**CS4990- Assignment 3: Hair Segmentation**

**Dataset:** Dataset used for the mini competition has training set of 1350 examples and 150 examples in testing data which is used for determining the final score making use of the trained model.

**Overview:** Using keras, I constructed a U-NET network, which implies it’s an end-to-end fully convolutional network (FCN), i.e. it contains only Convolutional layers and does not contain any Dense layer, therefore can accept image of any size.:

* Convolutional Layers: Two consecutive Convolution Layers are applied.
* c1, c2, …. c9 are the output tensors of Convolutional Layers
* p1, p2, p3 and p4 are the output tensors of Max Pooling Layers
* u6, u7, u8 and u9 are the output tensors of up-sampling (transposed convolutional) layers
* Encoder: The size of the image gradually reduces while the depth gradually increases. Starting from 128x128x3 to 8x8x256
* Decoder: The size of the image gradually increases and the depth gradually decreases. Starting from 8x8x256 to 128x128x1
* Dropout Layers: These randomly turns off a few neurons in the network for preventing the overfitting.

We use Keras callbacks to implement:

* Learning rate decay if the validation loss does not improve for 5 continues epochs.
* Early stopping if the validation loss does not improve for 10 continues epochs.
* Save the weights only if there is improvement in validation loss.

The network is compiled using Adam optimizer which uses a variable learning rate. Used binary\_crossentropy as the loss function. The hyper parameters defined for fitting the model are:

* epochs=16
* batch\_size=50

The data passes through the model 100 times and in batches of 100 images. After, the model is trained, the model is saved along with its weights, which is then loaded and used on test dataset to receive the final prediction. Then the final prediction is then saved in csv file. The libraries used in the program are keras, numpy and sklearn.

Techniques used for increasing the accuracy of the model include:

* Tuning the hyperparameters

**Results:**

Train on 1350 samples, validate on 150 samples

Epoch 1/50

1350/1350 [==============================] - 20s 15ms/step - loss: 0.3542 - mean\_iou: 0.4414 - val\_loss: 0.2886 - val\_mean\_iou: 0.4766

Epoch 00001: val\_loss improved from inf to 0.28861, saving model to model-dsbowl2018-1.h5

Epoch 2/50

1350/1350 [==============================] - 12s 9ms/step - loss: 0.2929 - mean\_iou: 0.4913 - val\_loss: 0.2699 - val\_mean\_iou: 0.4972

Epoch 00002: val\_loss improved from 0.28861 to 0.26988, saving model to model-dsbowl2018-1.h5

Epoch 3/50

1350/1350 [==============================] - 12s 9ms/step - loss: 0.2849 - mean\_iou: 0.5019 - val\_loss: 0.2681 - val\_mean\_iou: 0.5058

Epoch 00003: val\_loss improved from 0.26988 to 0.26809, saving model to model-dsbowl2018-1.h5

Epoch 4/50

1350/1350 [==============================] - 12s 9ms/step - loss: 0.2863 - mean\_iou: 0.5074 - val\_loss: 0.2735 - val\_mean\_iou: 0.5089

Epoch 00004: val\_loss did not improve from 0.26809

Epoch 5/50

1350/1350 [==============================] - 12s 9ms/step - loss: 0.2839 - mean\_iou: 0.5096 - val\_loss: 0.2704 - val\_mean\_iou: 0.5111

Epoch 00005: val\_loss did not improve from 0.26809

Epoch 6/50

1350/1350 [==============================] - 12s 9ms/step - loss: 0.2822 - mean\_iou: 0.5121 - val\_loss: 0.2658 - val\_mean\_iou: 0.5138

Epoch 00006: val\_loss improved from 0.26809 to 0.26584, saving model to model-dsbowl2018-1.h5

Epoch 7/50

1350/1350 [==============================] - 12s 9ms/step - loss: 0.2809 - mean\_iou: 0.5146 - val\_loss: 0.2647 - val\_mean\_iou: 0.5156

Epoch 00007: val\_loss improved from 0.26584 to 0.26474, saving model to model-dsbowl2018-1.h5

Epoch 8/50

1350/1350 [==============================] - 12s 9ms/step - loss: 0.2809 - mean\_iou: 0.5161 - val\_loss: 0.2628 - val\_mean\_iou: 0.5169

Epoch 00008: val\_loss improved from 0.26474 to 0.26281, saving model to model-dsbowl2018-1.h5

Epoch 9/50

1350/1350 [==============================] - 12s 9ms/step - loss: 0.2792 - mean\_iou: 0.5178 - val\_loss: 0.2704 - val\_mean\_iou: 0.5183

Epoch 00009: val\_loss did not improve from 0.26281

Epoch 10/50

1350/1350 [==============================] - 12s 9ms/step - loss: 0.2815 - mean\_iou: 0.5189 - val\_loss: 0.2647 - val\_mean\_iou: 0.5191

Epoch 00010: val\_loss did not improve from 0.26281

Epoch 11/50

1350/1350 [==============================] - 12s 9ms/step - loss: 0.2791 - mean\_iou: 0.5194 - val\_loss: 0.2659 - val\_mean\_iou: 0.5200

Epoch 00011: val\_loss did not improve from 0.26281

Epoch 12/50

1350/1350 [==============================] - 12s 9ms/step - loss: 0.2802 - mean\_iou: 0.5203 - val\_loss: 0.2654 - val\_mean\_iou: 0.5208

Epoch 00012: val\_loss did not improve from 0.26281

Epoch 13/50

1350/1350 [==============================] - 12s 9ms/step - loss: 0.2781 - mean\_iou: 0.5212 - val\_loss: 0.2623 - val\_mean\_iou: 0.5215

Epoch 00013: val\_loss improved from 0.26281 to 0.26230, saving model to model-dsbowl2018-1.h5

Epoch 14/50

1350/1350 [==============================] - 12s 9ms/step - loss: 0.2791 - mean\_iou: 0.5216 - val\_loss: 0.2722 - val\_mean\_iou: 0.5220

Epoch 00014: val\_loss did not improve from 0.26230

Epoch 15/50

1350/1350 [==============================] - 12s 9ms/step - loss: 0.2799 - mean\_iou: 0.5223 - val\_loss: 0.2632 - val\_mean\_iou: 0.5223

Epoch 00015: val\_loss did not improve from 0.26230

Epoch 16/50

1350/1350 [==============================] - 12s 9ms/step - loss: 0.2790 - mean\_iou: 0.5225 - val\_loss: 0.3476 - val\_mean\_iou: 0.5226

Epoch 00016: val\_loss did not improve from 0.26230

Epoch 17/50

1350/1350 [==============================] - 12s 9ms/step - loss: 0.2793 - mean\_iou: 0.5225 - val\_loss: 0.2632 - val\_mean\_iou: 0.5227

Epoch 00017: val\_loss did not improve from 0.26230

Epoch 18/50

1350/1350 [==============================] - 12s 9ms/step - loss: 0.2785 - mean\_iou: 0.5230 - val\_loss: 0.2619 - val\_mean\_iou: 0.5232

Epoch 00018: val\_loss improved from 0.26230 to 0.26195, saving model to model-dsbowl2018-1.h5

Epoch 19/50

1350/1350 [==============================] - 12s 9ms/step - loss: 0.2776 - mean\_iou: 0.5233 - val\_loss: 0.3446 - val\_mean\_iou: 0.5234

Epoch 00019: val\_loss did not improve from 0.26195

Epoch 20/50

1350/1350 [==============================] - 12s 9ms/step - loss: 0.2797 - mean\_iou: 0.5234 - val\_loss: 0.2813 - val\_mean\_iou: 0.5235

Epoch 00020: val\_loss did not improve from 0.26195

Epoch 21/50

1350/1350 [==============================] - 12s 9ms/step - loss: 0.2790 - mean\_iou: 0.5235 - val\_loss: 0.2617 - val\_mean\_iou: 0.5237

Epoch 00021: val\_loss improved from 0.26195 to 0.26168, saving model to model-dsbowl2018-1.h5

Epoch 22/50

1350/1350 [==============================] - 12s 9ms/step - loss: 0.2800 - mean\_iou: 0.5238 - val\_loss: 0.2637 - val\_mean\_iou: 0.5238

Epoch 00022: val\_loss did not improve from 0.26168

Epoch 23/50

1350/1350 [==============================] - 12s 9ms/step - loss: 0.2785 - mean\_iou: 0.5239 - val\_loss: 0.2646 - val\_mean\_iou: 0.5241

Epoch 00023: val\_loss did not improve from 0.26168

Epoch 24/50

1350/1350 [==============================] - 12s 9ms/step - loss: 0.2775 - mean\_iou: 0.5243 - val\_loss: 0.2768 - val\_mean\_iou: 0.5244

Epoch 00024: val\_loss did not improve from 0.26168

Epoch 25/50