International Journal of Mathematics and Statistics Invention (IJMSI)
E-ISSN: 2321 – 4767 P-ISSN: 2321 - 4759
www.ijmsi.org Volume 2 Issue 9 || September. 2014 || PP-01-03

AnAccurate and Dynamic Predictive Mathematical Model for Classification and Prediction

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ABSTRACT: *Artificial intelligence (AI) is the science and engineering of making intelligent machines. An AI is an intelligent agent that understands its environment and takes appropriate actionto resolve a problem. Machine learning makes use of computational methodsto improveperformance by mechanizing the acquisition of knowledge from experience. Machine learning is a major branch of AI that aims to mimic the intelligent abilities of humans with machines. Representation and generalization are used in machine learning. The representation of data instances and the functions evaluated based on instances are part of all machine learning methods. The generalization property ina machine learning method will provide predictions regarding previously unobserved data instances. One of the most important targets of using machine learning methods is classification or prediction. In fact, different machine learning methods provide different levels of accuracy with the same dataset. Existing models have conflicting results, and therefore, it is essential that a new model be developed. The focus of this paper is to develop a predictive mathematical model for classification and prediction that is both accurate and dynamic.*

KEYWORDS: *artificial intelligence, machine learning, classification and prediction*

I. INTRODUCTION

John McCarthy, who coined the term“artificial intelligence” in 1955, defined it as "the science and engineering of making intelligent machines" [1]. Artificial intelligence can be defined as “the study and design of intelligent agents”, where an intelligent agent is a system that perceives its environment and takes actions that maximize its chances of success [2]. AI can further be explained as a subject that addressescomputational methods of providing results or examples of behavior that are characteristic of human intelligence [3]. There are manyadvantages to using artificial intelligence, including flexibility, adaptability, pattern recognition and fast computing [4]. Machine learning can be described as “computational methods for improving performance by mechanizing the acquisition of knowledge from experience” [5]. Machine learning and its related methods are a major branch of AI [6,7]. In a nutshell, machine learning is the essence of machine intelligence [8]. Machine learning aims to mimic the intelligent abilities of humans with machines. Representation and generalization are used in machine learning. The representation of data instances and the functions evaluated on these instances are part of all machine learning methods. Generalization is the property according to which a machine learning method will provide predictions on previously unobserved data instances. Both supervised and unsupervised methods are used in machine learning [9]. One of the most important targets of machine learning methods is classification or prediction, terms that can be used interchangeably [10]. Classification and prediction can be used to extract models describing important data classes and to predict future data trends [11]. Classification or prediction is the ability to generalizefrom a data set. It means the ability to identifynew outcomes based on past data. Classification and prediction are sensitive to missing values [12]. A dynamic system is a concept in mathematics in whicha fixed rule describes the time dependence of a point in a geometrical space. Based on [13], Dynamic Prediction or Temporal Prediction is the ability to change the classification of an object over time. Supervised machine learning methods are used to provide classification or prediction [14]. In fact, different machine learning methods provide different levels of accuracy with the same dataset. Existing models have conflicting results, and therefore, it is important that a new model for accurate and dynamic predictions be developed. In the next section, a new mathematical model is introduced.

II. MATHEMATICAL MODEL OF ADPM

This model is proposed to provide a very accurate and Dynamic Classification or Prediction. It consists of multiple machine learning methods. Each machine learning method is weighted based on its accuracy. Dynamic Weighted Sum Multi-criteria Decision Making is used to integrate all methods side by side to provide an accurate and dynamic classification or prediction. This Model can be called an Accurate and Dynamic Predictive Model (ADPM) or an Accurate and Dynamic Classifier Model (ADCM). The decision and weight matrixes of the accurate and dynamic predictive model are presented in Fig.1. Mathematically, ADCM or ADPM can be stated as follows:

Let the weights in this model be the accuracy of the machine learning methods, $w = (w_1, w_2, \ldots\ldots w_n)$ *and* $i = 1, 2. \ldots\ldots n.$ $j = 1, 2. \ldots\ldots m$

where w_i *is the accuracy of the first Machine Learning Method* m_j.

The number of machine learning methods is n,and the number of outcomes is m.

$$W_j = \left(\sum_{j=1}^{m}\left(\left(\sum_{j=1}^{n} {}^{TP}{}_{i}(j)\right) + \left(\sum_{i=1}^{n} {}^{TN}{}_{i}(j)\right)\right) / \left(\left(\sum_{i=1}^{n} {}^{P}{}_{i}(j)\right) + \left(\sum_{i=1}^{n} {}^{N}{}_{i}(j)\right)\right)\right)$$

$$D = \begin{array}{c} \\ O_1 \\ O_2 \\ O_3 \\ O_4 \end{array} \begin{array}{c} \begin{array}{cccc} M_1 & M_2 & M_3 & M_4 \end{array} \\ \begin{bmatrix} x_{1,1} & x_{1,2} & x_{1,3} & x_{1,4} \\ x_{2,1} & x_{2,2} & x_{2,3} & x_{2,4} \\ x_{3,1} & x_{3,2} & x_{3,2} & x_{3,4} \\ x_{4,1} & x_{4,2} & x_{4,3} & x_{4,4} \end{bmatrix} \end{array} \qquad W = \begin{bmatrix} W_1 & W_2 & W_3 & W_4 \end{bmatrix}$$

The weights w_j *should be normalized so that*

$$\sum_{j=1}^{n} w_j = 1$$

Linear scale transformation is a straightforward process thatdivides the product of a definite criterion by its maximum value, on the condition that the criteria are defined as benefit criteria (the larger x_j *is, the greater the preference); then, the transformed result of* x_{ij} *is*

$r_{ij} = \frac{x_{ij}}{x^*_j}$ *where* $x^*_j = {}^{max}_{i} x_{ij}$

$0 < r_{ij} < 1$, *the value of* r_{ij} *will be between 0 and 1.*

O (s) are the outcomes, and the most accurate outcome O will be selected such that O* =* $\{O_i | {}^{max}_{i} \sum_{j=1}^{n} w_j x^*_{ij\,(t)} / \sum_{j=1}^{n} w_j\}$

where C_j *is the criterion, and* $x^*_{ij\,(t)}$ *is the outcome of the* i^{th} *outcome and* j^{th} *criterion at time (t)*

$x^*_{ij\,(t)}$ *can be changed based on the decision maker*

$x^*_{ij\,(t)} = \min x_{ij\,(t)}$

$x^*_{ij\,(t)} = \max x_{ij\,(t)}$

$x^{*}_{ij\ (t)} = mean\ x_{ij\ (t)}$

$x^{*}_{ij\ (t)} = median\ x_{ij\ (t)}$

III. CONCLUSION

An Accurate and Dynamic Predictive Model (ADPM) is mathematically introduced to yield accurate and dynamic prediction and classification. It is developed based on a number of Machine Learning Methods and Dynamic Weighted Sum Multi-criteria Decision Making. Each machine learning method is weighted by its accuracy and can therefore work side by side to classify and predict new unobserved data instances more accurately and dynamically.

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