CONSTRUCTING STRUCTURED SHAPE GRAMMARS

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Abstract. Shape grammar has been shown to be a frame of work applicable to design issues in various fields. Almost all published grammars work only on the bottom level of shape replacement, however in practice, when using grammars to generate designs, the designer may work on different levels of abstractions, concerning about the hierarchy of the design as well. This suggests that, to make the generating process more coherent, the grammar itself need be able to work on different levels, too. This paper introduces the research work that aims at proposing a set of guidelines for writing shape grammar with which the designer could write structured shape grammars that will be easily automated for generating designs.

1. Problem that the research is addressing

Shape grammars could be thought of as a type of production system based on geometry (Gips and Stiny, 1980). They have been shown to be a well-structured way of capturing design styles and have their applications in various fields (Stiny and Mitchell, 1978, Agarwal and Cagan, 1998,etc.). In all examples the grammars stick to shape grammar's definition (Stiny, 1980) by working on the bottom level of shape elements replacement, and that is one reason why most of the time the grammar needs so many rules to define a style (Agarwal and Cagan, 1998). However in practice, when the designer generates designs by applying rules in a grammar, she works on different levels of abstractions (Liew, 2004), most of the time not on the lowest level: a square could stand for a pattern, a window or a wall, each case will be treated differently. Therefore rules work indiscriminatingly on shape level will involve too many technic details and download onto the designer tremendous work. Just imagine how tedious it will be to generate a palladian design by the grammar given in (Stiny and Mitchell, 1978)! In contrast with the broad literature of published grammars, very little concern has been addressed against the issue of structured grammars.

2. Research questions I am trying to answer

- How to formulate shape grammars to allow the designer to work on different levels of abstractions when automating the grammars?
- How to represent a grammar to make it comprehensible to designers?

3. Expected contributions

This research aims at proposing a systematical way to write structured shape grammars. Grammars written in this way are expected to hide grammar implementation details from the designer by allowing her to work on different levels of abstractions, and thus could help grammar-based design method make more practical contributions in design activities.

4. Proposed solutions, methodology and tentative research plan

Shape grammars have their origins in the formal basis of natural language or phrase-structure grammars (Chiou and Krishnamurti, 1995). Given that the most successful example for string grammar implementation is the programming language, I believe principles in programming languages (Dijkstra, 1976, Abelson et al., 1996 etc)could serve to formulate the structure of shape grammars. Proposed methodology includes:

1) Analyze published analytic shape grammars to characterize the framework of grammar writing and automating.
2) Based on the framework, study relative disciplines in programming language field and build a set of guidelines to write structured shape grammars.
3) Modify an existing shape grammar system (Chau, 2002) to edit and execute structured shape grammars.

5. Current status, and of a tentative plan for future work

Tentatively I plan to extend this topic as part of my PhD dissertation. I am now in my first two stages of constructing analogies between shape grammar structures and programming language structures by studying literatures in both fields.

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