+ Code + Text

# BA870 - Using BERT to Predict a Company's Asset Intensity (Text Analysis)

## The goal of this notebook is to show the possibilities of predicting financial outcomes from textual data via DistilBERT transformer model.

This notebook builds uses Business Decriptions from Google Finance

(Example: See textual **Description** of AAPL (in this case from Yahoo Finance))"

link text

This Colab notebook uses the following files that are posted on the class webite:

- `company_des.csv` with Company descriptions of a large number of companues from Yahoo Finance
- `ta.csv` and `rev.csv` with total assets and revenue data. This financial data was downloaded from Yahoo Finance

The steps this ipynb goes through are below:

1. Upload `stock_des.csv` , ta.csv and rev.csv' from your local machine to the Colab working directory.
2. Install and load the necessary libraries.
3. Load, merge, clean the data.
4. Create the label variable.
5. Prepare the predictor.
6. Run the DistilBERT model.
7. Train logistic regression and evaluate its accuracy.

**Note**. Save this Colab notebook to your Drive via File > Save a copy in Drive to be able to edit it.

# 1. Upload data files

Please upload the necessary files ( `stock_des.csv`, `ta.csv`, `rev.csv` ) in your `project_folder` folder.

You can upload the files via `files.upload()` code cell below OR use the upload function in the window to the left (lcik on folder icon and then click on upload icon).

```
# Upload data
from google.colab import files
uploaded = files.upload()
```

Choose Files No file chosen Upload widget is only available when the cell has been executed in the current browser session. Please rerun this cell to enable.

```
Saving assigment3lyushensong.csv to assigment3lyushensong.csv
Saving stock_des.csv to stock_des.csv
```

# 2. Install, load the libraries

```
!pip install transformers
```

```
Requirement already satisfied: transformers in /usr/local/lib/python3.10/dist-packages (4.38.2)
Requirement already satisfied: filelock in /usr/local/lib/python3.10/dist-packages (from transformers) (3.13.
Requirement already satisfied: huggingface-hub<1.0,>=0.19.3 in /usr/local/lib/python3.10/dist-packages (from
Requirement already satisfied: numpy>=1.17 in /usr/local/lib/python3.10/dist-packages (from transformers) (1.
Requirement already satisfied: packaging>=20.0 in /usr/local/lib/python3.10/dist-packages (from transformers)
Requirement already satisfied: pyyaml>=5.1 in /usr/local/lib/python3.10/dist-packages (from transformers) (6.
Requirement already satisfied: regex!=2019.12.17 in /usr/local/lib/python3.10/dist-packages (from transforme
Requirement already satisfied: requests in /usr/local/lib/python3.10/dist-packages (from transformers) (2.31.
Requirement already satisfied: tokenizers<0.19,>=0.14 in /usr/local/lib/python3.10/dist-packages (from trans
Requirement already satisfied: safetensors>=0.4.1 in /usr/local/lib/python3.10/dist-packages (from transforme
Requirement already satisfied: tqdm>=4.27 in /usr/local/lib/python3.10/dist-packages (from transformers) (4.6
Requirement already satisfied: fsspec>=2023.5.0 in /usr/local/lib/python3.10/dist-packages (from huggingface-
Requirement already satisfied: typing-extensions>=3.7.4.3 in /usr/local/lib/python3.10/dist-packages (from hu
Requirement already satisfied: charset-normalizer<4,>=2 in /usr/local/lib/python3.10/dist-packages (from requ
```

```
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.10/dist-packages (from requests->trans
Requirement already satisfied: urllib3<3,>=1.21.1 in /usr/local/lib/python3.10/dist-packages (from requests->
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.10/dist-packages (from requests->
```

```
import numpy as np
import pandas as pd
import torch
import seaborn as sns
import matplotlib.pyplot as plt
from scipy.stats.mstats import winsorize
import transformers as ppb # pytorch transformers
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import train_test_split
```

```
DEVICE = torch.device("cuda:0" if torch.cuda.is_available() else "cpu")
```

```
print('Device:', torch.device('cuda:0'))
```

```
Device: cuda:0
```

```
torch.cuda.get_device_name(0)
```

```
'Tesla T4'
```

## 2. Load, merge, clean the data

```
# load the csv files
stock_des = pd.read_csv('stock_des.csv')
stock_data=pd.read_csv('/content/assigment3lyushensong.csv')
```

```
stock_data
```

| | gvkey | datadate | fyear | indfmt | consol | popsrc | datafmt | tic | conm | curcd | act | at |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 1004 | 2023-05-31 | 2022 | INDL | C | D | STD | AIR | AAR CORP | USD | 1097.900 | 1833.100 |
| **1** | 1045 | 2023-12-31 | 2023 | INDL | C | D | STD | AAL | AMERICAN AIRLINES GROUP INC | USD | 13572.000 | 63058.000 |
| **2** | 1075 | 2023-12-31 | 2023 | INDL | C | D | STD | PNW | PINNACLE WEST CAPITAL CORP | USD | 1926.967 | 24661.153 |
| **3** | 1076 | 2023-12-31 | 2023 | INDL | C | D | STD | PRG | PROG HOLDINGS INC | USD | NaN | 1491.255 |
| **4** | 1078 | 2023-12-31 | 2023 | INDL | C | D | STD | ABT | ABBOTT LABORATORIES | USD | 22670.000 | 73214.000 |
| **...** | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| **2330** | 325576 | 2023-12-31 | 2023 | INDL | C | D | STD | APG | API GROUP CORPORATION | USD | 2582.000 | 7590.000 |
| **2331** | 326688 | 2023-12-31 | 2023 | INDL | C | D | STD | NVT | NVENT ELECTRIC PLC | USD | 1336.100 | 6161.700 |
| **2332** | 328795 | 2023-12-31 | 2023 | INDL | C | D | STD | ACA | ARCOSA INC | USD | 912.000 | 3577.900 |
| **2333** | 345920 | 2023-12-31 | 2023 | INDL | C | D | STD | HYFM | HYDROFARM HLDNG GP INC | USD | 128.066 | 507.643 |
| **2334** | 347007 | 2023-12-31 | 2023 | INDL | C | D | STD | IBRX | IMMUNITYBIO INC | USD | 294.084 | 504.452 |

2335 rows × 19 columns

```
# clean up the column names
stock_data.rename(columns={'tic': 'ticker'}, inplace=True)
```

```
stock_data
```

| | gvkey | datadate | fyear | indfmt | consol | popsrc | datafmt | ticker | conm | curcd | act | at |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 1004 | 2023-05-31 | 2022 | INDL | C | D | STD | AIR | AAR CORP | USD | 1097.900 | 1833.100 |
| **1** | 1045 | 2023-12-31 | 2023 | INDL | C | D | STD | AAL | AMERICAN AIRLINES GROUP INC | USD | 13572.000 | 63058.000 |
| **2** | 1075 | 2023-12-31 | 2023 | INDL | C | D | STD | PNW | PINNACLE WEST CAPITAL CORP | USD | 1926.967 | 24661.153 |
| **3** | 1076 | 2023-12-31 | 2023 | INDL | C | D | STD | PRG | PROG HOLDINGS INC | USD | NaN | 1491.255 |
| **4** | 1078 | 2023-12-31 | 2023 | INDL | C | D | STD | ABT | ABBOTT LABORATORIES | USD | 22670.000 | 73214.000 |
| **...** | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| **2330** | 325576 | 2023-12-31 | 2023 | INDL | C | D | STD | APG | API GROUP CORPORATION | USD | 2582.000 | 7590.000 |
| **2331** | 326688 | 2023-12-31 | 2023 | INDL | C | D | STD | NVT | NVENT ELECTRIC PLC | USD | 1336.100 | 6161.700 |
| **2332** | 328795 | 2023-12-31 | 2023 | INDL | C | D | STD | ACA | ARCOSA INC | USD | 912.000 | 3577.900 |
| **2333** | 345920 | 2023-12-31 | 2023 | INDL | C | D | STD | HYFM | HYDROFARM HLDNG GP INC | USD | 128.066 | 507.643 |
| **2334** | 347007 | 2023-12-31 | 2023 | INDL | C | D | STD | IBRX | IMMUNITYBIO INC | USD | 294.084 | 504.452 |

2335 rows × 19 columns

```
stock_des
```

| | ticker | description |
|---|---|---|
| **0** | AAPL | Apple Inc. designs, manufactures, and markets ... |
| **1** | MSFT | Microsoft Corporation develops, licenses, and ... |
| **2** | AMZN | Amazon.com, Inc. engages in the retail sale of... |
| **3** | FB | Facebook, Inc. develops products that enable p... |
| **4** | GOOGL | Alphabet Inc. provides online advertising serv... |
| **...** | ... | ... |
| **2847** | SIEB | Siebert Financial Corp., through its subsidiar... |
| **2848** | SEAC | SeaChange International, Inc. provides multisc... |
| **2849** | XFOR | X4 Pharmaceuticals, Inc., a clinical-stage bio... |
| **2850** | WLL | Whiting Petroleum Corporation, an independent ... |
| **2851** | EVFM | Evofem Biosciences, Inc., a biopharmaceutical ... |

2852 rows × 2 columns

```
# merge the dataframes into one
df = pd.merge(stock_data, stock_des, on='ticker')
```

```
df.isnull().sum()
```

```
gvkey         0
datadate      0
fyear         0
indfmt        0
consol        0
popsrc        0
datafmt       0
ticker        0
```

```
conm             0
curcd            0
act            569
at               0
invt            41
lct            569
lt               6
ni               0
revt             0
sale             0
costat           0
description      0
dtype: int64
```

There are some missing values in the current liabilities, current assets, and inventories variables. Therefore, I decided to drop them, because I can't fill them with median and mean.

```
df = df.dropna()
```

```
df.drop(columns=['indfmt','curcd', 'gvkey','datafmt','consol','popsrc'], inplace=True)
```

Drop Unnecessary Columns that does not contain useful information

```
df.head()
```

| | datadate | fyear | ticker | conm | act | at | invt | lct | lt | ni | revt | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 2023-05-31 | 2022 | AIR | AAR CORP | 1097.900 | 1833.100 | 624.700 | 351.500 | 734.000 | 90.200 | 1990.600 | 1 |
| **1** | 2023-12-31 | 2023 | AAL | AMERICAN AIRLINES GROUP INC | 13572.000 | 63058.000 | 2400.000 | 22062.000 | 68260.000 | 822.000 | 52788.000 | 52 |
| **2** | 2023-12-31 | 2023 | PNW | PINNACLE WEST CAPITAL CORP | 1926.967 | 24661.153 | 493.547 | 2889.347 | 18376.291 | 501.557 | 4695.991 | 4 |
| **4** | 2023-12-31 | 2023 | ABT | ABBOTT LABORATORIES | 22670.000 | 73214.000 | 6570.000 | 13841.000 | 34387.000 | 5723.000 | 40109.000 | 40 |

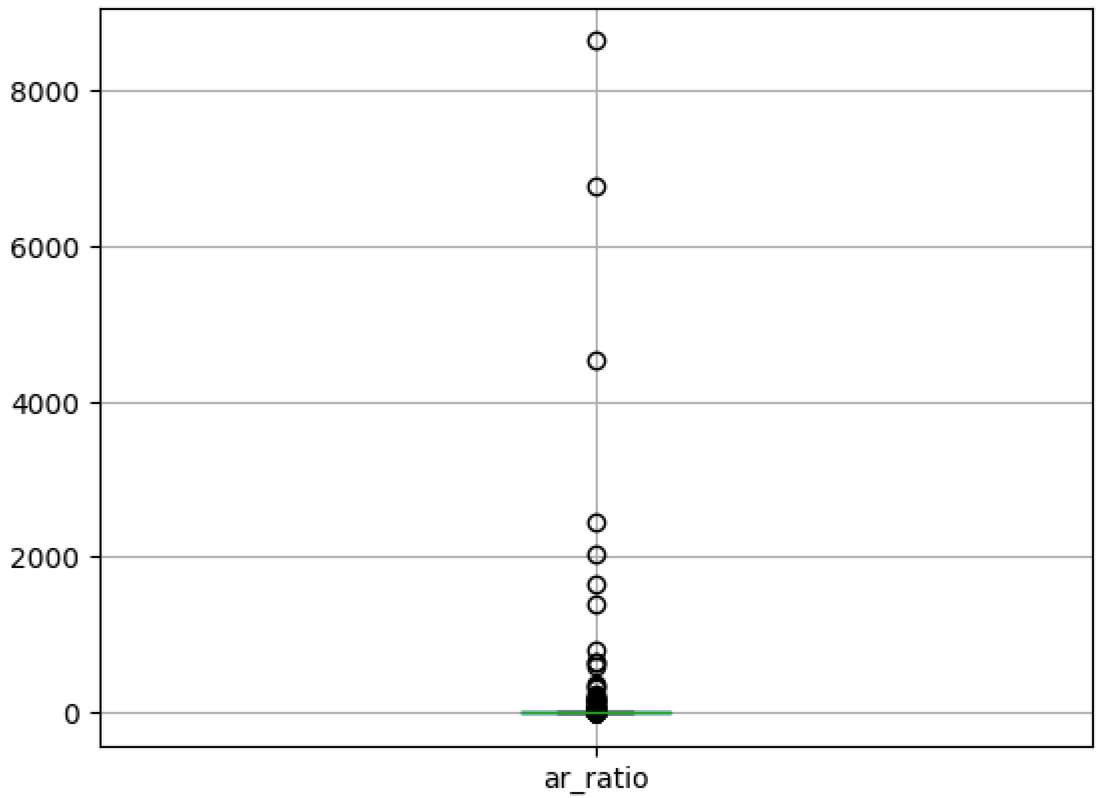
```
df.rename(columns={'act': 'current asset'}, inplace=True)
df.rename(columns={'at': 'total asset'}, inplace=True)
df.rename(columns={'lt': 'liabilities'}, inplace=True)
df.rename(columns={'sale': 'sales/turnover'}, inplace=True)
df.rename(columns={'ni': 'net income'}, inplace=True)
df.rename(columns={'lct': 'current liabilities'}, inplace=True)
df.rename(columns={'revt': 'revenue'}, inplace=True)
df.rename(columns={'invt': 'inventories'}, inplace=True)
```

```
df.head()
```

| | datadate | fyear | ticker | conm | current asset | total asset | inventories | current liabilities | liabilities | net income |
|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 2023-05-31 | 2022 | AIR | AAR CORP | 1097.900 | 1833.100 | 624.700 | 351.500 | 734.000 | 90.200 |
| **1** | 2023-12-31 | 2023 | AAL | AMERICAN AIRLINES GROUP INC | 13572.000 | 63058.000 | 2400.000 | 22062.000 | 68260.000 | 822.000 |
| **2** | 2023-12-31 | 2023 | PNW | PINNACLE WEST CAPITAL CORP | 1926.967 | 24661.153 | 493.547 | 2889.347 | 18376.291 | 501.557 |
| **4** | 2023-12-31 | 2023 | ABT | ABBOTT LABORATORIES | 22670.000 | 73214.000 | 6570.000 | 13841.000 | 34387.000 | 5723.000 |
| **5** | 2023-12-31 | 2023 | AMD | ADVANCED MICRO DEVICES | 16768.000 | 67885.000 | 4351.000 | 6689.000 | 11993.000 | 854.000 |

```
# create the assets to revenue ratio
df['ar_ratio'] = df['total asset']/df['revenue']
print(df['ar_ratio'].describe())
df.boxplot(column='ar_ratio');
```

```
count    1724.000000
mean       21.877924
std       302.355441
min         0.090086
25%         0.907457
50%         1.477851
75%         2.447725
max      8630.285714
Name: ar_ratio, dtype: float64
```




We have 6 outliers with the ratio of 1000+. Let's remove them.

```
df = df[df['ar_ratio']<50]
print(df.shape)
```

```
(1690, 15)
```

Create a binary variable that is 1 if the assets to revenue ratio is above its median and 0 otherwise.

This is the **dependent variable** (label) that we'll try to predict.

```
df['HIGH_ARR'] = (df['ar_ratio'].gt(df['ar_ratio'].median())).astype(int)
```

## Asset Intensity Ratio

```
df['asset_intensity']=df['revenue']/df['total asset']
```

Due to Colab's RAM limitations, limit the description size. We'll only keep 1st sentence of each description. In case if you have Pro subscription you can increase the number of sentences/try random sentences from descriptions/use full descriptions. (Observed improvement is marginal.)

## Three Financial Ratios

- Quick ratio: (Current Assets - Inventory) / Current Liabilities The quick ratio measures the liquidity of a company by measuring how well its current assets could cover its current liabilities. Here, I want to see how well these companies cover their short term liabilities within a shorter time.
- Current ratio: Current Assets / Current Liabilities Similar to Quick Ratio, current ratio measures a company's ability to pay short term liabilities with its current assets. On the other hand, the current ratio is more appropriate to show what resources a company has to pay its short term liabilities within 12 months.
- Return on Assets: Net Income / Total Assets Return on Assets shows a company's profitability based on its total assets. For this assignment, I want to see how efficient companies are using their assets to generate profit.

```
df.columns
```

```
Index(['datadate', 'fyear', 'ticker', 'conm', 'current asset', 'total asset',
       'inventories', 'current liabilities', 'liabilities', 'net income',
       'revenue', 'sales/turnover', 'costat', 'description', 'ar_ratio',
       'HIGH_ARR', 'asset_intensity'],
      dtype='object')
```

```
df['quick ratio']=(df['current asset']-df['inventories'])/df['current liabilities']
df['current ratio']=df['current asset']/df['current liabilities']
df['ROA']=df['net income']/df['total asset']
```

```
df['quick ratio'].describe()
```

```
count    1690.000000
mean        1.955605
std         2.248591
min         0.090486
25%         0.855237
50%         1.276287
75%         2.177798
max        25.441970
Name: quick ratio, dtype: float64
```

```
df['current ratio'].describe()
```

```
count    1690.000000
mean       -0.007352
std         0.263005
min        -2.665283
25%        -0.023754
50%         0.035726
75%         0.080925
max         5.019803
Name: ROA, dtype: float64
```

```
df['ROA'].describe()
```

```
count    1690.000000
mean       -0.007352
std         0.263005
min        -2.665283
25%        -0.023754
50%         0.035726
75%         0.080925
max         5.019803
Name: ROA, dtype: float64
```

Print out the general information about the three financial ratios that I created.

```
df['HIGH_quick_ratio'] = (df['quick ratio'].gt(df['quick ratio'].median())).astype(int)
df['HIGH_current_ratio'] = (df['current ratio'].gt(df['current ratio'].median())).astype(int)
df['HIGH_ROA'] = (df['ROA'].gt(df['ROA'].median())).astype(int)
```

Create a binary variable that is 1 if the net profit margin/inventory turnover/return on equity ratio is above its median and 0 otherwise.

These are the dependent variables (label) that we'll try to predict.

```
df.head()
```

| | datadate | fyear | ticker | conm | current asset | total asset | inventories | current liabilities | liabilities | net income | . |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 2023-05-31 | 2022 | AIR | AAR CORP | 1097.900 | 1833.100 | 624.700 | 351.500 | 734.000 | 90.200 | |
| **1** | 2023-12-31 | 2023 | AAL | AMERICAN AIRLINES GROUP INC | 13572.000 | 63058.000 | 2400.000 | 22062.000 | 68260.000 | 822.000 | |
| **2** | 2023-12-31 | 2023 | PNW | PINNACLE WEST CAPITAL CORP | 1926.967 | 24661.153 | 493.547 | 2889.347 | 18376.291 | 501.557 | |
| **4** | 2023-12-31 | 2023 | ABT | ABBOTT LABORATORIES | 22670.000 | 73214.000 | 6570.000 | 13841.000 | 34387.000 | 5723.000 | |
| **5** | 2023-12-31 | 2023 | AMD | ADVANCED MICRO DEVICES | 16768.000 | 67885.000 | 4351.000 | 6689.000 | 11993.000 | 854.000 | |

5 rows × 25 columns

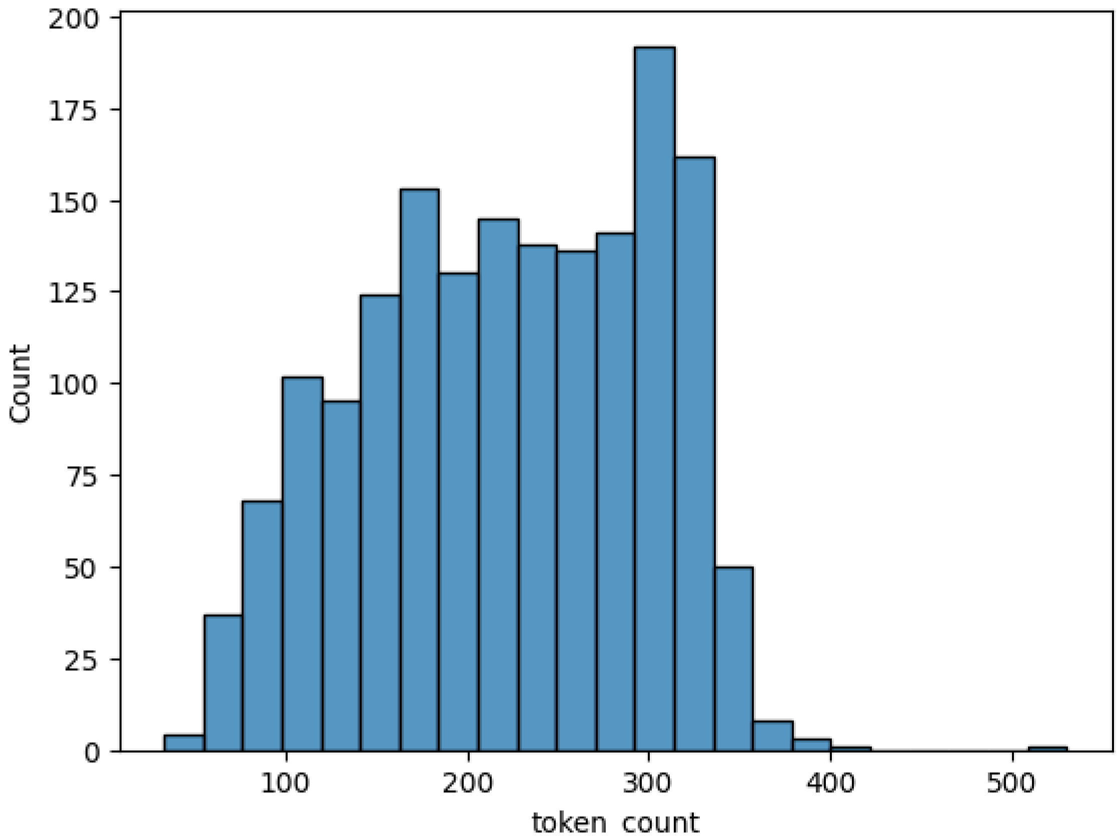
```
from nltk.tokenize import word_tokenize
import nltk
nltk.download('punkt')
# Count the number of tokens in the 'text' column
df['token_count'] = df['description'].apply(lambda x: len(word_tokenize(x)))
print(df.shape)
df
```

```
[nltk_data] Downloading package punkt to /root/nltk_data...
[nltk_data]   Unzipping tokenizers/punkt.zip.
(1690, 24)
```

| | datadate | fyear | ticker | conm | current asset | total asset | inventories | current liabilities | liabilities | net income |
|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 2023-05-31 | 2022 | AIR | AAR CORP | 1097.900 | 1833.100 | 624.700 | 351.500 | 734.000 | 90.200 |
| **1** | 2023-12-31 | 2023 | AAL | AMERICAN AIRLINES GROUP INC | 13572.000 | 63058.000 | 2400.000 | 22062.000 | 68260.000 | 822.000 |
| **2** | 2023-12-31 | 2023 | PNW | PINNACLE WEST CAPITAL CORP | 1926.967 | 24661.153 | 493.547 | 2889.347 | 18376.291 | 501.557 |
| **4** | 2023-12-31 | 2023 | ABT | ABBOTT LABORATORIES | 22670.000 | 73214.000 | 6570.000 | 13841.000 | 34387.000 | 5723.000 |
| **5** | 2023-12-31 | 2023 | AMD | ADVANCED MICRO DEVICES | 16768.000 | 67885.000 | 4351.000 | 6689.000 | 11993.000 | 854.000 |
| **...** | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| **2321** | 2023-03-31 | 2022 | LPG | DORIAN LPG LTD | 236.299 | 1708.914 | 2.642 | 94.597 | 835.068 | 172.444 |
| **2322** | 2023-12-31 | 2023 | APG | API GROUP CORPORATION | 2582.000 | 7590.000 | 150.000 | 1807.000 | 4722.000 | 153.000 |
| **2323** | 2023-12-31 | 2023 | NVT | NVENT ELECTRIC PLC | 1336.100 | 6161.700 | 485.400 | 733.600 | 3019.600 | 567.100 |
| **2324** | 2023-12-31 | 2023 | ACA | ARCOSA INC | 912.000 | 3577.900 | 401.800 | 431.200 | 1245.900 | 159.200 |
| **2325** | 2023-12-31 | 2023 | HYFM | HYDROFARM HLDNG GP INC | 128.066 | 507.643 | 75.354 | 37.652 | 217.033 | -64.813 |

1690 rows × 24 columns

```
import seaborn as sns
sns.histplot(data=df, x="token_count");
```




Looks like most descriptions are around 200 to 300 words.

```
import re
# Function to remove unusual characters
def remove_unusual_characters(text):
    pattern = r'[^a-zA-Z0-9.,?! ]'  # Pattern to match common English characters, numbers, and punctuation
    text = re.sub(pattern, '', text)
    return text

# Apply the function to the 'text' column
df['text'] = df['description'].apply(remove_unusual_characters)


# Remove very long descriptions
lower_threshold = df['token_count'].quantile(0.00)
upper_threshold = df['token_count'].quantile(0.99)

# Trim the DataFrame based on the 1% thresholds
trimmed_df = df[(df['token_count'] >= lower_threshold) & (df['token_count'] <= upper_threshold)]

trimmed_df.head(5)
```

| | datadate | fyear | ticker | conm | current asset | total asset | inventories | current liabilities | liabilities | net income | . |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 2023-05-31 | 2022 | AIR | AAR CORP | 1097.900 | 1833.100 | 624.700 | 351.500 | 734.000 | 90.200 | |
| **1** | 2023-12-31 | 2023 | AAL | AMERICAN AIRLINES GROUP INC | 13572.000 | 63058.000 | 2400.000 | 22062.000 | 68260.000 | 822.000 | |
| **2** | 2023-12-31 | 2023 | PNW | PINNACLE WEST CAPITAL CORP | 1926.967 | 24661.153 | 493.547 | 2889.347 | 18376.291 | 501.557 | |
| **4** | 2023-12-31 | 2023 | ABT | ABBOTT LABORATORIES | 22670.000 | 73214.000 | 6570.000 | 13841.000 | 34387.000 | 5723.000 | |
| **5** | 2023-12-31 | 2023 | AMD | ADVANCED MICRO DEVICES | 16768.000 | 67885.000 | 4351.000 | 6689.000 | 11993.000 | 854.000 | |

5 rows × 25 columns

```
trimmed_df=trimmed_df[trimmed_df["ticker"]!="LLY"] # these 2 have special characters in description, hence remov
trimmed_df=trimmed_df[trimmed_df["ticker"]!="BIIB"]
trimmed_df=trimmed_df.reset_index(drop=True)
```

```
from nltk.tokenize import sent_tokenize
# Function to keep first three sentences
def keep_n_sentences(text):
    sentences = sent_tokenize(text)
    first_three_sentences = sentences[:1]
    return ' '.join(first_three_sentences)

# Apply the function to the 'text' column
trimmed_df['text'] = trimmed_df['text'].apply(keep_n_sentences)
```

```
trimmed_df.head(3)
```

| | datadate | fyear | ticker | conm | current asset | total asset | inventories | current liabilities | liabilities | net income | ... | H: |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 2023-05-31 | 2022 | AIR | AAR CORP | 1097.900 | 1833.100 | 624.700 | 351.500 | 734.000 | 90.200 | ... | |
| **1** | 2023-12-31 | 2023 | AAL | AMERICAN AIRLINES GROUP INC | 13572.000 | 63058.000 | 2400.000 | 22062.000 | 68260.000 | 822.000 | ... | |
| **2** | 2023-12-31 | 2023 | PNW | PINNACLE WEST CAPITAL CORP | 1926.967 | 24661.153 | 493.547 | 2889.347 | 18376.291 | 501.557 | ... | |

3 rows × 25 columns

## Preparing the predictor and DistilBERT model

**Note**. Please enable GPU in Edit > Notebook settings > Hardware accelerator.

Load a pre-trained BERT model.

```
model_class, tokenizer_class, pretrained_weights = (ppb.DistilBertModel, ppb.DistilBertTokenizer, 'distilbert-ba

# Load pretrained model/tokenizer
tokenizer = tokenizer_class.from_pretrained(pretrained_weights, max_length=2)
model = model_class.from_pretrained(pretrained_weights)
```

```
/usr/local/lib/python3.10/dist-packages/huggingface_hub/utils/_token.py:88: UserWarning:
The secret `HF_TOKEN` does not exist in your Colab secrets.
To authenticate with the Hugging Face Hub, create a token in your settings tab (https://huggingface.co/settir
You will be able to reuse this secret in all of your notebooks.
Please note that authentication is recommended but still optional to access public models or datasets.
  warnings.warn(
```

tokenizer_config.json: 100% 28.0/28.0 [00:00<00:00, 1.63kB/s]

vocab.txt: 100% 232k/232k [00:00<00:00, 2.69MB/s]

tokenizer.json: 100% 466k/466k [00:00<00:00, 5.43MB/s]

config.json: 100% 483/483 [00:00<00:00, 32.1kB/s]

model.safetensors: 100% 268M/268M [00:01<00:00, 224MB/s]

Tokenize the textual data for DistilBERT.

```
trimmed_df.description[12]
```

```
'ABM Industries Incorporated provides integrated facility solutions in the United States and internationall
y. The company operates through Business &amp; Industry, Technology &amp; Manufacturing, Education, Aviatio
n, and Technical Solutions segments. It provides janitorial, facilities engineering, parking, custodial, lan
dscaping and ground, and mechanical and electrical services; and vehicle maintenance and other services to r
ental car providers. The company was founded in 1909 and is headquartered in New York, New York.'
```

```
trimmed_df.text[12]
```

```
'ABM Industries Incorporated provides integrated facility solutions in the United States and internationall
y.'
```

```
tokenized = trimmed_df['text'].apply((lambda x: tokenizer.encode(x, add_special_tokens=True)))
```

Pad all lists of tokenized values to the same size.

```
max_len = 0
for i in tokenized.values:
    if len(i) > max_len:
        max_len = len(i)

padded = np.array([i + [0]*(max_len-len(i)) for i in tokenized.values])
```

```
np.array(padded).shape
```

```
(1671, 69)
```

Create attention mask variable for BERT to ignore (mask) the padding when it's processing its input.

```
attention_mask = np.where(padded != 0, 1, 0)
attention_mask.shape
```

```
(1671, 69)
```

# DistilBERT model

We run the pretrained DistilBERT model on the prepared predictor and keep the result in `last_hidden_states` variable.

```
input_ids = torch.tensor(padded)
attention_mask = torch.tensor(attention_mask)

with torch.no_grad():
    last_hidden_states = model(input_ids,
                               attention_mask=attention_mask)
```

## Logistic regression model

Keep the first layer of the hidden states and assign the outcome variable to `labels`.

```
trimmed_df
```

| | datadate | fyear | ticker | conm | current asset | total asset | inventories | current liabilities | liabilities | net income |
|---|---|---|---|---|---|---|---|---|---|---|
| **0** | 2023-05-31 | 2022 | AIR | AAR CORP | 1097.900 | 1833.100 | 624.700 | 351.500 | 734.000 | 90.200 |
| **1** | 2023-12-31 | 2023 | AAL | AMERICAN AIRLINES GROUP INC | 13572.000 | 63058.000 | 2400.000 | 22062.000 | 68260.000 | 822.000 |
| **2** | 2023-12-31 | 2023 | PNW | PINNACLE WEST CAPITAL CORP | 1926.967 | 24661.153 | 493.547 | 2889.347 | 18376.291 | 501.557 |
| **3** | 2023-12-31 | 2023 | ABT | ABBOTT LABORATORIES | 22670.000 | 73214.000 | 6570.000 | 13841.000 | 34387.000 | 5723.000 |
| **4** | 2023-12-31 | 2023 | AMD | ADVANCED MICRO DEVICES | 16768.000 | 67885.000 | 4351.000 | 6689.000 | 11993.000 | 854.000 |
| **...** | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| **1666** | 2023-03-31 | 2022 | LPG | DORIAN LPG LTD | 236.299 | 1708.914 | 2.642 | 94.597 | 835.068 | 172.444 |
| **1667** | 2023-12-31 | 2023 | APG | API GROUP CORPORATION | 2582.000 | 7590.000 | 150.000 | 1807.000 | 4722.000 | 153.000 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **1668** | 2023-12-31 | 2023 | NVT | NVENT ELECTRIC PLC | 1336.100 | 6161.700 | 485.400 | 733.600 | 3019.600 | 567.100 |
| **1669** | 2023-12-31 | 2023 | ACA | ARCOSA INC | 912.000 | 3577.900 | 401.800 | 431.200 | 1245.900 | 159.200 |
| **1670** | 2023-12-31 | 2023 | HYFM | HYDROFARM HLDNG GP INC | 128.066 | 507.643 | 75.354 | 37.652 | 217.033 | -64.813 |