

Chapter X

Artificial Immune Systems

Introduction

We now consider the problem of introducing more intelligence into the artificial intelligence's responses in real-time strategy games (RTS). We discuss how the paradigm of **artificial immune systems** (AIS) gives us an effective model to improve the AI's responses and demonstrate with simple games how the AIS work. We further discuss how the AIS paradigm enables us to extend current games in ways which make the game more sophisticated for both human and AI.

In this chapter, we show how strategies may be dynamically created and utilised by an artificial intelligence in a real-time strategy (RTS) game. We develop as simple as possible RTS games in order to display the power of the method we use.

As discussed in the last chapter, units are powerful against one unit and weak against another. In a typical game world, scissors dominates paper which dominates stone which dominates scissors. For example, in Rise of Nations from Microsoft, cavalry are powerful against light infantry who are good against bowmen who are power-

ful against heavy infantry who in turn can overcome cavalry. Therefore knowing what strategy your opponent is going to use gives the human player a very great advantage.

In these games, the computer player's strategy is often extremely predictable. Typically, it will select what seems initially to be an optimal balance of each type of fighter but if that is known, it can be defended against. Thus the game reduces to the human player(s) simply identifying how the artificial intelligence (AI) will play and devising a strategy which will overcome the AI's strategy. The AI generally has no flexibility in its responses to the human strategies and so the game quickly becomes boring. At core is the fact that, for the AI, the strategies of the human player form an important part of an evolving environment. In giving it an *a priori* optimal strategy, the games developers may be giving it the best single static strategy but this will always be beaten by strategies which are learned during the course of the game and dynamically changed in response to the changing strategies met during the course of the game. We propose a system which allows the AI to respond dynamically to the strategies used by its human opponent; in effect, we wish to give the AI enough adaptability so that it may respond as a second human player would to the strategies of its human opponent.

The prototypical situation which we have in mind is that which exists when the AI and the human are both building civilisations with limited resources. Often during such games, the civilisations interact with one another in a hostile manner: the AI will typically launch attacks against the human player's civilisation and the human strategy becomes one of defending a civilisation whilst building up enough resources in order to be able to launch an overwhelming attack. While success in this type of game is initially satisfying, the fact that the same strategy can be used each time diminishes the enjoyment of the game. By giving the AI the ability to adapt, we hope that the human will gain more lasting enjoyment from the game.

Thus we propose to use artificial immune system (Dasgupta, 2000) methods; the immune system response attributes of specificity, diversity, memory, and self/non-self recognition are just what is needed in this situation. The next section discusses the immune system before we go on to describe the artificial immune system and how it may be used to optimise the AI's responses to human opponents. Finally we consider how the use of the immune system paradigm may allow us to develop more sophisticated games which are more like real life engagements.

The Immune System

We discuss only those aspects of artificial immune systems which are relevant to this chapter. For a fuller discussion, see for example works by Dasgupta (2000) and De Castro and von Zeuben (1999, 2000).

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