MOBS

Multi-agent Organized pedestrians with Built-in Specialization functions

User manual

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A detailed description of this work is provided in: Ballinas-Hernández, A, Muñoz-Meléndez, A, Rangel-Huerta, A (2011) "Multiagent System Applied to the Modeling and Simulation of Pedestrian Traffic in Counterflow". *Journal of Artificial Societies and Social Simulation* 14 (3) 2.
http://jasss.soc.surrey.ac.uk/14/3/2.html

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Chapter 1

Introduction to MOBS

MOBS (an acronym for Multi-agent Organized pedestrians with Built-in Specialization functions) is a program to simulate pedestrian crowds walking in counterflow. This program was developed using *Netlogo*, a programmable environment for simulating natural and social phenomena. For more details about the *Netlogo* environmenr visit the website: `http://ccl.northwestern.edu/netlogo`.

MOBS shows graphically the dynamics of a group of pedestrians walking along a corridor. The program interface allows users to change parameters to control general properties of the scenario, such as, corridor width, number of pedestrians, walking preferences of pedestrians, and so on. Users are also allowed to select a profile for creating pedestrians. These profiles correspond to three classes of pedestrians defined according to their walking preferences, *i.e.* standard, “relaxed”, and “hurried” pedestrians.

Additionally, MOBS provides online a quantitative characterization of the crowd performance through plots of average speed and average activity vs density of pedestrians.

Chapter 2

Getting Started

To run MOBS you need first to install the *Netlogo* environment on your computer. The current version of MOBS was developed using *Netlogo* version 4.1.3, and it runs on any compatible version of *Netlogo*. *Netlogo* runs on Windows, Mac OS X and Linux. You can download *Netlogo* from the website `http://ccl.northwestern.edu/netlogo/download.shtml`

2.1 System requirements

NetLogo is supported by different platforms including Linux, OS X, and Windows. Below is a brief description of specific requirements for the supported platforms.

Windows

- *NetLogo* runs on Windows 7, Vista, 2000, and XP.
- The *NetLogo* installer for Windows installs Java 6 for *NetLogo*'s private use only. Other programs on your computer are not affected.

Mac OS X

- Mac OS X 10.4 or newer is required for recent distributions of *Netlogo*. NetLogo 4.0 runs on Mac OS X 10.3 and 10.2.

- It is highly recommended to update the system using Software Update to ensure that the latest version of Java is available.

Linux and other platforms

- *NetLogo* should work on any platform on which Java 5 or later is installed. Java 6 or later is strongly recommended. If you have any trouble, make sure that you are using the official Java from Sun, and not some alternative implementation.

- You start *NetLogo* by running the script netlogo.sh, provided in the download page of *Netlogo*.

For more details about the *Netlogo* requirements see the website:
`http://ccl.northwestern.edu/netlogo/requirements.html`.

2.2 Opening the program

Once you have installed *NetLogo* you can run MOBS. Click directly the file Pedestrian_Flow.nlogo, or select the option File → Open, and the file Pedestrian_Flow.nlogo from the top menu bar of *Netlogo*. MOBS has been developed under *Netlogo* 4.1. If you have installed a more recent or a previous version of *Netlogo* you can get a warning message as illustrated in Figure 2.1. To run MOBS just select "Continue".

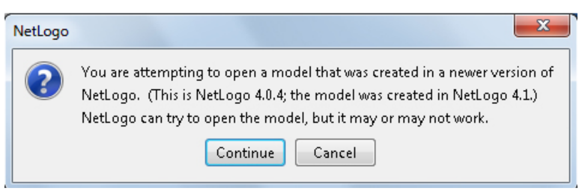


Figure 2.1: *NetLogo* warning popup window.

Chapter 3

Simulation Environment

Figure 3.1 shows a snapshot of the interface of MOBS. The simulation environment is divided into three parts, that are highlighted in this figure.

1 User controls

2 Simulation area

3 Performance measures

The **user controls** offer an easy way to define general parameters concerning the main properties of the corridor and pedestrians during a simulation, such as corridor width, number of pedestrians, pedestrian profiles, and maximum number of iterations. The button "go" starts a simulation given previous parameters.

The **simulation area** contains the top view of the corridor where the simulation takes place.

The **performance measures** show plots of both average speed and average activity vs density of pedestrians in order to quantify the performance of the crowd.

Below is a detailed description of the simulation setting and test.

3.1 Simulation setting

Before starting a simulation using MOBS it is necessary to configure general properties of the simulation environment. Figure 3.2 shows the ordered steps

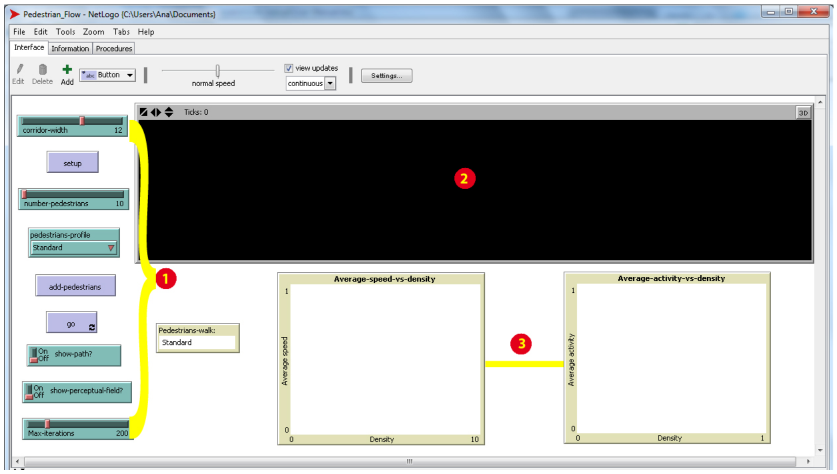


Figure 3.1: Interface of MOBS.

to run a simulation, and details of these steps are provided below. The steps are enumerated as indicated in Figure 3.2.

1 **SETUP:** By pressing this button, current settings of the corridor are initialized in the simulation area. If any parameter has been modified, default initial values are taken into account. The property of the corridor susceptible of modification is:

- **1.a** Corridor width: This slider box allows user to modify the corridor width from 3 cells to 19 cells. The default value of this parameter is 11 cells.

2 **ADD PEDESTRIANS:** By pressing this button, pedestrians are created and randomly distributed within the corridor. Before placing pedestrians on the corridor the following parameters can be modified:

- **2.a** Number pedestrians: This parameter can take any value from the interval 1 to the maximum number of pedestrians that fit in the corridor. The maximum number of pedestrians in a simulation depends on the width of the corridor. This value corresponds to the product of the width by the length of the corridor, where the later has a constant value of 100. For instance, in a corridor of width 3 the maximum number of pedestrians is 300, whereas in a corridor of width 19 the maximum of pedestrians is 1900. By default 10 pedestrians are added. One half of pedestrians are painted red and one half of them are painted blue. Red pedestrians move left-right, whereas blue pedestrians move right-left. Colliding pedestrians are painted black during simulations. Note that if this button is repeatedly pressed before to start a simulation, new pedestrians are added into the environment according to the new value of this parameter.

2.b Pedestrians profile: This parameter can take one of three values that represent the walking preferences of pedestrians: "relaxed", standard, or "hurried". By default the standard profile is selected.

3 GO: By pressing this button, the crowd simulation starts. The following parameters can affect the simulation:

3.a Show path?: This switch box allows user to show or hide the walking paths of pedestrians.

3.b Show perceptual field?: This switch box allows user to show or hide the individual perceptual field of each pedestrian. Note that perceptual fields are oriented according to the heading of pedestrians.

3.c Max iterations: This slider box allows user to select the maximum number of simulation iterations from the interval 100 to 500. By default 200 simulation iterations are executed.

Figure 3.3 shows two snapshots of the application of initial settings prior the running of a simulation. Figure 3.3(a) shows the simulation area after pressing the **setup** button using default values of parameters. Figure 3.3(b) shows 10 pedestrians distributed within the corridor after pressing the **add-pedestrian** button.

3.2 Running a simulation

To start a simulation it is necessary to push the button **go**. Figure 3.4 shows a snapshot of the start of a simulation comprising 10 standard pedestrians within a corridor 11-cells width. The plots of the dynamics of the crowd, average speed and average activity, are simultaneously updated in the bottom region of the interface that follows the performance measures. Note that these

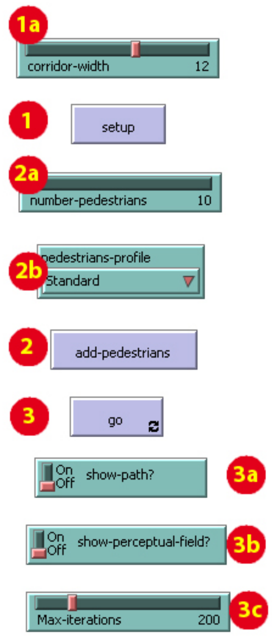


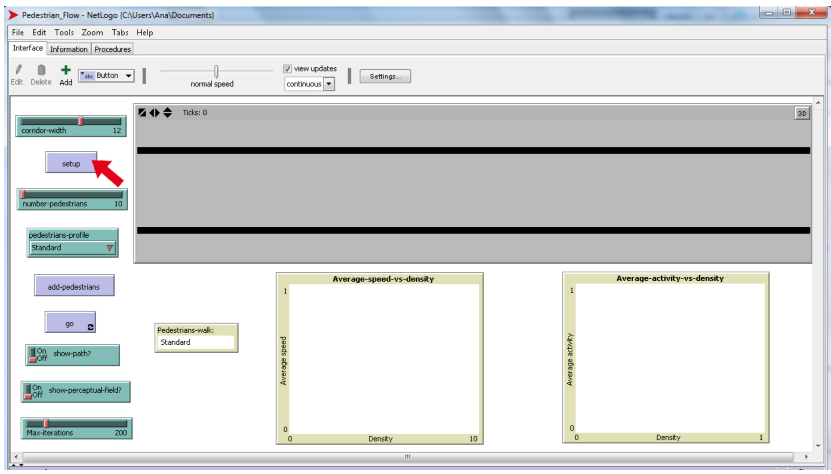
Figure 3.2: User controls.

plots are updated once the maximum number of iterations is reached. Some examples of these plots are provided in next chapter.

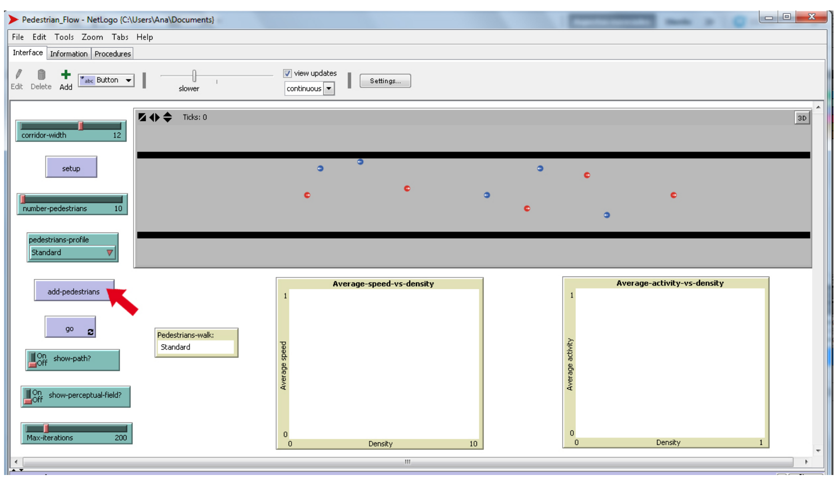
The options for showing the path of pedestrians as well as their perceptual fields are intended to look and follow detailed interactions and actions of pedestrians. When the former is turned on, traces of pedestrians paths are left on the environment, as illustrated in Figure 3.5(a). When the later is turned on the T-perceptual field of pedestrians is highlighted. As internally the simulation runs sequentially, the perceptual fields of pedestrians are highlighted one to one. Figure 3.5(b) shows a snapshot of a simulation in which the perceptual field of pedestrians is turned on.

It is worth to consider that the options to highlight interactions of pedestrians are illustrative at low densities and during the first steps of a simulation. Remember that the bigger the density the more crowded the corridor. Under crowded conditions the cited properties become indistinguishable.

Note that if the simulation settings are not properly defined the simulation wont start. That is the case, for instance, of attempts to run a simulation before to add the pedestrians involved in the simulation. In these cases an error message is printed in the Command Center window of *Netlogo*.



(a) Resetting the environment.



(b) Adding pedestrians.

Figure 3.3: Simulation setting.

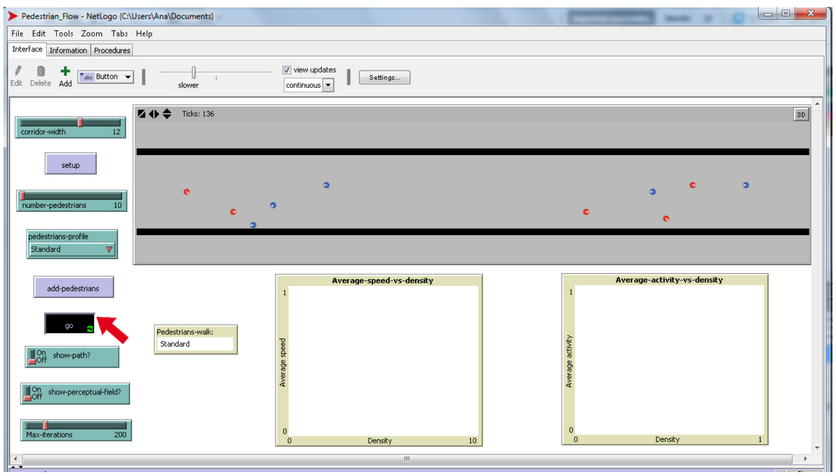
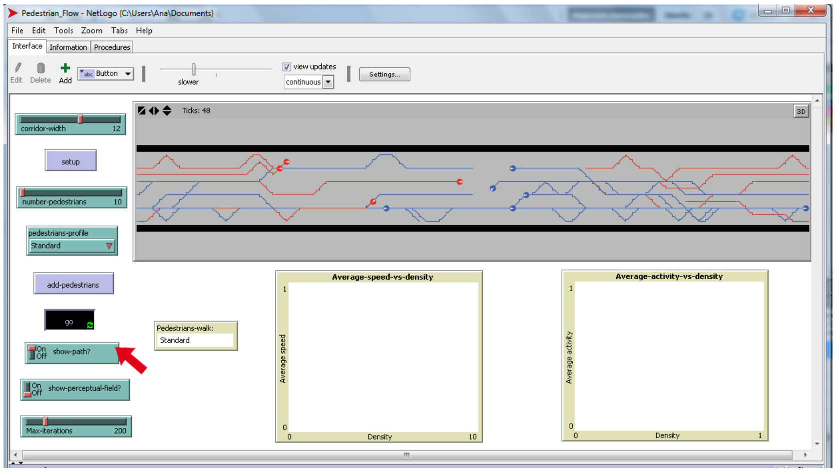
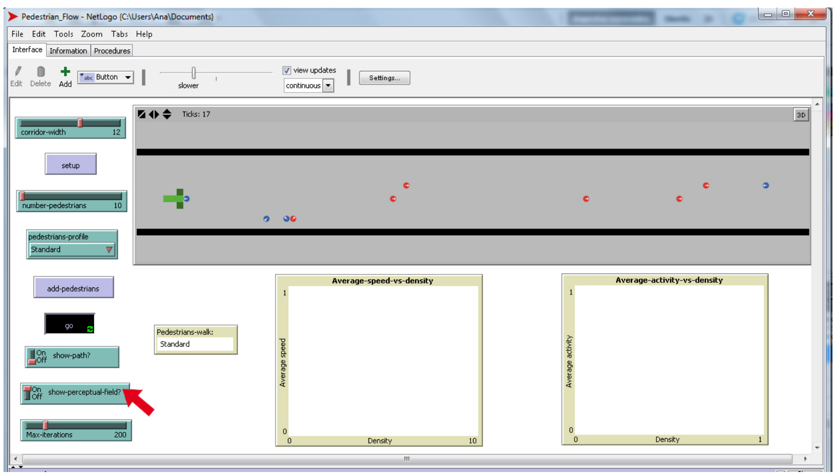


Figure 3.4: Starting a simulation.



(a) show-path? turned on



(b) show-perceptual-field? turned on

Figure 3.5: Running a simulation.

Chapter 4

Simulation Examples

In this chapter some experiments involving the variation of walking preferences and density of pedestrians using MOBS are shown.

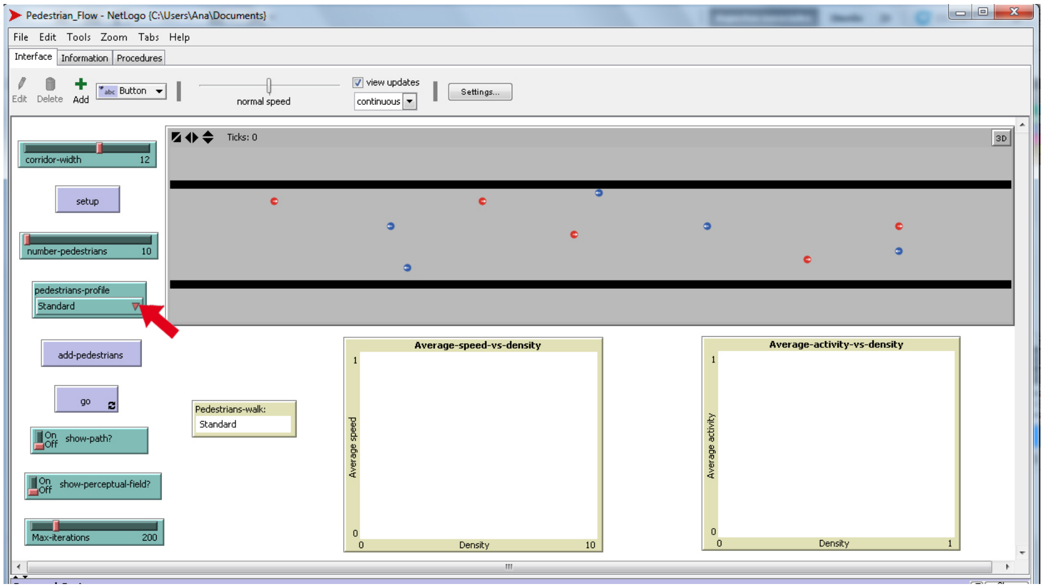
It is worth to recall that MOBS is designed to investigate the dynamics of pedestrian crowds under different circumstances, namely in conditions where the population size is changed gradually. For that, MOBS is ready to automatically perform a set of simulation runs starting from initial conditions defined by the user through the user controls. Thus, once the maximum number of iterations is achieved, MOBS increases the number of pedestrians by 10 and restarts a simulation run. This is repeated until a simulation comprising the maximum number of pedestrians is completed. These variations are captured by the plots of average speed and average activity vs density at the bottom of the interface.

Three examples involving different profile pedestrians are presented, standard (Figure 4.1), "relaxed" (Figure 4.2), and "hurried" (Figure 4.3). In all the examples presented in this chapter, four snapshots taken at different stages of the simulations are provided. Thus Figures 4.1(a), 4.2(a), and 4.3(a) show the initial distribution of pedestrians within the corridor for standard, "relaxed" and "hurried" profiles, respectively. Note that the plots of average speed and average activity vs density are initially empty.

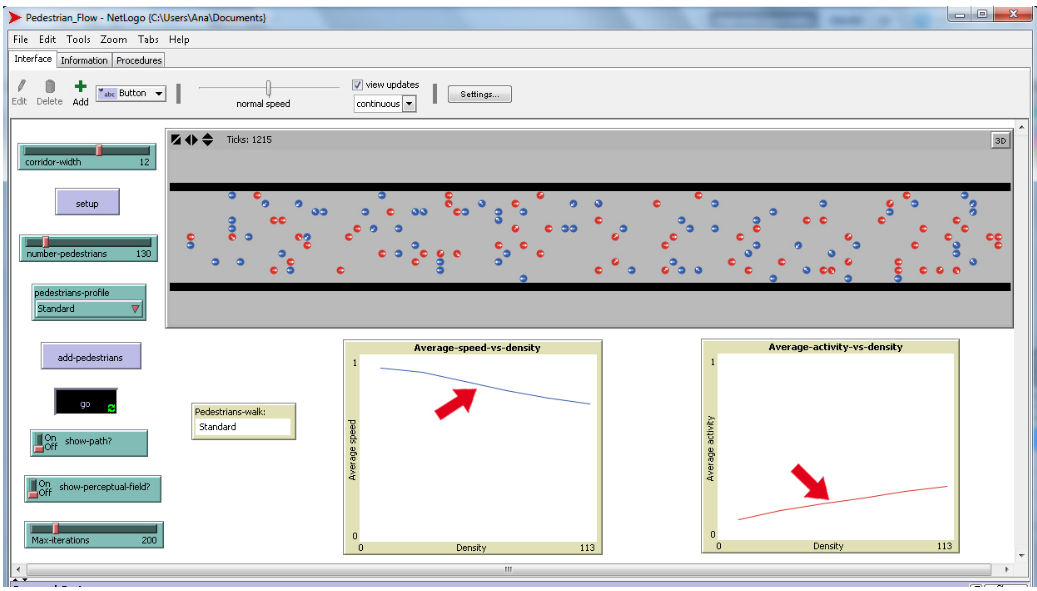
Figures 4.1(b), 4.2(b), and 4.3(b) show snapshots of the simulation and plots of the pedestrian dynamics at low densities for each profile, standard, "relaxed", and "hurried" pedestrians, respectively. As indicated by the red arrows superposed on the plots of these figures, the values of average velocity and average activity vary slighly at low densities.

Figures 4.1(c), 4.2(c), and 4.3(c) show snapshots of the simulation and plots of the pedestrian dynamics at intermediate densities for each profile. As it can be seen in these plots, a phase transition is shown in the plots of performance measures. Note that the flow corresponding to the average speed decays abruptly whereas the flow of the average activity increases abruptly at the same time. These tendencies are emphasized by the red arrows superposed on the plots of these figures.

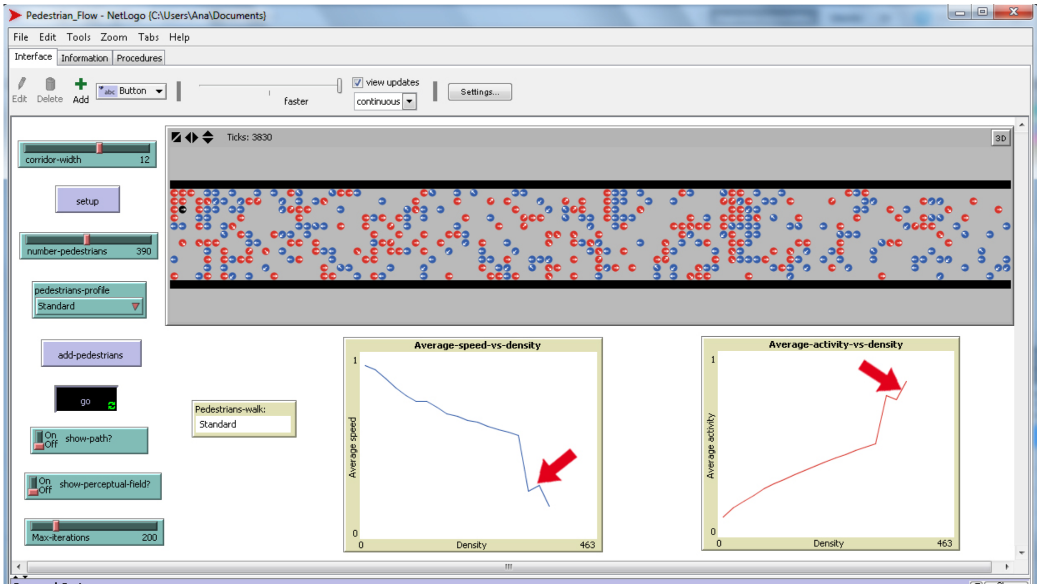
Finally, Figures 4.1(d), 4.2(d), and 4.3(d) show snapshots of the simulation where traffic jams are observed. The fundamental diagrams of velocity and activity for each crowd profile are also provided. Phase transitions are emphasized by the red arrows superposed on the plots of these figures.



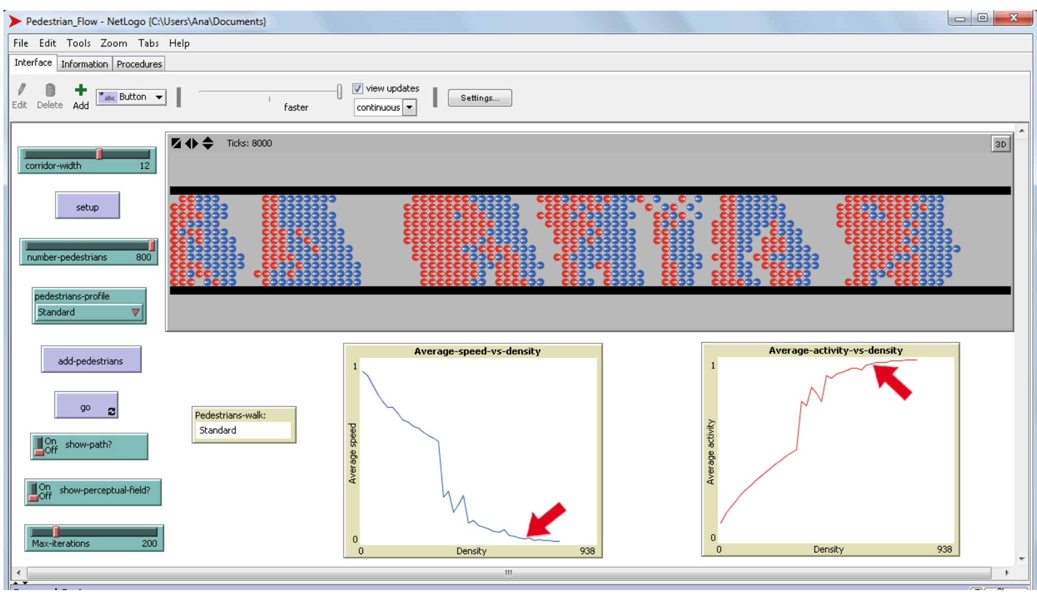
(a) Initial conditions for standard pedestrians.



(b) Standard pedestrians at low densities.

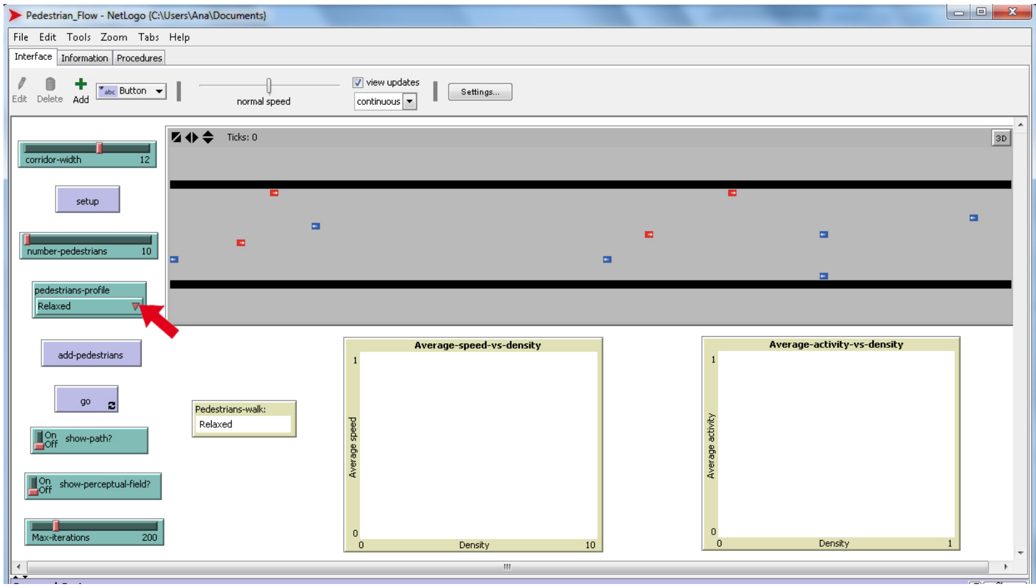


(c) Standard pedestrians at intermediate densities.

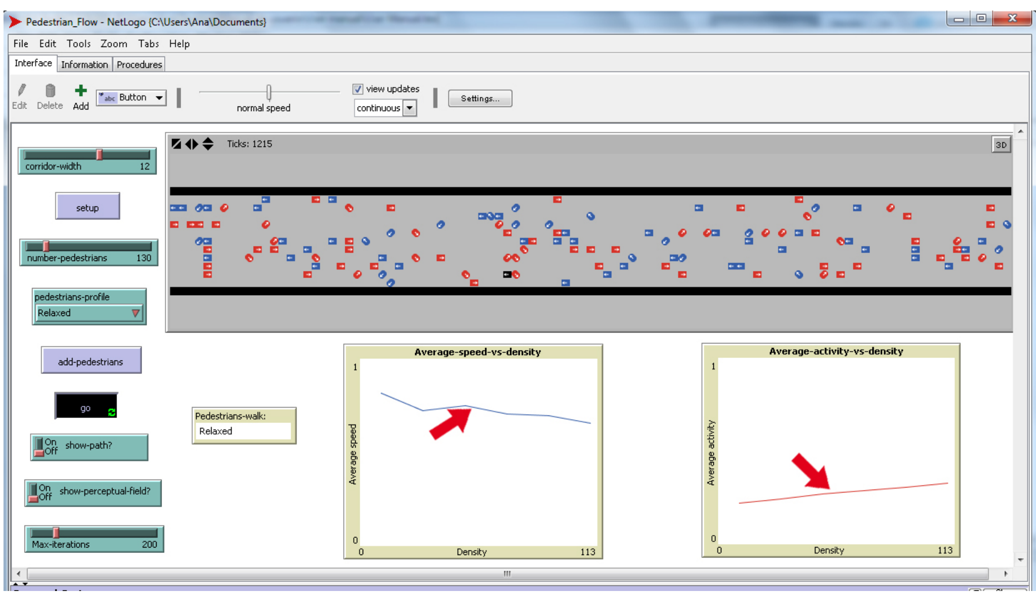


(d) Standard pedestrians at high densities.

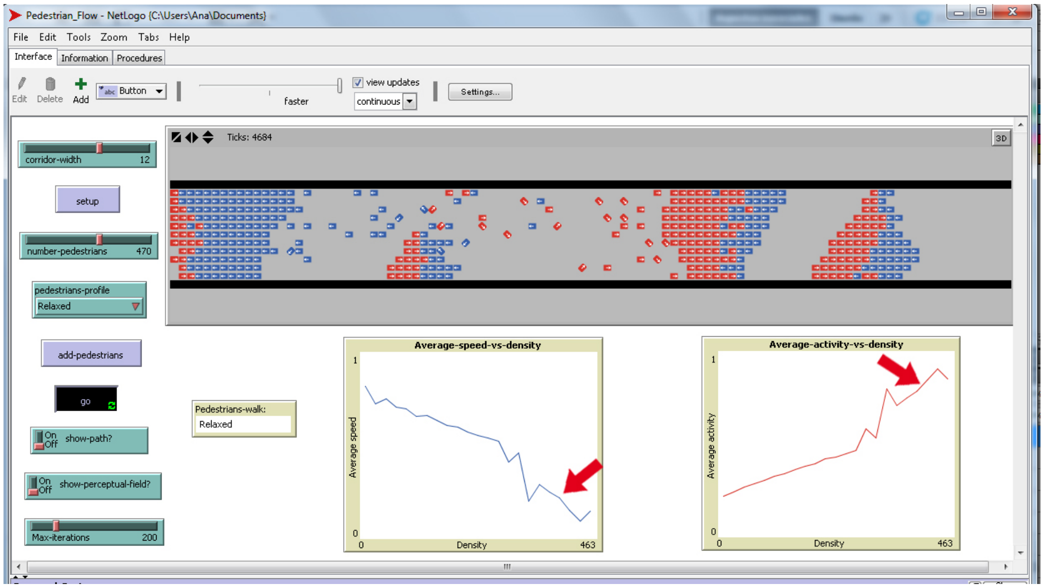
Figure 4.1: Simulation example of standard pedestrians.



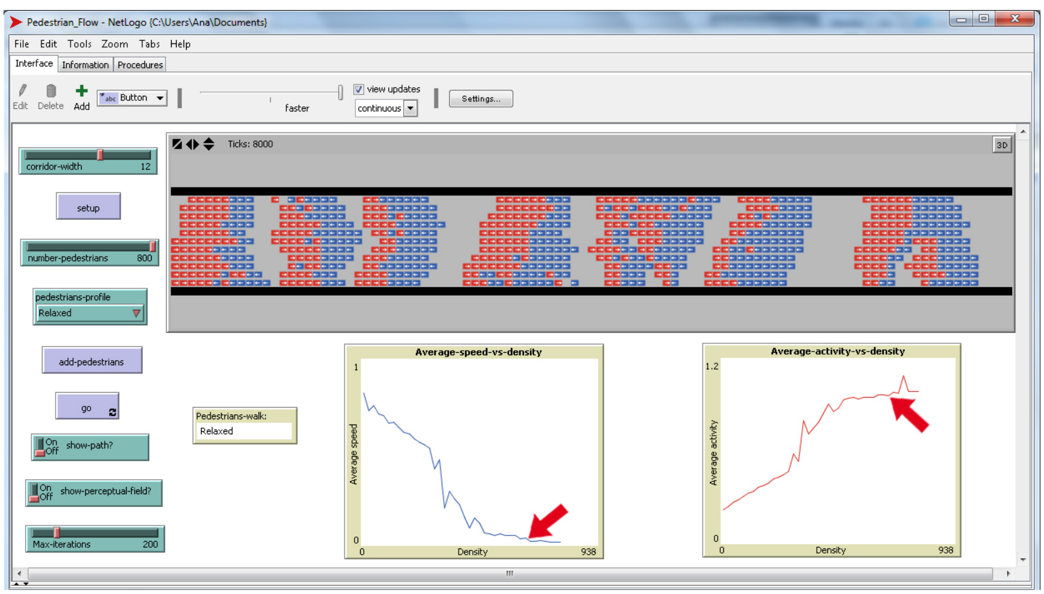
(a) Initial conditions for "relaxed" pedestrians.



(b) "Relaxed" pedestrians at low densities.

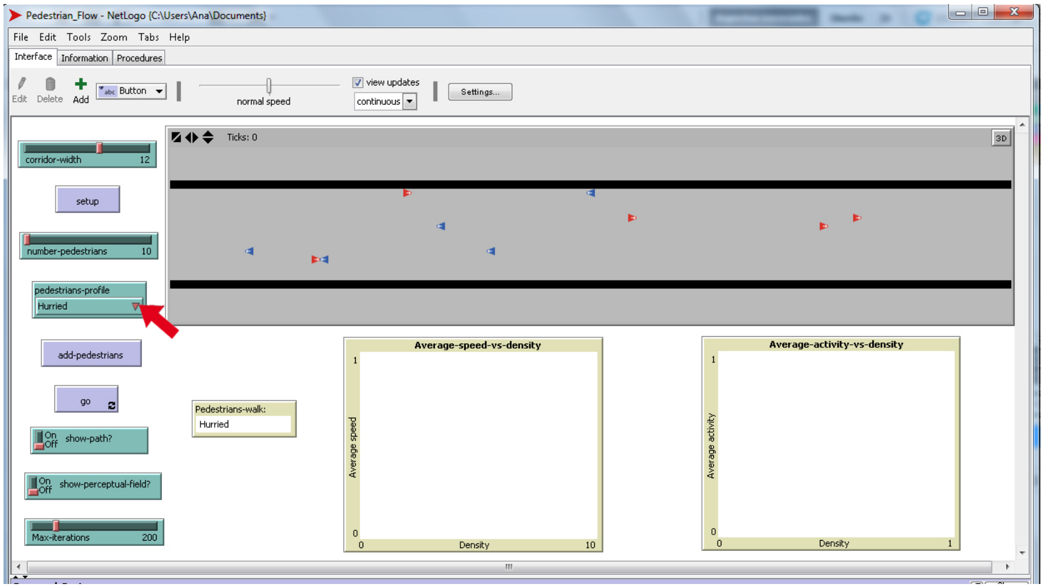


(c) “Relaxed” pedestrians at intermediate densities.

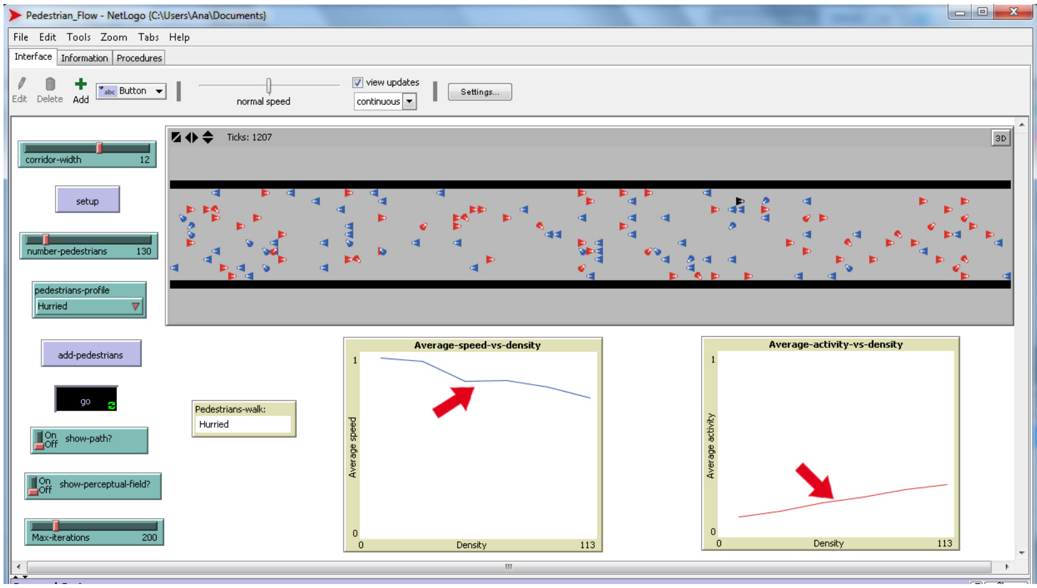


(d) “Relaxed” pedestrians at high densities.

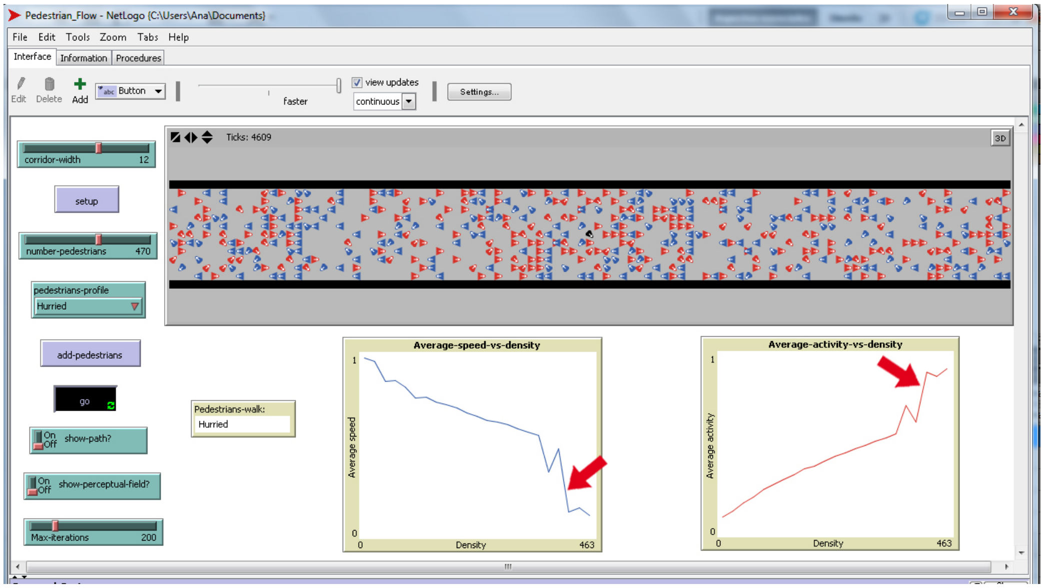
Figure 4.2: Simulation example of “relaxed” pedestrians.



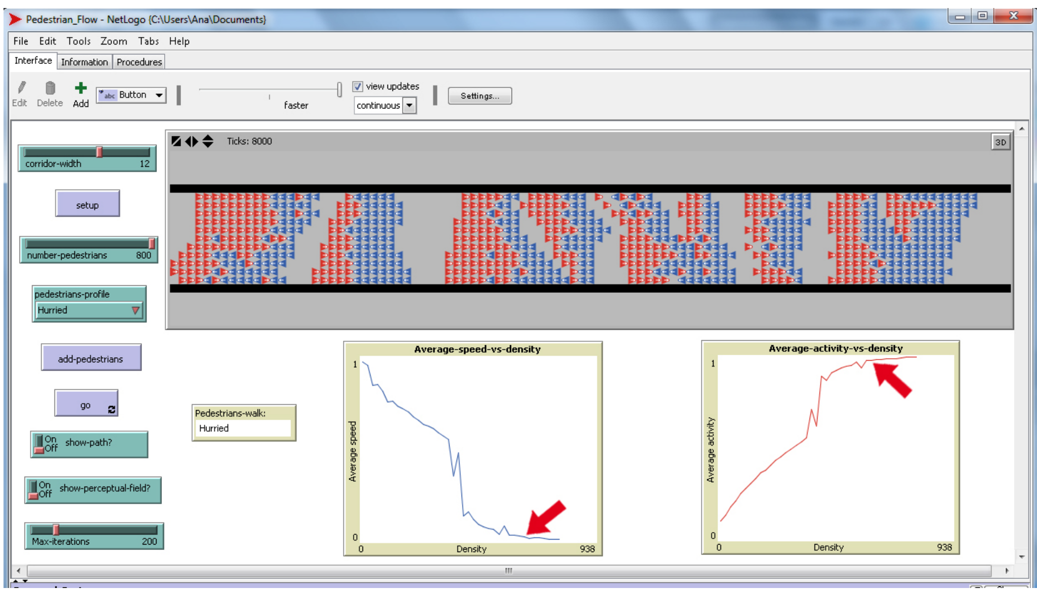
(a) Initial conditions for "hurried" pedestrians.



(b) "Hurried" pedestrians at low densities.



(c) "Hurried" pedestrians at intermediate densities.



(d) "Hurried" pedestrians at high densities.

Figure 4.3: Simulation example "hurried" pedestrian.