Thomas Jefferson Hallway Traffic Simulation

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Abstract

Simulations are efficient ways to model data, once the framework is set up. By looking at a simulation, the user can glean any amount of information about a system (in this case, a school). A simulation of TJHSST could be useful not just to the administration is determining the effect of certain alterations to school policies, but also to visitors in learning the layout of the school and how to best interact with the diverse student populous. Simulations of TJ have been done before, but they were almost exclusively data (text- or number-based) none of them took into account the social interactions between students and faculty, therefore missing out on a large part of what makes a school tick. My simulation is highly visual and interactive to make it most-easily-understood. The data layer can include congestion, student-area density, average speeds, times to the next class, and time spent dawdling.

1. Introduction

1.1. Purpose

A hallway traffic simulation at schools could serve to design better-laid-out hallways and classrooms. By using an agent-based model with great attention paid to social factors, an architect could determine where clusters of students will cause bottlenecks in hallways and how to best circumvent them. Simulations also provide for interesting insights into path-finding and social dynamics.

1.2. Scope

My intention is to model the traffic of people, both students and faculty, during the school day. Each agent would have social factors coded into it which may cause that agent's actions and movement to change based on interactions with other agents. My program is easily scalable and changeable in that it is easy to add or remove agents without restarting the simulation or to change the layout of a school. Because the decisions are generated dynamically, the agents will adapt to whatever shape and size environment they are generated in. I plan to be able to save simulations and (therefore, logically) be able to read in "save files" to pick up on a simulation from where it was left off.

1.3. Research Hypothesis

By simulating a school with as complete of a simulation as possible, architects will be able to identify bottlenecks during design, faculty will be able to interact better with the students, and visitors will be able to navigate the school better.

Keywords: *agent, agent-based modeling, simulation, interactive, hallway traffic*

2. Background

2.1. Online Research

I found one helpful article on portal.acm.org, which related to a study of social dynamics within a virtual ecosystem. It discussed a mathematical algorithm for assigning a numerical value to the compatibility between two agents. I found this numerical assignment interesting it started me thinking about a scale-based personality method rather than a numerically-unrelated system.

2.2. Past Computer Systems Lab Projects

There have been several tech-lab projects on the same general topic in the past.

2.2.1. Paul Wood (2009)

Paul Woods' simulation was also modeled after TJ's hallway traffic, but his simulation was focused on whether or not students were able to make it to their classes on time rather than how social factors affected the congregation areas.

2.2.2. Peter Riggs (2007)

Peter Riggs conducted a research project centered on simulating hallway traffic at TJ but, again, his project ignored the inter-student interactions and presented an (extremely inefficient and processor-heavy) algorithm for determining the most direct way for a student to find his or her way to their next class. Rather than using a dynamic collision detection model, Riggs chose to have *each agent* re-run his path-finding algorithm after each computational cycle so that its path would change depending on the new (integer-based) location of every other agent.

3. Theory

Simulations are efficient ways to predict how changes would affect a system. Several projects have been done before on hallway traffic at TJ, but those projects missed out on a very important factor; they took into account the path-finding aspects, but lacked any social aspect. Adding social factors - grade, gender, shared classes, and geographic location, for example – adds an entirely new spin on the situation. While the gender, shared classes, and geographic location would affect who a given agent interacts with, the grade is what I would consider the largest variable when determining how that agent detours around the school between classes. The most obvious examples would be each grade and their respective congregatory area: seniors to senior lounge, juniors to the physics hallway, etcetera.

4. Development

4.1. First Quarter

Throughout the first quarter, I tinkered around with how I wanted this simulation to work. I toyed with several different interface designs, control schemes, and data output methods. At the end, I had a very basic prototype of the direction in which I planned to take my project. That prototype included a skeletal school with rooms not arranged in any particular order, an integer-based movement grid, and no path-finding. Students themselves were in (almost) no way different and had no interactions with the others.

4.2. Second Quarter

During the second quarter I nearly completed the framework for my simulation program.

4.2.1. Control

- Improved dexterity of mouse controls (using both buttons) for selection and control
- Clickable dynamic buttons for both contextual and universal commands
- Keyboard commands for toggling directional, temporal, and spatial simulation controls

4.2.2. Interface

- Again, the on-screen buttons are a visual improvement.
- Improved data output conveys contextual information based on the selected student or room.
- Pathing for the selected student is drawn in that students own color. The selected student and room are highlighted with brightened colors to make it easier for the user to identify the selected student.

4.2.3. Framework

- Students find their way around corners without trying to travel through the wall. With an appropriately-laid-out grid, students can find their way from any location to any destination without getting stuck.

- Students no longer walk through each other, again, using a custom collision-detection algorithm.
- Using a float-based grid instead of an integer-based one, the agents can have different movement speeds and move at non-cardinal angles.
- Students now begin moving toward their next period after a staggered release. It's unrealistic for every student in the school to leave class at the same time, so I fixed that.
- When adding students, they "spawn" at realistic locations, such as entrances to the school or floor, rather than randomly in an open space.
- Each student is generated with their own schedule of seven classes to go to. They follow that schedule as the time ticker increments.

5. Results and Data Interpretation

5.1. Reading the Output

Now that my framework is robust enough for a full-blown simulation, I added hallway "blocks" to the mix. Each block will change its color and intensity based on the percentage of the total number of students contained in that block. The shift of the highest density of students is represented by the changing colored blocks.

5.2. Expected Results

Currently, my model provides accurate parallels to movement in the uppermost hallways. As IRL, the most crowded locations are the two intersections above Junior Lounge and the library. Later, more hot-spots will be highlighted, once I add the bottom floor of the school.

6. References

6.1. D. C. Brogan and J. K. Hodgins, “Group behaviors for systems with significant dynamics", *Autonomous Robots 4*, pp. 137-153, 1997.

6.2. D. C. Brogan, R. A. Metoyer, and J. K. Hodgins, “Dynamically simulated characters in virtual environments", *IEEE Computer Graphics & Applications* 18, pp. 58-69, September/October 1998.

6.3. Katkova, Alex. “Traffic Dynamics of Scholastic Environments ", *Thomas Jefferson High School for Science and Technology*. 2006 - 2007

6.4. Helmut Kopka and Patrick W. Daly, A Guide to LATEX, Addison-Wesley Publishing Co., Inc., 1993.

6.5. Ben-Zwi, Oren. “An Exact Almost Optimal Algorithim for Target Set Selection in Social Networks ", *Stanford*. 2009