2D-CNN

January 24, 2020

1 CNN 2D IoT Classification Model

[1]:
```
from __future__ import print_function
import h5py
import numpy as np
import matplotlib.pyplot as plt
from sklearn.utils import class_weight
from sklearn.metrics import classification_report
import keras
from keras.models import Sequential
from keras.layers import Dense, Dropout, Flatten, Input, Concatenate, Reshape
from keras.layers import Conv2D, MaxPooling2D, AveragePooling2D
from keras.utils import plot_model
from keras.models import Model
from keras.optimizers import adadelta as ada
from PIL import Image
import matplotlib.pyplot as plt
import pandas as pd
import copy
import pydot
from keras.utils import multi_gpu_model

from hyperopt import Trials, STATUS_OK, tpe
from hyperas import optim
from hyperas.distributions import choice, uniform

%matplotlib inline
```

```
Using TensorFlow backend.
c:\users\mrathbun2018\.conda\envs\mattwork\lib\site-
packages\tensorflow\python\framework\dtypes.py:516: FutureWarning: Passing
(type, 1) or '1type' as a synonym of type is deprecated; in a future version of
numpy, it will be understood as (type, (1,)) / '(1,)type'.
  _np_qint8 = np.dtype([("qint8", np.int8, 1)])
c:\users\mrathbun2018\.conda\envs\mattwork\lib\site-
packages\tensorflow\python\framework\dtypes.py:517: FutureWarning: Passing
(type, 1) or '1type' as a synonym of type is deprecated; in a future version of
numpy, it will be understood as (type, (1,)) / '(1,)type'.
```

```
  _np_quint8 = np.dtype([("quint8", np.uint8, 1)])
c:\users\mrathbun2018\.conda\envs\mattwork\lib\site-
packages\tensorflow\python\framework\dtypes.py:518: FutureWarning: Passing
(type, 1) or '1type' as a synonym of type is deprecated; in a future version of
numpy, it will be understood as (type, (1,)) / '(1,)type'.
  _np_qint16 = np.dtype([("qint16", np.int16, 1)])
c:\users\mrathbun2018\.conda\envs\mattwork\lib\site-
packages\tensorflow\python\framework\dtypes.py:519: FutureWarning: Passing
(type, 1) or '1type' as a synonym of type is deprecated; in a future version of
numpy, it will be understood as (type, (1,)) / '(1,)type'.
  _np_quint16 = np.dtype([("quint16", np.uint16, 1)])
c:\users\mrathbun2018\.conda\envs\mattwork\lib\site-
packages\tensorflow\python\framework\dtypes.py:520: FutureWarning: Passing
(type, 1) or '1type' as a synonym of type is deprecated; in a future version of
numpy, it will be understood as (type, (1,)) / '(1,)type'.
  _np_qint32 = np.dtype([("qint32", np.int32, 1)])
c:\users\mrathbun2018\.conda\envs\mattwork\lib\site-
packages\tensorflow\python\framework\dtypes.py:525: FutureWarning: Passing
(type, 1) or '1type' as a synonym of type is deprecated; in a future version of
numpy, it will be understood as (type, (1,)) / '(1,)type'.
  np_resource = np.dtype([("resource", np.ubyte, 1)])
c:\users\mrathbun2018\.conda\envs\mattwork\lib\site-
packages\tensorboard\compat\tensorflow_stub\dtypes.py:541: FutureWarning:
Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future
version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
  _np_qint8 = np.dtype([("qint8", np.int8, 1)])
c:\users\mrathbun2018\.conda\envs\mattwork\lib\site-
packages\tensorboard\compat\tensorflow_stub\dtypes.py:542: FutureWarning:
Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future
version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
  _np_quint8 = np.dtype([("quint8", np.uint8, 1)])
c:\users\mrathbun2018\.conda\envs\mattwork\lib\site-
packages\tensorboard\compat\tensorflow_stub\dtypes.py:543: FutureWarning:
Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future
version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
  _np_qint16 = np.dtype([("qint16", np.int16, 1)])
c:\users\mrathbun2018\.conda\envs\mattwork\lib\site-
packages\tensorboard\compat\tensorflow_stub\dtypes.py:544: FutureWarning:
Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future
version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
  _np_quint16 = np.dtype([("quint16", np.uint16, 1)])
c:\users\mrathbun2018\.conda\envs\mattwork\lib\site-
packages\tensorboard\compat\tensorflow_stub\dtypes.py:545: FutureWarning:
Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future
version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
  _np_qint32 = np.dtype([("qint32", np.int32, 1)])
c:\users\mrathbun2018\.conda\envs\mattwork\lib\site-
packages\tensorboard\compat\tensorflow_stub\dtypes.py:550: FutureWarning:
```

```
Passing (type, 1) or '1type' as a synonym of type is deprecated; in a future
version of numpy, it will be understood as (type, (1,)) / '(1,)type'.
  np_resource = np.dtype([("resource", np.ubyte, 1)])
```

1.1 Open and Read Data

[4]:
```
def data():
    hdf5_path = 'Data/dataset.hdf5'
    subtract_mean = True
    hdf5_file = h5py.File(hdf5_path, "r")
    if subtract_mean:
        mm = hdf5_file["train_mean"][0, ...]
        mm = mm[np.newaxis, ...]
    data_num = hdf5_file["train_flow"].shape[0]



    num_classes = 2
    epochs = 30

    flow_rows, flow_cols = 298, 17



    x_train = hdf5_file["train_flow"][:,...]
    if subtract_mean:
        x_train -= mm

    y_train = hdf5_file["train_labels"][:, ...]

    hdf5_file.close()

    hdf5_path = 'Data/dataset-IoT.hdf5'
    hdf5_file = h5py.File(hdf5_path, "r")

    x_test = hdf5_file["IoT_flow"][:,...]
    if subtract_mean:
        x_test -= mm

    y_test = hdf5_file["labels"][:, ...]

    hdf5_file.close()
```

```
    class_weights = class_weight.compute_class_weight('balanced',
                                                      np.unique(y_train),
                                                      y_train)
    d_class_weights = dict(enumerate(class_weights))

    input_shape = (x_train.shape[1], x_train.shape[2], x_train.shape[3])


    y_train = keras.utils.to_categorical(y_train, num_classes)
    y_test = keras.utils.to_categorical(y_test, num_classes)
    return x_train, y_train, x_test, y_test
```

1.2 Build Model

[5]:
```
def create_model(x_train, y_train, x_test, y_test):
    batch_size = {{choice([256,512,1024])}}
    epochs = 30
    filters={{choice([32,64,128])}}
    kernel_size={{choice([(2,2),(3,3)])}}
    activations={{choice(['relu', 'sigmoid', 'tanh'])}}
    pool_size={{choice([(2,2),(3,3)])}}
    dropout = {{uniform(0.1, 0.3)}}
    lr = {{uniform(0.0009, 0.00225)}}
    adam = keras.optimizers.Adam(lr=lr)
    rmsprop = keras.optimizers.RMSprop(lr=lr)
    sgd = keras.optimizers.SGD(lr=lr)

    choiceval = {{choice(['adam', 'sgd', 'rmsprop'])}}
    if choiceval == 'adam':
        optim = adam
    elif choiceval == 'rmsprop':
        optim = rmsprop
    else:
        optim = sgd

    layers = {{choice([1,2,3,4])}}
    model = Sequential()

    model.add(Conv2D(filters, kernel_size=kernel_size,activation=activations,␣
↪input_shape=input_shape,padding = "same"))
    for i in range(layers-1):
        model.add(Conv2D(filters,kernel_size=kernel_size,␣
↪activation=activations, padding = "valid"))

    model.add(MaxPooling2D(pool_size=(pool_size)))
    model.add(Flatten())
    model.add(Dropout(dropout))
```

```
    model.add(Dense(64, activation='relu'))
    model.add(Dense(32, activation='relu'))
    model.add(Dropout(dropout))
    model.add(Dense(num_classes, activation='softmax'))
    model.summary()
    try:
        model = multi_gpu_model(model, gpus = 4)
    except:
        pass
    model.compile(loss='binary_crossentropy', optimizer=optim,␣
↪metrics=['accuracy'])
    model.fit(x_train,y_train, batch_size=batch_size, epochs=epochs, verbose=0,␣
↪validation_split=0.2, class_weight=class_weights, shuffle=True)
    score = model.evaluate(x_test, y_test, verbose=0)
    loss = score[0]
    return {'loss': loss, 'status': STATUS_OK, 'model': model}
```

1.3 Run Model

[6]:
```
x_train, y_train, x_test, y_test = data()
best_run, best_model = optim.minimize(model=create_model, data=data, algo=tpe.
↪suggest, max_evals=100, trials=Trials(), eval_space=True,␣
↪notebook_name='2D-CNN')

print("Evalutation of best performing model:")
print(best_model.evaluate(x_test, y_test))
print("Best performing model chosen hyper-parameters:")
print(best_run)
```

```
>>> Imports:
#coding=utf-8

from __future__ import print_function

try:
    import h5py
except:
    pass

try:
    import numpy as np
except:
    pass

try:
    import matplotlib.pyplot as plt
except:
```

```
    pass

try:
    from sklearn.utils import class_weight
except:
    pass

try:
    from sklearn.metrics import classification_report
except:
    pass

try:
    import keras
except:
    pass

try:
    from keras.models import Sequential
except:
    pass

try:
    from keras.layers import Dense, Dropout, Flatten, Input, Concatenate,
Reshape
except:
    pass

try:
    from keras.layers import Conv2D, MaxPooling2D, AveragePooling2D
except:
    pass

try:
    from keras.utils import plot_model
except:
    pass

try:
    from keras.models import Model
except:
    pass

try:
    from keras.optimizers import adadelta as ada
except:
    pass
```

```
try:
    from PIL import Image
except:
    pass

try:
    import matplotlib.pyplot as plt
except:
    pass

try:
    import pandas as pd
except:
    pass

try:
    import copy
except:
    pass

try:
    import pydot
except:
    pass

try:
    from keras.utils import multi_gpu_model
except:
    pass

try:
    from hyperopt import Trials, STATUS_OK, tpe
except:
    pass

try:
    from hyperas import optim
except:
    pass

try:
    from hyperas.distributions import choice, uniform
except:
    pass

try:
    from sklearn.metrics import confusion_matrix
except:
```

```
    pass

try:
    from sklearn.metrics import roc_curve
except:
    pass

try:
    from sklearn.metrics import auc
except:
    pass

>>> Hyperas search space:

def get_space():
    return {
        'batch_size': hp.choice('batch_size', [256,512,1024]),
        'filters': hp.choice('filters', [32,64,128]),
        'kernel_size': hp.choice('kernel_size', [(2,2),(3,3)]),
        'activations': hp.choice('activations', ['relu', 'sigmoid', 'tanh']),
        'kernel_size_1': hp.choice('kernel_size_1', [(2,2),(3,3)]),
        'dropout': hp.uniform('dropout', 0.1, 0.3),
        'lr': hp.uniform('lr', 0.0009, 0.00225),
        'choiceval': hp.choice('choiceval', ['adam', 'sgd', 'rmsprop']),
        'layers': hp.choice('layers', [1,2,3,4]),
    }

>>> Data
   1:
   2: hdf5_path = 'Data/dataset.hdf5'
   3: subtract_mean = True
   4: hdf5_file = h5py.File(hdf5_path, "r")
   5: if subtract_mean:
   6:     mm = hdf5_file["train_mean"][0, …]
   7:     mm = mm[np.newaxis, …]
   8: data_num = hdf5_file["train_flow"].shape[0]
   9:
  10:
  11:
  12: num_classes = 2
  13: epochs = 30
  14:
  15: flow_rows, flow_cols = 298, 17
  16:
  17:
  18:
  19: x_train = hdf5_file["train_flow"][:,…]
  20: if subtract_mean:
```

```
    x_train -= mm

y_train = hdf5_file["train_labels"][:, …]

hdf5_file.close()

hdf5_path = 'Data/dataset-IoT.hdf5'
hdf5_file = h5py.File(hdf5_path, "r")

x_test = hdf5_file["IoT_flow"][:,…]
if subtract_mean:
    x_test -= mm

y_test = hdf5_file["labels"][:, …]

hdf5_file.close()




class_weights = class_weight.compute_class_weight('balanced',
                                                  np.unique(y_train),
                                                  y_train)
d_class_weights = dict(enumerate(class_weights))

input_shape = (x_train.shape[1], x_train.shape[2], x_train.shape[3])


y_train = keras.utils.to_categorical(y_train, num_classes)
y_test = keras.utils.to_categorical(y_test, num_classes)


>>> Resulting replaced keras model:

def keras_fmin_fnct(space):

    batch_size = space['batch_size']
    epochs = 30
    filters=space['filters']
    kernel_size=space['kernel_size']
    activations=space['activations']
    pool_size=space['kernel_size_1']
    dropout = space['dropout']
    lr = space['lr']
    adam = keras.optimizers.Adam(lr=lr)
    rmsprop = keras.optimizers.RMSprop(lr=lr)
```

```
  13:     sgd = keras.optimizers.SGD(lr=lr)
  14:
  15:     choiceval = space['choiceval']
  16:     if choiceval == 'adam':
  17:         optim = adam
  18:     elif choiceval == 'rmsprop':
  19:         optim = rmsprop
  20:     else:
  21:         optim = sgd
  22:
  23:     layers = space['layers']
  24:     model = Sequential()
  25:
  26:     model.add(Conv2D(filters,
kernel_size=kernel_size,activation=activations, input_shape=input_shape,padding
= "same"))
  27:     for i in range(layers-1):
  28:         model.add(Conv2D(filters,kernel_size=kernel_size,
activation=activations, padding = "valid"))
  29:
  30:     model.add(MaxPooling2D(pool_size=(pool_size)))
  31:     model.add(Flatten())
  32:     model.add(Dropout(dropout))
  33:     model.add(Dense(64, activation='relu'))
  34:     model.add(Dense(32, activation='relu'))
  35:     model.add(Dropout(dropout))
  36:     model.add(Dense(num_classes, activation='softmax'))
  37:     model.summary()
  38:     try:
  39:         model = multi_gpu_model(model, gpus = 4)
  40:     except:
  41:         pass
  42:     model.compile(loss='binary_crossentropy', optimizer=optim,
metrics=['accuracy'])
  43:     model.fit(x_train,y_train, batch_size=batch_size, epochs=epochs,
verbose=0, validation_split=0.2, class_weight=class_weights, shuffle=True)
  44:     score = model.evaluate(x_test, y_test, verbose=0)
  45:     loss = score[0]
  46:     return {'loss': loss, 'status': STATUS_OK, 'model': model}
  47:
  0%|
| 0/100 [00:00<?, ?it/s, best loss: ?]WARNING:tensorflow:From
c:\users\mrathbun2018\.conda\envs\mattwork\lib\site-
packages\keras\backend\tensorflow_backend.py:4070: The name tf.nn.max_pool is
deprecated. Please use tf.nn.max_pool2d instead.

Model: "sequential_1"
_________________________________________________________________
```

```
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_1 (Conv2D)            (None, 298, 17, 64)       640
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 149, 8, 64)        0
_________________________________________________________________
flatten_1 (Flatten)          (None, 76288)             0
_________________________________________________________________
dropout_1 (Dropout)          (None, 76288)             0
_________________________________________________________________
dense_1 (Dense)              (None, 64)                4882496
_________________________________________________________________
dense_2 (Dense)              (None, 32)                2080
_________________________________________________________________
dropout_2 (Dropout)          (None, 32)                0
_________________________________________________________________
dense_3 (Dense)              (None, 2)                 66
=================================================================
Total params: 4,885,282
Trainable params: 4,885,282
Non-trainable params: 0
_________________________________________________________________
  0%|
| 0/100 [00:00<?, ?it/s, best loss: ?]WARNING:tensorflow:From
c:\users\mrathbun2018\.conda\envs\mattwork\lib\site-
packages\tensorflow\python\ops\math_grad.py:1250:
add_dispatch_support.<locals>.wrapper (from tensorflow.python.ops.array_ops) is
deprecated and will be removed in a future version.
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
WARNING:tensorflow:From c:\users\mrathbun2018\.conda\envs\mattwork\lib\site-
packages\keras\backend\tensorflow_backend.py:422: The name tf.global_variables
is deprecated. Please use tf.compat.v1.global_variables instead.

Model: "sequential_2"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_2 (Conv2D)            (None, 298, 17, 64)       320
_________________________________________________________________
conv2d_3 (Conv2D)            (None, 297, 16, 64)       16448
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 148, 8, 64)        0
_________________________________________________________________
flatten_2 (Flatten)          (None, 75776)             0
_________________________________________________________________
dropout_3 (Dropout)          (None, 75776)             0
_________________________________________________________________
```

```
dense_4 (Dense)              (None, 64)                4849728
_________________________________________________________________
dense_5 (Dense)              (None, 32)                2080
_________________________________________________________________
dropout_4 (Dropout)          (None, 32)                0
_________________________________________________________________
dense_6 (Dense)              (None, 2)                 66
=================================================================
Total params: 4,868,642
Trainable params: 4,868,642
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_3"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_4 (Conv2D)            (None, 298, 17, 64)       640
_________________________________________________________________
conv2d_5 (Conv2D)            (None, 296, 15, 64)       36928
_________________________________________________________________
conv2d_6 (Conv2D)            (None, 294, 13, 64)       36928
_________________________________________________________________
max_pooling2d_3 (MaxPooling2 (None, 147, 6, 64)        0
_________________________________________________________________
flatten_3 (Flatten)          (None, 56448)             0
_________________________________________________________________
dropout_5 (Dropout)          (None, 56448)             0
_________________________________________________________________
dense_7 (Dense)              (None, 64)                3612736
_________________________________________________________________
dense_8 (Dense)              (None, 32)                2080
_________________________________________________________________
dropout_6 (Dropout)          (None, 32)                0
_________________________________________________________________
dense_9 (Dense)              (None, 2)                 66
=================================================================
Total params: 3,689,378
Trainable params: 3,689,378
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_4"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_7 (Conv2D)            (None, 298, 17, 128)      1280
_________________________________________________________________
conv2d_8 (Conv2D)            (None, 296, 15, 128)      147584
_________________________________________________________________
```

```
max_pooling2d_4 (MaxPooling2 (None, 98, 5, 128)        0
_________________________________________________________________
flatten_4 (Flatten)          (None, 62720)             0
_________________________________________________________________
dropout_7 (Dropout)          (None, 62720)             0
_________________________________________________________________
dense_10 (Dense)             (None, 64)                4014144
_________________________________________________________________
dense_11 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_8 (Dropout)          (None, 32)                0
_________________________________________________________________
dense_12 (Dense)             (None, 2)                 66
=================================================================
Total params: 4,165,154
Trainable params: 4,165,154
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_5"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_9 (Conv2D)            (None, 298, 17, 128)      1280
_________________________________________________________________
conv2d_10 (Conv2D)           (None, 296, 15, 128)      147584
_________________________________________________________________
conv2d_11 (Conv2D)           (None, 294, 13, 128)      147584
_________________________________________________________________
conv2d_12 (Conv2D)           (None, 292, 11, 128)      147584
_________________________________________________________________
max_pooling2d_5 (MaxPooling2 (None, 146, 5, 128)       0
_________________________________________________________________
flatten_5 (Flatten)          (None, 93440)             0
_________________________________________________________________
dropout_9 (Dropout)          (None, 93440)             0
_________________________________________________________________
dense_13 (Dense)             (None, 64)                5980224
_________________________________________________________________
dense_14 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_10 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_15 (Dense)             (None, 2)                 66
=================================================================
Total params: 6,426,402
Trainable params: 6,426,402
Non-trainable params: 0
_________________________________________________________________
```

```
Model: "sequential_6"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_13 (Conv2D)           (None, 298, 17, 32)       160
_________________________________________________________________
conv2d_14 (Conv2D)           (None, 297, 16, 32)       4128
_________________________________________________________________
conv2d_15 (Conv2D)           (None, 296, 15, 32)       4128
_________________________________________________________________
max_pooling2d_6 (MaxPooling2 (None, 148, 7, 32)        0
_________________________________________________________________
flatten_6 (Flatten)          (None, 33152)             0
_________________________________________________________________
dropout_11 (Dropout)         (None, 33152)             0
_________________________________________________________________
dense_16 (Dense)             (None, 64)                2121792
_________________________________________________________________
dense_17 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_12 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_18 (Dense)             (None, 2)                 66
=================================================================
Total params: 2,132,354
Trainable params: 2,132,354
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_7"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_16 (Conv2D)           (None, 298, 17, 128)      640
_________________________________________________________________
max_pooling2d_7 (MaxPooling2 (None, 99, 5, 128)        0
_________________________________________________________________
flatten_7 (Flatten)          (None, 63360)             0
_________________________________________________________________
dropout_13 (Dropout)         (None, 63360)             0
_________________________________________________________________
dense_19 (Dense)             (None, 64)                4055104
_________________________________________________________________
dense_20 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_14 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_21 (Dense)             (None, 2)                 66
=================================================================
```

```
Total params: 4,057,890
Trainable params: 4,057,890
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_8"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_17 (Conv2D)           (None, 298, 17, 128)      640
_________________________________________________________________
conv2d_18 (Conv2D)           (None, 297, 16, 128)      65664
_________________________________________________________________
conv2d_19 (Conv2D)           (None, 296, 15, 128)      65664
_________________________________________________________________
conv2d_20 (Conv2D)           (None, 295, 14, 128)      65664
_________________________________________________________________
max_pooling2d_8 (MaxPooling2 (None, 98, 4, 128)        0
_________________________________________________________________
flatten_8 (Flatten)          (None, 50176)             0
_________________________________________________________________
dropout_15 (Dropout)         (None, 50176)             0
_________________________________________________________________
dense_22 (Dense)             (None, 64)                3211328
_________________________________________________________________
dense_23 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_16 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_24 (Dense)             (None, 2)                 66
=================================================================
Total params: 3,411,106
Trainable params: 3,411,106
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_9"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_21 (Conv2D)           (None, 298, 17, 128)      1280
_________________________________________________________________
conv2d_22 (Conv2D)           (None, 296, 15, 128)      147584
_________________________________________________________________
conv2d_23 (Conv2D)           (None, 294, 13, 128)      147584
_________________________________________________________________
conv2d_24 (Conv2D)           (None, 292, 11, 128)      147584
_________________________________________________________________
max_pooling2d_9 (MaxPooling2 (None, 97, 3, 128)        0
_________________________________________________________________
```

```
flatten_9 (Flatten)          (None, 37248)             0
_________________________________________________________________
dropout_17 (Dropout)         (None, 37248)             0
_________________________________________________________________
dense_25 (Dense)             (None, 64)                2383936
_________________________________________________________________
dense_26 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_18 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_27 (Dense)             (None, 2)                 66
=================================================================
Total params: 2,830,114
Trainable params: 2,830,114
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_10"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_25 (Conv2D)           (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_26 (Conv2D)           (None, 296, 15, 32)       9248
_________________________________________________________________
conv2d_27 (Conv2D)           (None, 294, 13, 32)       9248
_________________________________________________________________
conv2d_28 (Conv2D)           (None, 292, 11, 32)       9248
_________________________________________________________________
max_pooling2d_10 (MaxPooling (None, 97, 3, 32)         0
_________________________________________________________________
flatten_10 (Flatten)         (None, 9312)              0
_________________________________________________________________
dropout_19 (Dropout)         (None, 9312)              0
_________________________________________________________________
dense_28 (Dense)             (None, 64)                596032
_________________________________________________________________
dense_29 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_20 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_30 (Dense)             (None, 2)                 66
=================================================================
Total params: 626,242
Trainable params: 626,242
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_11"
_________________________________________________________________
```

```
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_29 (Conv2D)           (None, 298, 17, 128)      640
_________________________________________________________________
conv2d_30 (Conv2D)           (None, 297, 16, 128)      65664
_________________________________________________________________
conv2d_31 (Conv2D)           (None, 296, 15, 128)      65664
_________________________________________________________________
conv2d_32 (Conv2D)           (None, 295, 14, 128)      65664
_________________________________________________________________
max_pooling2d_11 (MaxPooling (None, 98, 4, 128)        0
_________________________________________________________________
flatten_11 (Flatten)         (None, 50176)             0
_________________________________________________________________
dropout_21 (Dropout)         (None, 50176)             0
_________________________________________________________________
dense_31 (Dense)             (None, 64)                3211328
_________________________________________________________________
dense_32 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_22 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_33 (Dense)             (None, 2)                 66
=================================================================
Total params: 3,411,106
Trainable params: 3,411,106
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_12"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_33 (Conv2D)           (None, 298, 17, 64)       640
_________________________________________________________________
max_pooling2d_12 (MaxPooling (None, 149, 8, 64)        0
_________________________________________________________________
flatten_12 (Flatten)         (None, 76288)             0
_________________________________________________________________
dropout_23 (Dropout)         (None, 76288)             0
_________________________________________________________________
dense_34 (Dense)             (None, 64)                4882496
_________________________________________________________________
dense_35 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_24 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_36 (Dense)             (None, 2)                 66
=================================================================
```

```
Total params: 4,885,282
Trainable params: 4,885,282
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_13"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_34 (Conv2D)           (None, 298, 17, 128)      1280
_________________________________________________________________
conv2d_35 (Conv2D)           (None, 296, 15, 128)      147584
_________________________________________________________________
conv2d_36 (Conv2D)           (None, 294, 13, 128)      147584
_________________________________________________________________
conv2d_37 (Conv2D)           (None, 292, 11, 128)      147584
_________________________________________________________________
max_pooling2d_13 (MaxPooling (None, 97, 3, 128)        0
_________________________________________________________________
flatten_13 (Flatten)         (None, 37248)             0
_________________________________________________________________
dropout_25 (Dropout)         (None, 37248)             0
_________________________________________________________________
dense_37 (Dense)             (None, 64)                2383936
_________________________________________________________________
dense_38 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_26 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_39 (Dense)             (None, 2)                 66
=================================================================
Total params: 2,830,114
Trainable params: 2,830,114
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_14"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_38 (Conv2D)           (None, 298, 17, 128)      1280
_________________________________________________________________
max_pooling2d_14 (MaxPooling (None, 99, 5, 128)        0
_________________________________________________________________
flatten_14 (Flatten)         (None, 63360)             0
_________________________________________________________________
dropout_27 (Dropout)         (None, 63360)             0
_________________________________________________________________
dense_40 (Dense)             (None, 64)                4055104
_________________________________________________________________
```

```
dense_41 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_28 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_42 (Dense)             (None, 2)                 66
=================================================================
Total params: 4,058,530
Trainable params: 4,058,530
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_15"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_39 (Conv2D)           (None, 298, 17, 64)       640
_________________________________________________________________
max_pooling2d_15 (MaxPooling (None, 99, 5, 64)         0
_________________________________________________________________
flatten_15 (Flatten)         (None, 31680)             0
_________________________________________________________________
dropout_29 (Dropout)         (None, 31680)             0
_________________________________________________________________
dense_43 (Dense)             (None, 64)                2027584
_________________________________________________________________
dense_44 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_30 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_45 (Dense)             (None, 2)                 66
=================================================================
Total params: 2,030,370
Trainable params: 2,030,370
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_16"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_40 (Conv2D)           (None, 298, 17, 64)       320
_________________________________________________________________
max_pooling2d_16 (MaxPooling (None, 99, 5, 64)         0
_________________________________________________________________
flatten_16 (Flatten)         (None, 31680)             0
_________________________________________________________________
dropout_31 (Dropout)         (None, 31680)             0
_________________________________________________________________
dense_46 (Dense)             (None, 64)                2027584
_________________________________________________________________
```

```
dense_47 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_32 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_48 (Dense)             (None, 2)                 66
=================================================================
Total params: 2,030,050
Trainable params: 2,030,050
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_17"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_41 (Conv2D)           (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_42 (Conv2D)           (None, 296, 15, 32)       9248
_________________________________________________________________
max_pooling2d_17 (MaxPooling (None, 98, 5, 32)         0
_________________________________________________________________
flatten_17 (Flatten)         (None, 15680)             0
_________________________________________________________________
dropout_33 (Dropout)         (None, 15680)             0
_________________________________________________________________
dense_49 (Dense)             (None, 64)                1003584
_________________________________________________________________
dense_50 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_34 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_51 (Dense)             (None, 2)                 66
=================================================================
Total params: 1,015,298
Trainable params: 1,015,298
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_18"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_43 (Conv2D)           (None, 298, 17, 128)      1280
_________________________________________________________________
conv2d_44 (Conv2D)           (None, 296, 15, 128)      147584
_________________________________________________________________
conv2d_45 (Conv2D)           (None, 294, 13, 128)      147584
_________________________________________________________________
conv2d_46 (Conv2D)           (None, 292, 11, 128)      147584
_________________________________________________________________
```

```
max_pooling2d_18 (MaxPooling (None, 146, 5, 128)       0
_________________________________________________________________
flatten_18 (Flatten)         (None, 93440)             0
_________________________________________________________________
dropout_35 (Dropout)         (None, 93440)             0
_________________________________________________________________
dense_52 (Dense)             (None, 64)                5980224
_________________________________________________________________
dense_53 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_36 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_54 (Dense)             (None, 2)                 66
=================================================================
Total params: 6,426,402
Trainable params: 6,426,402
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_19"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_47 (Conv2D)           (None, 298, 17, 128)      1280
_________________________________________________________________
max_pooling2d_19 (MaxPooling (None, 149, 8, 128)       0
_________________________________________________________________
flatten_19 (Flatten)         (None, 152576)            0
_________________________________________________________________
dropout_37 (Dropout)         (None, 152576)            0
_________________________________________________________________
dense_55 (Dense)             (None, 64)                9764928
_________________________________________________________________
dense_56 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_38 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_57 (Dense)             (None, 2)                 66
=================================================================
Total params: 9,768,354
Trainable params: 9,768,354
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_20"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_48 (Conv2D)           (None, 298, 17, 128)      1280
_________________________________________________________________
```

```
max_pooling2d_20 (MaxPooling (None, 149, 8, 128)       0
_________________________________________________________________
flatten_20 (Flatten)         (None, 152576)            0
_________________________________________________________________
dropout_39 (Dropout)         (None, 152576)            0
_________________________________________________________________
dense_58 (Dense)             (None, 64)                9764928
_________________________________________________________________
dense_59 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_40 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_60 (Dense)             (None, 2)                 66
=================================================================
Total params: 9,768,354
Trainable params: 9,768,354
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_21"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_49 (Conv2D)           (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_50 (Conv2D)           (None, 296, 15, 32)       9248
_________________________________________________________________
max_pooling2d_21 (MaxPooling (None, 98, 5, 32)         0
_________________________________________________________________
flatten_21 (Flatten)         (None, 15680)             0
_________________________________________________________________
dropout_41 (Dropout)         (None, 15680)             0
_________________________________________________________________
dense_61 (Dense)             (None, 64)                1003584
_________________________________________________________________
dense_62 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_42 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_63 (Dense)             (None, 2)                 66
=================================================================
Total params: 1,015,298
Trainable params: 1,015,298
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_22"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
```

```
conv2d_51 (Conv2D)           (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_52 (Conv2D)           (None, 296, 15, 32)       9248
_________________________________________________________________
max_pooling2d_22 (MaxPooling (None, 98, 5, 32)         0
_________________________________________________________________
flatten_22 (Flatten)         (None, 15680)             0
_________________________________________________________________
dropout_43 (Dropout)         (None, 15680)             0
_________________________________________________________________
dense_64 (Dense)             (None, 64)                1003584
_________________________________________________________________
dense_65 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_44 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_66 (Dense)             (None, 2)                 66
=================================================================
Total params: 1,015,298
Trainable params: 1,015,298
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_23"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_53 (Conv2D)           (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_54 (Conv2D)           (None, 296, 15, 32)       9248
_________________________________________________________________
max_pooling2d_23 (MaxPooling (None, 98, 5, 32)         0
_________________________________________________________________
flatten_23 (Flatten)         (None, 15680)             0
_________________________________________________________________
dropout_45 (Dropout)         (None, 15680)             0
_________________________________________________________________
dense_67 (Dense)             (None, 64)                1003584
_________________________________________________________________
dense_68 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_46 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_69 (Dense)             (None, 2)                 66
=================================================================
Total params: 1,015,298
Trainable params: 1,015,298
Non-trainable params: 0
_________________________________________________________________
```

```
Model: "sequential_24"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_55 (Conv2D)           (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_56 (Conv2D)           (None, 296, 15, 32)       9248
_________________________________________________________________
max_pooling2d_24 (MaxPooling (None, 98, 5, 32)         0
_________________________________________________________________
flatten_24 (Flatten)         (None, 15680)             0
_________________________________________________________________
dropout_47 (Dropout)         (None, 15680)             0
_________________________________________________________________
dense_70 (Dense)             (None, 64)                1003584
_________________________________________________________________
dense_71 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_48 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_72 (Dense)             (None, 2)                 66
=================================================================
Total params: 1,015,298
Trainable params: 1,015,298
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_25"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_57 (Conv2D)           (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_58 (Conv2D)           (None, 296, 15, 32)       9248
_________________________________________________________________
conv2d_59 (Conv2D)           (None, 294, 13, 32)       9248
_________________________________________________________________
max_pooling2d_25 (MaxPooling (None, 98, 4, 32)         0
_________________________________________________________________
flatten_25 (Flatten)         (None, 12544)             0
_________________________________________________________________
dropout_49 (Dropout)         (None, 12544)             0
_________________________________________________________________
dense_73 (Dense)             (None, 64)                802880
_________________________________________________________________
dense_74 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_50 (Dropout)         (None, 32)                0
_________________________________________________________________
```

```
dense_75 (Dense)             (None, 2)                 66
=================================================================
Total params: 823,842
Trainable params: 823,842
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_26"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_60 (Conv2D)           (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_61 (Conv2D)           (None, 296, 15, 32)       9248
_________________________________________________________________
conv2d_62 (Conv2D)           (None, 294, 13, 32)       9248
_________________________________________________________________
conv2d_63 (Conv2D)           (None, 292, 11, 32)       9248
_________________________________________________________________
max_pooling2d_26 (MaxPooling (None, 97, 3, 32)         0
_________________________________________________________________
flatten_26 (Flatten)         (None, 9312)              0
_________________________________________________________________
dropout_51 (Dropout)         (None, 9312)              0
_________________________________________________________________
dense_76 (Dense)             (None, 64)                596032
_________________________________________________________________
dense_77 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_52 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_78 (Dense)             (None, 2)                 66
=================================================================
Total params: 626,242
Trainable params: 626,242
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_27"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_64 (Conv2D)           (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_65 (Conv2D)           (None, 296, 15, 32)       9248
_________________________________________________________________
max_pooling2d_27 (MaxPooling (None, 98, 5, 32)         0
_________________________________________________________________
flatten_27 (Flatten)         (None, 15680)             0
_________________________________________________________________
```

```
dropout_53 (Dropout)         (None, 15680)             0
_________________________________________________________________
dense_79 (Dense)             (None, 64)                1003584
_________________________________________________________________
dense_80 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_54 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_81 (Dense)             (None, 2)                 66
=================================================================
Total params: 1,015,298
Trainable params: 1,015,298
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_28"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_66 (Conv2D)           (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_67 (Conv2D)           (None, 296, 15, 32)       9248
_________________________________________________________________
max_pooling2d_28 (MaxPooling (None, 98, 5, 32)         0
_________________________________________________________________
flatten_28 (Flatten)         (None, 15680)             0
_________________________________________________________________
dropout_55 (Dropout)         (None, 15680)             0
_________________________________________________________________
dense_82 (Dense)             (None, 64)                1003584
_________________________________________________________________
dense_83 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_56 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_84 (Dense)             (None, 2)                 66
=================================================================
Total params: 1,015,298
Trainable params: 1,015,298
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_29"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_68 (Conv2D)           (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_69 (Conv2D)           (None, 296, 15, 32)       9248
_________________________________________________________________
```

```
conv2d_70 (Conv2D)           (None, 294, 13, 32)       9248
_________________________________________________________________
max_pooling2d_29 (MaxPooling (None, 98, 4, 32)         0
_________________________________________________________________
flatten_29 (Flatten)         (None, 12544)             0
_________________________________________________________________
dropout_57 (Dropout)         (None, 12544)             0
_________________________________________________________________
dense_85 (Dense)             (None, 64)                802880
_________________________________________________________________
dense_86 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_58 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_87 (Dense)             (None, 2)                 66
=================================================================
Total params: 823,842
Trainable params: 823,842
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_30"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_71 (Conv2D)           (None, 298, 17, 32)       160
_________________________________________________________________
conv2d_72 (Conv2D)           (None, 297, 16, 32)       4128
_________________________________________________________________
conv2d_73 (Conv2D)           (None, 296, 15, 32)       4128
_________________________________________________________________
max_pooling2d_30 (MaxPooling (None, 98, 5, 32)         0
_________________________________________________________________
flatten_30 (Flatten)         (None, 15680)             0
_________________________________________________________________
dropout_59 (Dropout)         (None, 15680)             0
_________________________________________________________________
dense_88 (Dense)             (None, 64)                1003584
_________________________________________________________________
dense_89 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_60 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_90 (Dense)             (None, 2)                 66
=================================================================
Total params: 1,014,146
Trainable params: 1,014,146
Non-trainable params: 0
_________________________________________________________________
```

```
Model: "sequential_31"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_74 (Conv2D)           (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_75 (Conv2D)           (None, 296, 15, 32)       9248
_________________________________________________________________
conv2d_76 (Conv2D)           (None, 294, 13, 32)       9248
_________________________________________________________________
max_pooling2d_31 (MaxPooling (None, 98, 4, 32)         0
_________________________________________________________________
flatten_31 (Flatten)         (None, 12544)             0
_________________________________________________________________
dropout_61 (Dropout)         (None, 12544)             0
_________________________________________________________________
dense_91 (Dense)             (None, 64)                802880
_________________________________________________________________
dense_92 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_62 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_93 (Dense)             (None, 2)                 66
=================================================================
Total params: 823,842
Trainable params: 823,842
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_32"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_77 (Conv2D)           (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_78 (Conv2D)           (None, 296, 15, 32)       9248
_________________________________________________________________
conv2d_79 (Conv2D)           (None, 294, 13, 32)       9248
_________________________________________________________________
max_pooling2d_32 (MaxPooling (None, 98, 4, 32)         0
_________________________________________________________________
flatten_32 (Flatten)         (None, 12544)             0
_________________________________________________________________
dropout_63 (Dropout)         (None, 12544)             0
_________________________________________________________________
dense_94 (Dense)             (None, 64)                802880
_________________________________________________________________
dense_95 (Dense)             (None, 32)                2080
_________________________________________________________________
```

```
dropout_64 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_96 (Dense)             (None, 2)                 66
=================================================================
Total params: 823,842
Trainable params: 823,842
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_33"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_80 (Conv2D)           (None, 298, 17, 32)       160
_________________________________________________________________
conv2d_81 (Conv2D)           (None, 297, 16, 32)       4128
_________________________________________________________________
conv2d_82 (Conv2D)           (None, 296, 15, 32)       4128
_________________________________________________________________
max_pooling2d_33 (MaxPooling (None, 98, 5, 32)         0
_________________________________________________________________
flatten_33 (Flatten)         (None, 15680)             0
_________________________________________________________________
dropout_65 (Dropout)         (None, 15680)             0
_________________________________________________________________
dense_97 (Dense)             (None, 64)                1003584
_________________________________________________________________
dense_98 (Dense)             (None, 32)                2080
_________________________________________________________________
dropout_66 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_99 (Dense)             (None, 2)                 66
=================================================================
Total params: 1,014,146
Trainable params: 1,014,146
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_34"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_83 (Conv2D)           (None, 298, 17, 64)       640
_________________________________________________________________
conv2d_84 (Conv2D)           (None, 296, 15, 64)       36928
_________________________________________________________________
conv2d_85 (Conv2D)           (None, 294, 13, 64)       36928
_________________________________________________________________
max_pooling2d_34 (MaxPooling (None, 147, 6, 64)        0
_________________________________________________________________
```

```
flatten_34 (Flatten)         (None, 56448)             0
_________________________________________________________________
dropout_67 (Dropout)         (None, 56448)             0
_________________________________________________________________
dense_100 (Dense)            (None, 64)                3612736
_________________________________________________________________
dense_101 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_68 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_102 (Dense)            (None, 2)                 66
=================================================================
Total params: 3,689,378
Trainable params: 3,689,378
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_35"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_86 (Conv2D)           (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_87 (Conv2D)           (None, 296, 15, 32)       9248
_________________________________________________________________
conv2d_88 (Conv2D)           (None, 294, 13, 32)       9248
_________________________________________________________________
conv2d_89 (Conv2D)           (None, 292, 11, 32)       9248
_________________________________________________________________
max_pooling2d_35 (MaxPooling (None, 97, 3, 32)         0
_________________________________________________________________
flatten_35 (Flatten)         (None, 9312)              0
_________________________________________________________________
dropout_69 (Dropout)         (None, 9312)              0
_________________________________________________________________
dense_103 (Dense)            (None, 64)                596032
_________________________________________________________________
dense_104 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_70 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_105 (Dense)            (None, 2)                 66
=================================================================
Total params: 626,242
Trainable params: 626,242
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_36"
_________________________________________________________________
```

```
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_90 (Conv2D)           (None, 298, 17, 32)       160
_________________________________________________________________
conv2d_91 (Conv2D)           (None, 297, 16, 32)       4128
_________________________________________________________________
conv2d_92 (Conv2D)           (None, 296, 15, 32)       4128
_________________________________________________________________
max_pooling2d_36 (MaxPooling (None, 98, 5, 32)         0
_________________________________________________________________
flatten_36 (Flatten)         (None, 15680)             0
_________________________________________________________________
dropout_71 (Dropout)         (None, 15680)             0
_________________________________________________________________
dense_106 (Dense)            (None, 64)                1003584
_________________________________________________________________
dense_107 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_72 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_108 (Dense)            (None, 2)                 66
=================================================================
Total params: 1,014,146
Trainable params: 1,014,146
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_37"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_93 (Conv2D)           (None, 298, 17, 64)       640
_________________________________________________________________
conv2d_94 (Conv2D)           (None, 296, 15, 64)       36928
_________________________________________________________________
conv2d_95 (Conv2D)           (None, 294, 13, 64)       36928
_________________________________________________________________
conv2d_96 (Conv2D)           (None, 292, 11, 64)       36928
_________________________________________________________________
max_pooling2d_37 (MaxPooling (None, 146, 5, 64)        0
_________________________________________________________________
flatten_37 (Flatten)         (None, 46720)             0
_________________________________________________________________
dropout_73 (Dropout)         (None, 46720)             0
_________________________________________________________________
dense_109 (Dense)            (None, 64)                2990144
_________________________________________________________________
dense_110 (Dense)            (None, 32)                2080
_________________________________________________________________
```

```
dropout_74 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_111 (Dense)            (None, 2)                 66
=================================================================
Total params: 3,103,714
Trainable params: 3,103,714
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_38"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_97 (Conv2D)           (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_98 (Conv2D)           (None, 296, 15, 32)       9248
_________________________________________________________________
conv2d_99 (Conv2D)           (None, 294, 13, 32)       9248
_________________________________________________________________
max_pooling2d_38 (MaxPooling (None, 98, 4, 32)         0
_________________________________________________________________
flatten_38 (Flatten)         (None, 12544)             0
_________________________________________________________________
dropout_75 (Dropout)         (None, 12544)             0
_________________________________________________________________
dense_112 (Dense)            (None, 64)                802880
_________________________________________________________________
dense_113 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_76 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_114 (Dense)            (None, 2)                 66
=================================================================
Total params: 823,842
Trainable params: 823,842
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_39"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_100 (Conv2D)          (None, 298, 17, 32)       160
_________________________________________________________________
conv2d_101 (Conv2D)          (None, 297, 16, 32)       4128
_________________________________________________________________
conv2d_102 (Conv2D)          (None, 296, 15, 32)       4128
_________________________________________________________________
conv2d_103 (Conv2D)          (None, 295, 14, 32)       4128
_________________________________________________________________
```

```
max_pooling2d_39 (MaxPooling (None, 98, 4, 32)         0
_________________________________________________________________
flatten_39 (Flatten)         (None, 12544)             0
_________________________________________________________________
dropout_77 (Dropout)         (None, 12544)             0
_________________________________________________________________
dense_115 (Dense)            (None, 64)                802880
_________________________________________________________________
dense_116 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_78 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_117 (Dense)            (None, 2)                 66
=================================================================
Total params: 817,570
Trainable params: 817,570
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_40"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_104 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_105 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
conv2d_106 (Conv2D)          (None, 294, 13, 32)       9248
_________________________________________________________________
conv2d_107 (Conv2D)          (None, 292, 11, 32)       9248
_________________________________________________________________
max_pooling2d_40 (MaxPooling (None, 146, 5, 32)        0
_________________________________________________________________
flatten_40 (Flatten)         (None, 23360)             0
_________________________________________________________________
dropout_79 (Dropout)         (None, 23360)             0
_________________________________________________________________
dense_118 (Dense)            (None, 64)                1495104
_________________________________________________________________
dense_119 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_80 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_120 (Dense)            (None, 2)                 66
=================================================================
Total params: 1,525,314
Trainable params: 1,525,314
Non-trainable params: 0
_________________________________________________________________
```

```
Model: "sequential_41"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_108 (Conv2D)          (None, 298, 17, 64)       320
_________________________________________________________________
conv2d_109 (Conv2D)          (None, 297, 16, 64)       16448
_________________________________________________________________
conv2d_110 (Conv2D)          (None, 296, 15, 64)       16448
_________________________________________________________________
max_pooling2d_41 (MaxPooling (None, 98, 5, 64)         0
_________________________________________________________________
flatten_41 (Flatten)         (None, 31360)             0
_________________________________________________________________
dropout_81 (Dropout)         (None, 31360)             0
_________________________________________________________________
dense_121 (Dense)            (None, 64)                2007104
_________________________________________________________________
dense_122 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_82 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_123 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,042,466
Trainable params: 2,042,466
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_42"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_111 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_112 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
conv2d_113 (Conv2D)          (None, 294, 13, 32)       9248
_________________________________________________________________
conv2d_114 (Conv2D)          (None, 292, 11, 32)       9248
_________________________________________________________________
max_pooling2d_42 (MaxPooling (None, 97, 3, 32)         0
_________________________________________________________________
flatten_42 (Flatten)         (None, 9312)              0
_________________________________________________________________
dropout_83 (Dropout)         (None, 9312)              0
_________________________________________________________________
dense_124 (Dense)            (None, 64)                596032
_________________________________________________________________
```

```
dense_125 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_84 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_126 (Dense)            (None, 2)                 66
=================================================================
Total params: 626,242
Trainable params: 626,242
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_43"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_115 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_116 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
conv2d_117 (Conv2D)          (None, 294, 13, 32)       9248
_________________________________________________________________
max_pooling2d_43 (MaxPooling (None, 98, 4, 32)         0
_________________________________________________________________
flatten_43 (Flatten)         (None, 12544)             0
_________________________________________________________________
dropout_85 (Dropout)         (None, 12544)             0
_________________________________________________________________
dense_127 (Dense)            (None, 64)                802880
_________________________________________________________________
dense_128 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_86 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_129 (Dense)            (None, 2)                 66
=================================================================
Total params: 823,842
Trainable params: 823,842
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_44"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_118 (Conv2D)          (None, 298, 17, 64)       640
_________________________________________________________________
conv2d_119 (Conv2D)          (None, 296, 15, 64)       36928
_________________________________________________________________
conv2d_120 (Conv2D)          (None, 294, 13, 64)       36928
_________________________________________________________________
```

```
conv2d_121 (Conv2D)          (None, 292, 11, 64)       36928
_________________________________________________________________
max_pooling2d_44 (MaxPooling (None, 146, 5, 64)        0
_________________________________________________________________
flatten_44 (Flatten)         (None, 46720)             0
_________________________________________________________________
dropout_87 (Dropout)         (None, 46720)             0
_________________________________________________________________
dense_130 (Dense)            (None, 64)                2990144
_________________________________________________________________
dense_131 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_88 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_132 (Dense)            (None, 2)                 66
=================================================================
Total params: 3,103,714
Trainable params: 3,103,714
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_45"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_122 (Conv2D)          (None, 298, 17, 32)       160
_________________________________________________________________
conv2d_123 (Conv2D)          (None, 297, 16, 32)       4128
_________________________________________________________________
conv2d_124 (Conv2D)          (None, 296, 15, 32)       4128
_________________________________________________________________
max_pooling2d_45 (MaxPooling (None, 98, 5, 32)         0
_________________________________________________________________
flatten_45 (Flatten)         (None, 15680)             0
_________________________________________________________________
dropout_89 (Dropout)         (None, 15680)             0
_________________________________________________________________
dense_133 (Dense)            (None, 64)                1003584
_________________________________________________________________
dense_134 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_90 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_135 (Dense)            (None, 2)                 66
=================================================================
Total params: 1,014,146
Trainable params: 1,014,146
Non-trainable params: 0
_________________________________________________________________
```

```
Model: "sequential_46"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_125 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_126 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
conv2d_127 (Conv2D)          (None, 294, 13, 32)       9248
_________________________________________________________________
conv2d_128 (Conv2D)          (None, 292, 11, 32)       9248
_________________________________________________________________
max_pooling2d_46 (MaxPooling (None, 97, 3, 32)         0
_________________________________________________________________
flatten_46 (Flatten)         (None, 9312)              0
_________________________________________________________________
dropout_91 (Dropout)         (None, 9312)              0
_________________________________________________________________
dense_136 (Dense)            (None, 64)                596032
_________________________________________________________________
dense_137 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_92 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_138 (Dense)            (None, 2)                 66
=================================================================
Total params: 626,242
Trainable params: 626,242
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_47"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_129 (Conv2D)          (None, 298, 17, 128)      1280
_________________________________________________________________
conv2d_130 (Conv2D)          (None, 296, 15, 128)      147584
_________________________________________________________________
conv2d_131 (Conv2D)          (None, 294, 13, 128)      147584
_________________________________________________________________
conv2d_132 (Conv2D)          (None, 292, 11, 128)      147584
_________________________________________________________________
max_pooling2d_47 (MaxPooling (None, 146, 5, 128)       0
_________________________________________________________________
flatten_47 (Flatten)         (None, 93440)             0
_________________________________________________________________
dropout_93 (Dropout)         (None, 93440)             0
_________________________________________________________________
```

```
dense_139 (Dense)            (None, 64)                5980224
_________________________________________________________________
dense_140 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_94 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_141 (Dense)            (None, 2)                 66
=================================================================
Total params: 6,426,402
Trainable params: 6,426,402
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_48"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_133 (Conv2D)          (None, 298, 17, 64)       320
_________________________________________________________________
max_pooling2d_48 (MaxPooling (None, 99, 5, 64)         0
_________________________________________________________________
flatten_48 (Flatten)         (None, 31680)             0
_________________________________________________________________
dropout_95 (Dropout)         (None, 31680)             0
_________________________________________________________________
dense_142 (Dense)            (None, 64)                2027584
_________________________________________________________________
dense_143 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_96 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_144 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,030,050
Trainable params: 2,030,050
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_49"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_134 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_135 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
conv2d_136 (Conv2D)          (None, 294, 13, 32)       9248
_________________________________________________________________
max_pooling2d_49 (MaxPooling (None, 98, 4, 32)         0
_________________________________________________________________
```

```
flatten_49 (Flatten)         (None, 12544)             0
_________________________________________________________________
dropout_97 (Dropout)         (None, 12544)             0
_________________________________________________________________
dense_145 (Dense)            (None, 64)                802880
_________________________________________________________________
dense_146 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_98 (Dropout)         (None, 32)                0
_________________________________________________________________
dense_147 (Dense)            (None, 2)                 66
=================================================================
Total params: 823,842
Trainable params: 823,842
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_50"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_137 (Conv2D)          (None, 298, 17, 128)      1280
_________________________________________________________________
conv2d_138 (Conv2D)          (None, 296, 15, 128)      147584
_________________________________________________________________
conv2d_139 (Conv2D)          (None, 294, 13, 128)      147584
_________________________________________________________________
conv2d_140 (Conv2D)          (None, 292, 11, 128)      147584
_________________________________________________________________
max_pooling2d_50 (MaxPooling (None, 97, 3, 128)        0
_________________________________________________________________
flatten_50 (Flatten)         (None, 37248)             0
_________________________________________________________________
dropout_99 (Dropout)         (None, 37248)             0
_________________________________________________________________
dense_148 (Dense)            (None, 64)                2383936
_________________________________________________________________
dense_149 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_100 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_150 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,830,114
Trainable params: 2,830,114
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_51"
_________________________________________________________________
```

```
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_141 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
max_pooling2d_51 (MaxPooling (None, 149, 8, 32)        0
_________________________________________________________________
flatten_51 (Flatten)         (None, 38144)             0
_________________________________________________________________
dropout_101 (Dropout)        (None, 38144)             0
_________________________________________________________________
dense_151 (Dense)            (None, 64)                2441280
_________________________________________________________________
dense_152 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_102 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_153 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,443,746
Trainable params: 2,443,746
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_52"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_142 (Conv2D)          (None, 298, 17, 64)       640
_________________________________________________________________
conv2d_143 (Conv2D)          (None, 296, 15, 64)       36928
_________________________________________________________________
conv2d_144 (Conv2D)          (None, 294, 13, 64)       36928
_________________________________________________________________
max_pooling2d_52 (MaxPooling (None, 98, 4, 64)         0
_________________________________________________________________
flatten_52 (Flatten)         (None, 25088)             0
_________________________________________________________________
dropout_103 (Dropout)        (None, 25088)             0
_________________________________________________________________
dense_154 (Dense)            (None, 64)                1605696
_________________________________________________________________
dense_155 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_104 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_156 (Dense)            (None, 2)                 66
=================================================================
Total params: 1,682,338
Trainable params: 1,682,338
```

```
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_53"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_145 (Conv2D)          (None, 298, 17, 128)      640
_________________________________________________________________
conv2d_146 (Conv2D)          (None, 297, 16, 128)      65664
_________________________________________________________________
conv2d_147 (Conv2D)          (None, 296, 15, 128)      65664
_________________________________________________________________
conv2d_148 (Conv2D)          (None, 295, 14, 128)      65664
_________________________________________________________________
max_pooling2d_53 (MaxPooling (None, 98, 4, 128)        0
_________________________________________________________________
flatten_53 (Flatten)         (None, 50176)             0
_________________________________________________________________
dropout_105 (Dropout)        (None, 50176)             0
_________________________________________________________________
dense_157 (Dense)            (None, 64)                3211328
_________________________________________________________________
dense_158 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_106 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_159 (Dense)            (None, 2)                 66
=================================================================
Total params: 3,411,106
Trainable params: 3,411,106
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_54"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_149 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
max_pooling2d_54 (MaxPooling (None, 149, 8, 32)        0
_________________________________________________________________
flatten_54 (Flatten)         (None, 38144)             0
_________________________________________________________________
dropout_107 (Dropout)        (None, 38144)             0
_________________________________________________________________
dense_160 (Dense)            (None, 64)                2441280
_________________________________________________________________
dense_161 (Dense)            (None, 32)                2080
_________________________________________________________________
```

```
dropout_108 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_162 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,443,746
Trainable params: 2,443,746
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_55"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_150 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_151 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
max_pooling2d_55 (MaxPooling (None, 98, 5, 32)         0
_________________________________________________________________
flatten_55 (Flatten)         (None, 15680)             0
_________________________________________________________________
dropout_109 (Dropout)        (None, 15680)             0
_________________________________________________________________
dense_163 (Dense)            (None, 64)                1003584
_________________________________________________________________
dense_164 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_110 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_165 (Dense)            (None, 2)                 66
=================================================================
Total params: 1,015,298
Trainable params: 1,015,298
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_56"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_152 (Conv2D)          (None, 298, 17, 128)      1280
_________________________________________________________________
conv2d_153 (Conv2D)          (None, 296, 15, 128)      147584
_________________________________________________________________
conv2d_154 (Conv2D)          (None, 294, 13, 128)      147584
_________________________________________________________________
conv2d_155 (Conv2D)          (None, 292, 11, 128)      147584
_________________________________________________________________
max_pooling2d_56 (MaxPooling (None, 97, 3, 128)        0
_________________________________________________________________
```

```
flatten_56 (Flatten)         (None, 37248)             0
_________________________________________________________________
dropout_111 (Dropout)        (None, 37248)             0
_________________________________________________________________
dense_166 (Dense)            (None, 64)                2383936
_________________________________________________________________
dense_167 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_112 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_168 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,830,114
Trainable params: 2,830,114
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_57"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_156 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_157 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
conv2d_158 (Conv2D)          (None, 294, 13, 32)       9248
_________________________________________________________________
max_pooling2d_57 (MaxPooling (None, 98, 4, 32)         0
_________________________________________________________________
flatten_57 (Flatten)         (None, 12544)             0
_________________________________________________________________
dropout_113 (Dropout)        (None, 12544)             0
_________________________________________________________________
dense_169 (Dense)            (None, 64)                802880
_________________________________________________________________
dense_170 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_114 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_171 (Dense)            (None, 2)                 66
=================================================================
Total params: 823,842
Trainable params: 823,842
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_58"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
```

```
conv2d_159 (Conv2D)          (None, 298, 17, 64)       320
_________________________________________________________________
max_pooling2d_58 (MaxPooling (None, 99, 5, 64)         0
_________________________________________________________________
flatten_58 (Flatten)         (None, 31680)             0
_________________________________________________________________
dropout_115 (Dropout)        (None, 31680)             0
_________________________________________________________________
dense_172 (Dense)            (None, 64)                2027584
_________________________________________________________________
dense_173 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_116 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_174 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,030,050
Trainable params: 2,030,050
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_59"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_160 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_161 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
max_pooling2d_59 (MaxPooling (None, 148, 7, 32)        0
_________________________________________________________________
flatten_59 (Flatten)         (None, 33152)             0
_________________________________________________________________
dropout_117 (Dropout)        (None, 33152)             0
_________________________________________________________________
dense_175 (Dense)            (None, 64)                2121792
_________________________________________________________________
dense_176 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_118 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_177 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,133,506
Trainable params: 2,133,506
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_60"
_________________________________________________________________
```

```
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_162 (Conv2D)          (None, 298, 17, 128)      1280
_________________________________________________________________
conv2d_163 (Conv2D)          (None, 296, 15, 128)      147584
_________________________________________________________________
conv2d_164 (Conv2D)          (None, 294, 13, 128)      147584
_________________________________________________________________
conv2d_165 (Conv2D)          (None, 292, 11, 128)      147584
_________________________________________________________________
max_pooling2d_60 (MaxPooling (None, 97, 3, 128)        0
_________________________________________________________________
flatten_60 (Flatten)         (None, 37248)             0
_________________________________________________________________
dropout_119 (Dropout)        (None, 37248)             0
_________________________________________________________________
dense_178 (Dense)            (None, 64)                2383936
_________________________________________________________________
dense_179 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_120 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_180 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,830,114
Trainable params: 2,830,114
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_61"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_166 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_167 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
conv2d_168 (Conv2D)          (None, 294, 13, 32)       9248
_________________________________________________________________
max_pooling2d_61 (MaxPooling (None, 98, 4, 32)         0
_________________________________________________________________
flatten_61 (Flatten)         (None, 12544)             0
_________________________________________________________________
dropout_121 (Dropout)        (None, 12544)             0
_________________________________________________________________
dense_181 (Dense)            (None, 64)                802880
_________________________________________________________________
dense_182 (Dense)            (None, 32)                2080
_________________________________________________________________
```

```
dropout_122 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_183 (Dense)            (None, 2)                 66
=================================================================
Total params: 823,842
Trainable params: 823,842
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_62"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_169 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_170 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
conv2d_171 (Conv2D)          (None, 294, 13, 32)       9248
_________________________________________________________________
max_pooling2d_62 (MaxPooling (None, 98, 4, 32)         0
_________________________________________________________________
flatten_62 (Flatten)         (None, 12544)             0
_________________________________________________________________
dropout_123 (Dropout)        (None, 12544)             0
_________________________________________________________________
dense_184 (Dense)            (None, 64)                802880
_________________________________________________________________
dense_185 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_124 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_186 (Dense)            (None, 2)                 66
=================================================================
Total params: 823,842
Trainable params: 823,842
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_63"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_172 (Conv2D)          (None, 298, 17, 32)       160
_________________________________________________________________
conv2d_173 (Conv2D)          (None, 297, 16, 32)       4128
_________________________________________________________________
max_pooling2d_63 (MaxPooling (None, 148, 8, 32)        0
_________________________________________________________________
flatten_63 (Flatten)         (None, 37888)             0
_________________________________________________________________
```

```
dropout_125 (Dropout)        (None, 37888)             0
_________________________________________________________________
dense_187 (Dense)            (None, 64)                2424896
_________________________________________________________________
dense_188 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_126 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_189 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,431,330
Trainable params: 2,431,330
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_64"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_174 (Conv2D)          (None, 298, 17, 64)       640
_________________________________________________________________
conv2d_175 (Conv2D)          (None, 296, 15, 64)       36928
_________________________________________________________________
conv2d_176 (Conv2D)          (None, 294, 13, 64)       36928
_________________________________________________________________
conv2d_177 (Conv2D)          (None, 292, 11, 64)       36928
_________________________________________________________________
max_pooling2d_64 (MaxPooling (None, 97, 3, 64)         0
_________________________________________________________________
flatten_64 (Flatten)         (None, 18624)             0
_________________________________________________________________
dropout_127 (Dropout)        (None, 18624)             0
_________________________________________________________________
dense_190 (Dense)            (None, 64)                1192000
_________________________________________________________________
dense_191 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_128 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_192 (Dense)            (None, 2)                 66
=================================================================
Total params: 1,305,570
Trainable params: 1,305,570
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_65"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
```

```
conv2d_178 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
max_pooling2d_65 (MaxPooling (None, 99, 5, 32)         0
_________________________________________________________________
flatten_65 (Flatten)         (None, 15840)             0
_________________________________________________________________
dropout_129 (Dropout)        (None, 15840)             0
_________________________________________________________________
dense_193 (Dense)            (None, 64)                1013824
_________________________________________________________________
dense_194 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_130 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_195 (Dense)            (None, 2)                 66
=================================================================
Total params: 1,016,290
Trainable params: 1,016,290
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_66"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_179 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_180 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
max_pooling2d_66 (MaxPooling (None, 148, 7, 32)        0
_________________________________________________________________
flatten_66 (Flatten)         (None, 33152)             0
_________________________________________________________________
dropout_131 (Dropout)        (None, 33152)             0
_________________________________________________________________
dense_196 (Dense)            (None, 64)                2121792
_________________________________________________________________
dense_197 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_132 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_198 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,133,506
Trainable params: 2,133,506
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_67"
_________________________________________________________________
```

```
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_181 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_182 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
max_pooling2d_67 (MaxPooling (None, 148, 7, 32)        0
_________________________________________________________________
flatten_67 (Flatten)         (None, 33152)             0
_________________________________________________________________
dropout_133 (Dropout)        (None, 33152)             0
_________________________________________________________________
dense_199 (Dense)            (None, 64)                2121792
_________________________________________________________________
dense_200 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_134 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_201 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,133,506
Trainable params: 2,133,506
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_68"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_183 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_184 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
max_pooling2d_68 (MaxPooling (None, 148, 7, 32)        0
_________________________________________________________________
flatten_68 (Flatten)         (None, 33152)             0
_________________________________________________________________
dropout_135 (Dropout)        (None, 33152)             0
_________________________________________________________________
dense_202 (Dense)            (None, 64)                2121792
_________________________________________________________________
dense_203 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_136 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_204 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,133,506
Trainable params: 2,133,506
```

```
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_69"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_185 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_186 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
max_pooling2d_69 (MaxPooling (None, 148, 7, 32)        0
_________________________________________________________________
flatten_69 (Flatten)         (None, 33152)             0
_________________________________________________________________
dropout_137 (Dropout)        (None, 33152)             0
_________________________________________________________________
dense_205 (Dense)            (None, 64)                2121792
_________________________________________________________________
dense_206 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_138 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_207 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,133,506
Trainable params: 2,133,506
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_70"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_187 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_188 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
max_pooling2d_70 (MaxPooling (None, 148, 7, 32)        0
_________________________________________________________________
flatten_70 (Flatten)         (None, 33152)             0
_________________________________________________________________
dropout_139 (Dropout)        (None, 33152)             0
_________________________________________________________________
dense_208 (Dense)            (None, 64)                2121792
_________________________________________________________________
dense_209 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_140 (Dropout)        (None, 32)                0
_________________________________________________________________
```

```
dense_210 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,133,506
Trainable params: 2,133,506
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_71"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_189 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_190 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
max_pooling2d_71 (MaxPooling (None, 148, 7, 32)        0
_________________________________________________________________
flatten_71 (Flatten)         (None, 33152)             0
_________________________________________________________________
dropout_141 (Dropout)        (None, 33152)             0
_________________________________________________________________
dense_211 (Dense)            (None, 64)                2121792
_________________________________________________________________
dense_212 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_142 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_213 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,133,506
Trainable params: 2,133,506
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_72"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_191 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_192 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
max_pooling2d_72 (MaxPooling (None, 148, 7, 32)        0
_________________________________________________________________
flatten_72 (Flatten)         (None, 33152)             0
_________________________________________________________________
dropout_143 (Dropout)        (None, 33152)             0
_________________________________________________________________
dense_214 (Dense)            (None, 64)                2121792
_________________________________________________________________
```

```
dense_215 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_144 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_216 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,133,506
Trainable params: 2,133,506
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_73"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_193 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_194 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
max_pooling2d_73 (MaxPooling (None, 148, 7, 32)        0
_________________________________________________________________
flatten_73 (Flatten)         (None, 33152)             0
_________________________________________________________________
dropout_145 (Dropout)        (None, 33152)             0
_________________________________________________________________
dense_217 (Dense)            (None, 64)                2121792
_________________________________________________________________
dense_218 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_146 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_219 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,133,506
Trainable params: 2,133,506
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_74"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_195 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_196 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
max_pooling2d_74 (MaxPooling (None, 148, 7, 32)        0
_________________________________________________________________
flatten_74 (Flatten)         (None, 33152)             0
_________________________________________________________________
```

```
dropout_147 (Dropout)        (None, 33152)             0
_________________________________________________________________
dense_220 (Dense)            (None, 64)                2121792
_________________________________________________________________
dense_221 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_148 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_222 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,133,506
Trainable params: 2,133,506
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_75"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_197 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_198 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
max_pooling2d_75 (MaxPooling (None, 148, 7, 32)        0
_________________________________________________________________
flatten_75 (Flatten)         (None, 33152)             0
_________________________________________________________________
dropout_149 (Dropout)        (None, 33152)             0
_________________________________________________________________
dense_223 (Dense)            (None, 64)                2121792
_________________________________________________________________
dense_224 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_150 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_225 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,133,506
Trainable params: 2,133,506
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_76"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_199 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_200 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
```

```
max_pooling2d_76 (MaxPooling (None, 148, 7, 32)        0
_________________________________________________________________
flatten_76 (Flatten)         (None, 33152)             0
_________________________________________________________________
dropout_151 (Dropout)        (None, 33152)             0
_________________________________________________________________
dense_226 (Dense)            (None, 64)                2121792
_________________________________________________________________
dense_227 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_152 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_228 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,133,506
Trainable params: 2,133,506
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_77"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_201 (Conv2D)          (None, 298, 17, 128)      1280
_________________________________________________________________
conv2d_202 (Conv2D)          (None, 296, 15, 128)      147584
_________________________________________________________________
max_pooling2d_77 (MaxPooling (None, 148, 7, 128)       0
_________________________________________________________________
flatten_77 (Flatten)         (None, 132608)            0
_________________________________________________________________
dropout_153 (Dropout)        (None, 132608)            0
_________________________________________________________________
dense_229 (Dense)            (None, 64)                8486976
_________________________________________________________________
dense_230 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_154 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_231 (Dense)            (None, 2)                 66
=================================================================
Total params: 8,637,986
Trainable params: 8,637,986
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_78"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
```

```
conv2d_203 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_204 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
max_pooling2d_78 (MaxPooling (None, 148, 7, 32)        0
_________________________________________________________________
flatten_78 (Flatten)         (None, 33152)             0
_________________________________________________________________
dropout_155 (Dropout)        (None, 33152)             0
_________________________________________________________________
dense_232 (Dense)            (None, 64)                2121792
_________________________________________________________________
dense_233 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_156 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_234 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,133,506
Trainable params: 2,133,506
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_79"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_205 (Conv2D)          (None, 298, 17, 32)       160
_________________________________________________________________
conv2d_206 (Conv2D)          (None, 297, 16, 32)       4128
_________________________________________________________________
max_pooling2d_79 (MaxPooling (None, 148, 8, 32)        0
_________________________________________________________________
flatten_79 (Flatten)         (None, 37888)             0
_________________________________________________________________
dropout_157 (Dropout)        (None, 37888)             0
_________________________________________________________________
dense_235 (Dense)            (None, 64)                2424896
_________________________________________________________________
dense_236 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_158 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_237 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,431,330
Trainable params: 2,431,330
Non-trainable params: 0
_________________________________________________________________
```

```
Model: "sequential_80"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_207 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_208 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
max_pooling2d_80 (MaxPooling (None, 148, 7, 32)        0
_________________________________________________________________
flatten_80 (Flatten)         (None, 33152)             0
_________________________________________________________________
dropout_159 (Dropout)        (None, 33152)             0
_________________________________________________________________
dense_238 (Dense)            (None, 64)                2121792
_________________________________________________________________
dense_239 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_160 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_240 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,133,506
Trainable params: 2,133,506
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_81"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_209 (Conv2D)          (None, 298, 17, 64)       640
_________________________________________________________________
conv2d_210 (Conv2D)          (None, 296, 15, 64)       36928
_________________________________________________________________
max_pooling2d_81 (MaxPooling (None, 148, 7, 64)        0
_________________________________________________________________
flatten_81 (Flatten)         (None, 66304)             0
_________________________________________________________________
dropout_161 (Dropout)        (None, 66304)             0
_________________________________________________________________
dense_241 (Dense)            (None, 64)                4243520
_________________________________________________________________
dense_242 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_162 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_243 (Dense)            (None, 2)                 66
=================================================================
```

```
Total params: 4,283,234
Trainable params: 4,283,234
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_82"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_211 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_212 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
max_pooling2d_82 (MaxPooling (None, 148, 7, 32)        0
_________________________________________________________________
flatten_82 (Flatten)         (None, 33152)             0
_________________________________________________________________
dropout_163 (Dropout)        (None, 33152)             0
_________________________________________________________________
dense_244 (Dense)            (None, 64)                2121792
_________________________________________________________________
dense_245 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_164 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_246 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,133,506
Trainable params: 2,133,506
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_83"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_213 (Conv2D)          (None, 298, 17, 128)      1280
_________________________________________________________________
conv2d_214 (Conv2D)          (None, 296, 15, 128)      147584
_________________________________________________________________
max_pooling2d_83 (MaxPooling (None, 148, 7, 128)       0
_________________________________________________________________
flatten_83 (Flatten)         (None, 132608)            0
_________________________________________________________________
dropout_165 (Dropout)        (None, 132608)            0
_________________________________________________________________
dense_247 (Dense)            (None, 64)                8486976
_________________________________________________________________
dense_248 (Dense)            (None, 32)                2080
_________________________________________________________________
```

```
dropout_166 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_249 (Dense)            (None, 2)                 66
=================================================================
Total params: 8,637,986
Trainable params: 8,637,986
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_84"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_215 (Conv2D)          (None, 298, 17, 32)       160
_________________________________________________________________
conv2d_216 (Conv2D)          (None, 297, 16, 32)       4128
_________________________________________________________________
max_pooling2d_84 (MaxPooling (None, 148, 8, 32)        0
_________________________________________________________________
flatten_84 (Flatten)         (None, 37888)             0
_________________________________________________________________
dropout_167 (Dropout)        (None, 37888)             0
_________________________________________________________________
dense_250 (Dense)            (None, 64)                2424896
_________________________________________________________________
dense_251 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_168 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_252 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,431,330
Trainable params: 2,431,330
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_85"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_217 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_218 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
max_pooling2d_85 (MaxPooling (None, 148, 7, 32)        0
_________________________________________________________________
flatten_85 (Flatten)         (None, 33152)             0
_________________________________________________________________
dropout_169 (Dropout)        (None, 33152)             0
_________________________________________________________________
```

```
dense_253 (Dense)            (None, 64)                2121792
_________________________________________________________________
dense_254 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_170 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_255 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,133,506
Trainable params: 2,133,506
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_86"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_219 (Conv2D)          (None, 298, 17, 64)       640
_________________________________________________________________
conv2d_220 (Conv2D)          (None, 296, 15, 64)       36928
_________________________________________________________________
max_pooling2d_86 (MaxPooling (None, 148, 7, 64)        0
_________________________________________________________________
flatten_86 (Flatten)         (None, 66304)             0
_________________________________________________________________
dropout_171 (Dropout)        (None, 66304)             0
_________________________________________________________________
dense_256 (Dense)            (None, 64)                4243520
_________________________________________________________________
dense_257 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_172 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_258 (Dense)            (None, 2)                 66
=================================================================
Total params: 4,283,234
Trainable params: 4,283,234
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_87"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_221 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_222 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
max_pooling2d_87 (MaxPooling (None, 148, 7, 32)        0
_________________________________________________________________
```

```
flatten_87 (Flatten)         (None, 33152)             0
_________________________________________________________________
dropout_173 (Dropout)        (None, 33152)             0
_________________________________________________________________
dense_259 (Dense)            (None, 64)                2121792
_________________________________________________________________
dense_260 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_174 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_261 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,133,506
Trainable params: 2,133,506
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_88"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_223 (Conv2D)          (None, 298, 17, 32)       160
_________________________________________________________________
conv2d_224 (Conv2D)          (None, 297, 16, 32)       4128
_________________________________________________________________
max_pooling2d_88 (MaxPooling (None, 148, 8, 32)        0
_________________________________________________________________
flatten_88 (Flatten)         (None, 37888)             0
_________________________________________________________________
dropout_175 (Dropout)        (None, 37888)             0
_________________________________________________________________
dense_262 (Dense)            (None, 64)                2424896
_________________________________________________________________
dense_263 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_176 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_264 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,431,330
Trainable params: 2,431,330
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_89"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_225 (Conv2D)          (None, 298, 17, 128)      1280
_________________________________________________________________
```

```
conv2d_226 (Conv2D)          (None, 296, 15, 128)      147584
_________________________________________________________________
max_pooling2d_89 (MaxPooling (None, 148, 7, 128)       0
_________________________________________________________________
flatten_89 (Flatten)         (None, 132608)            0
_________________________________________________________________
dropout_177 (Dropout)        (None, 132608)            0
_________________________________________________________________
dense_265 (Dense)            (None, 64)                8486976
_________________________________________________________________
dense_266 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_178 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_267 (Dense)            (None, 2)                 66
=================================================================
Total params: 8,637,986
Trainable params: 8,637,986
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_90"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_227 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_228 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
max_pooling2d_90 (MaxPooling (None, 148, 7, 32)        0
_________________________________________________________________
flatten_90 (Flatten)         (None, 33152)             0
_________________________________________________________________
dropout_179 (Dropout)        (None, 33152)             0
_________________________________________________________________
dense_268 (Dense)            (None, 64)                2121792
_________________________________________________________________
dense_269 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_180 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_270 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,133,506
Trainable params: 2,133,506
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_91"
_________________________________________________________________
```

```
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_229 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
max_pooling2d_91 (MaxPooling (None, 149, 8, 32)        0
_________________________________________________________________
flatten_91 (Flatten)         (None, 38144)             0
_________________________________________________________________
dropout_181 (Dropout)        (None, 38144)             0
_________________________________________________________________
dense_271 (Dense)            (None, 64)                2441280
_________________________________________________________________
dense_272 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_182 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_273 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,443,746
Trainable params: 2,443,746
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_92"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_230 (Conv2D)          (None, 298, 17, 64)       640
_________________________________________________________________
conv2d_231 (Conv2D)          (None, 296, 15, 64)       36928
_________________________________________________________________
max_pooling2d_92 (MaxPooling (None, 148, 7, 64)        0
_________________________________________________________________
flatten_92 (Flatten)         (None, 66304)             0
_________________________________________________________________
dropout_183 (Dropout)        (None, 66304)             0
_________________________________________________________________
dense_274 (Dense)            (None, 64)                4243520
_________________________________________________________________
dense_275 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_184 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_276 (Dense)            (None, 2)                 66
=================================================================
Total params: 4,283,234
Trainable params: 4,283,234
Non-trainable params: 0
_________________________________________________________________
```

```
Model: "sequential_93"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_232 (Conv2D)          (None, 298, 17, 32)       160
_________________________________________________________________
conv2d_233 (Conv2D)          (None, 297, 16, 32)       4128
_________________________________________________________________
max_pooling2d_93 (MaxPooling (None, 148, 8, 32)        0
_________________________________________________________________
flatten_93 (Flatten)         (None, 37888)             0
_________________________________________________________________
dropout_185 (Dropout)        (None, 37888)             0
_________________________________________________________________
dense_277 (Dense)            (None, 64)                2424896
_________________________________________________________________
dense_278 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_186 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_279 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,431,330
Trainable params: 2,431,330
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_94"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_234 (Conv2D)          (None, 298, 17, 128)      1280
_________________________________________________________________
conv2d_235 (Conv2D)          (None, 296, 15, 128)      147584
_________________________________________________________________
max_pooling2d_94 (MaxPooling (None, 148, 7, 128)       0
_________________________________________________________________
flatten_94 (Flatten)         (None, 132608)            0
_________________________________________________________________
dropout_187 (Dropout)        (None, 132608)            0
_________________________________________________________________
dense_280 (Dense)            (None, 64)                8486976
_________________________________________________________________
dense_281 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_188 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_282 (Dense)            (None, 2)                 66
=================================================================
```

```
Total params: 8,637,986
Trainable params: 8,637,986
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_95"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_236 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
max_pooling2d_95 (MaxPooling (None, 149, 8, 32)        0
_________________________________________________________________
flatten_95 (Flatten)         (None, 38144)             0
_________________________________________________________________
dropout_189 (Dropout)        (None, 38144)             0
_________________________________________________________________
dense_283 (Dense)            (None, 64)                2441280
_________________________________________________________________
dense_284 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_190 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_285 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,443,746
Trainable params: 2,443,746
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_96"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_237 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_238 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
max_pooling2d_96 (MaxPooling (None, 148, 7, 32)        0
_________________________________________________________________
flatten_96 (Flatten)         (None, 33152)             0
_________________________________________________________________
dropout_191 (Dropout)        (None, 33152)             0
_________________________________________________________________
dense_286 (Dense)            (None, 64)                2121792
_________________________________________________________________
dense_287 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_192 (Dropout)        (None, 32)                0
_________________________________________________________________
```

```
dense_288 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,133,506
Trainable params: 2,133,506
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_97"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_239 (Conv2D)          (None, 298, 17, 64)       320
_________________________________________________________________
conv2d_240 (Conv2D)          (None, 297, 16, 64)       16448
_________________________________________________________________
max_pooling2d_97 (MaxPooling (None, 148, 8, 64)        0
_________________________________________________________________
flatten_97 (Flatten)         (None, 75776)             0
_________________________________________________________________
dropout_193 (Dropout)        (None, 75776)             0
_________________________________________________________________
dense_289 (Dense)            (None, 64)                4849728
_________________________________________________________________
dense_290 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_194 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_291 (Dense)            (None, 2)                 66
=================================================================
Total params: 4,868,642
Trainable params: 4,868,642
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_98"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_241 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
conv2d_242 (Conv2D)          (None, 296, 15, 32)       9248
_________________________________________________________________
max_pooling2d_98 (MaxPooling (None, 148, 7, 32)        0
_________________________________________________________________
flatten_98 (Flatten)         (None, 33152)             0
_________________________________________________________________
dropout_195 (Dropout)        (None, 33152)             0
_________________________________________________________________
dense_292 (Dense)            (None, 64)                2121792
_________________________________________________________________
```

```
dense_293 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_196 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_294 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,133,506
Trainable params: 2,133,506
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_99"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_243 (Conv2D)          (None, 298, 17, 32)       320
_________________________________________________________________
max_pooling2d_99 (MaxPooling (None, 149, 8, 32)        0
_________________________________________________________________
flatten_99 (Flatten)         (None, 38144)             0
_________________________________________________________________
dropout_197 (Dropout)        (None, 38144)             0
_________________________________________________________________
dense_295 (Dense)            (None, 64)                2441280
_________________________________________________________________
dense_296 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_198 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_297 (Dense)            (None, 2)                 66
=================================================================
Total params: 2,443,746
Trainable params: 2,443,746
Non-trainable params: 0
_________________________________________________________________
Model: "sequential_100"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_244 (Conv2D)          (None, 298, 17, 128)      1280
_________________________________________________________________
conv2d_245 (Conv2D)          (None, 296, 15, 128)      147584
_________________________________________________________________
max_pooling2d_100 (MaxPoolin (None, 148, 7, 128)       0
_________________________________________________________________
flatten_100 (Flatten)        (None, 132608)            0
_________________________________________________________________
dropout_199 (Dropout)        (None, 132608)            0
_________________________________________________________________
```

```
dense_298 (Dense)            (None, 64)                8486976
_________________________________________________________________
dense_299 (Dense)            (None, 32)                2080
_________________________________________________________________
dropout_200 (Dropout)        (None, 32)                0
_________________________________________________________________
dense_300 (Dense)            (None, 2)                 66
=================================================================
Total params: 8,637,986
Trainable params: 8,637,986
Non-trainable params: 0
_________________________________________________________________
100%|

    | 100/100 [4:40:51<00:00, 168.51s/it, best loss: 0.2763788134875968]
Evalutation of best performing model:
42167/42167 [==============================] - 23s 552us/step
[0.2763788134875968, 0.8723646402359009]
Best performing model chosen hyper-parameters:
{'activations': 'sigmoid', 'batch_size': 1024, 'choiceval': 'rmsprop',
'dropout': 0.29104403739531765, 'filters': 32, 'kernel_size': (3, 3),
'kernel_size_1': (2, 2), 'layers': 2, 'lr': 0.001433773291970261}
```

1.4 Model Analysis

Classification Report

Confusion Matrix

Area Under Reciever Operating Characteristic Curve

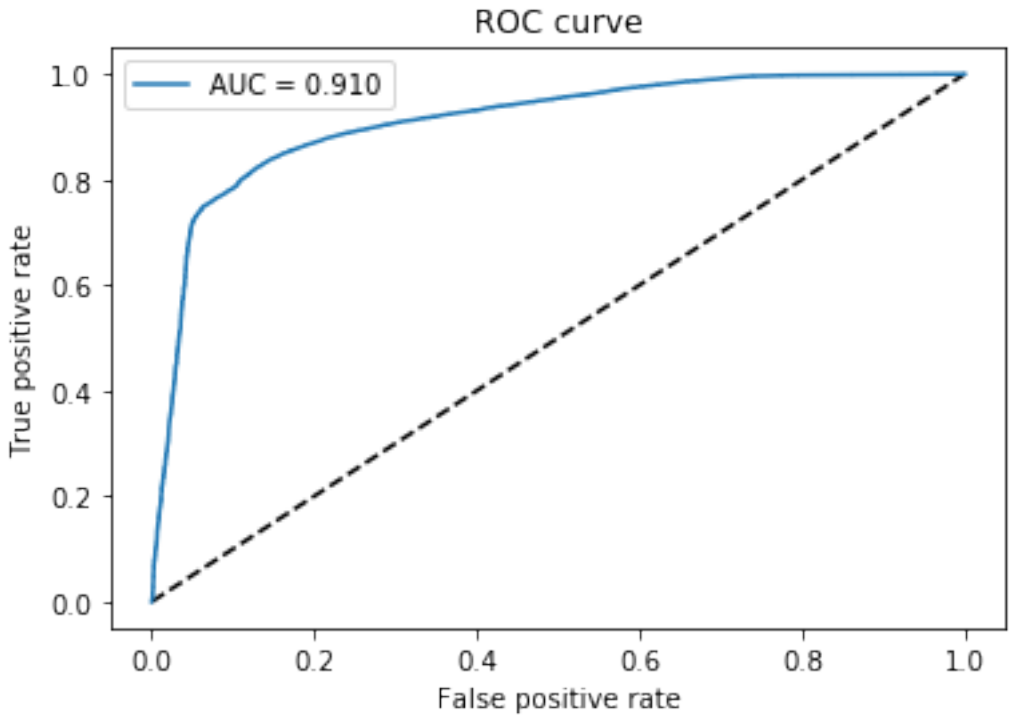
[16]:
```
y_pred = best_model.predict(x_test)
yy_test = [np.argmax(i) for i in y_test]

yy_pred = [np.argmax(i) for i in y_pred]

print(classification_report(yy_test, yy_pred))

new = np.vstack([yy_test,yy_pred])

from sklearn.metrics import confusion_matrix
from sklearn.metrics import roc_curve
from sklearn.metrics import auc

print(confusion_matrix(yy_test, yy_pred))
```

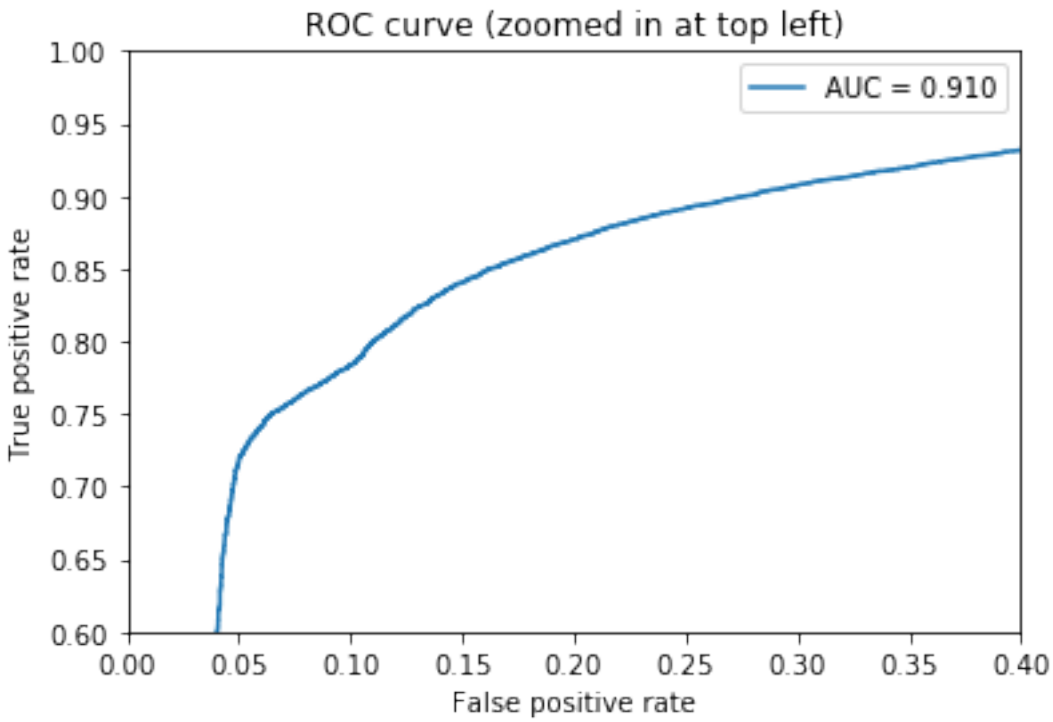
```
y_pred_keras = best_model.predict(x_test).ravel()
fpr_keras, tpr_keras, thresholds_keras = roc_curve(yy_test, y_pred[:
 ↪,0],pos_label=0)
auc_keras = auc(fpr_keras, tpr_keras)
print(auc_keras)

f1 = plt.figure()
plt.plot([0, 1], [0, 1], 'k--')
plt.plot(fpr_keras, tpr_keras, label='AUC = {:.3f}'.format(auc_keras))
plt.xlabel('False positive rate')
plt.ylabel('True positive rate')
plt.title('ROC curve')
plt.legend(loc='best')
plt.show()
f1.savefig("ROC-curve-cnn2D.pdf", bbox_inches='tight')

f2 = plt.figure()
plt.xlim(0, 0.4)
plt.ylim(0.6, 1)
plt.plot([0, 1], [0, 1], 'k--')
plt.plot(fpr_keras, tpr_keras, label='AUC = {:.3f}'.format(auc_keras))
plt.xlabel('False positive rate')
plt.ylabel('True positive rate')
plt.title('ROC curve (zoomed in at top left)')
plt.legend(loc='best')
plt.show()
f2.savefig("ROC-curve-zoomed-cnn2D.pdf", bbox_inches='tight')

from sklearn.metrics import precision_recall_curve
from sklearn.metrics import f1_score
from sklearn.metrics import auc
from sklearn.metrics import average_precision_score

precision, recall, thresholds = precision_recall_curve(yy_test,  y_pred[:
 ↪,0],pos_label=0)
# calculate F1 score
#f1 = f1_score(yy_test, y_pred)
# calculate precision-recall AUC
auc_score = auc(recall, precision)
print(auc_score)
# calculate average precision score
ap = average_precision_score(yy_test, y_pred[:,1])
print(ap)
#print('auc=%.3f ap=%.3f' % (auc, ap))
# plot no skill
f3 = plt.figure()
plt.plot([0, 1], [0, 1], linestyle='--')
```

```
# plot the precision-recall curve for the model
plt.plot( recall, precision,marker='.')
plt.xlabel('Recall')
plt.ylabel('Precision')
plt.title('Precision Recall Curve')

# show the plot
plt.show()
f3.savefig("precisionrecall-cnn2D.pdf", bbox_inches='tight')
num_positive = float(np.count_nonzero(yy_test))
num_negative = float(len(yy_test) - num_positive)
pos_weight = num_negative / num_positive
weights = np.ones_like(yy_test)
weights[yy_test != np.float64(0)] = pos_weight


precision_weighted, recall_weighted, thresholds_weighted =␣
 ↪precision_recall_curve(yy_test,  y_pred[:
 ↪,0],pos_label=0,sample_weight=weights)
#calculate F1 score
#f1 = f1_score(yy_test, y_pred)
# calculate precision-recall AUC
auc_score = auc(recall_weighted, precision_weighted)
print(auc_score)
# calculate average precision score
ap = average_precision_score(yy_test, y_pred[:,1])
print(ap)
#print('auc=%.3f ap=%.3f' % (auc, ap))
# plot no skill
f4 = plt.figure()
plt.plot([0, 1], [0, 1], linestyle='--')
# plot the weighted precision-recall curve for the model
plt.plot( recall_weighted, precision_weighted,marker='.')
plt.xlabel('Recall')
plt.ylabel('Precision')
plt.title('Weighted Precision Recall Curve')
# show the plot
plt.show()
f4.savefig("weightedprecisionrecall-cnn2D.pdf", bbox_inches='tight')
```

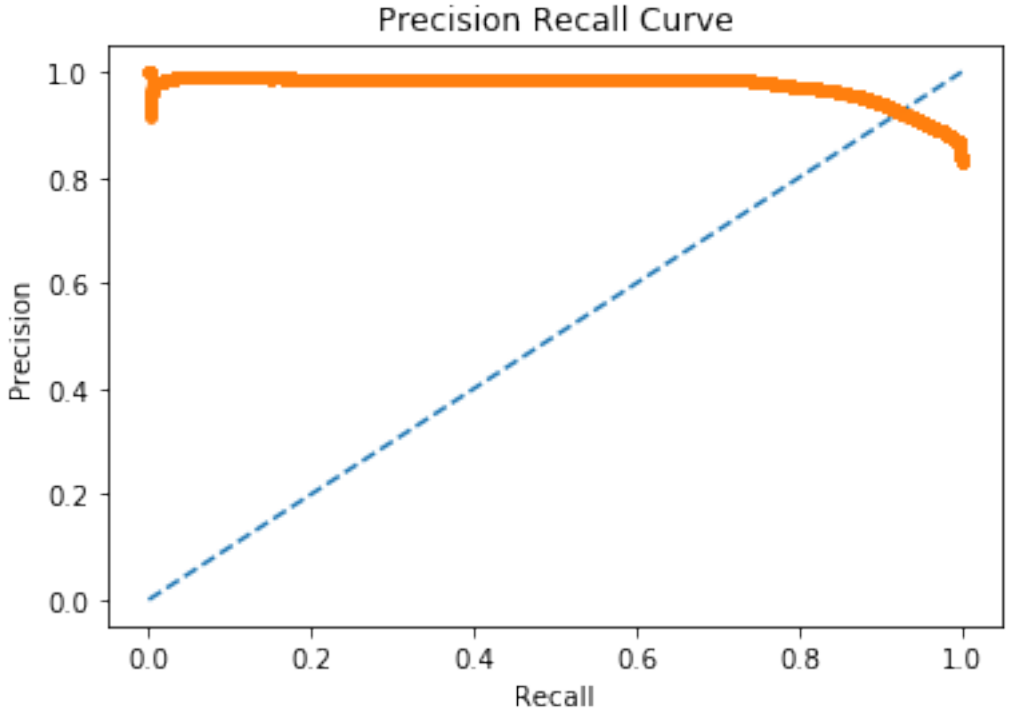
```
              precision    recall  f1-score   support

           0       0.87      0.99      0.93     34974
           1       0.91      0.28      0.43      7193

    accuracy                           0.87     42167
   macro avg       0.89      0.64      0.68     42167
```

```
weighted avg       0.88      0.87      0.84     42167

[[34777   197]
 [ 5185  2008]]
0.9102583153845071
```

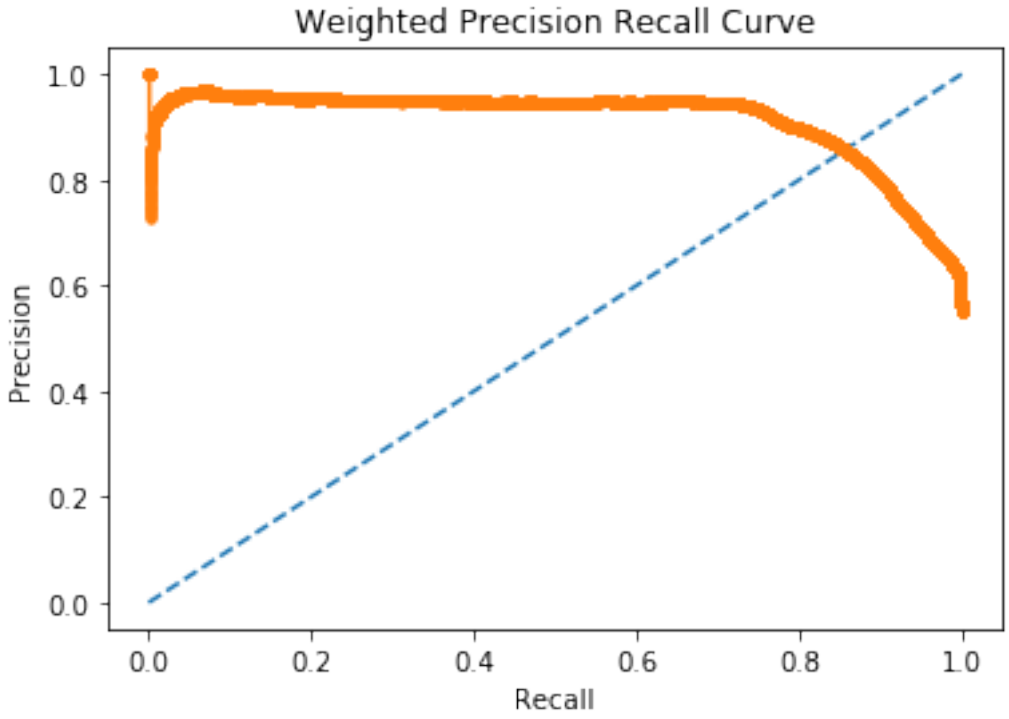





```
0.9755404721043346
0.7102951553437908
```



```
0.914544340316118
0.7102951553437908
```



[8]:
```
best_model.save('cnn2D.h5')
```

1.5 Save Model Analysis Data

[9]:
```
d = {'False Positive Rate': fpr_keras, 'True Positive Rate': tpr_keras ,␣
↪'Thresholds': thresholds_keras}
```

[10]:
```
roc_CNN2D = pd.DataFrame(data=d)
```

[11]:
```
roc_CNN2D.to_csv(path_or_buf ='rocCNN2D.csv', index=False)
```

[12]:
```
conf = confusion_matrix(yy_test, yy_pred)
```

[13]:
```
conf2D=pd.DataFrame(data=conf)
```

[14]:
```
conf2D.to_csv(path_or_buf='ConfusionCNN2D.csv',index=False)
```

[17]:
```
pd.DataFrame({"precision" : precision, "recall" :recall}).
 ↪to_csv("precisionrecall-CNN2D.csv", index=None)
pd.DataFrame({"precision" : precision_weighted, "recall" :recall_weighted}).
 ↪to_csv("weightedprecisionrecall-CNN2D.csv", index=None)
```

[ ]:
```

```