Preface

Medical diagnosis is an extremely complicated task due to the processes involved, which are vital to deciding the correct treatment procedure. Consequently, automation of medical image classification not only plays an important role in accurate diagnosis, it also serves to teach. Due to the developments in imaging modalities, considerable interest is being focussed on image processing. In recent years, significant technological advancements and progress in medical image processing in a number of areas have been achieved; however, various factors regarding the visual quality of images hinder automated analysis and the evaluation of disease. These include imperfections in the systems used for image acquisition, natural phenomena, transmission errors, coding artifacts and so on, all of which degrade the quality of an image due to induced noise. Advances in medical imaging technology supported by computer science have enhanced the interpretation of medical images to a considerable degree and have contributed to early diagnosis. The installation of computer-aided diagnosis systems in hospitals helps pathologists to evaluate their results effectively, as well as providing a second opinion to enable doctors to verify their results. Several classification structures have the potential to enhance the quality of medical care and to democratize its access.

This book on classification in biomedical applications presents original and valuable research work on advances in the automatic classification of biomedical images, and covers the taxonomy of both supervised and unsupervised models, standards, algorithms, applications and challenges. The book includes fundamental issues, designs, and optimization techniques and advances in artificial neural networks, support vector machines and other advanced classifiers.

This volume is comprised of three parts.

Part I Machine Learning Based Detection and Classification

Chapter "Medical Imaging and Its Objective Quality Assessment: An Introduction" gives an introduction and overview of different medical imaging technologies and automatic methods for the subjective and objective measurement of the quality of medical images such as Full Reference-based image quality assessment (IQA) (FR-IQA) algorithms, No Reference-based IQA (NR-IQA) algorithms and Reduced Reference-based IQA (RR-IQA) algorithms.

Chapter "A Novel Approach for the Classification of Liver MR Images Using Complex Orthogonal Ripplet-II and Wavelet-Based Transforms" presents a decision support system to aid radiologists in defining focal lesions in magnetic resonance images of the liver. A new method, the complex orthogonal Ripplet-II transform, is combined with artificial neural networks to classify the features as either a hemangioma or cyst, thereby making diagnosis more accurate.

Chapter "ECG Based Myocardial Infarction Detection Using Different Classification Techniques" presents a hybrid classification system for the diagnosis of myocardial infarction (MI) from an ECG signal using an artificial neural network (NN) (the Levenberg-Marquardt neural network) and the Hybrid Firefly and Particle Swarm Optimization (FFPSO) techniques. This method achieved 99.3% accuracy when used with MIT-BIH and NSR databases.

Chapter "Classification and Decision Making of Medical Infrared Thermal Images" discusses the available classification and decision-making methods that can be employed in medical infrared thermal imaging (MITI) technology, observing its particularities, principles, applications, advantages and disadvantages. These machine learning techniques allow the intelligent classification of a variety of diseases, such as diabetic foot ulcers, Raynaud's phenomenon, soft tissue rheumatism, blood pressure, Hand Arm Vibration Syndrome, peripheral nerve conditions, the assessment of rehabilitation medicinal procedures and so on.

Chapter "Evaluating the Efficacy of Gabor Features in Discrimination of Breast Density Patterns Using Various Classifiers" presents the various experimental results of an efficient computer-aided design (CAD) system for characterizing the density of breast tissue. The design includes extraction of Gabor wavelet transform (GWT) features and two different classifiers. The results indicated that CAD system design based on a neural network yielded better results compared with other classifier-based CAD system designs, showing a classification accuracy of 93.7 % for a two classes, and 87.5 % for three classes.

Chapter "Machine Learning-Based State-of-the-Art Methods for the Classification of RNA-Seq Data" presents various machine learning approaches for ribonucleic acid sequencing (RNA-Seq) data classification and provides powerful toolboxes that classify transcriptome information available through RNA-Seq data. These approaches are highly recommended for the diagnosis and classification of disease, and for monitoring disease at a molecular level as well as researching potential disease biomarkers.

Chapter "Two-Step Verifications for Multi-instance Features Selection: A Machine Learning Approach" presents the measurement of multi-instance features that help in identifying the characteristics that are encountered in various experimental events in biological data processing and a set of critical factors responsible for several diseases. Two-step verification is proposed to ensure faster data processing by denoising data and removing irrelevant datasets. A variety of filtering techniques, normalization and transformation are used to verify entire datasets with the aim of achieving the perfect dataset.

Chapter "Machine Learning Based Plant Leaf Disease Detection and Severity Assessment Techniques: State-of-the-Art" provides an overview of various methods and techniques for the feature extraction, segmentation and classification of patterns of captured leaves for the identification of plant leaf diseases and the estimation of their severity. The impetus of this chapter is to motivate researchers to focus and develop efficient machine learning-based classification techniques for leaf identification and disease detection to meet the new challenges in the field of agriculture.

Chapter "Crop Disease Protection Using Parallel Machine Learning Approaches" presents a machine-learning approach to extract useful information represented by candidate genes to enable the prediction of significant gene and pathogen–host interactions. The methodology includes the preprocessing of gene expression data, gene selection using a parallel approach, feature selection methods, a support vector machine (SVM) with recursive feature elimination (SVM-RFE), minimum redundancy maximum relevance (mRMR), principal component analysis (PCA), successive feature selection (SFS) and independent component analysis (ICA).

Part II Deep Learning and Fuzzy-based Computer-Aided Diagnosis

Chapter "Computer Aided Diagnosis in Ophthalmology: Deep Learning Applications" presents the current trend for applying deep learning techniques to medical data analysis for diagnosis, follow-up and prognosis in ophthalmology applications, such as diabetic retinopathy, age-related macular degeneration (ARMD) and glaucoma. The evolutions of the computing techniques and the use of convolutional neural networks (CNNs) to quantify some corneal endothelial morphometric parameters are included.

Chapter "Advanced Computational Intelligence Techniques Based Computer Aided Diagnosis System for Cervical Cancer Detection Using Pap Smear Images" describes a CAD system with two levels of classification to detect abnormal cells in pap smear images for the detection of cervical cancer. The first system involves the use of deep learning techniques to categorize the nucleus, cytoplasm and background from cervical cells; the second is an SVM classifier which operates on the features extracted from nucleus patches. After testing on the ISBI 2014 and 2015 datasets, the system achieved accuracy ratings of 97.5 and 90.9% for deep learning and the SVM, respectively.

Chapter "Deep Learning for Medical Image Processing: Overview, Challenges and the Future" discusses state-of-the-art deep learning architectures, techniques for their optimization and the challenges faced when these architectures are used for medical image segmentation and classification. The techniques included are SVMs, Neural Network (NNs) and k-nearest neighbor (KNN), and deep learning algorithms such as CNNs, recurrent neural networks (RNNs), long short-term memory (LSTM), extreme learning models (ELMs) and generative adversarial networks (GANs).

Chapter "On the Fly Segmentation of Intravascular Ultrasound Images Powered by Learning of Backscattering Physics" presents a method for the segmentation of lumen and external elastic laminae in intravascular ultrasound (IVUS) using: (i) ultrasonic backscattering physics and signal confidence estimation; (ii) the joint learning of estimates using techniques such as random forests for initial layer localization; and (iii) random walks for the fine segmentation of boundaries. Pullback segmentation using belief propagation across neighboring frames is also discussed. This method proved be more accurate and less time-consuming than previous techniques.

Part III Miscellaneous Applications

Chapter "ECG Signal Dimensionality Reduction-Based Atrial Fibrillation Detection" presents a classification approach for the detection of AF, which typically is a major challenge faced by the medical world in analyzing ECG signals. Various feature selection and extraction techniques are considered for performance evaluation: DWT, different orderings of complex Hadamard transform (CHT) and conjugate symmetric-complex Hadamard transform (CS-CHT), principal component analysis (PCA) and genetic algorithms (Gas). The results conclude that feature extraction using the Cal–Sal order of CS-CHT with a GA attains the maximum reduction in dimensionality with a notable 99.97% of accuracy.

Chapter "A Bio-application for Accident Victims' Identification Using Biometrics" presents a new approach to enhancing the accuracy of the identification of victims through the use of an autoencoder, ELM techniques and an optimal cost region matcher (OCRM) with deep learning techniques to minimize the complications of medical diagnosis by reducing the delay in initial treatment. This application aids in the identification of a victim and the identification of their blood group in emergency situations using machine learning methods.

This monograph is useful to researchers, practitioners, manufacturers, professionals and engineers in the field of biomedical systems engineering and may also be used by students as advanced material.

We would like to express our thanks to the authors for their contributions. Our gratitude is also extended to the reviewers for their diligence in reviewing the chapters. Special thanks go to our publisher, Springer.

As editors, we hope this book will stimulate further research in developing algorithms and optimization approaches related to machine learning for biomedical applications.

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Springer
http://www.springer.com/978-3-319-65980-0

Classification in BioApps
Automation of Decision Making
Dey, N.; Ashour, A.; Borra, S. (Eds.)
2018, XIII, 447 p. 228 illus., 123 illus. in color.,
Hardcover
ISBN: 978-3-319-65980-0