Transforming Text Classification with Hugging Face

MSBA 6331 - Group 5
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Current Issue Machine Learning Model

Big Data

Maintain & Monitor

Data Pattern Change

Stakeholders

Testing

Security

87%

Data Science Project **NOT** making it to production

*According to the Algorithmia's "2020 State of Enterprise ML" survey

87%

Data Science Project **NOT** making it to production

Solve some of these problems with pre-deployed model

*According to the Algorithmia's "2020 State of Enterprise ML" survey

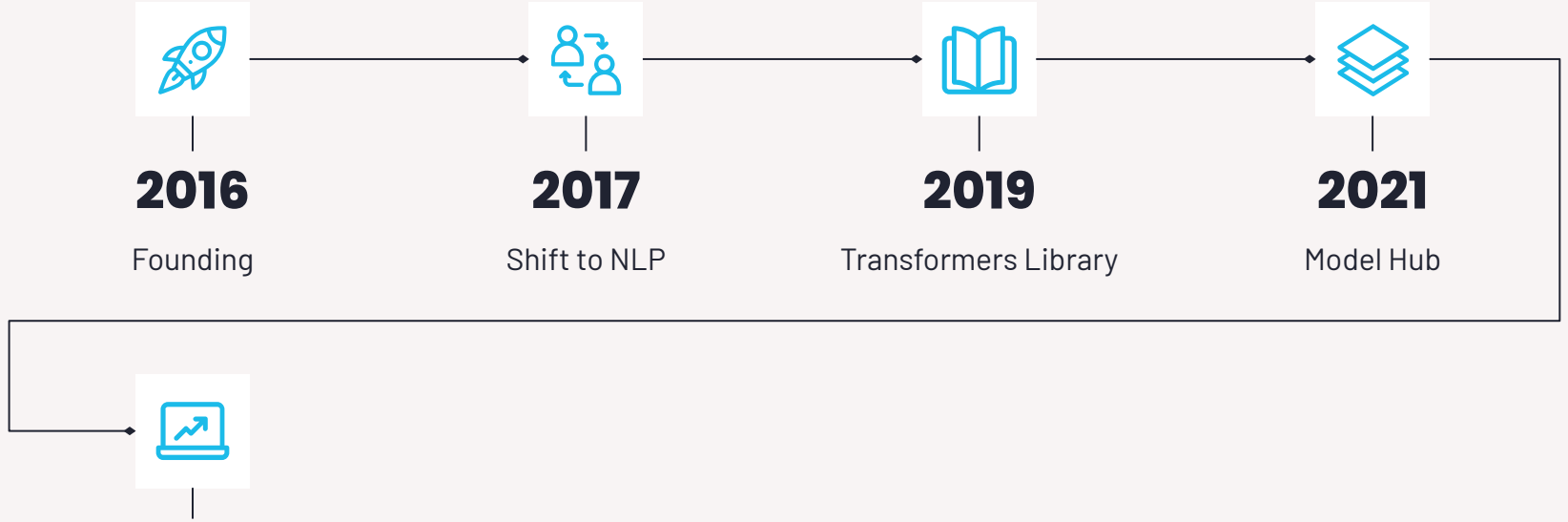
Introducing

Hugging Face

Hugging Face

- Leading company in the field of Natural Language Processing
- Development and democratization of state-of-the-art NLP models.
- Provides a collection of pre-trained models and tools for working with various NLP tasks
- Strong commitment to open source development
- Emphasizes the importance of ethical AI and responsible development practices.

Hugging Face Development Process



Hugging Face Use Case

NLU Chatbots

Developing chatbots with advanced natural language understanding capacities

Text Classification

Text classification tasks, such as sentiment analysis, spam detection, and topic categorization

Text Summarization

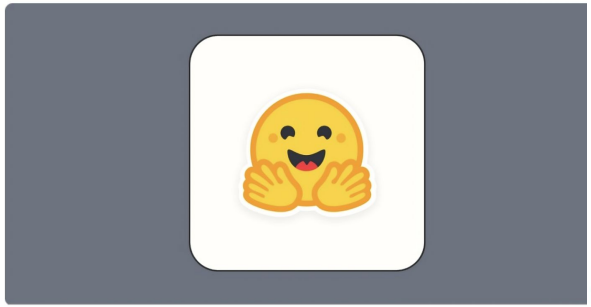
Analyze and summarize text from papers, articles, medical text, legal documents, etc.

Financial Sentiment Analysis

Analyze news articles, social media, and other text data to gauge market sentiment and make informed investment decisions

Hugging Face raises $235M from investors, including Salesforce and Nvidia

Kyle Wiggers @kyle_l_wiggers / 9:00 AM CDT • August 24, 2023



Dell Technologies and Hugging Face to Simplify Generative AI with On-Premises IT

DELL Technologies

NEWS PROVIDED BY
Dell Technologies →
14 Nov, 2023, 09:00 ET

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TECH

Google, Amazon, Nvidia and other tech giants invest in AI startup Hugging Face, sending its valuation to $4.5 billion

PUBLISHED THU, AUG 24 2023•10:00 AM EDT | UPDATED THU, AUG 24 2023•11:35 AM EDT

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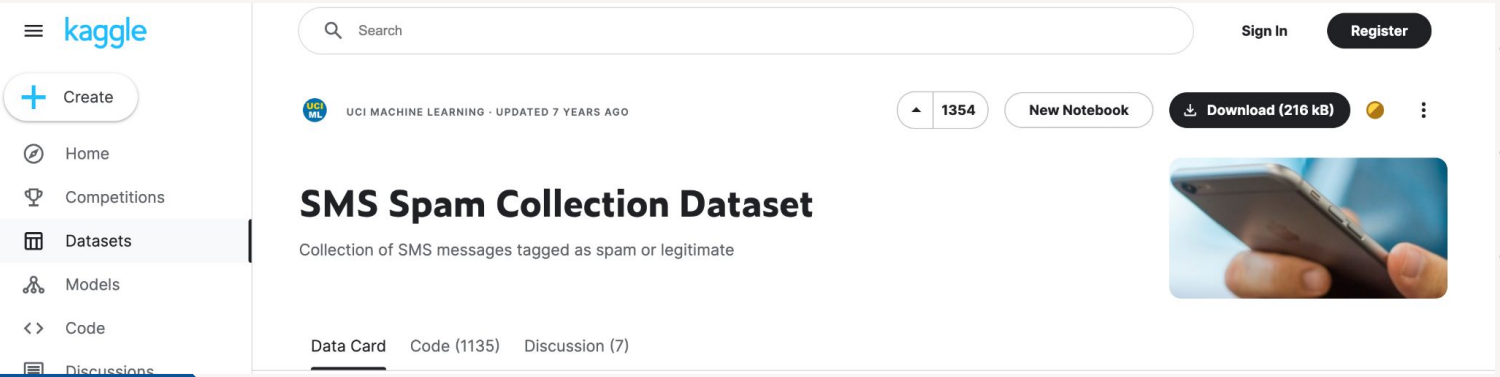
NEWS

Case Study and Dataset

- We want to compare the following thing:
  - The process of building the model
  - Running speed of the model
  - Accuracy of the model
  - User friendliness



+ SMS Spam Research
+ 5574 English Message
+ Tag as Ham/Spam

“Control Object”: Spark NLP

- NLP Library built on Apache Spark, an open source and distributed computing system
- Developed by John Snow Labs
- Scaled horizontally across a cluster of machines
- Offers pre-trained models for multiple NLP tasks (such as text classification, and sentiment analysis)

Spark NLP

Comparison between Hugging Face and SparkNLP

Hugging Face	SparkNLP
Emphasizes pre-trained models, model fine-tuning	Geared towards scalable and efficient NLP processing in big data environments
Large and active community of developers and researchers	Community support and engagement, but may not be as extensive as Hugging Face's.
Simple API for using models in various NLP applications	Requires knowledge of Spark for efficient utilization
Offers a diverse set of pre-trained models, including BERT, GPT-2, GPT-3, and more.	Provides models and pipelines specifically designed for Apache Spark.

Code and Result Demonstration

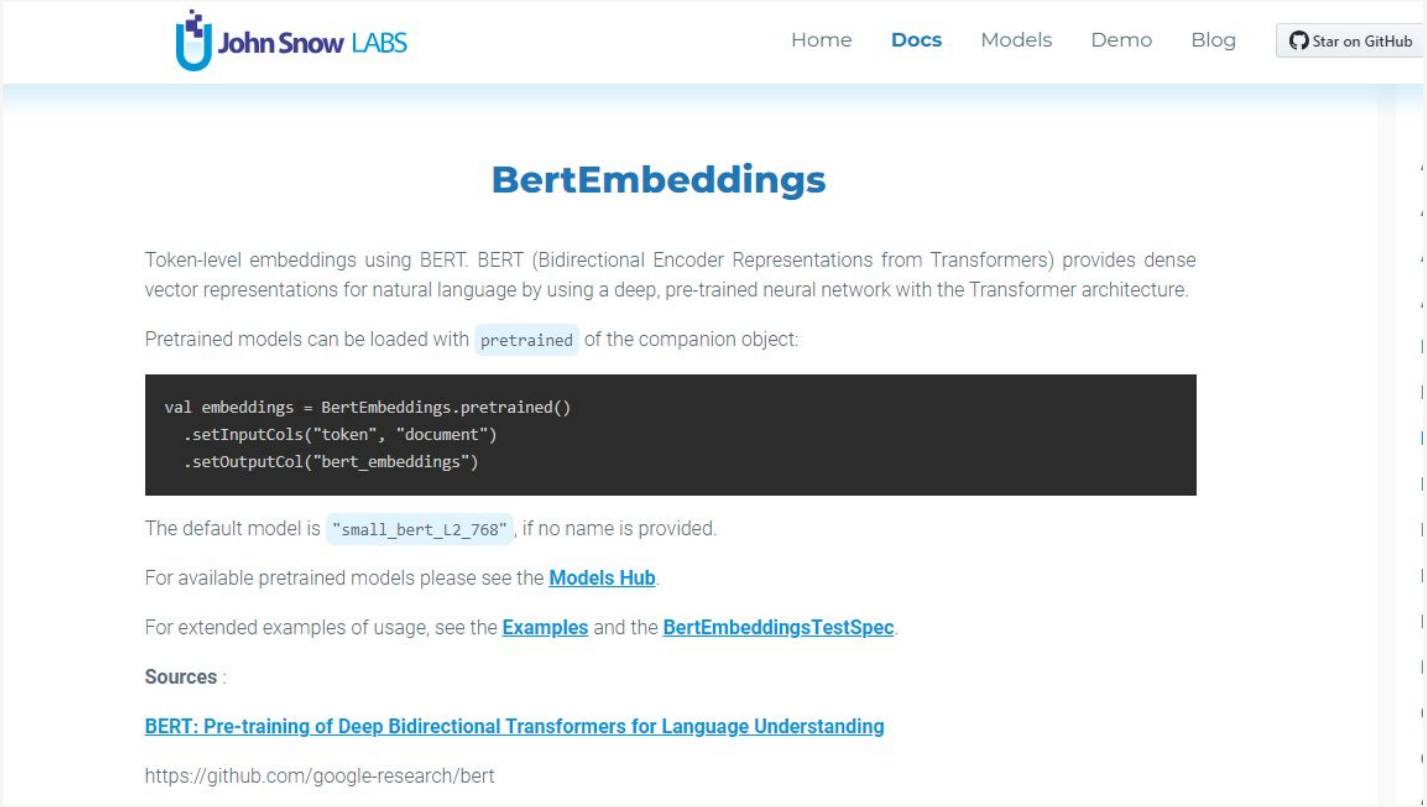
Spark NLP with Bert Classification model

```
import sparknlp
from sparknlp.base import *
from sparknlp.annotator import *
from pyspark.ml import Pipeline

# Initialize Spark NLP components
document_assembler = DocumentAssembler() \
    .setInputCol("text") \
    .setOutputCol("document")

tokenizer = Tokenizer() \
    .setInputCols(["document"]) \
    .setOutputCol("token")

bert_embeddings = BertEmbeddings.pretrained("bert_base_uncased", "en") \
    .setInputCols(["document", "token"]) \
    .setOutputCol("embeddings")

sentence_embeddings = SentenceEmbeddings() \
    .setInputCols(["document", "embeddings"]) \
    .setOutputCol("sentence_embeddings") \
    .setPoolingStrategy("AVERAGE")

classifier = ClassifierDLApproach() \
    .setInputCols(["sentence_embeddings"]) \
    .setOutputCol("class") \
    .setLabelColumn("label") \
    .setMaxEpochs(5) \
    .setBatchSize(8)

# Define the pipeline
pipeline = Pipeline().setStages([
    document_assembler,
    tokenizer,
    bert_embeddings,
    sentence_embeddings,
    classifier
])
```

```
from pyspark.sql.functions import col
from pyspark.sql.types import DoubleType
from pyspark.ml.evaluation import MulticlassClassificationEvaluator

# Ensure the prediction column is of type double
predictions = predictions.withColumn("prediction", col("prediction").cast(DoubleType()))

# Ensure the label column is also of type double
predictions = predictions.withColumn("label", col("label").cast(DoubleType()))

# Select the prediction and true label
predictions = predictions.select(col("prediction"), col("label"))

# Evaluate the model
evaluator = MulticlassClassificationEvaluator(predictionCol="prediction", labelCol="label", metricName="accuracy")
accuracy = evaluator.evaluate(predictions)
print(f"Accuracy: {accuracy}")
```

```
Accuracy: 0.8682242990654205
```

Spark NLP Bert embeddings



John Snow LABS

Home Docs Models Demo Blog Star on GitHub

BertEmbeddings

Token-level embeddings using BERT. BERT (Bidirectional Encoder Representations from Transformers) provides dense vector representations for natural language by using a deep, pre-trained neural network with the Transformer architecture.

Pretrained models can be loaded with `pretrained` of the companion object:

```
val embeddings = BertEmbeddings.pretrained()
  .setInputCols("token", "document")
  .setOutputCol("bert_embeddings")
```

The default model is `"small_bert_L2_768"`, if no name is provided.

For available pretrained models please see the **Models Hub**.

For extended examples of usage, see the **Examples** and the **BertEmbeddingsTestSpec**.

Sources :

BERT: Pre-training of Deep Bidirectional Transformers for Language Understanding

https://github.com/google-research/bert

Hugging Face pre-trained model

```python
from transformers import AutoTokenizer

# Load the tokenizer for "distilbert-base-uncased" model.
tokenizer = AutoTokenizer.from_pretrained("distilbert-base-uncased")
def tokenize_function(examples):
    # Pad/truncate each text to 512 tokens. Enforcing the same shape
    # could make the training faster.
    return tokenizer(
        examples["text"],
        padding="max_length",
        truncation=True,
        max_length=128,
    )

train_tokenized = train_dataset.map(tokenize_function).remove_columns(["text"]).shuffle(seed=42)
test_tokenized = test_dataset.map(tokenize_function).remove_columns(["text"]).shuffle(seed=42)
```

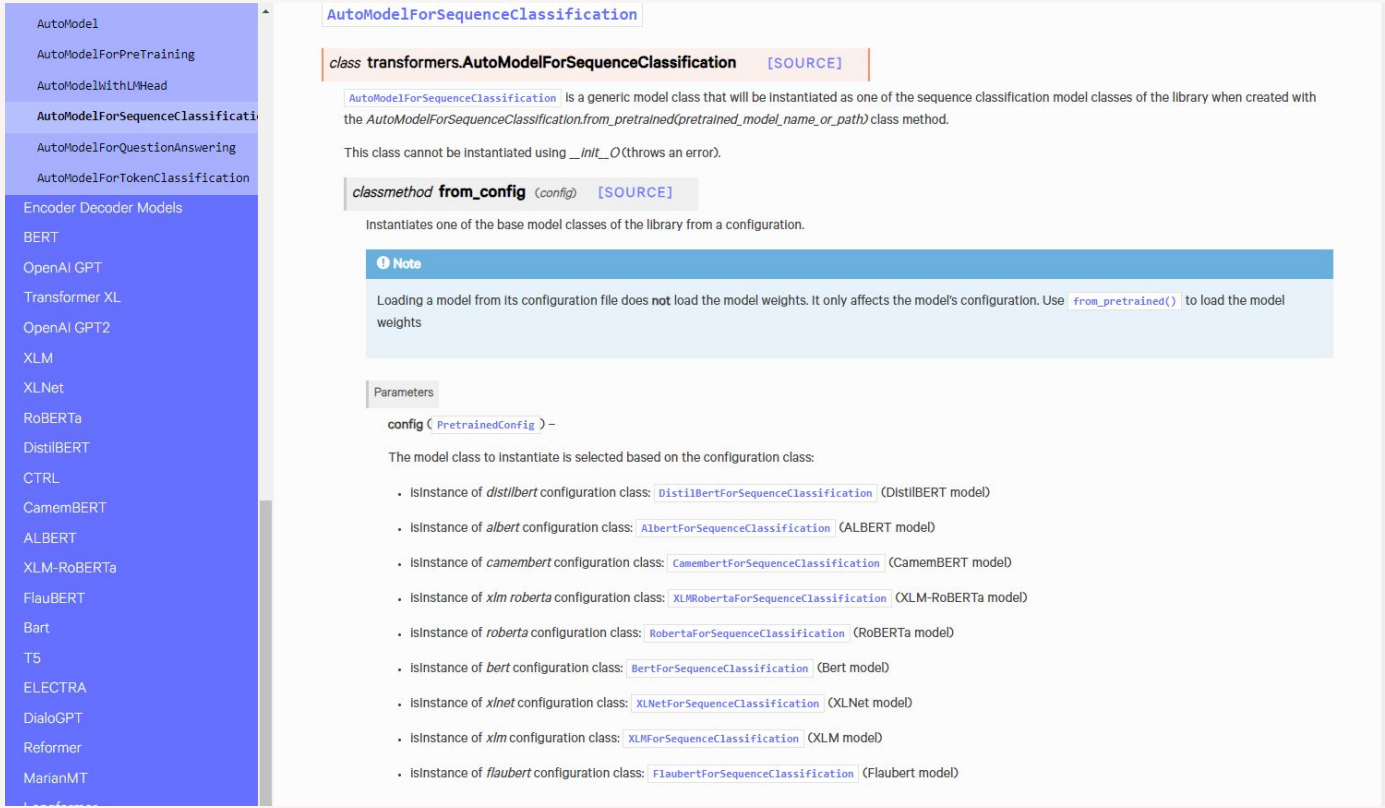
```
Map: 100% 4468/4468 [00:02<00:00, 1444.49 examples/s]
Map: 100% 1106/1106 [00:00<00:00, 1352.63 examples/s]
```

```python
from transformers import AutoModelForSequenceClassification

model = AutoModelForSequenceClassification.from_pretrained(
    "distilbert-base-uncased",
    num_labels=2,
    label2id=label2id,
    id2label=id2label,
)
```

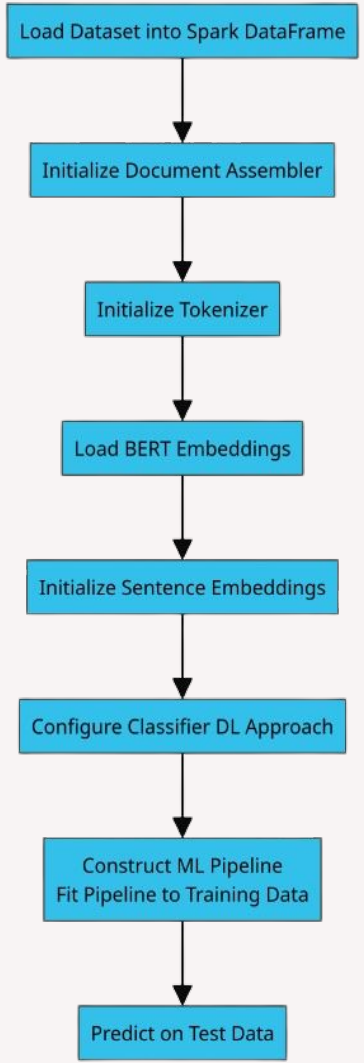
```python
accuracy = eval_result['eval_accuracy']

# Now print the accuracy
print(f"Accuracy: {accuracy}")
```

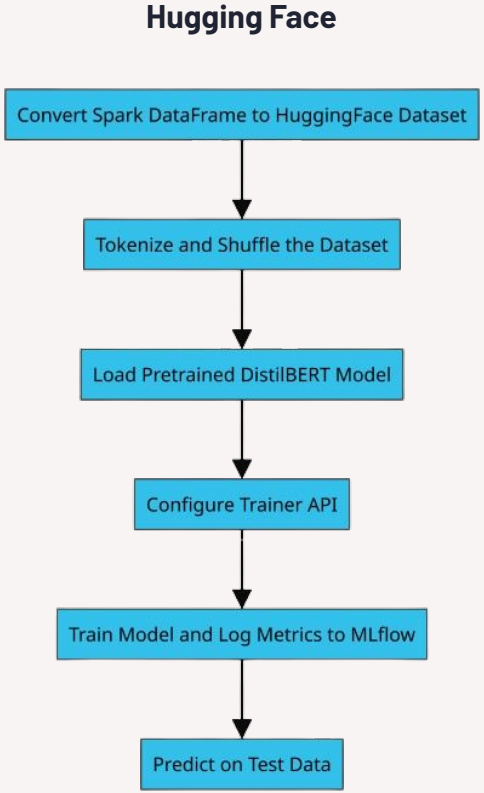
```
Accuracy: 0.9945750452079566
```

Hugging Face – AutoModels



Process steps for Spark NLP vs Hugging Face





Hugging Face Practicality

More than 50,000 organizations are using Hugging Face

Allen Institute for AI
Non-Profit • 228 models

AI at Meta
Company • 1877 models

Amazon Web Services
Company • 10 models

Google
Company • 617 models

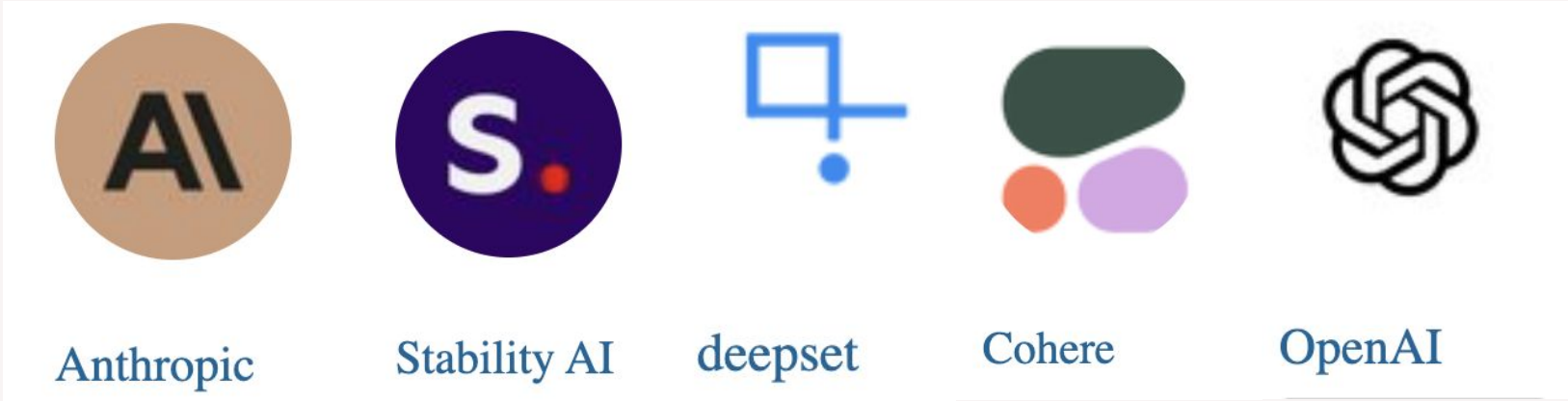
Intel
Company • 134 models

Microsoft
Company • 263 models

Grammarly
Company • 6 models

Writer *Enterprise*
Company • 8 models

COMPETITORS



Future Direction

1.We can see that Hugging Face face many challenges, and one of them is run time, so we can try to find other solutions that can give us the ease of Hugging Face (250.6172 seconds) but the speed of Spark NLP (123.48 seconds)

2. Create another case study for Hugging Face to test its ability using different dataset with different data constraint

Conclusion + Lesson Learnt

- Beneficial using pre-trained/pre-deployed model
    - Thorough testing
    - Less maintenance
    - Security
- Ease model development process
- Rapid prototyping
- Community powered by Model Hub

Hugging Face

References & Appendix

BERT embeddings of Spark NLP
https://sparknlp.org/docs/en/transformers#bertembeddings

AutoModelForSequenceClassification:
https://huggingface.co/transformers/v2.11.0/model_doc/auto.html#automodelforsequenceclassification

Getting started with NLP using Hugging Face transformers pipelines:https://www.databricks.com/blog/2023/02/06/getting-started-nlp-using-hugging-face-transformers-pipelines.html

Hugging Face:
https://www.techtarget.com/whatis/definition/Hugging-Face#:~:text=Hugging%20Face%20provides%20access%20to%20a%20vast%20community%2C%20continuously%20updated,Face's%20hosted%20models%20saves%20money