AGENT ANALYSIS IN DEPTHMAP10.14[1]

Manual

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Date: 01/12/2012

Citation: Al_Sayed, K., Turner, A. 2012, “Agent Analysis in Depthmap 10.14”, Bartlett School of Graduate Studies, UCL, London.

Draft Version 01 without appendices

The authors make absolutely no warranty that the information in this document is correct.

The Agent model is created by Alasdair Turner.

The first author; Kinda Al_Sayed apologises in advance for any errors, misrepresentations and misinterpretations in the manual which were impossible to verify due to the absence of Alasdair Turner.

Abstract. This manual is aimed to explain agent simulation methods that are incorporated with the Space Syntax tools in UCL Depthmap10.14. The Agent model, developed by Alasdair Turner, has different theoretical foundations than the Space Syntax model in that it looks for adaptive behaviour of individuals/agents in relation to space rather than spatial representation. Different Agent tools are provided on the 2D and 3D graph windows to visualize aggregate and individual agent movement. These tools were initially dedicated to form the experimental part of Alasdair Turner's research, for this reason further testing is needed to validate the rules on different building typologies and different architectural and urban scales. The manual explains the use of the Agent Analysis Setup toolbox in the graph window. The toolbox enables users to generate different patterns of aggregate behaviour by controlling the parameters and rules in the toolbox window. In addition, the manual explains some of the tools provided on the 3D view window that control the visualisation of the standard agents. The 3D view helps understanding how individual movement behaviour of standard automata/agents builds into aggregate patterns that might then be compared to human behaviour in space.

Introduction

This Manual describes the application part of a theoretical framework developed by Alasdair Turner; namely his theory on 'Embodied Space' in which he seeks to explain the natural visual interaction between the individual and the environment. To test his theoretical investigation, Turner devised an Agent's model architecture to simulate natural movement patterns in buildings and cities. His model reflects on several levels of investigation where he initially tests simple automata that act by means of direct visual affordances using simple rules. He then evolves his automata by assuming that his agents or animats can make choices about certain visual characteristics of the environment. The last stage of his investigation is where animats acquire the ability to learn and utilise memory in different environments. This investigation is partly implemented in the Agent analysis tool in Depthmap 10.14. The Agent model is instrumental to acquire a better understanding of the cognitive basis of natural movement and probably explain navigation and wayfinding.

In separate experiments that were implemented in previous EVAs application, Turner et. al. (2004) has also demonstrated possibilities for the Agent model to be devised as a generative design tool to coevolve agents and spaces. The design was an emergent product of users' movement using predefined rules. Turner's agents act upon their visual perception in relation to their position within the environment. As they move through space, the visual information they receive through their visual devices change and their reactions change accordingly. This process involves a dynamic component, and in this way it differs from Space Syntax representation. The Agent model starts from the irreducible elementary actor in the system, that is the individual, and present the visual dynamics that direct his movement aiming to understand and reproduce the process of inhabitation and occupation in space.

The Agent analysis tools in the 2D view window (Map window) are used to generate aggregate models of agents' movement in space. These aggregate models are governed by global parameters as well as parameters defining the behaviour of individual agents. The global parameters determine the duration of analysis, when, where and how many agents are released into the system. They also allow for externalising agents data to compare with movement traces and with observed gate counts. The agents' parameters will define their field of vision and the number of steps at which they decide to change their directions. The agents may follow different rules to see or take turns in the system. These rules are in need of further testing by measuring the correlation between the model and observed movement patterns. Empirical testing would help understanding the basic cognitive mechanisms that drive explorative and planned movement behaviour in relation to space.

The 3D view window provides the advantage of a 3D visualisation of agents in action. The 3D view may cast more light on the individual and situated behaviour of agents; hence help to understand the notion of situated cognition, as suggested by Alan Penn. It helps tracing the decision-making process embodied in agents' movement actions and reactions to spatial affordances. It allows for the observer to track localised movement patterns, thus helping to design a case-sensitive approach to simulate natural movement in a particular system. It must be emphasised here that the 3D view in this version of Depthmap10.14 can only show the standard automata, not the evolved or learning animats.

Agent Analysis

In this section, we are going to explain how to produce Agent analysis using the different parameter settings in Depthmap. First, create a new file in Depthmap and import a drawing file (either DXF or MIF file). The drawing you are importing should have closed boundaries in order for you to be able to make Visibility Graph before you start the agent tool. After you import the file follow the steps to make a visibility graph, first by setting the grid using the SET GRID button  . The default value –depending on the metric unit in your original DXF file- is 0.04. You could simply adjust this value by entering a different number, preferably to be 0.06 or 0.07 to match human scale. This is up to you and it depends on the resolution of the analysis you need to obtain. After you set the grid, you can fill the enclosed spaces using the FILL button  . Click inside the area you want to analyse and it will fill it with a different colour marking the enclosed space where agents can move. After you have prepared a space for the agent analysis and defined the grid resolution and the boundary of your analysis, you can make a visibility graph. In order for you to do that, go to

TOOLS---VISIBILITY---MAKE VISIBILITY GRAPH

A window will appear providing you with visibility graph options. Just click OK and it will make visibility graph. Now your settings are ready for Agent Analysis.

Go to TOOLS---AGENT TOOLS ---RUN AGENT ANALYSIS

The following window (figure 1) will appear.

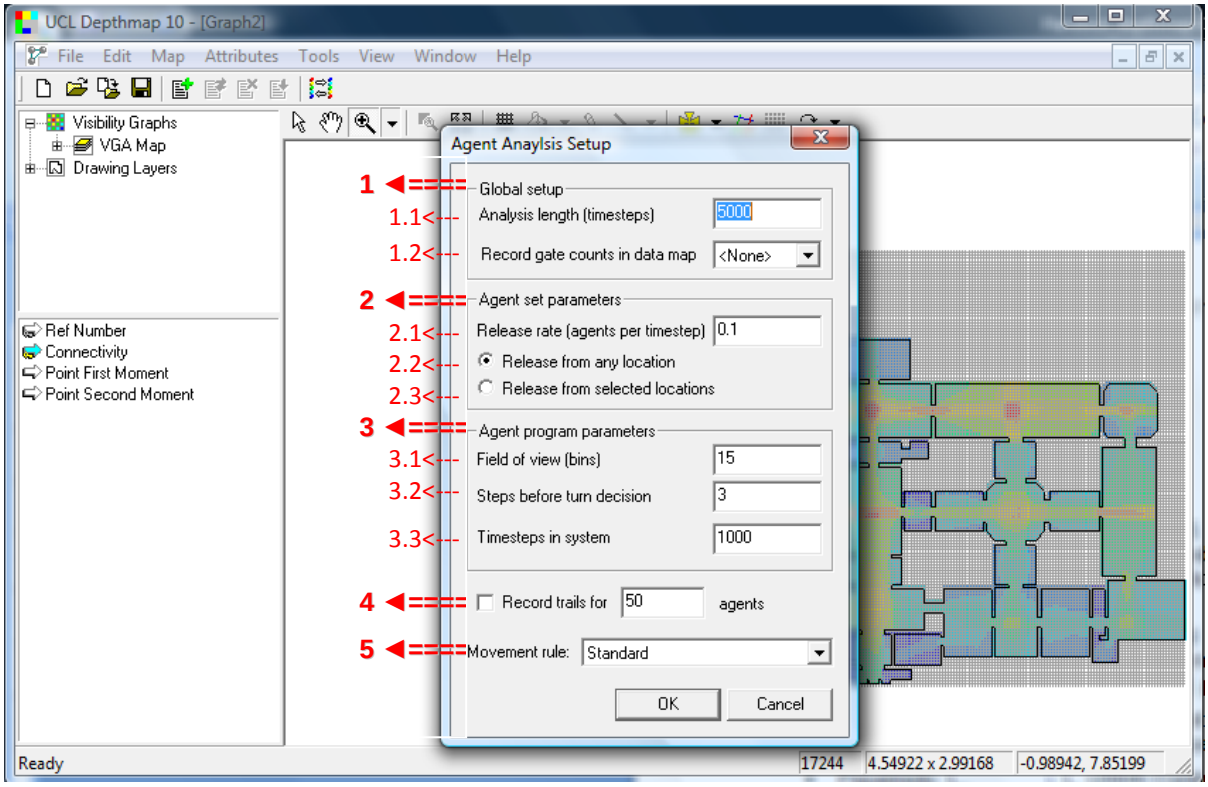

Figure 1. Agent Analysis Setup in Depthmap.

In order to explain the window we have marked the different parameters with numbers and a short explanation will be associated with each number.

1. **Global setup**

Sets the global attributes of the agent movement in the system

1.1. Analysis length (timesteps): Sets the period of the analysis in timesteps

1.2. Record gate counts in data map: records how many agents are passing through predefined gates in a new column. These gate count values are stored in a data map layer and can be compared to observed gate counts representing pedestrian flow per time unit in the real built environment. Normally you will need to log the values in one or both data map columns because the values might be exponentially distributed and in order to calculate their correlation coefficient they need to be normally distributed. You can log the value by just adding a log function when updating each column using the tool or by going to ATTRIBUTES --- EDIT COLUMN (see figure 2).

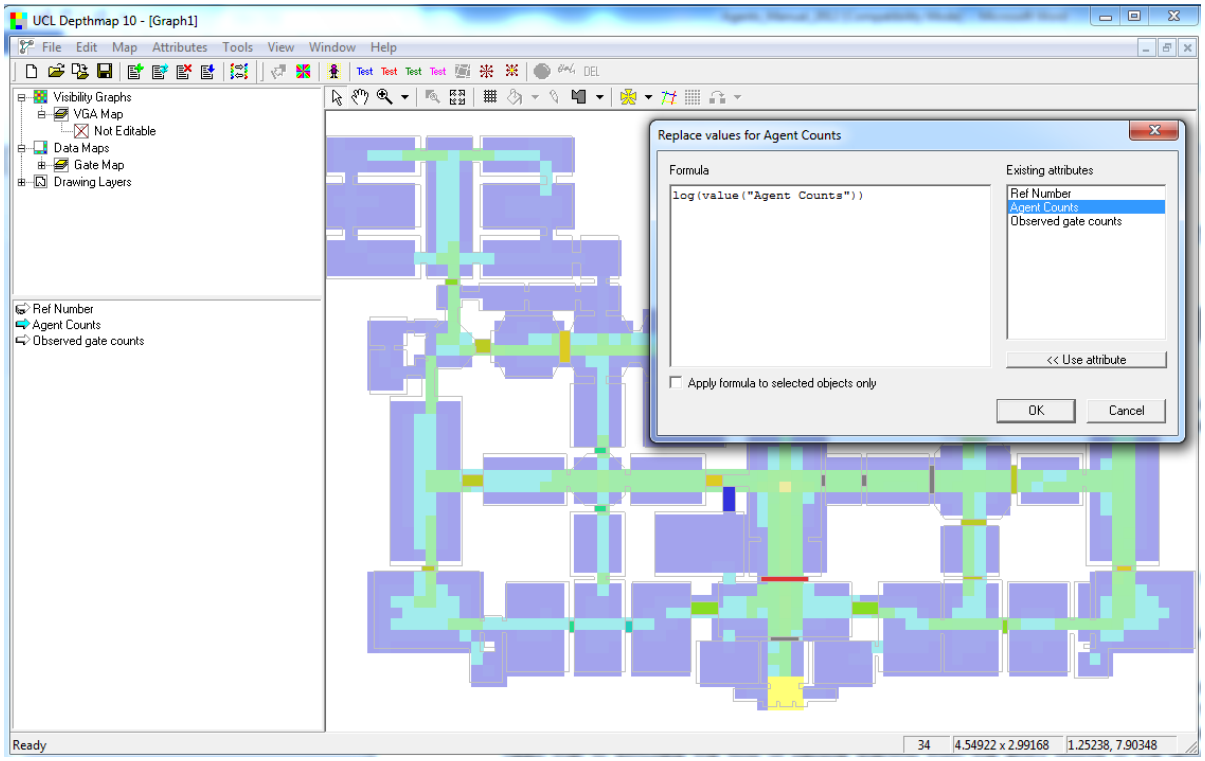

Figure 2. Editing columns in the formula window using SalaScript[2].

2. Agent set parameters

Sets the attributes of agents releasing mechanism in the system

2.1. Release rate (agents per timestep): Sets how many agents are released to the system within each time step.

2.2. Release from any location: A check box giving you the option of releasing agents randomly from any location in the predefined space.

2.3. Release from selected locations: A check box giving you the option of releasing agents from previously selected locations. You will have to select the locations from which you want the agents to be released before you start your Agent analysis. Normally you will need that to simulate the flow of people starting from the entry points in the layout such as the main entrance, stair cases or elevators. This technique also helps when the observer decides to compare observed movement traces from a certain entrance point to traces that agents leave behind when moving from the same point. In order to select locations on your grid you need to keep the left mouse button pressed while defining a window containing the selection and release it once you are done. If you want to add to your selection you will have to hold the SHIFT button while you define a new selection using your mouse.

[2] http://www.vr.ucl.ac.uk/depthmap/scripting/salascript.pdf

3. Agent program parameters

3.1. Field of view (bins): This attribute will define the field of view that each agent can see when moving in a certain direction. The default is 15 bins which is equivalent to 170 degrees. It has proven to be most effective when comparing to natural movement patterns in buildings. However, it is up to the researcher to change this field of view subject to the particularities of the case study.

3.2. Steps before turn decision: These are steps or grid points that the agent passes through before choosing to randomly change direction –in the case of standard automata-after an agent has arrived at the last step. The default is 3 steps. For standard agents/automata, it has proven to correlate best with natural movement patterns in buildings. These rules are very experimental; they were tested on limited number of buildings with specific functional types. Further experimentations and observations are needed to find the optimum rules for different building and urban layouts.

3.3. Timesteps in system: These are the time steps during which the agent moves in the system before it disappears. Normally this will be relative to the distance chosen between the grid points and the walking distance that a pedestrian may take in a certain urban or building environment.

4. Record trials for

This option will export the movement traces to a file called *trails* that will be stored within the folder where you have your original graph file. You can import that file after you have done your agent analysis and Depthmap will store it as a separate drawing layer.

5. Movement rule

There are different rules within this drop down list. It is advised that you use the standard rule which is the default. The rest of these rules are part of an ongoing research and need to be further tested before implementing in natural movement simulations. Further information about these experiments might be followed in Turner (2007a). The occlusion rules are of particular interest. However these rules will not work properly unless you calculate isovist properties before running agent analysis. For that you have to go to

TOOLS --- VISIBILITY --- RUN VISIBILITY GRAPH ANALYSIS --- CALCULATE ISOVIST PROPERTIES

Visualising agents movement in 3D view

In this section, we will demonstrate how to use the Agent tools in the 3D view window. The first step to do that is to open the 3D View from the Window Menu. A window similar to what you see in Figure 3 will appear and you will be able to see on top of the window as highlighted in red a set of icons that may be used to create, control, visualise and view Agents' movement. The functionality of each single tool is explained below.

 Click this icon to drop a new agent within the scene.

 Click this icon to enable agents' movement after you have deliberately stopped it

 Click this icon to pause agents' movement

 Click this icon to stop agents' movement

 Click this icon to enable traces to be drawn tracking agents' movement routes.

 Click this icon to control the orbit zoom of the 3D view.

 Click this icon to pan your view in different directions.

 Click this icon to zoom in your view

 Click this icon to have a continuous zoom

 Click this icon to see the gate count values and how they emerge and change as the agents plot different movement patterns on the grid.

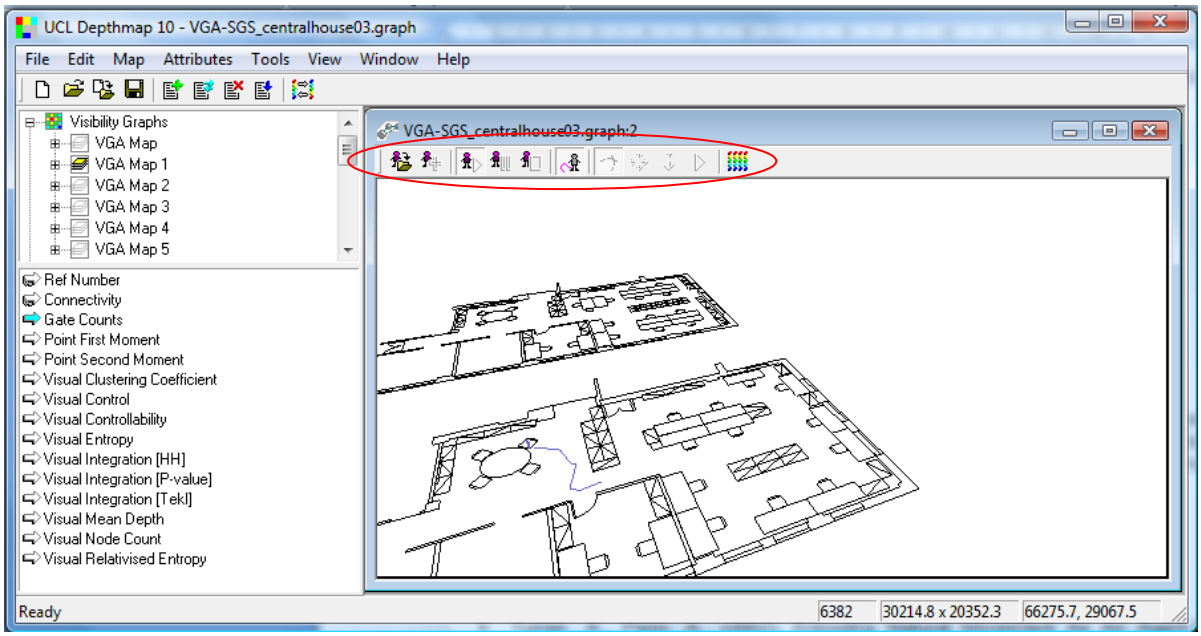

Figure 3. Agent tools for visualising real-time behaviour of automata in a 3D view window

Acknowledgments

This manual was written towards the end of Alasdair's life and was only completed after he passed away. The information provided is my very modest attempt -as the first author- to interpret his work and communicate it to the Depthmap community. I would have thought that Alasdair would really want to thank many community members for their contribution to his work, particularly to Alan Penn for his inspiring input and great support, for Bill Hillier and Philip Steadman for insightful conversations. Gratitude is also extended to many others in the Depthmap community and beyond who followed up with Alasdair's work; Mike Batty, Chiron Mottram, Ruth Conroy Dalton, Christoph Hoelscher, Eva Friedrich, Joao Pinelo, Sean Hanna, Martha Tsigkari, Kayvan Karimi, Pete Ferguson and many others.

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