Immune Inspired Fault Tolerance

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◆ Motivation

◆ Artificial immune systems

◆ Opportunities and challenges

Biology seems to be good at solving problems!

In the area of computational intelligence:

◆ Evolutionary algorithms, artificial neural networks, etc.

◆ The immune system has not been investigated a great deal

What does the immune system offer?

◆ Pattern recognition;

◆ Learning and memory;

◆ Robust and distributed;

◆ Adaptive and diverse;

AIS Definition

AIS are adaptive systems inspired by theoretical immunology and observed immune functions, principles and models, which are applied to complex problem domains;

Scope of AIS

◆ Fault and anomaly detection;

◆ Security of information systems;

◆ Data Analysis (data mining, machine learning, pattern recognition)

◆ Scheduling;

◆ Autonomous control;

◆ Optimisation;

◆ Robotics;

AIS for Fault Tolerance

◆ An immune system metaphor for fault tolerance:

  ◆ self / non-self discrimination;

◆ Self/ non-self discrimination metaphor provided inspiration for the negative selection algorithm:

  ◆ Generate detectors to detect undesirable changes to normal patterns or behaviour (self) of a system

Immune system	Fault Tolerance Domain
Self molecules	Self states/behaviours
Nonself molecules (antigenic patterns)	Abnormal states/behaviours
T-cells	Error detectors

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Negative Selection Algorithms

- ◆ Idea taken from the negative selection of T-cells in the thymus;

- ◆ Applied initially to computer security;

- ◆ Split into two parts:
  - ◆ Censoring;
  - ◆ Monitoring;
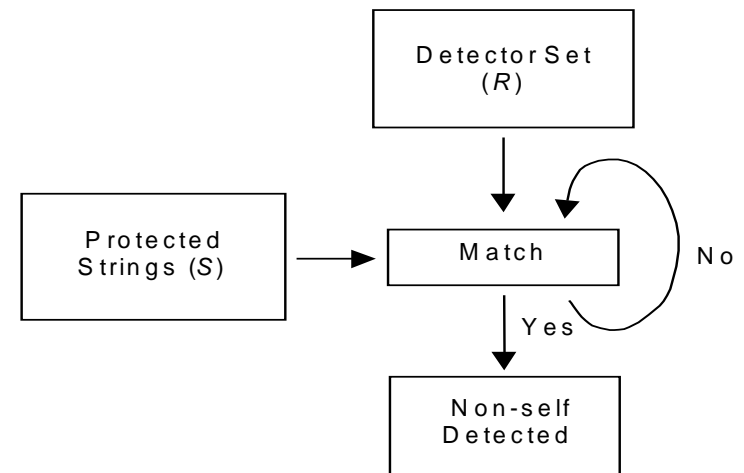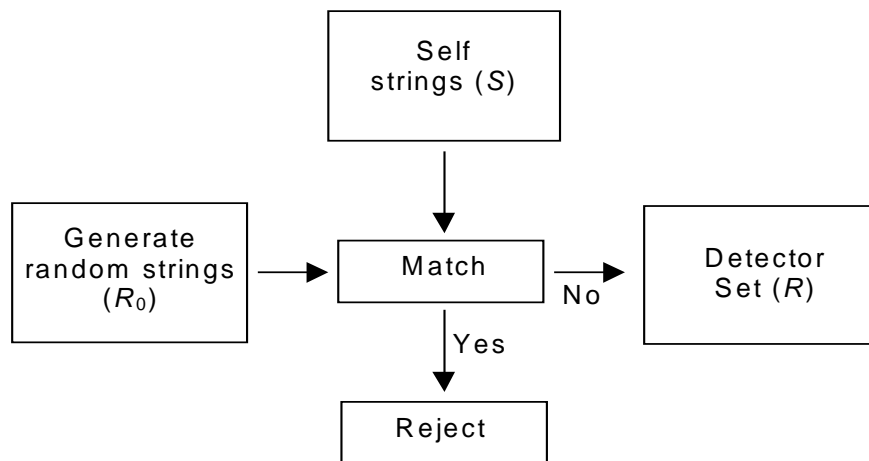
Opportunities:

◆ What artificial immune systems (AIS) promise that the existing approaches are not able to achieve?

　　◆ trustworthiness, scalability, adaptability and cost;

◆ What is the current evidence that these can be achieved?

Challenges:

◆ What are the challenges that AIS face when applied to dependable systems?

- ◆ What the system should know / learn?

  - ◆ self or non-self;

  - ◆ rare events;

- ◆ Minimal detector generation;

- ◆ Coverage of detectors;

- ◆ Adaptability;

- Immune network theory:

  - Metadynamics – adaptability;

  - Self-assertion view

    - adaptability;

    - no initial knowledge of self, which is developed over time;

- Danger theory;

- Incorporation of domain knowledge;