Crowd Creativity through Combination

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ABSTRACT
The goal of this research is to perform large-scale experiments to see if the crowd, mediated by technology, produces creative designs by combining designs. To fulfill this goal, a sequential combination system is built. The system is a variant on a human based genetic algorithm, through which the crowd participates in an iterative process of design, evaluation, and combination. The study will provide a way of creatively solving problems in a number of different domains. It will also shed light on the mechanisms of social creativity: how individuals can build on each other’s work and how technology can facilitate design by encouraging collaboration through shared designs.

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Crowdsourcing, creativity, design

ACM Classification Keywords
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ACM General Terms
Design

INTRODUCTION
How can a crowd be organized to generate creative ideas? Crowdsourcing makes it possible to assemble large numbers of workers in a short amount of time. It is a process that is part technology – an online marketplace with micropayments possible – and part organization – a coordination mechanism [10]. This process can be implemented with a wide range of possible structures, and many remain untired. In the proposed dissertation, I will look at a specific form of collaboration, in which members of the crowd combine the ideas of peers. This choice is motivated by the common claim made in management literature that innovation is at its heart the recombination of existing knowledge [3, 6]. Psychology researchers also claim that creativity results from a combination process [11, 12]. In a third literature, from the field of optimization, combination has been operationalized as crossover, a process in genetic algorithms [1, 4, 7]. In sum, these three different literatures suggest ways of addressing combination, but none in themselves are both specific enough to apply to design problems and flexible enough to tackle the types of ill-defined problems that characterize most product development.

Synthesizing ideas from the three fields, I propose such a process, calling it a sequential combination system: one crowd creates a first generation of designs, and then new crowds create successive generations by combining the designs made by previous crowds. I will describe the system in detail and report an experiment conducted with the system, one of several to be performed to complete my dissertation.

THE SEQUENTIAL COMBINATION SYSTEM
In order to clearly specify the sequential combination system, the way a genetic algorithm works will first be described. All variants of these algorithms start with a first generation population, and perform a fitness ranking. Then, members of the population are selected to become parents of the next generation. Most often, tournament selection is used: two parents are selected at random, and the fitter chosen. Another two parents are selected, and the fitter chosen. The two fit parents then produce offspring through a combination procedure. These offspring serve as a new population, which is then ranked, and the process repeats. Because combination can sometimes take the worst features of highly ranked parents, and thereby degrade the available genetic pool, a set of the strongest parents survive into the next generation without change, an attribute of the algorithm referred to as elitism [1].

The sequential combination system is based on the above description. It integrates together organizational processes, software tools, and a crowdsourcing market. The organizational process is based on the idea of a genetic algorithm [4, 7] implemented with human participants [9]: one crowd creates a first generation of designs, and then successive crowds create successive generations by combining the designs made by previous crowds. The fitness ranking in the system is based on the creativity scores of the designs, as evaluated by crowds. Tournament selection is used to pick the parents presented to the next generation crowds for combination. In each generation, 20 highest-rated designs are automatically promoted to the next generation in a process called elitism [1].

Figure 1. The generations of the experiment.
Specifically, the solicitation and management of participants are handled through Amazon Mechanical Turk. All participants receive nominal compensation for either generating or evaluating designs. When participants engage in idea generation, they are directed to a Google document page already opened as a drawing. This same page, in later generations, presents the designs to be combined. The drawing tool provides many menu choices including a freehand sketch option, a vector line, text, and pull-down shape palette. The system is run for three generations, as summarized in Figure 1.

THE EXPERIMENT AND RESULTS
In the experiment, participants were asked to design chairs for children and present their designs through sketches. It was run through three generations with 1207 participants. The creativity of the designs from the last generation was compared to the creativity of the initial designs from the first generation. The consensus in the creativity literature is that only original ideas that are also practical should be called creative [2]. Operationally, this leads to a binary measure of creativity that includes only designs that exceed a certain threshold on both the scales of originality and practicality [2]. All designs were evaluated by the crowd on two scales: originality and practicality. The designs were then further classified as being creative or not based on the two scales. The results show that the number of creative designs in the last generation is significantly greater than that in the first generation, as shown in Figure 2.

![Figure 2. On the left and right are example chairs from the first and third generation. The bar chart shows the proportion of creative designs. The error bars indicate 95% confidence intervals.](image)

FUTURE RESEARCH
Future research in the dissertation will focus on two directions. One direction considers a different evaluation mechanism, purchases in virtual worlds. The evaluation of designs in the reported experiments was based on the crowd’s judgments. Another important test of a creative design, though, happens after it is implemented and becomes an innovation. That is, eventually the consumer or user evaluates the product for purchase and ongoing use. However, for many products, such as the chair example discussed here, production tests are probably infeasible. Some virtual environments have products and economies – so it would be possible to design and sell designs without the need for any physical manufacturing. Therefore, a future experiment will run sequential combination on a virtual worlds problem: three-dimensional products will be designed, combined and sold.

A second direction seeks to understand exactly how combination works. The current results show that the sequential combination system as a whole influences the creativity of the later combined designs. Several processes are involved in the system: combination, tournament selection, and elitism. To test whether combination leads to creativity—the hypothesis behind this work—future experiments will be run to control for the effects of tournament selection and elitism. And the ways features propagate in the different conditions will be examined to determine how exactly people combine ideas, and how such design ideas propagate.

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