Beacon of Life -- Python Simulation of Best Evacuation Routes

Group: You Name it

Members:

Outline

1. **Problem**
2. **Modeling**
3. **Simulation**
4. **Conclusion**

Problem

Unexpected disaster claimed a huge number of people’s lives.

In order to reduce disaster casualty, it is important to develop an efficient evacuation system.

We use our classroom to set up the model.

Sangzao Middle School after earthquake
In the 2008 Wenchuan earthquake, Sangzao Middle School is the only school without a casualty.
Since 2004, the principal of the school has organized several emergency evacuation drills every semester.

Problem--Consideration

What do people take into consideration when evacuating?

Congestion

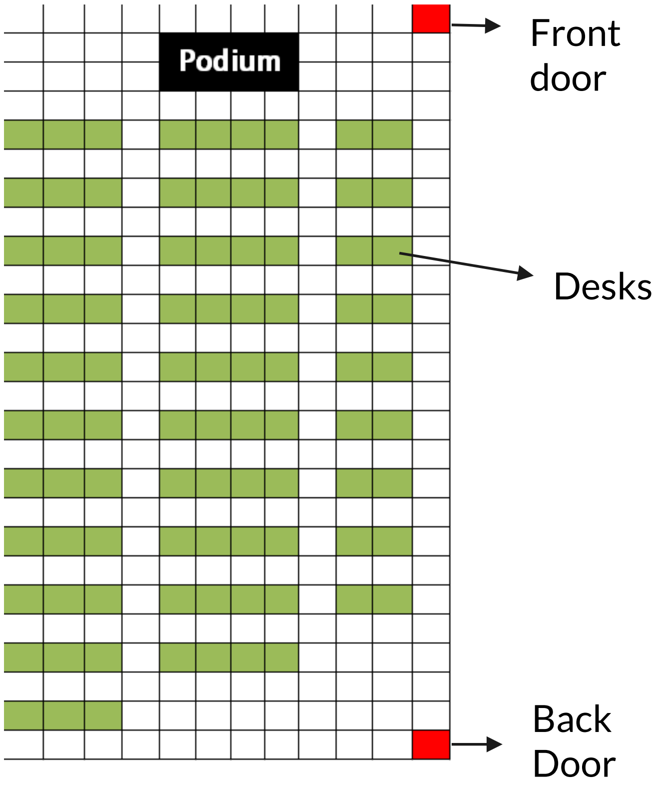
Distance

Barriers

Status of Exits
(width, new or old)

We can solve them one by one during modeling.

Modeling--Representing Classroom by Cells

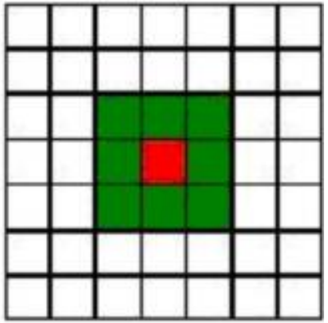


Square: 0.4*0.4m^2

12 cells wide, and 26 cells long

Each evacuee can occupy one blank cell only per time step, when reaching one of the red cells that represents the exits, the evacuation is done successfully.

Modeling--How does evacuee choose to move? Idea of Static Floor Field

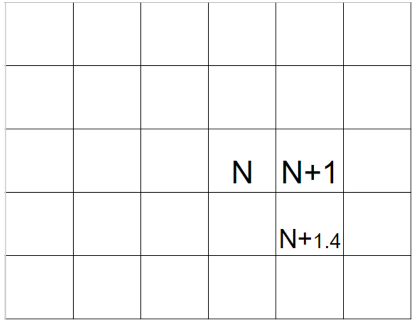


Moore Neighborhood:

The state of each cell is determined by the eight cells around it.

Static Floor Field:

1. Define the values of all the cells representing exits as zero.



2. Calculate every cell's value of static floor field based on the cells whose values are known.

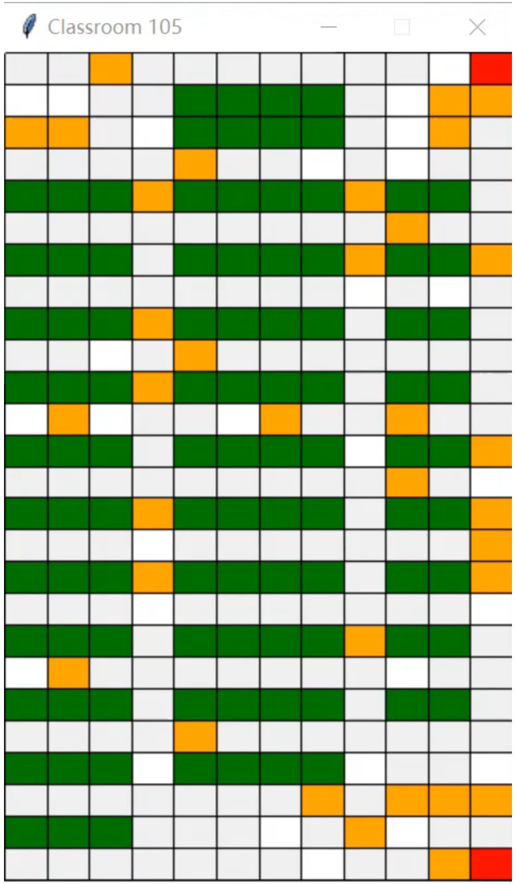
3. After figure out all the cells' q_n values, we get the maximum value of static field in the two-dimensional cellular space q_{max}. Replace q_n with $q_{max} - q_n$.

4. Replace the values of the cells which are occupied by barriers with zero.

Modeling -- Rules of movements

1. Utility Equation Describing People's Evacuation Behaviors: $U_{in} = V_{in} + \epsilon_{in}$
2. Evacuees always choose the exit that has the largest utility to them, so the probability of evacuee n choosing exit i is: $P_{in} = prob[U_{in} > U_{jn}, \forall j \neq i \in C_n]$
3. Pedestrians move at the same time, and one step each time
4. For each time step, the evacuee keeps the target exit with the probability P, otherwise it is based on the the probability P_{in} to determine the next target exit.

Simulation

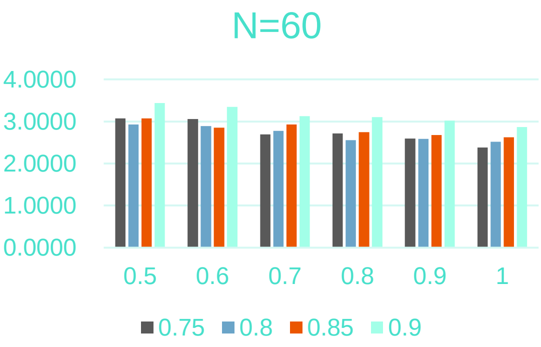


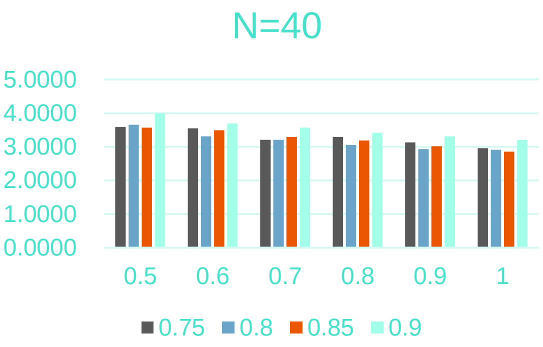
- ✓ First we start by defining key variables. Here we give 40 students, and each of them have 10 percent of chance of going at a random direction rather than the shortest one.
- ✓ Then we start simulating. 40 orange squares representing 40 students are randomly placed in the room.
- ✓ And they begin to move towards the doors.
- ✓ The simulation ends when everyone escapes. In this situation it took 85 steps to complete.

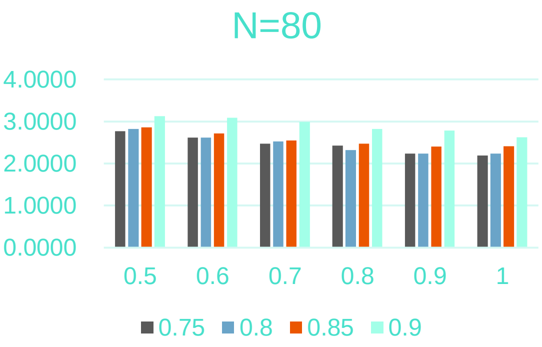
Simulation--Results

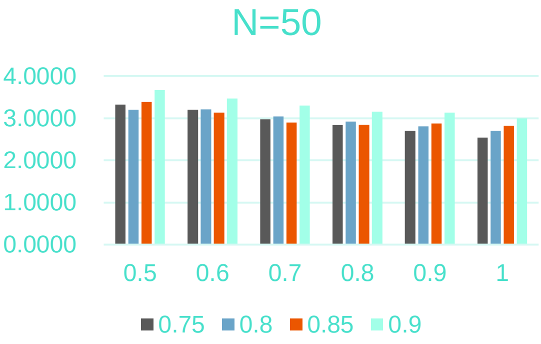
We can see that when there are a large number of people, change the escape route (the smaller the P), we can achieve a shorter average escape time. When there are less people, a better P value is showed as 0.8.

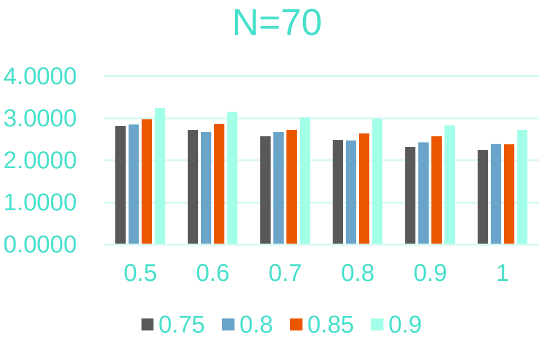
Simulation--Results











Conclusion

- When the model with small number of evacuees, the evacuation time is longer than expectation
- When the model with large number of evacuees, the evacuation time fits the expectation
- So our simulation is **preciser** when large size of evacuees