



# **Modeling and Simulating Moral Emotions in Organizations: exploring its impact on collaboration**

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# Modeling and Simulating Moral Emotions in Organizations: exploring its impact on collaboration

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**Abstract.** The paper presents how moral sensitivity and emotions are modeled in organizational setting by using the SocLab formal framework. Additionally simulation results, including an interesting tendency for a Free Rider model, will be given. SocLab is a platform for the modeling, simulation and analysis of cooperation relationships within social organizations – and more generally Systems of Organized Action. Taking into account the fact that decision-making processes are not merely driven by instrumental interest, the SocLab learning simulation algorithm has been extended to represent moral sensitivity, so actors can prevent bad emotions and search for good emotions. To this end, a moral sensitivity parameter has been introduced in the algorithm to equip virtual actors with moral and emotional behaviour.

**Keywords:** social simulation, modeling organization, moral emotions, strategic games.

## 1 Introduction

The paper presents how moral sensitivity and emotions can be modeled in organizational setting within the SocLab framework. SocLab is a platform for the modeling, simulation and analysis of cooperation relationships within social organizations that is inspired by a well-experienced theory of the sociology of organization, the Sociology of Organized Action, or Strategic Analysis, initiated by M. Crozier and by E. Friedberg (Crozier and Friedberg, 1980).

Social simulation consists in the modelling of social systems and the study of their behaviour by the performance of computer simulations (Axelrod, 1997), including economics, organization, politics, history or social-ecological systems (see for example the JASSS on-line journal for a number of examples).

Regarding the simulation of social relationships (Squazzoni, 2012), Sibertin-Blanc et al. (2013a) proposes a formalisation of the Sociology of the Organized Action (Crozier and Friedberg, 1980) which studies how social organizations are regularized, as a result of the counterbalancing processes among the power relationships of the social actors. This formalization is implemented in the SocLab environment (El Gemayel, 2013) which enables to define the structure of an organization as an instance



of a generic meta-model, to study its structural properties in an analytical way, to explore the space of its possible configurations (and so to discover its Pareto optima, Nash equilibriums, structural conflicts and so on), and to compute by simulation how it is plausible that each actor behaves with regard to others within this organizational context.

According to the Sociology of the Organized Action, the behaviour of each actor is strategic while being framed by a bounded rationality (Simon 1998). In this approach, the interaction context defines a *social game*, where each actor adjusts his behaviour with regard to others in order, as a meta-objective, to obtain a satisfying level of capability to reach its goals. The aim of a social game is to find stationary states, i.e. a configuration where actors no longer modify their behaviour because each one satisfies himself with the level of capability he obtains from the current state of the game, so that the organization is in a regularized configuration and can operate in this way.

The SocLab framework has been applied to the study of concrete organizations (see e.g. Sibertin et al., 2006; Adreit et al., 2010; El Gernayel et al., 2011; Sibertin et al., 2013a) on the basis of sociological inquiries. However in some cases, the simulation algorithm that makes actors to play the social game (Sibertin et al., 2013b) provides results about the behaviour of some actors that do not accurately match the field observations.

This gap between the observed and the computed behaviours can be ascribed to the fact that SocLab neglects emotions. However, it is well known that social emotions contribute to the regulation of actors' behaviours together with phenomena such reputation and trust (Giardini et al., 2013).

A moral sensitivity parameter has been introduced in the SocLab's learning based decision-making mechanism of actors. This parameter incites actors to select a behaviour that satisfies its aim, a mix of what it gives to and receives from others. Introducing this additional factor of human behaviour helps in understanding better the complexity of actors' action in organizational settings. Following the OCC (Ortony, Clore, Collins) theory of emotions, quantitative measures of moral emotions are defined in terms of the actor's situation at SocLab regulated configurations. A preliminary work was presented in Terán et al. (2014a, 2014b). To illustrate this, simulation results of a Free Rider model are offered, in which we have found the following tendency: when some actors have their largest value of moral sensitivity ( $ms=1$ ), and consequently are strongly collaborative, other actors take advantage of this and do not collaborate. Thus, the best level of collaboration within a System of Organised Action (SOA) is found when actors  $ms$  is somewhere below the maximal value (in  $[0.7, 0.9]$ ).

The paper is organized as follows. The second section introduces the SocLab modelling framework. The third section gives a short overview of the OCC theory. Section four explains how the moral sensitivity parameter is introduced in the learning algorithm, and defines some quantitative measures of emotions. Section five offers simulation results for a Free Rider Model. And, finally, section six depicts some conclusions.



## 2 SocLab

To enable the modelling of social relationships between the actors of an organization, SocLab proposes a meta-model that catches the common concepts and properties of social organizations and is instantiated on specific cases as models of concrete or virtual organizations or Systems of Organised Action (Crozier and Friedberg, 1980). Accordingly, the model of the structure of an organization is composed of instances of *actors* and *relations* that are linked by the *control* and *depend* associations.

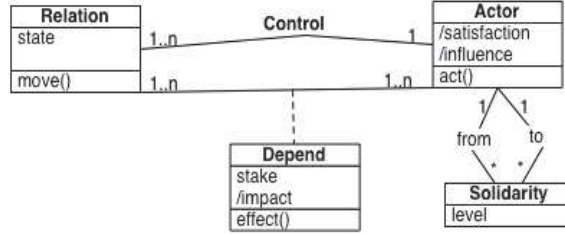


Fig. 1. The core of the meta-model of the structure of Systems of Organized Action

Fig. 1 shows the meta-model of organizations' structures as a UML class diagram. A relation is founded on an organization's resource, or a set of related resources, and it is controlled by a single actor. Resources are material or cognitive (factual or procedural believes or expectations) elements required to achieve some intended actions, so that their availability is necessary for some actors. The *state* attribute of a relation represents the behaviour of the controller actor with regard to the availability of the resource for the ones who needs it. Its range of value SB goes from the least cooperative behaviour, -1, of the controller preventing the access to the resource, to the most cooperative behaviours, 1, favouring this access, while the zero value stands for neutral behaviours.

The *stake* attribute of the dependence of an actor on a relation corresponds to the actor's need of the relation to reach its own goal, on a scale:

$$null = 0, negligible = 1, \dots, significant = 5, \dots, critical = 10.$$

The *effect function* evaluates how much the state of the relation makes the resource available to the actor, so that  $effect_r : A \times SB_r \rightarrow [-10, 10]$  has values in:

$$worst\ access = -10, \dots, neutral = 0, \dots, optimal\ access = 10.$$

In addition, actors may have solidarities the ones with regard to others, defined by as function  $solidarity(a, b) \rightarrow [1, -1]$ , where negative values correspond to hostilities and positive values to effective friendships.

Defining the state, or configuration, of an organization as the vector of all relations states, each state of the organization determines on the one hand how much each actor has the means he needs to achieve his goals, defined as:

$$satisfaction(a, s) = \sum_{c \in A} \sum_{r \in R} solidarity(a, c) * stake(c, r) * effect_r(c, s_r)$$

and, on the other hand, how much it contributes to the satisfactions of each other actor, defined as:

$$influence(a, b, s) = \sum_{r \in R; a\ controls\ r} \sum_{c \in A} solidarity(b, c) * stake(c, r) * effect_r(c, s_r).$$

This interaction context defines a *social game*, where each actor seeks, as a meta-objective, to obtain from others enough satisfaction to reach its goals and, to this end,



adjusts the state of the relations he controls. Doing so, it modifies the value of its influence and therefore the satisfaction of actors who depend on the relations it controls.

The aim of a social game is to reach a stationary state: there, actors do no longer change the state of the relations they control, because every one accepts his level of satisfaction provided by the current state of the game, so that the organization is in a *regularised configuration*.

The actors' strategic attitude is framed by a bounded rationality (Simon, 1998), where the actors' rationality is implemented as a process of trial and error based on a self-learning rule system. Each actor manages a variable that corresponds to his ambition, and the game ends when the satisfaction of every actor exceeds his ambition.

To sum up, each simulation run yields a regularised configuration which associates to each actor numerical values for its satisfaction and its influence, and these values may be used to determine whether this configuration is able to arouse a kind of emotion.

### 3 The OCC theory of emotions

We use the theory of Ortony, Clore and Collins (Ortony et al., 1988) (OCC) for the characterisation of the various kinds of emotions because: (1) it is well-funded and recognized as a standard in computer science, notably in MABS; and (2) it deals with most social emotions we have to consider.

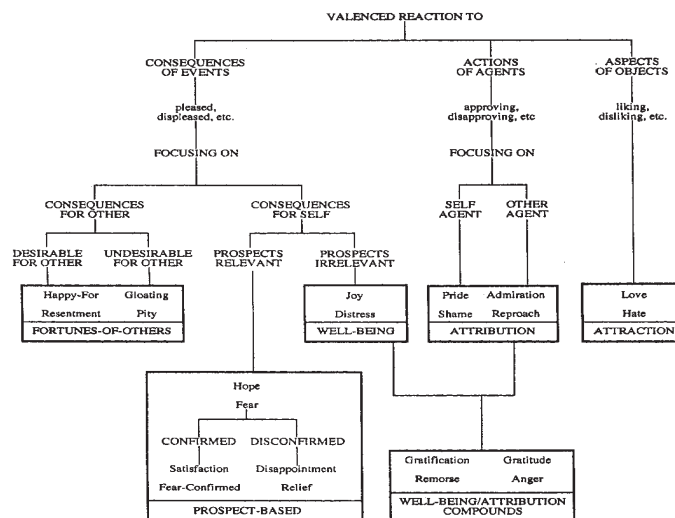


Fig. 2. The Ortony *et al.* (2000, pp 30) classification of emotions.

Following OCC, emotions are linked to events, to actions of people (oneself or other) or to objects. Emotions are classified in a tree structure (see Fig. 2), as follows: (1) in case the linked element is an event that affects the achievement of a goal, the outcome of the event is appraised either as desirable or as undesirable, and the actor



feels either pleased or displeased, correspondingly; (2) in case the linked element is an action that complies or not with a behavioural norm, the actor appraises the action either as praiseworthy or blameworthy, and his reaction will be either approval or disapproval; (3) in case the linked element is an object, the actor appraises the object either as appealing or unappealing, and so he will either likes or dislikes it. In SocLab only the two first kinds of emotions appear: goal-based (e.g. related with properties of a configuration whose occurrence is an event), and norm-based (e.g. regarding the behavior of one actor toward another one or towards the whole SOA).

## 4 SocLab decision-making algorithm and the quantification of emotions

In the original SocLab's actors' decision-making algorithm, actors seek to maximize their satisfaction. In the new algorithm being tested, maximizing an actor's satisfaction is replaced by maximizing the actor's aim. An actor's aim is defined as a linear combination of the actor's satisfaction or instrumental goal (what the actor receives), and what the actor gives to others, weighted by a moral sensitivity parameter, as follows:

$$Aim(ai, ms(ai), s) = (1-abs(ms(ai))) * Sat(ai, s) + ms(ai) * Inf(ai, s),$$

where:

- *abs* is the operator absolute value,
- *Sat(ai,s)* is what the actor *ai* receives from others at the configuration *s*, (see equation (1)),
- *Inf* is what the actor *ai* gives to others at the configuration *s* (see equation (2)),
- *ms(ai)* is the moral sensitivity of the actor *ai* defined in the interval [-1, 1]. It indicates the relative importance between the instrumental (*Sat*) and the moral (*Inf*) goals for the actor. The higher the value of this parameter, the more the actor consider its contribution to the satisfaction of others and thus the well-working of the organization. Usually, it takes values in [0, 1], as negative values mean that the lower the actor's collaboration (even if it is negative) the higher will be the actor's achievement of its aim, what rarely occurs. Moral sensitivity is defined as a disposition/motivation to give importance to moral issues, including moral emotions such as shame or pride: the larger the moral sensitivity of an actor, the higher the importance for the actor of both positive and negative feelings.

### 4.1 Quantifying Emotions in SocLab

Table 1 shows the emotions a SocLab actor is likely to feel in a configuration of the organization. The occurrence and intensity of an emotion at a configuration are given in pairs, defined as a potential (given in terms of a proportion) and two thresholds. If the potential is above the high threshold then the positive emotion occurs, and if it is below the low threshold then the negative emotion occurs. In case the potential is between the thresholds then no emotion appears. The potential of an emotion is always a comparison between what actually happens (e.g., the influence exerted by



the actor) and what could happen (e.g., the range of influence it could exert). Indeed, a social actor “appraises” the situation in the context of the possibilities available for it. The emotional interpretation of the values of each index depends on the very nature of the organization under consideration and of individual traits of each actor. Globally, considering as an example the Joy/Distress emotion, one could consider that Joy appears above 70% (high threshold) and distress under 50% (low threshold).

These indexes are not variables used by SocLab actors in their decision making process. They are based on essential properties of configurations, i.e., what is given (Influence) by a to b, and in what is received (Satisfaction) by a from b, where a and b may be: a particular actor, or the whole organization (SOA), as shown in Table 1. The higher the value of ms of an actor a, the higher the collaboration of a, and so what a gives to the others, which has two consequence in terms of emotions: a) the higher will be the contribution of a to the potential intensity of emotions of actors who receive from a (i.e., depend on the relation a controls), for instance, joy of an actor b (joy is based on what the actor receives from he itself and the others, including a, see below); and b) the higher will also be the intensity of emotions such as Pride of a, which depend on what the actor a itself gives (see also the definition of Pride below). We will use short names for the variables:  $Sat(a,s)$  for satisfaction(a,s),  $Inf(a,s)$  for influence(a,s),  $minSat(a)$  (resp.  $maxSat(a)$ ) for the minimal (resp. maximal) satisfaction a can receive from the whole. Because of the lack of space, we will only give the complete definition for the first emotion, and short summaries of some of the others (for a complete description of these quantitative measures of emotions see Terán (2014b)).

**Table 1.** Emotions Experienced by an actor in SocLab

		<i>Influence exercised by</i>				
		<i>Self</i>	<i>Other(s)</i>	<i>The SOA</i>	<i>SOA &amp; self</i>	<i>SOA &amp; other</i>
<i>Satisfaction Received by</i>	<i>Self</i>	pride /shame	Admiration /reproach	joy/distress		
	<i>Other</i>	pride /shame	Admiration /reproach	If pleased/displeased about ◦ desirable event: happy-for/resentment ◦ undesirable event: gloating/pity		
	<i>SOA</i>	pride /shame	Admiration /reproach	joy/distress	Gratification/ Remorse	Gratitude/ Anger

### 1. Well-being emotions: Joy/Distress

The OCC model defines joy (resp. distress) as to be pleased (resp. displeased) about the occurrence of a desirable (resp. undesirable) event. In the SocLab model of an organization, the occurrence of such an event corresponds to reaching a regulated configuration that is satisfying (resp. dissatisfying). Joy/Distress of an actor a is given as:

**Potential:**



$propSat(a,s) = (Sat(a,s) - minSat(a)) / (maxSat(a) - minSat(a))$ , which value is in  $[0, 1]$ .

**Thresholds:**  $JoyThresh(a)$  and  $DistressThresh(a)$  are the maximal (resp. minimal) values of the proportion of satisfaction a receives generating the emotion Joy (resp. Distress).

$JoyThresh(a)$  and  $DistressThresh(a)$  are the thresholds making actor a liable to these emotions

**Intensity:**  $Joy(a,s) = \max\{0, propSat(a,s) - JoyThresh(a)\}$   
 $Distress(a,s) = \max\{0, DistressThresh(a) - propSat(a,s)\}.$

## 2. Attribution emotions: Pride/Shame and Admiration/Reproach.

An actor could feel prideful (resp. guilty or shameful) when he approves (resp. disapproves) its own praiseworthy (resp. blameworthy) action regarding its effect on itself, or on some other actor(s) close to it. But an actor can also feel prideful by a praiseworthy action performed by another actor close to it. This proximity of an actor a toward another actor b can be evaluated as its Cognitive Unity  $cogUnit(a,b) \in [1, 1]$ . Thus, the pride/shame of a when it evaluates what b gives to c will be (it might be the case that either  $a=b$ ,  $a=c$  or  $b=c$ ):

$$Pride(a,b,c,s) = \max\{0, (propInf(b,c,s) - PrideThresh(b,c)) * cogUnit(a,b) * cogUnit(a,c)\},$$

$$Shame(a,b,c,s) = \max\{0, (ShameThresh(b,c) - propInf(b,c,s)) * cogUnit(a,b) * cogUnit(a,c)\},$$

provided that  $cogUnit(a,b) > 0$  and  $cogUnit(a,c) > 0$ , otherwise both pride and shame are null, and where:

$$propInf(b,c,s) = (Inf(b,c,s) - minInf(b,c)) / (maxInf(b,c) - minInf(b,c))$$

So, we define pride/shame as the product of a measure of actor a's approval of the action of b ( $propInf(a,b,s)$ ), multiplied by the cognitive units of a with b and with c. This is in accordance with the extension of OCC proposed by Steunebrink et al. (2012) (they consider only the case  $a = c$ ). Additionally, we propose to calculate cognitive unit as follows:  $cogUnit(a,b) = ms(a) * Sol(a,b)$ .

The case for Admiration/Reproach is similar but a sees b as another, i.e.  $cogUnit(a,b)$  is null and so it is not taken into account. Also, a has a positive cognitive unit towards c and it evaluates the influence of actor b on c.

## 3. Well-being/Attribution compounds emotions: Gratification/Remorse and Gratitude/Anger

OCC defines gratification (resp. remorse) as being pleased (resp. displeased) about a desirable (resp. undesirable) event or situation that results from one's own action and thus entails the approving (resp. disapproving) of one's own praiseworthy (resp. blameworthy) action. As said above, an event is related with the action of the whole SOA, which results from action of individuals. If the actor feels Joy (resp. Distress) about the situation of the SOA and it considers himself as responsible for it, then it will feel Gratification/Remorse, as follows:

$$Gratification(a,s) = \max\{0, (propGSat(s) - GratifThresh(a)) * ms(a) * propInf(a,s)\},$$

$$Remorse(a,s) = \max\{0, (RemorseThresh(a) - propGSat(s)) * ms(a) * propInf(a,s)\},$$

where  $propGSat(s)$  is the global proportion of satisfaction the SOA has.



Gratitude (anger) is a similar case to gratification (remorse), but it regards what is given by someone else instead of what is given by oneself (in the right side of the equation we will have  $propInf(b, s)$  rather than  $proInf(a, s)$ ).

## 5 A Case: the Free Rider model

This model includes four actors and four relations, where actor  $A_i$  controls relation  $R_i$ , for  $i = 1 \dots 4$ . As shown in the left side of Table 2,  $A_1$  depends on the three relations controlled by the other actors with a stake of 3 on each; actors  $A_2$ ,  $A_3$  and  $A_4$  highly depend on the relation controlled by  $A_1$  (with stake 9); and every actor depends much more on others than on the relation it controls, in the proportion  $1/9$ . There is no relationship between any pair of actors:  $A_2$ ,  $A_3$ ,  $A_4$ . The right side of Table 2 shows the effect functions: for each relation, the functions of the controller actor and of the other actor(s) have opposite slopes, that is, the interest of each actor on the relation it controls is contrary to the interest of other actors.

**Table 2.** In the left side: Stakes of the actors on the relations (in bold the relation is controlled by the actor) for structure  $1/9$ . In the right side, the effect functions of the relations on the actors: the satisfaction given to the actor (y-axis) depending on the state of the relation (x-axis).

		Actors				Relevance of the relation				
		A1	A2	A3	A4		A1	A2	A3	A4
relations	R1	<b>1.0</b>	9.0	9.0	9.0	28				
	R2	3.0	<b>1.0</b>	0.0	0.0	4				
	R3	3.0	0.0	<b>1.0</b>	0.0	4				
	R4	3.0	0.0	0.0	<b>1.0</b>	4				

### 5.1 Behaviour entailed by the moral sensitivity parameter

The simulation experiments usually converge toward the configurations given in Table 3, where each configuration represents a norm of behaviour, either all actors collaborate (conf. C1) or only one of the actors defects (C2...C4), rarely two of them defect (C5...C7), only in some extreme cases  $A_1$  defects (C8), and never three or all of them defect. When  $ms = 0$ , the reference case,  $A_1$  collaborates in any case and, in most cases, either  $A_2$ ,  $A_3$  or  $A_4$  defects while benefiting from the cooperation of the two others.

The graphs in Table 4 show the frequency of configurations for the following exploration of parameters: a) structure of the model, which takes the distribution of stakes  $1/9$  and  $2/8$ ; and b) moral sensitivity ( $ms$ ) of the actors ( $ms$  of  $A_i$  will be named  $A_i.ms$ ), as follows:

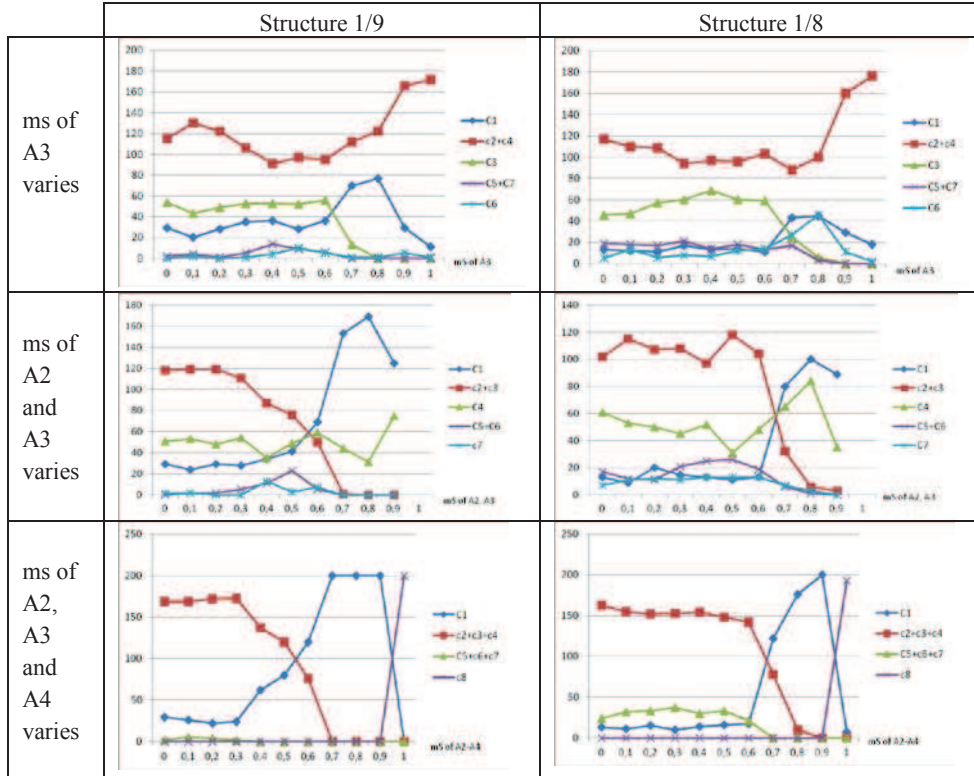


- A3.ms: [0, 0.1, 0.2, ..., 1.0]
- A2 and A3.ms: [0, 0.1, 0.2, ..., 1.0]
- A2, A3, and A4.ms: [0, 0.1, 0.2, ..., 1.0]

**Table 3.** Characterisation of the Configurations resulting from simulation, where a configuration is defined as (stater<sub>1</sub>, ..., stater<sub>4</sub>).

C1: (10, 10, 10, 10): all collaborate	C5: (10, -10, -10, 10): A2 & A3 do not collab.
C2: (10, -10, 10, 10): A2 does not collab.	C6: (10, -10, 10, -10): A2 & A4 do not collab.
C3: (10, 10, -10, 10): A3 does not collab.	C7: (10, 10, -10, -10): A3 & A4 do not collab.
C4: (10, 10, 10, -10): A4 does not collab.	C8: (-10, 10, 10, 10): A1 does not collab.

**Table 4.** Frequency of the configurations C1... C8 for a combination of the two factors: in columns, the structure of the organisation (1/9 or 2/8); in rows, ms varying from 0 to 1 for either A3; A2 and A3; A2, A3, and A4; (ms of A1 is kept in 0).



We can observe a noteworthy tendency: too much (unconditional) collaboration from one actor or from several actors is not good for the whole organization, as other actors take advantage from this. Let us explain using the graphs:



- First row of Table 4 (A3.ms is varied, and structure of the model is either 1/9 or 1/8) the higher the A3.ms (disposition to collaborate of A3), the higher the number of C1 (all actors collaborate) until A3.ms reaches the value 0.8; then, when A3.ms is larger than 0.8, the higher the value of A3.ms, the lower the number of C1, given that the number of defections of A2 and A4 (C2+C4) increases considerably.
- Second row of Table 4: the higher the ms of actors A2 and A3, the higher the number of C1 up to  $ms = 0.8$ . When  $ms = 0.9$ , the number of C1 decreases because A4 collaborate less; 127 experiments converged to the configurations C1 or C7, and four to the configuration C8. For  $ms = 1$  we had difficulties to characterise the simulation output, as the regulated states appeared defined in terms of decimal values – for instance [8.5, 3.75, 3, 10] – which are not in the set C1-C8 (this is also the case for about 63 experiments when  $ms = 0.9$ ). Because of such a difficulty, this set of experiments will not be taken into account in section 4.2.
- Third row of Table 4: The higher the disposition to collaborate of actors A2 to A4, the higher the number of C1, up to some point in which it reaches its maximal value (0.7 ... 0.9 in case of structure 1/9 and 0.9 in case of the structure 2/8), and then, when these actors collaborate unconditionally ( $ms = 1.0$ ), A1 does not collaborate anymore, and the C8 appears.

These results indicate that the best level of collaboration is between 0.7 and 0.9 rather than 1.0 (being unconditionally collaborative). This is consistent with the well known Prisoner Dilemma experiences, where the (Rapoport's) strategy tit-for-tat becomes better suited than all the other strategies and especially than unconditional collaboration (Axelrod, 1981).

## 5.2 Joy/distress of the actors and state of the relations

This subsection shows the intensity of Joy/Distress, where proportions are represented as percentages. Joy/distress was selected because it shows the overall state of each actor. We will consider three cases of variation of the moral sensitivity parameter: i) ms of A3 in [0,1]; ii) ms of A2, A3, and A4 in [0,1], and finally ms of A1 in [-1,0]. Only the model with the distribution of stakes 1/9 will be considered.

### *i) Case 1: Moral Sensitivity of A3 takes the values: 0, 0.1, 0.2,..., 1.0*

Table 5 indicates that joy of A1 increases up to  $A3.ms = 0.8$ , and then decreases; joy of the actors A2 and A4 keeps somewhat stable with intensity around 93, while joy of A3 decreases slightly. Joy of A1 decreases when ms of A3 is over 0.8, because A2 and A4 take advantage of the high collaboration of A3 and give less. In the lower part of Table 5, we see how A3 collaboration (i.e. the state of the relation R3) increases. We also see how the collaborations of A2 and A4 (R3 and R4) decrease after A3.ms is over 0.8. This result confirms the findings described above that actors A2 and A4 take advantage from A3's unconditional collaboration.



**Table 5.** Intensity of joy felt by the actors, and states of the relations; varied factor: A3.ms

	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
<b>A1</b>	64	62	64	64	63	61	64	71	71	64	63
<b>A2</b>	93	93	93	93	94	94	93	93	93	94	94.2
<b>A3</b>	93	92	93	93	93	93	93	91	90	90	90
<b>A4</b>	93	93	93	93	92	93	93	93	93	94	94.8
<b>R1</b>	10	10	10	10	10	10	10	10	10	10	10
<b>R2</b>	3.6	3	4.2	4	3	2.7	4.6	4.8	3.7	1.2	1.7
<b>R3</b>	4.4	5.3	5	4.2	3.3	3.9	3.8	8.7	10	10	10
<b>R4</b>	4.7	3	3.5	4.7	5.7	4.1	4.2	3.5	3.9	1.2	0.5

ii) Case 2: Moral Sensitivity of A2-A4 takes the values: 0.1, 0.2, ..., 1.0

Table 6 shows how A1 benefits (its joy increases) from the higher collaboration of A2, A3, A4 as their ms increases. The joy of A2...A4 suffers only slight changes. The highest collaboration of A2...A4 is reached when ms = 0.7, and stays at that level for higher values of ms. Interestingly, when actors A2 to A4 do collaborate unconditionally (their ms=1), A1 defects because it no longer needs to cooperate to obtain the others' collaboration. In this case joy of A1 reaches its maximal value (intensity 100), while actors A2...A4 are strongly distressed.

**Table 6.** Intensity of joy felt by the actors and states of the relations; varied factor: ms of A2, A3 and A4.

	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
<b>A1</b>	64	63	63	64	70	72	79	90	90	90	100
<b>A2</b>	93	93	93	93	93	92	90	90	90	90	0
<b>A3</b>	93	94	93	93	92	92	90	90	90	90	0
<b>A4</b>	93	93	93	93	92	92	90	90	90	90	0
<b>R1</b>	10	10	10	10	10	10	9.6	10	10	10	-10
<b>R2</b>	3.6	4.6	4.1	4.6	4.5	5.7	7.4	10	10	10	10
<b>R3</b>	4.4	3.1	4.1	4.5	5.2	5.8	7.4	10	10	10	10
<b>R4</b>	4.7	4.4	3.8	3.4	6.6	6.5	7.6	10	10	10	10

iii) Case 3: Moral Sensitivity of A1 takes the values: 0, -0.1, -0.2, ..., -1.0.

As A1 always cooperates in the reference (base) case, the question arises until how far of low moral sensitivity it does so. When ms of A1 decreases from zero, A1 collaborates less and less, reaching the lower point (R1 = -10) from ms = -0.5 (see Table 7). As A1 collaborates less, also A2, A3, and A4 also collaborate less. Surprisingly, when A1's ms decreases from -0.1 to -0.2, the collaboration of A2...A4 increases considerably. A possible interpretation for this fact is the following: the slightest collaboration from A1, when its ms passes from -0.1 to -0.2, leads A2, A3 and A4 to further cooperate in order to induce A1 to do the same. However, when collaboration of A1 is too low (below -0.2), there is no incentive for the other actors to collaborate as the organization is still in a bad state and they will get a low collaboration from A1 whatever their collaboration could be.



**Table 7.** Intensity of joy felt by the actors and state of the relations depending on A1.ms; from -0.6 to -1, the results are the same as with ms = -0.5.

	0	-0.1	-0.2	-0.3	-0.4	-0.5	-0.6	-0.7
A1	64	62	83	46	20.4	10	10	10
A2	93	94	57.4	25	12.4	10	10	10
A3	93	93	56.5	24	12.4	10	10	10
A4	93	93	57.8	24	12.5	10	10	10
R1	10	10	2.4	-5.3	-9.2	-10	-10	-10
R2	3.6	2.8	7.4	1.3	-7.5	-10	-10	-10
R3	4.4	2.6	8.8	0.1	-7.5	-10	-10	-10
R4	4.7	4.7	6.7	-0.2	-7.8	-10	-10	-10

## 6 Conclusion and further research

This paper has shown the introduction of a moral sensitivity parameter in the actors' decision process and the definition of social emotions in SocLab. In addition, quantitative measures of moral emotions of virtual actors in organizational setting have been given. The level of the moral sensitivity parameter affects the collaboration of the actor, what it gives, and consequently the intensity of the emotions felt by the actors who depend on such an actor, including itself. Some simulation results about actors' collaboration and emotions for a Free Rider Model were presented. A particular noteworthy tendency was: actors' unconditional collaboration occurring when their moral sensitivity reaches its highest value one (1) prevents collaboration from other actors (who take advantage from the unconditional collaboration), while values of moral sensitivity somewhat below the highest value (between 0.7 and 0.9) require collaboration from the others.

The introduction of the moral sensitivity parameter allows actors to orient their decisions not only by their search of instrumental satisfaction, but also to search for good emotions and to prevent bad emotions. It will hopefully permit to overcome some deficiencies of SocLab, represent more suitably social organisations, and get better results in further research and applications.

Further research will consider the inclusion of a parameter to represent actor's Group Identification (as defined, among others, by Simon), which might be more suitable than the moral sensitivity parameter to model actors' organizational engagement and motivation. Group identification is understood as an actor's self-concept derived from its knowledge of its membership in a group, along the value and emotional significance of that membership. This notion is also important to determine an actor's cognitive unit and emotions.

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