Train a text classifier using Amazon SageMaker BlazingText built-in algorithm

Introduction

In this lab you will use SageMaker BlazingText built-in algorithm to predict the sentiment for each customer review. BlazingText is a variant of FastText which is based on word2vec. For more information on BlazingText, see the documentation here: https://docs.aws.amazon.com/sagemaker/latest/dg/blazingtext.html (https://docs.aws.amazon.com/sagemaker/latest/dg/blazingtext.html)

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Let's install and import required modules.

In [2]:

```
# please ignore warning messages during the installation
!pip install --disable-pip-version-check -q sagemaker==2.35.0
!pip install --disable-pip-version-check -q nltk==3.5
```

```
WARNING: Running pip as the 'root' user can result in broken permission
s and conflicting behaviour with the system package manager. It is reco
mmended to use a virtual environment instead: https://pip.pypa.io/warni
ngs/venv
WARNING: Running pip as the 'root' user can result in broken permission
s and conflicting behaviour with the system package manager. It is reco
mmended to use a virtual environment instead: https://pip.pypa.io/warni
ngs/venv
```

In [3]:

```
import boto3
import sagemaker
import pandas as pd
import numpy as np
import botocore

config = botocore.config.Config(user_agent_extra='dlai-pds/c1/w4')

# low-level service client of the boto3 session
sm = boto3.client(service_name='sagemaker',
                  config=config)

sm_runtime = boto3.client('sagemaker-runtime',
                          config=config)

sess = sagemaker.Session(sagemaker_client=sm,
                         sagemaker_runtime_client=sm_runtime)

bucket = sess.default_bucket()
role = sagemaker.get_execution_role()
region = sess.boto_region_name
```

In [4]:

```
import matplotlib.pyplot as plt
%matplotlib inline
%config InlineBackend.figure_format='retina'
```

1. Prepare dataset

Let's adapt the dataset into a format that BlazingText understands. The BlazingText format is as follows:

```
__label__<label> "<features>"
```

Here are some examples:

```
__label__-1 "this is bad"
__label__0 "this is ok"
__label__1 "this is great"
```

Sentiment is one of three classes: negative (-1), neutral (0), or positive (1). BlazingText requires that `__label__` is prepended to each sentiment value.

You will tokenize the `review_body` with the Natural Language Toolkit (`nltk`) for the model training. `nltk` documentation can be found here (https://www.nltk.org/). You will also use `nltk` later in this lab to tokenize reviews to use as inputs to the deployed model.

1.1. Load the dataset

Upload the dataset into the Pandas dataframe:

In [5]:

```
!aws s3 cp 's3://dlai-practical-data-science/data/balanced/womens_clothing_ecommerce_reviews_balanced.csv' ./
```

```
download: s3://dlai-practical-data-science/data/balanced/womens_clothing_ecommerce_reviews_balanced.csv to ./womens_clothing_ecommerce_reviews_balanced.csv
```

In [6]:

```
path = './womens_clothing_ecommerce_reviews_balanced.csv'

df = pd.read_csv(path, delimiter=',')
df.head()
```

Out[6]:

	sentiment	review_body	product_category
0	-1	This suit did nothing for me. the top has zero...	Swim
1	-1	Like other reviewers i saw this dress on the ...	Dresses
2	-1	I wish i had read the reviews before purchasin...	Knits
3	-1	I ordered these pants in my usual size (xl) an...	Legwear
4	-1	I noticed this top on one of the sales associa...	Knits

1.2. Transform the dataset

Now you will prepend `__label__` to each sentiment value and tokenize the review body using `nltk` module. Let's import the module and download the tokenizer:

In [7]:

```
import nltk
nltk.download('punkt')
```

```
[nltk_data] Downloading package punkt to /root/nltk_data...
[nltk_data]   Unzipping tokenizers/punkt.zip.
```

Out[7]:

```
True
```

To split a sentence into tokens you can use `word_tokenize` method. It will separate words, punctuation, and apply some stemming. Have a look at the example:

In [8]:

```
sentence = "I'm not a fan of this product!"

tokens = nltk.word_tokenize(sentence)
print(tokens)
```

```
['I', "'m", 'not', 'a', 'fan', 'of', 'this', 'product', '!']
```

The output of word tokenization can be converted into a string separated by spaces and saved in the dataframe. The transformed sentences are prepared then for better text understending by the model.

Let's define a `prepare_data` function which you will apply later to transform both training and validation datasets.

Exercise 1

Apply the tokenizer to each of the reviews in the `review_body` column of the dataframe `df` .

In [9]:

```
def tokenize(review):
    # delete commas and quotation marks, apply tokenization and join back into a st
ring separating by spaces
    return ' '.join([str(token) for token in nltk.word_tokenize(str(review).replace
(',', '').replace('"', '').lower())])

def prepare_data(df):
    df['sentiment'] = df['sentiment'].map(lambda sentiment : '__label__{}'.format(s
tr(sentiment).replace('__label__', '')))
    ### BEGIN SOLUTION - DO NOT delete this comment for grading purposes
    df['review_body'] = df['review_body'].map(lambda review : tokenize(review)) # R
eplace all None
    ### END SOLUTION - DO NOT delete this comment for grading purposes
    return df
```

Test the prepared function and examine the result.

In [10]:

```
# create a sample dataframe
df_example = pd.DataFrame({
    'sentiment':[-1, 0, 1],
    'review_body':[
        "I don't like this product!",
        "this product is ok",
        "I do like this product!"]
})

# test the prepare_data function
print(prepare_data(df_example))

# Expected output:
#      sentiment                    review_body
# 0  __label__-1  i do n't like this product !
# 1   __label__0             this product is ok
# 2   __label__1       i do like this product !
```

```
     sentiment                    review_body
0  __label__-1  i do n't like this product !
1   __label__0             this product is ok
2   __label__1       i do like this product !
```

Apply the `prepare_data` function to the dataset.

In [11]:

```
df_blazingtext = df[['sentiment', 'review_body']].reset_index(drop=True)
df_blazingtext = prepare_data(df_blazingtext)
df_blazingtext.head()
```

Out[11]:

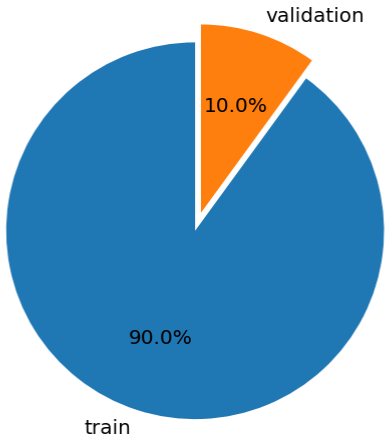
	sentiment	review_body
0	__label__-1	this suit did nothing for me . the top has zer...
1	__label__-1	like other reviewers i saw this dress on the c...
2	__label__-1	i wish i had read the reviews before purchasin...
3	__label__-1	i ordered these pants in my usual size (xl) ...
4	__label__-1	i noticed this top on one of the sales associa...

1.3. Split the dataset into train and validation sets

Split and visualize a pie chart of the train (90%) and validation (10%) sets. You can do the split using the `sklearn` model function.

In [12]:

```
from sklearn.model_selection import train_test_split

# Split all data into 90% train and 10% holdout
df_train, df_validation = train_test_split(df_blazingtext,
                                           test_size=0.10,
                                           stratify=df_blazingtext['sentiment'])

labels = ['train', 'validation']
sizes = [len(df_train.index), len(df_validation.index)]
explode = (0.1, 0)

fig1, ax1 = plt.subplots()

ax1.pie(sizes, explode=explode, labels=labels, autopct='%1.1f%%', startangle=90)

# Equal aspect ratio ensures that pie is drawn as a circle.
ax1.axis('equal')

plt.show()
print(len(df_train))
```




```
6399
```

Save the results as CSV files.

In [13]:

```
blazingtext_train_path = './train.csv'
df_train[['sentiment', 'review_body']].to_csv(blazingtext_train_path, index=False,
header=False, sep=' ')
```

In [14]:

```
blazingtext_validation_path = './validation.csv'
df_validation[['sentiment', 'review_body']].to_csv(blazingtext_validation_path, ind
ex=False, header=False, sep=' ')
```

1.4. Upload the `train` and `validation` datasets to S3 bucket

You will use these to train and validate your model. Let's save them to S3 bucket.

In [15]:

```
train_s3_uri = sess.upload_data(bucket=bucket, key_prefix='blazingtext/data', path=
blazingtext_train_path)
validation_s3_uri = sess.upload_data(bucket=bucket, key_prefix='blazingtext/data',
path=blazingtext_validation_path)
```

2. Train the model

Setup the BlazingText estimator. For more information on Estimators, see the SageMaker Python SDK documentation here: https://sagemaker.readthedocs.io/ (https://sagemaker.readthedocs.io/).

Exercise 2

Setup the container image to use for training with the BlazingText algorithm.

Instructions: Use the `sagemaker.image_uris.retrieve` function with the `blazingtext` algorithm.

```
image_uri = sagemaker.image_uris.retrieve(
    region=region,
    framework='...' # the name of framework or algorithm
)
```

In [16]:

```
image_uri = sagemaker.image_uris.retrieve(
    region=region,
    ### BEGIN SOLUTION - DO NOT delete this comment for grading purposes
    framework='blazingtext' # Replace None
    ### END SOLUTION - DO NOT delete this comment for grading purposes
)
```

Exercise 3

Create an estimator instance passing the container image and other instance parameters.

Instructions: Pass the container image prepared above into the `sagemaker.estimator.Estimator` function.

Note: For the purposes of this lab, you will use a relatively small instance type. Please refer to this (https://aws.amazon.com/sagemaker/pricing/) link for additional instance types that may work for your use case outside of this lab.

In [17]:

```
estimator = sagemaker.estimator.Estimator(
    ### BEGIN SOLUTION - DO NOT delete this comment for grading purposes
    image_uri=image_uri, # Replace None
    ### END SOLUTION - DO NOT delete this comment for grading purposes
    role=role,
    instance_count=1,
    instance_type='ml.m5.large',
    volume_size=30,
    max_run=7200,
    sagemaker_session=sess
)
```

Configure the hyper-parameters for BlazingText. You are using BlazingText for a supervised classification task. For more information on the hyper-parameters, see the documentation here: https://docs.aws.amazon.com/sagemaker/latest/dg/blazingtext-tuning.html (https://docs.aws.amazon.com/sagemaker/latest/dg/blazingtext-tuning.html)

The hyperparameters that have the greatest impact on word2vec objective metrics are: `learning_rate` and `vector_dim`.

In [18]:

```
estimator.set_hyperparameters(mode='supervised',   # supervised (text classificatio
n)
                              epochs=10,           # number of complete passes thro
ugh the dataset: 5 - 15
                              learning_rate=0.01,  # step size for the  numerical o
ptimizer: 0.005 - 0.01
                              min_count=2,         # discard words that appear less
than this number: 0 - 100
                              vector_dim=300,      # number of dimensions in vector
space: 32-300
                              word_ngrams=3)       # number of words in a word n-gr
am: 1 - 3
```

To call the `fit` method for the created estimator instance you need to setup the input data channels. This can be organized as a dictionary

```
data_channels = {
    'train': ..., # training data
    'validation': ... # validation data
}
```

where training and validation data are the Amazon SageMaker channels for S3 input data sources.

Exercise 4

Create a train data channel.

Instructions: Pass the S3 input path for training data into the `sagemaker.inputs.TrainingInput` function.

In [19]:

```
train_data = sagemaker.inputs.TrainingInput(
    ### BEGIN SOLUTION - DO NOT delete this comment for grading purposes
    train_s3_uri, # Replace None
    ### END SOLUTION - DO NOT delete this comment for grading purposes
    distribution='FullyReplicated',
    content_type='text/plain',
    s3_data_type='S3Prefix'
)
```

Exercise 5

Create a validation data channel.

Instructions: Pass the S3 input path for validation data into the `sagemaker.inputs.TrainingInput` function.

In [20]:

```
validation_data = sagemaker.inputs.TrainingInput(
    ### BEGIN SOLUTION - DO NOT delete this comment for grading purposes
    validation_s3_uri, # Replace None
    ### END SOLUTION - DO NOT delete this comment for grading purposes
    distribution='FullyReplicated',
    content_type='text/plain',
    s3_data_type='S3Prefix'
)
```

Exercise 6

Organize the data channels defined above as a dictionary.

In [21]:

```
data_channels = {
    ### BEGIN SOLUTION - DO NOT delete this comment for grading purposes
    'train': train_data, # Replace None
    'validation': validation_data # Replace None
    ### END SOLUTION - DO NOT delete this comment for grading purposes
}
```

Exercise 7

Start fitting the model to the dataset.

Instructions: Call the `fit` method of the estimator passing the configured train and validation inputs (data channels).

```
estimator.fit(
    inputs=..., # train and validation input
    wait=False # do not wait for the job to complete before continuing
)
```

In [22]:

```
estimator.fit(
    ### BEGIN SOLUTION - DO NOT delete this comment for grading purposes
    inputs=data_channels, # Replace None
    ### END SOLUTION - DO NOT delete this comment for grading purposes
    wait=False
)

training_job_name = estimator.latest_training_job.name
print('Training Job Name:  {}'.format(training_job_name))
```

```
Training Job Name:  blazingtext-2022-08-22-15-38-14-764
```

Review the training job in the console.

Instructions:

- open the link
- notice that you are in the section `Amazon SageMaker -> Training jobs`
- check the name of the training job, its status and other available information

In [23]:

```
from IPython.core.display import display, HTML

display(HTML('<b>Review <a target="blank" href="https://console.aws.amazon.com/sagemaker/home?region={}#/jobs/{}">Training job</a></b>'.format(region, training_job_name)))
```

Review [Training job (https://console.aws.amazon.com/sagemaker/home?region=us-east-1#/jobs/blazingtext-2022-08-22-15-38-14-764)](https://console.aws.amazon.com/sagemaker/home?region=us-east-1#/jobs/blazingtext-2022-08-22-15-38-14-764)

Review the Cloud Watch logs (after about 5 minutes).

Instructions:

- open the link
- open the log stream with the name, which starts from the training job name
- have a quick look at the log messages

In [24]:

```
from IPython.core.display import display, HTML

display(HTML('<b>Review <a target="blank" href="https://console.aws.amazon.com/cloudwatch/home?region={}#logStream:group=/aws/sagemaker/TrainingJobs;prefix={};streamFilter=typeLogStreamPrefix">CloudWatch logs</a> (after about 5 minutes)</b>'.format(region, training_job_name)))
```

Review [CloudWatch logs (https://console.aws.amazon.com/cloudwatch/home?region=us-east-1#logStream:group=/aws/sagemaker/TrainingJobs;prefix=blazingtext-2022-08-22-15-38-14-764;streamFilter=typeLogStreamPrefix)](https://console.aws.amazon.com/cloudwatch/home?region=us-east-1#logStream:group=/aws/sagemaker/TrainingJobs;prefix=blazingtext-2022-08-22-15-38-14-764;streamFilter=typeLogStreamPrefix) (after about 5 minutes)

Wait for the training job to complete.

This cell will take approximately 5-10 minutes to run.

In [25]:

```
%%time

estimator.latest_training_job.wait(logs=False)
```

```
2022-08-22 15:38:16 Starting - Starting the training job
2022-08-22 15:38:30 Starting - Preparing the instances for trainin
g.........................................................................

2022-08-22 15:51:33 Starting - Launched instance was unhealthy, replaci
ng it!.
2022-08-22 15:51:46 Starting - Preparing the instances for trainin
g.........................................................................

2022-08-22 16:04:49 Starting - Launched instance was unhealthy, replaci
ng it!..
2022-08-22 16:05:02 Starting - Preparing the instances for trainin
g..............
2022-08-22 16:06:30 Downloading - Downloading input data.........
2022-08-22 16:07:21 Training - Training image download completed. Train
ing in progress.......
2022-08-22 16:07:57 Uploading - Uploading generated training mode
l.........................................................................

2022-08-22 16:15:38 Completed - Training job completed
CPU times: user 1.91 s, sys: 218 ms, total: 2.13 s
Wall time: 37min 12s
```

Review the train and validation accuracy.

Ignore any warnings.

In [26]:

```
estimator.training_job_analytics.dataframe()
```

```
Warning: No metrics called train:mean_rho found
```

Out[26]:

	timestamp	metric_name	value
0	0.0	train:accuracy	0.5454
1	0.0	validation:accuracy	0.5260

Review the trained model in the S3 bucket.

Instructions:

- open the link
- notice that you are in the section `Amazon S3 -> [bucket name] -> [training job name]` (Example: `Amazon S3 -> sagemaker-us-east-1-82XXXXXXXXXX -> blazingtext-20XX-XX-XX-XX-XX-XX-XXX`)
- check the existence of the `model.tar.gz` file in the `output` folder

In [27]:

```
from IPython.core.display import display, HTML

display(HTML('<b>Review <a target="blank" href="https://s3.console.aws.amazon.com/s3/buckets/{}/{}/output/?region={}&tab=overview">Trained model</a> in S3</b>'.format(bucket, training_job_name, region)))
```

Review [Trained model (https://s3.console.aws.amazon.com/s3/buckets/sagemaker-us-east-1-009330141262/blazingtext-2022-08-22-15-38-14-764/output/?region=us-east-1&tab=overview)](https://s3.console.aws.amazon.com/s3/buckets/sagemaker-us-east-1-009330141262/blazingtext-2022-08-22-15-38-14-764/output/?region=us-east-1&tab=overview) in S3

3. Deploy the model

Now deploy the trained model as an Endpoint.

This cell will take approximately 5-10 minutes to run.

In [28]:

```
%%time

text_classifier = estimator.deploy(initial_instance_count=1,
                                   instance_type='ml.m5.large',
                                   serializer=sagemaker.serializers.JSONSerializer(),
                                   deserializer=sagemaker.deserializers.JSONDeserializer())

print()
print('Endpoint name:  {}'.format(text_classifier.endpoint_name))
```

```
-----!
Endpoint name:  blazingtext-2022-08-22-16-16-04-719
CPU times: user 108 ms, sys: 21 ms, total: 129 ms
Wall time: 2min 32s
```

Review the endpoint in the AWS console.

Instructions:

- open the link
- notice that you are in the section `Amazon SageMaker -> Endpoints -> [Endpoint name]` (Example: `Amazon SageMaker -> Endpoints -> blazingtext-20XX-XX-XX-XX-XX-XX-XXX`)
- check the status and other available information about the Endpoint

In [29]:

```
from IPython.core.display import display, HTML

display(HTML('<b>Review <a target="blank" href="https://console.aws.amazon.com/sagemaker/home?region={}#/endpoints/{}">SageMaker REST Endpoint</a></b>'.format(region,text_classifier.endpoint_name)))
```

Review [SageMaker REST Endpoint (https://console.aws.amazon.com/sagemaker/home?region=us-east-1#/endpoints/blazingtext-2022-08-22-16-16-04-719)](https://console.aws.amazon.com/sagemaker/home?region=us-east-1#/endpoints/blazingtext-2022-08-22-16-16-04-719)

4. Test the model

Import the `nltk` library to convert the raw reviews into tokens that BlazingText recognizes.

In [30]:

```
import nltk
nltk.download('punkt')
```

```
[nltk_data] Downloading package punkt to /root/nltk_data...
[nltk_data]   Package punkt is already up-to-date!
```

Out[30]:

```
True
```

Specify sample reviews to predict the sentiment.

In [31]:

```
reviews = ['This product is great!',
           'OK, but not great',
           'This is not the right product.']
```

Tokenize the reviews and specify the payload to use when calling the REST API.

In [32]:

```
tokenized_reviews = [' '.join(nltk.word_tokenize(review)) for review in reviews]

payload = {"instances" : tokenized_reviews}
print(payload)
```

```
{'instances': ['This product is great !', 'OK , but not great', 'This i
s not the right product .']}
```

Now you can predict the sentiment for each review. Call the `predict` method of the text classifier passing the tokenized sentence instances (`payload`) into the data argument.

In [33]:

```
predictions = text_classifier.predict(data=payload)
for prediction in predictions:
    print('Predicted class: {}'.format(prediction['label'][0].lstrip('__label__')))
```

```
Predicted class: 1
Predicted class: 1
Predicted class: -1
```

Upload the notebook into S3 bucket for grading purposes.

Note: you may need to click on "Save" button before the upload.

In [34]:

```
!aws s3 cp ./C1_W4_Assignment.ipynb s3://$bucket/C1_W4_Assignment_Learner.ipynb
```

```
upload: ./C1_W4_Assignment.ipynb to s3://sagemaker-us-east-1-0093301412
62/C1_W4_Assignment_Learner.ipynb
```

Please go to the main lab window and click on `Submit` button (see the `Finish the lab` section of the instructions).

In [ ]:

```

```