A GENETIC ALGORITHM BASED TOOL TO EXPLORE THE SOLUTION SPACE OF BUILDING FORMS ON THE HIGH-RISE-HIGH-DENSITY PLOTS

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1. Introduction

In the quickly urbanization process of Chinese cities, one of the daily works of urban designers is to produce suitable building forms on plots according to different land developing indexes (floor area ratio or FAR, building height, and land coverage are the three major indexes), the aim of which is to test and visualize the indexes provided by the planning bureau. However, in the case of high-rise-high-density plot type, this work becomes labour and time costly, because there are numerous building form options due to the high density. From the perspective of algorithm, to design a building form on one plot is to find a solution to the land indexes constraints. All possible solutions compose the solution space of the plot. The problem of the high-rise-high-density plots is the huge scale of the solution space, which is too broad to be covered by human ability. An efficient way to travel through the solution space needs to be discovered. In this research, a computational tool, which combines the parametric modelling technique and genetic algorithm, is developed to help solve the above problem. Two applications of the tool are presented in this paper.

2. A GA-based tool and its applications

A GA-based tool: supported by an empirical morphological study, a parametric model for the high-rise building complex is constructed (Figure 1). Diversified high-rise building forms could be developed from it. The genetic algorithm is applied to search solutions, with one of the major land indexes, FAR, as the basic evolutionary target. The output of the tool is a set of high-
rise building complexes, which have different forms from each other, and approximate the FAR target.

Application one: mapping the solution space (Figure 2). On a typical plot (1.5 ha with square shape), the tool produces 900 high-rise building samples fit the different FAR target which vary from 3 to 11. The samples are diversified, and marked in the height-FAR chart with additional land coverage information. From this chart, the distribution pattern of the solutions could be recognized, and the shape of the solution space is outlined. The complicate co-relations of the 3 major land indexes could be further studied form the chart.

Application two: developing urban form scenarios (Figure 3). In this application, the site of a real urban design project is chosen. Beside the basic evolutionary target, building height is included as the other target in the evolution process. 3 scenarios are produced with different building height orientation. The above applications, one in a theoretical way, and the other on the practical level, demonstrate the work ability of the tool.

Figure 1. The parametric model of high-rise building complex.  
Figure 2. The solution space of a typical plot.  
Figure 3. Different urban form scenarios for an urban design project.

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References