

Introduction to Evolutionary Algorithms and Drift Theorems

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Abstract

This paper provides an introduction to evolutionary algorithms (EAs) and drift theorems, aimed at readers with little prior knowledge of these topics. Evolutionary algorithms are versatile tools for exploring large search spaces little is known about, and drift theory offers insights into their runtime behavior. The motivation and applications of EAs will be discussed, and basic concepts such as Random Local Search and the (1+1) Evolutionary Algorithm will be explained. Test functions and their role in evaluating EAs will also be covered. Finally, the paper will introduce drift theorems and their application in analyzing the efficiency and performance of evolutionary algorithms. Furthermore, a visualization tool for gaining intuitive insights into various testing functions, as well as their expected runtime, will be presented.

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1 Introduction

Nowadays, artificial intelligence (AI) is on everyone's lips and has become one of the most prominent trending topics in public discussion. Many of the better-known models and techniques, such as neural networks, share a common trait: they operate within a well-specified problem space and are designed to identify patterns in given examples or training data.

Evolutionary algorithms (EAs), on the other hand, are a set of tools designed to explore vast and often poorly understood search spaces to find optimal or near-optimal solutions. These algorithms draw inspiration from the principles of natural evolution, employing mechanisms such as selection, mutation, and crossover to iteratively improve potential solutions. Given their versatility and robustness, EAs have been successfully applied to a wide range of problems across various fields.

To analyze the runtime behavior of these algorithms, it is essential to understand drift theorems. Drift theorems provide a framework for examining how certain stochastic processes, like those underlying EAs, evolve over time. By understanding the drift in an evolutionary algorithm, we can gain insights into its efficiency and performance.

This paper aims to introduce the fundamentals of evolutionary algorithms and drift theorems to readers with little prior knowledge. Additionally, a visualization tool will be presented to provide an intuitive understanding of various test functions and their expected runtime. Finally, further reading materials will be suggested for those interested in delving deeper into the topics discussed.

2 Motivation

2.1 General Applications of Evolutionary Algorithms

Provide a general overview of the applications of evolutionary algorithms in various fields.

2.2 Specific Example: Energy Consumption Optimization

Discuss the specific application of evolutionary algorithms in the energy consumption optimization of a high sulfur natural gas purification plant.

3 Fundamentals of Evolutionary Algorithms

3.1 Random Local Search and the (1+1) Evolutionary Algorithm

3.1.1 Random Local Search

Explain the concept of Random Local Search and its basic mechanisms.

3.1.2 The (1+1) Evolutionary Algorithm

Describe the (1+1) Evolutionary Algorithm, its principles, and how it differs from Random Local Search.

3.2 Test Functions

Discuss the importance of test functions in evaluating evolutionary algorithms and provide examples of commonly used test functions.

3.2.1 OneMax

3.2.2 LeadingOnes

3.2.3 Needle

4 Drift Theorems

4.1 Introduction to Drift Theorems

Introduce the concept of drift theorems and their relevance in the analysis of evolutionary algorithms.

4.2 Application of Drift Theorems

Explain how drift theorems can be applied to analyze the runtime behavior of evolutionary algorithms.

4.2.1 Expected Runtime of OneMax

4.2.2 Expected Runtime of LeadingOnes

5 Conclusion and Further Reading

Summarize the key points discussed in the paper and suggest further reading materials for readers interested in deepening their understanding of evolutionary algorithms and drift theorems.