Pedestrian Evacuation of Bobby Dodd Stadium

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Introduction

- Focus is **most efficient evacuation strategy** of Bobby Dodd Stadium (Fig. 1) at full capacity (~55,000 people).
- Goal was to **minimize the pedestrian evacuation time** of the stadium area as attendees leave following a home football game.
- Previous models have used **cellular automata**, **social force**, **agent-based** [1] approaches.
- Variety of interesting phenomena arise in pedestrian simulations: **jamming** [2], **clogging**, **arching**.
- In cellular automata literature, concept of **floor field** (secondary grid of cells underlying main grid) [3] has precedent. Acts as **substitute for pedestrian intelligence.**

Model

- Took a **stochastic**, **discrete** time-stepped approach based on **cellular automata**.
- Input: **pedestrians exiting the stadium** (Poisson).
- Selected pedestrian entrance, destination location at random from predefined groups.
- Output: **timesteps to evacuate** area around the stadium.
- System modeled as an undirected **weighted graph**.
- Modified Dijkstra's algorithm used for **computing shortest path** to pedestrian destination.
- Closing/opening/management of **intersections** used for parameterization.
- Took **object-oriented** software approach: Pedestrian, Intersection, Node, Edge classes.

Results

- For each of **10 intersection configurations**, 20 simulation runs were performed.
- Each 20-run set is basis for **90% confidence intervals** for average evacuation time.
- Closure of **intersection 9** results in approx. **15 minute increase** in evacuation time.
- Maximum confidence interval was **0.9 minutes**.

Intersection ID	1	2	3	4	5	6	7	8	9	10
1	open	normal	open	normal	open	normal	open	normal	normal	open
2	normal	open	open	normal	normal	open	open	normal	normal	normal
3	normal	closed	normal	normal	normal	closed	open	normal	closed	closed
4	normal	normal	normal	normal	normal	normal	normal	normal	normal	normal
5	open	normal	normal	normal	open	normal	open	open	closed	open
6	open	normal	closed	normal	open	normal	open	open	normal	open
7	normal	normal	normal	normal	normal	normal	normal	normal	normal	normal
8	normal	normal	normal	normal	normal	normal	normal	normal	normal	normal
9	normal	closed	normal	normal	closed	normal	normal	normal	closed	normal
10	normal	normal	normal	normal	normal	normal	normal	normal	normal	normal
11	normal	normal	normal	normal	normal	normal	normal	normal	normal	normal
12	normal	normal	normal	normal	normal	normal	normal	normal	normal	normal

Figure 4. 10 simulation configurations that were tested. Configurations are on the x-axis, intersection IDs (see Fig. 5) are on the y-axis. **Open** = open to pedestrians; **normal** = traffic cop supervision; **closed** = closed to pedestrians.

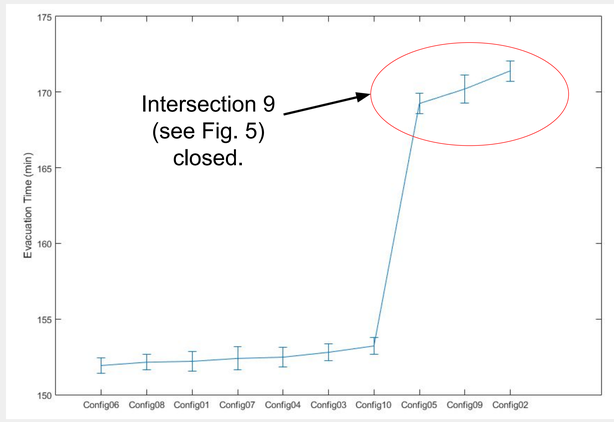

Figure 3. Simulation results. Different simulation configurations are on the x-axis, and minimum evacuation times with 90% confidence intervals are shown on the y-axis. **Lower is better.**

Conclusions

- All intersection configurations feature evacuation times within **~15 minutes** of each other.
- **No single configuration** yields significantly lower evacuation time.

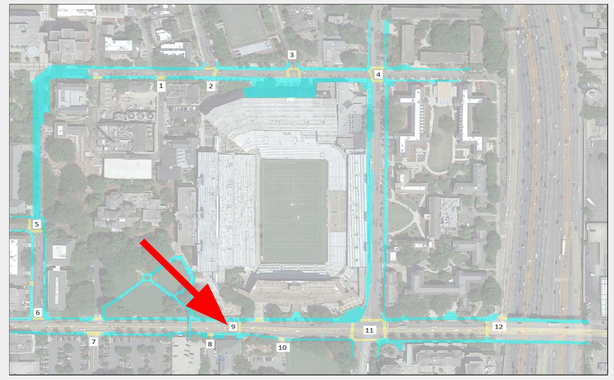

Figure 5. Map of the SUI with intersection 9 indicated by a red arrow. The closure of intersection 9 to pedestrian traffic appears to be pivotal in extending evacuation times.

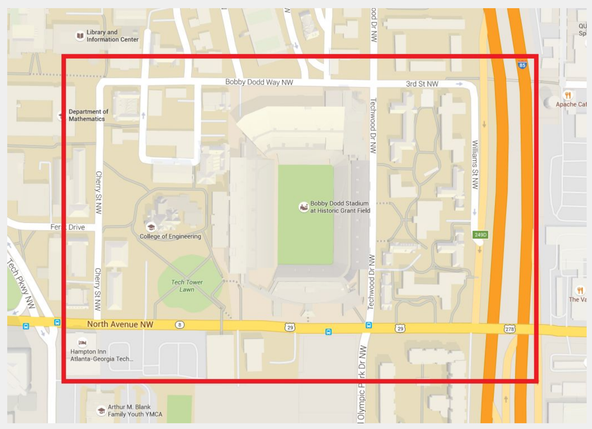

Figure 1. System Under Investigation (SUI). The area surrounding Bobby Dodd Stadium at Georgia Tech.

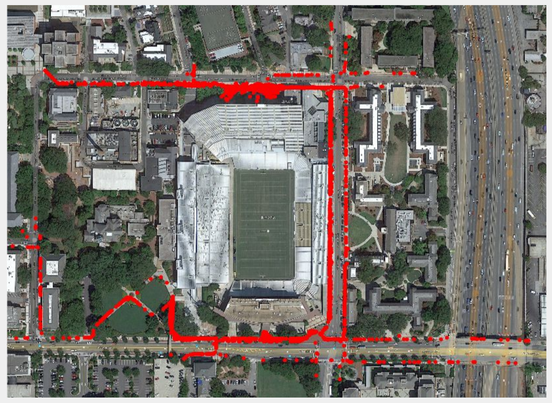

Figure 2. Sample simulation run. Red dots are pedestrians.

Bibliography

[1] Xiaoping Zheng, Tingkuan Zhong, and Mengting Liu. Modeling crowd evacuation of a building based on seven methodological approaches. Building and Environment, 44(3): 437–445, 2009.

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[3] Carsten Burstedde, Kai Klauck, Andreas Schadschneider, and Johannes Zittartz. Simulation of pedestrian dynamics using a two-dimensional cellular automaton. Physica A: Statistical Mechanics and its Applications, 295(3):507–525, 2001.