

A Meta-model for the Simulation of Social Organizations

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The project

- Together with sociologists of the Toulouse University,
- Consider a well-experienced sociological theory of organizations
 - Used by consultants to analyze disfonctionning organizations (==> many case studies)
 - Widely taught (==> well-known by many practitioners)
- Try to formalize this theory in such a way that it becomes possible to draw models of organization, to simulate their dynamics, ...

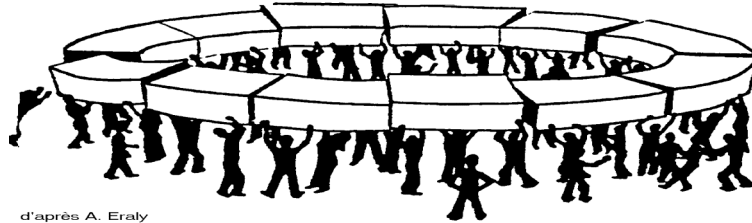
Plan

1. The Sociology of Organized Action
2. The Meta-model of Social Organizations
3. Structure and States of an Organization
4. Simulation of the Dynamics for Regulation
5. Conclusion

The Sociology of Organized Action

- A sociology theory
 - M. Crozier 1963: the bureaucratic phenomenon
 - Crozier & Friedberg 1977: The actor and the system
 - Friedberg 1993: the power and the law
- *System of Concrete Action*: a social organization that
 - includes actors, resources, means, ...
 - pursues some objectives ...
 - follows rules, protocols, norms ...
- Where come from
 - The actual regulation of an Organization ?
 - The (irreversible) evolution of an Organization ?

The Sociology of Organized Action



d'après A. Eraly

- Actors build the organization (to the best of their advantage) that constraints their behavior (to remain in the organization)
- Actors have a strategic behavior:
 - Each one intends to maintain or increase his *power* upon others, in order to have some *autonomy*, capacity to define and manage his action

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The Sociology of Organized Action

- The power is exerted through the mastering of *Resources* that are needed by actors
 - Each actor both controls and is depends on others by means of Resources
- The strategic behavior of an actor follows a bounded rationality (H. Simon)
 - He seeks for a satisficing power / autonomy, not the maximal one
- The paradigmatic social behavior is cooperative
 - He works to ensure the good operating of the organization
 - While keeping some autonomy to achieve his own goals

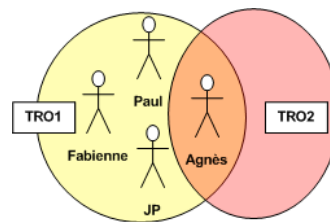
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The Trouville Casestudy

- *Travel-Tour*: a national tour operator
- Structured in regional zones: a hierarchical decentralized organization that motivates concurrency between local agencies
- Employment of most employees is not firm
- The case focuses on *TRO1* and *TRO2*, two agencies in the same city, *Trouville*.

- Paul, the director of *TRO1* agency:
 - Leads and animates the team, ...
 - Signs Agnès' contracts every week
- Agnès, the secretary:
 - In charge of administrative tasks ...
 - Her employment is *not firm*
 - Work at *part-time* in both agencies: *TRO1* and *TRO2*



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The Trouville Casestudy

- To encourage good results of *TRO1*, the regional director proposes
 - a *firm* employment for Agnès
 - at *full time* in *TRO1*
- Paul declines the proposal:
 - the good results of *TRO1* depends on information about *TRO2* activities that Agnès brings back
- Agnès declines the proposal:
 - working in two agencies let her a large space for organizing her work
- Both of them are rational:
 - they anticipate that the change would decrease their possibilities of acting

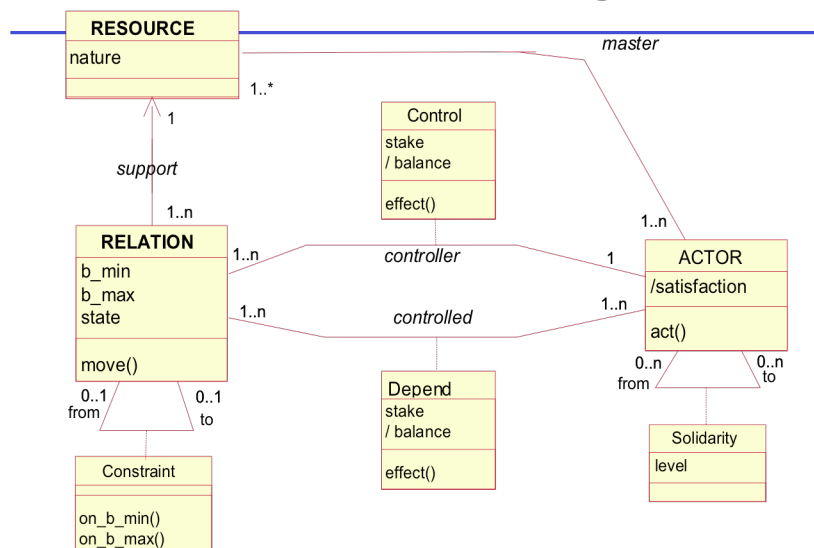
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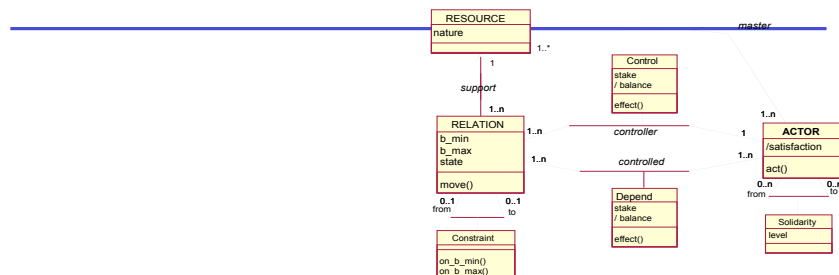
The Meta-Model of Social Organizations



The Relations

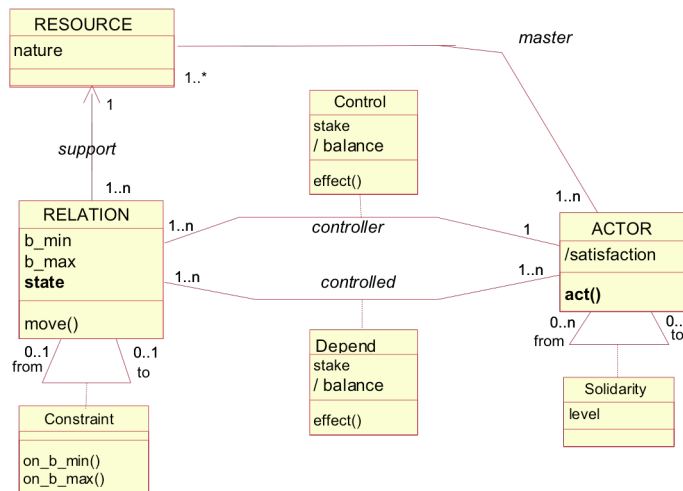
- A *specific way* to use or to access a Resource,
Relations are just the breakdown of Resources
- Controlled by a single one actor
one of those that master the resource
he determines the actual possibility to use the resource in this specific way
for himself and other actors
- Needed by other dependant actors
- The use of each relation gives rise to unequal negotiations,
transactions, bargaining between the controller and the dependent
actors

The Actors



- Some member which controls at least one Relation
Ex.: - one individual member
- a set of members having a similar or collective behavior
- a coalition
- Actor are mutually dependent,
each one both controls and depends on others trough Relations

Control and dependence: the state of a Relation



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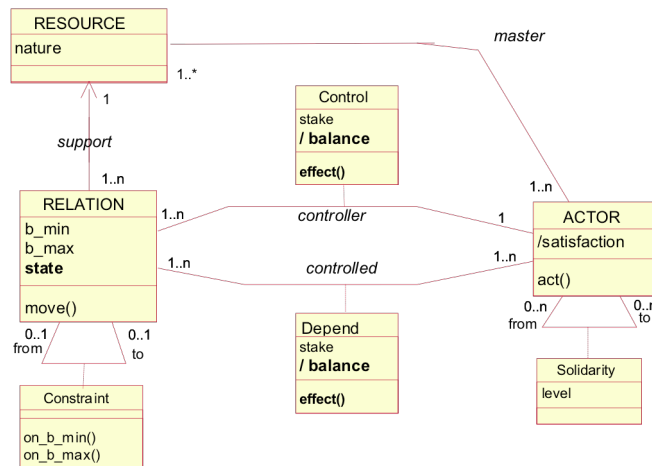
Control and dependence: the state of a Relation

- Each transaction about a Relation resolves in a *settlement*: the *state* of the Relation that determines how well each one may or can use the resource
- The range of value of states:
 - the space of choice for the Actor that controls the Relation: $[-1, +1]$
- The *action* of an Actor: to move the state of the Relations he controls

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Control and dependence: the balances for an actor



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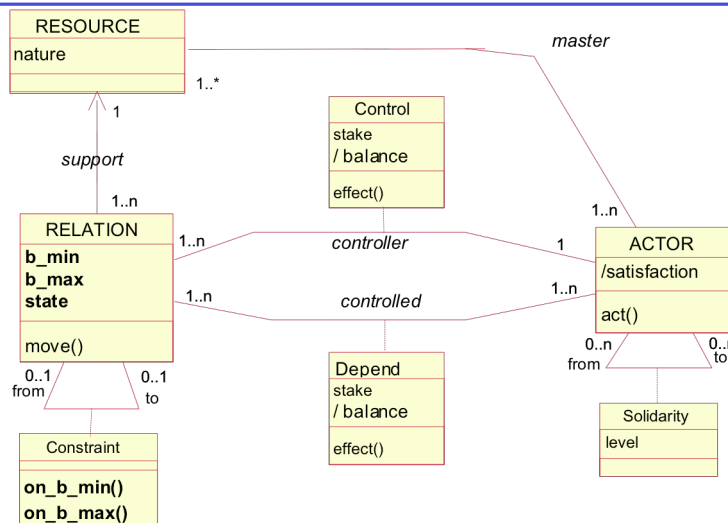
Control and dependence: the balances for an actor

- **Balance:**
how well the actor can access to the resource according to its current state
his possibility to effectively use it
- **The range of value of balances:**
execrable, ..., bad, ..., neutral, ..., good, ..., optimal
numerical, as negative than positive \implies an interval $[-10, +10]$
- **From the state of a Relation to the balance for Actors:**
for each participant a in a relation r ,
a function defines the *effect* of the state of r on the balance for a
 $\text{effect}_r(a)$: Space of choice of $r \longrightarrow$ Range of balances for a
 $[-1, +1] \longrightarrow [-10, +10]$
When r is in state $s \in [-1, +1]$, the balance for a is $\text{effect}_r(a, s)$

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Control and dependence: level of Control



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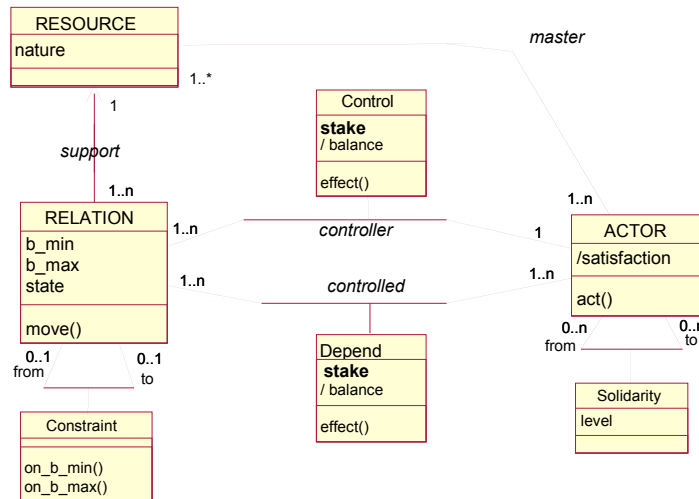
Control and dependence: level of control

- The actual *level of control* of a Relation by its controller Actor may be lower than the full space of choice
 theoretical, physical space of choice: $[-1, +1]$
 effective, actual space of choice: $[b_{min,r}, b_{max,r}]$,
 where $-1 \leq b_{min} \leq b_{max} \leq +1$
- The level of control of a relation r can be constrained by another relation r'
 then r' has two additional functions:
 Space of choice of r' -----> Space of choice of r
 $on_b_min: s \text{----->} b_{min} \text{ of } r$
 $on_b_max: s \text{----->} b_{max} \text{ of } r$

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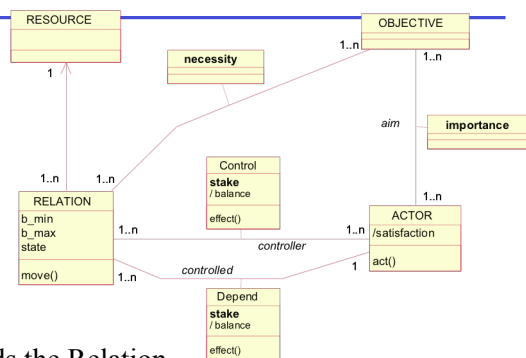
Control and dependence: the stakes



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Control and dependence: the stakes



- The stake:
how much the Actor needs the Relation
- Stake depends on the *necessity*
of the Relation to reach an *important* Objective
- The distribution of his stakes is the interface between an Actor
and the Organization

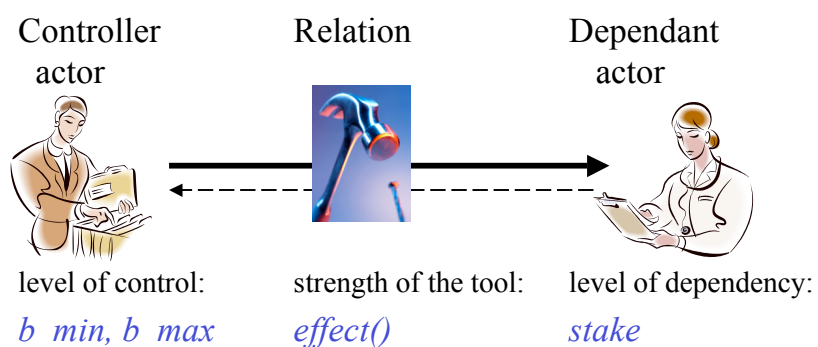
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Control and dependence: the stakes

- Range of value of stakes:
null, .. important, ..., essential : [0, 10]
- All Actors are given the same total of stake points: 10
 - all Actors have the same potential investment in the social game
 - normalization that allows comparisons between Actors
- An Actor could have several strategies at hand
 - ⇒ several alternative distributions of his points of stake

Control and dependence



The Trouville Casestudy

Control of relations

	Director	Secretary
information	<input type="radio"/>	<input checked="" type="radio"/>
work_content	<input checked="" type="radio"/>	<input type="radio"/>
work_firm	<input checked="" type="radio"/>	<input type="radio"/>

stakes

	Director	Secretary
information	7 <input type="button" value="v"/>	2 <input type="button" value="v"/>
work_content	2 <input type="button" value="v"/>	7 <input type="button" value="v"/>
work_firm	1 <input type="button" value="v"/>	1 <input type="button" value="v"/>

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The Trouville Casestudy

Effect functions

REL \ ACT	Director	Secretary
information		
work_content		
work_firm		

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Structure and State of an Organization

- **Structure:**
Actors, stakes, Relations, b_{\min} , b_{\max} , effect,
Diachronic changes in the structure: *Evolution*, structural dynamics
- **State:**
 $s = (s_{r1}, \dots, s_{rn}) \in [-1, +1]^{|R|}$
Synchronic changes in the state: *Functioning*, functional dynamics
- **The behavior of social actors impacts both the structure and the state of an organization**

Properties of the Structure of an Organization

- *Relevance* of a Relation r : $\sum_a \text{stake}(a, r)$
how much the relation r is important for all actors
- *Relevance* of an actor a : $\sum_{r \text{ ts } a \text{ controls } r} \text{relevance}(r)$
- *Autonomy* of an Actor a : $\sum_{r \text{ ts } a \text{ controls } r} \text{stake}(a, r)$
how much a controls the resources he needs
- *Dependence* of an actor a : $10 - \text{autonomy}(a)$
- *Strength* of a Relation r on an Actor a :
$$\text{Max}_s (\text{effect}_r (a, s)) - \text{Min}_s (\text{effect}_r (a, s))$$

The maximum variation of the balance that a can receive from r
- *Theoretical power* of an actor ego on an actor $alter$:
$$\sum_{r \text{ tq } ego \text{ controls } r} \text{stake}(alter, r) * \text{Strength}(r, alter)$$

Defines a *dependence network* among the actors
- ...

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Noteworthy States of an Organization

What about the situation of an actor
in a given state $s = (s_{r1}, \dots, s_{rn})$ of the organization ?

- *Position* of Actor a at s :
 $(\text{effect}_{r1}(a, s_{r1}), \dots, \text{effect}_{rn}(a, s_{rn}))$
the means at his disposal to reach his objectives
- $(\text{stake}(a, r_{r1}) * \text{effect}_{r1}(a, s_{r1}), \dots, \text{stake}(a, r_{rn}) * \text{effect}_{rn}(a, s_{rn})) =$
how well a can use the resources,
weighted by his need of each one
- *Satisfaction* $(a, s) = \sum_r \text{stake}(a, r) * \text{effect}_r (a, s_r)$:
the means at the Actor's disposal to reach his objectives
- To maintain or increase his level of satisfaction :
to maintain or increase his capacity to reach his objectives :
the meta-objective of each social actor

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Noteworthy states of an Organization

State of Relations

Satisfaction of actors

$s = (s_{r1}, \dots, s_{rn}) \text{ :-----} > (\text{satisfaction}(a1, s), \dots, \text{satisfaction}(am, s))$

What about the vector of actors' satisfactions
in a given state of the organization?

- Best/Worst satisfaction of a given actor
- Optimum de Pareto:
Each actor has the best satisfaction that does not decrease the satisfaction of another (cooperative)
- Nash Equilibrium:
Each actor has the minimal satisfaction he can ensure (defensive)
- (Anti)Elitist:
maximize (minimize) the highest satisfaction
- (Anti)Egalitarianist: maximize (minimize) the standard deviation of satisfactions

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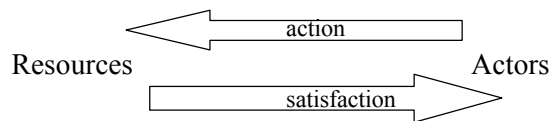
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Simulation of the functional dynamics

- **Remind**: the social dimension of an actor's act is to move (or not) the state of the relations he controls



- **Regulation**: the state of the organization is stationary
each actor accepts his own satisfaction
and does not discuss the satisfaction of others

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Simulation of the functional dynamics

We look for a model of the strategic behavior of actors that:
leads the organization towards a Pareto regulation
is compliant with the bounded rationality hypothesis

Behavior of each actor:

repeat

- Perceive the situation
- Select an action
- Perform the action

until (regulation)

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Simulation of the functional dynamics

- What are the minimal cognitive capacities to be a strategic social actor ?

Perception : knowledge about the structure and the state of the organization

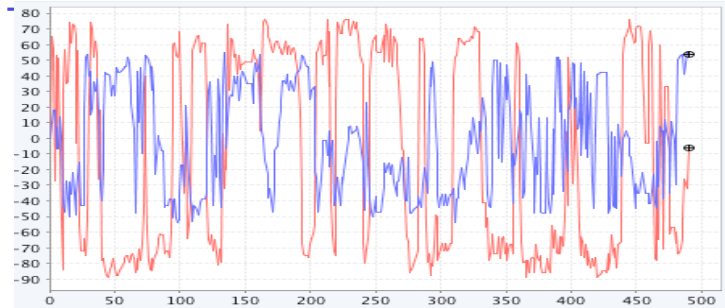
Selection : cognitive operations

- Reinforcement learning
- Each actor a builds a system of rules of the kind:
 {situation, action, strength}
 - *situation*: (effect_{r1}(a , s_{r1}), ..., effect_{rn}(a , s_{rn}))
 the state of the organization perceived by a
 - *action* = list of moves for the relations that a controls
 - *strength*: a numeric value of the quality of the rule

Simulation of the functional dynamics

- Required capacities:
 - perception of his current satisfaction
 - Comparison with his previous satisfaction (reinforcement)
 - Evaluation of the distance between his current situation and the one in rules (applicability of rules)
 - Knowledge of the relations he controls (action)
 - Management of a *satisfaction objective*
 evaluation of the distance between his current and objective satisfactions
 - ==> explore: when he is far below the objective
 - exploit: when he is near or over the objective
- Very few about the structure and the current state of the organization

The Trouville Casestudy: simulation

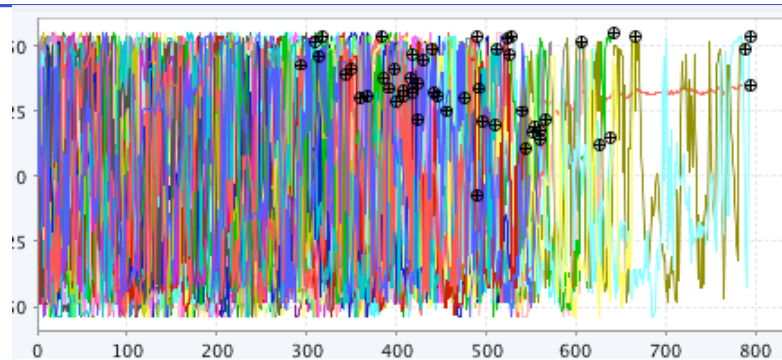


Satisfactions of the secretary and the director in the course of 1 simulation

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The Trouville Casestudy: simulation



the satisfaction of the director in the course of 50 Simulations

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Conclusions

Works in progress

- Test the capacity of our model to reproduce the results of case studies that are well-known in the sociology of organization community
- Develop a specific investigation methodology to model and analyze new cases
- Make SocLab a reliable and easy-to-use platform
- Introduce fuzziness in the model of the structure and of the actors' rationality
- Play the "social game" (experimental sociology)

Conclusions

Further works

- Study the mathematical properties of organizations' models for a theory of System of Concrete Action
- Model the structural dynamics of organizations
- Model actors' rationality for Nash, Elitist, ... regulations
- Do the same with another sociological theory

Conclusions

For Sociology

- A virtual laboratory
 - A tool for more formal diagnostics of organizations
 - Teaching
 - A virtual laboratory for new researches

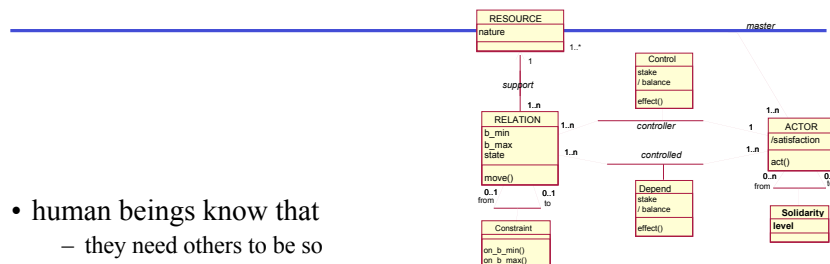
For Computer Science

- A socio-inspired coordination model for MAS
- Provide virtual characters and avatar with a social behavior

Conclusions (final)

- Pluri-diciplinary is costly
- Formalization of a sociological theory leads to deepen this theory

Actors: satisfaction and solidarity

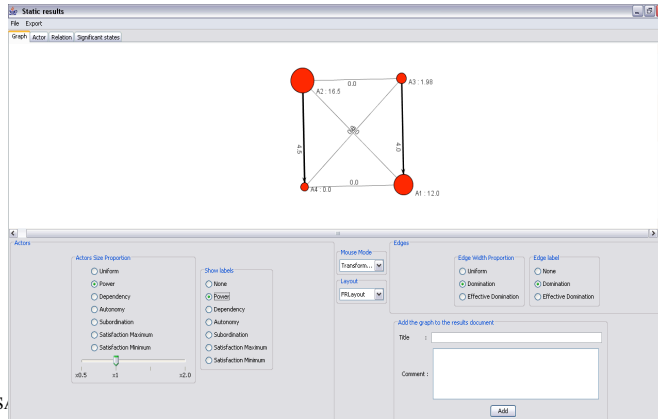


- human beings know that
 - they need others to be so
 - they have advantage to the continuation of the organisation
- Link(ego, alter):
 - how much Actor *ego* takes care of the satisfaction of Actor *alter*
 - with $\sum_a \text{link}(\text{ego}, a) = 1$
 - $0 \leq \text{link}(\text{ego}, a) \leq 1$: ego is solidar with a
 - $-1 \leq \text{link}(\text{ego}, a) \leq 0$: ego is against a
- Satisfaction(ego, s) =

$$\sum_a \text{link}(\text{ego}, a) * (\sum_r \text{stake}(a, r) * \text{effect}_r(a, s_r))$$

SocLab: analyzing

	Nash	Pareto	Maximum global	Minimum global	Minimum for A1	Maximum for A1	Minimum for A2	Maximum for A2	Minimum for A3	Maximum for A3
Te: R1	1.0	-1.0	-1.0	1.0	-1.0	1.0	-1.0	1.0	-1.0	1.0
Te: R2	1.0	-1.0	-1.0	1.0	1.0	-1.0	-1.0	1.0	-1.0	1.0
Te: R3	1.0	-1.0	-1.0	0.5	1.0	-1.0	-1.0	0.5	-1.0	0.5
Satisfactions: A1	-8.0	8.0	8.0	-7.0	-12.0	12.0	8.0	-11.0	12.0	-7.0
Satisfactions: A2	6.0	6.0	6.0	6.0	10.0	-10.0	6.0	10.0	10.0	6.0
Satisfactions: A3	-2.0	-2.0	-2.0	-3.5	-2.0	-2.0	-3.5	-2.0	-3.5	-4.0
Satisfactions: A4	2.0	6.0	6.0	2.0	6.0	6.0	2.0	6.0	2.0	6.0
Total satisfaction	-14.0	18.0	18.0	-14.5	-2.0	6.0	18.0	-2.5	6.0	-14.5



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