

Recombination and Representation methods for Evolutionary Design

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Abstract:

This research spotlights the issue that decisions made at the early stages of building design have the greatest and impact on cost implications for construction and the building lifecycle. While the design of services (heating, ventilation and air-conditioning) constitutes a large part of the construction cost, they are traditionally not considered at the early stages of design. Methods such as Multi-Objection Design Optimisation (MDO) generate many variations of the design object virtually, in order to negotiate what constitutes the optimum solution. This thesis examines the strategies faced when utilizing such techniques for the integration of service design at the early stages of building design - the means of representation and the mechanism of optimisation used to describe each instanced design variation – noting the complexity of handling both qualitative and quantitative criteria and ideas.

Keywords:

Evolutionary design, Artificial Intelligence, Recombination, Digital representations

Research Summary

1. *Problem being addressed*

The problem identified is the difficulty in representing architectural designs for evolutionary computation (genetic algorithms, evolutionary programming.) Typically schemes employed are either over or under-constrained i.e. they can be either a fine tuning process shifting a parameter that make a small change, or they are under-constrained and the design is not easily discernible. Adding to this problem is the difficulty in getting input from the (designer) user as most of these forms of algorithms require coding specific to the problem. This thesis will produce a generalised schema for representation design in such computation systems as well as the methods of interaction that is required.

2. *Research Question*

What forms of representation can be used to produce coherent models that:

- a. Can be extended to full architectural design schemes with sufficient detail.
- b. Are flexible enough to handle geometrical and topological changes.
- c. Can be used in simulation systems.
- d. Can be used for 'machine learning' algorithms.

3. *Expected contribution*

The research is expected to contribute the scheme for representation that will be used for evolutionary modelling within continued research at the Complex Urban Systems Project (QUT.) Future extensions of this will look at interactions at the urban scale

4. *Proposed solution and methodology*

The solution under investigation uses shape grammar systems linked with designer input from CAD packages. Using recombination at different levels of hierarchy allows for a much richer set of possible recombination between designs – accounting for both topological and geometric variations, but still keeping aspects that are important to the designer – composition, style, proportion etc.

5. *Current Status and Future Plans*

I am currently researching grammar and lower-level computation logic, in particular cellular automata. At this point quite a bit of code has been generated for the purposes of simulation and visualisation and design experimentation. Immediate research will begin implementing logic patterns using cellular automata and creating a framework that links shape grammars to this and further along, linking architectural design elements to the shape grammars.

Future work includes preparing demonstration of a working model as well as optimising system for high powered computing.

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