BENCHMARKING THE AIRS ARTIFICIAL IMMUNE SYSTEM FOR CLASSIFICATION

Peter van der Putten [a] Ling Jun Meng[b]

[a] *putten@liacs.nl; LIACS, Leiden University, The Netherlands*
[b] *mlj@sdu.edu.cn; Network Center, Shandong University, P.R.China*

Abstract

In this paper we present the results of an extensive benchmark on AIRS, an artificial immune systems algorithm for classification. We show that previous claims about AIRS were too strong, however the experiments indicate AIRS is mature and stable enough to be used for real world data mining applications.

1 Introduction

Recently, artificial immune systems have been introduced as a new type of biologically inspired data mining algorithm. These algorithms mimic the capabilities of the immune system to recognize new, unknown intruders and memorize past attacks. In our research we aim to provide the first independent, extensive benchmark of the Artificial Immune Recognition System (AIRS) algorithm for classification [3]. In earlier papers strong claims were made, for instance: "AIRS is competitive with the top five to eight classifiers out of 10-30 best classifiers on those problems","it was surprisingly successful as a general purpose classifier" and it "performed consistently strong across large scope of classification problems" [1, 2]. However, in our opinion these approaches were relatively limited, given that comparisons were made on a small number of data sets and algorithms and that the benchmark results were sourced from literature rather than obtained by experimentation under uniform conditions

In our opinion, to be accepted as a candidate algorithm for data mining *applications*, the source of inspiration for these algorithms is irrelevant. To some users, the fact that an algorithm is biologically inspired may even lead to suspicion, given the overhyped claims that were sometimes made in the early days of predecessors such as evolutionary computing and neural networks. Rather empirical evidence is needed that these algorithms produce high quality, reliable results over a wide variety of problems compared to a range of other approaches, without the need of expert fine-tuning. In our research we focus on providing such benchmarking results.

2 Benchmarking AIRS

The natural immune system uses a process of natural selection to adaptively react to new intruders. The AIRS algorithm follows the same idea to evolve a set of codebook vectors that represent a data set in pattern space. The main idea is that for a given training instance codes that are activated most are allowed to proliferate into new, similar codes. The most useful codes are retained. When training has converged, classification takes place by a simple k-nearest neighbor match on the codes [4].

The benchmarking results are shown in the table below. All experiments are carried out using 10-fold stratified cross validation, without ad hoc fine-tuning, on a representative set of classifiers. AIRS-1 (1 nearest neighbor in final classification) performs better than average (excluding decision stump and majority vote) on 3 of these 9 datasets and AIRS-7 is better than average on 6 of these 9 datasets. Our results show that AIRS may not be as strong as previously claimed, however it

	Sonar	**Wisc. Breast Cancer**	**Wave form**	**Iris**	**Iono- sphere**	**Pima dia- betes**	**Ger- man**	**TIC5050 credit**	**TIC5050**
Maj. Class	*53.4* ± 1.7	*65.5* ± 0.5	*33.8* ± 0.1	*33.3* ± 0.0	*64.1* ± 1.4	*65.1* ± 0.4	*70.0* ± 0.0	*49.7* ± 0.4	*49.7* ± 0.4
1NN	**86.6** ±7.0	95.3 ±3.4	73.6 ± 1.3	95.3 ± 5.5	86.3 ± 4.6	70.2 ± 4.7	72.0 ± 3.1	*55.9* ± 7.8	59.9 ± 5.1
7NN	80.8 ± 7.8	**96.6** ± 2.2	80.1 ± 1.1	**96.7** ± 3.5	85.2 ± 4.3	74.7 ± 5.0	74.0 ± 4.1	61.1 ± 3.2	65.4 ± 8.4
Dec. Stump	73.1 ± 8.3	*92.4* ± 4.4	*56.8* ± 1.5	*66.7* ± 0.0	*82.6* ± 4.8	71.9 ± 5.1	*70.0* ± 0.0	**68.5** ± 4.7	**68.5** ± 4.7
C45 (J48)	71.2 ± 7.1	94.6 ± 3.6	75.1 ± 1.3	**96.0** ± 5.6	**91.5** ± 3.3	73.8 ± 5.7	70.5 ± 3.6	**68.1** ± 5.5	**69.1** ± 4.4
Naive Bayes	*67.9* ± 9.3	96.0 ± 1.6	80.0 ± 2.0	**96.0** ± 4.7	*82.6* ± 5.5	**76.3** ± 5.5	**75.4** ± 4.3	62.8 ± 6.4	68.0 ± 3.3
Conj. Rules	*65.9* ± 8.7	*91.7* ± 4.5	*57.3* ± 1.3	*66.7* ± 0	*81.5* ± 5.4	*68.8* ± 8.67	*70.0* ± 0	**67.4** ± 3.7	68.3 ± 4.5
Bag- ging	77.4 ± 0.1	95.6 ± 3.1	**81.8** ± 1.4	94.0 ± 5.8	**90.9** ± 4.4	74.6 ± 3.6	**74.4** ± 4.9	59.9 ± 5.8	68.4 ± 4.1
Log. Regr.	73.1 ± 13.4	**96.6** ± 2.2	**86.6** ± 2.3	**96.0** ± 5.6	88.9 ± 4.9	**77.2** ± 4.6	**75.2** ± 3.4	62.7 ± 4.6	66.5 ± 3.4
MLP	**82.3** ± 10.7	95.3 ± 2.6	**83.6** ± 1.7	97.3 ± 3.4	**91.2** ± 2.8	**75.4** ± 4.7	71.6 ± 3.0	60.7 ± 4.3	65.4 ± 4.7
Dec. Table	74.5 ± 8.2	95.4 ± 2.7	73.8 ± 1.6	92.7 ± 5.8	89.5 ± 4.5	73.3 ± 3.6	72.2 ± 4.1	61.9 ± 4.5	**69.1** ± 5.7
AIRS1	**84.1** ± 7.4	96.1 ± 1.8	75.2 ± 1.7	**96.0** ± 5.6	86.9 ± 3.1	*67.4* ± 4.6	*68.0* ± 5.1	*56.8* ± 4.4	*55.0* ± 6.5
AIRS7	76.5 ± 8.4	**96.2** ± 1.9	79.6 ± 2 .2	95.3 ± 5.5	88.6 ± 5.0	73.6 ± 3.5	71.4 ± 3.1	57.8 ± 5.5	*59.1* ± 6.1

Table 1: Average accuracy and standard deviation on accuracy (ten fold) for AIRS and a range of benchmark algorithms. Best results in boldface, worst results in italics.

is mature and reliable enough to be added to the data miners toolbox. The top and bottom 3 classifiers are highlighted by using boldface and italics respectively (more in case of ties).

In follow up experiments we aim to characterize AIRS behavior further, for instance by identifying classifiers that consistently show similar patterns of performance across data sets. Initial experiments have show that, as expected, k-NN algorithms behave similar, however to our surprise neural networks generate similar performance patterns as well.

References

[1] D.E. Goodman, L. Boggess, and A. Watkins. Artificial immune system classification of multiple-class problems. In *Artificial Neural Networks in Engineering (ANNIE)*, 2002.

[2] D.E. Goodman, L. Boggess, and A. Watkins. An investigation into the source of power for AIRS, an artificial immune classification system. In *IJCNN-03*, 2003.

[3] L.J. Meng, P. van der Putten, and H. Wang. A comprehensive benchmark of the Artificial Immune Recognition System (AIRS). In *ADMA-05*, 2005.

[4] A. Watkins, J. Timmis, and L. Boggess. Artificial immune recognition system (AIRS): An immune-inspired supervised learning algorithm. *Genetic Programming and Evolvable Machines*, 5(3):291–317, 2004.