UNIVERSITY OF ADELAIDE

DOCTORAL THESIS

Parameterized Analysis of Bio-inspired Computation and the Traveling Salesperson Problem

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Declaration

I, Samadhi Nallaperuma certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint award of this degree.

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" Student: Dr. Einstein, Aren't these the same questions as last year's [physics] final exam ?
Dr. Einstein: Yes; But this year the answers are different."

- Albert Einstein

UNIVERSITY OF ADELAIDE

Abstract

Engineering, Computer and Mathematical Sciences
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Parameterized Analysis of Bio-inspired Computation and the Traveling Salesperson Problem

by Samadhi Nallaperuma

Bio-inspired algorithms such as evolutionary algorithms (EA) and ant colony optimization (ACO) have become very popular in recent years to solve a wide range of complex real world problems. However, the understanding about the conditions under which these algorithms perform well is still limited. Classical computational complexity analysis often taking a worst case perspective, hardly captures what is happening during the actual algorithm run and, lacks implications for guiding algorithm design. This issue is more significant on the problems such as the traveling salesperson problem (TSP) where the problem is hard in a theoretical sense and has a lot of real world applications. Thus, more practical perspectives of algorithm analysis and design are essential to bridge the gap between the theory and the practice in bio-inspired computation specially with respect to the hard problems such as the TSP. We introduce "parameterized analysis" of bio-inspired computation by linking together several emerging methods of algorithm analysis and design with the aim of explaining the relationship between various problem and algorithm parameters and their effects on the algorithm performance. Moreover, we gain novel insights into bio-inspired computation and the TSP through parameterized analysis.

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Abbreviations

TSP	**T**raveling **S**alesperson **P**roblem
MST	**M**inimum **S**panning **T**ree
EA	**E**volutionary **A**lgorithm
GA	**G**enetic **A**lgorithm
ACO	**A**nt **C**olony **O**ptimization
RLS	**R**andomized **L**ocal **S**search
RSH	**R**andomized **S**earch **H**euristics
MMAS	**M**ax **M**in **A**nt **S**ystem
NP	**N**ondeterministic **P**olynomial
FPT	**F**ix **P**arameter **T**ractable
XP	e**XP**onential
PTAS	**P**olynomial **T**ime **A**pproximation **S**cheme
w. l. o. g.	**w**ithout **l**oss **o**f **g**enerality
i. e.	**i**d **e**st (that is)
cf.	**c**onfer (compare)
e. g.	**e**xempli **g**ratia (for example)

In loving memory of Blacks and Pinky (2003 - 2014) . . .