spaCy

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About the Tutorial

spaCy, developed by software developers **Matthew Honnibal** and **Ines Montani**, is an open-source software library for advanced NLP (Natural Language Processing). It is written in **Python** and **Cython** (C extension of Python which is mainly designed to give C like performance to the Python language programs). spaCy is a relatively new framework but one of the most powerful and advanced libraries used to implement NLP.

Audience

This tutorial will be useful for graduates, post-graduates, and research students who either have an interest in NLP or have these subjects as a part of their curriculum. The reader can be a beginner or an advanced learner.

Prerequisites

The reader must have basic knowledge about NLP and artificial intelligence. He/she should also be aware about the basic terminologies used in English grammar and Python programming concepts.

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Table of Contents

1. spaCy — Introduction

In this chapter, we will understand the features, extensions and visualisers with regards to spaCy. Also, a features comparison is provided which will help the readers in analysis of the functionalities provided by spaCy as compared to Natural Language Toolkit (NLTK) and coreNLP. Here, NLP refers to Natural Language Processing.

What is spaCy?

spaCy, which is developed by the software developers **Matthew Honnibal** and **Ines Montani**, is an open-source software library for advanced NLP. It is written in **Python** and **Cython** (C extension of Python which is mainly designed to give C like performance to the Python language programs).

spaCy is a relatively a new framework but, one of the most powerful and advanced libraries which is used to implement the NLP.

Features

Some of the features of spaCy that make it popular are explained below:

Fast: spaCy is specially designed to be as fast as possible.

Accuracy: spaCy implementation of its labelled dependency parser makes it one of the most accurate frameworks (within 1% of the best available) of its kind.

Batteries included: The batteries included in spaCy are as follows:

- Index preserving tokenization.
- "Alpha tokenization" support more than 50 languages.
- Part-of-speech tagging.
- Pre-trained word vectors.
- Built-in easy and beautiful visualizers for named entities and syntax.
- Text classification.

Extensile: You can easily use spaCy with other existing tools like TensorFlow, Gensim, scikit-Learn, etc.

Deep learning integration: It has **Thinc**-a deep learning framework, which is designed for NLP tasks.

Extensions and visualisers

Some of the easy-to-use extensions and visualisers that comes with spaCy and are free, open-source libraries are listed below:

Thinc: It is Machine Learning (ML) library optimised for Central Processing Unit (CPU) usage. It is also designed for deep learning with text input and NLP tasks.

sense2vec: This library is for computing word similarities. It is based on Word2vec.

displaCy: It is an open-source dependency parse tree visualiser. It is built with **JavaScript**, **CSS (Cascading Style Sheets)**, and **SVG (Scalable Vector Graphics)**.

displaCy ^{ENT}: It is a built-in named entity visualiser that comes with spaCy. It is built with JavaScript and CSS. It lets the user check its model's prediction in browser.

Feature Comparison

The following table shows the comparison of the functionalities provided by spaCy, NLTK, and CoreNLP:

Features	spaCy	NLTK	CoreNLP
Python API	Yes	Yes	No
Easy installation	Yes	Yes	Yes
Multi-language Support	Yes	Yes	Yes
Integrated word vectors	Yes	No	No
Tokenization	Yes	Yes	Yes
Part-of-speech tagging	Yes	Yes	Yes
Sentence segmentation	Yes	Yes	Yes
Dependency parsing	Yes	No	Yes
Entity Recognition	Yes	Yes	Yes
Entity linking	Yes	No	No
Coreference Resolution	No	No	Yes

Benchmarks

spaCy has the fastest syntactic parser in the world and has the highest accuracy (within 1% of the best available) as well.

Following table shows the benchmark of spaCy:

System	Year	Language	Accuracy
spaCy v2.x	2017	Python and Cython	92.6
spaCy v1.x	2015	Python and Cython	91.8
ClearNLP	2015	Java	91.7
CoreNLP	2015	Java	89.6
MATE	2015	Java	92.5

Turbo	2015	C++	92.4

2. spaCy — Getting Started

This chapter will help the readers in understanding about the latest version of spaCy. Moreover, the readers can learn about the new features and improvements in the respective version, its compatibility and how to install spaCy.

Latest version

spaCy v3.0 is the latest version which is available as a nightly release. This is an experimental and alpha release of spaCy via a separate channel named **spacy-nightly.** It reflects "future spaCy" and cannot be use for production use.

To prevent potential conflicts, try to use a fresh virtual environment.

You can use the below given pip command to install it:

```
pip install spacy-nightly --pre
```

New Features and Improvements

The new features and improvements in the latest version of spaCy are explained below:

Transformer-based pipelines

It features all new transformer-based pipelines with support for multi-task learning. These new transformer-based pipelines make it the highest accurate framework (within 1% of the best available).

You can access thousands of pretrained models for your pipeline because, spaCy's transformer support interoperates with other frameworks like **PyTorch** and **HuggingFace** transformers.

New training workflow and config system

The spaCy v3.0 provides a single configuration file of our training run.

There are no hidden defaults hence, makes it easy to return our experiments and track changes.

Custom models using any ML framework

New configuration system of spaCy v3.0 makes it easy for us to customise the Neural Network (NN) models and implement our own architecture via ML library **Thinc**.

Manage end-to-end workflows and projects

The spaCy project let us manage and share end-to-end workflow for various use cases and domains.

It also let us organise training, packaging, and serving our custom pipelines.

On the other hand, we can also integrate with other data science and ML tools like **DVC (Data Vision Control)**, **Prodigy**, **Streamlit**, **FastAPI**, **Ray**, etc.

Parallel training and distributed computing with Ray

To speed up the training process, we can use Ray, a fast and simple framework for building and running distributed applications, to train spaCy on one or more remote machines.

New built-in pipeline components

This is the new version of spaCy following new trainable and rule-based components which we can add to our pipeline.

These components are as follows:

- SentenceRecognizer
- Morphologizer
- Lemmatizer
- AttributeRuler
- Transformer
- TrainablePipe

New pipeline component API

This SpaCy v3.0 provides us new and improved pipeline component API and decorators which makes defining, configuring, reusing, training, and analyzing easier and more convenient.

Dependency matching

SpaCy v3.0 provides us the new **DependencyMatcher** that let us match the patterns within the dependency parser. It uses **Semgrex** operators.

New and updated documentation

It has new and updated documentation including:

- A new usage guide on embeddings, transformers, and transfer learning.
- A guide on training pipelines and models.
- Details about the new spaCy projects and updated usage documentation on custom pipeline components.
- New illustrations and new API references pages documenting spaCy's ML model architecture and projected data formats.

Compatibility

spaCy can run on all major operating systems such as Windows, macOS/OS X, and Unix/Linux. It is compatible with 64-bit CPython 2.7/3.5+ versions.

Installing spaCy

The different options to install spaCy are explained below:

Using package manager

The latest release versions of spaCy is available over both the package managers, **pip** and **conda**. Let us check out how we can use them to install spaCy:

pip: To install Spacy using pip, you can use the following command:

```
pip install -U spacy
```

In order to avoid modifying system state, it is suggested to install spacy packages in a virtual environment as follows:

```
python -m venv .env

source .env/bin/activate

pip install spacy
```

conda: To install spaCy via conda-forge, you can use the following command:

```
conda install -c conda-forge spacy
```

From source

You can also install spaCy by making its clone from **GitHub repository** and building it from source. It is the most common way to make changes to the code base.

But, for this, you need to have a python distribution including the following:

- Header files
- A compiler
- pip
- virtualenv
- git

Use the following commands:

First, **update pip** as follows:

```
python -m pip install -U pip
```

Now, **clone spaCy** with the command given below:

```
git clone https://github.com/explosion/spaCy
```

Now, we need to **navigate into directory** by using the below mentioned command:

```
cd spaCy
```

Next, we need to **create environment in .env**, as shown below:

```
python -m venv .env
```

Now, **activate the above created virtual environment**.

```
source .env/bin/activate
```

Next, we need to **set the Python path to spaCy directory** as follows:

```
export PYTHONPATH=`pwd`
```

Now, **install all requirements** as follows:

```
pip install -r requirements.txt
```

At last, **compile spaCy**:

```
python setup.py build_ext --inplace
```

Ubuntu

Use the following command to install system-level dependencies in Ubuntu Operating System (OS):

```
sudo apt-get install build-essential python-dev git
```

macOS/OS X

Actually, macOS and OS X have preinstalled Python and git. So, we need to only install a recent version of XCode including CLT (Command Line Tools).

Windows

In the table below, there are Visual C++ Build Tools or Visual Studio Express versions given for official distribution of Python interpreter. Choose on as per your requirements and install:

DISTRIBUTION	VERSION
Python 2.7	Visual Studio 2008
Python 3.4	Visual Studio 2010
Python 3.5+	Visual Studio 2015

Upgrading spaCy

The following points should be kept in mind while upgrading spaCy:

- Start with a clean virtual environment.
- For upgrading spaCy to a new major version, you must have the latest compatible models installed.

- There should be no old shortcut links or incompatible model package in your virtual environment.
- In case if you have trained your own models, the train and runtime inputs must match i.e. you must retrain your models with the newer version as well.

The spaCy v2.0 and above provides a **validate** command, which allows the user to verify whether, all the installed models are compatible with installed spaCy version or not.

In case if there would be any incompatible models, **validate** command will print the tips and installation instructions. This command can also detect out-of-sync model links created in various virtual environments.

You can use the validate command as follows:

```
pip install -U spacy

python -m spacy validate
```

In the above command, **python -m** is used to make sure that we are executing the correct version of spaCy.

Running spaCy with GPU

spaCy v2.0 and above comes with neural network (NN) models that can be implemented in **Thinc**. If you want to run spaCy with Graphics Processing Unit (GPU) support, use the work of Chainer's CuPy module. This module provides a numpy-compatible interface for GPU arrays.

You can install spaCy on GPU by specifying the following:

- spaCy[cuda]
- spaCy[cuda90]
- spaCy[cuda91]
- spaCy[cuda92]
- spaCy[cuda100]
- spaCy[cuda101]
- spaCy[cuda102]

On the other hand, if you know your **cuda** version, the explicit specifier allows **cupy** to be installed. It will save the compilation time.

Use the following command for the installation:

```
pip install -U spacy[cuda92]
```

After a GPU-enabled installation, activate it by calling **spacy.prefer_gpu** or **spacy.require_gpu** as follows:

```
import spacy

spacy.prefer_gpu()

nlp_model = spacy.load("en_core_web_sm")
```

3. spaCy — Models and Languages

Let us learn about the languages supported by spaCy and its statistical models.

Language Support

Currently, spaCy supports the following languages:

LANGUAGE	CODE
Chinese	zh
Danish	da
Dutch	nl
English	en
French	fr
German	de
Greek	el
Italian	it
Japanese	ja
Lithuanian	lt
Multi-language	xx
Norwegian Bokmål	nb
Polish	pl
Portuguese	pt
Romanian	ro
Spanish	es
Afrikaans	af
Albanian	sq
Arabic	ar
Armenian	hy
Basque	eu
Bengali	bn
Bulgarian	bg

Catalan	ca
Croatian	hr
Czech	cs
Estonian	et
Finnish	fi
Gujarati	gu
Hebrew	he
Hindi	hi
Hungarian	hu
Icelandic	is
Indonesian	id
Irish	ga
Kannada	kn
Korean	ko
Latvian	lv
Ligurian	lij
Luxembourgish	lb
Macedonian	mk
Malayalam	ml
Marathi	mr
Nepali	ne
Persian	fa
Russian	ru
Serbian	sr
Sinhala	si
Slovak	sk
Slovenian	sl
Swedish	sv
Tagalog	tl
Tamil	ta
Tatar	tt
Telugu	te

Thai	th
Turkish	tr
Ukrainian	uk
Urdu	ur
Vietnamese	vi
Yoruba	yo

spaCy's statistical models

As we know that spaCy's models can be installed as Python packages, which means like any other module, they are a component of our application. These modules can be versioned and defined in **requirement.txt** file.

Installing spaCy's Statistical Models

The installation of spaCy's statistical models is explained below:

Using Download command

Using spaCy's **download** command is one of the easiest ways to download a model because, it will automatically find the best-matching model compatible with our spaCy version.

You can use the **download** command in the following ways:

The following command will download best-matching version of specific model for your spaCy version:

```
python -m spacy download en_core_web_sm
```

The following command will download best-matching default model and will also create a shortcut link:

```
python -m spacy download en
```

The following command will download the exact model version and does not create any shortcut link:

```
python -m spacy download en_core_web_sm-2.2.0 --direct
```

Via pip

We can also download and install a model directly via pip. For this, you need to use **pip install** with the URL or local path of the archive file. In case if you do not have the direct link of a model, go to model release, and copy from there.

For example,

The command for **installing model using pip with external URL** is as follows:

```
pip install https://github.com/explosion/spacy-
models/releases/download/en_core_web_sm-2.2.0/en_core_web_sm-2.2.0.tar.gz
```

The command for **installing model using pip with local file** is as follows:

```
pip install /Users/you/en_core_web_sm-2.2.0.tar.gz
```

The above commands will install the particular model into your site-packages directory. Once done, we can use **spacy.load()** to load it via its package name.

Manually

You can also download the data manually and place in into a custom directory of your choice.

Use any of the following ways to download the data manually:

- Download the model via your browser from the latest release.
- You can configure your own download script by using the URL (Uniform Resource Locator) of the archive file.

Once done with downloading, we can place the model package directory anywhere on our local file system. Now to use it with spaCy, we can create a shortcut link for the data directory.

Using models with spaCy

Here, how to use models with spaCy is explained.

Using custom shortcut links

We can download all the spaCy models manually, as discussed above, and put them in our local directory. Now whenever the spaCy project needs any model, we can create a shortcut link so that spaCy can load the model from there. With this you will not end up with duplicate data.

For this purpose, spaCy provide us the link command which can be used as follows:

```
python -m spacy link [package name or path] [shortcut] [--force]
```

In the above command, the first argument is the package name or local path. If you have installed the model via pip, you can use the package name here. Or else, you have a local path to the model package.

The second argument is the internal name. This is the name you want to use for the model. The **--force** flag in the above command will overwrite any existing links.

The examples are given below for both the cases.

Example

Given below is an example for setting up shortcut link to load installed package as **"default_model":**

```
python -m spacy link en_core_web_md en_default
```

An example for setting up shortcut link to load local model as **"my_default_model"** is as follows:

```
python -m spacy link /Users/Leekha/model my_default_en
```

Importing as module

We can also **import** an installed model, which can call its **load()** method with no arguments as shown below:

```
import spaCy
import en_core_web_sm
nlp_example = en_core_web_sm.load()
my_doc = nlp_example("This is my first example.")
my_doc
```

Output

The output is as follows:

```
This is my first example.
```

Using own models

You can also use your trained model. For this, you need to save the state of your trained model using **Language.to_disk()** method. For more convenience in deploying, you can also wrap it as a Python package.

Naming Conventions

Generally, the naming convention of **[lang_[name]]** is one such convention that spaCy expected all its model packages to be followed.

The name of spaCy's **model** can be further divided into following three components:

- **Type:** It reflects the capabilities of model. For example, **core** is used for general-purpose model with vocabulary, syntax, entities. Similarly, **depent** is used for only vocab, syntax, and entities.
- **Genre:** It shows the type of text on which the model is trained. For example, **web** or **news.**
- **Size:** As name implies, it is the model size indicator. For example, **sm** (for small), **md** (For medium), or **lg** (for large).

Model versioning

The model versioning reflects the following:

- Compatibility with spaCy.
- Major and minor model version.

For example, a model version r.s.t translates to the following:

- **r: spaCy major version.** For example, 1 for spaCy v1.x.
- **s: Model major version.** It restricts the users to load different major versions by the same code.
- **t: Model minor version.** It shows the same model structure but, different parameter values. For example, trained on different data for different number of iterations.

4. spaCy — Architecture

This chapter tells us about the data structures in spaCy and explains the objects along with their role.

Data Structures

The central data structures in spaCy are as follows:

- **Doc:** This is one of the most important objects in spaCy's architecture and owns the sequence of tokens along with all their annotations.
- **Vocab:** Another important object of central data structure of spaCy is Vocab. It owns a set of look-up tables that make common information available across documents.

The data structure of spaCy helps in centralising strings, word vectors, and lexical attributes, which saves memory by avoiding storing multiple copies of the data.

Objects and their role

The objects in spaCy along with their role and an example are explained below:

Span

It is a slice from **Doc** object, which we discussed above. We can create a Span object from the slice with the help of following command:

```
doc[start : end]
```

Example

An example of span is given below:

```
import spacy
import en_core_web_sm
nlp_example = en_core_web_sm.load()
my_doc = nlp_example("This is my first example.")
span = my_doc[1:6]
span
```

Output

The output is as follows:

```
is my first example.
```

Token

As the name suggests, it represents an individual token such as word, punctuation, whitespace, symbol, etc.

Example

An example of token is stated below:

```
import spacy
import en_core_web_sm
nlp_example = en_core_web_sm.load()
my_doc = nlp_example("This is my first example.")
token = my_doc[4]
token
```

Output

The output is as follows:

```
example
```

Tokenizer

As name suggests, tokenizer class segments the text into words, punctuations marks etc.

Example

This example will create a blank tokenizer with just the English vocab:

```
from spacy.tokenizer import Tokenizer
from spacy.lang.en import English
nlp_lang = English()
blank_tokenizer = Tokenizer(nlp_lang.vocab)
blank_tokenizer
```

Output

The output is given below:

```
<spacy.tokenizer.Tokenizer at 0x26506efc480>
```

Language

It is a text-processing pipeline which, we need to load once per process and pass the instance around application. This class will be created, when we call the method **spacy.load()**.

It contains the following:

- Shared vocabulary

- Language data
- Optional model data loaded from a model package
- Processing pipeline containing components such as tagger or parser.

Example

This example of language will initialise English Language object:

```
from spacy.vocab import Vocab
from spacy.language import Language
nlp_lang = Language(Vocab())
from spacy.lang.en import English
nlp_lang = English()
nlp_lang
```

Output

When you run the code, you will see the following output:

```
<spacy.lang.en.English at 0x26503773cf8>
```

5. spaCy — Command Line Helpers

This chapter gives information about the command line helpers used in spaCy.

Why Command Line Interface?

spaCy v1.7.0 and above comes with new command line helpers. It is used to download as well as link the models. You can also use it to show the useful debugging information. In short, command line helpers are used to download, train, package models, and also to debug spaCy.

Checking Available Commands

You can check the available commands by using **spacy - -help** command.

The example to check the available commands in spaCy is given below:

```
C:\Users\Leekha>python -m spacy --help
```

Output

The output shows the available commands.

```
Available commands

download, link, info, train, pretrain, debug-data, evaluate, convert, package,
init-model, profile, validate
```

Available Commands

The commands available in spaCy are given below along with their respective descriptions.

Command	Description
Download	To download models for spaCy.
Link	To create shortcut links for models.
Info	To print the information.
Validate	To check compatibility of the installed models.
Convert	To convert the files into spaCy's JSON format.
Pretrain	To pre-train the "token to vector (tok2vec)" layer of pipeline components.
Init-model	To create a new model directory from raw data.
Evaluate	To evaluate a model's accuracy and speed.

Package	To generate a model python package from an existing model data directory.
Debug-data	To analyse, debug, and validate our training and development data.
Train	To train a model.

Download command

As name implies, this command is used to download models for spacy. It works by finding the best-matching compatible version. Then, it uses the **pip install** command to download the model as a package. If the model was downloaded via a shortcut, this command will also create a shortcut link.

The download command is convenient, and is an interactive wrapper as compared to direct download because, it performs compatibility checks while downloading the models. It also prints detailed messages in case if the things go wrong.

The **download** command is as follows:

```
python -m spacy download [model] [--direct] [pip args]
```

Arguments

The table below explains its arguments:

ARGUMENT	TYPE	DESCRIPTION
Model	Positional	Here, we need to give model name or shortcut. For example, en, de, en_core_web_sm.
--direct, -d	Flag	It will force direct download of exact model version.
pip args	-	It represents the additional installation options to be passed to pip install, while installing the model package. For example, --user to install to the user home directory. This feature is new and was introduced in version2.1.
--help, -h	Flag	This argument will show help message and other available arguments.

Link command

As name implies, this command will create a shortcut link for models. The models can either be a Python package or a local directory. The shortcut link enables the users to let them load models from any location using a custom name via **spacy.load()**.

The **Link** command is as follows:

```
python -m spacy link [origin] [link_name] [--force]
```

Arguments

The table below explains its arguments:

ARGUMENT	TYPE	DESCRIPTION
Origin	positional	Here we need to provide the model name, whether it is package, or path to local directory.
link_name	positional	It is the name of the shortcut link to create.
--force, -f	flag	This argument will force overwriting of existing link.
--help, -h	flag	This argument will show help message and other available arguments.

Info command

As name implies, this command will print the information about:

- spaCy installation
- models
- local setups

It also generates Markdown-formatted markup to copy-paste into GitHub issues.

The **Info** command is as follows:

```
python -m spacy info [model] [--markdown] [--silent]
```

Arguments

The table below explains its arguments:

ARGUMENT	TYPE	DESCRIPTION
Model	positional	Here we need to provide the model name whether, it is package, or path (optional).
--markdown, -md	Flag	It will print the information as Markdown.
--silent, -s	Flag	It will not print anything but just return the values. This feature is new and was introduced in version2.0.12.
--help, -h	Flag	This argument will show help message and other available arguments.

Example

The below command will give the info about en_core_web_sm installed model.

```
C:\Users\Leekha>python -m spacy info en_core_web_sm
```

Output

This produces the following output:

```
==================== Info about model 'en_core_web_sm' ====================


lang              en

name              core_web_sm

license           MIT

author            Explosion

url               https://explosion.ai

email             contact@explosion.ai

description       English multi-task CNN trained on OntoNotes. Assigns context-
specific token vectors, POS tags, dependency parse and named entities.

sources           [{'name': 'OntoNotes 5', 'url':
'https://catalog.ldc.upenn.edu/LDC2013T19', 'license': 'commercial (licensed by
Explosion)'}]

pipeline          ['tagger', 'parser', 'ner']

version           2.2.0

spacy_version     >=2.2.0

parent_package    spacy

labels            {'tagger': ['$', "''", ',', '-LRB-', '-RRB-', '.', ':', 'ADD',
'AFX', 'CC', 'CD', 'DT', 'EX', 'FW', 'HYPH', 'IN', 'JJ', 'JJR', 'JJS', 'LS',
'MD', 'NFP', 'NN', 'NNP', 'NNPS', 'NNS', 'PDT', 'POS', 'PRP', 'PRP$', 'RB',
'RBR', 'RBS', 'RP', 'SYM', 'TO', 'UH', 'VB', 'VBD', 'VBG', 'VBN', 'VBP', 'VBZ',
'WDT', 'WP', 'WP$', 'WRB', 'XX', '_SP', '``'], 'parser': ['ROOT', 'acl',
'acomp', 'advcl', 'advmod', 'agent', 'amod', 'appos', 'attr', 'aux', 'auxpass',
'case', 'cc', 'ccomp', 'compound', 'conj', 'csubj', 'csubjpass', 'dative',
'dep', 'det', 'dobj', 'expl', 'intj', 'mark', 'meta', 'neg', 'nmod',
'npadvmod', 'nsubj', 'nsubjpass', 'nummod', 'oprd', 'parataxis', 'pcomp',
'pobj', 'poss', 'preconj', 'predet', 'prep', 'prt', 'punct', 'quantmod',
'relcl', 'xcomp'], 'ner': ['CARDINAL', 'DATE', 'EVENT', 'FAC', 'GPE',
'LANGUAGE', 'LAW', 'LOC', 'MONEY', 'NORP', 'ORDINAL', 'ORG', 'PERCENT',
'PERSON', 'PRODUCT', 'QUANTITY', 'TIME', 'WORK_OF_ART']}

source            C:\Users\Leekha\Anaconda3\lib\site-packages\en_core_web_sm
```

Validate command

As name implies, this command will find all the models installed in the current environment, packages as well as shortcut links, and check their compatibility with the current installed version of spaCy. It is recommended to run this command after upgrading spaCy.

The **Validate** command is as follows:

```
python -m spacy validate
```

The command will print the details about the compatibility of your installed models.

Example

An example for the validate command is stated below:

```
C:\Users\Leekha>python -m spacy validate
```

Output

Given below is the output of the code:

```
✔ Loaded compatibility table

====================== Installed models (spaCy v2.2.1) ======================
spaCy installation: C:\Users\Leekha\Anaconda3\lib\site-packages\spacy

TYPE       NAME              MODEL             VERSION
package    en-core-web-sm    en_core_web_sm    2.2.0     ✔
package    en-core-web-md    en_core_web_md    2.2.0     ✔
```

Convert command

As name implies, this command will convert files into spaCy's JavaScript Object Notation **(JSON) format** especially for the use with the **train** command and other experiment management functions.

The **Convert** command is as follows:

```
python -m spacy convert [input_file] [output_dir] [--file-type] [--converter][-
-n-sents] [--morphology] [--lang]
```

Arguments

The table below explains its arguments:

ARGUMENT	TYPE	DESCRIPTION
input_file	positional	It represents the input file.
output_dir	positional	This argument represents the output directory for converted file. Defaults to "-", meaning data will be written to stdout.
--file-type, -t	option	It is the type of file to create.
--converter, -c	option	It represents the name of the converter to use.
--n-sents, -n	option	It represents the number of sentences per document.
--seg-sents, -s	flag	It is used for Segment sentences (for -c ner).

--model, -b	option	It represents the model for parser-based sentence segmentation (for -s).
--morphology, -m	option	This argument enables appending morphology to tags.
--lang, -l	option	It is the language code and used if tokenizer required.
--help, -h	flag	This argument will show help message and other available arguments.

Following are the output file types, which can be generated with this command:

- **json:** It is regular JSON and default output file type.
- **jsonl:** It is Newline-delimited JSON.
- **msg:** It is Binary MessagePack format.

Converter Options

Following table shows the converter options:

ID	DESCRIPTION
Auto	It will automatically pick converter based on file extension and file content.
conll, conllu, conllubio	These are the universal dependencies **.conllu** or **.conll** format.
Ner	It is NER with IOB/IOB2 tags. In this, one token per line with columns is separated by whitespace. The first column is the token and the final column is the IOB tag. The sentences are separated by blank lines and documents are separated by the line **-DOCSTART- -X- O O.** Supports CoNLL 2003 NER format.
Iob	It is NER with IOB/IOB2 tags. In this, one sentence per line with tokens separated by whitespace and annotation separated by **|**, either **word|B-ENT or word|POS|B-ENT.**
Jsonl	It is NER data formatted as JSONL with one dict per line and a **"text"** and **"spans"** key.

Pretrain command

It is used to pre-train the “token to vector (tok2vec)” layer of pipeline components. For this purpose, it uses an approximate language-modeling objective.

The working can be understood with the help of following points:

- First, we need to load the pretrained vectors and then, train a component like CNN to predict vectors which will further match the pretrained ones.
- It will save the weights to a directory after each epoch.

- Once saved, we can now pass a path to one of these pretrained weights files to the **train** command.
- Now for loading weights back in during spacy train, it is recommended to ensure that all settings between pretraining and training are same.

The **Pretrain** command is as follows:

```
python -m spacy pretrain [texts_loc] [vectors_model] [output_dir][--width] [--
conv-depth] [--cnn-window] [--cnn-pieces] [--use-chars] [--sa-depth][--embed-
rows] [--loss_func] [--dropout] [--batch-size] [--max-length][--min-length]  [-
-seed] [--n-iter] [--use-vectors] [--n-save-every][--init-tok2vec] [--epoch-
start]
```

Arguments

The table below explains its arguments:

ARGUMENT	TYPE	DESCRIPTION
texts_loc	positional	This argument takes path to JSONL file with raw texts to learn from. The text is provided as the key **"text"** or tokens as the key **"tokens".**
vectors_model	positional	It is the path or name to spaCy model with vectors to learn from.
output_dir	positional	This argument represents the directory to write models to on each epoch.
--width, -cw	option	It represents the width of CNN layers.
--conv-depth, -cd	option	It represents the depth of CNN layers.
--cnn-window, -cW	option	Introduced in version 2.2.2, represents the window size for CNN layers.
--cnn-pieces, -cP	option	Introduced in version 2.2.2, represents Maxout size for CNN layers. For example, 1 for Mish.
--use-chars, -chr	flag	Introduced in version 2.2.2, defines whether to use character-based embedding or not.
--sa-depth, -sa	option	Introduced in version 2.2.2, represents the Depth of self-attention layers.
--embed-rows, -er	option	This argument takes the number of embedding rows.
--loss-func, -L	option	It represents the Loss function to use for the objective. For example, it can be either **"cosine", "L2"** or **"characters".**
--dropout, -d	option	It represents the dropout rate.
--batch-size, -bs	option	It is the number of words per training batch.

--max-length, -xw	option	With this argument, you can specify maximum words per example. Longer examples than specified length would be discarded.
--min-length, -nw	option	With this argument, you can specify minimum words per example. Shorter examples than specified length would be discarded.
--seed, -s	option	As name implies, it is the seed for random number generators.
--n-iter, -i	option	This argument is used to specify the number of iterations to pretrain.
--use-vectors, -uv	flag	It defines whether to use the static vectors as input features or not.
--n-save-every, -se	option	This argument will save the model every X batches.
--init-tok2vec, -t2v	option	Introduced in version 2.1, defines the path to pretrained weights for the token-to-vector parts of the models.
--epoch-start, -es	option	Introduced in version 2.1.5, represents the epoch to start counting at. It would only be relevant when using **--init-tok2vec** and the given weight file has been renamed. It also prevents unintended overwriting of existing weight files.

Following are the JSON format for raw text:

- **text:** Its type is Unicode, and it represents the raw input text. It would not be required if tokens are available. It is regular JSON and default output file type.
- **tokens:** Its type is list and takes one string per token. It is used for optional tokenization.

Init Model

Like **spacy model** command in version 1.x, **Init model** command is used to create a new model directory from raw data such as Brown clusters and word vectors.

The **Init model** command is as follows:

```
python -m spacy init-model [lang] [output_dir] [--jsonl-loc] [--vectors-loc][--
prune-vectors]
```

Arguments

The table below explains its arguments:

ARGUMENT	TYPE	DESCRIPTION
lang	positional	It represents the model language ISO code. For example, **en**.
output_dir	positional	This argument represents the model output directory. It will be created if it does not already exist.
--jsonl-loc, -j	option	It represents an optional location of JSONL-formatted vocabulary file with the lexical attributes.
--vectors-loc, -v	option	It represents an optional location of vectors. It should be a file where, the first row contains the dimensions of the vectors and followed by a space-separated Word2Vec table. The file can be provided either in **.txt** format or as a zipped text file in **.zip** or **.tar.gz** format.
--truncate-vectors, -t	option	Introduced in version 2.3, represents the number of vectors to truncate to when reading in vectors file. The default value is 0 indicates no truncation.
--prune-vectors, -V	option	This argument represents the number of vectors to prune the vocabulary to. The default value is -1 indicates no pruning.
--vectors-name, -vn	option	It is the name that is to be assigned to the word vectors in the meta.json. For example, **en_core_web_md.vectors**.
--omit-extra-lookups, -OEL	flag	Introduced in version 2.3, it will omit any of the extra lookups tables (cluster/prob/sentiment) from spacy-lookups-data in the model.

Evaluate Command

As name implies, this command will evaluate a model accuracy and speed. It will be done on JSON'-formatted annotated data. Evaluate command will print the results and optionally export **displaCy** visualisations of a sample set of parsers to HTML files (.html).

On the other hand, if the respective component is present in the model's pipeline, the visualizations for dependency parse and NER will be exported as separate files.

The **Evaluate** command is as follows:

```
python -m spacy evaluate [model] [data_path] [--displacy-path] [--displacy-limit][--gpu-id] [--gold-preproc] [--return-scores]
```

Arguments

The table below explains its arguments:

ARGUMENT	TYPE	DESCRIPTION
model	positional	This argument represents the model to be evaluated. It can be either a package or shortcut link name, or a path to a model data directory.
data_path	positional	It is the location of JSON-formatted evaluation data.
--displacy-path, -dp	option	This argument is the directory to output rendered parses as HTML. If this argument is not set, then no visualisations will be generated.
--displacy-limit, -dl	option	It represents the number of parses to generate per file. The default value is 25.
--gpu-id, -g	option	If you want to use GPU, you need to define here. The default value of -1 is for CPU.
--gold-preproc, -G	flag	This argument is for the use of gold preprocessing.
--return-scores, -R	flag	It will return dict containing model scores.

Package Command

As name implies, this command will generate a model python package from an existing model data directory. Using this command, all the data files are copied over. For example, if the path to a file **meta.json** is supplied, this file will be used.

On the other hand, the data can also be entered directly from the command line as well. Once packaging is done, to turn the model into an installable archive file, we can run **python setup.py sdist**.

The **Package** command is as follows:

```
python -m spacy package [input_dir] [output_dir] [--meta-path] [--create-meta]
[--force]
```

Arguments

The table below explains its arguments:

ARGUMENT	TYPE	DESCRIPTION
input_dir	positional	This represents the path to directory which contains model data.
output_dir	positional	This represents the directory to create package folder in.
--meta-path, -m	option	Introduced in version 2.0, represents the path to meta.json file. It is optional.

--create-meta, -c V2.0	flag	Introduced in version 2.0, this argument will create a meta.json file on the command line, even if one already exists in the directory. But, if an existing file is found, the entries will be shown as the defaults in the command line prompt.
--force, -f	flag	It will force overwriting of existing folder in output directory.
--help, -h	flag	This argument will show help message and other available arguments.

Debug-data Command

With the help of this command, we can analyse, debug, and validate our training and development data. We can also get some useful statistics, invalid entity annotations, cyclic dependencies, and low data labels etc.

The **Debug-data** command is as follows:

```
python -m spacy debug-data [lang] [train_path] [dev_path] [--base-model] [--
pipeline] [--ignore-warnings] [--verbose] [--no-format]
```

Arguments

The table below explains its arguments:

ARGUMENT	TYPE	DESCRIPTION
lang	Positional	This argument represents the model language.
train_path	Positional	This is the location of JSON-formatted training data which can be either a file or a directory of files.
dev_path	Positional	This is the location of JSON-formatted development data for evaluation, which can either be a file or a directory of files.
--tag-map-path, -tm V2.2.4	Option	Introduced in version 2.2.4 representing the location of JSON-formatted tag map.
--base-model, -b	Option	This argument is the name of base model to update. It is optional. It can be any loadable spaCy model.
--pipeline, -p	Option	This is comma-separated names of pipeline components to train. The default value is 'tagger,parser,ner'.
--ignore-warnings, -IW	Flag	As name implies, this argument will ignore the warnings and only show statistics as well as errors.
--verbose, -V	Flag	It will print additional information and explanations.
–no-format, -NF	Flag	It will print the results. You can use this argument, if you want to write to a file.

Train Command

As name implies, this command will train a model. The output will be in spaCy's JSON format and on every epoch the model will be saved out to the directory.

To package the model using spaCy package command, model details and accuracy scores will be added to meta.json file.

The **Train** command is as follows:

```
python -m spacy [lang] [output_path] [train_path] [dev_path]

[--base-model] [--pipeline] [--vectors] [--n-iter] [--n-early-stopping][--n-
examples] [--use-gpu] [--version] [--meta-path] [--init-tok2vec][--parser-
multitasks] [--entity-multitasks] [--gold-preproc] [--noise-level][--orth-
variant-level] [--learn-tokens] [--textcat-arch] [--textcat-multilabel][--
textcat-positive-label] [--verbose]
```

Arguments

The table below explains its arguments:

ARGUMENT	TYPE	DESCRIPTION
Lang	positional	This argument is used for model language.
output_path	positional	This argument represents the directory to store model in. It will be created if it does not pre-exist.
train_path	positional	It is the location of JSON-formatted training data which can be a file or a directory of files.
dev_path	positional	It is the location of JSON-formatted development data for evaluation which can be a file or a directory of files.
--base-model, -b	option	Introduced in version 2.1, represents the name of the base model to update. It is optional and can be any loadable spaCy model.
--pipeline, -p	option	It is also introduced in version 2.1. This is comma-separated names of pipeline components to train. The default value is 'tagger,parser,ner'.
--replace-components, -R	flag	This argument will replace components from the base model.
--vectors, -v	option	It is the model from which the vectors should be loaded.
--n-iter, -n	option	It will give the number of iterations. The default value is 30.
--n-early-stopping, -ne	option	It represents the maximum number of training epochs without dev accuracy improvement.

--n-examples, -ns	option	It will be the number of examples to use. The default value of 0 will use all examples.
--use-gpu, -g	option	Use this argument if you want to use GPU. You need to provide GPU-ID. The default value of -1 will be for CPU only.
--version, -V	option	It will be the model version.
--meta-path, -m	option	Introduced in version 2.0, represents an optional path to model meta.json. It will overwrite all the relevant properties like lang, pipeline and spacy_version.
--init-tok2vec, -t2v	option	Introduced in version 2.1, represents the path to pretrained weights for the token-to-vector parts of the models.
--parser-multitasks, -pt	option	It is the side objectives for parser CNN. For example, 'dep' or 'dep,tag'
--entity-multitasks, -et	option	It is the side objectives for NER CNN. For example, 'dep' or 'dep,tag'
--width, -cw	option	Introduced in version 2.2.4, represents the width of CNN layers of Tok2Vec component.
--conv-depth, -cd	option	Introduced in version 2.2.4, represents the depth of CNN layers of Tok2Vec component.
--cnn-window, -cW	option	Introduced in version 2.2.4, represents the window size for CNN layers of Tok2Vec component.
--cnn-pieces, -cP	option	Introduced in version 2.2.4, represents the maxout size for CNN layers of Tok2Vec component.
--bilstm-depth, -lstm	option	Introduced in version 2.2.4, represents the depth of BiLSTM layers of Tok2Vec component.
--embed-rows, -er	option	Introduced in version 2.2.4, represents the number of embedding rows of Tok2Vec component.
--noise-level, -nl	option	This argument indicates the amount of corruption for data augmentation. The value will be in float.
--orth-variant-level, -ovl	option	This argument indicates the orthography variation for data augmentation.
--gold-preproc, -G	flag	This flag will use gold preprocessing.
--learn-tokens, -T	flag	It is flag and Make parser learn gold-standard tokenization by merging the sub-tokens. It is typically used for languages like Chinese.
--textcat-multilabel, -TML	flag	Introduced in version 2.2, represents the text classification classes are not mutually exclusive (multilabel).

--textcat-arch, -ta	option	Introduced in version 2.2, represents the text classification model architecture. Default value is "bow".
--textcat-positive-label, -tpl	option	Introduced in version 2.2, represents the text classification positive label for binary classes with two labels.
--tag-map-path, -tm	option	Introduced in version 2.2.4, represents the location of JSON-formatted tag map.
--verbose, -VV	flag	Introduced in version 2.0.13,shows more detailed messages during training.
--help, -h	flag	This argument is used to show help message and available arguments.

6. spaCy — Top-level Functions

Here, we will be discussing some of the top-level functions used in spaCy. The functions along with the descriptions are listed below:

Command	Description
spacy.load()	To load a model.
spacy.blank()	To create a blank model.
spacy.info()	To provide information about the installation, models and local setup from within spaCy.
spacy.explain()	To give a description.
spacy.prefer_gpu()	To allocate data and perform operations on GPU.
spacy.require_gpu()	To allocate data and perform operations on GPU.

spacy.load()

As the name implies, this spacy function will load a model via following:

- Its shortcut links.
- The name of the installed model package.
- A Unicode paths.
- Path-like object.

spaCy will try to resolve the load argument in the below given order:

- If a model is loaded from a shortcut link or package name, spaCy will assume it as a Python package and call the model's own **load()** method.
- On the other hand, if a model is loaded from a path, spacy will assume it is a data directory and hence initialize the **Language** class.

Upon using this function, the data will be loaded in via **Language.from_disk**.

Arguments

The table below explains its arguments:

NAME	TYPE	DESCRIPTION
name	unicode / Path	It is the shortcut link, package name or path of the model to load.
disable	List	It represents the names of pipeline components to disable.

Example

In the below examples, spacy.load() function loads a model by using shortcut link, package, unicode path and a pathlib path:

Following is the command for spacy.load() function for loading a model by using the **shortcut link**:

```
nlp_model = spacy.load("en")
```

Following is the command for spacy.load() function for loading a model by using **package:**

```
nlp_model = spacy.load("en_core_web_sm")
```

Following is the command for spacy.load() function for loading a model by using the **Unicode path**:

```
nlp_model = spacy.load("/path/to/en")
```

Following is the command for spacy.load() function for loading a model by using the **pathlib path**:

```
nlp_model = spacy.load(Path("/path/to/en"))
```

Following is the command for spacy.load() function for loading a model **with all the arguments**:

```
nlp_model = spacy.load("en_core_web_sm", disable=["parser", "tagger"])
```

spacy.blank()

It is the twin of spacy.blank() function, creates a blank model of a given language class.

Arguments

The table below explains its arguments:

NAME	TYPE	DESCRIPTION
name	unicode	It represents the ISO code of the language class to be loaded.
disable	list	This argument represents the names of pipeline components to be disabled.

Example

In the below examples, spacy.blank() function is used for creating a blank model of "en" language class.

```
nlp_model_en = spacy.blank("en")
```

spacy.info()

Like info command, spacy.info() function provides information about the installation, models, and local setup from within spaCy.

If you want to get the model meta data as a dictionary, you can use the **meta-attribute** on your **nlp** object with a loaded model. For example, **nlp.meta**.

Arguments

The table below explains its arguments:

NAME	TYPE	DESCRIPTION
model	unicode	It is the shortcut link, package name or path of a model.
markdown	bool	This argument will print the information as Markdown.

Example

An example is given below:

```
spacy.info()
spacy.info("en")
spacy.info("de", markdown=True)
```

spacy.explain()

This function will give us a description for the following:

- POS tag
- Dependency label
- Entity type

Arguments

The table below explains its arguments:

NAME	TYPE	DESCRIPTION
term	unicode	It is the term which we want to be explained.

Example

An example for the use of spacy.explain() function is mentioned below:

```
import spacy
import en_core_web_sm
nlp= en_core_web_sm.load()
```

```
spacy.explain("NORP")
doc = nlp("Hello TutorialsPoint")
for word in doc:
   print(word.text, word.tag_, spacy.explain(word.tag_))
```

Output

The output is as follows:

```
Hello UH interjection
TutorialsPoint NNP noun, proper singular
```

spacy.prefer_gpu()

If you have GPU, this function will allocate data and perform operations on GPU. But the data and operations will not be moved to GPU, if they are already available on CPU. It will return a Boolean output whether the GPU was activated or not.

Example

An example for the use of spacy.prefer_gpu() is stated below:

```
import spacy
activated = spacy.prefer_gpu()
nlp = spacy.load("en_core_web_sm")
```

spacy.require_gpu()

This function is introduced in version 2.0.14 and it will also allocate data and perform operations on GPU. It will raise an error if there is no GPU available. The data and operations will not be moved to GPU, if they are already available on CPU.

It is recommended that this function should be called right after importing spacy and before loading any of the model. It will also return a Boolean type output.

Example

An example for the use of spacy.require_gpu() function is as follows:

```
import spacy
spacy.require_gpu()
nlp = spacy.load("en_core_web_sm")
```

7. spaCy — Visualization Function

Visualizer functions are mainly used to visualize the dependencies and also the named entities in browser or in a notebook. As of spacy version 2.0, there are two popular visualizers namely **displaCy** and **displaCy^{ENT}**.

They both are the part of spacy's built-in visualization suite. By using this visualization suite namely displaCy, we can visualize a dependency parser or named entity in a text.

displaCy()

Here, we will learn about the displayCy dependency visualizer and displayCy entity visualizer.

Visualizing the dependency parse

The displaCy dependency visualizer (dep) will show the POS(Part-of-Speech) tags and syntactic dependencies.

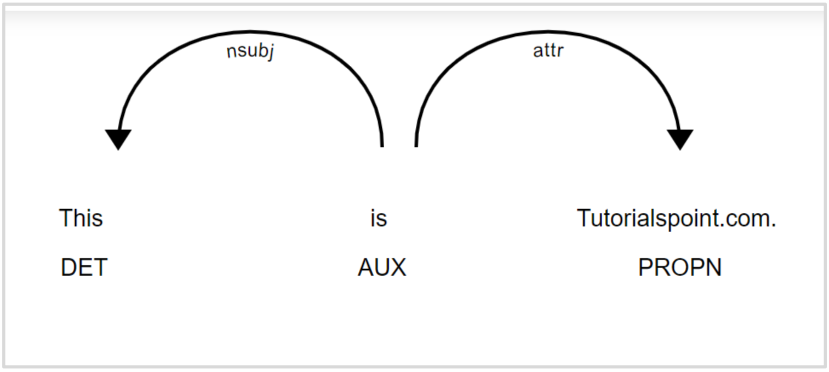
Example

An example for the use of displaCy() dependency visualizer for visualizing the dependency parse is given below:

```
import spacy
from spacy import displacy
nlp = spacy.load("en_core_web_sm")
doc = nlp("This is Tutorialspoint.com.")
displacy.serve(doc, style="dep")
```

Output

This gives the following output:



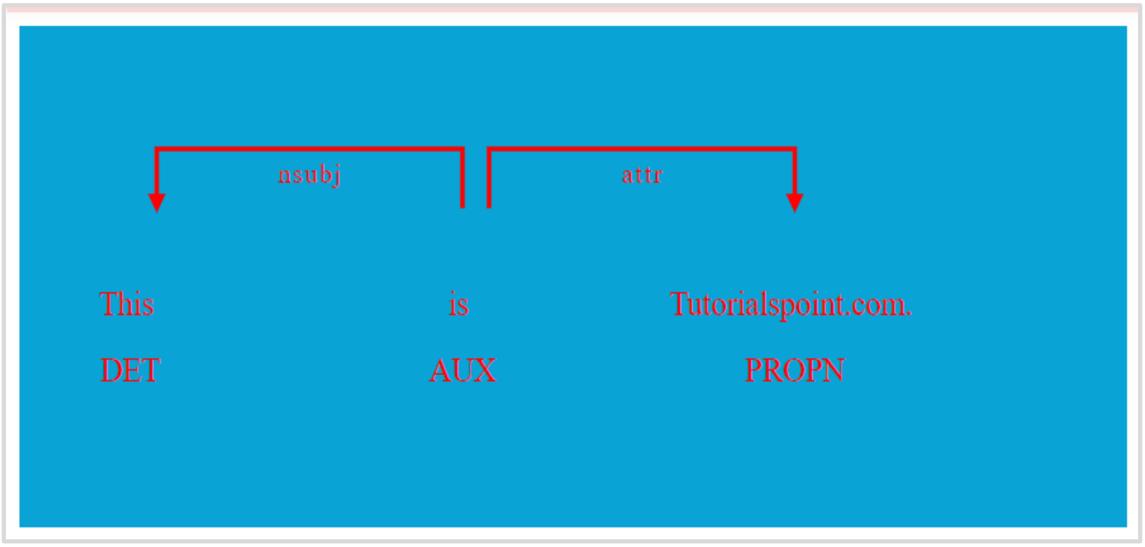
We can also specify a dictionary of settings to customize the layout. It will be under argument **option** (we will discuss in detail later).

The example with options is given below:

```
import spacy
from spacy import displacy
nlp = spacy.load("en_core_web_sm")
doc = nlp("This is Tutorialspoint.com.")
options = {"compact": True, "bg": "#09a3d5",
           "color": "red", "font": "Source Sans Pro"}
displacy.serve(doc, style="dep", options=options)
```

Output

Given below is the output:



Visualizing named entities

The displaCy entity visualizer (ent) will highlight named entities and their labels in a text.

Example

An example for the use of displaCy entity visualizer for named entities is given below:

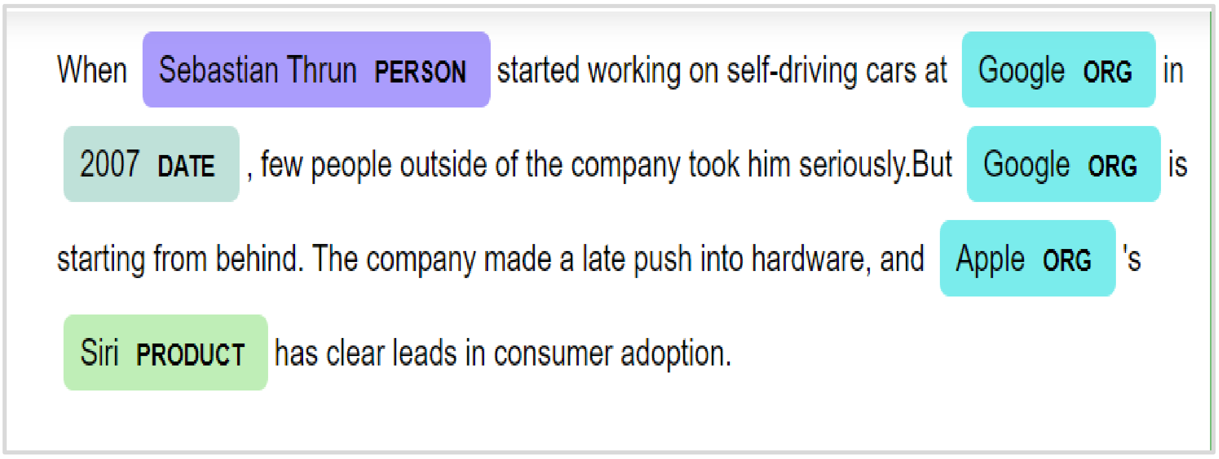
```
import spacy
from spacy import displacy

text = "When Sebastian Thrun started working on self-driving cars at Google in
2007, few people outside of the company took him seriously. But Google is
starting from behind. The company made a late push into hardware, and Apple's
Siri has clear leads in consumer adoption."

nlp = spacy.load("en_core_web_sm")
doc = nlp(text)
displacy.serve(doc, style="ent")
```

Output

The output is stated below:



When Sebastian Thrun PERSON started working on self-driving cars at Google ORG in 2007 DATE , few people outside of the company took him seriously.But Google ORG is starting from behind. The company made a late push into hardware, and Apple ORG 's Siri PRODUCT has clear leads in consumer adoption.

We can also specify a dictionary of settings to customize the layout. It will be under argument **option** (we will discuss in detail later).

The example with options is given below:

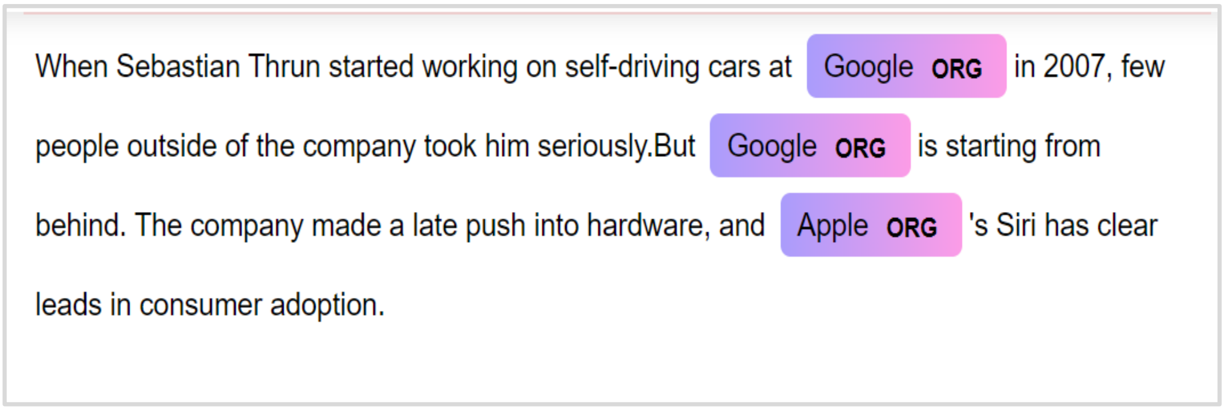
```
import spacy
from spacy import displacy

text = "When Sebastian Thrun started working on self-driving cars at Google in
2007, few people outside of the company took him seriously. But Google is
starting from behind. The company made a late push into hardware, and Apple's
Siri has clear leads in consumer adoption."

nlp = spacy.load("en_core_web_sm")
doc = nlp(text)
colors = {"ORG": "linear-gradient(90deg, #aa9cfc, #fc9ce7)"}
options = {"ents": ["ORG"], "colors": colors}
displacy.serve(doc, style="ent", options=options)
```

Output

The output is mentioned below:


When Sebastian Thrun started working on self-driving cars at Google ORG in 2007, few people outside of the company took him seriously.But Google ORG is starting from behind. The company made a late push into hardware, and Apple ORG 's Siri has clear leads in consumer adoption.

displaCy() methods

As of version 2.0, displaCy () function has two methods namely serve and render. Let's discuss about them in detail. A table is given below of the methods along with their respective descriptions.

Method	Description
displayCy.serve	It will serve the dependency parse tree.
displayCy.render	It will render the dependency parse tree.

displaCy.serve

It is the method that will serve a dependency parse tree/ named entity visualization to see in a web browser. It will run a simple web browser.

Arguments

The table below explains its arguments:

NAME	TYPE	DESCRIPTION	DEFAULT
Docs	list, doc, Span	It represents the document to visualize.	
Style	Unicode	We have two visualization style namely 'dep', or 'ent'.	The default value is 'dep'.
Page	bool	It will render the markup as full HTML page.	The default value is true.
minify	bool	This argument will minify the HTML markup.	The default value is false.

options	dict	It represents the visualizers-specific options. For example, colors.	{}
manual	bool	This argument will not parse Doc and instead, expect a dict or list of dicts.	The default value is false.
Port	int	It is the port number to serve visualization.	5000
Host	unicode	It is the Host number to serve visualization.	'0.0.0.0'

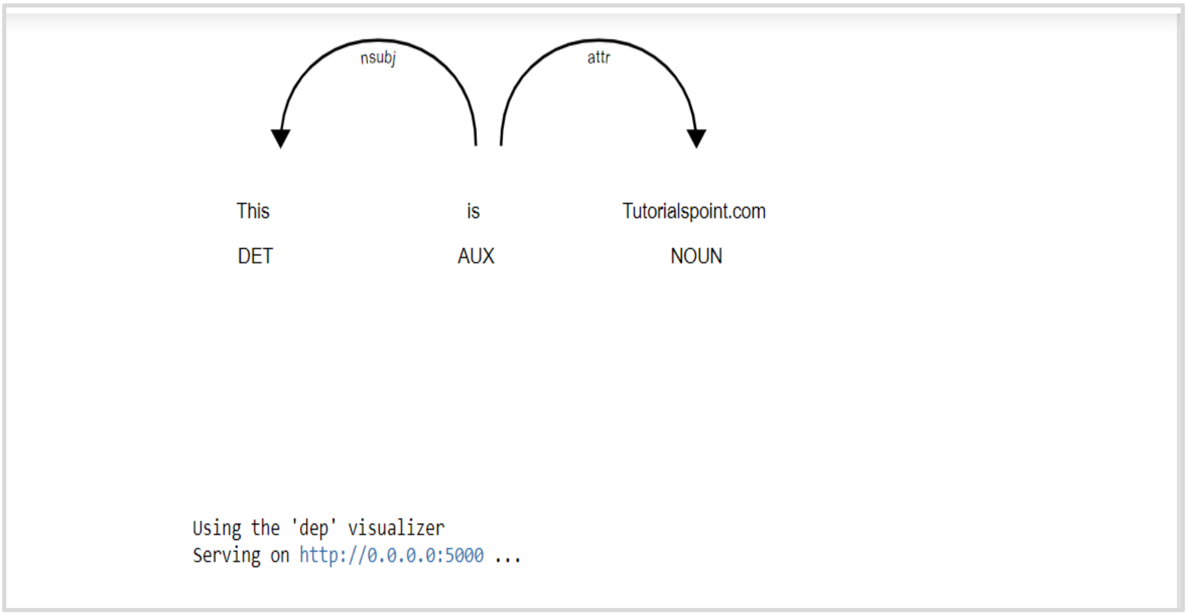
Example

An example for **displayCy.serve** method is given below:

```
import spacy
from spacy import displacy
nlp = spacy.load("en_core_web_sm")
doc1 = nlp("This is Tutorialspoint.com")
displacy.serve(doc1, style="dep")
```

Output

This gives the following output:



```
Using the 'dep' visualizer
Serving on http://0.0.0.0:5000 ...
```

displaCy.render

This displaCy method will render a dependency parse tree or named entity visualization.

Arguments

The table below explains its arguments:

NAME	TYPE	DESCRIPTION	DEFAULT
Docs	list, doc, Span	It represents the document to visualize.	
Style	Unicode	We have two visualization style namely ‘dep’, or ‘ent’.	The default value is ‘dep’.
Page	Bool	It will render the markup as full HTML page.	The default value is false.
minify	Bool	This argument will minify the HTML markup.	The default value is false.
options	Dict	It represents the visualizers-specific options. For example, colors.	{}
manual	Bool	This argument will not parse Doc and instead, expect a dict or list of dicts.	The default value is false.
jupyter	Bool	To return markup ready to be rendered in a notebook, this argument will explicitly enable or disable the Jupyter mode. If we will not provide this argument, it will automatically detect.	None

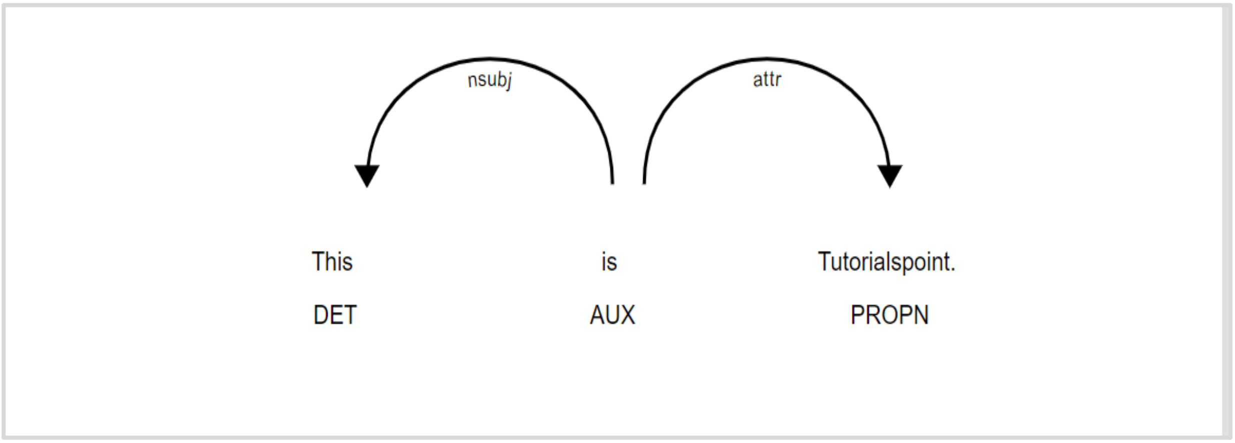
Example

An example for the **displaCy.render** method is stated below:

```
import spacy
from spacy import displacy
nlp = spacy.load("en_core_web_sm")
doc = nlp("This is Tutorialspoint.")
html = displacy.render(doc, style="dep")
```

Output

The output is as follows:



Visualizer options

The **option** argument of dispaCy () function lets us specify additional settings for each visualizer, dependency as well as named entity visualizer.

Dependency Visualizer options

The table below explains the Dependency Visualizer options:

NAME	TYPE	DESCRIPTION	DEFAULT
fine_grained	bool	Put the value of this argument True, if you want to use fine-grained part-of-speech tags (Token.tag_), instead of coarse-grained tags (Token.pos_).	The default value is False.
add_lemma	bool	Introduced in version 2.2.4, this argument prints the lemma's in a separate row below the token texts.	The default value is False.
collapse_punct	bool	It attaches punctuation to the tokens.	The default value is True.
collapse_phrases	bool	This argument merges the noun phrases into one token.	The default value is False.
compact	bool	If you will take this argument as true, you will get the "Compact mode" with square arrows that takes up less space.	The default value is False.
color	unicode	As name implies, this argument is for the text color (HEX, RGB or color names).	'#000000'
bg	unicode	As name implies, this argument is for the Background color (HEX, RGB or color names).	'#ffffff'
font	unicode	It is for the font name.	Default value is 'Arial'.

offset_x	int	This argument is used for spacing on left side of the SVG in px.	The default value of this argument is 50.
arrow_stroke	int	This argument is used for adjusting the width of arrow path in px.	The default value of this argument is 2.
arrow_width	int	This argument is used for adjusting the width of arrow head in px.	The default value of this argument is 10 / 8 (compact).
arrow_spacing	int	This argument is used for adjusting the spacing between arrows in px to avoid overlaps.	The default value of this argument is 20 / 12 (compact).
word_spacing	int	This argument is used for adjusting the vertical spacing between words and arcs in px.	The default value of this argument is 45.
distance	int	This argument is used for adjusting the distance between words in px.	The default value of this argument is 175 / 150 (compact).

Named Entity Visualizer options

The table below explains the Named Entity Visualizer options:

NAME	TYPE	DESCRIPTION	DEFAULT
ents	list	It represents the entity types to highlight. Put None for all types.	The default value is None.
colors	Dict	As name implies, it is use for color overrides. The entity types in uppercase must mapped to color name.	{}

8. spaCy — Utility Functions

We can find some small collection of spaCy's utility functions in spacy/util.py. Let us understand those functions and their usage.

The utility functions are listed below in a table with their descriptions.

Utility Function	Description
Util.get_data_path	To get path to the data directory.
Util.set_data_path	To set custom path to the data directory.
Util.get_lang_class	To import and load a Language class.
Util.set_lang_class	To set a custom Language class.
Util.lang_class_is_loaded	To find whether a Language class is already loaded or not.
Util.load_model	This function will load a model.
Util.load_model_from_path	This function will load a model from a data directory path.
Util.load_model_from_init_py	It is a helper function which is used in the load() method of a model package.
Util.get_model_meta	To get a model's meta.json from a directory path.
Util.update_exc	This function will update, validate, and overwrite tokenizer expectations.
Util.is_in_jupyter	To check whether we are running the spacy from a Jupyter notebook.
Util.get_package_path	To get the path of an installed spacy package.
Util.is_package	To validate model packages.
Util.compile_prefix_regex	This function will compile a sequence of prefix rules into a regex object.
Util.compile_suffix_regex	This function will compile a sequence of suffix rules into a regex object.
Util.compile_infix_regex	This function will compile a sequence of infix rules into a regex object.
Util.compounding	This function will yield an infinite series of compounding values.
Util.decaying	This function will yield an infinite series of linearly decaying values.

Util.itershuffle	To shuffle an iterator.
Util.filter_spans	To filter a sequence of span objects and to remove the duplicates.

Util.get_data_path

This function is used to get path to the data directory where spaCy looks for models. The default path is spacy/data. The output of this function would be a Data Path or none.

Argument

The table below explains its argument:

NAME	TYPE	DESCRIPTION
require_exists	bool	It will return path if it exists, otherwise it will return None.

Example

An example for util.get_data_path() function is stated below:

```
import spacy
spacy.util.get_data_path()
```

Output

The output is as follows:

```
WindowsPath('C:/Users/Leekha/Anaconda3/lib/site-packages/spacy/data')
```

Util.set_data_path

This function is used to set custom path to the data directory, where spaCy looks for models.

Argument

The table below explains its argument:

NAME	TYPE	DESCRIPTION
Path	unicode/Path	It will be the path to the new data directory where spacy looks for models.

Example

An example for util.set_data_path() function is as follows:

```
import spacy
spacy.util.set_data_path(r"C:\Users\Leekha\Anaconda3\pkgs")
spacy.util.get_data_path()
```

Output

The output is given below:

```
WindowsPath('C:/Users/Leekha/Anaconda3/pkgs')
```

You can see from the above output it has changed the path to the path we have provided.

Util.get_lang_class

As the name implies, this function is used to import and load a **Language** class. It will return a Language class for which, we also add a custom language code using util.set_lang_class function.

Argument

The table below explains its argument:

NAME	TYPE	DESCRIPTION
lang	unicode	It will be a two-letter language code. For example, 'de' for German.

Example

An example for util.get_lang_class() function is as follows:

```
import spacy
for language_id in ["de"]:
    language_class = spacy.util.get_lang_class(language_id)
    language = language_class()
language
```

Output

The output is mentioned below:

```
<spacy.lang.de.German at 0x207b96b0dd8>
```

Util.set_lang_class

As name implies, with the help of this function you can set a custom Language class name that can later be loaded via **util.get_lang_class** function.

Arguments

The table below explains its arguments:

NAME	TYPE	DESCRIPTION
name	unicode	It represents the two-letter language code. For example, 'en' for English.
cls	Language	It represents the language class. For example, 'English'.

Example

An example for util.set_lang_class() function is as follows:

```
from spacy.lang.en import English
spacy.util.set_lang_class('en', English)
lang_class = spacy.util.get_lang_class('en')
lang_class
```

Output

The output is stated below:

```
spacy.lang.en.English
```

Util.lang_class_is_loaded

It is introduced in version 2.1. This function can be used to find whether a **Language** class is already loaded or not. It will return Boolean True or False.

Argument

The table below explains its arguments:

NAME	TYPE	DESCRIPTION
name	unicode	It represents the two-letter language code. For example, 'en' for English.

Example 1

An example for util.lang_class_is_loaded() function for English language is given below:

```
import spacy
spacy.util.lang_class_is_loaded("en")
```

Output

The output for example 1 is as follows:

```
True
```

Example 2

An example for util.lang_class_is_loaded() function for German language is given below:

```
import spacy
spacy.util.lang_class_is_loaded("de")
```

Output

The output for example 2 is as stated below:

```
True
```

Example 3

An example for util.lang_class_is_loaded() function for a language is given below. Here, you can see that the language code is incorrect.

```
import spacy
spacy.util.lang_class_is_loaded("fe")
```

Output

The output for example 3 is as follows:

```
False
```

Util.load_model

It is introduced in version 2.0 and is like spacy.load() function. As the name implies, this utility function will load a model via the following:

- Its shortcut links.
- The name of the installed model package
- A Unicode paths.
- Path-like object.

spaCy will try to resolve the load argument in the below given order:

- If a model is loaded from a shortcut link or package name, spaCy will assume it as a Python package and call the model's own **load()** method.
- On the other hand, if a model is loaded from a path, spacy will assume it is a data directory and hence initialize the **Language** class.

Arguments

The table below explains its arguments:

NAME	TYPE	DESCRIPTION
name	unicode / Path	It is the shortcut link, package name or path of the model to load.
disable	List	It represents the names of pipeline components to disable.

Example

An example for util.load_model() utility function is stated below:

```
import spacy
```

Following is an example of util.load_model utility function by **using the shortcut link**:

```
nlp_model = spacy.util.load_model("en")
```

Following is an example of util.load_model utility function by **using the package**:

```
nlp_model = spacy.util.load_model("en_core_web_sm")
```

Following is an example of util.load_model utility function by **using the Unicode path:**

```
nlp_model = spacy.util.load_model ("/path/to/data")
```

Util.load_model_from_path

It is introduced in version 2.0. As the name suggests, this function will load a model from a data directory path.

It works by creating the language class and pipeline based on directory's meta.json. Later on, it will call from_disk with the specified path. With this utility function, we can also easily test a new model that is yet to be packaged.

Arguments

The table below explains its arguments:

NAME	TYPE	DESCRIPTION
model_path	unicode	It is the path to the model the data directory.
disable	List	It represents the names of pipeline components to disable.
meta	Dict	It is model meta data. If this value is false, spaCy will try to load the meta from a meta.json in the same directory.

Example

An example for util.load_model_from_path() function is given below:

```
import spacy
nlp_model = spacy.util.load_model_from_path ("/path/to/data")
```

Util.load_model_from_init_py

It is introduced in version 2.0. It is a helper function, which is used in the load() method of a model package's _init_.py</>.

Arguments

The table below explains its arguments:

NAME	TYPE	DESCRIPTION
init_file	unicode	It is the path to model's _ _init_ _.py.
overrides	-	It represents specific overrides such as the names of pipeline components to disable.

Example

An example of util.load_model_from_init_py() helper function is stated below:

```
import spacy
from spacy.util import load_model_from_init_py
def load(**overrides):
    return load_model_from_init_py(__file__, **overrides)
```

Util.get_model_meta

It is introduced in version 2.0 and is used to get a model's meta.json from a directory path. This function also validate its contents.

Arguments

The table below explains its argument:

NAME	TYPE	DESCRIPTION
path	Unicode/path	It is the path to the model directory.

Example

An example of util.get_model_meta() function is stated below:

```
import spacy
meta_data = spacy.util.get_model_meta("/path/to/model")
```

Util.update_exc

As the name suggests, this function will update, validate, and overwrite tokenizer expectations. We can also use it to combine the global exceptions with custom, language-specific exceptions.

Arguments

The table below explains its arguments:

NAME	TYPE	DESCRIPTION
base_exceptions	Dict	It represents the base tokenizer exceptions.
addition_dicts	Dicts	These are the exception dictionaries that should be added to the base exceptions in order.

Example

An example of util.update_exc() function is as follows:

```
import spacy
BASE =  {"a.": [{ORTH: "a."}], ":)": [{ORTH: ":)"}]}
NEW = {"a.": [{ORTH: "a.", NORM: "all"}]}
exceptions_to_add = spacy.util.update_exc(BASE, NEW)
```

Util.is_in_jupyter

This utility function is used to check whether, we are running the spacy from a Jupyter notebook or not. It is done by detecting the IPython kernel. This utility function is mainly used for the **displaCy** visualizer.

Example

An example of util.is_in_jupyter() function is as follows:

```
import spacy
info = "<h1>This is Tutorialspoint.com!</h1>"
if spacy.util.is_in_jupyter():
    from IPython.core.display import display, HTML
    display(HTML(info))
```

Output

You will see the following output:

```
This is Tutorialspoint.com!
```

Util.get_package_path

As the name implies, this utility function is used to get the path of an installed spacy package. It is mainly used to resolve the location of spacy model packages.

Argument

The table below explains its argument:

NAME	TYPE	DESCRIPTION
package_name	Unicode	It is the name of the installed package.

Example

An example of util.get_package_path() function is as follows:

```
import spacy
spacy.util.get_package_path("en_core_web_sm")
```

Output

When you run the code, you will see the following output:

```
WindowsPath('C:/Users/Leekha/Anaconda3/lib/site-packages/en_core_web_sm')
```

Util.is_package

This utility function is mainly used to validate model packages and to check, if the string maps to an installed package or not.

Argument

The table below explains its argument:

NAME	TYPE	DESCRIPTION
name	Unicode	It is the name of the installed package.

Example 1

An example of util.is_package() function is as follows:

```
import spacy
spacy.util.is_package("en_core_web_sm")
```

Output

When you execute the above code, you should see the following output:

```
True
```

Example 2

An another example for util.is_package() function is given below:

```
spacy.util.is_package("English")
```

Output

When you execute the above code, you should see the following output:

```
False
```

Util.compile_prefix_regex

This utility function will compile a sequence of prefix rules into a regex object.

Argument

The table below explains its argument:

NAME	TYPE	DESCRIPTION
entries	tuple	This argument represents the prefix rules. For example, lang.punctuation.TOKENIZER_PREFIXES</>.

Syntax

```
prefixes = ("§", "%", "=", r"+")
prefix_reg = spacy.util.compile_prefix_regex(prefixes)
nlp.tokenizer.prefix_search = prefix_reg.search
```

Example

```
import spacy
nlp = spacy.load('en_core_web_sm')

prefixes = list(nlp.Defaults.prefixes)
prefixes.remove('\\[')
prefix_regex = spacy.util.compile_prefix_regex(prefixes)
nlp.tokenizer.prefix_search = prefix_regex.search

doc = nlp("[A] works for [B] in [C].")
print([t.text for t in doc])
# ['[A]', 'works', 'for', '[B]', 'in', '[C]', '.']
```

Output

```
['[A', ']', 'works', 'for', '[B', ']', 'in', '[C', ']', '.']
```

Util.compile_suffix_regex

This utility function will compile a sequence of suffix rules into a regex object.

Argument

The table below explains its argument:

NAME	TYPE	DESCRIPTION
entries	Tuple	This argument represents the suffix rules. For example, lang.punctuation.TOKENIZER_SUFFIXES</>.

Syntax

```
suffixes = ("'s", "'S", r"(?<=[0-9])+")
suffix_reg = util.compile_suffix_regex(suffixes)
nlp.tokenizer.suffix_search = suffix_reg.search
```

Example

```
import spacy
nlp = spacy.load('en_core_web_sm')
suffixes = list(nlp.Defaults.suffixes)
suffixes.remove('\\]')
suffix_regex = spacy.util.compile_suffix_regex(suffixes)
nlp.tokenizer.suffix_search = suffix_regex.search

doc = nlp("[A] works for [B] in [C].")
print([t.text for t in doc])
# ['[A]', 'works', 'for', '[B]', 'in', '[C]', '.']
```

Output

```
['[', 'A]', 'works', 'for', '[', 'B]', 'in', '[', 'C]', '.']
```

Util.compile_infix_regex

This utility function will compile a sequence of infix rules into a regex object.

Argument

The table below explains its argument:

NAME	TYPE	DESCRIPTION
entries	Tuple	This argument represents the infix rules. For example, lang.punctuation.TOKENIZER_INFIXES</>.

Syntax

```
infixes = ("…", "-", "—", r"(?<=[0-9])[+-*^](?=[0-9-])")
infix_reg = util.compile_infix_regex(infixes)
nlp.tokenizer.infix_finditer = infix_reg.finditer
```

Example

```
import spacy
nlp = spacy.load('en_core_web_sm')
infixes = ('')
infix_reg = spacy.util.compile_infix_regex(infixes)
nlp.tokenizer.infix_finditer = infix_reg.finditer
doc = nlp("[A] works for [B] in [C].")
print([t.text for t in doc])
# ['[A]', 'works', 'for', '[B]', 'in', '[C]', '.']
```

Output

```
['[', 'A', ']', 'w', 'o', 'r', 'k', 's', 'f', 'o', 'r', '[', 'B', ']', 'i',
'n', '[', 'C', ']', '.']
```

Util.compounding

This utility function will yield an infinite series of compounding values. Whenever the generator is called, a value is produced by multiplying the previous value by that compound rate.

Arguments

The table below explains its arguments:

NAME	TYPE	DESCRIPTION
start	int/float	It represents the first value.
stop	Int/float	It represents the maximum value.
compound	Int/float	It is the compounding factor.

Example 1

An example of util.compounding() utility function is as follows:

```
import spacy
sizes = spacy.util.compounding(5., 50., 5.5)
next(sizes) == 5.
```

Output

The output is given below:

```
True
```

Example 2

An another example of util.compounding() function is given below:

```
next(sizes) == 5. * 5.5
```

Output

The output is as follows:

```
True
```

Example 3

Here is one more example of util.compounding() function. However, here the output is False.

```
next(sizes) == 6.5 * 5.5
```

Output

The output is given below:

```
False
```

Util.decaying

This utility function will yield an infinite series of linearly decaying values.

Arguments

The table below explains its arguments:

NAME	TYPE	DESCRIPTION
Start	int/float	It represents the first value.
Stop	Int/float	It represents the maximum value.
compound	Int/float	It is the compounding factor.

Example 1

An example of util.decaying() function is as follows:

```
import spacy
sizes = spacy.util.decaying(50., 5., 0.001)
next(sizes) == 50.
```

Output

You will receive the following output:

```
True
```

Example 2

An another example of util.decaying() function is as follows:

```
next(sizes) == 50. - 0.001
```

Output

You will receive the following output:

```
True
```

Example 3

Here is one more example of util.decaying() function. However, here the output is False.

```
next(sizes) == 9.999 - 0.001
```

Output

You will receive the following output:

```
False
```

Util.itershuffle

This utility function was introduced in version 2.0, which will shuffle an iterator. This function is good for batching and works by holding the **bufsize** items back and yielding them sometimes later.

Arguments

The table below explains its arguments:

NAME	TYPE	DESCRIPTION
iterable	iterable	It represents the iterator to shuffle.
bufsize	int	This the buffer size for items to hold back. The default value is 1000.

Example

An example of util.itershuffle() function is as follows:

```
import spacy

value = range(1000)
```

```
shuffled_value = spacy.util.itershuffle(values)
shuffled_value
```

Output

The output is stated below:

```
<generator object itershuffle at 0x00000207BBBE4A20>
```

Util.filter_spans

This utility function was introduced in version 2.0. It will filter a sequence of span objects and also removes the duplicates. This function is very useful for creating the named entities.

Argument

The table below explains its argument:

NAME	TYPE	DESCRIPTION
spans	iterable	It represents the spans to filter.

Example

An example of util.filter_spans() function is as follows:

```
import spacy
text = nlp("This is Tutorialspoint.com.")
spans = [text[0:2], text[0:2], text[0:4]]
filtered_document = spacy.util.filter_spans(spans)
filtered_document
```

Output

You will receive the following output:

```
[This is Tutorialspoint.com.]
```

9. spaCy — Compatibility Functions

As we know that all Python codes are written in an intersection of Python2 and Python3 which may be not that fine in Python. But, that is quite easy in Cython.

The compatibility functions in spaCy along with its description are listed below:

Compatibility Function	Description
Spacy.compat()	Deals with Python or platform compatibility.
compat.is_config()	Checks whether a specific configuration of Python version and operating system (OS) matches the user's setup.

Spacy.compat()

It is the function that has all the logic dealing with Python or platform compatibility. It is distinguished from other built-in function by suffixed with an underscore. For example, unicode_.

Some examples are given in the table below:

NAME	PYTHON 2	PYTHON 3
compat.bytes_	str	bytes
compat.unicode_	unicode	str
compat.basestring_	basestring	str
compat.input_	raw_input	input
compat.path2str	str(path) with .decode('utf8')	str(path)

Example

An example of spacy.compat() function is as follows:

```
import spacy
from spacy.compat import unicode_
compat_unicode = unicode_("This is Tutorialspoint")
compat_unicode
```

Output

Upon execution, you will receive the following output:

```
'This is Tutorialspoint'
```

compat.is_config()

It is the function that checks whether a specific configuration of Python version and operating system (OS) matches the user's setup. This function is mostly used for displaying the targeted error messages.

Arguments

The table below explains its arguments:

NAME	TYPE	DESCRIPTION
python2	Bool	Whether spaCy is executed with Python 2.x or not.
python3	Bool	Whether spaCy is executed with Python 3.x or not.
windows	Bool	Whether spaCy is executed on Windows or not.
linux	Bool	Whether spaCy is executed on Linux or not.
OS X	Bool	Whether spaCy is executed on OS X or not.

Example

An example of compat.is_config() function is as follows:

```
import spacy
from spacy.compat import is_config
if is_config(python3=True, windows=True):
    print("Spacy is executing on Python 3 on Windows.")
```

Output

Upon execution, you will receive the following output:

```
Spacy is executing on Python 3 on Windows.
```

10. spaCy — Containers

In this chapter, we will learn about the spaCy's containers. Let us first understand the classes which have spaCy's containers.

Classes

We have four classes which consist of spaCy's containers:

Doc

Doc, a container for accessing linguistic annotations, is a sequence of token objects. With the help of Doc class, we can access sentences as well as named entities.

We can also export annotations to numpy arrays and serialize to compressed binary strings as well. The Doc object holds an array of TokenC structs while, Token and Span objects can only view this array and can't hold any data.

Token

As the name suggests, it represents an individual token such as word, punctuation, whitespace, symbol, etc.

Span

It is a slice from Doc object, which we discussed above.

Lexeme

It may be defined as an entry in the vocabulary. As opposed to a word token, a Lexeme has no string context. It is a word type hence, it does not have any PoS(Part-of-Speech) tag, dependency parse or lemma.

Now, let us discuss all four classes in detail:

Doc Class

The arguments, serialization fields, methods used in Doc class are explained below:

Arguments

The table below explains its arguments:

NAME	TYPE	DESCRIPTION
text	unicode	This attribute represents the document text in Unicode.
text_with_ws	unicode	It is an alias of Doc.text. It is especially provided for duck-type compatibility with Span and Token.

mem	Pool	As name implies, this attribute is for the document's local memory heap, for all C data it owns.
vocab	Vocab	It stores all the lexical types.
tensor	ndarray	Introduced in version 2.0, it is a container for dense vector representations.
cats	dict	Introduced in version 2.0, this attribute maps a label to a score for categories applied to the document. Note that the label is a string, and the score should be a float value.
user_data	-	It represents a generic storage area mainly for user custom data.
lang	int	Introduced in version 2.1, it is representing the language of the document's vocabulary.
lang_	unicode	Introduced in version 2.1, it is representing the language of the document's vocabulary.
is_tagged	bool	It is a flag that indicates whether the document has been part-of-speech tagged or not. It will return True, if the Doc is empty.
is_parsed	bool	It is a flag that indicates whether the document has been syntactically parsed or not. It will return True, if the Doc is empty.
is_sentenced	bool	It is a flag that indicates whether the sentence boundaries have been applied to the document or not. It will return True, if the Doc is empty.
is_nered	bool	This attribute was introduced in version 2.1. It is a flag that indicates whether the named entities have been set or not. It will return True, if the Doc is empty. It will also return True, if any of the tokens has an entity tag set.
sentiment	float	It will return the document's positivity/negativity score (if any available) in float.
user_hooks	dict	This attribute is a dictionary allowing customization of the **Doc's** properties.
user_token_hooks	dict	This attribute is a dictionary allowing customization of properties of **Token** children.
user_span_hooks	dict	This attribute is a dictionary allowing customization of properties of **Span** children.
_	Underscore	It represents the user space for adding custom attribute extensions.

Serialization fields

During serialization process, to restore various aspects of the object, spacy will export several data fields. We can also exclude data fields from serialization by passing names via one of the arguments called **exclude**.

The table below explains the serialization fields:

NAME	DESCRIPTION
Text	It represents the value of the **Doc.text** attribute.
Sentiment	It represents the value of the **Doc.sentiment** attribute.
Tensor	It represents the value of the **Doc.tensor** attribute.
user_data	It represents the value of the **Doc.user_data** dictionary.
user_data_keys	It represents the keys of the **Doc.user_data** dictionary.
user_data_values	It represents the values of the **Doc.user_data** dictionary.

Methods

Following are the methods used in Doc class:

Method	Description
Doc._ _init_ _	To construct a Doc object.
Doc._ _getitem_ _	To get a token object at a particular position.
Doc._ _iter_ _	To iterate over those token objects from which the annotations can be easily accessed.
Doc._ _len_ _	To get the number of tokens in the document.

Doc._ _init_ _

This is one of the most useful methods of Doc class. As the name implies, it is used to construct a **Doc** object.

Arguments

The table below explains its arguments:

NAME	TYPE	DESCRIPTION
vocab	vocab	This argument represents a storage container for the lexical types.
words	iterable	It represents the list of strings which needs to be added to the container.

spaces	iterable	It is the list of Boolean values which indicates whether each word has a subsequent space or not. If you will specify it, you need to keep its length same as words. The default value will be true.

Example 1

An example of **Doc._ _init_ _** method for the **construction via nlp object** is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("This is Tutorialspoint.com.")
doc
```

Output

When you run the code, you will see the following output:

```
This is Tutorialspoint.com.
```

Example 2

An example of **Doc._ _init_ _** method for the **construction via DOC class** is as follows:

```
import spacy
from spacy.tokens import Doc
words = ["This is Tutorialspoint.com."]
doc = Doc(nlp_model.vocab, words=words)
doc
```

Output

When you run the code, you will see the following output:

```
This is Tutorialspoint.com.
```

Doc._ _getitem_ _

This method of Doc class is used to get a token object at a particular position say n. Here, n is an integer. It also supports the negative indexing and follows the usual Python semantics.

For example, doc[-2] is doc[len(doc) - 2].

Argument

The table below explains its argument:

NAME	TYPE	DESCRIPTION
N	integer	It represents the index of the token.

We can also get a span object which starts at a position say start and ends at a position say end. Both these positions are token index.

Example 1

An example of Doc._ _getitem_ _ method is given below:

```
import spacy
doc = nlp_model("This is Tutorialspoint.com")
doc[0].text
```

Output

When you run the code, you will see the following output:

```
'This'
```

Example 2

Refer the example of Doc._ _getitem_ _ method given below:

```
doc[-1].text
```

Output

When you run the code, you will see the following output:

```
'Tutorialspoint.com'
```

Example 3

Here is an another example of Doc._ _getitem_ _ method:

```
span = doc[1:3]
span.text
```

Output

When you run the code, you will see the following output:

```
'is Tutorialspoint.com'
```

Doc._ _iter_ _

This method of Doc class will iterate over those token objects from which the annotations can be easily accessed.

Example

An example Doc._ _iter_ _ is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("This is Tutorialspoint.com.")
[t.text for t in doc]
```

Output

The output is given below:

```
['This', 'is', 'Tutorialspoint.com']
```

Doc._ _len_ _

As name implies, this method of Doc class will get the number of tokens in the document.

Example

An example of Doc._ _len_ _is given below:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("This is Tutorialspoint.com.")
len(doc)
```

Output

The output is as follows:

```
3
```

ClassMethods

Following are the classmethods used in Doc class:

Classmethod	Description
Doc.set_extension	It defines a custom attribute on the Doc.
Doc.get_extension	It will look up a previously extension by name.
Doc.has_extension	It will check whether an extension has been registered on the Doc class or not.
Doc.remove_extension	It will remove a previously registered extension on the Doc class.

Doc.set_extension

This class method was introduced in version 2.0. It defines a custom attribute on the Doc. Once done, that attribute will become available via Doc._.

Arguments

The table below explains its arguments:

NAME	TYPE	DESCRIPTION
name	Unicode	This argument represents the name of the attribute to set by the extension. For example, 'his_attr' will be available as doc._.his_attr.
default	-	It is the optional default value of the attribute for the case when no getter or method is defined.
method	callable	It is used to set a custom method on the object. For example, doc._.compare(other_doc).
getter	callable	This attribute represents the getter function that will takes the object and will return an attribute value. It is mainly called when the user accesses the ._ attribute.
setter	callable	This attribute represents the Setter function that will take the Doc & a value and will modify the object. It is mainly called when the user writes to the Doc._ attribute.
Force	bool	It will forcefully overwrite an existing attribute.

Example

An example of Doc.set_extension classmethod is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
from spacy.tokens import Doc
city = lambda doc: any(city in doc.text for city in ("New York", "India",
"USA"))
Doc.set_extension("has_city", getter=city, force = True)
doc = nlp_model("I like India")
doc._.has_city
```

Output

The output is as follows:

```
True
```

Doc.get_extension

As the name implies, this class method will look up for a previously extension by name. It was also introduced in version 2.0 and will return a 4-tuple (default, method, getter, setter) value.

Example

An example of Doc.get_extension classmethod is given below:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
from spacy.tokens import Doc
Doc.set_extension('has_city', default=False, force = True)
extension = Doc.get_extension('has_city')
extension
```

Output

The output is given below:

```
(False, None, None, None)
```

Doc.has_extension

As name implies, this class method will check whether an extension has been registered on the Doc class or not.

Example

Refer the example for Doc.has_extension classmethod given below:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
from spacy.tokens import Doc
Doc.set_extension('has_city', default=False, force = True)
Doc.has_extension('has_city')
```

Output

The output is mentioned below:

```
True
```

Doc.remove_extension

As the name implies, this class method will remove a previously registered extension on the Doc class.

Example

An example of Doc.remove_extension classmethod is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
from spacy.tokens import Doc
Doc.set_extension('has_city', default=False, force = True)
Removed_ext = Doc.remove_extension('has_city')
Doc.has_extension('has_city')
```

Output

The output is as follows:

```
False
```

11. spaCy — Doc Class ContextManager and Property

In this chapter, let us learn about the context manager and the properties of Doc Class in spaCy.

Context Manager

It is a context manager, which is used to handle the retokenization of the Doc class. Let us now learn about the same in detail.

Doc.retokenize

When you use this context manager, it will first modify the Doc's tokenization, store it, and then, make all at once, when the context manager exists.

The advantage of this context manager is that it is more efficient and less error prone.

Example 1

Refer the example for Doc.retokenize context manager given below:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
from spacy.tokens import Doc
doc = nlp_model("This is Tutorialspoint.com.")
with doc.retokenize() as retokenizer:
    retokenizer.merge(doc[0:0])
doc
```

Output

You will see the following output:

```
is Tutorialspoint.com.
```

Example 2

Here is another example of Doc.retokenize context manager:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
from spacy.tokens import Doc
doc = nlp_model("This is Tutorialspoint.com.")
with doc.retokenize() as retokenizer:
    retokenizer.merge(doc[0:2])
doc
```

Output

You will see the following output:

```
This is Tutorialspoint.com.
```

Retokenize Methods

Given below is the table, which provides information about the retokenize methods in a nutshell. The two retokenize methods are explained below the table in detail.

Method	Description
Retokenizer.merge	It will mark a span for merging.
Retokenizer.split	It will mark a token for splitting into the specified orths.

Retokenizer.merge

This retokenizer method will mark a span for merging.

Arguments

The table below explains its arguments:

NAME	TYPE	DESCRIPTION
Span	Span	It represents the span to merge.
Attrs	dict	These are the attributes to set on the merged token.

Example

An example of Retokenizer.merge method is given below:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("This is Tutorialspoint.com.")
with doc.retokenize() as retokenizer:
    attrs = {"LEMMA": "Tutorialspoint.com"}
    retokenizer.merge(doc[2:4], attrs=attrs)
doc
```

Output

You will receive the following output:

```
This is Tutorialspoint.com.
```

Retokenizer.split

This retokenizer method will mark a token for splitting into the specified orths.

Arguments

The table below explains its arguments:

NAME	TYPE	DESCRIPTION
Token	Token	It represents the token to split.
Orths	List	It represents the verbatim text of the split tokens. The condition is that it must match the text of original token.
Heads	List	It is the list of tokens or tuples that specifies the tokens to attach the newly split sub-tokens to.
Attrs	Dict	These are the attributes to set on all split tokens. It is required that attribute names must be mapped to the list of per-token attribute values.

Example

An example of Retokenizer.split method is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("I like the Tutorialspoint.com")
with doc.retokenize() as retokenizer:
    heads = [(doc[3], 1), doc[2]]
    attrs = {"POS": ["PROPN", "PROPN"],
              "DEP": ["pobj", "compound"]}
    retokenizer.split(doc[3], ["Tutorials", "point.com"], heads=heads,
attrs=attrs)
doc
```

Output

You will receive the following output:

```
I like the Tutorialspoint.com
```

Properties

The properties of Doc Class in spaCy are explained below:

Doc Property	Description
Doc.ents	Used for the named entities in the document.
Doc.noun_chunks	Used to iterate over the base noun phrases in a particular document.
Doc.sents	Used to iterate over the sentences in a particular document.
Doc.has_vector	Represents a Boolean value which indicates whether a word vector is associated with the object or not.
Doc.vector	Represents a real-valued meaning.
Doc.vector_norm	Represents the L2 norm of the document's vector representation.

Doc.ents

This doc property is used for the named entities in the document. If the entity recognizer has been applied, this property will return a tuple of named entity span objects.

Example 1

An example of Doc.ents property is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("This is Tutorialspoint.com.")
ents = list(doc.ents)
ents[0].label
```

Output

When you execute the code, you will see the following output:

```
383
```

Example 2

Here is an another example of Doc.ents property:

```
ents[0].label_
```

Output

The output is as follows:

```
'ORG'
```

Example 3

Given below is an example of Doc.ents property:

```
ents[0].text
```

Output

The output is as follows:

```
'Tutorialspoint.com'
```

Doc.noun_chunks

This doc property is used to iterate over the base noun phrases in a particular document. If the document has been syntactically parsed, then this property will yield base noun-phrase Span objects.

Example 1

An example of Doc.noun_chunks property is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("The website is Tutorialspoint.com.")
chunks = list(doc.noun_chunks)
chunks[0].text
```

Output

The output is mentioned below:

```
'The website'
```

Example 2

Here is an example of Doc.noun_chunks property:

```
chunks[1].text
```

Output

The output is given below:

```
'Tutorialspoint.com'
```

Doc.sents

As name suggests, this doc property is used to iterate over the sentences in a particular document. If the parser is disabled, then the **sents** iterator will be unavailable.

Example 1

Refer the example of Doc.sents property given below:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("The website is Tutorialspoint.com. It is having best technical
tutorials.")
sents = list(doc.sents)
len(sents)
```

Output

You will get the following output:

```
2
```

Example 2

An another example of Doc.sents property is given below:

```
[a.root.text for a in sents]
```

Output

The output is given below:

```
['is', 'having']
```

Doc.has_vector

As the name suggests, this doc property represents a Boolean value which indicates whether a word vector is associated with the object or not.

Example

An example of Doc.has_vector is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("The website is Tutorialspoint.com.")
doc.has_vector
```

Output

The output is as follows:

```
True
```

Doc.vector

This doc property represents a real-valued meaning. The default value is an average of the token vectors.

Example 1

An example of Doc.vector property is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("The website is Tutorialspoint.com.")
doc.vector.dtype
```

Output

The output is as follows:

```
dtype('float32')
```

Example 2

An another example of Doc.vector property is as follows:

```
doc.vector.shape
```

Output

The output of the code is as follows:

```
(96,)
```

Doc.vector_norm

This doc property represents the L2 norm of the document's vector representation.

Example 1

Refer the example of Doc.vector_norm property given below:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc1 = nlp_model("The website is Tutorialspoint.com.")
doc2 = nlp_model("It is having best technical tutorials.")
doc1.vector_norm
```

Output

The output is as follows:

```
11.126218933074995
```

Example 2

Given below is an example of Doc.vector_norm property:

```
doc2.vector_norm
```

Output

The output is as follows:

```
9.99526963324649
```

Example 3

Here is another example of Doc.vector_norm property.

```
doc1.vector_norm != doc2.vector_norm
```

Output

The output is given below:

```
True
```

12. spaCy — Container Token Class

This chapter will help the readers in understanding about the Token Class in spaCy.

Token Class

As discussed previously, Token class represents an individual token such as word, punctuation, whitespace, symbol, etc.

Attributes

The table below explains its attributes:

NAME	TYPE	DESCRIPTION
Doc	Doc	It represents the parent document.
sent	Span	Introduced in version 2.0.12, represents the sentence span that this token is a part of.
Text	unicode	It is Unicode verbatim text content.
text_with_ws	unicode	It represents the text content, with trailing space character (if present).
whitespace_	unicode	As name implies it is the trailing space character (if present).
Orth	int	It is the ID of the Unicode verbatim text content.
orth_	unicode	It is the Unicode Verbatim text content which is identical to Token.text. This text content exists mostly for consistency with the other attributes.
Vocab	Vocab	This attribute represents the vocab object of the parent Doc.
tensor	ndarray	Introduced in version 2.1.7, represents the token's slice of the parent Doc's tensor.
Head	Token	It is the syntactic parent of this token.
left_edge	Token	As name implies it is the leftmost token of this token's syntactic descendants.
right_edge	Token	As name implies it is the rightmost token of this token's syntactic descendants.
I	Int	Integer type attribute representing the index of the token within the parent document.
ent_type	int	It is the named entity type.

ent_type_	unicode	It is the named entity type.
ent_iob	int	It is the IOB code of named entity tag. Here, 3 = the token begins an entity, 2 = it is outside an entity, 1 = it is inside an entity, and 0 = no entity tag is set.
ent_iob_	unicode	It is the IOB code of named entity tag. "B" = the token begins an entity, "I" = it is inside an entity, "O" = it is outside an entity, and "" = no entity tag is set.
ent_kb_id	int	Introduced in version 2.2, represents the knowledge base ID that refers to the named entity this token is a part of.
ent_kb_id_	unicode	Introduced in version 2.2, represents the knowledge base ID that refers to the named entity this token is a part of.
ent_id	int	It is the ID of the entity the token is an instance of (if any). This attribute is currently not used, but potentially for coreference resolution.
ent_id_	unicode	It is the ID of the entity the token is an instance of (if any). This attribute is currently not used, but potentially for coreference resolution.
Lemma	int	Lemma is the base form of the token, having no inflectional suffixes.
lemma_	unicode	It is the base form of the token, having no inflectional suffixes.
Norm	int	This attribute represents the token's norm.
norm_	unicode	This attribute represents the token's norm.
Lower	int	As name implies, it is the lowercase form of the token.
lower_	unicode	It is also the lowercase form of the token text which is equivalent to Token.text.lower().
Shape	int	To show orthographic features, this attribute is for transform of the token's string.
shape_	unicode	To show orthographic features, this attribute is for transform of the token's string.
Prefix	int	It is the hash value of a length-N substring from the start of the token. The defaults value is N=1.
prefix_	unicode	It is a length-N substring from the start of the token. The default value is N=1.
Suffix	int	It is the hash value of a length-N substring from the end of the token. The default value is N=3.
suffix_	unicode	It is the length-N substring from the end of the token. The default value is N=3.

is_alpha	bool	This attribute represents whether the token consist of alphabetic characters or not? It is equivalent to token.text.isalpha().
is_ascii	bool	This attribute represents whether the token consist of ASCII characters or not? It is equivalent to all(ord(c) < 128 for c in token.text).
is_digit	Bool	This attribute represents whether the token consist of digits or not? It is equivalent to token.text.isdigit().
is_lower	Bool	This attribute represents whether the token is in lowercase or not? It is equivalent to token.text.islower().
is_upper	Bool	This attribute represents whether the token is in uppercase or not? It is equivalent to token.text.isupper().
is_title	bool	This attribute represents whether the token is in titlecase or not? It is equivalent to token.text.istitle().
is_punct	bool	This attribute represents whether the token a punctuation?
is_left_punct	bool	This attribute represents whether the token a left punctuation mark, e.g. '(' ?
is_right_punct	bool	This attribute represents whether the token a right punctuation mark, e.g. ')' ?
is_space	bool	This attribute represents whether the token consist of whitespace characters or not? It is equivalent to token.text.isspace().
is_bracket	bool	This attribute represents whether the token is a bracket or not?
is_quote	bool	This attribute represents whether the token a quotation mark or not?
is_currency	bool	Introduced in version 2.0.8, this attribute represents whether the token is a currency symbol or not?
like_url	bool	This attribute represents whether the token resemble a URL or not?
like_num	bool	This attribute represents whether the token represent a number or not?
like_email	bool	This attribute represents whether the token resemble an email address or not?
is_oov	bool	This attribute represents whether the token have a word vector or not?

is_stop	bool	This attribute represents whether the token is part of a "stop list" or not?
Pos	int	It represents the coarse-grained part-of-speech from the Universal POS tag set.
pos_	unicode	It represents the coarse-grained part-of-speech from the Universal POS tag set.
Tag	int	It represents the fine-grained part-of-speech.
tag_	unicode	It represents the fine-grained part-of-speech.
Dep	int	This attribute represents the syntactic dependency relation.
dep_	unicode	This attribute represents the syntactic dependency relation.
Lang	Int	This attribute represents the language of the parent document's vocabulary.
lang_	unicode	This attribute represents the language of the parent document's vocabulary.
Prob	float	It is the smoothed log probability estimate of token's word type.
Idx	int	It is the character offset of the token within the parent document.
Sentiment	float	It represents a scalar value that indicates the positivity or negativity of the token.
lex_id	int	It represents the sequential ID of the token's lexical type which is used to index into tables.
Rank	int	It represents the sequential ID of the token's lexical type which is used to index into tables.
Cluster	int	It is the Brown cluster ID.
_	Underscore	It represents the user space for adding custom attribute extensions.

Methods

Following are the methods used in Token class:

Method	Description
Token._ _init_ _	It is used to construct a Token object.
Token.similarity	It is used to compute a semantic similarity estimate.
Token.check_flag	It is used to check the value of a Boolean flag.

Token._ _len_ _	It is used to calculate the number of Unicode characters in the token.

Token._ _init_ _

This is one of the most useful methods of Token class. As name implies, it is used to construct a **Token** object.

Arguments

The table below explains its arguments:

NAME	TYPE	DESCRIPTION
vocab	Vocab	This argument represents a storage container for the lexical types.
Doc	Doc	It represents the parent document.
ffset	Int	An integer type argument that represents the token within the document.

Example

An example of Token._ _init_ _ method is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("The website is Tutorialspoint.com.")
token = doc[3]
token.text
```

Output

You will get the following output:

```
'Tutorialspoint.com'
```

Token.similarity

This method is used to compute a semantic similarity estimate. The default is cosine over vectors.

Argument

The table below explains its argument:

NAME	TYPE	DESCRIPTION
other	-	It is the object with which the comparison will be done. By default, it will accept Doc, Span, Token, and Lexeme objects.

Example 1

An example of Token.similarity method is given below:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
apples, _, bananas = nlp_model("apples and bananas")
apples_bananas = apples.similarity(bananas)
bananas_apples = bananas.similarity(apples)
apples_bananas
```

Output

The output is as follows:

```
0.5698063
```

Example 2

An another example of Token.similarity method is given below:

```
bananas_apples
```

Output

The output is mentioned below:

```
0.5698063
```

Token.check_flag

This method is used to check the value of a Boolean flag.

Argument

The table below explains its argument:

NAME	TYPE	DESCRIPTION
flag_id	Int	It represents the attribute ID of the flag which is to be checked.

Example 1

An example of Token.check_flag method is given below:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
```

```
from spacy.attrs import IS_TITLE
doc = nlp_model("This is TutorialsPoint.com.")
token = doc[0]
token.check_flag(IS_TITLE)
```

Output

The output is mentioned below:

```
True
```

Example 2

An another example of Token.check_flag method is given below:

```
token = doc[1]
token.check_flag(IS_TITLE)
```

Output

The output is given below:

```
False
```

Token.__len__

This method is used to calculate the number of Unicode characters in the token.

Example

An example of Token._ _len_ _ method is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("This is TutorialsPoint.com.")
token = doc[0]
len(token)
```

Output

The output is as follows:

```
4
```

ClassMethods

Following are the classmethods used in Token class:

Classmethod	Description
Token.set_extension	It defines a custom attribute on the Token.
Token.get_extension	It will look up a previously extension by name.
Token.has_extension	It will check whether an extension has been registered on the Token class or not.
Token.remove_extension	It will remove a previously registered extension on the Token class.

Token.set_extension

This class method was introduced in version 2.0. It defines a custom attribute on the Token. Once done, that attribute will become available via Token._.

Arguments

The table below explains its arguments:

NAME	TYPE	DESCRIPTION
name	Unicode	This argument represents the name of the attribute to set by the extension. For example, 'his_attr' will be available as doc._.his_attr.
default	-	It is the optional default value of the attribute for the case when no getter or method is defined.
method	callable	It is used to set a custom method on the object. For example, token._.compare(other_token).
getter	callable	This attribute represents the getter function that will takes the object and will return an attribute value. It is mainly called when the user accesses the ._ attribute.
setter	callable	This attribute represents the Setter function that will take the Doc & a value and will modify the object. It is mainly called when the user writes to the Token._ attribute.
Force	bool	It will forcefully overwrite an existing attribute.

Example 1

An example of Token.set_extension class method is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
from spacy.tokens import Token
fruit_getter = lambda token: token.text in ("apple", "pear", "banana")
Token.set_extension("is_fruit", getter=fruit_getter, force=True)
doc = nlp_model("I have an pear")
```

```
doc[3]._.is_fruit
```

Output

The output is given below:

```
True
```

Example 2

An another example of Token.set_extension class method is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
from spacy.tokens import Token
fruit_getter = lambda token: token.text in ("apple", "pear", "banana")
Token.set_extension("is_fruit", getter=fruit_getter, force=True)
doc = nlp_model("I have a car")
doc[3]._.is_fruit
```

Output

The output is mentioned below:

```
False
```

Token.get_extension

As the name implies, this class method will look up for a previous extension by name. It was also introduced in version 2.0 and will return a 4-tuple(default, method, getter, setter) value.

Argument

The table below explains its argument:

NAME	TYPE	DESCRIPTION
Name	Unicode	This argument represents the name of the extension.

Example

An example of Token.get_extension class method is given below:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
from spacy.tokens import Token
Token.set_extension("is_fruit", default=False, force=True)
```

```
extension_to_check = Token.get_extension("is_fruit")
extension_to_check
```

Output

The output is stated below:

```
(False, None, None, None)
```

Token.has_extension

As the name implies, this class method will check whether an extension has been registered on the Token class or not.

Argument

The table below explains its argument:

NAME	TYPE	DESCRIPTION
Name	Unicode	This argument represents the name of the extension to be checked.

Example

An example of Token.has_extension class method is given below:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
from spacy.tokens import Token
Token.set_extension("is_fruit", default=False, force=True)
Token.has_extension("is_fruit")
```

Output

The output is mentioned below:

```
True
```

Token.remove_extension

As the name implies, this class method will remove a previously registered extension on the Token class.

Example

An example of Token.remove_extension class method is given below:

```
import spacy
```

```
nlp_model = spacy.load("en_core_web_sm")
from spacy.tokens import Token
Token.set_extension("is_fruit", default=False, force=True)

Removed_ext = Token.remove_extension(“is_fruit”)
Token.has_extension("is_fruit")
```

Output

The output is given below:

```
False
```

13. spaCy — Token Properties

In this chapter, we will learn about the properties with regards to the Token class in spaCy.

Properties

The token properties are listed below along with their respective descriptions.

Token Property	Description
Token.ancestors	Used for the rightmost token of this token's syntactic descendants.
Token.conjuncts	Used to return a tuple of coordinated tokens.
Token.children	Used to return a sequence of the token's immediate syntactic children.
Token.lefts	Used for the leftward immediate children of the word.
Token.rights	Used for the rightward immediate children of the word.
Token.n_rights	Used for the number of rightward immediate children of the word.
Token.n_lefts	Used for the number of leftward immediate children of the word.
Token.subtree	This yields a sequence that contains the token and all the token's syntactic descendants.
Token.vector	This represents a real-valued meaning.
Token.vector_norm	This represents the L2 norm of the token's vector representation.

Token.ancestors

This token property is used for the rightmost token of this token's syntactic descendants.

Example

An example of Token.ancestors property is given below:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
from spacy.tokens import Token
doc = nlp_model("Give it back! He pleaded.")

it_ancestors = doc[1].ancestors
```

```
[t.text for t in it_ancestors]
```

Output

The output is given below:

```
['Give']
```

Token.conjuncts

This token property is used to return a tuple of co-ordinated tokens. Here, the token itself would not be included.

Example

An example of Token.conjuncts property is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
from spacy.tokens import Token
doc = nlp_model("I like cars and bikes")
cars_conjuncts = doc[2].conjuncts
[t.text for t in cars_conjuncts]
```

Output

The output is mentioned below:

```
['bikes']
```

Token.children

This token property is used to return a sequence of the token's immediate syntactic children.

Example

An example of Token.children property is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
from spacy.tokens import Token
doc = nlp_model("This is Tutorialspoint.com.")
give_child = doc[1].children
[t.text for t in give_child]
```

Output

The output is as follows:

```
['This', 'Tutorialspoint.com', '.']
```

Token.lefts

This token property is used for the leftward immediate children of the word. It would be in the syntactic dependency parse.

Example

An example of Token.lefts property is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
from spacy.tokens import Token
doc = nlp_model("This is Tutorialspoint.com.")
left_child = [t.text for t in doc[1].lefts]
left_child
```

Output

You will get the following output:

```
['This']
```

Token.rights

This token property is used for the rightward immediate children of the word. It would be in the syntactic dependency parse.

Example

An example of Token.rights property is given below:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
from spacy.tokens import Token
doc = nlp_model("This is Tutorialspoint.com.")
right_child = [t.text for t in doc[1].rights]
right_child
```

Output

The output is as follows:

```
['Tutorialspoint.com', '.']
```

Token.n_rights

This token property is used for the number of rightward immediate children of the word. It would be in the syntactic dependency parse.

Example

An example of Token.n_rights property is given below:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
from spacy.tokens import Token
doc = nlp_model("This is Tutorialspoint.com.")
doc[1].n_rights
```

Output

The output is as follows:

```
2
```

Token.n_lefts

This token property is used for the number of leftward immediate children of the word. It would be in the syntactic dependency parse.

Example

An example of Token.n_lefts property is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
from spacy.tokens import Token
doc = nlp_model("This is Tutorialspoint.com.")
doc[1].n_lefts
```

Output

The output is stated below:

```
1
```

Token.subtree

This token property yields a sequence that contains the token and all the token's syntactic descendants.

Example

An example of Token.subtree property is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
from spacy.tokens import Token
doc = nlp_model("This is Tutorialspoint.com.")
subtree_doc = doc[1].subtree
[t.text for t in subtree_doc]
```

Output

The output is given below:

```
['This', 'is', 'Tutorialspoint.com', '.']
```

Token.vector

This token property represents a real-valued meaning. It will return a one-dimensional array representing the token's semantics.

Example 1

An example of Token.vector property is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("The website is Tutorialspoint.com.")
doc.vector.dtype
```

Output

The output is stated below:

```
dtype('float32')
```

Example 2

An another example of Token.vector property is given below:

```
doc.vector.shape
```

Output

The output is stated below:

```
(96,)
```

Token.vector_norm

This token property represents the L2 norm of the token’s vector representation.

Example

An example of Token.vector_norm property is given below:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc1 = nlp_model("The website is Tutorialspoint.com.")
doc2 = nlp_model("It is having best technical tutorials.")
doc1[2].vector_norm !=doc2[2].vector_norm
```

Output

The output is given below:

```
True
```

14. spaCy — Container Span Class

This chapter will help you in understanding the Span Class in spaCy.

Span Class

It is a slice from **Doc** object, we discussed above.

Attributes

The table below explains its arguments:

NAME	TYPE	DESCRIPTION
doc	Doc	It represents the parent document.
tensor V2.1.7	Ndarray	Introduced in version 2.1.7 represents the span's slice of the parent **Doc's** tensor.
sent	Span	It is actually the sentence span that this span is a part of.
start	Int	This attribute is the token offset for the start of the span.
end	Int	This attribute is the token offset for the end of the span.
start_char	Int	Integer type attribute representing the character offset for the start of the span.
end_char	Int	Integer type attribute representing the character offset for the end of the span.
text	Unicode	It is a Unicode that represents the span text.
text_with_ws	Unicode	It represents the text content of the span with a trailing whitespace character if the last token has one.
orth	Int	This attribute is the ID of the verbatim text content.
orth_	Unicode	It is the Unicode Verbatim text content, which is identical to **Token.text.** This text content exists mostly for consistency with the other attributes.
label	Int	This integer attribute is the hash value of the span's label.
label_	Unicode	It is the label of span.
lemma_	Unicode	It is the lemma of span.

kb_id	Int	It represents the hash value of the knowledge base ID, which is referred to by the span.
kb_id_	Unicode	It represents the knowledge base ID, which is referred to by the span.
ent_id	Int	This attribute represents the hash value of the named entity the token is an instance of.
ent_id_	Unicode	This attribute represents the string ID of the named entity the token is an instance of.
sentiment	Float	A float kind scalar value that indicates the positivity or negativity of the span.
_	Underscore	It is representing the user space for adding custom attribute extension.

Methods

Following are the methods used in Span class:

Methods	Description
Span._ _init_ _	To construct a Span object from the slice doc[start : end].
Span._ _getitem_ _	To get a token object at a particular position say n, where n is an integer.
Span._ _iter_ _	To iterate over those token objects from which the annotations can be easily accessed.
Span._ _len_ _	To get the number of tokens in span.
Span.similarity	To make a semantic similarity estimate.
Span.merge	To retokenize the document in a way that the span is merged into a single token.

Span._ _init_ _

This is one of the most useful methods of Span class. As name implies, it is used to construct a **Span** object from the slice doc[start : end].

Arguments

The table below explains its arguments:

NAME	TYPE	DESCRIPTION
Doc	Doc	It represents the parent document.
Start	Int	It is the index of the first token of the span.
End	Int	It represents the index of the first token after the span.

Label	int / unicode	It is the label, which is to attach to the span. For example, the named entities. As of version 2.1, the label can be a unicode string also.
kb_id	int / unicode	It represents a knowledge base ID, which is to attach to the span. For example, the named entities. This ID can be an integer as well as a unicode string also.
vector	numpy.ndarray[ndim=1, dtype='float32']	It is a meaning representation of the span.

Example 1

An example of Span._ _init_ _ method is given below:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("This is Tutorialspoint.com.")
span = doc[1:4]
span
```

Output

When you execute the above code, you should see the following output:

```
is Tutorialspoint.com.
```

Example 2

An another example of Span._ _init_ _ method is given below:

```
 [t.text for t in span]
```

Output

When you execute the above code, you should see the following output:

```
['is', 'Tutorialspoint.com', '.']
```

Span._ _getitem_ _

This method of Span class is used to get a token object. at a particular position say n. Here n is an integer.

Argument

The table below explains its argument:

NAME	TYPE	DESCRIPTION
N	Integer	It represents the index of the token within the span.

Example

An example of Span._ _getitem_ _ method is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("This is Tutorialspoint.com.")
span = doc[1:4]
span[1].text
```

Output

When you run the code, you will see the following output:

```
'Tutorialspoint.com'
```

Span._ _iter_ _

This method of Span class will iterate over those token objects from which the annotations can be easily accessed.

Example

Refer the example of Span._ _iter_ _ method which is given below:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("This is Tutorialspoint.com.")
span = doc[1:4]
[t.text for t in span]
```

Output

When you run the code, you will see the following output:

```
['is', 'Tutorialspoint.com', '.']
```

Span._ _len_ _

As name implies, this method of Span class will get the number of tokens in span.

Example

An example of Span._ _len_ _ method is given below:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("This is Tutorialspoint.com.")
```

```
span = doc[1:4]
len(span)
```

Output

When you run the code, you will see the following output:

```
3
```

Span.similarity

This method is used to make a semantic similarity estimate. The default is cosine similarity using an average of word vectors.

Argument

The table below explains its argument:

NAME	TYPE	DESCRIPTION
other	-	It is the object with which the comparison will be done. By default, it will accept Doc, Span, Token, and Lexeme objects.

Example

An example of Span.similarity method is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("red car and black bike")
red_car = doc[:2]
black_bike = doc[3:]
car_bike = red_car.similarity(black_bike)
bike_car = black_bike.similarity(red_car)
car_bike == bike_car
```

Output

When you run the code, you will see the following output:

```
True
```

Span.merge

As the name implies, this method of Span class will retokenize the document in a way that the span is merged into a single token.

Example

An example of Span.merge method is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("This is Tutorialspoint.com.")
span = doc[1:4]
doc[2].text
```

Output

When you run the code, you will see the following output:

```
'Tutorialspoint.com'
```

ClassMethods

Following are the classmethods used in Span class:

Classmethod	Description
Span.set_extension	It defines a custom attribute on the Span.
Span.get_extension	To look up a previously extension by name.
Span.has_extension	To check whether an extension has been registered on the Span class or not.
Span.remove_extension	To remove a previously registered extension on the Span class.

Span.set_extension

This class method was introduced in version 2.0. It defines a custom attribute on the Span. Once done, that attribute will become available via Span._.

Arguments

The table below explains its arguments:

NAME	TYPE	DESCRIPTION
name	Unicode	This argument represents the name of the attribute to set by the extension. For example, 'his_attr' will be available as span._.his_attr.
default	-	It is the optional default value of the attribute for the case when no getter or method is defined.
method	callable	It is used to set a custom method on the object. For example, **span._.compare(other_doc).**

getter	callable	This attribute represents the getter function that will takes the object and will return an attribute value. It is mainly called when the user accesses the ._ attribute.
setter	callable	This attribute represents the Setter function that will take the Doc & a value and will modify the object. It is mainly called when the user writes to the Span._ attribute.
Force	bool	It will forcefully overwrite an existing attribute.

Example

An example of Span.set_extension class method is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
from spacy.tokens import Span
city = lambda span: any(city in doc.text for city in ("New York", "India",
"USA"))
Span.set_extension("has_city", getter=city, force = True)
doc = nlp_model("I like India")
doc[0:3]._.has_city
```

Output

Upon execution, you will receive the following output:

```
True
```

Span.get_extension

As the name implies, this class method will look up for a previous extension by name. It was also introduced in version 2.0 and will return a 4-tuple (default, method, getter, setter) value.

Example

An example of Span.get_extension class method is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
from spacy.tokens import Span
Span.set_extension('is_city', default=False, force = True)
extension = Span.get_extension('is_city')
extension
```

Output

Upon execution, you will receive the following output:

```
(False, None, None, None)
```

Span.has_extension

As the name implies, this class method will check whether an extension has been registered on the Span class or not.

Example

An example of Span.has_extension class method is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
from spacy.tokens import Span
Span.set_extension('is_city', default=False, force = True)
Span.has_extension('is_city')
```

Output

Upon execution, you will receive the following output:

```
True
```

Span.remove_extension

As the name implies, this class method will remove a previously registered extension on the Span class.

Example

An example of Span.remove_extension class method is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
from spacy.tokens import Span
Span.set_extension('is_city', default=False, force = True)
Removed_ext = Span.remove_extension('is_city')
Span.has_extension('is_city')
```

Output

Upon execution, you will receive the following output:

```
False
```

15. spaCy — Span Class Properties

In this chapter, let us learn the Span properties in spaCy.

Properties

Following are the properties with regards to Span Class in spaCy.

Span Properties	Description
Span.ents	Used for the named entities in the span.
Span.as_doc	Used to create a new Doc object corresponding to the Span. It will have a copy of data too.
Span.root	To provide the token with the shortest path to the root of the sentence.
Span.lefts	Used for the tokens that are to the left of the span whose heads are within the span.
Span.rights	Used for the tokens that are to the right of the span whose heads are within the span.
Span.n_rights	Used for the tokens that are to the right of the span whose heads are within the span.
Span.n_lefts	Used for the tokens that are to the left of the span whose heads are within the span.
Span.subtree	To yield the tokens that are within the span and the tokens which descend from them.
Span.vector	Represents a real-valued meaning.
Span.vector_norm	Represents the L2 norm of the document’s vector representation.

Span.ents

This Span property is used for the named entities in the span. If the entity recogniser has been applied, this property will return a tuple of named entity span objects.

Example 1

An example of Span.ents property is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("This is Tutorialspoint.com.")
span = doc[0:5]
```

```
ents = list(span.ents)
ents[0].label
```

Output

You will receive the following output:

```
383
```

Example 2

An another example of Span.ents property is as follows:

```
ents[0].label_
```

Output

You will receive the following output:

```
‘ORG’
```

Example 3

Given below is another example of Span.ents property:

```
ents[0].text
```

Output

You will receive the following output:

```
'Tutorialspoint.com'
```

Span.as_doc

As the name suggests, this Span property will create a new Doc object corresponding to the Span. It will have a copy of data too.

Example

An example of Span.as_doc property is given below:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("I like India.")
span = doc[2:4]
doc2 = span.as_doc()
doc2.text
```

Output

You will receive the following output:

```
India
```

Span.root

This Span property will provide the token with the shortest path to the root of the sentence. It will take the first token, if there are multiple tokens which are equally high in the tree.

Example 1

An example of Span.root property is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("I like New York in Autumn.")
i, like, new, york, in_, autumn, dot = range(len(doc))
doc[new].head.text
```

Output

You will receive the following output:

```
'York'
```

Example 2

An another example of Span.root property is as follows:

```
doc[york].head.text
```

Output

You will receive the following output:

```
'like'
```

Example 3

Given below is an example of Span.root property:

```
new_york = doc[new:york+1]
new_york.root.text
```

Output

You will receive the following output:

```
'York'
```

Span.lefts

This Span property is used for the tokens that are to the left of the span, whose heads are within the span.

Example

An example of Span.lefts property is mentioned below:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("This is Tutorialspoint.com.")
lefts = [t.text for t in doc[1:4].lefts]
lefts
```

Output

You will receive the following output:

```
['This']
```

Span.rights

This Span property is used for the tokens that are to the right of the span whose heads are within the span.

Example

An example of Span.rights property is given below:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("This is Tutorialspoint.com.")
rights = [t.text for t in doc[1:2].rights]
rights
```

Output

You will receive the following output:

```
['Tutorialspoint.com', '.']
```

Span.n_rights

This Span property is used for the tokens that are to the right of the span whose heads are within the span.

Example

An example of Span.n_rights property is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("This is Tutorialspoint.com.")
doc[1:2].n_rights
```

Output

You will receive the following output:

```
2
```

Span.n_lefts

This Span property is used for the tokens that are to the left of the span whose heads are within the span.

Example

An example of Span.n_lefts property is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("This is Tutorialspoint.com.")
doc[1:2].n_lefts
```

Output

You will receive the following output:

```
1
```

Span.subtree

This Span property yields the tokens that are within the span and the tokens which descend from them.

Example

An example of Span.subtree property is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("This is Tutorialspoint.com.")
subtree = [t.text for t in doc[:1].subtree]
subtree
```

Output

You will receive the following output:

```
['This']
```

Span.vector

This Span property represents a real-valued meaning. The defaults value is an average of the token vectors.

Example 1

An example of Span.vector property is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("The website is Tutorialspoint.com.")
doc[1:].vector.dtype
```

Output

You will receive the following output:

```
dtype('float32')
```

Example 2

An another example of Span.vector property is as follows:

```
doc[1:].vector.shape
```

Output

You will receive the following output:

```
(96,)
```

Span.vector_norm

This doc property represents the L2 norm of the document's vector representation.

Example

An example of Span.vector_norm property is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("The website is Tutorialspoint.com.")
```

```
doc[1:].vector_norm

doc[2:].vector_norm

doc[1:].vector_norm != doc[2:].vector_norm
```

Output

You will receive the following output:

```
True
```

16. spaCy — Container Lexeme Class

In this chapter, Lexeme Class in spaCy is explained in detail.

Lexeme Class

Lexeme class is an entry in the vocabulary. It has no string context. As opposed to a word token, it is a word type. That's the reason it has no POS(part-of-speech) tag, dependency parse or lemma.

Attributes

The table below explains its arguments:

NAME	TYPE	DESCRIPTION
vocab	Vocab	It represents the vocabulary of the lexeme.
text	unicode	A Unicode attribute representing verbatim text content.
orth	int	It is an integer type attribute that represents ID of the verbatim text content.
orth_	unicode	It is the Unicode Verbatim text content which is identical to Lexeme.text. This text content exists mostly for consistency with the other attributes.
rank	int	It represents the sequential ID of the lexeme's lexical type which is used to index into tables.
flags	int	It represents the container of the lexeme's binary flags.
norm	int	This attribute represents the lexeme's norm.
norm_	unicode	This attribute represents the lexeme's norm.
lower	int	As name implies, it is the lowercase form of the word.
lower_	unicode	It is also the lowercase form of the word.
shape	int	To show orthographic features, this attribute is for transform of the word's string.
shape_	unicode	To show orthographic features, this attribute is for transform of the word's string.
prefix	int	It is the hash value of a length-N substring from the start of the word. The defaults value is N=1.
prefix_	unicode	It is a length-N substring from the start of the word. The default value is N=1.

suffix	int	It is the hash value of a length-N substring from the end of the word. The default value is N=3.
suffix_	unicode	It is the length-N substring from the end of the word. The default value is N=3.
is_alpha	bool	This attribute represents whether the lexeme consist of alphabetic characters or not? It is equivalent to lexeme.text.isalpha().
is_ascii	bool	This attribute represents whether the lexeme consist of ASCII characters or not? It is equivalent to all(ord(c) < 128 for c in lexeme.text).
is_digit	Bool	This attribute represents whether the lexeme consist of digits or not? It is equivalent to lexeme.text.isdigit().
is_lower	Bool	This attribute represents whether the lexeme is in lowercase or not? It is equivalent to lexeme.text.islower().
is_upper	Bool	This attribute represents whether the lexeme is in uppercase or not? It is equivalent to lexeme.text.isupper().
is_title	bool	This attribute represents whether the lexeme is in titlecase or not? It is equivalent to lexeme.text.istitle().
is_punct	bool	This attribute represents whether the lexeme a punctuation?
is_left_punct	bool	This attribute represents whether the lexeme a left punctuation mark, e.g. '(' ?
is_right_punct	bool	This attribute represents whether the lexeme a right punctuation mark, e.g. ')' ?
is_space	bool	This attribute represents whether the lexeme consist of whitespace characters or not? It is equivalent to lexeme.text.isspace().
is_bracket	bool	This attribute represents whether the lexeme is a bracket or not?
is_quote	bool	This attribute represents whether the lexeme a quotation mark or not?
is_currency	bool	Introduced in version 2.0.8, this attribute represents whether the lexeme is a currency symbol or not?
like_url	bool	This attribute represents whether the lexeme resemble a URL or not?
like_num	bool	This attribute represents whether the lexeme represent a number or not?

like_email	bool	This attribute represents whether the lexeme resemble an email address or not?
is_oov	bool	This attribute represents whether the lexeme have a word vector or not?
is_stop	bool	This attribute represents whether the lexeme is part of a “stop list” or not?
Lang	Int	This attribute represents the language of the parent document’s vocabulary.
lang_	unicode	This attribute represents the language of the parent document’s vocabulary.
Prob	float	It is the smoothed log probability estimate of lexeme’s word type.
cluster	int	It represents the brown cluster ID.
Sentiment	float	It represents a scalar value that indicates the positivity or negativity of the lexeme.

Methods

Following are the methods used in Lexeme class:

Methods	Description
Lexeme._ _init_ _	To construct a Lexeme object.
Lexeme.set_flag	To change the value of a Boolean flag.
Lexeme.check_flag	To check the value of a Boolean flag.
Lexeme.similarity	To compute a semantic similarity estimate.

Lexeme._ _init_ _

This is one of the most useful methods of Lexeme class. As name implies, it is used to construct a **Lexeme** object.

Arguments

The table below explains its arguments:

NAME	TYPE	DESCRIPTION
Vocab	Vocab	This argument represents the parent vocabulary.
Orth	int	It is the orth id of the lexeme.

Example

An example of Lexeme._ _init_ _ method is given below:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
doc = nlp_model("The website is Tutorialspoint.com.")
lexeme = doc[3]
lexeme.text
```

Output

When you run the code, you will see the following output:

```
'Tutorialspoint.com'
```

Lexeme.set_flag

This method is used to change the value of a Boolean flag.

Arguments

The table below explains its arguments:

NAME	TYPE	DESCRIPTION
flag_id	Int	It represents the attribute ID of the flag, which is to be set.
value	bool	It is the new value of the flag.

Example

An example of Lexeme.set_flag method is given below:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
New_FLAG = nlp_model.vocab.add_flag(lambda text: False)
nlp_model.vocab["Tutorialspoint.com"].set_flag(New_FLAG, True)
New_FLAG
```

Output

When you run the code, you will see the following output:

```
25
```

Lexeme.check_flag

This method is used to check the value of a Boolean flag.

Argument

The table below explains its argument:

NAME	TYPE	DESCRIPTION
flag_id	Int	It represents the attribute ID of the flag which is to be checked.

Example 1

An example of Lexeme.check_flag method is given below:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
library = lambda text: text in ["Website", "Tutorialspoint.com"]
my_library = nlp_model.vocab.add_flag(library)
nlp_model.vocab["Tutorialspoint.com"].check_flag(my_library)
```

Output

When you run the code, you will see the following output:

```
True
```

Example 2

Given below is another example of Lexeme.check_flag method:

```
nlp_model.vocab["Hello"].check_flag(my_library)
```

Output

When you run the code, you will see the following output:

```
False
```

Lexeme.similarity

This method is used to compute a semantic similarity estimate. The default is cosine over vectors.

Argument

The table below explains its argument:

NAME	TYPE	DESCRIPTION
Other	-	It is the object with which the comparison will be done. By default, it will accept Doc, Span, Token, and Lexeme objects.

Example

An example of Lexeme.similarity method is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
```

```
apple = nlp.vocab["apple"]
orange = nlp.vocab["orange"]
apple_orange = apple.similarity(orange)
orange_apple = orange.similarity(apple)
apple_orange == orange_apple
```

Output

When you run the code, you will see the following output:

```
True
```

Properties

Following are the properties of Lexeme Class.

Property	Description
Lexeme.vector	It will return a 1-dimensional array representing the lexeme's semantics.
Lexeme.vector_norm	It represents the L2 norm of the lexeme's vector representation.

Lexeme.vector

This Lexeme property represents a real-valued meaning. It will return a one-dimensional array representing the lexeme's semantics.

Example

An example of Lexeme.vector property is given below:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
apple = nlp_model.vocab["apple"]
apple.vector.dtype
```

Output

You will see the following output:

```
dtype('float32')
```

Lexeme.vector_norm

This token property represents the L2 norm of the lexeme's vector representation.

Example

An example of Lexeme.vector_norm property is as follows:

```
import spacy
nlp_model = spacy.load("en_core_web_sm")
apple = nlp.vocab["apple"]
pasta = nlp.vocab["pasta"]
apple.vector_norm != pasta.vector_norm
```

Output

You will see the following output:

```
True
```

17. spaCy — Training Neural Network Model

In this chapter, let us learn how to train a neural network model in spaCy.

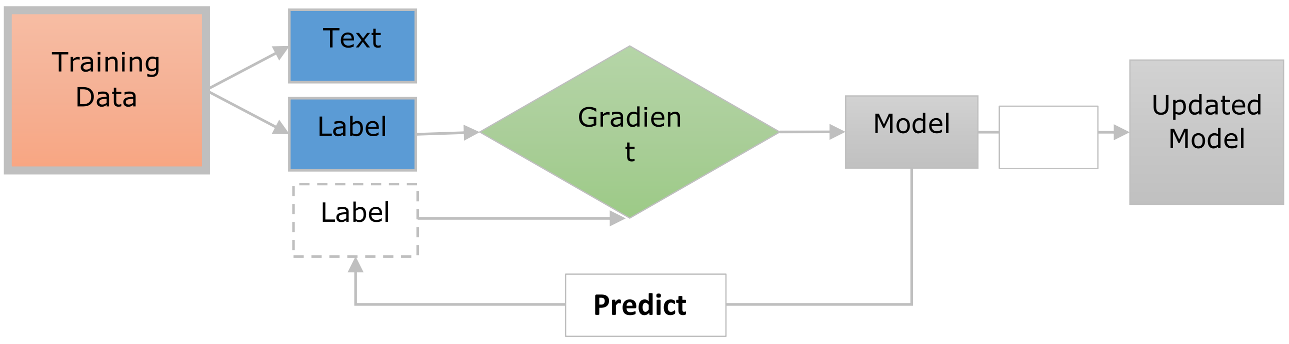
Here, we will understand how we can update spaCy's statistical models to customize them for our use case. For Example, to predict a new entity type in online comments. To customize, we first need to train own model.

Steps for Training

Let us understand the steps for training a neural network model in spaCy.

- Step1: **Initialization -** If you are not taking pre-trained model, then first, we need to initialize the model weights randomly with **nlp.begin_training**.
- Step2: **Prediction** - Next, we need to predict some examples with the current weights. It can be done by calling **nlp.updates**.
- Step3: **Compare** - Now, the model will check the predictions against true labels.
- Step4: **Calculate** - After comparing, here, we will decide how to change weights for better prediction next time.
- Step5: **Update** - At last make a small change in the current weights and pick the next batch of examples. Continue calling **nlp.updates** for every batch of examples you take.

Let us now understand these steps with the help of below diagram:



Here:

- **Training Data:** The training data are the examples and their annotations. These are the examples, which we want to update the model with.
- **Text:** It represents the input text, which the model should predict a label for. It should be a sentence, paragraph, or longer document.

- **Label:** The label is actually, what we want from our model to predict. For example, it can be a text category.
- **Gradient:** Gradient is how we should change the weights to reduce the error. It will be computed after comparing the predicted label with true label.

Training the Entity Recognizer

First, the entity recognizer will take a document and predict the phrases as well as their labels.

It means the training data needs to include the following:

- Texts.
- The entities they contain.
- The entity labels.

Each token can only be a part of one entity. Hence, the entities cannot be overlapped.

We should also train it on entities and their surrounding context because, entity recognizer predicts entities in context.

It can be done by showing the model a text and a list of character offsets.

For example, In the code given below, phone is a gadget which starts at character 0 and ends at character 8.

```
("Phone is coming", {"entities": [(0, 8, "GADGET")]})
```

Here, the model should also learn the words other than entities.

Consider another example for training the entity recognizer, which is given below:

```
("I need a new phone! Any suggestions?", {"entities": []})
```

The main goal should be to teach our entity recognizer model, to recognize new entities in similar contexts even if, they were not in the training data.

spaCy's Training Loop

Some libraries provide us the methods that takes care of model training but, on the other hand, spaCy provides us full control over the training loop.

Training loop may be defined as a series of steps which is performed to update as well as to train a model.

Steps for Training Loop

Let us see the steps for training loop, which are as follows:

Step 1: Loop - The first step is to loop, which we usually need to perform several times, so that the model can learn from it. For example, if you want to train your model for 20 iterations, you need to loop 20 times.

Step 2: Shuffle - Second step is to shuffle the training data. We need to shuffle the data randomly for each iteration. It helps us to prevent the model from getting stuck in a suboptimal solution.

Step 3: Divide – Later on divide the data into batches. Here, we will divide the training data into mini batches. It helps in increasing the readability of the gradient estimates.

Step 4: Update - Next step is to update the model for each step. Now, we need to update the model and start the loop again, until we reach the last iteration.

Step 5: Save- At last, we can save this trained model and use it in spaCy.

Example

Following is an example of spaCy's Training loop:

```
DATA = [
    ("How to order the Phone X", {"entities": [(20, 28, "GADGET")]})
]
# Step1: Loop for 10 iterations
for i in range(10):
    # Step2: Shuffling the training data
    random.shuffle(DATA)
    # Step3: Creating batches and iterating over them
    for batch in spacy.util.minibatch(DATA):
        # Step4: Splitting the batch in texts and annotations
        texts = [text for text, annotation in batch]
        annotations = [annotation for text, annotation in batch]
        # Step5: Updating the model
        nlp.update(texts, annotations)
# Step6: Saving the model
nlp.to_disk(path_to_model)
```

18. spaCy — Updating Neural Network Model

In this chapter, we will learn how to update the neural network model in spaCy.

Reasons to update

Following are the reasons to update an existing model:

- The updated model will provide better results on your specific domain.
- While updating an existing model, you can learn classification schemes for your problem.
- Updating an existing model is essential for text classification.
- It is especially useful for named entity recognition.
- It is less critical for POS tagging as well as dependency parsing.

Updating an existing model

With the help of spaCy, we can update an existing pre-trained model with more data. For example, we can update the model to improve its predictions on different texts.

Updating an existing pre-trained model is very useful, if you want to improve the categories which the model already knows. For example, "person" or "organization". We can also update an existing pre-trained model for adding new categories.

It is recommended to always update an existing pre-trained model with examples of the new category as well as examples of the other categories, which the model previously predicted correctly. If not done, improving the new category might hurt the other categories.

Setting up a new pipeline

From the below given example, let us understand how we can set up a new pipeline from scratch for updating an existing model:

- First, we will start with blank English model by using **spacy.blank** method. It only has the language data and tokenization rules and does not have any pipeline component.
- After that we will create a blank entity recognizer and will add it to the pipeline. Next, we will add the new string labels to the model by using **add_label**.
- Now, we can initialize the model with random weights by calling **nlp.begin_training**.
- Next, we need to randomly shuffle the data on each iteration. It is to get better accuracy.

- Once shuffled, divide the example into batches by using spaCy's **minibatch** function. At last, update the model with texts and annotations and then, continue to loop.

Examples

Given below is an example for **starting with blank English model by using spacy.blank:**

```
nlp = spacy.blank("en")
```

Following is an example for **creating blank entity recognizer and adding it to the pipeline:**

```
ner = nlp.create_pipe("ner")
nlp.add_pipe(ner)
```

Here is an example for **adding a new label by using add_label:**

```
ner.add_label("GADGET")
```

An example for **starting the training by using nlp.begin_training** is as follows:

```
nlp.begin_training()
```

This is an example for **training for iterations and shuffling the data on each iteration.**

```
for itn in range(10):
    random.shuffle(examples)
```

This is an example for **dividing the examples into batches using minibatch utility function for batch in spacy.util.minibatch(examples, size=2).**

```
texts = [text for text, annotation in batch]
annotations = [annotation for text, annotation in batch]
```

Given below is an example for **updating the model with texts and annotations:**

```
nlp.update(texts, annotations)
```