Supermind Ideator: Exploring generative AI to support creative problem-solving

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ABSTRACT

Previous efforts to support creative problem-solving have included (a) techniques (such as brainstorming and design thinking) to stimulate creative ideas, and (b) software tools to record and share these ideas. Now, generative AI technologies can suggest new ideas that might never have occurred to the users, and users can then select from these ideas or use them to stimulate even more ideas. Here, we describe such a system, Supermind Ideator. The system uses a large language model and adds prompting, fine tuning, and a user interface specifically designed to help people use creative problem-solving techniques. Some of these techniques can be applied to any problem; others are specifically intended to help generate innovative ideas about how to design groups of people and/or computers ("superminds").

KEYWORDS

Design, Creativity, Innovation, Collective Intelligence, Information Seeking & Search, User Experience

1 INTRODUCTION

Creative problem-solving is critical to success in many kinds of human activity [6, 10, 14, 32, 38]. It is, therefore, not surprising that many techniques to improve creative problem-solving have been proposed over the years, including brainstorming, design thinking, mind-mapping, crowdsourcing, and many others [13, 17, 37].

In this work, we investigate the potential of a new kind of tool–generative AI–for supporting creative problem-solving. In particular, we focus on how large language models (LLMs; e.g., GPT (Generative Pre-trained Transformer) [5]) can take natural language descriptions of a problem as input and produce as output natural language ideas about how to reframe or solve the problem.

To do this, we developed an LLM-based system, called Supermind Ideator, that uses specialized prompts, fine-tuning, and a user interface to generate ideas that help users reflect upon their problems and generate possible solutions. The system does this using a set of conceptual *moves*–techniques that humans can use to trigger creative ideas. By sequencing these moves in different orders and combinations, users can explore many different ideas for a given problem.

Most of the techniques we currently use in the Supermind Ideator are based on the "Supermind Design" methodology [12]. Some of these techniques, such as looking at sub-parts or analogies, can be helpful for addressing any problem. Other techniques are specifically intended to help generate innovative ideas about how to design *superminds*, defined as *groups of individuals acting together in ways that seem intelligent* [30]. For instance, one such supermind design technique encourages users to consider how a problem could be solved with different kinds of groups, such as hierarchies, democracies, markets, or communities.

In other words, "superminds" is a short way of saying "collectively intelligent systems," and the rest of this paper is about how the Supermind Ideator uses the Supermind Design methodology to help design such systems.

2 RELATED WORK

Prior work has extensively discussed creative problem-solving approaches that use techniques ranging from Design Thinking to collective intelligence. These approaches predominantly focus on groups using organizational and methodological approaches to address issues such as design fixation, knowledge curation, and creative inspiration.

2.1 Facilitated Idea Generation

From the early days of design being applied in the scientifc arena [7] to modern-day frameworks for using Design Thinking methodologies [8], creative problem-solving techniques have evolved significantly. For example, the mix of deep problem understanding and iterative solution generation, most notably combined in the Double Diamond [2], enables a rigorous and empathetic approach to integrate the needs of people, the possibilities of technology, and the requirements for business success. In the first of the two diamonds, practitioners (a) *diverge* by considering different ways to frame the problem and then (b) *converge* to narrow down to a useful problem definition. Then, in the second diamond, they (a) *diverge* by considering different potential solutions to the problem and then (b) *converge* on a few of the best solutions.

Other prior work has studied the phenomenon of creative ideation through sociocultural lenses [10, 13, 14, 28, 35], digging into specific topics and issues such as design fixation [6, 27, 40, 43], bias [32], inspiration [11, 42], and innovation [18, 35]. According to Gabora,

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for instance, ideas emerge, evolve, and manifest as creative products through the formation of combinations and reorganization of existing ideas [14]. The process can be modeled by constraint-based iteration to transform ideas into tangible solutions.

However, idea-generation activities can be long and laborious, and mental tendencies, such as functional fixedness, often lead to design fixation [6, 19]. Design fixation hinders and overly constrains the domain of idea generation, functionally falling into a local maximum and missing the wider absolute maximum available. Prevention methods such as concept mapping, remote association, facilitated design thinking, and exposure to other new and unrelated content have been developed to combat this[18, 40, 43]. More recent work has examined the potential for collective intelligence approaches such as crowdsourcing idea generation, crowd-based ratings, and other forms of computer-supported cooperative work to help alleviate design fixation and access diverse types of knowledge [16, 21, 25, 29, 44]. All of these approaches, however, still largely rely on human effort and access to knowledge resources that do not easily scale.

2.2 Generative AI

Systems like GPT (Generative Pre-trained Transformer) rapidly produce large-scale human-quality text output from a small input [5]. It has been shown that LLMs are capable of very wide-ranging idea generation [41], and generating more ideas can lead to greater creativity [34]. Generative technologies are able to create unexpected inputs and stimuli for human designers, and this can increase the range of possibilities to be considered by humans. Thoughtfully designing the way a system guides and facilitates this process could improve the probability that designers will find better solutions faster than they would have otherwise.

Interestingly, even though one widely discussed limitation of today's LLMs is that they sometimes produce incorrect or irrelevant outputs [3, 15, 39], this limitation is usually not a problem when the generative AI system is used to augment human creativity instead of replacing it. In this case, human users can often easily decide which of the outputs from the system are useful enough to consider further and which aren't. And even ideas that may at first seem irrelevant can sometimes trigger further useful ideas for human users. In fact, trying to make connections between a problem and seemingly unrelated ideas is one simple technique for triggering creative ideas [26].

3 THE SUPERMIND DESIGN METHODOLOGY

The Supermind Ideator is based on the Supermind Design methodology, which includes a set of conceptual moves that people can use to spur their creativity about how to design collectively intelligent groups [12]. These moves have been used successfully in multiple settings [23, 24].

The methodology includes the following *basic design moves* that are based on general techniques for any kind of creative problem-solving [1, 4, 9, 22, 31, 33]:

- *Zoom In - Parts*: What are the parts of this problem?
- *Zoom In - Types*: What are the types of this problem?
- *Zoom Out - Parts*: What is this problem a part of?
- *Zoom Out - Types*: What is this problem a type of?
- *Analogize*: What are analogies for this problem?

The methodology also includes the following *supermind design moves* that are specifically for generating ideas about how to design superminds (i.e., collectively intelligent groups) [12, 30]:

- *Groupify*: What types of groups could help solve the problem? Possibilities include:
  - *Democracy* - where group decisions are made by voting
  - *Market* - where group decisions are the combination of all the pairwise agreements between individual buyers and sellers
  - *Community* - where group decisions are made by informal consensus based on shared norms and reputations
- *Cognify*: What types of group cognitive processes could help solve the problem? Possibilities include:
  - *Create* - How can groups create things collectively?
  - *Decide* - How can groups make decisions?
  - *Sense* - How can groups sense what is happening in the environment?
  - *Remember* - How can groups remember useful information from the past?
  - *Learn* - How can groups learn from past experiences to improve their performance over time?
- *Technify*: How can technologies be used to help solve the problem?

Finally, the methodology includes three *experimental moves* which have not, to our knowledge, been previously used as part of systematic ideation exercises but which appear to take advantage of GPT's capabilities and are incorporated in the Supermind Ideator:

- *Reflect* - What is missing from the current problem statement?
- *Reformulate* - How could the problem be reformulated?
- *Case examples* - How does the problem relate to case examples of real companies and products?

4 THE SUPERMIND IDEATOR

The Supermind Ideator [1] was designed to guide a user into a focused state of idea generation and reflection, and as such is intentionally kept minimalistic. After users type in their problem, they are given three options: *Explore Problem*, *Explore Solutions*, and *More Choices*. These options are meant to provide scaffolding for novice users who may not know where to begin, as well as to support more advanced users who already know what they want to do next. The first two options, Explore Problems and Explore Solutions, comprise what we have called "move sets," or groups of moves that focus on a specific aspect of the idea generation and refinement process.

The Explore Problem move set supports the problem definition part of the double diamond approach using the *basic design moves* and the *experimental moves* from the Supermind Design methodology. In this way, it helps users reflect on how they can generalize and specialize the various parts and types of their problem, consider relevant analogies to their problem, and identify potentially missing aspects of their problem statement.

The Explore Solutions move set supports the solution generation part of the double diamond approach using the *supermind design*

[1] https://ideator.mit.edu/

moves from the Supermind Design methodology. For example, it helps users consider how different kinds of groups (such as markets, communities, and democracies) could help solve their problem. It also helps users think about how innovative ways of performing different cognitive processes (such as creating, deciding, and sensing) or using various kinds of technologies could help solve their problem.

More Choices allows a user to select any individual move(s) they want. The More Choices option also exposes a more advanced parameter that the GPT API calls "temperature" - a measure of the amount of randomness used to generate output. Lower temperature leads to less random (more conventional) outputs, and higher temperature leads to more random (more potentially creative) outputs. To avoid confusion, we name this "Creativity" and provide three choices: Low, Medium, and High, corresponding to temperatures of 0.7, 1.0, and 1.3, respectively.

In each of the above cases, the Ideator system generates one or more ideas for each move. Users can rate each of these ideas with a Thumbs Up or Thumbs Down button, and they can Bookmark ideas they particularly like to save these ideas in their personal collection.

5 EVALUATION

To collect early feedback, we ran a formative study with 40 participants. The participants were professional consultants, designers, and others who work in and around organizational innovation practices in a variety of industries, including management consulting, IT services, pharmaceuticals, and universities. Most participants had at least 10 to 20 years of professional experience in their particular field.

All study activity occurred remotely through online meetings which averaged about 45 minutes in length. The researcher ran a think-aloud protocol with each participant, first explaining the Supermind Ideator application, and then asking the participant to suggest a problem statement to kick off the session. As the system generated ideas, participants were asked to reflect on and respond to the output. As this was a formative study, we collected (a) UX insights related to which aspects of the application 'made sense' to participants and which did not, and (b) measures of professional applicability, such as where and how participants might make use of the application in their professional lives.

Generally, participants responded positively to the application, expressing excitement at the potential for the Supermind Ideator to help them innovate. As one participant put it, "the tool could be invaluable to help us, and our clients, explore multiple dimensions of a problem at the inception of a project. Today we struggle to ensure that all projects and all teams think broadly and systematically about the contours of the problem space." Another noted that "the [Supermind Ideator] helps effortlessly bring up questions that my colleagues and I need to have an answer to." A third remarked that the system "can help me and especially my teams break down client problems when we don't have an intimate understanding of their domain space. It helps us come up to speed much, much faster." Yet another noted "it helps us look at many different angles, and recombine them to get to new ideas. And it makes that discovery so much faster."

Some participants also brought to light limitations of the current system that suggest potential ways it could be extended in the future. One participant noted, "[the Supermind Ideator] could be much more powerful if it could explore parts of the problems farther away from where I pointed it at... the tool kept thinking about how to make the [problem] more efficient while the real answer is to look at the upstream possibility... It could have abstracted one level more, or looked at up and downstream problems, to get there." Another remarked that "the tool structure is very portable to a variety of problems, and can be easily repurposed."

Finally, it was noteworthy that our participants organically realized the power of augmenting human abilities rather than replacing them, noting "it is fantastic to see that the tool is intended to help people, instead of sidelining them."

6 FUTURE WORK

It appears that the Ideator has the potential to provide substantial assistance to humans doing creative problem-solving. Much work remains to be done for this potential to be fully realized, and more complete, quantitative evaluations of factors such as the user experience of people using the system and the speed and quality of the ideas they generate are currently underway. We also see at least two short-term paths forward to improve Ideator:

6.1 Adding Moves

It is possible to include moves to support other methodologies for thinking about business questions and collective intelligence, such as Porter's 5-forces [36] or Blue Ocean Strategy [20].

6.2 Evaluating Ideas

Currently, the moves we have implemented only cover the divergent aspects of idea generation: generating possible ways of re-framing the problem and generating possible solutions to the problem. As the double diamond process suggests, however, evaluating and selecting among these possibilities is also necessary to be able to actually use the results.

7 CONCLUSION

This work suggests how large language models can be used to help people do creative problem-solving in many areas, but we have focused especially on designing collectively intelligent groups of people and computers. We hope that tools like this will help design innovative kinds of such superminds to deal with our most important problems in business, government, science, and many other areas of society.

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