Classification of Service Types from Customer Feedback Using Deep Learning Methods

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Abstract

This paper proposes a classification model using Long Short-Term Memory of Recurrent Neural Network (LSTM) for the customer feedback. To evaluate the customer feedback, the customer relationship management (CRM) system and the dataset of 275,670 responses in transportation sector are also used in this research. The collected customer feedback can be classified into two categories which are complaints and commendations. To build the LSTM model using dataset, we provide 192,970 samples for training dataset, 41,350 samples for validation dataset, and 41,350 samples for test dataset. After the model's evaluations, the performance results of LSTM model in terms of accuracy, precision, recall, and f-measure are 99.04%, 96.73%, 90.12%, and 93.15%, respectively. In the same way, the performance results of bidirectional LSTM (Bi-LSTM) model in terms of accuracy, precision, recall, and f-measure are 99.05%, 97.00%, 90.13%, and 93.27% respectively. It is clear that the both of system models are comparable and could be used for CRM.

1. Introduction

CURRENTLY, customer behavior has changed. Most customers are accustomed to using more online services, such as ordering goods, finding information, products, and services. To obtain or inform the online transfer, it becomes part of daily life and is a trading channel in the form of continuous growth of the industry. E-commerce from the report of Internet User behavior survey in Thailand Year 2018 found that Thai people use the Internet for an average of 10 hours a day, 5 minutes increased from the year 2017 3 hours, 30 minutes, the reason for Internet use increases. Part of the government policy that promotes the high-speed Internet infrastructure coverage of all areas. Besides,

the development of advanced communication technology is fast. Able to respond to mobile phone users in any need Every time and every place [1] consists of a marketing study of Griffin and Lowenstein [2], the probability of success in the sale of the original customer, the average 60-70 percent, and the likelihood of success in the purchase of a lost customer with only 5-20 percent, indicating that the operator requires management of customer service tasks that can respond quickly and continuously to customer experiences and provide service channels to customers such as service centers, services, and so on Customer support for customer feedback, so that education and service classifications of employees who are responsible for performing a classification of services may require a long processing time, as the data associated with the service has a data volume and complexity. Also, understanding these data tends to crash or respond late to customer expectations. This can result in an impact on the operator's image and the chances of losing a customer. And previously some researchers [3] but recent technology higher performance as such

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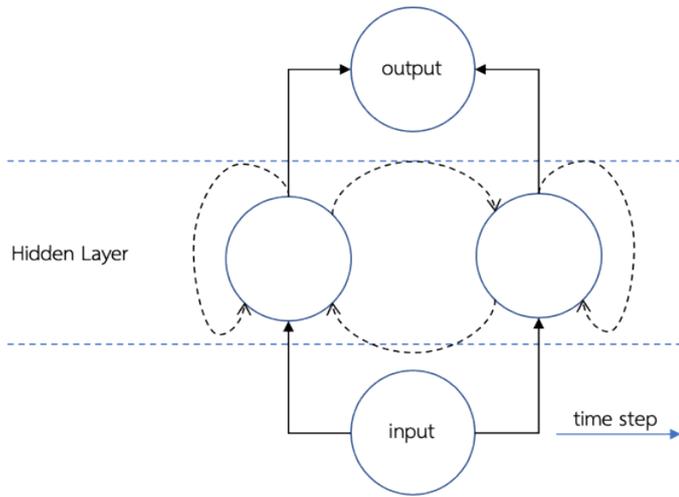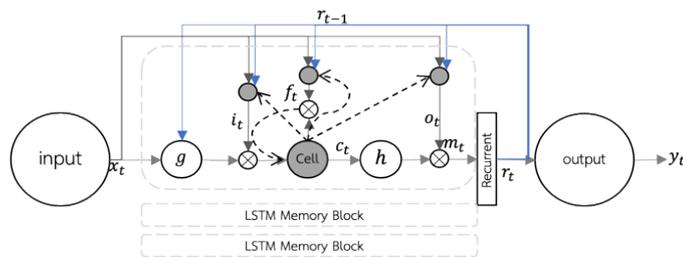Email address:* sooksawaddee.na@spu.ac.th (Sooksawaddee Nattawuttisit)

Fig. 1. RNN structure.

Fig. 2. LSTM structure.

Fig. 3. Research process.

Fig. 4. The structure of LSTM model.

as deep leaning method.

From such a problem. The researchers took the idea and interest to bring up modern information technology. The application is a tool to do research by bringing in-depth learning technology with the technique Long Short-Term Memory Unit of Recurrent Neural Network type classification. The service categories from customer feedback to resolve and improve customer relationship management, which will enhance the quality of the service. The knowledge provided by this research can also be used as a way to further expand the future of learning.

2. Literature Reviews

2.1. Service

Service is a process initiated by one of the user's desires, and then bring the action or practice and deliver the service to the user to fulfill the desire. The characteristic of the services that make it different from that product is not able to be captured. Cannot be separated, no exact stability. Cannot be stored and cannot be owned by the ownership [4].
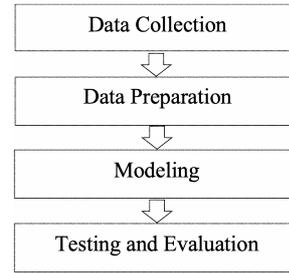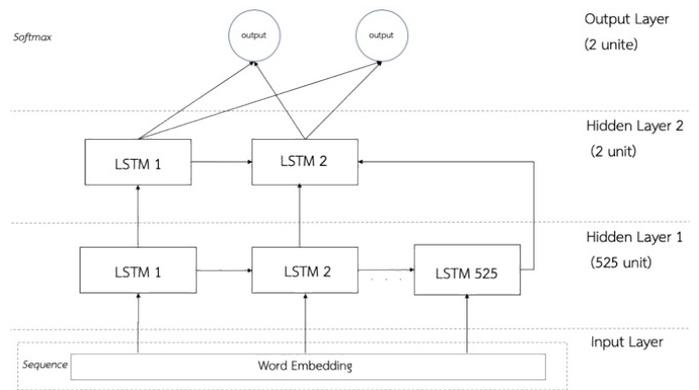
2.2. Feedback

Feedback refers to beliefs, thoughts, decisions, or expressions of feelings towards something. By using knowledge, experience, and environment and opinions as an expression of various internal emotions, which may be merely intentions, beliefs, and values as behaviors Inside that no one can observe or know, other than that person. But opinions are external behaviors. That others clearly perceive or understand [5].

Customer Feedback is information that provides useful or critiques about operations Actions of individuals, organizations that reflect customers' thoughts in response to the organization's products, services and policies [6].

2.3. Word Tokenization

Word Tokenization is use corpus, which uses statistical methods to process the language by using the data corpus as a database to store the frequency used for word token. Which the word cut using the data corpus is divided into 2 ways: cutting the word by using probability (Probabilistic word segmentation). Cutting words based on the possibility of the Markov model or Engram model will calculate the likelihood of character sequences that occur together as a word of the word's probability can be estimated from the data corpus created. To convert text into numeric values to be used in computer processing. The model will have a

Training Data

Fig. 5. The word cloud visual for training.

Table 1. The Samples of MTA Customer Feedback Dataset Characteristics.

Type	Subject	Feedback	Year
Commendation	Employees	Train Conductor Performance Under Stress	2018
Complaint	Telephone / Website / Mobile Apps	Website Not working / Out of service	2018
Complaint	Station /Bus Stop /Facility /Structure	Advertisements	2017
Complaint	Telephone / Website / Mobile Apps	Website Printing Error	2017
Complaint	Employees	Platform Controller Did Not Correct Conduct of Passenger	2017
Complaint	Employees	Train Conductor Performance Under Stress	2017
Complaint	Station /Bus Stop /Facility /Structure	Advertisements	2017
Complaint	Telephone / Website / Mobile Apps	Mobile App Hard To Read	2017
Complaint	Employees	Train Conductor Performance Under Stress	2017

unit used in the model, which is called a gram, which is a word or character of many sizes, starting from 1 to n, which is the Markov assumption. One word is based on the previous word, $n − 1$ [7]. With the following equation (1) [8].

$$P(w_1, w_2, \ldots, w_n) = P(w_1 | Start) \prod_{i=1}^{n-1} P(w_{i+1} | w_i) \qquad (1)$$

Where,

P is probability of word.

$(w_1, w_2, \ldots, w_n)$ is word.

i is the sequence of words with the first order.

n is number of grams.

Table 2. Collected Data for Training Validation and Testing The Model.

Type	Training	Validation	Testing
Complaint	185, 358	39,719	39,719
Commendation	7,612	1,631	1,631
Summary	192,970	41,350	41,350

Table 3. Results of The Performance for LSTM Model.

Model	LSTM			
Performance	Accuracy	Precision	Recall	F-measure
	99.04%	96.73%	90.12%	93.15%

Probability estimation from the corpus can be calculated from the equation (2) [9].

$$P(w_i | w_{i-1}) = \frac{Count(w_{i-1} w_i)}{Count(w_{i-1})} \qquad (2)$$

2.4. Activation Function

The Activation is used as a function that controls the operation of the artificial neurons for the transmission of values within the neurons that decide that the incoming data will pass to the next cell go back to fix weight. The links will depend on the amount of weight. After receiving the value, it will be multiplied by the weight and bias and the sum of each cell to calculate to find the value before sending to target which will be it will be compared to the target and error value. The error will be returned for the network to learn, and the calculation of the error is small. The best by converting nonlinear values used in artificial neural networks Will change the data to the range between 0 and 1 or -1 to 1, the stimulation function as follows.

Sigmoid Function is a function used to classify the discriminative classifier sigmoid gives the result y from 0-1, which is a constant value suitable for use as a probability value and then converted to a classification.

Hyperbolic Tangent Function is a function similar to Sigmoid, by giving the result value (y) in the range 1 to -1 [10].

2.5. Recurrent Neural Network (RNN)

The recurrent neural network is a network that has the characteristics of sending data forward and able to send the previous data back to calculate in order of time by having the structure as shown in Fig. 1.

Table 4. Results of The Performance for Bi-LSTM Model.

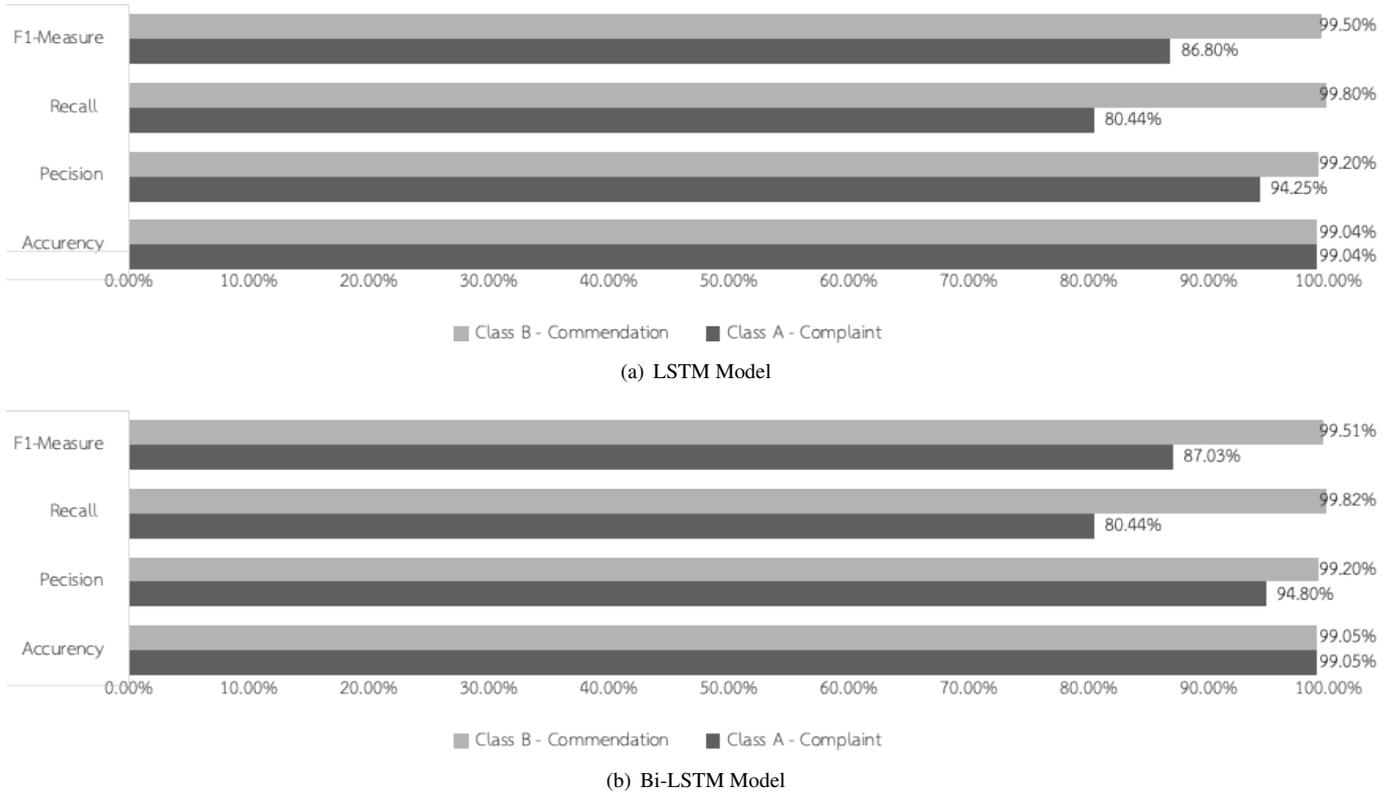| Model	Bi-LSTM			
Performance	Accuracy	Precision	Recall	F-measure
	99.05%	97.00%	90.13%	93.27%

(a) LSTM Model

(b) Bi-LSTM Model

Fig. 6. The performance results of both models.

The advantage is that in addition to learning information from the current state, it is possible to determine the data from the previous state [11].

2.6. Long Short-Term Memory Neural Networks (LSTM)

Long Short-Term Memory Neural Networks type is a network that has a specific unit feature called a memory block, which is located in a hidden layer in which memory blocks consist of memory cells. Which is responsible for storing data for temporary periods each memory block in the architecture has an input gate, an output gate, and a forget gate, which controls the flow of information in the memory cell. The exit gate controls the cell outflow. Next, the forgotten gate acts to clear the memory. It is designed to have an architecture that predicts information by incorporating previous state information to help predict it. Over time, the data that should exist will not disappear with time, but the records are kept. This can be done by establishing internal connections with memory.

The LSTM can be divided into 2 types by direction, single directional (LSTM) and bidirectional (Bi-LSTM), in which two-direction operation is to connect two sets of unidirectional but use the input layer. And the output first together, the first set will be learning from the left to the right, in the form of input data will be learning from 1 to t while the second set will be learning from the right to the left in appearance. The input will be from t to 1 [12].

Emsawas and Kijsirikul [13] found that the classification method for Optical Character Recognition (OCR) by LSTM and that results of this demonstrated improved accuracy of our strategy to offer superior system LSTM standard programming and other businesses for Thai OCR.

2.7. Performance Measurement

The resulting testing of the model by the Confusion Matrix is used for showing the performance of information classification type as a table. In which the table line represents that the model anticipated the anticipated class and the actual class section is the real type of services information that is placed into the predicate information. Expectation results can likewise be isolated into positive and negative forecasts for each sort of type. The performance values can be defined as follows [14].

$$\text{Accuracy} = (TP + TN)/(TP + FP + TN + FN) \quad (3)$$

$$\text{Precision} = TP/(TP + FP) \quad (4)$$

$$\text{Recall} = TP/(TP + FN) \quad (5)$$

$$\text{F} - \text{measuere} = \frac{2 \times \text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}} \quad (6)$$

Where,

TP is the number of customer feedback data that is in a class, and the model predicts that it is in class.

TN is the amount of customer feedback data that is not in a class, and the model predicts that it is not in class.

FP is the amount of customer feedback data that is not in a class, but the model predicts that it is in class.

FN is the number of customer feedback data that is in a class, but the model predicts that it is not in class.

3. Proposed Model

This research has divided the operating procedures into four phases for the research operations.

3.1. Data Collection

This research has collected dataset from demographic groups, customer feedback from government agencies, Information Technology Services of U.S. General Services Administration (GSA) [15] that provides public information services to the public that can access for use academic researchers. The dataset is about MTA Customer Feedback from the Metropolitan Transport Authority (MTA), collected during 2014 – 2018. It contains of 275,670 records, and 13 attributes (as shown in Table 1). This research use 4 attribute for input into the model is Subject, Feedback and Year.

The samples were categorized into 2 main types of services: Complaint and Commendation. The data was divided into 70% for learning, 15% for validation, and 15% for testing. This research is supervised learning and labelling information into 2 types of services (as shown in Table 2).

3.2. Data Preparation

The dataset is indication each to be a short message models need to adjust the format. The following steps.

- Check messages include a specific form of message types such as HTTP, www. Text representing emotions such as :): Information hashtags (Hashtags) such as #Ticket

- Perform special characters and remove the stop points such as markers, ?!

- Adjust font is all lowercase.

- Character conversion agent in the form of a series of documents that contain the word (token) by tokenization the word. The results of this example. "ticket clerk station agent very helpful friendly," "toll policy proposed fare toll change."

3.3. Modelling

The developed model using the MATLAB R2018 on a computer with the processor features Intel Core i5 generation 8 model quad-core speed 2.3 GHz, memory LPDDR 3 speed 2,133 MHz size 8 GB. As a tool to create a neural network model developed. Leading to the sequence of characters into 1 unit of the input node, 2 hidden layers, and each layer have the LSTM unit of 525. Unit-based on the number of words in the string and the output node 2 unit, the leading out of two data categories for classification. Learning rate 0.01, number of 10-cycle learning cycles.

3.4. Testing and Evaluation

For the study, the performance of models of service classifications, the number of 41,350 in the test is used to determine the accuracy, precision, recall and the F-measure as a measure to evaluation criteria the results of the test.

4. The Results

The researcher developed the service classification model based on customer feedback using both one and bi-LSTM neural network technique. The researcher found that the processing time for one LSTM was 5 hours, 04 minutes, 33 seconds to learn from cycle 1 to cycle 10 epoch completion. Unlike one LSTM, a bi-LSTM neural network model, the processing time is 13 hours 27 minutes 59 seconds. Learning from cycle 1 to cycle 10 epochs completed in two directions, takes more than 8 hours 23 minutes 26 seconds. We found LSTM has been processing faster than bi-LSTM because of LSTM with the one-directional work direction that does not require reverse processing on the previous node, considering the processing time. The performance of models classifies services from customer feedback with bi-LSTM provided better performance.

5. Conclusions

The researcher has classified the type of services based on customer feedback with LSTM neural network techniques. From the data collection of 275,670 feedback through the use of MATLAB and 4 hours 53 minutes for single directional (LSTM) and 20 hours 1 minute for bidirectional (Bi-LSTM) in the learning process of the model The results showed that LSTM models 99.04% accuracy value, 96.73% precision value, 90.12% recall value, and 93.15% F-measure value, and Bi-LSTM model. 99.05% accuracy, 97.00% precision value, 90.13% recall value and 93.27% F-measure value.

In conclusion, the results showed that the model had an excellent level of efficiency. That can be classified, categorized, text data which can be used with the customer service system in automatic classification type of services for increasing the efficiency of customer relationship management. That will help improve the

quality of service for customers. The knowledge gained from this research can also be used as a guideline to expand the experience in the future both in the commercial and academic or solving similar problems such as Thai text and business aspects in predictive analysis, time-series data such as seasonal sales, stock prices, currency exchange rates.

The data sets for conducting research. The researcher found a lot of obstacles in seeking public information that allowed them to be used in education. May be due to negative customer information or feedback, for example, complaints. The complaints have a feature that is sensitive to the business, which will affect the image of the organization, including the personal information, privacy data of the customer. Therefore, when researching on customer feedback, it is necessary to pay attention and be cautious in the dissemination of information according to academic guidelines and does not affect any data owners.

Acknowledgement

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Biography

Pongsuda Banchuen received her D.Sc. in Computer Science from North Bangkok University.

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