WHAT IS IT?

The Pedestrian Scramble model is an agent-based model intended to demonstrate the function of scramble crossings and establish a more efficient flow of pedestrian traffic with the presence of diagonal crosswalks measured by travel times.

HOW IT WORKS

After initializing this model with the SETUP button, the agents/pedestrians are separated into 4 different colors: red, blue, yellow, and green. The color-coded agents spawn inside quadrants that are farthest from their destinations and thereafter diffuse slightly within their quadrant. For instance, the red agents are attempting to reach the pink quadrant at the top right quadrant but are initially spawned at the bottom left quadrant (lime). Similarly, yellow agents are heading toward the orange quadrant, blue agents are heading toward the turquoise quadrant, and the green agents are heading toward the lime quadrant. Depending on the option selected for the “diagonals” parameter prior to setting up, a series of diagonal white patches across which the agents can walk appear as well.

Pressing GO will run the model and allow the pedestrians to start moving toward their respective destinations. If the “diagonal” switch is set to ON before intialization, all agents will travel diagonally across the crosswalk in order to reach their destinations. Otherwise, each agent are given a 50/50 chance to travel to one of two intermediate quadrants and travel to their final destination from there. For instance, the red agents may choose to either travel upwards to the turquoise quadrant or right to orange quadrant in various ways depending on the choice of the agent-type-(color) Choosers before initialization.

Agent Movement Types

Described here are the different movement styles/rules that a type of agent follows.

- **Relaxed Movement:** Agents with this type of movement attempt to reflect real-life pedestrians who are travelling in a relaxed manner. They travel at a regular walking pace (slower than those who are in a hurry with the Hurried Movement style) and observe how many other pedestrians are within 4 patches of the individual agent with a normal scope of vision (45 degrees to the left and right). Depending on the number of agents in front of an individual agent with this movement type, they will attempt to swerve out of the way to avoid collisions. In addition, their walking speed can also fluctuate depending on the number of agents within this scope of vision.

- **Rebellious Movement:** Agents with this type of movement serve as malicious actors to the real-life pedestrian crossing process. In the context of this model, these rebels will attempt to take a shortcut by not heading toward their intermediate quadrants before heading towards their final destinations when no diagonals are present, essentially providing them the opportunity to create a diagonal path of their own. Whether an agent of this type follows the traditional path or form a new diagonal path is made whenever an agent of this type is above any white patch of a vertical or horizontal crosswalk with a 90% chance of forming a diagonal path. In addition, these rebels do not record the number of agents in front of them, meaning that they can freely collide with other agents without harming their own progress.

- **Hurried Movement:** Agents with this type of movement reflect real-life pedestrians who happen to be in a hurry. As such, these agents travel at the fastest pace out of all of the movement styles and need to react to the presence of agents at a farther distance and than that of agents with relaxed movement. As aresult, they measure the number of agents within 6 patches as opposed to 4. In addition, these agents are provided a larger scope of vision from which to count the number of agents in front of them in order for them to react quicker (60 degrees to the left and right).

- **Passive Movement:** Agents with this type of movement try to look for the optimal path with the least amount of collisions with not only other agent types but also other agents that share this movement style, and they reflect real-life pedestrians who may be overwhelmed by the sheer amount of foot traffic in scramble crossings. For an individual agent to calculate such path, they first need a scenario where at least 35 other agents are within 3 patches of itself. From there, it now changes its bearing from facing the final destination to facing the nearest patch with the least amount of agents within 5 patches of itself. Their range of walking pace is set to be the same as that of the relaxed agent, regardless of the number of other agents within 3 patches of an agent with this movement type.

HOW TO USE IT

The SETUP button initializes the model.

The GO button runs the model.

Immediately below the SETUP and GO buttons is a Chooser titled DIAGONALS that selects whether or not a diagonal path is added during initialization.

From there, 4 Choosers are provided establish the movement types of the red, blue, yellow, and green agents, respectively, during intialization.

Next is the PEDESTRIANS slider that adjusts the total number of agents spawned during initalization. The number of agents need to be divided equally into four groups, so this slider ranges from 100 to 400, incrementing by 4 per step.

Finally, the STOPTIME slider dictates the maximum number of ticks that the agents have to complete crossing. The model will stop when all agents have crossed or the number of ticks is equal to the value of the STOPTIME slider, whichever comes first.

THINGS TO NOTICE

To the left of the model is an output screen that informs when a group of colored agents has finished crossing. If all the agents that share a color have not finished crossing by the tick value of STOPTIME, nothing about that color will be mentioned on the screen by the end of a run of this model. This screen allows to note when an agent type fully completes the crossing with respect to other agent types.

To the right of the model is a graph that informs the number of agents of a certain color that has yet to fully complete their crossing for any given tick. This graph will allow to view the rate at which each agent type completes crossing throughout a run of this model.

THINGS TO TRY

Provided that all agents possess the same movement style (e.g. all four agent groups move under the Rebellious Movement rule), try to find the minimum amount of ticks for all agents to complete crossing. Also try to perform this both with and without the use of a diagonal.

Given a certain arrangement of agents and movement types, try adjusting the number of pedestrians to see how the number of ticks for all agents to complete crossing changes. Try this both with and without the use of a diagonal.

EXTENDING THE MODEL

Unlike traditional agent-based models, each individual agent in this model does not have the ability to adapt to their surroundings aside from avoiding collisions with other agents. Each agent is unable change their movement styles based on their surroundings; rather, their movement styles are fixed to a group of individuals during initialization and do not change their movement styles under any circumstances during a run. Implementing the ability for individual agents to change their movement styles (e.g. if a relaxed agent sees more than 50 agents clumped together in front of them, that agent may consider turning “rebellious” and implement a shortcut on their own) can make this model a more accurate representation of pedestrian scrambles. How would the minimum ticks taken for all agents to cross change under such change to the current code?

In addition, the circumstances of this pedestrian scramble model assumes the “worst case scenario” where every agent has to travel to the farthest quadrant as their final destinations as opposed to making any intermediate quadrants their final destination. Such change can be theoretically implemented by providing agents three choices of going vertically to an intermediate quadrant, going horizontally to an intermediate quadrant, or going diagonally to their final quadrant with each agent having a 1/3 chance of deciding on one choice ina run with diagonals enabled. Once again, how would the minimum ticks taken for all agents to cross change under such change to the current code?

This current model is also limited in the sense that it is only capable of having 400 moving agents/pedestrians at one time. Japan's Shibuya Crossing, the world's busiest pedestrian scramble crossing, can see up to 3,000 pedestrians crossing at once. Would the minimum ticks taken for all agents to cross change if more than 400 pedestrians were crossing at one time?

NETLOGO FEATURES

This model makes heavy use of random number generation, but when a random number between a certain range of values is desired in our model, the random-normal primitive is one method of producing such values. This particular primitive reports a normally distributed random floating point number around an average value and a standard deviation.

RELATED MODELS

Braess Paradox: Located in the Social Science suite of models in NetLogo, this serves as the main reference for the Pedestrian Scramble model. The phenomenon behind the Braess Paradox model suggests that implementing additional routes to a traffic network actually leads to worse individual and global outcomes (i.e. travel times) as opposed to improving traffic. The phenomenon that drives our model differs from that behind the Braess Paradox, however, suggesting how adding routes can improve certain types of traffic.

CREDITS AND REFERENCES

Information on the Pedestrian Scramble:
https://www.wise-geek.com/what-is-the-pedestrian-scramble.htm

Information on Shibuya Crossing:
https://web.archive.org/web/20200812012537/https://www.worldatlas.com/articles/what-is-the-world-s-busiest-pedestrian-crossing.html

Rasmussen, L. and Wilensky, U. (2019). NetLogo Braess Paradox model. http://ccl.northwestern.edu/netlogo/models/BraessParadox. Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL.

Wilensky, U. (1999). NetLogo. http://ccl.northwestern.edu/netlogo/. Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL.