ICONIP'04 TUTORIAL

Title
EVOLUTIONARY ALGORITHMS FOR PATTERN ANALYSIS

Tutorial Speaker
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Duration
3 hours

Abstract

Numerous problems in data analysis such as classification, clustering, and feature analysis naturally reduce to optimization problems. Although these optimization problems can potentially be complex and multi-modal, the usage of evolutionary global optimization algorithms to solve these problems has been somewhat limited. This may be due to the large size of these datasets and the computational demand of the evolutionary algorithms. It may be recalled that the evolutionary algorithms were considered to be computationally too demanding in the 60s and 70s to solve even moderately complex optimization problems. With the advancements in computing and in the efficiency of evolutionary algorithms, in recent years the evolutionary algorithms are widely used to solve numerous real world optimization problems. It is anticipated that the evolutionary algorithms will increasingly be employed to solve complex data analysis problems as technology and evolutionary algorithms make further advances. Evolutionary algorithms possess several advantages. For example, the evolutionary algorithms are able to handle non-differentiable / non-functional objectives, to deal with non-homogeneous problems and to generate a population of alternative solutions. In particular, the ability to generate a population of solutions can be advantageously exploited in data analysis. If we are interested in developing evolutionary pattern classifiers or clustering algorithms, then the population of solutions can naturally lead to classifier or clustering ensemble. If we perform feature selection, we could easily identify the most important features by their relatively higher frequency of presence in the final population of solutions. This tutorial is timely and significant, as it provides a comprehensive overview of an emerging and important field. The main topics of this tutorial are listed below:

A. Introduction to Evolutionary Algorithms (EAs)

a. Basics of EAs (population, genetic operators, fitness, coding of solutions, etc.)
b. State of the art real coded and binary EAs including the Particle Swarm Optimizer
c. Multi-objective EAs (eg. NSGA II)

B. Feature Analysis

1. Supervised and Unsupervised Feature Selection
   a. Definition of the problem (wrapper, filter, hybrid methods)
   b. Evolutionary feature selection
   c. Multi-objective feature selection
2. Feature Extraction
   a. Description of the problem
   b. Evolutionary feature extraction techniques

C. Cluster Analysis

a. Description of cluster analysis (prototype-based, similarity-based, hierarchical)
b. Cluster validity measures and determination of the number of clusters
c. Evolutionary clustering algorithm.
d. Cluster ensembles (different cluster validity measures, multi-objective ensemble clustering)
e. Integrated unsupervised feature selection/weighting and cluster analysis

D. Evolving Pattern Classifiers

a. Evolving neural nets
b. Evolutionary ensemble classifiers (negatively correlated ensembles)
c. Evolutionary kernel classifiers, evolutionary SVM
d. Integrated supervised feature selection/extraction and classifier design

E. Potential Data Sets for Performance evaluation

a. Synthetic and UCI data sets
b. Image segmentation and classification
c. Biometric classification
d. Bioinformatics data sets

Targeted audience

This tutorial targets a broad audience including students, industrial practitioners and researchers interested in evolutionary optimization formulations in pattern recognition, cluster analysis, feature analysis, kernel classifier design and ensemble methods. The tutorial includes applications in handwritten word recognition, biometric recognition, medical image analysis and bioinformatics. This tutorial will be beneficial to researchers in the evolutionary computation field too, as a number of recent evolutionary algorithms will also be presented. We will also include some of the results of our recent collaboration with Professors Xin Yao (http://www.cs.bham.ac.uk/~xin/) and Kalyanmoy Deb (http://www.iitk.ac.in/kangal/deb.htm). Although this tutorial does not require any prerequisites, some basic knowledge of evolutionary computation, cluster analysis, feature analysis and pattern recognition would be useful.

Biography

P N Suganthan (http://www.ntu.edu.sg/home/EPNSugan/) received the B.A degree, Postgraduate Certificate and M.A degree in Electrical and Information Engineering from the University of Cambridge, UK in 1990, 1992 and 1994, respectively. He obtained his PhD degree from the School of Electrical and Electronic Engineering, Nanyang Technological University, Singapore. He was a pre-doctoral Research Assistant in the Department of Electrical Engineering, University of Sydney in 1995–96 and a lecturer in the Department of Computer Science and Electrical Engineering, University of Queensland in 1996–99. Since 1999 he has been with the School of Electrical and Electronic Engineering, Nanyang Technological University, Singapore where he was an Assistant Professor and now is an Associate Professor. He is an associate editor of the Pattern Recognition Journal and International Journal of Computational Intelligence. His research interests include evolutionary computation, applications of evolutionary computation, pattern recognition, bioinformatics and neural networks. He is a senior member of the IEEE and an associate member of the IEE.