

Study on Swarm Intelligence on Medical Field

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ABSTRACT

Swarm intelligence is one of the important concepts in artificial intelligence and computer science with evolving properties. The vital design of swarm intelligence algorithms is to make use of many simple agents applying almost no rule which in turn leads to an evolving global behavior. This paper provides a study on Swarm Intelligence on Medical fields with various techniques and methods.

Keywords : Swarm Intelligence, Diabetes Care, MES, KADIS, CDSS, HIS, GMM, PID, ICU-DWH

I. INTRODUCTION

The collective behavior emerged from social insects working under very few rules is the Swarm intelligence. Self-organization is the central idea with limited boundaries from interactions among agents. Birds flock, fish school and bugs swarm are the prominent examples of swarm intelligence. The social communications among individual manager help them to adapt to the environment more powerfully while more information are gathered from the entire swarm. This paper introduces some well-known and interesting algorithms applicable in medical field to solve various problems.

II. SWARM INTELLIGENCE

It is the regulation that deals with natural and artificial systems composed of many individuals that deals with decentralized control and self-organization. In particular, the regulation focuses on the collective behaviors that result from the local communications of the individuals with each other and with their environment.

General Principles

To model the broad behaviors arisen from a swarm, several general principles for swarm intelligence are:

A. Proximity principle:

The fundamental units of a swarm should be capable of simple computation correlated to its surrounding environment. Therefore, the computation is regarded as a direct behavioral response to environmental variance, such as those triggered by communications among agents. Depending on the complexity of agents involved, responses may vary significantly. However, some primary behaviors are shared, such as living-resource searching and nest building.

B. Quality Principle

Apart from primary computation capacity, a swarm should be able to response to quality factors, such as food and safety. Principle of diverse response Resources should not be determined in narrow region. The allotment should be designed so that each agent will be maximally protected facing environmental fluctuations.

C. Principle of Stability and Adaptability

Since mode changing costs energy, Swarms are expected to adapt environmental fluctuations without swiftly changing modes.

III. LITERATURE SURVEY

1. Model-based Decision support in Diabetes Care

To provide facts based advice for physicians in their daily efforts, the model based Karlsburg Diabetes Management System (KADIS) has been developed as a patient focused decision support tool. This tool is used to optimize metabolic control in diabetes care of their patients on an individualized center. For this purpose, KADIS was reputable in terms of a adapted, interactive *in silico* simulation system, implemented into a problem connected diabetes health care network and evaluated under different circumstances by conducting open-label mono- and polycentric trials, and a case-control study, and in usual diabetes outpatient care. The tryout clearly confirms that the recommendations provided to the physicians by KADIS lead to considerable development of metabolic control. This also provides an excellent tool to effectively guide physicians in modified decision-making to attain best possible metabolic control for their patients.

2. An HL7-CDA wrapper for facilitating semantic interoperability to rule-based Clinical Decision Support Systems

The success of Clinical Decision Support Systems (CDSS) depends on its facility of being included in Health Information Systems (HIS). A number of proposals have been available to authorize CDSS gathering patient data from HIS. Some stand the CDSS data input on the HL7 reference model. However, they are adapted to specific CDSS, or do not focus on standardizing the CDSS resultant awareness. In this paper, a solution for facilitating semantic interoperability to rule-based CDSS focusing on standardized input and output documents conforming an HL7-CDA wrapper was proposed. Patient data and rule inference results are mapped respectively to and from the CDSS by means of a binding method based on an XML binding file. The results of a CDSS can present clinical and legal validity as an independent clinical document. The final solution is being applied in a CDSS for providing patient-specific recommendations for the care management of outpatients with diabetes mellitus.

3. The internet-based knowledge acquisition and management method to construct large-scale distributed medical expert systems

The Internet offers an extraordinary prospect to construct powerful large-scale medical expert systems (MES). In these systems, a management scheme and cost-effective medical knowledge acquisition (KA) are highly desirable. They are used to handle large quantities of, often differing, medical information collected from medical experts in different geographical regions and from different medical fields. The three tier architecture for managing the medical system called medical KA was proposed. The knowledge in the system is managed/stored in three knowledge bases. The knowledge flow through these knowledge bases is controlled by the maturity of the medical. An 8-digit numeric coding scheme with a weight value system is proposed to facilitate the knowledge representation and application in these knowledge bases with information retrieval across the Internet. During testing the final result contains a method for the viable solution to build, adapt, and enlarge a distributed MES through the Internet.

4. Automatic segmentation of corpus collasum using Gaussian mixture modeling and Fuzzy C means Methods

A relative revise of the achievement and feat of the Gaussian mixture modeling and Fuzzy C means methods to decide the volume and cross sectionals areas of the corpus collasum (CC) using simulated and real MR brain images are presented. To identify image classes, the GMM uses weighted sum of Gaussian distributions in the means of applying statistical decision measures. The image classes are represented using Fuzzy C means (FCM). From simulated and real brain images an automatic segmentation for midsagittal section of the CC was achieved. Sagittal sections areas are used to obtain the volume of CC. Segmentation accuracy, Jaccard similarity and time consuming for segmentation were calculated to compare the success of the methods. GMM is more accurate. But the FCM method resulted in faster segmentation than GMM. For the doctors, in the planning of treatment and the diagnosis of diseases disturbing the size of the CC was developed based on an accurate and automatic segmentation system that allows opportunity for quantitative comparison. This study can be modified to perform segmentation on other regions of the brain. Thus, it can be operated as practical use in the clinic.

5. Development of a clinical data warehouse from an intensive care clinical information system

The development of a clinical data warehouse is a challenge because of data types and definitions, and the alleged incompleteness of clinical information systems. For intensive care unit (ICU-DWH), the in-house development of an integral part of the data warehouse was reported. It uses Atos Origin Metadata Frame method to deal with data. The use of data warehouses in intensive care is discussed briefly.

6. A new hybrid intelligent system for accurate detection of Parkinson's disease

Aged people are commonly affected by Parkinson's disease (PD). It is one of the most common neurodegenerative disorders owe to the loss of dopamine-producing brain cells. People with PD's (PWP) might have complexity in walking, talking or completing other simple tasks. To treat PD there are numerous medications. To differentiate PD patients from the healthy persons voice signals are used. PD is detected using several dysphonia features, feature reduction/selection techniques and classification algorithms. The hybrid intelligent system is projected which includes feature pre-processing using Model-based clustering (Gaussian mixture model), feature reduction/selection using principal component analysis (PCA), linear discriminate analysis (LDA), sequential forward selection (SFS) and sequential backward selection (SBS), and classification using three supervised classifiers such as least-square support vector machine (LS-SVM), probabilistic neural network (PNN) and general regression neural network (GRNN). The accuracy of 100% for the Parkinson's dataset is achieved through the combination of feature pre-processing, feature reduction/selection methods and classification gives a maximum classification.

7. Optimal bone density distributions: Numerical analysis of the osteocyte spatial influence in bone remodeling

A control and optimization procedure for bone remodeling simulations was adopted to learn the effect of the osteocyte influence range on the predicted density distribution. To achieve the above goal, the osteocyte network regulating bone remodeling process in a 2-D bone sample was numerically simulated. The connection to the error signal between the strain energy

density and a selected target was made by the assumed proportional-integral-derivative (PID) bone remodeling rule. Moreover the control parameters and the target were optimally determined minimizing a appropriate cost index: the objective was to minimize the final mass and the energy thus maximizing the hardness. The continuum model results confirm that the developed and modified trabecular structure was reliable with the applied loads and only depended on the external forces, the value of the cost index, the maximum attainable elastic modulus value (hence, the maximum density value) and the value of the energy target. The remodeling phenomenon dogged the number and thickness of the trabeculae which are produced from a uniform distribution of mass density in the considered domain; this number and these thicknesses are restricted by the values assigned to the parameters of the model. The trabecular pattern formations are affected by the osteocyte decay distance (D) of the influence range. So, this results in viewing a vital effect in the adaptive capacity of the optimization numerical model.

8. Linear and nonlinear analysis of normal and CAD-affected heart rate signals

One of the dangerous cardiac disease, often may lead to sudden cardiac death is a Coronary artery disease (CAD). It seems very tricky to identify CAD using electrocardiogram (ECG) signals. To automate this detection task, the heart rates (HR) from the ECG signals are extracted and used them as base signal for further analysis. The HR signals of both normal and CAD subjects are analysed. A unique recurrence, Poincare and HOS plots for normal and CAD subjects are presented. The significant variations in the range of these features with respect to normal and CAD classes are observed. For CAD subjects the RQA parameters were high. ApEn and SampEn signifies lower entropy for CAD. More or less all HOS parameters showed higher values for the CAD group, signifying the presence of higher frequency content in the CAD signals. Thus, this provides a deep insight into how such nonlinear features could be oppressed to successfully and constantly detect the presence of CAD.

9. Genetic algorithms as a useful tool for trabecular and cortical bone segmentation

The main objective of this paper was to find a semi-automatic method of bone segmentation on the basis of

computed tomography (CT) scan series in order to recreate corresponding 3D objects. So, it was vital for the segmentation to be smooth between adjacent scans. The idea of graphics pipeline computing was used. The input of the entire stream was the CT scan and the output corresponded to the binary mask showing where a given tissue is located in the input image. In this loop the main job consists in finding the suitable sequence, types and parameters of graphics filters constructing the pipeline. Because of the high number of desired parameters, a little modified genetic algorithm was used. To find out the fitness value, comparison between the mask obtained from the parameters found through genetic algorithms (GA) and the manually prepared were made. Dice's coefficient was defined with the numerical value corresponding to such a comparison. The only action done manually by a human expert was the Preparation of reference masks for a few scans among the several hundreds of them. Excellent results both for trabecular and cortical bones were obtained using this method. When no real border exists between trabecular and cortical bone types, the manually prepared reference masks were quite predictable and therefore charged with errors. At the same time as GA is a non-deterministic method, the present work also contains a statistical analysis of the relations presenting between various GA parameters and fitness function. At last, the best sets of the GA parameters are anticipated.

10. Supervised hybrid feature selection based on PSO and rough sets for medical diagnosis

Feature Selection (FS), finds a subset of well-known features to improve prognostic accuracy and to remove the unnecessary features in the medical datasets. Thus, the learning model receives a crisp structure without forfeiting the prognostic accuracy built by using only the selected well-known features. Therefore, FS is a crucial part of knowledge discovery. A new supervised feature selection method is used for diagnosing diseases.

11. Reverse Engineering of Gene Regulatory Networks Using Dissipative Particle Swarm Optimization

The gene regulatory networks (GRNs), is a model used by different genes of different organisms to interact different proteins. There are different models that crack to model GRNs. In this paper, the S-System is used to

model small networks. This model yields good results in solving different evolutionary computation techniques. Yet, there are no models that attain a perfect reconstruction of the network. For optimizing this model, variation of particle swarm optimization (PSO), called dissipative PSO (DPSO), is used. Comparison between the use of an L1 regularizer and other evolutionary computing approaches were also made. To the best of this paper's knowledge, neither the DPSO nor L1 optimizer has been jointly used to solve the S-System. The grouping of S-System and DPSO offers more advantages than preceding methods, and presents best results for inferring larger and more complex networks.

12. A Distance-Based Locally Informed Particle Swarm Model for Multimodal Optimization

Real-parameter multimodal optimization problems can be solved using Niching particle swarm optimizers (PSOs) in evolutionary computation community. Because of their poor local search ability and requirement of prior knowledge to specify certain niching parameters, the majority of the PSO-based niching algorithms are difficult to follow. This paper proposes a distance-based locally informed particle swarm (LIPS) optimizer, to solve this problem by eliminating the need to specify any niching parameter and enhance the fine search ability of PSO. Each particles are guided with several *local bests*, instead of using the global best particle. By means of using the information provided by its neighborhoods LIPS can operate as a constant niching algorithm. The neighborhoods are predictable in terms of Euclidean distance. The algorithm is compared with a number of state-of-the-art evolutionary multimodal optimizers. Statistically superior and more consistent performance over the existing niching algorithms on the test functions, without incurring any severe computational burdens are proposed.

13. Particle Swarm Optimization with an Aging Leader and Challengers

This proposes a PSO with an aging leader and challengers (ALC-PSO) by transplanting the aging mechanism to particle swarm optimization (PSO). Early convergence without extensively impairing the fast-converging feature of PSO can be overcome using ALC-PSO. It is characterized by handing over the head of the swarm with a growing age and a lifespan, and

allowing the other individuals to dispute the headship when the head becomes aged. The lifespan of the head is adaptively tuned according to the head's ruling power. If a head shows strong ruling power, it has long lifespan to magnetize the swarm toward better positions. Or else, if a head fails to recover the swarm and gets aged, new particles come forward to dispute and argue the headship, which brings in assortment. Like this, the idea "aging" in ALC-PSO essentially serves as a demanding mechanism for promoting a suitable head to lead the swarm. By comparing with eight popular PSO variants its high performance is established.

14. Association rule mining using binary particle swarm optimization

A binary particle swarm optimization (BPSO) based association rule miner was developed. The association rules from the transactional database were generated by BPSO based association rule miner by formulating a combinatorial global optimization problem, without specifying the minimum support and minimum confidence distinct from the a priori algorithm. The proposed algorithm generates the best M rules from the given database, where M is a given number. The feature of the rule is calculated by a fitness function defined as the product of support and confidence. The efficiency of the algorithm is tested on a real life bank dataset from commercial bank in India and three transactional datasets. On the basis of results, the proposed approach can be used in alteration of a priori algorithm and the FP-growth algorithm.

15. An Adaptive Differential Evolution Algorithm for Global Optimization in Dynamic Environments

To solve dynamic optimization problems (DOPs) a multipopulation-based adaptive differential evolution (DE) algorithm has been proposed. To maintain the diversity and exploration ability of the population DE individuals are used along with Brownian and adaptive quantum individuals known as Dynamic DE with Brownian and quantum individuals (DDEBQ). For controlling the perturbation and avoid convergence quickly, a neighborhood-driven double mutation strategy. To enhance the optima tracking ability of the algorithm, an exclusion rule is used. To prevent algorithm from stagnating at any local optimum an aging mechanism is used. Then DDEBQ is compared

with various evolutionary algorithms and found that DDEBQ performs better in DOP instances.

16. Rule-Based Cooperative Continuous Ant Colony Optimization to Improve the Accuracy of Fuzzy System Design

To address the accuracy-oriented fuzzy systems (FSs) design problems a cooperative continuous ant colony optimization (CCACO) algorithm was proposed. All free parameters are optimized using CCACO in the zero-order Takagi-Sugeno-Kang (TSK)FS. Multiple ant colonies are used to perform optimization in CCACO using fuzzy rule. From each colony, a complete FS has been constructed using a complete parameter solution vector (formed by selecting a subsolution component). A new continuous ant colony optimization algorithm yields subsolutions which are independent to each other. In the CCACO, Solutions are updated as same as simple ACO using Pheromone trails. Then, the proposed CCACO was compared with other population-based optimization algorithms and stated that CCACO is superior.

17. Ant Colony Optimization for Mixed-Variable Optimization Problems

To tackle mixed-variable optimization problems an extended ACOR (Ant Colony Optimization) algorithm was proposed and named as ACOMV. The decision variables of this algorithm can be declared as continuous, ordinal, or categorical to delight them effectively. There are three solution mechanisms used by ACOMV to tackle the above problem. They are continuous optimization mechanism (ACOR), for ordinal variables – continuous relaxation mechanism (ACOMV-o) and for categorical variables – categorical optimization mechanism (ACOMV-c). A novel procedure is used to tune ACOMV's parameters automatically and to generate artificial, mixed-variable benchmark functions. When the algorithm was compared with real world and mixed-variable continuous optimization problems, it provides efficiency and robustness.

18. An Improved Parent-Centric Mutation with Normalized Neighborhoods for Inducing Niching Behavior in Differential Evolution

Evolutionary multimodel optimization algorithms are used to find multiple optimal solutions for optimization problems. They use niching operations to detect and maintain optimal solutions in their framework. Differential Evolution (DE) is one the Evolutionary Algorithm combined with niching scheme to propose synchronous crowding replacement rule with parent-centric mutation operator. With the use of local neighborhoods, the population diversity at an optimum level is maintained by the mutation operator. While comparing the proposed approach, the results provides superiority of the proposed niching algorithm.

19. History-Based Topological Speciation for Multimodal Optimization

To find multiple optima of optimization problem Evolutionary algorithm integrated with niching technique is used. Speciation-based niching techniques are used to partition a population into subpopulations, where each occupies different region on the fitness landscape. The speciation methods may be either distance-based or topology-based. The proposed speciation method was History-based topology speciation (HTS). To capture the landscape topology it depends on the search history. It is the parameter-free speciation moment. Based on the comparison made, it is found that HTS was outperformed.

20. MOMMOP: Multiobjective Optimization for Locating Multiple Optimal Solutions of Multimodal Optimization Problems

For locating optimal solutions in a single run, niching methods are combined with evolutionary algorithms while MMOP (Multimodel optimization problems) involves multiple optimal solutions. MOMMOP (Multiobjective optimization for MMOP) was proposed. First, it transforms MMOP into a multiobjective optimization problem with two conflicting objectives. Then, all the optimal solutions of an MMOP become the Pareto optimal solutions. Finally, the proposed approach is used to find a set of representative Pareto optimal solutions of the transformed problem. Thus, in a single run multiple optimal solutions of the original MMOP could be simultaneously located. But MOMMOP is the hidden method. When it combines with nondominated sorting and differential evolution it

will be used to solve multimodel benchmark test functions.

21. An Evolutionary Algorithm with Double-Level Archives for Multiobjective Optimization

A Multiobjective Evolutionary algorithm (MOEA) with double-level archives was developed with advantages of multiobjective-problem level and sub-problem level approaches with two archives as global and sub-archive. New individuals are produced by self-reproduction with global archive and cross-reproduction among global archive and sub-archive. The framework produced during cross-reproduction retains fast convergence and handles solution distribution along Pareto front (PF). The proposed algorithm offers advantages in distance to the PF, Solution convergence and search speed.

22. A Hybrid Swarm-Based Approach to University Timetabling

An automated hybrid approach is used for fixing the university timetabling problem based on ABC (Artificial Bee Colony) algorithm. The above algorithm is able to solve wide range of optimization problems. A global best model inspired from particle swarm optimization is used during hybridizing with the great deluge (GD) to enhance the global exploration by the ABC algorithm to overcome the disadvantages like inefficient exploration and exploitation which leads to slow convergence speed within the search process. Also a traditional local search approach is integrated within the GD algorithm by improving the performance of hybrid method. The proposed method produces best results on comparison with other approaches.

23. Simple Probabilistic Population-Based Optimization

For solving combinatorial optimization problems, the principles from population-based ant colony optimization (PACO) and simplified swarm optimization (SSO) were used for designing and classifying simple probabilistic population-based optimization (SPPBO) algorithm by a generic scheme is proposed in this work. The scheme which identifies different types of archives and their influence on the construction of new solutions are called SPPBO. This scheme (SPPBO) is used to describe adaptation of SSO

for solving combinatorial optimization problems and relationship with PACO. Many new variants and combinations of SSO and PACO are also proposed in this study.

24. Constraint Consensus Mutation-Based Differential Evolution for Constrained Optimization

Differential Evolution (DE) uses various mutation strategies as search operators to improve fitness value and maintaining diversity. But, they are not capable to reduce the constraint violations of constrained problems. To overcome this problem a constraint handling techniques is used by most evolutionary algorithms which is not a part of search process. A new DE mutation operator used to reduce constraint violations during search process with the help of mechanism based on constraint consensus was proposed.

Based on the comparison made it provides better solutions on comparing with the standard DE algorithm.

25. Multimodal Estimation of Distribution Algorithms

A multimodel EDA (Estimation of distribution algorithm) was proposed for preserving high diversity. It operates at niche level and produces two algorithms by integrating with clustering strategies for crowding and speciation. Those algorithms use three distinctive techniques as a dynamic cluster sizing strategy, an alternative utilization of Gaussian and Cauchy distributions to generate offspring and an adaptive local search. The potential balance between exploration and exploitation is achieved along with decrease in sensitivity of cluster size in the niching methods. By alternatively using Gaussian and Cauchy distributions, the offsprings are produced at the niche level. According to fitness values of the seeds, the probabilities are self-adaptively determined when a new local search scheme probabilistically conducted around seeds of niches to increase solution accuracy. With many local optima, the proposed algorithm is used to solve complex problems.

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