Guest Editorial

Special Issue: Knowledge-based intelligent systems and their applications

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Intelligent techniques derived from knowledge-based engineering and related computing paradigms have provided useful concepts and tools to undertake a variety of real-world problems. These systems mimic the analytical and learning capabilities of the human brain. They harness the benefits of knowledge and intelligence to form an integrated framework for problem solving. In this special issue, a total of thirteen articles comprising extended papers from the 12th International Conference on Knowledge-Based and Intelligent Information & Engineering Systems (KES2008) as well as from other submissions that highlight a small number of innovative knowledge-based intelligent systems and their applications to solving problems in different domains are presented. A summary of each article is as follows.

With the development of advanced travelers information systems, it is important to have a prompt and accurate travel time prediction system for road networks. In the first article, two travel time prediction algorithms using naïve Bayesian classification and rule-based classification are proposed. Based on a historical traffic database, the algorithms are able to yield high accuracy in travel time prediction. The algorithms are also useful for road networks with arbitrary travel routes. The results also reveal that naïve Bayesian classification produces better mean absolute relative error than that of rule-based classification.

For large-scale complex process plants that involve safety critical systems, real-time diagnosis is an important aspect. In the second article, an ontology for representing operating, safety and control procedures is proposed. The procedure ontology is defined within interconnected components of the process plant and the diagnostic analysis based on risk assessment information. A novel diagnostic method using the suggested procedures and combining observed malfunctions with failure mode and effects analysis information is also proposed. An example is used to illustrate the proposed procedure ontology, with the diagnostic principle and the diagnostic algorithm described.

Ambient intelligence envisages the concept of smart environments which are able to provide users with timely and effective services and information, without users themselves being aware of the underlying intelligent infrastructure. In the third article, a Situation Description Language (SDL) is introduced. SDL allows activity recognition templates to be specified as simple programs. It also provides suitable tools to translate programs into symbolic structures maintained within an ontology. Formal specification of formulas and corresponding translation within the ontology are described. Examples to demonstrate the benefits on context modeling introduced by the adoption of SDL are presented.

A machine cannot understand the true meaning of a conversation like a human. To circumvent this, a response production method on chatting systems is proposed in the fourth paper. The system attempts to gather information from the speaker by performing conversation with the system. Based on the information gathered, flexible replies from the speaker become possible. The approach uses association of input sentences, which requires general knowledge about the relations between words as well as commonsense of the words. A case study to evaluate the effectiveness of the proposed approach is presented.

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The asymmetric travelling salesman problem is a well-known benchmark task in discrete or combinatorial optimization. In the fifth paper, a new metric, based on the concept from descriptive statistics of relative frequency, is proposed to discriminate the effectiveness of algorithms in undertaking the general asymmetric travelling salesman problem. The use of classification as a means for predictive learning (a data-mining technique) in meta-heuristic algorithm selection is also proposed. Experiments are conducted to evaluate a number of meta-heuristic algorithms, which include, the genetic algorithm, tabu search, random search, and scatter search, for solving the asymmetric travelling salesman problem. It is concluded that it is possible to improve discrimination by adding another metric to the asymmetric travelling salesman problem.

Artificial neural networks have been used as a useful prognostic and diagnostic decision support tool in the medical domain. In the sixth article, a hybrid model based on the Gaussian ARTMAP network and the Generalized Regression Neural Network is described. A number of enhancements to the hybrid network are proposed. The applicability of enhanced hybrid network to pattern classification and fuzzy rule extraction problems is evaluated using medical data sets. The results demonstrate that the proposed model is able to yield high accuracy rates and, at the same time, produce useful fuzzy rules for undertaking medical pattern classification tasks.

Extracting useful knowledge from raw sensor data is not a trivial task, owing to uncertainties in measurement as well as other issues. In the seventh article, a conceptual connection between the sensors/estimators domain and the world knowledge concerning the measured plant and the fundamental measure theory is presented. The key is to introduce world knowledge into sensors and estimators through the use of internal models. A specific architecture of sensors that relies on modeling techniques and some internal model estimators for velocity and for weariness of railway cars is used to illustrate the role of the models in sensors and estimators.

Landmines constitute a significant threat in many countries around the world. In the eighth article, the wavelet transform technique and neural networks are used to perform feature extraction and classification of metal detectors signals collected from buried landmines. The Daubechies wavelet transform technique is used to extract representative signal features. Two types of classifiers are implemented, i.e., ratio comparison with voting and weighted average, and individual and ensemble Fuzzy ARTMAP (FAM) neural networks. The experimental results reveal the usefulness of an ensemble of voting FAM classifiers in yielding good classification accuracy for landmine detection, and the potential of using the wavelet transform and FAM method to devise as a decision support system for automated target discrimination.

Scene understanding is important for mobile robots to explore an unknown territory. In the ninth article, a study on an autonomous multi-vehicle robot cooperative for scene understanding is presented. The cooperative of robots has the ability to track moving objects with very limited sensing capability. The simultaneous localization and mapping method is adopted. The strategy is to localize the static elements of the scene and then estimate the velocity and trajectory of moving objects. Co-ordination and steering strategies for reducing the errors associated with the estimated parameters are also used. Experimental results demonstrate that the proposed approach is useful for mobile robot in scene understanding.

Path planning is an important topic in robots for their applications in the real world. In the tenth paper, a new fuzzy logic-based navigation method for a mobile robot moving in an unknown environment is proposed. A fuzzy rule base that comprises rules from human reasoning in obstacle avoidance and goal seeking behaviours is constructed. The reinforcement fuzzy Q-learning algorithm is applied to finetune the parameters of the navigator. A simulated problem that evaluates the capability of a mobile robot in obstacles avoidance and goal seeking without being trapped in local minima and without collusion with obstacles is presented. The simulation results indicate the effectiveness of the proposed approach in tackling robot path planning problems.

A fuzzy logic-based controller can be viewed as a means of emulating a skilled human operator, and is useful for modelling the human decision-making process. In the eleventh paper, a fuzzy controller for solving the cart-pole inverted pendulum problem in real-time is described. The fuzzy controller implements swing-up and stabilization of the inverted pendulum directly in its structure. The fuzzy controller is designed using Matlab-Simulink and realised in a DSP board. The effectiveness of the fuzzy controller is evaluated subject to internal and external disturbances applied to the inverted pendulum. The results demonstrate the robustness of the proposed fuzzy controller in controlling the inverted pendulum under disturbances.

Failure mode and effect analysis is an effective problem prevention methodology that can be used with many engineering and reliability methods. In the twelfth article, fuzzy inference techniques are proposed to enhance the existing failure mode and effect analysis method. In particular, fuzzy rule interpolation and reduction techniques are adopted to design new fuzzy models for failure mode and effect analysis. A real-world case study pertaining to the test handler process in a semiconductor manufacturing plant is conducted. The results demonstrate that the proposed fuzzy models are able to produce predictions that are in agreement with domain experts in failure risk evaluation, ranking, and prioritization.

Strategic outsourcing decisions require more than just intuition and past experiences. In the thirteenth paper, two hybrid decision making models, i.e., AHP-Fuzzy PROMETHEE and AHP-Fuzzy TOPSIS, are proposed for handling decision making problems under uncertainties. The PROMETHEE and TOPSIS methods are used to reduce the number of immense pairwise comparisons as required in AHP. Fuzzy linguistic variables are also incorporated into PROMETHEE and TOPSIS to capture the subjective knowledge of the evaluators effectively. The proposed models are applied to a strategic outsourcing decision task of a company that seeks to evaluate their training providers. The results indicate that both AHP-Fuzzy TOPSIS and AHP-Fuzzy PROMETHEE are able to achieve consistent results and to arrive at the same ranking order.

The guest editors would like to thank the authors for their contributions, the reviewers for their time and effort in reviewing the manuscripts, and the journal production team for their support and help in producing this special issue.