



Platinum Jubilee Series

Statistical Science and
Interdisciplinary Research — Vol. 2

Advances in Intelligent Information Processing

Tools and Applications

Editors

B. Chanda

C. A. Murthy

Series Editor: Sankar K. Pal



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Advances in Intelligent Information Processing

Tools and Applications

Statistical Science and Interdisciplinary Research

Series Editor: Sankar K. Pal (*Indian Statistical Institute*)

Description:

In conjunction with the Platinum Jubilee celebrations of the Indian Statistical Institute, a series of books will be produced to cover various topics, such as Statistics and Mathematics, Computer Science, Machine Intelligence, Econometrics, other Physical Sciences, and Social and Natural Sciences. This series of edited volumes in the mentioned disciplines culminate mostly out of significant events — conferences, workshops and lectures — held at the ten branches and centers of ISI to commemorate the long history of the institute.

Vol. 1 Mathematical Programming and Game Theory for Decision Making
edited by S. K. Neogy, R. B.apat, A. K. Das & T. Parthasarathy
(*Indian Statistical Institute, India*)

Vol. 2 Advances in Intelligent Information Processing:
Tools and Applications
edited by B. Chandra & C. A. Murthy
(*Indian Statistical Institute, India*)

Foreword

The Indian Statistical Institute (ISI) was established on 17th December, 1931 by a great visionary Professor Prasanta Chandra Mahalanobis to promote research in the theory and applications of statistics as a new scientific discipline in India. In 1959, Pandit Jawaharlal Nehru, the then Prime Minister of India introduced the ISI Act in parliament and designated it as an *Institution of National Importance* because of its remarkable achievements in statistical work as well as its contribution to economic planning.

Today, the Indian Statistical Institute occupies a prestigious position in the academic firmament. It has been a heaven for bright and talented academics working in a number of disciplines. Its research faculty has done India proud in the arenas of Statistics, Mathematics, Economics, Computer Science, among others. Over seventy-five years, it has grown into a massive banyan tree, like the institute emblem. The Institute now serves the nation as a unified and monolithic organization from different places, namely Kolkata, the Head Quarter, Delhi and Bangalore, two centers, a network of six SQC-OR Units located at Mumbai, Pune, Baroda, Hyderabad, Chennai and Coimbatore, and a branch (field station) at Giridih.

The platinum jubilee celebrations of ISI have been launched by Honorable Prime Minister Dr. Manmohan Singh on December 24, 2006, and the Government of India has declared 29th June as the "Statistics Day" to commemorate the birthday of Professor Mahalanobis nationally.

Professor Mahalanobis, was a great believer in interdisciplinary research, because he thought that this will promote the development of not only Statistics, but also the other natural and social sciences. To promote interdisciplinary research, major strides were made in the areas of computer science, statistical quality control, economics, biological and social sciences, physical and earth sciences.

The Institute's motto of 'unity in diversity' has been the guiding principle of all its activities since its inception. It highlights the unifying role of statistics in relation to various scientific activities.

In tune with this hallowed tradition, a comprehensive academic programme, involving Nobel Laureates, Fellows of the Royal Society, and other dignitaries, has been implemented throughout the Platinum Jubilee year, highlighting the emerging areas of ongoing frontline research in its various scientific divisions, centres, and outlying units. It includes international and national-level seminars, symposia, conferences and workshops, as well as series of special lectures. As an outcome of these events, the Institute is bringing out a series of comprehensive volumes in different subjects under the title *Statistical Science and Interdisciplinary Research*, published by World Scientific Publishing, Singapore.

The present volume titled *Advances in Intelligent Information Processing: Tools and Applications* is the second one in the series. It has thirteen chapters, written by eminent scientists from different parts of the world, dealing with different aspects, characteristics and methodologies of intelligent information processing with real life applications. Both classical and modern techniques are used. Chapters on image and video processing mainly deal with challenging problems like curve evolution for partially occluded patterns, contour tracking, region classification, object category identification in video sequence, facial expression recognition, duplicate image detection for efficient video retrieval, and hardware architecture for pixel classification. Besides, the issues of uncertainty handling in class definition by integrating fuzzy sets and rough sets with an application on bioinformatics data, and the reuse of domain knowledge in soft computing framework for efficient modeling of intelligent systems are described in two chapters. I believe the state-of-the-art studies presented in this book will be very useful to readers.

Thanks to the contributors for their excellent research contributions and to volume editors Professors Bhabatosh Chanda and C.A. Murthy for their sincere effort in bringing out the volume nicely in time. Thanks are also due to World Scientific for their initiative in publishing the series and being a part of the Platinum Jubilee endeavor of the Institute.

December 2007
Kolkata

Sankar K. Pal
Series Editor and
Director, ISI

Preface

Intelligent information processing methodologies adopt one of the two major approaches: model based or rule based. In the first approach a model is developed from the sufficient training data, the domain knowledge as well as the knowledge of the physical process giving out the data. All the subsequent analysis and decision making is based on the model itself. Hence, though does not cover much wide spectrum, the method developed by this approach is very robust. Second approach develops a rule-base based on extensive and meticulous observation of the system and its outcome as well as reasoning. This approach covers a wide spectrum of situation, but may not be as reliable as the first one.

In the first paper, Joshi and Brady have developed a novel non-parametric mixture model for the histogram of image intensities. This leads to the evolution of level sets in a Bayesian framework, which are applied to region classification and image segmentation problem. The experimental results on medical images demonstrate the effectiveness of the method. The next paper by Chattopadhyay and Mukherjee, describes the level set based curve evolution method for pattern generation in 2D space. The reaction-diffusion and shape optimization models are used to derive constraints for curve evolution. The proposed model is extended successfully to the reconstruction of partially occluded patterns, which is a problem in Computer vision. The problem of instability in curve evolution, while using active contours for object segmentation and tracking, is tackled by Srikrishnan and Chaudhuri in the third paper. They propose the use of an additional tangential component for stability while the shape of the curve remains intact. The next article deals with object tracking, object recognition and object reconstruction using a completely different approach, i.e., general state modeling and estimation. In this work, the method proposed by Derichs, Deutsch, Wenhardt, Niemann and Denzlery here is based on determining the next best view in active state estimation using the concept of mutual information. The problem of 3D

object recognition is tackled by Zografos and Buxton in the fifth article. Their method combines linearly a few 2-dimensional intensity images of the same 3d object taken from vicinity but arbitrary viewpoints to obtain an overall idea about the object. They finally used an evolutionary algorithm for obtaining the 'optimal parameters for linear combination of views. Harit and Bharatia and Chaudhury present an approach for object category identification in video sequences. The proposed approach integrates object model knowledge with the perceptual organization process in human beings. The methods we have presented so far are for object segmentation, tracking and recognition in image or video. Emotion and expression recognition from an image is also an active research area nowadays. The article of Buciu and Pitas is on recognition of six basic facial expressions. The authors have developed a novel way of extracting features using discriminant non-negative matrix factorization algorithm. They successfully demonstrated the superior performance of their methodology over the competing strategies. Another active research area is retrieval of image and video from a large database. Search can be made more efficient and recall can be improved if the duplicate images can be trimmed off. Ghosh, Gelasca, Ramakrishnany and Manjunath tackled the problem of duplicate image detection in very large databases in the next article. They used a 12 dimensional descriptor based on Fourier Mellin transform. The detection of duplicate images is dependant on the dissimilarity measure. Another application of dissimilarity analysis may be found in the change detection problem in satellite images. Patra, Ghosh and Ghosh exploited the properties of self-organized feature map to reach a satisfactory solution to this problem. Another two important aspects of dealing with image and video data are compression and processing time. Liu, Zhu, Bosch and Delp provide an excellent review article describing the recent advances in video compression techniques. They additionally described the latest video coding standard. Compression is an essential tool for efficient storage and transmission of data. Another essential consideration is the processing time required for a given task. Hardware implementation of an algorithm always improves its efficiency in terms of speed. In the next article by Bishnu, Bhowmick, Bhattacharya, Kundu, Murthy and Acharya, a combinatorial approach is described for designing a hardware architecture for the classification each pixel into one of the three classes, namely, crest, valley and slope. The proposed pipeline design can be used to build a fast coprocessor for online finger print analysis. Intelligent information processing system should be able to handle uncertainties. Almost all the methods presented so far have some means of satisfying this criterion. For example, self-organized feature map, which is used in change detection in satellite image, has inherent capability to handle uncertainties to some extent. Rough set and fuzzy set based tools also have similar capabilities.

Maji and Pal propose a roughfuzzy C-medoids algorithm to select most informative bio-bases for amino acid sequence analysis in bioinformatics. The superior performance of the proposed method is demonstrated on different protein datasets. As indicated in the beginning the success of an intelligent information processing system greatly depends on the proper exploitation of domain and process knowledge. In the final article, Pedrycz describes the concept of knowledge reuse in the computational intelligence models. New performance index is defined whose minimization helps in the most effective level of knowledge reuse. The utility of the proposed methodology is demonstrated on fuzzy rule based systems.

First of all we express our heart-felt gratitude towards the contributors of this volume. This volume contains extended version of some articles presented at ICCTA. So we are grateful to Organizing Committee and Programme Committee of ICCTA to allow us to use the review reports of the articles. We also like to thank the reviewers of the articles processed for this volume. We also express our gratitude to the Indian Statistical Institute Platinum Jubilee Core Committee and the Series Editor for giving us opportunity to edit this volume. Finally, the help of Mr. Dilip Gayen and Mr. Indranil Dutta to prepare the camera-ready version is gratefully acknowledged.

Bhabatosh Chanda
C. A. Murthy
Editors

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