Simulation of Pedestrian Evacuation with Obstacles
Based on Cellular Automata

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Introduction
A simulation of pedestrian evacuation flow in room with obstacles will be presented based on cellular automata (CA). Using two basic dynamic parameters in Dynamic Parameters Model (DPM) to simplify tactically the decision-making process of pedestrians in their evacuation movements. First, the computations of two basic dynamic parameters are described in detail, which need actual shortest distance from anyone cell site to the exits in room with obstacles. Second, a special technique will be introduced to compute actual shortest distance, which is the actual shortest walking distance that pedestrians avoid and pass by obstacles and leave evacuation room in ideal condition. Finally, pedestrian evacuation flow with obstacles is simulated and studied.

Basic rules
1. Simulation model is defined on a discrete (W+2)×(H+2) cell grid in the two-dimensional system.
2. Each cell can either be empty or occupied by no more than one particle.
3. Pedestrian may not stride or cross over obstacles and wall; and can only avoid and pass by obstacles.
4. Pedestrian must leave evacuation system through room exit. After leaving system, pedestrian will not reenter the room.
5. In pedestrian movement, obstacles cannot block the view line of pedestrian. pedestrian can see and be familiar with the layout of all obstacles.

Dynamic parameter
In every time step, pedestrian can choose any cell of the movement field as the possible choice of position. Pedestrians choose to wait or move according to the corresponding transition payoff (Pij). In movement field, every cell possesses two dynamic parameters: Empty-parameter (Eij) and Direction-parameter (Dij). Eij indicates whether the cell is occupied or empty; Dij indicates the cell’s degree of approximation to the pedestrian destination, i.e. room exit.

Actual shortest distance computation
It is hypothesized that there are an imaginary flows starting from exit and spreading to anyone cell direction with constant speed. When imaginary flows encounter obstacles, the directions of spreading will be changed and continue to spread. In the process of spreading, imaginary flow will be expanded forward to neighboring eight directions from the cell at the frontal edge of imaginary flow possessing the smallest actual shortest distance. Cell(i, j) already passed by imaginary flow is labeled with P-tag, which indicates that actual shortest distance from the cell to exit is confirmed as P(i, j). Cell(i, j) generated by imaginary flow expanding at the frontal edge and without being compared to seek actual shortest distance is labeled with E-tag, which indicates that the actual shortest distance is estimated as E(i, j). Cell without being passed or expanded is labeled with T-tag, which indicates that the cell will be expand and passed by imaginary flow in the future.

Simulation
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