Reference line-based Estimation of Distribution Algorithm for many-objective optimization

Sun, Yanan Yen, Gary G. Yi, Zhang

Multi-Objective Evolutionary Algorithms (MOEAs) are preferred in solving multi-objective optimization problems due to their considerable performance giving decision-maker a set of not only convergent but diversified promising solutions. However, the scalability of MOEAs deteriorates in addressing many objective optimization problems which involve more than three conflicting objectives. The principal reason is largely due to the deficiency of the existing genetic operators which cannot generate promising offspring from parents chosen by the Pareto-dominance rule in these MOEAs. Estimation of Distribution Algorithms (EDAs) generate offspring with a probabilistic model built from the statistics extracting upon existing solutions to expectedly alleviate the weakness arisen in genetic operators. In this paper, a reference line-based EDA is proposed for effectively solving many-objective optimization problems. Specifically, the estimation model is built based on the reference lines in the decision space to sample solutions with favorable proximity. Then solutions with considerable diversity in Pareto-optimal front are selected. These two phases collectively promote the needed convergence and diversity for the proposed algorithm. To evaluate the performance, extensive experiments are performed against four state-of-the-art many objective evolutionary algorithms and two EDAs over DTLZ and WFG test suites with 5-, 8-, 10-, and 15-objective. Experimental results quantified by the selected performance metrics indicate that the proposed algorithm shows significant competitiveness in tackling many-objective optimization problems. (C) 2017 Elsevier B.V. All rights reserved.

[Paper](https://www.webofscience.com/wos/alldb/full-record/WOS:000407184900011)

Uncertain resource leveling problem

Ke, Hua Zhao, Chenkai

Resource leveling problem is to make a schedule for the minimization of resource fluctuation subject to precedence constraint and other specific constraints. When indeterminacies come into play, the leveled baseline schedule obtained by solving deterministic resource leveling problem can hardly be executed as planned and this schedule may even become infeasible. In this paper, on the basis of uncertainty theory, we consider an uncertain resource leveling problem in which activity durations are estimated by experts. In order to deal with these estimations, three uncertainty-theory-based project scheduling models are proposed and we utilize revised estimation of distribution algorithms to search quasi-optimal schedules. Numerical experiments are also provided to illustrate the effectiveness of the algorithms.

[Paper](https://www.webofscience.com/wos/alldb/full-record/WOS:000411449700031)

Probabilistic Analysis of Pareto Front Approximation for a Hybrid Multi-objective Bayesian Estimation of Distribution Algorithm

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Metaheuristics that explore the decision variables space to construct probabilistic modeling from promising solutions, like estimation of distribution algorithms (EDAs), are becoming very popular in the context of Multi-objective Evolutionary Algorithms (MOEAs). The probabilistic model used in EDAs captures certain statistics of problem variables and their interdependencies. Moreover, the incorporation of local search methods tends to achieve synergy of MOEAs' operators and local heuristics aiming to improve the performance. In this work, we aim to scrutinize the probabilistic graphic model (PGM) presented in Hybrid Multi-objective Bayesian Estimation of Distribution Algorithm (HMOBEDA), which is based on a Bayesian network. Different from traditional EDA-based approaches, the PGM of HMOBEDA provides the joint probability of decision variables, objectives, and configuration parameters of an embedded local search. HMOBEDA has shown to be very competitive on instances of Multi-Objective Knapsack Problem (MOKP), outperforming state-of-the-art approaches. Two variants of HMOBEDA are proposed in this paper using different sample methods. We aim to compare the learnt structure in terms of the probabilistic Pareto Front approximation produced at the end of evolution. Results on instances of MOKP with 2 to 8 objectives show that both proposed variants outperform the original approach, providing not only the best values for hypervolume and inverted generational distance indicators, but also a higher diversity in the solution set.

[Paper](https://www.webofscience.com/wos/alldb/full-record/WOS:000428685400065)

Non-Gaussian System Identification Based on Improved Estimation of Distribution Algorithm

Zhou, Jinglin Jia, Yiqing Zhang, Han Wang, Jing Zhu, Haijiang

In this paper, an improved estimation of distribution algorithm (EDA) is proposed and applied to the identification of ARMA model parameters. The system parameter identification problem is transformed into the optimization problem in high dimensional parameter space. Based on the traditional EDA algorithm, the parameters of preliminary estimation and data selection are added to improve the speed of searching and optimization precision. Because the mean and the variance are not enough to describe the uncertainty of non-Gaussian system, the entropy is regarded as fitness value to achieve the parameter identification of non-Gaussian system. Finally, an example of improved EDA identification is given to illustrate the effectiveness of the proposed approach.

[Paper](https://www.webofscience.com/wos/alldb/full-record/WOS:000432014402134)

Multiobjective decomposition-based Mallows Models estimation of distribution algorithm. A case of study for permutation flowshop scheduling problem

Zangari, Murilo Mendiburu, Alexander Santana, Roberto Pozo, Aurora

Estimation of distribution algorithms (EDAs) have become a reliable alternative to solve a broad range of single and multi-objective optimization problems. Recently, distance-based exponential models, such as Mallows Model (MM) and Generalized Mallows Model (GMM), have demonstrated their validity in the context of EDAs to deal with permutation-based optimization problems. The aim of this paper is two-fold. First, we introduce a novel general multi-objective decomposition-based EDA using Kernels of Mallows models (MEDA/D-MK framework) for solving multi-objective permutation-based optimization problems. Second, in order to demonstrate the validity of the MEDA/D-MK, we have applied it to solve the multi-objective permutation flowshop scheduling problem (MoPFSP) minimizing the total flow time and the makespan. The permutation flowshop scheduling problem is one of the most studied problems of this kind due to its fields of application and algorithmic challenge. The results of our experiments show that MEDA/D-MK outperforms an improved MOEA/D variant specific tailored for minimizing makespan and total flowtime. Furthermore, our approach achieves competitive results compared to the best-known approximated Pareto fronts reported in the literature for the benchmark considered. (C) 2017 Elsevier Inc. All rights reserved.

[Paper](https://www.webofscience.com/wos/alldb/full-record/WOS:000399506800009)

Motion Generation of Multi-Legged Robot in Complex Terrains by using Estimation of Distribution Algorithm

Jiang, Min Huang, Zhongqiang Jiang, Guiying Shi, Minghui Zeng, Xiangxiang

Motion generation is one of the most important and challenging problems in multi-legged robot research. Most of the existing methods show a good fulfillment of the requirements of robots in structured environments. However, it still faces many challenges to generate motions effectively and quickly for multi-legged robot works in complex environments. In this paper, we put forward a method which converts the motion generation problem into a Multi-objective Optimization Problem (MOP), which will make the robot not only run as fast as possible, but also save energy, and then use a distribution estimation algorithm, the trend prediction model method, to obtain motions for a six-legged robot. Experiments show that this method is effective.

[Paper](https://www.webofscience.com/wos/alldb/full-record/WOS:000428251400017)

Fast reliability evaluation method for composite power system based on the improved EDA and double cross linked list

Liu, Wenxia Cheng, Rui Xu, Yahui Liu, Zongqi

To improve the computational efficiency of Monte Carlo simulation in composite power systems reliability evaluation, this study presents a method based on the improved estimation of distribution algorithm (EDA) and double cross linked list. Compared to traditional techniques, this method is comprehensively improved in the stage of both sampling and state evaluation. In the sampling stage, the population-based incremental learning algorithm is presented, where the probability vector is updated based on the distribution characteristics of excellent samples in population of previous generations. Meanwhile, setting a limit to the probabilities of elements in normal state and mutation strategy are introduced, which improves the excellent characteristics of the population. In the state evaluation stage, the state search and match process is speed up by utilising the intelligent storage technology based on the double across linked list. It avoids calling the optimal power flow for the same state repeatedly. Finally, the proposed method is tested in IEEE RTS 79. As the result shows, compared with other methods ever used in reliability evaluation, this method is not only more efficient in computation but also more accurate. Thus, the proposed method is proved to be reliable and effective.

[Paper](https://www.webofscience.com/wos/alldb/full-record/WOS:000415379700021)

Estimation of Distribution with Restricted Boltzmann Machine for Adaptive Service Composition

Peng, Shunshun Wang, Hongbing Yu, Qi

Many enterprises have a growing interest in service composition to construct their business applications. With the increase of alternative services, Quality of Service (QoS) becomes an important indicator of obtaining optimal composite services. Due to the dynamic nature of the service environment, a composite service may not guarantee to deliver an overall optimal QoS. Re-optimization approaches have been developed to handle a dynamic environment. However, these approaches do not consider the diversity of alternative solutions, which may lead to better solutions. In this work, we introduce an adaptive approach, called estimation of distribution algorithm based on Restricted Boltzmann Machine (rEDA). rEDA effectively maintains the diversity of alternative solutions, by leveraging the inference ability of Restricted Boltzmann Machine to capture the potential solutions. It also provides a predictive guidance for the exploration of solution space, by considering the degree of how well a service contributes to the global QoS. The experimental evaluation shows that rEDA has a significant improvement on effectiveness and efficiency over existing approaches.

[Paper](https://www.webofscience.com/wos/alldb/full-record/WOS:000427074500015)

Effective multiobjective EDA for bi-criteria stochastic job-shop scheduling problem

Hao, Xinchang Gen, Mitsuo Lin, Lin Suer, Gursel A.

This paper proposes an effective multiobjective estimation of distribution algorithm (MoEDA) which solves the bi-criteria stochastic job-shop scheduling problem with the uncertainty of processing time. The MoEDA proposal minimizes the expected average makespan and the expected total tardiness within a reasonable amount of computational time. With the framework of proposed MoEDA, the probability model of the operation sequence is estimated firstly. For sampling the processing time of each operation with the Monte Carlo methods, allocation method is used to decide the operation sequence, and then the expected makespan and total tardiness of each sampling are evaluated. Subsequently, updating mechanism of the probability models is proposed according to the best solutions to obtain. Finally, for comparing with some existing algorithms by numerical experiments on the benchmark problems, we demonstrate the proposed effective estimation of distribution algorithm can obtain an acceptable solution in the aspects of schedule quality and computational efficiency.

[Paper](https://www.webofscience.com/wos/alldb/full-record/WOS:000394365700034)

Design and optimization of heat-integrated distillation configurations with variable feed composition by using a Boltzmann-based estimation of distribution algorithm as optimizer

Gutierrez-Guerra, Roberto Murrieta-Duenas, Rodolfo Cortez-Gonzalez, Jazmin Gabriel Segovia-Hernandez, Juan Hernandez, Salvador Hernandez-Aguirre, Arturo

The economic, energetic, and environmental performance of heat-integrated distillation columns used to separate close-boiling mixtures with variable feed composition is presented. A Boltzmann-based estimation of distribution algorithm was used as optimizer. The total annual cost was defined as the fitness function of the problem. We study three mixtures of hydrocarbons and one mixture of polar compounds. The results show that the BUMDA algorithm leads continuously to obtain good values of the fitness function. The analysis carried out showed that the influence of the feed composition was larger in the energy consumption than in the TAC at each case study. In addition, the best compromise between energy consumption and the total annual cost was obtained in mixtures with a feed composition of 0.75/0.25 for most case studies. These HIDiC configurations showed energy savings between 85 and 87%. Thus, similar reductions in the energy consumption, carbon dioxide emissions and cooling water were obtained. On the other hand, the TAC of the best HIDiC designs varies from HIDiC designs with a reduction of 27% to HIDiC schemes with a TAC 2% larger than the corresponding TAC of the traditional configurations. (C) 2017 Institution of Chemical Engineers. Published by Elsevier B.V. All rights reserved.

[Paper](https://www.webofscience.com/wos/alldb/full-record/WOS:000407661500004)

An Adaptive Sampling-Estimation of Distribution Algorithm for Robust Scheduling in the Steelmaking-Continuous Casting Process

Jiang, Sheng-long Liu, Qie

Uncertainty is an important feature of industrial systems, and it extensively exists in the steelmaking industry. This paper focuses on the uncertain scheduling problem arising from the steelmaking-continuous casting (SCC) process. Based on the Benders decomposition strategy, the SCC scheduling problem (SCCSP) is decomposed into two sub-problems: the machine allocation problem (MAP) and the timetabling problem (TTP). To solve the uncertain SCCSP with interval processing times, an estimation of distribution algorithm (EDA) combined with robust optimization (RO) is proposed. First, a novel EDA with multiple probabilistic models and adaptive sampling policy is developed to solve the MAP. Second, the RO approach with ellipsoidal sets is embedded in the EDA and used to solve the TTP. To verify the proposed algorithm, a number of instances are generated from real-world industrial data. The final simulation results show that the proposed algorithm is efficient and effective to solve the uncertain SCCSP with interval processing times.

[Paper](https://www.webofscience.com/wos/alldb/full-record/WOS:000428014600078)

A novel hybrid estimation of distribution algorithm for solving hybrid flowshop scheduling problem with unrelated parallel machine

Sun, Ze-wen Gu, Xing-sheng

The hybrid flow shop scheduling problem with unrelated parallel machine is a typical NP-hard combinatorial optimization problem, and it exists widely in chemical, manufacturing and pharmaceutical industry. In this work, a novel mathematic model for the hybrid flow shop scheduling problem with unrelated parallel machine (HFSPUPM) was proposed. Additionally, an effective hybrid estimation of distribution algorithm was proposed to solve the HFSPUPM, taking advantage of the features in the mathematic model. In the optimization algorithm, a new individual representation method was adopted. The (EDA) structure was used for global search while the teaching learning based optimization (TLBO) strategy was used for local search. Based on the structure of the HFSPUPM, this work presents a series of discrete operations. Simulation results show the effectiveness of the proposed hybrid algorithm compared with other algorithms.

[Paper](https://www.webofscience.com/wos/alldb/full-record/WOS:000410818500010)

An estimation of distribution algorithm coupled with the generalized Mallows distribution for a school bus routing problem with bus stop selection

Perez-Rodriguez, Ricardo Hernandez-Aguirre, Arturo

Although the estimation of distribution algorithms were originally designed for solving integer or real-valued domains, this contribution applies the algorithms mentioned to deal with a permutation-based problem, called school bus routing problem with bus stop selection, using the generalized Mallows distribution as an attempt to describe and obtain an explicit probability distribution over a set of school bus routes. In addition, a mutation operator is considered for improving the estimation of the central permutation, a parameter of the Mallows distribution. Different and diverse instances served as input and test parameters in order to show that permutation-based optimization problems such as the school bus routing problem with bus stop selection can be solved by means of a probability model, and improving the estimation of the central permutation helps the performance of the algorithm.

[Paper](https://www.webofscience.com/wos/alldb/full-record/WOS:000405160800009)