Artificial Creative Systems: Completing the Creative Cycle

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Abstract

Human creativity is personally, socially and culturally situated: creative individuals work within environments rich in personal experiences, social relationships and cultural knowledge. Computational models of creative processes typically neglect some or all of these aspects of human creativity. How can we hope to capture this richness in computational models of creativity? This paper introduces recent work at the Design Lab where we are attempting to develop a model of artificial creative systems that can combine important aspects at personal, social and cultural levels.

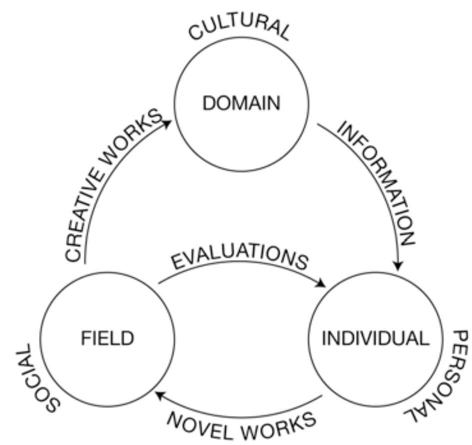

Figure 1: The DIFI model of creative systems

1 Introduction

The Domain Individual Field Interaction (DIFI) framework is a unified approach to studying human creativity that provides an integrated view of individual creativity within a social and cultural context [1]. According to this framework, a creative system has three interactive subsystems: domain, individual and field. A domain is an organised body of knowledge, including specialised languages, rules, and technologies. An individual is the generator of new works in a creative system, based on their knowledge of the domain. A field contains all individuals who can affect the content of a domain, e.g., creators, audiences, critics, and educators. The interactions between individuals, fields and domains illustrated in Figure 1 form the basis of the creative process in the DIFI framework: individuals acquire knowledge from domains and propose new knowledge evaluated by the field; if the field accepts a proposed addition, it becomes part of the domain and available for use by other individuals.

1.1 Artificial Creative Systems

Inspired by the DIFI framework, we have used *curious agents* to develop computational models of creative fields to investigate emergent social phenomena, e.g., the formation of cliques. Curious agents embody a

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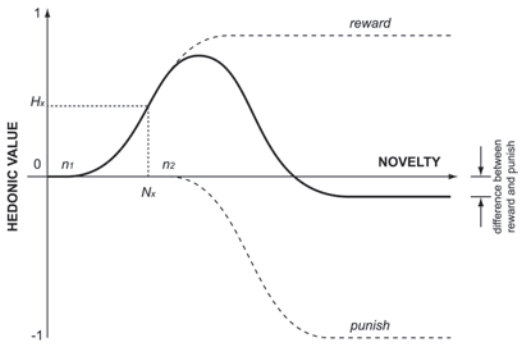

Figure 2: The Wundt Curve: An hedonic function for generating rewards for interest based on novelty.

computational model of curiosity based on studies of humans and other animals, where curiosity is triggered by a perceived lack of knowledge about a situation and motivates behaviour to reduce uncertainty through exploration [2]. Unlike earlier models of creative processes that try to maximise some utility function, curious agents are motivated to discover 'interesting' works based on their previous experiences using an hedonic function, the Wundt curve (see Figure 2).

Using curious agents to model creative fields allowed us to produce a simple model of the creative fields where curious agents share 'interesting' works with peers for evaluation. Works that are determined to be 'interesting' by individuals other than the creator are added to a central repository of 'creative' works.

These early models of creative systems incorporated a simple model of the domain, where highly-valued works could be added to a repository if found sufficiently interesting by agents other than the creator such that they can be subsequently used as starting points for the production of new works. This computational model of the domain, while capturing some of the fundamental features of domains described in the DIFI model, is insufficient to model many important aspects of culture, mostly because of the lack of a domain specific language.

As a first step towards developing a model of culturally situated creativity, we are focussing on developing a model of the evolution of specialised languages associated with one or more creative domains. In doing so, we are exploring the ways in which the evolution of language and creative behaviour of individuals and fields affect each other. How does creative behaviour affect the evolution of language? How does the evolution of language affect creative behaviour?

2 Language Games

A language game is an abstract and simplified method of communication [3]. A simple example of a language game is a dialogue between a builder and his assistants. Wittgenstein describes language games can be used to describe objects, report events, give commands and solve problems. As a tool in multi-agent system development, language games enable the dissemination of concepts and biases throughout a population. Such models are capable of producing lexicons of words with meanings grounded in experience and that these meanings can differ between social groups.

Anyone who has communicated across disciplinary boundaries will likely have experienced something similar, e.g., familiar words having unfamiliar meanings. The resolution of tensions created when individuals from different fields communicate has the potential for creative output as the meanings of words are negotiated. We are developing language games based on the interactions within a creative systems, where *speaker* and *listener* become *creator*, *audience* and *critic*. In a society of curious agents, we are using language games to model the development of specialised languages within fields as the agents explore the domain for 'interesting' works.

2.1 Guessing Games

The language games of Steels are guessing games, where one agent describes an object to another and the second attempts to identify the correct topic from the description [4]. Steels guessing games have been used to discriminate between different agents [5], between other objects in the agents context [6] and between real objects as presented to a pair of robotic "Talking Heads" [7]. Steels has shown that agents repeated playing these guessing games drives the emergence of a shared lexicon.

2.2 Imitation Games

Another form of language game, an imitation game, has been used to explore the self-organisation of vowel systems [8] and the evolution of music [9]. In the case of the adaptive vowel systems the agents imitate each other by producing an expression of the sounds they perceive. In the society of musical agents, compositions are shared through agents performing for each other.

2.3 Generation Games

We have recently introduced a new type of language game, which we call a *generation game* [10]. A generation game involves a request by a "client" to a "creator": the client encodes a set of requirements in its request; and the job of the creator is to generate a work that satisfies the requirements. Unlike imitation games, where the requirements and the expression are the same, the requirements contain a set of features that a work must contain but the specific form will depend on the generative capabilities of the creator. Many possible works may satisfy requirements opening the possibility for judging success or failure beyond the ability of a work to satisfy requirements. In our models, an implicit requirement is used for all works to be 'interesting'.

3 Modelling Creativity

There are several different kinds of creative individual [11] and each kind may take part in different types of language games as they interact. Exploring models of the evolution of language in creative domains opens up the potential to investigate a range of potentially important aspects of creativity that are outside the scope of studies focussed on individuals, for example:

- the emergence of specialised languages that are grounded in the practices of a field;
- the effects of a common education on the production and evaluation of creative works;
- the emergence of sub-domains as a consequence of differences in language use across a field.

3.1 Clients and Creators

The generation game is a simplification of a working creative partnership that serves as a model of how the creative process is sometimes shared between different stake-holders. The client generates a set of required features as words and utters this to the creator, e.g., "small dark round". The creator uncovers the meaning of this expression and works according to its understanding of the meaning, which may be different from the client's depending on how well defined the concepts have become in the system. To produce the work, the creator constructs an evaluation function using distance metrics appropriate to each sensory channel in the requirements. The creator then performs a search of the space of possible works to find an "interesting" pattern that achieves a high score for the constructed evaluation function.

3.2 Teachers and Students

The guessing game is capable of developing common agreement on the use of words over a population. As such it represents a language game that can be used to model forms of education in a creative domain, where the goal of the repeated application is to provide a common communicative framework. Education plays an important role in an individual's mastery of a domain.

To model such an educative role, the initiator agent takes on the role of teacher, selects a context and a topic from the works already present in the repository of the domain. A distinctive feature set is constructed within the context of the other valued objects in the domain and an expression is constructed. The recipient agent takes on the role of student and must attempt to identify the pattern being described by the initiator agent.

3.3 Multiple Domains

Systems based on the evolution of language are open, agents can be added or removed at any time. We plan to use this capacity to develop models of multiple domains where agents can move freely between different fields. This type of movement will allow agents to both adapt and affect the development of language as it transports meanings and words from one domain to another.

To facilitate this we are developing a catalogue of simple sensory processes based on the evolution of "visual routines" to allow language games to be played between domains containing visual artefacts. Naturally, in domains that use very different generative systems, the lexicons will evolve differently to reflect the distinctive features of works produced, however, features shared across domains will result in overlapping lexicons that share some common words.

4 Discussion

It is certain that computational modelling will continue to focus on the developing analogues for creative cognition and individual creative behaviour. After all, the promise of developing computer programs able to solve problems in ways that are obviously "creative" is so tantalising that we cannot help ourselves. What this paper seeks to accomplish, however, is to show that the potential exists for developing computational models that capture how creativity works within social and cultural environment.

The computational model presented here advances the computational modelling of the DIFI framework by introducing a way for language used to describe of requirements to evolve from the interactions within a creative system. Future work in this area will need to also need to incorporate similar mechanisms for the evolution of descriptions, critiques, instructions, policies and rules. The ultimate goal of this work is to create an approach for developing computational models of creative systems that allow the cycle of creative interactions by supporting important personal, social and cultural aspects of creativity.

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