StationSim GCS

Keiran Suchak

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1 ODD Protocol

ODD (Overview, Design Concepts, Details) is a protocol for outlining and documenting agent-based models [1, 2, 3]. The aim of such a protocol is to allow researchers to share and reproduce their models via a standardised format. The protocol consists of three components, each of which cover a number of different topics:

1. Overview providing an overview of the model, touching upon each of the following topics outlined in Section 1.1.
2. Design Concepts: detailing which of the following design concepts are relevant to the model (detailed in Section 1.2).
3. Details: elaborating on the internal mechanics of the model, which will cover each of the topics outlined in Section 1.3.

1.1 Overview

The Overview section of ODD aims to provide a cursory overview of the model that is being documented. This includes subsections on each of the following topics:

1. Purpose and patterns: What can a user expect the model to do/achieve, and what patterns might the model be fit to simulation [4]?
2. Entities, state variables and scales: What types of agents and environments are we looking to model, what variables are we using to represent them, and what spatial and temporal scales are we working at?
3. Process overview and scheduling: What processes govern the interactions in the model, and in what order to they occur?

This information should enable others to develop and outline of the what the model looks like at a functional level.

1.2 Design Concepts

When designing an agent-based model, there are a number of design concepts that are often incorporated. The following is a non-exhaustive list of the design concepts that may be involved in an agent-based model:

1. Basic principles
2. Emergence
3. Adaptation
4. Objectives
5. Learning
6. Prediction
7. Sensing
8. Interaction
9. Stochasticity
10. Collectives
11. Observation

These design concepts are detailed in greater depth in [2].

1.3 Details

The Details section of ODD aims to build upon the above sections, providing the specifics required to build a fully functioning model. This takes the form of the following topics:

1. Initialisation: What information is required to start the model with respect to defining the initial model state and calibrating parameter values?
2. Input data: What information does the model require as it runs?
3. Submodels: How do the individual processes governing model behaviour work?

2 ODD for StationSim GCS

2.1 Overview

2.1.1 Purpose and patterns

StationSim GCS is an updated version of the StationSim model. The original StationSim aimed to simulate the motion of pedestrians across a hypothetical rectangular station with 3 entrances on one side and 2 exits on the opposite side as shown in Figure 1. The new StationSim GCS also aims to simulation the motion of pedestrians across a station; however, in this case the model is based on the real-world example of Grand Central Station in New York, focusing specifically on the concourse area highlighted in Figure 2. This is reflected in the simulation environment shown in Figure 3. The environment consists of X gates which act simultaneously as both entrances and exits. Each pedestrian in the simulation is assigned an entrance and an exit and, upon entering the environment, seeks to move as directly as possible towards their assigned exit without colliding with other pedestrians. Where collisions are more likely to occur (e.g. close to entrances/exits and around solid obstacles), we typically observe crowding as population densities increase.

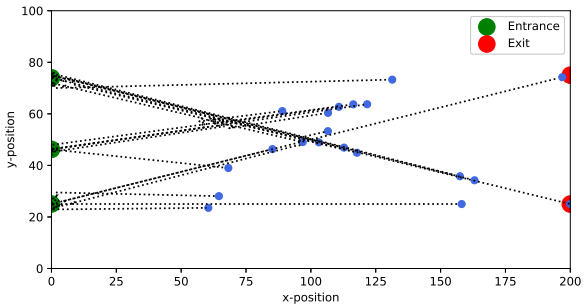

Figure 1: Layout of environment in original StationSim model.

2.1.2 Entities, state variables and scales

The StationSim GCS model consists of agents representing pedestrians moving around an environment. Agent attributes are detailed in Table X.

INSERT TABLES OF VARIABLES

- Agents

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- Gates

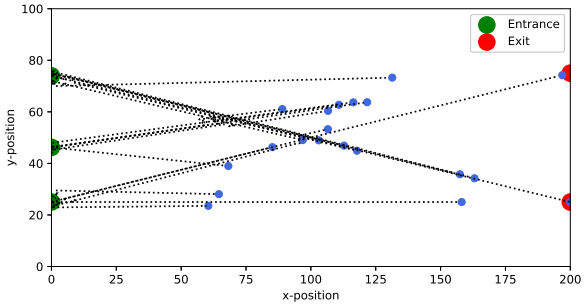

Figure 2: Layout of Grand Central Station concourse.

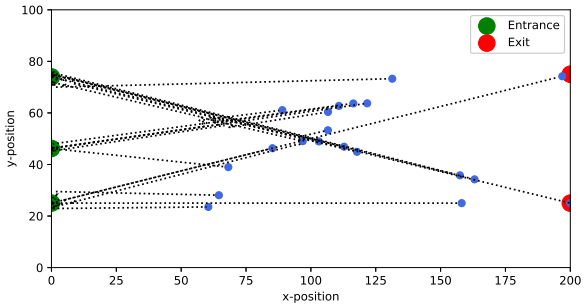

Figure 3: Layout of environment in StationSim GCS model.

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- Environment

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- Obstacles

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2.1.3 Process overview and scheduling

INSERT FLOW DIAGRAM OF OVERARCHING PROCESS OF MODEL

2.2 Design Concepts

1. Basic principles
2. Emergence
3. Adaptation

4. Objectives
5. Learning
6. Prediction
7. Sensing
8. Interaction
9. Stochasticity
10. Collectives
11. Observation

2.3 Details

2.3.1 Initialisation

2.3.2 Input data

2.3.3 Submodels

References

[1] Volker Grimm, Uta Berger, Finn Bastiansen, Sigrunn Eliassen, Vincent Ginot, Jarl Giske, John Goss-Custard, Tamara Grand, Simone K Heinz, Geir Huse, et al. A standard protocol for describing individual-based and agent-based models. *Ecological modelling*, 198(1-2):115–126, 2006.

[2] Volker Grimm, Uta Berger, Donald L DeAngelis, J Gary Polhill, Jarl Giske, and Steven F Railsback. The odd protocol: a review and first update. *Ecological modelling*, 221(23):2760–2768, 2010.

[3] Volker Grimm, Steven F Railsback, Christian E Vincenot, Uta Berger, Cara Gallagher, Donald L DeAngelis, Bruce Edmonds, Jiaqi Ge, Jarl Giske, Juergen Groeneveld, et al. The odd protocol for describing agent-based and other simulation models: A second update to improve clarity, replication, and structural realism. *Journal of Artificial Societies and Social Simulation*, 23(2), 2020.

[4] Volker Grimm and Steven F Railsback. Pattern-oriented modelling: a 'multi-scope'for predictive systems ecology. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 367(1586):298–310, 2012.