

# Columbia University in the City of New York

AI and OR at Scale on the Cloud

## Assignment 6

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### Step 1: Creating a preprocessing library which has the following features:

- clean text
  - remove stopwords
  - removes twitter handles
  - remove URLs
- tokenize text
- create padding
- converts tokens to indices in the dictionary

This preprocessing library is then uploaded to S3:

Amazon S3 > ai-ops-skand-a6 > preprocessing\_library

ai-ops-skand-a6

Overview

Q Type a prefix and press Enter to search. Press ESC to clear.

Upload Create folder Download Actions

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Name	Last modified	Size	Storage class
Preprocessing_library.zip	Mar 5, 2020 10:24:10 PM GMT-0500	6.7 MB	Standard

### Step 2: Shuffling the data splitting into 3 parts: Train, Dev and Eval.

Train test split of data

```
In [1]: 1 import pandas as pd
        2 from sklearn.utils import shuffle

In [2]: 1 ## Reading data
        2 df = pd.read_csv("training.full.csv")

In [3]: 1 ## Splitting data
        2 data = shuffle(df)
        3 train = data.iloc[0:int(0.85*len(data)),]
        4 dev = data.iloc[int(0.85*len(data)):int(0.95*len(data)),]
        5 eval = data.iloc[int(0.95*len(data)):,:]

In [4]: 1 ## Writing the data
        2 train.to_csv("training.csv",index=False)
        3 dev.to_csv("dev.csv",index=False)
        4 eval.to_csv("eval.csv",index=False)
```

### Step 3: Creating a crawler job to create tables for the three datasets

TRAIN:

Crawler for Train dataset

Crawlers > a4\_train\_crawler

Run crawler

Edit

Name	a4_train_crawler
Description	
Create a single schema for each S3 path	false
Security configuration	
Tags	-
State	Ready
Schedule	
Last updated	Thu Feb 20 19:53:44 GMT-500 2020
Date created	Thu Feb 20 19:53:44 GMT-500 2020
Database	a4_db
Service role	service-role/AWSGlueServiceRole-a2-role
Selected classifiers	
Data store	S3
Include path	s3://ai-ops-skand-a4/data/train
Exclude patterns	

Configuration options

Schema updates in the data store	Update the table definition in the data catalog.
Inherit schema from table	Update all new and existing partitions with metadata from the table.
Object deletion in the data store	Mark the table as deprecated in the data catalog.

Athena output for train dataset

New query 1New query 2New query 3New query 4New query 5New query 6New query 7New query 10

```
1 SELECT * FROM "a4_db"."train" limit 10;
```

Run querySave asCreate (Run time: 2.05 seconds, Data scanned: 338.55 KB)Format queryClear

Use Ctrl + Enter to run query, Ctrl + Space to autocomplete

Results

	sentiment	twitterid	date	querytype	userid	tweet
1	4	2182173030	Mon Jun 15 12:49:08 PDT 2009	NO_QUERY	thelovelysaraho	well im 1 year older....feels great had a blast sat night...im dieing here z
2	0	1975397572	Sat May 30 15:04:21 PDT 2009	NO_QUERY	boneystarks	..My man Redman sound make me feel so old tombout how you had to
3	0	2245999837	Fri Jun 19 16:57:02 PDT 2009	NO_QUERY	highsockmojo	@AdamMcCalvy NOOOO any day but Saturday Hoping to see Camer
4	0	1548724027	Fri Apr 17 21:46:42 PDT 2009	NO_QUERY	icebeenie	@taylorswift13 it's about prom time again, isn't it? ahhh I miss it. I shou
5	0	2176561970	Mon Jun 15 04:11:54 PDT 2009	NO_QUERY	roxijonas	@jbmcdlts thanks so much! I hope
6	4	1880636646	Fri May 22 01:57:22 PDT 2009	NO_QUERY	pinktonic	@kilawinguwak thank you!
7	0	2013716528	Tue Jun 02 23:23:04 PDT 2009	NO_QUERY	lilpandagee	oh and of course.. something has to fail
8	0	2002060249	Tue Jun 02 03:00:35 PDT 2009	NO_QUERY	prateekgupta	@brainstuck @radha_ You guys totally Rawk!!! I can't believe I forgot tl

# EVAL

## Crawler for Eval dataset

Crawlers > a6-eval

Run crawler

Edit

Name

a6-eval

Description

Create a single schema for each S3 path

Security configuration

false

Tags

-

State

Ready

Schedule

Last updated

Thu Mar 05 21:48:11 GMT-500 2020

Date created

Thu Mar 05 21:48:11 GMT-500 2020

Database

a6

Service role

Assignment\_2\_twitter

Selected classifiers

Data store

S3

Include path

s3://aiops-a6/raw\_data/eval

Exclude patterns

Configuration options

Schema updates in the data store

Update the table definition in the data catalog.

Inherit schema from table

Update all new and existing partitions with metadata from the table.

Object deletion in the data store

Mark the table as deprecated in the data catalog.

## Athena output for Eval dataset

New query 1

1 SELECT \* FROM "a6"."eval" LIMIT 10;

Press "tab", then "enter".

Run query

Save as

Create

(Run time: 2.08 seconds, Data scanned: 111.98 KB)

Format query

Clear

Use Ctrl + Enter to run query, Ctrl + Space to autocomplete

Results

	sentiment	twitterid	date	querytype	userid	tweet
1	4	1881285773	Fri May 22 04:12:15 PDT 2009	NO_QUERY	bash	Thanks to @jonreed and @fieldreports for the #followfriday props. Lovely meeting you at #media140.
2	0	2224718195	Thu Jun 18 09:50:50 PDT 2009	NO_QUERY	datboyart	I'm so hungry.... not driving sucks.
3	4	2191684223	Tue Jun 16 05:46:26 PDT 2009	NO_QUERY	crysalis82	start again.. for a brand new exam..
4	0	1961551290	Fri May 29 09:40:39 PDT 2009	NO_QUERY	Sianypoos	isn't lookin 4ward 2 work 2mz.. n if its gna b like 2day-weatherwise- itl b even worse xo
5	0	1981879874	Sun May 31 10:04:45 PDT 2009	NO_QUERY	phollow	@mixero mixero doesn't work well under Linux
6	0	2191932827	Tue Jun 16 06:13:30 PDT 2009	NO_QUERY	lhotfoot	@inournuclearage
7	0	2008642637	Tue Jun 02 14:26:18 PDT 2009	NO_QUERY	BeaWise	phone is dead til friday. lsd screen broke i am tweeting blind.
8	0	1795595272	Thu May 14 08:02:39 PDT 2009	NO_QUERY	mantablog	@Itzike ????? ??? ???
9	4	1989560010	Mon Jun 01 01:59:41 PDT 2009	NO_QUERY	nibby01	@warzabidul happy first day of June
10	4	2189686002	Tue Jun 16 00:38:40 PDT 2009	NO_QUERY	FilmGirl007	come one 9 more baby, 9 more! Give it to me

DEV

Crawler for Dev dataset

Crawlers > a6-dev

Run crawler

Edit

Name	a6-dev
Description	
Create a single schema for each S3 path	false
Security configuration	
Tags	-
State	Ready
Schedule	
Last updated	Thu Mar 05 21:47:11 GMT-500 2020
Date created	Thu Mar 05 21:47:11 GMT-500 2020
Database	a6
Service role	Assignment_2_twitter
Selected classifiers	
Data store	S3
Include path	s3://aiops-a6/raw_data/dev
Exclude patterns	

Configuration options

Schema updates in the data store	Update the table definition in the data catalog.
Inherit schema from table	Update all new and existing partitions with metadata from the table.
Object deletion in the data store	Mark the table as deprecated in the data catalog.

Athena output for Dev dataset

New query 1

```
1 SELECT * FROM "a6"."dev" LIMIT 10;
```

Run query

Save as

Create

(Run time: 2.25 seconds, Data scanned: 112.84 KB)

Format query

Clear

Use Ctrl + Enter to run query, Ctrl + Space to autocomplete

Results

	sentiment	twitterid	date	querytype	userid	tweet
1	4	2018880143	Wed Jun 03 10:39:19 PDT 2009	NO_QUERY	CrazyAvvy	@TheRealJordin I honestly could spend a whole day in Ikea and not realize it
2	4	2063917906	Sun Jun 07 04:34:41 PDT 2009	NO_QUERY	Starshadow	@zuzufalta yay! It's always good when one enjoys a movie. at least you don't feel you wasted the money, yes?
3	0	2247950996	Fri Jun 19 19:52:32 PDT 2009	NO_QUERY	industrialgirl	I am sucking at 1 vs. 100 But it's totally fun. I LOVE trivial
4	0	2256761607	Sat Jun 20 13:15:53 PDT 2009	NO_QUERY	itscookie	@NadiaNV WIFEY I TEXTED YOU THIS MORNING NO RESPONSE me getting no love
5	0	2260879114	Sat Jun 20 19:55:05 PDT 2009	NO_QUERY	pdxmark2	50ish guys who try to look 20ish make me sad.
6	4	2063700106	Sun Jun 07 03:43:54 PDT 2009	NO_QUERY	MangaKate	today there will be heavy showers all across the west midland and we can summerise that dad its not a good day for fishing! lol xD
7	0	2059063829	Sat Jun 06 16:10:27 PDT 2009	NO_QUERY	comparingapples	@gen_rox III let @comparingAPPLE know...
8	4	1793635375	Thu May 14 03:26:49 PDT 2009	NO_QUERY	toysrevil	@philipreed them's the plan = &quot;wearing them will make you eviler&quot; is my tagline
9	0	2194277998	Tue Jun 16 09:34:49 PDT 2009	NO_QUERY	PrctclyPerfect	My baby boy is sick. I want him better and running around again!
10	0	2002428326	Tue Jun 02 04:11:05 PDT 2009	NO_QUERY	royalee	I DONT WANT TO GO TO MELBOURNE IN JULY I hate boys.

New in AWS Glue

Streaming ETL in AWS Glue (preview): Process streaming data and make it available for analysis in seconds. [Learn More](#)

Reduced start times for AWS Glue Spark jobs (preview): Glue Spark jobs will start in under a minute. [Learn More](#)

User preferences

Add job

Action

Filter by tags and attributes

Showing: 1 - 3

<input type="checkbox"/> Name	Type	ETL language	Script location	Last modified	Job bookmark
<input checked="" type="checkbox"/> a6-eval-preprocessing	Spark	python	s3://aws-glue-scripts-2...	5 March 2020 10:19 PM UTC-5	Disable
<input type="checkbox"/> a6-preprocessing	Spark	python	s3://aws-glue-scripts-2...	5 March 2020 10:12 PM UTC-5	Disable
<input type="checkbox"/> word_count	Spark	python	s3://aws-glue-scripts-2...	8 February 2020 11:12 PM UTC-5	Disable

History

Details

Script

Metrics

View run metrics

Rewind job bookmark

Showing: 1 - 2

Run ID	Retry attempt	Run status	Error	Logs	Error logs	Glue version	Maximum capacity	Triggered by	Start time	End time	Execution time	Timeout	Delay	Job run input
<a href="#">jr_610e4d87dc9a29cb...</a>	-	Succeeded		<a href="#">Logs</a>		1.0	5		5 March 2...	5 March 2...	18 mins	2880 mins		s3://aws-glue-temporar...
<a href="#">jr_6118fa175cf68599...</a>	-	Succeeded		<a href="#">Logs</a>		1.0	5		5 March 2...	5 March 2...	33 secs	2880 mins		s3://aws-glue-temporar...

The JSON file generated in S3

aiops-a6

Overview

Q Type a prefix and press Enter to search. Press ESC to clear.

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Viewing 1 to 1

<input type="checkbox"/>	Name	Last modified	Size	Storage class
<input type="checkbox"/>	eval	Mar 6, 2020 11:42:34 AM GMT-0500	27.2 MB	Standard

Viewing 1 to 1

DEV

Successful completion of the Glue job

Jobs A job is your business logic required to perform extract, transform and load (ETL) work. Job runs are initiated by triggers which can be scheduled or driven by events.

New in AWS Glue  
Streaming ETL in AWS Glue (preview): Process streaming data and make it available for analysis in seconds. [Learn More](#)  
Reduced start times for AWS Glue Spark jobs (preview): Glue Spark jobs will start in under a minute. [Learn More](#)

User preferences

Add job

Action

Q Filter by tags and attributes

Showing: 1 - 3

<input type="checkbox"/>	Name	Type	ETL language	Script location	Last modified	Job bookmark
<input type="checkbox"/>	a6-eval-preprocessing	Spark	python	s3://aws-glue-scripts-2...	5 March 2020 10:19 PM UTC-5	Disable
<input checked="" type="checkbox"/>	a6-preprocessing	Spark	python	s3://aws-glue-scripts-2...	5 March 2020 10:12 PM UTC-5	Disable
<input type="checkbox"/>	word_count	Spark	python	s3://aws-glue-scripts-2...	8 February 2020 11:12 PM UTC-5	Disable

History

Details

Script

Metrics

View run metrics

Rewind job bookmark

Showing: 1 - 2

	Run ID	Retry attempt	Run status	Error	Logs	Error logs	Glue version	Maximum capacity	Triggered by	Start time	End time	Execution time	Timeout	Delay	Job run input
<input type="radio"/>	j_r_a6a79af200777929a...	-	Succeeded		<a href="#">Logs</a>		1.0	5		5 March 2...	5 March 2...	35 mins	2880 mins		s3://aws-glue-temporar...
<input type="radio"/>	j_r_9ed5bba94b27e530...	-	Succeeded		<a href="#">Logs</a>		1.0	5		5 March 2...	5 March 2...	1 min	2880 mins		s3://aws-glue-temporar...

The JSON file generated in S3

aiops-a6

Overview

Q Type a prefix and press Enter to search. Press ESC to clear.

Upload

Create folder

Download

Actions

US East (N. Virginia)

Viewing 1 to 1

<input type="checkbox"/>	Name	Last modified	Size	Storage class
<input type="checkbox"/>	dev	Mar 6, 2020 11:42:09 AM GMT-0500	54.4 MB	Standard

Viewing 1 to 1

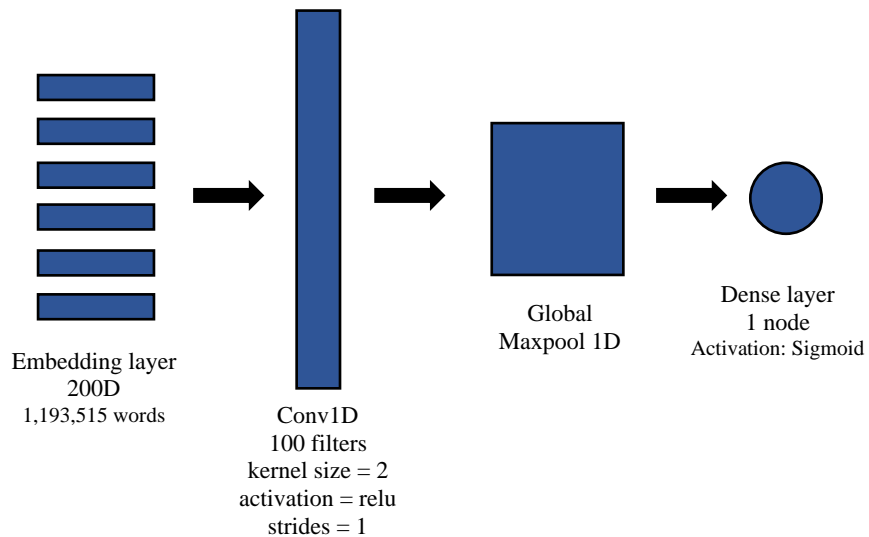
## Step 5: Model training :

We tried various models which belong to 5 distinct categories:

1. CNN: as given in assignment 4 (we treated this model as the benchmark)
2. Dense Neural Network
3. Deep CNN
4. GRU (Gated recurrent unit)
5. LSTM (Long Short Term Memory)

Let us look into these models in detail:

### 1. CNN: as given in assignment 4 (we treated this model as the benchmark)



Learning rate = 0.0005

Loss = Binary cross-entropy

Optimizer = Adam

Epochs = 3

Batch size = 1000

Training accuracy = 0.8186

Validation accuracy = 0.7941

Test accuracy = 0.7941

Model: "sequential"

Layer (type)	Output Shape	Param #
embedding (Embedding)	(None, 100, 200)	238703000
conv1d (Conv1D)	(None, 99, 100)	40100
global_max_pooling1d (Global	(None, 100)	0
dense (Dense)	(None, 100)	10100
dense_1 (Dense)	(None, 1)	101
Total params: 238,753,301		
Trainable params: 238,753,301		
Non-trainable params: 0		

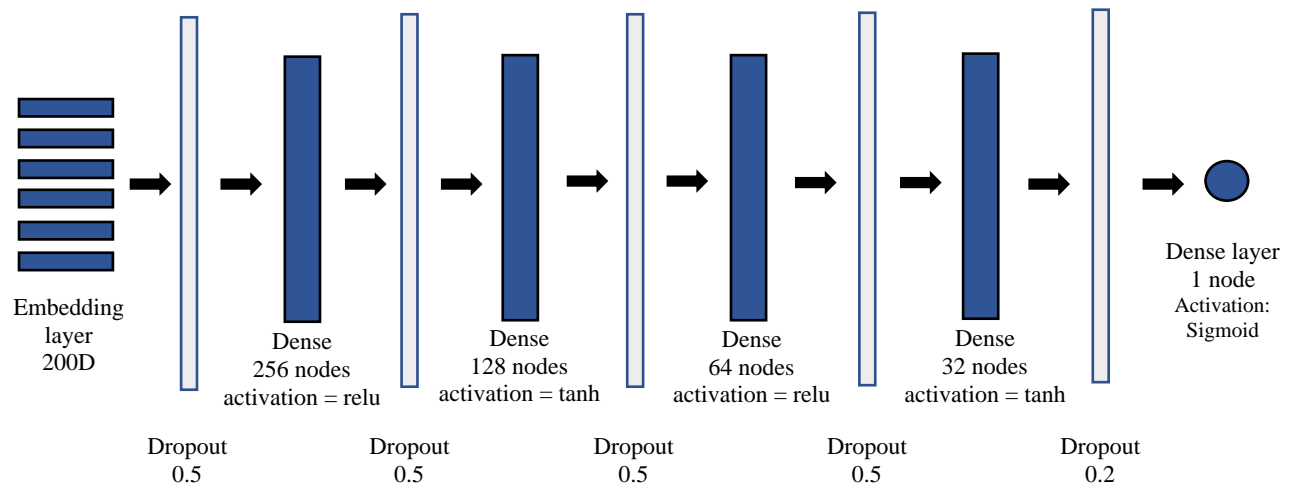
```
Train on 1360 samples, validate on 1000 samples
Epoch 1/3
1360/1360 [=====] - 346s 255ms/step - loss: 0.4635 - acc: 0.7766 - val_loss: 0.4426 - val_ac
c: 0.7911
Epoch 2/3
1360/1360 [=====] - 324s 238ms/step - loss: 0.4221 - acc: 0.8033 - val_loss: 0.4378 - val_ac
c: 0.7944
Epoch 3/3
1360/1360 [=====] - 323s 238ms/step - loss: 0.3966 - acc: 0.8186 - val_loss: 0.4399 - val_ac
c: 0.7941
Test loss:0.4395864550024271
Test accuracy:0.7940875291824341
```

### Hyperparameters tuned:

- Learning rate: selected a learning rate which was not too high and too low. Tried different values between 0.00001 to 0.005
- Batch size: a batch size of 1000 gave us better computational performance and fast convergence
- Epochs: We trained for more epochs and observed when the validation accuracy started decreasing. The no. of epochs with the highest validation accuracy was then selected
- We did not change the architecture in this case as this was our benchmark model



## 2. Dense Neural Network



Learning rate = 0.0005

Loss = Binary cross-entropy

Optimizer = Adam

Epochs = 3

Batch size = 1000

Training accuracy = 0.7982

Validation accuracy = 0.7885

Test accuracy = 0.7865

### Hyperparameters tuned:

- #Layers, nodes, activation, dropout %: tried different architectures and selected the one with the highest validation accuracy
- Learning rate: selected a learning rate which was not too high and too low. Tried different values between 0.00001 to 0.005
- Batch size: a batch size of 1000 gave us better computational performance and fast convergence
- Optimizer: Adam optimizer helped us achieve faster convergence
- Epochs: We trained for more epochs and observed when the validation accuracy started decreasing. The no. of epochs with the highest validation accuracy was then selected

Model: "sequential"

Layer (type)	Output Shape	Param #
embedding (Embedding)	(None, 100, 200)	238703000
flatten (Flatten)	(None, 20000)	0
dense (Dense)	(None, 256)	5120256
dropout (Dropout)	(None, 256)	0
dense_1 (Dense)	(None, 128)	32896
dropout_1 (Dropout)	(None, 128)	0
dense_2 (Dense)	(None, 64)	8256
dropout_2 (Dropout)	(None, 64)	0
dense_3 (Dense)	(None, 32)	2080
dropout_3 (Dropout)	(None, 32)	0
dense_4 (Dense)	(None, 1)	33
Total params: 243,866,521		
Trainable params: 243,866,521		
Non-trainable params: 0		

Train on 1360 samples, validate on 1000 samples

Epoch 1/3

1360/1360 [=====] - 316s 232ms/step - loss: 0.4979 - acc: 0.7587 - val\_loss: 0.4585 - val\_ac

c: 0.7836

Epoch 2/3

1360/1360 [=====] - 299s 220ms/step - loss: 0.4545 - acc: 0.7880 - val\_loss: 0.4545 - val\_ac

c: 0.7865

Epoch 3/3

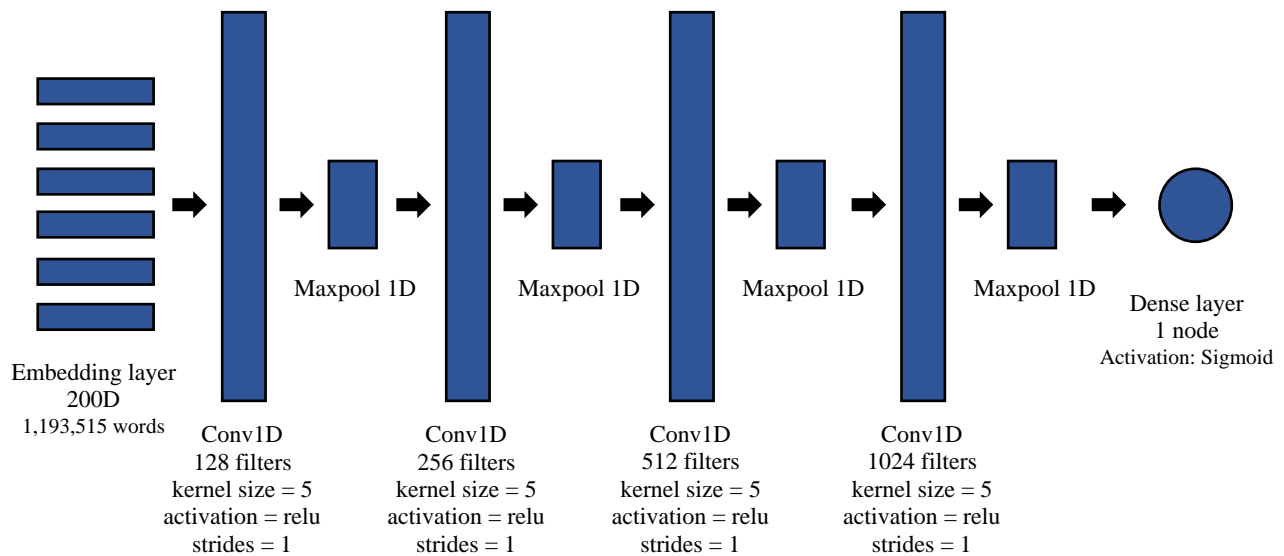
1360/1360 [=====] - 299s 220ms/step - loss: 0.4369 - acc: 0.7982 - val\_loss: 0.4518 - val\_ac

c: 0.7885

Test loss:0.45280549079179766

Test accuracy:0.7864999771118164

### 3. Deep CNN



Learning rate = 0.0005

Loss = Binary cross-entropy

Optimizer = Adam

Epochs = 2

Batch size = 1000

Training accuracy = 0.8066

Validation accuracy = 0.7974

Test accuracy = 0.7974

#### Hyperparameters tuned:

- #Layers, nodes, activation: tried different architectures and selected the one with the highest validation accuracy
- Learning rate: selected a learning rate which was not too high and too low. Tried different values between 0.00001 to 0.005
- Batch size: a batch size of 1000 gave us better computational performance and fast convergence
- Optimizer: Adam optimizer helped us achieve faster convergence
- Epochs: We trained for more epochs and observed when the validation accuracy started decreasing. The no. of epochs with the highest validation accuracy was then selected

Model: "sequential\_1"

Layer (type)	Output Shape	Param #
embedding (Embedding)	(None, 100, 200)	238703000
conv1d (Conv1D)	(None, 96, 128)	128128
max_pooling1d (MaxPooling1D)	(None, 48, 128)	0
conv1d_1 (Conv1D)	(None, 44, 256)	164096
max_pooling1d_1 (MaxPooling1D)	(None, 22, 256)	0
conv1d_2 (Conv1D)	(None, 18, 512)	655872
max_pooling1d_2 (MaxPooling1D)	(None, 9, 512)	0
conv1d_3 (Conv1D)	(None, 5, 1024)	2622464
max_pooling1d_3 (MaxPooling1D)	(None, 2, 1024)	0
flatten (Flatten)	(None, 2048)	0
dense (Dense)	(None, 1024)	2098176
dense_1 (Dense)	(None, 1)	1025
Total params: 244,372,761		
Trainable params: 244,372,761		
Non-trainable params: 0		

Train on 1360 samples, validate on 1000 samples

Epoch 1/2

1360/1360 [=====] - 580s 427ms/step - loss: 0.4583 - acc: 0.7804 - val\_loss: 0.4381 - val\_ac

c: 0.7928

Epoch 2/2

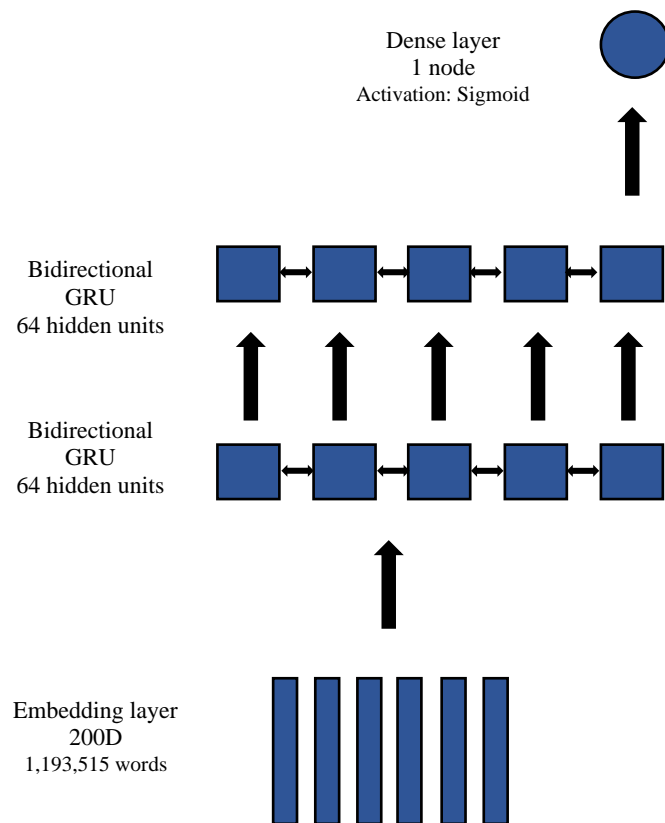
1360/1360 [=====] - 559s 411ms/step - loss: 0.4169 - acc: 0.8066 - val\_loss: 0.4323 - val\_ac

c: 0.7974

Test loss:0.4322528585791588

Test accuracy:0.7974374890327454

#### 4. GRU (Gated recurrent unit)



Learning rate = 0.0005

Loss = Binary cross-entropy

Optimizer = Adam

Epochs = 4

Batch size = 1000

Training accuracy = 0.8009

Validation accuracy = 0.7963

Test accuracy = 0.7947

### Hyperparameters tuned:

- Bidirectional, single direction, hidden units, dropout %: tried different architectures and selected the one with the highest validation accuracy
- Learning rate: selected a learning rate which was not too high and too low. Tried different values between 0.00001 to 0.005
- Batch size: a batch size of 1000 gave us better computational performance and fast convergence
- Optimizer: Adam optimizer helped us achieve faster convergence
- Epochs: We trained for more epochs and observed when the validation accuracy started decreasing. The no. of epochs with the highest validation accuracy was then selected

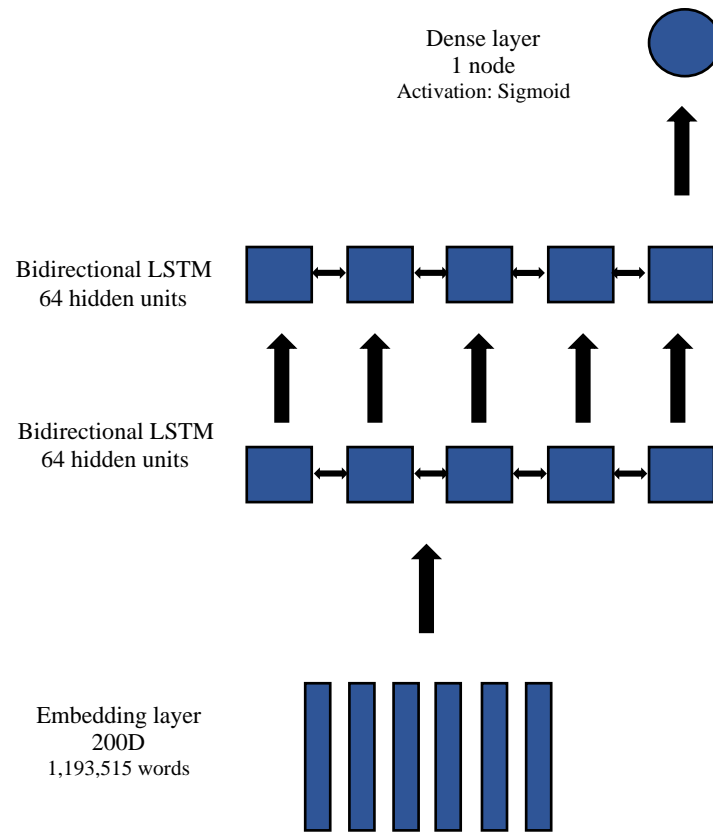
Model: "sequential"

Layer (type)	Output Shape	Param #
embedding (Embedding)	(None, 100, 200)	238703000
bidirectional (Bidirectional)	(None, 100, 128)	101760
bidirectional_1 (Bidirectional)	(None, 128)	74112
dense (Dense)	(None, 1)	129
Total params: 238,879,001		
Trainable params: 238,879,001		
Non-trainable params: 0		

Train on 1360 samples, validate on 1000 samples

```
Epoch 1/4
1360/1360 [=====] - 1381s 1s/step - loss: 0.4950 - acc: 0.7566 - val_loss: 0.4497 - val_acc: 0.7882
Epoch 2/4
1360/1360 [=====] - 1353s 995ms/step - loss: 0.4514 - acc: 0.7864 - val_loss: 0.4415 - val_acc: 0.7929
Epoch 3/4
1360/1360 [=====] - 1354s 996ms/step - loss: 0.4376 - acc: 0.7949 - val_loss: 0.4389 - val_acc: 0.7944
Epoch 4/4
1360/1360 [=====] - 1352s 994ms/step - loss: 0.4271 - acc: 0.8009 - val_loss: 0.4374 - val_acc: 0.7963
Test loss:0.4378286588937044
Test accuracy:0.7947624921798706
```

## 5. LSTM (Long Short Term Memory)



Learning rate = 0.0005

Loss = Binary cross-entropy

Optimizer = Adam

Epochs = 5

Batch size = 1000

Training accuracy = 0.8084

Validation accuracy = 0.7969

Test accuracy = 0.7961

- Bidirectional, single direction, hidden units, dropout %: tried different architectures and selected the one with the highest validation accuracy
- Learning rate: selected a learning rate which was not too high and too low. Tried different values between 0.00001 to 0.005
- Batch size: a batch size of 1000 gave us better computational performance and fast convergence
- Optimizer: Adam optimizer helped us achieve faster convergence
- Epochs: We trained for more epochs and observed when the validation accuracy started decreasing. The no. of epochs with the highest validation accuracy was then selected

Model: "sequential"

Layer (type)	Output Shape	Param #
embedding (Embedding)	(None, 100, 200)	238703000
bidirectional (Bidirectional)	(None, 100, 128)	135680
bidirectional_1 (Bidirectional)	(None, 128)	98816
dense (Dense)	(None, 1)	129
Total params: 238,937,625		
Trainable params: 238,937,625		
Non-trainable params: 0		

Train on 1360 samples, validate on 1000 samples

```
Epoch 1/5
1360/1360 [=====] - 1316s 968ms/step - loss: 0.4941 - acc: 0.7577 - val_loss: 0.4514 - val_a
cc: 0.7869
Epoch 2/5
1360/1360 [=====] - 1264s 929ms/step - loss: 0.4499 - acc: 0.7871 - val_loss: 0.4419 - val_a
cc: 0.7928
Epoch 3/5
1360/1360 [=====] - 1285s 945ms/step - loss: 0.4345 - acc: 0.7966 - val_loss: 0.4390 - val_a
cc: 0.7941
Epoch 4/5
1360/1360 [=====] - 1250s 919ms/step - loss: 0.4233 - acc: 0.8028 - val_loss: 0.4366 - val_a
cc: 0.7964
Epoch 5/5
1360/1360 [=====] - 1291s 949ms/step - loss: 0.4141 - acc: 0.8084 - val_loss: 0.4374 - val_a
cc: 0.7969
Test loss:0.43729878440499304
Test accuracy:0.7961750030517578
```

**The best validation accuracy was achieved using Deep CNN**



[illegible]

### Misclassification:

Next, we manually checked which tweets are getting misclassified to improve the model further (if there is scope)

Tweet	Prediction	Actual Sentiment	Comments
@Itzike ???? ??? ???	0.76422673	0	<i>No sentiment</i>
Grill in the oven is almost as good as on a grill. But I have no yard to grill in	0.95532244	0	<i>Mixed emotions</i>
Reading reviews.. One big flaw, only 8GB of storage on the palm. LAF!! Roll on iPhone release - 32GB on board. Defo not iPhone killer. X	0.2646958	1	<i>Confusing</i>
thinking of you..	0.51759243	0	<i>Subject to interpretation</i>
I am so bored, someone entertain me?	0.2892712	1	<i>Neutral</i>
No more ice	0.72411424	0	<i>Subject to interpretation</i>
wow the things that could happen to LeBRON James. SMH. lol.	0.26916614	1	<i>Confusing SMH and lol together</i>
m off... studying again	0.046333984	1	<i>May be mislabeled</i>
First day of finals and I don't have any	0.47228208	1	<i>Confusing</i>
@kirawr OMG..and you didnt tell me this before..Hhmm?!?! I cant see not zombie sicing on you tho bwahahaha i love you	0.52002203	0	<i>Mixed emotions</i>
@luckyluckster lol so we are quoting tupac now? i am not mad at it	0.21758725	1	<i>Confusing</i>
@hye_jin i'm actually back at tcnj taking classes omgsh you're in belize?! so lucky!! how long are you there for?? oo what are the NCLEX?	0.5652111	0	<i>Looks mislabeled</i>
@v18rocks MAGIC. only hope left.	0.21589482	1	<i>Looks mislabeled</i>

Most of the misclassification that we found while skimming at the misclassified tweets were mostly correct or just could not be improved any further. 20% of error looks like a reasonable estimate that even a human would be prone to while labelling the tweets. Therefore, we believe that the model performs as per our expectations.

## Step 6: Sagemaker Implementation for hosting model:

Model implementation required serving the model as an endpoint. Our models with 200D embeddings were huge in size (>3GB) and AWS Educate as well as free tier account did not allow us to serve these models.

To reduce the model size we kept our model architecture the same but reduced our embedding dimensions to 25D. However, this led to a very small decrease in test accuracy (~0.25%)

### Stored model in S3:

[Amazon S3](#) > [aiops-a6-skand](#) > model

aiops-a6-skand

Overview

Q

Type a prefix and press Enter to search. Press ESC to clear.

Upload

Create folder

Download

Actions

US East (N. Virginia)

Viewing 1 to 2

<input type="checkbox"/>	Name	Last modified	Size	Storage class
<input type="checkbox"/>	test	--	--	--
<input type="checkbox"/>	model.tar.gz	Mar 9, 2020 5:48:48 AM GMT-0400	173.5 MB	Standard

Viewing 1 to 2

Sagemaker Model:

Resource Groups

skandupmanyu

N. Virginia

Support

Amazon SageMaker

Models

Models

Create endpoint

Create endpoint configuration

Actions

Create model

Search models

< 1 >

Name	ARN	Creation time
a6final	arn:aws:sagemaker:us-east-1:587999363644:model/a6final	Mar 09, 2020 04:50 UTC

Resource Groups

skandupmanyu

N. Virginia

Support

Amazon SageMaker

Models

a6final

a6final

Actions

Create batch transform job

Create endpoint

Model settings

Name	ARN	Creation time	IAM role ARN
a6final	arn:aws:sagemaker:us-east-1:587999363644:model/a6final	Mar 09, 2020 04:50 UTC	<a href="#">arn:aws:iam::587999363644:role/ser-vice-role/AmazonSageMaker-ExecutionRole-20200227T175313</a>


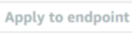



Container 1

Container Name	Model data location
Container 1	<a href="#">s3://aiops-a6-skand/model/model.tar.gz</a>
Image	Mode
763104351884.dkr.ecr.us-east-1.amazonaws.com/tensorflow-inference:1.14.0-cpu	Single model

## Config:

Resource Groups ▾ ★

Amazon SageMaker > Endpoint configuration

Endpoint configuration     


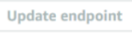


Search endpoint configuration

	Name ▾	ARN	Creation time ▾
<input type="radio"/>	<a href="#">a6-endpoint-config</a>	arn:aws:sagemaker:us-east-1:587999363644:endpoint-config/a6-endpoint-config	Mar 09, 2020 07:11 UTC


## Endpoint:

Resource Groups ▾ ★

Amazon SageMaker > Endpoints


Endpoints    

Search endpoints



	Name ▾	ARN	Creation time ▾	Status ▾	Last updated
<input type="radio"/>	<a href="#">a6-endpoint</a>	arn:aws:sagemaker:us-east-1:587999363644:endpoint/a6-endpoint	Mar 09, 2020 07:12 UTC	 InService	Mar 09, 2020 07:20 UTC

Resource Groups ▾ ★

Amazon SageMaker > Endpoints > a6-endpoint

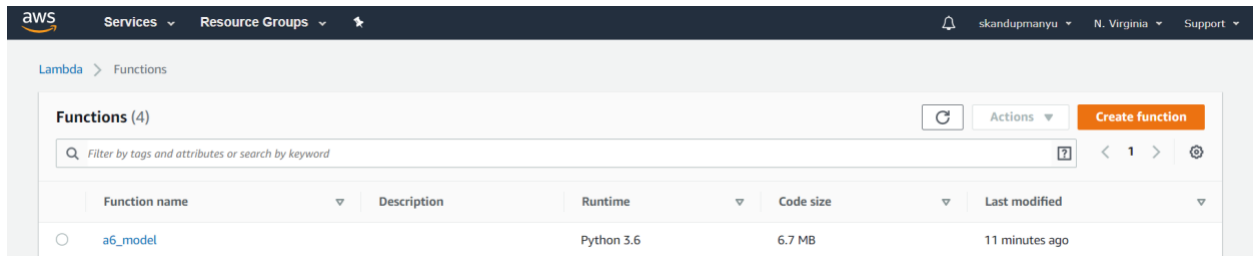
a6-endpoint 

Endpoint settings

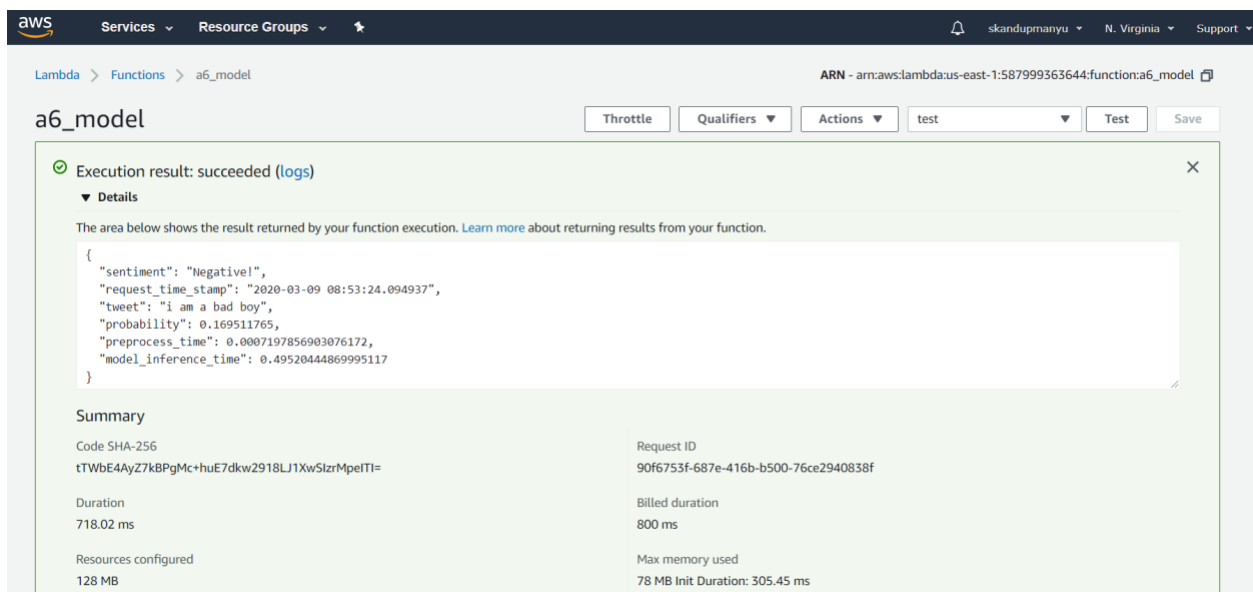
Name	Status	URL
a6-endpoint	 InService	<a href="https://runtime.sagemaker.us-east-1.amazonaws.com/endpoints/a6-endpoint/invocations">https://runtime.sagemaker.us-east-1.amazonaws.com/endpoints/a6-endpoint/invocations</a>
ARN	Creation time	<a href="#">Learn more about the API</a> 
arn:aws:sagemaker:us-east-1:587999363644:endpoint/a6-endpoint	Mon Mar 09 2020 03:12:48 GMT-0400 (Eastern Daylight Time)	
	Last updated	
	Mon Mar 09 2020 03:20:11 GMT-0400 (Eastern Daylight Time)	

## Step 7: API Gateway and Lambda implementation:

Lambda:



The screenshot shows the AWS Lambda console. At the top, there's a navigation bar with the AWS logo, 'Services', 'Resource Groups', and a user profile 'skandupmanyu' in 'N. Virginia'. Below the navigation bar, the breadcrumb 'Lambda > Functions' is visible. The main content area is titled 'Functions (4)' and includes a search bar with the placeholder 'Filter by tags and attributes or search by keyword'. Below the search bar is a table with columns: 'Function name', 'Description', 'Runtime', 'Code size', and 'Last modified'. One function is listed: 'a6\_model' with runtime 'Python 3.6' and code size '6.7 MB', last modified '11 minutes ago'.

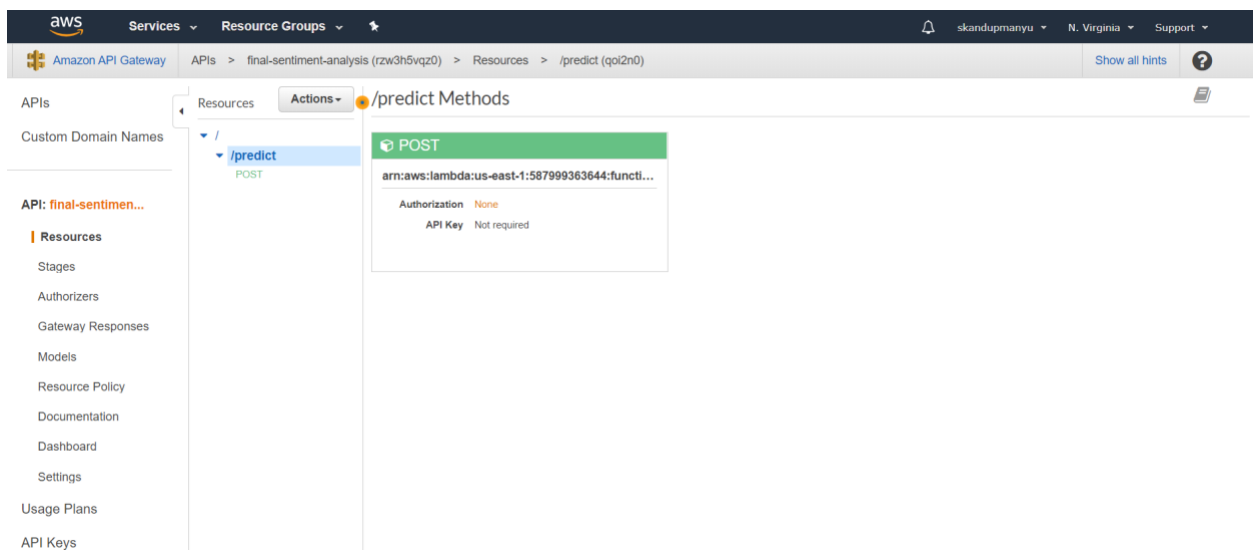


The screenshot shows the AWS Lambda console for the 'a6\_model' function. The breadcrumb is 'Lambda > Functions > a6\_model'. The function's ARN is 'arn:aws:lambda:us-east-1:587999363644:function:a6\_model'. There are buttons for 'Throttle', 'Qualifiers', 'Actions', 'test', 'Test', and 'Save'. A green box indicates 'Execution result: succeeded (logs)'. Below this, the 'Details' section shows the result returned by the function execution: 

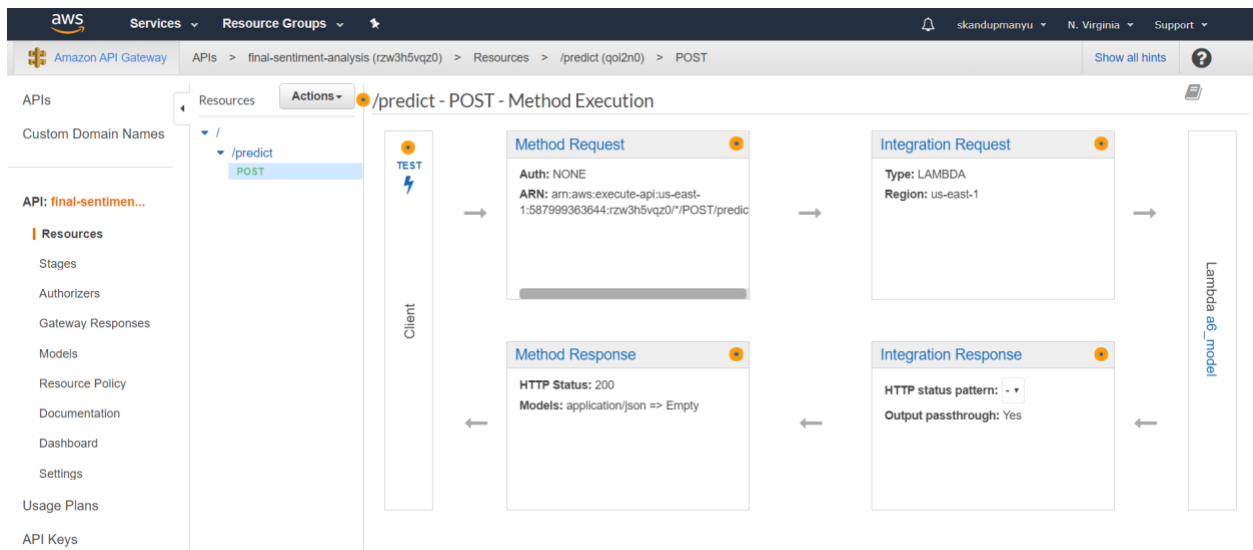
```
{  "sentiment": "Negative!",  "request_time_stamp": "2020-03-09 08:53:24.094937",  "tweet": "i am a bad boy",  "probability": 0.169511765,  "preprocess_time": 0.0007197856903076172,  "model_inference_time": 0.49520444869995117}
```

 Below the details is a 'Summary' section with two columns of information: Code SHA-256 (tTWbE4AyZ7kBPgMc+huE7dkw2918LJ1XwSlzrMpelTI=), Request ID (90f6753f-687e-416b-b500-76ce2940838f), Duration (718.02 ms), Billed duration (800 ms), Resources configured (128 MB), and Max memory used (78 MB Init Duration: 305.45 ms).

API Gateway:



The screenshot shows the AWS API Gateway console. The breadcrumb is 'Amazon API Gateway > APIs > final-sentiment-analysis (rzw3h5vqz0) > Resources > /predict (qol2n0)'. The left sidebar shows the 'Resources' tab selected. The main content area shows the configuration for the '/predict' resource, which is a POST method. The resource is associated with the Lambda function 'arn:aws:lambda:us-east-1:587999363644:func...'. The authorization is set to 'None' and the API key is 'Not required'.



aws Services Resource Groups

Amazon API Gateway APIs > final-sentiment-analysis (rzw3h5vqz0) > Stages > v1

APIs Custom Domain Names

API: final-sentimen...

Resources

Stages

Authorizers

Gateway Responses

Models

Resource Policy

Documentation

Dashboard

Settings

Stages Create

v1 Stage Editor

Delete Stage Configure Tags

Invoke URL: https://rzw3h5vqz0.execute-api.us-east-1.amazonaws.com/v1

Settings Logs/Tracing Stage Variables SDK Generation Export Deployment History Documentation History Canary

Cache Settings

Enable API cache

Default Method Throttling

Choose the default throttling level for the methods in this stage. Each method in this stage will respect these rate and burst settings. Your current account level throttling rate is 10000 requests per second with a burst of 5000 requests. [Read more about API Gateway throttling](#)

Enable throttling

Rate 10000 requests per second

Burst 5000 requests

APIs > final-sentiment-analysis (rzw3h5vqz0) > Resources > /predict (qoi2n0) > POST Show all hints ?

Resources Actions ← Method Execution /predict - POST - Method Test

/

▼ /predict

POST

Make a test call to your method with the provided input

**Path**

No path parameters exist for this resource. You can define path parameters by using the syntax **{myPathParam}** in a resource path.

**Query Strings**

**{predict}**

param1=value1&param2=value2

**Headers**

**{predict}**

Use a colon (:) to separate header name and value, and new lines to declare multiple headers, eg. Accept:application/json.

**Stage Variables**

No [stage variables](#) exist for this method.

**Request Body**

**Request: /predict**

**Status: 200**

**Latency: 452 ms**

**Response Body**

```
{
  "sentiment": "Positive!",
  "request_time_stamp": "2020-03-09 09:11:22.195298",
  "tweet": "i love apples",
  "probability": 0.850960672,
  "preprocess_time": 0.00031113624572753906,
  "model_inference_time": 0.2289724349975586
}
```

**Response Headers**

```
{
  "X-Amzn-Trace-Id": "Root=1-5e660839-bbcc3189b208a76b70c59aff;Sampled=0",
  "Content-Type": "application/json"
}
```

**Logs**

```
Execution log for request a42264e4-7087-454e-9ee2-00565f4b6351
Mon Mar 09 09:11:21 UTC 2020 : Starting execution for request: a42264e4-7087-454e-9ee2-00565f4b6351
```

API call for the final model:

```
(base) Skands-MacBook-Air:~ skand$ curl -X POST https://rzw3h5vqz0.execute-api.us-east-1.amazonaws.com/v1/predict --header "Content-Type:application/json" --data '{"tweet": "I love my life"}'
{"sentiment": "Positive!", "request_time_stamp": "2020-03-09 17:13:07.266727", "tweet": "I love my life", "probability": 0.848078251, "preprocess_time": 0.00012183189392089844, "model_inference_time": 0.04193758964538574}(base) Skands-MacBook-Air:~ skand$
```



## Logs:

Amazon S3 > aiops-a6-skand > logs

aiops-a6-skand

Overview

Q Type a prefix and press Enter to search. Press ESC to clear.

Upload Create folder Download Actions

US East (N. Virginia)

Viewing 1 to 10

Name	Last modified	Size	Storage class
2020-03-09 07:50:19.290929.txt	Mar 9, 2020 3:50:20 AM GMT-0400	220.0 B	Standard
2020-03-09 08:40:39.221032.txt	Mar 9, 2020 4:40:40 AM GMT-0400	220.0 B	Standard
2020-03-09 08:43:18.563387.txt	Mar 9, 2020 4:43:19 AM GMT-0400	220.0 B	Standard
2020-03-09 08:53:24.094937.txt	Mar 9, 2020 4:53:25 AM GMT-0400	220.0 B	Standard
2020-03-09 08:53:30.552010.txt	Mar 9, 2020 4:53:31 AM GMT-0400	222.0 B	Standard

## API Gateway link

<https://rzw3h5vqz0.execute-api.us-east-1.amazonaws.com/v1/predict>

## API call:

```
curl -X POST https://rzw3h5vqz0.execute-api.us-east-1.amazonaws.com/v1/predict --header "Content-Type:application/json" --data '{"tweet": "I love my life"}'
```

## Github:

<https://github.com/skandupmanyu/AI-Ops-A6>

## Notes:

- If you find the endpoint is not active, kindly let us know. We'll start it immediately.
- Also, kindly let us know when the evaluation is complete, so that we can delete our model endpoint (our model is being served in our private account due to limitations in AWS Educate)