



Computational Intelligence Techniques

SMART COMPUTATIONAL INTELLIGENCE IN BIOMEDICAL AND HEALTH INFORMATICS

Edited by

Amit Kumar Manocha, Mandeep Singh, Shruti Jain,
and Vishal Jain



Smart Computational Intelligence in Biomedical and Health Informatics

Edited by

*Amit Kumar Manocha, Mandeep Singh,
Shruti Jain, and Vishal Jain*



CRC Press

Taylor & Francis Group

Boca Raton London New York

CRC Press is an imprint of the
Taylor & Francis Group, an **informa** business

First edition published 2022

by CRC Press

6000 Broken Sound Parkway NW, Suite 300, Boca Raton, FL 33487-2742

and by CRC Press

2 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN

© 2022 selection and editorial matter, Amit Kumar Manocha, Mandeep Singh, Shruti Jain, and Vishal Jain; individual chapters, the contributors

First edition published by CRC Press 2022

CRC Press is an imprint of Taylor & Francis Group, LLC

Reasonable efforts have been made to publish reliable data and information, but the author and publisher cannot assume responsibility for the validity of all materials or the consequences of their use. The authors and publishers have attempted to trace the copyright holders of all material reproduced in this publication and apologize to copyright holders if permission to publish in this form has not been obtained. If any copyright material has not been acknowledged please write and let us know so we may rectify in any future reprint.

Except as permitted under U.S. Copyright Law, no part of this book may be reprinted, reproduced, transmitted, or utilized in any form by any electronic, mechanical, or other means, now known or hereafter invented, including photocopying, microfilming, and recording, or in any information storage or retrieval system, without written permission from the publishers.

For permission to photocopy or use material electronically from this work, access www.copyright.com or contact the Copyright Clearance Center, Inc. (CCC), 222 Rosewood Drive, Danvers, MA 01923, 978-750-8400. For works that are not available on CCC please contact mpkbookspermissions@tandf.co.uk

Trademark notice: Product or corporate names may be trademarks or registered trademarks and are used only for identification and explanation without intent to infringe.

Library of Congress Cataloging-in-Publication Data

A catalog record has been requested for this book

ISBN: 9780367624125 (hbk)

ISBN: 9780367624149 (pbk)

ISBN: 9781003109327 (ebk)

Typeset in Times

by KnowledgeWorks Global Ltd.

Contents

List of Figures	vii
List of Tables	ix
Preface	xi
Acknowledgments	xiii
Editors	xv
List of Contributors	xvii

Chapter 1	Impact of Gender on the Lipid Profile of Patients with Coronary Artery Disease: A Bayesian Analytical Approach.....	1
------------------	---	---

*Vivek Verma, Ashwani Kumar Mishra, Anita Verma,
Hafiz T. A. Khan, Dilip C. Nath, and Rajiv Narang*

Chapter 2	Implementation of Wearable ECG Monitor Interfaced with Real-Time Location Tracker.....	13
------------------	--	----

*Aditya Anand Doshi, Utkarsh Nitin Kasar,
and Suchitra Khoje*

Chapter 3	AI and Deep Learning for Biomedical Image Analysis	29
------------------	--	----

R. Priyatharshini and R. Reena Roy

Chapter 4	Deep Learning: A Review on Supervised Architectures and their Applications to Decision Support Systems in the Medical Field.....	37
------------------	--	----

*Tajinder Pal Singh, Sheifali Gupta, Meenu Garg,
and Deepali Gupta*

Chapter 5	Automated View Orientation Classification for X-ray Images Using Deep Neural Networks	61
------------------	---	----

K. Karthik and Sowmya Kamath S

Chapter 6	Sustainable e-Health Solutions for Routine and Emergency Treatment: Scope of Informatics and Telemedicine in India	73
------------------	--	----

*Arindam Chakrabarty, Uday Sankar Das,
and Saket Kushwaha*

Chapter 7	Predicting Medical Procedures from Diagnostic Sequences Using Neural Machine Translation	89
	<i>Siddhanth Pillay and Sowmya Kamath S</i>	
Chapter 8	Sensing the Mood-Application of Machine Learning in Human Psychology Analysis and Cognitive Science.....	101
	<i>Ahona Ghosh and Sriparna Saha</i>	
Chapter 9	Speech Emotion Recognition using Manta Ray Foraging Optimization Based Feature Selection.....	115
	<i>Soham Chattopadhyay, Arijit Dey, Hritam Basak, and Sriparna Saha</i>	
Chapter 10	Internet of Things in Healthcare Informatics	141
	<i>A. Vijayalakshmi and A. Hridya</i>	
Chapter 11	Deep Learning for the Prediction and Detection of Alzheimer’s Disease (AD): An Overview and Future Trends.....	153
	<i>Pavanalaxmi, Roopashree</i>	
Chapter 12	A Text Analytics-based E-Healthcare Decision Support Model Using Machine Learning Techniques.....	169
	<i>A. Sheik Abdullah, R. Parkavi, P. Karthikeyan, and S. Selvakumar</i>	
Index		183

Figures

Figure 1.1	Gender-wise empirical distributional patterns of the lipid parameters pattern of no CAD participants (Male = 450; Female = 504), black denotes male and dashed denotes female.....	6
Figure 1.2	Gender-wise empirical distributional patterns of the lipid parameters pattern of CAD participants (Male = 55; Female = 36), black denotes male and dashed denotes female.....	6
Figure 2.1	System Overflow	17
Figure 2.2	Architecture of System Hardware and Software	20
Figure 2.3	Results and Validation.....	24
Figure 3.1	Step-by-step process involved in skin disease classification.....	33
Figure 3.2	Process of coronary artery stenosis detection and classification	34
Figure 4.1	General architecture of a CNN	40
Figure 4.2	(a) Regular neural network, (b) Squashing of regular neural network, (c) Two-arrow network, and (d) Standard representation of an RNN	43
Figure 4.3	Long short-term memory unit	45
Figure 5.1	Proposed approach for view/body orientation classification.....	65
Figure 5.2	Proposed architecture of ViewNet	67
Figure 5.3	Sample dataset images showing the IRMA code and its description	68
Figure 6.1	Improvised rural e-health framework along with blended services	82
Figure 6.2	Perceptual immunity center framework.....	84
Figure 7.1	Preprocessing tasks performed to generate the training dataset.....	93
Figure 7.2	An example of the EDM at work. Here, a diagnosis code sequence is processed code by code by the encoder to generate the vector representation, which the decoder uses to generate procedure sequences.....	93
Figure 7.3	Evaluation of loss on the training set	96

Figure 8.1	Types of machine learning methods applied in human psychology analysis and cognitive science.....	102
Figure 8.2	Pictorial representation of a decision tree.....	110
Figure 8.3	Support vector machine (SVM) working diagram.....	111
Figure 9.1	Workflow of our proposed method.....	118
Figure 9.2	Manta Ray optimization algorithm	125
Figure 9.3	[1] Hyperparameter selection for Manta Ray optimizer: graphical representation of (a) classification accuracy vs. omega value (b) classification accuracy vs. somersault constant(s), and (c) classification accuracy vs. population size. [2] Graphical representation of (a) classification accuracy vs. hidden units in each layer of MLP (b) classification accuracy vs. the number of hidden layers of MLP, and (c) classification accuracy vs. the number of nearest neighbors of KNN classifier. [3] Receiver operating characteristics of KNN classifier on (a) EmoDB dataset and (b) SAVEE dataset: receiver operating characteristics of MLP classifier on (c) EmoDB dataset and (d) SAVEE dataset. [4] Comparative study of the performance of classifiers (i.e. MLP and KNN) with the same features on two different datasets (a) EmoDB dataset and (b) SAVEE dataset.....	126
Figure 10.1	Data processing in IoT.....	142
Figure 10.2	IoT architecture for health care	143
Figure 10.3	IoT components and data science.....	148
Figure 12.1	Analytics process and its stages	170
Figure 12.2	Accuracy estimation iteration vs. accuracy.....	177
Figure 12.3	Standard deviation estimation SD vs. K value.....	179

Tables

Table 1.1	Demographic and Clinical Characteristics of the Patients with CAD Versus No CAD.....	5
Table 1.2	Classical and Bayesian Evaluation of Gender Differences in Association of Lipid Profile Among Total Patients (Large Sample Size)	7
Table 1.3	Classical and Bayesian Evaluation of Gender Differences in Association of Lipid Profile Among Patients with No Cad (Large Sample Size)	8
Table 1.4	Classical and Bayesian Evaluation of Gender Differences in Association of Lipid Profile Among Patients with Cad (Small Sample Size)	9
Table 4.1	Reviewed Article Distribution According to Their Applications.....	47
Table 4.2	Research Articles that Applied DNNs to Facilitate Decision Making in Diabetes Mellitus, Heart Disease, and Neurosurgery	48
Table 5.1	Classification Model Parameters	67
Table 5.2	Observed Classification Performance Warrants Different CNN Models (<i>Before Class Label Refinement</i>).....	69
Table 5.3	Observed Classification Performance Warrants Different CNN Models (<i>After Class Label Refinement</i>)	70
Table 6.1	Telemedicine Usage in India 2018.....	79
Table 6.2	Indicative List of Telemedicine Services Provided by the Government of India.....	79
Table 6.3	Indicative List of Telemedicine Firms in India	80
Table 7.1	Performance of EDM Model of Depth 50 on Batches of varying sizes, trained for 20 Epochs, without Dropout	96
Table 7.2	Performance of EDM Model of Depth 50, trained for 20 Epochs and with optimal Batch size of 64, at different Dropout rates	97
Table 8.1	Comparative Analysis Between the Existing Methods	105
Table 9.1	Variation of Different Evaluation Parameters with Varying Hyperparameters. The bold numbers are the optimal results achieved.....	127

Table 9.2	Selected Hyperparameters for the MLP and the KNN Classifier	128
Table 9.3	Quantitative Evaluation Results of KNN Classifier Using 5-fold Validation on SAVEE Dataset	132
Table 9.4	Quantitative Evaluation Results of MLP Classifier Using 5-fold Validation on SAVEE Dataset	132
Table 9.5	Quantitative Evaluation Results of KNN Classifier Using 5-fold Validation on EmoDB Dataset	133
Table 9.6	Quantitative evaluation results of MLP classifier using 5-fold validation on EmoDB dataset	133
Table 9.7	Comparison of Manta Ray Optimization with Other Feature Selection Algorithms in Terms of Accuracy, Precision, Recall, and F1 Score	134
Table 9.8	Comparative Analysis of the Obtained Result with the Existing Results	135
Table 9.9	Comparison of our Proposed Approach with the Recently Evolved Methodologies on the EmoDB Dataset Along with Their Brief Descriptions	135
Table 11.1	Correlation of Various Structures of Profound Learning	159
Table 12.1	Experimental Results	177
Table 12.2	Sample Prediction Data with Confidence Level	178

Preface

Health informatics involves multidisciplinary domains to extract information and knowledge from physiological data to use in decision making for improved human health through the effective use of recently developed technologies and algorithms. The aim is to provide a cross-disciplinary forum to share information on research, simulations and modeling, measurement and control, analysis, information extraction, and monitoring of physiological data in clinical medicine and the biological sciences. Emphasis is placed on contributions dealing with the practical, applications-led research on the use of methods and devices in clinical diagnosis, disease prevention, patient monitoring, and management. Health informatics is closely related to artificial intelligence where heuristic as well as metaheuristic algorithms are designed to provide better and optimized solutions in reasonable amounts of time. These algorithms have been successfully applied to different application domains in biomedical, bioinformatics, and biological sciences. The practice of recent biomedical research requires sophisticated information technologies to manage patient information, and plan for diagnostics, prognostics, procedures, interpretation, and investigations. This provides a conceptual framework and practical inspiration for the quickly growing and promising engineering and scientific disciplines of computer science, decision science, information science, cognitive science, and biomedicine. The objective of this book is to provide the researchers a platform to present state-of-the-art innovations, research, design, and implement methodological and algorithmic solutions to data processing problems by designing and analyzing evolving trends in health informatics and computer-aided diagnosis. This book will provide support and aid to the researchers involved in designing decision support systems that will permit the societal acceptance of ambient intelligence. The overall goal of this book is to present the latest snapshot of the ongoing research as well as shed further light on future directions in this space. This book presents novel technical studies as well as position and vision papers comprising hypothetical/speculative scenarios.

Amit Kumar Manocha
Mandeep Singh
Shruti Jain
Vishal Jain

Acknowledgments

We want to extend our gratitude to all the chapter authors for their sincere and timely support to make this book a grand success. We are equally thankful to all CRC Press executive board members for their kind approval and granted permission for us as editors of this book. We want to extend our sincere thanks to Dr. Gagandeep Singh and Mr. Lakshay Gaba at CRC Press for their valuable suggestions and encouragement throughout the project.

It is with immense pleasure that we express our thankfulness to our colleagues for their support, love, and motivation in all our efforts during this project. We are grateful to all the reviewers for their timely review and consent, which helped us improve the quality of this book.

We may have inadvertently left out many others, and we sincerely thank all of them for their help.

Amit Kumar Manocha
Mandeep Singh
Shruti Jain
Vishal Jain

Editors

Dr. Amit Kumar Manocha is presently working as an Associate Professor in Electrical Engineering at Maharaja Ranjit Singh Punjab Technical University, in Bathinda, India. Dr. Manocha obtained his Ph.D. in 2015, M.E. in 2006 and B.Tech in 2004. He is the author of more than 50 research papers in refereed journals and international and national conferences. Dr. Manocha successfully organized five international conferences in the capacity of conference chair, convener, and editor of conference proceedings and more than 25 workshops and seminars. He participated in many international conferences as an advisory committee member, session chair, and member of technical committees in international conferences. He is a member on editorial boards for many international journals. His area of research includes Biomedical Instrumentation, Remote Monitoring and Control Systems. He has guided more than 10 Master's degree and five Ph.D. candidates. He has been granted/published 03 Patents and Rs. 36 Lacs from the Department of Science and Technology, Government of India for a research project on Identification of adulterants in Indian spices.

Dr. Mandeep Singh is currently a Professor and Former Head in the Electrical and Instrumentation Engineering Department, Thapar Institute of Engineering & Technology, in Patiala, India. Dr. Singh obtained his Ph.D. in Tele-Cardiology, Master of Engineering in Computer Science, and Bachelor of Engineering in Electronics (Instrumentation and Control). Dr. Singh is a BEE Certified Energy Auditor and an Empaneled Consultant for PAT Scheme. Dr. Singh has more than 20 years of teaching experience. His current area of research interest includes Biomedical Instrumentation, Energy Conservation, Alternative Medicine, and Cognition Engineering. In addition to his regular responsibilities, he has served the Thapar Institute of Engineering & Technology as Faculty Advisor (Electrical) for more than eight years. Dr. Singh is currently handling two research projects with DIPAS-DRDO related to fatigue detection and wireless monitoring of ambulatory subjects.

Dr. Shruti Jain is an Associate Professor in the Department of Electronics and Communication Engineering at Jaypee University of Information Technology, in Wanknaghat, H.P, India and has received her Doctor of Science (D. Sc.) degree in Electronics and Communication Engineering. She has 16 years of teaching experience and has filed five patents, out of which one patent is granted and four are published. She has published more than 15 book chapters, and 100 research papers in reputed indexed journals and in international conferences. She has also published six books. She has completed two government-sponsored projects. She has guided 6 Ph.D. students and now has 2 registered students. She has also guided 11 M.Tech scholars and more than 90 B.Tech undergrads. Her research interests are Image and Signal Processing, Soft Computing, Bioinspired Computing, and Computer-Aided Design of FPGA and VLSI circuits. She is a senior member of IEEE, life member and Editor-in-Chief of the Biomedical Engineering Society of India, and a member of

the International Association of Engineers. She is a member of the editorial board of many reputed journals. She is also a reviewer of many journals and a member of the technical program committees of different conferences. She was awarded a Nation Builder Award in 2018–19.

Dr. Vishal Jain is presently working as an Associate Professor at the Department of Computer Science and Engineering, School of Engineering and Technology, Sharda University, in Greater Noida, U. P., India. Before that, he worked for several years as an Associate Professor at Bharati Vidyapeeth's Institute of Computer Applications and Management (BVICAM), in New Delhi. He has more than 14 years of experience in academics. He has earned several degrees: Ph.D. (CSE), MTech (CSE), MBA (HR), MCA, MCP, and CCNA. He has more than 370 research citations with Google Scholar (h-index score 9 and i-10 index 9) and has authored more than 70 research papers in professional journals and conferences. He has authored and edited more than 10 books with various publishers, including Springer, Apple Academic Press, CRC Press, Taylor & Francis Group, Scrivener, Wiley, Emerald, and IGI-Global. His research areas include information retrieval, semantic web, ontology engineering, data mining, ad hoc networks, and sensor networks. He received a Young Active Member Award for the year 2012–13 from the Computer Society of India, and Best Faculty Award for the year 2017 and Best Researcher Award for the year 2019 from BVICAM, New Delhi.

List of Contributors

A. Sheik Abdullah

Thiagarajar College of Engineering
Chennai, India

Hritam Basak

Jadavpur University
West Bengal, India

Arindam Chakrabarty

Department of Management,
Rajiv Gandhi University (Central
University)
Arunachal Pradesh, India

Soham Chattopadhyay

Jadavpur University
West Bengal, India

Uday Sankar Das

Department of Management &
Humanities, National Institute
of Technology
Arunachal Pradesh

Arijit Dey

Maulana Abul Kalam Azad University
of Technology
West Bengal, India

A. Hridya

CHRIST Deemed to be University
Uttar Pradesh, India

Aditya Anand Doshi

MIT College of Engineering
Pune, India

Meenu Garg

Chitkara University Institute of
Engineering and Technology,
Chitkara University
Punjab, India

Ahona Ghosh

Maulana Abul Kalam Azad University
of Technology
West Bengal, India

Deepali Gupta

Chitkara University Institute of
Engineering and Technology,
Chitkara University
Punjab, India

Sheifali Gupta

Chitkara University Institute of
Engineering and Technology,
Chitkara University
Punjab, India

Sowmya Kamath S

National Institute of Technology
Karnataka
Surathkal, India

K. Karthik

National Institute of Technology
Karnataka
Surathkal, India

P. Karthikeyan

Thiagarajar College of Engineering
Chennai, India

Utkarsh Nitin Kasara

MIT College of Engineering
Pune, India

Hafiz T.A. Khan

University of West London
London, England

Suchitra Khojeb

MIT College of Engineering
Pune, India

R. Priyatharshini

Easwari Engineering College
Tamil Nadu, India

Saket Kushwaha

Rajiv Gandhi University
(Central University)
Arunachal Pradesh, India

Pavanalaxmi

Sahyadri College of Engineering &
Management
Karnataka, India

Ashwani Kumar Mishra

All India Institute of Medical Sciences
(AIIMS)
New Delhi, India

Rajiv Narang

All India Institute of Medical Sciences
(AIIMS)
New Delhi, India

Dilip C. Nath

Assam University
Assam, India

Siddhanth Pillay

National Institute of Technology
Karnataka
Surathkal, India

R. Parkavi

Thiagarajar College of
Engineering
Chennai, India

Reena R. Roy

Easwari Engineering College
Tamil Nadu, India

Sriparna Saha

Maulana Abul Kalam Azad University
of Technology
West Bengal, India

S. Selvakumar

GKM College of Engineering and
Technology
Tamil Nadu, India

Tajinder Pal Singh

Chitkara College of Applied
Engineering, Chitkara University
Punjab, India

Anita Verma

All India Institute of Medical Sciences
(AIIMS)
New Delhi, India

Vivek Verma

All India Institute of Medical Sciences
(AIIMS)
New Delhi, India

A. Vijayalakshmi

CHRIST Deemed to be University
Uttar Pradesh, India

Roopashree

Sahyadri College of Engineering &
Management
Karnataka, India