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Situated interpretation in computational creativity

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ABSTRACT

This paper describes, formalises and implements an approach to computational creativity based on situated interpretation. The paper introduces the notions of framing and reframing of conceptual spaces based on empirical studies as the driver for this research. It uses concepts from situated cognition, and situated interpretation in particular, to be the basis of a formal model of the movement between conceptual spaces. This model is implemented using rules within interacting neural networks. This implementation demonstrates behaviour similar to that observed in studies of human designers.

1. Introduction

Attempts to understand, support and automate aspects of human-like creativity are grounded in the notions of search and transformation of a space of possible solutions [7,44]. Within this paradigm for computational creativity, a system may discover useful and novel or surprising artefacts (in the P-creativity sense), through search within a defined space or through exploration that transforms this space in some way [7,24,71]. Creative systems have been produced that can successfully search or transform an identifiable space to produce P-creative (and potentially H-creative) artefacts in diverse domains such as architecture [52,62], art [11,50], mathematics [12,45] and music [55,67]. A challenge for creative systems that has not yet been adequately addressed is the *framing* of creative tasks, the production and development of the space within which creative activity occurs [14,18,63,65].

For systems aiming to frame creative activity in a way that is inspired by human phenomena the literature suggests that: (i) the system will have knowledge from experience; (ii) the system will draw upon these experiences to set up the space within which creative activity will occur; and (iii) the system will change this space during creative activity. For example, in studies where designers 'think aloud' whilst designing it has been observed that designers are able to re-interpret their work in a novel way that changes their understanding of what it is that they are doing [64,68,69]. The designer has produced a design artefact within one framing of the problem – and then, from within this frame, been able to find entirely unexpected features within the same artefact.

In this paper a situated framework is articulated and implemented to explain the interaction between experience, expectation and a changing frame for a creative task. The process of interpretation within a creative system is where this interaction occurs, due to the clear distinction between the thing being perceived (e.g. an image of a pipe) and the interpretation of that thing (e.g. it need not be interpreted as a pipe). Each time a system interprets, we may ask the question why it produced this interpretation and not another. The claim being made is that for systems aiming at human-like creativity, movement between frames can be triggered by interpretation, and that this can be modelled and explained as the interaction between experience (what the system knows), expectation (what is in and implied by the current frame) and the stimulus (what is being interpreted).

Adapting nomenclature from Wiggins [70] two different spaces can be identified for a system. The first is the *universe*, the space of artefacts potentially accessible to the system without limits upon time or resources. In many creative systems (e.g. any that permits an agglomerative production rule) the universe is an infinite space. Within a particular state of the system creative activity takes place in a smaller space within this universe, based upon the experiences (or knowledge) of the system and the notions to which it is

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currently attending. This reduced space will be referred to as the *conceptual space* of the system.

These two spaces are illustrated in Fig. 1, inspired by studies of designers engaged in creative activity [68,69]. The rectangle in Fig. 1 represents the universe of the designer. Within this space the designer searches for a solution within the limited conceptual space (grey ellipse), a space that is constrained by the designer's conception of the design task as well as their past experiences. Something causes a change to the conceptual space, leading to a new space that can potentially be highly dislocated from the preceding space. This kind of a dislocated movement in conceptual space is sometimes described as a 'moment of insight' [15].

This paper describes and models the way that the process of interpretation can move a system from one conceptual space to another in a way that is useful to the creative task. It occurs through the interaction between the conceptual space, the implicit expectations of that space and the stimulus being interpreted. The paper is structured by first introducing notions of situatedness and interpretation, followed by the formulation of simple examples of systems to distinguish situated interpretation, followed by an implementation of situated interpretation. The paper concludes with a discussion of the significance of this modelling.

2. Theoretical background

2.1. Situatedness

In a *situated* system knowledge is something that is developed through experience of interaction with the world and is constrained by the way that the system conceives of its own activities [10]. As the system continues to experience the world, "subsequent experiences categorise and hence give meaning to what was experienced before" [10,16]. An example of this can be seen in the way that perceptual symbol systems (PSS) represent and utilise concepts [2]. Concepts in a PSS are conceived as convergence zones that co-ordinate the re-enaction of elements of, rather than whole entities of, perceptual experiences. This re-enacting occurs within and is a function of the current conceptual space, in contradistinction to the notion of concepts as static identifiers that are stored and retrieved [3,4]. An implication of situated enaction of perceptual experiences rather than retrieval of static concepts (a higher level of abstraction) is that the combinatorial possibilities from those perceptual experiences are exponentially greater.

In this work situations are considered as a construct emerging from experience with the co-ordination of concepts. A situated system is one in which the co-ordination of concepts changes. Similar definitions that assist in clarifying what is meant by this are those systems in which the internal context changes [41], the epistemic frame changes [66], the ecology of mind changes [20] or the use of grounded knowledge from experience within the world changes [5].

2.2. Situated interpretation

Interpretation is defined as a process by which the experiences of the system are used to create an internal representation from a source, where the term source refers to the artefact (internal or external) being interpreted. *Situated interpretation* is said to occur in systems that: (i) interpret; (ii) are situated; and (iii) utilise expectations in interpreting. It is a process through which a source, the current conceptual space and the past experiences of the system interact to produce an internal representation. Change to the conceptual space can occur during this process.

2.2.1. Expectations in situated interpretation

One type of interpretation can be seen in systems that relate a source to one of a collection of static identifiers through a relationship of 'as a', e.g. identifying an unknown object as a BLOCK [57,60]. In contrast to this, a situated interpretation system commences with an expectation of what will be interpreted, and proceeds to construct an interpretation based upon a 'pull' from these expectations and a 'push' from the source to produce an internal representation [26,39,40]. In an unchanging or constrained environment a system may be able to develop expectations that are useful for all circumstances. However, in a dynamic or unbounded environment a system will likely find circumstances in which adaptation of expectations is required. Interpretation is concerned with this need for a balance between a push from the "buzzing blooming confusion" of a source [36] and a pull from the stability of expectations.

Through pull, interpretation attempts to construct an internal representation of the world that fits with what is expected. The expectation is present prior to the stimulus, with pull attempting to see whether it can adequately construct what is expected using the data present in the stimulus. For example, when participants in an experiment are played the sound of a single note followed by the sound of white noise they are able to 'hear' the note within the white noise [59]. The expectation of the note prior to the white noise forms the basis for perceiving a note within the random signal.

Push is the part of interpretation concerned with data that are not expected that may still require perception and allows for expectations to change based upon what is found in the source. Push deals with those circumstances where for a number of reasons expectations might not be useful (e.g. not a good fit with the world). An example of push from the source into interpretation is the way that the sound of a police siren is heard even if it is not expected.

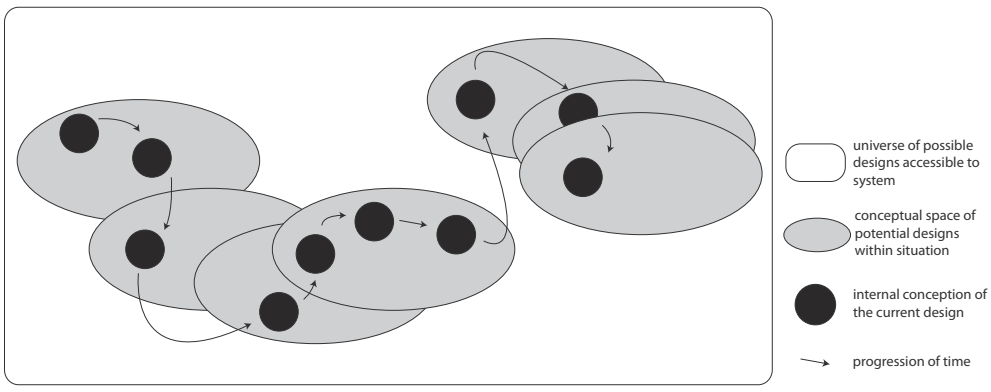

Fig. 1. Movement between conceptual spaces during creative activity (after [39]).