The combination of SQL database queries and stochastic search methods used to explore generative design solutions

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Abstract

The exploration of a range of possible solutions as a means of searching for new solutions has long been seen as a valuable tool in the design process. Numerous studies in the latter half of the 20th century attempt to describe or even formularize this process. Some form of exploration is generally common to these methods. Osborn describes "ideation, piling up alternatives by way of ideas"[1]. Koberg and Bagnall describe ideation as a way to "generate options" and "search out all possible ways of realizing the major goals."[2] Most stochastic optimization techniques, such as genetic algorithms (GAs), include a search operator which essentially explores the solution space in search of good solutions. Unfortunately most GAs do not maintain a history of the search progress and only have a 'memory' of the current generation. So although these techniques do "generate options" the do not really "pile up alternatives" since they lack any recorded memory of the search. Of course one solution is to simply store the solutions as they are generated, but a more useful approach is to actually incorporate a SQL database into the search process so that solutions are not only saved, but more importantly can late be explored interactively. This is much closer to Osborn's concept of ideation.

ParaGen is a method that has been developed over the past several years at the University of Michigan's Taubman College.[3] ParaGen combines both a GA and a SQL database for solution exploration and performance optimization. Multi-performance optimization has been successfully demonstrated on numerous problems using stochastic algorithms like GAs. But for many problems which include visual aspects of form, like architectural design, quantitative performance values alone are not the only criteria needed to search for a good design. In architecture as in other design fields with a visual component, aesthetics, human comfort and other qualitative aspects need to be considered.

By allowing designers to make visual comparisons of solution forms that have been found through performance driven search, ParaGen is able to respond to both quantitative and qualitative aspects of design. In this paper an example is given where a combination of quantitative performance criteria along with qualitative criteria based on the designer's visual selection are used to search for better performing dome forms. An example is shown based on the design of an irregular wooden reticulated dome. Quantitative performance criteria based on structural response to uniform loadings as well as qualitative aesthetic judgement based on rendered depictions of the architectural form are used to choose good solutions during the exploration of the design space. The final set of chosen solutions demonstrates how ParaGen is able to incorporate both quantitative and qualitative aspects of design, in an automated exploration of well preforming architectural forms.

References

[1] A. Osborn, *Applied Imagination – Principles and Procedures of Creative Writing*, Scribner's, Oxford, England, 1953.

[2] D. Koberg and J. Bagnall, *The Universal Traveler,* William Kaufmann, Inc., Los Altos, USA, 1972.

[3] P. von Buelow, "ParaGen: Performative Exploration of Generative Systems" in *Journal of the International Association for Shell and Spatial Structures*. Vol. 53 (2012) No. 4, pp. 271-284.