DataTalks.Club's Capstone 2 project by Alexander D. Rios

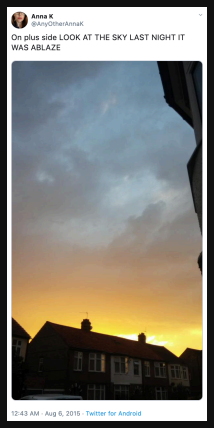
🌋 Natural Language Processing with Disaster Tweets

Source: EarthDailyAnalytics

Competition Description

Twitter has become an important communication channel in times of emergency. The ubiquitousness of smartphones enables people to announce an emergency they're observing in real-time. Because of this, more agencies are interested in programatically monitoring Twitter (i.e. disaster relief organizations and news agencies).

But, it's not always clear whether a person's words are actually announcing a disaster. Take this example:



The author explicitly uses the word "ABLAZE" but means it metaphorically. This is clear to a human right away, especially with the visual aid. But it's less clear to a machine.

In this competition, we're challenged to build a machine learning model that **predicts which Tweets are about real disasters and which one's aren't**. We'll have access to a dataset of

10,000 tweets that were hand classified.

> Disclaimer: The dataset for this competition contains text that may be considered profane, vulgar, or offensive.

Acknowledgments

This dataset was created by the company figure-eight and originally shared on their 'Data For Everyone' website here.

Tweet source: https://twitter.com/AnyOtherAnnaK/status/629195955506708480

Dataset Description

Each sample in the train and test set has the following information:

- The `text` of a tweet
- A `keyword` from that tweet (although this may be blank!)
- The `location` the tweet was sent from (may also be blank)

What am I predicting?

You are predicting whether a given tweet is about a real disaster or not. If so, predict a 1. If not, predict a 0.

Evaluation

Submissions are evaluated using F1 between the predicted and expected answers.

F1 is calculated as follows:

$$F_1 = 2 * \frac{precision * recall}{precision + recall}$$

where:

$$precision = \frac{TP}{TP + FP}$$

$$recall = \frac{TP}{TP + FN}$$

and:

```
True Positive [TP] = your prediction is 1, and the ground
truth is also 1 - you predicted a positive and that's true!
False Positive [FP] = your prediction is 1, and the ground
truth is 0 - you predicted a positive, and that's false.
```

False Negative [FN] = your prediction is 0, and the ground truth is 1 - you predicted a negative, and that's false.

From Kaggle to Colab environment

In [ ]:
```
# IMPORTANT: SOME KAGGLE DATA SOURCES ARE PRIVATE
# RUN THIS CELL IN ORDER TO IMPORT YOUR KAGGLE DATA SOURCES.
import kagglehub
import os
import shutil
def download_dataset():
    for dir in ["kaggle", "kaggle/input", "kaggle/input/nlp-getting-started"
        if not os.path.exists(dir):
            os.mkdir(dir)

    nlp_getting_started_path = kagglehub.competition_download('nlp-getting-s
    rtatman_english_word_frequency_path = kagglehub.dataset_download('rtatma
    yk1598_479k_english_words_path = kagglehub.dataset_download('yk1598/479k

    target_dir = "kaggle/input/nlp-getting-started/"
    file_names = os.listdir(nlp_getting_started_path)
    for file_name in file_names:
        shutil.move(os.path.join(nlp_getting_started_path, file_name), target

    target_dir = "kaggle/input/479k-english-words/"
    file_names = os.listdir(yk1598_479k_english_words_path)
    for file_name in file_names:
        shutil.move(os.path.join(yk1598_479k_english_words_path, file_name),

    target_dir = "kaggle/input/english-word-frequency/"
    file_names = os.listdir(rtatman_english_word_frequency_path)
    for file_name in file_names:
        shutil.move(os.path.join(rtatman_english_word_frequency_path, file_na

    print("Data source import complete.")
    return
download_dataset()
```

```
Downloading from https://www.kaggle.com/api/v1/competitions/data/download-al
l/nlp-getting-started...
100%|██████████| 593k/593k [00:00<00:00, 29.0MB/s]
Extracting files...
Downloading from https://www.kaggle.com/api/v1/datasets/download/rtatman/engl
ish-word-frequency?dataset_version_number=1...
100%|██████████| 2.13M/2.13M [00:00<00:00, 23.9MB/s]
Extracting files...
Downloading from https://www.kaggle.com/api/v1/datasets/download/yk1598/479k-
english-words?dataset_version_number=1...
100%|██████████| 1.40M/1.40M [00:00<00:00, 19.6MB/s]
Extracting files...
```

```
Data source import complete.
```

Installing some packages

In [ ]:
```
!pip install wordninja num2words mplcyberpunk spacy

!python3 -m spacy download en_core_web_lg
```

Loading packages

In [ ]:
```
import numpy as np
import pandas as pd
import warnings
pd.options.mode.copy_on_write = True
warnings.simplefilter(action='ignore', category=FutureWarning)

import tensorflow as tf
from tensorflow import keras
from tensorflow.keras.preprocessing.text import Tokenizer
from tensorflow.keras.preprocessing.sequence import pad_sequences
from tensorflow.data import Dataset
from tensorflow.keras import Model, Input, Sequential
from tensorflow.keras.layers import Embedding, Conv1D, MaxPooling1D, Dropout,
from tensorflow.keras.optimizers import Adam, SGD
from tensorflow.keras.callbacks import ReduceLROnPlateau, EarlyStopping, CSVL
from tensorflow.keras.regularizers import L2
from tensorflow.keras.metrics import F1Score, BinaryAccuracy
from tensorflow.keras.utils import plot_model
import tensorflow_text as text

from keras_nlp.models import BertPreprocessor, BertBackbone

from sklearn.feature_extraction.text import CountVectorizer
from sklearn.model_selection import train_test_split
from sklearn.utils.class_weight import compute_class_weight
from sklearn.metrics import f1_score, accuracy_score, precision_score, recal

import spacy
from spacy.matcher import Matcher
from spacy import displacy
import wordninja as wn
from num2words import num2words
from collections import OrderedDict
import string
import re
import itertools
from pprint import pprint

import matplotlib.pyplot as plt
import seaborn as sns
from wordcloud import WordCloud, STOPWORDS
```

```
import cloudpickle

import mplcyberpunk
plt.style.use("cyberpunk")

nlp = spacy.load("en_core_web_lg")

src_path = "./kaggle/input/"
dst_path = "./kaggle/working/"
```

Setting for reproducibility

In [ ]:
```
import random

seed = 42
os.environ['PYTHONHASHSEED'] = str(seed)
random.seed(seed)
np.random.seed(seed)
```

Creating a word dictionary

Counting the words in the dataset English Words 479k

In [ ]:
```
with open(src_path+'479k-english-words/english_words_479k.txt', 'r') as txt:
    words = txt.read().split('\n')
    words = [x.lower() for x in words]

print(f"Number of words: {len(words)}")
```

```
Number of words: 466545
```

In [ ]:
```
words[0:8]
```

Out[ ]:
```
['2', '1080', '&c', '10-point', '10th', '11-point', '12-point', '16-point']
```

Counting the words in the dataset English Word Frecuency

In [ ]:
```
words2 = pd.read_csv(src_path+'english-word-frequency/unigram_freq.csv')['wo

print(f"Number of words: {len(words2)}")
```

```
Number of words: 333333
```

In [ ]:
```
words2[0:10]
```

Out[ ]:
```
['the', 'of', 'and', 'to', 'a', 'in', 'for', 'is', 'on', 'that']
```

Cleaning the word list

In [ ]:
```
def solve(s):
    d = dict()
    for c in s:
        if c not in d:
            d[c] = 0
        d[c] += 1
    return ''.join(d.keys())

print(f"Total number of words before cleaning: {len(words) + len(words2)}")

all_words = words + [str(x).lower() for x in words2]
all_words = sorted(list(set(words)))

all_words = [x for x in all_words if (len(x) > 2
                                      and x.isalpha()
                                      and len(x.replace("a", "").replace("e", "").re
                                      and len(solve(x)) > 2
                                      and x not in nlp.Defaults.stop_words)]

print(f"Total number of words after cleaning: {len(all_words)}")
```

```
Total number of words before cleaning: 799878
Total number of words after cleaning: 414698
```

Let's create it

In [ ]:
```
dict_words = {}
for letter1 in string.ascii_lowercase:
    dict_words[letter1] = {}
    for letter2 in string.ascii_lowercase:
        dict_words[letter1][letter2] = [x for x in all_words if x[0:2] == le
        dict_words
```

Exploratory data analysis

Take a look in the training dataset

In [ ]:
```
df = pd.read_csv(src_path+"nlp-getting-started/train.csv", index_col="id")
df.head()
```

Out[ ]:

id	keyword	location	text	target
1	NaN	NaN	Our Deeds are the Reason of this #earthquake M...	1
4	NaN	NaN	Forest fire near La Ronge Sask. Canada	1
5	NaN	NaN	All residents asked to 'shelter in place' are ...	1
6	NaN	NaN	13,000 people receive #wildfires evacuation or...	1
7	NaN	NaN	Just got sent this photo from Ruby #Alaska as ...	1

In [ ]:
```
df_shape = df.shape
print(f"There {df_shape[1]} features and {df_shape[0]} instances")
```

```
There 4 features and 7613 instances
```

Working on the null data

In [ ]:
```
df.isna().sum()
```

Out[ ]:
```
keyword       61
location    2533
text           0
target         0
dtype: int64
```

In [ ]:
```
print(f'The missing values in location feature represent the {round(df.isna(
print(f'The missing values in keyword feature represent the {round(df.isna()
```

```
The missing values in location feature represent the 33.27% of our dataset
The missing values in keyword feature represent the 0.8% of our dataset
```

In [ ]:
```
df_cl_nl = df.drop(df[df["keyword"].isna()].index)
df_cl_nl = df_cl_nl.drop(["location"], axis=1)
```

In [ ]:
```
df_cl_nl.isna().sum()
```

Out[ ]:
```
keyword    0
text       0
target     0
dtype: int64
```

In [ ]:
```
df_shape = df_cl_nl.shape
print(f"There {df_shape[1]} features and {df_shape[0]} instances")
```

```
There 3 features and 7552 instances
```

Working on the duplicated data

In [ ]:
```
mask = df_cl_nl.duplicated(subset=["text"])
df_cl_nl.loc[mask]
```

Out[ ]:

id	keyword	text	target
68	ablaze	Check these out: http://t.co/rOI2NSmEJJ http:/...	0
165	aftershock	320 [IR] ICEMOON [AFTERSHOCK] | http://t.co/vA...	0
172	aftershock	320 [IR] ICEMOON [AFTERSHOCK] | http://t.co/TH...	0
238	airplane%20accident	Experts in France begin examining airplane deb...	1
898	bioterrorism	To fight bioterrorism sir.	0
...	...	...	...
10071	typhoon	abcnews - Obama Declares Disaster for Typhoon-...	1
10080	typhoon	(#LosDelSonido) Obama Declares Disaster for Ty...	1
10220	volcano	USGS reports a M1.94 #earthquake 5km S of Volc...	1
10771	wreckage	Wreckage 'Conclusively Confirmed' as From MH37...	1
10776	wreckage	Wreckage 'Conclusively Confirmed' as From MH37...	1

105 rows × 3 columns

In [ ]:
```
df_cl = df_cl_nl.drop_duplicates(subset=["text"])

df_shape = df_cl.shape
print(f"There {df_shape[1]} features and {df_shape[0]} instances")
```

```
There 3 features and 7447 instances
```

Checking the balance of the target

In [ ]:
```
print(f"This dataset is a imbalace dataset that contains {values[1]} disaste
```

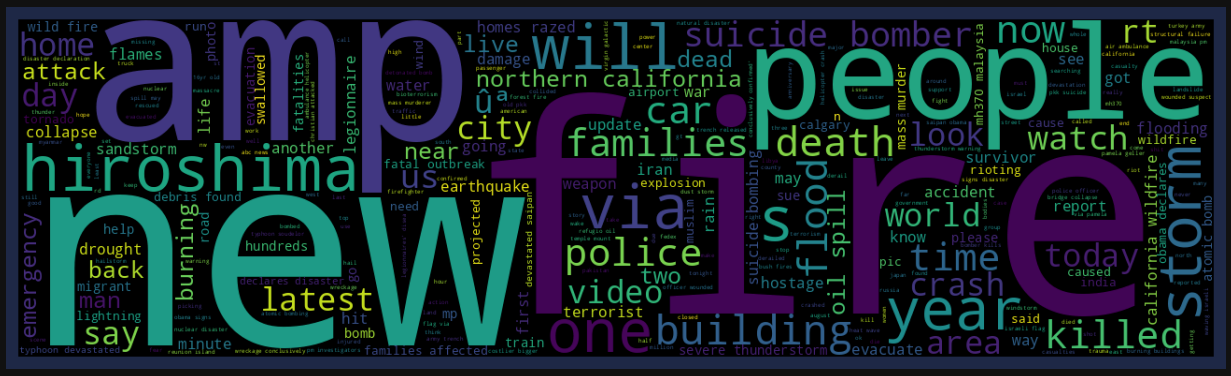
```
This dataset is a imbalace dataset that contains 3161 disaster tweets and 428
6 non-disaster tweets.
```

In [ ]:
```
labels = ["Non-disaster Tweets", "Disaster Tweets",]
values = [df_cl[df_cl['target'] == 0].shape[0], df_cl[df_cl['target'] == 1].

plt.figure(figsize=(20, 2))
sns.barplot(y=labels, x=values)
plt.tight_layout();
```

Word clouds

Most frequent words in Disasters Tweets

In [ ]:
```
aux = STOPWORDS.copy()
aux.update(["t"])
aux.update(["co"])
aux.update(["https"])
aux.update(["w"])
aux.update(["Û_"])
aux.update(["Û"])
aux.update(["U"])
aux.update(["ûª"])
aux.update(["ûò"])

alltext = ' '.join(df_cl.loc[df_cl['target'] == 1, "text"])
word_cloud = WordCloud(width=1280, height=360, stopwords=aux, max_words=300)

plt.figure(figsize=(10, 20), dpi=2000)
plt.imshow(word_cloud)
plt.axis("off")
plt.tight_layout();
```



We can see that the most common words in disaster tweets are related to natural disasters, accidents, and fatalities, such as fire, storm, Hiroshima, and suicide bomber.

Most frequent words in Non-disasters Tweets

In [ ]:
```
alltext = ' '.join(df_cl.loc[df_cl['target'] == 0, "text"])
word_cloud = WordCloud(width=1280, height=360, stopwords=aux, max_words=300)

fig = plt.figure(figsize=(10, 20), dpi=1000)
plt.imshow(word_cloud)
plt.axis("off")
plt.show()
```

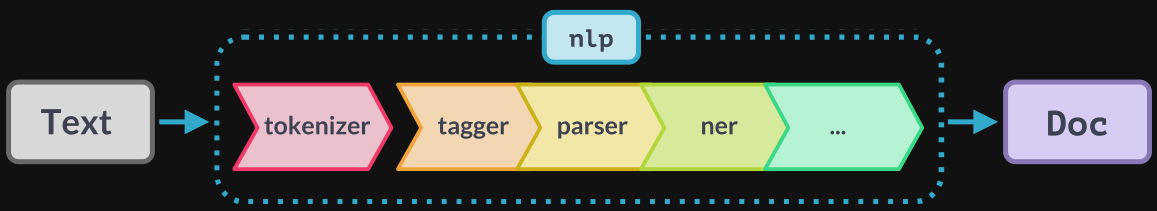
We can see that the most common words in non-disaster tweets are related to cotidian words.

Feature engineering

spaCy for NLP

spaCy is a free, open-source library for advanced Natural Language Processing (NLP) in Python. It's designed specifically for production use and helps you build applications that process and "understand" large volumes of text. It can be used to build information extraction or natural language understanding systems.

The processing pipeline consists of one or more pipeline components that are called on the Doc in order. The tokenizer runs before the components.



Working on the text of the tweets

Explaining the preprocessing pipeline that we will use in this project

1. Digits to words
2. Dealing with the Twitter mentions
3. Dealing with the hashtags
4. Dealing with the emoticons
5. Extracting, replacing and removing special and numerical characters, puntuactions, mentions, URLs and hashtags
6. Lemmatizing
7. Named-Entity Recognition
8. Lowercasing

9. Stopword removal
10. Tokenization
11. Padding sequence

In [ ]:
```
raw_text="""Floods brought on by days of heavy rainfalls have been ravaging
            the Czech Republic and Austria, with thousands of people being e
            Austrian Chancellor Karl Nehammer on Monday said in a post on so
            that was translated by CNBC, that two more people had died follo
            This is in addition to a firefighter who died Sunday."""

text1 = nlp(raw_text)
displacy.render(text1, style="ent")
```

Floods brought on by days of heavy rainfalls have been ravaging countries including Poland GPE , Romania GPE , the Czech Republic GPE and Austria GPE , with thousands CARDINAL of people being evacuated as the death toll rises. Austrian NORP Chancellor Karl Nehammer PERSON on Monday DATE said in a post on social media platform X, that was translated by CNBC ORG , that two CARDINAL more people had died following floods in the country. This is in addition to a firefighter who died Sunday DATE .

Creating a example text

In [ ]:
```
example_text = "Hello, my name is Alexander Daniel Rios. I'm 30 years old, a
```

Digits to words

In [ ]:
```
matcher = Matcher(nlp.vocab)

pattern = [{"IS_DIGIT": True}]
matcher.add("NUMBERS", [pattern])

def digits2words(text, to_print=False):
    doc = nlp(text)
    matches = matcher(doc)
    for match_id, start, end in matches:
        if doc.vocab.strings[match_id] == "NUMBERS":
            if to_print:
                text = text.replace(doc[start:end].text, '\033[4m\033[32m'+n
            else:
                text = text.replace(doc[start:end].text, num2words(doc[start
    return text

print(f"ORIGINAL TEXT\n\033[100m{example_text}\033[0m\n")
print(f"MODIFIED TEXT\n\033[100m{digits2words(example_text, to_print=True)}\
```

```
ORIGINAL TEXT
Hello, my name is Alexander Daniel Rios. I'm 30 years old, and I live in Arge
ntina. Currently, I am studying at National Technological University. You can
find my GitHub profile at the following link: https://github.com/aletbm or with
my username @aletbm. #DataScientist #MLZoomCamp ;) :-)

MODIFIED TEXT
Hello, my name is Alexander Daniel Rios. I'm thirty years old, and I live in
Argentina. Currently, I am studying at National Technological University. You
can find my GitHub profile at the following link: https://github.com/aletbm or
with my username @aletbm. #DataScientist #MLZoomCamp ;) :-)
```

Dealing with the Twitter mentions

In [ ]:
```
pattern = [{"TEXT": {"REGEX":r"@\w+"}}]
matcher.add("TWITTER_MENTIONS", [pattern])

def replace_mentions(text):
    doc = nlp(text)
    matches = matcher(doc)
    for match_id, start, end in matches:
        if doc.vocab.strings[match_id] == "TWITTER_MENTIONS":
            text = text.replace(doc[start:end].text, "")#"@PERSON")
    return text

print(f"ORIGINAL TEXT\n\033[100m{example_text}\033[0m\n")
print(f"MODIFIED TEXT\n\033[100m{replace_mentions(example_text)}\033[0m")
```

```
ORIGINAL TEXT
Hello, my name is Alexander Daniel Rios. I'm 30 years old, and I live in Arge
ntina. Currently, I am studying at National Technological University. You can
find my GitHub profile at the following link: https://github.com/aletbm or with
my username @aletbm. #DataScientist #MLZoomCamp ;) :-)

MODIFIED TEXT
Hello, my name is Alexander Daniel Rios. I'm 30 years old, and I live in Arge
ntina. Currently, I am studying at National Technological University. You can
find my GitHub profile at the following link: https://github.com/aletbm or with
my username . #DataScientist #MLZoomCamp ;) :-)
```

Dealing with the hashtags

In [ ]:
```
pattern = [{'ORTH': '#'},{"TEXT": {"REGEX":r"\w+"}}]
matcher.add("HASHTAGS", [pattern])

def replace_hashtags(text, to_print=False):
    doc = nlp(text)
    matches = matcher(doc)
    for match_id, start, end in matches:
        if doc.vocab.strings[match_id] == "HASHTAGS":
            list_words = wn.split(doc[start+1:end].text)
            hashtag_converted = ' '.join(list_words)
            if to_print:
                text = text.replace(doc[start:end].text, '\033[4m\033[32m'+'
```

```
            else:
                text = text.replace(doc[start:end].text, '#'+hashtag_convert
    return text

print(f"ORIGINAL TEXT\n\033[100m{example_text}\033[0m\n")
print(f"MODIFIED TEXT\n\033[100m{replace_hashtags(example_text, to_print=Tru
```

```
ORIGINAL TEXT
Hello, my name is Alexander Daniel Rios. I'm 30 years old, and I live in Arge
ntina. Currently, I am studying at National Technological University. You can
find my GitHub profile at the following link: https://github.com/aletbm or with
my username @aletbm. #DataScientist #MLZoomCamp ;) :-)

MODIFIED TEXT
Hello, my name is Alexander Daniel Rios. I'm 30 years old, and I live in Arge
ntina. Currently, I am studying at National Technological University. You can
find my GitHub profile at the following link: https://github.com/aletbm or with
my username @aletbm. #Data Scientist #ML Zoom Camp ;) :-)
```

Dealing with the emoticons

In [ ]:
```
EMOTICONS = {':)': 'smile', ':-)': 'smile', ';d': 'wink', ':-E': 'vampire',
             ':-(': 'sad', ':-<': 'sad', ':P': 'raspberry', ':O': 'surprise
             ':-@': 'shocked', ':@': 'shocked',':-$': 'confused', ':\\': 'a
             ':#': 'mute', ':X': 'mute', ':^)': 'smile', ':-&': 'confused',
             '@@': 'eyeroll', ':-!': 'confused', ':-D': 'smile', ':-0': 'ye
             '<(-_-)>': 'robot', 'd[-_-]b': 'dj', ":'-)": 'sadsmile', ';)':
             ';-)': 'wink', 'O:-)': 'angel','O*-)': 'angel','(:-D': 'gossip

def replace_emojis(text, to_print=False):
    for emoji in EMOTICONS.keys():
        if to_print:
            text = text.replace(emoji, '\033[4m\033[32m'+ EMOTICONS[emoji]+'
        else:
            text = text.replace(emoji, EMOTICONS[emoji])
    return text

print(f"ORIGINAL TEXT\n\033[100m{example_text}\033[0m\n")
print(f"MODIFIED TEXT\n\033[100m{replace_emojis(example_text, to_print=True)
```

```
ORIGINAL TEXT
Hello, my name is Alexander Daniel Rios. I'm 30 years old, and I live in Arge
ntina. Currently, I am studying at National Technological University. You can
find my GitHub profile at the following link: https://github.com/aletbm or with
my username @aletbm. #DataScientist #MLZoomCamp ;) :-)

MODIFIED TEXT
Hello, my name is Alexander Daniel Rios. I'm 30 years old, and I live in Arge
ntina. Currently, I am studying at National Technological University. You can
find my GitHub profile at the following link: https://github.com/aletbm or with
my username @aletbm. #DataScientist #MLZoomCamp wink smile
```

Extracting, replacing and removing special and numerical characters, puntuactions, mentions, URLs

and hashtags

On the Tweet texts

In [ ]:

```
def get_list(text, c='#'):
    regex = ""
    if c == "https":
        regex = r"("+c+"?://[^\s]+)"
    elif c == "punct":
        regex = r"[!$%&´\'\"\(\)*,-./:;<=>?\\^_`\[\]{|}~+]"
    else:
        regex = r"("+c+"[^\s]+)"
    return re.findall(regex, text)

def clear_tweet(text, list_c):
    for c in list_c:
        if c in ["#", "@"]:
            lista = c
        else:
            lista = get_list(text, c)
        for item in lista:
            text = text.replace(item, " ").replace("  ", " ")
    text = re.sub(r'[^\x00-\x7F]+','', text)
    return text

def cleaner(text):
    hashtags = get_list(text, c='#')
    mentions = get_list(text, c='@')
    urls = get_list(text, c='https')
    clean_text = clear_tweet(text, ["#", "@", "https"])
    punctuations = get_list(clean_text, c="punct")
    clean_text = clear_tweet(clean_text, ["punct"])

    return clean_text, len(clean_text.split()), len(clean_text), len(hashtag

#df_cl["clean_text"], df_cl["n_words"], df_cl["n_characters"], df_cl["n_hash
clean_text, n_words, n_characters, n_hashtags, n_mentions, n_urls, n_punctua

print(f"ORIGINAL TEXT\n\033[100m{example_text}\033[0m\n")
print(f"MODIFIED TEXT\n\033[100m{clean_text}\033[0m\n")
print(f"Number of words: {n_words}")
print(f"Number of characters: {n_characters}")
print(f"Number of hashtags: {n_hashtags}")
print(f"Number of mentions: {n_mentions}")
print(f"Number of URLs: {n_urls}")
print(f"Number of punctuations: {n_punctuations}")
```

```
ORIGINAL TEXT
Hello, my name is Alexander Daniel Rios. I'm 30 years old, and I live in Arge
ntina. Currently, I am studying at National Technological University. You can
find my GitHub profile at the following link: https://github.com/aletbm or with
my username @aletbm. #DataScientist #MLZoomCamp ;) :-)

MODIFIED TEXT
Hello my name is Alexander Daniel Rios I m 30 years old and I live in Argenti
na Currently I am studying at National Technological University You can find m
y GitHub profile at the following link or with my username aletbm DataScientis
t MLZoomCamp

Number of words: 42
Number of characters: 246
Number of hashtags: 2
Number of mentions: 1
Number of URLs: 1
Number of punctuations: 14
```

On the keyword

In [ ]:
```
df_cl.loc[df_cl.keyword.str.contains("%20"), "keyword"].unique()
```

Out[ ]:
```
array(['airplane%20accident', 'blew%20up', 'blown%20up', 'body%20bag',
       'body%20bagging', 'body%20bags', 'bridge%20collapse',
       'buildings%20burning', 'buildings%20on%20fire',
       'burning%20buildings', 'bush%20fires', 'chemical%20emergency',
       'cliff%20fall', 'dust%20storm', 'emergency%20plan',
       'emergency%20services', 'fire%20truck', 'first%20responders',
       'forest%20fire', 'forest%20fires', 'heat%20wave', 'loud%20bang',
       'mass%20murder', 'mass%20murderer', 'natural%20disaster',
       'nuclear%20disaster', 'nuclear%20reactor', 'oil%20spill',
       'radiation%20emergency', 'structural%20failure', 'suicide%20bomb',
       'suicide%20bomber', 'suicide%20bombing', 'violent%20storm',
       'war%20zone', 'wild%20fires'], dtype=object)
```

In [ ]:
```
def replace_spaces(text):
    text = text.replace("%20", " ")
    return text

df_cl.loc[df_cl.keyword.str.contains("%20"), "keyword"].apply(replace_spaces
```

Out[ ]:
```
array(['airplane accident', 'blew up', 'blown up', 'body bag',
       'body bagging', 'body bags', 'bridge collapse',
       'buildings burning', 'buildings on fire', 'burning buildings',
       'bush fires', 'chemical emergency', 'cliff fall', 'dust storm',
       'emergency plan', 'emergency services', 'fire truck',
       'first responders', 'forest fire', 'forest fires', 'heat wave',
       'loud bang', 'mass murder', 'mass murderer', 'natural disaster',
       'nuclear disaster', 'nuclear reactor', 'oil spill',
       'radiation emergency', 'structural failure', 'suicide bomb',
       'suicide bomber', 'suicide bombing', 'violent storm', 'war zone',
       'wild fires'], dtype=object)
```

Lemmatizing

On the Tweet texts

In [ ]:
```
def lemmatize(text):
    doc = nlp(text)
    for token in doc:
        text = text.replace(token.text, token.lemma_)
    return text

print(f"ORIGINAL TEXT\n\033[100m{example_text}\033[0m\n")
print(f"MODIFIED TEXT\n\033[100m{lemmatize(example_text)}\033[0m")
```

```
ORIGINAL TEXT
Hello, my name is Alexander Daniel Rios. I'm 30 years old, and I live in Arge
ntina. Currently, I am studying at National Technological University. You can
find my GitHub profile at the following link: https://github.com/aletbm or with
my username @aletbm. #DataScientist #MLZoomCamp ;) :-)

MODIFIED TEXT
hello, my nbee be Alexander Daniel Rios. Ibe 30 year old, and I live in Argen
tina. currently, I be study at National Technological University. you can find
my GitHub profile at the follow link: https://github.com/aletbm or with my use
rnbee @aletbm. #DataScientbet #MLZoomCbep ;) :-)
```

On the keyword

In [ ]:
```
df_cl.keyword.apply(replace_spaces).unique()[-10:]
```

Out[ ]:
```
array(['weapons', 'whirlwind', 'wild fires', 'wildfire', 'windstorm',
       'wounded', 'wounds', 'wreck', 'wreckage', 'wrecked'], dtype=object)
```

In [ ]:
```
df_cl.keyword.apply(replace_spaces).apply(lemmatize).unique()[-10:]
```

Out[ ]:
```
array(['volcano', 'war zone', 'weapon', 'whirlwind', 'wild fire',
       'wildfire', 'windstorm', 'wound', 'wreck', 'wreckage'],
      dtype=object)
```

Named-Entity Recognition

In [ ]:
```
def replace_entities(text, to_print=False):
    doc = nlp(text)
    for ent in doc.ents:
        if to_print:
            text = text.replace(ent.text, '\033[4m\033[32m'+ent.label_+'\033
        else:
            text = text.replace(ent.text, ent.label_)
    return text

print(f"ORIGINAL TEXT\n\033[100m{example_text}\033[0m\n")
print(f"MODIFIED TEXT\n\033[100m{replace_entities(example_text, to_print=Tru
```

```
ORIGINAL TEXT
Hello, my name is Alexander Daniel Rios. I'm 30 years old, and I live in Arge
ntina. Currently, I am studying at National Technological University. You can
find my GitHub profile at the following link: https://github.com/aletbm or with
my username @aletbm. #DataScientist #MLZoomCamp ;) :-)

MODIFIED TEXT
Hello, my name is PERSON. I'm DATE, and I live in GPE. Currently, I am studyi
ng at ORG. You can find my ORG profile at the following link: https://github.co
m/aletbm or with my username ORG. MONEYMLZoomCamp ;) :-)
```

Lowercasing

In [ ]:
```
print(f"ORIGINAL TEXT\n\033[100m{example_text}\033[0m\n")
print(f"MODIFIED TEXT\n\033[100m{example_text.lower()}\033[0m")
```

```
ORIGINAL TEXT
Hello, my name is Alexander Daniel Rios. I'm 30 years old, and I live in Arge
ntina. Currently, I am studying at National Technological University. You can
find my GitHub profile at the following link: https://github.com/aletbm or with
my username @aletbm. #DataScientist #MLZoomCamp ;) :-)

MODIFIED TEXT
hello, my name is alexander daniel rios. i'm 30 years old, and i live in arge
ntina. currently, i am studying at national technological university. you can
find my github profile at the following link: https://github.com/aletbm or with
my username @aletbm. #datascientist #mlzoomcamp ;) :-)
```

Stopword removal

In [ ]:
```
def remove_stopwords(text):
    doc = nlp(text)
    filtered_sentence = []
    for token in doc:
        if (token.is_stop == False
            and len(token) > 2
            and token.is_ascii
            and token.is_alpha
            and token.text in dict_words[token.text[0]][token.text[1]]):
            filtered_sentence.append(token.text)

    return ' '.join(filtered_sentence)

print(f"ORIGINAL TEXT\n\033[100m{example_text.lower()}\033[0m\n")
print(f"MODIFIED TEXT\n\033[100m{remove_stopwords(example_text.lower())}\033
```

```
ORIGINAL TEXT
hello, my name is alexander daniel rios. i'm 30 years old, and i live in arge
ntina. currently, i am studying at national technological university. you can
find my github profile at the following link: https://github.com/aletbm or with
my username @aletbm. #datascientist #mlzoomcamp ;) :-)

MODIFIED TEXT
hello alexander daniel years old live argentina currently studying national t
echnological university find profile following link
```

Tokenization

In [ ]:
```python
def tokenize(text, tokenizer, fit=False):
    if fit == True:
        tokenizer.fit_on_texts(text)
    return tokenizer.texts_to_sequences(text)

tokenizer = Tokenizer(oov_token="<OOV>")
tokenized_text = tokenize([example_text], tokenizer, fit=True)

print(f"ORIGINAL TEXT\n\033[100m{example_text}\033[0m\n")
print(f"TOKENIZED TEXT\n\033[100m{tokenized_text}\033[0m\n")
print(f"DICTONARY OF CONVERTION\n\033[100m{dict(itertools.islice(tokenizer.i
```

```
ORIGINAL TEXT
Hello, my name is Alexander Daniel Rios. I'm 30 years old, and I live in Arge
ntina. Currently, I am studying at National Technological University. You can
find my GitHub profile at the following link: https://github.com/aletbm or with
my username @aletbm. #DataScientist #MLZoomCamp ;) :-)

TOKENIZED TEXT
[[7, 2, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 3, 18, 19, 20, 21, 3, 22, 23,
4, 24, 25, 26, 27, 28, 29, 2, 5, 30, 4, 31, 32, 33, 34, 5, 35, 6, 36, 37, 2,
38, 6, 39, 40]]

DICTONARY OF CONVERTION
{1: '<OOV>', 2: 'my', 3: 'i', 4: 'at', 5: 'github', 6: 'aletbm', 7: 'hello',
8: 'name', 9: 'is', 10: 'alexander', 11: 'daniel', 12: 'rios', 13: "i'm", 14:
'30', 15: 'years', 16: 'old', 17: 'and', 18: 'live', 19: 'in', 20: 'argentin
a', 21: 'currently', 22: 'am', 23: 'studying', 24: 'national', 25: 'technolog
ical', 26: 'university', 27: 'you', 28: 'can', 29: 'find', 30: 'profile', 31:
'the', 32: 'following', 33: 'link', 34: 'https', 35: 'com', 36: 'or', 37: 'wi
th', 38: 'username', 39: 'datascientist', 40: 'mlzoomcamp'}
```

Padding sequence

In [ ]:
```python
max_length_tweet = 21*3

padded_text = pad_sequences(tokenized_text, maxlen=max_length_tweet, padding

print(f"TOKENIZED TEXT\n\033[100m{tokenized_text}\033[0m\n")
print(f"TEXT WITH PADDING\n\033[100m{padded_text}\033[0m")
```

```
TOKENIZED TEXT
[[7, 2, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 3, 18, 19, 20, 21, 3, 22, 23,
4, 24, 25, 26, 27, 28, 29, 2, 5, 30, 4, 31, 32, 33, 34, 5, 35, 6, 36, 37, 2,
38, 6, 39, 40]]

TEXT WITH PADDING
[[ 7  2  8  9 10 11 12 13 14 15 16 17  3 18 19 20 21  3 22 23  4 24 25 26
  27 28 29  2  5 30  4 31 32 33 34  5 35  6 36 37  2 38  6 39 40  0  0  0
   0  0  0  0  0  0  0  0  0  0  0  0  0  0  0]]
```

All preprocessing steps in a single function

Cleaning the Tweet text

In [ ]:

```python
def init_configure():
    matcher = Matcher(nlp.vocab)

    pattern = [{"IS_DIGIT": True}]
    matcher.add("NUMBERS", [pattern])

    pattern = [{"TEXT": {"REGEX":r"@\w+"}}]
    matcher.add("TWITTER_MENTIONS", [pattern])

    pattern = [{'ORTH': '#'},{"TEXT": {"REGEX":r"\w+"}}]
    matcher.add("HASHTAGS", [pattern])

    tokenizer = Tokenizer(oov_token="<OOV>")

    max_length_tweet = 21*5
    max_length_keyword = 3*2
    return matcher, tokenizer, max_length_tweet, max_length_keyword

def preprocessing_text(text):
    doc = nlp(text)
    matches = matcher(doc)
    for match_id, start, end in matches:
        if doc.vocab.strings[match_id] == "NUMBERS":
            text = text.replace(doc[start:end].text, num2words(doc[start:end
        #if doc.vocab.strings[match_id] == "TWITTER_MENTIONS":
        #    text = text.replace(doc[start:end].text, "")#"@PERSON")
        #if doc.vocab.strings[match_id] == "HASHTAGS":
            #list_words = wn.split(doc[start+1:end].text)
            #hashtag_converted = ' '.join(list_words)
            #text = text.replace(doc[start:end].text, '#'+hashtag_converted)

    #text = replace_emojis(text)
    text, n_words, n_characters, n_hashtags, n_mentions, n_urls, n_punctuati
    text = lemmatize(text)
    #text = replace_entities(text)
    text = text.lower()
    clean_text = remove_stopwords(text)

    return clean_text, n_words, n_characters, n_hashtags, n_mentions, n_urls
```

```
def preprocessing_keyword(text):
    text = replace_spaces(text)
    clean_text = lemmatize(text)
    return clean_text

matcher, tokenizer, max_length_tweet, max_length_keyword = init_configure()

df_cl["clean_text"], df_cl["n_words"], df_cl["n_characters"], df_cl["n_hasht
df_cl["clean_keyword"] = df_cl.keyword.apply(lambda text: preprocessing_keyw
df_cl.head()
```

Out[ ]:

id	keyword	text	target	clean_text	n_words	n_characters	n_hashtags	n_
48	ablaze	@bbcmtd Wholesale Markets ablaze http://t.co/I...	1	wholesale markets ablaze	4	33	0	
49	ablaze	We always try to bring the heavy. #metal #RT h...	0	try bring heavy metal	9	42	2	
50	ablaze	#AFRICANBAZE: Breaking news:Nigeria flag set a...	1	break news nigeria flag set ablaze	9	58	1	
52	ablaze	Crying out for more! Set me ablaze	0	cry set ablaze	7	33	0	
53	ablaze	On plus side LOOK AT THE SKY LAST NIGHT IT WAS...	0	plus look sky night ablaze	12	54	0	

Tokenization and Padding

In [ ]:

```
def get_tokens(text, max_length, fit=False, padding=False):
    preprocessed_text = tokenize(text, tokenizer, fit)
    if padding:
        preprocessed_text = pad_sequences(preprocessed_text, maxlen=max_leng
    return preprocessed_text

df_cl["tokenized_text"] = list(get_tokens(df_cl["clean_text"].tolist(), max_
df_cl["tokenized_keyword"] = list(get_tokens(df_cl["clean_keyword"].tolist()
df_cl.head()
```

Out[ ]:

id	keyword	text	target	clean_text	n_words	n_characters	n_hashtags	n_
48	ablaze	@bbcmtd Wholesale Markets ablaze http://t.co/l...	1	wholesale markets ablaze	4	33	0	
49	ablaze	We always try to bring the heavy. #metal #RT h...	0	try bring heavy metal	9	42	2	
50	ablaze	#AFRICANBAZE: Breaking news:Nigeria flag set a...	1	break news nigeria flag set ablaze	9	58	1	
52	ablaze	Crying out for more! Set me ablaze	0	cry set ablaze	7	33	0	
53	ablaze	On plus side LOOK AT THE SKY LAST NIGHT IT WAS...	0	plus look sky night ablaze	12	54	0	

Vocabulary size

In [ ]:
```
vocab_size = len(tokenizer.word_index) + 1
vocab_size
```

Out[ ]: 8826

Let's take a look at the vocabulary

In [ ]:
```
pprint(dict(itertools.islice(tokenizer.index_word.items(), 20)))
```

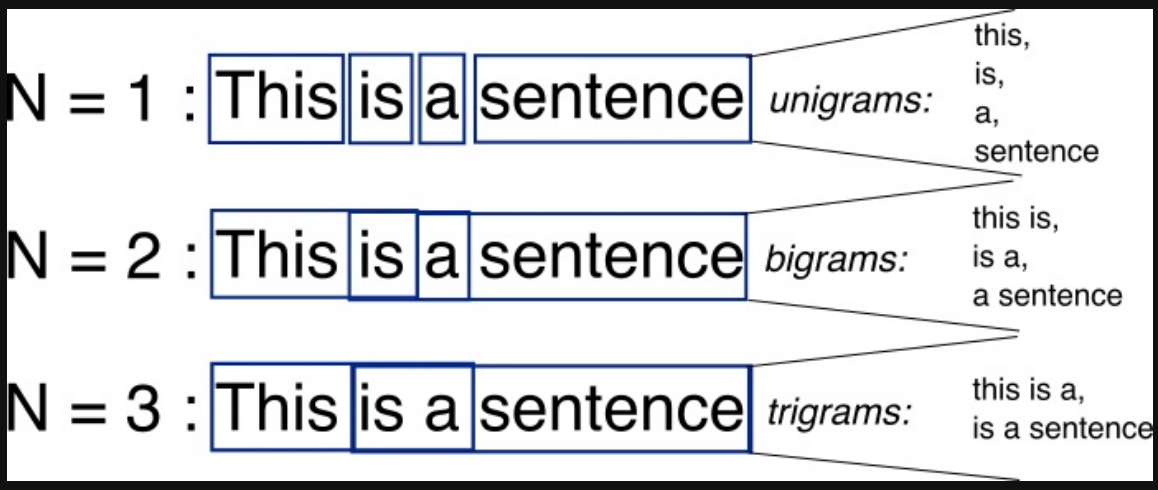
```
{1: '<OOV>',
 2: 'fire',
 3: 'like',
 4: 'amp',
 5: 'thousand',
 6: 'emergency',
 7: 'burn',
 8: 'body',
 9: 'bomb',
 10: 'disaster',
 11: 'crash',
 12: 'storm',
 13: 'flood',
 14: 'new',
 15: 'attack',
 16: 'collapse',
 17: 'building',
 18: 'scream',
 19: 'suicide',
 20: 'drown'}
```

Saving the preprocessors with CloudPickle for the baseline model

In [ ]:
```
with open('tokenizer.bin', 'wb') as f_out:
    cloudpickle.dump((tokenizer, dict_words), f_out)
```

N-grams

N-grams are contiguous sequences of 'n' items, typically words in the context of NLP.



Unigrams

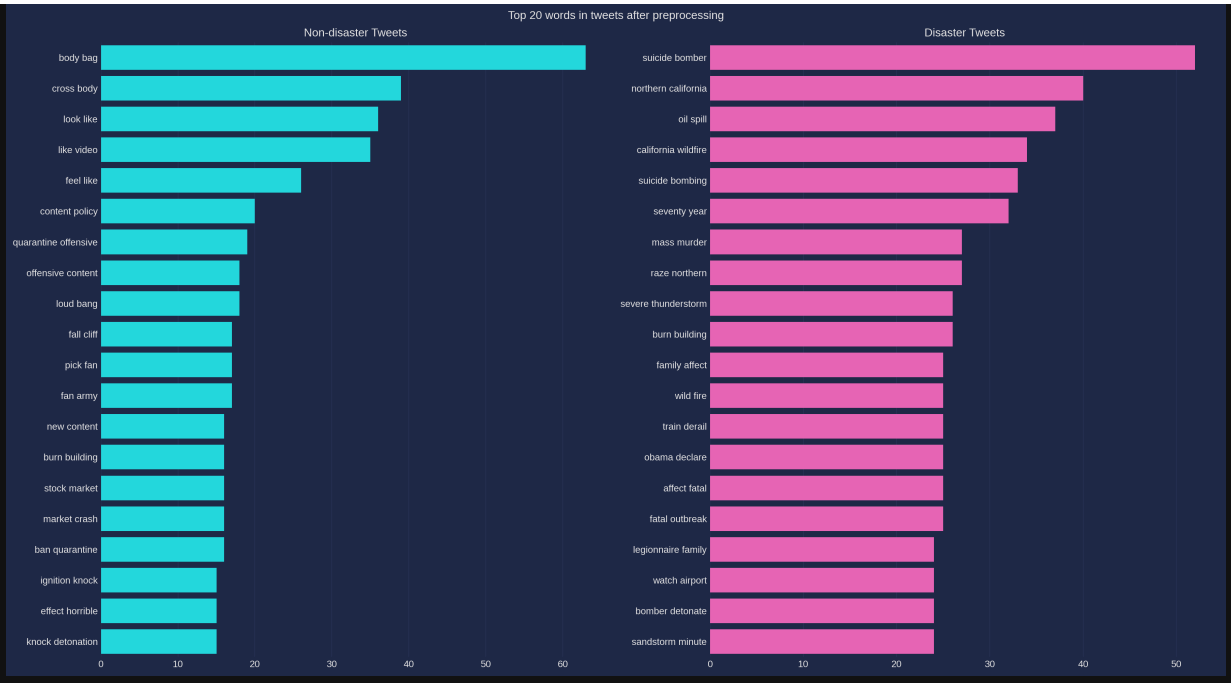
In [ ]:
```
def get_top_n_words(data, ngram_range=(1, 1)):
    vectorizer = CountVectorizer(ngram_range=ngram_range)
    count_matrix = vectorizer.fit_transform(data)
    count_array = count_matrix.toarray()
```

```
    bag_of_words = pd.DataFrame(data=count_array,columns = vectorizer.get_fe
    return bag_of_words

def plot_top_words(data, bag_of_words, top=20):
    top_word_disaster = bag_of_words[data["target"] == 1].sum().sort_values(
    top_word_disaster = top_word_disaster[:top]

    top_word_notdisaster = bag_of_words[data["target"] == 0].sum().sort_valu
    top_word_notdisaster = top_word_notdisaster[:top]

    plt.subplots(1, 2, figsize=(18, 10), dpi=200)

    plt.subplot(1, 2, 1)
    sns.barplot(y=top_word_notdisaster.index, x=top_word_notdisaster, color=
    plt.title("Non-disaster Tweets")

    plt.subplot(1, 2, 2)
    sns.barplot(y=top_word_disaster.index, x=top_word_disaster, color='#FE53
    plt.title("Disaster Tweets")
    plt.suptitle(f"Top {top} words in tweets after preprocessing")
    plt.tight_layout()
    return

bag_of_words = get_top_n_words(data=df_cl['clean_text'], ngram_range=(1, 1))
plot_top_words(data=df_cl, bag_of_words=bag_of_words, top=20)
```

We can see the difference between the unigrams of disaster tweets and non-disaster tweets. The disaster tweets contain unigrams with negative connotations.

Bigrams

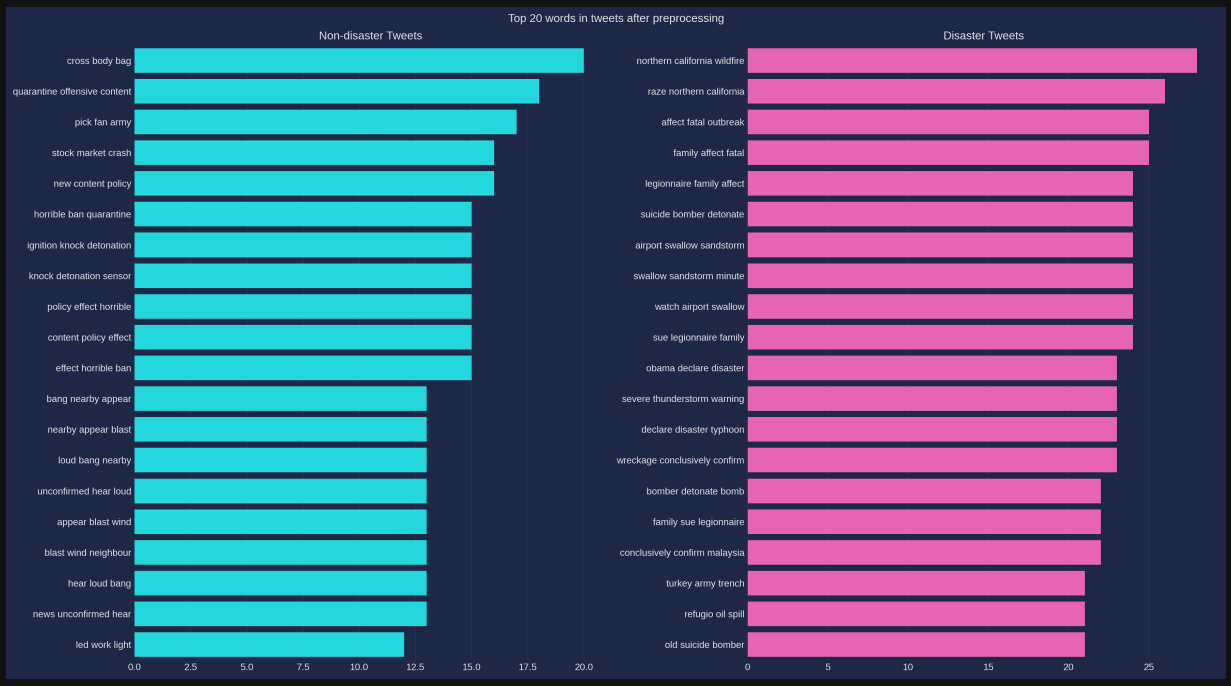
In [ ]:
```
bag_of_words = get_top_n_words(data=df_cl['clean_text'], ngram_range=(2, 2))
plot_top_words(data=df_cl, bag_of_words=bag_of_words, top=20)
```



We can see the difference between the bigrams of disaster tweets and non-disaster tweets. The disaster tweets contain bigrams with negative connotations.

Trigrams

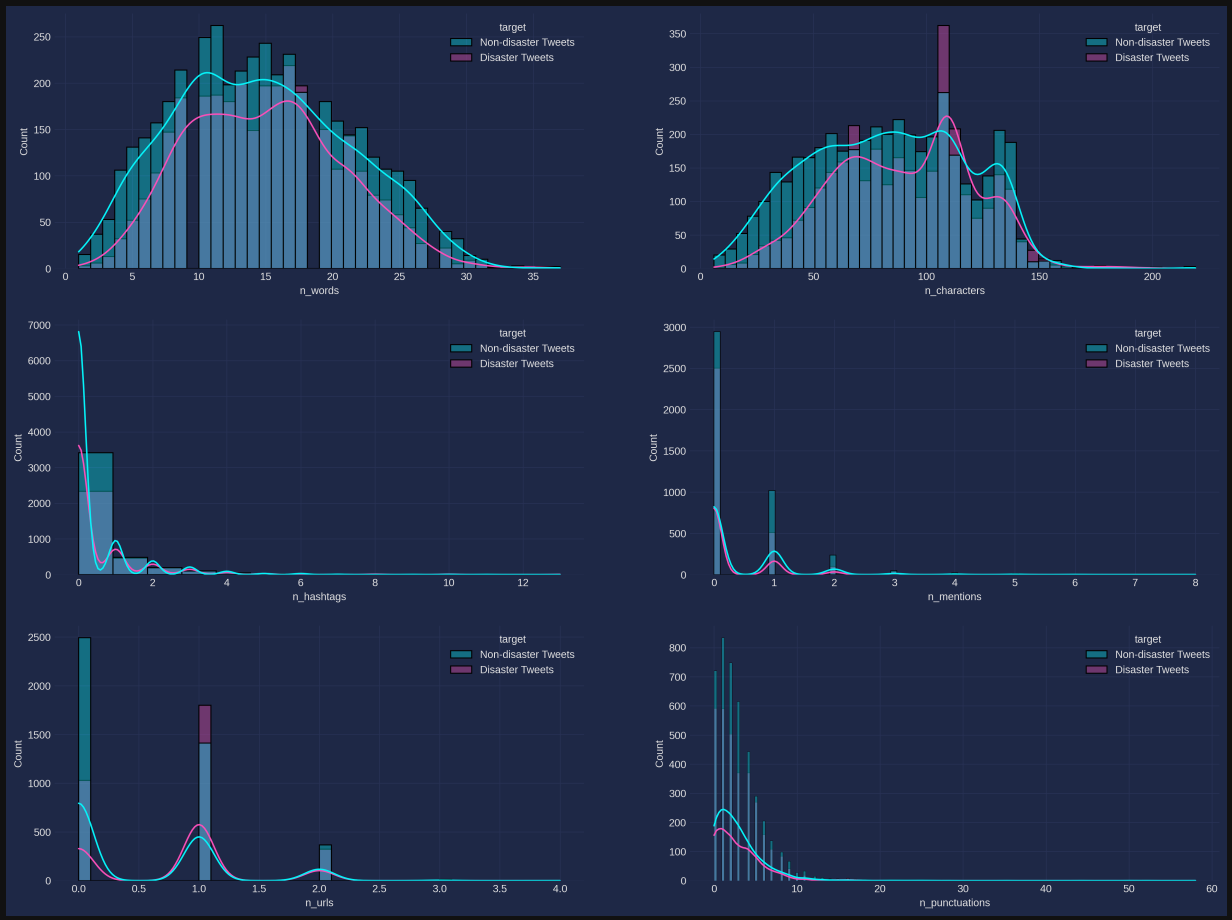
In [ ]:
```
bag_of_words = get_top_n_words(data=df_cl['clean_text'], ngram_range=(3, 3))
plot_top_words(data=df_cl, bag_of_words=bag_of_words, top=20)
```



We can see the difference between the trigrams of disaster tweets and non-disaster tweets. The disaster tweets contain trigrams with negative connotations.

Distribution of the context feature by tweet type

In [ ]:
```
pd.set_option("mode.copy_on_write", False)
target = df_cl["target"].map({0: "Non-disaster Tweets", 1: "Disaster Tweets"

plt.subplots(3, 2, figsize=(20, 15), dpi=300)
for i, col in enumerate(["n_words", "n_characters", "n_hashtags", "n_mention
    plt.subplot(3, 2, i+1)
    sns.histplot(x=df_cl[col], hue=target, hue_order=["Non-disaster Tweets",
```



Statistical analysis of context features in non-disaster tweets

In [ ]:
```
df_cl.loc[df_cl["target"] == 0, ["n_words", "n_characters", "n_hashtags", "n
```

Out[ ]:

	count	mean	std	min	25%	50%	75%	max
n_words	4286.0	14.655623	6.563463	1.0	10.0	14.0	19.0	37.0
n_characters	4286.0	82.882408	34.296479	6.0	56.0	84.0	110.0	219.0
n_hashtags	4286.0	0.383341	0.990170	0.0	0.0	0.0	0.0	11.0
n_mentions	4286.0	0.425338	0.771670	0.0	0.0	0.0	1.0	8.0
n_urls	4286.0	0.511433	0.667103	0.0	0.0	0.0	1.0	4.0
n_punctuations	4286.0	2.993234	3.279255	0.0	1.0	2.0	4.0	58.0

Statistical analysis of context features in disaster tweets

In [ ]:
```
df_cl.loc[df_cl["target"] == 1, ["n_words", "n_characters", "n_hashtags", "n
```

Out[ ]:

	count	mean	std	min	25%	50%	75%	max
n_words	3161.0	14.937678	5.742379	1.0	10.0	15.0	19.0	36.0
n_characters	3161.0	90.240430	30.637671	9.0	67.0	91.0	112.0	202.0
n_hashtags	3161.0	0.506485	1.198643	0.0	0.0	0.0	1.0	13.0
n_mentions	3161.0	0.278709	0.630315	0.0	0.0	0.0	0.0	5.0
n_urls	3161.0	0.782347	0.625982	0.0	0.0	1.0	1.0	3.0
n_punctuations	3161.0	2.933249	2.801385	0.0	1.0	2.0	4.0	21.0

In general terms, the context features have very similar statistical characteristics between the different tweet types.

Splitting the dataset

Separating the target

In [ ]:
```
X = df_cl.drop(["target"], axis=1)
y = df_cl["target"]
```

Creating the training and validation set

In [ ]:
```
X_train, X_val, y_train, y_val = train_test_split(X, y, test_size=0.20, stra
X_val, X_test, y_val, y_test = train_test_split(X_val, y_val, test_size=0.50
X_train.head()
```

Out[ ]:

id	keyword	text	clean_text	n_words	n_characters	n_hasht
3015		death	I feel like death	feel like death	4	17
276		ambulance	#reuters Twelve feared killed in Pakistani air...	reuters fear kill pakistani air ambulance heli...	10	74
3075		deaths	real magic in real life:\n\nwomen went missing...	real magic real life woman miss ohio town focu...	20	106
2209	chemical%20emergency		Emergency Response and Hazardous Chemical Mana...	emergency response hazardous chemical manageme...	9	78
996		blazing	SHOUOUT TO @kasad1lla CAUSE HER VOCALS ARE BLA...	cause vocals blaze hot like weather	14	78

Dealing with an imbalance target

In [ ]:
```
class_weight = compute_class_weight(class_weight="balanced", classes=np.uniq
class_weight = dict(zip(np.unique(y_train), class_weight))
class_weight
```

Out[ ]:
```
{0: 0.8688739789964994, 1: 1.1777382364570976}
```

Training a baseline model for Tweet classification

Creating the dataset for my baseline model

Selecting the useful columns

In [ ]:
```
X_train_tokenized = X_train.loc[:, ["tokenized_text", "tokenized_keyword", "
X_val_tokenized = X_val.loc[:, ["tokenized_text", "tokenized_keyword", "n_wo
```

```
X_test_tokenized = X_test.loc[:, ["tokenized_text", "tokenized_keyword", "n_

X_train_tokenized.head()
```

Out[ ]:

id	tokenized_text	tokenized_keyword	n_words	n_characters	n_hashtags	n_mentions
3015	[81, 2, 36, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0...	[23, 0, 0, 0, 0, 0]	4	17	0	0
276	[560, 61, 10, 727, 227, 242, 439, 12, 0, 0, 0,...	[137, 0, 0, 0, 0, 0]	10	74	1	0
3075	[251, 1442, 251, 38, 128, 188, 2612, 540, 1472...	[23, 0, 0, 0, 0, 0]	20	106	0	0
2209	[13, 878, 364, 278, 1895, 5292, 993, 0, 0, 0, ...	[175, 6, 0, 0, 0, 0]	9	78	0	0
996	[47, 4799, 187, 99, 2, 175, 0, 0, 0, 0, 0, 0, ...	[70, 0, 0, 0, 0, 0]	14	78	0	1

Creating a Tensorflow Dataset

In [ ]:

```
train_text, train_keyword, train_context = X_train_tokenized["tokenized_text
train_data_text = Dataset.from_tensor_slices(train_text)
train_data_keyword = Dataset.from_tensor_slices(train_keyword)
train_data_context = Dataset.from_tensor_slices(train_context)
train_labels = Dataset.from_tensor_slices(np.expand_dims(y_train.values, axi

val_text, val_keyword, val_context = X_val_tokenized["tokenized_text"].to_li
val_data_text = Dataset.from_tensor_slices(val_text)
val_data_keyword = Dataset.from_tensor_slices(val_keyword)
val_data_context = Dataset.from_tensor_slices(val_context)
val_labels = Dataset.from_tensor_slices(np.expand_dims(y_val.values, axis=-1

test_text, test_keyword, test_context = X_test_tokenized["tokenized_text"].t
test_data_text = Dataset.from_tensor_slices(test_text)
test_data_keyword = Dataset.from_tensor_slices(test_keyword)
test_data_context = Dataset.from_tensor_slices(test_context)
test_labels = Dataset.from_tensor_slices(np.expand_dims(y_test.values, axis=

train_data_tokenized_ = Dataset.zip(((train_data_text, train_data_keyword, t
val_data_tokenized_ = Dataset.zip(((val_data_text, val_data_keyword, val_dat
test_data_tokenized_ = Dataset.zip(((test_data_text, test_data_keyword, test

AUTOTUNE = tf.data.AUTOTUNE
```

Baseline model architecture

In [ ]:
```
def get_baseline_model():
    tf.keras.backend.clear_session()

    inp1 = Input(shape=(max_length_tweet,), name="text")
    x = Embedding(input_dim=vocab_size, output_dim=16, input_length=max_leng
    x = Bidirectional(LSTM(4, dropout=0.4, recurrent_dropout=0.0))(x)
    out1 = Dense(1, activation="sigmoid")(x)

    inp2 = Input(shape=(max_length_keyword,), name="keyword")
    t = Embedding(input_dim=vocab_size, output_dim=16, input_length=max_leng
    t = Bidirectional(LSTM(4, dropout=0.4, recurrent_dropout=0.0))(t)
    out2 = Dense(1, activation="sigmoid")(t)

    inp3 = Input(shape=(6,), name="context")
    z = Dense(32, activation="relu")(inp3)
    z = Dropout(0.4)(z)
    z = Dense(16, activation="relu")(z)
    out3 = Dense(1, activation="sigmoid")(z)

    k = Concatenate()([out1, out2, out3])
    out = Dense(1, activation="sigmoid")(k)

    model = Model(inputs=[inp1, inp2, inp3], outputs=out)
    return model

model_base = get_baseline_model()
model_base.summary()
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/core/embedding.py:9
0: UserWarning: Argument `input_length` is deprecated. Just remove it.
  warnings.warn(
```

Model: "functional"

Layer (type)	Output Shape	Param
context (InputLayer)	(None, 6)	0
text (InputLayer)	(None, 105)	0
keyword (InputLayer)	(None, 6)	0
dense_2 (Dense)	(None, 32)	224
embedding (Embedding)	(None, 105, 16)	141,216
embedding_1 (Embedding)	(None, 6, 16)	141,216
dropout (Dropout)	(None, 32)	0
bidirectional (Bidirectional)	(None, 8)	672
bidirectional_1 (Bidirectional)	(None, 8)	672
dense_3 (Dense)	(None, 16)	528
dense (Dense)	(None, 1)	9
dense_1 (Dense)	(None, 1)	9
dense_4 (Dense)	(None, 1)	17
concatenate (Concatenate)	(None, 3)	0
dense_5 (Dense)	(None, 1)	4

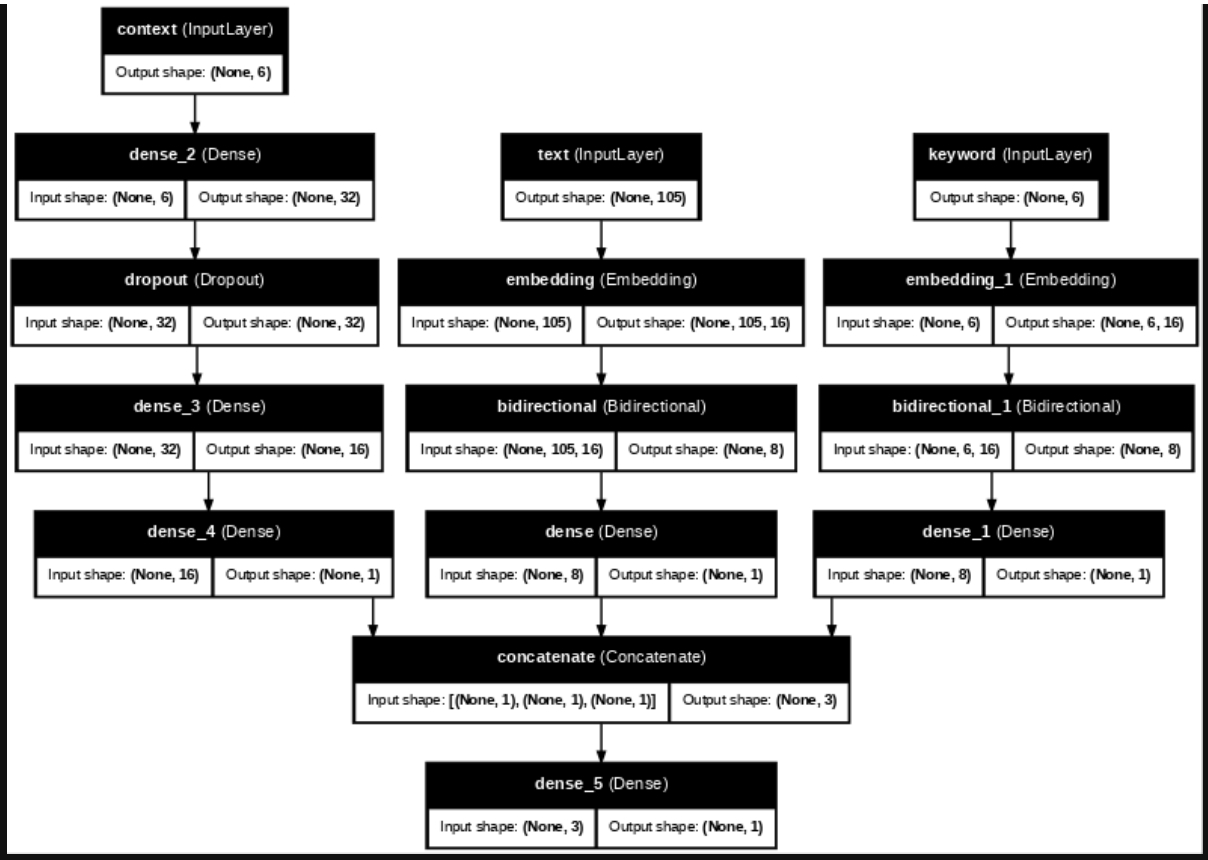
Total params: 284,567 (1.09 MB)

Trainable params: 284,567 (1.09 MB)

Non-trainable params: 0 (0.00 B)

In [ ]:
```
plot_model(model_base, show_layer_names=True, show_shapes=True, dpi=50)
```

Out [ ]:



Let's train

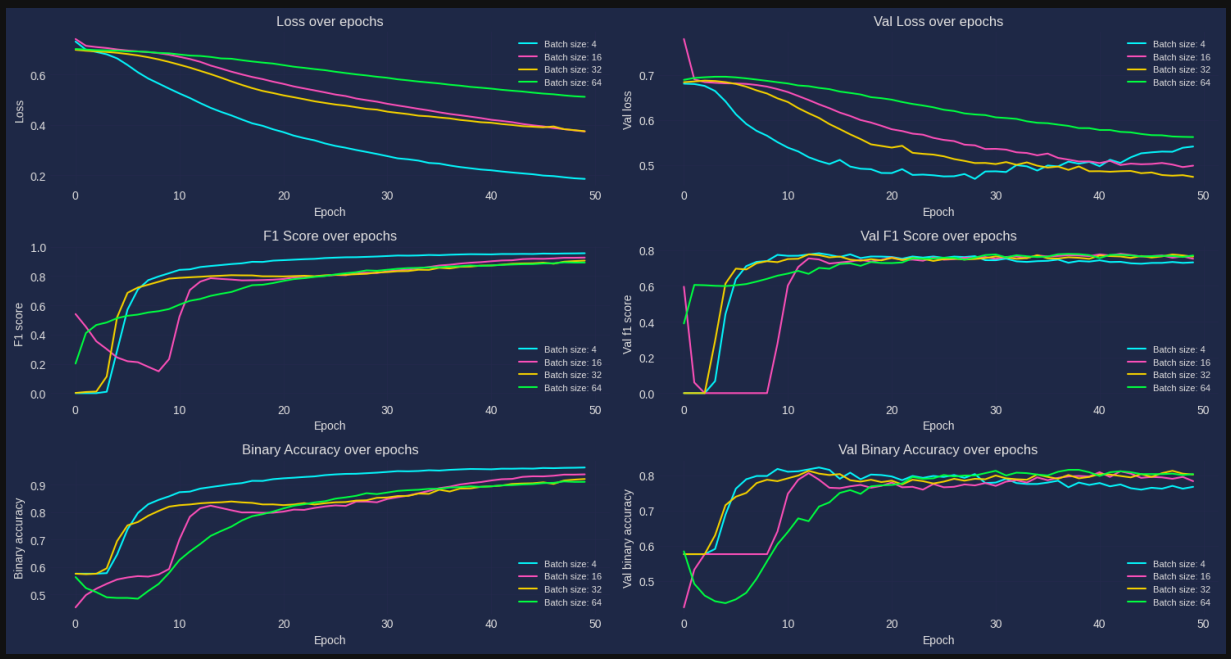
Effect of varying the batch size Parameter

In [ ]:

```
def train_model(model, train_data, val_data, batch_size=32, epochs=100, vers
    csvlogger = CSVLogger(dst_path+f"histories/history_model_{version}.csv",

    model.compile(optimizer=Adam(learning_rate=1e-4), loss='binary_crossentr
    history = model.fit(train_data,
                        validation_data=val_data,
                        batch_size=batch_size,
                        validation_batch_size=batch_size,
                        epochs=epochs,
                        callbacks=[csvlogger],
                        class_weight=class_weight
                       )
    return history

for bs in [4, 16, 32, 64]:
    train_data_tokenized = train_data_tokenized_.batch(bs).prefetch(buffer_si
    val_data_tokenized = val_data_tokenized_.batch(bs).prefetch(buffer_size=A
    test_data_tokenized = test_data_tokenized_.batch(bs).prefetch(buffer_size
    model_base = get_baseline_model()
    history_base = train_model(model=model_base,
                               train_data=train_data_tokenized,
                               val_data=val_data_tokenized,
                               batch_size=bs,
                               epochs=50,
```

```
                                    version=f"base_{bs}"
                                   )
```

In [ ]:
```
parameters = ["loss", "val_loss", "f1_score", "val_f1_score", "binary_accura
fig, axs = plt.subplots(3, 2, figsize=(15, 8))
for bs in [4, 16, 32, 64]:
    version=f"base_{bs}"
    df_hist = pd.read_csv(dst_path+f"histories/history_model_{version}.csv")

    for i, col in enumerate(parameters):
        plt.subplot(3, 2, i+1)
        param = col.replace('_', ' ').title()
        plt.plot(df_hist.index, df_hist[col], label=f"Batch size: {bs}")
        plt.ylabel(col.capitalize().replace("_", " "))
        plt.xlabel("Epoch")
        plt.legend(fontsize=8)
        plt.grid(True, alpha=0.3, which="both")
        plt.title(f"{param} over epochs")
plt.tight_layout()
```



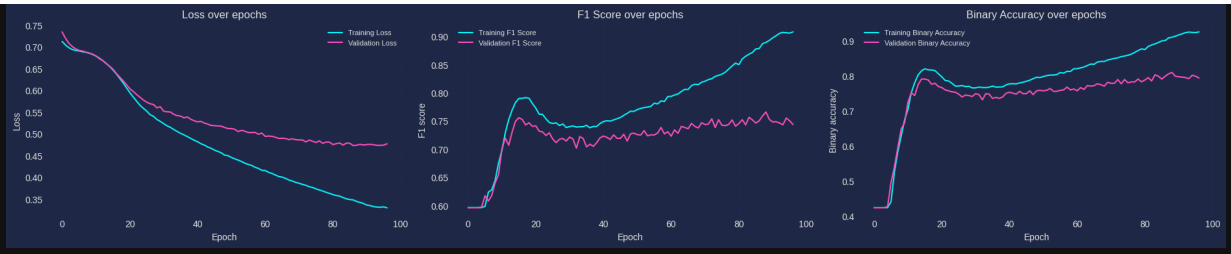
If we focus on the validation loss, we can see that a batch size of 4 shows a slight increase in the last epochs, while batch sizes of 16 and 32 show a decrease in the last epoch.

In [ ]:
```
def train_model(model, train_data, val_data, epochs=100, version="base"):
    checkpoint_filepath = dst_path+f'models/model_{version}.keras'
    checkpoint = ModelCheckpoint(checkpoint_filepath, monitor='val_loss', sav
    reduce = ReduceLROnPlateau(monitor='val_loss', patience=6, verbose=1)
    early = EarlyStopping(monitor='val_loss', patience=10, verbose=1, restor
    csvlogger = CSVLogger(dst_path+f"histories/history_model_{version}.csv",

    model.compile(optimizer=Adam(learning_rate=1e-4), loss='binary_crossentr
    history = model.fit(train_data,
                        validation_data=val_data,
                        epochs=epochs,
                        callbacks=[reduce, early, checkpoint, csvlogger],
```

```
                          class_weight=class_weight
                         )
    return history

batch_size = 32
train_data_tokenized = train_data_tokenized_.batch(batch_size).prefetch(buffe
val_data_tokenized = val_data_tokenized_.batch(batch_size).prefetch(buffer_si
test_data_tokenized = test_data_tokenized_.batch(batch_size).prefetch(buffer_

history_base = train_model(model=model_base,
                           train_data=train_data_tokenized,
                           val_data=val_data_tokenized,
                           epochs=200,
                           version="base"
                          )
```

Visualizing the metrics over training epochs of the baseline model

In [ ]:
```
def delete_empty_subplots(fig, axs):
    for ax_row in axs:
        for ax in ax_row:
            if ax.title.get_text() == "":
                fig.delaxes(ax)
    return fig, axs

def show_history(version, parameters=None):
    df_hist = pd.read_csv(dst_path+f"histories/history_model_{version}.csv")
    fig, axs = plt.subplots(2, 4, figsize=(25, 7))

    for i, col in enumerate(parameters):
        plt.subplot(2, 4, i+1)
        param = col[0].replace('_', ' ').title()
        plt.plot(df_hist.index, df_hist[col[0]], label=f"Training {param}")
        plt.plot(df_hist.index, df_hist[col[1]], label=f"Validation {param}"
        plt.ylabel(col[0].capitalize().replace("_", " "))
        plt.xlabel("Epoch")
        plt.legend(fontsize=8)
        plt.grid(True, alpha=0.3, which="both")
        plt.title(f"{param} over epochs")

    fig, axs = delete_empty_subplots(fig, axs)
    plt.tight_layout()
    plt.show()
    return

show_history(version="base", parameters=[["loss", "val_loss"],["f1_score", "
```

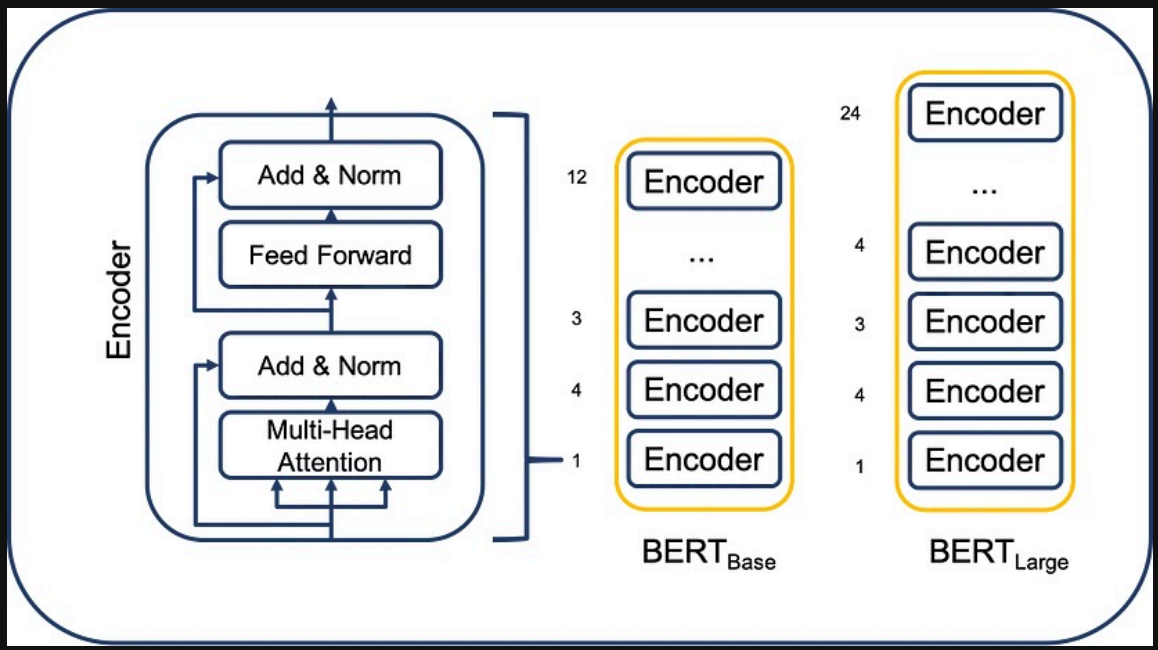


Evaluating the baseline model

```
In [ ]: model_base.evaluate(test_data_tokenized)
```

```
24/24 ━━━━━━━━━━━━━━━━━━━━ 0s 7ms/step - binary_accuracy: 0.803
1 - f1_score: 0.7502 - loss: 0.4989
Out[ ]: [0.49932780861854553, 0.7437184453010559, 0.7946308851242065]
```

Fine-Tuning with the BERT architecture (Bidirectional Encoder Representations from Transformers)



Creating the dataset for the BERT model

Selecting the useful columns

```
In [ ]: X_train_clean = X_train.loc[:, "text"]
        X_val_clean = X_val.loc[:, "text"]
        X_test_clean = X_test.loc[:, "text"]
```

```
X_train_clean
```

Out[ ]:
```
id
3015                                    I feel like death
276      #reuters Twelve feared killed in Pakistani air...
3075     real magic in real life:\n\nwomen went missing...
2209     Emergency Response and Hazardous Chemical Mana...
996      SHOUOUT TO @kasad1lla CAUSE HER VOCALS ARE BLA...
                               ...
10137    Ancient Mayan Tablet with Hieroglyphics Honors...
1061        @KatRamsland Yes I'm a bleeding heart liberal.
3509     MP trains derailment: ÛÏIt's the freakiest ...
4022     DISASTER AVERTED: Police kill gunman with 'hoa...
1501     US ÛÏInstitute Of PeaceÛª Chairman Wants Rus...
Name: text, Length: 5957, dtype: object
```

Creating a Tensorflow Dataset

In [ ]:
```
train_data_bert = Dataset.from_tensor_slices(X_train_clean.values)
train_labels = Dataset.from_tensor_slices(np.expand_dims(y_train.values, axi

val_data_bert = Dataset.from_tensor_slices(X_val_clean.values)
val_labels = Dataset.from_tensor_slices(np.expand_dims(y_val.values, axis=-1

test_data_bert = Dataset.from_tensor_slices(X_test_clean.values)
test_labels = Dataset.from_tensor_slices(np.expand_dims(y_test.values, axis=

train_data_bert = Dataset.zip((train_data_bert, train_labels))
val_data_bert = Dataset.zip((val_data_bert, val_labels))
test_data_bert = Dataset.zip((test_data_bert, test_labels))

AUTOTUNE = tf.data.AUTOTUNE
batch_size = 32

preset = "bert_small_en_uncased"
preprocessor = BertPreprocessor.from_preset(preset, trainable=True)

train_data_bert = train_data_bert.map(preprocessor).batch(batch_size).prefet
val_data_bert = val_data_bert.map(preprocessor).batch(batch_size).prefetch(b
test_data_bert = test_data_bert.map(preprocessor).batch(batch_size).prefetch
```

BERT model architecture

In [ ]:
```
def get_bert_model(preset):
    tf.keras.backend.clear_session()
    tokens_ids = Input(shape=(512,), name='token_ids')
    padding_mask = Input(shape=(512,), name='padding_mask')
    segment_ids = Input(shape=(512, ), name='segment_ids')
    encoder = BertBackbone.from_preset(preset)
    for i, layer in enumerate(encoder.layers):
        encoder.layers[i].trainable = True
    outputs = encoder({'token_ids':tokens_ids, 'padding_mask':padding_mask,
```

```
    my_net = outputs["pooled_output"]
    my_net = Dense(64, activation="relu")(my_net)
    my_net = Dropout(0.4)(my_net)
    my_net = Dense(1, activation="sigmoid")(my_net)
    return Model(inputs={'token_ids':tokens_ids, 'padding_mask':padding_mask

model_bert = get_bert_model(preset)
model_bert.summary()
```

Model: "functional"

Layer (type)	Output Shape	Param
padding_mask (InputLayer)	(None, 512)	0
segment_ids (InputLayer)	(None, 512)	0
token_ids (InputLayer)	(None, 512)	0
bert_backbone (BertBackbone)	[(None, 512), (None, 512, 512)]	28,763,648
dense (Dense)	(None, 64)	32,832
dropout_4 (Dropout)	(None, 64)	0
dense_1 (Dense)	(None, 1)	65

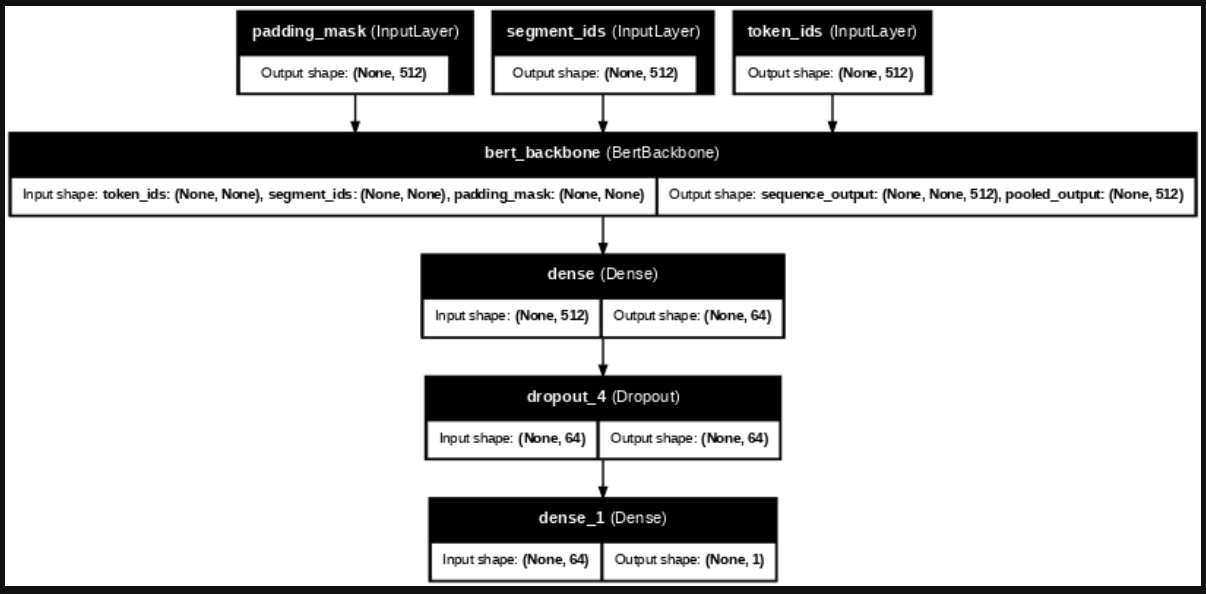
Total params: 28,796,545 (109.85 MB)

Trainable params: 28,796,545 (109.85 MB)

Non-trainable params: 0 (0.00 B)

In [ ]:
```
plot_model(model_bert, show_layer_names=True, show_shapes=True, dpi=50)
```

Out[ ]:

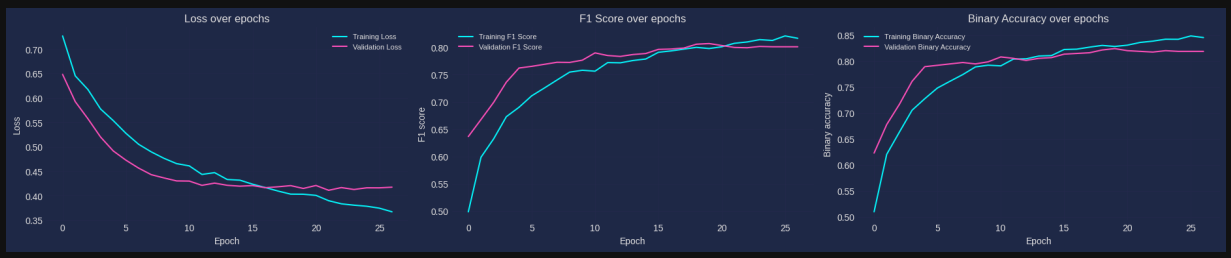


Let's train the BERT model

In [ ]:
```
def train_model(model, train_data, val_data, epochs=100, version="base"):
    checkpoint_filepath = dst_path+f'models/model_{version}.keras'
    checkpoint = ModelCheckpoint(checkpoint_filepath, monitor='val_loss', sav
    reduce = ReduceLROnPlateau(monitor='val_loss', patience=3, verbose=1)
    early = EarlyStopping(monitor='val_loss', patience=5, verbose=1, restore
    csvlogger = CSVLogger(dst_path+f"histories/history_model_{version}.csv",

    model.compile(optimizer=Adam(learning_rate=1e-6), loss = 'binary_crossen
    history = model.fit(train_data,
                        validation_data=val_data,
                        epochs=epochs,
                        callbacks=[reduce, early, checkpoint, csvlogger],
                        class_weight=class_weight
                       )
    return history

history_bert = train_model(model_bert, train_data_bert, val_data_bert, epoch
```

Visualizing the metrics over training epochs of the BERT model

In [ ]:
```
show_history(version="bert", parameters=[["loss", "val_loss"],["f1_score", "
```



Evaluating the BERT model

In [ ]:
```
model_bert.evaluate(test_data_bert)
```

```
24/24 ━━━━━━━━━━━━━━━━━━━━ 2s 82ms/step - binary_accuracy: 0.80
77 - f1_score: 0.7672 - loss: 0.4223
```

Out[ ]:
```
[0.4325513541698456, 0.7717041373252869, 0.809395968914032]
```

Saving the preprocessor with CloudPickle

In [ ]:
```
with open('preprocessor.bin', 'wb') as f_out:
    cloudpickle.dump(preprocessor, f_out)
```

Evaluation metrics

Comparison table

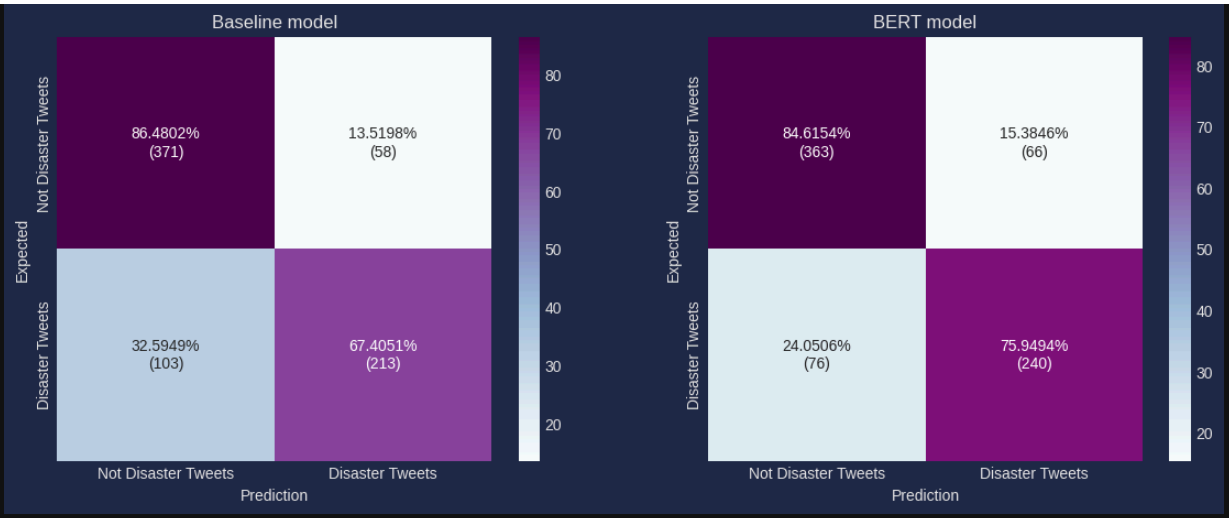
In [ ]:
```
def get_scores(y_true, y_pred, y_pred_proba):
    return {'AUC_ROC':roc_auc_score(y_true, y_pred_proba),
            'F1_Score':f1_score(y_true, y_pred, average='weighted'),
            'Accuracy':accuracy_score(y_true, y_pred),
            'Precision':precision_score(y_true, y_pred, average='weighted'),
            'Recall':recall_score(y_true, y_pred, average='weighted')}

scores = []

y_test_pred_proba_base = model_base.predict(test_data_tokenized, verbose=0)
y_test_pred_base = tf.math.round(y_test_pred_proba_base)
scores.append(get_scores(y_test, y_test_pred_base, y_test_pred_proba_base))

y_test_pred_proba_bert = model_bert.predict(test_data_bert, verbose=0)
y_test_pred_bert = tf.math.round(y_test_pred_proba_bert)
scores.append(get_scores(y_test, y_test_pred_bert, y_test_pred_proba_bert))

comparison = pd.DataFrame(data=scores, index=["Baseline Model", "BERT model"
comparison.style.highlight_max(color = 'green', axis = 0).highlight_min(colo
```

Out[ ]:

	AUC_ROC	F1_Score	Accuracy	Precision	Recall
Baseline Model	0.826001	0.780994	0.783893	0.784091	0.783893
BERT model	0.875719	0.808962	0.809396	0.808825	0.809396

Confusion matrix

In [ ]:
```
def my_cm(y_true, y_pred, title):
    cm_val = confusion_matrix(y_true, y_pred)
    cm_pgs = np.round(confusion_matrix(y_true, y_pred, normalize='true')*100

    formatted_text = (np.asarray([f"{pgs}%\n({val})" for val, pgs in zip(cm_

    sns.heatmap(cm_pgs, annot=formatted_text, fmt='', cmap='BuPu', yticklabe
    plt.title(title)
    plt.xlabel("Prediction")
    plt.ylabel("Expected")
    return

classes = ["Non-disaster Tweets", "Disaster Tweets"]
plt.subplots(1, 2, figsize=(14, 5))

plt.subplot(1, 2, 1)
my_cm(y_test, y_test_pred_base, title="Baseline model")

plt.subplot(1, 2, 2)
my_cm(y_test, y_test_pred_bert, title="BERT model")
```



Generating the submission file

Loading a sample submission

In [ ]:
```
pd.read_csv(src_path+"nlp-getting-started/sample_submission.csv").head()
```

Out[ ]:

	id	target
0	0	0
1	2	0
2	3	0
3	9	0
4	11	0

Loading the test file

In [ ]:
```
df_submission = pd.read_csv(src_path+"nlp-getting-started/test.csv", usecols
df_submission.head()
```

Out[ ]:

	id	text
0	0	Just happened a terrible car crash
1	2	Heard about #earthquake is different cities, s...
2	3	there is a forest fire at spot pond, geese are...
3	9	Apocalypse lighting. #Spokane #wildfires
4	11	Typhoon Soudelor kills 28 in China and Taiwan

Classifying the tweets in the test file

In [ ]:
```
preprocessed_text = preprocessor(df_submission.text)
prediction = model_bert.predict(preprocessed_text)
prediction = tf.cast(tf.math.round(prediction), tf.uint8)
prediction
```

```
102/102 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 13s 103ms/step
```

Out[ ]:
```
<tf.Tensor: shape=(3263, 1), dtype=uint8, numpy=
array([[1],
       [1],
       [1],
       ...,
       [1],
       [1],
       [1]], dtype=uint8)>
```

Creating the submission file

In [ ]:
```
df_submission["target"] = prediction
submission = df_submission.loc[:, ["id", "target"]]
submission.head()
```

Out[ ]:

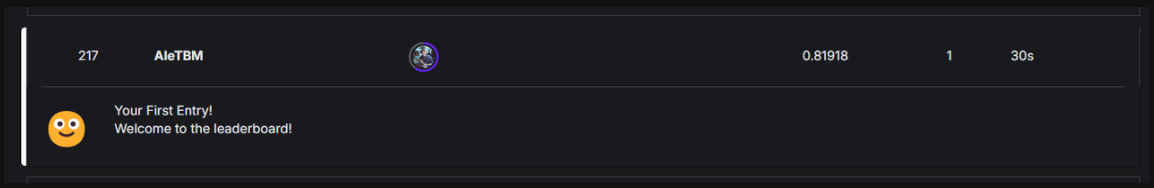
	id	target
0	0	1
1	2	1
2	3	1
3	9	1
4	11	1

Save the submission file

In [ ]:
```
submission.to_csv("submission.csv", index=False)
```

My leaderboard position in the competition

Currently, my position is #217



Thank you for your time! 😀

Converting Notebook to PDF

In [1]:
```
!apt-get install texlive-xetex texlive-fonts-recommended texlive-plain-gener
!pip install pypandoc nbconvert[webpdf]
!playwright install
!playwright install-deps

from google.colab import drive
from IPython.display import clear_output
drive.mount('/content/drive')
clear_output(wait=False)
```

In [ ]:
```
%%capture
!jupyter nbconvert --to webpdf /content/drive/MyDrive/ML_Zoomcamps_2024/Caps
```