

# Deep Learning in GBAR

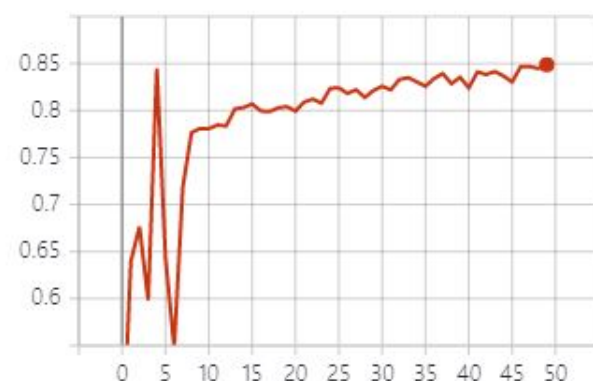
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# FCN : Classwise

- Last time, I performed FCN for 300,000 signal datas.  
: up, down, background 100,000 each.
- This time, two 200,000 signal datas.  
: up & background / down & background

# Up & Background

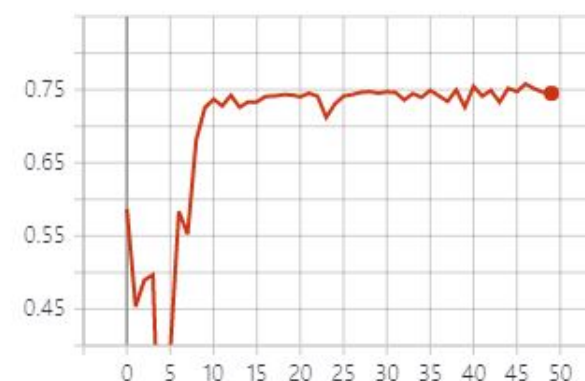
acc\_bg



acc\_dw



acc\_up



categorical\_accuracy



loss



one\_acc



two\_acc



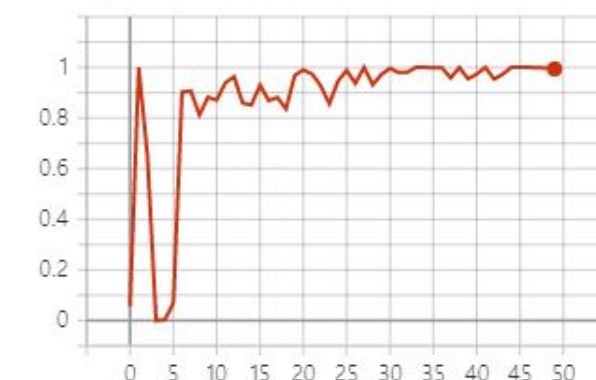
val\_acc\_bg



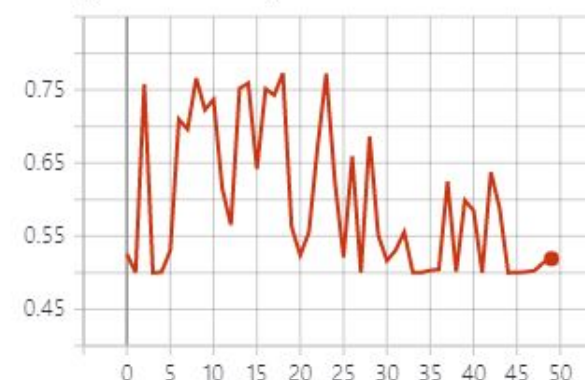
val\_acc\_dw



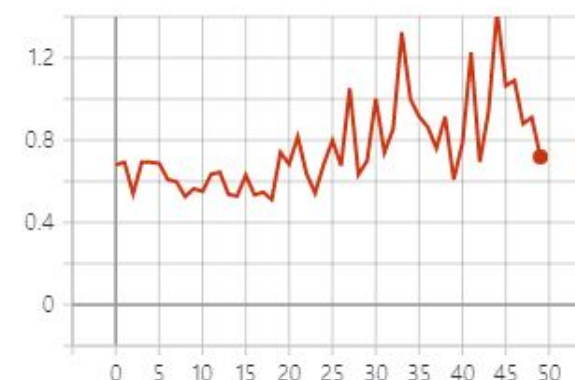
val\_acc\_up



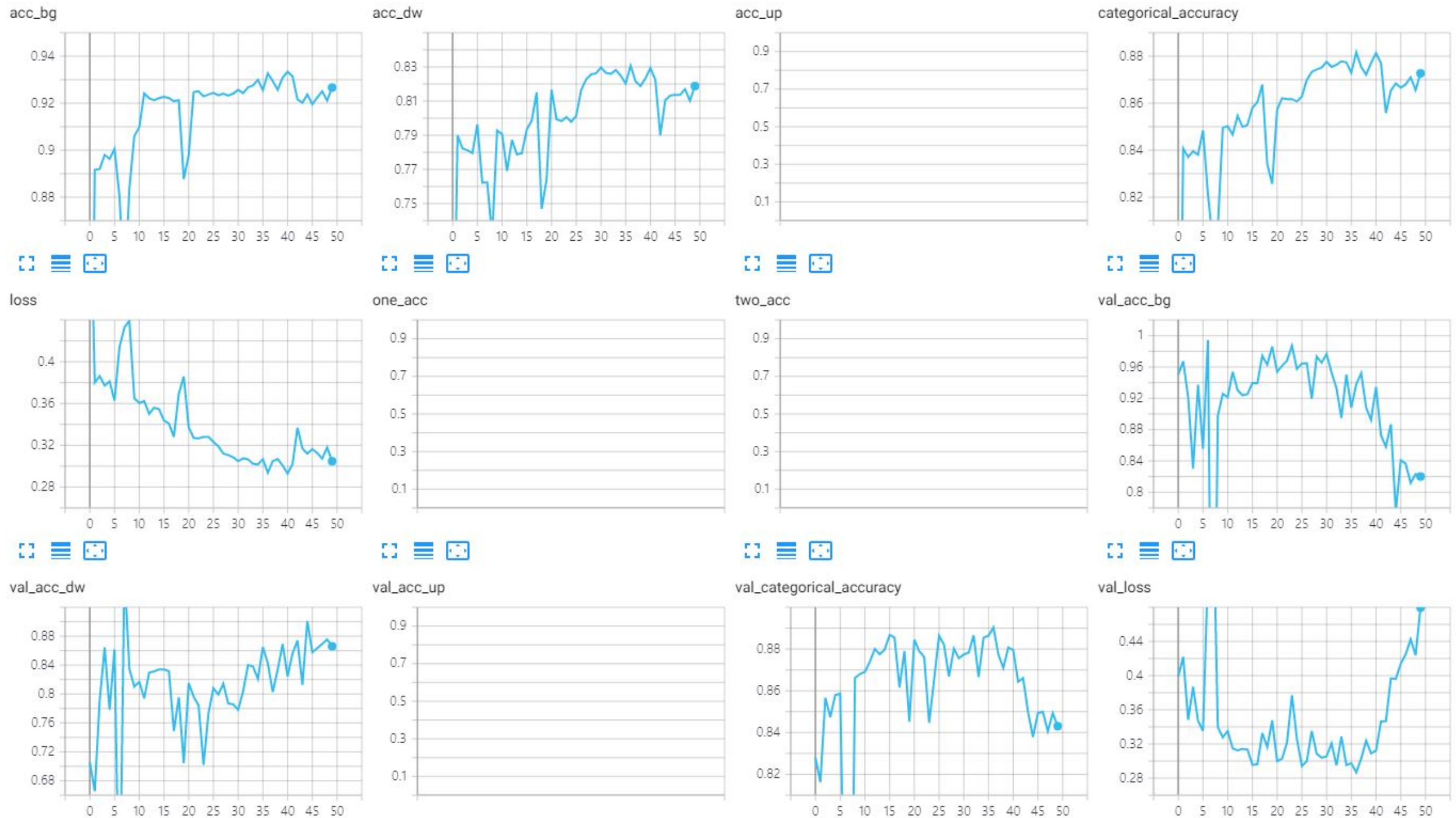
val\_categorical\_accuracy



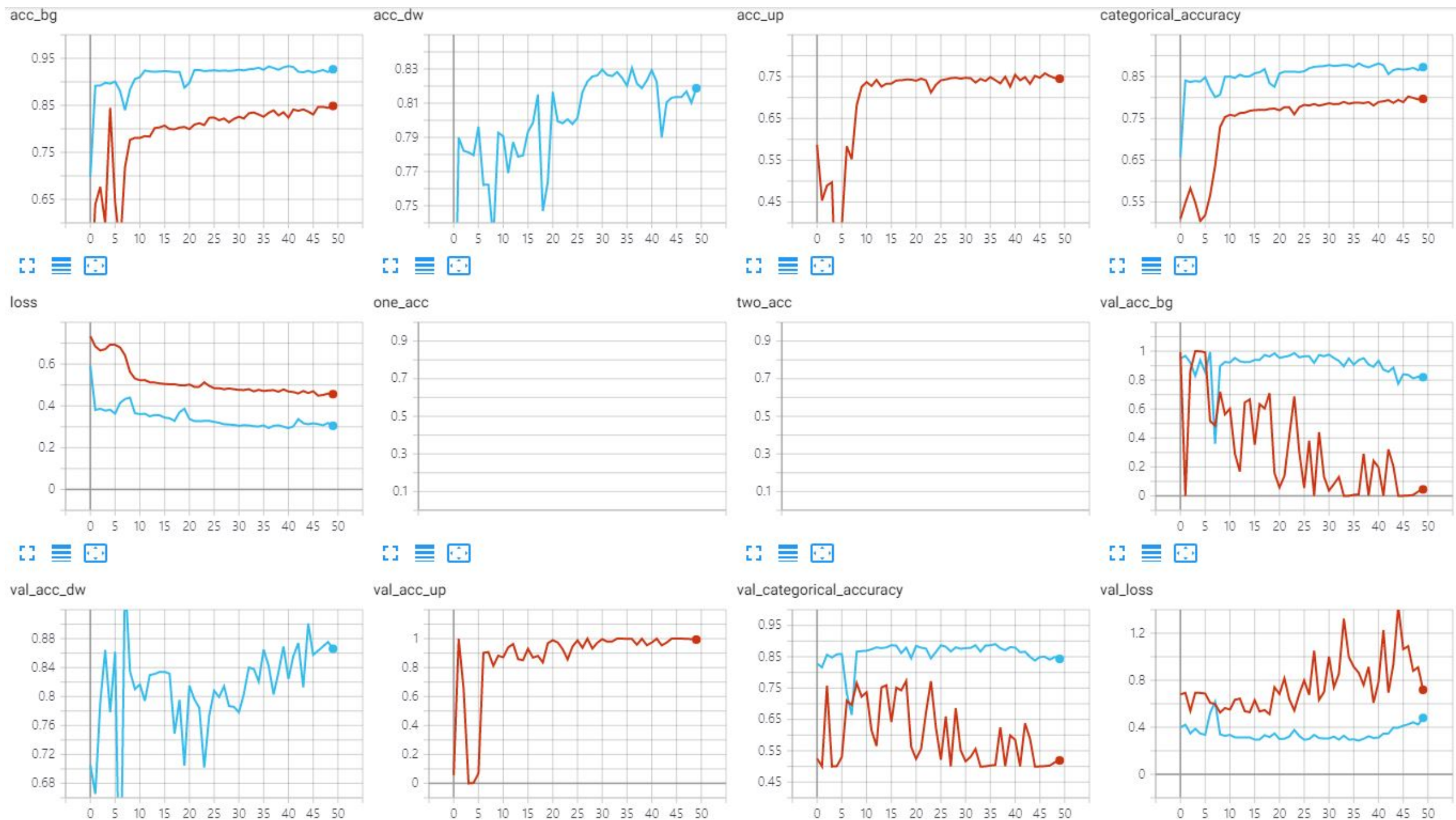
val\_loss



# Down & Background



# Total



**CNN?**

# We got serious problems.

1. Home desktop cannot manage the convolutional network.
2. Even with Hobin Lee's desktop, there is some problems in performing the Convolutional Network.



# Convolutional Layers

Model: "sequential\_5"

| Layer (type)                                 | Output Shape        | Param # |
|----------------------------------------------|---------------------|---------|
| reshape_5 (Reshape)                          | (None, 112, 88, 1)  | 0       |
| conv2d_19 (Conv2D)                           | (None, 105, 81, 16) | 1040    |
| batch_normalization_18 (Batch Normalization) | (None, 105, 81, 16) | 64      |
| activation_24 (Activation)                   | (None, 105, 81, 16) | 0       |
| conv2d_20 (Conv2D)                           | (None, 98, 74, 16)  | 16400   |
| batch_normalization_19 (Batch Normalization) | (None, 98, 74, 16)  | 64      |
| activation_25 (Activation)                   | (None, 98, 74, 16)  | 0       |
| max_pooling2d_9 (MaxPooling2D)               | (None, 49, 37, 16)  | 0       |
| conv2d_21 (Conv2D)                           | (None, 42, 30, 32)  | 32800   |
| batch_normalization_20 (Batch Normalization) | (None, 42, 30, 32)  | 128     |
| activation_26 (Activation)                   | (None, 42, 30, 32)  | 0       |
| conv2d_22 (Conv2D)                           | (None, 35, 23, 32)  | 65568   |
| batch_normalization_21 (Batch Normalization) | (None, 35, 23, 32)  | 128     |
| activation_27 (Activation)                   | (None, 35, 23, 32)  | 0       |
| max_pooling2d_10 (MaxPooling2D)              | (None, 17, 11, 32)  | 0       |
| flatten_2 (Flatten)                          | (None, 5984)        | 0       |
| dense_7 (Dense)                              | (None, 512)         | 3064320 |
| activation_28 (Activation)                   | (None, 512)         | 0       |
| dropout_4 (Dropout)                          | (None, 512)         | 0       |
| dense_8 (Dense)                              | (None, 2)           | 1026    |
| activation_29 (Activation)                   | (None, 2)           | 0       |

Total params: 3,181,538  
Trainable params: 3,181,346  
Non-trainable params: 192



# Does it learn well?

```
Epoch 1/50
180000/180000 [=====] - 105s 583us/step - loss: 0.3238 - categorical_accuracy: 0.8849 - acc_dw: 0.82
87 - acc_bg: 0.9423 - val_loss: 16.0481 - val_categorical_accuracy: 0.5000 - val_acc_dw: 1.0000 - val_acc_bg: 0.0000e+00
Epoch 2/50
180000/180000 [=====] - 103s 572us/step - loss: 0.1928 - categorical_accuracy: 0.9279 - acc_dw: 0.87
57 - acc_bg: 0.9807 - val_loss: 11.9224 - val_categorical_accuracy: 0.5000 - val_acc_dw: 1.0000 - val_acc_bg: 0.0000e+00
Epoch 3/50
180000/180000 [=====] - 103s 572us/step - loss: 0.1695 - categorical_accuracy: 0.9343 - acc_dw: 0.88
70 - acc_bg: 0.9821 - val_loss: 1.3171 - val_categorical_accuracy: 0.6829 - val_acc_dw: 0.9508 - val_acc_bg: 0.4129
Epoch 4/50
180000/180000 [=====] - 103s 572us/step - loss: 0.1615 - categorical_accuracy: 0.9373 - acc_dw: 0.89
23 - acc_bg: 0.9829 - val_loss: 0.6136 - val_categorical_accuracy: 0.8113 - val_acc_dw: 0.9379 - val_acc_bg: 0.6819
Epoch 5/50
180000/180000 [=====] - 103s 573us/step - loss: 0.1554 - categorical_accuracy: 0.9388 - acc_dw: 0.89
54 - acc_bg: 0.9829 - val_loss: 1.2527 - val_categorical_accuracy: 0.7157 - val_acc_dw: 0.4324 - val_acc_bg: 1.0000
Epoch 6/50
180000/180000 [=====] - 103s 573us/step - loss: 0.1533 - categorical_accuracy: 0.9393 - acc_dw: 0.89
67 - acc_bg: 0.9823 - val_loss: 0.7705 - val_categorical_accuracy: 0.7322 - val_acc_dw: 0.4727 - val_acc_bg: 0.9900
Epoch 7/50
180000/180000 [=====] - 103s 572us/step - loss: 0.1485 - categorical_accuracy: 0.9418 - acc_dw: 0.90
09 - acc_bg: 0.9833 - val_loss: 2.5715 - val_categorical_accuracy: 0.5019 - val_acc_dw: 0.0038 - val_acc_bg: 1.0000
Epoch 8/50
180000/180000 [=====] - 103s 573us/step - loss: 0.1455 - categorical_accuracy: 0.9427 - acc_dw: 0.90
22 - acc_bg: 0.9837 - val_loss: 14.2042 - val_categorical_accuracy: 0.5000 - val_acc_dw: 1.0000 - val_acc_bg: 0.0000e+00
Epoch 9/50
180000/180000 [=====] - 103s 572us/step - loss: 0.1432 - categorical_accuracy: 0.9432 - acc_dw: 0.90
43 - acc_bg: 0.9825 - val_loss: 2.3792 - val_categorical_accuracy: 0.5038 - val_acc_dw: 0.9997 - val_acc_bg: 0.0079
Epoch 10/50
180000/180000 [=====] - 103s 573us/step - loss: 0.1404 - categorical_accuracy: 0.9445 - acc_dw: 0.90
58 - acc_bg: 0.9835 - val_loss: 1.5741 - val_categorical_accuracy: 0.5616 - val_acc_dw: 0.1225 - val_acc_bg: 1.0000
Epoch 11/50
180000/180000 [=====] - 103s 572us/step - loss: 0.1393 - categorical_accuracy: 0.9447 - acc_dw: 0.90
60 - acc_bg: 0.9839 - val_loss: 4.1201 - val_categorical_accuracy: 0.5000 - val_acc_dw: 1.0000 - val_acc_bg: 0.0000e+00
Epoch 12/50
180000/180000 [=====] - 103s 571us/step - loss: 0.1361 - categorical_accuracy: 0.9462 - acc_dw: 0.91
03 - acc_bg: 0.9824 - val_loss: 1.8910 - val_categorical_accuracy: 0.5001 - val_acc_dw: 1.0000 - val_acc_bg: 9.9671e-05
Epoch 13/50
180000/180000 [=====] - 103s 571us/step - loss: 0.1341 - categorical_accuracy: 0.9465 - acc_dw: 0.91
24 - acc_bg: 0.9811 - val_loss: 27.7825 - val_categorical_accuracy: 0.5000 - val_acc_dw: 1.0000 - val_acc_bg: 0.0000e+00
Epoch 14/50
180000/180000 [=====] - 103s 571us/step - loss: 0.1326 - categorical_accuracy: 0.9474 - acc_dw: 0.91
34 - acc_bg: 0.9818 - val_loss: 47.7752 - val_categorical_accuracy: 0.5000 - val_acc_dw: 1.0000 - val_acc_bg: 0.0000e+00
```

# Solutions

- Change the learning rate.
- Change the architecture and the method of convolution.
- etc.