimal, goal-oriented representation of reality)



4. Principles of Sociology from a Cognitic and Robotic Perspective 3 de 17

- Sociology as a well-founded conceptual framework, like the MCS cognition theory, is bound to inherit both from the essential merits and from the limits of its precursors.
- In classical sociology, quantitative, scientific methods have always been practiced
  - They typically appear in terms of collected statistics
  - Similarly, information is also quantitatively based on a probability calculus.
  - It would therefore not be a total revolution to complement ad hoc traditional statistical approaches with corresponding, compatible, more standard information-theoretic techniques; with values measured in [bit].

4. Principles of Sociology from a Cognitic and Robotic Perspective 4 de 17

- In principle, for MCS theory:
  - a group can globally be considered just like any other cognitive system (CS).
  - The behavioral model adopted for CS can be applied at any granularity level:
    - at the global level of an entity (re. in particular Fig. 1.a),
    - and also
      - at lower levels (re. internal information flows while thinking, among multiple differentiated subsystems),
      - reciprocally at higher levels where integration prevails (notion of a group; re. Fig.)
      - possibly recursively, on many levels

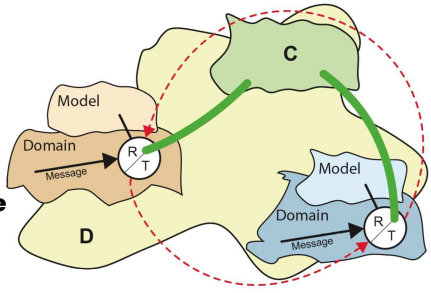
4. Principles of Sociology from a Cognitic and Robotic Perspective 5 de 17

- The sequel of this paragraph mostly borrows from [6].
- Yet a group is, in principle, more than an individual. Additional concepts are useful to handle this more complex form of organization. After a general definition, three views follow where we then adjust the focus on the holistic aspects, the individual properties, and, finally, the way the structure can be coordinated.
- Essential properties of a group organization can typically be viewed as including the following elements:
  - The holistic behavior of the group as a body with collective properties
  - The individual properties of group members
  - The way the structure and means can support coordination (culture, communication, spirit).

4. Principles of Sociology from a Cognitic and Robotic Perspective 6 de 17

Group.

- 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 meta-level, the individual members may be considered as merging, to yield a new individual (the group) with its own collective model (C). (From [6])



4. Principles of Sociology from a Cognitic and Robotic Perspective 7 de 17

- In the context of MCS core theory,
  - the behavior at global level characterizes a group, becoming a (new, integrated) CS.
  - Quantitatively, all the metrics defined for the properties of CS apply.
  - With the behavioral approach, there is, in principle, no necessity to explicitly describe how groups are internally organized.
  - Nevertheless, in the same way as cognition may address subsystems for analytical or design purpose, groups may be considered at the level of individual group members as well.

4. Principles of Sociology from a Cognitic and Robotic Perspective 8 de 17

- In the context of MCS core theory,
  - group members appear themselves as ordinary, elementary CS with their respective cognitive domains mostly defining their specificity.
  - "Phase change" :
    - Surprisingly, even though a group is essentially made of individual members, the observation of those members alone may not say much of overall group behavior
      - A strong individual contribution may not affect the group
      - A contribution that looks negligible at elementary level may gain momentum as it coalesces with other ones in the group (re. emergence)
  - In the context of sociology, an attribute of particular interest for a group member would be its sociable character, its ability to relate with others in order to foster, support, or withstand building-up of the group.

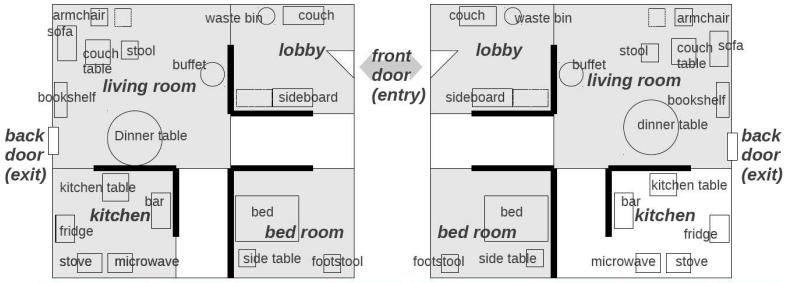
4. Principles of Sociology from a Cognitic and Robotic Perspective 9 de 17

- The communication channel
  - typically a physical medium that supports the transmission of information.
  - For example in @Home groups, interaction between robots and humans may notably rely on vision, gestures, voice, distance estimation and forces.
  - Additionally, robots in a group may typically communicate with each other using wifi. All these channels can be quantitatively characterized.
- The socialization process
  - operationally binds members together (coordinates them) in order to yield overall group properties.
  - Prerequisites include
    - availability of a communication channel
    - some common culture and spirit.

4. Principles of Sociology from a Cognitic and Robotic Perspective 10 de 17

- We can view spirit and culture as a set of intangible underlying factors:
  - ensuring the coordination of individuals in order to achieve a specific collective identity and behavior
  - consisting in a system of common, shared references:
    - values
    - objectives
    - domain of interest
    - all of them possibly dynamically evolving
    - for example in Robocup@Home competitions
      - a list of 20 names is typically defined each year as the common standard for denoting persons involved in Who's who tests (John, Mary, et al.)
      - similarly, some objects and locations are defined [12]

4. Principles of Sociology from a Cognitic and Robotic Perspective 11 de 17



[12]

#	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 (2nd 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	

4. Principles of Sociology from a Cognitic and Robotic Perspective 12 de 17

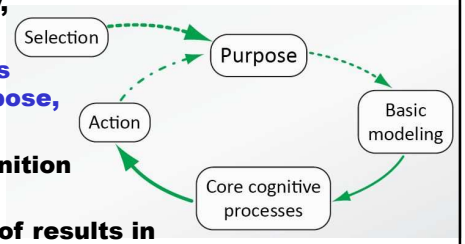
- **Culture and spirit**
  - **Always necessary,**
  - **Like the group itself, they may not actually exist per se**
    - **that is, they are not implemented out of the members themselves**
    - **even though books, bylaws, charts or rulebooks for example may attempt to describe and support them.**
  - **Example 1: Consider an orchestra (playing without conductor)**
    - **here, the group is the orchestra**
    - **members are musicians**
    - **spirit is the name retained for what makes it possible for the musicians to play together in a coherent way, (even when there is no additional conductor nor outside regulating factor),**
    - **culture is the name retained for their common references**
  - **Example 2 : @Home competitions**

4. Principles of Sociology from a Cognitic and Robotic Perspective 13 de 17

- For humans, through ages numerous kinds of collective structures have been explored and defined in addition to the notion of group (re. sociology).
- Nevertheless for MCS theory,
  - only the cognitive aspects are retained;
  - all cognitive concepts denoted in sociology-jargon should just be considered as domain-specific synonyms of corresponding standard MCS entities.

4. Principles of Sociology from a Cognitic and Robotic Perspective 14 de 17

- From a cognitic perspective, the strong modeling limit illustrated previously, calls for a pragmatic process
  - the complexity of reality requires first the selection of a goal (purpose, ethics)
  - only then, can modeling and cognition proceed
  - finally, the symmetric necessity of results in the real world requires action (operability, agency), for example by robots
    - cognitive results must be put to work, with energy etc.,
    - thereby closing of the loop (iteration, and ultimately, in general, survival); from [3].



4. Principles of Sociology from a Cognitic and Robotic Perspective 16 de 17

- The first new domain to consider for a full solution in life refers to the selection of purpose, of goal.
  - Notions closely related to this issue
    - egocentric aspects (self-oriented needs and desires, in particular for survival and freedom),
    - constraints set by the environment (realism, ethics, possibly including altruistic and group-oriented aspects).
- In classical sociology, the respected work by John Child [10] also addresses the critical role of goal selection, "the role of strategic choice" in the context of organizational structure, environment and performance.
- Example: In @Home experimental validation tests, goals are precisely defined for all, humans and machines, in very technical and detailed way, reaching to the concrete value points to be collected (re. rulebook and score sheets).

4. Principles of Sociology from a Cognitic and Robotic Perspective 17 de 17

- The second required domain, to complement cognition for effective changes in life, is
  - action, operation (re. the end of section 2), possibly of robotic nature.
  - The etymologies of the word robot, as well as of operation given above, consistently refer to the concept of work.

Content

1. Introduction
2. Machine-based Cognition and Cooperation
3. Human and Robotic Arts of Cooperation
4. Principles of Sociology from a Cognitic and Robotic Perspective
5. Meta-human and Secular Sociology of Cothinkers and Coagents
6. Conclusion

5. Meta-human and Secular Sociology of Cothinkers and Coagents 1 de 7

- Section 4 has presented basic entities
  - CS and
  - group,
  - both applicable at multiple granularity levels, or scopes
  - humans and robots can similarly enter collective structures of various scales
- Humans commonly belong to
  - small social structures (re. families or friendship circles)
  - most extreme cases:
    - the self; zero level of sociability and typically corresponds in humans to pathologies (autism)
    - nations, religious communities, to name the most common, or globally, mankind.

5. Meta-human and Secular Sociology of Cothinkers and Coagents 2 de 7

- **Members of a group in principle**
  - **share values and goals,**
  - **are ready to give up some of their own judgment and freedom for the sake of group success and collective well-being**
  - **in short, they cooperate**
- **By contrast, competition typically applies**
  - **with respect to possible entities outside the group under consideration,**
  - **especially when resources are scarce.**

5. Meta-human and Secular Sociology of Cothinkers and Coagents 3 de 7

- **It is therefore very important well to identify the limits and priorities of group memberships, which**
  - **in time may vary and**
  - **simultaneously apply to numerous different groups and corresponding scopes,**
  - **for example: companion (shares the bread), comrade (shares the room), compatriot (shares the state ancestors), co-religionists.**
- **From an historic perspective, innovation in specific focus, here (planet Earth) and now (this century), has allowed to define a common cooperative framework for multiple and otherwise possibly conflicting religions (re. secularization process).**
- **Today some people extend beyond mankind the scope of collectivity they adhere to, to possibly encompass, in addition to other humans, animals, insects, even plants (vegetable kingdom) and all forms of life (it is consequently not surprising in such a context that radical limits to the rights of humans may follow). Domestication is a mild example in that direction.**

5. Meta-human and Secular Sociology of Cothinkers and Coagents 4 de 7

- As addressed in title, an effective progress can be expected :
  - extend the scope of thinking people and human agents to accommodate machine-based resources capable of cognition and action,
  - develop collectively a meta-human, secular sociology of co-thinkers and co-agents.
  - For example, it might be rational in such a context,
    - for a robot to stop operation before hurting a human, or
    - for a human, to give some of one's time to relieve a machine resource perceived as critical for collective success at group level.

5. Meta-human and Secular Sociology of Cothinkers and Coagents 5 de 7

- In RoboCup@Home for example,
  - great care and numerous measures have been especially taken in order to avoid human casualties.
  - guidelines have been proposed for safe operation in the cardinal task for a robot to follow humans [11]
  - similarly a modest move in the direction of technical standards might allow for better results in medium term
  - even though some experts still prefer to keep providing a constraint-free context, perceived by them to be more prone to foster ideal, universal robotic and cognitive solutions.

5. Meta-human and Secular Sociology of Cothinkers and Coagents 6 de 7

- Concretely, in the future, the international community should develop the following responsibilities
  - helping to provide a summary of the progress achieved, and
  - defining in a rigorous way an ontology of the objects and operations typical in a domestic context.
  - Standards might also be recommended
    - to simplify robotic automation
    - to make it more reliable and cost-effective,
    - thus achieving useful and widespread automation
  - In human societies, a culture seems always to have developed, which allows for members
    - to behave and to communicate efficiently with each other,
    - about issues relating to their common life and environment.

5. Meta-human and Secular Sociology of Cothinkers and Coagents 7 de 7

- Evident examples of such an approach :
  - natural language, in all societies, through history
  - more recently, car driving conventions or
  - currently, Internet protocols
- In the view of improving the quality of life of humans at home,
  - design intelligent machines and
  - provide novel solutions,
  - in particular a common culture for the field;
  - for humans and also for robots

Content

1. Introduction
2. Machine-based Cognition and Cooperation
3. Human and Robotic Arts of Cooperation
4. Principles of Sociology from a Cognitic and Robotic Perspective
5. Meta-human and Secular Sociology of Cothinkers and Coagents
6. Conclusion

6. Conclusion 1 of 2

- Advances in sciences and technologies are such that today machine-based cognition and cooperation abilities start to emerge in robots, as e.g. RoboCup and more especially its @Home league can prove it.
- Primarily, cooperation is understood here between robots and humans; it can however also be considered in other fields: among multiple robots; and, either by analogy, or as epistemologically founded, making use of millennia of experience, among humans.
- Consequently, time has come to develop knowledge in sociology, in order to improve robotic performance and possibly better explain how humans can cooperate and build-up collectivities.

6. Conclusion 2 of 2

- **Sociable behavior is crucial for gathering individuals and subgroups into larger structures.**
- **As machine-based agents get capable of cognitive performance and robots contribute to get things done, time as come to expand the secular social framework traditionally exclusively reserved for humans, in order to possibly integrate machine-based co-thinkers and co-agents.**
- **Key concepts have now been made and exposed. They have started to be validated by real size implementation and experimentation in the domain of homes (re. e.g. RoboCup@Home initiative), as well as in industrial or public environments. This is worth to be further developed.**

F3A | Cognitive Systems | Samda A

14:00-15:40

Chair: Oliver Zweigle, University of Stuttgart, Germany
Chair: Jean-Daniel Dessimoz, HESSO, Switzerland

F3A. 4 15:00-15:20

A Sociology of Intelligent, Autonomous Cothinkers and Coagents

Jean-Daniel Dessimoz[1], Jean-François Gauthey[1] and Hayato Omori[2]
[1]*West Switzerland University of Applied Sciences, Switzerland,* [2]*Chuo University, Japan*

Scientific and technological progress has brought robots where machine-based cognition and cooperation abilities start to emerge; not only between robots and humans but also among multiple robots themselves. In order to technically improve performances in latter case, as well as, by analogy, to better understand how humans can interact with one another and grow communities, time as come to further, scientifically and technically develop sociology-related knowledge and ontologies. Critical theoretical bases for cognition have been built and demonstrated, both in the human and machinebased cases, providing valuable contributions in this regard. Now sociable competences are considered, allowing for incrementally binding individuals and small groups into holistic units of increasing scope. Ultimately, what is also considered here is a kind of common, meta-human, secular framework where robots and humans can best co-think and co-act. Concepts have now been complemented and validated by real size implementation and experimentation in the domain of homes, as well as industrial and public environments. This should motivate the reader to get familiar with the proposed formal, quantitative MCS framework, thereby getting better insight in judgment and better ability to quantify requirements.

F3A
Cognitive
Systems

www.ias-12.org 75

Acknowledgements

- **The authors acknowledge numerous contributions from colleagues and students at HEIG-VD, and especially from Michel Cornioley, Sudarat "Amy" Tangnimitchok, and Promphan "Kim" Ounchanum, recently.**
- **Thanks also for several helpful suggestions from the reviewers.**

References 1 de n

1. M. Asada, M. Veloso, M. Tambe, I. Noda, H. Kitano, G.K. Kraetzschmar, “Overview of RoboCup-98”, Springer Lecture Notes in Computer Science, (2000).
2. International RoboCup Federation, http://wiki.robocup.org/
3. Jean-Daniel Dessimoz, "Cognition for a Purpose - Cognitics for Control", CogSys2010, 4th International Conference on Cognitive Systems, 27th & 28th January (2010), ETH Zurich, Switzerland
4. Tijn van der Zant and Thomas Wisspeintner, « RoboCup X: A proposal for a new league where RoboCup goes real world » In: Itsuki Noda et al.(Eds.) RoboCup-2005: Robot Soccer World Cup IX, Lecture Notes in Artificial Intelligence, Springer, 7pp (2006).
5. Daniele Nardi, Jean-Daniel Dessimoz, Peter Ford Dominey, Luca Iocchi, Javier Ruiz-del-Solar, Paul E. Rybski, Jesus Savage, Stefan Schiffer, Komei Sugiura, Thomas Wisspeintner, Tijn van der Zant. Amin Yazdani , Dirk Holz , Gerhard Kraetzschmar, David Gossow, et al. “Rulebook” for the League RoboCup@Home (2006..2011), http://www.ai.rug.nl/robocupathome/.

References 2 de n

6. Jean-Daniel Dessimoz, "Cognitics - Definitions and metrics for cognitive sciences and thinking machines", Roboptics Editions, Cheseaux-Noréaz, Switzerland, ISBN 978-2-9700629-1-2, pp169, January 2011
7. Jean-Daniel Dessimoz, "What Role for Emotions in Cooperating Robots? – The Case of RH3-Y", Proc. Conf. Eurobot 2009, Internat. Conf. on Robotics Research and Education, La Ferté-Bernard, France, Achim Gottscheber, David Obdržálek and Colin Schmidt Eds., Communications in Computer and Information Science, Springer Verlag Heidelberg Berlin, pp.38-46, Vol.82, ISBN 978-3-642-21369-2, Cop. 2010, videos: http://rahe.populus.ch
8. M. John McCarthy, What is Artificial Intelligence?, rev. 12 Nov. 2007, http://www-formal.stanford.edu/jmc/whatisai/whatisai.html , 21 Jan. (2010)
9. T. Fong, I. Nourbakhsh, and Kerstin Dautenhahn, “A survey of socially interactive robots”, Robotics and autonomous systems, 2003, Elsevier
10. John Child “Organizational structure, environment and performance: the role of strategic choice”, Sociology, 1972
11. Jean-Daniel Dessimoz and Pierre-François Gauthey, "Domestic Service Robots in the Real World: the Case of Robots Following Humans", Proc. Domestic Service Robots in the Real World Workshop, SIMPAR-2010, 2nd International Conference on Simulation, Modeling and Programming for Autonomous Robots, November 15-18, 2010, Darmstadt, Germany

References 3 de n

12. Dirk Holz, “atHome Arena Map (official) », Robocup@Home, e-mail, 20 June 2012.

Thanks for your attention!