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Event Classification And Optimization Methods Using Artificial Intelligence And Other Relevant Techniques: Sharing The Experiences

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Abstract. Classification of large data into respected classes or groups could be carried out with the help of artificial intelligence (AI) tools readily available in the market. To get the optimum or best results, optimization tool could be applied on those data. Classification and optimization have been used by researchers throughout their works, and the outcomes were very encouraging indeed. Here, the authors are trying to share what they have experienced in three different areas of applied research.

Keywords: AI techniques, classification, optimization

INTRODUCTION

Today, AI is the branch of computer science concerned with making computers behave and solve problems like humans. This term was coined in 1956 by John McCarthy at the Massachusetts Institute of Technology, USA [1]. AI is the science and engineering of making intelligent machines, especially intelligent computer programs [2]. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable. Intelligence is the computational part of the ability to achieve the goals. Some of the advantages of AI are more powerful and more useful computers, new and improved interfaces, solving new problems, better handling of information, relieves information overload, and conversion of information into knowledge. On the other hand, the disadvantages of AI are increased costs, difficulty with software development (slow and expensive), few experienced programmers, and few practical products have yet reached the market. The main purpose of this paper is to share the information obtained by the authors with others especially the younger generations regarding classification and optimization in the engineering field of study.

TECHNICAL BACKGROUND

In this article, we present only three different fields of engineering that utilizing AI optimization method for solving their problems, namely personalized word error classification, fault detection in nuclear facility and polymer blend composite properties. Nevertheless, there are a lot more fields that can apply AI method in solving any engineering problems

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Personalized Word Error Classification

Personalized word error correction system or spelling checker is presently unavailable in Malaysia. Personalized means a system or checker that caters specifically to the needs of one person. A person tends to use the same groups or sets of words that one most familiar with during texting or writing a short meaningful sentence. Thus, the personalized environment could create a much smaller and lighter smart devices, and at the same time, cheaper in cost. Today's word correction system is still not at the ideal level of performance ability. Taking the examples of Edit Distance technique utilized in Microsoft Word, one can find that while searching for a correct word to replace a word with spelling errors or missing character(s), one could observe that the system usually gives more than one possible correct words or answers, sometimes the lists include strange words too. Besides, certain word correction algorithm may replace the wrong word with a word that one has never used before. One of the possible tool is support vector machines (SVM).

Fault Detection in Nuclear Facility

Failures in generating the correct control action that due to invalid or faulty sensor often lead to total shutdown or hazards creating significant economic losses and sometimes even endangering both system and human safety. So noisy or faulty sensor or transducer must then be promptly detected and their signals shall be corrected in order to avoid wrong measurement and control decisions. As an example, real data from area radiation monitor (ARM) is acquired where noise-like fluctuations or other forms of signal may present and it is the input for ANNs function, and its output will determine/ interpret the condition of ARM equipment or other aspects that associated with ARM reading. These outputs will depend on how we define their relationships to the inputs. In another word, the ANNs function is like a model to describe the physical principles existing between the input and the output of a system. The ANNs can approximate these relationships independent of the size and complexity of a problem.

Polymer Blend Composite Properties

Many research works have been carried out to study the effect of processing parameters on the resulted polymer composites. This is due to the fact that only at certain processing condition the composite achieves the expected properties. This condition is regarded as the optimal processing condition for that particular system. However, to arrive at this optimal condition, many experimental trials are needed as the number of parameters involved increased. A complete set of parameter combination is established by using full factorial design. The purpose is to understand the relationship between the different processing parameters and finally arrive at the optimal processing condition. It is crucial to identify contribution of each parameter to the system as during processing the materials are subjected to mechanical and thermal stresses, radiation, and other types of influences simultaneously. Full factorial design suffers a drawback in term of time and cost which lead to another technique, fractional factorial design. The technique investigates only a fraction of all the possible combinations. This technique reduces time and cost but still requires rigorous mathematical treatment, both in the design of the experiment and in the analysis of the results. This later leads to simplification and standardization of the fractional factorial design or known as Taguchi method [10].

RESULTS AND DISCUSSION

Event Classification

An event is defined as the occurrence of something at a particular time and place [3]. When events occur, man often has insufficient time to analyze the said event in urgent situations, and has to infer and determine the best action using his brain knowledge. Many studies have used AI techniques databases in event identification and diagnostics [4]. To classify an event, the datasets are divided into model development data and test data accordingly, for example, in a 60:40 ratio, and the class type could be either 2-class or multi-class, for example, vowels and consonants in a 2-class classification system [5]. Table 1 shows a classification of datasets could be carried out using different classification tools such as support vector classification (SVC), deep neural network (DNN), genetic algorithm (GA), and others.

For event classification, there was no such optimal number that could produce the best classification results, whereby authors have taken different number of classification parameters based on areas type of studies as shown in Table 1. Meaning, ones has to decide by oneself whether the model selected and used has provided ones expectations based on how many parameters during training. Generally, a large numbers of datasets are

collected and used to meet the classification process to minimize under fitting problems, whereby under fitting will degrade to a certain degree the classification result [5].

TABLE 1. Studies on Classification/*Optimization.*

Author	Classification/ *Optimization* Tool	Event Type	No. of Classification/ *Optimization* Parameters	No. of Datasets
Y. G. No, et. al.	SVC	Nuclear Disaster	15	330
Z. Kons, et. al.	DNN	Audio	64	84 files (contain 228 minutes of audio recordings)
S. M. Kamruzzaman	Hybrid (associative rule, naïve Bayes classifier, GA)	Text	5	296
O. Hungr, et. al.	Genetic and morphological aspects	Landslides	5	n/a
A. Aziz Mohamed, et. al.	Taguchi Analysis	Polymer Blend Composite Properties	4	18
D. Saxena, et. al.	Various AI Tools	Power Quality	2	21
N. Konig, et. al.	Statistical Analysis (PCA, SPSS)	Female Faller	9	92
A. Bakar Ghazali, et. al.	ANFIS in nuclear data	Fault detection	7	2600
E.L. Geist	a compilation of different techniques	Tsunami and Earthquakes	7	26
A. Bakar Hasan	SVM	Personalized word error correction	10	1626

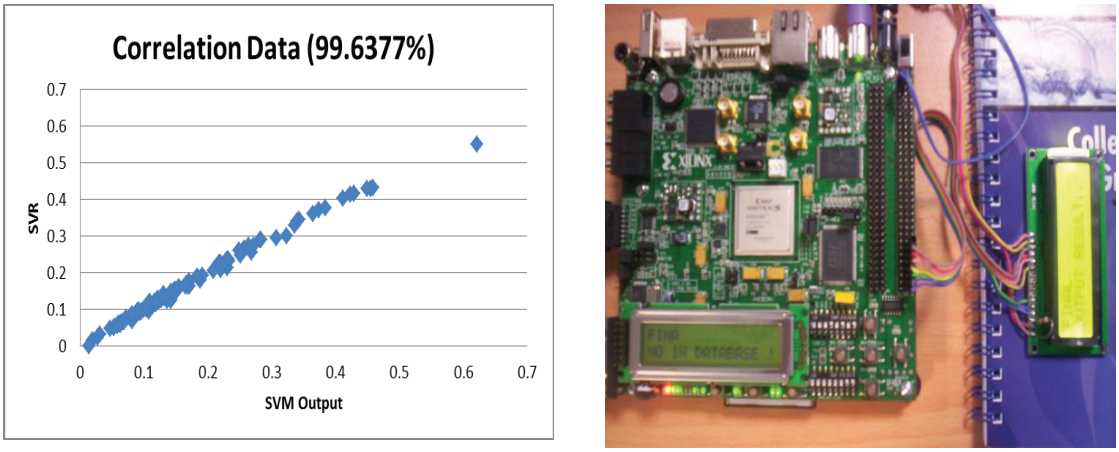
TABLE 2. No. of classification parameters vs test accuracy.

No. of Classification Parameters	Test Accuracy (%)
7	77.0
7 + 3	78.27
7 + 3 + 1	78.27

TABLE 3. Comparison of Techniques

Classification Techniques	1142-Word Lexicon Test Accuracy (%)
Minimum Edit Distance (use grope)	62
Similarity Key (use Bocast Token Reconstruction)	78
Simple n-gram Vector Distance (use Hamming Distance)	68
Probabilistic (use Kernighan-Church-Gale Error Probe)	78
Neural Network (use Back Propagation classifier)	75
Support Vector Machines (use Radial Basis Function)	78.27

Bakar [5] found out that by choosing the right parameters could result in a better correlation data percentage (Figure 1(a)) between the actual and predicted output. The developed algorithm was successfully tested on a FPGA chip (Figure 1(b)), thus leading to a prototype in the near future.



(a) (b)

FIGURE 1. (a) Plot of Actual Output vs Predicted Output (b) FPGA Implementation.

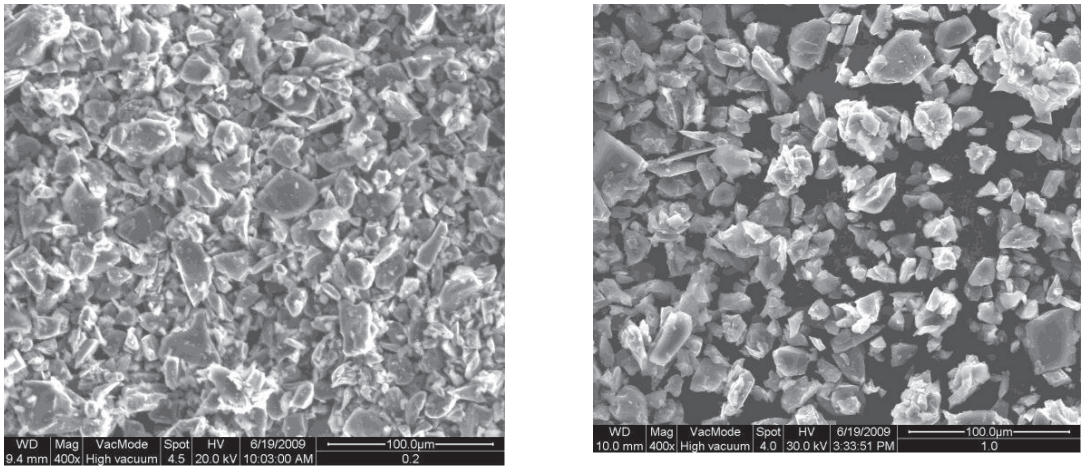
Optimization

Basically, optimization provides the tool in achieving the best or optimal classification results out of a given datasets. Table 4 shows the different optimization methodologies. For example, artificial intelligence (AI) technique provides a large numbers of optimization methods such as Tabu search, simulated annealing, and others. Using optimization tools may be tedious for some cases, and produces insignificant results. A simpler way to optimize the classification results is to use more than one function classifier and different number of classification parameters as shown in Table 4 and 2 respectively.

TABLE 4. Search and Optimization Methodology

Techniques	Method	Tools
Calculus-based		Newton Raphson, Cubic, Gradient-based
Enumerative	Complete	Explicit, Implicit
	Incomplete	
AI	Swarm intelligence algorithm	Ant Colony, Particle swarm
	Gradient-based	Hill Climbing
	Simulated annealing	Monte Carlo
	Evolutionary algorithm	Genetic algorithm, Genetic programming
	Tabu search	

In the study of polymeric materials microstructures and its related mechanical and nuclear properties, Aziz et. al. [8] have chosen four parameters, namely, filler size, filler loading, ball mixing time and dispersion agent concentration, in their work to find on experimental conditions optimization in polymer blend composite preparation. They found that filler loading and ball mixing time were the most and least influencing parameter on the tensile strength and neutron absorption, respectively (Figure 2).



(a) (b)

FIGURE 2. Treated particles with (a) 0.8% dispersant (400X), (b) 1.0% dispersant (400X).

In fault diagnosis and analysis application, as indicate in Table 1, A Bakar Ghazali, et. al. [9] had applied ANFIS (Adaptive neuro fuzzy inference system) method in searching the appropriate ARX model parameters for nuclear data. From a dataset of a nuclear reactor plant in normal operation, it can be trained for which parameters that will be dominant and selected as a model. For SISO in discrete system, the output $y(t)$ can be presented as:

$$\mathbf{A}\, y(t) = \mathbf{B}\, u(t) \tag{1}$$

where **A** and **B** are polynomial of n^{th} order. In a nuclear reactor, the reactor power will indicate many relevant parameters such as the reactor fuel temperature and the area radiation monitoring (ARM) dose level or vice versa. If we assume that y and u are the reactor power and ARM level respectively, and n = 3, the model can be represented as:

$$\mathbf{A} = 1 + a_1 z^{-1} + a_2 z^{-2} + a_3 z^{-3} \tag{2}$$

and,

$$\mathbf{B} = b_1 z^{-1} + b_2 z^{-2} + b_3 z^{-3} \tag{3}$$

where z^{-1} is a delay operator, then,

$$z^{-1}u(t) = u(t\text{-}1),\ ..,\ z^{-3}u(t) = u(t\text{-}3),\ z^{-1}y(t) = y(t\text{-}1),\ ..,\ z^{-3}y(t) = y(t\text{-}3) \tag{4}$$

i.e. the present data of $y(t)$ will depend on the first, second and third previous input and output data respectively. Coefficients of a_i and b_i, i = 1, 2, 3 are determined by ANFIS method. It is then further optimize to select the terms in the model which are dominant, also by ANFIS, that is, search function. As for the real data used in [9], it was found that only $y(t\text{-}1)$, $y(t\text{-}3)$ and $u(t\text{-}1)$ terms are the best combination to model the plant dynamics, $u(t)$. A structure of a fault detection system is shown in Figure 3 where the error, $e(t)$ between the actual reading of ARM, $u_a(t)$ and the ANFIS output, $u(t)$ will decide whether the ARM reading as well as the plant is in normal or faulty conditions with $\mathbf{F}_1$, ..., and $\mathbf{F}_5$ categories.

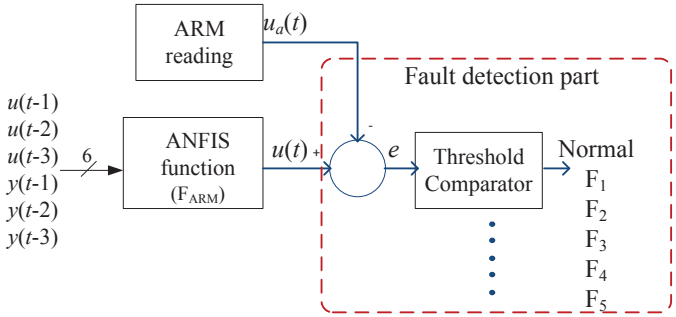


FIGURE 3. A structure of the fault detection system

CONCLUSION

The different types of AI tools could be used not necessarily to a specific problem [6,7], where it is possible that a particular tool is more suitable for a particular solution. For example, the ANT algorithm is normally used in computer game design. This paper has indirectly shown that AI tools have translate men to depend on machines in manipulating large data into solutions in a matter of time, where it was out of the human mind a hundred year ago.

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