


Boosting Convolutional Neural Networks Using a Bidirectional Fast Gated Recurrent Unit for Text Categorization

Assia Belherazem, SIMPA Laboratory, Université des Sciences et de la Technologie d'Oran Mohamed Boudiaf, Algeria*

 <https://orcid.org/0000-0003-3058-4062>

Redouane Tlemsani, Université des Sciences et de la Technologie d'Oran Mohamed Boudiaf, Algeria

ABSTRACT

This paper proposes a hybrid text classification model that combines 1D CNN with a single bidirectional fast GRU (BiFaGRU) termed CNN-BiFaGRU. Single convolution layer captures features through a kernel by applying 128 filters which are slid over these embeds to find convolutions and drop the entire 1D feature maps by using spatial dropout and combined vectors using max-pooling layer. Then, the bidirectional CUDNNGRU block is used to extract temporal features. The results of this layer are normalized by the batch normalization layer and transmitted to the fully connected layer. The output layer produces the final classification results. Precision/loss score was used as the main criterion on five different datasets (WebKb, R8, R52, AG-News, and 20 NG) to assess the performance of the proposed model. The results indicate that the precision score of the classifier on WebKb, R8, and R52 data sets significantly improved from 90% up to 97% compared to the best result achieved by other methods such as LSTM and Bi-LSTM. Thus, the proposed model shows higher precision and lower loss scores than other methods.

KEYWORDS

Convolutional Neural Networks, Deep Neural Network, Gated Recurrent Unit, Natural Language Processing, Text Classification

INTRODUCTION

This paper proposes an automatic approach to categorizing text using deep learning. Text categorization is the associating documents process to predefined classes (categories or labels) written in natural language using natural language processing (NLP). Many researchers have used text classification with deep learning architectures that assure high precision with less need for engineering features. The key aspect of deep learning is that the resultant layers of features are not designed by human engineers, but, rather, are learned from data using a general-purpose learning procedure.

In particular, the recurrent neural network (RNN) is a very powerful dynamic system and an important implementation mechanism of deep learning. The RNN method can find the dependencies

DOI: 10.4018/IJAIML.308815

*Corresponding Author

This article published as an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>) which permits unrestricted use, distribution, and production in any medium, provided the author of the original work and original publication source are properly credited.

relationship of time series that provide more effective ways for time memory to operate. Loop memory can extract valuable information from the history data through memory cell execution and other control mechanisms. The long short-term memory (LSTM) and gated recurrent units (GRUs) are two kinds of special memory cells of RNN that employ different memory cell mechanisms. LSTM and GRU networks use special hidden units whose natural function is remembering inputs for a long time (Hochreiter & Schmidhuber, 1997). However, regarding a load of power data with obvious time series and cycles characteristics, load forecasting can take advantage of history information via the LSTM and the GRU cell (Zhang, Wu et al., 2018).

This paper examines the multiclass automatic classification applying a hybrid approach by integrating convolution neural network (CNN) and bidirectional fast gated recurrent unit (BiFaGRU) termed as CNN-BiFaGRU. CNN-BiFaGRU is a supervised text classification testing on different textual databases (Reuters8, Reuters52, WebKB, 20NewsGroup, and AG NEWS) using the GloVe word embedding proposed by Pennington et al. (2014). The model is evaluated using different metrics such as accuracy, precision, recall, F1-score, and the confusion matrix. The obtained results are detailed in the section of results and discussion.

The main contributions of this paper are summarized as follows:

- The implementation of a new model using a 1D CNN followed by a single bidirectional CuDNNGRU performs the classification.
- The use of both CNN and Bi-CuDNNGRU maximizes the potential of the text representation with the capability to generate complex content sequences with minimal storage requirements.
- Experiments on five commonly used datasets demonstrate that the proposed model yields remarkable computing time and precision performance with a low loss against state-of-the-art methods.

The rest of the paper is organized as follows: The second section represents the related work; the third section defines the proposed model, how it works, how the authors implemented the hybrid model and the implementation of other four models to compare them with their best model; The fourth section focuses on the problem statement, description of the datasets, and the exploratory data analysis and settings used to solve the problem; in addition, the fourth section explains in detail how the data were prepared and represented, which word emblems were used, how the dataset was divided for training and testing, and which evaluation criteria were used to assess the performance of the proposed model; The fifth section presents the results using various words embedding; the sixth section discusses the results obtained; finally, the seventh section concludes the paper.

STATE OF THE ART

Many approaches have been proposed in the past few years. Johnson and Zhang's (2015b) ConvNets model or char-level CNN applies only to a character. It can work in different languages (Johnson & Zhang, 2015a). The Kim's (2014) TextCNN model uses the Word2vec (Mikolov et al., 2013). This architecture is a variant Collobert et al.'s (2011) CNN architecture; it is training only on labeled data.

Yang et al. (2016) explored LSTM encoders for text classification tasks, the researchers proposed a hierarchical attention network for document classification, also Liu et al. (2016) proposed LSTM, and Bi-LSTM, the LSTM uses the last hidden state to represent the text and a bidirectional LSTM, commonly used in text classification with pretrained word embeddings. LSTMs are similar to BiLSTMs in their recurrent bidirectional message flow between words, but different in the design of state transition. Dai and Le (2015) proposed two approaches: LM-LSTM is to predict what comes next in a sequence, and SA-LSTM used a sequence auto-encoder, which reads the input sequence into a vector and predicts the input sequence again.

18 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage: www.igi-global.com/article/boosting-convolutional-neural-networks-using-a-bidirectional-fast-gated-recurrent-unit-for-text-categorization/308815

Related Content

Developing a Data Lakehouse for a South African Government-Sector Training Authority: Implementing Quality Control for Incremental Extract-Load-Transform Pipelines in the Ingestion Layer

Priyanka Govender, Nalindren Naicker, Sulaiman Saleem Patel, Seena Joseph, Devraj Moonsamy, Ayotuyi Tosin Akinola, Lavanya Madamshetty and Thamotharan Prinavin Govender (2024). *Machine Learning and Data Science Techniques for Effective Government Service Delivery* (pp. 157-184).

www.irma-international.org/chapter/developing-a-data-lakehouse-for-a-south-african-government-sector-training-authority/343114

Recommendation System: A New Approach to Recommend Potential Profile Using AHP Method

Safia Baali (2021). *International Journal of Artificial Intelligence and Machine Learning* (pp. 1-14).

www.irma-international.org/article/recommendation-system/279278

Sensors and Data in Mobile Robotics for Localisation

Victoria J. Hodge (2023). *Encyclopedia of Data Science and Machine Learning* (pp. 2223-2238).

www.irma-international.org/chapter/sensors-and-data-in-mobile-robotics-for-localisation/317618

Efficient Closure Operators for FCA-Based Classification

Nida Meddouri and Mondher Maddouri (2020). *International Journal of Artificial Intelligence and Machine Learning* (pp. 79-98).

www.irma-international.org/article/efficient-closure-operators-for-fca-based-classification/257273

A Survey on Arabic Handwritten Script Recognition Systems

Soumia Djaghbello, Abderraouf Bouziane, Abdelouahab Attia and Zahid Akhtar (2021). *International Journal of Artificial Intelligence and Machine Learning* (pp. 1-17).

www.irma-international.org/article/a-survey-on-arabic-handwritten-script-recognition-systems/279276