The Maintenance of Conceptual Spaces Through Social Interactions

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For this research, a computational social creativity [6] simulation has been developed using the Variational Autoencoder (VAE) [4] as a computational model of conceptual spaces. Due to their probabilistic nature and their compression and generative capabilities, VAEs are a good fit for mechanising conceptual spaces. Based on these characteristics this research assumes that the VAE is a reasonable abstraction of conceptual spaces. Subsequently, the simulation investigates how the conceptual spaces are influenced by social interactions.

Creativity is a social phenomenon. As individuals share their perspectives, ideas emerge that none could have had on their own [7]. These perspectives are embedded in an individual's conceptual space, which plays a central role in the search for novel ideas and artefacts. In a general cognitive view, Gärdenfors [3] proposes conceptual spaces are geometric mental structures that organise thought. In the context of creativity, conceptual spaces are a key aspect in Boden's framework for creativity to support the explorative and transformative modes of creativity [1]. However, due to her abstract definition, it is difficult to use for computational purposes. By combining Boden's approach for examining and Gärdenfors' geometric view for traversing conceptual spaces, this research proposes to model conceptual spaces using VAEs.

The widely accepted systems view of creativity [2] is used as the basis of the simulation. In this view, creativity is observed in the interactions between its three components: *the domain,* the *individual,* and *the field*. The domain is an abstract cultural repository, the individual produces variations based on knowledge held in the domain, and the field is a social space for the individuals where variations are selected to be preserved in the domain.

By using VAEs to model each individual's conceptual space, the domain is distributed amongst all of the individuals. To allow the analysis of the simulation a pretrained global VAE is introduced as an overarching view of the distributed domain and determines the initial training of the agents. During the simulation, a recommender system uses a shortcut to the global VAE to serve as a matchmaker to find 'like-minded' agents, acting as a proxy for socio-cultural gatekeepers (e.g. art galleries) by enforcing the fields ideology.

Each round in the simulation consists of three steps. During the first step, each agent receives artefacts selected by the field, then trains their conceptual space and produces new variations guided by their preference for novelty. In the second step, the recommender system determines the position of each agent.

Finally, the artefacts for the next round are selected from the pool of artefacts produced by the agent and its neighbours, as determined by the fields' ideology.

The evaluation of the VAEs shows that finding the correct scale of artefacts selected and produced and the amount of training each round is crucial for the maintenance of conceptual spaces. Initially, a small scale and a high number of training epochs resulted in heavy overfitting from round to round. With an increased scale and a lower number of training epochs, the VAEs stabilized, suggesting the adaption to the artefacts selected by the field.

To investigate the influence of ideologies on the development of conceptual spaces distributed across fields, three were simulated: neutral, progressive and conservative. The neutral ideology is the same as no ideology and uniformly selects artefacts. The progressive ideology favours artefacts in less explored areas. The conservative ideology favours frequently and recently selected artefacts. As the progressive ideology pushes for exploring novelty it leads to a better maintenance of the conceptual spaces, exposing the individuals to a diverse range of artefacts. Conversely, the conservative ideology deteriorates, likely because the same artefacts are too frequently selected.

On the individual level, a novelty preference was introduced by changing the standard deviation used when sampling the latent spaces to generating new artefacts. Novelty can be viewed as the disruption of expectedness [5]. Sampling with a lower standard deviation produces less unexpected results, while a higher standard deviation pushes towards the edges where less information is embedded. The results show that a higher novelty preference leads to more distributed interaction between the agents (Fig. 1). While the maintenance is stable, the VAEs are less performant compared to simulations with lower novelty preferences.

The utility of Variational Autoencoders is demonstrated for use during the simulation and as a tool for analysing creative behaviours and output. Additionally, the influence of different ideologies of the field and novelty preferences of the individuals has been explored and shows that the maintenance of the VAE is aligned with the social interactions of the individuals. This contribution suggests the possibility of evaluating creative output on learned relations without the use of predetermined rules.

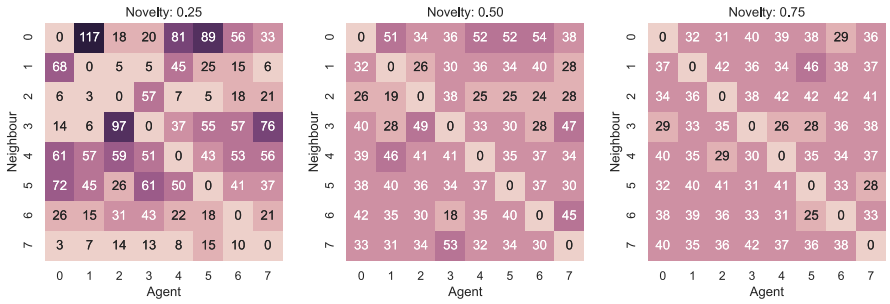

Fig. 1. The communication matrices indicate the number of interactions between the agents. With a low novelty preference, the individuals tend to stick with individuals with similar conceptual spaces, while higher preferences leads to more distributed communication.

References

1. Boden, M.: The Creative Mind: Myths and Mechanisms. Routledge, London (2004)
2. Csikszentmihalyi, M.: Society, Culture, and Person: A Systems View of Creativity, pp. 47–61. Springer Netherlands, Dordrecht (2014)
3. Gärdenfors, P.: Conceptual spaces: The geometry of thought. MIT press (2004)
4. Kingma, D.P., Welling, M.: Auto-encoding variational bayes (2013)
5. Martindale, C.: The clockwork muse: The predictability of artistic change. Basic Books (1990)
6. Saunders, R., Bown, O.: Computational social creativity. Artificial Life **21**(3), 366–378 (2015)
7. Vygotsky, L.S.: Imagination and creativity in childhood. Journal of Russian & East European Psychology **42**(1), 7–97 (2004)