Interactional Co-Creativity of Human and AI in Analogy-Based Design

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Abstract

The locus of co-creativity in human-AI creative tasks has not been resolved. We explore a sub-part of this problem through the use of analogies for reframing a conceptual design task. In our scenarios, the human proposes an analogy, and then the human and a conversational UI to a Large Language Model (LLM) collaboratively explore design features based on that analogy. In one scenario, the human asks the AI to propose the analogy. In our experiments, co-creativity occurs in the interactional shared space between human and AI.

Introduction

Eleven years ago, Maher asked, "who's being creative?" (Maher 2012), and proposed several analytical spaces of creative applications, with dimensions of ideation and interaction. Maher's question led to Jordanous's PPPPerspectives framework, in which a creative act could be performed by *either* human or AI (Jordanous 2016), and the 5Cs framework of Kantosalo and Takala, in which creative acts were performed by a *Collective* consisting of both human AI working together (Kantosalo and Takala 2020).¹

However, less is agreed about the locus of creativity in interactions between human and AI. The Mixed Initiative Creative Interfaces approach proposed a basic set of finegrained activities that could be performed by either human or AI as a kind of structured conversation (Deterding et al. 2017; Spoto and Oleynik 2017), which was subsequently extended for generative applications (Muller, Weisz, and Geyer 2020), refined for specific algorithmic approaches (Grabe, Duque, and Zhu 2022), and critiqued for other algorithmic approaches (Zheng 2023). While these approaches generated overlapping analytic vocabularies of actions, they did not settle the question of *where* creativity took place (and by whom or by what) through those actions.

In this short paper, we provide several examples of one answer to that question. Re-using the *Collective* concept from the 5Cs of Kantosalo and Takala (2020), we propose that one type of creativity may emerge asymmetrically in the interactional (Rezwana and Maher 2022) spaces between human and AI. We illustrate this conjecture through human-AI dialogs using a highly-interactive UI, intermediating between human actions and the GPT-3-turbo large language model (OpenAI 2023). Repurposing the work of Ross et al. (Ross et al. 2023), the UI was tuned for brief conversational turns, and was further conditioned to use conversational hedges (e.g., (Niculae and Danescu-Niculescu-Mizil 2016)) and other methods to reduce the impression of "objectivity" or "confidence" in the outcomes that it provided from the LLM. These approaches were intended to maintain human control of the interactions (Shneiderman 2022).

To choose a creativity task, we consulted recent reviews of creativity methods (Schleith et al. 2022; Wu et al. 2021). For a first series of experiments, we decided to experiment with analogies-based reframing, based on its importance in human-AI co-creativity (Cook et al. 2019). In each case, we looked for a design concept (the frame) to present a technical idea in every-day concepts. For brevity in this short paper, we explored only a single frame in each of the three scenarios. Each scenario is presented in full, with the exception of UI buffer preparation and omission of repetitive material; these exceptions are described with the number of conversational turns in each case.

Dialogic Experiments with A Conversational UI to a LLM

We conducted a series of experiments with a highlyconversational UI to GPT3.5-turbo. We illustrate several "toy" design exercises to create interfaces for end-users without formal training in technologies.

Scenario 1: "If a database is like a toolbox..."

In a first series of experiments, we explored analogies (similes) for a database. Our design goal was to avoid technicalities, so that the UI to database operations could re-use concepts from ordinary life. We framed our problem as treating a database as a container for heterogeneous content. We had previously asked the UI for synonyms for the concept of "container." We experimented with two of the responses: "suitcase" and "toolbox." We report here the results with "toolbox" as the framing analogy.

We began the analogies session by asking the UI to review definitions of "analogy" and "simile," in order to push

¹The creative human–computer *Collective* consists of human and AI, engaged in a *Collaboration* to make a *Contribution* to a *Community* in a *Context* (Kantosalo and Takala 2020).

those concepts into the UI's buffer (2 user requests, 2 UI responses). Then we began the analogies interactions.

User: Here is our core simile: A database is like a toolbox, because it contains tools for doing data-work. UI: That's a good simile. Just like a toolbox contains different tools for different tasks, a database contains different tools for managing, storing, and manipulating data. And just like you need to know how to use each tool in a toolbox, you need to know how to use each feature of a database to effectively work with data.

User: If a database is like a toolbox, what data-tools would we find in the toolbox?

UI: Just like a toolbox contains different tools for different tasks, a database contains different tools for managing, storing, and manipulating data. Here are some common data-tools that you might find in a database toolbox:

1. Relational database management system

(RDBMS) - a software system that manages relational databases.

2. Structured Query Language (SQL) - a programming language used to manage and manipulate data in a relational database.... [additional 8 data-tools]

User: That's good. Now, what tools would we find in a physical toolbox?

UI: A physical toolbox typically contains a variety of tools for different tasks. Here are some common tools you might find in a physical toolbox:

1. Screwdrivers - used to tighten or loosen screws.

2. Wrenches - used to tighten or loosen nuts and bolts.... [additional 8 physical tools]

After establishing those terms, we asked a series of questions:

User: If a database is like a toolbox, what data-tool is like a screwdriver?

UI: If a database is like a toolbox, then a data-tool that is like a screwdriver might be a tool used for manipulating or modifying individual pieces of data within a database. In this case, a Structured Query Language (SQL) UPDATE statement might be a good analogy for a screwdriver. Just like a screwdriver is used to tighten or loosen screws, an UPDATE statement is used to modify or update individual rows of data within a database.

User: If a database is like a toolbox, what data-tool is like a wrench?

UI: If a database is like a toolbox, then a data-tool that is like a wrench might be a tool used for managing the relationships between different pieces of data within a database. In this case, a Relational Database Management System (RDBMS) might be a good analogy for a wrench. Just like a wrench is used to tighten or loosen nuts and bolts, an RDBMS is used to manage the relationships between tables and data within a database....

We continued the interaction to elicit similes for each of the physical tools (6 interactions are not shown for reasons of space). Whether or not we agreed with each analogy, we argue that each analogy is presented with a plausible rationale. The user can exercise human control (e.g., (Shneiderman 2022) to accept or reject each analogy, and can also request modifications.

Scenario 2: "If a product-ordering system is like a restaurant..."

In a second informal experiment, we reframed technical operations on a product-ordering system with ordinary-life concepts based on a restaurant. We used a similar sessionopening as in the previous scenario (i.e., pushing concepts of "analogy" and "simile" into the UI's buffer; 2 user requests, 2 UI responses). Then we asked about restaurant activities by two different types of human roles.

User: If a product-ordering system is like a restaurant, what operations would a customer perform?

UI: I think a customer using a product-ordering system would perform operations similar to those of a customer in a restaurant. They might browse a menu or list of available products, select the ones they want to order, and then proceed to checkout to pay for their order. They might also be able to view their order history or track the status of their current order, just as a restaurant customer might be able to check on the status of their meal.

User: Great. If a product-ordering system is like a restaurant, what operations would the staff perform?....

UI: I think the staff operations in a restaurant might involve managing the inventory of ingredients, updating the menu, taking orders from customers, preparing and serving food, handling payment transactions, and managing customer service inquiries. They might also be responsible for ensuring that the restaurant is clean and well-maintained, and that customers have a positive experience.

User: From the customer's perspective, please make a series of one-to-one mappings of product-ordering operations and their analogous restaurant operations.

UI: I will try to make a series of one-to-one mappings of product-ordering operations and their analogous restaurant operations from the customer's perspective:

1. Browsing the menu or list of available products in a product-ordering system is like looking at the menu in a restaurant.

2. Selecting items to order in a product-ordering system is like placing an order with a waiter in a restaurant.

3. Proceeding to checkout and paying for an order in a product-ordering system is like paying for a meal at a restaurant.

4. Viewing order history or tracking the status of a current order in a product-ordering system is like checking the status of a meal in a restaurant.

(continued)

5. Leaving a review or rating for a product in a product-ordering system is like leaving a review or rating for a restaurant on a website or app.

We then asked the UI to construct its own series of analogies:

User: From the staff's perspective, please make a series of one-to-one mappings of product-ordering operations and their analogous restaurant operations.

UI: I will try to make a series of one-to-one mappings of product-ordering operations and their analogous restaurant operations from the staff's perspective:

1. Managing the inventory of products in a productordering system is like managing the inventory of ingredients in a restaurant.

2. Updating the menu or list of available items in a product-ordering system is like updating the menu in a restaurant.

3. Processing orders in a product-ordering system is like taking orders from customers in a restaurant.

4. Handling payment transactions in a product-

ordering system is like handling payment transactions in a restaurant.

5. Managing customer service inquiries in a productordering system is like managing customer service inquiries in a restaurant.

6. Ensuring that orders are fulfilled accurately and on time in a product-ordering system is like ensuring that meals are prepared and served accurately and on time in a restaurant.

In this scenario, the UI was able to maintain two distinct perspectives - customer and staff - for each of a series of analogies. Most of the artifacts in the restaurant analogy took on the attributes of "boundary objects," which are perceived differently by different stakeholders (Star 2010). The representation of different states of knowledge and action is related to contemporary interests in theory of mind tasks (e.g., (Moghaddam and Honey 2023)).²

Scenario 3: "What is a good metaphor for a human interacting with a computer?"

In our third experiment, we asked the UI to propose a simile. We also asked the UI to go beyond its original metaphor, to include novel concepts.

Similar to the above scenarios, we inserted concepts into the buffer by asking the UI for definitions of "analogy," "simile," and in this scenario, "metaphor" (3 user requests, 3 UI responses). We then asked: **User**: What is a good metaphor for a human interacting with a computer?

UI: I will try to come up with a metaphor for a human interacting with a computer. How about this: "A human interacting with a computer is like a conductor leading an orchestra. The conductor gives instructions to the musicians, just as a human gives commands to the computer, and the orchestra plays the music, just as the computer performs the requested tasks."

Unlike the preceding two examples, we asked the UI for the framing concept. We adopted that concept for the experiment.

After asking for a review of actions by human and computer, and by conductor and orchestra (4 user requests, 4 UI responses), we asked:

User: From the human user's perspective, please make a series of one-to-one mappings of human actions with a computer, and their analogous conductor actions.

UI: I will try to make a series of one-to-one mappings of human actions with a computer, and their analogous conductor actions, as per your request:

1. Human action: Providing input to the computer through a keyboard, mouse, or other input device. Conductor action: Setting the tempo and rhythm of the music...

4. Human action: Interacting with the computer through voice commands or gestures.

Conductor action: Interpreting the composer's intentions and conveying them to the musicians... [total of five analogous actions]

And correspondingly,

User: From the orchestra's perspective, please make a series of one-to-one mappings of computer actions, and their analogous orchestra actions.

UI: I will try to make a series of one-to-one mappings of computer actions, and their analogous orchestra actions, as per your request:

1. Computer action: Processing input from the user. Orchestra action: Listening to the conductor's instructions...

3. Computer action: Storing and retrieving data. Orchestra action: Remembering and recalling musical themes and motifs.... [total of 5 analogies]

Finally, we noted an incomplete detail in the preceding analogy. We asked the UI to complete it.

²Theory of mind tasks require the ability to represent the internal knowledge or intention state of two or more actors (Moghaddam and Honey 2023).

User: The conductor and orchestra have an audience. What is the audience of a human operating a computer?

UI: I think the audience of a human operating a computer could be other humans who are observing or benefiting from the results of the computer's tasks. For example, a person using a computer to create a presentation may have an audience of colleagues or clients who will view the finished product. Similarly, a person using a computer to perform data analysis may have an audience of other researchers or stakeholders who will use the results of the analysis to make decisions or take action.

This scenario extended the explorations of the preceding two scenarios. As in the first scenario, we used a framing concept to co-create a metaphorical design. As in the second scenario, we showed that the UI could maintain the perspectives of two different categories of stakeholders. However, in this third scenario, we expanded the role of the UI to include creating the conceptual frame for the design ("what is a good metaphor for a human interacting with a computer?"), and extending that frame in a consistent manner when we noted a further design opportunity ("what is the audience of a human operating a computer?").

Discussion

Within the Collective of human and AI (Kantosalo and Takala 2020), we used a highly conversational UI (similar to (Ross et al. 2023)) to explore Maher's question, *Who's being creative?* (Maher 2012). Through a series of three scenarios, we showed increasingly abstract co-creative outcomes in metaphorical design exercises.

In the first, Toolbox scenario, the human chose the frame, and the UI contributed to filling-in the frame in response to very specific queries from the human. The metaphorical design might have been created by the human alone, although a human might or might not have created each of the analogies offered by the UI. We note that the metaphorical design could not have been created by the UI alone. We would like to claim that the co-creativity occurred interactionally between human and AI, similar to the concept of Rezwana and Maher (Rezwana and Maher 2022), but in a more conversational environment.

In the second, Restaurant scenario, the human chose the frame. The human asked more macro-level questions - e.g., "make a series of one-to-one mappings..." The outcome was a reasonably integrated series of mappings. Importantly, the UI maintained two perspectives, and responded to the human's request with metaphors for each. Again, the details of the design were co-created by human and AI.

In the third, Orchestra scenario, the AI chose the frame in response to the human's question, and was able to extend the frame beyond the AI's original proposition of conductor and orchestra, to include audience as well. Again, the details of the design were co-created by human and AI.

All three scenarios involved human agency and control of the co-creative process, in line with Shneiderman principle of *human-in-control* (Shneiderman 2022). Despite this

commonality, the co-creative dynamics and initiatives were different across the three scenarios. In the first "toolbox" scenario, the human chose the frame and determined each step of the analyis. In the second "restaurant" scenario, the human allowed the AI to propose distinct perspectives of different stakeholders. In the third "orchestra" scenario, the human accepted the AI's proposal and then probed further to understand that proposal.

We note that, while the human had ultimate *agency* to decide whether to accept or reject the UI's proposals, the *control* for originating design-aspects shifted by degrees from human to AI across the three scenarios, and that the human allocated *initiative* according to that changing degree of control. Similar variations were seen in the mixed initiative creative interfaces project (Deterding et al. 2017; Spoto and Oleynik 2017). While earlier work tended to treat concepts of control and initiative as interchangeable (Allen, Guinn, and Horvtz 1999; Chanel et al. 2020; Hardin and Goodrich 2009; Jiang and Arkin 2015), we use these examples to begin to unpack concepts of agency, control, and initiative. We propose a hierarchy of

agency > control > initiative

in which *agency* relates to choosing and pursuing a strategic goal, *control* relates to tactical means of achieving the goal, and *initiative* refers to which party currently is acting. In our examples, the human maintains strategic agency and manages tactical interactions to achieve that goal, allocating initiative to human or AI as the work proceeds.

These three scenarios constitute a single composite case in which we distinguished among agency, control, and initiative. We propose that further practical examples and theoretical developments are needed to disentangle these concepts further as we continue to answer Maher's question (Maher 2012), in which she anticipated Kantosalo's and Takala's Collective concept (Kantosalo and Takala 2020). Thereby, with Maher, we ask "Who *are* being creative?"

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