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Refereed Journal Papers

- [peiyan-01:2014] Yan Pei. Chaotic Evolution: Fusion of Chaotic Ergodicity and Evolutionary Iteration for Optimization. *Natural Computing*, 13(1):79–96, 2014.

We propose a novel population-based optimization algorithm, Chaotic Evolution (CE), which uses ergodic property of chaos to implement exploration and exploitation functions of an evolutionary algorithm. CE introduces a mathematical mechanism into an iterative process of evolution and simulates ergodic motion in a search space with a simple principle. A control parameter, direction factor rate, is proposed to guide search direction in CE. It is easy to extend its search capability by using different chaotic system in CE algorithm framework. The scalability of CE is higher than that of some other evolutionary computation algorithms. A series of comparative evaluations and investigations is conducted to analyse characteristics of the proposal. Our proposal can obtain better optimization performance by comparing with differential evolution and some of its variants. We point out that the chaos theory is used not only to describe and explain a non-linear system, but also to implement a variety of optimization algorithms based on its ergodic property.

- [peiyan-02:2014] Yan Pei, Qingfu Zhao, and Yong Liu. Kernel Method Based Human Model for Enhancing Interactive Evolutionary Optimization. *The Scientific World Journal*, 2015:1–12, 2015.

A fitness landscape presents the relationship between individual and its reproductive success in evolutionary computation (EC). However, discrete and approximate landscape in an original search space may not support enough and accurate information for EC search, especially in interactive EC (IEC). The fitness landscape of human subjective evaluation in IEC is very difficult and impossible to model, even with a hypothesis of what its definition might be. In this paper, we propose a method to establish a human model in projected high dimensional search space by kernel classification for enhancing IEC search. Because bivalent logic is a simplest perceptual paradigm, the human model is established by considering this paradigm principle. In feature space, we design a linear classifier as a human model to obtain user preference knowledge, which cannot be supported linearly in original discrete search space. The human model is established by this method for predicting potential perceptual knowledge of human. With the human model, we design an evolution control method to enhance IEC search. From experimental evaluation results with a

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pseudo-IEC user, our proposed model and method can enhance IEC search significantly.

[qf-zhao-01:2014] Y. Kaneda and Q. F. Zhao. Inducing high performance and compact neural networks based on decision boundary making. *IEEE Transactions on Electronics, Information and Systems*, 134(9):1299–1309, 9 2014.

In recent years, portable computing devices (PCDs) are becoming very popular. To improve the quality of service (QoS) for each individual user, it is necessary to develop application programs that can be aware of the user intention, preference, situation, etc., so that proper services can be recommended at proper timing. We call these kinds of programs awareness agents (A-agents). To satisfy various needs of a user, many A-agents should work together in one PCD. Since the computing resource in a PCD is limited, it is necessary to reduce the implementation costs of the A-agents while preserving their performance. For this purpose, we propose two decision boundary making (DBM) algorithms in this paper. The basic idea of DBM is to generate new training data using given ones to fit the decision boundary (DB) of the given problem, and induce small neural networks (NNs) using the new data. Both algorithms proposed here are simplified versions of the decision boundary learning (DBL) algorithm proposed by us earlier. Using the new algorithms, the cost for data generation can be greatly reduced. Experimental results show that if the new data are generated properly in positions close to the DB, the induced small NNs can perform even better than support vector machines, which are known as the state-of-the-art learning models.

[yliu-01:2014] H. Wang, Z. Wu, S. Rahnamayan, H. Sun, Y. Liu, and J. Pan. Multi-strategy ensemble artificial bee colony algorithm. *Information Sciences*, 279:587–603, 2014.

Artificial bee colony (ABC) is a recently proposed optimization technique which has shown to be competitive to other population-based stochastic algorithms. However, ABC is good at exploration but poor at exploitation because of its solution search strategy. Thus, to obtain optimal performance, different characteristics of solution search strategies can be appropriate during different stages of the search process to achieve a tradeoff between exploration and exploitation. In this paper, we propose a multi-strategy ensemble ABC (MEABC) algorithm. In MEABC, a pool of distinct solution search strategies coexists throughout the search process and competes to produce offspring. Experiments are conducted on a set of numerical benchmark functions. Results

show that MEABC performs significantly better than, or at least comparable to, some evolutionary algorithms.

Refereed Proceeding Papers

[peiyan-03:2014] Yan Pei, Hideyuki Takagi, Qiangfu Zhao, and Yong Liu. A Comprehensive Analysis on Optimization Performance of Chaotic Evolution and Its Parameter Distribution. In *2014 IEEE International Conference on Systems, Man, and Cybernetics (IEEE SMC2014)*, pages 3496–3501, 2014.

In this paper, we analyse and discuss the relationship between optimization performance of chaotic evolution (CE) algorithm and distribution characteristic of chaotic parameter. CE is an evolutionary computation algorithm that simulates chaotic motion of a chaotic system in a search space for implementing optimization. However, its optimization performance, internal process mechanism and optimization principle are not well studied. In this paper, we investigate distribution characteristics of chaotic systems, which support chaotic parameter in CE algorithm. Compared with other two parameter generators, i.e., a quadratic-like random generator and an uniform random generator, CE algorithm with chaotic parameter generated by the logistic map ($r = 4$) shows better optimization performance significantly. We also make an algorithm comparison with differential evolution and an algorithm ranking by Friedman test and Bonferroni-Dunn test. The related topics on relationship between optimization performance of CE algorithm and chaotic parameter distribution are analysed and discussed. From these analyses and discussions, it indicates that chaotic parameter distribution is a significant factor that influences optimization performance of CE algorithm.

[qf-zhao-02:2014] Qiangfu Zhao Yuya Kaneda, Yan Pei and Yong Liu. Study on the Effect of Learning Parameters on Decision Boundary Making Algorithm. In IEEE, editor, *IEEE International Conference on Systems, Man, and Cybernetics (IEEE SMC2014)*, pages 705–710. IEEE SMC Society, IEEE, 10 2014.

The purpose of our study is to induce compact and high performance machine learning models. In our earlier study, we proposed a decision boundary making (DBM) algorithm. The main philosophy of the DBM algorithm is to reconstruct a high performance model with much smaller cost. In our study,

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we use support vector machine as a high performance model, and a multilayer neural network, i.e., multilayer perceptron (MLP), as the small model. Experimental results obtained so far show that high performance and compact MLPs can be obtained using DBM. However, there are several parameters of DBM that need to be adjusted appropriately in order to achieve better performance. In this paper, we investigate the effect of parameter N, which is the number of newly generated data, on the performance of obtained MLPs. We discuss the issue that how many new data we should generate to obtain a better performance of DBM. We also investigate the effect of outliers on the performance of the obtained MLPs. Outliers are generally known to be harmful for pattern recognition. Our experimental results show, however, that for some databases, outliers can be useful for obtaining high performance MLPs.

[qf-zhao-03:2014] Kentaro Sekine Yutaro Minakawa, Mitsuru Abe and Qiangfu Zhao. Neural Network Based Feature Point Detection for Image Morphing. In IEEE, editor, *IEEE International Conference on Awareness Science and Technology (iCAST2014)*, page NA. IEEE SMC Japan Chapter, IEEE, 10 2014.

In recent years, information security becomes more necessary than it used to be. Steganography is one of the effective mechanisms to protect ones privacy and secrets. Recently, we proposed a morphing based steganography, in which a morphed image is used as the cover image, the encryption key, as well as the stego-key. A key point to ensure the security is the “naturalness” of the morphed images. To obtain natural images through morphing, we may manually specify the feature points in the given reference images. This, however, is a very tedious task in practice. To increase the efficiency, we study in this paper automatic feature point detection based on neural networks (NNs). In this method, the difference between a sub-image A and a sub-image B is used as the input of the NN, and the output is the estimated difference between the coordinates of the centers of A and B. Thus, if B is centered by one of the feature points, and the NN is properly designed, we can obtain an estimated coordinate of the corresponding feature point directly from the NN output, given A-B as the input. This paper introduces the process for obtaining the training data and the teacher signals, and provides some initial experimental results to verify the proposed approach.

[qf-zhao-04:2014] Kazuki Murakami Ryota Hanyu and Qiangfu Zhao. Verification of an Image Morphing Based Technology for Improving the Security in Cloud Storage Services. In IEEE, editor, *IEEE Symposium Series on*

Computational Intelligence (SSCI 2014), page NA. IEEE CI Society, IEEE, 12 2014.

Recently, many kinds of cloud computing based services are provided and they are becoming more and more popular. But we think it is an urgent problem to improve the security of cloud services especially for storage services because the number of cyber-attacks is increasing. Currently, our research group proposed an image morphing based technology for improving the security of cloud services. This technology provides a novel way both for encrypting and for hiding secret information. In this paper, we verify and discuss about the vulnerability of the proposed technology, and suggest possible methods for further improvement.

[qf-zhao-05:2014] Qiangfu Zhao Kazuki Murakami and Ryota Hanyu. A New Steganography Protocol for Improving Security of Cloud Storage Services. In IEEE, editor, *Proc. IEEE Symposium Series on Computational Intelligence (SSCI 2014)*, page NA. IEEE CI Society, IEEE, 12 2014.

In recent years, cloud computing services have become a must in our daily lives. Although well-known security technologies are used for system protection and data protection, the security of existing service systems is far from enough. The main problem is that existing systems and/or programs usually have some unknown issues or vulnerabilities, and can be attacked by some unauthorized persons in some unexpected ways. To solve the problem, at least partially, we have proposed a new steganography protocol for improving information security in cloud storage services. The key point in this protocol is to synthesize an image that can be used as the encryption/decryption key, the stego-key, as well as the cover data. Initial analysis shows that the new protocol is very secure. This paper formulates the protocol in a more formal way, so that based on the formulation, we can find possible weak points more easily, and make the protocol more practically useful.

[yliu-02:2014] Y. Liu, Q. Zhao, and Y. Pei. From low negative correlation learning to high negative correlation learning. In *Proceedings of 2014 International Joint Conference on Neural Networks (IJCNN 2014)*, pages 171–174. IEEE Computational Intelligence Society, IEEE, July 2014.

Besides the studied transition learning between the two different ensemble learning algorithms such as negative correlation learning and balanced ensemble learning, transition learning could also implemented in negative correlation learning with different correlation penalties. On one hand, negative corre-

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lation learning with the lower correlation penalty named as low negative correlation learning might learn too much the training data while generating less negatively correlated neural networks. On the other hand, negative correlation learning with the higher correlation penalty called as high negative correlation learning might not be able to learn the training data, but be capable of generating highly negatively correlated neural networks. By conducting transition learning from low negative correlation learning to high negative correlation learning, this paper shows that the ensembles could have both the good performance and the diverse individual neural networks.

[yliu-03:2014] Y. Liu, Q. Zhao, and Y. Pei. Control of correlation in negative correlation learning. In *Proceedings of 2014 10th International Conference on Natural Computation (ICNC 2014)*, pages 7–11. IEEE, Aug. 2014.

Balanced ensemble learning is developed from negative correlation learning by shifting the learning targets. Compared to the negative correlation learning, balanced ensemble learning is able to learn faster and achieve the higher accuracy on the training sets for a number of the tested classification problems. However, it has been found that the higher accuracy balanced ensemble learning obtained on the training sets, the higher risks it might be trapped in overfitting. In order to lessen the degree of overfitting in balanced ensemble learning, two parameters of the lower bound of error rate (LBER) and the upper bound of error output (UBEO) were set to decide whether a training point should be learned or ignored in the learning process. Such selective learning could prevent the ensembles from learning too much on the training set to have a good performance on the testing set. This paper show how LBER and UBEO would affect the performance of balanced ensemble learning in view of correlation control.

[yliu-04:2014] Y. Liu, Q. Zhao, and Y. Pei. Ensemble learning with correlation-based penalty. In *Proceedings of 2014 World Ubiquitous Science Congress (U-Science 2014)*, pages 350–353. IEEE Computer Society, Aug. 2014.

Ensemble learning system could lessen the degree of overfitting that often appear in the supervised learning process for a single learning model. However, overfitting had still been observed in negative correlation learning that is an ensemble learning method with correlation-based penalty. Two constraints were introduced into negative correlation learning in order to conquer such overfitting. One is the lower bound of error rate (LBER). The other is the

upper bound of error output (UBEO). With LBER and UBEO, negative correlation learning will selectively learn the data points. After the performance becomes better than LBER, those unlearned data points with the error output larger than UBEO would not be learned anymore in negative correlation learning. This paper presented the experimental results to explain how these two constraints would affect the performance of negative correlation learning.

Unrefereed Papers

- [peiyan-04:2014] Noboru Murata, Ryuei Nishii, Hideyuki Takagi, and Yan Pei. Estimation Methods of the Convergence Point of Moving Vectors Between Generations. In *Japanese Society for Evolutionary Computation Symposium 2014*, 2014.
- [peiyan-05:2014] Yan Pei. Establishing theoretical fundamental of algorithmic mechanism design for evolutionary computation. In *Japanese Society for Evolutionary Computation Symposium 2014*, 2014.
- [peiyan-06:2014] Yan Pei and Hideyuki Takagi. Local Information of Fitness Landscape Obtained by Paired Comparison-based Memetic Search for Interactive Differential Evolution. In *the 7th Evolutionary Computing Meeting*, 2014.
- [peiyan-07:2014] Yan Pei. Chaotic Evolution. In *6th Evolutionary Computation Meeting*, 2014.

Grants

- [yliu-05:2014] Y. Liu. The Grant-In-Aid for Scientific Research Fund (Kakenhi), 2015-2017.

Ph.D and Others Theses

- [qf-zhao-06:2014] Chia-Ming Tsai. Master thesis, Graduate School, 9 2014.

The basic concept of smart environment is to be aware of the context information related to environmental and human behavioral changes, and to provide appropriate services accordingly. To obtain the context information, people often use

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video cameras, microphones, and other devices. These devices can obtain complex environmental data but they also need powerful equipment for handling the data. In addition, cameras and microphones often have privacy issues. In this paper, we study human behavior identification based on simple sensors. Since humans cannot easily use the language to express amount of activity. Activities are easily affected by external factors cause, the activities contained uncertainty factor. Monitoring equipment susceptible to external factors cause data loss or noise. In order to effectively deal with these problems, we propose to use fuzzy logic to analysis the sensor data and to identify resident activities. Different activities may generate the same data, It is easy to let the system cannot make the right decisions. We use weight to distinguish the system cannot distinguish the situation to strengthen the recognition rate of activity. According to the experimental results, the proposed method can effectively identify 83.7% useful for designing smart homes, smart office, and so on.

[qf-zhao-07:2014] Kai-Ming Chang. Master thesis, Graduate School, 9 2014.

With the rapid development of computer technology and wide spread of communication devices, distance communication between people via electronic technology is now a reality. However, speaking messages can be corrupted by various noises, and this can be an obstacle for human-machine or even for human-human communication. Since noises are often environment dependent, it is better to purify the messages at recording time before passing them to the communication network. Generally speaking, a microphone array can obtain different versions of the same message, and thus the original message can be extracted more effectively by integrating information of all microphones in the array. In this thesis we propose a new method for microphone array based de-noising. The proposed method uses support vector regression (SVR) to learn the correlation between the true signal and its different versions received by the microphones in an array, and can remove the noises even if we do not know exactly the positions of the signal source, the noise source, and the microphones. Experimental results obtained with a synthesized signal and a real voice signal show that the SVR-based method can improve the SNR significantly, compared with the delay-and-sum beamforming method.

[qf-zhao-08:2014] Yu-Hsien Ting. Master thesis, Graduate School, 9 2014.

People are now spending more for medical care than ever before. It is known that unhealthy diet, irregular life, work pressure and other factors can result in a number of diseases. Diabetes mellitus, cardiovascular, peptic ulcer and gastroenteritis are just a few examples. To reduce these diseases and thus to reduce the

expenses in medical care, diet management is becoming an indispensable part in our daily lives. The main purpose of this study is to build a diet management system that can provide the user's correct nutritional information based on a recipe ontology. The long term goal is to construct a recipe ontology that defines various food nutrients needed for healing some common diseases, and an inference engine that can, given the user's health conditions as well as his/her preferences, recommend a proper menu in each day based on the recipe ontology. As the first step, in this study we try to build a prototype system that can provide personalized recipe recommendation for each user. Specifically, we propose a recipe ontology (RO) which is built based on SPARQL Protocol and RDF Query Language (SPARQL); and a dietary recommendation system (DRS) based on the above RO and a JENA Semantic Web Framework (JENA). The current design goal is to make the DRS able to provide recipe recommendations based on the user's health situation and preference. For the time being, the number of situations, the number of user preferences, and the number of recipes, are limited. However, the proposed system can be extended easily in the future.

[qf-zhao-09:2014] Yuta Kobiyama. Graduation thesis, Undergraduate school, 3 2015.

In constructing Smart Environment, cameras or voice recorders are often used to collect data to analyze the life pattern of residents. To protect one's privacy, we suggest using only simple sensors, avoiding excessive collection of data. The goal of this research is to validate the potential of using only simple sensors to correctly analyze life rhythm and activity patterns of residents. Based on the data gathered through an experiment, this paper reports on the possibility of using data gathered from simple sensors to analyze life patterns of inhabitants. Our results suggest that resident life rhythms can be roughly estimated using data from one simple sensor. This study helps constructing smart environment while we protect the privacy of residents.

[qf-zhao-10:2014] Yuki Nagao. Graduation thesis, Undergraduate school, 3 2015.

Today, Deep Learning is becoming one focus point in the machine learning field. Deep Learning is a method that trains deep structured neural networks. Generally, a deep structured neural network shows higher performance than a shallow one. But it is difficult to train deep structured neural networks. We study the way to train deep structured neural networks, and compare a performance with shallow ones.

[qf-zhao-11:2014] Ryota Hanyu. Graduation thesis, Undergraduate school, 3 2015.

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Recently, many kinds of cloud computing based services are provided, and they are becoming more and more popular. But we think it is urgent to improve the security of cloud services especially for storage services because the number of cyber-attacks is increasing. Currently, our research group proposed an image morphing based technology for improving the security of cloud services. This technology provides a novel way both for encrypting and for hiding secret information. In this paper, we verify and discuss the vulnerability of the proposed technology and suggest possible methods for further improvement.

[qf-zhao-12:2014] Takumi Endo. Graduation thesis, Undergraduate school, 3 2015.

In recent years, bio-metric authentication technology has been used in all over the world. System for unlocking by recognizing the face with a camera attached to the top of the door. Moreover, a system for unlocking by holding the cards that contains face images and personal information. Since there are such a system, it is true that many of the personal data exist in the world. They are protected by security, but some people to steal information. It is need to strengthen the security in order to protect important information. Therefore, In our laboratory, we have proposed an image morphing based information hiding technology. To obtain natural images, we have researched about the detection of feature points. Here, we show that to generate an intermediate face images of two people using two human face image. The positions of feature points of the face parts are important in order to generate a natural face image by image morphing. Therefore, we detect the feature points automatically and accurately using the SIFT algorithm. In the case of our research, we need 12 feature points. In this paper, we will propose how to detect feature points by SIFT algorithm in order to generate a natural face image.

[yliu-06:2014] Masayuki Takei. Evolving Rock-Paper-Scissors Game Strategies Using Genetic Algorithm, University of Aizu, 2014.

Thesis Advisor: Y. Liu

[yliu-07:2014] Michihito Narita. Experimental Results of Othello Program Using the Game Trees, University of Aizu, 2014.

Thesis Advisor: Y. Liu

[yliu-08:2014] Masato Adachi. Evolution of Cooperation in Prisoner's Dilemma Problem, University of Aizu, 2014.

Thesis Advisor: Y. Liu