The C^{2}Create Authoring Tool: Fostering Creativity via Game Asset Creation

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***Abstract*—In this paper we introduce the *Crayon Co-Create* (C^{2}Create) drawing tool as a mixed-initiative design approach for fostering the creativity of young learners. C^{2}Create follows the principles of mixed-initiative iterative design utilizing variants of novelty search for generating abstract drawings that act as a visual disruptor during the creation process. The authoring tool finds a multitude of uses both as a standalone gameful activity and, most importantly, offering abstract visual assets that can form parts of game components across various types of games that can either be shared in a social environment or played.**

I. Introduction

Computer-aided design systems have been used for decades, offering designers a broad range of toolsets capable of facilitating and hastening the design process. Mixed-Initiative Co-Creation (MI-CC) [1] systems attribute a more proactive role to the software in the creation process, by offering suggestions which exhibit certain valuable properties [2] or by fulfilling certain constraints [3]. Although these systems offer solutions to designers within the design space, their capacity to facilitate human expression and foster human creativity has only been considered very recently. As the sole example of such a study, the Sentient Sketchbook MI-CC tool [1] has explored the potential of mixed-initiative systems in stimulating the creativity of human designers.

Designing a mixed-initiative tool which aims to foster the creativity of its users is not a trivial task. In order for the user to perceive the software as a collaborator with a creativity of its own, it should be able to autonomously create content of comparable quality to the human user. Genetic algorithms have shown potential in creating high-quality content under the search-based procedural content generation (PCG) paradigm [4]. However, search becomes challenging when the quality of content is subjective, unknown, or simply too complicated to mathematically define, e.g. in evolutionary art and music. When designing a mixed-initiative drawing tool without a specific objective, search-based procedural content generation can focus on creating diverse content in order to motivate its user to "think outside the box" [5] and foster *visual diagrammatic reasoning* [1].

In this demonstration paper we introduce the C^{2}Create tool, a playful activity based on the MI-CC paradigm, where players create diagrammatic game assets for a variety of game types. Suggestions are generated through variants of novelty search [6], where the most novel suggestions are presented to the players with the aim to break their *lateral path* [5]. Unlike Sentient Sketchbook [7], C^{2}Create is not specifically designed for game or level designers, but for young learners without specific game design knowledge. It is also envisioned as a social-based game asset creator, where users share their creations in order to use them in a multitude of games such as story-making and puzzle games (see details in Section III).

II. Crayon Co-Create (C^{2}Create) Tool

The C^{2}Create tool is designed to establish itself as a *colleague* [8] with the objective of fostering visual diagrammatic aspects of creativity in young learners, by influencing their lateral path [5] and broadening their possibility space with surprising ideas generated by the software. This is achieved via a suggestion system, which constantly generates new drawings for users to consider while they interact with the tool. In this section we outline the key aspects of the user interface of C^{2}Create (Section II-A) and proceed by briefly presenting the algorithm that drives the generation of content in C^{2}Create (Section II-B).

A. User Interface

The tool interface (see Fig. 1) is divided into three main windows. The *toolbox* window on the far left allows control over the shape being drawn, the shape's color, as well as allowing existing shapes to be erased. For this prototype there are 3 shape types: *square*, *circle* and *line* shapes. Additional shapes (e.g. triangles) are considered for future implementations. The *canvas* is the main drawing window, placed at the center of the user interface. On the canvas users can draw their selected shapes through dragging and dropping. The *suggestions* window on the far right displays up to eight suggestions generated by the software, while the user interacts with the tool. At any time, users can replace their current drawing with a suggestion.

B. Suggestions

In the current C^{2}Create implementation suggestions are evolved through a mutation-based novelty search scheme [6]. Novelty is measured in a similar fashion to [7] as the pixel-to-pixel difference between two drawings. The algorithm transfers the most novel individual in the next generation (elitism size 1), and replaces all other parents with their offspring. Parent selection is performed via fitness-proportionate roulette wheel.

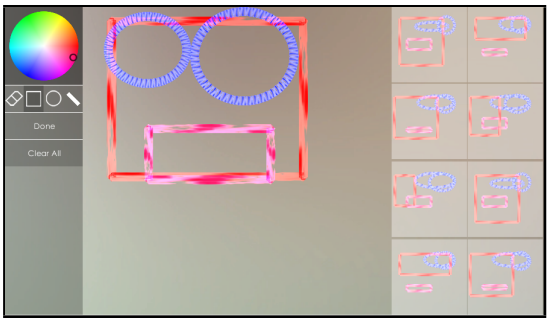

Fig. 1: The C^{2}Create graphical user interface: the canvas is at the center of the screen, with the toolbox to the left and the suggestions to the right.

Drawings are currently evolved exclusively via *displacement*: i.e. a uniformly distributed random number picks which shape coordinates are altered. The generated suggestions presented to the user currently consist of the eight most novel individuals found by the genetic algorithm. Due to space considerations we omit any further details of the suggestion system as this follows the principles of Sentient Sketchbook [7].

III. Games with C^{2}Create

C^{2}Create is currently being designed as a game asset authoring tool, where players create custom content which is shared in a common gamified social environment and is usable in multiple games of various genres during play. One of the early uses of asset authoring has been in the creation of card-like assets where users create a diagrammatic representation based on a semantic concept (e.g. a word or a phrase), which players may then use as a card in their game (see Fig.2). This is particularly useful for the creation of cards for story-making games, where the diagrammatic and semantic asset act as both a story-telling stimulus and a constraint for players on their turn. Popular story-making games like *Once Upon A Time* (Atlas Games, 1993) use very similar types of card-like systems, where players are forced to use the cards in their hand in order to progress the story and win the game.

Due to the inherent nature of the tool, the creation of abstract diagrammatic assets is particularly facilitated. The advantageous nature of abstract drawings is that they allow for multiple interpretations, a core gameplay mechanic in the popular game *Dixit* (Libellud, 2009). Much like the assets within the game of *Dixit*, the diagrammatic representations are abstract in order to create ambiguity among the players with a multitude of interpretations. This is a core concept within the game's own scoring system, where players try to achieve a middle ground between ambiguity and specificity when declaring their interpretation of a drawing to the rest of the players.

Continuing on the idea of abstract drawings, the act of creating an asset could also be successfully gamified. By mixing core concepts found in *Dixit* and the game *Pictionary* (Hasbro, 1994), players would be tasked in creating ambiguous drawings based on a semantic concept from a list of concepts. Players would then try and guess which concept ties to which

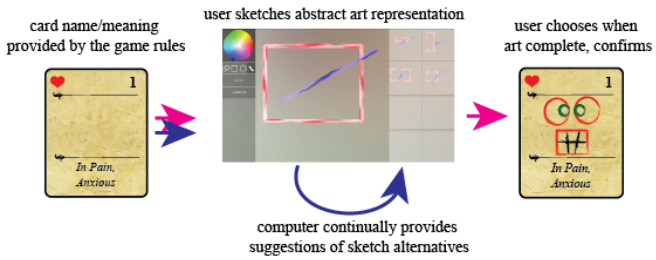

Fig. 2: Example of the creation of a card element.

drawing. Players who draw images that at least one player, but not all, guesses correctly would obtain more game rewards.

The above examples are just a few of the possible applications of the C^{2}Create tool, exemplifying the diverse capabilities of such an authoring tool. In further prototypes users will also have the ability of sharing their own creations with others, as well as rate each other's creations. This is especially useful for players looking for a constant stream of fresh in-game assets.

IV. Future Work

C^{2}Create is still a prototype in the early stages of its development and will constantly evolve in further iterations. Future iterations are set to include additional shapes usable by the players, different aesthetic metrics, better optimized co-creation experience (i.e. faster generation of suggestions), a more elaborate, responsive and stylized user interface and some gamification elements (i.e. achievements, content sharing and peer-to-peer evaluation of content).

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