Artificial Creativity: Emergent Notions of Creativity in Artificial Societies of Curious Agents

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What is creativity? Generally, artefacts are labelled as creative if they are both novel and appropriate; individuals are regarded as creative if they produce creative works [1]. More specific definitions of creativity vary greatly in the details of what makes someone or something creative. Some definitions require that creative products must be the result of some creative mental processes, effectively ruling out the possibility of computationally modelling creativity until these processes are understood. Many computational models of creativity have been developed to gain this understanding by simulating mental processes thought to play an important role in creative thinking, e.g. Simon [2], Hofstadter et al. [3].

Other researchers consider the details of an individual's creative process to be less important and consider the socio-cultural environment to have a significant effect on the production of creative works. Csikszentmihalyi [4] proposed that the processes essential to creativity are not only to be found in the minds of creators but also in the interactions between individuals and their socio-cultural environment. Csikszentmihalyi's systems view of creativity is illustrated in Figure 1.

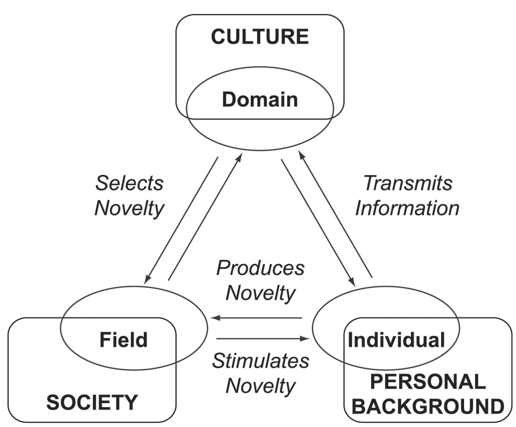


Figure 1. Csikszentmihalyi's systems view of creativity.

The systems view of creativity proposed by Csikszentmihalyi echoes the views of researchers studying situated cognition in the fields of cognitive science, artificial intelligence and artificial life: emphasising the emergent nature of creativity as the result of the interactions between the components of a creative systems.

To gain a better understanding of the emergent nature of creativity we have developed the artificial creativity approach to producing creative systems. The goal of artificial creativity is to simulate the interactions of agents within a creative system. The requirements of an artificial creativity system are:

- The model contains a society of agents situated in a cultural environment.
- There is no agent that can direct the behaviour of all of the other agents.
- There are no rules embodied in the systems that dictate global behaviour.
- Agents interact with other agents to exchange artefacts and evaluations.
- Agents interact with the environment to access cultural symbols.
- Agents independently evaluate the creativity of artefacts and other agents.

The most challenging aspect of developing artificial creativity systems is that each of the agents must be able to independently evaluate the creativity of artefacts. Few computational models can recognise the novelty of their own works, most can only evaluate their appropriateness using heuristics: often the potential creativity of these systems can only be fully realised with the guidance of a person [5][6].

We have developed a computational model of a creative system, similar to those proposed by Csikszentmihalyi using curious design agents interacting within an artificial society exploring a domain of genetic artworks similar to those produced by Karl Sims [7]. Figure 2 illustrates the type of genetic artwork evolved by a human using the interactive evolutionary system used by the curious design agents.

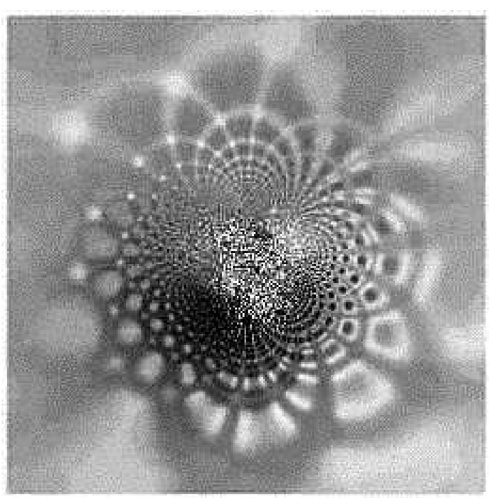


Figure 2. A genetic artwork evolved using interactive evolution by a human.

The curious design agents interact by sharing artefacts and evaluations; by monitoring the communications of agents the most creative individuals can be tracked. We use curious design agents to model individuals because they implement a model of curiosity that allows them to independently evaluate the novelty of artefacts with respect to their previous experiences.

Curious design agents determine the novelty of artefacts using a special type of artificial neural network called a novelty detector. Novelty detectors determine how unexpected, or atypical, an input is with respect to all of its previous inputs. Curious design agents determine the novelty of an artefact by comparing it to a model of previous artefacts constructed by its novelty detector. An hedonic function based on Berlyne's model of arousal is used to transform the output of a novelty detector into a judgement of subjective interestingness used to determine the creativity of new artefacts [8]. The hedonic function rises to a maximum value for similar-yet-different artefacts and falls away rapidly as novelty increases. Figure 3 illustrates the hedonic function used to model the arousal of a curious design agent in novel works.

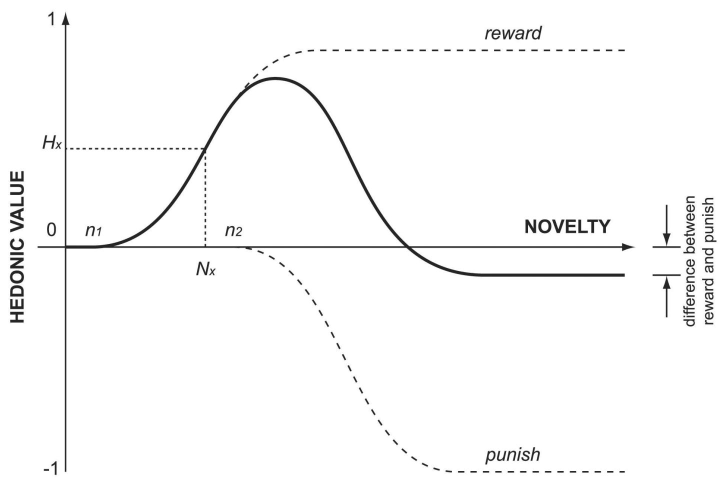


Figure 3. The hedonic function, called the Wundt Curve, used to model arousal in a curious agent due to novelty.

In "The Clockwork Muse" Martindale presented a thought experiment called the "Law of Novelty" to illustrate the effects that the search for novelty has on the development of creative styles over time [9]. Martindale proposed that in a society that punished repetition by ignoring them communication between agents would become exercises in circumlocution, as increasingly complex language would have to be used to express simple ideas in novel ways. Martindale suggested that artists have to obey such a Law of Novelty because if they do not innovate in appropriate ways their audience will ignore them.

Curious design agents with different hedonic functions were used to simulate the application of Martindale's Law of Novelty within an artificial creativity system. In a group of twelve agents, ten were given the same preference for novelty (N=11), one was given a preference for less novelty (N=3) and one was given a preference for more novelty (N=19). The results of running the simulation for 50 time steps were that the agents with preferences for greater or lesser novelty than the norm were awarded no credit for their works (see Figure 4), while all the other agents each received some credit from their peers (avg.=5.57).

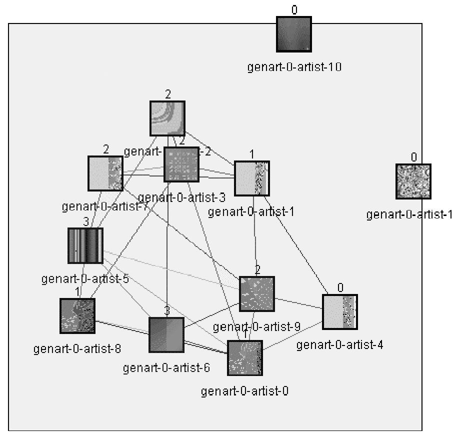
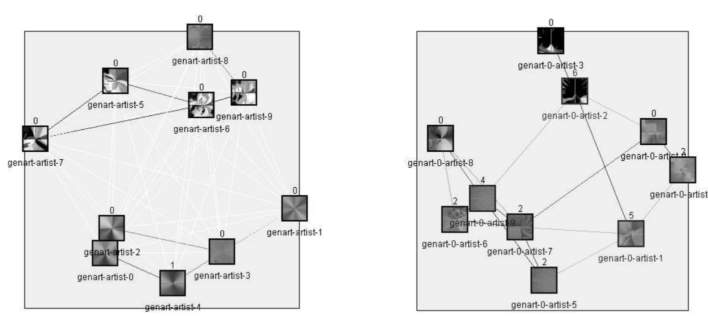


Figure 4. An illustration of the ‘law of novelty’ as proposed by Martindale. The images represent the current state of curious design agents and the arcs drawn between images represent current communications between agents.

Repeating the experiment over a range of preferences for novelty suggests that agents can only appreciate the creativity of other agents with similar hedonic functions. A consequence of this bias is that a society of agents with a range of hedonic functions will tend to form “cliques”. Agents communicate artefacts and evaluations frequently with other members of their clique but rarely to outsiders (see Figure 5a). Sometimes artefacts will successfully pass from one clique to another when the complexity of a work produced by one clique tends towards the complexity of works within another clique. In this way, styles of work can be transmitted between groups (see Figure 5b).



(a) (b)

Figure 5. Two examples of clique formation in separate runs of the artificial creativity simulator: (a) complete separation of two cliques with preferences for novelty N=6 and N=15, (b) partial separation of two cliques with preferred novelty of N=9 and N=12.

In a limited form, the computational system presented here models the search for novelty described by Martindale and its effects on the emergence of styles in the creative arts. It also illustrates the emergence of groups of like-minded individuals often found in human society and the transferral of new styles from high art to popular culture as they become tempered for more moderate tastes. Perhaps more importantly, however, is the closed world nature of artificial creativity systems. The agents within these systems do not produce works for human observers outside the creative system; instead they produce works for the appreciation of their peers. Through the interactions of the agents within an artificial creativity system definitions of whom and what are creative emerge that are unique to the creative system's history.

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