

Theory of Simple Genetic Algorithms

by

Yan Ping

Master of Science in Mathematics

2000



**Faculty of Science and Technology
University of Macau**

TABLE OF CONTENTS

LIST OF FIGURES	iii
LIST OF TABLES	iv
GLOSSARY	v
LIST OF ABBREVIATIONS	vi
Chapter 1 INTRODUCTION	1
1.1 General Introduction to Genetic Algorithms.....	1
1.2 Theory of Vose's Simple Genetic Algorithm.....	4
1.3 Structure of the Thesis.....	5
1.4 A Vose's Simple Genetic Algorithm.....	6
Chapter 2 ALGEBRA MODEL FOR GENETIC ALGORITHM	
OPERATIONS	13
2.1 Binary Algebra.....	13
2.2 Representations of Binary Strings and Permutation Operators.....	17
2.3 Population Spaces and Population Vectors.....	19
2.4 Selection Vectors.....	21
2.5 Crossover Masks and Crossover Vectors.....	22
2.6 Mutation Masks and Mutation Vectors.....	25
2.7 Relations between Crossover and Mutation.....	26
2.8 The Mixing Matrix.....	31
2.9 The Heuristic Function and the Mixing Function.....	34
Chapter 3 MARKOV CHAIN ANALYSIS	38
3.1 Calculation of $\Pr(p_{k+1} = q p_k = p)$	38
3.2 The Markov Chain Model.....	40
3.3 The Asymptotical Behavior.....	42
Chapter 4 RANDOM HEURISTIC SEARCH	46
4.1 Framework of Random Heuristic Search.....	47
4.2 Distribution, Expectation, and Variance of $\tau(p)$	50

4.3	Approximation of Distribution of $\tau(p)$	55
4.4	The Transient Behavior.....	63
4.5	Markov Chains Induced by Random Heuristic Search.....	68
4.6	Vose's Simple Genetic Algorithm as an Exampe of Random Heuristic Search.....	70
Chapter 5	THE WALSH TRANSFORM.....	73
5.1	The Walsh Matrix and the Walsh Transform.....	74
5.2	Walsh Transform of the Permutation Matrix Family $\{\sigma_k, 0 \leq k < n\}$	81
5.3	Walsh Transform of the Mixing Matrix and its Twist.....	85
5.4	Spectrum of the Differential of the Mixing Function \mathcal{M} at Points of A_n	92
	BIBLIOGRAPHY.....	99
Appendix A	MATLAB SOURCE CODES OF VOSE'S SIMPLE GENETIC ALGORITHM.....	101
Appendix B	NOTES TO CHAPTER 2.....	106