GOALS ONTOLOGY & DYNAMICS
in Mind & Society.
The Agent & MAS Modeling

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ISSUES

- Beyond the Tolemaic view of Cognition
- “Autonomy” and Goals
- The “Agent” perspective
- Goal Ontology
- Goal Dynamics
- Goal Value
- Knowledge & Goals: the “Value” of Knowledge
- Knowledge & Goals: belief-based Goal processing
- Sociality & Goals: Adoption, Delegation, Influence
- Sociality & Goals: Social Links & Networks
I will put aside several promised issues

(like: *Goal-Oriented systems vs. Goal-Directed systems; Goals vs. Functions; Anticipatory Classifiers vs. True Goals; Drives and Goals; Emotions*)

and

I will not discuss *important literatures on GOALS* (also Agent & MAS)

hold (like Cohen&Levesque; Allen; Rao& Georgeff; Coelho….) and recent (Dastani, Hindriks, van Riemsdijk; Lesperance; Duff et al; Braubach; Padgham, Thangaraja, et al.; Tettamanzi, Pereira; and many others ….)

**SORRY!**
The dominant TOLEMAIC view of Cognition

a KNOWLEDGE-centered universe
The dominant TOLEMAIC view of Cognition

a KNOWLEDGE-centered universe

>> “information”, “representation” = Knowledge

And what matters is *K* acquisition, storage, organization, efficient search, reasoning, *K* provision, …..
The non-dominant COPERNICAN revolution on Cognition

a **GOAL/ACTION-centered** universe
The non-dominant COPERNICAN revolution on Cognition

a GOAL/ACTION-centered universe

>> “information”, “representation” =/= Knowledge

Also “Goals” are “representations” with a very specific use/function (and - obviously - also the cybernetic feedback and set-point are “information processing”)

GOAL is the center of the cognitive universe; or better, the center is “goal-directed” action: changing, adapting the world.
The non-dominant COPERNICAN revolution on Cognition

a **GOAL/ACTION-centered** universe

- **Action** is for Goals (and Goals are for potential Actions)
- **Knowledge** is for Goals
- **Intelligence** is for Goals
  (solving problems via mental representations)
- **Sociality** is for Goals and Goal-based
1. AUTONOMY & Goals

The centrality of Goals
   for Agency
   for Autonomy

=================

Few words on Agents & MAS paradigm
Agents & MAS paradigm

Just a Technology?

I stress those aspects still needing a theory (that we cannot just buy and import from the cognitive and social sciences) also because it is important not reducing “Agents” (and MAS) to a technology. This is not only an impoverishing move but even a risky move (remember the serious mistake that AI did with the “expert systems”).

“Agents” are an intellectual (and formal-computational) framework; a way of thinking and of analyzing dynamic and complex phenomena that involve active, partially independent, distributed but interfering and interactive entities, producing common (either planned or unplanned) collective results, for individual or collective advantages.
Agents & MAS paradigm

Just a Technology?

“Agents” are a fundamental scientific frame, which deals with complex and layered (micro-macro) phenomena by providing two related levels of modeling:

- the “architecture” of the agent and the mechanisms behind its behavior,
- and the interaction or communication channels, and the emergent networks, and the collective outcome, and its feedback on and within the agents.

“GOALS” at both levels:

- Internal, “psychological” GOALS (set-points)
- External, emerging “functions” of behaviors (“goal-oriented” but not “goal-directed”)
1. AUTONOMY & Goals

The centrality of GOALS for AGENCY and AUTONOMY

Not really interesting “agency” in efficient cause “agents” (like rain or cold), or in S-R “agents” (goal-oriented, functional but not “goal-directed/driven”: no internal/cognitive representation of the Goal)

Real “Agents”: *internally regulated by their Goal*: true “action” not just “behavior”. Real “autonomy” from the environment and the stimulus: in a sense the stimulus for the action is “internal”: what does it *means* this *Stimulus* from the environment?

- **That the Goal is satisfied?** => inaction;
- **That the Goal is not satisfied?** => *Action*!

Autonomous *from the environment* because the behavior depends on the internal state and representation/interpretation; but also because *it is regulated by “unreality” representation*, what is not-there: the anticipation of the future, of possible outcomes of the actions (“mind”).
1. AUTONOMY & Goals

(i) “AUTONOMY” is a RELATIONAL notion.

X is autonomous FROM Y (but not - for example - from Z) (be Y the “environment with its effective causes and stimuli; or being another Agent: Social Autonomy

(ii) “AUTONOMY” is a CONTEXT-DEPENDENT notion

X is autonomous FROM Y in a given context C but not in another context.

(iii) “AUTONOMY” is a GOAL-CENTERED notion:

First: X is AUTONOMOUS from Y AS FOR REALIZING A GIVEN GOAL /performing a given action (but not for another one)

Second:

the complete/deep/true form of Autonomy is “goal-Autonomy”: X has its own "goals":

Motivational Autonomy, not just “executive” autonomy
12. AUTONOMY & Goals

Where do goals come from??

Different origins:

- **INBORN/GIVEN:**
  - due to evolution/selection
  - designed (a fix set of predefined/engineered “motives”)
  - imposed/written from outside (no real choice, no “adoption”)

- **LEARNED:**
  - for INSTRUMENTAL: imitation; accidental effects and new “action repertoire”
  - for new TERMINAL Goals (motives): various mechanisms from means to end; pleasure & pain; ..

- **ADOPTED**:
  - orders; norms (possibility to violate. Choice. X has to have some “motive” for doing)
  - free help; exchange; cooperation;

- **DISCOVERED by reasoning**:
  - for INSTRUMENTAL goals: planning, problem-solving: creating “means”
Goals ONTOLOGY
2. Goal Ontology

The general and basic notions.

(i) Goals: basic misunderstandings

>> “Goals” are mental “representations”
   - “Representation” is not synonym of “knowledge” or of “doxastic/epistemic” representation
   - “Representation” does not mean “propositional representation”.
   - The representation, object of the Mental Attitude is NOT the “object”, the content, of the Goal
     (S. Tommaso)

>> Goals are not necessarily (to be) ‘pursued’

>> “Goals” are not “desires” (just a special kind of Goal: pleasant & endogenous)
Not all our GOALS are endogenous and comes from “Desires”

Help,
Requests
Promises,
Duties,
Norms,
Goals are not necessarily (to be) ‘pursued’

“Passive” goal-states:

Reliance:
- **To Wish/Hope** (I can do nothing);
- **To Let**: I might interfere but I let that Ag1 (natural or social) realizes something;
- **To Delegate**: I could realize my goal but I make/let Ag1 achieve it.

“Actively” pursued goals:

The realization depends on me, is up to me, I have to act:
- **To Try** (the result is not subjectively sure);
- **To intentionally pursue**: I confidently expect the desired outcome

HOWEVER: any possible action actually (consciously or unconsciously) relies on some external process/agent for its accomplishment.
2. Goal Ontology

(i) Goals: KINDS

Not all our goals are 'felt', also because not all of them are defined in a sensory-motor format.

>> Desires
   ("feel the desire", “foretaste”…: anticipating /imagining pleasant sensations)

>> Needs
   (lack of something; current unpleasant sensations)

There is complementarity and affinity between felt Needs and Desires:
A felt need implies a pleasant relief; a felt desire implies a current potential lack and sufferance
2. Goal **Ontology**

(i) **Goals**: KINDS

>> **Intentions**

Not another “primitive”: **just a kind of Goal**: the final stage of Goal-Processing, after the choice, the decision to act, the formulation of a possible action/plan:

the 'intention' is the transformation, instrumental specification, and commitment of a preliminary goal (the source-goal), which is not always a desire (even when a desire motivates the 'adoption'). In our model, the original goal, the source-goal (which in BDI model is the 'desire') after the decision becomes part of the 'intention' guiding the behavior: it becomes the 'intention that' motivating the 'intention to do'.

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The two-stages Structure of INTENTIONS

> I intend to do a given action/plan A (I have decided and planned),
> in order to realize my higher moving goal THAT p (that depends on me, I have preferred, I believe it is achievable, etc.)
2. Goal Ontology

(ii) Process-related notions and goal-kinds.

>> Instrumental goals or means

>> Higher-goals

>> Terminal goals or ends

>> Starting or motivating goals (‘motive’)

>> Conflicting goals

– (i) The conflict is either due to intrinsic (unsolvable) reasons of logic contradiction between G1 and G2: G1 is or logically implies the negation of G2. G1:p & G2: Not p.

  or

– (ii) The conflict is due to resources scarcity, to contextual and pragmatic reasons: for achieving G1 it is needed the resource R (effort, time, money, ....), the same R is necessary for realizing G2, and it is not enough.
EXPECTED RESULTS

POSITIVE (satisfied goals)

NEGATIVE: costs, harms, renunciations, ... (frustrated goals)

MOTIVATING results

NON MOTIVATING results
Goals DYNAMICS
GOALS-DYNAMICS in DECISION: MOTIVATED (goal-driven) RATIONALITY

A TOP-DOWN and BOTTOM-UP process:

> From Ends to Means (sub-goals, actions and plans for)
> from Means to additional Ends in order to chose

The system has both: to be sure to realize a given goal, and, to be sure to have a satisfying ‘economic’ balance.

In fact, also a (specific-goal)-directed system can eventually renounce, give up its moving goal; but it real “goal” is not just maximizing utility in any possible way, independently from the given objectives. Different from the Economic rationality view.
GOALS-DYNAMICS in DECISION:
MOTIVATED (goal-driven) RATIONALITY

[ "How can I realize G1 in this world?"
]

[ "Which other goals to achieve or sacrifice? How to better employ my resources (while maintaining my objective)?"
]
Goal Ontology

(ii) Process-related notions and goal-kinds.

Let’s thus give the following definition:

Motivating Goals:

*Necessary and sufficient* foreseen/expected outcomes for deciding and for pursuing.

There are two kinds of *motivating* goals:

- (i) the starting ones, the “motives”, what activates and “moves” us in search of how to realize it.
- (ii) the ‘diriment’ additional ones: one wouldn’t chose that (sub)goal, wouldn’t do that action without also the perspective to realize that non-original goal.
Decision as ‘Negotiation’

Process-related notions and goal-kinds. ONTOLOGY for Negotiation Th

>> All/Nothing vs. gradable Goals:
Some goals can be achieved gradually (very much, quite a lot, not so much,...), or partially: 80%, 50%, 30%. (for example, “to be rich”, “to eat all this chicken”, “to by A and B”). Other goals on the contrary are Yes or No, all or nothing (for example, “to marry Paul”, “to take a degree”).

The psychology of those goals is very different
Fundamental distinction for “negotiation” and “compromises”.

>> Non-releasable / un-negotiable Goals
   • Negotiation and decisions becomes impossible if there are conflicting but ‘non-releasable’ and irreducible goals.

==============

>> Avoidance Goals vs. Promotion Goals (Higgins)
The ‘Value’ of Goals
The “reason-based” value of goals

due to means-end reasoning (beliefs) and decision-making

Goal Hierarchies and Value inheritance

Basic principle:

> The value of Means derives from the value of their Ends

Or better: pros & cons evaluation

➢ It derives from the value of the Expected Outcomes (evaluated against goals): the motivating results, the additional positive results, the possible Costs, Harms, Risks.

When it is reason based, “arguable”, (more or less well) supported and justified, it derives in fact from beliefs about instrumental and consequential relations: pros & cons
The *felt* value of Goals

In a lot of “decisions” preferences are not reason-based

The *value of the goals*, their weight in the decision, *does not always depend only from beliefs.*
Not “arguable”!

the value of the goals (and their success in decision) can be the outcome also of **different mechanisms**; not of *cognitive evaluation*.

Damasio (somatic markers) ; Bargh (post hoc evaluations); (“affective heuristics”)
The *felt* value of Goals

“sensations” - for example physiological needs, current felt emotions - can **modify the value of a goal** (Lisetti e Gmytrasiewicz) ('impulses')

and thus the result of a **choice**

*The more intense the sensation (the need, or the emotion) the more important the activated goal* (Brehm, )

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The ‘Value’ of Knowledge
The ‘Value’ of Knowledge

Also knowledge should be better conceived in relation to goals.

We need for example a better

Theory of “Relevance”:

data informativeness, novelty, reliability/truth, efficient search and retrieval, circulation, sharing, ... are not enough.

>> We search and elaborate information, data, knowledge for something.

And “relevance” is not necessarily related to communication pragmatics and dialogue (Wilson & Sperber).
The ‘Value’ of Knowledge

Theory of “Relevance”:

Relevance is the “value” and polarization of knowledge relative to our goals: its utility.

• How precious, useful, important is a given piece of knowledge? How much I would spend/invest for accessing it?
• What kind of information is “useful” for my goal/interest G, and WHY?
• The “instrumental” nature of Knowledge!

Thesis:

The most valuable/important the GOAL G1 &
The most useful and necessary K for G1

==> The most valuable K
PART II

SOCIALITY and GOALS
4. SOCIALITY & Goals

The centrality of Goals

> for Social (inter)Action and Relation
> for Social Networks

“Social computing” should be goal-centered,

since sociality means coordination, cooperation, or competition and conflict, which are goal-based notions.
4. SOCIALITY & Goals

Cooperation

We cannot really model and support “cooperation” without making explicit the goals the agents pursue by their coordinated actions.

Are those goals shared? Are they mutually known? Do the agents converge on previous common goals or some agent adopts the goal of the other? Do they cooperate having in mind a common plan, and knowing the role and action of the other; or are they unconsciously cooperating in a plan that is not in their own mind (and they do not understand the final goal), or are they just parts of an emergent, self-organizing cooperative phenomenon?
4. **SOCIALITY & Goals**

**BASIC SOCIAL MOVES:**

- Goal Adoption,
- Goal Delegation, Reliance
- Influence: changing Goals
Social Agents - Micro-Sociality

Delegation or Reliance

to exploit

Goal adoption

to help

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4. SOCIALITY & Goals

Goal-Adoption

How is it possible that the goal (need, desire, objective, request, order, ...) of another entity succeeds in regulating my own autonomous behavior?

How such a goal is ‘imported’ in my regulatory, purposive system?
Social-Agent’s Architecture and Multiple Goal-Sources

Help, Requests, Promises, Norms, .......

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The ‘prodigy’ is that those *self-regulated*, goal-driven systems can *import goals* from other goal-driven, purposive systems, from outside:

- They put their ‘body’, skills, problem-solving capacity, and resources at disposal of the needs/desires of another agent.
- They spend their powers, and actively pursue the goal of another and for another; and, vice versa, **Y exploits X’s body/powers for her purposes**.

“*Auto-nomos*” “*self-motivated*” “*Goal-driven*” ... doesn’t mean: “*Selfish*”
**Goal-Adoption**

\(X\) believes that \(Y\) has the goal that \(p\) \((G_y p)\) and comes to have (and possibly pursue) the Goal that \(p\) \((G_x p)\) just because he believes this.

\[
\text{(Goal-adopt } x \ y \ p) = \text{def } (\text{R-Goal } x \ p \ (\text{BEL } x \ (\text{Goal } y \ p)))
\]

This is ‘goal-adoption’, and can be *motivated* by different reasons.
Beliefs about Y’s goals

A fundamental condition is an intentional stance of X (the adopter) towards Y (the adopted guy), and more precisely – if Y is considered a cognitive agent – a mind-reading attitude in X towards Y.

>> Not only Communication, but Mind reading!

X has to ascribe to Y a given internal goal (of any kind)

Bel x (Goal y p)

and X decides to “appropriate” that goal, since and until it is the goal of Y. So X comes to have the same goal:

(Goal x p)

but relativized to that belief.
A Complex Goal Structure

- Motivation: various possible motives (selfish or other-regarding)
- Adoptive goal: Obtain Y p
- Adopted goal: p
- Intention: Do X A
Kinds & Motives of Goal-Adoption
Goal Adoption

is not ‘benevolence’ or ‘altruism’

..... Social Preferences

does something for the others

there are various motives for doing something for the others

there are various kinds of goal-adoption
**a) Terminal or Altruistic** Adoption can (rarely) be ‘altruistic,’ that is disinterested, non motivated by, non instrumental to higher personal (non-adoptive) calculated advantages (goals);

**b) Instrumental** Adoption can be instrumental to personal/private returns, part of a selfish plan; like in commerce, where: “It is not from the benevolence of the butcher, the brewer, or the baker that we expect our dinner, but from their regard to their own interest. We address ourselves, not to their humanity but to their self-love, and never talk to them of our own necessities but of their advantages” (A. Smith, *An Inquiry into the Nature and Causes of the Wealth of Nations*, 1776)

In Smith’s perfect description of exchange in merely selfish terms it is clear that there is non benevolence or altruism at all; and that has the goal to understand and realize the selfish goal of Y (that per se is indifferent - or bad - to X) only in order to satisfy (through Y’s reciprocal adoption) his own selfish and personal goal. So having the goal to realize your goal (as what you like and because you like it) is not necessarily altruistic at all.
c) **Cooperative:** it can be instrumental to a personal advantage, but shared with the other: for a *common goal* (strict ‘cooperation’): X and Y depend on each other for one and the same goal.

One might consider (c) a sub-case of (b) (instrumental adoption) but actually the situation is significantly different.
‘Cooperation’ is based on Adoption
Intentional ‘**Cooperation**’

is Adoption (and Delegation) based

**In ‘Exchange’** (bilateral dependence, individual goals)

\[X \text{ adopts the goal of } Y\]

*if and in order* \(Y\) adopts her goal

**In strict ‘**Cooperation**’** (common goal & mutual dependence)

\[X \text{ adopts the goal of } Y\]

> because \(Y\) relies on her (and \(X\) accepts this); and

> because she relies on \(Y\)’s action

(do not interfere, to facilitate: true **Collaboration**)
4. **SOCIALITY & Goals**

**GOAL DELEGATION**

_X allocates her Goal to Y; relies on Y as for realizing that Goal:_

> _X either exploits Y’s autonomous actions; or_

> _Tries to “influence” Y, to induce Y to “adopt” her Goal_
4. SOCIALITY & Goals

INFLUENCE/MANIPULATION:
changing the other’s goals

“Sociality” is not just adjusting our own behavior to the others’ interference; it also is changing the others’ behavior.

When they are cognitive agents this means:
Changing their MIND (goals!) in order to change their behavior!

I have goals about the other mind, not just beliefs.
The problem is:

*Where, how, to act upon your mind to change your behavior?*

*A model is needed: (putting aside ‘affect’)*
The problem is:

**Where, how, to act upon your mind to change your behavior?**

A model is needed: (putting aside ‘affect’)

**Diagram:**

- **Belief** (BEL) connected to **Goal** (GOAL)
- **Belief** (BEL) connected to **Intention** (INTENTION)
- **Intention** (INTENTION) connected to **Action** (ACTION)
The problem is:

*Where, how, to act upon your mind to change your behavior?*

A model is needed: (putting aside ‘affect’)

![Diagram](ICAART-2011-Castelfranchi)
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The problem is:

Where, how, to act upon your mind to change your behavior?

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Common world = INTERFERENCE
NOT necessarily “COMMUNICATION”
Social Structures

Acquaintance

I know her

Communication

I can send a message to her

Dependence

I need her

I adopt a task

I delegate a task

S-Commitment
A central construct of social studies

> their **STRUCTURE & DYNAMICS**

Fundamental

for **EMERGENT PROPERTIES** and **COMPLEXITY**

*Complex systems* are characterized by:

- **non linear** behavior/dynamics, in part casual;
- **many components** and **many interactions** among them;
- **multi-layered** (self-organizing, emerging); ..
What must be carefully preserved and taken into account are:

(i) The “semantics” of the link, the specific nature of the relation (GOAL defined) it represents, with all its properties and arguments; and the "nature" of the link: (unilateral? bilateral? reciprocal/mutual?)

The qualitative & quantitative aspects of links;
their strength and so on;
the “transmission” and transitivity properties.

(ii) The cognitive aspects that qualify that relation (given that the network nodes are “actors/agents”): what the agents believe, understand, prefer,... : their “mind” in the network (mind-based links: Trust) and about the network.

It is not only a network on actions and of positions; it is a network of minds (ex. shared non-shared mental states; contagion or not; ..)
NETWORKS

Few examples focused on

The CENTRALITY of GOALS in the links:

> Dependence Net

> Trust Net
DEPENDENCE-Network
DEPENDENCE-Network

The basis/ground are
INDIVIDUALS with their personal GOALS & POWERS
DEPENDENCE-Network

The basis/ground: relative to Goals!

POWERS (skills, resources): the basic layer

• If A has Goal q and is NOT able & in condition to achieve it, &

• If B has the “power of” realizing q by action $\alpha$,

$\Rightarrow$ Then: $X$ objectively DEPENDS on B as for action $\alpha$ and goal q

The basis of DEPENDENCE are:
- “power of” & “lack of power of”

GIVEN A BUNCH of AGENTS (with their needs (goals) and personal powers (skills and resources),

an OBJECTIVE DEPENDENCE NETWORK EMERGES
Reciprocal S-Dependence

Exchange: they depend on each other for two different and individual GOALS
- cheating, defeating,
- problems of reciprocation, ....
Mutual S-Dependence

strict **cooperation:** they depend on each other for just one and the same GOALS

- common goal, co-interested agents,
- to defeat is self-defeating....
DEPENDENCE-Network

[Diagram showing network relationships with labels A, B, control, S-Dep, and Dep]
DEPENDENCE-Network

A → S-Dep → B → S-Dep → C
Dep
control

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NO trivial “transitivity”:

\[ A \text{ Dep on } B \& B \text{ Dep on } C \implies A \text{ Dep on } C \]
NO trivial “transitivity”:

\[ A \text{ Dep on } B \text{ & } B \text{ Dep on } C \implies A \text{ Dep on } C \]

\[ A \text{ Dep on } B \text{ as for action } \alpha \text{ for realizing } \text{GOAL } q, \text{ but } \]
\[ B \text{ Dep on } C \text{ as for performing } \alpha \]

Then: \( A \text{ Dep on } C \text{ as for realizing his GOAL } q \)
Subjective DEPENDENCE-Network
A wrongly believes to be Dep on C

A doesn’t know E

A doesn’t know G

A knows H but doesn’t believe to be Dep on H

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Levels of emergence...

cognitive emergence: awareness

objective dependence network

agents in a common world

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Feedback into the minds

cognitive emergence: awareness

objective dependence network

agents in a common world

NEW GOALS!

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TRUST-Network

The TRUSTOR’s perspective

Predictions
The strength of X’s trust in Y is a predictor of X’s choosing Y for reliance, of X’s counting upon Y. But this is not a perfect predictor, i.e. the differential amount of X’s trust in Y (compared with X’s trust in Z or W) does not completely determine X’s choice. There are also other factors. How much is X dependent on Y, Z or W? How much does X need each of them? And which is the cost of relying upon Y rather than upon Z or W? Not always the chosen partner is the most trusted. Although more risky certain relationships can be preferable.
TRUST-Network

BUT…. All trust relations are GOAL-RELATIVE:

X trusts Y AS FOR a given outcome, result, action, good, service,… he NEEDS or DESIRES!

IMPORTANT for the LINK DYNAMICS!
**TRUST-Network**

**NO trivial “transitivity”:**

\[ A \text{ Trusts } B \& B \text{ Trusts } C \implies A \text{ Trust } C \]

A “trusts” B for what?! and B “trusts” C for what?!
IF

A Trust B as for being a good evaluator of $\alpha$ performances, & B Trusts C as for performing $\alpha$ (two kinds of Trust!)

Then: A Trust C as for performing $\alpha$
The TRUSTEE’s perspective: TRUST “CAPITAL”

For which GOALS the others trust X and search for X? Which are X’s perceived “virtues”, “qualities”, “skills”, .. ?
TRUST-Capital
Trust as *Relational Capital*

To be trusted:

> gives me power!

> increases my chances to be requested or accepted as a partner for exchange or cooperation;

> improves the ‘price’, the contract that I can obtain.
Dynamics of Relational Capital

- There is a cost of this Capital.

- One has to invest to acquire it

Example: in iterated strategic games, the cost of building my Reputation is an investment for future interaction
Thank you for your attention!
I like to thank our research group in Cognitive Science at ISTC: the ‘GOAL group’

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A part from Rosaria Conte (LABSS Group)
A functional continuum (Pezzulo- Castelfranchi):

- The top portion is more similar to BDI (Rao and Georgeff, 1995)
- The lower portion is more similar to Behavior Networks (Maes, 1989) and uses anticipatory classifiers (Butz, 2000)
POWER-Networks
from DEPENDENCE-Network to POWER-Network