The Artificial Immune System with Evolved Lymphocytes

by

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Abstract

The main purpose of the natural immune system is to protect the body against any unwanted foreign cells that could infect the body and lead to devastating results. The natural immune system has different lymphocytes to detect and destroy these unwanted foreign patterns. The natural immune system can be modeled into an artificial immune system that can be used to detect any unwanted patterns in a non-biological environment. One of the main tasks of an immune system is to learn the structure of these unwanted patterns for a faster response to future foreign patterns with the same or similar structure. The artificial immune system (AIS) can therefore be seen as a pattern recognition system. The AIS contains artificial lymphocytes (ALC) that classify any pattern either as part of a predetermined set of patterns or not. In the immune system, lymphocytes have different states: Immature, Mature, Memory or Annihilated. Lymphocytes in the annihilated state needs to be removed from the active set of ALCs. The process of moving from one state to the next needs to be controlled in an efficient manner. This dissertation presents an AIS for detection of unwanted patterns with a dynamical active set of ALCs and proposes a threshold function to determine the state of an ALC. The AIS in the dissertation uses evolutionary computation techniques to evolve an optimal set of lymphocytes for better detection of unwanted patterns and removes ALCs in the annihilated state from the active set of ALCs.

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KEYWORDS:

Self, non-self, artificial lymphocytes, artificial immune system, affinity distance threshold, life counter transition function, genetic algorithms, classification system, negative selection, positive selection, mature, memory

Opsomming

Die hoofdoel van die biologiese immuun stelsel is om die liggaam te beskerm teen enige ongewenste vreemde selle wat die liggaam kan binnedring en sodoende skade aan die liggaam veroorsaak. Die immuun stelsel in die menslike liggaam het verskillende limfosiete wat die ongewenste selle raaksien en vernietig. Dit is moontlik om die biologiese immuun stelsel te modeleer as 'n kunsmatige immuun stelsel wat gebruik kan word om enige ongewenste patrone in 'n nie-biologiese omgewing raak te sien. Een van die hoof funksies van die biologiese immuun stelsel is om die struktuur van die ongewenste selle aan te leer om sodoende 'n vinniger immuun reaksie teenoor moontlike toekomstige ongewenste selle met naastenby of presies dieselfde struktuur te hê. Die kunsmatige immuun stelsel (KIS) kan dus gesien word as 'n patroonherkenningstelsel. Die KIS gebruik kunsmatige limfosiete (KLS) wat enige patroon kan klassifiseer as deel van 'n vooraf-bepaalde stel patrone al dan nie. In die immuun stelsel het die limfosiete verskillende toestande: Onvolwasse, Volwasse, Geheue en Vernietig. Die KLS'e wat in die vernietig-toestand is, moet van die aktiewe stel van KLS'e verwyder word. Die proses om van een toestand na 'n ander toestand oor te gaan moet op 'n doeltreffende wyse bepaal en beheer word. Die verhandeling lê 'n KIS voor om ongewenste patrone met 'n dinamiese aktiewe stel van KLS'e te herken en stel 'n toestands-veranderingsfunksie voor om die toestand van 'n KLS te bepaal. Die KIS in die verhandeling maak gebruik van evolusionêre komputasie tegnieke om 'n optimale stel van KLS'e te evoleer wat ongewenste patrone beter kan herken, en verwyder KLS'e in die vernietig-toestand vanuit die aktiewe stel van KLS'e.

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"If all your peers understand what you've done, it's not creative."

- H. Heimlich

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