

Handbook of Genetic Programming Applications

Amir H. Gandomi • Amir H. Alavi • Conor Ryan
Editors

Handbook of Genetic Programming Applications

 Springer

Editors

Amir H. Gandomi
BEACON Center for the Study
of Evolution in Action
Michigan State University
East Lansing, MI, USA

Amir H. Alavi
Department of Civil and Environmental
Engineering
Michigan State University
East Lansing, MI, USA

Conor Ryan
Department of Computer Science
and Information Systems
University of Limerick
Limerick, Ireland

Supplementary material and data can be found on link.springer.com

ISBN 978-3-319-20882-4 ISBN 978-3-319-20883-1 (eBook)
DOI 10.1007/978-3-319-20883-1

Library of Congress Control Number: 2015945115

Springer Cham Heidelberg New York Dordrecht London
© Springer International Publishing Switzerland 2015

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made.

Printed on acid-free paper

Springer International Publishing AG Switzerland is part of Springer Science+Business Media (www.springer.com)

To my love, Elnaz, meaning of my life ...

Amir H. Gandomi

To my wife, Fariba, echo of my heart ...

Amir H. Alavi

*To Beautiful Heather, my own global
optimum ...*

Conor Ryan

Foreword

In the past two decades, artificial intelligence algorithms have proved to be promising tools for solving a multitude of tough scientific problems. Their success is due, in part, to the elegant manner in which they avoid the sort of handicaps that often plague mathematical programming-based tools, such as smooth and continuous objective functions. Thus, globally optimal (or close approximations of) design can be achievable with a finite and reasonable number of search iterations.

One of the most exciting of these methods is Genetic Programming (GP), inspired by natural evolution and the Darwinian concept of “Survival of the Fittest”. GP’s ability to evolve computer programs has seen it enjoy a veritable explosion of use in the last 10 years in almost every area of science and engineering.

This handbook brings together some of the most exciting new developments in key applications of GP and its variants, presented in a hands-on manner to facilitate researchers tackle similar applications and even use the same data for their own experiments.

The handbook is divided into four parts, starting with review chapters to quickly get readers up to speed, before diving into specialized applications in Part II. Part III focuses on hybridized systems, which marry GP to other technologies, and Part IV wraps up the book with a detailed look at some recent GP software releases.

The handbook serves as an excellent reference providing all the details required for a successful application of GP and its branches to challenging real-world problems. Therefore, for most chapters, the used data are either available as supplementary materials or publicly accessible.

East Lansing, MI, USA
East Lansing, MI, USA
Limerick, Ireland

Amir H. Gandomi
Amir H. Alavi
Conor Ryan

Contents

Part I Overview of Genetic Programming Applications

1	Graph-Based Evolutionary Art	3
	Penousal Machado, João Correia, and Filipe Assunção	
2	Genetic Programming for Modelling of Geotechnical Engineering Systems	37
	Mohamed A. Shahin	
3	Application of Genetic Programming in Hydrology	59
	E. Fallah-Mehdipour and O. Bozorg Haddad	
4	Application of Gene-Expression Programming in Hydraulic Engineering	71
	A. Zahiri, A.A. Dehghani, and H.Md. Azamathulla	
5	Genetic Programming Applications in Chemical Sciences and Engineering	99
	Renu Vyas, Purva Goel, and Sanjeev S. Tambe	
6	Application of Genetic Programming for Electrical Engineering Predictive Modeling: A Review	141
	Seyyed Soheil Sadat Hosseini and Alireza Nemati	
7	Mate Choice in Evolutionary Computation	155
	António Leitão and Penousal Machado	

Part II Specialized Applications

8	Genetically Improved Software	181
	William B. Langdon	

9	Design of Real-Time Computer-Based Systems Using Developmental Genetic Programming	221
	Stanisław Deniziak, Leszek Ciopiński, and Grzegorz Pawiński	
10	Image Classification with Genetic Programming: Building a Stage 1 Computer Aided Detector for Breast Cancer	245
	Conor Ryan, Jeannie Fitzgerald, Krzysztof Krawiec, and David Medernach	
11	On the Application of Genetic Programming for New Generation of Ground Motion Prediction Equations.....	289
	Mehdi Mousavi, Alireza Azarbakht, Sahar Rahpeyma, and Ali Farhadi	
12	Evaluation of Liquefaction Potential of Soil Based on Shear Wave Velocity Using Multi-Gene Genetic Programming ...	309
	Pradyut Kumar Muduli and Sarat Kumar Das	
13	Site Characterization Using GP, MARS and GPR.....	345
	Pijush Samui, Yıldırım Dalkılıç, and J Jagan	
14	Use of Genetic Programming Based Surrogate Models to Simulate Complex Geochemical Transport Processes in Contaminated Mine Sites	359
	Hamed Koohpayehzadeh Esfahani and Bithin Datta	
15	Potential of Genetic Programming in Hydroclimatic Prediction of Droughts: An Indian Perspective	381
	Rajib Maity and Kironmala Chanda	
16	Application of Genetic Programming for Uniaxial and Multiaxial Modeling of Concrete	399
	Saeed K. Babanajad	
17	Genetic Programming for Mining Association Rules in Relational Database Environments	431
	J.M. Luna, A. Cano, and S. Ventura	
18	Evolving GP Classifiers for Streaming Data Tasks with Concept Change and Label Budgets: A Benchmarking Study	451
	Ali Vahdat, Jillian Morgan, Andrew R. McIntyre, Malcolm I. Heywood, and Nur Zincir-Heywood	

Part III Hybrid Approaches

- 19 A New Evolutionary Approach to Geotechnical and Geo-Environmental Modelling** 483
Mohammed S. Hussain, Alireza Ahangar-asr, Youliang Chen,
and Akbar A. Javadi
- 20 Application of GFA-MLR and G/PLS Techniques in QSAR/QSPR Studies with Application in Medicinal Chemistry and Predictive Toxicology** 501
Partha Pratim Roy, Supratim Ray, and Kunal Roy
- 21 Trading Volatility Using Highly Accurate Symbolic Regression** 531
Michael F. Korn

Part IV Tools

- 22 GPTIPS 2: An Open-Source Software Platform for Symbolic Data Mining** 551
Dominic P. Searson
- 23 eCrash: a Genetic Programming-Based Testing Tool for Object-Oriented Software** 575
José Carlos Bregieiro Ribeiro, Ana Filipa Nogueira, Francisco
Fernández de Vega, and Mário Alberto Zenha-Rela