Predictive System for Food Management

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Abstract. This paper aims in designing a Machine Learning model using neural network to predict the amount of food required, given the number of people of each category: *Children, Adults and Elderly*. This approach minimizes the amount of food wasted during major family occasions by predicting the amount of food that will be sufficient for the people invited. Subsequently, another model will aim to predict the list of food that is favourable, based on the distribution of people across the categories mentioned above.

Keywords: Neural networks, Linear regression, Food prediction, Gradient descent.

1 Introduction

In many occasions, the organizers find the process of predicting the amount of food required to be a daunting task. If there is a system that predicts the amount of food required for an occasion based on the expected count of people, the process would be much more simplified. The current scenario leads to lot of food wastage due to lack of a proper predictive system. This work aims to aleviate this problem by predicting the amount of food required (raw materials in kgs). A machine learning approach using neural networks (model 1) and linear regression is used for this task. The linear regression model (model 2) is helpful to predict the most favourable food list based on the ratio of people from different categories. This project will help to avoid large amounts of food wastage as well solve the confusion of selecting the most preferred food list.

2 Literature Survey

Food wastage is a huge problem arising in today's world. It has become a serious issue in our society in the last years that affects “poor and rich countries” equally and according to the Food and Agriculture Organization (FAO) almost half of all produced food will never be consumed. By wasting food we also waste the “time and energy” that we have used to produce the food and as well our “natural resources” which could be handled in a much sustainable way in 2017, the average amount of waste was 2,215 tons/day. In that, food waste is accounted for 57.40%, and that it affects badly on environment. The prevention of food waste requires new networked and collaborating competences, in the light of the increasing inefficiencies of modern economic growth models and the improvement of new paradigms for sustainable development. Sabrina Bonomi et al.[6] in her paper titled “ Innovation for Sustainable Development by Educating the Local Community. ” addressed food waste at the level of several organizations throughout the supply chain, implemented a recovering process to reduce food impairment. Quin Lo et al.[5] in his case study tried improving the user’s usability of garbage bags by combining the use of WeChat, so that the users

can develop their habit of changing garbage bags every day. His work involves a variety of innovative design methods in the process of usability analysis.This analysis method has methodological reference significance for the application of user experience design in terms of university students' domestic waste management. SireiratanaThay et al.[1] in his work performed data collection to identify key factors influencing food waste management in Phnom Penh, Cambodia. The data was collected based on eight hypothesized factors extracting from waste-related literature, including bio-digester, member in a family, packing size, population growth, promotion, shelf-life, shopping frequency, and tax payment. The results reveal importance of the eight key factors in managing food waste. It will later be used to build a dynamic model to track amount of food waste in the long term in Phnom Penh, Cambodia.

3 Proposed System

3.1 Model 1

1) Neural network is trained using a dataset of no of people, amt. of food ordered, amt. of food wasted from 1000 occasions.
2) During forward propagation, the cost function is calculated.
3) During back propagation, the cost gradient is calculated and the value for weights (theta) is learnt using gradient descent.
4) The user enters the no of people expected to attend the occasion.
5) The input is mapped with the value of theta obtained to get the required amt. of food based on the dataset.

3.2 Model 2

1) A Linear regression model is trained using a dataset of no of people of each category and the list of food ordered in that occasion.
2) Gradient descent is used to minimize the cost function and calculate the weights to be assigned to each category.
3) The no of people is given as input and an optimal food list is predicted.
4) The amt. of calories for a person of each category is referred from another dataset and the total calorie count is calculated for all the people.
5) The calorie count of the predicted food list is divided by the total count to get the number of servings expected for a person.
6) The total quantity of raw materials required is predicted.

4 Implementation

4.1 Model 1

I. The first model will be designed using neural networks.
II. A dataset consisting of the columns: no of children, adults, elderly people, amt. of food ordered, amt. of food wasted is collected from 1000 occasions and will be used to train the neural network.

III. The neural network will consist of one hidden layer with five neurons since the number of attributes is five.
IV. The output layer calculates the amount of food required for the event along with the quantity expected to be wasted.
V. Each neuron functions as a linear regression unit calculating the amount of food required and wasted using the weights it derived from the feature vector.
VI. The output layer finds the minimum of the values predicted by all the neurons and outputs it. The hidden and the output layers are going to be fully connected layers.
VII. Each neuron is initialized with a random value of theta so that they arrive at a slightly different global optima.
VIII. During forward propagation, the cost function is calculated and during the back propagation, the differential of the cost function is used to minimize the value of the cost function.

$$J\left(\theta_i, \theta_j\right) = \frac{1}{2m} \sum_{i=1}^{m} \left(h\left(x\right) - y\right)^2 \quad (1)$$

Equation 1 gives the cost function used to reduce the error. At each iteration, the cost function is calculated and it is reduced using equation 2.

$$\theta_j = \theta_j - \alpha \frac{\partial}{\partial \theta_j} J(\theta_i, \theta_j) \quad (2)$$

At each iteration, the cost function is reduced by a value equal to the product of learning rate and differential value. The gradient descent algorithm is run for each neuron and at the end, the final value of the cost function is taken when it is the least. The weights are calculated and it is used to predict the output.

IX. Once the values of theta are finalized, they are used to predict the output from the input given by the user.

4.2 Model 2

I. The second model will be designed using a linear regression algorithm.
II. A dataset consisting of the different combinations of ratio between the people of the said categories and the food preferred by them is used to train the model.
III. The model learns the weights using gradient descent method and predicts the preferred food from the ratio of people belonging to the said categories.
IV. Once the preferred food is finalized, the following information is gathered from online databases: *1) calorie count of the food as a whole. 2) The raw materials needed for preparing one serving of the above food item 3) calorie requirement of one person of each category.*
V. The calorie requirement of each person is multiplied by the amount of people of that category to figure out how much calories of food is required.
VI. The total calorie count is divided by the calorie count for one serving of food to find out the number of servings required.
VII. The raw materials required for one serving of food is multiplied by the no of servings to find out the quantity of raw materials required to prepare the most preferred food for the total people invited.

5 Results

Table 1.weights calculated by the 5 neurons

neuron	weights
1	-0.01, 0.17, 0.16
2	-0.21, 0.25, 0.23
3	0.65, -0.12, 0.42
4	0.21, 0.06, 0.30
5	0.30, 0.03, 0.29

Table 1 gives the value of weights calculated by all the neurons after running gradient descent. From the table, we can see that all the neurons calculate nearly the same weights even though they were randomly initialized.

Table 2. Output food amount predicted by all the neurons

Sno.	Actual food ordered	food predicted				
		neuron1	neuron2	neuron3	neuron4	neuron5
1	24	21	17	18	23	17
2	60	53	58	57	52	57
3	21	19	20	20	18	20
4	51	41	41	41	42	41
	...	...	...	...	...	...
996	63	51	52	52	51	52
997	25	33	34	33	32	34
998	63	29	23	24	31	23
999	35	37	29	39	36	39

Table 2 gives the value of the output predicted by all the 5 neurons. From the values shown in the table we can see that all the neurons have arrived at the same output value. Table 3 gives the root mean squared error value for the 5 neurons. Lower the value of RMSE higher the accuracy. We have acquired an accuracy of around 70.6% . Finally the average of the outputs predicted will be shown to the user.

Table 3. Root mean square error values calculated for each neuron

	RMSE	
neuron	Test	Cross Validation
1	6.73	6.42
2	6.72	6.40
3	7.59	7.36
4	6.91	6.60
5	6.89	6.57

6 Conclusion

The neural network consisting of one hidden layer and 5 neurons was very well able to predict the amount of food required to prepare food for the members attending the function. The dataset from a 1000 functions were collected and the model was able to successfully learn the weights for the input features no. of children, no. of adults and no of elderly people. Each neuron was able to successfully perform linear regression on its own and arrive at the least global minimum. Using this model, we can alleviate the difficulty of guessing the amount of food that will be required since our model predicts the amount of food required by itself given the number of people from various categories.

7 References

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