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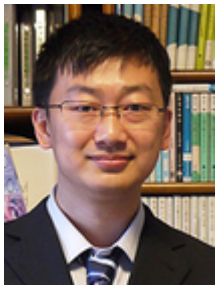

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The main stream in our lab is related to computational intelligence. So far we have focused our study on three key words: recognition, learning and understanding. The goal of our research is to develop some learning models that are flexible enough to adapt changing environment, and also simple enough to be realized, interpreted and re-used. The ultimate goal is to design a system that can think, and decide what to do and how to grow-up based on its own thinking. For this purpose, many approaches have been studied - e.g., neuro-computation, memetic algorithms, reinforcement learning, awareness computing, and so on. Of course, results proposed in conventional symbol based artificial intelligence are also included.

In 2015, we successfully organized the 7-th International Conference on Awareness Science and Technology (iCAST2015), which was sponsored by IEEE SMC Japan Chapter, and technically co-sponsored by IEEE SMC Society. We have been trying to promote awareness scicence and technology through collaboration with different universities or organizations around the world. We also received the best paper award at the 2nd IEEE International Conference on Cybernetics. Our dream is to propose a new and better approach to realization of artificial intelligence.

So far we have used or proposed the following learning models:

- Neural network trees (NNTrees),
- Nearest neighbor classification trees (NNC-Trees),
- Support vector machines (SVMs),
- Neural network ensembles,
- Modular neural networks,

- Cellular automata, and
- Recurrent neural networks.

Based on the above learning models, we have proposed many new algorithms. Examples include:

- IEA: individual evolutionary algorithm (also called the $R4$-rule),
- CoopCEA: cooperative co-evolutionary algorithms,
- EPNet: evolutionary programming neural net,
- Evolutionary design of neural network trees,
- Induction of NNC-Trees with the $R4$-rule,
- Fast neural network for face detection,
- Decision boundary making for inducing high performance neural networks, and
- 3-factor user authentication based on image morphing.

To verify and to improve the models and learning algorithms proposed so far, we have being studying on-line growing of neural network trees, evolution of neural network ensemble, evolutionary design of decision trees, and so on. Currently, we are very interested in applying our models and algorithms to solving practical problems related to producing a "safe, secure and healthy" society. Examples include: face detection, face/expression recognition, automatic image morphing, text mining, user authentication, steganography, and so on.

Refereed academic journal

[peiyan-105-036-01:2015] Yan Pei. Algorithmic Mechanism Design of Evolutionary Computation. *International Journal of Machine Learning and Cybernetics*, Article ID 591954, 2015.

We consider algorithmic design, enhancement, and improvement of evolutionary computation as a mechanism design problem. All individuals or several groups of individuals can be considered as self-interested agents. The individuals in evolutionary computation can manipulate parameter settings and operations by satisfying their own preferences, which are defined by an evolutionary computation algorithm designer, rather than by following a fixed algorithm rule. Evolutionary computation algorithm designers or self-adaptive methods should construct proper rules and mechanisms for all agents (individuals) to conduct their evolution behaviour correctly in order to definitely achieve the desired and preset objective(s). As a case study, we propose a formal framework on parameter setting, strategy selection, and algorithmic design of evolutionary computation by considering the Nash strategy equilibrium of a mechanism design in the search process. The evaluation results present the efficiency of the framework. This primary principle can be implemented in any evolutionary computation algorithm that needs to consider strategy selection issues in its optimization process. The final objective of our work is to solve evolutionary computation design as an algorithmic mechanism design problem and establish its fundamental aspect by taking this perspective. This paper is the first step towards achieving this objective by implementing a strategy equilibrium solution (such as Nash equilibrium) in evolutionary computation algorithm.

[peiyan-105-036-02:2015] Yan Pei. Study on Efficient Search in Evolutionary Computation. *Transactions of the Japanese Society for Artificial Intelligence*, 30(1):124, 2015.

Enhancing the search capability of evolutionary computation (EC) and increasing its optimization performance are important but have not completed yet. EC is applicable to high dimensional, non-linear, non-differentiable, and/or other hard problems. However, obtaining an optimal performance is still hard for practical EC applications. For example, user fatigue is a serious issue of applying interactive EC, and reducing fatigue is a practical requirement for its applications. As implementing an efficient search method in EC algorithm is one of the methods for reducing user fatigue, it is valuable to

study on the efficient search methods for EC. In this dissertation, we propose six novel approaches on this subject and discuss them within three research directions. They are: (1) approximating fitness landscape in lower dimensional search space and elite local search, (2) Fourier analysis on fitness landscape and its enhancement methods, (3) Fourier niche method for multi-modal optimization, (4) triple and quadruple comparison-based interactive differential evolution (IDE) and differential evolution (DE), (5) EC acceleration by the accelerating transition from exploration to exploitation, and (6) a new EC algorithm - chaotic evolution. The first research direction among three directions in this dissertation is the fitness landscape approximation method that tries to obtain the knowledge of the problem structure and search condition in a search space. Once we obtain these kinds of information, we can propose specific search strategies, introducing local search to EC, and others to enhance EC search capability. The second research direction is developing a new search mechanism. We propose a new triple and quadruple comparison-based IDE and DE, not only to enhance IDE search as well as reducing IDE user fatigue, but also to enhance canonical DE search. By introducing transition from exploration to exploitation, a new EC mechanism is proposed to enhance EC research performance. The third research direction is developing new EC algorithms. We propose a new EC algorithm based on chaotic ergodicity. This idea is inspired by ergodicity of chaotic systems to combine with EC.

[peiyan-105-036-03:2015] Ying Tan Yan Pei, Shaoqiu Zheng and Hideyuki Takagi. Effectiveness of Approximation Strategy in Surrogate-assisted Fireworks Algorithm. *International Journal of Machine Learning and Cybernetics*, 6(5):795–810, 2015.

We consider algorithmic design, enhancement, and improvement of evolutionary computation as a mechanism design problem. All individuals or several groups of individuals can be considered as self-interested agents. The individuals in evolutionary computation can manipulate parameter settings and operations by satisfying their own preferences, which are defined by an evolutionary computation algorithm designer, rather than by following a fixed algorithm rule. Evolutionary computation algorithm designers or self-adaptive methods should construct proper rules and mechanisms for all agents (individuals) to conduct their evolution behaviour correctly in order to definitely achieve the desired and preset objective(s). As a case study, we propose a formal framework on parameter setting, strategy selection, and algorithmic design of evolutionary computation by considering the Nash strategy equilibrium

of a mechanism design in the search process. The evaluation results present the efficiency of the framework. This primary principle can be implemented in any evolutionary computation algorithm that needs to consider strategy selection issues in its optimization process. The final objective of our work is to solve evolutionary computation design as an algorithmic mechanism design problem and establish its fundamental aspect by taking this perspective. This paper is the first step towards achieving this objective by implementing a strategy equilibrium solution (such as Nash equilibrium) in evolutionary computation algorithm.

[peiyan-105-036-04:2015] Yan Pei. From Determinism and Probability To Chaos: Chaotic Evolution Towards Philosophy and Methodology Of Chaotic Optimization. *The Scientific World Journal*, Article ID.704587, 2015.

We present and discuss philosophy and methodology of chaotic evolution that is theoretically supported by chaos theory. We introduce four chaotic systems, that is, logistic map, tent map, Gaussian map, and Henon map, in a well-designed chaotic evolution algorithm framework to implement several chaotic evolution (CE) algorithms. By comparing our previous proposed CE algorithm with logistic map and two canonical differential evolution (DE) algorithms, we analyse and discuss optimization performance of CE algorithm. An investigation on the relationship between optimization capability of CE algorithm and distribution characteristic of chaotic system is conducted and analysed. From evaluation result, we find that distribution of chaotic system is an essential factor to influence optimization performance of CE algorithm. We propose a new interactive EC (IEC) algorithm, interactive chaotic evolution (ICE) that replaces fitness function with a real human in CE algorithm framework. There is a paired comparison-based mechanism behind CE search scheme in nature. A simulation experimental evaluation is conducted with a pseudo-IEC user to evaluate our proposed ICE algorithm. The evaluation result indicates that ICE algorithm can obtain a significant better performance than or the same performance as interactive DE. Some open topics on CE, ICE, fusion of these optimization techniques, algorithmic notation, and others are presented and discussed.

[qf-zhao-105-036-01:2015] T. Murata G. Chakraborty, R. Kozma and Q. Zhao. Awareness in brain, society, and beyond: a bridge connecting raw data to perception and cognition. *IEEE System, Man, and Cybernetics Magazine*, 1(3):9–16, July 2015.

The goal of computational awareness (CA) research is to build systems that

are aware. Awareness is related to a system's ability to perceive, to feel, or to develop conscious experiences. For cybernetics the study of awareness is fundamental. In this article, first we describe awareness and perception in the brain and introduce spatio-temporal dynamic models with intermittent phase transitions. We then propose a 3-valued logic model that can be useful to interpret awareness mechanisms. Finally CA applications in human societies are used as examples to show the potential impact of CA in the age of big-data. There are still many theoretical and practical problems to solve. The paper describes in four sections the diverse views of the co-authors, which helps to expose various aspects of CA. We hope that this comprehensive review helps to promote this emerging field and that interested researchers would join CA research and also join the SMC Technical Committee on Awareness Computing, so that we can promote this emerging field together.

[qf-zhao-105-036-02:2015] Y.C. Lin R. C. Chen, S. W. Huang and Q. F. Zhao. An indoor location system based on neural network and genetic algorithm Vol. 19, No. 3/4, 2015. *International Journal of Sensor Networks*, 19(3/4):204–216, 2015.

In recent years, the position location applications have increasingly. In this paper, we will use multiple Back-Propagation neural networks with genetic algorithm (GA) for a radio frequency identification (RFID) indoor location system to provide location services named indoor location with multiple neural networks and genetic algorithms (ILMNGA). In Section 1, we collect received signal strength (RSS) information from reference points to train the neural network models. In Section 2, genetic algorithm (GA) is used to find the weight of each neural network based on the performance of each neural network. Finally, we input the RSS information of each tracking object into the model that will provide the location of tracking objects based on the RSS information. The location will be integrated using the weights produced by the GA. The experiment conducted our methodology can provide better accuracy than a single neural network.

[qf-zhao-105-036-03:2015] Q. F. Zhao and Y. Liu. Awareness computing for intelligent control. *Journal of the Society of Instrument and Control Engineers*, 54(8):594–599, August 2015.

This is an invited article. In this article, we introduce the basic concept of awareness computing and the structure of an aware system, and provide a case study for automatic car driving.

[qf-zhao-105-036-04:2015] J. Brine Q. F. Zhao and D. P. Filev. Defining cybernetics: reflections on the science of governance. *IEEE Systems, Man, and Cybernetics Magazine*, 1(2):18–26, April 2015.

Cybernetics, as defined by Plato and later by Ampere, is the science of governance. In the 1940s, Wiener used cybernetics as an umbrella term to cover control and communication in animals and machines. Later, the term has been defined in various ways by different researchers, and for this reason, cybernetics has been perceived rather generally as a nomad science. In our time, few people understand the true meaning of cybernetics. For the healthy development of cybernetics, we think it is necessary to re-consider the meaning and the scope of cybernetics so that we can have a relatively clear mission in our research. In this paper, we try to provide a sort of governance message that can be advisory, but nevertheless helpful for the cybernetics community to become cybernetic itself.

[qf-zhao-105-036-05:2015] Q. F. Zhao Y. Kaneda, Y. Pei and Y. Liu. Improving the Performance of the Decision Boundary Making Algorithm via Outlier Detection. *Journal of Information Processing*, 23(4):497 – 504, April 2015.

Outlier detection is one of the methods for improving the performance of machine learning models. Since outliers often affect the performance of the learning models negatively, it is desired to detect and remove outliers be-fore model construction. In this paper, we try to improve the performance of the decision boundary making (DBM) algorithm via outlier detection. DBM has been proposed by us for inducing compact and high performance learning models that are suitable for implementation in portable computing devices. The basic idea of DBM is to generate data that can fit the decision boundary (DB) of a high performance model, and then induce a compact model based on the generated data. In our study, support vector machine (SVM) is used as the high performance model, and a single hidden layer multilayer perceptron (MLP) is used as the compact model. Experimental results obtained so far show that DBM performs well in many cases, but still its performance is not good enough for some applications. In this paper, we use SVM not only for obtaining the DB, but also for detecting the outliers, so that better MLP can be induced using cleaner data. We use a threshold delta to control the number of outliers to remove. Experimental results show that, if we select delta properly, the DBM incorporated with outlier detection outperforms the

original DBM, and it is better than or comparable to SVM for all databases used in the experiments.

[yliu-105-036-01:2015] Y. Kaneda, Y. Pei, Q. Zhao, and Y. Liu. Improving the performance of the decision boundary making algorithm via outlier detection. *Journal of Information Processing*, 23(4):497–504, 2015.

In this paper, we use SVM not only for obtaining the decision boundary, but also for detecting outliers so that the better MLP can be induced using cleaner data.

Refereed proceedings of an academic conference

[peiyan-105-036-05:2015] Yan Pei and Hideyuki Takagi. Local Information of Fitness Landscape Obtained by Paired Comparison-Based Memetic Search for Interactive Differential Evolution. In *2015 IEEE Congress on Evolutionary Computation (IEEE CEC2015)*, pages 2215–2221, 2015.

We propose a triple comparison-based interactive differential evolution (IDE) algorithm. The comparison of target vector and trail vector supports a local fitness landscape for IDE algorithm to conduct a memetic search. Besides target vector and trail vector in canonical IDE algorithm framework, we conduct a memetic search around whichever is the vector with better fitness. We use a random number from a normal distribution generator or a uniform distribution generator to perturb the vector for generating a third vector. By comparing the target vector, the trail vector and the third vector, we implement a triple comparison mechanism in IDE algorithm. A Gaussian mixture model is applied as a pseudo IDE user in our evaluation. We compare our proposal with canonical IDE and triple comparison-based IDE implemented by opposite-based learning, and apply several statistical tests to investigate the significance of our proposed algorithm. From the evaluation results, our proposed triple comparison-based IDE algorithm shows significantly better performance optimization. We also investigate potential issues arising from our proposal, and discuss some open topics and future opportunities.

[peiyan-105-036-06:2015] Yan Pei. Strategy Equilibrium of Evolutionary Computation: towards Its Algorithmic Mechanism Design. In *2015 IEEE International Conference on Systems, Man, and Cybernetics (IEEE SMC2015)*, volume 1, pages 2101–2107, Oct. 2015.

We consider algorithmic design, enhancement, and improvement of evolutionary computation (EC) as a mechanism design problem. All individuals or several groups of individuals can be considered as self-interested agents. The individuals in EC can manipulate the parameter settings and operations of an EC algorithm by satisfying their own preferences rather than by following a fixed algorithm rule. EC algorithm designers or EC self-adaptive methods should construct appropriate rules and mechanisms for all agents (individuals) to conduct their evolution behavior correctly in order to definitely achieve the desired and pre-set objective(s) definitively. We propose a formal framework on parameter setting, strategy selection, and algorithmic design of EC by considering the strategy equilibrium implementation of a mechanism design problem in the search process. We attempt to use Nash strategy equilibrium (NE) concept in an implementation of an algorithmic mechanism design problem, but our proposed framework is not limited to Nash strategy equilibrium. The evaluation results present the efficiency of the framework. Its primary principle can be implemented in any EC algorithm that needs to consider the strategy selection issue in its optimization process. The final objective of our work is to implement EC design as an algorithmic mechanism design problem and establish EC fundamental aspects based on this perspective.

[peiyan-105-036-07:2015] Yan Pei. Linear Principal Component Discriminate Analysis. In *2015 IEEE International Conference on Systems, Man, and Cybernetics (IEEE SMC2015)*, pages 2108–2113, 2015.

We propose a series of data analysis methods for both supervised and unsupervised learning techniques. Three objectives of data relationship and characteristics are used to establish a uniform framework of our proposed methods, which are inspired by principal component analysis and linear discriminant analysis. By using the three objectives and some combinations of them, we investigate and illustrate the performance of the proposed methods. We use simulation data and classical Iris data to investigate the proposed methods. Some discoveries and issues are analysed and discussed arising from the evaluation results. The advantages of the proposed framework do not only depend on its explanation capability of data relationship, but also depend on the fusion of multiple data projection techniques. We investigate some potential research issues of the proposed methods. Some works which extend the current study with kernel method are analysed theoretically. We also present some characteristics of the proposal and discuss some open opportunities and future works.

[qf-zhao-105-036-06:2015] K. Omomo Y. Kobiyama, Q. Zhao and M. Taya. Analyzing Correlation of Resident Activities Based on Infrared Sensors. In IEEE, editor, *IEEE 7th International Conference on Awareness Science and Technology*, pages 1–6. IEEE, IEEE, September 2015.

Smart environment enriches resident's lives by assisting the residents in many situations via recognition of their activities. Some equipment such as video camera are often used for collecting the resident activity information. However, the data so collected also include extra information not necessary for assisting resident's lives. Many people feel uncomfortable with these privacy related data. To protect the privacy, it is better to use only simple sensors like infrared sensor, pressure sensor, and so on. Data related to privacy can be greatly reduced if we use these simple sensors. On the other hand, information for recognizing the resident activities is also limited. The goal of this research is to validate the potentiality of using only simple sensors to correctly analyze resident life styles and activities. For this purpose, we conducted experiments in several ordinary Japanese families. This paper reports some results we obtained in analyzing correlations between members in the same family. Results show that even if we use infrared sensor alone, it is possible to understand some normal activity patterns.

[qf-zhao-105-036-07:2015] Kazuki Omomo Masato Taya Yuta Kobiyama, Qiangfu Zhao. Analyzing resident life cycle based on short-time cross-correlation. In IEEE, editor, *TENCON 2015 - 2015 IEEE Region 10 Conference*, pages 1–6. IEEE, IEEE, November 2015.

The main purpose of smart environment (SE) is to assist human daily lives by analyzing and recognizing related information. Usually, equipments such as video cameras and voice recorders are useful to capture the information. However, the data often contain unnecessary information related to privacy. To solve this problem, it is important to construct SE by using simple sensors like motion sensor, pressure sensor, and so on. To validate the potentiality of simple sensors for analyzing and recognizing activities, in this paper, we focus on infrared sensors. We try to inspect the resident's activity regularity based on sensor data obtained in several ordinary Japanese houses. To obtain more concrete results, we introduce the concept short-time cross-correlation (STCC). Similar to short-time Fourier transform, STCC calculates the cross-correlation in a sliding window. From the results we can see when and how a resident's activity is regular or irregular. Thus, STCC can be a useful tool for

analyzing the resident life styles and for constructing privacy preserving SE in general.

[qf-zhao-105-036-08:2015] Qiangfu Zhao. 3VL-MLP: A way for realizing interpretable aware systems. In IEEE, editor, *Machine Learning and Cybernetics (ICMLC), 2015 International Conference on*, volume 1, pages 116–122. IEEE, IEEE, July 2015.

The goal of awareness computing (AC) is to establish a win-win relation between service systems and their users. If a system is aware of the user needs and the proper timing for providing proper services, the system will be popular and profitable. In many cases, it is also necessary to tell the users reasons why certain services are provided at a certain time point. The ability of providing understandable reasons can make the system more trustable, and thus more popular and profitable. We believe that designing interpretable aware systems is extremely important to achieve the goal of AC. In this paper, we first provide a formal definition of aware systems, and then consider a way to build interpretable aware systems based on 3-valued logic. As a concrete example, we use a 3-valued logic multilayer perceptron (3VL-MLP) to show a way for realizing interpretable aware systems. Results on several public databases show that the 3VL-MLPs perform relatively well, and can be useful in practice.

[qf-zhao-105-036-09:2015] Qiangfu ZHAO. Aware system, aware unit and aware logic (Best paper award). In IEEE, editor, *Cybernetics (CYBCONF), 2015 IEEE 2nd International Conference on*, pages 42–47. IEEE, IEEE, June 2015.

In recent years, various aware systems have been developed in the context of ubiquitous computing to improve the quality of services (QoS). The ultimate goal of awareness computing (AC) is to establish a win-win relation between producers and consumers. On the other hand, the main purpose of computational awareness (CA) is to understand the mechanism of awareness in human or animal brains, so that awareness, consciousness, and even intelligence can be realized step-by-step in computing machines. In this paper, we first provide a formal definition of aware systems, and then consider a way to build interpretable aware systems based on 3-valued logic. Some primary experiments show that it is possible to realize interpretable aware systems via discretizing multilayer feedforward neural network.

[qf-zhao-105-036-10:2015] Qiangfu Zhao Zhi-Yong Qiu and Michael Cohen.

Matting-based restoration and enhancement for high performance panoramic imaging. In IEEE, editor, *2015 IEEE 7th International Conference on Awareness Science and Technology*, pages 184–189. IEEE, IEEE, September 2015.

It is known that images seen by human eyes and those captured by camera lens are evidently different. In general, a human eye can see the majority of the view field. However, a lens has limited visual range due to various specifications and uses. We can obtain a panoramic image that has a wider view field using stitching techniques from input images captured by putting the lens in different view angles. However, the panorama image may not be clear enough due to various reasons. In this study, we address a challenging problem where each input image is focused to a certain view point with a different distance. Since the lens has a finite depth-of-field, part of the image must contain some out-of-focus blur. To synthesize a clear panorama image from such kind of blurred input images, it is necessary to de-blur the input images first. In this paper, we assume that the spatially variant out-of-focus blur in an input image is approximately uniform, and study a matting-based method for restoring the image via de-convolving the input image.

[yliu-105-036-02:2015] Y. Liu, Q. Zhao, and Y. Pei. Bounded learning for neural network ensembles. In *Proceedings of IEEE International Conference on Information and Automation*, pages 1216–1221. IEEE, August 2015.

Two error bounds were introduced in the learning process of balanced ensemble learning. These two error bounds would decide whether a training data point should be further learned or not after balanced ensemble learning has reached certain stage.

[yliu-105-036-03:2015] Y. Liu, Q. Zhao, and Y. Pei. Error awareness by lower and upper bounds in ensemble learning. In *Proceedings of 2015 11th International Conference on Natural Computation*, pages 14–18. IEEE, August 2015.

Two constraints are introduced into negative correlation learning for preventing overfitting. One is the lower bound of error rate. The other is the upper bound of error output.

[yliu-105-036-04:2015] Y. Liu, Q. Zhao, and Y. Pei. Balanced ensemble learning with adaptive bounds. In *Proceedings of the 2015 IEEE International Conference on Signal Processing, Communications and Computing*, pages 699–704. IEEE, September 2015.

This paper examines the differences among the individual models in the ensemble by negative correlation learning with two bounds to determine how the two bounds should be adapted in negative correlation learning.

[yliu-105-036-05:2015] Y. Liu. Negative correlation learning with difference learning. In *CCIS 575: Communications in Computer and Information Science*, pages 264–274. Springer, February 2016.

In order to control the complexity of neural network ensembles, difference learning is introduced into negative correlation learning. The idea of difference learning is to let each individual in an ensemble learn to be different to the ensemble on some selected data points when the outputs of the ensemble are too close to the target values of these data points.

Writing a textbook or technical book

[yliu-105-036-06:2015] K. Li, J. Li, Y. Liu, and A. Castiglione (Eds.). *Computational Intelligence and Intelligent Systems*. Number 575 in Communications in Computer and Information Science. Springer, 2016.

Writing a part of textbook or technical book

[qf-zhao-105-036-11:2015] Qiangfu Zhao and Yong Liu. *Memetic Algorithms*, volume 2, handbook on computational intelligence 17, pages 607–632. World Scientific, 2016.

Roughly speaking, genes carry information for constructing a body, in which they usually work in groups to construct a meaningful body. Similarly, memes carry information for constructing a culture, in which many memes usually work together to construct a meaningful culture. Although in real world genes and memes are realized in different forms (e.g., DNA for genes and language for memes), in evolutionary computation (EC), both of them can be represented using strings defined on some alphabetic set. Thus, in EC we can study genetic evolution and memetic evolution in the same way. We can also combine them together to improve the efficiency and efficacy of the evolutionary search process. Memetic algorithms (MAs) are search algorithms obtained by combining genetic evolution andmemetic evolution. InMAs, genetic evolution is often used for global search andmemetic evolution is used to find the best local search strategy. So far, a great number of MAs have

been proposed in the literature. In this chapter, we first define some fundamental concepts related to memetic evolution, and then introduce several templates that may cover most existing MAs. For each template, we provide a pseudo code, so that readers can understand the algorithms easily, and can develop programs to solve their own problems

Research grants from scientific research funds and public organizations

[yliu-105-036-07:2015] Y. Liu. The Grant-In-Aid for Scientific Research Fund (Kakenhi), 2015-2017.

Academic society activities

[yliu-105-036-08:2015] Y. Liu, November 2015.

Program Chair, ISICA 2015.

Advisor for undergraduate research and graduate research

[qf-zhao-105-036-12:2015] Masato Hashimoto. Graduation thesis, The University of Aizu, March 2015.

We propose a cloud system using an extreme learning machine (ELM) to reduce the classification cost and to improve the security of mobile computing devices. In our system, ELM is divided into two parts: 1) weights between input and hidden layers, and 2) weights between hidden and output layers. The former is saved into a server, and the latter is saved into a client. Hidden neurons are calculated on the server, and output neurons are calculated on the client when the system classifies data. We also attempt to improve the accuracy of ELM by generating weights between input layer and hidden layer at random near the centroids, which are created by k-means clustering. Finally, we compare the performance test result of two generally used methods in implementing ELM for mobile devices to the method we use in our study.

[qf-zhao-105-036-13:2015] Satoshi Watanabe. Graduation thesis, The University of Aizu, March 2015.

Recently, concern for information security is increasing. Image-based steganography is an information hiding technique for increasing information security. Its purpose is to prevent others being aware of the existence of secret data. Recently, a stego-image detection scheme was proposed in the literature, which uses the so called extreme learning machine and features generated by markov chain. Verification results show that some steganography techniques are in fact not very secure. In this study, we investigate detection rates under different conditions and analyze the efficacy of the features using support vector machines. Results show that although the accuracy is not as high as the one given in the literature, the possibility of detecting the stego-images is very high.

[qf-zhao-105-036-14:2015] Tomoya Furukawa. Graduation thesis, The University of Aizu, March 2015.

Recently, a security of digital information has been important. Steganography is studied as a method for to conceal information in images. In contrast, steganalysis analyses an image for to distinguish image embedded information from a normal image. At the present, it is not discussed enough that how to safely use steganography. In this paper, we will show that the boundary to safely use steganography, which is a embedding rate of major steganographic methods. We compare classification accuracy of each embedding rate using Extreme Learning Machine, and then, we study the boundary.

[qf-zhao-105-036-15:2015] Kentaro Sekine. Master thesis, Graduate School, The University of Aizu, March 2015.

Nowadays, information security becomes more necessary as development of information technology. Steganography is one of the effective ways to protect secrets and privacy. In steganography, secrets are usually hidden in the cover image with some stego keys. The security of steganography can be improved if we use cover images generated by morphing. This method was proposed in our group earlier. The key point to use this method is that the morphed images must be natural. To generate a natural image by morphing, it is necessary to define the feature points properly. However, this is very tedious work in practice. The goal of this study is to propose a neural network-based method for detecting the feature points automatically. In this thesis, we will first introduce the basic steps for the designing the neural network feature point detectors. Then, we will show some experimental results obtained with virtual images. The virtual images are generated via morphing, and they are usually easier for feature point detection. Next, we will show some results obtained with natural images. From these results, we will see that although the neural network detectors can detect

the positions of the feature points roughly, the detected points usually cannot be used for morphing. To improve the performance, we propose to use scale invariant feature transform (SIFT) and provide result to verify the effectiveness of the method.

[qf-zhao-105-036-16:2015] Kazuki Murakami. Master thesis, Graduate School, The University of Aizu, March 2015.

In recent years, digital information security is becoming an important topic in our daily lives. Many data protection technologies / methods have been proposed, and embedded in many working services. Data hiding technology is known as one of the data protection technologies. Digital image steganography is one part of data hiding technology, and this technology uses digital image for data hiding. To validate the efficacy of this technology and related algorithms, digital image steganalysis (stego-analysis) is one important tool. Steganography and steganalysis are two opposite operations. The former is to hide information into some cover data, and the latter is to detect information from a given data. This paper focuses on digital image steganography technology, and evaluates the efficacy of some well-known digital image steganography technologies for data hiding based on steganalysis. Machine learning models such as support vector machine and extreme learning machine are used to implement steganalysis, and statistical features extracted based on Markov random process will be used for information detection.

[qf-zhao-105-036-17:2015] Kazuki Omomo. Master thesis, Graduate School, The University of Aizu, March 2015.

Our purpose is to propose new services based on electricity data obtained by smart meters located in residential houses. In this thesis, we investigate how actions and features of families affects electricity data. Then we do the prediction by using electricity data and confirm the accuracy. In the result, we confirmed that it is hard to predict actions and features of families from electricity data. As a next step, we try to predict the future amount of electricity consumption based on electricity data. If the future amount of electricity consumption is known, electricity companies can generate a proper amount of electricity, and the cost of the generation can be reduced. In the result, we confirmed that the accuracy of the prediction depends on family structure. Experimental results show that for single-person families, it is almost impossible to predict the electricity, even if we use non-linear models like SVR. For multi-person families, on the other hands, we can predict the electricity relatively well even if we use linear model like ARIMA.

[qf-zhao-105-036-18:2015] Hideho Nakajima. Master thesis, Graduate School, The University of Aizu, March 2015.

There is a plan called JAMP (Japan Astrobiology Mars Project) in MELOS. In the project, there is a mission to perform the fluorescent microscope photography of the microbe at the Mars surface. It is necessary to sort the image on Rover. This depends on limitation necessary for an unmanned space experiment. There is no self-evident characteristics to shown that there is life on the Mars. Therefore, it is necessary to investigate if it is possible to detect Mars life using existing techniques. In this research, we examine some techniques that may detect life automatically from the photographed images. As detection technique, we use machine learning. In the experiments, we used images acquired from the soil of Mount Fuji in LDM. These images were provided by Prof. Yamagishi and Prof. Miyakawa in Tokyo University of Pharmacy and Life Sciences. We used SVM and fisher face for identification. The features are histogram and Fourier coefficients. Results show that higher recognition rate can be obtained if we use SVM and the histogram.

[qf-zhao-105-036-19:2015] Zhi-Yong Qiu. Master thesis, Graduate School, The University of Aizu, August 2015.

Images as seen by human vision and as captured by camera lens are evidently different. In general, a human eye can see the majority of the view field. However, a lens has limited visual range due to various specifications and uses. We can obtain a panoramic image that has a wider view field using stitching techniques from input images captured by aiming the lens in different view angles. However, the panorama image may not be clear enough due to various reasons, such as motion blur, out-of-focus blur, and atmospheric turbulence blur. In this study, we address a challenging problem where each input image is focused to a certain view point with a different distance. Since the lens has a finite depth-of-field, part of the image must contain some out-of-focus blur. To synthesize a clear panorama image from such kind of blurred input images, it is necessary to de-blur input images first. In this thesis, we assume that spatially variant out-of-focus blur in an input image can be locally approximated by a uniform blur, and study a matting-based method for restoring the image via de-convolving the input image.

[qf-zhao-105-036-20:2015] Yu-Wen Lo. Master thesis, Graduate School, The University of Aizu, August 2015.

Research results on medicine and health show that people nowadays tend to have

some common diseases because of abnormal eating habits, irregular lifestyles, fast-food culture, etc. Diabetes and high blood pressure are just two examples. This study is based on an ontology-based dietary management system established by our group earlier. The main contribution of this thesis is to propose a method for synthesizing new recipes based on existing ones, and recommending proper recipes based on machine learning. The new recipes are combinations of several existing ones. They are recommended to the user only if necessary nutrition is properly contained in the recipe. Outlier analysis is used to judge if a recipe is good or not. Some primary experiments are conducted to show the usefulness of the proposed method.

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