Modelling layers of artificial intelligence within a virtual world

John Jamieson

Eastern Institute of Technology, Hawke's Bay
Taradale, NZ
jjamieson@eit.ac.nz

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ABSTRACT

The purpose of this paper is to present a programming model for connecting heterogeneous layers of artificial intelligence (AI). The model is based on a virtual world like Earth. Various elements, biomass, activities, etc within the virtual world is represented as a layer. The layers take on an AI as a controller and maintain a certain level of independence of one other. The layers overlap each other, covering the same surface area within the virtual world. Interlayer communication is provided by an XML interface. The use of XML allows for a distributed implementation, say within a network, making use additional processing power.

The function and level of detail (LOD) within each layer is dependent on what virtual world element is being represented. This Model allows for scaling with regards to the LOD. Essentially the Model is more concerned with the design and construction of the layers and not so much as what AI is being used for or how the AI works.

1. INTRODUCTION

This paper addresses the structural composition of combining different types of artificial intelligence (AI). The approach taken here is best imagined as an interactive, networked model of AI constructs. The idea for taking this approach rests in the fact that current AI literature treats the different types of AI material independently. Various measurable properties such as biomass, human activities, climate, etc. that exist within a simulated world provides the basis of what could be represented as layers of AI. These layers take on this AI as a controller within a contained environment. The layers, whilst independent of each other, overlap and cover the same surface area within the contained environment. As an interface mechanism between these layers, XML is used as the communications protocol. The use of XML provides for a distributed processing within the network environment.

The conceptualization of a contained environment came about when examining Artificial Intelligence (AI) used in computer games. Computer games make rather extensive use of AI in order to simulate a real world environment. AI models used within games are pretty much restricted to specific game itself, and do not provide a more generic transportable model that could fit any situation. The models used in computer games still make use of common AI techniques, but the implementation thereof becomes the restriction with regards to the portability of the AI.

1.1 BACKGROUND DECISIONS

The Virtual world model presented in this paper could be discussed by means of a mathematical model. Owing to the scope of this paper, the discussion of the mathematical model has been reserved for a more detailed paper.

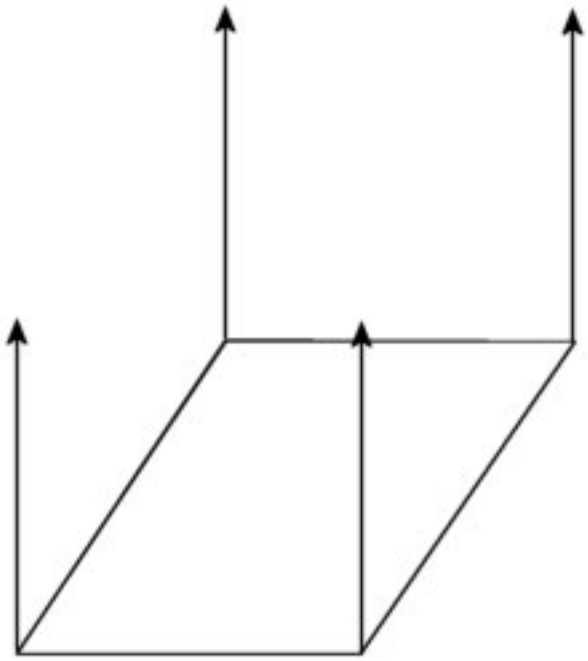

Figure 1 WCE bounding area.

2. THE WORLD CONTAINMENT ENVIRONMENT

The world containment environment (WCE) provides the area in which various AI layers function. It resembles an open-ended cube shape as seen in Figure 1.

This cubed dimension provides the "The world" in which AI layers operate effectively thus acting as the main system controller. All inter-layer communications is controlled by the WCE by making use of an XML (Extensible Markup Language) parser discussed later in the paper (see section 4.3). The WCE is designed to fit the processing capabilities of desktop computers. The WCE provides the constraints in which the various AI layers operate, thereby reducing the number of parameters and variables that have to be processed.

Simulating such a colossal environment as the earth requires the fastest computer, the Earth Simulator. The Earth Simulator, a massive parallel computer of the distributed memory type developed by NEC, was created to simulate climate and other geographical events at a global scale operating at a phenomenal speed of 35, 860Gflops, where GFlops are a billion floating-point operations per second.

2.1 LEVEL OF DETAIL (LOD)

The LOD determines how much information is visible to the observer of the WCE system. Observing human behavior right down to viral infection is an example of LOD. The LOD is dependent on the amount of data that has to be processed and the resolution of the resulting information.

The LOD provides a means to scale into and out of the AI layers. The observer could look at an individual object and the affect of another object upon the observed object. The observer could also look at all the objects collectively and see the affect a specific AI layer has on the collective objects.

3. THE AI LAYERS

The AI layers within the WCE perform all the work. Reference to the WCE is only for boundary constraints and layer communications. Each layer is a self-contained system and is expected, in most cases, to operate independent of other AI layers. This enables any layer to have its own AI implementation and maintain its own variables and parameters.

The layers are created to fill the boundaries of the WCE but only parts of the layer may be functional. In other words, an AI layer for a virus may only be interacting with a few people represented within the next layer. Graphically, the layer may look like a sheet of paper with patches all over it as seen in Figure 2. These patches represent the intensity of the AI activity; simply stated, no patch, no activity.

3.1 INTRA-LAYER COMMUNICATION

The Intra-layer communication is the AI interaction inside of the AI layer. The objects within the AI are able to pass data between each other without having any affect on other layers. Two people, represented in an AI layer, having a conversation would be an example of the intra- layer communication. The conversation could be the exchange of decisions or triggering of events inside the layer. The effect could affect other agents inside of the layer that in-turn, when accessed, could affect the data of another layer. This level of communication would only have an indirect affect to other AI layers.

The mode of communication at this level is independent of the WCE and other AI layers. It depends mainly on the type of AI being used, but could be anything like semaphores or shared memory access.

3.2 INTER-LAYER COMMUNICATION

At this level, the individual AI layers are able to communicate with each other independently and irrespective of the type of AI. Requests and responses are exchanged between the various layers and the layers could choose whether to act upon the message, if it can use it, or totally ignore it. A person agent in one layer could change an environment setting (air-conditioner) in another layer. The climate layer could

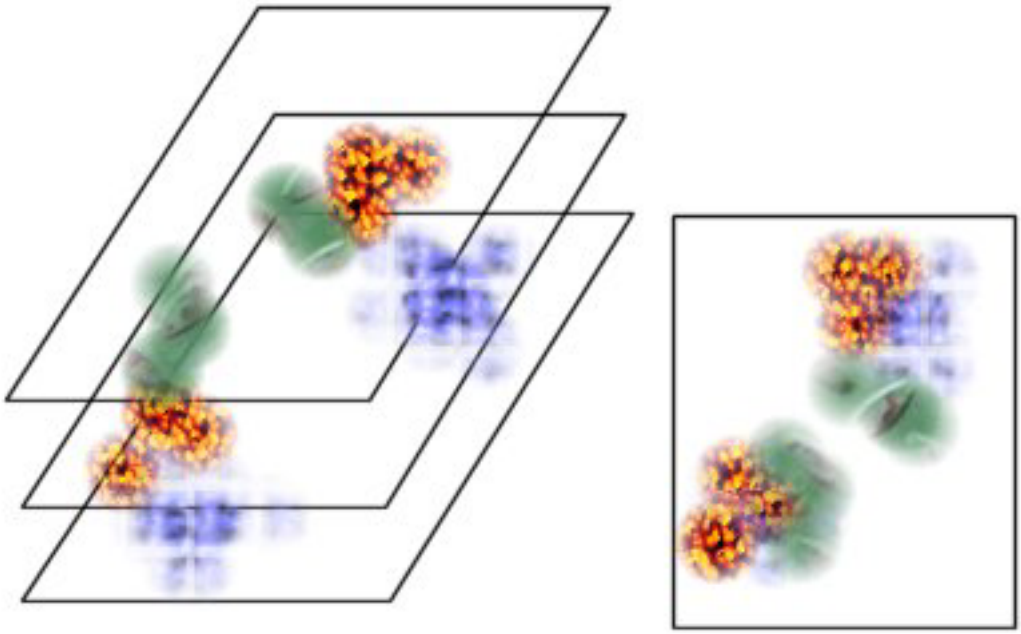

Figure 2: AI layers, side and top views.

respond by changing the setting or appear damaged by ignoring it. The event generated by this agent would have an impact in the climate layer and affect another person or group of people elsewhere in the layer of the person generating the event.

The mode of communication at this level is controlled by the WCE and uses XML as the interface.

3.3. XML AS AN AI LAYER INTERFACE

In order for the various heterogeneous AI layers to communicate, some form of mechanism has to be identified. For this, Model XML was chosen as the interface language for of the following reasons:

- ♦ It is ideal for storing structured and semi-structured text;
- ♦ It provides a convenient data wrapper for data transfers (EDI);
- ♦ It offers a platform independence for distributed processing; and,
- ♦ It facilitates the generation and management of meta-data (information *about* information).

The XML provides a standard means of communication when the system is implemented in a distributed environment with the perpetual insertion and removal of AI layers.

A DTD (Document Type Definition) is a powerful feature of XML, in that it is a document that defines a formal set of rules and provides document structure. In the case of this Model, the DTD will provide the definition of the communications message that is passed between the various AI layers. Each layer would then have shared access to this DTD, owing to the WCE acting as the communications controller, to ascertain the structure of the message being communicated.

The details of the interface implementation, in XML, are beyond the scope of this paper.

4. DISTRIBUTED AI PROCESSING

Having access to the power of a machine like the Earth Simulator is beyond the reach of most researchers. Technology has progressed to a point where cost effective parallel processing systems like Clusters and Grid computing become a desirable solutions. Grid computing is an infrastructure that clusters and integrates computers, networks, and other devices to form a virtual supercomputer on which users can work collaboratively. They basically utilize the resources and processing power of idle computers. Clusters, on the other hand, are groups of dedicated machines in a similar infrastructure.

The Model is essentially a client-server model allowing it to execute individual AI layers across a network, thereby utilizing maximum available resources. Once again, all inter-layer communications is handled by the WCE; this time the WCE acts as the server and the various AI layers become the clients.

All the intra-layer communications remain in the AI layer, the client, thus reducing the processing load on the WCE the server.

5. EXAMPLES

The Model is best described by examples. The example is not indicative of a complete simulated system and only lists possible AI layers. For the purpose of this paper, specific details of each layer have been left out.

5.1 OBSERVING A VIRAL INFECTION

A viral infection in a human body presents a simple illustration of AI interaction as shown by the following points. These points show the possible types of layers that could be found within a simulated system.

♦ WCE - The boundaries of the human body, including the surface of the body. Also includes details about external environmental conditions.

♦ PERSON:SKIN - possible area of infection depending on virus.

♦ PERSON:BLOODSYSTEM - affects distribution of virus and medicine.

♦ PERSON:ORGANS - can be broken into more layers for each organ-LOD.

♦ VIRUS:A - Virus A & B could affect each other within the body.

♦ VIRUS:B - Virus A & B could affect each other within the body.

♦ MEDICINE - A possible cure or counter agent for either one or both viruses.

5.2 INTERACTION OF PEOPLE IN AN OFFICE

A far more complex example of AI interaction would be considering people in an office.

This example accommodates people's moods and attitudes. The following points show possible types of layers that could be found within the simulated environment. Once again, the example is not indicative of a complete system only a list of possible AI layers.

WCE - The boundaries of an office. Also includes details about the initial office environmental conditions. People entering and leaving the office is an example of AI agents being inserted and removed from a specific layer.

♦ PEOPLE:MOOD - shows the attitude and mood of each person.

♦ PEOPLE:ACTIVITY - what each person is doing.

♦ PEOPLE:CLOTHING - type of clothing could affect other people's moods or attitudes

♦ PEOPLE:PERSONALITLY - contributes towards the mood and attitude

♦ OFFICE:EQUIPMENT - type of equipment or furniture affecting mood or attitude

♦ OFFICE:CLIMATE CONTROL - general office temperature

6. CONCLUSION

This paper has provided a fairly brief look at a model that can replicate not only an earth- like environment, but also diverse systems such as a viral infection or possibly people's interactions in an office environment.

There are various areas of the basic Model that can be researched further. Some of these possible areas are:

♦ Mathematical modeling defining the whole system;

♦ A functional implementation of the system;

♦ Discussion on the implementations of different AI within in the AI layers;

♦ An actual definition of the DTD and XML used in the AI layer interfacing; and,

♦ Identify and generate possible scenarios to be tested within the system.

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