Assignment1_EE782

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1 HyperParameter Tuning : Experiments and Reports

1.1 Advanced Machine Learning

1.1.1 T Sanjev Vishnu

[257]:
```
import tensorflow as tf
import numpy as np
import pandas as pd
import numpy as np
import os
import pydicom
import matplotlib.pyplot as plt
import cv2 as cv
from PIL import Image, ImageDraw
import random
from tensorflow import keras
from sklearn.model_selection import train_test_split
from tensorflow.keras.layers import Activation, Conv2D, MaxPooling2D, Dropout,␣
↪Reshape, Conv2DTranspose, concatenate, Input, BatchNormalization
from tensorflow.keras import models, layers
from keras.optimizers import Adam
from tensorflow.keras.losses import binary_crossentropy
```

[85]:
```
def pad_up_to(t, max_in_dims, constant_values):
    s = tf.shape(t)
    paddings = [[0, m-s[i]] for (i,m) in enumerate(max_in_dims)]
    return tf.pad(t, paddings, 'CONSTANT', constant_values=constant_values)
```

[2]:
```
path = "TrainingSet/"
y = []
for i in range(1,17):
    dynamic_path = path + "P" + str(i).zfill(2) + "list.txt"
    #print(dynamic_path)
    f = open(dynamic_path)
    data = f.read()
    data = data.split("\n")
    for i in data:
```

```
        if len(i) > 1:
            y.append(i[-28:])
```

[5]:
```
images = [line[:8] for line in y]
```

[7]:
```
img_ext = ".dcm"
i = 0
x_train = []
for i in range(len(images)):
    if i%2 == 0:
        ds_img = pydicom.dcmread("TrainingSet/"+images[i]+img_ext)
        numpy_array = ds_img.pixel_array
        #cv.imwrite(images[i]+".jpg",numpy_array)
        x_train.append(numpy_array)
        #plt.figure(frameon=False)
        #plt.title("Patient ID "+images[i])
        #plt.axis("off")
        plt.imsave(images[i]+".png",ds_img.pixel_array)
        #plt.imshow(ds_img.pixel_array)
```

[107]:
```
y_train = []
for h in range(243):
    cont_f = open("TrainingSet/"+y[(h*2)])
    cont_f = cont_f.read()
    coordinates = cont_f.split("\n")
    c = []
    for i in range(len(coordinates) - 1):
        cc = coordinates[i].split()
        x1, y1 = float(cc[0]), float(cc[1])
        ccc = (x1, y1)
        c.append(ccc)
    ocont_f = open("TrainingSet/"+y[(h*2)+1])
    ocont_f = ocont_f.read()
    ocoordinates = ocont_f.split("\n")
    o = []
    for i in range(len(ocoordinates) - 1):
        oo = ocoordinates[i].split()
        x1, y1 = float(oo[0]), float(oo[1])
        ooo = (x1, y1)
        o.append(ooo)
    #print(images[2*h])
    w, height = x_train[h].shape
    oim = Image.new("L",size=(height, w))
    odraw = ImageDraw.Draw(oim)
    iim = Image.new("L",size=(height, w))
    idraw = ImageDraw.Draw(iim)
    idraw.polygon(c, fill="white")
```

```
    odraw.polygon(o, fill="white")
    oim.save("OuterContour/"+images[h*2]+"o"+".png","PNG")
    iim.save("InnerContour/"+images[h*2]+"i"+".png","PNG")
    yy = cv.imread("InnerContour/"+images[h*2]+"i"+".png",0)
    #print(yy.shape)
    y_train.append(yy)
    if h%10 == 2:
        print("*", end="")
```

****

[254]:
```
X, Y  = [], []
for i in range(len(x_train)):
    #if x_train[i].shape == (256,216):
    wid, hei = x_train[i].shape
    temp = tf.convert_to_tensor((x_train[i].reshape(1,wid,hei,1))/255.000,␣
 ↪dtype=tf.float32)
    X.append(pad_up_to(temp, [1,256,256,1], 0))
    wid, hei = y_train[i].shape
    temp = tf.convert_to_tensor((y_train[i].reshape(1,wid,hei,1))/255.000,␣
 ↪dtype=tf.float32)
    Y.append(pad_up_to(temp, [1,256,256,1], 0))
    #print(x_train[i].shape, y_train[i].shape)
```

[304]:
```
#print(type(Y))
def split_dataset(split):
    if split <= 1 and split > 0:
        split_point = int(len(X) - split*len(X))
        train_split_X = X[:split_point]
        train_split_Y = Y[:split_point]
        test_split_X = X[split_point:]
        test_split_Y = Y[split_point:]
        tr_lsdx = tf.data.Dataset.from_tensor_slices(train_split_X)
        tr_lsdy = tf.data.Dataset.from_tensor_slices(train_split_Y)
        tr_lsdd = tf.data.Dataset.zip((tr_lsdx, tr_lsdy))
        ts_lsdx = tf.data.Dataset.from_tensor_slices(test_split_X)
        ts_lsdy = tf.data.Dataset.from_tensor_slices(test_split_Y)
        ts_lsdd = tf.data.Dataset.zip((ts_lsdx, ts_lsdy))
        return tr_lsdd, ts_lsdd
    else :
        return("Split cannot be negative")
```

[149]:
```
def display(display_list):
  plt.figure(figsize=(15, 15))

  title = ['Input Image', 'True Mask', 'Predicted Mask']
```

```
  for i in range(len(display_list)):
    plt.subplot(1, len(display_list), i+1)
    plt.title(title[i])
    plt.imshow(tf.keras.preprocessing.image.array_to_img(display_list[i]))
    plt.axis('off')
  plt.show()
```

[474]:
```
def conv2d_block(input_tensor,l1, l2, n_filters, kernel_size = 3, batchnorm =␣
↪True):
    """Function to add 2 convolutional layers with the parameters passed to␣
↪it"""
    # first layer
    x = Conv2D(filters = n_filters, kernel_size = (kernel_size, kernel_size),\
              kernel_initializer = 'he_normal', padding = 'same',␣
↪kernel_regularizer=tf.keras.regularizers.l1_l2(l1, l2))(input_tensor)
    if batchnorm:
        x = BatchNormalization()(x)
    x = Activation('relu')(x)

    # second layer
    x = Conv2D(filters = n_filters, kernel_size = (kernel_size, kernel_size),\
              kernel_initializer = 'he_normal', padding = 'same',␣
↪kernel_regularizer=tf.keras.regularizers.l1_l2(l1, l2))(input_tensor)
    if batchnorm:
        x = BatchNormalization()(x)
    x = Activation('relu')(x)

    return x
```

[475]:
```
def get_unet(input_img,l1, l2, n_filters = 16, dropout = 0.1, batchnorm = True):
    """Function to define the UNET Model"""
    # Contracting Path
    c1 = conv2d_block(input_img,l1, l2, n_filters * 1, kernel_size = 3,␣
↪batchnorm = batchnorm)
    p1 = MaxPooling2D((2, 2))(c1)
    p1 = Dropout(dropout)(p1)

    c2 = conv2d_block(p1,l1, l2, n_filters * 2, kernel_size = 3, batchnorm =␣
↪batchnorm)
    p2 = MaxPooling2D((2, 2))(c2)
    p2 = Dropout(dropout)(p2)

    c3 = conv2d_block(p2,l1, l2, n_filters * 4, kernel_size = 3, batchnorm =␣
↪batchnorm)
    p3 = MaxPooling2D((2, 2))(c3)
    p3 = Dropout(dropout)(p3)
```

```
    c4 = conv2d_block(p3,l1, l2, n_filters * 8, kernel_size = 3, batchnorm =␣
↪batchnorm)
    p4 = MaxPooling2D((2, 2))(c4)
    p4 = Dropout(dropout)(p4)

    c5 = conv2d_block(p4,l1, l2, n_filters = n_filters * 16, kernel_size = 3,␣
↪batchnorm = batchnorm)

    # Expansive Path
    u6 = Conv2DTranspose(n_filters * 8, (3, 3), strides = (2, 2), padding =␣
↪'same',kernel_regularizer=tf.keras.regularizers.l1_l2(l1, l2))(c5)
    u6 = concatenate([u6, c4])
    u6 = Dropout(dropout)(u6)
    c6 = conv2d_block(u6,l1, l2, n_filters * 8, kernel_size = 3, batchnorm =␣
↪batchnorm)

    u7 = Conv2DTranspose(n_filters * 4, (3, 3), strides = (2, 2), padding =␣
↪'same',kernel_regularizer=tf.keras.regularizers.l1_l2(l1, l2))(c6)
    u7 = concatenate([u7, c3])
    u7 = Dropout(dropout)(u7)
    c7 = conv2d_block(u7,l1, l2, n_filters * 4, kernel_size = 3, batchnorm =␣
↪batchnorm)

    u8 = Conv2DTranspose(n_filters * 2, (3, 3), strides = (2, 2), padding =␣
↪'same',kernel_regularizer=tf.keras.regularizers.l1_l2(l1, l2))(c7)
    u8 = concatenate([u8, c2])
    u8 = Dropout(dropout)(u8)
    c8 = conv2d_block(u8,l1, l2, n_filters * 2, kernel_size = 3, batchnorm =␣
↪batchnorm)

    u9 = Conv2DTranspose(n_filters * 1, (3, 3), strides = (2, 2), padding =␣
↪'same',kernel_regularizer=tf.keras.regularizers.l1_l2(l1, l2))(c8)
    u9 = concatenate([u9, c1])
    u9 = Dropout(dropout)(u9)
    c9 = conv2d_block(u9,l1, l2, n_filters * 1, kernel_size = 3, batchnorm =␣
↪batchnorm)

    outputs = Conv2D(1, (1, 1), activation='sigmoid')(c9)
    model1 = models.Model(inputs=[input_img], outputs=[outputs])
    return model1
```

[466]:
```
def dice_coefficient(y_true, y_pred):
    numerator = 2 * tf.reduce_sum(y_true * y_pred)
    denominator = tf.reduce_sum(y_true + y_pred)
    return numerator / (denominator + tf.keras.backend.epsilon())
```

[487]:
```
def loss(y_true, y_pred):
    return (binary_crossentropy(y_true, y_pred))
```

[476]:
```
model1.summary()
```

```
Model: "model_6"
_________________________________________________________________________________
_________________
Layer (type)                 Output Shape              Param #     Connected to
=================================================================================
=================
img (InputLayer)             [(None, 256, 256, 1) 0
_________________________________________________________________________________
_________________
conv2d_241 (Conv2D)          (None, 256, 256, 16) 160         img[0][0]
_________________________________________________________________________________
_________________
batch_normalization_138 (BatchN (None, 256, 256, 16) 64
conv2d_241[0][0]
_________________________________________________________________________________
_________________
activation_137 (Activation)  (None, 256, 256, 16) 0
batch_normalization_138[0][0]
_________________________________________________________________________________
_________________
max_pooling2d_52 (MaxPooling2D) (None, 128, 128, 16) 0
activation_137[0][0]
_________________________________________________________________________________
_________________
dropout_100 (Dropout)        (None, 128, 128, 16) 0
max_pooling2d_52[0][0]
_________________________________________________________________________________
_________________
conv2d_243 (Conv2D)          (None, 128, 128, 32) 4640
dropout_100[0][0]
_________________________________________________________________________________
_________________
batch_normalization_140 (BatchN (None, 128, 128, 32) 128
conv2d_243[0][0]
_________________________________________________________________________________
_________________
activation_139 (Activation)  (None, 128, 128, 32) 0
batch_normalization_140[0][0]
_________________________________________________________________________________
_________________
max_pooling2d_53 (MaxPooling2D) (None, 64, 64, 32)   0
activation_139[0][0]
```

```
____________________________________________________________________________
__________________
dropout_101 (Dropout)           (None, 64, 64, 32)   0
max_pooling2d_53[0][0]
____________________________________________________________________________
__________________
conv2d_245 (Conv2D)             (None, 64, 64, 64)   18496
dropout_101[0][0]
____________________________________________________________________________
__________________
batch_normalization_142 (BatchN (None, 64, 64, 64)   256
conv2d_245[0][0]
____________________________________________________________________________
__________________
activation_141 (Activation)     (None, 64, 64, 64)   0
batch_normalization_142[0][0]
____________________________________________________________________________
__________________
max_pooling2d_54 (MaxPooling2D) (None, 32, 32, 64)   0
activation_141[0][0]
____________________________________________________________________________
__________________
dropout_102 (Dropout)           (None, 32, 32, 64)   0
max_pooling2d_54[0][0]
____________________________________________________________________________
__________________
conv2d_247 (Conv2D)             (None, 32, 32, 128)  73856
dropout_102[0][0]
____________________________________________________________________________
__________________
batch_normalization_144 (BatchN (None, 32, 32, 128)  512
conv2d_247[0][0]
____________________________________________________________________________
__________________
activation_143 (Activation)     (None, 32, 32, 128)  0
batch_normalization_144[0][0]
____________________________________________________________________________
__________________
max_pooling2d_55 (MaxPooling2D) (None, 16, 16, 128)  0
activation_143[0][0]
____________________________________________________________________________
__________________
dropout_103 (Dropout)           (None, 16, 16, 128)  0
max_pooling2d_55[0][0]
____________________________________________________________________________
__________________
conv2d_249 (Conv2D)             (None, 16, 16, 256)  295168
dropout_103[0][0]
```

```
__________________________________________________________________________________
__________________
batch_normalization_146 (BatchN (None, 16, 16, 256)  1024
conv2d_249[0][0]
__________________________________________________________________________________
__________________
activation_145 (Activation)     (None, 16, 16, 256)  0
batch_normalization_146[0][0]
__________________________________________________________________________________
__________________
conv2d_transpose_49 (Conv2DTran (None, 32, 32, 128)  295040
activation_145[0][0]
__________________________________________________________________________________
__________________
concatenate_29 (Concatenate)    (None, 32, 32, 256)  0
conv2d_transpose_49[0][0]
activation_143[0][0]
__________________________________________________________________________________
__________________
dropout_104 (Dropout)           (None, 32, 32, 256)  0
concatenate_29[0][0]
__________________________________________________________________________________
__________________
conv2d_251 (Conv2D)             (None, 32, 32, 128)  295040
dropout_104[0][0]
__________________________________________________________________________________
__________________
batch_normalization_148 (BatchN (None, 32, 32, 128)  512
conv2d_251[0][0]
__________________________________________________________________________________
__________________
activation_147 (Activation)     (None, 32, 32, 128)  0
batch_normalization_148[0][0]
__________________________________________________________________________________
__________________
conv2d_transpose_50 (Conv2DTran (None, 64, 64, 64)   73792
activation_147[0][0]
__________________________________________________________________________________
__________________
concatenate_30 (Concatenate)    (None, 64, 64, 128)  0
conv2d_transpose_50[0][0]
activation_141[0][0]
__________________________________________________________________________________
__________________
dropout_105 (Dropout)           (None, 64, 64, 128)  0
concatenate_30[0][0]
__________________________________________________________________________________
__________________
```

```
conv2d_253 (Conv2D)             (None, 64, 64, 64)   73792
dropout_105[0][0]
__________________________________________________________________________________
__________________
batch_normalization_150 (BatchN (None, 64, 64, 64)   256
conv2d_253[0][0]
__________________________________________________________________________________
__________________
activation_149 (Activation)     (None, 64, 64, 64)   0
batch_normalization_150[0][0]
__________________________________________________________________________________
__________________
conv2d_transpose_51 (Conv2DTran (None, 128, 128, 32) 18464
activation_149[0][0]
__________________________________________________________________________________
__________________
concatenate_31 (Concatenate)    (None, 128, 128, 64) 0
conv2d_transpose_51[0][0]
activation_139[0][0]
__________________________________________________________________________________
__________________
dropout_106 (Dropout)           (None, 128, 128, 64) 0
concatenate_31[0][0]
__________________________________________________________________________________
__________________
conv2d_255 (Conv2D)             (None, 128, 128, 32) 18464
dropout_106[0][0]
__________________________________________________________________________________
__________________
batch_normalization_152 (BatchN (None, 128, 128, 32) 128
conv2d_255[0][0]
__________________________________________________________________________________
__________________
activation_151 (Activation)     (None, 128, 128, 32) 0
batch_normalization_152[0][0]
__________________________________________________________________________________
__________________
conv2d_transpose_52 (Conv2DTran (None, 256, 256, 16) 4624
activation_151[0][0]
__________________________________________________________________________________
__________________
concatenate_32 (Concatenate)    (None, 256, 256, 32) 0
conv2d_transpose_52[0][0]
activation_137[0][0]
__________________________________________________________________________________
__________________
dropout_107 (Dropout)           (None, 256, 256, 32) 0
concatenate_32[0][0]
```

```
__________________________________________________________________________________
__________________
conv2d_257 (Conv2D)             (None, 256, 256, 16) 4624
dropout_107[0][0]
__________________________________________________________________________________
__________________
batch_normalization_154 (BatchN (None, 256, 256, 16) 64
conv2d_257[0][0]
__________________________________________________________________________________
__________________
activation_153 (Activation)     (None, 256, 256, 16) 0
batch_normalization_154[0][0]
__________________________________________________________________________________
__________________
conv2d_258 (Conv2D)             (None, 256, 256, 1)  17
activation_153[0][0]
==================================================================================
==================
Total params: 1,179,121
Trainable params: 1,177,649
Non-trainable params: 1,472
__________________________________________________________________________________
__________________
```

[477]:
```
def dice_metric_plot(m,titl):
    plt.figure(figsize = (8,8))
    plt.title(titl)
    loss_normal = max(np.max(m.history["loss"]), np.max(m.history["val_loss"]))
    plt.plot(m.history["loss"]/loss_normal, label="loss")
    plt.plot(m.history["val_loss"]/loss_normal, label="val_loss")
    plt.plot(m.history["dice_coefficient"], label="dice_coefficient")
    plt.plot(m.history["val_dice_coefficient"], label="val_dice_coefficient")
    plt.plot( np.argmax(m.history["val_dice_coefficient"]), np.max(m.
 ↪history["val_dice_coefficient"]), marker=6, color="b", label="Maxima")
    plt.xlabel("Number of Epochs")
    plt.ylabel("Metrics")
    plt.legend();
    plt.savefig(str(m)+".png")
```

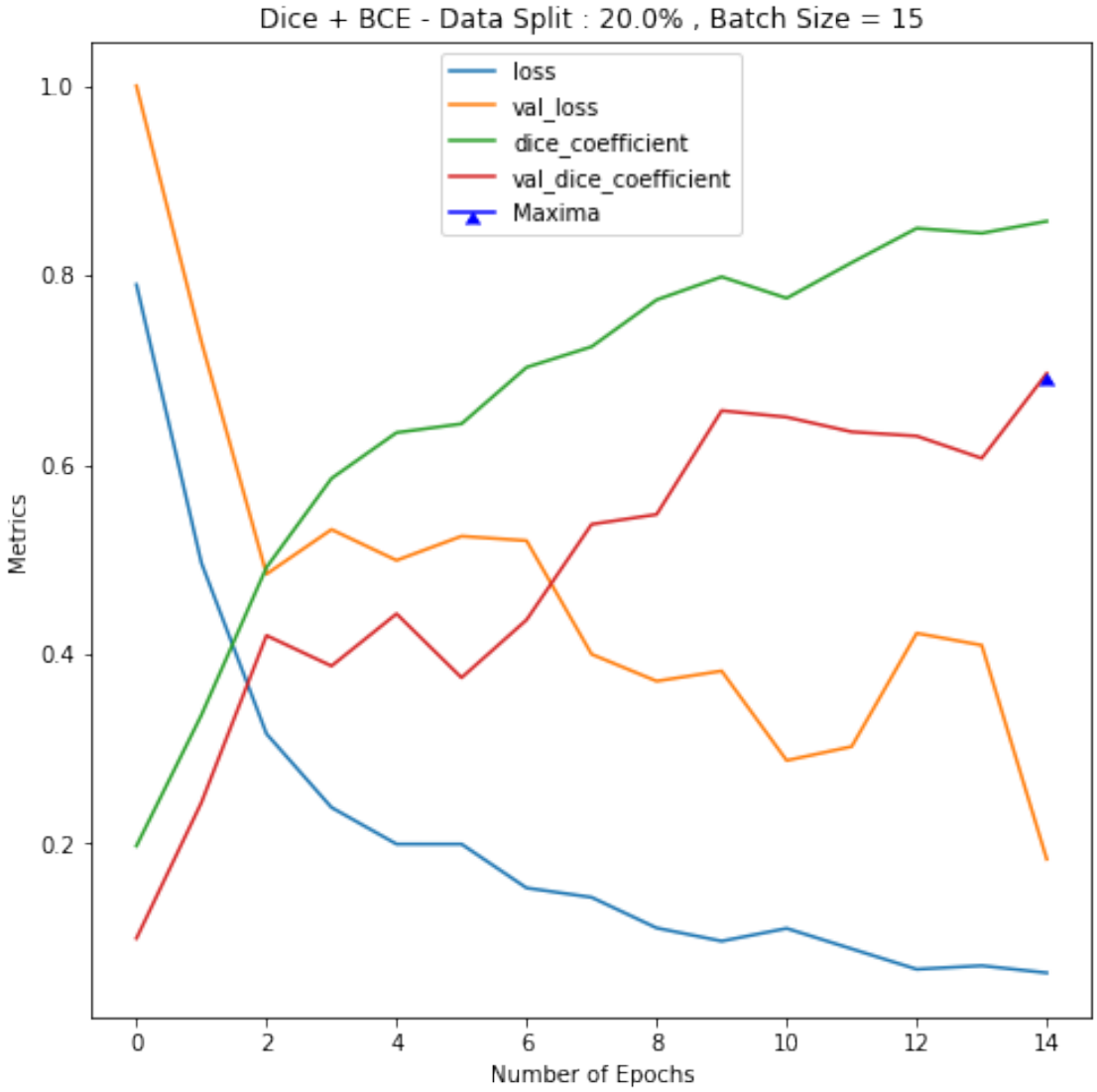
[ ]:
```
for image, mask in lsdd.take(100):
    pred_mask = dicelossmodel.predict(image)
    #print(tf.shape(pred_mask))
    sample_image, sample_mask, sample_pred_mask = tf.reshape(image, [ 256, 256,␣
 ↪1]), tf.reshape(mask, [ 256, 256, 1]), tf.reshape(pred_mask, [ 256, 256, 1])
    display([sample_image, sample_mask, sample_pred_mask])
```

[488]:
```
def experiment1(split_percent, batch_size, epochs, lamb1, lamb2):
    im_width = 256
    im_height = 256
    input_img = Input((im_height, im_width, 1), name='img')
    dicelossmodel = get_unet(input_img,lamb1, lamb2, n_filters=16, dropout=0.
↪05, batchnorm=True)
    dicelossmodel.compile(optimizer=Adam(), loss = loss ,␣
↪metrics=[dice_coefficient])
    tra, tes = split_dataset(split_percent)
    diceresults = dicelossmodel.fit(tra, batch_size = batch_size, epochs =␣
↪epochs, validation_data = tes)
    dice_metric_plot(diceresults, "BCE - Data Split :␣
↪"+str(split_percent*100)+"% , Batch Size = "+ str(batch_size) + " Lambda 1 =␣
↪"+str(lamb1)+" Lambda 2 = "+str(lamb2))
```

[461]:
```
experiment1(0.2, 15, 15)
```

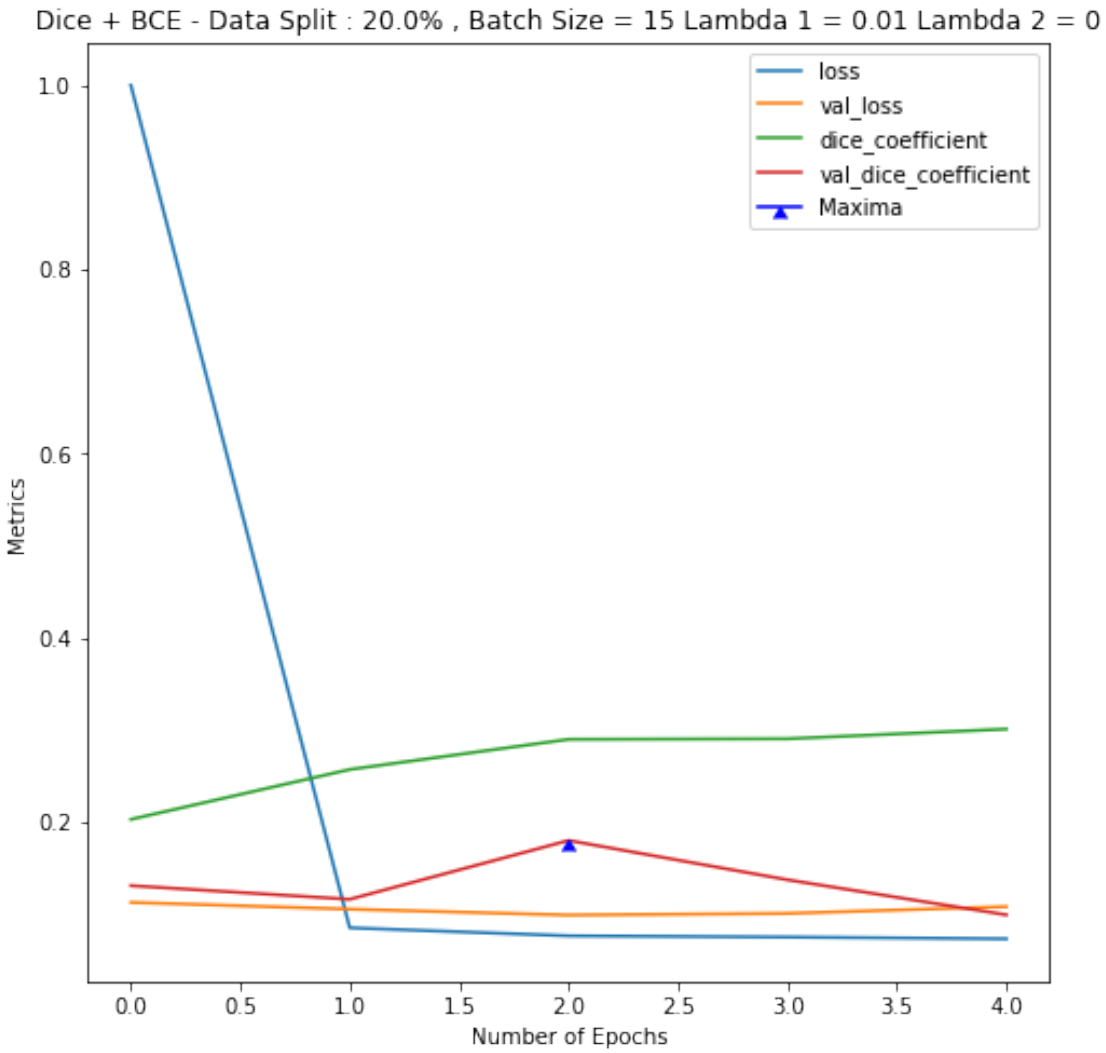
```
Epoch 1/15
194/194 [==============================] - 66s 338ms/step - loss: 2.4042 -
dice_coefficient: 0.1974 - val_loss: 3.0428 - val_dice_coefficient: 0.0999
Epoch 2/15
194/194 [==============================] - 65s 337ms/step - loss: 1.5097 -
dice_coefficient: 0.3358 - val_loss: 2.2203 - val_dice_coefficient: 0.2434
Epoch 3/15
194/194 [==============================] - 63s 327ms/step - loss: 0.9611 -
dice_coefficient: 0.4916 - val_loss: 1.4743 - val_dice_coefficient: 0.4197
Epoch 4/15
194/194 [==============================] - 63s 326ms/step - loss: 0.7244 -
dice_coefficient: 0.5855 - val_loss: 1.6175 - val_dice_coefficient: 0.3875
Epoch 5/15
194/194 [==============================] - 64s 331ms/step - loss: 0.6068 -
dice_coefficient: 0.6339 - val_loss: 1.5183 - val_dice_coefficient: 0.4426
Epoch 6/15
194/194 [==============================] - 64s 329ms/step - loss: 0.6067 -
dice_coefficient: 0.6432 - val_loss: 1.5960 - val_dice_coefficient: 0.3751
Epoch 7/15
194/194 [==============================] - 65s 335ms/step - loss: 0.4659 -
dice_coefficient: 0.7028 - val_loss: 1.5816 - val_dice_coefficient: 0.4362
Epoch 8/15
194/194 [==============================] - 66s 339ms/step - loss: 0.4358 -
dice_coefficient: 0.7246 - val_loss: 1.2168 - val_dice_coefficient: 0.5371
Epoch 9/15
194/194 [==============================] - 63s 326ms/step - loss: 0.3373 -
dice_coefficient: 0.7741 - val_loss: 1.1303 - val_dice_coefficient: 0.5475
Epoch 10/15
194/194 [==============================] - 63s 323ms/step - loss: 0.2951 -
dice_coefficient: 0.7984 - val_loss: 1.1629 - val_dice_coefficient: 0.6571
```

```
Epoch 11/15
194/194 [==============================] - 58s 301ms/step - loss: 0.3359 -
dice_coefficient: 0.7758 - val_loss: 0.8754 - val_dice_coefficient: 0.6502
Epoch 12/15
194/194 [==============================] - 55s 284ms/step - loss: 0.2702 -
dice_coefficient: 0.8134 - val_loss: 0.9200 - val_dice_coefficient: 0.6347
Epoch 13/15
194/194 [==============================] - 59s 302ms/step - loss: 0.2047 -
dice_coefficient: 0.8496 - val_loss: 1.2843 - val_dice_coefficient: 0.6302
Epoch 14/15
194/194 [==============================] - 58s 298ms/step - loss: 0.2161 -
dice_coefficient: 0.8444 - val_loss: 1.2457 - val_dice_coefficient: 0.6068
Epoch 15/15
194/194 [==============================] - 60s 310ms/step - loss: 0.1931 -
dice_coefficient: 0.8571 - val_loss: 0.5583 - val_dice_coefficient: 0.6964
```



[479]:
```
experiment1(0.2,15,5, 0.01, 0)
```

```
Epoch 1/5
194/194 [==============================] - 59s 303ms/step - loss: 53.2470 -
dice_coefficient: 0.2027 - val_loss: 5.9899 - val_dice_coefficient: 0.1307
Epoch 2/5
194/194 [==============================] - 59s 304ms/step - loss: 4.5196 -
dice_coefficient: 0.2568 - val_loss: 5.5974 - val_dice_coefficient: 0.1159
Epoch 3/5
194/194 [==============================] - 59s 304ms/step - loss: 4.0574 -
dice_coefficient: 0.2896 - val_loss: 5.2572 - val_dice_coefficient: 0.1797
Epoch 4/5
194/194 [==============================] - 59s 304ms/step - loss: 3.9849 -
dice_coefficient: 0.2902 - val_loss: 5.3519 - val_dice_coefficient: 0.1370
Epoch 5/5
194/194 [==============================] - 58s 298ms/step - loss: 3.8826 -
dice_coefficient: 0.3007 - val_loss: 5.7433 - val_dice_coefficient: 0.0990
```



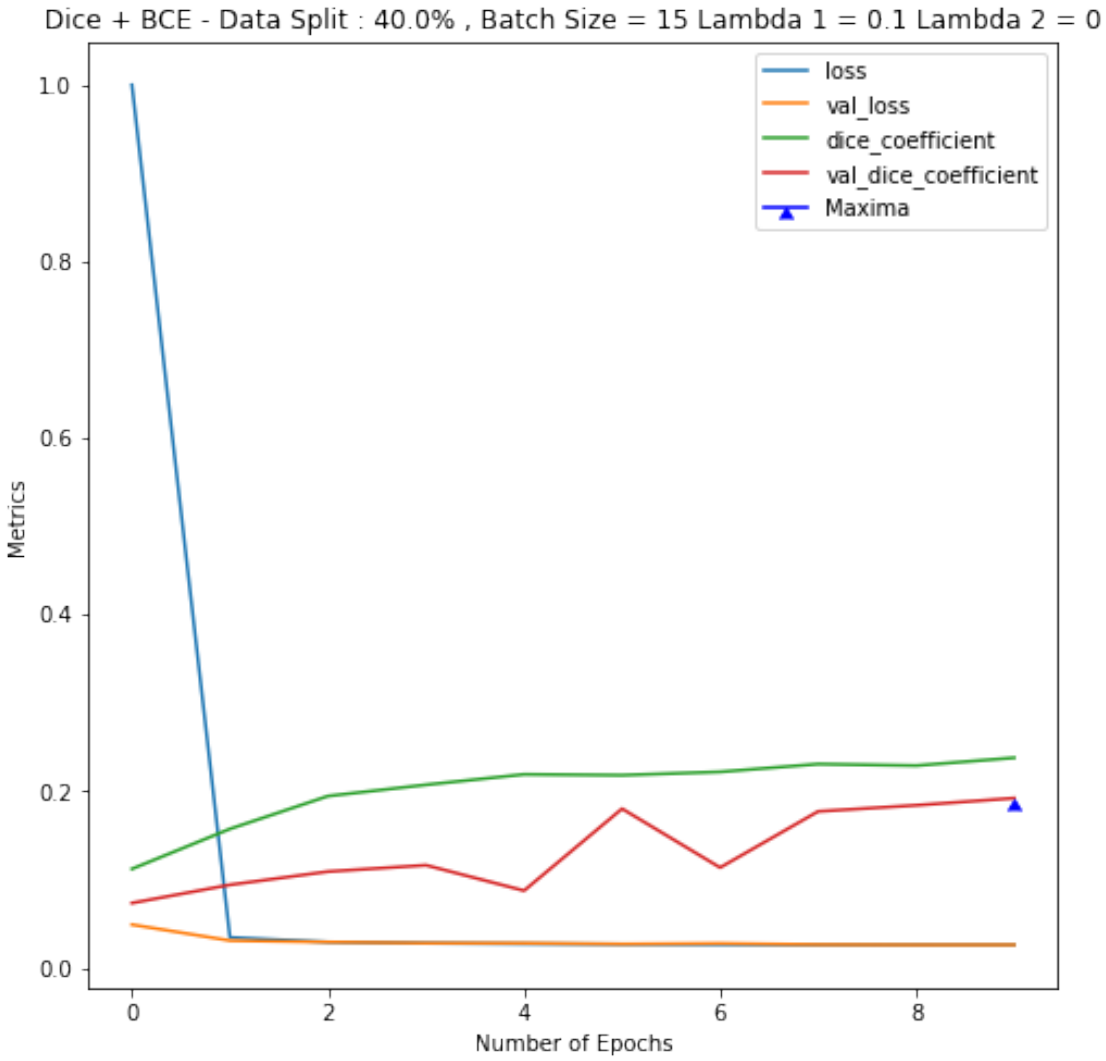
[481]:
```
experiment1(0.4, 15, 10, 0.1, 0)
experiment1(0.4, 15, 10, 0.005, 0)
experiment1(0.4, 15, 10, 0.001, 0)
experiment1(0.4, 15, 10, 0.0005, 0)
```

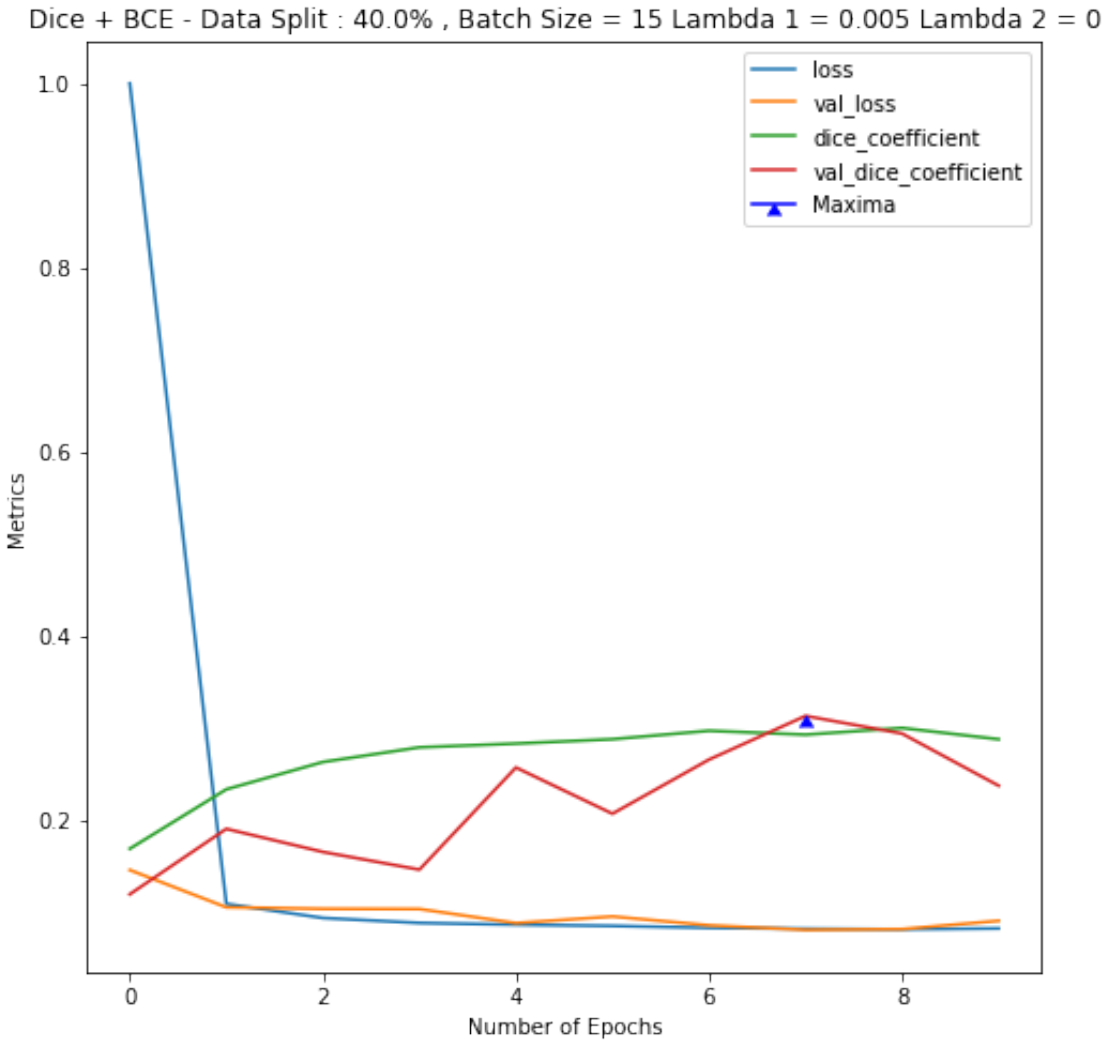
```
Epoch 1/10
145/145 [==============================] - 48s 328ms/step - loss: 663.5779 -
dice_coefficient: 0.1119 - val_loss: 32.4188 - val_dice_coefficient: 0.0733
Epoch 2/10
145/145 [==============================] - 47s 324ms/step - loss: 22.7729 -
dice_coefficient: 0.1573 - val_loss: 20.4340 - val_dice_coefficient: 0.0939
Epoch 3/10
145/145 [==============================] - 47s 326ms/step - loss: 19.3286 -
dice_coefficient: 0.1945 - val_loss: 19.3086 - val_dice_coefficient: 0.1090
Epoch 4/10
```

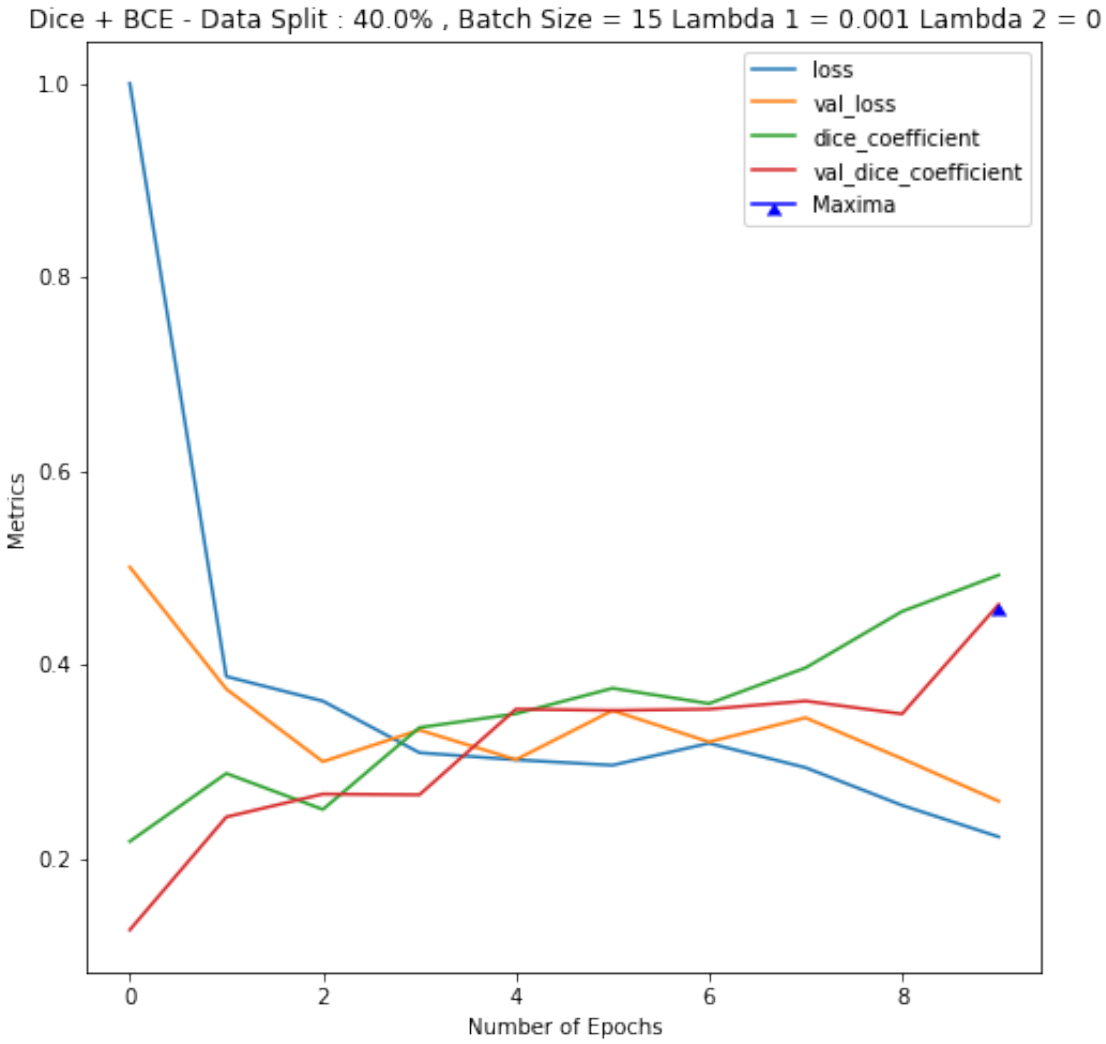
```
145/145 [==============================] - 49s 340ms/step - loss: 18.4711 -
dice_coefficient: 0.2072 - val_loss: 18.5358 - val_dice_coefficient: 0.1161
Epoch 5/10
145/145 [==============================] - 46s 314ms/step - loss: 17.9862 -
dice_coefficient: 0.2190 - val_loss: 18.5002 - val_dice_coefficient: 0.0873
Epoch 6/10
145/145 [==============================] - 44s 304ms/step - loss: 17.6625 -
dice_coefficient: 0.2181 - val_loss: 17.8203 - val_dice_coefficient: 0.1801
Epoch 7/10
145/145 [==============================] - 44s 302ms/step - loss: 17.4799 -
dice_coefficient: 0.2219 - val_loss: 18.2768 - val_dice_coefficient: 0.1135
Epoch 8/10
145/145 [==============================] - 45s 308ms/step - loss: 17.2816 -
dice_coefficient: 0.2307 - val_loss: 17.4000 - val_dice_coefficient: 0.1771
Epoch 9/10
145/145 [==============================] - 45s 307ms/step - loss: 17.1888 -
dice_coefficient: 0.2290 - val_loss: 17.1992 - val_dice_coefficient: 0.1840
Epoch 10/10
145/145 [==============================] - 45s 308ms/step - loss: 17.2053 -
dice_coefficient: 0.2378 - val_loss: 17.2359 - val_dice_coefficient: 0.1921
Epoch 1/10
145/145 [==============================] - 47s 322ms/step - loss: 36.6087 -
dice_coefficient: 0.1697 - val_loss: 5.3695 - val_dice_coefficient: 0.1203
Epoch 2/10
145/145 [==============================] - 45s 311ms/step - loss: 4.0245 -
dice_coefficient: 0.2342 - val_loss: 3.8886 - val_dice_coefficient: 0.1913
Epoch 3/10
145/145 [==============================] - 46s 317ms/step - loss: 3.4642 -
dice_coefficient: 0.2638 - val_loss: 3.8281 - val_dice_coefficient: 0.1663
Epoch 4/10
145/145 [==============================] - 45s 309ms/step - loss: 3.2672 -
dice_coefficient: 0.2797 - val_loss: 3.8201 - val_dice_coefficient: 0.1471
Epoch 5/10
145/145 [==============================] - 45s 308ms/step - loss: 3.1975 -
dice_coefficient: 0.2838 - val_loss: 3.2595 - val_dice_coefficient: 0.2579
Epoch 6/10
145/145 [==============================] - 45s 309ms/step - loss: 3.1496 -
dice_coefficient: 0.2886 - val_loss: 3.5231 - val_dice_coefficient: 0.2077
Epoch 7/10
145/145 [==============================] - 45s 310ms/step - loss: 3.0719 -
dice_coefficient: 0.2977 - val_loss: 3.1718 - val_dice_coefficient: 0.2665
Epoch 8/10
145/145 [==============================] - 45s 312ms/step - loss: 3.0373 -
dice_coefficient: 0.2935 - val_loss: 2.9914 - val_dice_coefficient: 0.3138
Epoch 9/10
145/145 [==============================] - 45s 311ms/step - loss: 3.0135 -
dice_coefficient: 0.3007 - val_loss: 3.0210 - val_dice_coefficient: 0.2947
Epoch 10/10
```

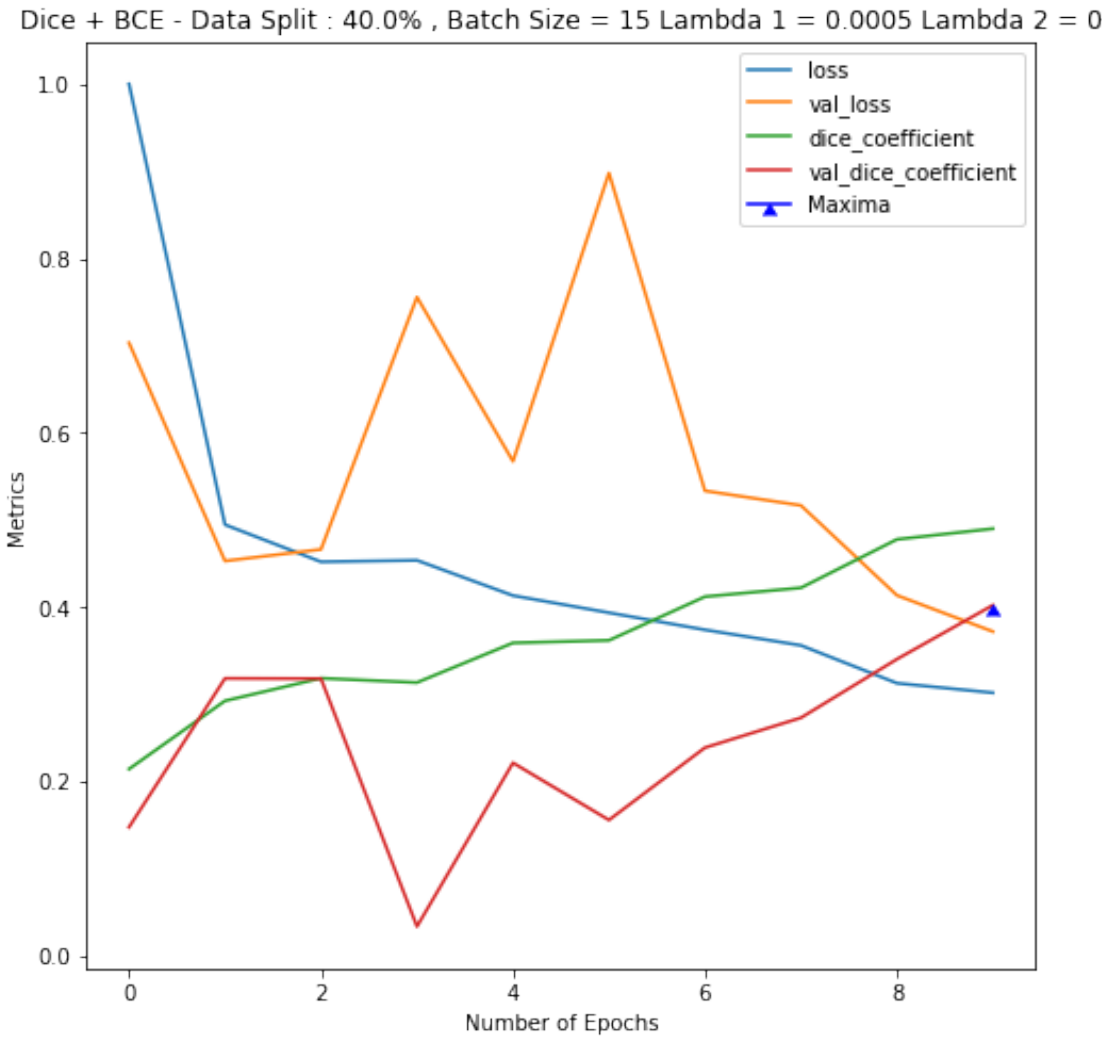
```
145/145 [==============================] - 45s 310ms/step - loss: 3.0487 -
dice_coefficient: 0.2885 - val_loss: 3.3508 - val_dice_coefficient: 0.2381
Epoch 1/10
145/145 [==============================] - 47s 327ms/step - loss: 10.7543 -
dice_coefficient: 0.2173 - val_loss: 5.3841 - val_dice_coefficient: 0.1260
Epoch 2/10
145/145 [==============================] - 44s 300ms/step - loss: 4.1686 -
dice_coefficient: 0.2875 - val_loss: 4.0290 - val_dice_coefficient: 0.2426
Epoch 3/10
145/145 [==============================] - 45s 310ms/step - loss: 3.8956 -
dice_coefficient: 0.2503 - val_loss: 3.2233 - val_dice_coefficient: 0.2662
Epoch 4/10
145/145 [==============================] - 45s 310ms/step - loss: 3.3223 -
dice_coefficient: 0.3349 - val_loss: 3.5740 - val_dice_coefficient: 0.2655
Epoch 5/10
145/145 [==============================] - 45s 310ms/step - loss: 3.2434 -
dice_coefficient: 0.3492 - val_loss: 3.2451 - val_dice_coefficient: 0.3539
Epoch 6/10
145/145 [==============================] - 45s 312ms/step - loss: 3.1831 -
dice_coefficient: 0.3755 - val_loss: 3.7905 - val_dice_coefficient: 0.3526
Epoch 7/10
145/145 [==============================] - 45s 310ms/step - loss: 3.4274 -
dice_coefficient: 0.3596 - val_loss: 3.4421 - val_dice_coefficient: 0.3539
Epoch 8/10
145/145 [==============================] - 46s 314ms/step - loss: 3.1566 -
dice_coefficient: 0.3966 - val_loss: 3.7102 - val_dice_coefficient: 0.3623
Epoch 9/10
145/145 [==============================] - 45s 312ms/step - loss: 2.7381 -
dice_coefficient: 0.4548 - val_loss: 3.2558 - val_dice_coefficient: 0.3490
Epoch 10/10
145/145 [==============================] - 46s 314ms/step - loss: 2.3885 -
dice_coefficient: 0.4923 - val_loss: 2.7838 - val_dice_coefficient: 0.4620
Epoch 1/10
145/145 [==============================] - 46s 317ms/step - loss: 7.2039 -
dice_coefficient: 0.2148 - val_loss: 5.0665 - val_dice_coefficient: 0.1481
Epoch 2/10
145/145 [==============================] - 44s 304ms/step - loss: 3.5648 -
dice_coefficient: 0.2930 - val_loss: 3.2653 - val_dice_coefficient: 0.3187
Epoch 3/10
145/145 [==============================] - 45s 312ms/step - loss: 3.2583 -
dice_coefficient: 0.3189 - val_loss: 3.3608 - val_dice_coefficient: 0.3184
Epoch 4/10
145/145 [==============================] - 46s 318ms/step - loss: 3.2706 -
dice_coefficient: 0.3139 - val_loss: 5.4440 - val_dice_coefficient: 0.0343
Epoch 5/10
145/145 [==============================] - 45s 314ms/step - loss: 2.9796 -
dice_coefficient: 0.3594 - val_loss: 4.0886 - val_dice_coefficient: 0.2219
Epoch 6/10
```

```
145/145 [==============================] - 46s 319ms/step - loss: 2.8381 -
dice_coefficient: 0.3623 - val_loss: 6.4680 - val_dice_coefficient: 0.1564
Epoch 7/10
145/145 [==============================] - 47s 325ms/step - loss: 2.6969 -
dice_coefficient: 0.4124 - val_loss: 3.8444 - val_dice_coefficient: 0.2393
Epoch 8/10
145/145 [==============================] - 48s 328ms/step - loss: 2.5683 -
dice_coefficient: 0.4225 - val_loss: 3.7240 - val_dice_coefficient: 0.2735
Epoch 9/10
145/145 [==============================] - 47s 328ms/step - loss: 2.2561 -
dice_coefficient: 0.4780 - val_loss: 2.9815 - val_dice_coefficient: 0.3407
Epoch 10/10
145/145 [==============================] - 47s 323ms/step - loss: 2.1769 -
dice_coefficient: 0.4903 - val_loss: 2.6825 - val_dice_coefficient: 0.4026
```




Dice + BCE - Data Split : 40.0% , Batch Size = 15 Lambda 1 = 0.005 Lambda 2 = 0
loss
val_loss
dice_coefficient
val_dice_coefficient
Maxima
Metrics
Number of Epochs
1.0
0.8
0.6
0.4
0.2
0
2
4
6
8

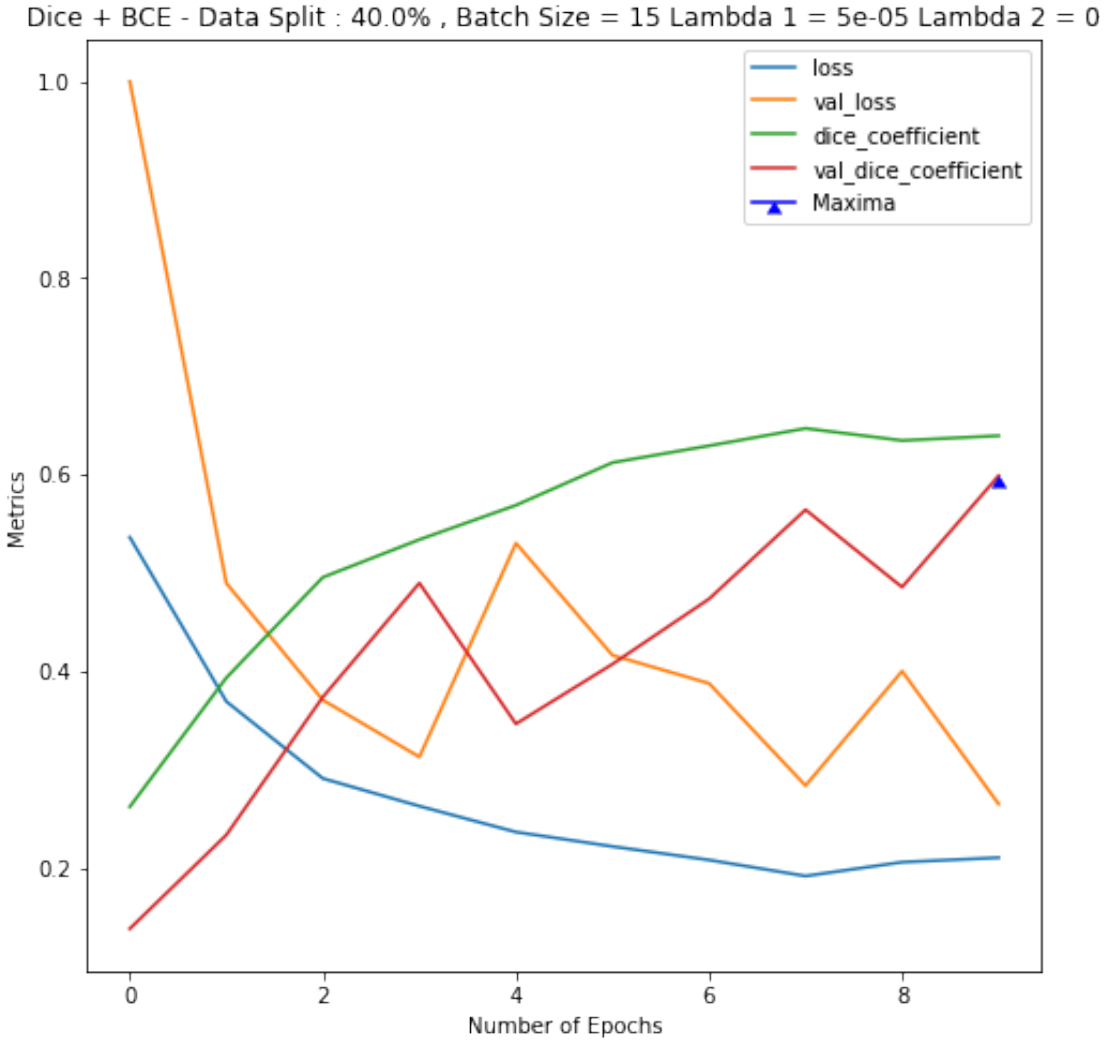

Dice + BCE - Data Split : 40.0% , Batch Size = 15 Lambda 1 = 0.001 Lambda 2 = 0
loss
val_loss
dice_coefficient
val_dice_coefficient
Maxima
Metrics
Number of Epochs
1.0
0.8
0.6
0.4
0.2
0
2
4
6
8



[482]:
```
experiment1(0.4, 15, 10, 0.00005, 0)
```

```
Epoch 1/10
145/145 [==============================] - 45s 311ms/step - loss: 3.0978 -
dice_coefficient: 0.2622 - val_loss: 5.7745 - val_dice_coefficient: 0.1382
Epoch 2/10
145/145 [==============================] - 45s 312ms/step - loss: 2.1331 -
dice_coefficient: 0.3935 - val_loss: 2.8278 - val_dice_coefficient: 0.2336
Epoch 3/10
145/145 [==============================] - 46s 315ms/step - loss: 1.6807 -
dice_coefficient: 0.4957 - val_loss: 2.1413 - val_dice_coefficient: 0.3739
Epoch 4/10
145/145 [==============================] - 45s 311ms/step - loss: 1.5183 -
dice_coefficient: 0.5340 - val_loss: 1.8070 - val_dice_coefficient: 0.4898
Epoch 5/10
```

```
145/145 [==============================] - 46s 315ms/step - loss: 1.3661 -
dice_coefficient: 0.5690 - val_loss: 3.0626 - val_dice_coefficient: 0.3466
Epoch 6/10
145/145 [==============================] - 46s 315ms/step - loss: 1.2814 -
dice_coefficient: 0.6123 - val_loss: 2.4044 - val_dice_coefficient: 0.4074
Epoch 7/10
145/145 [==============================] - 46s 320ms/step - loss: 1.2019 -
dice_coefficient: 0.6295 - val_loss: 2.2396 - val_dice_coefficient: 0.4736
Epoch 8/10
145/145 [==============================] - 47s 325ms/step - loss: 1.1076 -
dice_coefficient: 0.6472 - val_loss: 1.6387 - val_dice_coefficient: 0.5644
Epoch 9/10
145/145 [==============================] - 47s 322ms/step - loss: 1.1892 -
dice_coefficient: 0.6348 - val_loss: 2.3111 - val_dice_coefficient: 0.4857
Epoch 10/10
145/145 [==============================] - 46s 317ms/step - loss: 1.2154 -
dice_coefficient: 0.6397 - val_loss: 1.5308 - val_dice_coefficient: 0.5990
```



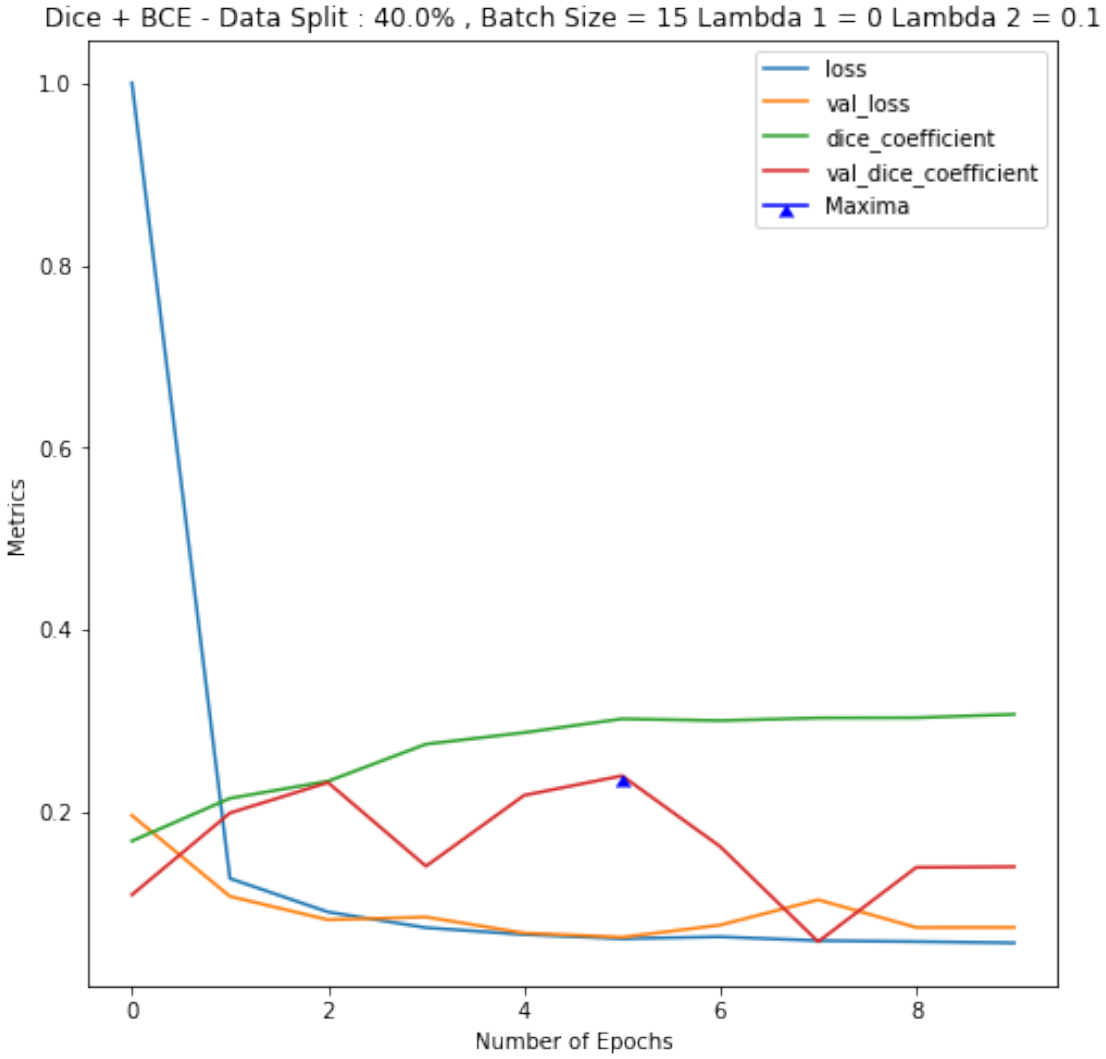
[483]:
```
# Experimenting with values of Lambda 2 hyperparameter of L2 Penalty
experiment1(0.4, 15, 10, 0, 0.1)
experiment1(0.4, 15, 10, 0, 0.01)
experiment1(0.4, 15, 10, 0, 0.001)
experiment1(0.4, 15, 10, 0, 0.0005)
experiment1(0.4, 15, 10, 0, 0.00005)
```

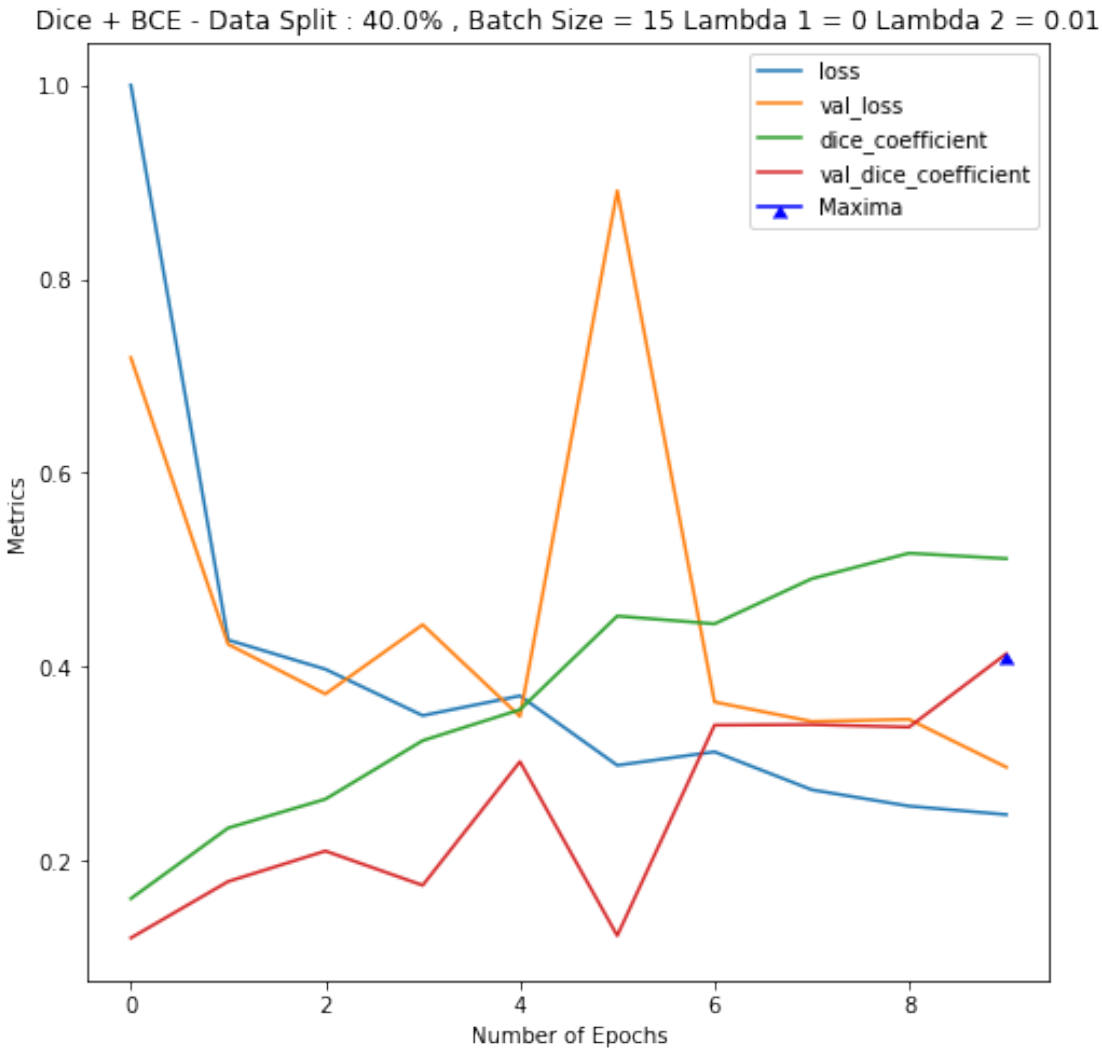
```
Epoch 1/10
145/145 [==============================] - 47s 326ms/step - loss: 37.3791 -
dice_coefficient: 0.1686 - val_loss: 7.3513 - val_dice_coefficient: 0.1096
Epoch 2/10
145/145 [==============================] - 46s 316ms/step - loss: 4.7661 -
dice_coefficient: 0.2155 - val_loss: 4.0326 - val_dice_coefficient: 0.1994
Epoch 3/10
145/145 [==============================] - 46s 315ms/step - loss: 3.3940 -
dice_coefficient: 0.2342 - val_loss: 3.0740 - val_dice_coefficient: 0.2328
Epoch 4/10
145/145 [==============================] - 48s 333ms/step - loss: 2.7500 -
dice_coefficient: 0.2749 - val_loss: 3.1865 - val_dice_coefficient: 0.1410
Epoch 5/10
145/145 [==============================] - 44s 304ms/step - loss: 2.4699 -
dice_coefficient: 0.2875 - val_loss: 2.5310 - val_dice_coefficient: 0.2187
Epoch 6/10
145/145 [==============================] - 44s 303ms/step - loss: 2.2989 -
dice_coefficient: 0.3026 - val_loss: 2.3597 - val_dice_coefficient: 0.2402
Epoch 7/10
145/145 [==============================] - 44s 303ms/step - loss: 2.3774 -
dice_coefficient: 0.3006 - val_loss: 2.8559 - val_dice_coefficient: 0.1626
Epoch 8/10
145/145 [==============================] - 46s 319ms/step - loss: 2.2195 -
dice_coefficient: 0.3036 - val_loss: 3.8952 - val_dice_coefficient: 0.0582
Epoch 9/10
145/145 [==============================] - 46s 319ms/step - loss: 2.1805 -
dice_coefficient: 0.3038 - val_loss: 2.7594 - val_dice_coefficient: 0.1397
Epoch 10/10
145/145 [==============================] - 46s 316ms/step - loss: 2.1269 -
dice_coefficient: 0.3076 - val_loss: 2.7632 - val_dice_coefficient: 0.1404
Epoch 1/10
145/145 [==============================] - 48s 328ms/step - loss: 6.8764 -
dice_coefficient: 0.1610 - val_loss: 4.9436 - val_dice_coefficient: 0.1205
Epoch 2/10
145/145 [==============================] - 45s 309ms/step - loss: 2.9417 -
dice_coefficient: 0.2339 - val_loss: 2.9112 - val_dice_coefficient: 0.1787
Epoch 3/10
145/145 [==============================] - 45s 313ms/step - loss: 2.7341 -
```

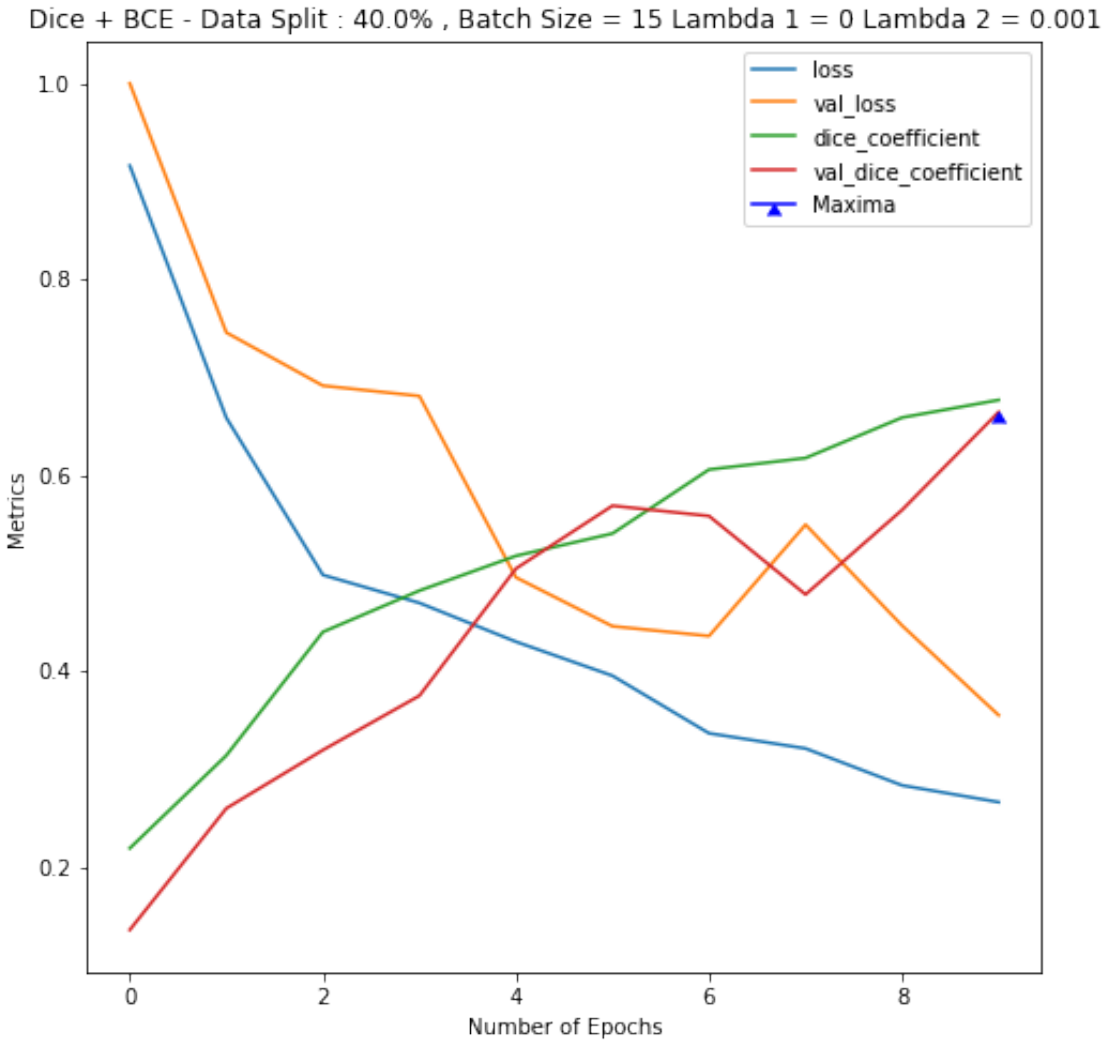
```
dice_coefficient: 0.2636 - val_loss: 2.5588 - val_dice_coefficient: 0.2102
Epoch 4/10
145/145 [==============================] - 47s 322ms/step - loss: 2.4058 -
dice_coefficient: 0.3240 - val_loss: 3.0502 - val_dice_coefficient: 0.1748
Epoch 5/10
145/145 [==============================] - 49s 339ms/step - loss: 2.5455 -
dice_coefficient: 0.3559 - val_loss: 2.3996 - val_dice_coefficient: 0.3023
Epoch 6/10
145/145 [==============================] - 56s 388ms/step - loss: 2.0528 -
dice_coefficient: 0.4525 - val_loss: 6.1272 - val_dice_coefficient: 0.1228
Epoch 7/10
145/145 [==============================] - 53s 368ms/step - loss: 2.1485 -
dice_coefficient: 0.4444 - val_loss: 2.5020 - val_dice_coefficient: 0.3400
Epoch 8/10
145/145 [==============================] - 49s 341ms/step - loss: 1.8792 -
dice_coefficient: 0.4910 - val_loss: 2.3638 - val_dice_coefficient: 0.3405
Epoch 9/10
145/145 [==============================] - 49s 335ms/step - loss: 1.7634 -
dice_coefficient: 0.5173 - val_loss: 2.3787 - val_dice_coefficient: 0.3379
Epoch 10/10
145/145 [==============================] - 51s 351ms/step - loss: 1.7032 -
dice_coefficient: 0.5117 - val_loss: 2.0391 - val_dice_coefficient: 0.4136
Epoch 1/10
145/145 [==============================] - 50s 345ms/step - loss: 3.2252 -
dice_coefficient: 0.2189 - val_loss: 3.5211 - val_dice_coefficient: 0.1355
Epoch 2/10
145/145 [==============================] - 50s 344ms/step - loss: 2.3188 -
dice_coefficient: 0.3137 - val_loss: 2.6253 - val_dice_coefficient: 0.2596
Epoch 3/10
145/145 [==============================] - 49s 340ms/step - loss: 1.7535 -
dice_coefficient: 0.4398 - val_loss: 2.4342 - val_dice_coefficient: 0.3192
Epoch 4/10
145/145 [==============================] - 52s 357ms/step - loss: 1.6530 -
dice_coefficient: 0.4820 - val_loss: 2.3969 - val_dice_coefficient: 0.3747
Epoch 5/10
145/145 [==============================] - 51s 350ms/step - loss: 1.5135 -
dice_coefficient: 0.5175 - val_loss: 1.7447 - val_dice_coefficient: 0.5045
Epoch 6/10
145/145 [==============================] - 51s 350ms/step - loss: 1.3912 -
dice_coefficient: 0.5403 - val_loss: 1.5691 - val_dice_coefficient: 0.5687
Epoch 7/10
145/145 [==============================] - 51s 350ms/step - loss: 1.1842 -
dice_coefficient: 0.6056 - val_loss: 1.5340 - val_dice_coefficient: 0.5582
Epoch 8/10
145/145 [==============================] - 50s 347ms/step - loss: 1.1296 -
dice_coefficient: 0.6174 - val_loss: 1.9343 - val_dice_coefficient: 0.4781
Epoch 9/10
145/145 [==============================] - 53s 363ms/step - loss: 0.9969 -
```

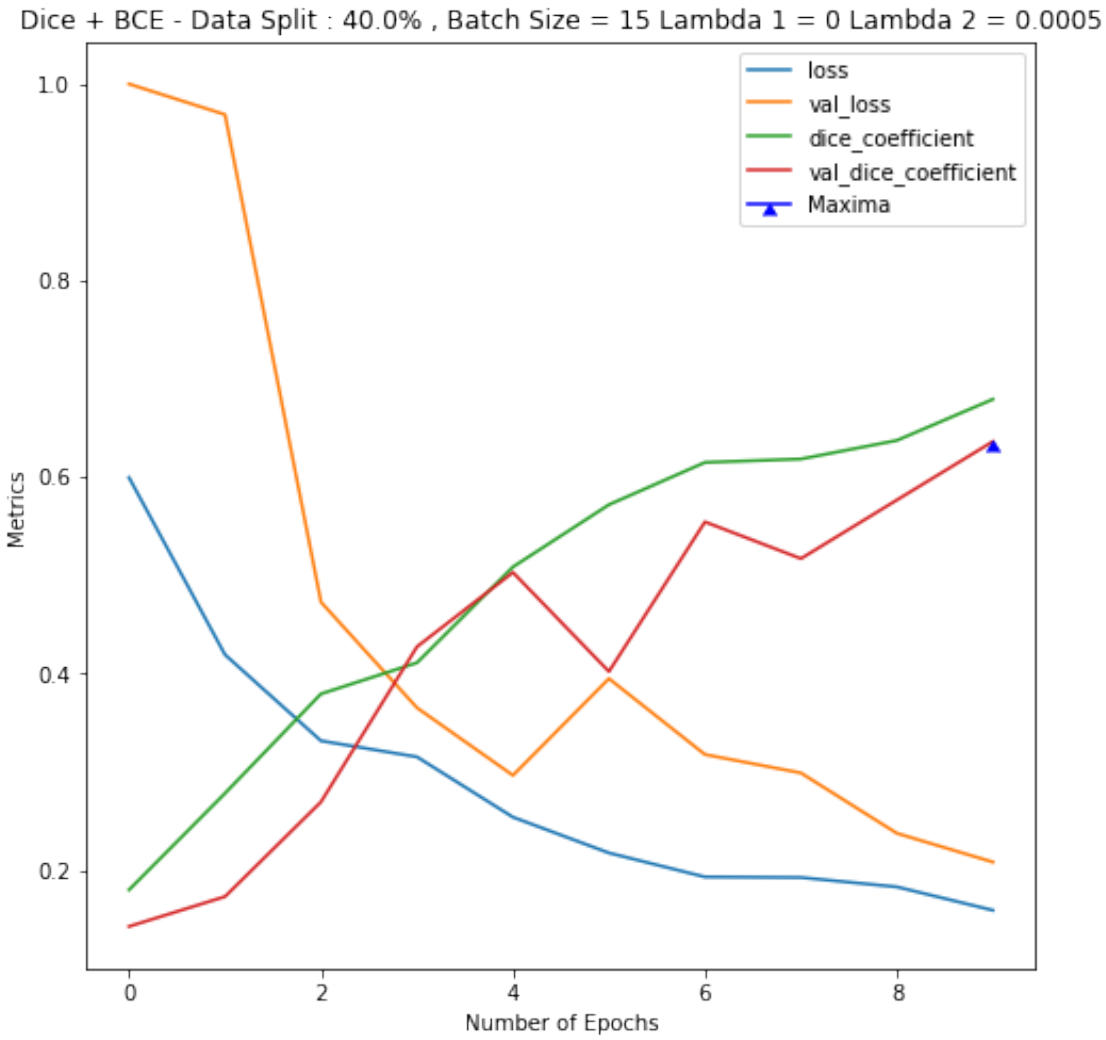
```
dice_coefficient: 0.6587 - val_loss: 1.5714 - val_dice_coefficient: 0.5644
Epoch 10/10
145/145 [==============================] - 50s 346ms/step - loss: 0.9367 -
dice_coefficient: 0.6767 - val_loss: 1.2492 - val_dice_coefficient: 0.6644
Epoch 1/10
145/145 [==============================] - 49s 335ms/step - loss: 3.1594 -
dice_coefficient: 0.1798 - val_loss: 5.2701 - val_dice_coefficient: 0.1425
Epoch 2/10
145/145 [==============================] - 47s 324ms/step - loss: 2.2089 -
dice_coefficient: 0.2780 - val_loss: 5.1061 - val_dice_coefficient: 0.1729
Epoch 3/10
145/145 [==============================] - 48s 330ms/step - loss: 1.7468 -
dice_coefficient: 0.3792 - val_loss: 2.4911 - val_dice_coefficient: 0.2693
Epoch 4/10
145/145 [==============================] - 46s 319ms/step - loss: 1.6607 -
dice_coefficient: 0.4109 - val_loss: 1.9242 - val_dice_coefficient: 0.4272
Epoch 5/10
145/145 [==============================] - 46s 315ms/step - loss: 1.3374 -
dice_coefficient: 0.5085 - val_loss: 1.5616 - val_dice_coefficient: 0.5029
Epoch 6/10
145/145 [==============================] - 52s 357ms/step - loss: 1.1455 -
dice_coefficient: 0.5718 - val_loss: 2.0806 - val_dice_coefficient: 0.4020
Epoch 7/10
145/145 [==============================] - 49s 339ms/step - loss: 1.0169 -
dice_coefficient: 0.6148 - val_loss: 1.6736 - val_dice_coefficient: 0.5543
Epoch 8/10
145/145 [==============================] - 48s 332ms/step - loss: 1.0138 -
dice_coefficient: 0.6183 - val_loss: 1.5746 - val_dice_coefficient: 0.5169
Epoch 9/10
145/145 [==============================] - 47s 325ms/step - loss: 0.9632 -
dice_coefficient: 0.6372 - val_loss: 1.2507 - val_dice_coefficient: 0.5766
Epoch 10/10
145/145 [==============================] - 47s 324ms/step - loss: 0.8380 -
dice_coefficient: 0.6791 - val_loss: 1.0966 - val_dice_coefficient: 0.6361
Epoch 1/10
145/145 [==============================] - 46s 318ms/step - loss: 2.7233 -
dice_coefficient: 0.1765 - val_loss: 6.2330 - val_dice_coefficient: 0.0597
Epoch 2/10
145/145 [==============================] - 48s 328ms/step - loss: 1.9354 -
dice_coefficient: 0.2688 - val_loss: 3.9465 - val_dice_coefficient: 0.0857
Epoch 3/10
145/145 [==============================] - 48s 328ms/step - loss: 1.4800 -
dice_coefficient: 0.3636 - val_loss: 1.9575 - val_dice_coefficient: 0.3705
Epoch 4/10
145/145 [==============================] - 47s 321ms/step - loss: 1.1740 -
dice_coefficient: 0.4534 - val_loss: 1.4831 - val_dice_coefficient: 0.4578
Epoch 5/10
145/145 [==============================] - 47s 323ms/step - loss: 0.9482 -
```

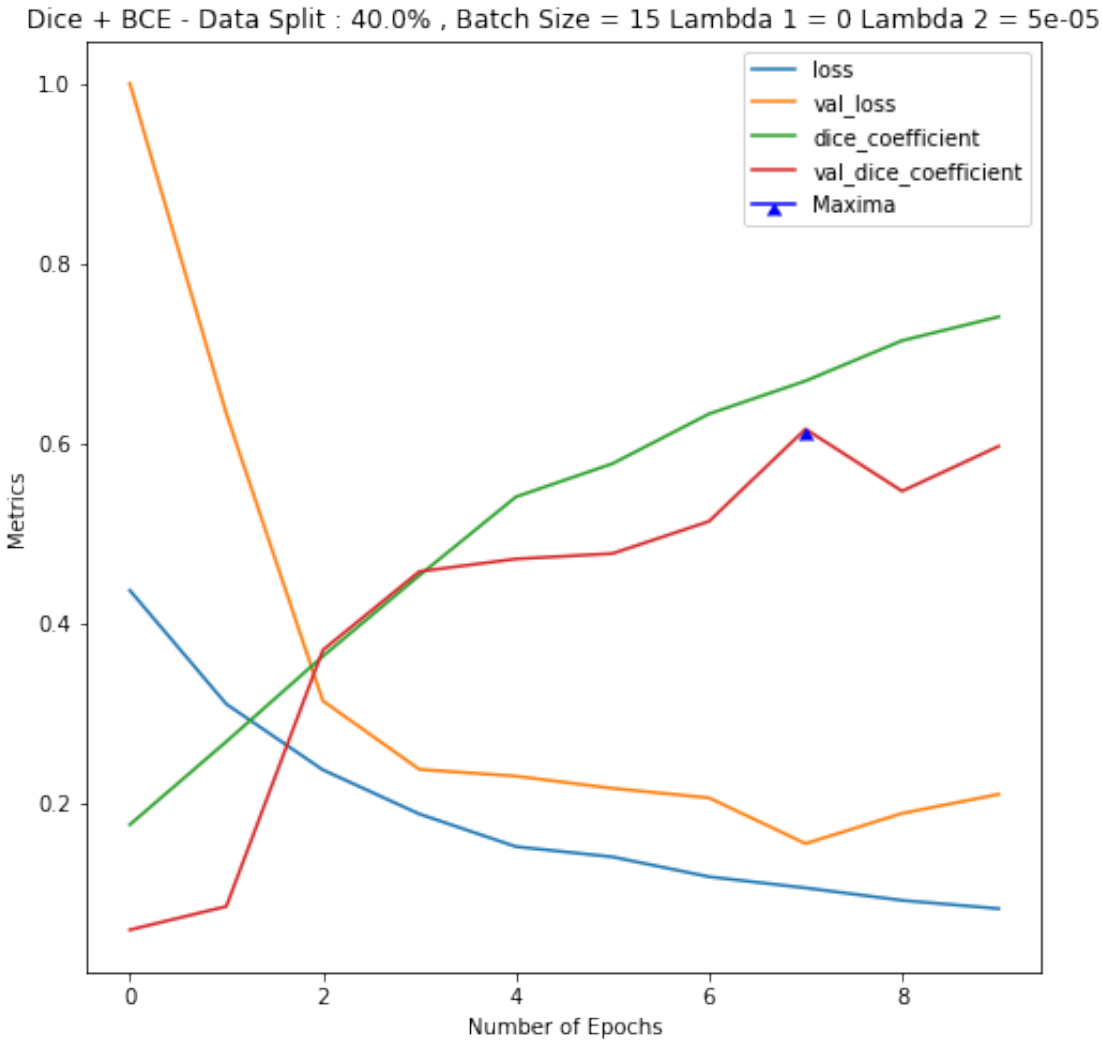
```
dice_coefficient: 0.5407 - val_loss: 1.4365 - val_dice_coefficient: 0.4717
Epoch 6/10
145/145 [==============================] - 47s 323ms/step - loss: 0.8772 -
dice_coefficient: 0.5776 - val_loss: 1.3517 - val_dice_coefficient: 0.4777
Epoch 7/10
145/145 [==============================] - 48s 330ms/step - loss: 0.7397 -
dice_coefficient: 0.6328 - val_loss: 1.2863 - val_dice_coefficient: 0.5135
Epoch 8/10
145/145 [==============================] - 47s 323ms/step - loss: 0.6624 -
dice_coefficient: 0.6695 - val_loss: 0.9694 - val_dice_coefficient: 0.6160
Epoch 9/10
145/145 [==============================] - 47s 322ms/step - loss: 0.5761 -
dice_coefficient: 0.7143 - val_loss: 1.1787 - val_dice_coefficient: 0.5471
Epoch 10/10
145/145 [==============================] - 47s 322ms/step - loss: 0.5189 -
dice_coefficient: 0.7407 - val_loss: 1.3109 - val_dice_coefficient: 0.5969
```




Dice + BCE - Data Split : 40.0% , Batch Size = 15 Lambda 1 = 0 Lambda 2 = 0.01
loss
val_loss
dice_coefficient
val_dice_coefficient
Maxima
Metrics
1.0
0.8
0.6
0.4
0.2
0
2
4
6
8
Number of Epochs


Dice + BCE - Data Split : 40.0% , Batch Size = 15 Lambda 1 = 0 Lambda 2 = 0.001
loss
val_loss
dice_coefficient
val_dice_coefficient
Maxima
Metrics
1.0
0.8
0.6
0.4
0.2
0
2
4
6
8
Number of Epochs

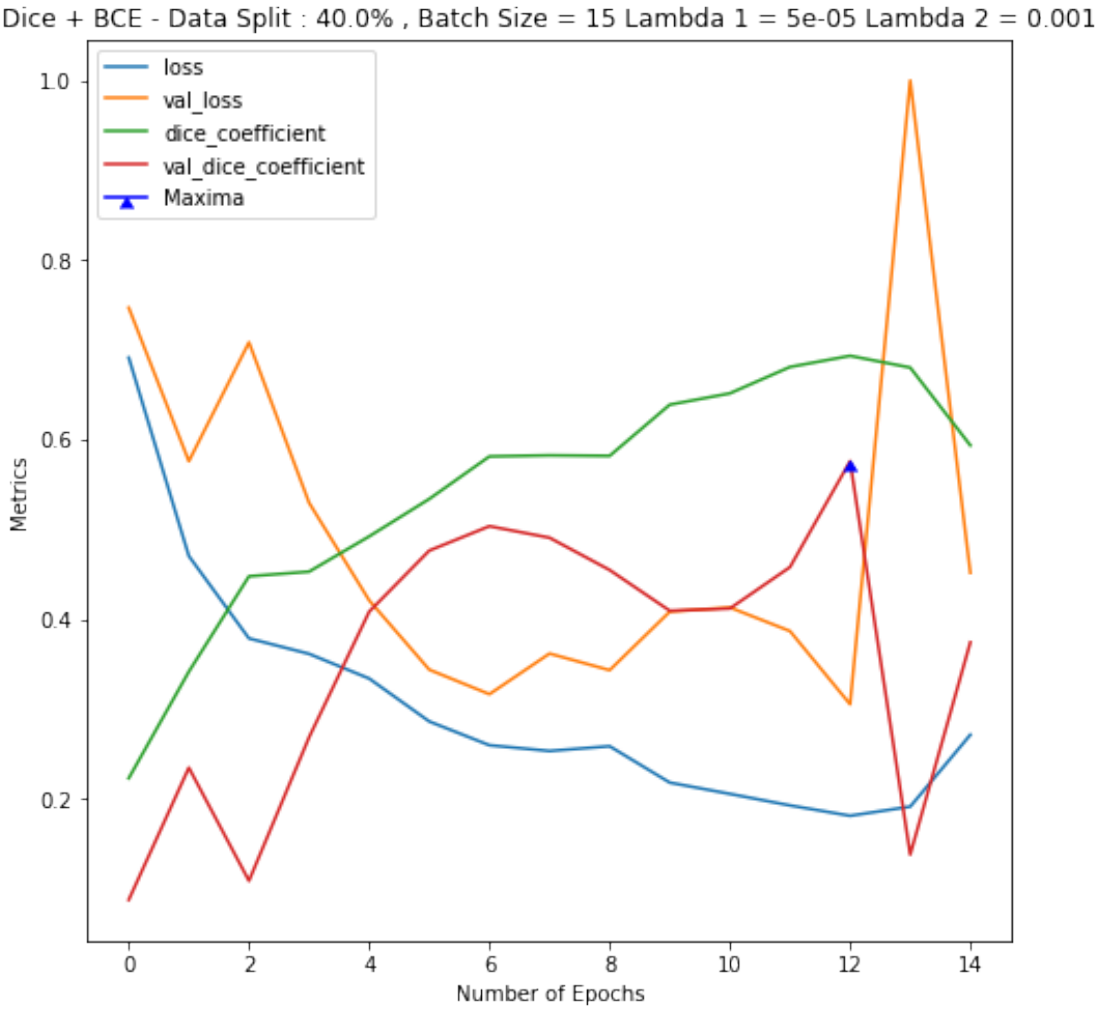

Dice + BCE - Data Split : 40.0% , Batch Size = 15 Lambda 1 = 0 Lambda 2 = 0.0005
loss
val_loss
dice_coefficient
val_dice_coefficient
Maxima
Metrics
Number of Epochs
1.0
0.8
0.6
0.4
0.2
0
2
4
6
8



[485]:
```
experiment1(0.4, 15, 15, 0.00005, 0.001)
```

```
Epoch 1/15
145/145 [==============================] - 48s 330ms/step - loss: 3.8506 -
dice_coefficient: 0.2233 - val_loss: 4.1601 - val_dice_coefficient: 0.0880
Epoch 2/15
145/145 [==============================] - 47s 324ms/step - loss: 2.6209 -
dice_coefficient: 0.3420 - val_loss: 3.2086 - val_dice_coefficient: 0.2350
Epoch 3/15
145/145 [==============================] - 49s 336ms/step - loss: 2.1103 -
dice_coefficient: 0.4481 - val_loss: 3.9453 - val_dice_coefficient: 0.1092
Epoch 4/15
145/145 [==============================] - 47s 327ms/step - loss: 2.0146 -
dice_coefficient: 0.4533 - val_loss: 2.9510 - val_dice_coefficient: 0.2689
Epoch 5/15
```

```
145/145 [==============================] - 47s 322ms/step - loss: 1.8615 -
dice_coefficient: 0.4925 - val_loss: 2.3462 - val_dice_coefficient: 0.4088
Epoch 6/15
145/145 [==============================] - 47s 325ms/step - loss: 1.5955 -
dice_coefficient: 0.5342 - val_loss: 1.9164 - val_dice_coefficient: 0.4767
Epoch 7/15
145/145 [==============================] - 47s 325ms/step - loss: 1.4482 -
dice_coefficient: 0.5815 - val_loss: 1.7646 - val_dice_coefficient: 0.5039
Epoch 8/15
145/145 [==============================] - 50s 346ms/step - loss: 1.4125 -
dice_coefficient: 0.5827 - val_loss: 2.0164 - val_dice_coefficient: 0.4910
Epoch 9/15
145/145 [==============================] - 47s 327ms/step - loss: 1.4421 -
dice_coefficient: 0.5822 - val_loss: 1.9133 - val_dice_coefficient: 0.4551
Epoch 10/15
145/145 [==============================] - 48s 331ms/step - loss: 1.2166 -
dice_coefficient: 0.6391 - val_loss: 2.2761 - val_dice_coefficient: 0.4097
Epoch 11/15
145/145 [==============================] - 47s 327ms/step - loss: 1.1467 -
dice_coefficient: 0.6517 - val_loss: 2.3021 - val_dice_coefficient: 0.4122
Epoch 12/15
145/145 [==============================] - 47s 326ms/step - loss: 1.0751 -
dice_coefficient: 0.6811 - val_loss: 2.1558 - val_dice_coefficient: 0.4583
Epoch 13/15
145/145 [==============================] - 48s 329ms/step - loss: 1.0109 -
dice_coefficient: 0.6935 - val_loss: 1.7021 - val_dice_coefficient: 0.5763
Epoch 14/15
145/145 [==============================] - 47s 327ms/step - loss: 1.0675 -
dice_coefficient: 0.6805 - val_loss: 5.5685 - val_dice_coefficient: 0.1384
Epoch 15/15
145/145 [==============================] - 47s 325ms/step - loss: 1.5129 -
dice_coefficient: 0.5939 - val_loss: 2.5172 - val_dice_coefficient: 0.3746
```



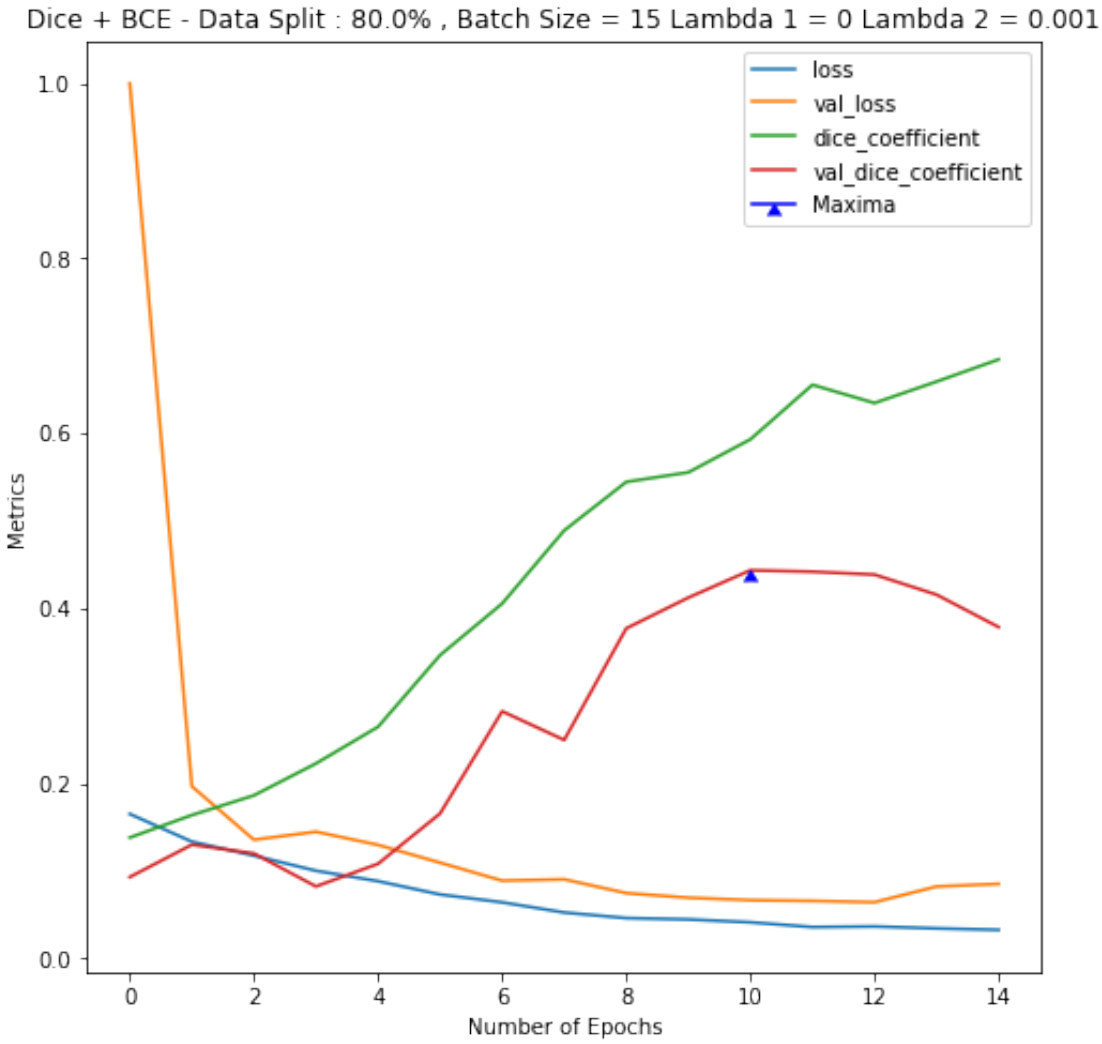
[486]:
```
experiment1(0.8, 15, 15, 0, 0.001)
experiment1(0.6, 15, 15, 0, 0.001)
experiment1(0.2, 15, 15, 0, 0.001)
```

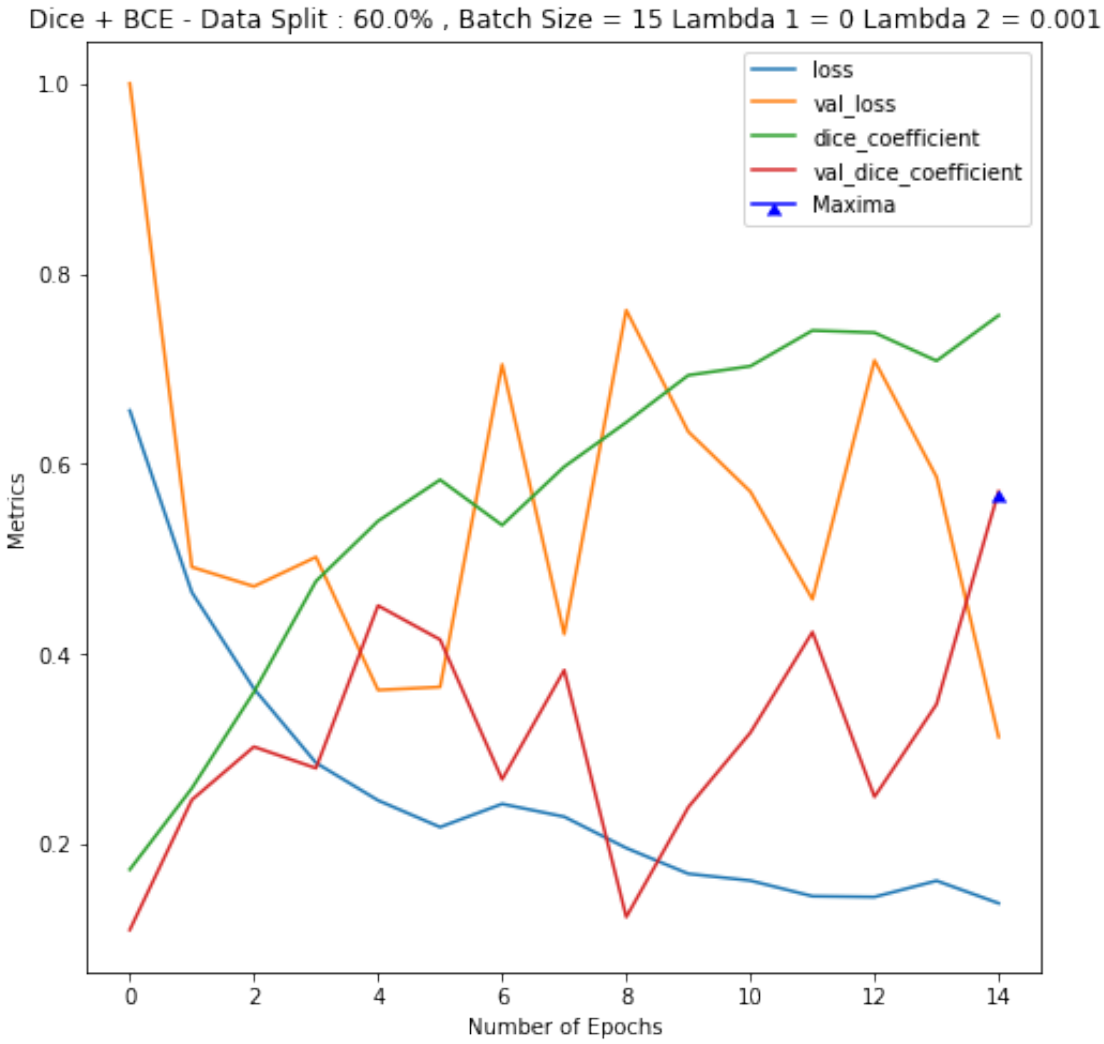
```
Epoch 1/15
48/48 [==============================] - 22s 466ms/step - loss: 4.3856 -
dice_coefficient: 0.1381 - val_loss: 26.5607 - val_dice_coefficient: 0.0930
Epoch 2/15
48/48 [==============================] - 22s 464ms/step - loss: 3.5451 -
dice_coefficient: 0.1638 - val_loss: 5.2259 - val_dice_coefficient: 0.1300
Epoch 3/15
48/48 [==============================] - 23s 477ms/step - loss: 3.1205 -
dice_coefficient: 0.1863 - val_loss: 3.6026 - val_dice_coefficient: 0.1200
Epoch 4/15
48/48 [==============================] - 22s 467ms/step - loss: 2.6623 -
dice_coefficient: 0.2228 - val_loss: 3.8456 - val_dice_coefficient: 0.0823
```

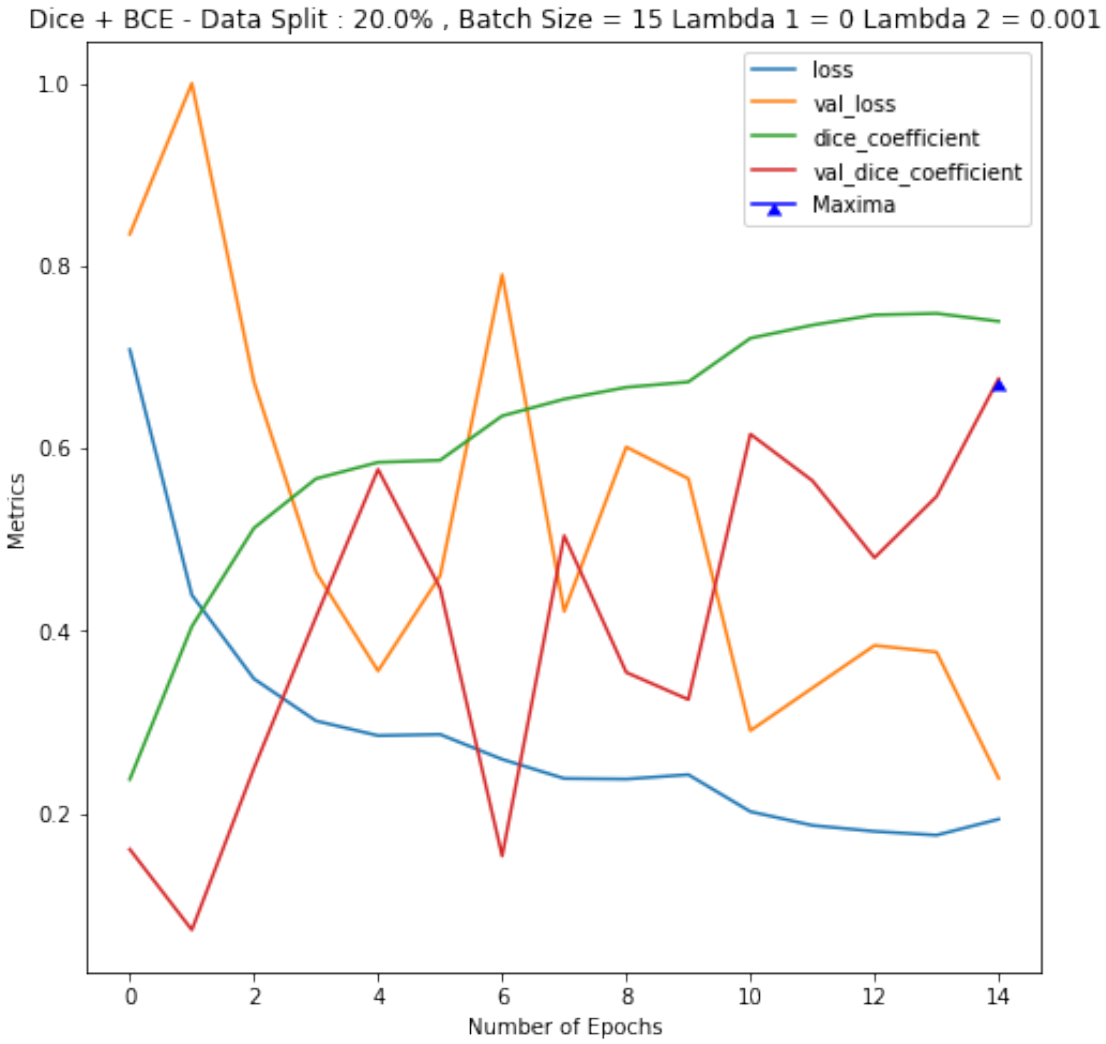
```
Epoch 5/15
48/48 [==============================] - 23s 469ms/step - loss: 2.3456 -
dice_coefficient: 0.2647 - val_loss: 3.4465 - val_dice_coefficient: 0.1081
Epoch 6/15
48/48 [==============================] - 23s 474ms/step - loss: 1.9425 -
dice_coefficient: 0.3466 - val_loss: 2.9075 - val_dice_coefficient: 0.1656
Epoch 7/15
48/48 [==============================] - 23s 471ms/step - loss: 1.7033 -
dice_coefficient: 0.4055 - val_loss: 2.3615 - val_dice_coefficient: 0.2824
Epoch 8/15
48/48 [==============================] - 23s 470ms/step - loss: 1.3940 -
dice_coefficient: 0.4891 - val_loss: 2.4018 - val_dice_coefficient: 0.2497
Epoch 9/15
48/48 [==============================] - 23s 473ms/step - loss: 1.2249 -
dice_coefficient: 0.5446 - val_loss: 1.9836 - val_dice_coefficient: 0.3772
Epoch 10/15
48/48 [==============================] - 23s 476ms/step - loss: 1.1855 -
dice_coefficient: 0.5555 - val_loss: 1.8436 - val_dice_coefficient: 0.4123
Epoch 11/15
48/48 [==============================] - 23s 475ms/step - loss: 1.0973 -
dice_coefficient: 0.5932 - val_loss: 1.7695 - val_dice_coefficient: 0.4436
Epoch 12/15
48/48 [==============================] - 23s 479ms/step - loss: 0.9531 -
dice_coefficient: 0.6555 - val_loss: 1.7466 - val_dice_coefficient: 0.4420
Epoch 13/15
48/48 [==============================] - 23s 477ms/step - loss: 0.9708 -
dice_coefficient: 0.6347 - val_loss: 1.7073 - val_dice_coefficient: 0.4387
Epoch 14/15
48/48 [==============================] - 23s 477ms/step - loss: 0.9125 -
dice_coefficient: 0.6592 - val_loss: 2.1839 - val_dice_coefficient: 0.4157
Epoch 15/15
48/48 [==============================] - 24s 495ms/step - loss: 0.8673 -
dice_coefficient: 0.6845 - val_loss: 2.2626 - val_dice_coefficient: 0.3787
Epoch 1/15
97/97 [==============================] - 37s 382ms/step - loss: 3.5395 -
dice_coefficient: 0.1736 - val_loss: 5.3943 - val_dice_coefficient: 0.1102
Epoch 2/15
97/97 [==============================] - 39s 397ms/step - loss: 2.5087 -
dice_coefficient: 0.2591 - val_loss: 2.6521 - val_dice_coefficient: 0.2469
Epoch 3/15
97/97 [==============================] - 37s 382ms/step - loss: 1.9623 -
dice_coefficient: 0.3602 - val_loss: 2.5421 - val_dice_coefficient: 0.3027
Epoch 4/15
97/97 [==============================] - 36s 370ms/step - loss: 1.5417 -
dice_coefficient: 0.4767 - val_loss: 2.7085 - val_dice_coefficient: 0.2802
Epoch 5/15
97/97 [==============================] - 34s 355ms/step - loss: 1.3290 -
dice_coefficient: 0.5400 - val_loss: 1.9545 - val_dice_coefficient: 0.4511
```

```
Epoch 6/15
97/97 [==============================] - 34s 345ms/step - loss: 1.1773 -
dice_coefficient: 0.5834 - val_loss: 1.9717 - val_dice_coefficient: 0.4153
Epoch 7/15
97/97 [==============================] - 33s 345ms/step - loss: 1.3088 -
dice_coefficient: 0.5357 - val_loss: 3.8006 - val_dice_coefficient: 0.2685
Epoch 8/15
97/97 [==============================] - 33s 344ms/step - loss: 1.2361 -
dice_coefficient: 0.5970 - val_loss: 2.2720 - val_dice_coefficient: 0.3832
Epoch 9/15
97/97 [==============================] - 35s 358ms/step - loss: 1.0588 -
dice_coefficient: 0.6437 - val_loss: 4.1085 - val_dice_coefficient: 0.1238
Epoch 10/15
97/97 [==============================] - 35s 357ms/step - loss: 0.9129 -
dice_coefficient: 0.6932 - val_loss: 3.4194 - val_dice_coefficient: 0.2391
Epoch 11/15
97/97 [==============================] - 35s 361ms/step - loss: 0.8739 -
dice_coefficient: 0.7027 - val_loss: 3.0801 - val_dice_coefficient: 0.3176
Epoch 12/15
97/97 [==============================] - 35s 360ms/step - loss: 0.7855 -
dice_coefficient: 0.7403 - val_loss: 2.4698 - val_dice_coefficient: 0.4232
Epoch 13/15
97/97 [==============================] - 35s 366ms/step - loss: 0.7812 -
dice_coefficient: 0.7380 - val_loss: 3.8237 - val_dice_coefficient: 0.2501
Epoch 14/15
97/97 [==============================] - 34s 355ms/step - loss: 0.8731 -
dice_coefficient: 0.7083 - val_loss: 3.1624 - val_dice_coefficient: 0.3475
Epoch 15/15
97/97 [==============================] - 35s 363ms/step - loss: 0.7455 -
dice_coefficient: 0.7561 - val_loss: 1.6883 - val_dice_coefficient: 0.5711
Epoch 1/15
194/194 [==============================] - 60s 310ms/step - loss: 2.9907 -
dice_coefficient: 0.2370 - val_loss: 3.5258 - val_dice_coefficient: 0.1604
Epoch 2/15
194/194 [==============================] - 60s 312ms/step - loss: 1.8545 -
dice_coefficient: 0.4046 - val_loss: 4.2236 - val_dice_coefficient: 0.0720
Epoch 3/15
194/194 [==============================] - 58s 300ms/step - loss: 1.4669 -
dice_coefficient: 0.5125 - val_loss: 2.8424 - val_dice_coefficient: 0.2491
Epoch 4/15
194/194 [==============================] - 58s 302ms/step - loss: 1.2720 -
dice_coefficient: 0.5666 - val_loss: 1.9611 - val_dice_coefficient: 0.4149
Epoch 5/15
194/194 [==============================] - 59s 302ms/step - loss: 1.2037 -
dice_coefficient: 0.5846 - val_loss: 1.5030 - val_dice_coefficient: 0.5769
Epoch 6/15
194/194 [==============================] - 58s 299ms/step - loss: 1.2093 -
dice_coefficient: 0.5869 - val_loss: 1.9437 - val_dice_coefficient: 0.4466
```

```
Epoch 7/15
194/194 [==============================] - 58s 301ms/step - loss: 1.0940 -
dice_coefficient: 0.6355 - val_loss: 3.3381 - val_dice_coefficient: 0.1531
Epoch 8/15
194/194 [==============================] - 63s 323ms/step - loss: 1.0052 -
dice_coefficient: 0.6539 - val_loss: 1.7788 - val_dice_coefficient: 0.5042
Epoch 9/15
194/194 [==============================] - 59s 305ms/step - loss: 1.0024 -
dice_coefficient: 0.6668 - val_loss: 2.5402 - val_dice_coefficient: 0.3543
Epoch 10/15
194/194 [==============================] - 59s 304ms/step - loss: 1.0229 -
dice_coefficient: 0.6727 - val_loss: 2.3936 - val_dice_coefficient: 0.3246
Epoch 11/15
194/194 [==============================] - 60s 309ms/step - loss: 0.8518 -
dice_coefficient: 0.7206 - val_loss: 1.2267 - val_dice_coefficient: 0.6155
Epoch 12/15
194/194 [==============================] - 59s 303ms/step - loss: 0.7880 -
dice_coefficient: 0.7350 - val_loss: 1.4243 - val_dice_coefficient: 0.5644
Epoch 13/15
194/194 [==============================] - 59s 303ms/step - loss: 0.7603 -
dice_coefficient: 0.7462 - val_loss: 1.6213 - val_dice_coefficient: 0.4800
Epoch 14/15
194/194 [==============================] - 59s 303ms/step - loss: 0.7428 -
dice_coefficient: 0.7478 - val_loss: 1.5904 - val_dice_coefficient: 0.5472
Epoch 15/15
194/194 [==============================] - 59s 304ms/step - loss: 0.8166 -
dice_coefficient: 0.7392 - val_loss: 1.0066 - val_dice_coefficient: 0.6763
```


Dice + BCE - Data Split : 80.0% , Batch Size = 15 Lambda 1 = 0 Lambda 2 = 0.001
loss
val_loss
dice_coefficient
val_dice_coefficient
Maxima
Metrics
Number of Epochs
0.0
0.2
0.4
0.6
0.8
1.0
0
2
4
6
8
10
12
14


Dice + BCE - Data Split : 60.0% , Batch Size = 15 Lambda 1 = 0 Lambda 2 = 0.001
loss
val_loss
dice_coefficient
val_dice_coefficient
Maxima
Metrics
Number of Epochs
1.0
0.8
0.6
0.4
0.2
0
2
4
6
8
10
12
14



[489]:
```
experiment1(0.8, 15, 15, 0, 0)
experiment1(0.6, 15, 15, 0, 0)
experiment1(0.4, 15, 15, 0, 0)
experiment1(0.2, 15, 15, 0, 0)
```

```
Epoch 1/15
48/48 [==============================] - 22s 452ms/step - loss: 0.5083 -
dice_coefficient: 0.1005 - val_loss: 1.5263 - val_dice_coefficient: 0.1122
Epoch 2/15
48/48 [==============================] - 22s 454ms/step - loss: 0.3182 -
dice_coefficient: 0.1008 - val_loss: 0.4457 - val_dice_coefficient: 0.1006
Epoch 3/15
48/48 [==============================] - 22s 453ms/step - loss: 0.2529 -
dice_coefficient: 0.1152 - val_loss: 0.4143 - val_dice_coefficient: 0.0981
Epoch 4/15
```

```
48/48 [==============================] - 22s 454ms/step - loss: 0.2158 -
dice_coefficient: 0.1207 - val_loss: 0.2437 - val_dice_coefficient: 0.1125
Epoch 5/15
48/48 [==============================] - 22s 458ms/step - loss: 0.1845 -
dice_coefficient: 0.1363 - val_loss: 0.2418 - val_dice_coefficient: 0.1286
Epoch 6/15
48/48 [==============================] - 22s 456ms/step - loss: 0.1676 -
dice_coefficient: 0.1501 - val_loss: 0.1965 - val_dice_coefficient: 0.1412
Epoch 7/15
48/48 [==============================] - 22s 457ms/step - loss: 0.1448 -
dice_coefficient: 0.1885 - val_loss: 0.1814 - val_dice_coefficient: 0.1367
Epoch 8/15
48/48 [==============================] - 22s 456ms/step - loss: 0.1230 -
dice_coefficient: 0.2389 - val_loss: 0.1495 - val_dice_coefficient: 0.2050
Epoch 9/15
48/48 [==============================] - 22s 461ms/step - loss: 0.1011 -
dice_coefficient: 0.3273 - val_loss: 0.2080 - val_dice_coefficient: 0.2757
Epoch 10/15
48/48 [==============================] - 22s 459ms/step - loss: 0.0961 -
dice_coefficient: 0.3460 - val_loss: 0.2812 - val_dice_coefficient: 0.2950
Epoch 11/15
48/48 [==============================] - 22s 463ms/step - loss: 0.0763 -
dice_coefficient: 0.4264 - val_loss: 0.1285 - val_dice_coefficient: 0.3630
Epoch 12/15
48/48 [==============================] - 22s 454ms/step - loss: 0.0769 -
dice_coefficient: 0.4317 - val_loss: 0.2386 - val_dice_coefficient: 0.3388
Epoch 13/15
48/48 [==============================] - 23s 469ms/step - loss: 0.0644 -
dice_coefficient: 0.4760 - val_loss: 0.1001 - val_dice_coefficient: 0.3610
Epoch 14/15
48/48 [==============================] - 23s 489ms/step - loss: 0.0518 -
dice_coefficient: 0.5422 - val_loss: 0.1047 - val_dice_coefficient: 0.3631
Epoch 15/15
48/48 [==============================] - 24s 507ms/step - loss: 0.0453 -
dice_coefficient: 0.5773 - val_loss: 0.1035 - val_dice_coefficient: 0.3358
Epoch 1/15
97/97 [==============================] - 37s 382ms/step - loss: 0.4102 -
dice_coefficient: 0.0963 - val_loss: 0.3471 - val_dice_coefficient: 0.1112
Epoch 2/15
97/97 [==============================] - 37s 381ms/step - loss: 0.2133 -
dice_coefficient: 0.1204 - val_loss: 0.1862 - val_dice_coefficient: 0.1113
Epoch 3/15
97/97 [==============================] - 36s 374ms/step - loss: 0.1653 -
dice_coefficient: 0.1392 - val_loss: 0.1591 - val_dice_coefficient: 0.1610
Epoch 4/15
97/97 [==============================] - 36s 369ms/step - loss: 0.1310 -
dice_coefficient: 0.1920 - val_loss: 0.1239 - val_dice_coefficient: 0.1836
Epoch 5/15
```

```
97/97 [==============================] - 36s 369ms/step - loss: 0.1056 -
dice_coefficient: 0.2868 - val_loss: 0.0999 - val_dice_coefficient: 0.2647
Epoch 6/15
97/97 [==============================] - 36s 369ms/step - loss: 0.0778 -
dice_coefficient: 0.3963 - val_loss: 0.0875 - val_dice_coefficient: 0.3702
Epoch 7/15
97/97 [==============================] - 36s 371ms/step - loss: 0.0580 -
dice_coefficient: 0.4999 - val_loss: 0.0903 - val_dice_coefficient: 0.4864
Epoch 8/15
97/97 [==============================] - 36s 372ms/step - loss: 0.0504 -
dice_coefficient: 0.5517 - val_loss: 0.0668 - val_dice_coefficient: 0.4429
Epoch 9/15
97/97 [==============================] - 36s 373ms/step - loss: 0.0384 -
dice_coefficient: 0.6103 - val_loss: 0.0582 - val_dice_coefficient: 0.5066
Epoch 10/15
97/97 [==============================] - 36s 372ms/step - loss: 0.0317 -
dice_coefficient: 0.6497 - val_loss: 0.0601 - val_dice_coefficient: 0.5189
Epoch 11/15
97/97 [==============================] - 36s 369ms/step - loss: 0.0267 -
dice_coefficient: 0.6808 - val_loss: 0.0671 - val_dice_coefficient: 0.4837
Epoch 12/15
97/97 [==============================] - 36s 371ms/step - loss: 0.0238 -
dice_coefficient: 0.7058 - val_loss: 0.0762 - val_dice_coefficient: 0.4371
Epoch 13/15
97/97 [==============================] - 37s 377ms/step - loss: 0.0216 -
dice_coefficient: 0.7283 - val_loss: 0.0627 - val_dice_coefficient: 0.5645
Epoch 14/15
97/97 [==============================] - 37s 378ms/step - loss: 0.0189 -
dice_coefficient: 0.7543 - val_loss: 0.0642 - val_dice_coefficient: 0.5213
Epoch 15/15
97/97 [==============================] - 36s 373ms/step - loss: 0.0172 -
dice_coefficient: 0.7712 - val_loss: 0.0704 - val_dice_coefficient: 0.5171
Epoch 1/15
145/145 [==============================] - 49s 337ms/step - loss: 0.3227 -
dice_coefficient: 0.1150 - val_loss: 0.3504 - val_dice_coefficient: 0.1313
Epoch 2/15
145/145 [==============================] - 48s 333ms/step - loss: 0.1570 -
dice_coefficient: 0.2011 - val_loss: 0.6175 - val_dice_coefficient: 0.1666
Epoch 3/15
145/145 [==============================] - 48s 334ms/step - loss: 0.1141 -
dice_coefficient: 0.2882 - val_loss: 0.1272 - val_dice_coefficient: 0.3164
Epoch 4/15
145/145 [==============================] - 49s 336ms/step - loss: 0.0845 -
dice_coefficient: 0.3993 - val_loss: 0.0825 - val_dice_coefficient: 0.3543
Epoch 5/15
145/145 [==============================] - 49s 339ms/step - loss: 0.0670 -
dice_coefficient: 0.4819 - val_loss: 0.0585 - val_dice_coefficient: 0.5011
Epoch 6/15
```

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145/145 [==============================] - 48s 333ms/step - loss: 0.0494 -
dice_coefficient: 0.5618 - val_loss: 0.0607 - val_dice_coefficient: 0.5168
Epoch 7/15
145/145 [==============================] - 48s 331ms/step - loss: 0.0435 -
dice_coefficient: 0.5988 - val_loss: 0.0594 - val_dice_coefficient: 0.5106
Epoch 8/15
145/145 [==============================] - 49s 338ms/step - loss: 0.0360 -
dice_coefficient: 0.6399 - val_loss: 0.0504 - val_dice_coefficient: 0.5568
Epoch 9/15
145/145 [==============================] - 49s 340ms/step - loss: 0.0328 -
dice_coefficient: 0.6719 - val_loss: 0.0505 - val_dice_coefficient: 0.5831
Epoch 10/15
145/145 [==============================] - 50s 347ms/step - loss: 0.0318 -
dice_coefficient: 0.6745 - val_loss: 0.0625 - val_dice_coefficient: 0.5742
Epoch 11/15
145/145 [==============================] - 49s 335ms/step - loss: 0.0291 -
dice_coefficient: 0.6965 - val_loss: 0.0465 - val_dice_coefficient: 0.6202
Epoch 12/15
145/145 [==============================] - 48s 333ms/step - loss: 0.0275 -
dice_coefficient: 0.7115 - val_loss: 0.0460 - val_dice_coefficient: 0.6271
Epoch 13/15
145/145 [==============================] - 48s 333ms/step - loss: 0.0240 -
dice_coefficient: 0.7289 - val_loss: 0.0503 - val_dice_coefficient: 0.5529
Epoch 14/15
145/145 [==============================] - 48s 334ms/step - loss: 0.0222 -
dice_coefficient: 0.7529 - val_loss: 0.0293 - val_dice_coefficient: 0.6880
Epoch 15/15
145/145 [==============================] - 49s 338ms/step - loss: 0.0192 -
dice_coefficient: 0.7723 - val_loss: 0.0411 - val_dice_coefficient: 0.6293
Epoch 1/15
194/194 [==============================] - 61s 316ms/step - loss: 0.2587 -
dice_coefficient: 0.1347 - val_loss: 0.3118 - val_dice_coefficient: 0.1361
Epoch 2/15
194/194 [==============================] - 62s 317ms/step - loss: 0.1358 -
dice_coefficient: 0.2040 - val_loss: 0.1566 - val_dice_coefficient: 0.1906
Epoch 3/15
194/194 [==============================] - 62s 318ms/step - loss: 0.1080 -
dice_coefficient: 0.2679 - val_loss: 0.1139 - val_dice_coefficient: 0.2416
Epoch 4/15
194/194 [==============================] - 61s 317ms/step - loss: 0.0867 -
dice_coefficient: 0.3683 - val_loss: 0.1152 - val_dice_coefficient: 0.2521
Epoch 5/15
194/194 [==============================] - 61s 314ms/step - loss: 0.0717 -
dice_coefficient: 0.4464 - val_loss: 0.1157 - val_dice_coefficient: 0.2539
Epoch 6/15
194/194 [==============================] - 60s 311ms/step - loss: 0.0585 -
dice_coefficient: 0.5175 - val_loss: 0.1260 - val_dice_coefficient: 0.2477
Epoch 7/15
```

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194/194 [==============================] - 60s 307ms/step - loss: 0.0476 -
dice_coefficient: 0.5808 - val_loss: 0.0711 - val_dice_coefficient: 0.4011
Epoch 8/15
194/194 [==============================] - 60s 309ms/step - loss: 0.0394 -
dice_coefficient: 0.6294 - val_loss: 0.0429 - val_dice_coefficient: 0.5072
Epoch 9/15
194/194 [==============================] - 60s 310ms/step - loss: 0.0322 -
dice_coefficient: 0.6758 - val_loss: 0.0338 - val_dice_coefficient: 0.5628
Epoch 10/15
194/194 [==============================] - 62s 317ms/step - loss: 0.0266 -
dice_coefficient: 0.7096 - val_loss: 0.0311 - val_dice_coefficient: 0.5970
Epoch 11/15
194/194 [==============================] - 60s 309ms/step - loss: 0.0233 -
dice_coefficient: 0.7426 - val_loss: 0.0312 - val_dice_coefficient: 0.6018
Epoch 12/15
194/194 [==============================] - 61s 312ms/step - loss: 0.0209 -
dice_coefficient: 0.7643 - val_loss: 0.0343 - val_dice_coefficient: 0.6175
Epoch 13/15
194/194 [==============================] - 60s 308ms/step - loss: 0.0181 -
dice_coefficient: 0.7871 - val_loss: 0.0306 - val_dice_coefficient: 0.6130
Epoch 14/15
194/194 [==============================] - 60s 309ms/step - loss: 0.0164 -
dice_coefficient: 0.8056 - val_loss: 0.0345 - val_dice_coefficient: 0.6214
Epoch 15/15
194/194 [==============================] - 61s 316ms/step - loss: 0.0164 -
dice_coefficient: 0.8085 - val_loss: 0.0292 - val_dice_coefficient: 0.6569
```
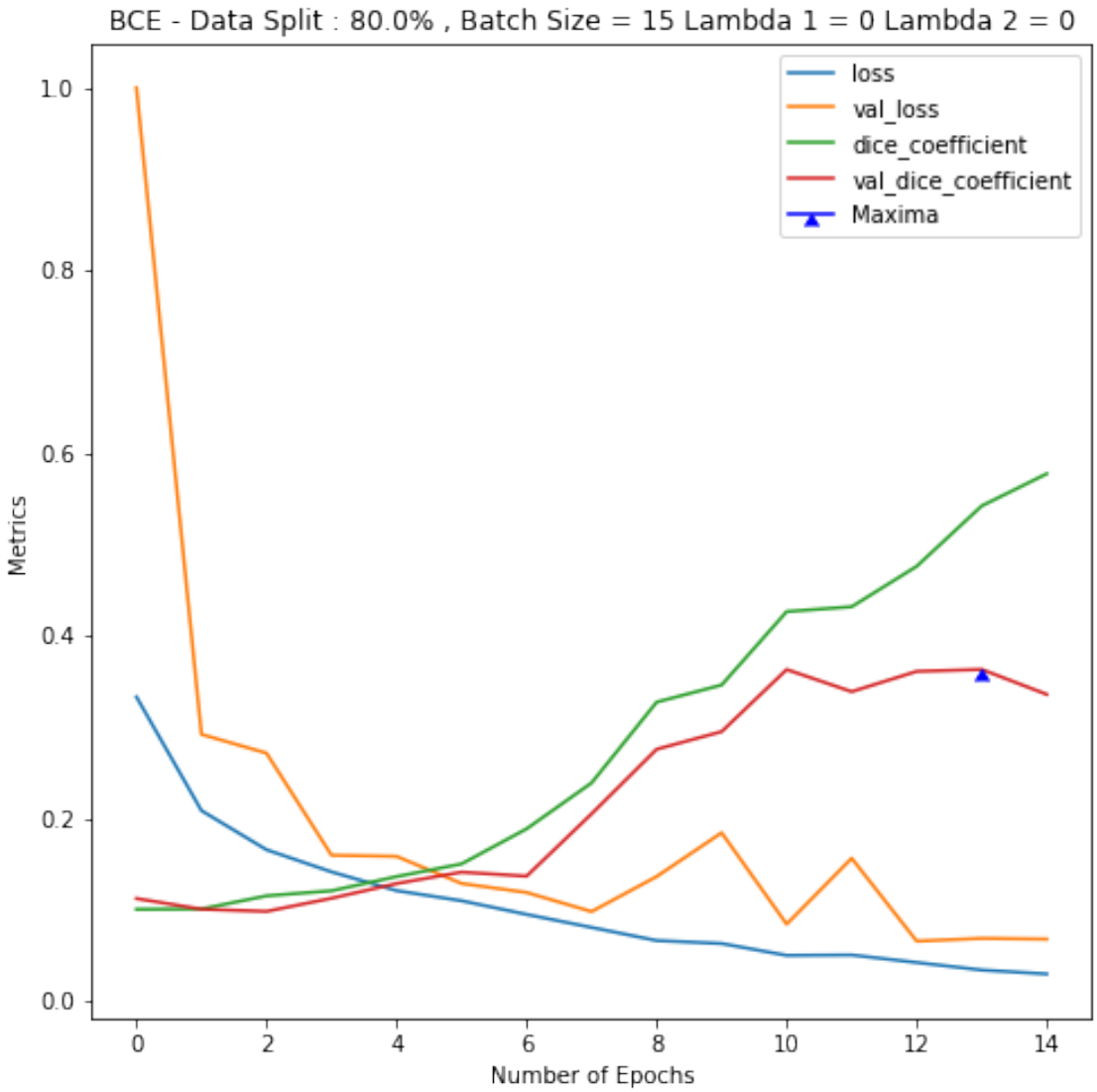
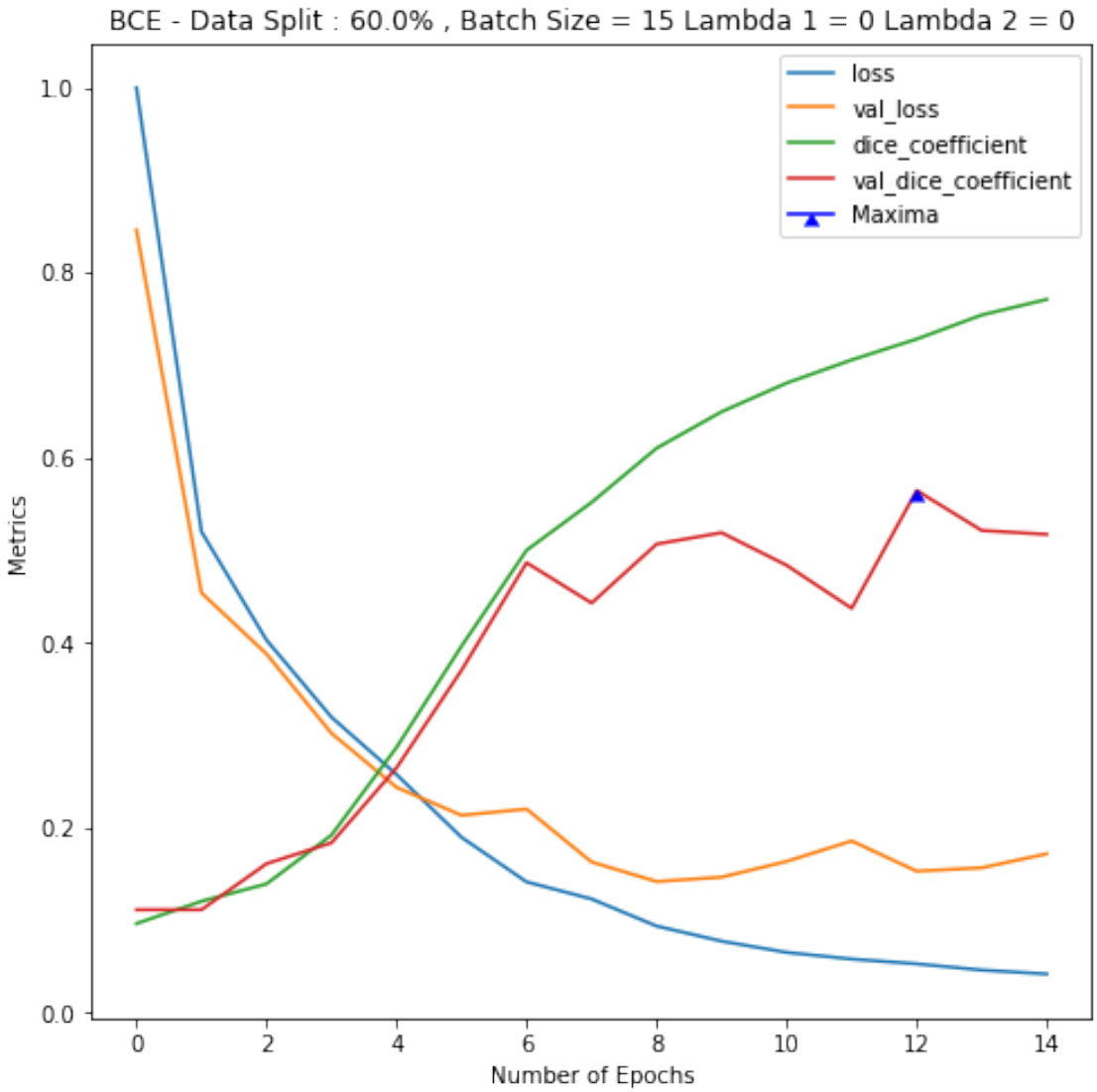
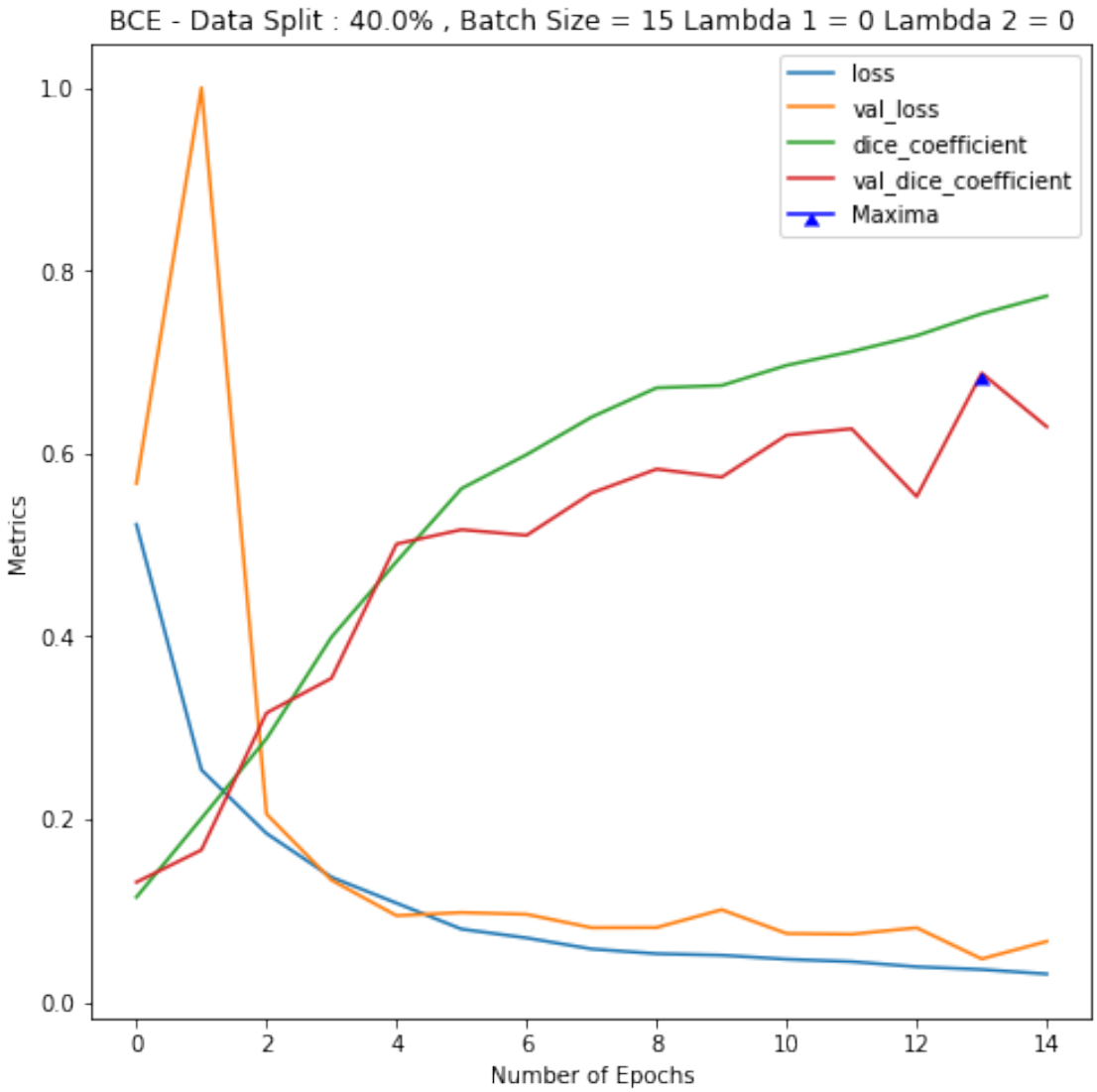
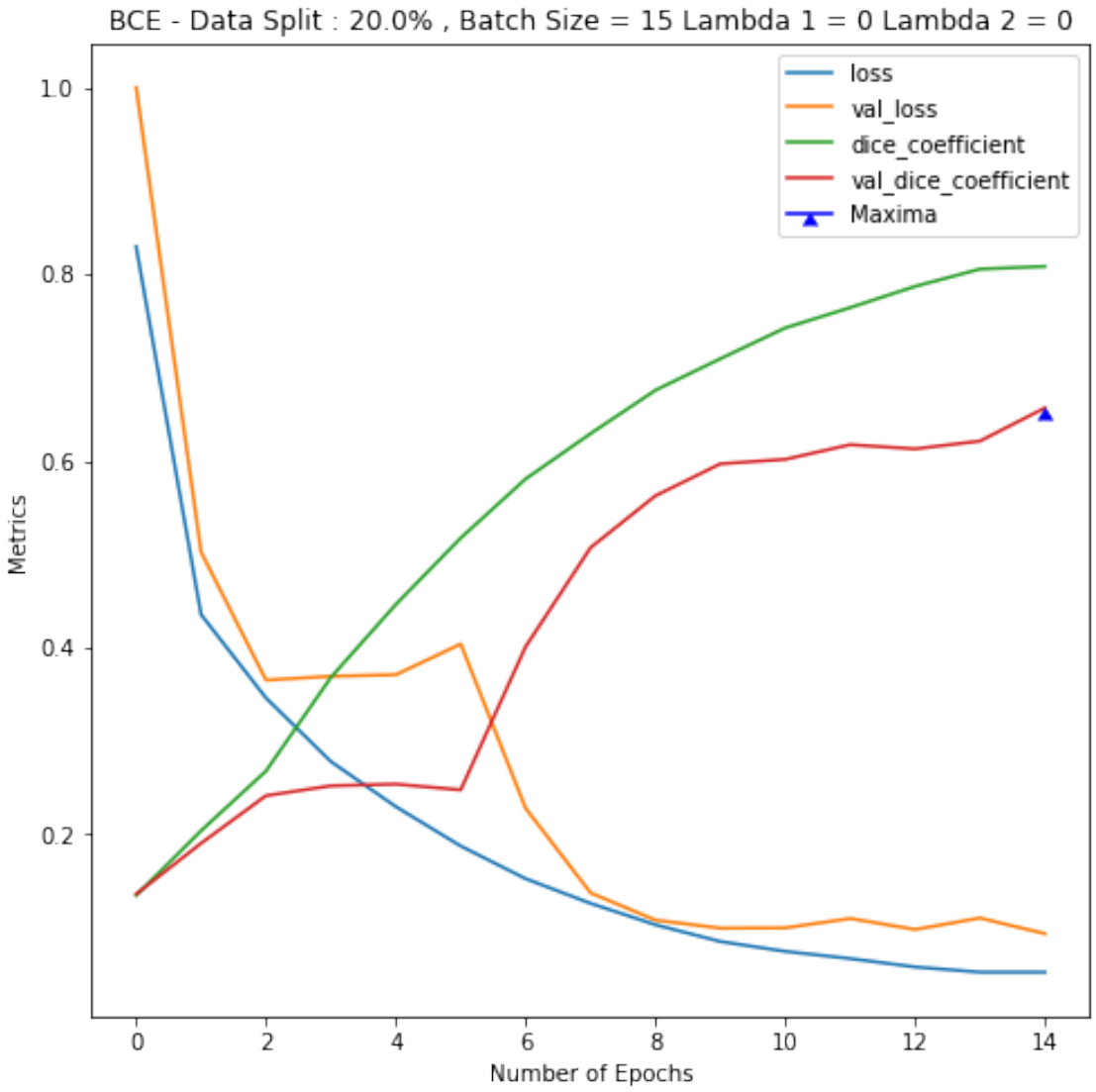


BCE - Data Split : 80.0% , Batch Size = 15 Lambda 1 = 0 Lambda 2 = 0
loss
val_loss
dice_coefficient
val_dice_coefficient
Maxima
Metrics
Number of Epochs
0.0
0.2
0.4
0.6
0.8
1.0
0
2
4
6
8
10
12
14


BCE - Data Split : 60.0% , Batch Size = 15 Lambda 1 = 0 Lambda 2 = 0
loss
val_loss
dice_coefficient
val_dice_coefficient
Maxima
Metrics
Number of Epochs
0.0
0.2
0.4
0.6
0.8
1.0
0
2
4
6
8
10
12
14


BCE - Data Split : 40.0% , Batch Size = 15 Lambda 1 = 0 Lambda 2 = 0
loss
val_loss
dice_coefficient
val_dice_coefficient
Maxima
Metrics
Number of Epochs
0.0
0.2
0.4
0.6
0.8
1.0
0
2
4
6
8
10
12
14


BCE - Data Split : 20.0% , Batch Size = 15 Lambda 1 = 0 Lambda 2 = 0
loss
val_loss
dice_coefficient
val_dice_coefficient
Maxima
Metrics
Number of Epochs
0.2
0.4
0.6
0.8
1.0
0
2
4
6
8
10
12
14

[ ]: