Chapter 1
Determination of Rate of Medical Waste Generation Using RVM, MARS and MPMR

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ABSTRACT

The prediction of medical waste generation is an important task in hospital waste management. This article uses Relevance Vector Machine (RVM), Multivariate Adaptive Regression Spline (MARS) and Minimax Probability Machine Regression (MPMR) for prediction of rate of medical waste generation. Type of hospital, Capacity and Bed Occupancy has been used as inputs of RVM, MARS and MPMR. RVM is a probabilistic bayesian learning framework. MARS builds flexible model by using piecewise linear regressions. MPMR maximizes the minimum probability that future predicted outputs of the regression model will be within some bound of the true regression function. MARS, RVM and MPMR have been used as regression techniques. The results show that the developed RVM, MPMR and MARS give excellent models for determination of rate of medical waste generation.

INTRODUCTION

All over the world, wastes are generally interpreted as industrial or domestic. However, one kind of waste, on the rise, is bio-medical waste, disposed by hospitals. The number of hospitals is on the rise but these hospitals carry their share of potentially harmful baggage, that is, bio-medical wastes. These wastes, which can be municipal, pathological, sharps, etc, pose several threats such as environmental pollution, unfavourable smell. If they serve as breeding grounds for rodents, insects, they aid in affecting

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human and animal health by spreading diseases like typhoid, cholera, hepatitis and AIDS due to reuse of contaminated syringes, etc. The best possible method to tackle this is efficient and effective waste management. Unfortunately, collection, transport and disposal of waste have no proper strategy or planning behind its implementation. It urgently needs to that needs to be regulated by definitive rules (Askariana et al., 2004). Thus, the data that is needed primarily is the rate of waste generation. This depends upon several factors such as (i) number of bed/patient available at the hospital; (ii) type of specialization (type and range of care); and (iii) number, kind, and size of departments (Award et al., 2004). The objective of this paper is to predict the rate based on these factors as it will directly assist in planning an efficient waste management strategy. Artificial Neural Network (ANN) and Multiple Linear Regression (MLR) have been used for this purpose (Jahandideh et al., 2009). But they have shortcomings such as the low accuracy of MLR and the black box approach, over fitting issues, lack of generalization capability and slow convergence rate of ANN (Park & Rilett, 1999; Kecman, 2001).

This article adopts Relevance Vector Machine (RVM), Minimax Probability Machine Regression (MPMR) and Multivariate Adaptive Regression Spline (MARS) for determination of rate of medical waste generation. This article adopts the database collected from the work of Jahandideh et al., (2009). The dataset contains information about type of hospital, Capacity(C), Bed Occupancy (B_0) and Waste generation rates (kg/day) (w_t). RVM is based on Bayesian Estimation Theory. The distinctive advantage is that it gives rise to sparse regressors without affecting the performance (Tipping, 2000). RVM typically uses very less basis functions and it has proven its accuracy (Tipping, 2001). It has been used to solve different problems in engineering (Wang et al., 2012; Hsu et al., 2013; Cui et al., 2014). In MPMR, prediction is done while ensuring that the maximum probability of error is minimized (Lanckriet et al., 2002). This method has a plus point over ANN as control on future prediction data is possible (Lanckriet et al., 2002). MPMR has been used to solve different engineering problems (Sun et al., 2009; Yang et al., 2010; Zhou et al., 2013). GPR is a generic supervised learning method used to solve regression problems. This is developed based on Gaussian Processes. This is done by modelling the random processes as Gaussian processes. This method is versatile, practical, allows for generalization, and can specify very flexible non-linear regression too. This has been implemented for solving different problems in engineering (Heyns et al., 2012; Verrelst et al., 2013; Sun et al., 2014). A comparative study has been presented between the developed MARS, MPMR and RVM models.

DETAILS OF MARS

MARS uses basis functions to model the complex relationship between input(x) and output(y). The expression of MARS model is given below.

$$y = a_0 + \sum_{m=1}^{M} a_m B_m\left(x\right) \tag{1}$$

where a_0 is coefficient, $B_m(x)$ is basis function, a_m is coefficient of $B_m(x)$ and M is the number of basis functions. In this study, $x = \left[C, B_0, x_3, x_4, x_5, x_6\right]$ and $y = \left[w_t\right]$. Table 1 shows the value x_3, x_4, x_5 and x_6 for the different hospitals.