Artificial Creative Societies: Adaption, Intention, and Evaluation

Max Peeperkorn
mp770@kent.ac.uk
University of Kent
Canterbury, Kent, UK

ABSTRACT

The thesis project presented aims to use social information in conjunction with modern AI/ML techniques to develop artificial creative societies. The main objective is to explore social creativity as it could be. The scope consists of three core aspects: adaption, intention, and evaluation. Current work exploring mechanising conceptual spaces is discussed, and future work directions are provided. The research trajectory consists of three phases. Each phase explores the core aspect concerning the individual, the field, and the domain. This work contributes new approaches toward adaptive CC systems, evaluation methods, and subsequently, the potential to inform other disciplines, such as art & design.

CCS CONCEPTS

• **Computing methodologies** → **Philosophical/theoretical foundations of artificial intelligence**; **Modeling and simulation**.

KEYWORDS

computational creativity, social creativity, adaptive creativity, generative creativity, conceptual spaces, variational autoencoders, agent-based simulation

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1 INTRODUCTION

Creativity is a social phenomenon. Throughout society, humans share ideas and artefacts and draw inspiration from this exchange of information. Social interactions are essential for human creativity. While we might attribute a creative act to a single individual, this creative act is, in turn, shaped by others. Exemplary for that interaction is Csikszentmihalyi's Systems View of Creativity [5]. This doctoral project revolves around the hypothesis that interactions and exchanges of social information shape our creative abilities and that this information is valuable to consider for Computational Creativity (CC) systems. This project aims to integrate modern AI/ML techniques with social information to study the dynamics of social creativity and social creativity as it could be. As such, I have identified three important aspects: adaption, intention, and evaluation. These three aspects form the scope for the thesis project to investigate the structure of the CC systems and to evaluate the creative acts and processes which emerge from such a structure and social interaction. How can the system adapt itself to new experiences? How can a creative system show intention, a perspective, in a given domain? How do we evaluate such creative systems, and can they evaluate themselves? To attempt to answer these questions, I intend to develop an artificial creativity society. In the simulation, I introduce novel techniques and approaches involved with the creative processes related to adaption, intention, and evaluation of creative systems. In the following section, I discuss related work, followed by a summary of current research. Then the thesis scope and its expected trajectory. The paper concludes with contributions to the field of Computational Social Creativity, Computational Social Sciences, the Creative Industries, and ultimately, art and design.

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2 BACKGROUND

The field of Computational Creativity focuses on the development and the perception of (individual) creative systems. However, the social aspects of and influences on these systems are still underexplored. In the psychology literature, creativity as a social phenomenon has been widely established [5, 10, 20, 28]. Moreover, social interactions and communications is one of the 14 key components for the evaluation of a creative system [16]. Saunders & Bown established the subfield of Computational Social Creativity (CSC) and outlined challenges, and research goals, and describe efforts to investigate the social factors of creativity in combination with and complementary to CC [27].

Saunders outlines how we might approach building such autonomous creative systems [26], and identifies two systems theories that are suitable for this purpose: Csikszentmihalyi's Systems View of Creativity [5] and Iba's Autopoietic Systems View of Creativity [13]. The widely accepted Systems View of Creativity [5] emerges in many social creativity simulations. It is especially appealing for modelling experiments as it concerns where creativity is found instead of what it is. Csikszentmihalyi argues that creativity can be found in the interaction between the three forces of the system: the domain (culture), the individual (personal), and the field (social). The Systems View of Creativity was subsequently adapted to the Domain-Individual-Field Interaction (DIFI) model [7]. Autopoiesis was first proposed by Maturana & Varela [21] to describe the self-maintenance of living systems. Luhmann [19] adopted this into a systems theory for autopoietic societies. He proposes two autopoietic systems, the first is the psychic system, whose element is consciousness, and secondly, a social system whose element is communication. Both these systems are closed, and they can only be observed from the outside through utterances. Iba [13] extended Luhmann's theory to make it suitable for creativity purposes by adding another autopoietic system whose element is discovery. This

effort is mainly directed to approach autonomy (self-motivated and self-directed creation) within the creative agent [26]. Due to its complexity, implementing an autopoietic society is challenging, but the self-maintenance and adaptive nature of this theory make it an interesting mechanism to explore in the current context. Creative individuals within a social system need to constantly adapt and recalibrate their perspectives as new artefacts come along. As such, socially creative systems will exhibit some autopoietic features, and therefore, these two systems theories could complement each other.

Two other relevant and useful notions are generative and adaptive creativity [3]. Generative creativity is creating according to a set of generative rules without regard for value. Adaptive creativity is, on the other hand, creating for the benefit of the creator. In other words, the individual adapts; it changes some structure within the individual, which influences future creative output. Bown argues that adaptive creativity occurs on both the individual and social levels and generative creativity only on the social level. This division does not mean mutual exclusivity – adaptive and generative creativity can coexist. A critique of generative and adaptive creativity in the context of creative machines is that it is based on a strictly anthropocentric view [12]. The question is if these notions, while useful for human creativity, also hold for computational agents. Instead, Guckelsberger et al. [12] argue for a focus on the intentional agency of CC systems, so they might answer *"Why"* they are creative. They argue this should be the point of departure to understanding what computational creative processes and products are. This research direction is, in turn, valuable for human creativity; a challenge that remains: how to bridge the explanatory gap?

Finding success in computational creativity comes down to evaluation. How creative is the CC system or the underlying process? While the creative process could be very different for the machine, we can only reference the human notion of creativity. Creativity evaluation is the key to determining the success of a creative system and is an essential research area within CC [4]. Several methods exist to assess creativity in computational systems, for example, the FACE/IDEA frameworks [22]. The most extensive framework for that purpose is SPECS developed by Jordanous [14]. The 4P's framework was originally developed by Rhodes [24] and has later been adapted for CC by broadening its definition, to allow the inclusion of CC systems, from person to producer [15]. The framework is used for viewing a system through different lenses: the producer, product, process and the press/environment. It is particularly appealing for evaluating social CC systems because of its wide scope.

3 MECHANISING CONCEPTUAL SPACES

The work outlined in this paper finds its origin in my master thesis project [23]. It explores the use of Variational Autoencoders (VAE) [17] as a computational model for conceptual spaces, and how these models can be maintained and adapted in an agent-based social simulation. VAEs appear to be a good fit for this purpose because they learn fuzzy relations in the data and produce a smooth latent space.

3.1 Conceptual Spaces

Conceptual spaces are defined according to two views: a general cognitive view and a creativity view. Gärdenfors proposed conceptual spaces as a geometric mental structure to organise thought [9]. This account of the conceptual space intends to bridge the symbolic and the sub-symbolic. This allows for finding similarities between symbols that cannot be derived from those symbols alone. Boden's view is more abstract and less formally defined. It is primarily a metaphor, "Map of the Mind", to support the explorative and transformative modes of creativity [2]. These two views are useful for reasoning about what the VAE as a conceptual space should be. The assumption is that a VAE is a reasonable abstraction for the formation of concepts and properties. This approach might enable the evaluation of creative output on learned relations without the need for predetermined rules for the given domain.

3.2 Simulation

As in many social creativity models, the DIFI model [5, 7] emerges in this simulation. Using this framework, we propose different mechanics for each force. The domain is distributed amongst the individuals and embedded in the VAEs. The individuals are tasked with perceiving, interpreting and producing artefacts. The field is used as a proxy for socio-cultural gatekeepers (e.g., museums, art galleries, and cultural exhibitions and events), which are institutions influential in propagating ideas, art, craft, and design throughout society. To this end, the field matches agents together to share their created artefacts and dictates the selection of artefacts for the next round. Selection is done according to different ideologies: neutral, progressive, and conservative. In the simulation, a recommender system (a pre-trained VAE with knowledge of the whole domain) can be queried by the field to find agents in similar positions, whose newly produced artefacts are similar, which can then be shared amongst them. Additionally, the recommender system serves as a baseline to evaluate the dynamics of the simulation. For this experiment, we used a simplified musical domain, a string of midi notes in the chromatic scale. The randomly generated dataset is used to train the recommender system and is subsequently split, according to the latent space, into a subset providing basic education for each agent at the start of the simulation. The work demonstrates the utility of VAEs in agent-based social simulations. The results suggest that new relations are learned and maintained. However, this is a work in progress, and additional research is needed to further explore and understand the different facets of the simulation.

3.3 Current and Future Work

As part of the doctoral project, work continues to further improve, verify and validate the use of VAEs for this purpose. The original synthetic dataset turned out to be very limiting and proved to be problematic for validating performance on unseen data, instead, a shift was made to a new synthetic dataset based on real-world music data. Additionally, we refined the approach by performing hyperparameter optimisation and developed a new strategy for evaluating the simulation. Next, the focus will be on the field's ideologies and the respective methods, followed by another look at the agents' novelty preference and artefact production. Additionally, the plan is to visualise the domain throughout the simulation and

make the simulation experienceable. Further research directions are outlined in the trajectory section.

4 THESIS

The aim of the doctoral project is to explore theories and methods to develop novel techniques that leverage exchanges of social information and explore social creativity as it could be. This is a broad objective, and to narrow down the scope, I have identified three core aspects: Adaption, Intention, and Evaluation. In the following sections, I will further discuss these aspects and clarify the aim and scope, followed by an expected trajectory of the research.

4.1 Adaption, Intention, and Evaluation

For this project, an artificial social environment is required in which the individuals, field, and domain can be integrated. This will take the form of an agent-based social simulation. There are two key questions to explore how social information propagates through an artificial creative society: How does an agent process social information in a meaningful way? How is social information then useful for evaluating creative output?

Adaption concerns the structure of the CC system or agent. There are two directions relevant to investigate, a parameter-based structure and a topology-based structure. Parameter-based structures can be found in generative deep learning models [6, 11, 17] and their latent spaces. On the other hand, topology-based structures change the architecture of the model itself. Weight Agnostic Neural Networks [8] are an example of topology-based search. The main challenge is how to update these structures so that the CC system produces typical and domain-valid artefacts. Essentially, the aim is to develop concept drift in a meaningful way.

Intention is about the way the agents perceive the world and relates to explainability, but not necessarily in a human readable way. Computational systems that have some means to evaluate artefacts generally do this using the artefact itself, as exemplified by Lamb & Brown [18] and Elgammal et al. [6]. However, artefacts contain only limited information. The challenge is to develop methods and techniques compatible with the structure of the agent to generate meaningful social information, inform about the agent's autonomy and intention, and possibly provide explainability.

Evaluation is essential for any creativity model or system. For this aspect, the scope is to explore how to leverage the social information within the model for (self-) evaluation purposes. The main approach is to build upon Automated Machine Learning techniques using ensembles. The hypothesis is that these ensembles are a good fit with evaluation techniques, such as the Consensual Assessement Technique [1], which has been applied in CC before [18].

These three core aspects are interdependent, each providing a piece of the puzzle. In general, the usual challenges that have haunted creativity remain. What is good? What is surprising? What is valuable? However, with these aspects, the goal is to find ways to work around these issues with techniques that might not require well-defined domains. The scope presented does not aim to provide a social creativity framework towards artificial general creativity. Instead, uses social creativity to explore new approaches to utilise AI/ML techniques in creativity contexts.

4.2 Trajectory

The project consists of three phases exploring the evaluation of creativity in agent-based simulations at the individual, social and cultural levels. Each phase contains the experiments that are scoped by the three aspects identified earlier.

Phase 1 focuses is on exploring individual models of creativity that are compatible with social and cultural environments. The experiments in this phase aim at embedding the individual agent in a creative society. How does the individual adapt according to evaluation feedback from its social environment? Ultimately, an agent should be able to adapt its view on creative output according to its existing knowledge and new experiences. This relates to the current work on using VAEs as conceptual spaces.

Phase 2 explores different communication policies and their effects on the evaluation of creative artefacts. The experiments in this phase investigate how domain knowledge is shared and selected between agents. How do other agents evaluate creative output, and does that influence the current agent's evaluation?

Phase 3 revolves around the cultural domain. The goal is to examine the structure of domain knowledge and its impact on creativity evaluation and vice versa. These experiments aim at exploring the maintenance and distribution of that domain knowledge.

The simulations will operate in the creative domains of music and/or language. Music is suitable because it is well-defined and language has the potential to share works through associative descriptions [25] and is human interpretable. Concluding the three phases, a framework will be developed, and its assumptions will be analysed and verified for their applicability to existing knowledge of computational creativity.

5 CONTRIBUTIONS

This research takes a computational approach to explore how humans work together by sharing ideas and artefacts and how that influences the generation of new creative marvels. Expanding our understanding of the social and cultural influences on the creative process will be valuable for improving the way we work in an ever-increasing digital environment. The outcome will raise new ideas on how we can maintain or improve our creative productivity within our organizations while utilising new technologies and continue adapting to working with AI and machine learning systems. By considering social factors in artificial (creative) systems, this research contributes new insights towards understanding creative acts and processes in computational systems and aims for more productive human-computer interactions and enhance our tools to support our creativity.

An important element of this research is the approach to determining the quality and value of creative output by considering socio-cultural factors. Subsequently, providing new insights and approaches for (automated) creativity evaluation. These are valuable for machine evaluation, and although that is still far ahead of us, this project emphasises new approaches beyond traditional algorithms. The framework developed with this project covers two other significant computational challenges. Firstly, it explores how an individual model of creativity can be embedded within a (computational) socio-cultural environment. Secondly, it aims to incorporate

adaptive mechanisms in a systems-based model. These contributions are powerful research directions for CSC, computational social science, artificial life, and the creative industries.

Creativity is a curious and unpredictable aspect of human intelligence. Developing a framework that considers society, culture, and communication is valuable for many disciplines, such as art & design, education, business studies and economics. CSC models have to potential to better inform policy decisions in those domains. For example, cultural projects are not easy to express by absolute values, and for a good reason, however, understanding the dynamics of how creative ouptut influences others might help understanding how to value such projects. Another significant potential of CSC models is to spark the development of new types of creativity support systems and tools for the benefit of organisations and industry. Finally, this project takes an approach that explores creativity as a collaborative effort, and thereby, the importance of environments that enable everyone to make valuable and creative contributions to society.

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