Jason Brownlee

Clever Algorithms

Modern Artificial Intelligence Recipes

Preface

About the book

how did the book come about, what was the history? the clever algorithms project and the methodology that was used to produce this book

About the author

who is this guy, a phd and a hacker!

Acknowledgments

who was totally awesome and helped?

Contents

Part I

Background

Chapter 1

Introduction

hello and welcome statement.

1.1 What is AI

What are all the fields and subfields we need to know about? taxonomy

1.1.1 Artificial Intelligence

Messy and Neat AI

1.1.2 Computational Intelligence

Fuzzy Logic, Artificial Neural Networks, and Evolutionary Computation

1.1.3 Natural Computation

Biologically Inspired Computation, Computation with Biology, Computational Biology

1.1.4 Metaheuristics

Heuristics for driving heuristics. also hyper heuristics

1.1.5 Machine Learning

Statistical methods for learning, data mining?

1.2 Algorithms

What do we need to know about this general class of algorithms: unconventional optimization nomenclature

1.2.1 Black Box Methods

They make little or few assumptions about the problem domain

1.2.2 Randomness

The are stochastic processes.

1.2.3 State Space

The typically require the problem to be phrased as a search space which is traversed and sampled. We care about the size of moves, the patters of sampling and re-sampling, the number of samples managed.

1.2.4 Induction

The typically learn by doing (trial and error) generate, guess, revise

1.2.5 Problems

What types of computational problems are we solving with these algorithms? Give example classes for each, give canonical instances for each (all covered in this book)

Function Optimization

Generate a set of parameters (continuous) or something like a permutation (combinatorial).

Function Approximation

Generate a representation that produces outputs in the presence of inputs.

1.3 Book Organization

How the book is structured?

1.3.1 Background

Provide you with enough information to understand the presented algorithms.

1.3.2 Algorithms

The presentation of all the algorithms, partitioned by a taxonomy. About the kingdoms, about the standardized algorithm description template.

1.3.3 Extensions

Things to think about once you have mastered a number of a algorithms.

1.4 How to Read this Book

Who is this book for and how should it be read?

1.4.1 Research Scientists

ways in which scientists may read this material

1.4.2 Developers

ways in which programmers and developers may read this material

1.4.3 Students

ways in which students may read this material

1.4.4 Interested Amateurs

ways in which amateurs may read this material

Part II

Algorithms

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Stochastic Algorithms

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A textual description of the inspiring system.

6.5.3 Metaphor

A textual description of the algorithm by analogy.

6.5.4 Strategy

A textual description of the information processing strategy.

6.5.5 Procedure

A pseudo code description of the algorithms procedure.

6.5.6 Heuristics

A bullet-point listing of best practice usage.

6.5.7 Tutorial

A textural narrative for realizing the algorithm with complete source code.

6.5.8 References

An bullet-point annotated reference list of primary sources and useful resources.

6.6 Rank-Based Ant System

The heading and alternate headings for the algorithm description.

6.6.1 Taxonomy

A small tree diagram showing related fields and algorithms.

6.6.2 Inspiration

A textual description of the inspiring system.

6.6.3 Metaphor

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6.6.4 Strategy

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6.6.8 References

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6.7 Ant Colony System

The heading and alternate headings for the algorithm description.

6.7.1 Taxonomy

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6.7.2 Inspiration

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6.7.4 Strategy

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6.7.6 Heuristics

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6.7.7 Tutorial

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6.7.8 References

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6.8 Multiple Ant Colony System

The heading and alternate headings for the algorithm description.

6.8.1 Taxonomy

A small tree diagram showing related fields and algorithms.

6.8.2 Inspiration

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6.8.3 Metaphor

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6.8.7 Tutorial

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6.8.8 References

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6.9 Population-based Ant Colony Optimization

The heading and alternate headings for the algorithm description.

6.9.1 Taxonomy

A small tree diagram showing related fields and algorithms.

6.9.2 Inspiration

A textual description of the inspiring system.

6.9.3 Metaphor

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6.9.4 Strategy

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6.9.5 Procedure

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6.9.6 Heuristics

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6.9.7 Tutorial

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6.9.8 References

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6.10 Bees Algorithm

The heading and alternate headings for the algorithm description.

6.10.1 Taxonomy

A small tree diagram showing related fields and algorithms.

6.10.2 Inspiration

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6.10.3 Metaphor

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6.10.4 Strategy

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6.10.5 Procedure

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6.10.7 Tutorial

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6.10.8 References

An bullet-point annotated reference list of primary sources and useful resources.

6.11 Bacterial Foraging Optimization Algorithm

The heading and alternate headings for the algorithm description.

6.11.1 Taxonomy

A small tree diagram showing related fields and algorithms.

6.11.2 Inspiration

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6.11.3 Metaphor

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6.11.4 Strategy

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6.11.5 Procedure

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6.11.6 Heuristics

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6.11.7 Tutorial

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6.11.8 References

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6.12 Summary

todo

Chapter 7

Immune Algorithms

7.1 Overview

todo

7.2 Clonal Selection Algorithm

The heading and alternate headings for the algorithm description.

7.2.1 Taxonomy

A small tree diagram showing related fields and algorithms.

7.2.2 Inspiration

A textual description of the inspiring system.

7.2.3 Metaphor

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7.2.4 Strategy

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7.2.5 Procedure

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7.2.6 Heuristics

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7.2.7 Tutorial

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7.2.8 References

An bullet-point annotated reference list of primary sources and useful resources.

7.3 Negative Selection Algorithm

The heading and alternate headings for the algorithm description.

7.3.1 Taxonomy

A small tree diagram showing related fields and algorithms.

7.3.2 Inspiration

A textual description of the inspiring system.

7.3.3 Metaphor

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7.3.4 Strategy

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7.3.5 Procedure

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7.3.6 Heuristics

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7.3.7 Tutorial

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7.3.8 References

An bullet-point annotated reference list of primary sources and useful resources.

7.4 Artificial Immune Recognition System

The heading and alternate headings for the algorithm description.

7.4.1 Taxonomy

A small tree diagram showing related fields and algorithms.

7.4.2 Inspiration

A textual description of the inspiring system.

7.4.3 Metaphor

A textual description of the algorithm by analogy.

7.4.4 Strategy

A textual description of the information processing strategy.

7.4.5 Procedure

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7.4.6 Heuristics

A bullet-point listing of best practice usage.

7.4.7 Tutorial

A textural narrative for realizing the algorithm with complete source code.

7.4.8 References

An bullet-point annotated reference list of primary sources and useful resources.

7.5 Immune Network Algorithm

The heading and alternate headings for the algorithm description.

7.5.1 Taxonomy

A small tree diagram showing related fields and algorithms.

7.5.2 Inspiration

A textual description of the inspiring system.

7.5.3 Metaphor

A textual description of the algorithm by analogy.

7.5.4 Strategy

A textual description of the information processing strategy.

7.5.5 Procedure

A pseudo code description of the algorithms procedure.

7.5.6 Heuristics

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7.5.7 Tutorial

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7.5.8 References

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7.6 Dendritic Cell Algorithm

The heading and alternate headings for the algorithm description.

7.6.1 Taxonomy

A small tree diagram showing related fields and algorithms.

7.6.2 Inspiration

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7.6.3 Metaphor

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7.6.4 Strategy

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7.6.5 Procedure

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7.6.6 Heuristics

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7.6.7 Tutorial

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7.7 Summary

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Part III

Extensions

Chapter 8

Advanced Topics

A chapter focused on applying, testing, visualizing, saving results, and comparing algorithms. The meta concerns once an algorithm is selected for a given practical problem solving scenario.

8.1 Programming Paradigms

Algorithms can be implements on many different programming paradigms. Take the GA for example and realize it using a bunch of different paradigms.

8.1.1 Procedural Programming

The GA under a procedural paradigm

8.1.2 Object-Oriented Programming

The GA under a object oriented paradigm. Strategy pattern. modular operators, etc.

8.1.3 Agent Oriented Programming

A GA under an agent oriented programming paradigm. not really suited. algorithm as an agent with goals?

8.1.4 Functional Programming

The GA under a functional paradigm. closure etc

8.1.5 Meta-Programming

A GA under meta programming. A DSL i guess.

8.1.6 Flow Programming

A GA under a data flow or pipeline model.

8.1.7 Map Reduce

A GA under a map reduce paradigm.

8.2 Devising New Algorithms

A methodology for devising new unconventional optimization algorithms...

8.2.1 Conceptual Framework for Bio-Inspired Algorithms

A generic methodology for devising new biologically inspired algorithms

8.2.2 Information Processing Methodology

An info processing centric approach to devising new algorithms

8.2.3 Investigation

small models, rigor

8.2.4 Communication

you need to effectively describe them, like as in this book! goal is to be known and used, make it open and usable by anyone. like open source, documented, common languages, benchmark problems, a website, lots of papers

8.3 Testing Algorithms

This section will focus on the problem that 'adaptive systems work even when they are not implemented correctly' (they work in-spite of the developer). Topics will include unit testing algorithms, system testing software, specific concerns when testing inspired algorithms, examples of testing algorithms with the ruby unit testing framework, examples of testing algorithms with rspec.

8.3.1 Types of Testing

unit, TDD, system, user acceptance, black box, white box

8.3.2 Algorithm Testing Methodology

testing is hard these systems 'work' even with bugs, hard to test present a methodology for testing - discrete unit tests, behavior testing

8.3.3 Example

develop and show tests for the GA

8.4 Visualizing Algorithms

This section will focus on the use of visualization as a low-fidelity form of system testing. Topics will include free visualization packages such as R, GNUPlot and Processing. Examples visualizing a decision surface, a functions response surface, and candidate solutions.

8.4.1 Visualizing

we can do it as a form of testing. research aid - view on a complex process, can observe, take notes, formulate hypothesis think of all the measures you can, than measure them

Offline Plots

examples?

Online Plots

examples?

8.4.2 Visualization Tools

can use lots of things, can use lots of things

8.4.3 Example

Visuzlize genes through time for a ga run, with fitness graphs, and plots of domain

8.5 Saving Algorithm Results

This section will focus on algorithms and techniques as a fallible means to an end and the need to maintain save results. Topics will include check-pointing, storage in a database, storage on the filesystem, and algorithm restarting. Examples will be given for database, filesystem checkpointing and algorithm restarting.

8.5.1 Check-pointing

algorithms crash and it sucks, need to be able to pickup where you left off

8.5.2 Share Results

make them public with papers and source code

8.5.3 Example

show an example of check pointing

8.6 Comparing Algorithms

This section will focus on comparing algorithm's based on the solutions they provide. Topics will include the use statistical hypothesis testing and free software such as R, algorithm parameter selection, distribution testing, distribution comparisons. Examples will be given for algorithm parameter selection, result distribution classification, and pair-wise result distribution comparison.

8.6.1 No Free Lunch

all same over all problems with no prior info

8.6.2 Benchmarking

standard problem instances what problems? what algorithms? what configurations what are you measuring? what are you comparing?

8.6.3 Statistical Hypothesis Testing

you need stats or you will be killed by Zed Shaw need stats to compare results

8.6.4 Example

genetic algorithm vs something, use R to compare

8.7 Summary

We learned lots of advanced topics, there are more.