

Big Data and Predictive Analytics for Waste Management

Introduction

Big Data and Predictive Analytics can be used to predict patterns based on historical data. This helps in preparing accordingly for future. To do that algorithms are used to create statistical models which can be utilized to guess events based on inputs. This paper reviews applications of Big Data based predictions in the Waste Management industry.

Commercial Applications of Big Data and Predictive Analytics in Waste Management

Smart Bins

Smart Bins are waste bins which double as IoT devices. These solar powered bins contain sensors which monitor the level of trash inside the bin helping waste regulators to collect waste only when necessary [1]. Ecube labs, a major vendor of the bins, also uses the information from the sensors to provide data driven solutions to the waste collection agencies [2]. They create predictive models from the data, which can be used to find optimum time to collect the garbage from locations. It can also be used to allocate the number and size of bins at the locations and route planning for garbage trucks. Ecube labs currently sell their bins for around \$2000 - \$3000 [1], and charge fees on their big data solution based on the number of bins. They claim increased recycling diversion rate of 54% and 82% reduction in operational costs for four different universities in Seoul [3][4].

Waste Collection Software

There are numerous small vendors operating in the urban Waste Management industry, who cater to small businesses. Rubicon, an Atlanta based startup, provides software based solutions to both vendors and the vendor's clients to streamline the process. They collect the data and utilize Machine Learning algorithms to predict urban waste patterns [7]. The patterns are helpful for their vendors who can streamline their businesses accordingly and expand. Their vendors charge around \$150 - \$300 per month to businesses[6], which they say save the businesses money and make them sustainable [5].

Fleet Management

A big part of the spending in waste management comes from running the trucks. Waste Management, the largest company operating, is installing DriveCam trackers in their trucks to manage the fleet efficiently [8]. They are estimating it to save their fuel costs by 12% initially. The data collected from their fleet of trucks can be used to optimally plan their routes [10]. They charge \$21 - \$677 per trashcan (varies by area and size) to their enterprise clients for their service [9].

Technology being used for Big Data and Predictive Analytics

The general procedure of doing predictive analytics using big data can be divided into the steps: (1) Exploration of data, (2) Model building and validation and (3) Deployment [11]. The current solutions use the chronology of steps for their usage.

Exploration of data involves collecting data from sources and cleaning them. Cleaning the data involves selecting and transforming the features of the data. This helps bring the number of dimensions to a manageable level. Feature selection and transformation can be done using algorithms like Principal Component Analysis (PCA), wrapped learners etc [11].

Model building and validation involves using various algorithms to build models. The algorithms include Bagging, Boosting, Stacking and Meta Learning. All of them contain machine learning algorithms like neural networks and classification/ regression trees [11]. After building the different models, the one having the best result is chosen for deployment. This is done by testing the data on a test set, which was not utilized in building the model.

Deployment is the last step which involves deploying the model chosen in the field. The model is further improved over time based on the data provided.

Implementation of Big Data and Predictive Analytics in Waste Management

To do predictive analytics for Waste Management, sensors need to be used to collect data from trucks and garbage bins and then relayed to a central server using internet or other proprietary protocols. To do this there should be microcontrollers in the bins and trucks. The data will go through the same general procedure stated above and the model generated can be used to predict pattern of waste generated over an area the type. This information can be utilized to plan efficient waste retrieval and disposal.

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