Towards a Categorical Theory of Creativity for Music, Discourse, and Cognition

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Abstract. This article presents a first attempt at establishing a category-theoretical model of creative processes. The model, which is applied to musical creativity, discourse theory, and cognition, suggests the relevance of the notion of "colimit" as a unifying construction in the three domains as well as the central role played by the Yoneda Lemma in the categorical formalization of creative processes.

1 Historical Introduction to a Formal Theory of Creativity

Although the notion of *creativity* seems to be incompatible with formal and mathematical approaches, there have historically been many attempts to grasp the creative process using computational models. The history of algorithmic music composition, from information theory to algebraic models, exemplifies approaches that describe the computational component of creative process. For example, the use of *entropy* and *redundancy* as parameters to describe stylistic properties of artistic expression was one of the fundamental hypotheses of information theory; a theory which, according to Shannon and Weaver, is "so general that one does not need to say what kinds of symbols are being considered whether written letters or words, or musical notes, or spoken words, or symphonic music, or pictures. The theory is deep enough so that the relationships it reveals indiscriminately apply to all these and to other forms of communication" [29].

The underlying hypothesis, which also guided AI paradigms, was to simulate creative behavior by means of computer programs. In Douglas Hofstadter's words, "the notions of analogy and fluidity are fundamental to explain how the human mind solves problems and to create computer programs that show intelligent behavior" [18]. Within different computer-aided models of creative process, music and musical creativity occupy a distinguished place. According to David

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Cope, creativity is "the initialization of connections between two or more multifaceted things, ideas, or phenomena hitherto not otherwise considered actively connected. [...] It does not depend exclusively on human inspiration, but can originate from other sources, such as machine programs. [It] should not be confused with novelty. [It] does not originate from a vacuum, but rather synthesizes the work of others, no matter how original the results may seem" [4].

Despite the increasing number of studies on computer-aided models of creativity, many questions about its formal and conceptual character as well as its relationships with cognitive processes remain open. Clearly formal models of creativity do not reduce to algorithmic and computational ones. In Margaret Boden's influential model (as discussed, for example, in [3]), creativity occurs as a result of three different types of mental process: combinatorial, exploratory, and transformational. Although combinatorial creativity refers to unfamiliar combinations of familiar ideas, exploratory and transformational creativity arise within structured concept spaces. In conclusion, "if researchers can define those [conceptual] spaces and specify ways of navigating and even transforming them it will be possible not only to map the contents of the mind but also to understand how it is possible to generate novel, surprising, and valuable ideas" [3].

Interestingly, music offers a variety of concept spaces, particularly once geometrical models and algebraic methods are used to characterize the structural property of these concept spaces, as initially suggested by Gärdenfors [10] and recently discussed by Acotto and Andreatta [1]. Among different approaches that try to combine computational models of creative processes and concept spaces, one has to mention the notion of "conceptual blending", introduced in an informal way by Fauconnier and Turner [8] and further extended via algebraic and categorical methods by Goguen [11]. As observed by Pereira from a AI-oriented perspective, "Conceptual Blending is an elaboration of other works related to creativity, namely Bisociation, Metaphor and Conceptual Combination. As such, it attracts the attention of computational creativity modelers and, regardless of how Fauconnier and Turner describe its processes and principles, it is unquestionable that there is some kind of blending happening in the creative mind" [26]. In Goguen's algebraic semiotic approach to conceptual blending, Peirce's tripartite sign model is combined with categorical formalism, so that a structural component is added to the computational character of creativity. As claimed by the author, "the category of sign systems with semiotic morphisms has some additional structure over that of a category: it is an ordered category, because of the orderings by quality of representation that can be put on its morphisms. This extra structure gives a richer framework for considering blends; I believe this approach captures what Fauconnier and Turner have called 'emergent' structure, without needing any other machinery" [11]. This approach has been recently applied to style modeling (see [12]), providing an alternative to AI-oriented unifying models of conceptual spaces [9]. Our research is deeply related to this structural account of concept spaces and creative processes, as we will show by firstly focusing on music and then trying to make evident possible connections with the problem of a categorical analysis of the sense of discourse as well as explaining