Modelling rituals for *Homo biologicus*

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Abstract. This paper builds on a generic conceptual model to be used in research that uses agent-based models. The aim is to model human social interaction at a detailed level, such as would be needed for believable interactions of embodied virtual characters. This means we model *Homo biologicus*, not *Homo economicus*. The present conceptual article investigates the modelling of rituals as a basic unit of group interaction. The ideas introduced here aim at modelling the unwritten rules of social interaction across cultures. The main example is about smoking in bars.

Keywords: meta-model, human social biology, drives, emotions, culture, personality, rituals, moral circle

1 Introduction

Suppose that you are walking around on your own in an unknown city. You enter into a bar. Your first action will probably be to assess the atmosphere. If everybody looks up as you enter, you will sense that you have interrupted something. That 'something' involved shared attention by all people present. If you find out that there seems to be a private celebration going on, or a meeting, you might leave discreetly, so as to avoid interfering. What you have sensed is the sacredness of ritual. This is an important element of human social life.

Upon meeting an old friend in that bar, how would you start talking? That would depend on who it is; you want to present things relevant to that person and to the context. There might be shared knowledge such as shocking news, and social events such as meetings and breaks. Most of these would be mundane on an ordinary day. But if you have not met for the past year, you would pick highlights: holidays, celebrations, funerals, diploma ceremonies.

These highlights that we consider worth telling about tend to be rituals that change our social order. Most of the other things we do, although they do not change things, partly serve to confirm the existing order. For instance, describing the news of the day both informs our interlocutor and posits us as members of a community.

So it appears that there is a lot of ritual, small and grand, in our everyday lives. Rothenbuhler [[1]] devoted an entire book to defining the communicative aspects of ritual in an inclusive way, including quite a few mundane behaviours that are not included in the grand rituals mentioned above. His definition (p. 27) is

"Ritual is the voluntary performance of appropriately patterned behavior to symbolically effect or participate in the serious life".

We follow his definition in this paper. One crucial element in this definition is "appropriately patterned" – so there are unwritten rules, if no written ones, about what counts as appropriate. A second one is the aim to symbolically effect the serious life – a ritual is a social act. A third important element is that it does not matter whether one is alone or not; even people who are alone frequently engage in behaviour satisfying the above definition, as e.g. when they wash their hands before or after certain actions. Even so, the vast majority of rituals involve several people, and our examples are concerned with that situation.

Rituals could be convenient in modelling social behaviour in situations where its emergent nature is important, where one zooms in on particular group interactions rather than to model average tendencies. Such a fine granularity is e.g. required to model the social interactions of embodied virtual characters [2]. This paper will explore conceptually how it could be done.

The possibility of defining agents with different goals and different emotional profiles has facilitated their individualisation. However, humans live in societies, which are organized around groups. Collaboration with such groups is essential to survive. As such, to model socially intelligent agents, it is also important to encompass aspects of the social group(s) the agent is part of, defining how those aspects influence the agent's individual behaviour, namely its beliefs, desires, intentions and emotions. The idea here is that for much of our lives, our main objective is not to do with organizations or benefits but with enacting our place in the social order of which we are a part, as is confirmed by social scientific research [3], [1], [4]. We here tread the slippery terrain of grand ideas about human nature, and from there to the formalism of a working simulation model is quite a journey, of which this paper hopes to draw a tentative conceptual map. This work can then be used by others to create or enhance implementations.

1.1 Related research

The social world is so complex that modelling its operation is by definition a daunting task, and simplification of some kind is imperious. But what to leave out, and why? The choice depends on one's objectives, as well as ones disciplinary background. The state of the art is quite varied.

First, there is a stream of research strongly inspired by economics, as exemplified in the Artificial Economics conference series. Here, individual, more or less rational *Homo economicus* is usually the subject. There are increasing forays into social science; for instance the 2010 [5] and 2011 [6] conferences in the series include treatment of social learning and of social facilitation. There are also links with game theory. The granularity is such that actual interactions between individuals are much iconized, and rituals are not dealt with.

Then, there is an active community with a background in computing science. Building systems that can actually run on computers is a major focus here, as is the architecture of such systems. The recent *Handbook of research on Multi-Agent Systems [7]* shows that semantics and dynamics of organizational models are active topics in this community. Organization is a level of aggregation that promises to allow for systems that will run on computers and have a manageable complexity. The

complexity of organization, and the links between formal and informal organization, and between individual-level and organization-level behaviour, are all explored here. In almost all contributions, motivations of individuals are deemed to coincide with organizational objectives. An exception is a contribution from cognitive science [8], in which the author advocates to build systems in which agents might go against organizational rules based on their own powers, goals or relationships. The possibility of emerging rules in addition to deontic ones is also present in [9]. Here again, rituals are not dealt with; one could say *Homo cognitivus* is the main actor.

A third relevant community, overlapping with the others, is that of social simulation as joined in the WCSS and ESSA conferences. Here, the emphasis is on applying a variety of social scientific theories in agent-based and other computational techniques. Subjects include communication, learning, social dynamics and change, and other aspects of human social structure and behaviour. Again, the fine granularity of actual interactions is not currently a much-studied topic. Creating agents that are able to act in a social context in a similar manner as humans is still a very challenging problem, and so far the results are limited. One of the reasons is due to the fact that many elements need to be considered in order to achieve a behaviour that is socially believable, such as perceiving the actions of others, inferring the intentions behind such actions and reacting emotionally to them.

1.2. Relation to the BDI and OCC theories

These challenges have motivated the research on agent architectures that consider social interaction. Many of these architectures are based on the general Beliefs-Desires-Intentions (BDI) paradigm [10] and on appraisal theories of emotion such as the OCC theory [11].

A BDI agent [10] is an agent that is imbued with three particular concepts in its reasoning: beliefs, desires, and intentions. Beliefs represent the information the agent knows about its environment, including information about itself and other agents. Desires represent the goals the agent wants to achieve given the opportunity to do so and an intention represents a commitment to achieve a certain desire.

Following the BDI paradigm, rituals can be seen as desires to which the agent forms an intention to achieve when he believes that the preconditions of the ritual are true. Given that the actions of the ritual are prescribed, the performance of a ritual is done in a predetermined manner. As such, rituals share some similarities with the notion of plan recipes used in traditional BDI architectures. An important difference is that the actions of a ritual are performed mainly for their symbolic value, whereas the actions in a traditional plan are performed for their instrumental value. As such, the focus on a ritual is primarily in the symbolical meaning of the actions and not on what they physically accomplish.

As for the OCC theory of emotion [11], because it is comparably easy to implement in a computational manner, it is the appraisal theory most commonly used in software agents. The theory views emotions as the result of a valenced reaction to events in relation to the agent's goals, standards, and attitudes. It defines a hierarchical organization for emotion types which represent a family of related emotions differing in terms of their intensity and manifestation. For instance, the emotion type Pride refers to the possible set of emotions that result from appraising an

important action performed by the agent which is highly praiseworthy according to the agent's standards.

As rituals are mostly related to the standards of the agent, performing a ritual is a likely an antecedent of Pride. On the other hand, breaking a ritual, a blameworthy action, elicits Shame, with an intensity that is proportional to the importance the agent gives to that ritual. Asides from Pride and Shame, there are other two emotion types in the OCC theory that are related to the praiseworthiness of the event: Admiration and Reproach. The difference with Pride and Shame lies on the agent's responsibility for the event. When an agent is responsible for an event it elicits Pride or Shame, but when it is another agent who is responsible, the agent elicits Admiration or Reproach for that agent.

It follows that rituals can be used with BDI agents that have OCC-based emotions, provided symbolic meaning of actions is given value. To do this well, an operational concept of a moral circle to which a ritual is meaningful, is desirable. With such an operationalization, the simulation can let social emotions that occur during a ritual be shared by all its participants.

Embodied virtual characters are found in games, of which there is an enormous proliferation. Research has come up with some games that pay attention to cultural believability. One publication explicitly introduces ritual [2]. Ritual is here defined as a tuple < T, R, C, S, O >: Type (e.g. greeting), set of Roles, Context of activation, set of Steps, set of Ordering constraints.

This work fits with our current perspective. A strong feature is that shared attention is modelled: the ritual knowledge is shared by all participants. This can be the basis for an operational concept of moral circle: each agent can have a basic moral circle, as well as one that is currently active in a ritual.

To conclude the tour along the literature: there is a case for bottom-up modelling of human social behaviour, including rituals. Here we shall extract a formal model of ritual processes that can be used in social simulations. It will remain for later contributions to actually use these ideas in agent-based simulations. Such simulations could be inspired by any of the research traditions mentioned above.

2 Rituals

2.1 Definition

We now return to rituals. Rothenbühler's definition given above is "Ritual is the voluntary performance of appropriately patterned behaviour to symbolically effect or participate in the serious life". Wikipedia specifies what 'the serious life' often amounts to: "A ritual is a set of actions, performed mainly for their symbolic value. It may be prescribed by a religion or by the traditions of a community. The term usually excludes actions which are arbitrarily chosen by the performers." This leaves us with the question how much of our behaviours are actually arbitrary. The odds are out on this question, see e.g. [2]. In this article there is no need to decide, since we are dealing with a subset of explicit collective behaviours only.

Hofstede et al 2010, in discussing culture, define rituals in a way that fits our objectives, as "collective activities that are technically superfluous to reach desired ends but that, within a culture, are considered socially essential". This definition is

close to the Wikipedia one but excludes non-social activities. It is not always easy to apply though, for a number of reasons:

- Different perceptions
  Normally, a ritual involves shared attention. This is important for a simulation, since it can be used for economy of memory: all participants have the same knowledge about the ritual and its progress. However, in reality it is quite possible that one person – probably an insider - would consider an action technically necessary while another – probably an observer - merely considers it a ritual (see e.g. [12]). This is for instance the case for cleaning practices imposed on infants; they vary enormously across cultures, are justified by those who engage in them in terms of practical relevance, but might be considered largely ritual, or even practically harmful, by cross-cultural observers. When activities are linked to the things that a researcher holds sacred, even investigating the distinction between the practical and the ritual could be taboo.
- Mixed activities
  Many activities combine the practical and the ritual. Consider a football match: its meaning is obviously a ritual battle. But to some it might be a real battle with real stakes, for instance to those who bet on it, or to those who attack underperforming players after the match. To the players and watchers, practical aspects of ball handling technique are important. To some, the whole realm of football is socially essential while to others it is meaningless.

From these two points we can conclude that as a side effect, rituals actually serve to create or maintain groups: those who engage in them, those who believe in them, those who ignore them, and so on. This is important. Behind the stated aim of a ritual, there is what we could call a meta-aim at group level, pertaining to the life cycle of that group.

2.2 Markers of the social order of the moral circle

There are certainly social behaviours that are more obviously ritualistic than others, for instance: marriages, funerals, diploma ceremonies, *rites de passage*. These are all events that *change the social order* in a group or community. Other rituals that are usually less intense serve to reinforce existing order: church services, parties of friends, family meals. In every case it is important to determine to whom the ritual is meaningful. This is what we shall call the rituals' *moral circle* ([3]).

The moral circle is a fluid concept, meaning "all who belong". In our context an operational definition might be "all who are present in an agent's mind, and who influence that agent's actions". The most obvious moral circle is an ethnic, religious or national community; one could call this the basic moral circle of an agent. However, moral circles are nested, until the transient, e.g. a team at work, or even the ephemeral, a queue at a counter. Each context shapes its own moral circle. Religious communities and peoples keep their rituals and identities across generations. It follows that several moral circles can affect the actions of any one person at any time, and rituals at one level might be overridden by rituals at another – for instance, in most cultures, leaving work duties to marry or to bury a family member would be allowable, or even endorsed. The accepted priority between events is itself symbolic of a prioritization among moral circles. How much nesting of moral circles to account

for, and how to prioritize, is an important design variable of models. Particularly when one studies cross-cultural differences, the relative importance that agents attach to e.g. national authority and law, religious taboo, organization rules, and individual volition is crucial [13] k.

Rituals can be seen as markers of the social order. That social order defines identity, relationships and obligations, or in the words of this article, group membership, dominance and affiliation relationships. The degree to which these relationships are codified is associated with culture. The stronger the codification, the stronger the ritual needs to be that either reinforces or changes it.

Meta-aims of rituals

This action of a ritual on the social order of the moral circle is its meta-aim. Meta-aims can be categorized in various ways.

First, one could categorize rituals according to which basic drives are at stake: Sex, Affiliation, Novelty, Dominance? Rituals tend to affect more than one of these at the same time. They frequently also include Maslow's [14] basic needs for nutrition or safety. In a model that takes into account agents' drive satisfaction level, this is an important distinction.

Second, one could look at the profoundness of change brought about by the ritual, on a scale from tremendous change (state formation, merging of religions, declaration of war) via routinely occurring change (marriages, funerals, *rites de passage*) to confirmations of the status quo (religious services, sports tournaments – although these latter do change dominance hierarchies).

A third categorization, and one useful for modelling, is one that distinguishes the level of action of a ritual within its moral circle.

- Group level: the entire moral circle is affected. The ritual could be about increasing coherence, about mobilization against a threat, about confirming the group's status (e.g. a national celebration).
- Relationship level: a relationship between a number of participants of the moral circle - frequently two – is begun, reaffirmed, or ended (e.g. a marriage; government change).
- Individual level: an individual changes its group affiliation, e.g. enter group; change status; leave group. Taking up or quitting smoking could be a case in point.

A problem with this categorization is that it could be ambiguous. The same ritual can have effects at two or more levels if the nested nature of moral circles is taken into account.

2.3. Rituals as a process

Based on the above we shall now investigate how rituals could be used as elements in models of *Homo biologicus.* We shall use examples of smoking in bars.

We distinguish the following phases: preconditions, start of the ritual, course of the ritual (with probably repeated actions), conclusion.

Preconditions

If a ritual is a marker of the social order we can expect it to happen under specified conditions. These could pertain to contextual factors and to factors in the minds of the potential participants.

Context

A ritual requires context factors for it to begin: people are required to fill certain roles, and those people should have certain qualities and be in proper state; and time / place / environment conditions need to be met. For instance, a party without drinks and with only two people cannot take off.

In the mind: Rules of the social game

Norms, both institutionalized 'deontic' ones and emergent 'social' ones, specify which social or socio-contextual states are acceptable and what could be done to cope with non-acceptable states. They can be consulted by agents (and this could be an unconscious process as far as their minds are concerned) to see whether a ritual should be started.

A simulation could search for these conditions and decide that a ritual might start. For instance, if the simulation encounters two agents in search of a person to talk to, willing to smoke, and satisfying the particular constraints of the society to which they belong for addressing one another, then they might start a ritual of proposing and accepting cigarettes as an ice-breaker. If this all happens in a place where smoking is forbidden, and where more agents are around that are willing to enforce that rule, then those others might start a norm-enforcing ritual.

How does a ritual begin?

A strongly codified ritual might have a codified scheduling, e.g. each morning, each Friday, each Sunday. Other rituals might start in more haphazard ways, e.g. upon a chance meeting. Our example of smoking in bars is mainly concerned with the latter category.

Initiating move

A ritual begins when one person makes an initiating move. This could be no more than a brief glance at someone – a signal that could be ignored without attracting general attention - , or it could be a signal action such as banging a hammer on a table, or sounding a bell – signals much harder to ignore. In our example it could be producing a packet of cigarettes.

Response
The initiating move then leads to a response. Responses can be classified according to two dimensions: direction (going along with the initiating move or opposing it); and strength of the response. See table 2.

Table 2: possible responses to ritual-initiating moves

direction	strength			
	low			high
positive	acquiesce	accept	support	reinforce
neutral	ignore discreetly	annotate	modify	
negative	ignore ostensibly	constrain	oppose	oppose fiercely

When modelling a ritual, depending on the level of granularity and on the representation, one could use only part of these responses, or even abstract to the direction only. There might be a problem with the current table 2 in that the same response may mean different things across cultures; e.g. 'acquiesce' might be an improper way to show intensity of response in indulgent, individualistic cultures, but a perfectly normal way in restrained, collectivistic ones. So the table might need to be calibrated for culture.

A crucial element of these responses is their moral charge related to the moral circle. This charge has to do with feedback about the moral quality of the proposal. Such feedback depends strongly on culture. In an individualistic culture, explicit feedback, modified by the personal relation that the proposer and the responder have, could be expected. In a collectivistic culture, group-level emotions such as pride and shame would be more likely to be invoked, and this might be done implicitly.

Reaction to response: fate of the ritual
The response will then trigger more action from the initiator, or from others who are present. The result could be

- Following up on a positive response, the ritual goes on as intended by the initiator
- Following up on a modification response, the ritual takes on a different form or context (e.g. moving to a different place to smoke there)
- Following up on opposition, part of the group leaves the ritual, or the initiator leaves the group, or the ritual's intensity diminishes, or the ritual is aborted.

Course of the ritual: emergent properties
Once a ritual has taken off it can run for some time. A model might not necessarily wish to capture every single interaction at this stage but it could focus on the emergent properties of the ritual-in-action. The initial responses' directions and strengths, as a result of the states and drives of participants and of context factors, can lead to different ways of enacting the ritual. Just how this happens is quite hard to determine; it involves contagion of emotion and arousal. One could model the level

and direction of contagion depending on relative status, emotional states and perhaps other person-level variables. Anyway, participants to a ritual keenly feel ritual-level qualities once they have emerged. This could be expressed as ritual homogeneity (are participants equally involved; from disjoint to concerted) and intensity (the level of commitment to the ritual; from noncommittal to intense). In a simulation, these ritual-level variables could be useful for determining when the ritual ends. For instance

- Low-intensity responses can lead to noncommittal ritual enactment, as opposed to intense ones.
- Concerted responses lead to coherent ritual enactment, with at its opposite end chaotic ritual enactment, or perhaps splitting up.

Such variables could be useful in simulations about crowd behaviours.

Deontic versus instance attributes of rituals

Each instance of a ritual has its variables, but the ritual also has a deontic level of sacredness. This is determined by its social purpose and by the moral circle for which it serves that purpose. The sacredness of a ritual can be bolstered by its actual enactment but is partially pre-defined in norms. How to represent this in a model? The ritual's purpose, discussed above, could be a clue, as would the moral circle to which it applies and the entity that sets the rules. Rituals for which religious or state authorities set the rules tend to be particularly sacred. In our smoking example, the relationship between citizens and their government will be crucial. This relationship is culturally mediated. As an example, consider the three cigarette packs in figure 3. The leftmost one (front and back shown) was sold at Madrid airport on 2007, and it flings the EU smoking ban at the buyer, couched in terms that invoke personal independence. Similar messages can now be found on most cigarette packages across the EU. The middle one was sold in China in 2009, where officials were forced to smoke their quota of local cigarettes or face public disgrace; smoking fills the province's treasury which is a patriotic thing to do. It pictures Tiananmen, says 'China' and gives the Shanghai manufacturer's name. The rightmost was sold in Slovenia in 2003. In nonintrusive print, it provides a personalized message stating "The minister says smoking is bad for you". This symbolizes a fatherly (personal and authoritarian) relationship between the minister and the would-be smoker that is absent from the EU rhetoric.

Figure 3: messages on cigarette packs, from left to right: EU, China, Slovenia.

Relative status of the initiator and the other group members, in combination with cultural factors, will strongly impact the ritual's fate. One could also take contextual factors into account; for instance there could be practical impediments to carrying out the ritual.

During all of these steps each of the ritual's participants will have to engage in mental activity. We could model this as follows

- Continuously perceiving the ritual's intensity and perhaps other ritual-level variables
- Perhaps making a correcting or a ritual-ending move, based on this assessment and one's own state, or modifying one's level of commitment
- Influencing one another through social contagion, leading to a new ritual-level state in terms of homogeneity and intensity.

When somebody else makes a move, the following might happen:

1 Perceiving a move or response from one or several others
2 Interpreting it, based on theory of mind about those who make the move
3 Assessing what this means for one's own arousal, and for one's drive satisfaction in terms of affiliation, novelty and dominance (and here, cultural filters will be particularly strong; e.g. "is it 'taking initiative' or 'fitting in' that is socially endorsed for somebody in my position?"
4 Selecting a response.

End of the ritual

At each turn, every participant can thus influence the ritual's continuation. Whether the ritual comes to an end will depend on

- Punctuation of the ritual. There may be points at which ending is prohibited by the ritual's rules, e.g. during the smoking of a cigarette, and points at which it is allowed, e.g. upon finishing one.
- Each agent's state; they might have the aim to stay close to others in the ritual, or to get away.

In what way the ritual ends will depend on its parameters. A low-sanctity, heterogeneous, low-intensity ritual might just dissolve without any formal closure. A high-sanctity and / or high-intensity ritual will require a formal act of closure that will itself be highly ritualistic. The nature of the ending of a ritual is quite culture-dependent.

The ritual's level of sanctity and intensity, and each participant's drive satisfaction, at the ritual's conclusion may be taken into account as a parameter that the participants memorize and use to decide whether to engage in new instances.

3 Concluding remarks

Rituals are so varied in form and so omnipresent in human lives that their use in agent models is in all likelihood a great advantage. Finding the middle ground between the generic attributes of rituals and the richness required to model a certain phenomenon

is challenging. The conceptual model presented here is particularly suited to modelling the unwritten rules of social interaction across cultures. It will still have to show its value in practice.

One important phenomenon that has not been taken into account is the potential co-occurrence of rituals. A model that deals with it will have to work with interrupts, perhaps based on the urgency (as different from sacredness) of a ritual.

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References

1. Rothenbuhler, E.W.: Ritual Communication, From Everyday conversation fo Mediated Ceremony. Sage, thousand Oaks, Ca (1998)
2. Mascarenhas, S., Enz, S., Paiva, A.: Using Rituals to Express Cultural Differences in Synthetic Characters. In: Decker, K.S., Sichman, J.S., Sierra, C., Castelfranchi, C. (eds.) International Conference on Autonomous Agents and Multi-Agent Systems, pp. 305-312. IFAAMAS, Budapest (2009)
3. Hofstede, G., Hofstede, G.J., Minkov, M.: Cultures and Organizations, Software of the Mind. McGraw Hill, New York (2010)
4. Turner, V.: The Ritual Process: Structure and Anti-Structure. Aldine Transaction, New Brunswick (1969)
5. LiCalzi, M., Milone, L., Pellizzari, P. (eds.): Progress in Artificial Economics: Computational and Agent-Based Models. Springer, Heidelberg (2010)
6. Osinga, S.A., Hofstede, G.J., Verwaart, T. (eds.): Emergent Results of Artificial Economics. Springer, Heidelberg (2011)
7. Dignum, V. (ed.): Handbook of Research on Multi-Agent Systems: Semantics and Dynamics of Organizational Models. IGI Global, Hershey (2009)
8. Castelfranchi, C.: Grounding Organizations in the Minds of the Agents. In: Dignum, V. (ed.) Handbook of Research on Multi-Agent Systems: Semantics and Dynamics of Organizational Models, pp. 242-262. IGI Global, Hershey (2009)
9. Vecht, B.v.d., Dignum, F., Meyer, J.-J.C.: Autonomous Agents Adopting Organizational Rules. In: Dignum, V. (ed.) Handbook of Research on Multi-Agent Systems: Semantics and Dynamics of Organizational Models, pp. 314-333. IGI Global, Hershey (2009)
10. Georgeff, M.P., Ingrand, F.F.: Decision-making in an embedded reasoning system. International Joint Conferences on Artificial Intelligence, vol. 2, pp. 972-978 (1989)
11. Ortony, A., Clore, G., Collins, A.: The Cognitive Structure of Emotions. Cambridge University Press, Cambridge, UK (1998)
12. Kyriakidis, E. (ed.): The Archaeology of Ritual. UCLA publications (2007)
13. McBreen, J., DiTosto, G., Dignum, F., Hofstede, G.J.: Linking Norms and Culture. Culture & Computing, Kyoto (2011, accepted)

14. Maslow, A.H.: Motivation and Personality. Harper & Row, New York (1970)