

Collaborative Bio-Inspired Algorithms

Lecture 11 : Clonal Selection Algorithms

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Outline

Quick Primer

Static Clonal Selection

AIRS

Dynamic Clonal Selection

AISEC

Summary

Quick Primer

- ▶ Supervised machine learning
- ▶ When you know the class of an instance before you start
- ▶ Wish to build a model of that data so you can then classify instances you have not seen before
- ▶ Many approaches including:
 - ▶ Neural networks, rule induction, Bayesian, ILP . . .

Learning in the Immune System

- ▶ Recall the learning and memory capabilities in the clonal selection process
- ▶ Exploit this local v global search in a learning context
- ▶ Evolve a set of detectors that can generalise well enough to classify unseen data items

Artificial Immune Recognition System (AIRS)

- ▶ Artificial Immune Recognition System (AIRS) [2]
- ▶ Uses the concepts of ARB's (Artificial Recognition Balls)
- ▶ Resource based competition for survival in order to control the population
- ▶ One-shot learning system

Go to the board and describe algorithm . . .

AIRS Results

Data Set	Accuracy
Iris	96%
Ionosphere	95.6%
Diabetes	74.2%
Sonar	84.9%

Continuous Learning

- ▶ Used when you want to classify changes over time (the notion of what is in a class)
- ▶ Levels of what you are interested in may change over time or the context of where you are working or what you are doing
- ▶ Web content mining is a perfect testbed for these ideas
- ▶ This study looked at email classification of interesting v un-interesting

Email Filtering

- ▶ Dynamic supervised classification algorithm
 - ▶ E-mail classified as interesting and uninteresting
 - ▶ Uses constant feedback from user
 - ▶ Capable of continuous adaptation
 - ▶ This tracks concept drift and can also handle concept shift
- ▶ **Representation:** Subject, Sender and Return address (based on existing literature, this is all you really need)
- ▶ **Affinity measure:** Proportion of words found in one cell compared to another (very naive)

AISEC I

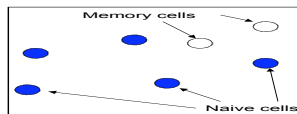


Figure: (1) System is initialised with *uninteresting* emails

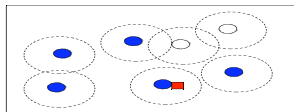


Figure: (2) Email classified as uninteresting if high stimulation

AISEC II



Figure: (3) Highly stimulated cell reproduces, as in clonal selection

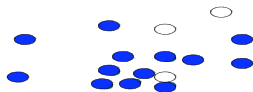


Figure: (4) Highest affinity cell rewarded through promotion to memory cell

AISEC II

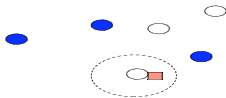


Figure: (5) Any cell responsible for incorrect classification is removed

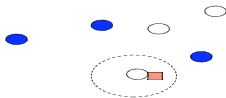


Figure: (6) Aged cells (and un-stimulated) die

Results

- ▶ 2268 e-mails (742 uninteresting) received over 6 months [1]
- ▶ E-mails presented in chronological order
- ▶ Feedback given after EVERY classification and AISEC run 10 times

Technique	Accuracy
C5	83.9%
Naive Baysian (static)	85%
Neural network	85.6%
AISEC (static)	86%
Naive Baysian (dynamic)	88.05%
AISEC (dynamic)	89.05%

Results

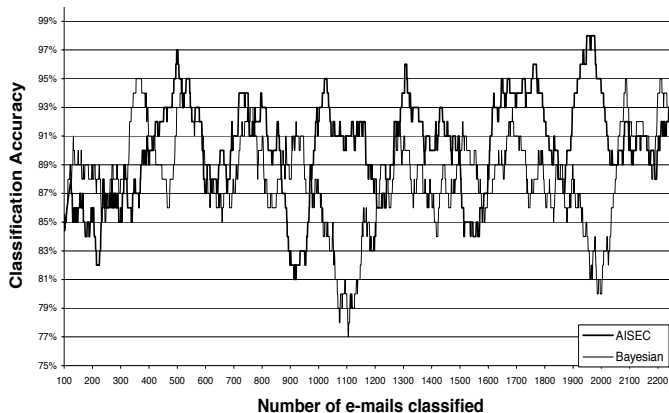


Figure: Classification accuracy over time

Summary

- ▶ Learning in the immune system
- ▶ Static clonal selection: AIRS
- ▶ Dynamic clonal selection: AISEC
- ▶ Many other variants, not covered here. Read the supporting literature.



A. Secker, A. Freitas, and J. Timmis.

AISEC an artificial immune system for email classification.

In Proceedings of the Congress on Evolutionary Computation, pages 131–139, 2003.



A. Watkins, J. Timmis, and L. Boggess.

Artificial immune recognition system (AIRS): An immune-inspired supervised learning algorithm.

Genetic Programming and Evolvable Machines, 5(1):291–317, 2004.