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Application of the Standard Deviation in Regulating Design Variation of Urban Solutions Generated through Evolutionary Computation

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Abstract : Computational applications of natural evolutionary processes as problem-solving tools have been well established since the mid-20th century. However, their application within architecture and design has only gained ground in recent years, with an increasing number of academics and professionals in the field electing to utilize evolutionary computation to address problems comprised from multiple conflicting objectives with no clear optimal solution. Recent advances in computer science and its consequent constructive influence on the architectural discourse has led to the emergence of multiple algorithmic processes capable of simulating the evolutionary process in nature within an efficient timescale. Many of the developed processes of generating a population of candidate solutions to a design problem through an evolutionary based stochastic search process are often driven through the application of both environmental and architectural parameters. These methods allow for conflicting objectives to be simultaneously, independently, and objectively optimized. This is an essential approach in design problems with a final product that must address the demand of a multitude of individuals with various requirements. However, one of the main challenges encountered through the application of an evolutionary process as a design tool is the ability for the simulation to maintain variation amongst design solutions in the population while simultaneously increasing in fitness. This is most commonly known as the 'golden rule' of balancing exploration and exploitation over time; the difficulty of achieving this balance in the simulation is due to the tendency of either variation or optimization being favored as the simulation progresses. In such cases, the generated population of candidate solutions has either optimized very early in the simulation, or has continued to maintain high levels of variation to which an optimal set could not be discerned; thus, providing the user with a solution set that has not evolved efficiently to the objectives outlined in the problem at hand. As such, the experiments presented in this paper seek to achieve the 'golden rule' by incorporating a mathematical fitness criterion for the development of an urban tissue comprised from the superblock as its primary architectural element. The mathematical value investigated in the experiments is the standard deviation factor. Traditionally, the standard deviation factor has been used as an analytical value rather than a generative one, conventionally used to measure the distribution of variation within a population by calculating the degree by which the majority of the population deviates from the mean. A higher standard deviation value delineates a higher number of the population is clustered around the mean and thus limited variation within the population, while a lower standard deviation value is due to greater variation within the population and a lack of convergence towards an optimal solution. The results presented will aim to clarify the extent to which the utilization of the standard deviation factor as a fitness criterion can be advantageous to generating fitter individuals in a more efficient timeframe when compared to conventional simulations that only incorporate architectural and environmental parameters.

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