SyntaxNet; How computers understand human language

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Abstract

SyntaxNet, the open-source Natural Network framework developed by Google, uses Tensorflow in the background which provides the framework with all the functionalities for Natural Language Understanding. In a very simplified way, SyntaxNet tags words provided in a sentence with labels that describe the word's syntactic function.

SyntaxNet; How computers understand human language

The key to helping computers know how humans express themselves is understanding the grammatical structure of sentences. It might sound easy, but in reality, it is not. There are many problems that computers face when parsing text structures, one of them is ambiguity. A sentence that for a human would be the natural way of speaking, for a computer it could lead to analyzing a sentence with hundreds of syntactic structures.

In order to tackle this arduous task, Google created a Natural Network Understanding framework called SyntaxNet, the syntactic parser framework has been open-sourced as a package for TensorFlow.

Before getting into more technical aspects of how SyntaxNet works, let me introduce some concepts that will be handy to get a better picture of SyntaxNet.

Syntactic Parsers

Parsing[1] is the process of separating a sentence into units (words), to then analyze its syntactic structure and be able to extract a meaning. Parsing has different objectives, from understanding a sentence, to detecting whether a sentence structure is correct or not.

There are several ways to parse a sentence but one of the most common ones is by using a dependency tree, which draws the relationships between all the words in the sentence and labels them by their syntactic function (E.x. verb, noun, direct object, indirect object).

Parsey McParseface

Parsey McParseface is just the fancy name Google gave to their pre-trained English model. It is built with ML algorithms that learn the linguistic structure of a language, in this case, English.

[1] https://en.wikipedia.org/wiki/Parsing

Beam Search[2]

Beam search is an optimized graph exploration algorithm. It uses breadth-first search[3] and it is considered a greedy algorithm[4].

More about SyntaxNet

Now that we've covered some useful concepts, let's try to scratch the surface of how SyntaxNet works.

SyntaxNet is a syntactic parser, it determines the syntactic relationships between words in a given sentence, to do this, it uses Parsey McParseface as the English pre-trained model and in order to determine the relationships between words, SyntaxNet builds a relationship tree using beam search. When building this relationship tree, SyntaxNet faces several problems, one of the hardest ones being ambiguity. For instance,

> *"The man saw a horse with a telescope."*

As you may notice, this sentence can be interpreted in two different ways,

a) The man had a telescope which he used to observe a horse,

b) The man saw a horse that was carrying a telescope.

For us, as humans, it would be quite obvious to know that option a) is the correct one, but for a computer, this is not that simple. According to Google,

> *"Moderate length sentences - say 20 or 30 words in length - to have hundreds, thousands, or even tens of thousands of possible syntactic structures"*[5]

[2] https://en.wikipedia.org/wiki/Beam_search
[3] https://en.wikipedia.org/wiki/Breadth-first_search
[4] https://en.wikipedia.org/wiki/Greedy_algorithm
[5] https://ai.googleblog.com/2016/05/announcing-syntaxnet-worlds-most.html

Thanks to the complex neural networks and enhanced search algorithms, SyntaxNet can overcome these complex problems. According to Google's measurements, their Parsey McParseface has over 94% accuracy, being the best model available at the moment.

Conclusion

Natural Language Understanding and processing is a hard and complex process. SyntaxNet was one of the first open-sourced frameworks that allowed analysing complex sentences with high accuracy. While the model was not perfect, it approached human precision and efforts are being made to make it even better.

After deep research, I couldn't find any relevant articles published after 2018. There are several tools that Google has released since SyntaxNet was first released. Among the many of them, there is one particularly interesting called Dialogflow[6]. Dialogflow is not just a framework it is a whole Natural Language Understanding platform, it makes it possible to quickly build and deploy solutions without the need for deep knowledge in coding. Besides Dialogflow there are a couple of other tools provided by google such as the Natural Language API[7] which might be worth considering and studying for future projects.

[6] https://cloud.google.com/dialogflow/docs
[7] https://cloud.google.com/natural-language/docs/basics

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