# Hypercell as a hybrid artificial immune system model

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*Abstract* - **A new artificial immune model based on the principles of Negative Selection algorithm is introduced. The key features of the hypercell are described.**

*Keywords* – **Negative Selection, Hypercell, Detector.**

## I. INTRODUCTION

Using Artificial Immune Systems (AIS) in the diagnostics of complex objects and systems is a promising area of scientific research. AIS is a computational system inspired by various immunological theories that explain the behaviour of human adaptive immune system. The major mechanism that controls the behaviour of AIS is discrimination between self and nonself [1]. The most common techniques used in artificial immune system are negative selection, clonal selection, and immune network models.

## II. NEGATIVE SELECTION

Negative selection was proposed by Forrest et al [1] in 1994 and attracted many researchers. It originally was designed to detect changes in stable systems. It models the processes that happen in thymus. Thymus is an imortant component of human immune system, that produces lymphocites capable of detecting nonself cells. This is done by storing self samples inside thymus. When a new random lymphocite is produced, it is being compated with self sample and if it matches any of them, it should be destroyed inside thymus and will not be emitted.

This results in a set of lymphocites that cover the nonself area. This feature of negative selection model allows to detect changes inside the system. If a new (nonself) cell gets into the system if can easily be detected by the population of negative detectors (lymphocites), thus will be destroyed.

An important quality of negative selection model is that it can be trained using only nomal (self) data and then will react to any nonself cell activity. This quality makes it possible to use negative selection model for computer virus detection, spam filtering, intrusion detection etc.

In spite of this, negative selection has a significant drawback. The process of generating random detectors that do not match self cells becomes computationally difficult if the size of self gets large. That is why there are some doubts about negative selection applicability [2].

## III. HYPERCELL

Hypercell is a self-organized object that combines characterisitcs of a single detector and a model. A special feature of hypercell is the ability to deside whether it should behave as a model or as a detector. The difference is that a detector is able only to match cells using the affinity measure, but model determines the behaviour of the set of detectors – it can create new ones, destroy loosely generted detectors and perform other actions over detector set. Hypercell behaviour as a model is based on negative selection algorithm.

Hypercell can be repesented as a tree. The root is a top-level hypercell, the leaves are atomic hypercells, that act like simple detectors. Other nodes are composite hypercells (like the root). Atomic hypercells can exist on every hierarchy level. The criteria $\delta$ is used to take the desision of swithing behaviour from atomic to composite is descriped in Eq 1.

$$\delta = \exists ag \in A_g : aff\,(ag,h) < \lambda \,, \qquad (1)$$

where $\lambda$ is a minimal affinity threshold; $h$ is the current hypercell; $Ag$ is a set of antigens.

There can be the other reasons to leave hypercell atomic – if we have a tree with too-large depth or if the given hypercell has too many child nodes of the same class – then such node should be pruned.

This makes hypercell a good alternative to negative selection algorithm. Training hypercell model is a fast process, because processing a tree takes less time, then processing a list. At the same time, hypercell model is similar to negative selection model, because it can be trained using one-class training set, it uses negative representation of information, it uses detectors as the detection mechanism, it can be easily distributed to get more performance.

Experiments were carried out to prove its superiority. Two-dimenstional real-valued data were used. The results have shown that hypercell trains 23 times faster and it's accuracy was about 5% comparing to 11% for classical models.

## IV. CONCLUSION

AIS models was the area of research. The goal was to reduce or eliminate disadvantages of negative selection model.

Scientific novelty of the research consist in the following: exising AIS models were analyzed and a new hybrid AIS model is proposed, which allowed to improve negative selection model.

Practical significance consists in a possibility of using hypercell model for solving real-life problems, like spam filtering, security, defects identifying etc.

## REFERENCES

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