Coreference Resolution [NLP, Python]

Yash Jain · Following

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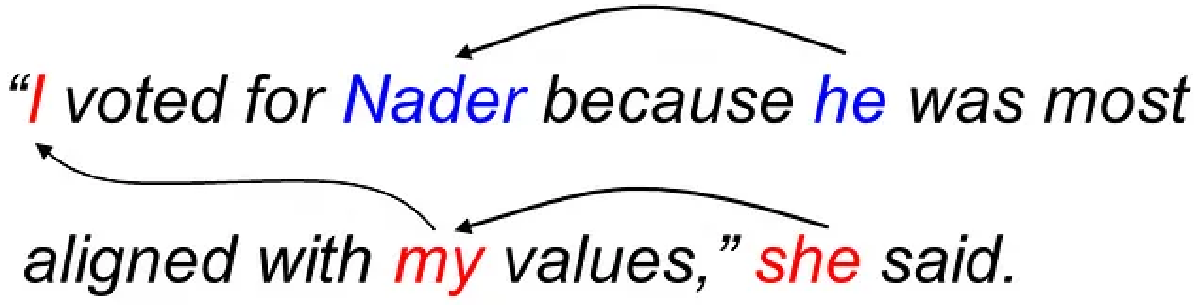


"I voted for Nader because he was most aligned with my values," she said.

Source: https://nlp.stanford.edu/projects/coref.shtml

Coreference resolution is the task of finding all referring expressions like — (he, I, that, this…, or any subject or noun) is referred to which entity (referents like any person, thing, subject etc…)

Some types of References

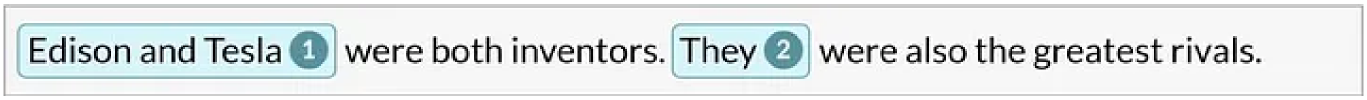
- **Anaphora** — acc. to Wikipedia → "*anaphora is the use of an expression whose interpretation depends specifically upon another (antecedent) expression*" or you can say "*when the referring expression(anaphor) is pointing backwards*"

> *Example:- **The music** was so loud that **it** couldn't be enjoyed*
>
> ***it** → here it is referring to **The music,** here "it" appeared after "The music" in sentence.*

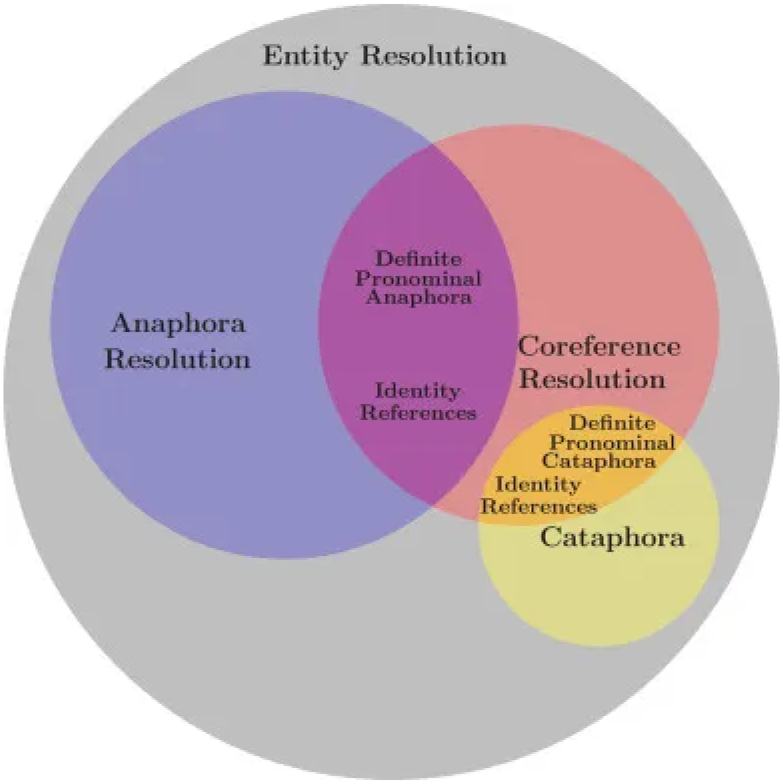
- **Cataphora** — its said to be just reverse of anaphora →"*the use of an expression that depends upon a postcedent expression*" or you can say "*when the referring expression is pointing forward*"

> *Example:- When **he** arrived home, **John** went to sleep.*
>
> ***he** is referred to **John,** and "he" came before "John" in sentence.*

Split antecedents It's an anaphoric expression where the pronoun (2) refers to more than one antecedent (1).



Edison and Tesla 1 were both inventors. They 2 were also the greatest rivals.



Source: ScienceDirect.com

We'll focus on **Coreference Resolution** - it is the task of determining whether two or more mentions *corefer (meaning do they refer to same entity…)*

A coreferent expression is only anaphoric if its interpretation depends on a previous expression in the text (i.e., its antecedent)

> *Example of named mentions instead of pronouns:-*
> *1.* ***International Business Machines*** *sought patent compensation from Amazon;* ***IBM*** *had previously sued other companies.*
> *Well you can see IBM referred to International Business Machines…. these type of references are also there..*
>
> ***2. Barack Obama*** *traveled to ….* ***Obama*** *…*
> *So we can see "obama" and "Barack Obama" are referred to same person.*

Coreference resolution thus comprises two tasks (although they are often performed jointly): (1) identifying the mentions, and (2) clustering them into coreference chains/discourse entities

Let's see another example

> *"Victoria Chen, CFO of Megabucks Banking, saw her pay jump to $2.3 million, as the 38-year-old became the company's president. It is widely known that she came to Megabucks from rival Lotsabucks"*

Let's make cluster of above example:

1. Victoria Chen, her, the 38-year-old, She
2. Megabucks Banking, the company, Megabucks
3. her pay
4. Lotsabucks

An entity that has only a single mention in a text (like Lotsabucks and her pay) is called a **singleton**.

Applications:

- Text Summarization
- Machine Translation
- Information Extraction
- Chatbots / Question-Answer system

> Let’s take a real life example of question answer engine:-

Content provided to QnA engine →
“*Joseph Robinette Biden Jr*. is an American politician who is the 46th and current president of the United States. A member of the Democratic Party, he served as the 47th vice president from 2009 to 2017 under Barack Obama and represented Delaware in the United States Senate from 1973 to 2009.”

Now if we ask question → “Who served as the 47th vice president from 2009 to 2017?”

In QnA engine **without reference resolution** it will give us → “**he**” but that is not the answer we want right? We know here that “**he**” is referred to **Joseph Robinette Biden.** and we want his name as an answer right..? That’s where coreference resolution comes in. It let’s us knows that he was referred to Joseph Robinette Biden so that we work something out and replace “he” or any other mentions, behind the scene. So that we get appropriate answer.

Implementation

spaCy-huggingface(NeuralCoref) coreference resolution

NeuralCoref is a pipeline extension for spaCy 2.1+ which annotates and resolves coreference clusters using a neural network. NeuralCoref is production-ready, integrated in spaCy’s NLP pipeline and extensible to new training datasets.

some more attributes other than `coref_clusters`, `coref_resolved` are there that you can checkout on github here.

To train neural coreference model you can checkout blog here.

Allennlp coreference resolution

```
 pip install allennlp
```

```
pip install allennlp-models
```

If you notice above output cluster formed are [0 to 3 and 26 to 26] and [34 to 34 and 56 to 56]these are the indexes that are given to tokens. See below which are these

```
print(prediction['document'])
```

Output:

```
['Joseph', 'Robinette', 'Biden', 'Jr.', 'is', 'an', 'American',
'politician', 'who', 'is', 'the', '46th', 'andcurrent', 'president',
'of', 'the', 'United', 'States', '.', 'A', 'member', 'of', 'the',
'Democratic', 'Party', ',', 'he', 'served', 'as', 'the', '47th',
'vice', 'president', 'from', '2009', 'to', '2017', 'under', 'Barack',
'Obama', 'andrepresented', 'Delaware', 'in', 'the', 'United',
'States', 'Senate', 'from', '1973', 'to', '2009', '.']
```

and if you notice index 0–3 which represents `Joseph Robinette Biden Jr.` (0,1,2,3) and index 26 (`‘he’`) these are 1 cluster. Another one is `2009` with itself so we can ignore that.

Read this blog about how to make and effective coreference resolution model.
It also explains that **Allennlp seems to find much more clusters than Huggingface neuralcoref**, and Huggingface have some problems while detecting cataphora, allennlp detects cataphora in sentence but it replaces with its first mention in cluster because it considers first mentions as its head. In this beautifully explained blog Martha has explained how to overcome that issue and make some improvements. You can checkout blog **here** and code **here**… These libraries with improvement will still give us good but not perfect result. There is still research going on, on how to make better coreference resolution model.

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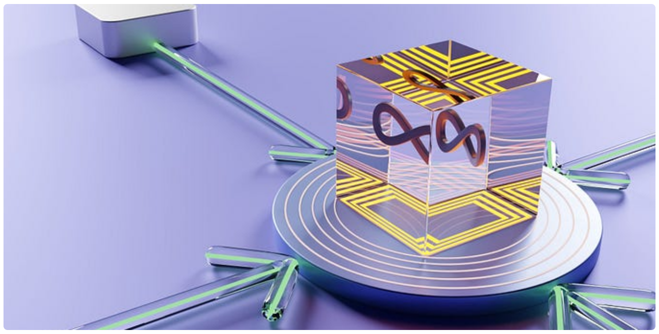

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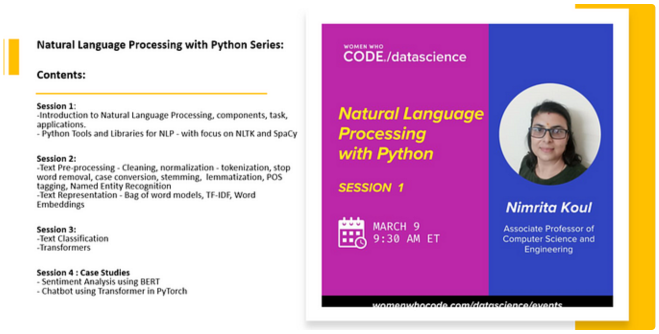

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	Conda	Pip	LibTorch	Source
e	Python	C++ / Java		
e Platform	CUDA 11.7	CUDA 11.8	~~ROCm 5.4.2~~	CPU
Command:	pip3 install torch torchvision torchaudio --index-url https://download.p orch.org/whl/cu117			

```
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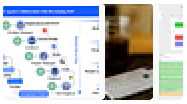

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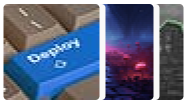

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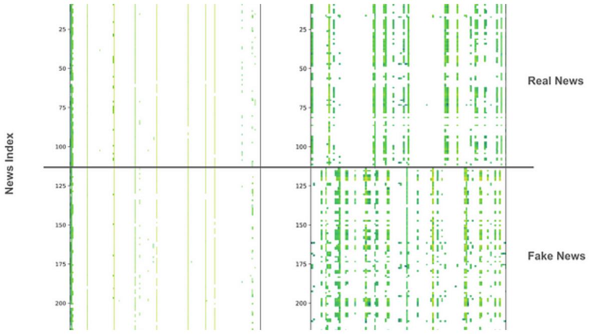

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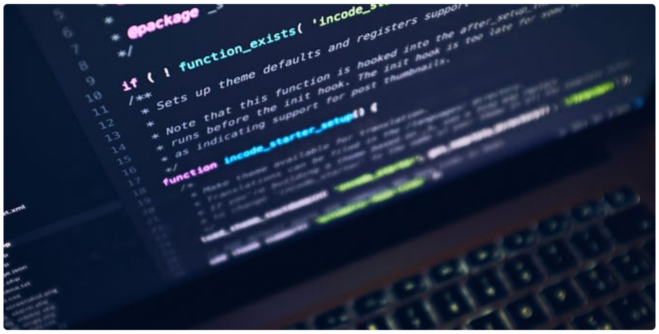

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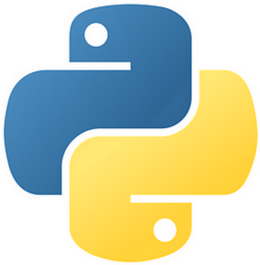

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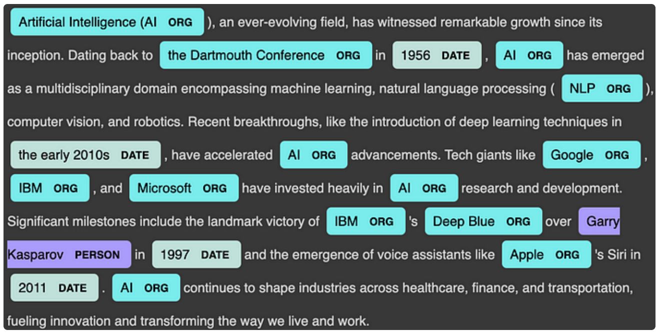

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