

Week Starting 11th July.

My main aim for the week was to familiarise myself with the Human Immune System metaphor applied to computing, and to get an idea for the application of such a system by carefully reading through some papers that use AISs for various types of problem solving. I also planned to have started to learn MATLAB.

I started to read “Artificial Immune Systems: An Emerging Technology”, a slide based tutorial written by J Timmis, though the presentation was confusing without the background Immune System knowledge, so I decided to spend the next couple of days doing some background reading into how the Human Immune System functions in some detail, so that I could fully appreciate the AIS metaphor.

I read first;

<http://science.howstuffworks.com/immune-system.htm>

Although not very detailed, this extensive article provided an overview of the complete Human Immune System.

After finishing the article, I checked that the MATLAB GSCF Modular Robot would run, and spent the end of the evening looking through the MATLAB IDE, and wrote an obligatory “Hello World!” program using simply `disp(...)` and `msgbox(..., ...)`.

On Tuesday I continued to look at the Human Immune System, by reading http://en.wikipedia.org/wiki/Immune_system, and the related pages, and wrote my own summary of terminology, and of both the Cellular Immune System, and of the Humeral Immune System.

In the evening, I re-read “Artificial Immune Systems: An Emerging Technology”, and understood that in AISs, there are currently three key processes;

Negative Selection: T-cells maturing in Thymus, where self-binding T-cells are removed.

Clonal Selection: evolution of B-Cells through proliferation, differentiation and genetic mutation.

Immune Network: the network effect of stimulation and suppression, where molecules can react to self as well as non-self, though I don’t currently understand how this is applied, or works.

I also searched the internet for more papers by Timmis, and other AIS groups. The main article I found, and read the following morning was;

“Artificial Immune Systems: A Novel Paradigm to Pattern Recognition” by L.N. Castro and J. Timmis, which is a fuller text based on the material of the tutorial I’d just read. It talked about applying AIS theory to pattern recognition through negative and clonal selection, and the main points that need to be addressed. Discussion included how data should be represented, and the notion of an affinity function which corresponds to how well a receptor (or antibody) matches an antigen. Affinity is proportional to proliferation, but inversely proportional to mutation.

The final section, a comparison between Artificial Immune Systems, and Artificial Neural Networks was very interesting, and highlighted main differences in the two (since both form a strong methodology for pattern recognition in computing). The article points out that ANNs adapt purely by learning, and AISs adapt through a combination of both learning and evolution; Evolution being a “change in the population”, and learning being a “gain in experience”. It also mentions that AISs have been successfully applied to non-linearly separable tasks, though it seems AIS theory is not well enough established to provide proof on AIS behaviour.

I went on to read some papers applying AISs to specific problems;

“An Artificial Immune System Based Visual Analysis Model and its Real-Time Terrain Surveillance Application” and “Immune System Approaches to Intrusion Detection - A Review”.

The most interesting thing about this paper is its binary hamming shape-space, but with an un-usual affinity measure based on the notion of “don’t cares” in receptors. This will lead to a reduced number of “antibodies” required, and a smaller search space, but I’m uncertain that the classification of patterns used will scale well.

“IS Approaches to Intrusion detection – A Review”

This paper really only focuses on some fine adjustments to the algorithms of implemented intrusion detection systems. It may be more relevant when I come to playing with the named algorithms.

“Towards a Conceptual Framework for Artificial Immune Systems”

This paper calls on a need for a framework for AISs, but doesn't really go anyway towards defining one. The paper wants to see more inter-disciplinary research, largely into the network theory of the HIS, and says that current AIS algorithms are "naïve". I agree that there is a lot of room for research, but think the computational methodologies of negative and particularly clonal selection have a lot to offer, and are quite brilliant in their simplicity.

Over Wednesday night and Thursday morning, I read the introductory paper to the General Suppression Framework, entitled "Immunologic Control Framework for Automated Material Handling". The paper relates various aspects of the autonomous guided vehicles to the human immune system, but uses none of the powerful computational properties such as negative or clonal selection. The system designed does not feel as though it were inspired by AISs, but rather compared to it. The main point of the document however is in contrasting the fully distributed nature of the AGVs compared to a centralised approach, and provides models to demonstrate the performance increase. I'm not convinced though that the centralised system used is representative of the most efficient centralised system possible. The paper ends in suggesting that the research will move toward making use of features such as clonal selection, which would be very interesting.

I spent the rest of Thursday and Friday morning working through the MATLAB tutorial, and intend to continue on Sunday when I resume work. I'll spend next week writing my first MATLAB programs, and playing with the example MATLAB code that I have in order to get to grips with MATLAB, and read a few more papers from Lau, Wong and Ko on their General Suppression Framework. By the End of next week I intend to be proficient in MATLAB programming and modelling.