

Implementation and Evaluation of Recent Neuroevolution Algorithms

Master Thesis



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By
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Approval

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It is assumed that the reader has fundamental knowledge of computer science.

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Abstract

Neuroevolution is a method for optimizing the topology or parameters of neural networks by means of evolutionary algorithms. This technique is more general than white-box approaches, such as supervised learning, and can therefore be applied to a wider range of problems. It has been studied in research for decades and has been successfully applied to problems such as artificial life, evolutionary robotics and continuous domains of reinforcement learning. In this thesis, we present a framework that implements neuroevolution algorithms and that is used to evaluate these algorithms on a selection of benchmark problems. Algorithms and benchmarks were collected from the state of the art in applied and theoretical research in the field of neuroevolution. The framework, implemented in Rust, allows for a visualization of key problem characteristics and the evolution process through a graphical user interface. Selected algorithms and benchmarks are presented in detail. Results collected from the conducted experiments are analyzed, discussed and used to provide a series of guidelines for the choice of algorithms and parameters with respect to problem classes.

TODO Discuss results, guidelines...

Acknowledgements

TODO

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Chapter 1

Introduction

Neuroevolution is a subfield of artificial intelligence which consists in the evolution of ANNs (artificial neural networks). ANNs are traditionally trained using gradient-based methods, such as stochastic gradient descent. Over the years, these methods have been successfully applied to a variety of problems, such as image classification, speech recognition and natural language processing. Such problems allow for supervised learning, where ANNs are trained on a dataset of input-output pairs. However, there is a class of problems for which supervised learning is not applicable, where instead of input-output pairs, only a measure of performance is available. In addition, the performance of ANNs is also heavily impacted by their architectures. The design of ANNs architecture is a complex and time-consuming task, which is typically done by hand, based on experience.

Neuroevolution, on the other hand, as a more general approach, can in particular be applied to this other class of problems, as well as to the design of ANNs architectures. This method is based on evolutionary algorithms, which are inspired by the process of natural selection. These algorithms maintain a population of individuals, which are mutated and recombined to evolve towards optimal solutions. They have shown success for black-box problems and have successfully been applied to a wide range of engineering problems.

The field of neuroevolution has been researched for over 40 years, hence many different algorithms, benchmarks and applications have been proposed.

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1.0.1 Overview

TODO

Appendix A

Title

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