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Enabling generative, emergent artificial culture

Jaroslaw KOCHANOWICZ

Ah-hwee TAN
Singapore Management University, ahtan@smu.edu.sg

Daniel THALMANN

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Enabling Generative, Emergent Artificial Culture

Jaroslaw Kochanowicz
SCE & IMI, NTU
50 Nanyang Drive, Level 03-01
Singapore 637553
Phone: (65) 8550-3754
jarek108@gmail.com

Tan Ah-Hwee
SCE, NTU
Blk N4-02A-26, Nanyang Avenue
Singapore 639798
Phone: (65) 6790-4326
asahtan@ntu.edu.sg

Daniel Thalmann
IMI, NTU
50 Nanyang Drive, Level 03-01
Singapore 637553
Phone: (65) 6592-1891
danielthalmann@ntu.edu.sg

ABSTRACT
Despite the demand for culturally placed agent models, an adequate simulation approach to the relationship between group-cultural and individual-psychological qualities, including culture emergence, is just appearing. It could be argued that we are at the beginning of a domain forming process, a dawn of generative, emergent artificial culture. In this context we discuss current limitations and argue e.g. that too far reaching agent simplicity within Agent Based Modeling limits the emergence of realistic cultural-conventional level and we advocate psychologically rich models of culture forming mechanisms. We propose an approach to cultural phenomena modeling based on the interaction of habitual, affective and rational mechanisms. Next, we introduce an agent component addressing habit and custom driven behavior to explicitly model "conventional reasoning" and its relation to rational and affective decision making. Finally, we present a simple example agent implementation with dynamic and subjective use of roles, values, norms, group identities and social situations resulting in culturally modulated behavior and emotional characteristics.

Categories and Subject Descriptors
I.2.0 [**Artificial Intelligence**]: General – *Cognitive Simulation*

General Terms
Design, Human Factors, Theory

Keywords
Artificial culture, social agents, artificial societies, cognitive-affective architectures, social simulation, social emergence

1. INTRODUCTION
While computational power pushes the simulation boundaries, certain limitations remain unaffected. In a range of applications the ability to model human individual and group behavior remains the fundamental limitation and one of the greatest challenges largely determining what AI can and cannot become in the next decades. As would be expected in the case of such a deep and broad problem, many research fields have emerged, tackling the problem from different backgrounds and abstraction levels. One currently mainstream field is agent based computing **(ABC)**, including agent based social modeling **(ABSM),** which addresses group phenomena with relatively simple agents. Other fields like cognitive-affective architectures **(CAA),** virtual or robotic social agents are more focused on the affect elicitation, reason-affect relations, mood or personality etc. of the character.

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1.1 Emergent Artificial Culture
Such strong research standards have not yet been formed in the case of the challenging and much less researched problem of simulating the relationship between group-cultural qualities and individual-psychological ones, including culture emergence. As Aylett et al. [1] state "studies with synthetic characters have so far infrequently considered the link between behavior and culture; (…) it may become an invisible background (…) directly encoded into the design". This problem lies outside the modeling of the complex-but-single individual or large-but-simple group. It may be seen as a challenge of placing CAA in the social context with new habitual socio-cultural convention enabling components of human thinking. On the other hand, it is an expansion of ABSM towards culture emergence based on psychologically rich agents. It could be argued that we are in fact in the beginning stage of a domain forming process - a dawn of "generative artificial culture".

Societies generate traditions and conventions that are twofold "habitual". They 1) are based on our habitual mechanisms, and 2) form customs - "habits within the society" [2]. Discrimination, rituals, customs, prejudice or stereotypes are clear examples of collective phenomena born from the interaction of individual habitual, affective and rational mechanisms. However everyday thinking is also characterized by such convention-driven elements that carry great normative and emotional power, but their informal and fuzzy nature makes capturing them a challenge. *Subjective, individual and subconscious models of structure and relations in group, power distribution, roles, norms or values determine objective culture via agent actions*. **It is what we refer to as the culture emergence**. In general such psychosocial mechanisms are rarely explicitly modeled in CAA or ABSM, especially on the individual agent level or only single element like role or norm are included with little or no link to affective mechanisms.

In the next chapter we present 4 observations that aim to overcome the current paradigm limitations; conventional-habitual module is presented in chapter 3. Lastly, we will briefly describe implementation and conclude with plans of future work.

2. POSTULATES OF THE EMERGENT CULTURE

In this section we will list discuss four observations we believe are necessary to embrace within the field of emergent culture.

1. **Abandonment of simplistic agents.** We argue that agent simplicity, an integral part of the ABC paradigm [3-5], which enables emergence of some social phenomena, is currently too far reaching and not sufficient for emergence of the mentioned cultural phenomena. Psychologically rich CAA-like models are necessary since culture at the individual level is based on specific psychosocial mechanisms [2] of archetypical and stereotypical nature, in conjunction with goals, personality, emotion etc. Therefore both circularly codependent aspects of the problem 1) culture influence on the individual behavior and 2) group culture formation from individual behavior require more agent psychological complexity than traditional ABSM proposes.

2. **Abandonment of direct, collective and objective group culture representation.** Unfortunate application of dimensions from cultural analysis as a basic culture feature in those rare models [1, 6] that explicitly address it is another tendency. E.g. "collectivist-individualist" from Hofstede culture theory may be a useful metrics in culture analysis. However direct hardcoding of similar sociological constructs as a predefined feature in culture simulation not only oversimplifies it, but also forbids actual cultural emergence from agent psychological features. This criticism applies to most of the known culture addressing systems and we believe that this is a required modeling shift in the perspective on culture. It should not be modeled as an object with simple unambiguous feature vector but a process emerging from multiple subjective sets of cultural contents within agents. Measurements of group metrics e.g. Hofstede dimensions should be based on the character of member actions the way sociologists measure them in real groups.

A related issue is the redefinition of social terms like role, norm, group identity etc. from usual organizational, structural [7-9] to psychosocial context. E.g. "role" is usually used in ABSM to introduce objectively different agent functions or types within a group. We postulate it should also be a part of the mentioned rich psychological structure, as a psychological "archetype", perhaps defined differently from individual to individual even within one culture or group. Analogously norms, group identities etc. should be moved from objective to subjective space, or rather their formal, objective and verbalized vs. informal, subjective and subconscious versions should have their place within an agent model, since they address different notions and share little more than a name. This way agent‟s behavior would not only depend on his and other‟s objective roles (norms, group identity etc.) in a formal organizational sense but also emerge from the interplay of archetypical roles attributed to self and others in a given moment. Such role attributions could be partly coherent or incoherent within some groups or contexts as it is the case in real societies.

3. **Inclusion of the explicit habitual-cultural/conventional elements and their links to affective and rational processes**. Humans make decisions based on a mixture of rational thinking and emotional factors, but also using individually and socially obtained habitual patterns that construct both internal representation of the world and the decision making process. It is what we call the 3rd mode of reasoning, addressing conventional-habitual aspects that are neither fully rational nor emotional but influence and are influenced by those two decision making modes.

Explicit habitual-conventional mechanism modeling used in conjunction with cognitive and affective aspects would not only increase psychological soundness but also stimulate realistic convention emergence. Storming the "generative culture" with pure cognition and affect may only produce a collection of puppets communicating only social signals like smiles or gestures, while pursuing their goals. Proposed mechanisms could make them maintain multiple group identities, values, role models, stereotypical, emotional relationships to other groups and themselves. 2-3 decades ago researchers accepted that cognitive models should be expanded to cognitive-affective ones that form the mainstream now. Interest in social and cultural context [6, 10, 11] shows that we are ready to expand our models further with explicit psychosocial convention generating mechanisms.

4. **Expansion of the predicate centered models to predicate-connectionist hybrids**. Most culture modeling systems are purely predicate based with formal ontologies [10]. We suggest that the connectionist paradigm may be better suited for capturing some of the elements from point 3, because of their subsymbolic, fuzzy, interconnected and informal nature.

3. CONVENTIONAL-HABITUAL MODULE

Of all habitual structures, especially the socially shared, conventional patterns are of great importance to culture modeling. They constitute normative structures responsible for the shaping of morality, style, traditions, stereotypes, social structure etc. within the societies we all know. For this reason we introduce a concept of conventional-habitual module (CHM) containing what we call habitual units (HU) - internal mechanisms directly maintaining agent‟s subjective network of culture related notions. HU are a uniform and domain independent representation of sociological concepts like group stereotypes, role patterns, "scene" or situation patterns, values and norms within the agent‟s model. It is important to distinguish between informal, subjective and codified, objective interpretation of those terms. CHM addresses only the former.

Due to the nature of represented cultural contents CHM is:

1. subjective, informal and dynamic
2. modulating and modulated by cognition and affect
3. formed by related habitual patterns with homogenic structure and heterogenic function of both private and social genesis
4. necessarily ill structured and fuzzy, "spaghetti-coded"; hard to represent with predicate logic; semi-connectionist but linked to a formal symbolic level e.g. by world model

Furthermore CHM or its functional equivalent should address certain psychologically well-grounded mechanisms discussed later. CHM is composed of HU representing elements of the socio-conventional world image, habitual decision making and their relation to affect and cognition. We have identified five types of influence CHM may have on the typical social agent architecture and defined corresponding five types of habitual effectors **(HE)**, which HU may include. Both HU and HE have specific correlates in both everyday life and psycho-sociological literature. We will now describe the types of HU proposed and introduce HU structure, including HE types.

3.1 Types of Habitual Units

HU can be functionally categorized. A list of their types is highly disputable; it may and should be expanded. We propose below elements, since they are present in social modeling (albeit usually with more "organizational" connotations), intuitively understood and at the same time well studied in psychology [2, 12, 13] and address a large subset of social mechanisms.

1. **Group culture stereotypes.** A stereotype is a pattern that captures generalizations of group types, collective agent characterization and the nature of their relationships. It not only represents an "average" group member image, but also its "atmosphere". It strongly modulates activations of other HU types. Example stereotypical gro the number of known groups and a new stereotype would only be introduced if it translates into significantly different correlation pattern (probable roles, values in the group etc.). Many actual groups would be linked to one stereotype and at the same time each group to several stereotypes. For example, an agent who is not fond of religion could "put them all in one box" – "religious" with HE of appropriate negative character. At the same time he would be able for example to link Buddhist monks to "benevolent", some sects to "oppressive" and Crusaders to "militaristic", adjusting CHM activation and consequently his behavior, emotional relation to its members etc.

2. **Role archetypes**. Another important culture building block is role. It stands for the informal and subconscious archetypical contents like "father", "king/boss", "teacher", "bandit", "hero", "villain" etc. Those heavily emotionally and normatively rooted subjective notions may or may not have connotations with formal organization positions. Furthermore, unlike formal roles with close to static agent-role attribution, here a role is constantly changing. An agent may be a "friend" based on interaction history, next become a "teacher" due to indulging into what is perceived as his field of expertise and an "opponent" when they start some kind friendly rivalry. All those changes will influence emotional setting, acceptable actions etc. and may have little to do with any formal positions. Again, multiple pattern activations are possible ("friend" + "opponent").

3. **Social situations or scenes.** Within each group there are certain conditions that constitute special situations or "social scenes". Sociologists claim that most of our ordinary experiences like meeting a friend seem unregulated but in fact a ritual of an eye contact, hand shake, words spoken etc. formulate a scene[2]. Those scenes may be defined by events, time, place, agents present or internally by moods, role pattern activation, pursuit of certain goal etc. and in turn alter related roles, norms, values and behaviors. An example situation is a funeral, lecture, party, or professional event.

4. **Values**. Values are abstract qualities like "virtue", "honor", "faith" etc. Their list, definitions and correlations are deeply culturally altered. Perception, group, role and scene activations influence what values are important to follow in the current context and in turn they will alter norms, affective space, behavior and formal goals.

5. **Norms**. Elements of CAA e.g. appraisal systems often use behavioral norms; in this case as a basis of emotion elicitation. An agent"s opinion about applicability of those norms should be dynamic and dependent on his individual "cultural filter". By linking norm activation with CHM such a dynamic cultural norm filter can be achieved.

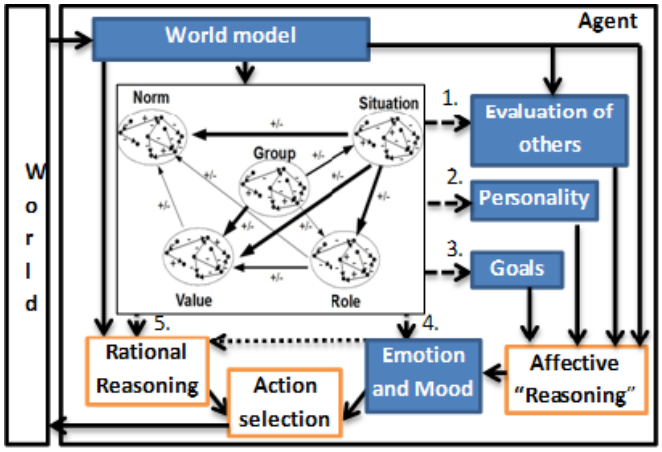

Figure 1. CHS within a typical affective agent model. HU are grouped by types with symbolic connections marked. Numbered lined arrows show how corresponding HE may be linked to cognitive and affective elements outside CHS

3.2 Habitual Unit Elements

HU are connectionist in nature and their activation level is determined by two types of connections:

- **Perceptual and affective anchoring**. Both perception of the external world (people, places, series of behaviors etc.) and own moods and emotions can be connected with specific HU. (Fear and helplessness triggering habitual "role of a victim")
- **Inter unit connections**. HU are linked to each other. Situations and types of group influence the probability of role activations; they dictate value shifts in a context.

To influence the rest of the agent, each HU may contain 5 types of HE (depicted in the agent architecture context on **Figure 1**):

1. **Normative bias**. Systems like appraisal models use norms i.e. for affect generation. Linking HU activation level to norm priorities captures norm"s context and cultural dependency. E.g.: "At war we do things we wouldn"t normally do."
2. **Personality shift**. People may shift their temperament e.g. at work or when playing with children. If a model represents personality e.g. in "The Big Five" representation HU may change it to represent the shift. E.g.: "Entering a courtroom as a judge, she becomes despotic like a different person."
3. **Priority shift**. Social context changes the agent goals. Activation of HU may influence goal weights to reflect that. E.g.: "When the party starts, our only aim is to have fun!"
4. **Affective marker**. Direct, non-appraisal link to affect space that may change mood or emotional center depending on a model. E.g.: "I feel scared in responsible roles."
5. **Reasoning bias.** By linking HU with subplan applicability a socially placed reasoning may be represented. E.g.: "When he starts with „being a boss", he only sees one way."

4. EXAMPLE IMPLEMENTATION

As a "proof of concept", a character - "Ahmed the friendly jihadist" was implemented. He exemplifies realistic and complex influences of the agent"s dynamic cultural interpretation of the situation on his personality, emotion, goals etc. Overall 40 HU were defined (several for each of the 5 types) and 400 connections between them, perception and output. The agent recognized

various religious, humorous, professional etc. roles, situations or groups and dynamically adjusted subgoals, affect and personality based on the cultural specification and the current context. He depicted a friendly, benevolent introvert with friends, more serious and stiff in a professional context and when his religious values or honor were perceived as threatened, he became an aggressive individual. Network of HU connections was created representing rules like "being a part of religious group makes role of a devotee more probable" etc. Next this network was connected to a simple perception (e.g. "military uniform and American nationality activate archetype of oppressor for the other agent"). The resulting network activation was connected to simple subgoals, personality and affect ("role of martyr increases arousal, dominance, lowers pleasure; value of life decreases, attack is more acceptable"). Changes in CHM in the same situation led to different emotional and behavioral reaction; small but culturally essential changes (presence of religious friends etc.) led to the classification of what previously was an innocent joke, to a serious insult via activation of different norms, values, groups and roles. HU were represented by single neurons, so the problem of linear separation was an issue. Multilayer perceptron could be useful in some HU connections, and example based learning could be required for their design.

This example was designed to demonstrate how the presented ideas could be used and what kind of culturally dependent dynamics may be achieved with them. Groups of such agents may show role etc. differentiation not via objective agent assignment but emergence from member cultural specifications allowing more realistic and expressive simulations. More detail presentation of the implementation and result will be published in the future.

5. CONCLUSION

In this paper a paradigm discussion, model draft and an implementation were presented to address the current limitations in agent modeling, and enable culture emergence with psycho-sociological culture forming mechanisms. A modeling approach was proposed with explicitly culturally dependent personality, emotionality, goals etc. The presented conventional-habitual module may be easily applied to the most of existing architectures by linking it to their cognitive and affective elements in a described fashion expanding them with explicit culture forming mechanism.

In the future more elaborate simulations and embodiment of CHM in complex agent architectures are needed. Simulations of groups based on similar architecture and investigation of emerging agent roles and group structure will be of interest. For this purpose development of methods and tools for automatic group creation is crucial. For example by specifying a variability range of cultural boundaries (e.g. by HU connection ranges), the designer should be able to generate semi-random agents with similar cultural features. Character stability testing tools based on test scenarios should be introduced to support the creative process of artificial agent and group development. The problem of example based learning of cultural structure will also be important challenge.

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