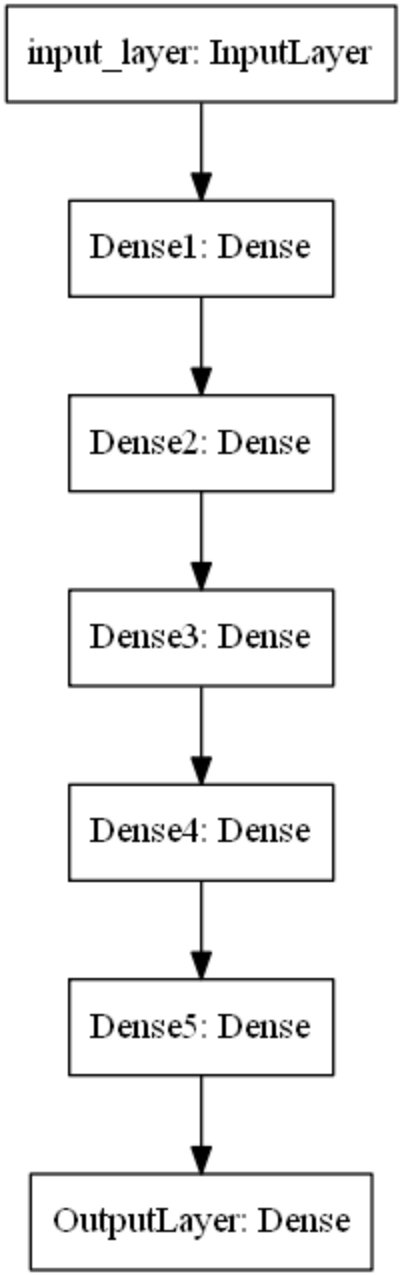
1. Download the data from here (https://drive.google.com/file/d/15dCNcmKskcFVjs7R0ElQkR61Ex53uJpM/view?usp=sharing)

2. Code the model to classify data like below image



3. Write your own callback function, that has to print the micro F1 score and AUC score after each epoch.

4. Save your model at every epoch if your validation accuracy is improved from previous epoch.

5. you have to decay learning based on below conditions
    Cond1. If your validation accuracy at that epoch is less than previous epoch accuracy, you have to decrese the learning rate by 10%.
    Cond2. For every 3rd epoch, decay your learning rate by 5%.

6. If you are getting any NaN values(either weigths or loss) while training, you have to terminate your training.

7. You have to stop the training if your validation accuracy is not increased in last 2 epochs.

8. Use tensorboard for every model and analyse your gradients. (you need to upload the screenshots for each model for evaluation)

9. use cross entropy as loss function

10. Try the architecture params as given below.

Model-1

1. Use tanh as an activation for every layer except output layer.
2. use SGD with momentum as optimizer.
3. use RandomUniform(0,1) as initilizer.
3. Analyze your output and training process.

Model-2

1. Use relu as an activation for every layer except output layer.
2. use SGD with momentum as optimizer.
3. use RandomUniform(0,1) as initilizer.
3. Analyze your output and training process.

Model-3

1. Use relu as an activation for every layer except output layer.
2. use SGD with momentum as optimizer.
3. use he_uniform() as initilizer.
3. Analyze your output and training process.

Model-4

1. Try with any values to get better accuracy/f1 score.

1. Loading dataset and Visualize

In [231]:
```
import numpy as np
import tensorflow as tf
import pandas as pd
```

In [232]:
```
data = pd.read_csv("data.csv")
```

In [233]:
```
data.head()
```

Out[233]:

	f1	f2	label
0	0.450564	1.074305	0.0
1	0.085632	0.967682	0.0
2	0.117326	0.971521	1.0
3	0.982179	-0.380408	0.0
4	-0.720352	0.955850	0.0

In [234]:
```
data.describe()
```

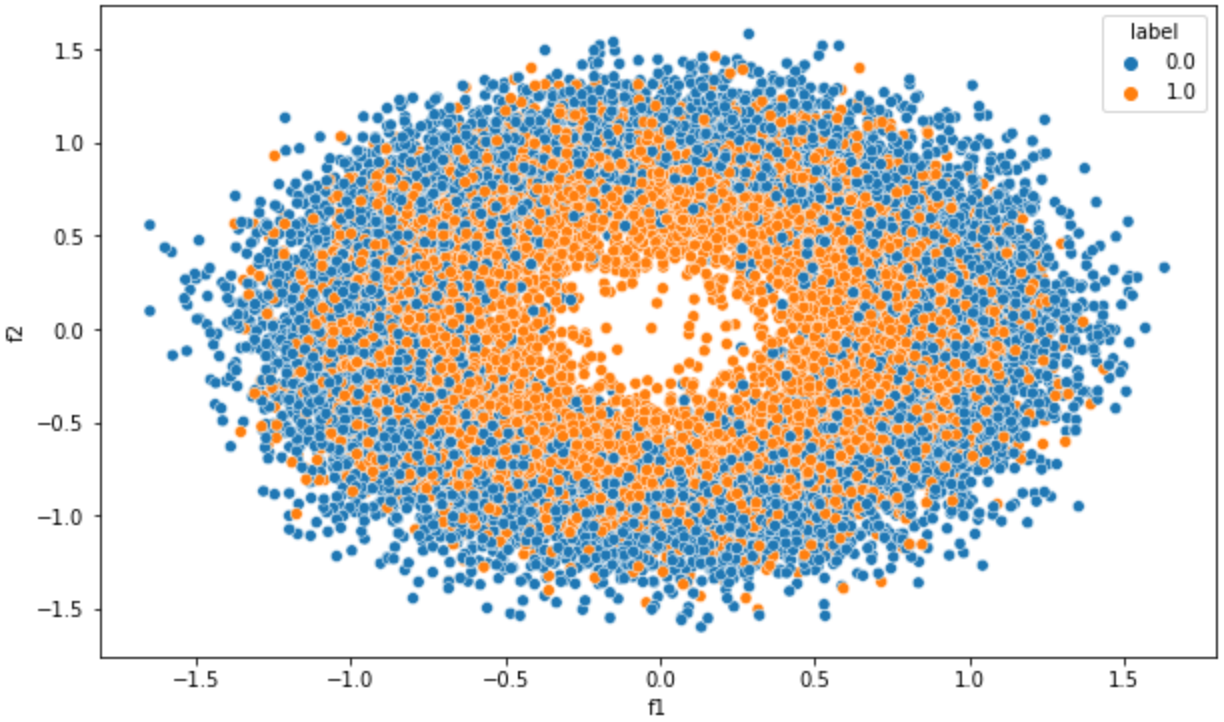
Out[234]:

	f1	f2	label
count	20000.000000	20000.000000	20000.000000
mean	0.000630	-0.000745	0.500000
std	0.671165	0.674704	0.500013
min	-1.649781	-1.600645	0.000000
25%	-0.589878	-0.596424	0.000000
50%	0.001795	-0.003113	0.500000
75%	0.586631	0.597803	1.000000
max	1.629722	1.584291	1.000000

In [235]:
```
import matplotlib.pyplot as plt
import seaborn as sns
```

In [236]:
```
plt.figure(figsize=(10,6))
sns.scatterplot(x='f1', y='f2', hue='label', data=data)
```

Out[236]: <matplotlib.axes._subplots.AxesSubplot at 0x7f827e4a78d0>



Observations

1. data is in circular shape
2. positive datapoints residing towards inside of the circle
3. Negative datapoints residing towards outside of the circle.
4. There is a lot of overlap between the dataset classes.
5. Linear Algorithms can't classify it better
6. Even traditional ML Algorithms will survive to classify it better.
7. DL Algorithms is the best option for this

reshaping the data

In [237]:
```
X, Y = data[['f1','f2']], data['label']
X.shape, Y.shape
```

Out[237]:
```
((20000, 2), (20000,))
```

In [238]:
```
from sklearn.model_selection import train_test_split
```

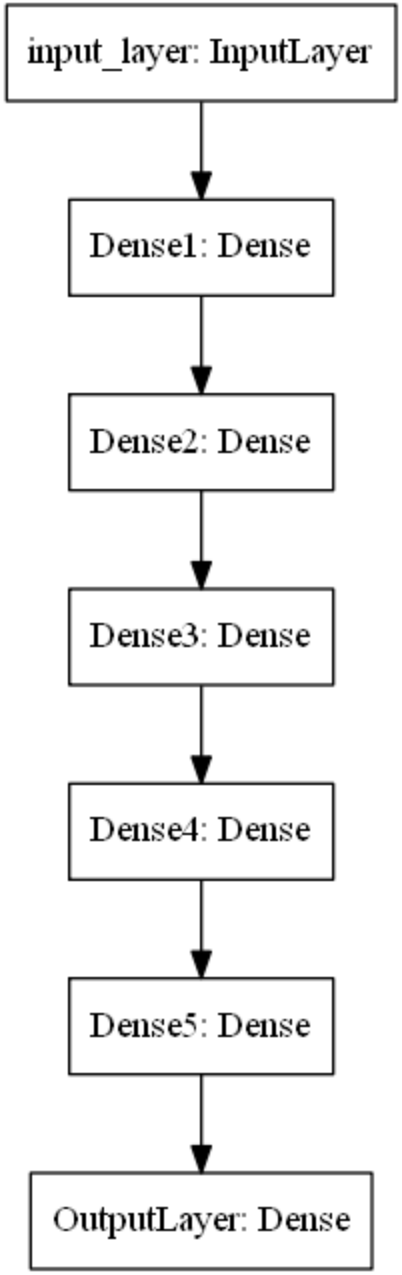
In [239]:
```
X_train, X_test, y_train, y_test = train_test_split(X,Y, test_size=0.2, random_state=42)
```

In [240]:
```
X_train.shape, y_train.shape, X_test.shape, y_test.shape
```

Out[240]:
```
((16000, 2), (16000,), (4000, 2), (4000,))
```

In [240]:
```

```

2. Code the model to classify data like below image



In [244]:
```
tf.keras.backend.clear_session()
def create_model():
    return tf.keras.models.Sequential([
        tf.keras.layers.InputLayer(input_shape=(2,)),
        tf.keras.layers.Dense(512, activation='relu'),
        tf.keras.layers.Dense(256, activation='relu'),
        tf.keras.layers.Dense(128, activation='relu'),
        tf.keras.layers.Dense(84, activation='relu'),
        tf.keras.layers.Dense(32, activation='relu'),
        tf.keras.layers.Dense(1, activation='sigmoid')
    ])
```

In [245]:
```
model = create_model()
```

In [246]:
```
model.summary()
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense (Dense)                (None, 512)               1536
_________________________________________________________________
dense_1 (Dense)              (None, 256)               131328
_________________________________________________________________
dense_2 (Dense)              (None, 128)               32896
_________________________________________________________________
dense_3 (Dense)              (None, 84)                10836
_________________________________________________________________
dense_4 (Dense)              (None, 32)                2720
_________________________________________________________________
dense_5 (Dense)              (None, 1)                 33
=================================================================
Total params: 179,349
Trainable params: 179,349
Non-trainable params: 0
_________________________________________________________________
```

In [246]:
```

```

3. Write you own Callback function

that has to print the micro F1 score and AUC score after each epoch.

In [246]:
```

```

In [247]:
```
from sklearn.metrics import f1_score, roc_auc_score
class GetScore(tf.keras.callbacks.Callback):
    def __init__(self, validation_data, batch_size=64):
        super().__init__()
        self.validation_data = validation_data
        self.batch_size = batch_size

    def on_train_begin(self, logs= {}):
        self.mf1s = []
        self.auc = []

    def on_epoch_end(self, epoch, logs= {}):
#         print("self : ",dir(self))
#         print("self.model : ",dir(self.model))
#         print(self.validation_data)
        y_pred  = (np.asarray(self.model.predict(self.validation_data[0]))).round()

        y_true  = (np.asarray(self.validation_data[1]).reshape((-1,1))).round()

        y_score = (np.asarray(self.model.predict_proba(self.validation_data[0])).reshape((-1,1))).round()
        # https://scikit-learn.org/stable/modules/generated/sklearn.metrics.f1_score.html
        val_mf1s = f1_score(y_true, y_pred, average='micro')
        val_auc  = roc_auc_score(y_true, y_score)

        self.mf1s.append(val_mf1s)
        self.auc.append(val_auc)

        print(' - micro f1 score = {} - auc = {}'.format(val_mf1s,val_auc))
        return
```

In [248]:
```
score = GetScore((X_test,y_test))
```

In [249]:
```
# print(score.mf1s, score.auc)
```

In [250]:
```
optimizer = tf.keras.optimizers.Adam(0.1)
model.compile(optimizer=optimizer,
              loss='binary_crossentropy',
              metrics=['accuracy']
              )
```

In [251]:
```
X_test.shape, y_test.shape
```

Out[251]:
```
((4000, 2), (4000,))
```

In [252]:
```
model.fit(X_train, y_train,
          validation_data=(X_test,y_test),
          epochs=10,
          batch_size=64,
          callbacks=[score]
          )
```

```
Epoch 1/10
250/250 [==============================] - 2s 7ms/step - loss: 6.6625 - accuracy: 0.5151 - val_loss: 0.6934 - val_accu
racy: 0.5008
 - micro f1 score = 0.50075 - auc = 0.5
Epoch 2/10
250/250 [==============================] - 2s 7ms/step - loss: 0.6940 - accuracy: 0.5041 - val_loss: 0.6937 - val_accu
racy: 0.5008
 - micro f1 score = 0.50075 - auc = 0.5
Epoch 3/10
250/250 [==============================] - 2s 7ms/step - loss: 0.6941 - accuracy: 0.5048 - val_loss: 0.6934 - val_accu
racy: 0.5008
 - micro f1 score = 0.50075 - auc = 0.5
Epoch 4/10
250/250 [==============================] - 2s 7ms/step - loss: 0.6944 - accuracy: 0.4994 - val_loss: 0.6934 - val_accu
racy: 0.4992
 - micro f1 score = 0.49925 - auc = 0.5
Epoch 5/10
250/250 [==============================] - 2s 7ms/step - loss: 0.6939 - accuracy: 0.4967 - val_loss: 0.6939 - val_accu
racy: 0.5008
 - micro f1 score = 0.50075 - auc = 0.5
Epoch 6/10
250/250 [==============================] - 2s 7ms/step - loss: 0.6945 - accuracy: 0.4992 - val_loss: 0.6950 - val_accu
racy: 0.5008
 - micro f1 score = 0.50075 - auc = 0.5
Epoch 7/10
250/250 [==============================] - 2s 7ms/step - loss: 0.6939 - accuracy: 0.4997 - val_loss: 0.6934 - val_accu
racy: 0.4992
 - micro f1 score = 0.49925 - auc = 0.5
Epoch 8/10
250/250 [==============================] - 2s 7ms/step - loss: 0.6944 - accuracy: 0.4970 - val_loss: 0.6935 - val_accu
racy: 0.4992
 - micro f1 score = 0.49925 - auc = 0.5
Epoch 9/10
250/250 [==============================] - 2s 6ms/step - loss: 0.6944 - accuracy: 0.4952 - val_loss: 0.6944 - val_accu
racy: 0.4992
 - micro f1 score = 0.49925 - auc = 0.5
Epoch 10/10
250/250 [==============================] - 2s 6ms/step - loss: 0.6942 - accuracy: 0.4971 - val_loss: 0.6935 - val_accu
racy: 0.5008
 - micro f1 score = 0.50075 - auc = 0.5
```

Out[252]: `<tensorflow.python.keras.callbacks.History at 0x7f826ffd6490>`

In [253]:
```
print("AUC scores:")
score.auc
```

```
AUC scores:
```

Out[253]:
```
[0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.5]
```

In [254]:
```
print('Micro f1 score for each epoch')
score.mf1s
```

```
Micro f1 score for each epoch
```

Out[254]:
```
[0.50075,
 0.50075,
 0.50075,
 0.49925,
 0.50075,
 0.50075,
 0.49925,
 0.49925,
 0.49925,
 0.50075]
```

In [254]:
```
```

4. Save your model at every epoch

If your validation accuracy is improved from previous epoch.

In [261]:
```
from tensorflow.keras.callbacks import ModelCheckpoint
```

In [262]:
```
filepathw = 'model_save/weights-{epoch:02d}-{val_accuracy:.4f}.hdf5'

checkpoint = ModelCheckpoint(
    filepath = filepathw,
    monitor ='val_accuracy',
    verbose = 1,
    save_best_only=True,
    mode = 'max' # max in case of accuracy # min=> loss # auto=> detect automatic
)
```

In [263]:
```
optimizer = tf.keras.optimizers.Adam(0.11)
model.compile(optimizer=optimizer,
              loss='binary_crossentropy',
              metrics=['accuracy']
              )
```

In [264]:
```
model.fit(X_train, y_train,
          validation_data=(X_test,y_test),
          epochs=15,
          batch_size=32,
          callbacks=[checkpoint]
          )
```

```
Epoch 1/15
500/500 [==============================] - 3s 6ms/step - loss: 0.6949 - accuracy: 0.5028 - val_loss: 0.6941 - val_accu
racy: 0.5008

Epoch 00001: val_accuracy improved from -inf to 0.50075, saving model to model_save/weights-01-0.5008.hdf5
Epoch 2/15
500/500 [==============================] - 3s 5ms/step - loss: 0.6943 - accuracy: 0.4981 - val_loss: 0.6937 - val_accu
racy: 0.4992

Epoch 00002: val_accuracy did not improve from 0.50075
Epoch 3/15
500/500 [==============================] - 3s 5ms/step - loss: 0.6955 - accuracy: 0.4974 - val_loss: 0.6942 - val_accu
racy: 0.5008

Epoch 00003: val_accuracy did not improve from 0.50075
Epoch 4/15
500/500 [==============================] - 3s 5ms/step - loss: 0.6942 - accuracy: 0.5098 - val_loss: 0.6931 - val_accu
racy: 0.5008

Epoch 00004: val_accuracy did not improve from 0.50075
Epoch 5/15
500/500 [==============================] - 3s 5ms/step - loss: 0.6947 - accuracy: 0.4982 - val_loss: 0.6940 - val_accu
racy: 0.5008

Epoch 00005: val_accuracy did not improve from 0.50075
Epoch 6/15
500/500 [==============================] - 3s 5ms/step - loss: 0.6954 - accuracy: 0.4979 - val_loss: 0.6996 - val_accu
racy: 0.5008

Epoch 00006: val_accuracy did not improve from 0.50075
Epoch 7/15
500/500 [==============================] - 3s 5ms/step - loss: 0.6957 - accuracy: 0.5056 - val_loss: 0.6953 - val_accu
racy: 0.5008

Epoch 00007: val_accuracy did not improve from 0.50075
Epoch 8/15
500/500 [==============================] - 3s 5ms/step - loss: 0.6965 - accuracy: 0.4956 - val_loss: 0.6961 - val_accu
racy: 0.5008

Epoch 00008: val_accuracy did not improve from 0.50075
Epoch 9/15
500/500 [==============================] - 3s 5ms/step - loss: 0.6960 - accuracy: 0.4916 - val_loss: 0.6931 - val_accu
racy: 0.5008

Epoch 00009: val_accuracy did not improve from 0.50075
Epoch 10/15
500/500 [==============================] - 3s 5ms/step - loss: 0.6958 - accuracy: 0.4912 - val_loss: 0.6932 - val_accu
```

```
racy: 0.4992

Epoch 00010: val_accuracy did not improve from 0.50075
Epoch 11/15
500/500 [==============================] - 3s 5ms/step - loss: 0.6946 - accuracy: 0.5103 - val_loss: 0.6957 - val_accu
racy: 0.5008

Epoch 00011: val_accuracy did not improve from 0.50075
Epoch 12/15
500/500 [==============================] - 3s 5ms/step - loss: 0.6945 - accuracy: 0.5067 - val_loss: 0.6962 - val_accu
racy: 0.4992

Epoch 00012: val_accuracy did not improve from 0.50075
Epoch 13/15
500/500 [==============================] - 3s 5ms/step - loss: 0.6961 - accuracy: 0.4940 - val_loss: 0.6949 - val_accu
racy: 0.5008

Epoch 00013: val_accuracy did not improve from 0.50075
Epoch 14/15
500/500 [==============================] - 3s 5ms/step - loss: 0.6944 - accuracy: 0.5080 - val_loss: 0.7029 - val_accu
racy: 0.5008

Epoch 00014: val_accuracy did not improve from 0.50075
Epoch 15/15
500/500 [==============================] - 3s 5ms/step - loss: 0.6974 - accuracy: 0.4903 - val_loss: 0.6936 - val_accu
racy: 0.4992

Epoch 00015: val_accuracy did not improve from 0.50075
```

Out[264]:
```
<tensorflow.python.keras.callbacks.History at 0x7f826fdcf550>
```

In [ ]:
```
```

5. Decay learning

you have to decay learning based on below conditions

cond1. If your validation accuracy at that epoch is less than previous epoch accuracy, you have to decrease the learning rat
e by 10%.
cond2. For every 3rd epoch, decay your learning rate by 5%.

In [265]:
```
from tensorflow.keras.callbacks import LearningRateScheduler
```

In [266]:
```
class decayLR(tf.keras.callbacks.Callback):
    """
    This is custom callback class to implement decay the Learning Rate.
    Author: Muhammad Iqbal Bajmi @AppliedAICourse.com
    """
    def on_train_begin(self, logs={}):
        self.valid_acc = {'accuracy':[]}
    def on_epoch_begin(self, epoch, logs={}):
        print(epoch)
        print("Learning rate is : {}".format(float(self.model.optimizer.learning_rate)))
        if epoch>1:
            if (epoch+1)%3==0:
                lr = self.model.optimizer.learning_rate
                self.model.optimizer.learning_rate = self.model.optimizer.learning_rate - (lr*0.05)
    def on_epoch_end(self, epoch, logs={}):
        self.valid_acc['accuracy'].append(logs.get('val_accuracy'))
        if epoch>0: # because epoch starts from 0
            if self.valid_acc['accuracy'][epoch] < self.valid_acc['accuracy'][epoch-1]:
                lr = self.model.optimizer.learning_rate
                self.model.optimizer.learning_rate = self.model.optimizer.learning_rate - (lr*0.1)
```

In [267]:
```
decaylr = decayLR()
```

In [268]:
```
optimizer = tf.keras.optimizers.Adam(0.1)
model.compile(optimizer=optimizer,
              loss='binary_crossentropy',
              metrics=['accuracy']
              )
```

In [269]:
```
model.fit(X_train, y_train,
          validation_data=(X_test,y_test),
          epochs=20,
          batch_size=64,
          callbacks=[decaylr]
          )
```

```
Epoch 1/20
0
Learning rate is : 0.10000000149011612
250/250 [==============================] - 2s 7ms/step - loss: 0.6940 - accuracy: 0.5157 - val_loss: 0.6939 - val_accu
racy: 0.4992
Epoch 2/20
1
Learning rate is : 0.10000000149011612
250/250 [==============================] - 2s 6ms/step - loss: 0.6945 - accuracy: 0.5081 - val_loss: 0.6933 - val_accu
racy: 0.4992
Epoch 3/20
2
Learning rate is : 0.10000000149011612
250/250 [==============================] - 2s 7ms/step - loss: 0.6942 - accuracy: 0.5039 - val_loss: 0.6934 - val_accu
racy: 0.5008
Epoch 4/20
3
Learning rate is : 0.0949999988079071
250/250 [==============================] - 2s 6ms/step - loss: 0.6944 - accuracy: 0.5080 - val_loss: 0.6931 - val_accu
racy: 0.5008
Epoch 5/20
4
Learning rate is : 0.0949999988079071
250/250 [==============================] - 2s 6ms/step - loss: 0.6947 - accuracy: 0.4991 - val_loss: 0.6932 - val_accu
racy: 0.5008
Epoch 6/20
5
Learning rate is : 0.0949999988079071
250/250 [==============================] - 2s 6ms/step - loss: 0.6939 - accuracy: 0.5017 - val_loss: 0.6980 - val_accu
racy: 0.5008
Epoch 7/20
6
Learning rate is : 0.09025000035762787
250/250 [==============================] - 2s 7ms/step - loss: 0.6949 - accuracy: 0.4985 - val_loss: 0.6932 - val_accu
racy: 0.4992
Epoch 8/20
7
Learning rate is : 0.08122500032186508
250/250 [==============================] - 2s 6ms/step - loss: 0.6941 - accuracy: 0.4960 - val_loss: 0.6942 - val_accu
racy: 0.5008
Epoch 9/20
8
Learning rate is : 0.08122500032186508
250/250 [==============================] - 2s 6ms/step - loss: 0.6941 - accuracy: 0.4924 - val_loss: 0.6932 - val_accu
racy: 0.4992
Epoch 10/20
9
```

```
Learning rate is : 0.06944737583398819
250/250 [==============================] - 2s 6ms/step - loss: 0.6941 - accuracy: 0.4949 - val_loss: 0.6939 - val_accu
racy: 0.4992
Epoch 11/20
10
Learning rate is : 0.06944737583398819
250/250 [==============================] - 2s 6ms/step - loss: 0.6942 - accuracy: 0.4885 - val_loss: 0.6932 - val_accu
racy: 0.4992
Epoch 12/20
11
Learning rate is : 0.06944737583398819
250/250 [==============================] - 2s 6ms/step - loss: 0.6940 - accuracy: 0.5051 - val_loss: 0.6932 - val_accu
racy: 0.5008
Epoch 13/20
12
Learning rate is : 0.06597501039505005
250/250 [==============================] - 2s 6ms/step - loss: 0.6938 - accuracy: 0.4930 - val_loss: 0.6935 - val_accu
racy: 0.4992
Epoch 14/20
13
Learning rate is : 0.059377510100603104
250/250 [==============================] - 2s 6ms/step - loss: 0.6938 - accuracy: 0.4935 - val_loss: 0.6952 - val_accu
racy: 0.5008
Epoch 15/20
14
Learning rate is : 0.059377510100603104
250/250 [==============================] - 2s 6ms/step - loss: 0.6941 - accuracy: 0.4949 - val_loss: 0.6932 - val_accu
racy: 0.5008
Epoch 16/20
15
Learning rate is : 0.05640863627195358
250/250 [==============================] - 2s 6ms/step - loss: 0.6942 - accuracy: 0.4998 - val_loss: 0.6952 - val_accu
racy: 0.4992
Epoch 17/20
16
Learning rate is : 0.050767771899700165
250/250 [==============================] - 2s 6ms/step - loss: 0.6941 - accuracy: 0.5025 - val_loss: 0.6933 - val_accu
racy: 0.4992
Epoch 18/20
17
Learning rate is : 0.050767771899700165
250/250 [==============================] - 2s 6ms/step - loss: 0.6937 - accuracy: 0.5042 - val_loss: 0.6940 - val_accu
racy: 0.5008
Epoch 19/20
18
Learning rate is : 0.04822938144207001
250/250 [==============================] - 2s 7ms/step - loss: 0.6943 - accuracy: 0.4984 - val_loss: 0.6935 - val_accu
racy: 0.4992
```

```
Epoch 20/20
19
Learning rate is : 0.04340644180774689
250/250 [==============================] - 2s 6ms/step - loss: 0.6936 - accuracy: 0.4942 - val_loss: 0.6933 - val_accu
racy: 0.4992
```

Out[269]:
```
<tensorflow.python.keras.callbacks.History at 0x7f826f52b610>
```

In [ ]:
```
```

6.Terminate training if getting NaN

6. If you are getting any NaN values(either weights or loss) while training, you have to terminate your training.

In [270]:
```
from tensorflow.keras.callbacks import TerminateOnNaN
```

In [271]:
```
terminate = TerminateOnNaN()
```

In [272]:
```
class TerminateNaN(tf.keras.callbacks.Callback):
    def __init__(self):
        self.we = 0
    def on_epoch_end(self, epoch, logs={}):
        import numpy as np
        loss = logs.get('loss')
        w = self.model.get_weights()
        w = np.array(w)
        self.we = w
        if loss is not None:
            if np.isnan(loss) or np.isinf(loss):
                print("Invalid loss and terminated at epoch {}".foramt(epoch))
                self.model.stop_training = True

        for i in range(6):
            layer   = self.model.layers[i]
            weights = layer.get_weights()[0]
            biases  = layer.get_weights()[1]

            if np.isnan(weights).any() or np.isinf(weights).any():
                print("Invalid weights and terminated at epoch ={}".format(epoch))
                self.model.stop_training = True
```

In [273]:
```
terminate = TerminateNaN()
```

In [274]:
```
optimizer = tf.keras.optimizers.Adam(0.1)
model.compile(optimizer=optimizer,
              loss='binary_crossentropy',
              metrics=['accuracy']
              )
```

In [275]:
```
model.fit(X_train, y_train,
          validation_data=(X_test,y_test),
          epochs=10,
          batch_size=64,
          callbacks=[terminate]
          )
```

```
Epoch 1/10
250/250 [==============================] - 2s 7ms/step - loss: 0.6945 - accuracy: 0.5010 - val_loss: 0.6945 - val_accu
racy: 0.4992
Epoch 2/10
250/250 [==============================] - 2s 6ms/step - loss: 0.6951 - accuracy: 0.4875 - val_loss: 0.6960 - val_accu
racy: 0.5008
Epoch 3/10
250/250 [==============================] - 2s 6ms/step - loss: 0.6960 - accuracy: 0.4984 - val_loss: 0.6967 - val_accu
racy: 0.4992
Epoch 4/10
250/250 [==============================] - 2s 6ms/step - loss: 0.6946 - accuracy: 0.4932 - val_loss: 0.6932 - val_accu
racy: 0.4992
Epoch 5/10
250/250 [==============================] - 2s 6ms/step - loss: 0.6945 - accuracy: 0.5006 - val_loss: 0.6947 - val_accu
racy: 0.5008
Epoch 6/10
250/250 [==============================] - 2s 6ms/step - loss: 0.6944 - accuracy: 0.5030 - val_loss: 0.6940 - val_accu
racy: 0.4992
Epoch 7/10
250/250 [==============================] - 2s 6ms/step - loss: 0.6947 - accuracy: 0.5020 - val_loss: 0.6935 - val_accu
racy: 0.5008
Epoch 8/10
250/250 [==============================] - 2s 6ms/step - loss: 0.6944 - accuracy: 0.4985 - val_loss: 0.6943 - val_accu
racy: 0.4992
Epoch 9/10
250/250 [==============================] - 2s 6ms/step - loss: 0.6942 - accuracy: 0.4972 - val_loss: 0.7005 - val_accu
racy: 0.5008
Epoch 10/10
250/250 [==============================] - 2s 7ms/step - loss: 0.6953 - accuracy: 0.4955 - val_loss: 0.6934 - val_accu
racy: 0.5008
```

Out[275]:
```
<tensorflow.python.keras.callbacks.History at 0x7f826ebc6a50>
```

In [ ]:
```
```

7. Stop training if validation_accuracy not improved

You have to stop the training if your validation accuracy is not increased in last 2 epochs.

In [276]:
```
from tensorflow.keras.callbacks import EarlyStopping
```

In [277]:
```
earlystop = EarlyStopping(
    monitor  = 'val_accuracy',
    mode     = 'max',
    patience = 2
)
```

In [278]:
```
optimizer = tf.keras.optimizers.Adam(0.1)
model.compile(optimizer=optimizer,
              loss='binary_crossentropy',
              metrics=['accuracy']
              )
```

In [279]:
```
model.fit(X_train, y_train,
          validation_data=(X_test,y_test),
          epochs=10,
          batch_size=64,
          callbacks=[earlystop]
          )
```

```
Epoch 1/10
250/250 [==============================] - 2s 7ms/step - loss: 0.6949 - accuracy: 0.4940 - val_loss: 0.6952 - val_accu
racy: 0.5008
Epoch 2/10
250/250 [==============================] - 2s 6ms/step - loss: 0.6941 - accuracy: 0.5007 - val_loss: 0.6932 - val_accu
racy: 0.4992
Epoch 3/10
250/250 [==============================] - 2s 6ms/step - loss: 0.6948 - accuracy: 0.5008 - val_loss: 0.6932 - val_accu
racy: 0.4992
```

Out[279]:
```
<tensorflow.python.keras.callbacks.History at 0x7f826e9c54d0>
```

In [ ]:

8. Use tensorboard

In [280]:
```
import datetime
import tensorflow as tf
```

In [281]:
```
log_dir="logs/fit/" + datetime.datetime.now().strftime("%Y%m%d-%H%M%S")
tensorboard_callback = tf.keras.callbacks.TensorBoard(log_dir=log_dir,histogram_freq=1, write_graph=True)
```

In [282]:
```
!rm -rf ./logs/
```

In [283]:
```
optimizer = tf.keras.optimizers.Adam(0.1)
model.compile(optimizer=optimizer,
              loss='binary_crossentropy',
              metrics=['accuracy']
              )
```

In [284]:
```
model.fit(X_train, y_train,
          validation_data=(X_test,y_test),
          epochs=10,
          batch_size=64,
          callbacks=[tensorboard_callback]
          )
```

```
Epoch 1/10
250/250 [==============================] - 3s 9ms/step - loss: 0.6943 - accuracy: 0.5023 - val_loss: 0.6937 - val_accu
racy: 0.5008
Epoch 2/10
250/250 [==============================] - 2s 7ms/step - loss: 0.6946 - accuracy: 0.5000 - val_loss: 0.6956 - val_accu
racy: 0.4992
Epoch 3/10
250/250 [==============================] - 2s 7ms/step - loss: 0.6955 - accuracy: 0.4922 - val_loss: 0.6933 - val_accu
racy: 0.5008
Epoch 4/10
250/250 [==============================] - 2s 7ms/step - loss: 0.6947 - accuracy: 0.4915 - val_loss: 0.6950 - val_accu
racy: 0.5008
Epoch 5/10
250/250 [==============================] - 2s 7ms/step - loss: 0.6951 - accuracy: 0.4926 - val_loss: 0.6980 - val_accu
racy: 0.4992
Epoch 6/10
250/250 [==============================] - 2s 7ms/step - loss: 0.6953 - accuracy: 0.5016 - val_loss: 0.6937 - val_accu
racy: 0.4992
Epoch 7/10
250/250 [==============================] - 2s 6ms/step - loss: 0.6955 - accuracy: 0.4931 - val_loss: 0.6933 - val_accu
racy: 0.5008
Epoch 8/10
250/250 [==============================] - 2s 6ms/step - loss: 0.6942 - accuracy: 0.5022 - val_loss: 0.6936 - val_accu
racy: 0.5008
Epoch 9/10
250/250 [==============================] - 2s 6ms/step - loss: 0.6943 - accuracy: 0.5064 - val_loss: 0.6952 - val_accu
racy: 0.4992
Epoch 10/10
250/250 [==============================] - 2s 6ms/step - loss: 0.6951 - accuracy: 0.4945 - val_loss: 0.6933 - val_accu
racy: 0.4992
```

Out[284]:
```
<tensorflow.python.keras.callbacks.History at 0x7f826e93d8d0>
```

In [285]:
```
%load_ext tensorboard
```

```
The tensorboard extension is already loaded. To reload it, use:
  %reload_ext tensorboard
```

In [286]:
```
!kill 1179
```

```
/bin/bash: line 0: kill: (1179) - No such process
```

In [287]:
```
%tensorboard --logdir logs/fit/
```

```
Reusing TensorBoard on port 6006 (pid 1135), started 5:24:17 ago. (Use '!kill 1135' to kill it.)
```

In [288]:
```
# delete previous models from the memory
tf.keras.backend.clear_session()
```

10. Try different architectures

Model-1

1. Use tanh as an activation for every layer except output layer.
2. use SGD with momentum as optimizer.
3. use RandomUniform(0,1) as initializer.
4. Analyze your output and training process.

In [289]:
```
# defining model 1
initializer = tf.keras.initializers.RandomUniform(0,1)
def create_model1():
    return tf.keras.models.Sequential([
        tf.keras.layers.Dense(512,
                              input_shape=(2,),
                              activation='tanh',
                              kernel_initializer=initializer
                             ),
        tf.keras.layers.Dense(256,
                              activation='tanh',
                              kernel_initializer=initializer
                             ),
        tf.keras.layers.Dense(128,
                              activation='tanh',
                              kernel_initializer=initializer
                             ),
        tf.keras.layers.Dense(84,
                              activation='tanh',
                              kernel_initializer=initializer
                             ),
        tf.keras.layers.Dense(32,
                              activation='tanh',
                              kernel_initializer=initializer
                             ),
        tf.keras.layers.Dense(1,
                              activation='sigmoid',
                              kernel_initializer=initializer
                             )
    ])
```

In [290]:
```
model1 = create_model1()
```

In [291]:
```
model1.summary()
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense (Dense)                (None, 512)               1536
_________________________________________________________________
dense_1 (Dense)              (None, 256)               131328
_________________________________________________________________
dense_2 (Dense)              (None, 128)               32896
_________________________________________________________________
dense_3 (Dense)              (None, 84)                10836
_________________________________________________________________
dense_4 (Dense)              (None, 32)                2720
_________________________________________________________________
dense_5 (Dense)              (None, 1)                 33
=================================================================
Total params: 179,349
Trainable params: 179,349
Non-trainable params: 0
_________________________________________________________________
```

In [291]:

In [292]:
```
# remove previous logs
! rm -rf logs
```

In [293]:
```
score = GetScore((X_test, y_test))# => Mf1s, auc score

filepathw = 'model_save/weights-{epoch:02d}-{val_accuracy:.4f}.hdf5'
checkpoint = ModelCheckpoint(
    filepath = filepathw,
    monitor ='val_accuracy',
    verbose = 1,
    save_best_only=True,
    mode = 'max' # max in case of accuracy # min=> loss # auto=> detect automatic
)
decay_lr = decayLR() # => decaying learning rate
terminate_nan = TerminateNaN()# => terminating on NaN
earlystop = EarlyStopping(
    monitor  = 'val_accuracy',
    mode     = 'max',
    patience = 2
)
# stop_training = StopTraining() # stop training on some conditions ,,,, Not gonna use custom stop training instead use
EarlyStopping
# save_model = SaveModel() # to save model=>  ,,,, Not gonna use custom save_model instead use Checkpoint

log_dir="logs/fit/" + datetime.datetime.now().strftime("%Y%m%d-%H%M%S")
tensorboard_callback = tf.keras.callbacks.TensorBoard(log_dir=log_dir,histogram_freq=1, write_graph=True)
```

In [294]:
```
callback_list = [score, checkpoint, decay_lr, terminate_nan, earlystop, tensorboard_callback]
```

In [295]:
```
# remove all previous saved models
!rm -rf model_save # comment this if you don't want to remove previous saved models
```

In [296]:
```
import warnings
```

In [297]:
```
warnings.filterwarnings('ignore')
```

In [298]:

```
optimizer = tf.keras.optimizers.SGD(learning_rate=0.1, momentum=0.9)
model1.compile(optimizer=optimizer,
               loss='binary_crossentropy',
               metrics=['accuracy']
               )
model1.fit(X_train, y_train,
           validation_data=(X_test,y_test),
           epochs=20,
           batch_size=64,
           callbacks=[callback_list]
           )
```

```
Epoch 1/20
0
Learning rate is : 0.10000000149011612
  3/250 [..............................] - ETA: 10s - loss: 9.1194 - accuracy: 0.4505 WARNING:tensorflow:Callback meth
od `on_train_batch_end` is slow compared to the batch time (batch time: 0.0050s vs `on_train_batch_end` time: 0.0123
s). Check your callbacks.
250/250 [==============================] - 2s 7ms/step - loss: 1.8425 - accuracy: 0.4981 - val_loss: 0.6952 - val_accu
racy: 0.5008
 - micro f1 score = 0.50075 - auc = 0.5

Epoch 00001: val_accuracy improved from -inf to 0.50075, saving model to model_save/weights-01-0.5008.hdf5
Epoch 2/20
1
Learning rate is : 0.10000000149011612
250/250 [==============================] - 1s 6ms/step - loss: 0.7153 - accuracy: 0.5102 - val_loss: 0.7026 - val_accu
racy: 0.5113
 - micro f1 score = 0.51125 - auc = 0.5112462753041195

Epoch 00002: val_accuracy improved from 0.50075 to 0.51125, saving model to model_save/weights-02-0.5113.hdf5
Epoch 3/20
2
Learning rate is : 0.10000000149011612
250/250 [==============================] - 1s 6ms/step - loss: 0.7435 - accuracy: 0.5039 - val_loss: 0.6939 - val_accu
racy: 0.5113
 - micro f1 score = 0.51125 - auc = 0.5112462753041195

Epoch 00003: val_accuracy did not improve from 0.51125
Epoch 4/20
3
Learning rate is : 0.0949999988079071
250/250 [==============================] - 1s 6ms/step - loss: 0.7456 - accuracy: 0.5055 - val_loss: 0.7673 - val_accu
racy: 0.4888
 - micro f1 score = 0.48875 - auc = 0.4887537246958806

Epoch 00004: val_accuracy did not improve from 0.51125
```

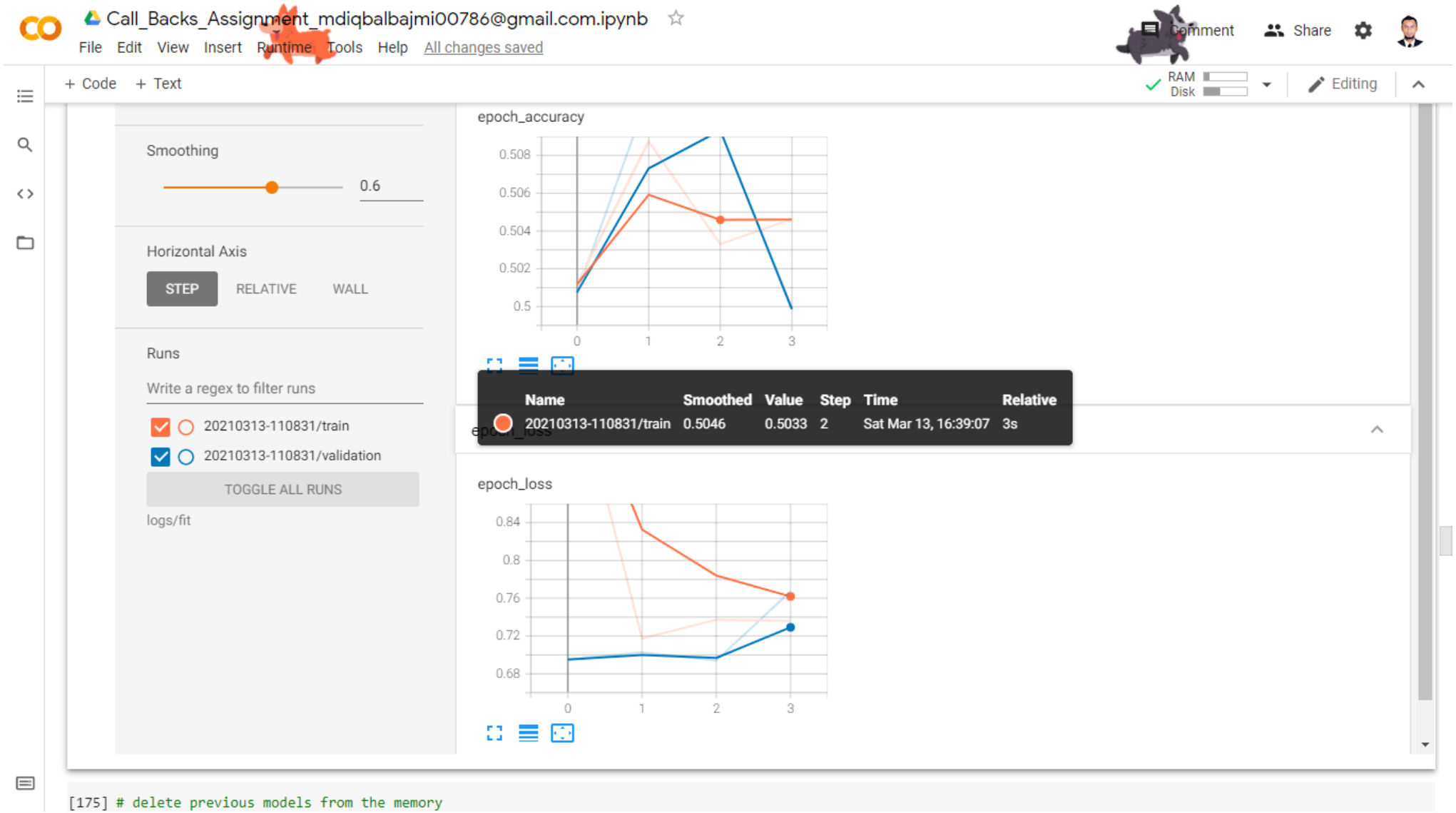
Out[298]: `<tensorflow.python.keras.callbacks.History at 0x7f827ea00610>`

Summary of model 1:

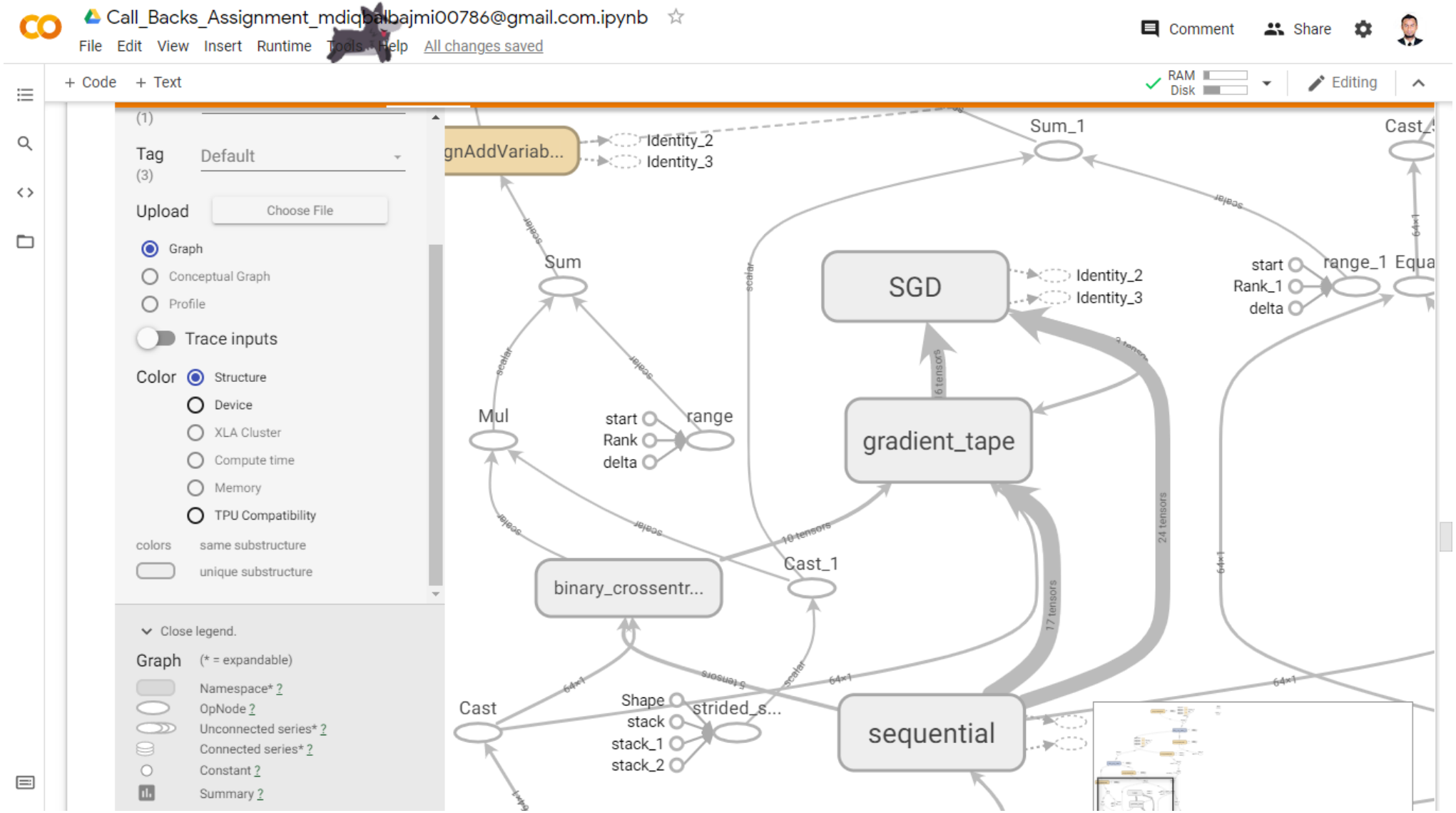
1. Model 1 ran upto 4 epochs
2. best Validation accuracy : 0.5113
3. best micro f1 score : 0.5112

Screenshots from Model 1

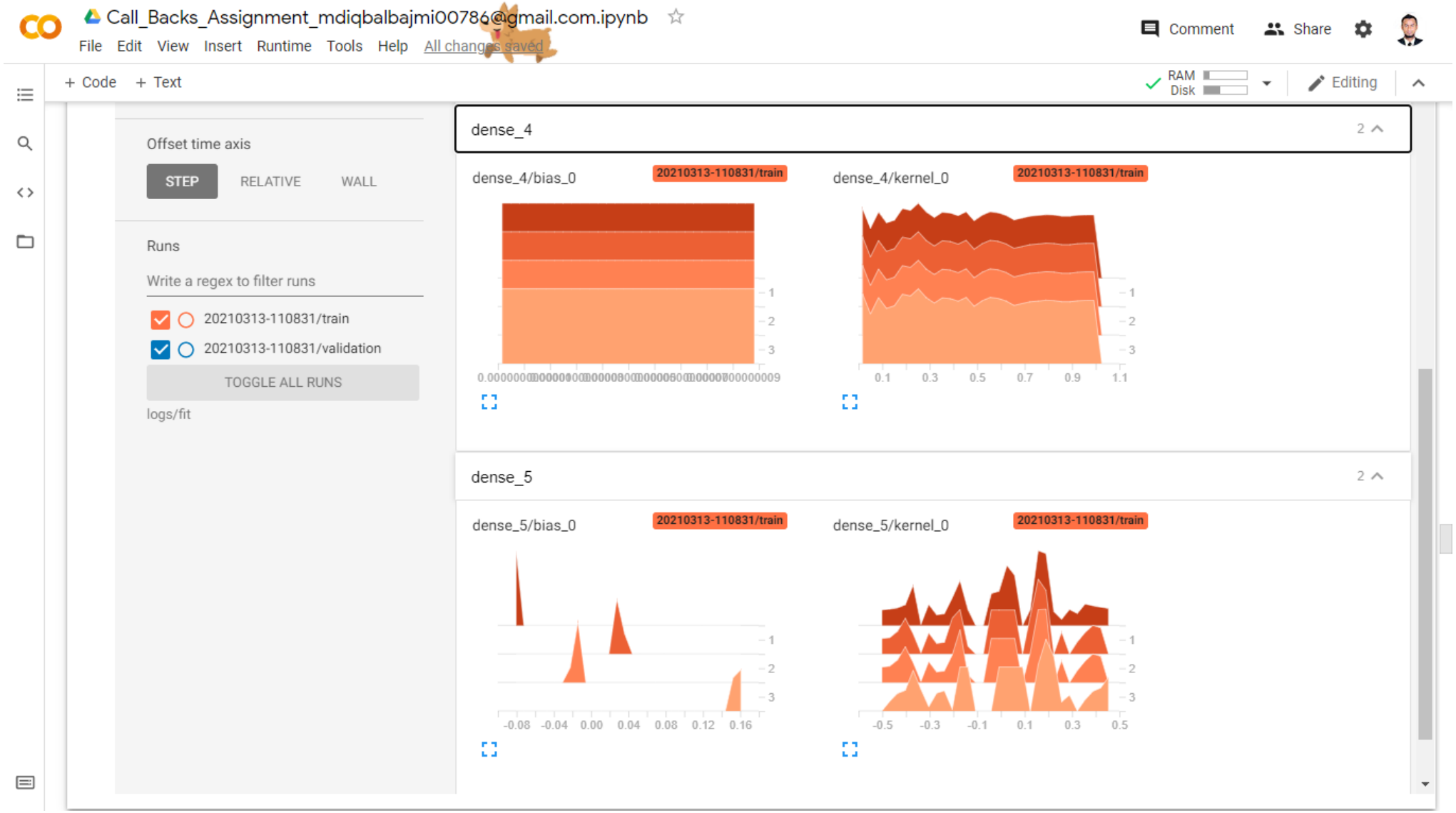
epoch accuracy and loss



model architecture shot



dense 4 and dense 5 layer's bias and kernel



In [299]:
```
%load_ext tensorboard
```

```
The tensorboard extension is already loaded. To reload it, use:
  %reload_ext tensorboard
```

In [300]:
```
%tensorboard --logdir logs/fit
```

```
Reusing TensorBoard on port 6007 (pid 1489), started 5:08:56 ago. (Use '!kill 1489' to kill it.)
```

In [301]:
```
# delete previous models from the memory
tf.keras.backend.clear_session()
```

Model 2:

1. Use relu as an activation for every layer except output layer.
2. Use SGD with momentum as optimizer.
3. Use RandomUniform(0,1) as initializer.
4. Analyze your output and training process.

In [302]:

```
# defining model 2
initializer = tf.keras.initializers.RandomUniform(0,1)
def create_model2():
    return tf.keras.models.Sequential([
        tf.keras.layers.Dense(512,
                              input_shape=(2,),
                              activation='relu',
                              kernel_initializer=initializer
                             ),
        tf.keras.layers.Dense(256,
                              activation='relu',
                              kernel_initializer=initializer
                             ),
        tf.keras.layers.Dense(128,
                              activation='relu',
                              kernel_initializer=initializer
                             ),
        tf.keras.layers.Dense(84,
                              activation='relu',
                              kernel_initializer=initializer
                             ),
        tf.keras.layers.Dense(32,
                              activation='relu',
                              kernel_initializer=initializer
                             ),
        tf.keras.layers.Dense(1,
                              activation='sigmoid',
                              kernel_initializer=initializer
                             )
    ])
```

In [303]:
```
model2 = create_model2() # creating model
model2.summary() # model summary
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense (Dense)                (None, 512)               1536
_________________________________________________________________
dense_1 (Dense)              (None, 256)               131328
_________________________________________________________________
dense_2 (Dense)              (None, 128)               32896
_________________________________________________________________
dense_3 (Dense)              (None, 84)                10836
_________________________________________________________________
dense_4 (Dense)              (None, 32)                2720
_________________________________________________________________
dense_5 (Dense)              (None, 1)                 33
=================================================================
Total params: 179,349
Trainable params: 179,349
Non-trainable params: 0
_________________________________________________________________
```

In [303]:

In [304]:

```
# remove previous logs
!rm -rf logs
# remove previous saved files
!rm -rf model_save

# initializing optimizer
optimizer = tf.keras.optimizers.SGD(learning_rate=0.1, momentum=0.9)
# compiling the model
model2.compile(optimizer=optimizer,
             loss='binary_crossentropy',
             metrics=['accuracy']
             )
# Fit the model
model2.fit(X_train, y_train,
         validation_data=(X_test,y_test),
         epochs=20,
         batch_size=64,
         callbacks=[callback_list]
         )
```

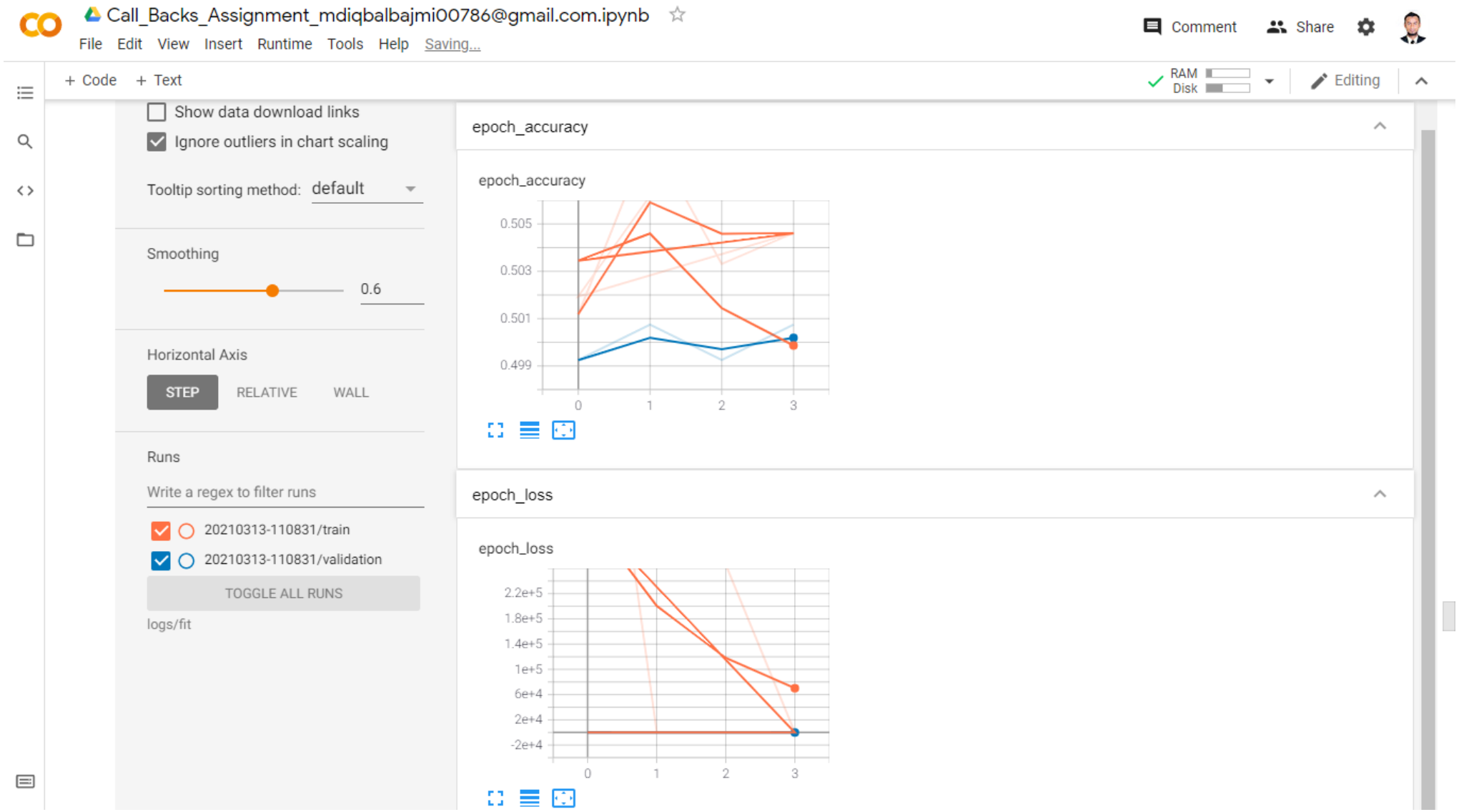
```
Epoch 1/20
0
Learning rate is : 0.10000000149011612
  3/250 [..............................] - ETA: 10s - loss: 121816249.3333 - accuracy: 0.5321 WARNING:tensorflow:Callb
ack method `on_train_batch_end` is slow compared to the batch time (batch time: 0.0056s vs `on_train_batch_end` time:
0.0125s). Check your callbacks.
250/250 [==============================] - 2s 7ms/step - loss: 4848125.8745 - accuracy: 0.5032 - val_loss: 0.6943 - va
l_accuracy: 0.4992
 - micro f1 score = 0.49925 - auc = 0.5

Epoch 00001: val_accuracy did not improve from 0.51125
Epoch 2/20
1
Learning rate is : 0.10000000149011612
250/250 [==============================] - 2s 6ms/step - loss: 0.6935 - accuracy: 0.5110 - val_loss: 0.6995 - val_accu
racy: 0.5008
 - micro f1 score = 0.50075 - auc = 0.5

Epoch 00002: val_accuracy did not improve from 0.51125
Epoch 3/20
2
Learning rate is : 0.10000000149011612
250/250 [==============================] - 2s 6ms/step - loss: 0.6938 - accuracy: 0.5075 - val_loss: 0.6935 - val_accu
racy: 0.4992
 - micro f1 score = 0.49925 - auc = 0.5

Epoch 00003: val_accuracy did not improve from 0.51125
Epoch 4/20
3
Learning rate is : 0.08550000190734863
250/250 [==============================] - 2s 6ms/step - loss: 0.6939 - accuracy: 0.5003 - val_loss: 0.6932 - val_accu
racy: 0.5008
 - micro f1 score = 0.50075 - auc = 0.5

Epoch 00004: val_accuracy did not improve from 0.51125
```

Out[304]: `<tensorflow.python.keras.callbacks.History at 0x7f82776a6c90>`

Summary of model 2:

1. Model 2 ran upto 4 epochs
2. Validation accuracy : 0.51125
3. micro f1 score : 0.50075

accuracy and loss



Kernel and bias distributions

Call_Backs_Assignment_mdiqbalbajmi00786@gmail.com.ipynb

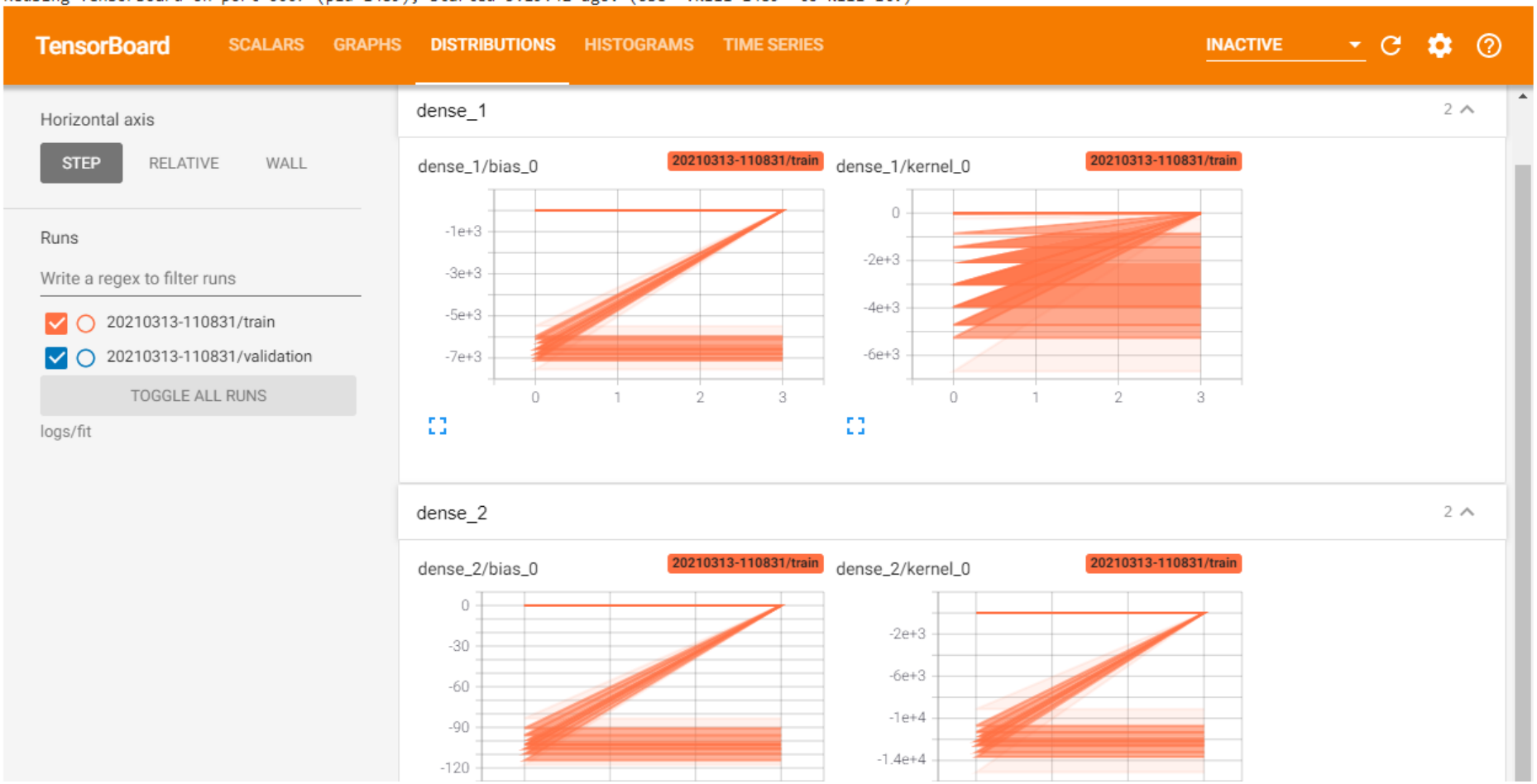
File Edit View Insert Runtime Tools Help All changes saved

Comment Share

+ Code + Text

RAM Disk Editing

```
Reusing TensorBoard on port 6007 (pid 1489), started 5:19:42 ago. (Use '!kill 1489' to kill it.)
```



Runs

Write a regex to filter runs

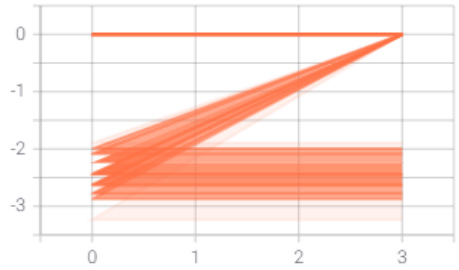
20210313-110831/train

20210313-110831/validation

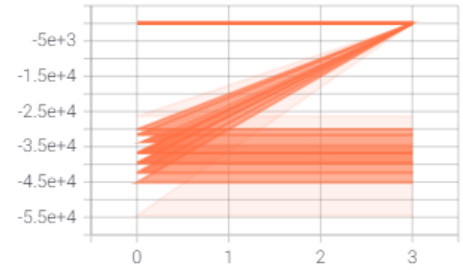
TOGGLE ALL RUNS

logs/fit

dense_3/bias_0 20210313-110831/train

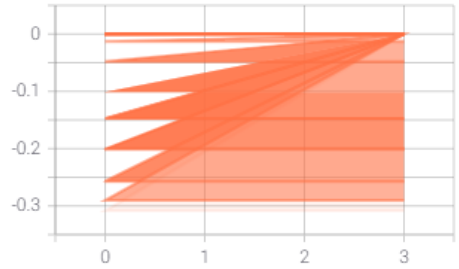


dense_3/kernel_0 20210313-110831/train

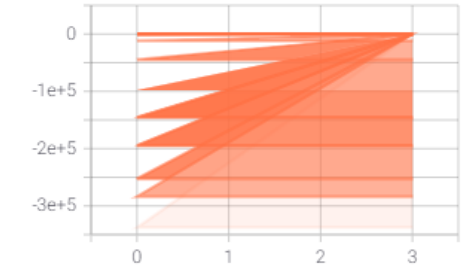


dense_4 2

dense_4/bias_0 20210313-110831/train



dense_4/kernel_0 20210313-110831/train



dense_5 2

In [ ]:

In [305]:
```
%tensorboard --logdir logs/fit
```

```
Reusing TensorBoard on port 6007 (pid 1489), started 5:19:42 ago. (Use '!kill 1489' to kill it.)
```

In [306]:
```
# clear all sessions
tf.keras.backend.clear_session()
```

Model-3

1. Use relu as an activation for every layer except ouput layer.
2. Use SGD with momentum as optimizer.
3. Use he_uniform() as initializer.
4. Analyze your output and training process.

In [307]:

```
# defining model 3
initializer = tf.keras.initializers.he_uniform()
activation = 'relu'
def create_model3():
    return tf.keras.models.Sequential([
        tf.keras.layers.Dense(512,
                              input_shape=(2,),
                              activation=activation,
                              kernel_initializer=initializer
                             ),
        tf.keras.layers.Dense(256,
                              activation=activation,
                              kernel_initializer=initializer
                             ),
        tf.keras.layers.Dense(128,
                              activation=activation,
                              kernel_initializer=initializer
                             ),
        tf.keras.layers.Dense(84,
                              activation=activation,
                              kernel_initializer=initializer
                             ),
        tf.keras.layers.Dense(32,
                              activation=activation,
                              kernel_initializer=initializer
                             ),
        tf.keras.layers.Dense(1,
                              activation='sigmoid',
                              kernel_initializer=initializer
                             )
    ])

# creating an object of model 3
model3 = create_model3()
model3.summary()
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense (Dense)                (None, 512)               1536
_________________________________________________________________
dense_1 (Dense)              (None, 256)               131328
_________________________________________________________________
dense_2 (Dense)              (None, 128)               32896
_________________________________________________________________
dense_3 (Dense)              (None, 84)                10836
_________________________________________________________________
dense_4 (Dense)              (None, 32)                2720
_________________________________________________________________
dense_5 (Dense)              (None, 1)                 33
=================================================================
Total params: 179,349
Trainable params: 179,349
Non-trainable params: 0
_________________________________________________________________
```

In [308]:

```
# remove previous logs
!rm -rf logs
# remove previous saved files
!rm -rf model_save

# initializing optimizer
optimizer = tf.keras.optimizers.SGD(learning_rate=0.1, momentum=0.9)
# compiling the model
model3.compile(optimizer=optimizer,
             loss='binary_crossentropy',
             metrics=['accuracy']
             )
# Fit the model
model3.fit(X_train, y_train,
         validation_data=(X_test,y_test),
         epochs=20,
         batch_size=64,
         callbacks=[callback_list]
         )
```

```
Epoch 1/20
0
Learning rate is : 0.10000000149011612
  3/250 [..............................] - ETA: 10s - loss: 0.8119 - accuracy: 0.4861 WARNING:tensorflow:Callback meth
od `on_train_batch_end` is slow compared to the batch time (batch time: 0.0060s vs `on_train_batch_end` time: 0.0128
s). Check your callbacks.
250/250 [==============================] - 2s 7ms/step - loss: 0.6923 - accuracy: 0.5687 - val_loss: 0.6534 - val_accu
racy: 0.6018
 - micro f1 score = 0.60175 - auc = 0.6013482280335131

Epoch 00001: val_accuracy improved from 0.51125 to 0.60175, saving model to model_save/weights-01-0.6018.hdf5
Epoch 2/20
1
Learning rate is : 0.10000000149011612
250/250 [==============================] - 1s 6ms/step - loss: 0.6434 - accuracy: 0.6344 - val_loss: 0.7136 - val_accu
racy: 0.4997
 - micro f1 score = 0.49975 - auc = 0.5004992511233151

Epoch 00002: val_accuracy did not improve from 0.60175
Epoch 3/20
2
Learning rate is : 0.09000000357627869
250/250 [==============================] - 2s 6ms/step - loss: 0.6358 - accuracy: 0.6316 - val_loss: 0.6393 - val_accu
racy: 0.6553
 - micro f1 score = 0.65525 - auc = 0.6553298494921613

Epoch 00003: val_accuracy improved from 0.60175 to 0.65525, saving model to model_save/weights-03-0.6553.hdf5
Epoch 4/20
3
Learning rate is : 0.08550000190734863
250/250 [==============================] - 1s 6ms/step - loss: 0.6205 - accuracy: 0.6572 - val_loss: 0.6256 - val_accu
racy: 0.6587
 - micro f1 score = 0.65875 - auc = 0.6586663569993032

Epoch 00004: val_accuracy improved from 0.65525 to 0.65875, saving model to model_save/weights-04-0.6587.hdf5
Epoch 5/20
4
Learning rate is : 0.08550000190734863
250/250 [==============================] - 2s 6ms/step - loss: 0.6168 - accuracy: 0.6586 - val_loss: 0.6288 - val_accu
racy: 0.6405
 - micro f1 score = 0.6405 - auc = 0.6402599405848665

Epoch 00005: val_accuracy did not improve from 0.65875
Epoch 6/20
5
Learning rate is : 0.07694999873638153
250/250 [==============================] - 2s 6ms/step - loss: 0.6151 - accuracy: 0.6635 - val_loss: 0.6263 - val_accu
```

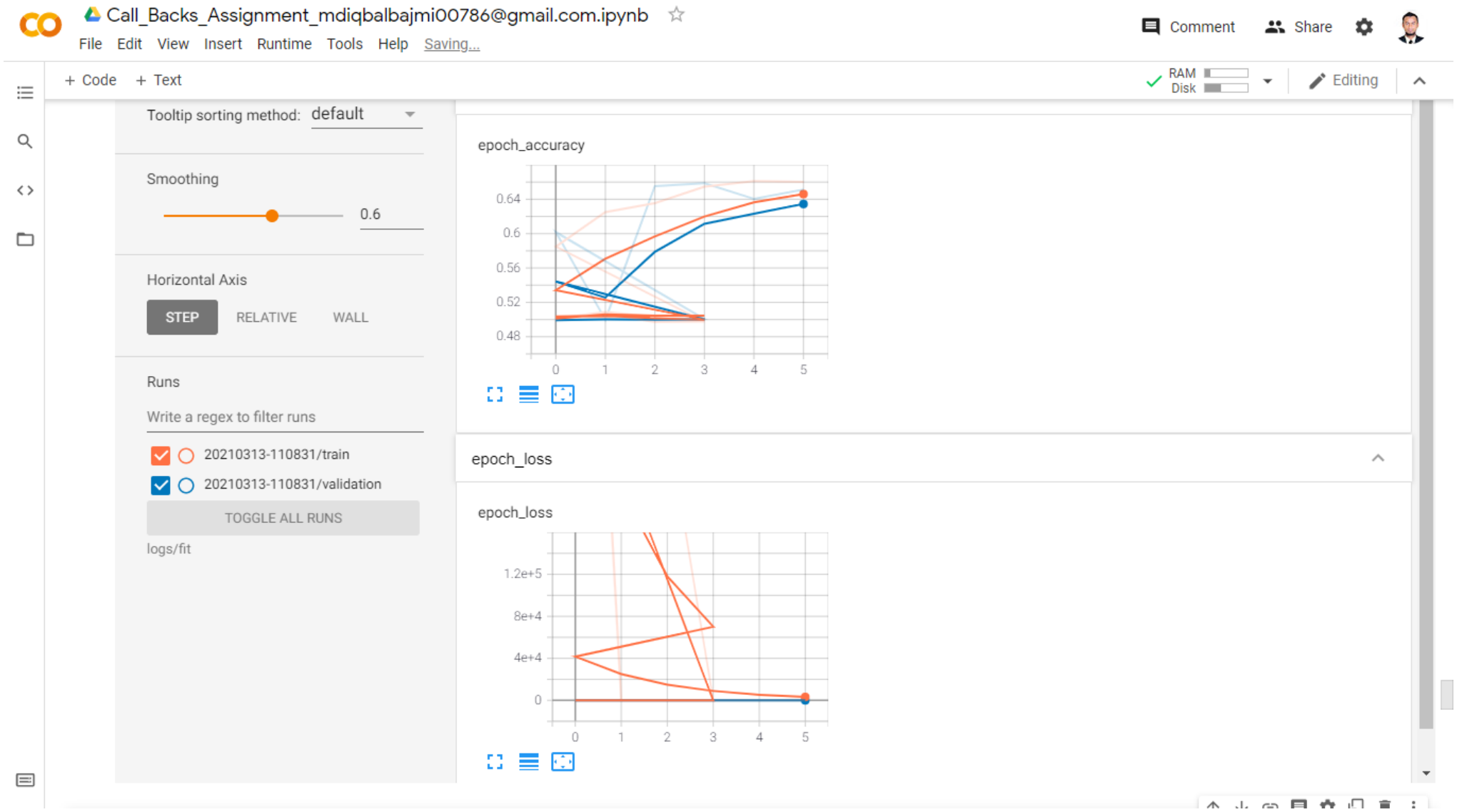
```
racy: 0.6513
 - micro f1 score = 0.65125 - auc = 0.6511498400871402

Epoch 00006: val_accuracy did not improve from 0.65875
```

Out[308]:
```
<tensorflow.python.keras.callbacks.History at 0x7f826e63c690>
```

Summary of model 3:

1. Model 3 ran upto 7 epochs
2. Validation accuracy : 0.6587
3. micro f1 score : 0.6515

accuracy and loss



Kernel and bias distributions

Horizontal axis

STEP RELATIVE WALL

Runs

Write a regex to filter runs

20210313-110831/train

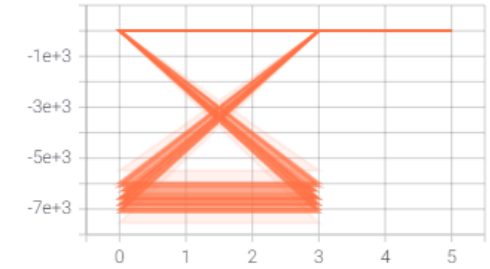
20210313-110831/validation

TOGGLE ALL RUNS

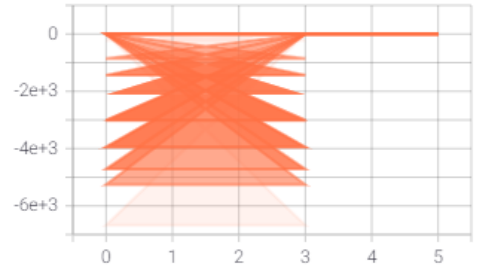
logs/fit

dense_1 2

dense_1/bias_0 20210313-110831/train

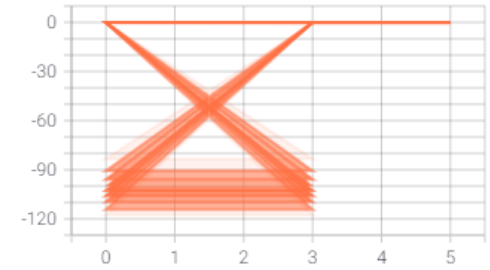


dense_1/kernel_0 20210313-110831/train

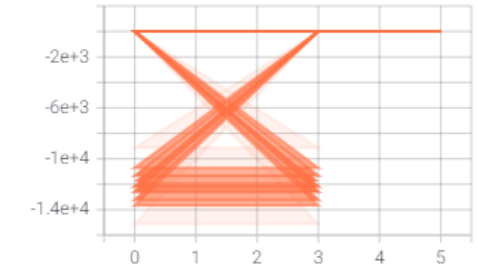


dense_2 2

dense_2/bias_0 20210313-110831/train



dense_2/kernel_0 20210313-110831/train



STEP RELATIVE WALL

Runs

Write a regex to filter runs

20210313-110831/train

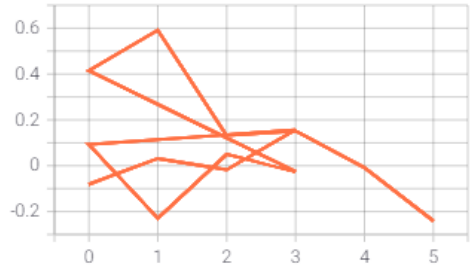
20210313-110831/validation

TOGGLE ALL RUNS

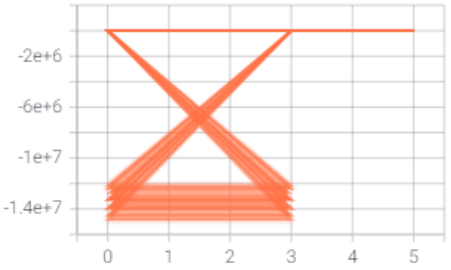
logs/fit

dense_5 2

dense_5/bias_0 20210313-110831/train

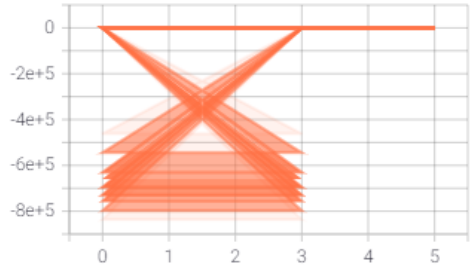


dense_5/kernel_0 20210313-110831/train

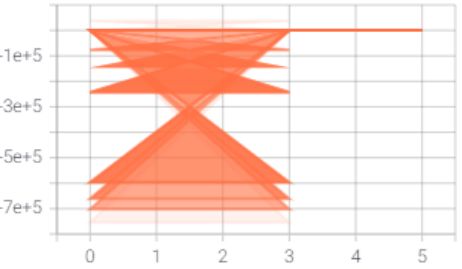


dense 2

dense/bias_0 20210313-110831/train



dense/kernel_0 20210313-110831/train



OVERLAY OFFSET

Offset time axis

STEP RELATIVE WALL

Runs

Write a regex to filter runs

20210313-110831/train

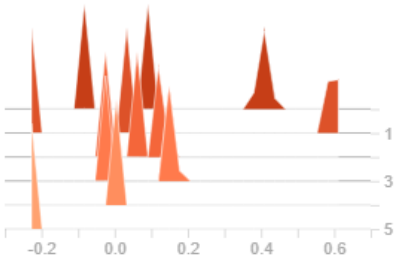
20210313-110831/validation

TOGGLE ALL RUNS

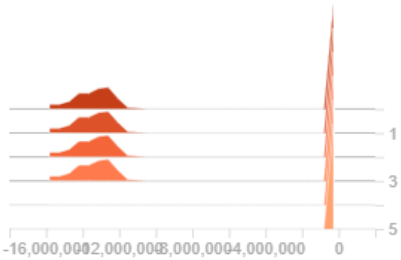
logs/fit

dense_5 2

dense_5/bias_0 20210313-110831/train

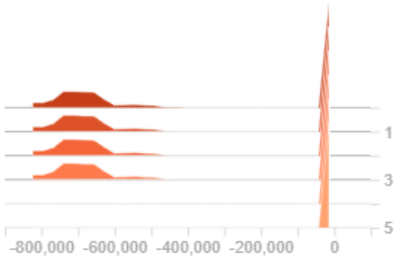


dense_5/kernel_0 20210313-110831/train

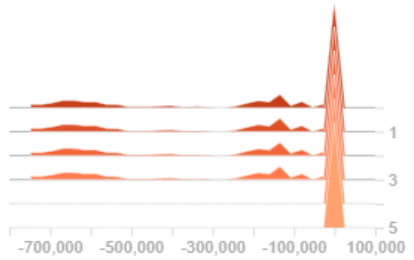


dense 2

dense/bias_0 20210313-110831/train



dense/kernel_0 20210313-110831/train



In [ ]:

In [309]:
```
%tensorboard --logdir logs/fit
```

```
Reusing TensorBoard on port 6007 (pid 1489), started 5:25:49 ago. (Use '!kill 1489' to kill it.)
```

In [ ]:

In [310]:
```
# clear all sessions
tf.keras.backend.clear_session()
```

Model-4

1. Try with any values to get better accuracy/f1 score.

In [311]:

```
# clear all sessions
tf.keras.backend.clear_session()

# defining model 4
initializer = tf.keras.initializers.he_normal()
activation = 'relu'
def create_model4():
    return tf.keras.models.Sequential([
        tf.keras.layers.Dense(512,
                              input_shape=(2,),
                              activation=activation,
                              kernel_initializer=initializer
                             ),
        tf.keras.layers.Dense(256,
                              activation=activation,
                              kernel_initializer=initializer
                             ),
        #tf.keras.layers.Dropout(.2),
        tf.keras.layers.Dense(128,
                              activation=activation,
                              kernel_initializer=initializer
                             ),
        tf.keras.layers.Dense(84,
                              activation=activation,
                              kernel_initializer=initializer
                             ),
        tf.keras.layers.Dense(32,
                              activation=activation,
                              kernel_initializer=initializer
                             ),
        tf.keras.layers.Dense(1,
                              activation='sigmoid',
                              kernel_initializer=initializer
                             )
    ])

# creating an object of model 3
model4 = create_model4()
model4.summary()
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
dense (Dense)                (None, 512)               1536
_________________________________________________________________
dense_1 (Dense)              (None, 256)               131328
_________________________________________________________________
dense_2 (Dense)              (None, 128)               32896
_________________________________________________________________
dense_3 (Dense)              (None, 84)                10836
_________________________________________________________________
dense_4 (Dense)              (None, 32)                2720
_________________________________________________________________
dense_5 (Dense)              (None, 1)                 33
=================================================================
Total params: 179,349
Trainable params: 179,349
Non-trainable params: 0
_________________________________________________________________
```

In [312]:

```
# remove previous logs
!rm -rf logs
# remove previous saved files
!rm -rf model_save

# initializing optimizer
optimizer = tf.keras.optimizers.Adam(0.1)
# compiling the model
model4.compile(optimizer=optimizer,
             loss='binary_crossentropy',
             metrics=['accuracy']
             )
# Fit the model
model4.fit(X_train, y_train,
         validation_data=(X_test,y_test),
         epochs=20,
         batch_size=64,
         callbacks=[callback_list]
         )
```

```
Epoch 1/20
0
Learning rate is : 0.10000000149011612
  3/250 [..............................] - ETA: 11s - loss: 289.7768 - accuracy: 0.4887WARNING:tensorflow:Callback met
hod `on_train_batch_end` is slow compared to the batch time (batch time: 0.0064s vs `on_train_batch_end` time: 0.0131
s). Check your callbacks.
250/250 [==============================] - 2s 8ms/step - loss: 22.2963 - accuracy: 0.5709 - val_loss: 0.6495 - val_acc
uracy: 0.6382
 - micro f1 score = 0.63825 - auc = 0.6380073105164487

Epoch 00001: val_accuracy did not improve from 0.65875
Epoch 2/20
1
Learning rate is : 0.10000000149011612
250/250 [==============================] - 2s 7ms/step - loss: 0.6122 - accuracy: 0.6633 - val_loss: 0.6382 - val_accu
racy: 0.6398
 - micro f1 score = 0.63975 - auc = 0.6395568140028316

Epoch 00002: val_accuracy did not improve from 0.65875
Epoch 3/20
2
Learning rate is : 0.10000000149011612
250/250 [==============================] - 2s 7ms/step - loss: 0.6163 - accuracy: 0.6582 - val_loss: 0.6255 - val_accu
racy: 0.6497
 - micro f1 score = 0.64975 - auc = 0.6497240868791955

Epoch 00003: val_accuracy did not improve from 0.65875
Epoch 4/20
3
Learning rate is : 0.0949999988079071
250/250 [==============================] - 2s 7ms/step - loss: 0.6050 - accuracy: 0.6705 - val_loss: 0.6250 - val_accu
racy: 0.6545
 - micro f1 score = 0.6545 - auc = 0.6544947226131259

Epoch 00004: val_accuracy did not improve from 0.65875
Epoch 5/20
4
Learning rate is : 0.0949999988079071
250/250 [==============================] - 2s 7ms/step - loss: 0.6122 - accuracy: 0.6629 - val_loss: 0.6530 - val_accu
racy: 0.6382
 - micro f1 score = 0.63825 - auc = 0.638168560879262

Epoch 00005: val_accuracy did not improve from 0.65875
Epoch 6/20
5
Learning rate is : 0.08550000190734863
250/250 [==============================] - 2s 7ms/step - loss: 0.6108 - accuracy: 0.6600 - val_loss: 0.6243 - val_accu
```

```
racy: 0.6543
 - micro f1 score = 0.65425 - auc = 0.6541708468844055

Epoch 00006: val_accuracy did not improve from 0.65875
```

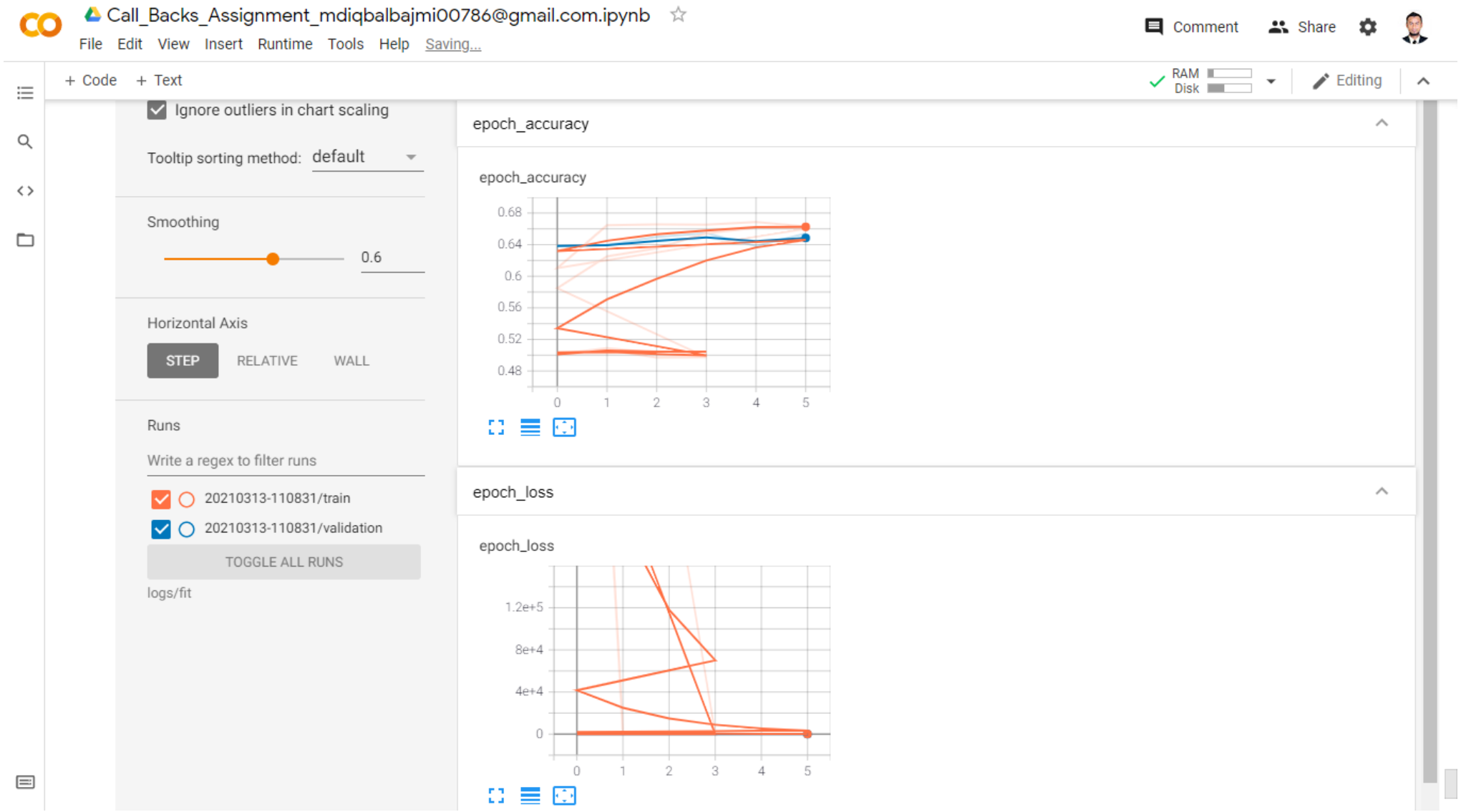
Out[312]:
```
<tensorflow.python.keras.callbacks.History at 0x7f8267af8bd0>
```

Summary of model 4:

1. Model 4 ran upto 6 epochs
2. Validation accuracy : 0.65875
3. micro f1 score : 0.65425

slightly better than all other model

accuracy and loss



Kernel and bias distributions

Horizontal axis

STEP RELATIVE WALL

Runs

Write a regex to filter runs

20210313-110831/train

20210313-110831/validation

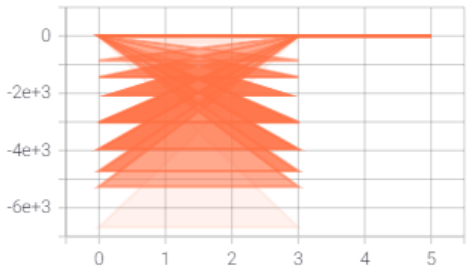
TOGGLE ALL RUNS

logs/fit

dense_1 2

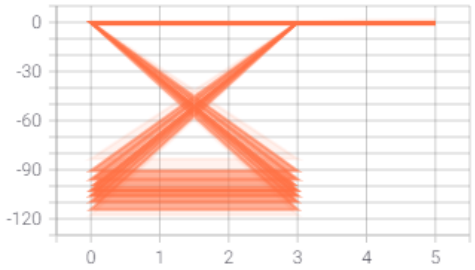
dense_1/bias_0 20210313-110831/train

dense_1/kernel_0 20210313-110831/train

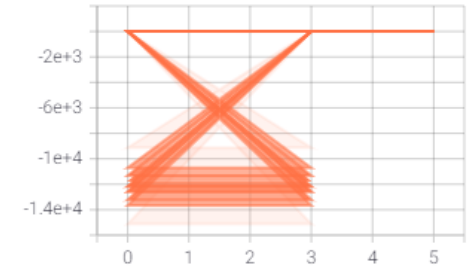


dense_2 2

dense_2/bias_0 20210313-110831/train



dense_2/kernel_0 20210313-110831/train



Runs

Write a regex to filter runs

20210313-110831/train

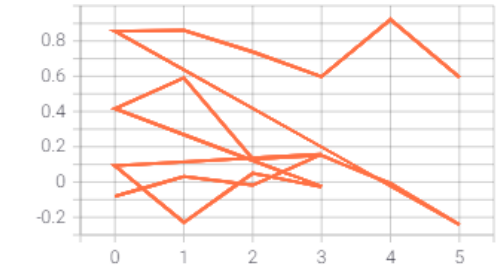
20210313-110831/validation

TOGGLE ALL RUNS

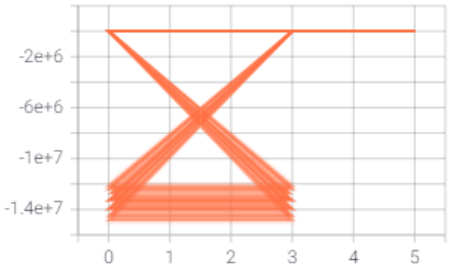
logs/fit

dense_5 2

dense_5/bias_0 20210313-110831/train

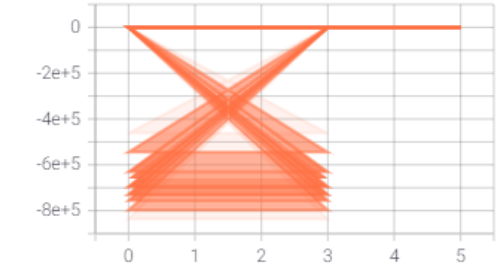


dense_5/kernel_0 20210313-110831/train

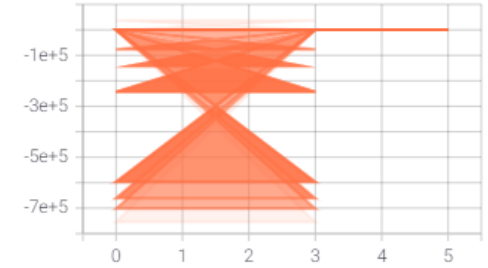


dense 2

dense/bias_0 20210313-110831/train



dense/kernel_0 20210313-110831/train



Call_Backs_Assignment_mdiqbalbajmi00786@gmail.com.ipynb

File Edit View Insert Runtime Tools Help Saving...

Comment Share

+ Code + Text

RAM Disk Editing

Offset time axis

STEP RELATIVE WALL

Runs

Write a regex to filter runs

20210313-110831/train

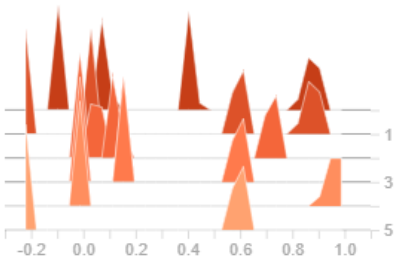
20210313-110831/validation

TOGGLE ALL RUNS

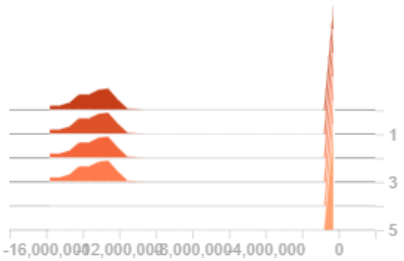
logs/fit

dense_5 2

dense_5/bias_0 20210313-110831/train

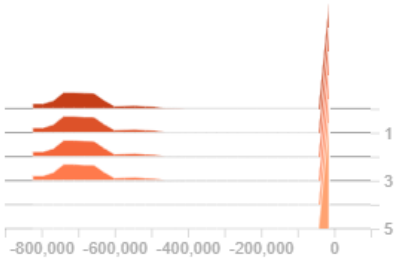


dense_5/kernel_0 20210313-110831/train

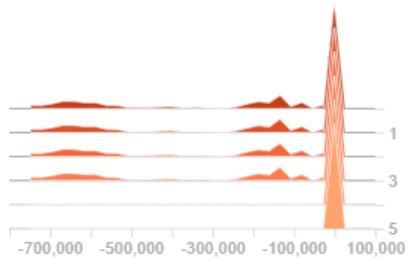


dense 2

dense/bias_0 20210313-110831/train



dense/kernel_0 20210313-110831/train



In [ ]:

In [ ]:

In [313]:
```
%tensorboard --logdir logs/fit
```

```
Reusing TensorBoard on port 6007 (pid 1489), started 5:33:54 ago. (Use '!kill 1489' to kill it.)
```

In [ ]: