Implementation of XLM-Roberta and DistilBert Transformer models for classification of Multilinguistic Toxic Comments

Model-1 XLM-Roberta Model

Importing required Libraries

In [1]:
```
!pip install --upgrade pip
!pip install -q textstat
```

```
Collecting pip
  Downloading pip-20.3.3-py2.py3-none-any.whl (1.5 MB)
     |████████████████████████████████| 1.5 MB 3.0 MB/s eta 0:00:0
1
Installing collected packages: pip
  Attempting uninstall: pip
    Found existing installation: pip 20.1.1
    Uninstalling pip-20.1.1:
      Successfully uninstalled pip-20.1.1
Successfully installed pip-20.3.3
```

In [2]:
```
import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_c
sv)


import gc
import os
import time
import math
import random
import warnings
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

from datetime import date
from transformers import *
from sklearn.metrics import *
from tqdm.notebook import tqdm
```

```python
import torch
import torch.nn as nn
import torch.utils.data
import torch.nn.functional as F



import warnings
warnings.filterwarnings("ignore")

import os
import gc
import re
import folium
import textstat
from scipy import stats
from colorama import Fore, Back, Style, init

import math
import numpy as np
import scipy as sp
import pandas as pd

import random
import networkx as nx
from pandas import Timestamp

from PIL import Image
from IPython.display import SVG
from keras.utils import model_to_dot

import requests
from IPython.display import HTML

import seaborn as sns
from tqdm import tqdm
import matplotlib.cm as cm
import matplotlib.pyplot as plt

tqdm.pandas()

import plotly.express as px
import plotly.graph_objects as go
import plotly.figure_factory as ff
from plotly.subplots import make_subplots

import transformers
import tensorflow as tf

from tensorflow.keras.callbacks import Callback
from sklearn.metrics import accuracy_score, roc_auc_score
from tensorflow.keras.callbacks import ModelCheckpoint, ReduceLROnP
lateau, CSVLogger
```

```
from tensorflow.keras.models import Model
from kaggle_datasets import KaggleDatasets
from tensorflow.keras.optimizers import Adam
from tokenizers import BertWordPieceTokenizer
from tensorflow.keras.layers import Dense, Input, Dropout, Embeddin
g
from tensorflow.keras.layers import LSTM, GRU, Conv1D, SpatialDropo
ut1D

from tensorflow.keras import layers
from tensorflow.keras import optimizers
from tensorflow.keras import activations
from tensorflow.keras import constraints
from tensorflow.keras import initializers
from tensorflow.keras import regularizers

import tensorflow.keras.backend as K
from tensorflow.keras.layers import *
from tensorflow.keras.optimizers import *
from tensorflow.keras.activations import *
from tensorflow.keras.constraints import *
from tensorflow.keras.initializers import *
from tensorflow.keras.regularizers import *

from sklearn import metrics
from sklearn.utils import shuffle
from gensim.models import Word2Vec
from sklearn.cluster import KMeans
from sklearn.decomposition import PCA
from sklearn.feature_extraction.text import TfidfVectorizer,\
                                            CountVectorizer,\
                                            HashingVectorizer

from nltk.stem.wordnet import WordNetLemmatizer
from nltk.tokenize import word_tokenize
from nltk.tokenize import TweetTokenizer

import nltk
from textblob import TextBlob

from nltk.corpus import wordnet
from nltk.corpus import stopwords
from nltk import WordNetLemmatizer
from nltk.stem import WordNetLemmatizer
from wordcloud import WordCloud, STOPWORDS
from nltk.sentiment.vader import SentimentIntensityAnalyzer

stopword=set(STOPWORDS)

lem = WordNetLemmatizer()
tokenizer=TweetTokenizer()
```

```
np.random.seed(0)
```

```
wandb: WARNING W&B installed but not logged in.  Run `wandb login`
or set the WANDB_API_KEY env variable.
```

Setup TPU configuration

In [3]:
```
AUTO = tf.data.experimental.AUTOTUNE

tpu = tf.distribute.cluster_resolver.TPUClusterResolver()
tf.config.experimental_connect_to_cluster(tpu)
tf.tpu.experimental.initialize_tpu_system(tpu)
strategy = tf.distribute.experimental.TPUStrategy(tpu)
print(strategy.num_replicas_in_sync)

BATCH_SIZE = 16 * strategy.num_replicas_in_sync
```

```
8
```

Importing required datasets from .CSV files

In [4]:
```
train1 = pd.read_csv("../input/jigsaw-multilingual-toxic-comment-cl
assification/jigsaw-toxic-comment-train.csv")


train2 = pd.read_csv("/kaggle/input/jigsaw-multilingual-toxic-comme
nt-classification/jigsaw-unintended-bias-train.csv")
train2.toxic = train2.toxic.round().astype(int)

train3 = pd.read_csv('../input/jigsaw-train-multilingual-coments-go
ogle-api/jigsaw-toxic-comment-train-google-es-cleaned.csv')


valid = pd.read_csv('/kaggle/input/jigsaw-multilingual-toxic-commen
t-classification/validation.csv')
test = pd.read_csv('/kaggle/input/jigsaw-multilingual-toxic-comment
-classification/test.csv')
sub = pd.read_csv('/kaggle/input/jigsaw-multilingual-toxic-comment-
classification/sample_submission.csv')


toxic = len(train2[['comment_text', 'toxic']].query('toxic==1'))
# Combine train1 with a subset of train2
train_cat = pd.concat([
    train1[['comment_text', 'toxic']],
    train2[['comment_text', 'toxic']].query('toxic==1'),

    train3[['comment_text', 'toxic']].query('toxic==0'),
    train3[['comment_text', 'toxic']].query('toxic==1'),

]).sample(n=500000).reset_index(drop=True) #restricting data to 500
,000 records due to memory issue

test_data = test
train_data = train_cat

maxlen = 192
```

In [5]:
```
print(len(train_data))
train_data.head()
```

```
500000
```

Out[5]:

	comment_text	toxic
0	"\n\nVandalismo\nEsta edición constituye vanda...	0
1	De acuerdo, Doug, lo he llevado a WP: RSN segú...	0
2	Usted (nuevamente) ha estado modificando las c...	0
3	Smh....15, age you are eligible to undergo a t...	1
4	Why on Earth is a post mentioning fraud commit...	1

In [6]:
```
valid.head()
```

Out[6]:

	id	comment_text	lang	toxic
0	0	Este usuario ni siquiera llega al rango de ...	es	0
1	1	Il testo di questa voce pare esser scopiazzato...	it	0
2	2	Vale. Sólo expongo mi pasado. Todo tiempo pasa...	es	1
3	3	Bu maddenin alt başlığı olarak uluslararası i...	tr	0
4	4	Belçika nın şehirlerinin yanında ilçe ve belde...	tr	0

Data Preprocessing

Clean the text (remove usernames and links)

In [7]:
```
val = valid
train = train_data

def clean(text):
    text = text.fillna("fillna").str.lower()
    text = text.map(lambda x: re.sub('\\n',' ',str(x)))
    text = text.map(lambda x: re.sub("\[\[User.*",'',str(x)))
    text = text.map(lambda x: re.sub("\d{1,3}\.\d{1,3}\.\d{1,3}\.\d
{1,3}",'',str(x)))
    text = text.map(lambda x: re.sub("\(http://.*?\s\(http://.*\)",
'',str(x)))
    return text

val["comment_text"] = clean(val["comment_text"])
test_data["content"] = clean(test_data["content"])
train["comment_text"] = clean(train["comment_text"])
```

More Text Cleaning

Applying text cleaning techniques like clean_text,replace_typical_misspell,handle_contractions,fix_quote on train,test and validation set

In [8]:
```
puncts = [',', '.', '"', ':', ')', '(', '-', '!', '?', '|', ';', "'
", '$', '&', '/', '[', ']', '>', '%', '=', '#', '*', '+', '\\', '•'
,  '~', '@', '£',
 '·', '_', '{', '}', '©', '^', '®', '`',  '<', '→', '°', '€', '™',
'›',  '♥', '←', '×', '§', '″', '′', 'Â', '█', '½', 'à', '…', '\xa0'
```

```
, '\t',
 '“', '★', '”', '–', '●', 'â', '►', '−', '¢', '²', '¬', '░', '¶', '
↑', '±', '¿', '▾', '═', '¦', '║', '―', '¥', '▓', '—', '‹', '─', '\u
3000', '\u202f',
 '▒', '：', '¼', '⊕', '▼', '▪', '†', '■', '’', '▀', '¨', '▄', '♫',
'☆', 'é', '¯', '♦', '¤', '▲', 'è', '¸', '¾', 'Ã', '⋅', '‘', '∞', '«
'
 ,
 '∙', '）', '↓', '、', '│', '（', '»', '，', '♪', '╩', '╚', '³', '・'
, '╦', '╣', '╔', '╗', '▬', '❤', 'ï', 'Ø', '¹', '≤', '‡', '√']

mispell_dict = {"aren't" : "are not",
"can't" : "cannot",
"couldn't" : "could not",
"couldnt" : "could not",
"didn't" : "did not",
"doesn't" : "does not",
"doesnt" : "does not",
"don't" : "do not",
"hadn't" : "had not",
"hasn't" : "has not",
"haven't" : "have not",
"havent" : "have not",
"he'd" : "he would",
"he'll" : "he will",
"he's" : "he is",
"i'd" : "I would",
"i'd" : "I had",
"i'll" : "I will",
"i'm" : "I am",
"isn't" : "is not",
"it's" : "it is",
"it'll":"it will",
"i've" : "I have",
"let's" : "let us",
"mightn't" : "might not",
"mustn't" : "must not",
"shan't" : "shall not",
"she'd" : "she would",
"she'll" : "she will",
"she's" : "she is",
"shouldn't" : "should not",
"shouldnt" : "should not",
"that's" : "that is",
"thats" : "that is",
"there's" : "there is",
"theres" : "there is",
"they'd" : "they would",
"they'll" : "they will",
"they're" : "they are",
"theyre":  "they are",
"they've" : "they have",
"we'd" : "we would",
"we're" : "we are",
"weren't" : "were not",
"we've" : "we have",
"what'll" : "what will",
"what're" : "what are",
"what's" : "what is",
"what've" : "what have",
"where's" : "where is",
"who'd" : "who would",
"who'll" : "who will",
"who're" : "who are",
"who's" : "who is",
"who've" : "who have",
"won't" : "will not",
"wouldn't" : "would not",
"you'd" : "you would",
"you'll" : "you will",
"you're" : "you are",
"you've" : "you have",
"'re": " are",
"wasn't": "was not",
"we'll":" will",
"didn't": "did not",
"tryin'":"trying"}


def clean_text(x):
    x = str(x).replace('\n','')
    for punct in puncts:
        x = x.replace(punct, '')
    return x

def clean_numbers(x):
   result = ''.join([i for i in x if not i.isdigit()])
   return result
```

In [9]:
```
from nltk.tokenize.treebank import TreebankWordTokenizer
tokenizer = TreebankWordTokenizer()

def handle_contractions(x):
    x = tokenizer.tokenize(x)
    return x

def fix_quote(x):
    x = [x_[1:] if x_.startswith("'") else x_ for x_ in x]
    x = ' '.join(x)
    return x

def _get_mispell(mispell_dict):
    mispell_re = re.compile('(%s)' % '|'.join(mispell_dict.keys()))
    return mispell_dict, mispell_re


def replace_typical_misspell(text):
    mispellings, mispellings_re = _get_mispell(mispell_dict)

    def replace(match):
        return mispellings[match.group(0)]

    return mispellings_re.sub(replace, text)


def clean_data(df, columns: list):
    for col in columns:
        df[col] = df[col].apply(lambda x: clean_numbers(x))
        df[col] = df[col].apply(lambda x: clean_text(x.lower()))
        df[col] = df[col].apply(lambda x: replace_typical_misspell(
x))
        df[col] = df[col].apply(lambda x: handle_contractions(x))
        df[col] = df[col].apply(lambda x: fix_quote(x))

    return df
```

In [10]:
```
%%time
input_columns = [
    'comment_text'
]

'''applying text cleaning techniques like clean_text,replace_typica
l_misspell,handle_contractions,fix_quote
on train,test and validation set'''

train = clean_data(train, input_columns )
val = clean_data(val, input_columns )
```

```
CPU times: user 6min 21s, sys: 2.76 s, total: 6min 24s
Wall time: 6min 25s
```

In [11]:
```
train_data.head(20)
```

Out[11]:

	comment_text	toxic
0	vandalismo esta edición constituye vandalismo ...	0
1	de acuerdo doug lo he llevado a wp rsn según s...	0
2	usted nuevamente ha estado modificando las cif...	0
3	smh age you are eligible to undergo a transgen...	1
4	why on earth is a post mentioning fraud commit...	1
5	i think that is actually useful information th...	0
6	ok thanks ill be looking for that just in case...	0
7	outsider once again we agree it seems that thi...	1
8	y qu todo esto significa que tiene un techo ba...	0
9	lol referring to your comment if youre just a ...	0
10	get out of america we dont want another suprem...	1
11	vaya ahora hay muchos artículos que deben revi...	0
12	its not about getting in trouble its about you...	0
13	sin evidencia qu broma otro bromista que no ve...	0
14	no destroce las páginas como lo hizo con esta ...	0
15	and of course history and origins section need...	0
16	occasional wording all of you listen there is ...	0
17	oh save the stupidity lefty this story is abou...	1
18	hablando solo para mí puede ser el caso de que...	0
19	no estamos en peligro de confundir a un dandy ...	0

In [12]:
```
%%time
input_columns = [
    'content'
]
test_data = clean_data(test_data, input_columns )

del tokenizer
```

```
CPU times: user 48.1 s, sys: 9.85 ms, total: 48.2 s
Wall time: 48.2 s
```

In [13]:
```
test_data.head(20)
```

Out[13]:

	id	content	lang
0	0	doctor who adlı viki başlığına doctor olarak b...	tr
1	1	вполне возможно но я пока не вижу необходимост...	ru
2	2	quindi tu sei uno di quelli conservativi che p...	it
3	3	malesef gerçekleştirilmedi ancak şöyle bir şey...	tr
4	4	resimseldabagcanjpg resminde kaynak sorunu res...	tr
5	5	le truc le plus important dans ta tirade c est...	fr
6	6	px caro editor encontramos problemas na edição...	pt
7	7	el skate es unos de los deportes favoritos de ...	es
8	8	me doy la bienvenida a este usuari le gusta co...	es
9	9	es notablemente tendencioso no se habla de cua...	es
10	10	merhaba düzelttiğin için teşekkürler İngilizc...	tr
11	11	stacy uma garoat cat cat cat que vai te seduzi...	pt
12	12	c est surtout un sacr dvot et calotin idiot un...	fr
13	13	le contributeur y tente de prouver par l absur...	fr
14	14	quer ofender vai editar a desciclopdia que mui...	pt
15	15	já a segunda ou terceira vez que insiste nesse...	pt
16	16	propos de lon le langage sauvage le discours c...	fr
17	17	merhaba abuk sabuk ankara şehir maddesiyle ilg...	tr
18	18	под вашу ответственность nb эсбе значит говно ...	ru
19	19	pour qui tu te prends comment osestu dire que ...	fr

Roc-Auc Evaluation metric

In [14]:
```
class RocAucEvaluation(Callback):
    def __init__(self, validation_data=(), interval=1):
        super(Callback, self).__init__()

        self.interval = interval
        self.X_val, self.y_val = validation_data


    def on_epoch_end(self, epoch, logs={}):
        if epoch % self.interval == 0:
            y_pred = self.model.predict(self.X_val, verbose=0)
            score = roc_auc_score(self.y_val, y_pred)
            print("\n ROC-AUC - epoch: {:d} - score: {:.6f}".format
(epoch+1, score))
```

Tokenization of comments

In [15]:
```
def regular_encode(texts, tokenizer, maxlen=512):
    enc_di = tokenizer.batch_encode_plus(
        texts,
        return_attention_masks=False,
        return_token_type_ids=False,
        pad_to_max_length=True,
        max_length=maxlen
    )

    return np.array(enc_di['input_ids'])
```

Loading XLM-Roberta model tokenizer

In [16]:
```
MODEL = 'jplu/tf-xlm-roberta-large'
# First load the real tokenizer
tokenizer = AutoTokenizer.from_pretrained(MODEL)

save_path = '/kaggle/working/xlmr_large/'
if not os.path.exists(save_path):
    os.makedirs(save_path)
tokenizer.save_pretrained(save_path)
```

Out[16]:
```
('/kaggle/working/xlmr_large/sentencepiece.bpe.model',
 '/kaggle/working/xlmr_large/special_tokens_map.json',
 '/kaggle/working/xlmr_large/added_tokens.json')
```

Encoding train, validation and test data

In [17]:
```
%%time
x_train = regular_encode(train.comment_text.astype(str),
                      tokenizer, maxlen=maxlen)
x_valid = regular_encode(val.comment_text.astype(str).values,
                      tokenizer, maxlen=maxlen)
x_test = regular_encode(test_data.content.astype(str).values,
                     tokenizer, maxlen=maxlen)

y_valid = val.toxic.values
y_train = train.toxic.values
```

```
CPU times: user 6min 2s, sys: 3.26 s, total: 6min 6s
Wall time: 6min 6s
```

In [18]:
```
x_train
```

Out[18]:
```
array([[    0,   131,  2465, ...,      1,      1,      1],
       [    0,     8, 27219, ...,      1,      1,      1],
       [    0, 52364, 22334, ...,      1,      1,      1],
       ...,
       [    0,   173,    31, ...,      1,      1,      1],
       [    0,  3514,    53, ...,      1,      1,      1],
       [    0, 14701,   525, ...,      1,      1,      1]])
```

In [19]:
```
x_valid
```

Out[19]:
```
array([[    0,   473, 54367, ...,      1,      1,      1],
       [    0,   211, 52645, ...,      1,      1,      1],
       [    0, 17159, 17646, ...,      1,      1,      1],
       ...,
       [    0,    36,  4689, ...,      1,      1,      1],
       [    0,    88, 18587, ...,      1,      1,      1],
       [    0, 44563,   266, ...,      1,      1,      1]])
```

In [20]:
```
x_test
```

Out[20]:
```
array([[     0,  22072,   2750, ...,      1,      1,      1],
       [     0,  49637,  23334, ...,      1,      1,      1],
       [     0,  14410,    370, ...,      1,      1,      1],
       ...,
       [     0,   2083,     76, ...,      1,      1,      1],
       [     0,  32699, 130611, ...,      1,      1,      1],
       [     0,    120,      6, ...,      1,      1,      1]])
```

Training the data with train,validation and test dataset

In [21]:
```
%%time
train_dataset = (
    tf.data.Dataset
    .from_tensor_slices((x_train, y_train))
    .repeat()
    .shuffle(2048)
    .batch(BATCH_SIZE)
    .prefetch(AUTO)
)

valid_dataset = (
    tf.data.Dataset
    .from_tensor_slices((x_valid, y_valid))
    .batch(BATCH_SIZE)
    .cache()
    .prefetch(AUTO)
)

test_dataset = (
    tf.data.Dataset
    .from_tensor_slices(x_test)
    .batch(BATCH_SIZE)
)
```

```
CPU times: user 665 ms, sys: 2.38 s, total: 3.04 s
Wall time: 4.16 s
```

Focal Loss

In [22]:
```
from tensorflow.keras import backend as K

def focal_loss(gamma=2., alpha=.2):
    def focal_loss_fixed(y_true, y_pred):
        pt_1 = tf.where(tf.equal(y_true, 1), y_pred, tf.ones_like(y
_pred))
        pt_0 = tf.where(tf.equal(y_true, 0), y_pred, tf.zeros_like(
y_pred))
        return -K.mean(alpha * K.pow(1. - pt_1, gamma) * K.log(pt_1
)) - K.mean((1 - alpha) * K.pow(pt_0, gamma) * K.log(1. - pt_0))
    return focal_loss_fixed
```

Building the model and summary check

In [23]:
```
def build_model(transformer, loss='binary_crossentropy', max_len=51
2):
    input_word_ids = Input(shape=(max_len,), dtype=tf.int32, name="
input_word_ids")
    sequence_output = transformer(input_word_ids)[0]
    cls_token = sequence_output[:, 0, :]
    x = tf.keras.layers.Dropout(0.3)(cls_token)
    out = Dense(1, activation='sigmoid')(x)

    model = Model(inputs=input_word_ids, outputs=out)
    model.compile(Adam(lr=3e-5), loss=loss, metrics=[tf.keras.metri
cs.AUC()])

    return model
```

In [24]:
```
%%time
with strategy.scope():
    transformer_layer = transformers.TFXLMRobertaModel.from_pretrai
ned(MODEL)
    model = build_model(transformer_layer,loss='binary_crossentropy
', max_len=maxlen)
model.summary()
```

```
Model: "model"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input_word_ids (InputLayer)  [(None, 192)]             0
_________________________________________________________________
tfxlm_roberta_model (TFXLMRo ((None, 192, 1024), (None 559890432
_________________________________________________________________
tf_op_layer_strided_slice (T [(None, 1024)]            0
_________________________________________________________________
dropout_74 (Dropout)         (None, 1024)              0
_________________________________________________________________
dense (Dense)                (None, 1)                 1025
=================================================================
Total params: 559,891,457
Trainable params: 559,891,457
Non-trainable params: 0
_________________________________________________________________
CPU times: user 2min 11s, sys: 43.6 s, total: 2min 54s
Wall time: 3min 32s
```

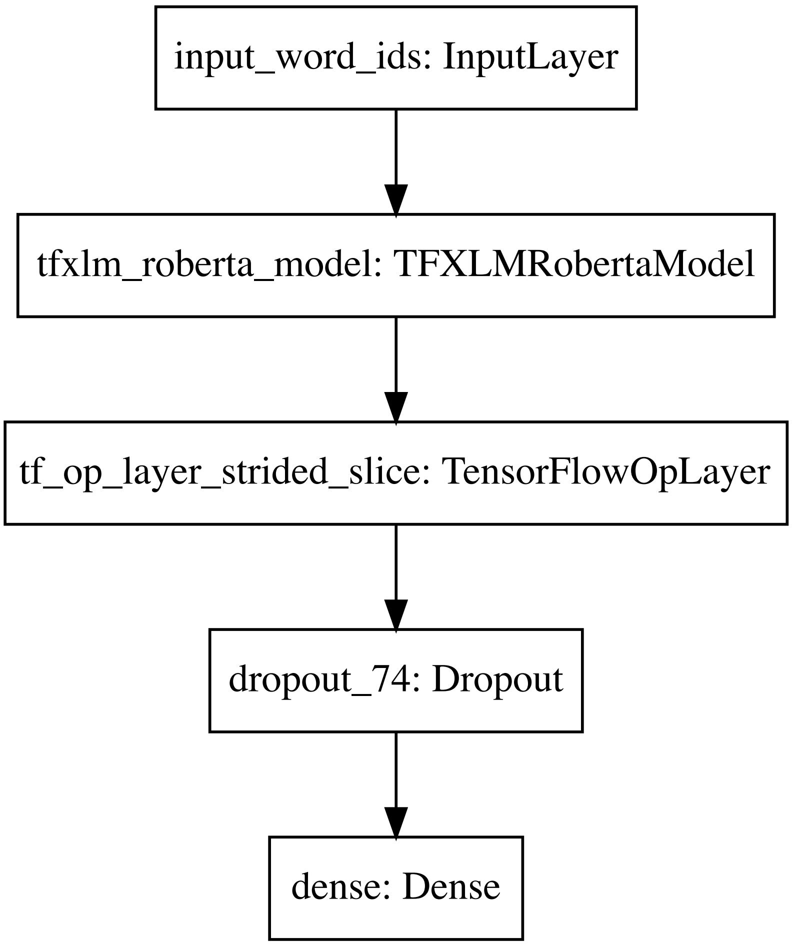
Define Define ReduceLROnPlateau callback

In [25]:
```
def callback():
    cb = []

    reduceLROnPlat = ReduceLROnPlateau(monitor='val_loss',
                                       factor=0.3, patience=2,
                                       verbose=1, mode='auto',
                                       epsilon=0.0001, cooldown=1, min
_lr=0.000001)
    cb.append(reduceLROnPlat)
    log = CSVLogger('log.csv')
    cb.append(log)

    RocAuc = RocAucEvaluation(validation_data=(x_valid, y_valid), i
nterval=1)
    cb.append(RocAuc)

    return cb
```

Visualization of model architecture

In [26]:
```
SVG(tf.keras.utils.model_to_dot(model, dpi=80).create(prog='dot', f
ormat='svg'))
```

Out[26]:

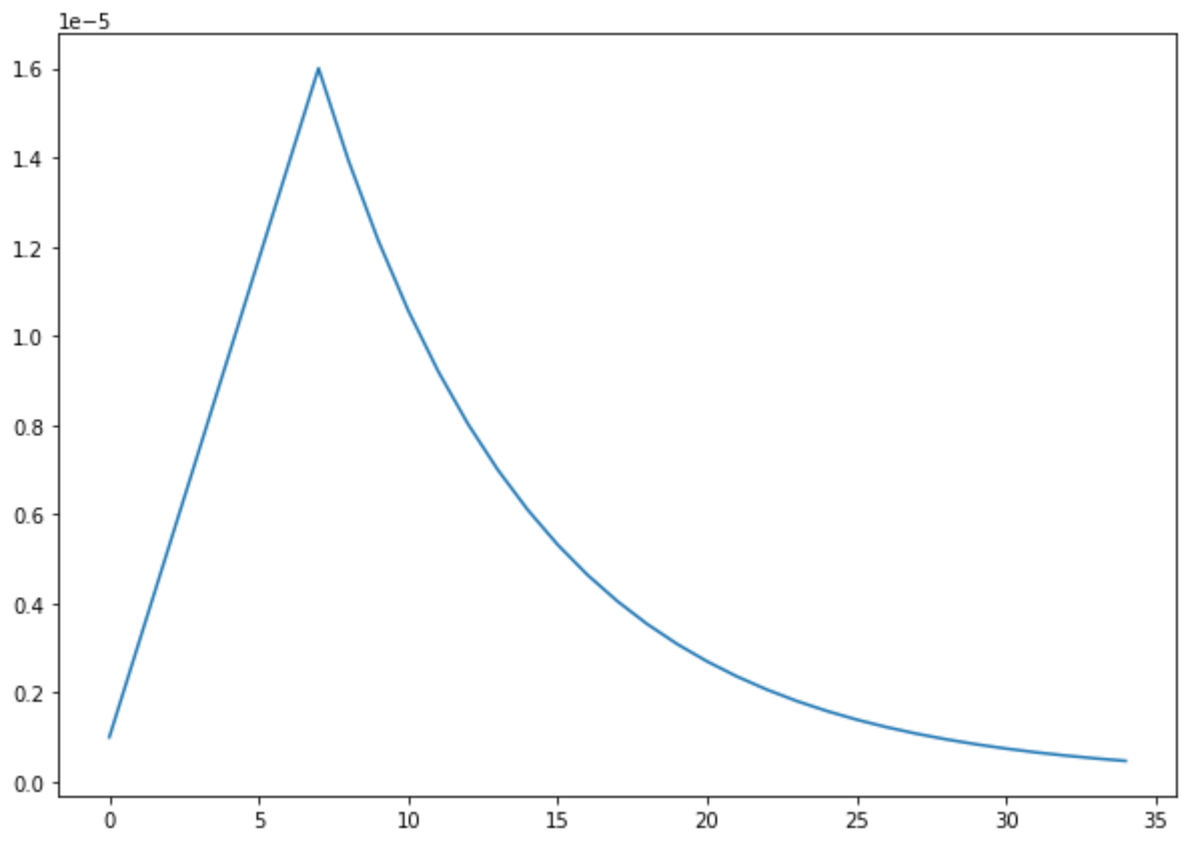

input_word_ids: InputLayer
tfxlm_roberta_model: TFXLMRobertaModel
tf_op_layer_strided_slice: TensorFlowOpLayer
dropout_74: Dropout
dense: Dense

Learning rate schedule

In [27]:

```
def build_lrfn(lr_start=0.000001, lr_max=0.000002,
               lr_min=0.0000001, lr_rampup_epochs=7,
               lr_sustain_epochs=0, lr_exp_decay=.87):
    lr_max = lr_max * strategy.num_replicas_in_sync

    def lrfn(epoch):
        if epoch < lr_rampup_epochs:
            lr = (lr_max - lr_start) / lr_rampup_epochs * epoch + l
r_start
        elif epoch < lr_rampup_epochs + lr_sustain_epochs:
            lr = lr_max
        else:
            lr = (lr_max - lr_min) * lr_exp_decay**(epoch - lr_ramp
up_epochs - lr_sustain_epochs) + lr_min
        return lr

    return lrfn
```

In [28]:
```
import matplotlib.pyplot as plt

plt.figure(figsize=(10, 7))

lrfn = build_lrfn()
plt.plot([i for i in range(35)], [lrfn(i) for i in range(35)]);
```



In [29]:
```
model_path = 'jigsawMultilingual.hdf5'
model_path1 = '/kaggle/working/jigsawMultilingual.hdf5'
```

In [30]:
```
from tensorflow.keras.callbacks import EarlyStopping, ModelCheckpoi
nt, LearningRateScheduler

checkpoint = ModelCheckpoint(model_path, monitor='val_accuracy', mo
de='max', save_best_only=True)
es = EarlyStopping(monitor='val_accuracy', mode='max', patience=2,
                   restore_best_weights=True, verbose=1)
lr_callback = LearningRateScheduler(lrfn, verbose=1)

callback_list = [checkpoint,  lr_callback]
```

Training

Fitting the model with 3 epochs run due to limited availablity of Ram memory

In [31]:
```
%%time
N_STEPS = x_train.shape[0] // BATCH_SIZE
EPOCHS = 3
train_history = model.fit(
    train_dataset,
    steps_per_epoch=N_STEPS,
    validation_data=valid_dataset,
    callbacks=callback_list,
    epochs=EPOCHS
)
```

```
Epoch 00001: LearningRateScheduler reducing learning rate to 1e-06
.
Epoch 1/3
3906/3906 [==============================] - 1726s 442ms/step - lo
ss: 0.2599 - auc: 0.9479 - val_loss: 0.2974 - val_auc: 0.9076 - lr
: 1.0000e-06

Epoch 00002: LearningRateScheduler reducing learning rate to 3.142
857142857143e-06.
Epoch 2/3
3906/3906 [==============================] - 1657s 424ms/step - lo
ss: 0.1327 - auc: 0.9859 - val_loss: 0.3238 - val_auc: 0.9043 - lr
: 3.1429e-06

Epoch 00003: LearningRateScheduler reducing learning rate to 5.285
714285714285e-06.
Epoch 3/3
3906/3906 [==============================] - 1659s 425ms/step - lo
ss: 0.1078 - auc: 0.9906 - val_loss: 0.3516 - val_auc: 0.8899 - lr
: 5.2857e-06
CPU times: user 8min 10s, sys: 25.4 s, total: 8min 35s
Wall time: 1h 27min 20s
```

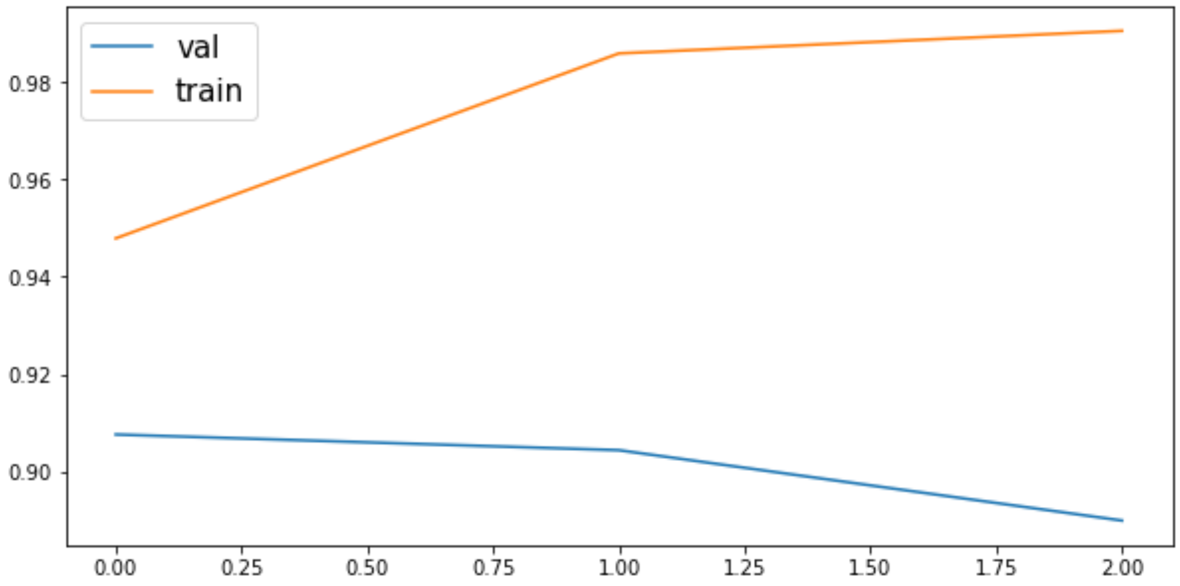
In [32]:
```
train_history_df1 = pd.DataFrame.from_dict(train_history.history)
train_history_df1
```

Out[32]:

	loss	auc	val_loss	val_auc	lr
0	0.259894	0.947915	0.297423	0.907574	1.000000e-06
1	0.132681	0.985946	0.323793	0.904346	3.142857e-06
2	0.107759	0.990583	0.351620	0.889877	5.285714e-06

In [33]:
```
import matplotlib.pyplot as plt
plt.figure(figsize=(10, 5))
plt.plot(train_history_df1['val_auc'], label='val')
plt.plot(train_history_df1['auc'], label='train')
plt.legend(fontsize=15)
```

Out[33]:
```
<matplotlib.legend.Legend at 0x7fc8bf9edcd0>
```



In [34]:
```
if os.path.exists(model_path1):
    model.load_weights(model_path1)
```

Evaluating the model fit

In [35]:
```
score = model.evaluate(x_valid, y_valid, verbose=1)

print("Test Score:", score[0])
print("Test Accuracy:", score[1])
```

```
250/250 [==============================] - 10s 40ms/step - loss: 0
.3514 - auc: 0.8896
Test Score: 0.35144925117492676
Test Accuracy: 0.8895758390426636
```

In [36]:
```
log_dir = "/kaggle/working/log.csv"
if os.path.exists(log_dir):
    os.remove(log_dir)
```

Predicting the toxicity - Output

In [37]:
```
output = pd.read_csv('../input/jigsaw-multilingual-toxic-comment-cl
assification/' + 'sample_submission.csv')
output['toxic'] = model.predict(test_dataset, verbose=1)
output.to_csv('output_xml.csv', index=False)
```

```
499/499 [==============================] - 76s 153ms/step
```

In [38]:
```
output
```

Out[38]:

	id	toxic
0	0	0.000025
1	1	0.000007
2	2	0.120784
3	3	0.000010
4	4	0.000016
...	...	...
63807	63807	0.011993
63808	63808	0.000107
63809	63809	0.002484
63810	63810	0.000071
63811	63811	0.000005

63812 rows × 2 columns

In [39]:
```
y_pred1 = model.predict(test_dataset, verbose=1)
```

```
499/499 [==============================] - 56s 112ms/step
```

In [40]:
```
y_pred1
```

Out[40]:
```
array([[2.5421381e-05],
       [7.0631504e-06],
       [1.2078422e-01],
       ...,
       [2.4839342e-03],
       [7.0750713e-05],
       [5.0365925e-06]], dtype=float32)
```

In [41]:
```
import random
spl = random.sample(range(len(y_pred1)), 10)
for text, sentiment in zip(test.content[spl], y_pred1[spl]):
    print(sentiment, text)
```

```
[9.119511e-06] obrigado por wikiaprendermãos a obra siga o link ve
```

```
rmelho acima com o nome do artigo boas contribuições andrezitos ms
gmail
[0.6305814] eu tambm já me enganei tanto lixo que deixa a gente to
nto luís felipe braga
[0.00070539] sto impazzendo ufficialmente penso che tu abbia visto
l inizio di edit war tra sostenitori della o paulox e della a akel
a ho messo un po di ordine si era creata una doppia discussione e
si era persa la cronologia paulox aveva copiaincollato redirect e
articolo per invertirli non li aveva spostati correttamente e si e
ra creato il panico nel frattempo ho spostato il tuo intervento in
discussionescoutismo di cui ora discussionescautismo redirect e ho
meso una nota guarda se sei d accordo ciao e grazie shaka you talk
in to me giu cest
[0.2428748] s il le fallait encore voil une dmonstration de votre
mauvaise foi abyssale le terme youpin c est si j ose crire la ceri
se sur le gteau l essentiel ce sont les paroles haineuses du capit
aine de gaulle les juifs sont les fourriers la rvolution marxiste
ils sont comploteurs et cupides par nature sa lettre est un amalga
me caricatural du juif homme d argent et rvolutionnaire il parle d
es juifs dtests mort au moment où de braves catholiques polonais m
assacrent leurs compatriotes isralites par dizaines sinon par cent
aines le moins qu on puisse dire donc c est que le de gaulle de ta
it contamin par l atmosphre antismite de l poque debr et dassault
n taient plus juifs quand ils se sont rallis de gaulle debr avait
même reni sa religion pour rester dans l administration de vichy e
t prêter serment au marchal en novembre eh oui quant jaurs il n a
jamais utilis le mot youpin et n a jamais dcrit les juifs comme de
s comploteurs par nature françois mitterrand non plus□□□□lucrce
[8.583069e-06] pessoal acho que não há motivos para preocupação co
m duas wikipdias já existem projetos que estão muito próximos de s
erem aprovados sobre a unificação da língua portuguesa assim ambos
os países terão de abrir mão e acostumaremse a escrever de uma for
ma diferente por exemplo os portugueses escreveriam ação no lugar
de acção para saberem mais leiam em httpportpravdarusaotomeeprinci
pehtml abraço a todos cleiton
[0.9251092] настоящая сволочь была этот ваш скобелевпоэтому эта св
олочь и умерла так рано так ему и надо
[1.5258789e-05] давайте сначала определимся генерал бригады это вы
ше полковника но ниже генералмайора в россии такого звания пока не
т следующее звание генерал дивизии соответствует генералмайору и д
ействительно в российской дивизии командует генералмайор мы же сра
вниваем не по количеству звёзд на погоне в россии вот нет полосок
а в польше и они есть а по соответствию присваиваемых званий конкр
етной должности
[0.0022122] leftpx sevgili kullanıcı büyük ihtimalle enerji dolu b
ir gençsin bugüne kadar vikipedi den seninle aynı şeyi deneyen hey
ecanlı gençlerden binlercesi geldi geçti sen de şu an sonuncusun
öyle diyelim şunu bilmeni istiyoruz ki bu heyecanını ve enerjini d
oğru konulara doğru yerlere harcayabilirsin sana istediğin sayfayı
değiştirme hakkını vermiş olmamız şu an kullandığımız yazılımın bi
r özelliğidir bu ansiklopedi projesi böyle işliyor insanların bilg
iye para vermeden ulaşmasını böyle sağlıyoruz senin de diğer yüz b
inler gibi ansiklopediye verecek bir şeyin olduğuna inanıyoruz ve
```

```
özgür ansiklopedide özgürce hareket etmeni sağlıyoruz bu sayfalara
hacked yazan ilk kişi değilsin maalesef sonuncu da olmayacaksın an
cak umuyoruz ki yaşın biraz daha ilerleyince bugün yaptığının ne k
adar komik olduğunun farkına varıp kutsal diye nitelendirmekten çe
kinmeyeceğimiz amacımıza katkıda bulunmak isteyeceksin şimdi diler
sen buraya tıklayıp kayıt olabilir olumlu değişiklikler yaparak in
sanlara yararlı olma yolunu seçebilirsin hatta kayıt olmadan da bu
nu yapabilirsin sevgilerböcürt
[6.327033e-05] sevgili dostum xberger merhaba nasılsın burada haka
n patırer i silinmeye aday sayfalar sayfada kalsın diye oy oy kull
anır mısın rica etsem hakanp mesaj
[0.08235487] bence bundan önceki sürüm daha iyiydi neden tekrar de
ğiştirildi oh bambii cried so hard when those hunters shot your mo
mmy
```

DistilBert Model Implementation

Loading the required libraries

In [42]:
```
import os
import gc
import numpy as np
import pandas as pd
import re
import matplotlib.pyplot as plt
import glob
```

In [43]:
```
import string
from sklearn.model_selection import train_test_split, RandomizedSea
rchCV, GridSearchCV, StratifiedKFold


from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.pipeline import Pipeline
from gensim import utils
import gensim.parsing.preprocessing as gsp

from sklearn.model_selection import cross_val_score
from sklearn.metrics import accuracy_score, f1_score, roc_auc_score

import seaborn as sns

import tensorflow as tf
from tensorflow.keras.layers import Dense, Dropout, Input
from tensorflow.keras.optimizers import Adam
from tensorflow.keras.models import Model
from tensorflow.keras.callbacks import ReduceLROnPlateau, EarlyStop
ping, ModelCheckpoint
from kaggle_datasets import KaggleDatasets
import transformers
from tqdm.notebook import tqdm
import tokenizers
from tokenizers import BertWordPieceTokenizer
```

Loading the required dataset from .CSV files

In [44]:
```
# Loading train data
needed_cols = ['toxic', 'comment_text']

translated_train_files = glob.glob('/kaggle/input/jigsaw-train-mult
ilingual-coments-google-api/jigsaw-toxic-comment-train-google-*-cle
aned.csv')
translated_train_dfs = []
for filename in translated_train_files:
    df = pd.read_csv(filename, usecols=needed_cols)
    lang = re.findall('train-google-(.*)-cleaned.csv', filename)[0]
    df['lang'] = lang
    translated_train_dfs.append(df)

train_en = pd.read_csv("/kaggle/input/jigsaw-multilingual-toxic-com
ment-classification/jigsaw-toxic-comment-train.csv", usecols=needed
_cols)
train_en['lang'] = 'en'

translated_train_dfs.append(train_en)

train_df = pd.concat(translated_train_dfs).sample(n=500000).reset_i
ndex(drop=True) #Training dataset

y_train = train_df['toxic'].values


del df, translated_train_dfs, train_en
gc.collect()
```

Out[44]:
```
48180
```

In [45]:
```
print(len(train_df))
train_df.head(10)
```

```
500000
```

Out[45]:

	comment_text	toxic	lang
0	"\n\n Bien sûr, cet utilisateur a un agenda. I...	0	fr
1	"\n :::: Yetim bot'un etiketlemesi sonucunda ...	0	tr
2	Lütfen crony saçmalığını durdur. Ben kimseye s...	1	tr
3	It is about the remarkable popularity of the p...	0	en
4	: Obrigado, meu erro.	0	pt
5	, 8 Ağustos 2006 (UTC)\n Bu bağlantıda referan...	0	tr
6	":: Parece viável. No entanto, acho que a idéi...	0	pt
7	"\n\nI read the cited reference. It is extreme...	0	en
8	Novembro de 2005 (UTC)\n\nA gordura nunca é co...	0	pt
9	"\n{| class = "" messagebox conversa-padrão ""...	0	pt

Data Preprocessing

In [46]:
```
def clean_text(text):
    text = str(text)
    text = re.sub(r'[0-9"]', '', text) # number
    text = re.sub(r'#[\S]+\b', '', text) # hash
    text = re.sub(r'@[\S]+\b', '', text) # mention
    text = re.sub(r'https?\S+', '', text) # link
    text = re.sub(r'\s+', ' ', text) # multiple white spaces
#     text = re.sub(r'\W+', ' ', text) # non-alphanumeric
    return text.strip()
```

In [47]:
```
def text_process(text):
    ws = text.split(' ')
    if(len(ws)>160):
        text = ' '.join(ws[:160]) + ' ' + ' '.join(ws[-32:])
    return text
```

Loading DistilBert Tokenizer

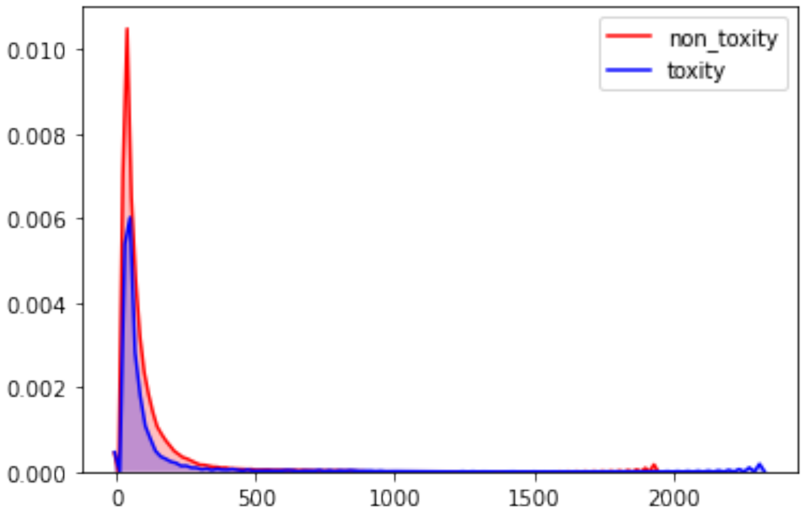
In [48]:
```
# First load the real tokenizer
tokenizer = transformers.DistilBertTokenizer.from_pretrained('disti
lbert-base-multilingual-cased')

save_path = '/kaggle/working/distilbert_base_uncased/'
if not os.path.exists(save_path):
    os.makedirs(save_path)
tokenizer.save_pretrained(save_path)

fast_tokenizer = BertWordPieceTokenizer('distilbert_base_uncased/vo
cab.txt', lowercase=False)
```

Encoding of comments

In [49]:
```
def fast_encode(texts, tokenizer, chunk_size=256, maxlen=512):

    tokenizer.enable_truncation(max_length=maxlen)
    tokenizer.enable_padding(max_length=maxlen)
    all_ids = []

    for i in tqdm(range(0, len(texts), chunk_size)):
        text_chunk = texts[i:i+chunk_size].tolist()
        encs = tokenizer.encode_batch(text_chunk)
        all_ids.extend([enc.ids for enc in encs])

    return np.array(all_ids)
```

In [50]:
```
def len_sent(data):
    return len(data.split())
train_df["num_words_comment_text"] = train_df["comment_text"].apply
(lambda x : len_sent(x))
sns.kdeplot(train_df[train_df["toxic"] == 0]["num_words_comment_tex
t"].values, shade = True, color = "red", label='non_toxity')
sns.kdeplot(train_df[train_df["toxic"] == 1]["num_words_comment_tex
t"].values, shade = True, color = "blue", label='toxity')

del train_df['toxic']; gc.collect()
```

Out[50]:
```
181
```



Configuration setup

In [51]:
```
AUTO = tf.data.experimental.AUTOTUNE
SHUFFLE = 2048
EPOCHS1 = 20
EPOCHS2 = 4
BATCH_SIZE = 16 * strategy.num_replicas_in_sync
MAX_LEN = 192
VERBOSE = 1
```

Detect hardware to return appropriate distribution strategy

In [52]:
```
# Detect hardware, return appropriate distribution strategy
try:
    # TPU detection. No parameters necessary if TPU_NAME environmen
t variable is
    # set: this is always the case on Kaggle.
    tpu = tf.distribute.cluster_resolver.TPUClusterResolver()
    print('Running on TPU ', tpu.master())
except ValueError:
    tpu = None

if tpu:
    tf.config.experimental_connect_to_cluster(tpu)
    tf.tpu.experimental.initialize_tpu_system(tpu)
    strategy = tf.distribute.experimental.TPUStrategy(tpu)
else:
    # Default distribution strategy in Tensorflow. Works on CPU and
single GPU.
    strategy = tf.distribute.get_strategy()

print("REPLICAS: ", strategy.num_replicas_in_sync)
```

```
Running on TPU  grpc://10.0.0.2:8470
REPLICAS:  8
```

Encoding train data

In [53]:
```
train_df['comment_text'] = train_df['comment_text'].apply(lambda x:
clean_text(x))
train_df['comment_text'] = train_df['comment_text'].apply(lambda x:
text_process(x))
x_train = fast_encode(train_df['comment_text'].astype(str), fast_to
kenizer, maxlen=MAX_LEN)
```

In [54]:
```
x_train
```

Out[54]:
```
array([[  101, 27448, 10326, ..., 53388, 16946,   102],
       [  101,   131,   131, ..., 10457, 17145,   102],
       [  101, 23859, 10123, ...,     0,     0,     0],
       ...,
       [  101, 17622, 90139, ...,     0,     0,     0],
       [  101,   113, 11780, ...,     0,     0,     0],
       [  101, 16466, 10228, ...,     0,     0,     0]])
```

Loading and cleaning validation dataset

```
In [55]: valid = pd.read_csv('/kaggle/input/jigsaw-multilingual-toxic-commen
         t-classification/validation.csv')
         valid['comment_text'] = valid.apply(lambda x: clean_text(x['comment
         _text']), axis=1)
         valid['comment_text'] = valid['comment_text'].apply(lambda x: text_
         process(x))
```

Encoding validation dataset

```
In [56]: x_valid = fast_encode(valid['comment_text'].astype(str), fast_token
         izer, maxlen=MAX_LEN)
         y_valid = valid['toxic'].values
```

Build dataset objects

```
In [57]: train_dataset = (
             tf.data.Dataset
             .from_tensor_slices((x_train, y_train))
             .repeat()
             .shuffle(SHUFFLE)
             .batch(BATCH_SIZE)
             .prefetch(AUTO)
         )

         valid_dataset = (
             tf.data.Dataset
             .from_tensor_slices((x_valid, y_valid))
             .batch(BATCH_SIZE)
             .cache()
             .prefetch(AUTO)
         )

         gc.collect()

Out[57]: 26
```

Call Backs

In [58]:
```
lrs = ReduceLROnPlateau(monitor='val_auc', mode ='max', factor = 0.
7, min_lr= 1e-7, verbose = 1, patience = 2)
es1 = EarlyStopping(monitor='val_auc', mode='max', verbose = 1, pat
ience = 5, restore_best_weights=True)
es2 = EarlyStopping(monitor='auc', mode='max', verbose = 1, patienc
e = 1, restore_best_weights=True)
callbacks_list1 = [lrs,es1]
callbacks_list2 = [lrs,es2]
```

Build model

In [59]:
```
def build_model(transformer, max_len=512):

    input_word_ids = Input(shape=(max_len,), dtype=tf.int32, name="
input_word_ids")
    sequence_output = transformer(input_word_ids)[0]
    cls_token = sequence_output[:, 0, :]
    x = tf.keras.layers.Dropout(0.4)(cls_token)
    out = Dense(1, activation='sigmoid')(cls_token)

    model = Model(inputs=input_word_ids, outputs=out)
    model.compile(Adam(lr=1e-5), loss='binary_crossentropy', metric
s=[tf.keras.metrics.AUC(name='auc'), 'accuracy'])

    return model
```

Loading model into TPU

In [60]:
```
%%time
with strategy.scope():
    transformer_layer = (
        transformers.TFDistilBertModel
        .from_pretrained('distilbert-base-multilingual-cased')
    )
    model = build_model(transformer_layer, max_len=MAX_LEN)
model.summary()
```

```
Model: "model_1"
_________________________________________________________________
Layer (type)                 Output Shape              Param #   
=================================================================
input_word_ids (InputLayer)  [(None, 192)]             0         
_________________________________________________________________
tf_distil_bert_model (TFDist ((None, 192, 768),)       134734080 
_________________________________________________________________
tf_op_layer_strided_slice_1  [(None, 768)]             0         
_________________________________________________________________
dense_1 (Dense)              (None, 1)                 769       
=================================================================
Total params: 134,734,849
Trainable params: 134,734,849
Non-trainable params: 0
_________________________________________________________________
CPU times: user 38.2 s, sys: 15.4 s, total: 53.5 s
Wall time: 56.6 s
```

Training the model

In [61]:
```
n_steps = len(y_train) // (BATCH_SIZE*8)

train_history = model.fit(
    train_dataset,
    steps_per_epoch=n_steps,
    validation_data=valid_dataset,
    epochs=EPOCHS1,
    callbacks=callbacks_list1,
    verbose=VERBOSE
)

del train_dataset; gc.collect()
```

```
Epoch 1/20
488/488 [==============================] - 72s 147ms/step - loss:
0.2110 - accuracy: 0.9206 - auc: 0.8839 - val_loss: 0.3000 - val_a
ccuracy: 0.8740 - val_auc: 0.8736 - lr: 1.0000e-05
Epoch 2/20
488/488 [==============================] - 54s 110ms/step - loss:
```

```
0.1580 - accuracy: 0.9377 - auc: 0.9421 - val_loss: 0.2713 - val_a
ccuracy: 0.8825 - val_auc: 0.8948 - lr: 1.0000e-05
Epoch 3/20
488/488 [==============================] - 53s 109ms/step - loss:
0.1430 - accuracy: 0.9438 - auc: 0.9526 - val_loss: 0.2629 - val_a
ccuracy: 0.8839 - val_auc: 0.9031 - lr: 1.0000e-05
Epoch 4/20
488/488 [==============================] - 53s 110ms/step - loss:
0.1364 - accuracy: 0.9463 - auc: 0.9565 - val_loss: 0.2870 - val_a
ccuracy: 0.8824 - val_auc: 0.9049 - lr: 1.0000e-05
Epoch 5/20
488/488 [==============================] - 54s 110ms/step - loss:
0.1279 - accuracy: 0.9501 - auc: 0.9616 - val_loss: 0.2769 - val_a
ccuracy: 0.8840 - val_auc: 0.9085 - lr: 1.0000e-05
Epoch 6/20
488/488 [==============================] - 55s 113ms/step - loss:
0.1284 - accuracy: 0.9487 - auc: 0.9616 - val_loss: 0.2523 - val_a
ccuracy: 0.8914 - val_auc: 0.9122 - lr: 1.0000e-05
Epoch 7/20
488/488 [==============================] - 52s 106ms/step - loss:
0.1244 - accuracy: 0.9511 - auc: 0.9656 - val_loss: 0.2912 - val_a
ccuracy: 0.8874 - val_auc: 0.9097 - lr: 1.0000e-05
Epoch 8/20
488/488 [==============================] - 54s 110ms/step - loss:
0.1233 - accuracy: 0.9517 - auc: 0.9654 - val_loss: 0.2764 - val_a
ccuracy: 0.8858 - val_auc: 0.9127 - lr: 1.0000e-05
Epoch 9/20
488/488 [==============================] - 52s 107ms/step - loss:
0.1153 - accuracy: 0.9538 - auc: 0.9705 - val_loss: 0.2803 - val_a
ccuracy: 0.8881 - val_auc: 0.9111 - lr: 1.0000e-05
Epoch 10/20
488/488 [==============================] - 54s 110ms/step - loss:
0.1098 - accuracy: 0.9561 - auc: 0.9730 - val_loss: 0.2583 - val_a
ccuracy: 0.8905 - val_auc: 0.9139 - lr: 1.0000e-05
Epoch 11/20
488/488 [==============================] - 52s 107ms/step - loss:
0.1071 - accuracy: 0.9570 - auc: 0.9744 - val_loss: 0.2623 - val_a
ccuracy: 0.8888 - val_auc: 0.9127 - lr: 1.0000e-05
Epoch 12/20
488/488 [==============================] - ETA: 0s - loss: 0.1064
- accuracy: 0.9570 - auc: 0.9743
Epoch 00012: ReduceLROnPlateau reducing learning rate to 6.9999998
231651255e-06.
488/488 [==============================] - 52s 106ms/step - loss:
0.1064 - accuracy: 0.9570 - auc: 0.9743 - val_loss: 0.2947 - val_a
ccuracy: 0.8866 - val_auc: 0.9047 - lr: 1.0000e-05
Epoch 13/20
488/488 [==============================] - 52s 106ms/step - loss:
0.1005 - accuracy: 0.9599 - auc: 0.9773 - val_loss: 0.2678 - val_a
ccuracy: 0.8848 - val_auc: 0.9097 - lr: 7.0000e-06
Epoch 14/20
488/488 [==============================] - ETA: 0s - loss: 0.1004
- accuracy: 0.9593 - auc: 0.9770
```

```
Epoch 00014: ReduceLROnPlateau reducing learning rate to 4.8999997
48886329e-06.
488/488 [==============================] - 52s 106ms/step - loss:
0.1004 - accuracy: 0.9593 - auc: 0.9770 - val_loss: 0.2587 - val_a
ccuracy: 0.8905 - val_auc: 0.9127 - lr: 7.0000e-06
Epoch 15/20
488/488 [==============================] - ETA: 0s - loss: 0.0988
- accuracy: 0.9604 - auc: 0.9791Restoring model weights from the e
nd of the best epoch.
488/488 [==============================] - 60s 123ms/step - loss:
0.0988 - accuracy: 0.9604 - auc: 0.9791 - val_loss: 0.2769 - val_a
ccuracy: 0.8871 - val_auc: 0.9105 - lr: 4.9000e-06
Epoch 00015: early stopping
```

Out[61]:

```
70351
```

In [62]:

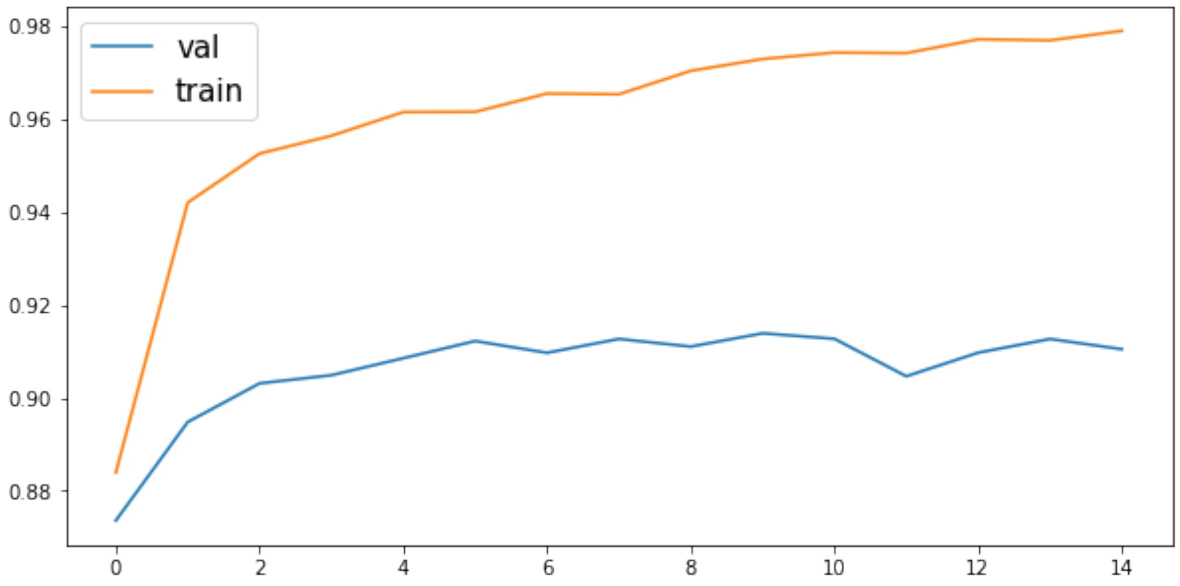
```
train_history_df = pd.DataFrame.from_dict(train_history.history)
train_history_df
```

Out[62]:

	loss	accuracy	auc	val_loss	val_accuracy	val_auc	lr
0	0.211017	0.920626	0.883905	0.299954	0.874000	0.873566	0.000010
1	0.157979	0.937708	0.942069	0.271348	0.882500	0.894792	0.000010
2	0.143050	0.943792	0.952631	0.262888	0.883875	0.903119	0.000010
3	0.136372	0.946337	0.956478	0.286966	0.882375	0.904885	0.000010
4	0.127919	0.950067	0.961578	0.276948	0.884000	0.908549	0.000010
5	0.128382	0.948738	0.961627	0.252323	0.891375	0.912249	0.000010
6	0.124358	0.951060	0.965568	0.291195	0.887375	0.909711	0.000010
7	0.123346	0.951684	0.965416	0.276413	0.885750	0.912699	0.000010
8	0.115343	0.953829	0.970461	0.280346	0.888125	0.911052	0.000010
9	0.109814	0.956071	0.973015	0.258257	0.890500	0.913913	0.000010
10	0.107083	0.957015	0.974397	0.262288	0.888750	0.912726	0.000010
11	0.106438	0.956967	0.974277	0.294655	0.886625	0.904651	0.000010
12	0.100530	0.959929	0.977261	0.267821	0.884750	0.909742	0.000007
13	0.100376	0.959337	0.977025	0.258683	0.890500	0.912691	0.000007
14	0.098768	0.960361	0.979078	0.276857	0.887125	0.910487	0.000005

In [63]:
```
import matplotlib.pyplot as plt
plt.figure(figsize=(10, 5))
plt.plot(train_history_df['val_auc'], label='val')
plt.plot(train_history_df['auc'], label='train')
plt.legend(fontsize=15)
```

Out[63]:
```
<matplotlib.legend.Legend at 0x7fc701072850>
```



Evaluating the model fit

In [64]:
```
score = model.evaluate(x_valid,y_valid, verbose=1)

print("Test Score:", score[0])
print("Test Accuracy:", score[1])
```

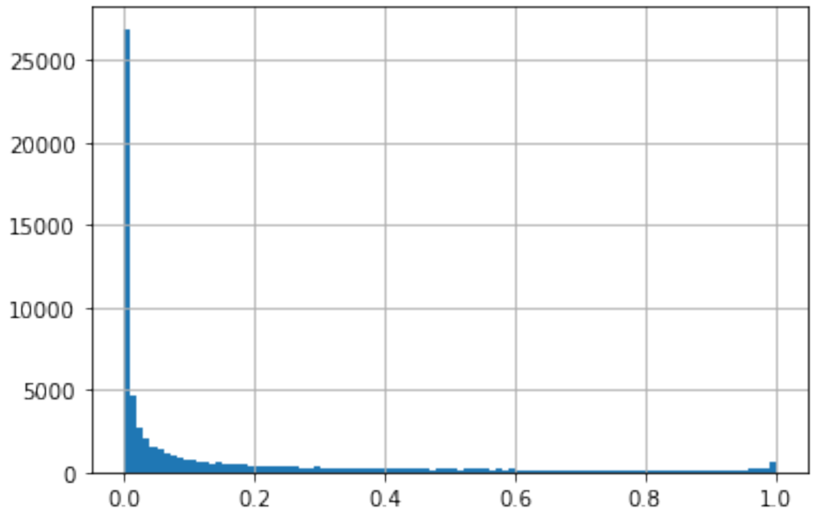
```
250/250 [==============================] - 4s 18ms/step - loss: 0.
2583 - accuracy: 0.8910 - auc: 0.9139
Test Score: 0.25825056433677673
Test Accuracy: 0.9138783812522888
```

Test data toxic prediction

In [65]:
```
test = pd.read_csv('/kaggle/input/jigsaw-multilingual-toxic-comment
-classification/test.csv')
test['content'] = test.apply(lambda x: clean_text(x['content']), ax
is=1)
test['content'] = test['content'].apply(lambda x: text_process(x))
x_test = fast_encode(test.content.astype(str), fast_tokenizer, maxl
en=MAX_LEN)
test_dataset = (
    tf.data.Dataset
    .from_tensor_slices(x_test)
    .batch(BATCH_SIZE)
)

output_distil = pd.read_csv('/kaggle/input/jigsaw-multilingual-toxi
c-comment-classification/sample_submission.csv')
```

In [66]:
```
output_distil['toxic'] = model.predict(test_dataset, verbose=1)
output_distil['toxic'].hist(bins=100, log=False, alpha=1)
output_distil.to_csv('output_distilbert.csv', index=False)
```

```
499/499 [==============================] - 20s 39ms/step
```



In [67]:
```
output_distil
```

Out[67]:

	id	toxic
0	0	0.057943
1	1	0.000119
2	2	0.351046
3	3	0.008145
4	4	0.000582
...	...	...
63807	63807	0.075397
63808	63808	0.001275
63809	63809	0.296671
63810	63810	0.065612
63811	63811	0.001952

63812 rows × 2 columns

In [68]:
```
y_pred = model.predict(test_dataset, verbose=1)
```

```
499/499 [==============================] - 14s 29ms/step
```

In [69]:
```
y_pred
```

Out[69]:
```
array([[5.7942778e-02],
       [1.1917949e-04],
       [3.5104576e-01],
       ...,
       [2.9667085e-01],
       [6.5612227e-02],
       [1.9518137e-03]], dtype=float32)
```

In [70]:
```
import random
spl = random.sample(range(len(y_pred)), 10)
for text, sentiment in zip(test.content[spl], y_pred[spl]):
    print(sentiment, text)
```

```
[0.21027511] , onay almadan, kimseye sormadan kafana göre resimler
i çıkartıyorsun. Bilgi vermek amaçlı, tanıtmak amaçlı konmuş o fot
oğraflar, istediğin gibi hareket ediyorsun. Ben geri alıp tartışma
sayfasına git diyince senden değil den cevap alıyorum. Hayır yani,
muhattabım senken bu kişinin olaya böyle gelmesi çok saçma değil m
i? Neden karışıyorsun olaya Kudelski, avukat mısın sen? Bu ikinci
kez avukat demem sana, her şeye karışmak gibi bir vazifen yok, top
lumu kaosa sürüklüyorsun. Kibele kendisini ifade edip savunabilece
```

```
k bir kullanıcı. Kür Şad mesaj
[0.00164601] Приводите авторитетные источники, и участники их расс
мотрят. Только пожалуйста без очередного саенс-фрика , которого об
идела официальная наука . Про Лысенко опять же уже сто раз сказано
- человек примазался к власть имущим, поэтому особо активные крити
ки были посланы куда подальше.
[0.6750128] y no estoy utilizando como foro pero tambien debes de
tener en cuenta que es un estudio cientifico y que en otros paises
(porque asi lo he notado cuando viajo)piensan que colombia (y otro
s paises de sur america) son de puros negritos que andan casi en t
apa rabos!!!! imaginate que estupides tan tonta...porque por mas q
ue se luche siempre existita el racismo y no solo por parte de los
blancos hacia las demas etnias sino tambien de las demas etnias ha
cia los blancos por que asi lo he sentido en muchas partes!!!!
[0.00358897] left|px|Uyarı Lütfen Vikipedi maddelerine imza atmayı
nız, isim yazmayınız, telefon numarası, e-posta adresi vb. eklemey
iniz. . Vikipedi de imzalar sadece tartışma sayfalarında ve kullan
ıcı mesaj sayfalarında kullanılmaktadır. Bunun dışında bazı özel,
sadece tartışmaların yer aldığı sayfalarda veya bildiri sayfaların
da, örneğin Vikipedi:Köy Çeşmesi, imza atılabilir. Bahsi geçen say
falar haricindeki hiçbir Vikipedi sayfasına imza atmayınız. İyi de
ğişiklikler! Nooneas
[0.07360163] Tam anlamıyla saçma sapan şeyler yazımış; ermenilerin
katliam yapması, kürtlerin kaçanlara saldırmaları... Ekseriyeti er
meni ve kürtlerden oluşan bir şehirde zalimler bu halklar mağdurla
r ise bilinmiyor. Heryerde bulunabilecek, gerçeklikle hiçbir ilgis
i olmayan milliyetçi söylemler. Acilen düzeltilmesi gerekir, düzel
tilene kadar da bu metin buradan alınmalıdır.
[0.04355794] Sexo anal Caro editor iniciante, por favor não apague
informação, não insira informações que sabe serem erradas nem crie
artigos com textos sem sentido, o que pode ser considerado vandali
smo . Encontramos problemas no artigo Sexo anal , editado por você
. Se quiser experimentar o software da Wikipédia pode fazê-lo na p
ágina de testes , à sua vontade. Apesar disso, seja Fabianopires
[0.00048092] К сожалению, вряд ли. Большая часть источников, цитир
уемых в тех работах, которые сейчас включены в статью, попросту не
доступна онлайн. Так что этой статье, видимо, суждено остаться про
сто обычной статьёй уровня чуть выше среднего. Deinocheirus (обс)
[0.00025806] А-то, что до сих не представлены АИ, где говорится пр
о «факт ошибки». «Это могло быть заимствовано из других некачестве
нных источников, сам он не мог это придумать.» — Вы можете предста
вить на этот счёт? «Поэтому такие некачественные источники в этой
статье неуместны, это можно было бы еще пропустить в статье, где т
ема СИ не является основной, но не здесь.» — Есть какой-то АИ (нау
чная статья, монография), который оценил качество? Tempus / обс
[0.02464569] + ...io non lo so che faceva sircana (conversava, oss
ervava...) in ogni caso direi unA transessuale.
[0.40784207] Burada pek fenerbahçeli moderator yok ne yazıkki - ki
şi var onlarda girerse ancak düzeltiyor. Sizin gibi değerli insanl
arın burayı takip etmesi gerekiyor ve hatta buraya düzenleme yapac
ak gönülleri yönlendirmesi gerekiyor. Bunların gözü dönmüş diğer d
illerde bile aptal aptal şeyler yazıyorlar. Ne yazıkki Fenerbahçel
ilerin eksik olduğu tek ansiklopedi burası gslilerle bjkliler almı
```

```
ş başını burda gidiyor.
```