Impact of Neural Networks in NLP

Omkar Nandkishor Shelte

MSC IT Department, Model College (Dombivli),

University of Mumbai, India

***Abstract*—This document is the research paper on Applications of Neural Networks in Natural Language Processing. Here we are going to see the introduction to neural network and natural language processing.The model of neural networks being used in natural language processing and various applications of neural networks in natural language processing.**

Keywords—Neural networks, NLP,RNN,.CNN

Introduction

Aartificial neural networks allow modeling of nonlinear processes, they have turned into a very popular and useful tool for solving many problems such as classification, clustering, regression, pattern recognition, dimension reduction, structured prediction, machine translation, anomaly detection, decision making, visualization, computer vision, and others. This wide range of abilities makes it possible to use artificial neural networks in many areas. In this article, we discuss applications of artificial neural networks in Natural Language Processing tasks (NLP).

NLP includes a wide set of syntax, semantics, discourse, and speech tasks. We will describe prime tasks in which neural networks demonstrated state-of-the-art performance.

I. Natural Language Processing

Natural Language Processing (NLP) is a sub-field of computer science and artificial intelligence, dealing with processing and generating natural language data.
Although there is still research that is outside of the machine learning, most NLP is now based on language models produced by machine learning.NLP is a good use case for RNNs and is used in the article to explain how RNNs can be constructed.

II. Language Models

The aim for a language model is to minimise how confused the model is having seen a given sequence of text.It is only necessary to train one language model per domain, as the language model encoder can be used for different purposes such as text generation and multiple different classifiers within that domain.As the longest part of training is usually creating the language model encoder, reusing the encoder can save significant training time.

III. Recurrent Neural Networks and Natural Language Processing.

Recurrent Neural Networks (RNNs) are a form of machine learning algorithm that are ideal for sequential data such as text, time series, financial data, speech, audio, video among others. RNNs are ideal for solving problems where the sequence is more important than the individual items themselves.An RNNs is essentially a fully connected neural network that contains a refactoring of some of its layers into a loop. That loop is typically an iteration over the addition or concatenation of two inputs, a matrix multiplication and a non-linear function.Among the text usages, the following tasks are among those RNNs perform well at:

- Sequence labelling
- Natural Language Processing (NLP) text classification
- Natural Language Processing (NLP) text generation

Other tasks that RNNs are effective at solving are time series predictions or other sequence predictions that aren't image or tabular based.There has been several highlighted and controversial reports in the media over the advances in text generation, in particular OpenAI's GPT-2 algorithm. In many cases the generated text is often indistinguishable

from text written by humans.RNNs effectively have an internal memory that allows the previous inputs to affect the subsequent predictions. It's much easier to predict the next word in a sentence with more accuracy, if you know what the previous words were.Often with tasks well suited to RNNs, the sequence of the items is as or more important than the previous item in the sequence.

IV. CONVOLUTIONAL NEURAL NETWORK

In deep learning, a **convolutional neural network (CNN, or ConvNet)** is a class of deep neural networks, most commonly applied to analyzing visual imagery. They are also known as **shift invariant or space invariant artificial neural networks (SIANN),** based on their shared-weights architecture and translation invariance characteristics.They have applications in image and video recognition, recommender systems, image classification, medical image analysis, and natural language processing.

CNNs are regularized versions of multilayer perceptrons. Multilayer perceptrons usually mean fully connected networks, that is, each neuron in one layer is connecte to all neurons in the next layer. The "fully-connectedness" of these networks makes them prone to overfitting data. Typical ways of regularization include adding some form of magnitude measurement of weights to the loss function. CNNs take a different approach towards regularization: they take advantage of the hierarchical pattern in data and assemble more complex patterns using smaller and simpler patterns. Therefore, on the scale of connectedness and complexity, CNNs are on the lower extreme.

Convolutional network
were inspired by biological processes in that the connectivity pattern between neurons resembles the organization of the animal visual cortex. Individual cortical neurons respond to stimuli only in a restricted region of the visual field known as the receptive field. The receptive fields of different neurons partially overlap such that they cover the entire visual field.

CNNs use relatively little pre-processing compared to other image classification algorithms. This means that the network learns the filters that in traditional algorithms were hand-engineered. This independence from prior knowledge and human effort in feature design is a major advantage.

V. APPLICATIONS OF ARTIFICIAL NEURAL NETWORKS IN NATURAL LANGUAGE PROCESSING

A. TEXT CLASSIFICATION AND CATEGORIZATION

This is probably the first thing that comes to everyone's mind.Text classification is an essential part in many applications, such as web searching, information filtering, language identification, readability assessment, and sentiment analysis. Neural networks are actively used for these tasks. Use a neural network to classify things. One of the most popular algorithms can be found here Convolutional Neural Networks for Sentence Classification

B. NAMED ENTITY RECOGNITION (NER)

The main task of named entity recognition (NER) is to classify named entities, such as Guido van Rossum, Microsoft, London, etc., into predefined categories like persons, organizations, locations, time, dates, and so on. Many NER systems were already created, and the best of them use neural networks. POS and NER tagging. These two tasks can be combined into the single category of sequence labeling.

C. PART-OF-SPEECH TAGGING

Part-of-speech (POS) tagging has many applications including parsing, text-to-speech conversion, information extraction, and so on. In the work, Part-of-Speech Tagging with Bidirectional Long Short-Term Memory Recurrent Neural Network a recurrent neural network with word embedding for part-of-speech (POS) tagging task is presented . The model was tested on the Wall Street Journal data from Penn Treebank III data set and achieved a performance of 97.40% tagging accuracy.

D. SEMANTIC PARSING AND QUESTION ANSWERING

Question Answering systems automatically answer different types of questions asked in natural languages including definition questions, biographical questions, multilingual questions, and so on. Neural networks usage makes it possible to develop high performing question answering systems.

E. PARAPHRASE DETECTION

Paraphrase detection determines whether two sentences have the same meaning. This task is especially important for question answering systems since there are many ways to ask the same question.Detecting Semantically Equivalent Questions in Online User Forums suggests a method for identifying semantically equivalent questions based on a convolutional neural network.

F. LANGUAGE GENERATION AND MULTI-DOCUMENT SUMMARIZATION

Natural language generation has many applications such as automated writing of reports, generating texts based on analysis of retail sales data, summarizing electronic medical records, producing textual weather forecasts from weather data, and even producing jokes. The ability of language generation allows production of abstractive summaries of multiple user reviews that often have reasonable quality.

G. Machine Translation

Machine translation software is used around the world despite its limitations. In some domains, the quality of translation is not good. To improve the results researchers try different techniques and models, including the neural network approach. The purpose of Neural-based Machine Translation for Medical Text Domain study is to inspect the effects of different training methods on a Polish-English machine translation system used for medical data. To train neural and statistical network-based translation systems The European Medicines Agency parallel text corpus was used. It was demonstrated that a neural network requires fewer resources for training and maintenance. In addition, a neural network often substituted words with other words occurring in a similar context

H. Speech Recognition

Speech recognition has many applications, such as home automation, mobile telephony, virtual assistance, hands-free computing, video games, and so on. Neutral networks are widely used in this area.In Convolutional Neural Networks for Speech Recognition, scientists explain how to apply CNNs to speech recognition in a novel way, such that the CNN's structure directly accommodates some types of speech variability like varying speaking rate. TIMIT phone recognition and a large-vocabulary voice search tasks were used.

I. Character Recognition

Character Recognition systems also have numerous applications like receipt character recognition, invoice character recognition, check character recognition, legal billing document character recognition, and so on. The article Character Recognition Using Neural Network presents a method for the recognition of handwritten characters with 85% accuracy

J. Spell Checking

Most text editors let users check if their text contains spelling mistakes. Neural networks are now incorporated into many spell-checking tools.In Personalized Spell Checking using Neural Networks a new system for detecting misspelled words was proposed. This system is trained on observations of the specific corrections that a typist makes. It outwits many of the shortcomings that traditional spell-checking methods have.

Acknowledgment

Natural Language Processing problems that can be solved using neural networks. As we showed, neural networks have many applications such as text classification, information extraction, semantic parsing, question answering, paraphrase detection, language generation, multi-document summarization, machine translation, and speech and character recognition. In many cases, neural networks methods outperform other methods.

References

1. https://medium.com/@datamonsters/artificial-neural-networks-in-natural-language-processing-bcf62aa9151a
2. https://en.wikipedia.org/wiki/Convolutional_neural_network
3. https://www.quora.com/How-are-neural-networks-used-in-Natural-Language-Processing
4. https://arxiv.org/abs/1709.04109
5. https://arxiv.org/abs/1408.5882
6. https://towardsdatascience.com/recurrent-neural-networks-and-natural-language-processing-73af640c2aa1