Project 1 Checkpoint

CSE6730 16Spring Group 12

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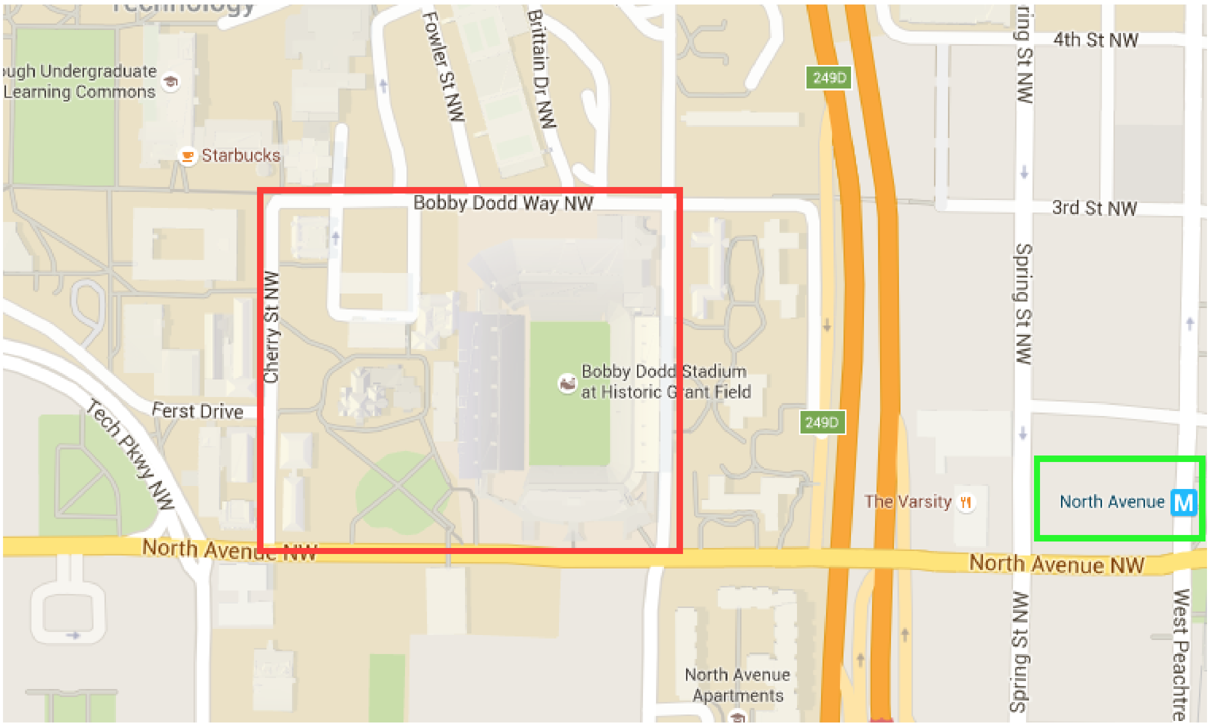
1. Problem Description

The project is intended for simulation of pedestrian egress of Georgia Tech Bobby Dodd Stadium after a football game. An efficient evacuation plan should be come up with the simulation to optimize the evacuation time. A stochastic cellular automata model would be developed incorporating the individual behavior of pedestrians. In the scope of this project, since it is too time and memory consuming to model the whole campus with all possible destinations, the geographic range of simulation is defined as the red rectangular shown in the picture below.

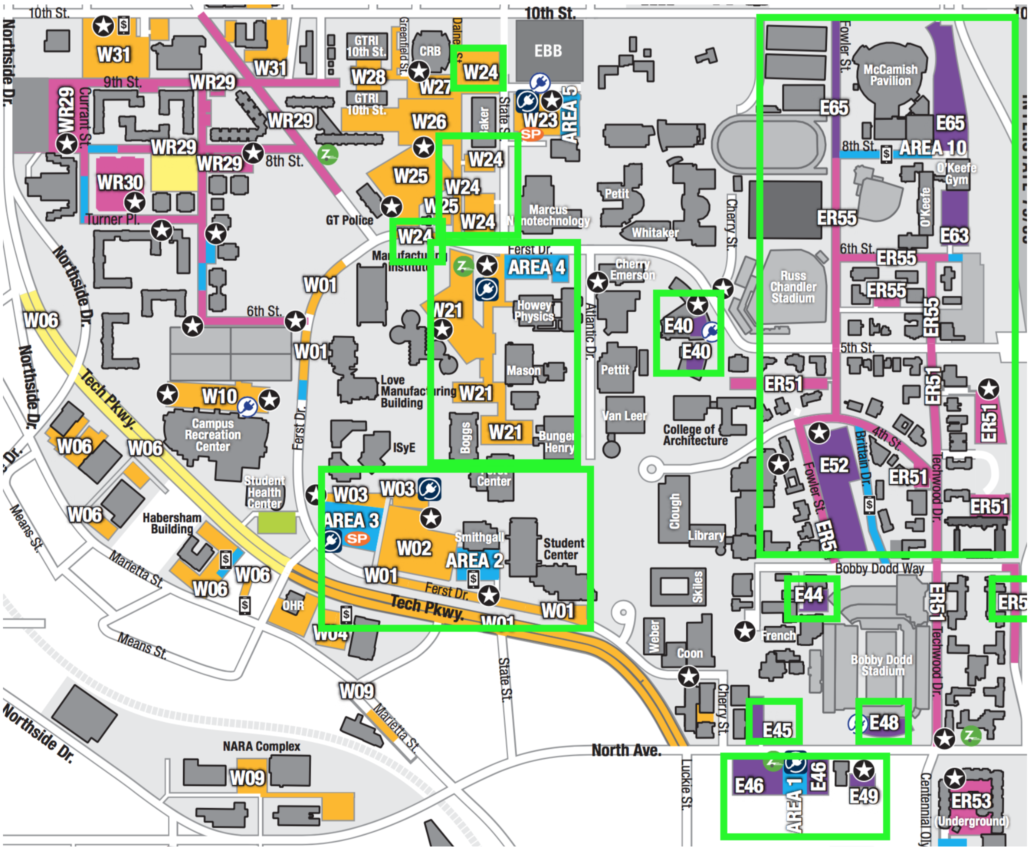


Several exits related to people’s final destinations will be assigned on specific locations along the red circle, these exit points are refered as notional destination. Once people from the stadium have reached the notional destination, that people instance will be removed from the modeled area at the next step.

The final destinations could be divided into three categories: North Avenue MARTA Station, Vistor paking lots around the campus and student residence halls.

North Avenue MARTA Station is shown in the picture above with a green box.

Gameday vistor parking lots are highlighted in the picture below by green boxes.



Students residence halls are marked as yellow blocks in the map below.

2. Literature Review

As for how to model the pedestrian behaviors and dynamics, we found that two models are the most popular based on our research. The first is social force model. Based on [1], the first force needed to be defined is the acceralation. The pedestrians are always assumed to go on the fastest road to his/her destination. Secondly, to model the interaction between pedestrians, each pedestrian is assigned an ellipse based on his speed and the density of floor. That ellipse represents the occupied space, which has a repulsive force to other pedestrians. Thirdly, attractive force springs from other persons (friends, street artists, etc.) or objects (e.g. , window displays) is defined as well. Lastly, a fluctuation term is imported to model the random behavior of pedestrians. Later, this model is further expanded, such as in [2], special characteristics (e.g group evasion) of pedestrian crossing behavior is further taken into account to better model condition of pedestrian in signalized crosswalk. In addition to the social force model, the other classic model for modeling pedestrian dynamics is the floor field model, which we think is very suitable to use with cellular automation. In [3], it says that the transition probability of a pedestrian is composed of three parts -- the pedestrian's preference, static floor field and also the dynamic floor field. The pedestrian's preference is determined by the pedestrian's relative position to his destination. The static field represents the attractive spots for pedestrians, such as the exits. Lastly, the dynamic floor is used to model the long and short distance interaction between pedestrians. It's evolving with time. Similar to social force model, the floor field model is also extended and updated later to simulate the evacuation process [4] and also movement of pedestrians in 3D dimension [5]. The transitional matrix including static and dynamic floor model is improved in order to match the reality better without explicit matrix of preference [6].

References:

[1] D. Helbing, A mathematical model for the behavior of individuals in a social field, Journal of Mathematical Sociology, 19 (3) (1994), pp. 189–219

[2] Weiliang Zeng, Hideki Nakamura, Peng Chen, A Modified Social Force Model for Pedestrian Behavior Simulation at Signalized Crosswalks, Procedia - Social and Behavioral Sciences, Volume 138, 14 July 2014, Pages 521-530, ISSN 1877-0428, http://dx.doi.org/10.1016/j.sbspro.2014.07.233.

[3] C Burstedde, K Klauck, A Schadschneider, J Zittartz, Simulation of pedestrian dynamics using a two-dimensional cellular automaton, Physica A: Statistical Mechanics and its Applications, Volume 295, Issues 3–4, 15 June 2001, Pages 507-525, ISSN 0378-4371, http://dx.doi.org/10.1016/S0378-4371(01)00141-8.

[4] Xiao Yang, Binxu Wang, and Zheng Qin, "Floor Field Model Based on Cellular Automata for Simulating Indoor Pedestrian Evacuation," Mathematical Problems in Engineering, vol. 2015, Article ID 820306, 10 pages, 2015. doi:10.1155/2015/820306

[5] Jun, Chulmin, and Hyeyoung Kim. "A 3D Indoor Pedestrian Simulator Using an Enhanced Floor Field Model." Agents and Artificial Intelligence. Springer Berlin Heidelberg, 2010. 133-146.

[6] Kirchner A, Schadschneider A. Simulation of evacuation processes using a bionics-inspired cellular automaton model for pedestrian dynamics[J]. Physica A: Statistical Mechanics and its Applications, 2002, 312(1): 260-276.

3. Conceptual Model

3.1. Input

3.1.1. A distribution of the flow over time at stadium exits after the end of football game

3.1.2. The stochastic destination assignment to pedestrians

3.1.3. The stochastic group assignment to pedestrians

3.1.4. An evacuation plan involving closing streets and routing people to their destination

3.1.5. Signals at the crosswalk

3.2. Output

3.2.1. The evacuation time

3.2.2. The visualized dynmaic evacuation process

3.2.3. Congestion analysis

3.3. Content {Attributes}

3.3.1. Pedestrian{
ID(No.),
Coordinates,
Speed(associated with the cell density),
Destination,
Preferred exit(associated with destination),
Size of Group,
preference matrix
}

3.3.2. Cell{
Coordinate,
State(<0 when no walking is permitted, =1 when occupied, =0 when available),
density
}

3.3.3. Stadium Exit{
Coordinates,
flow distribution
}

3.3.4. Pedestrian Signal{
Coordinates(on a crosswalk where vehicles are permitted),
state(stop/pass),
ControlCell
}

3.4. Event and Activity

3.4.1. Pedestrian:

- Walk(either direction or stop)

- Exit(out of the borders)

3.4.2. Stadium Exit:
- Stadium discharge flow

3.4.3. Crosswalk Signal:
- State change

3.5. Assumptions and Simplifications

3.5.1. Assume that intervals between people released from stadium during egress process, the distribution is similiar to classroom evacuation after class.

3.5.2. People's movement inside the stadium is not modelled. Assume each stadium exit has the same flow distribution over time when there is no conjection at the exit.

3.5.3. Assume a random number range from 1 to 6 is assigned to denote the group size. Assume a group of people always stay toghther and share the destination during the whole period.

3.5.4. All entities are assumed to have the same speed without congestion despite the different sizes of groups.

3.5.5. Once people's density reaches 4 people per square meter, it is assumed to be a congestion incidence. If a congestion incidence last as long as 10% of total egress period, it is considered a severe one.

3.5.6. Once a congestion take place at the stadium exits, assume people who are inside the stadium about to come out, are temporarily paused from evacuating process.

3.5.7. People are randomly assigned a final destination with equal probability(the possible destinations are limited to Marta station, several on campus dormitories and several campus parking lots).

3.5.8. Assign each final destination a notional destiation on on the edge of the model. People who once arrived at the notional destination will be removed from the model map, and assumed to reach this final destination.

3.5.9. Assume people always obey crosswalk signals; Once traffic signal turns red, pedestrains who on the crossing area will reach the other side immediately, and the crossing will be cleared.

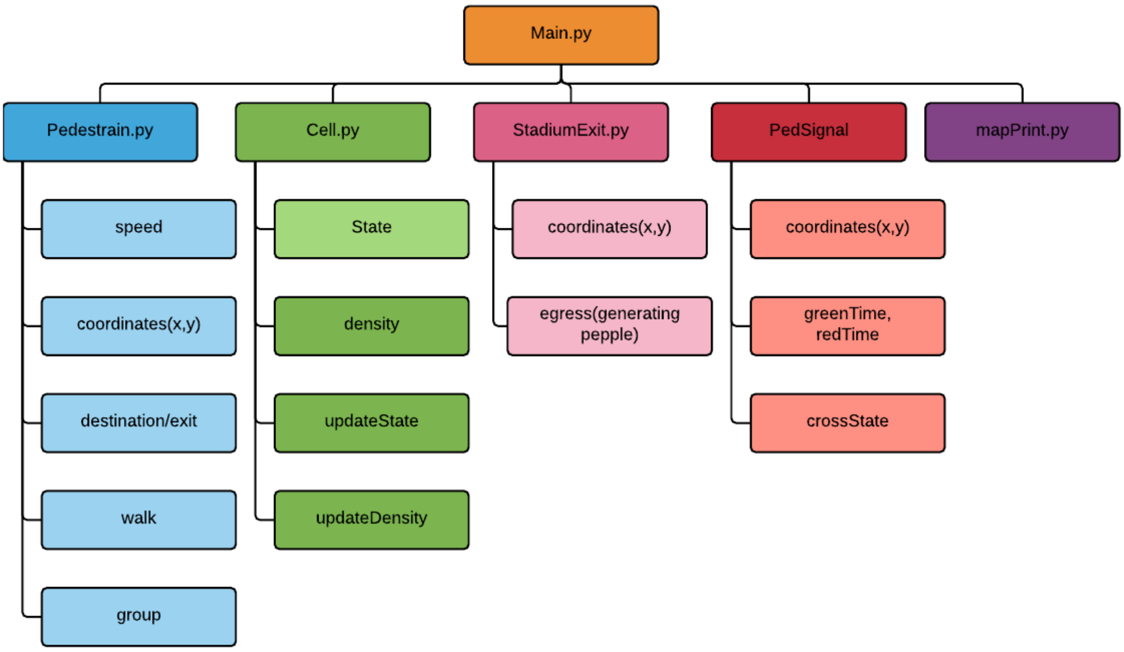
3.5.10. Assume that the transitional probability is combined with the static floor field, the dynamic floor field and the matrix of preference. The implicit assumption is the choice of pedestrain depends both on the distance from the exist and on the social influence by the surrounding population.

3.5.11. The conflict solution is that if two pedestrain have the same target cell, they have equal opportunity to occupy it, and the other pedestrain or group choose the second optimized target cell.

4. Description of Simulation software

Architecture & Interfaces:

The class hierarchy is shown below:



The simulation procedure shown in the Main.py could be summarized as the pseudo-code below:

```
Initialize the CA model map as a matrix with instances of Cell as elements

Draw the map with more details: walking zones, no walking zones, signals(crosswalk), stadium exits

#simulation begins!
while numberOfPeopleOnTheField>0:
    timeStep + 1

    generating people from exit
        check conjection

    signal state check

    people movement(walking)
        if people get out of the field:
            numberOfPeopleOnTheField -1

    print the map with GUI
```

5. Work Simulator Code

A README.txt file with Working Simulator Code (at a preliminary level) attached seperatly.