

Drawing Apprentice: An Enactive Co-Creative Agent for Artistic Collaboration

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ABSTRACT

This paper describes a co-creative web-based drawing application called the Drawing Apprentice. This system collaborates with users in real time abstract drawing. We describe the theory, interaction design, and user experience of the Drawing Apprentice system. We evaluate the system with formative user studies and expert evaluations from a juried art competition in which a Drawing Apprentice submission won the code-based art category.

Author Keywords

Computational Creativity, Creativity Support Tools, Art, Collaboration, Cognitive Science

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

During collaboration, ideas mix, fuse, and combine to form unexpected results [4]. The feedback offered in collaboration helps individuals iterate and refine ideas through time, often leading to more creative outcomes [4]. Collaboration therefore offers a compelling mechanism to enhance the creative process and stimulate creative engagement through time.

The Drawing Apprentice is a co-creative drawing agent that collaborates with human users in real time artistic collaboration. It is aimed at supporting the creative process of users by inspiring and pushing their creative boundaries similar to a human collaborator (as opposed to the typical focus of creativity support tools: *improving the creative product* [5]).

The system is designed to stimulate the user's creativity by introducing unexpected contributions at the right time in the creative process. However, determining when to make an expected or an unexpected contribution is difficult to know

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Figure 1. User collaborating with the Drawing Apprentice web application.

without understanding what the user is thinking as they draw. The Drawing Apprentice system analyzes each of the user's lines as they are drawn in real time. The agent develops a dynamic model of the user's creative behavior through time to generate and modify creative actions.

RELATED WORK

There are many effective methods to model creativity and collaboration, such as shared mental models [2] and turn taking [6]. However, many approaches face a similar knowledge engineering bottleneck in open-ended creative contexts. The complexity and unpredictability of human creativity presents a challenge to many approaches in artificial intelligence.

Recent advances of interactive machine learning (IML) [3] present a potential solution to some of those knowledge engineering requirements. In IML, agents observe humans and form models of their actions. According to the agents' demonstrations, users can provide feedback to facilitate learning [3]. In this approach, knowledge is acquired through real-time interaction rather than offline knowledge engineering. Implementing IML systems in meaningful creative contexts presents a new set of challenges surrounding social coordination and interaction dynamics.

DRAWING APPRENTICE INTERACTION DESIGN

To facilitate interactive machine learning in artistic collaboration, the Drawing Apprentice interface features

several forms of feedback to help train the system's algorithms. The interaction design of the system is inspired by the ideas of participatory sense-making in the cognitive science theory of enaction [1]. For example, the system features up/down voting buttons to inform the system whether the user liked the last contribution (shown on the right side of Figure 1). To teach the system about meaningful relationships in the drawing, we enable an additional form of 'line grouping' feedback. Once users click the grouping button, they can lasso several lines on the canvas to 'group' them. Once grouped, the agent can interact with this entire group of lines as if it were one shape object, i.e. draw inside vs. outside the shape, redraw the entire shape, modify part of the shape, etc.

SYSTEM EVALUATION

Our system evaluation includes informal demonstrations (~30 users), formative user studies (6 novice users), and expert evaluation at a juried art competition. During semi-structured interviews, users report that Drawing Apprentice motivates them to continue their artistic task to explore how the agent responds. Users were both impressed and puzzled by the agent's line responses because the agent sometimes appeared to understand their intention while it obviously violated it at other times. Often, the user's mental models seemed to attribute a greater degree of 'intentionality' and 'creativity' to the Drawing Apprentice system than researchers predicted.

The most common request from users was better pattern recognition. For example, several users wanted the system to complete simple patterns, such as a filling in the missing petals on a flower. Users report some emotional connection to the agent anchored by the character used to represent the Drawing Apprentice on the drawing canvas. We predict animating this character will serve as helpful feedback to increase this emotional connection and help facilitate more effective collaborations.

Figure 2 shows a Drawing Apprentice collaboration that won the code-based art category of the Clough Art Competition. The juror provided an evaluation of the system and artwork, "The act of collaboration between a person and the enactive agent (presented live or through video documentation) is a visually exciting back-and-forth exchange worth watching, or perhaps even participating in yourself. Stepping Stones excellently demonstrates the way technology can partner in an artist's creative process, as well transform passive viewers into collaborators themselves" [7]. The submission was evaluated based on the image in Figure 2 and a video demonstration (refer to ACM digital library to see the video).

CONCLUSIONS

This paper introduced a co-creative drawing agent called the Drawing Apprentice. This system collaborates with users in real time on abstract drawings. Our approach



Figure 2: Drawing Apprentice submission to the Georgia Tech Clough Art Competition in code-based art category titled 'Stepping Stones to Enactive Computing' [7].

extends the recent work on interactive machine learning designed to reduce the knowledge engineering requirements for building creative agents. We present the interaction design and initial evaluation of the system based on expert evaluation and user feedback.

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