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URBAN GROWTH MODELING WITH ROAD NETWORK EXPANSION AND LAND USE DEVELOPMENT

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As a complex system, urban consists of various interactive sub-systems, among which land use and transportation systems are considered as two most important sub-systems determining urban form and structure, and they are assumed to mutually influence each other over time. Most of previous land use models used static transport network to calculate travel time, traffic assignment and etc. While in the field of urban reconstruction and city modeling, most road generation methods used existing land use maps or population density maps as input data. In this research, we intend to build a long-term urban growth model, by combining land use and transportation systems together to study the relationship between land use change and transportation network growth.

Our urban simulation mainly consists of two parts: one is vector road network growth, and the other is grid land use changes. In the road network growth model, we define two road types: major roads and minor roads, and generate a dynamic road network instead of a static one which is usually based on a current population density map. The road growth strategy is mainly based on previous works with one improvement: we add a traffic flow model to control road growth. Point-based metrics in space syntax are adopted to estimate the distribution of traffic flow. We calculate each node's local integration, and sum them into individual roads, which are extracted from road segments according to self-best-fit principle. The roads with high local integrations are chosen as major roads. The land use simulation includes five land use categories: residential, industrial, commercial, roads and parks. There are two behavior sub-models: one is mobility model, which moves a subset of land developer agents to new places in each period, and the other is location choice model. As for residential, commercial, and industrial agents, their location choices depend on various attributes: such as distance to center, terrain, accessibility, clustering, neighborhood and etc. One novelty of accessibility calculation here we not only calculate the distance to the nearest roads dynamically, but all roads within a radius. Besides we use the estimated traffic flow as a weight parameter for each road.

Our simulation results show some similar urban patterns as the real cities. Residential areas attempts to develop with high accessibility to roads and segregate themselves from industrial areas. Commercial areas are drawn to city center and areas of high road density, and close to major roads. Industrial areas tend to develop in urban periphery. With city growing, some remain while the others move to new city fringe. Major roads show a skeleton of the growing city. Some roads change from major roads in an early time to minor roads in the next period, depending on the traffic flow along the roads.

In conclusion, this research generates a long-term urban growth model instead of creating a static one. This model combines vector road network with grid land use. Vector model has advantages in topological analysis while grid model is easy to visualize land cover changes. Space syntax metrics are introduced to control road network generation by calculating traffic flow, which is also used for accessibility calculation. Our model has several limitations and needs to be improved in the future. For examples, behavioral models used here are rather simple and could be improved. A demographic model is demanded because dynamic population distribution and density maps are critical for road growth.