Table of Contents

Chapter 1: Genetic Synthesis of Recurrent Neural Networks 1
- Introduction 1
- Background 3
- Network Architecture 6
- Goals of this Research 9
- Overview of the Thesis 9

Chapter 2: The Standard Genetic Algorithm 11
- Introduction 11
- Natural and Artificial Evolution 12
- The Genetic Algorithm 13
- Genetic Operators 15
- Selective Pressure 18
- Population Size and Mutation Rate 20
- Mixed Specimen Populations 20

Chapter 3: The XOR Problem 23
- Introduction 23
- Network Fitness 24
- Experiments and Results 27
- Discussion of Results 35

Chapter 4: Enhancing the Genetic Algorithm 38
- Introduction 38
- Gray Scale Encoding 40
  - Introduction 40
  - Experiment 41
  - Results 42
- Tournament Selection 44
  - Introduction 44
  - Experiment 45
  - Results 45
- Steady State progression 47
  - Introduction 47
  - Experiment 47
  - Results 48
- Mixed Size Population 51
  - Introduction 51
  - Experiment 51

Results 52
Conclusion 55
Chapter 5: Learning Finite State Machines 58
Introduction 58
Network Structure and Fitness 60
Experiments and Results for the Tomita #4 FSM 62
Initial Results 62
Complementary Clock Inputs 64
Sequential Biased Fitness Function 65
Experiments and Results for the Parity FSM 68
Discussion of Results 72
Chapter 6: Balancing an Inverted Pendulum 73
Introduction 73
Network Structure and Fitness 75
Experiments and Results 77
Discussion of Results 80
Chapter 7: Discussion and Further Work 83
Introduction 83
Applicability of GAs to RNNs 83
Practical Issues of Applying GAs 85
Future Work 87
Finding Better GA Parameters and Methods 88
Incorporating Lamarckism 89
Variable Length Genome Representations 90
Conclusion 91
Appendix A: Effects of Genetic Parameters on Population
Appendix A: Diversity 93
Bibliography 113