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SyntaxNet: Neural Models of Syntax from Google

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Introduction

In the past, it was very difficult for computers to interpret a human's language, especially in some ambiguous contexts, for example, "A human saw a boy with a telescope." can both be translated as "A human used a telescope to look at a boy." or "A human saw a boy and the boy was holding a telescope." These kinds of ambiguities were usually the harder part of Natural Language Understanding[1]. And it is important to use text retrieval and analysis techniques to disambiguate a piece of text through its syntactical structure and the context around it.

SyntaxNet[2] is Google's open-source neural network framework that was developed for Natural Language Understanding. Its release includes the source code required to train a SyntaxNet model, and McParseface[3], a parser implemented by Google that is very strong in analyzing English text.

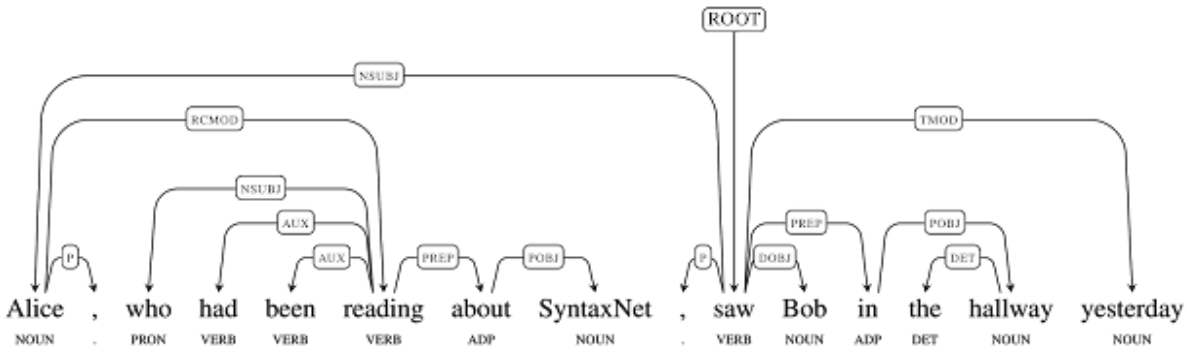
In this paper, I will give a brief overview of SyntaxNet including how it works and its recent upgrade.

[1] "Natural-Language Understanding." Wikipedia, Wikimedia Foundation, 25 June 2021, https://en.wikipedia.org/wiki/Natural-language_understanding.
[2] "Announcing SyntaxNet: The World's Most Accurate Parser Goes Open Source." Google AI Blog, 12 May 2016, https://ai.googleblog.com/2016/05/announcing-syntaxnet-worlds-most.html.
[3] "Parsey McParseface." DeepAI, https://deepai.org/machine-learning-model/parseymcparseface.

How does SyntaxNet work?

Firstly, a sentence is entered as input to SyntaxNet and SyntaxNet will tag each word with what is known as POS[4] tags, i.e. part-of-speech tags. These tags describe the word's syntactic function and determine the word's syntactic relationship with other words in the sentence. This is represented in the dependency parse tree.

Below is an example of the dependency parse tree for the sentence "Alice, who had been reading about SyntaxNet, saw Bob in the hallway yesterday." It's notable that SyntaxNet is capable of parsing sentences with both simple and complex syntactic structures.



It is very common for sentences to have a length of 20 to 30 words. While sentences of this length are usually very easy for humans to comprehend, for computers, there can be up to tens of thousands of different syntactic interpretations. SyntaxNet chooses between the interpretations by looking at the context and finding the most plausible structure.

SyntaxNet solves the problem by applying neural networks to find the correct syntactic structures for the sentences. It processes each sentence from left to right and when

[4] "Part-of-Speech Tagging." Wikipedia, Wikimedia Foundation, 25 Sept. 2021, https://en.wikipedia.org/wiki/Part-of-speech_tagging.

ambiguity arises, a neural network gives scores for each alternative based on their plausibility. Thus, the model uses beam search[5] which is a greedy search algorithm that explores a graph by expanding the most promising node in a limited selection. At each point of decision in time, multiple partial hypotheses are kept. And each hypothesis will only be rejected if there are multiple other higher-ranked hypotheses at the same time.

Recent upgrade of SyntaxNet

When SyntaxNet was first released, it solved a lot of language parsing problems with the state-of-the-art NLU models and McParseface the English language parser. However, it didn't address the problem for languages other than English.

Thus in 2017, it released an upgrade to address the issue. The new technology allowed learning of richly layered representations of input sentences. This includes extending TensorFlow[6] to enable joint modeling of multiple levels of linguistic structure and create dynamic neural network architectures in real time during the processing of a piece of document.

Moreover, the upgrade allows building character-based models, which learn to compose individual characters into words easily. This means that models know that words are related to each other because they share common prefixes and suffixes.

The newest upgrades were incorporated into a new pretrained model called ParseySaurus, which reduces error rate by 25% compared to Parsey's Cousins[7], the pretrained models released right after the initial release of SyntaxNet.

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[5] "Beam Search." *Wikipedia*, Wikimedia Foundation, 28 Oct. 2021, https://en.wikipedia.org/wiki/Beam_search.
[6] "Tensorflow." *TensorFlow*, https://www.tensorflow.org/.
[7] "Meet Parsey's Cousins: Syntax for 40 Languages, plus New SyntaxNet Capabilities." *Google AI Blog*, 8 Aug. 2016, https://research.googleblog.com/2016/08/meet-parseys-cousins-syntax-for-40.html.

Conclusion

SyntaxNet is a very accurate neural network framework developed in TensorFlow that efficiently solves the problem of syntactic ambiguity when a computer tries to understand a sentence. With its initial release that solved the problem for the English language with McParseface, its subsequent release of ParseySaurus in 2017 also solved the problem for other languages. The future of NLU will include incorporating more languages into the database and further improving the accuracy of understanding, as well as increasing the accuracy of disambiguating between the tens of thousands alternatives of understanding a sentence.

References

1. “Announcing SyntaxNet: The World's Most Accurate Parser Goes Open Source.” *Google AI Blog*, 12 May 2016, https://ai.googleblog.com/2016/05/announcing-syntaxnet-worlds-most.html.
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5. “Beam Search.” *Wikipedia*, Wikimedia Foundation, 28 Oct. 2021, https://en.wikipedia.org/wiki/Beam_search.
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