Coursework 2
CASA0011 – Agent-Based Modelling

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1. RESEARCH QUESTION

1. What is the influence of the number of pedestrians, speed limit, and time to cross on the number of pedestrians waiting to cross a street?
2. How can the number of people waiting to cross a street define the optimal space for sidewalks close to pedestrians crossing?

2. ODD DESCRIPTION

2.1. Purpose and patterns

This model serves as a simplified micro-simulation of a street intersection to investigate the connection between pedestrians' spatial concentration and their waiting time to cross the street. It does not aim to replicate a realistic street intersection with all its agents but focuses on understanding pedestrian behaviour within commuting flows and the available sidewalk space. The model explores three distinct patterns:

- High concentration near pedestrian crossings
- Alternating density in opposite sidewalk regions
- Non-proportional crossing time

By examining these patterns, the model aims to understand how pedestrian behaviour, commute flows, and sidewalk availability are interconnected.

2.2. Entities, state variables, and scales

Entities

The entities in the project are the pedestrians who are walking in random directions, aiming to cross the street to continue the walk. In that context, the model also has the street, the sidewalk and the building representing the built environment. Besides that, it also has a pedestrian crossing and a separation in the middle of the streets.

State variables

Variable name	Variable type and units	Meaning
meaning	String	Represents the role of the patch
will-cross?	Boolean	Indicates whether anybody is going to cross the street
used	Numeric	How many pedestrians are using the crossing
speed	Numeric	The current speed of a person
walk-time	Numeric	How long the person will walk before crossing the road
crossing-part	Numeric	Divides the crossing into parts
waiting?	Boolean	Indicates whether the pedestrian is waiting to cross the road
num-of-people	Numeric	The desired number of people in the simulation
time-to-crossing	Numeric	Represents the time taken to cross the road

Table 2.1: State variables

Scales
The model has not a specified scale.

2.3. Process overview and scheduling

The model is developed to simulate pedestrians' movement when they cross the street. The pedestrians follow specific rules such as walking on the sidewalk, waiting at the wait point close to the pedestrian crossing and then crossing the streets. Thus, the micro-simulation progress each interaction in the main loop following this step, allowing for tracking the movement and control of the interaction through the number of pedestrians, time to crossing and speed. To summarize, the simulations occur in that sequence:

1. Setup the environment 2. Main loop 3. Move pedestrians 4. Walking rules 5. Crossing the street 6. Simulation track

2.4. Design concepts

Basic principles

This model is based on the concept of agent pedestrian modelling in order to understand how ABM can support the understanding of pedestrian behaviour in the urban environment(Batty 2001). Thus, this analysis is based on studies related to the simulation of pedestrians at intersections and their relationship with traffic accidents(Cohen 2018), and also in order to understand pedestrian flow in a broader context(Chen and Crooks 2021). To build this model, methods presented in the Town-Traffic & Crowd simulation model(Lukas 2023) were applied to test the interaction of different agents in traffic.

Emergence

Despite giving a range of rules for pedestrians' movements, the number of people waiting to cross the streets and the location of people flow is a consequence of the behaviour of agents in the given environment; the output of this micro-simulation depends on this interaction.

2.5. Initialization

The code starts with the agents' definitions (breed [crossings crossing] and breed [person person], representing the road crossings and pedestrians. And then, Is defines the Patches variables and person variables as mentioned before. Thus, 'to setup' initialise the simulation environment, creating the street network, crossings, and sidewalks, and placing the pedestrians in the environment. First, in 'draw-roads', this procedure creates the crossroads setting the patches in grey colour in four directions(road-up, road-down, road-left and road-right).

Second, it created the sidewalks in 'draw-sidewalk', setting the patch colour in brown. After that is drawn the crossing on roads going up and down with a white square shape. The position is randomly positioned along the y-axis and x-axis. Besides that, it is implemented the wait points for pedestrians.

Third, this procedure places people on the sidewalks according to the desired number of people ('number-of-people). The model selects a random sidewalk patch and distributes the turtles with random attributes(speed, size, walk time, shape).

2.6. Input data

In the scenario presented, there are initially 75 people(0 to 1000 units). Crossing time ranges from 400 to 5000 units, with an initial value set at 1300 units. The speed limit for pedestrians is set between 30 and 150 units, with a default value of 50 units representing normal speed. The model's settings include a central location of origin, with a maximum x-coordinate and y-coordinate of 17 units each. The patch size is 10 units, and the font size for any displayed information is 10. The frame rate for visual updates is set at 30 frames per second.

2.7. Submodels

The submodels were built based on the model (Lukas 2023)

move-people

This procedure aims to move the person agents with the following rules:

- Check if the Walk-time of a person is greater than or equal to the time-to-crossing
- Check if the person is at the crossing point(crossing-part>=1)
- Check if the agent is at a wait point, and then indicate the intention to cross.
- Make the person close to the nearest wait point and then request a 'walk procedure' to move the agent
- If walk-time is not sufficient for reaching the crossing, it calls the 'walk' procedure

walk

This submodel is responsible for the basic walking behaviour:

- It checks the patch in front of the person's current position
- If the patch is a sidewalk or wait point, It checks if there is any other agent on that patch
- If the patch is not a sidewalk or wait point, the agent randomly turns right or left
- At the end, it checks if the agent has reached a wait point and updates the attribute (Waiting?)

cross-the-street

This procedure is focused on the agent's behaviour when crossing the street:

- If the crossing part is 1, the agent faces the next wait point2 with a specific radius and sets the crossing part to 2

- If the crossing part is 2, the person adjusts its direction
- the agent set the crossing part from 3 to 0, indicating the crossing is complete, and then the walk time is reset to 0
- the agent moves forward by a fraction of their speed and then the waiting? Attribute change to false to indicate that it is no longer waiting.

3. BRIEF METHODOLOGY

The methodology employed in this analysis involves conducting an experiment using behaviour space. The objective is to examine the relationship between three key factors: the number of pedestrians, the speed limit imposed on pedestrians, and the time required to cross the street. The aim is to determine how these factors influence the number of individuals waiting before crossing the street. By conducting this experiment and analyzing the outcomes, the analysis seeks to establish parameters defining the critical aspects to consider in urban design, particularly street intersections.

REFERENCES

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