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Schedule webpage: http://ims.nus.edu.sg/events/2018/wpso/wk.php

An Introduction to Nature-inspired Metaheuristic Algorithms

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ABSTRACT

This tutorial will introduce some of the numerous nature inspired search and optimization algorithms. The talk will give some suggestions for selecting these methods over the conventional methods. An attempt will be made to show relationships between some of these algorithms. Some theoretical works will also be highlighted. Finally, some promising future research directions will also be provided for some of these algorithms.

A Multiobjective Memetic Algorithm Based on Particle Swarm Optimization

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ABSTRACT

In this paper, a memetic algorithm (MA) for multiobjective (MO) optimization is proposed, which combines the global search ability of particle swarm optimization with a synchronous local search heuristic for directed local fine-tuning. A new particle updating strategy is proposed based upon the concept of fuzzy global-best to deal with the problem of premature convergence and diversity maintenance within the swarm. The proposed features are examined to show their individual and combined effects in MO optimization. The comparative study shows the effectiveness of the proposed MA, which produces solution sets that are highly competitive in terms of convergence, diversity, and distribution.

A Novel Discrete Particle Swarm Optimization Approach to Large-Scale Survey Planning

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ABSTRACT

Singapore has been facing a rapidly ageing population in recent years, as total fertility rate has been below the population replacement rate for the past three decades. This creates a societal pressure, as there will be less economically active adults to financially support an increasing cohort of elderly r esidents. As such, the Central Provident Fund Board (CPFB), the state pension agency, commissioned a large-scale nationwide face-to-face survey to collect data on retirement adequacy and to study the social issues and public health needs related to retirement amongst the local resident population aged 45 to 85 years old. Nielsen, being the leading market research and intelligence company in Singapore, has been appointed the execution agency to conduct the survey and data collection on behalf of CPFB.

One of the key execution challenges in conducting such a large-scale face-to-face survey is the efficient deployment and allocation of manpower resources to conduct the interviews in an orderly and competent manner to enhance productivity, while ensuring a high quality data collection process. For this project, we proposed an evolutionary-based algorithm to autonomously perform the allocation of interviewers to survey respondents to facilitate the fieldwork planning of a survey involving close to 32,000 pre-selected respondents and 100 Nielsen recruited interviewers. The allocation is done in two stages. Firstly, K-means clustering is used to group/cluster the survey respondents based on their geographical locations. This ensures that respondents staying close to one another are visited by the same interviewer in the same survey period. The second stage employs a novel Selective Probabilistic Discrete Particle Swarm Optimization (SPD-PSO) technique to assign the respective clusters of respondents to the interviewers to minimize the travel distance of each interviewer while trying to achieve a near-even spread of the survey workload across all the interviewers. The effectiveness of the proposed SPD-PSO algorithm is then evaluated by comparing its allocation results against those of two selected benchmark methods.

Stable Matching-Based Selection in Evolutionary Multiobjective Optimization

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ABSTRACT

Multiobjective evolutionary algorithm based on decomposition (MOEA/D) decomposes a multiobjective optimization problem into a set of scalar optimization subproblems and optimizes them in a collaborative manner. Subproblems and solutions are two sets of agents that naturally exist in MOEA/D. The selection of promising solutions for subproblems can be regarded as a matching between subproblems and solutions. Stable matching, proposed in economics, can effectively resolve conflicts of interests among selfish agents in the market. In the first part of the presentation, we advocate the use of a simple and effective stable matching (STM) model to coordinate the selection process in MOEA/D. In this model, subproblem agents can express their preferences over the solution agents, and vice versa. The stable outcome produced by the STM model matches each subproblem with one single solution, and it tradeoffs convergence and diversity of the evolutionary search. Comprehensive experiments have shown the effectiveness and competitiveness of our MOEA/D algorithm with the STM model. In addition, we will introduce the concept of incomplete preference lists into the stable matching model to remedy the loss of population diversity. In particular, each solution is only allowed to maintain a partial preference list consisting of its favorite subproblems. We implement two versions of stable matching-based selection mechanisms with incomplete preference lists: one achieves a two-level one-one matching and the other obtains a many-one matching. Furthermore, an adaptive mechanism is developed to automatically set the length of the incomplete preference list for each solution according to its local competitiveness. The effectiveness and competitiveness of our proposed methods are validated and compared with several state-of-the-art evolutionary multi-objective optimization algorithms on 62 benchmark problems.

A Partition-based Random Search for Multi-objective Optimization via Simulation

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ABSTRACT

In this research, we consider multi-objective problems over discrete solution space, where noise-corrupted observations of the objective measures are evaluated via stochastic simulation. We call them multi-objective optimization via simulation. These problems are widely seen in the real world and can be extremely hard to solve due to the lack of rich structure of the search space. To address these issues, we propose two algorithms using the partition-based random search method, called MPRS-C for the constrained case and MPRS-U for the unconstrained case. MPRS-C selects several most promising regions (MPR) in each iteration based on the local and global random search and partitions them systematically into sub-regions which are further sampled to update MPR. MPRS-U utilizes breadth-first search, and the search space is expanded from an initial hyperrectangle to its neighbor hyperrectangles iteratively. To further improve the search efficiency, simulation allocation rules can be incorporated to reduce the observation noise. The proposed algorithms are proven to converge to the global Pareto set with probability one for both constrained and unconstrained cases. Numerical experiments are conducted to demonstrate the effectiveness and robustness of the proposed algorithms compared to benchmarks.

Data Stream Analytics in Complex Environments

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ABSTRACT

The era of big data in highly complex environments calls for algorithmic development of advanced machine learning techniques and visualizations to transform massive amounts of information into useful references to help decision making process in real-time. This talk aims to discuss online real-time strategies for data stream analytics that provide concrete solutions to unsolved issues in data streams analytics, namely uncertainty in data distribution, uncertainty in data representation, uncertainty in data dimensions, uncertainty in data processing, and uncertainty in data visualization.

Numerical Optimization by Differential Evolution

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ABSTRACT

Differential Evolution (DE) is one of the most powerful stochastic real-parameter optimization algorithms of current interest. This talk will begin with an overview of the basic concepts related to DE, its algorithmic components and control parameters. It will subsequently discuss some of the significant algorithmic variants of DE for bound constrained single-objective optimization. The talk will discuss the effects of incorporating ensemble learning in DE. The talk will also discuss neighbourhood topologies based DE and adaptive DEs to improve the performance of DE. The talk will also highlight a few promising research directions.

Nature-Inspired metaheuristic algorithms for finding optimal designs for high dimensional biostatistical problems

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ABSTRACT

Algorithms are practical ways to find optimal experimental designs. Most published work in the statistical literature concerns optimal design problems with a small number of factors. With big data, there are increasingly more design problems with many factors and current algorithms do not work well. I discuss potential of nature-inspired metaheuristic algorithms to help solve high dimensional design problems and review past successes using particle swarm optimization techniques. I will discuss more complicated optimal design problems in biostatistics and explore their difficulties and solutions using nature-inspired metaheuristic methods.

EC at work: Opportunities and Challenges

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ABSTRACT

Evolutionary Computing (EC), which is based on the principles of natural selection and genetic inheritance, is often considered a global optimization methodology with a metaheuristic or stochastic optimization character. It is distinguished by the use of a population of candidate solutions rather than traditional approach of iterating over a single point in the search space. EC is being increasingly applied to many problems, ranging from practical applications in industry to cutting-edge scientific r esearch. The talk will provide a brief overview of this exciting research field i ncluding o pportunities a nd challenges faced in applying EC to a variety of real-world multi-objective problems, such as design automation, robust optimization and logistic application. In particular, a case study involving the estimation of remaining useful life (RUL) for turbofan engines in the area of robust prognostic will be studied. As one of the key enablers of condition-based maintenance, prognostic involves the core task of determining the RUL of the system. The talk will also present an application of evolutionary deep learning ensembles to improve the prediction accuracy of RUL estimation for turbofan engines