

Artificial Immune System Thesis Bibliography

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Abstract-This work is an artificial immune systems masters thesis and doctoral dissertation bibliography. The aggregate listing provides (1) a complete listing of theses and dissertations in the field, (2) an inductive resource for research-degree projects in the field, and (3) insightful information regarding the 'state of the art' and longer-term 'trends in the field'.

Keywords- Artificial Immune Systems, AIS, Dissertation, Thesis, Masters, Ph.D., Bibliography

I. INTRODUCTION

The masters and doctoral projects in a field reveal information regarding the 'current state of the field' and medium to long-term 'trends in the field'. This paper is a complete¹ summary of doctoral dissertations and master (and internationally equivalent) thesis in the field of Artificial Immune Systems (AIS).

The goal of this work is to provide:

1. A complete listing of theses and dissertations in the field of AIS
2. An inductive resource for the field of AIS from a research-degree project perspective
3. Extract and summarise insightful trends from the collection and listing of theses

Work on collecting theses and dissertations was begun by Jason Brownlee in early 2005 using the bookmarking website tool del.icio.us [66]. In late 2005 this bookmark collection was aggregated into its own independent resource on Brownlee's website [23], which has been kept up-to-date since its inception. This report seeks to extend the basic list structure provided in the website to include data summary and qualitative assessments.

There are other efforts to construct bibliographic aggregations for the field of artificial immune systems. The most successful is the ongoing AIS Bibliography by Dasgupta, et al. [16]². That project seeks to list all references in the field of AIS including; books, thesis, dissertations, people, websites, events, journal articles, conference papers, and technical reports. What that project does not do is extract any meaning from the aggregate listings.

¹ To the author's knowledge given intense Googling and emailing.

² I encourage collaboration with the AIS Bibliography project and the sharing/replication of all aggregated bibliographic information in this work

Acceptance criterion for this listing are simple. The thesis must be (1) on a topic in the field of artificial immune systems, or (2) strongly related to topics in the field of artificial immune systems (such as computer sciences projects in theoretical immunology). The definition of artificial immune systems is taken from the spirit of definitions in [40] (page 58), which may be distilled to computational systems inspired by aspects of the biological immune system.

This is a living document, meaning that as amendments and additions are discovered, new revisions of this document will be released³. The report reference number and document footer reflect the version and date information for reference purposes.

II. DOCTORAL DISSERTATIONS

This section contains a listing of doctoral dissertations in the field of artificial immune systems ordered by author surname.

Surname	Thesis Title	Ref
Ayara	An Immune Inspired Approach For Adaptable Error Detection in Embedded Systems	[48]
Carneiro	Towards a comprehensive view of the immune system	[28]
Cruz Cortés	Artificial immune system to solve problems of optimization	[49]
de Castro Silva	Immune Engineering: Development of Computational Tools Inspired by the Artificial Immune Systems	[41]
Detours	Modèles Formels de la Sélection des Cellules B et T	[64]
Esponda	Negative Representations of Information	[19]
Gonzalez	A Self-Adaptive Evolutionary Negative Selection Approach for Anomaly Detection	[44]
Gonzalez	A Study of Artificial Immune Systems Applied to Anomaly Detection	[18]
Hart	Immunology as a Metaphor for Computational Information Processing Fact of Fiction?	[17]
Hightower	Computational Aspects of Antibody Gene Families	[56]
Hofmeyr	An Immunological Model of Distributed Detection and its Application to Computer Security	[59]
Ji	Negative Selection Algorithms from the Thymus to V-detector	[67]
Kim	Integrating Artificial Immune Algorithms for Intrusion Detection	[32]
Knight	MARIA: A Multilayered Unsupervised Machine Learning Algorithm Based on the Vertebrate Immune System	[61]
Ko	The Design of an Immunity-based Search and Rescue System for Humanitarian Logistics	[2]
Meshref	Modelling Autonomous Agents' Behavior Using Neuro-Immune Networks	[21]
Milutinovic	Stochastic Model of Micro-Agent populations	[14]

³ Time and interest of the author permitting

Nicosia	Immune Algorithms for Optimization and Protein Structure Prediction	[20]
Oprea	Antibody Repertoires and Pathogen Recognition The Role of Germline Diversity and Somatic Hypermutation	[47]
Secker	Artificial Immune Systems for Web Content Mining Focusing on the Discovery of Interesting Information	[8]
Smith	The Cross-Reactive Immune Response Analysis, Modeling, and Application to Vaccine Design	[15]
Somayaji	Operating System Stability and Security through Process Homeostasis	[9]
Stibor	On the Appropriateness of Negative Selection for Anomaly Detection and Network Intrusion Detection	[62]
Suzuki	Biologically-inspired Autonomous Adaptability in Communication Endsystem An Approach Using an Artificial Immune Network	[33]
Timmis	Artificial Immune Systems A novel data analysis technique inspired by the immune network theory	[27]
Wang	Immune evolutionary computation and its application	[42]
Watkins	Exploiting Immunological Metaphors in the Development of Serial, Parallel, and Distributed Learning Algorithms	[7]

Table 1 - Summary of doctoral dissertations in the field of artificial immune systems

III. MASTERS THESES

This section contains a listing of masters' theses (or equivalent) in the field of artificial immune systems ordered by author surname.

Surname	Thesis Title	Ref
Aycock	Using an Inductive Learning Algorithm to Improve Antibody Generation in a Single Packet Computer Defence Immune System	[57]
Balachandran	Multi-shaped detector generation using real valued representation for anomaly detection	[58]
Balthrop	RIOT: A Responsive System for Mitigating Computer Network Epidemics and Attacks	[34]
Barrishi	Modeling the artificial immune system to the human immune system with the use of agents	[10]
Bebo	Using Relational Schemata in a Computer Immune System to Detect Multiple-Packet Network Intrusions	[25]
Cardinale	A Constructive Induction Approach to Computer Immunology	[37]
Edmonds	Artificial Immune Networks for Function Optimisation	[11]
Esslinger	An Artificial Immune System Strategy for Robust Chemical Spectra Classification via Distributed Heterogeneous Sensors	[45]
Graaff	The artificial immune system with evolved lymphocytes	[4]
Greensmith	New Frontiers For An Artificial Immune System	[31]
Harmer	A Distributed Agent Architecture for a Computer Virus Immune System	[55]
Ibrahim	Assessing the Performance of a Modified Negative Selection Algorithm against traditional data-mining techniques on a cancer database	[1]
Jang	AISEC An Empirical Investigation into an Artificial Immune System for Email Classification	[24]
Juca	An Approach for Intrusion Detection with Immune System	[35]
Kelsey	An Immune Inspired Algorithm for Function Optimisation	[26]
Kilgour	Developing a Practical Artificial Immune System for Email Classification	[3]
Lawal	Investigation of Novel Mutation Mechanisms for Immune: Inspired Optimisation Algorithms	[53]
Lord	An Emergent Model of Immune Cognition	[12]
Majumdar	Anomaly Detection in Single and Multidimensional Datasets Using Artificial Immune Algorithms	[50]
Matthews	Immunotronics Self-repairing finite state machines	[36]
Meng	Artificial Immune System for Knowledge Discovery	[43]

Morrison	Similarity Measure Building for Website Recommendation within an Artificial Immune System	[63]
O'Brien	Using Sequence Analysis to Perform Application-Based Anomaly Detection Within an Artificial Immune System Framework	[38]
Oda	A Spam-Detecting Artificial Immune System	[60]
Olsson	Anomaly Detection Using Self/Nonself Discrimination	[39]
Pacheco	Computational Power of Killers and Helpers in the Immune System	[29]
Prattipati	Improvement and Evaluation of an immune-based email classification system	[51]
Ranang	An Artificial Immune System Approach to Preserving Security in Computer Networks	[46]
Rantonen	An Artificial Immune System for Document Classification	[52]
Shapiro	An Evolutionary Algorithm to Generate Ellipsoid Detectors for Negative Selection	[30]
Stow	Towards an immunological approach to network management learning, memory and cross-reactivity in an artificial immune system	[13]
Twycross	An Immune System Approach to Document Classification	[22]
Wang	Artificial Immune Optimization and Its Application in Industrial Electronics	[65]
Watkins	AIRS: A resource limited artificial immune classifier	[6]
Whitbrook	An idiotypic immune network for mobile robot control	[5]
Williams	Warthog Towards a Computer Immune System for Detecting "Low and Slow" Information System Attacks	[54]

Table 2 - Summary of masters (or equivalent) thesis in the field of artificial immune systems

IV. TRENDS

This section provides some data summary and basic qualitative observations regarding the aggregate listings of Masters and Ph.D. theses.

A. General Observations

Each thesis represents a culmination of a research project, thus the research topics are at least interesting enough to spend one to three (at least) years investigating. Further, doctoral theses represent a larger investment of time and resources than Masters, thus data derived from those works may have more relative meaning (such as measures of interest or predictive power).

There are 36 Masters thesis, which is 9 more than the total 27 doctoral thesis.

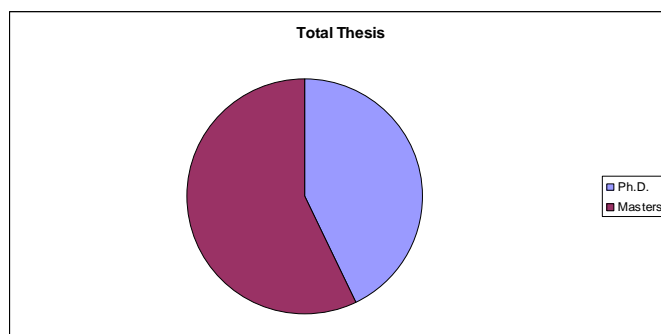


Figure 1 - Total Masters and Ph.D. Thesis

B.Time

A bubble of masters projects completed in 2003 and 2004 (approximately 48% of all masters projects). The trend shows that this bubble was on the rise since 1999, although since its height in 2003 and 2004, the masters release rate declined.

The trend for Ph.D. completion is relatively stable through time. There may be some seasonality with an approximate three-year cycle peaking in the years 1996, 1999, 2002, 2005. The peaks have been increasing through time.

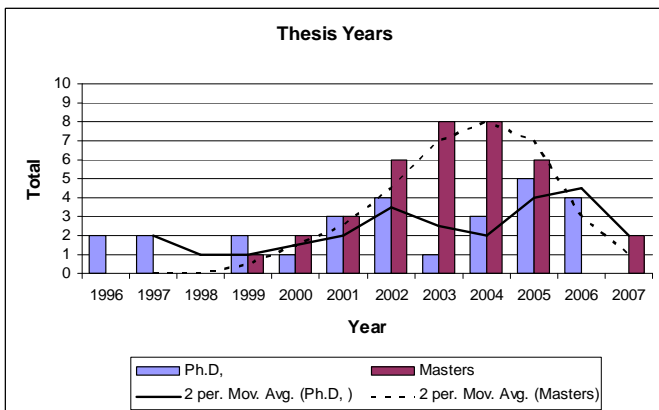


Figure 2 - These production rate over time

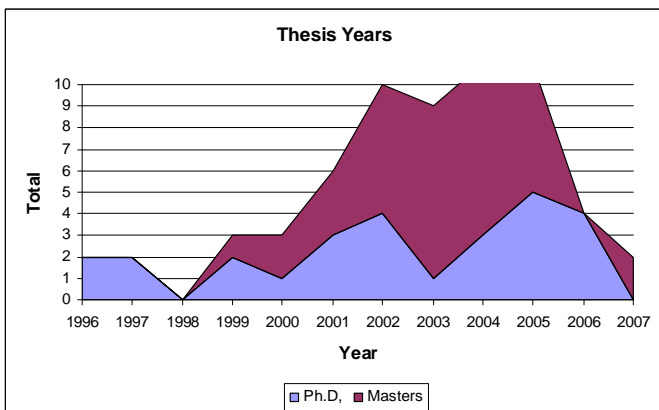


Figure 3 - Stacked thesis over time showing trends

C.Geography

The United States and the United Kingdom are the largest contributors of thesis with approximately 62% of Ph.D. thesis and approximately 72% of Masters coming from those two countries combined. The spread of remainder countries is relatively uniform.

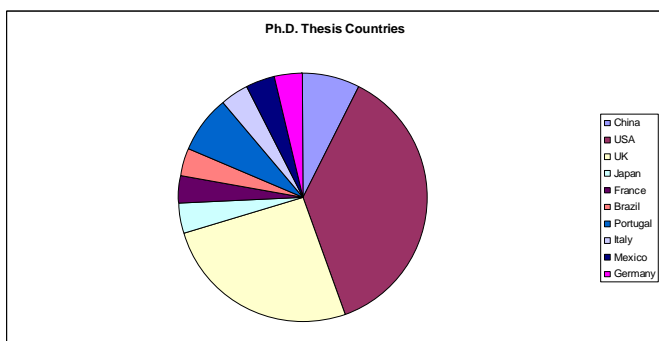


Figure 4 Ph.D. Thesis Countries

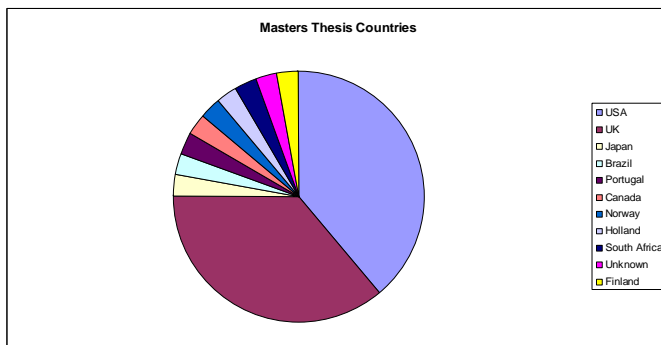


Figure 5 - Master Thesis Countries

D.Topic Areas

Theses were classified into one of four immunological paradigms: negative selection, clonal selection, network theory, danger theory, and other/unknown. Assignment was subjective, and theses were classified as other/unknown if ambiguous.

The classification scheme chosen is dubious as approximately 33% of Ph.D., and approximately 60% of Masters thesis did not classify as one of the four immunological paradigms. Given the dubiousness qualifier, approximately 26% of all thesis were related to the negative selection paradigm, and approximately 15% of all these were related to the clonal selection paradigm.

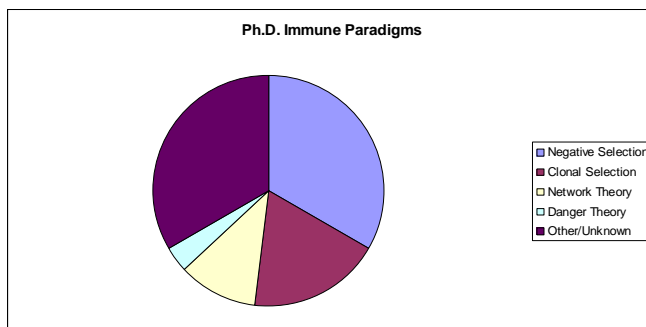


Figure 6 - Ph.D. thesis Immune Paradigms

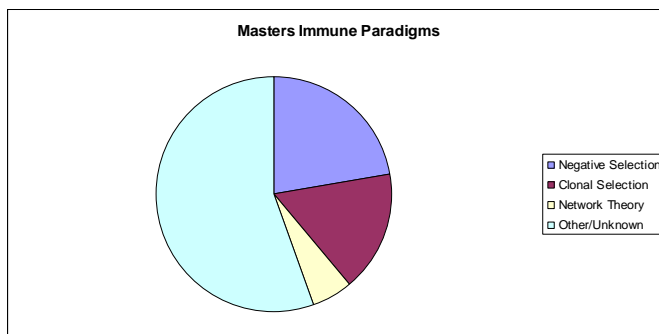


Figure 7 - Masters thesis Immune Paradigms

V.EXTENSIONS

This section suggests extensions to this work.

1. **More Theses:** An obvious extension is additions and amendments to the listing. This may be achieved through contacting supervisors and thesis

assessors, contacting the members or heads of research groups with interests in AIS, and through an intensive use of Google.

2. **More Trends:** A lot more interesting information may be gleaned from the aggregate thesis listing. Some examples of addition trends include:
 - a. *Supervisors* – What supervisors have been popular through time?
 - b. *Groups* – What research groups have facilitated AIS research and what have been their popularities through time?
 - c. *Applications* – To what applications have AIS been applied?
3. **More Access:** All theses should be made available online at no cost such that anyone interested may collect and read the contributions at their leisure.

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