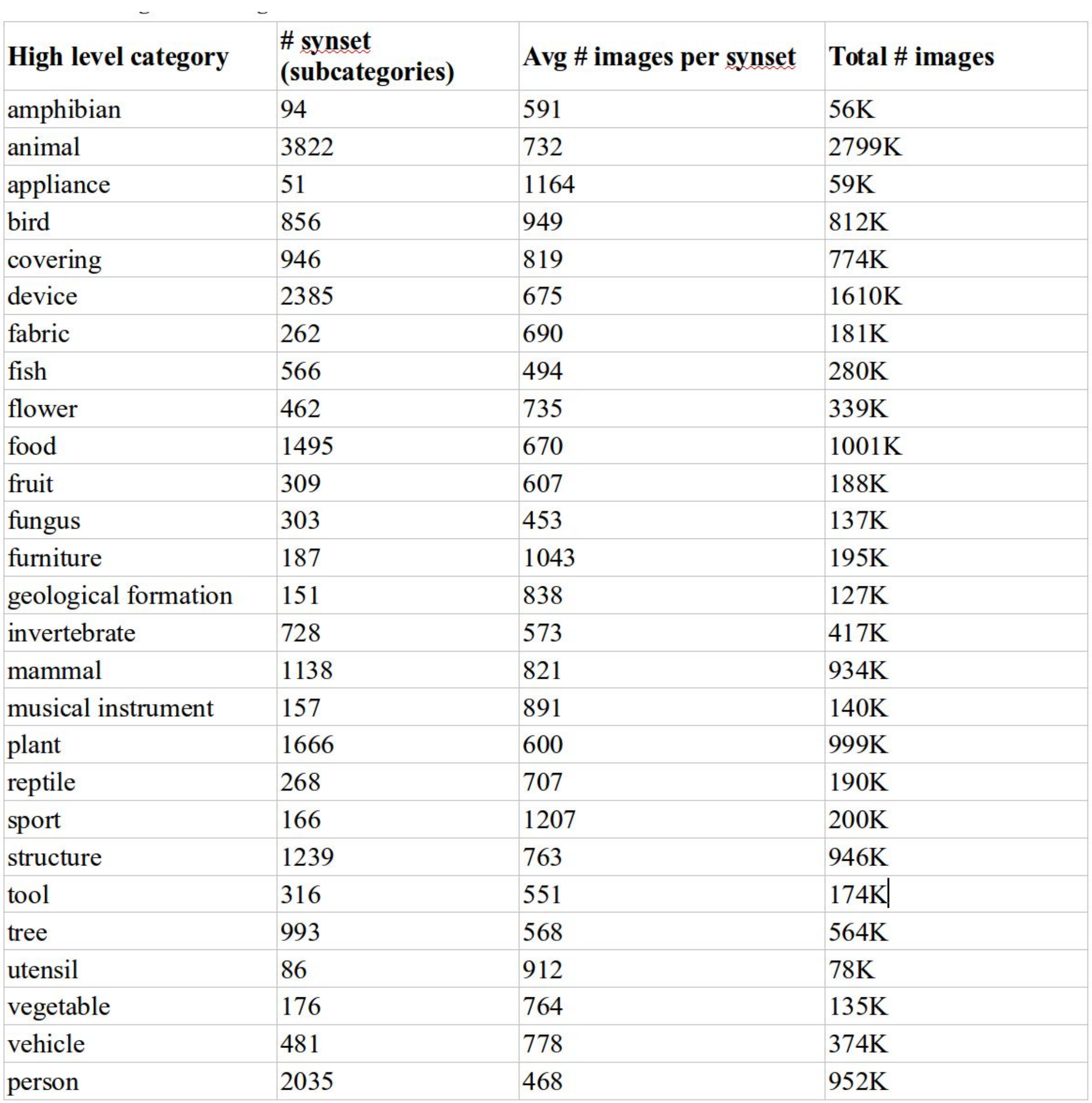
# Face Recognition Using Vgg16

# Imagenet



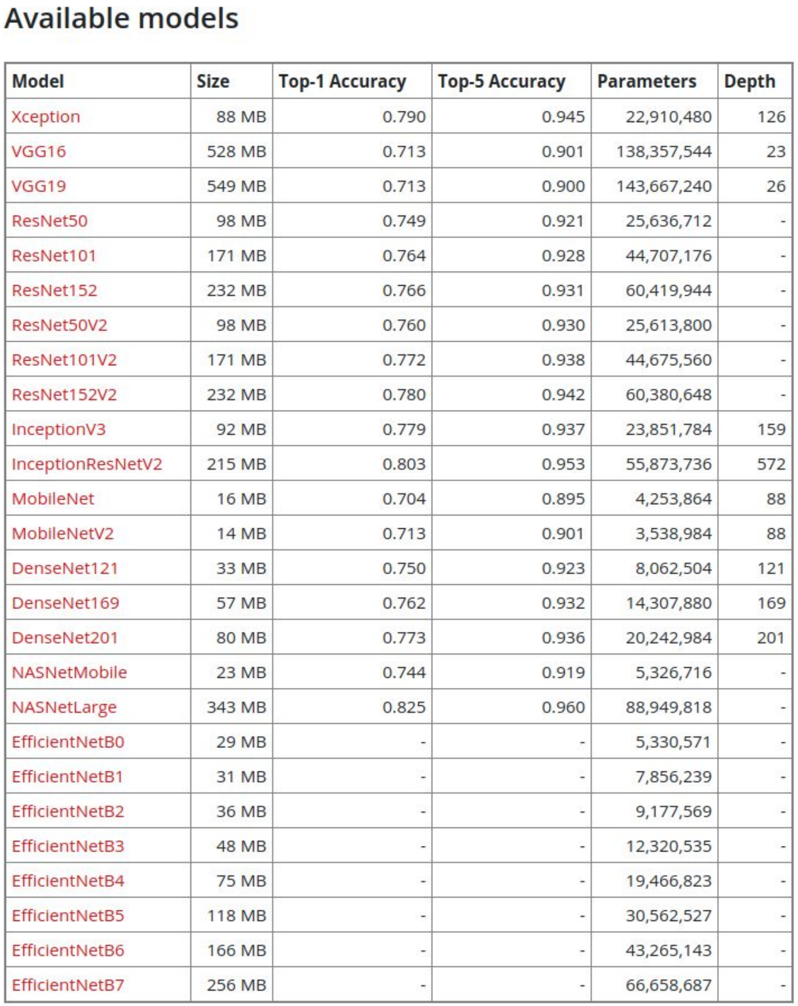
| High level category | # synset (subcategories) | Avg # images per synset | Total # images |
|---|---|---|---|
| amphibian | 94 | 591 | 56K |
| animal | 3822 | 732 | 2799K |
| appliance | 51 | 1164 | 59K |
| bird | 856 | 949 | 812K |
| covering | 946 | 819 | 774K |
| device | 2385 | 675 | 1610K |
| fabric | 262 | 690 | 181K |
| fish | 566 | 494 | 280K |
| flower | 462 | 735 | 339K |
| food | 1495 | 670 | 1001K |
| fruit | 309 | 607 | 188K |
| fungus | 303 | 453 | 137K |
| furniture | 187 | 1043 | 195K |
| geological formation | 151 | 838 | 127K |
| invertebrate | 728 | 573 | 417K |
| mammal | 1138 | 821 | 934K |
| musical instrument | 157 | 891 | 140K |
| plant | 1666 | 600 | 999K |
| reptile | 268 | 707 | 190K |
| sport | 166 | 1207 | 200K |
| structure | 1239 | 763 | 946K |
| tool | 316 | 551 | 174K |
| tree | 993 | 568 | 564K |
| utensil | 86 | 912 | 78K |
| vegetable | 176 | 764 | 135K |
| vehicle | 481 | 778 | 374K |
| person | 2035 | 468 | 952K |

# VGGFace

- Number Of Images= 2.6 million

- Number Of subjects=2,622

# ImageNet Pre-trained models



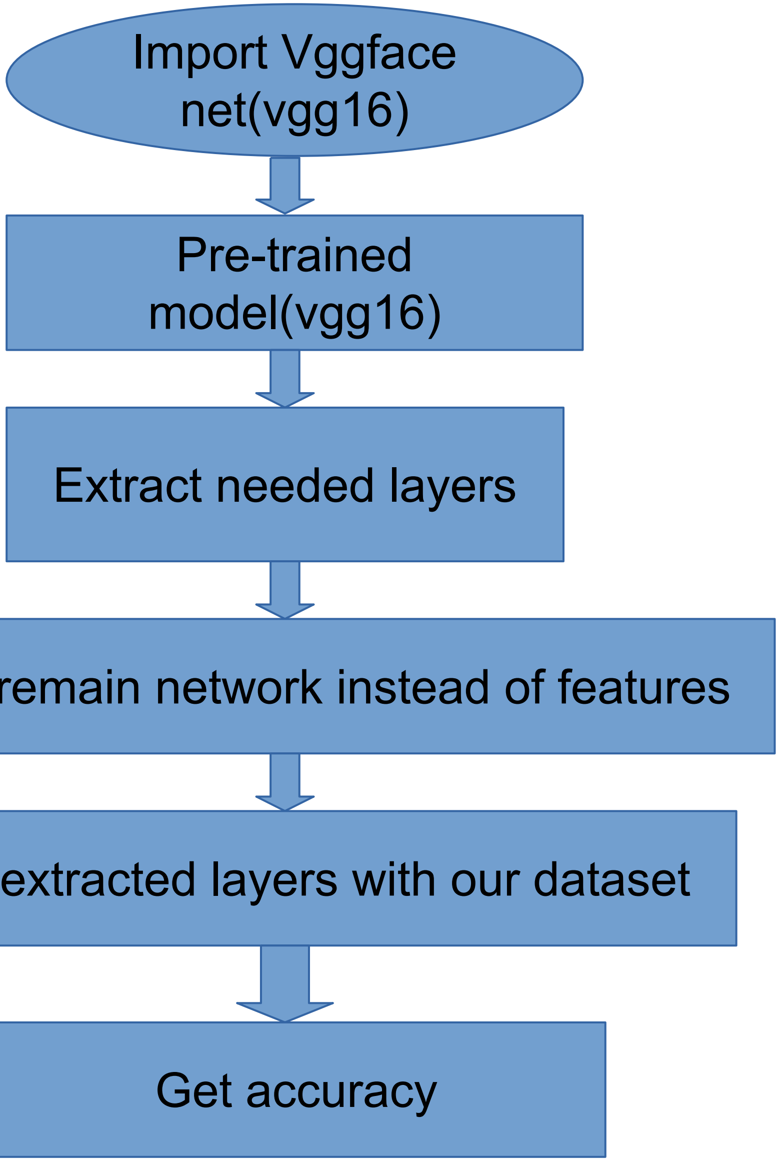
## Available models

| Model | Size | Top-1 Accuracy | Top-5 Accuracy | Parameters | Depth |
|---|---|---|---|---|---|
| Xception | 88 MB | 0.790 | 0.945 | 22,910,480 | 126 |
| VGG16 | 528 MB | 0.713 | 0.901 | 138,357,544 | 23 |
| VGG19 | 549 MB | 0.713 | 0.900 | 143,667,240 | 26 |
| ResNet50 | 98 MB | 0.749 | 0.921 | 25,636,712 | - |
| ResNet101 | 171 MB | 0.764 | 0.928 | 44,707,176 | - |
| ResNet152 | 232 MB | 0.766 | 0.931 | 60,419,944 | - |
| ResNet50V2 | 98 MB | 0.760 | 0.930 | 25,613,800 | - |
| ResNet101V2 | 171 MB | 0.772 | 0.938 | 44,675,560 | - |
| ResNet152V2 | 232 MB | 0.780 | 0.942 | 60,380,648 | - |
| InceptionV3 | 92 MB | 0.779 | 0.937 | 23,851,784 | 159 |
| InceptionResNetV2 | 215 MB | 0.803 | 0.953 | 55,873,736 | 572 |
| MobileNet | 16 MB | 0.704 | 0.895 | 4,253,864 | 88 |
| MobileNetV2 | 14 MB | 0.713 | 0.901 | 3,538,984 | 88 |
| DenseNet121 | 33 MB | 0.750 | 0.923 | 8,062,504 | 121 |
| DenseNet169 | 57 MB | 0.762 | 0.932 | 14,307,880 | 169 |
| DenseNet201 | 80 MB | 0.773 | 0.936 | 20,242,984 | 201 |
| NASNetMobile | 23 MB | 0.744 | 0.919 | 5,326,716 | - |
| NASNetLarge | 343 MB | 0.825 | 0.960 | 88,949,818 | - |
| EfficientNetB0 | 29 MB | - | - | 5,330,571 | - |
| EfficientNetB1 | 31 MB | - | - | 7,856,239 | - |
| EfficientNetB2 | 36 MB | - | - | 9,177,569 | - |
| EfficientNetB3 | 48 MB | - | - | 12,320,535 | - |
| EfficientNetB4 | 75 MB | - | - | 19,466,823 | - |
| EfficientNetB5 | 118 MB | - | - | 30,562,527 | - |
| EfficientNetB6 | 166 MB | - | - | 43,265,143 | - |
| EfficientNetB7 | 256 MB | - | - | 66,658,687 | - |

# Oxford VGGFace Implementation

- from keras_vggface.vggface import VGGFace
- vggface = VGGFace(model='vgg16')
- vggface = VGGFace(model='resnet50')
- vggface = VGGFace(model='senet50')

# Flowchart



Import Vggface net(vgg16)

Pre-trained model(vgg16)

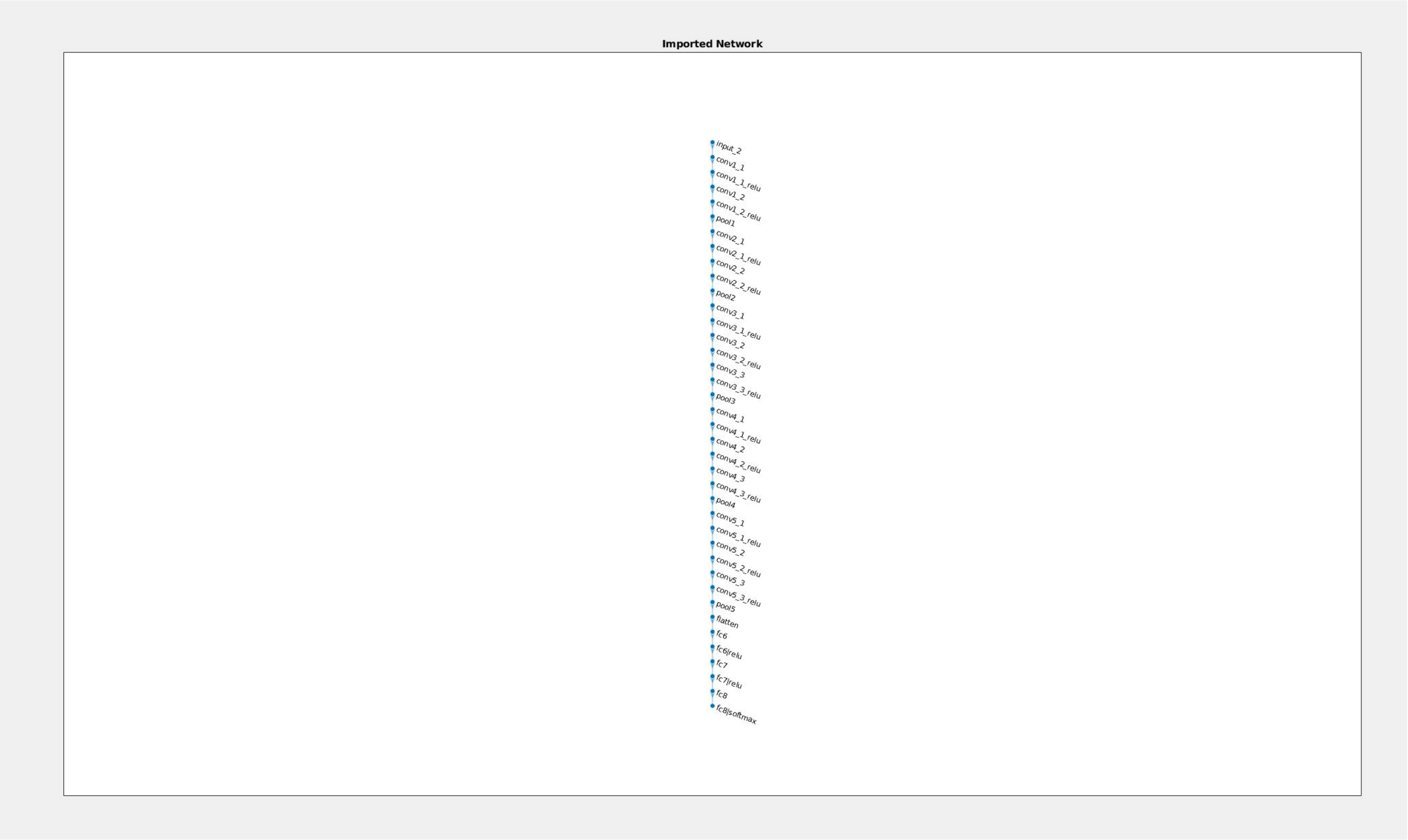
Extract needed layers

Use remain network instead of features

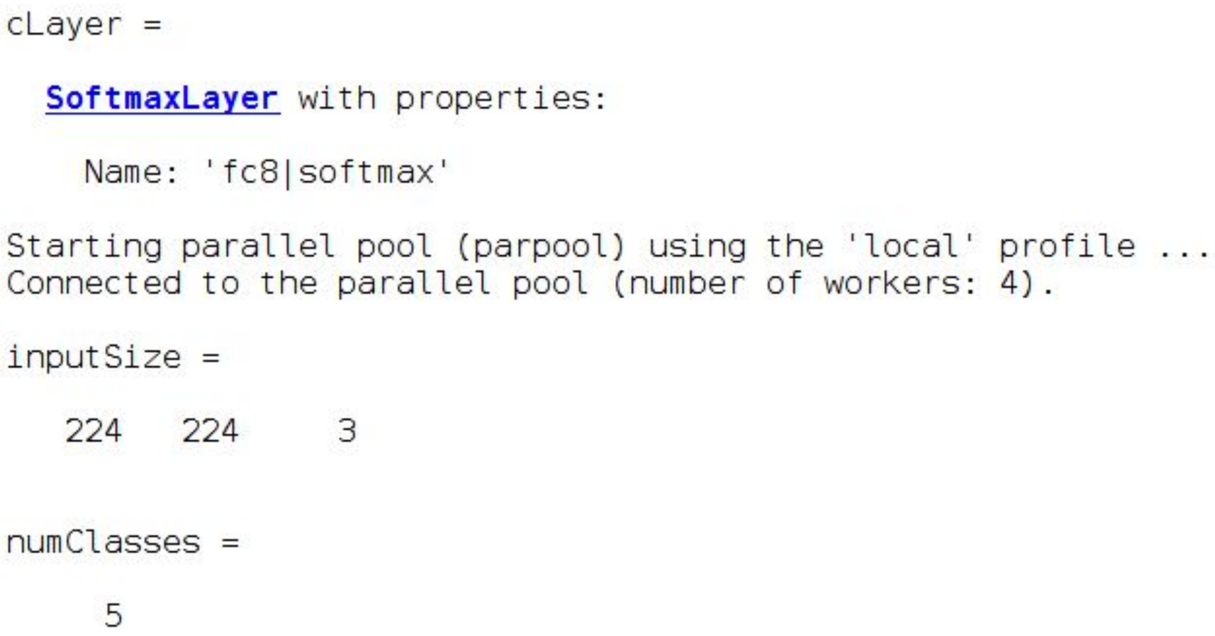
Train extracted layers with our dataset

Get accuracy

# Imported Network



# Program results

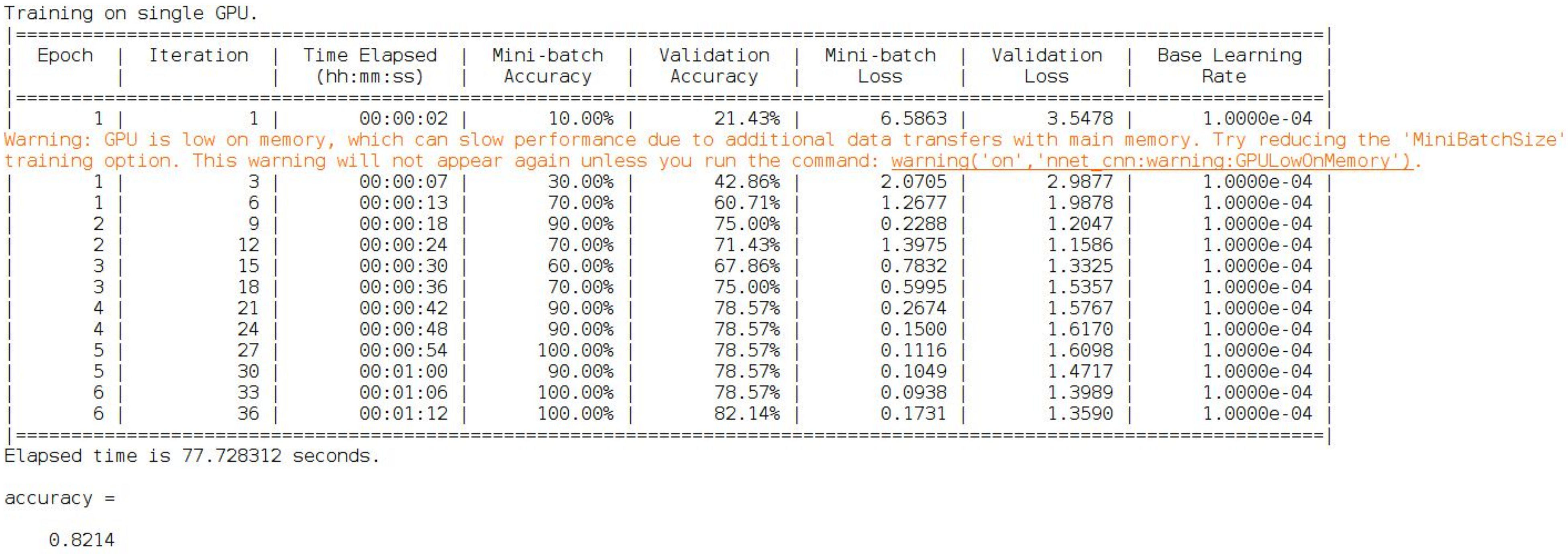


```
cLayer =

  SoftmaxLayer with properties:

    Name: 'fc8|softmax'

Starting parallel pool (parpool) using the 'local' profile ...
Connected to the parallel pool (number of workers: 4).

inputSize =

   224   224     3


numClasses =

     5
```

# Transfer all layers except 2 last ones

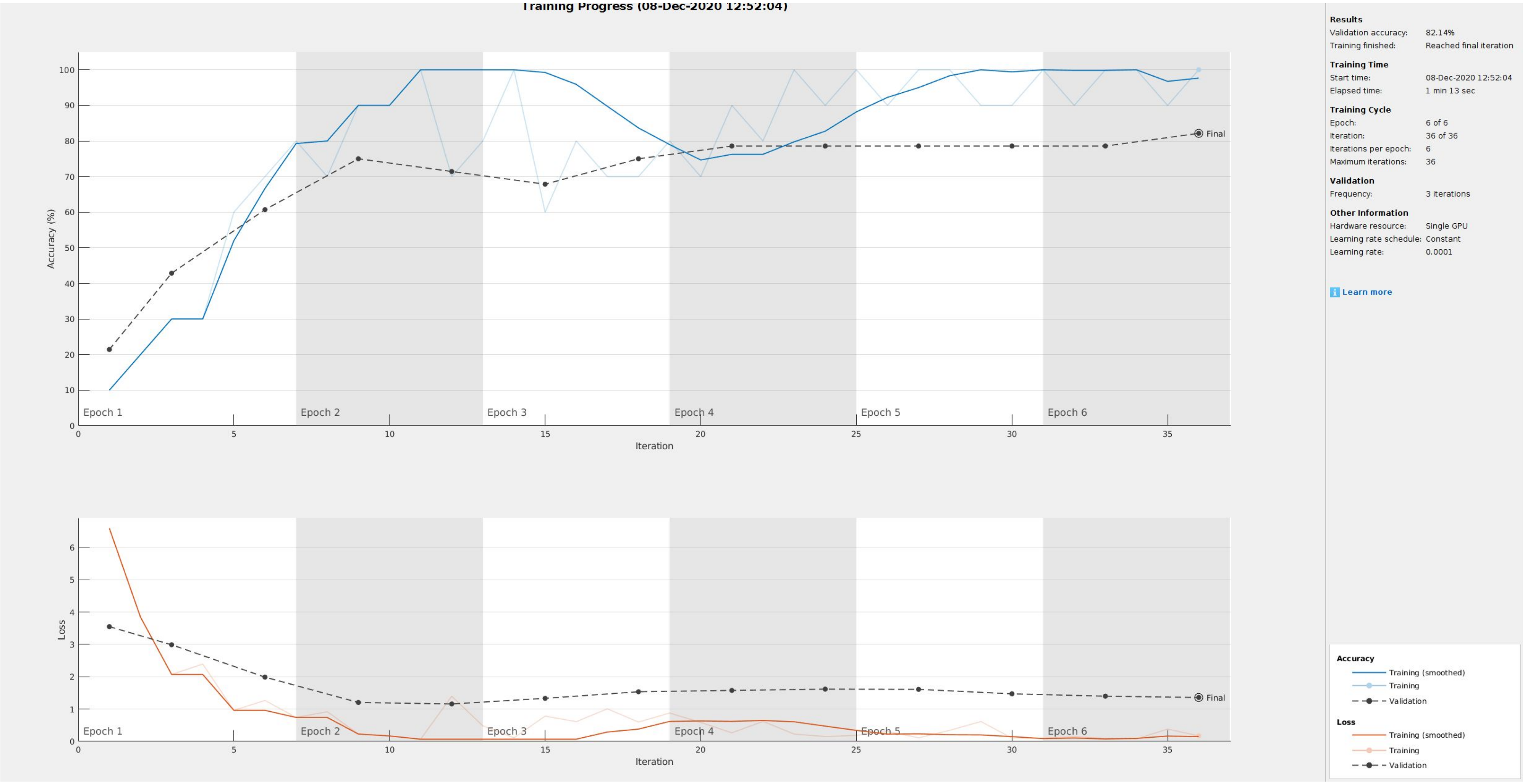
- Extract 2 last layers (Fc8 & Soft max )
- layersTransfer = net.Layers(1:end-2);
- Train the extracted layers with our images
- 5 celebrates dataset used to train the last layers.
- About 100 images

# Training Progress



```
Training on single GPU.
|=========================================================================================================================|
|  Epoch  |  Iteration  |  Time Elapsed  |  Mini-batch  |  Validation  |  Mini-batch  |  Validation  |  Base Learning  |
|         |             |   (hh:mm:ss)   |   Accuracy   |   Accuracy   |     Loss     |     Loss     |      Rate       |
|=========================================================================================================================|
|       1 |           1 |       00:00:02 |       10.00% |       21.43% |       6.5863 |       3.5478 |      1.0000e-04 |
Warning: GPU is low on memory, which can slow performance due to additional data transfers with main memory. Try reducing the 'MiniBatchSize'
training option. This warning will not appear again unless you run the command: warning('on','nnet_cnn:warning:GPULowOnMemory').
|       1 |           3 |       00:00:07 |       30.00% |       42.86% |       2.0705 |       2.9877 |      1.0000e-04 |
|       1 |           6 |       00:00:13 |       70.00% |       60.71% |       1.2677 |       1.9878 |      1.0000e-04 |
|       2 |           9 |       00:00:18 |       90.00% |       75.00% |       0.2288 |       1.2047 |      1.0000e-04 |
|       2 |          12 |       00:00:24 |       70.00% |       71.43% |       1.3975 |       1.1586 |      1.0000e-04 |
|       3 |          15 |       00:00:30 |       60.00% |       67.86% |       0.7832 |       1.3325 |      1.0000e-04 |
|       3 |          18 |       00:00:36 |       70.00% |       75.00% |       0.5995 |       1.5357 |      1.0000e-04 |
|       4 |          21 |       00:00:42 |       90.00% |       78.57% |       0.2674 |       1.5767 |      1.0000e-04 |
|       4 |          24 |       00:00:48 |       90.00% |       78.57% |       0.1500 |       1.6170 |      1.0000e-04 |
|       5 |          27 |       00:00:54 |      100.00% |       78.57% |       0.1116 |       1.6098 |      1.0000e-04 |
|       5 |          30 |       00:01:00 |       90.00% |       78.57% |       0.1049 |       1.4717 |      1.0000e-04 |
|       6 |          33 |       00:01:06 |      100.00% |       78.57% |       0.0938 |       1.3989 |      1.0000e-04 |
|       6 |          36 |       00:01:12 |      100.00% |       82.14% |       0.1731 |       1.3590 |      1.0000e-04 |
|=========================================================================================================================|
Elapsed time is 77.728312 seconds.

accuracy =

    0.8214
```

# Training Progress



**Results**

| | |
|---|---|
| Validation accuracy: | 82.14% |
| Training finished: | Reached final iteration |

**Training Time**

| | |
|---|---|
| Start time: | 08-Dec-2020 12:52:04 |
| Elapsed time: | 1 min 13 sec |

**Training Cycle**

| | |
|---|---|
| Epoch: | 6 of 6 |
| Iteration: | 36 of 36 |
| Iterations per epoch: | 6 |
| Maximum iterations: | 36 |

**Validation**

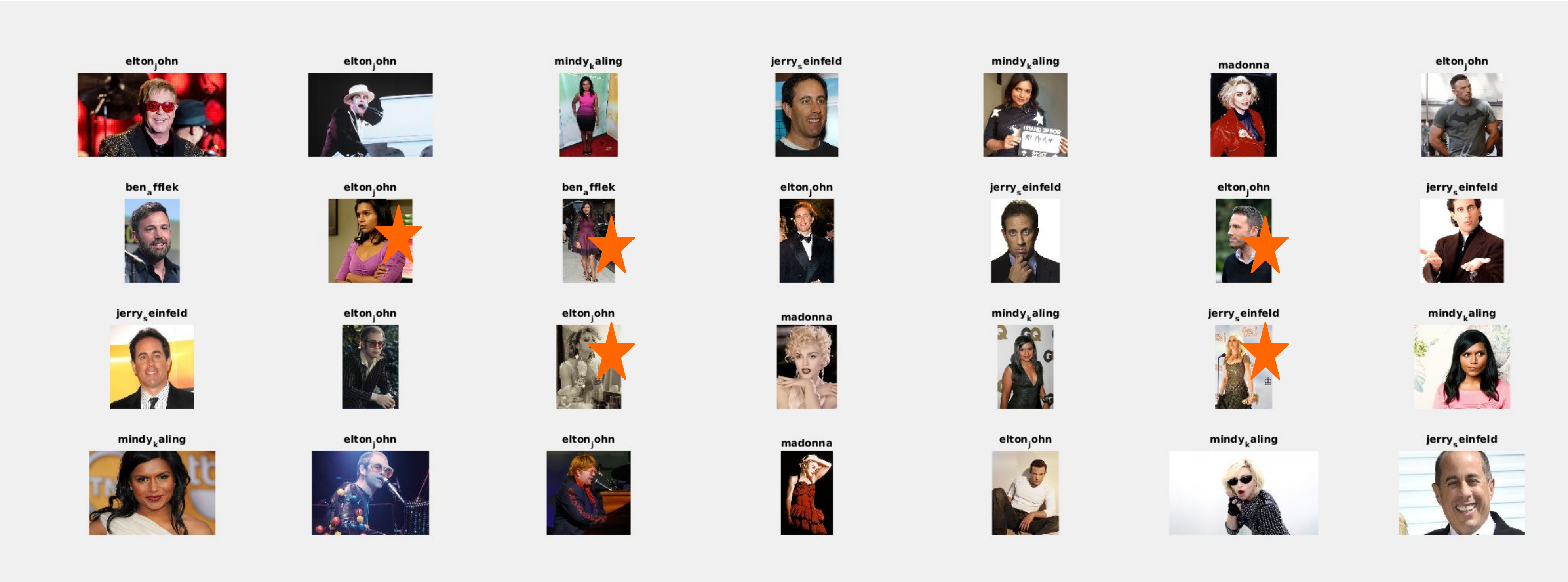
| | |
|---|---|
| Frequency: | 3 iterations |

**Other Information**

| | |
|---|---|
| Hardware resource: | Single GPU |
| Learning rate schedule: | Constant |
| Learning rate: | 0.0001 |

ℹ **Learn more**

# Face recognition of 28 validation images



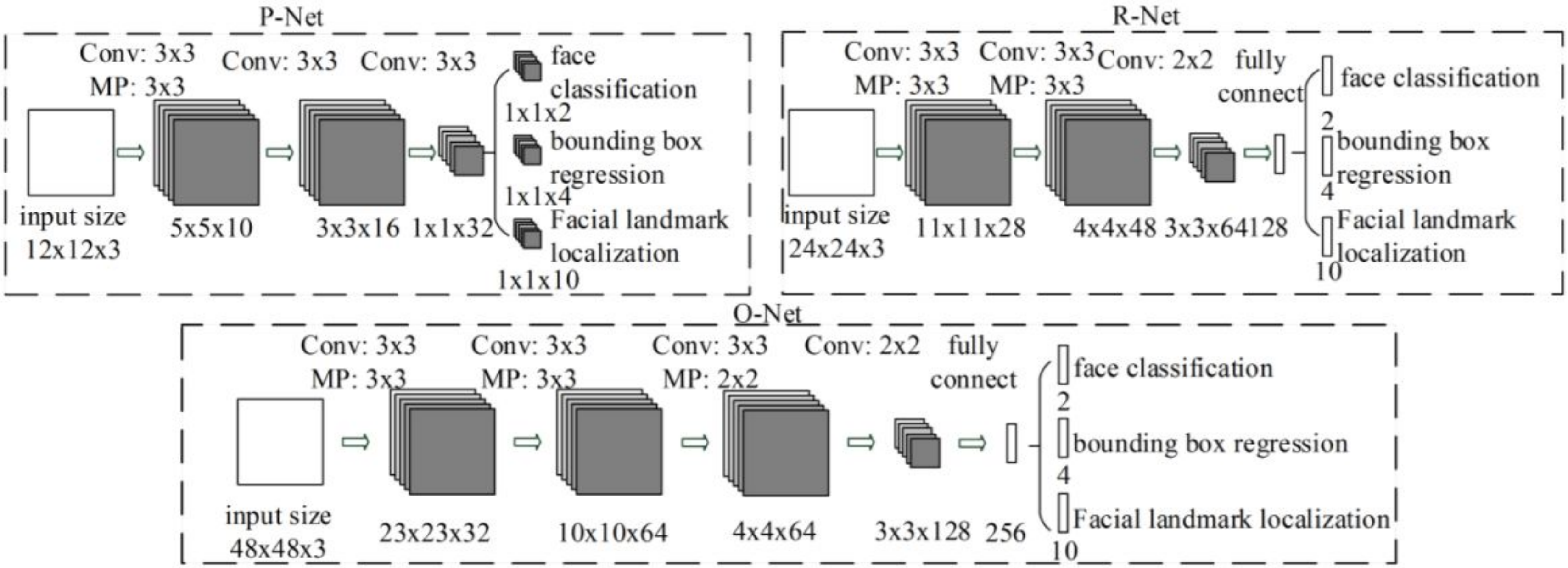
# Add preprocessing method

- 1- MTCNN

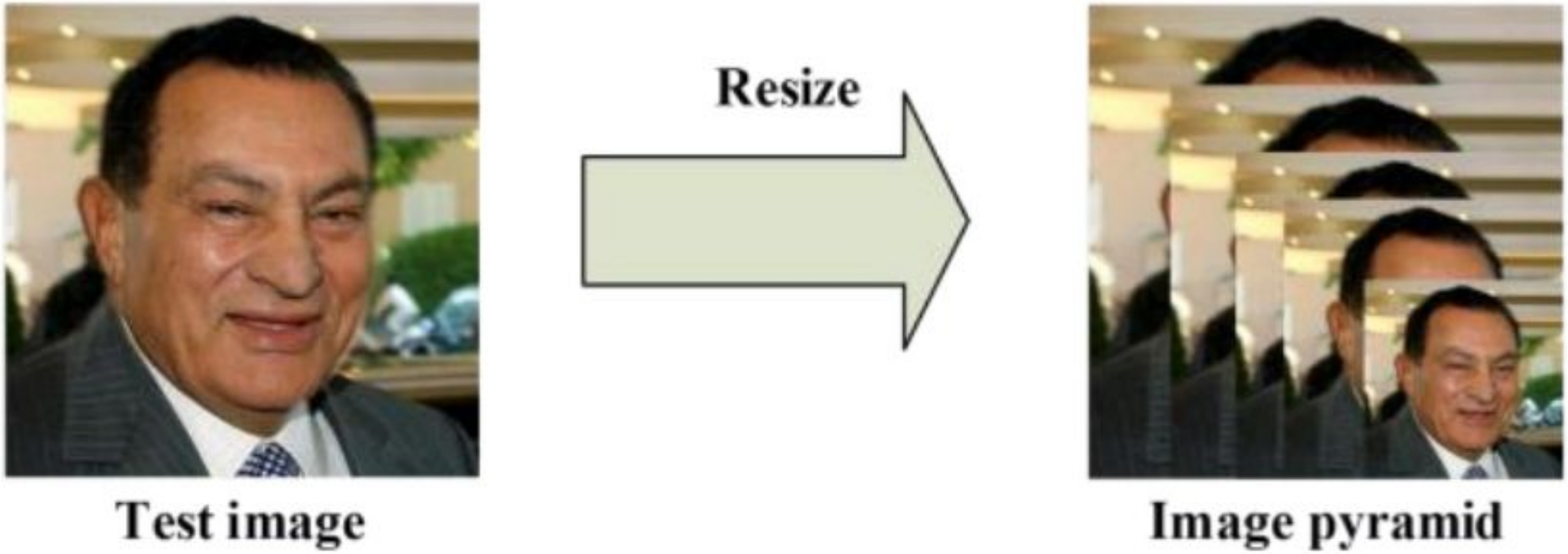
- 2- Vision.CascadeObjectDetector

# Multi-task Cascaded Convolutional Network (MTCNN)

- Has three convolutional networks (P-Net, R-Net, and O-Net)



# How does MTCNN work?



# Train a Cascade Object Detector

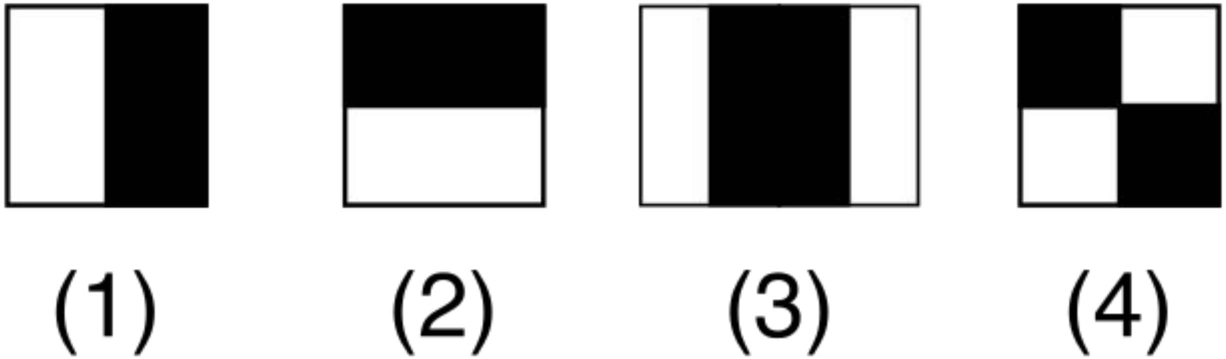
- The cascade object detector uses the Viola-Jones algorithm to detect people’s faces, noses, eyes, mouth, or upper body.
- Robust
- Real time
- Face detection only (not recognition)

# Viola-Jones algorithm

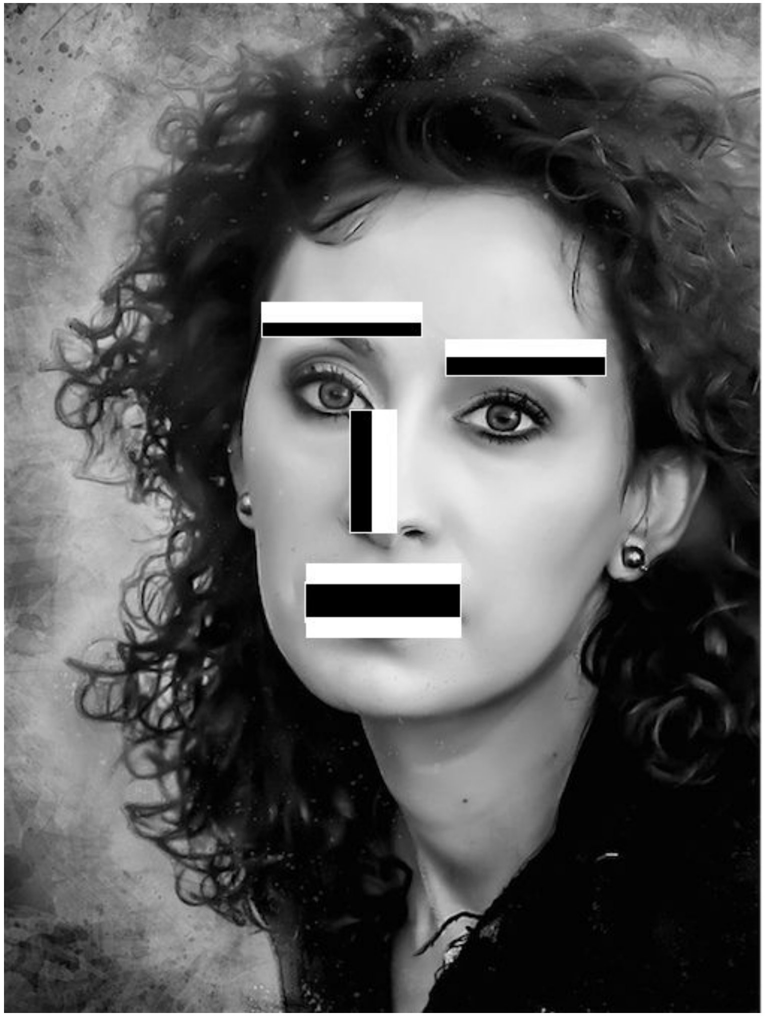
- The algorithm has four stages:
- 1-Haar Feature Selection
- 2-Creating an Integral Image
- 3-Adaboost Training
- 4-Cascading Classifiers

# Haar Features

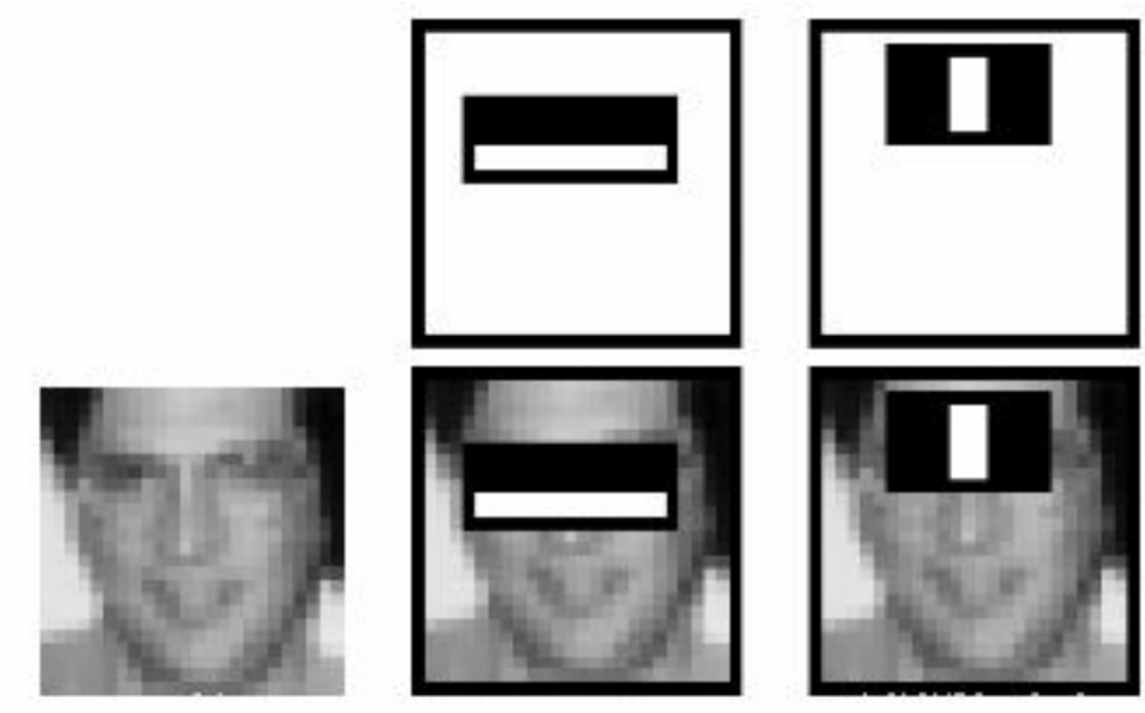
- All human faces share some similar properties. These regularities may be matched using Haar Features.



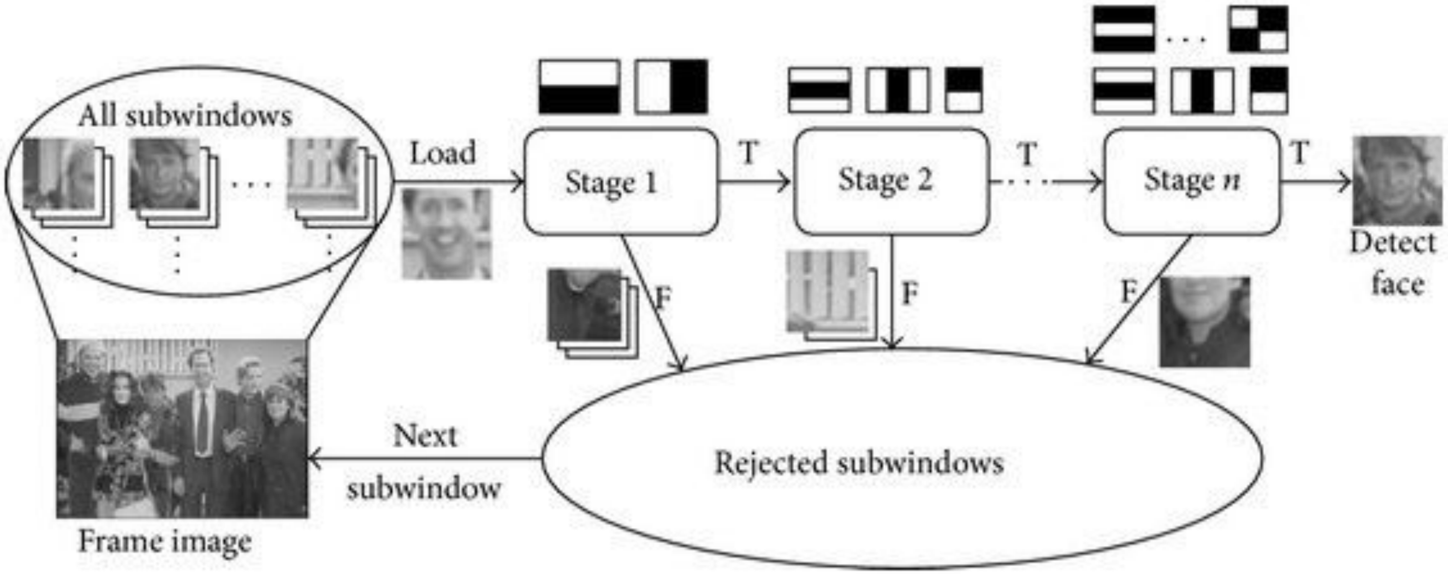
# Haar Features



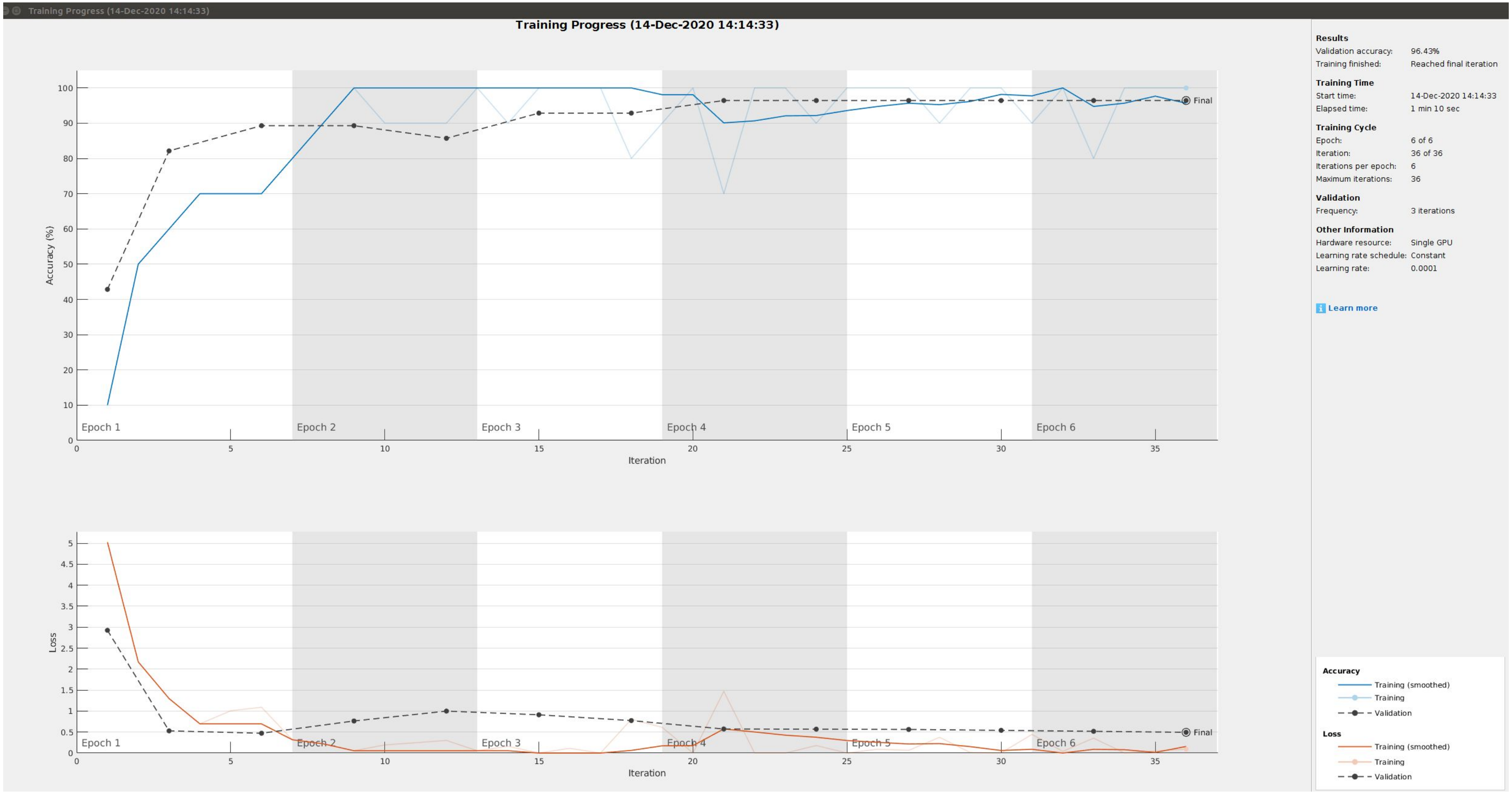
# Adaboost Training



# Haar Cascade Classifiers

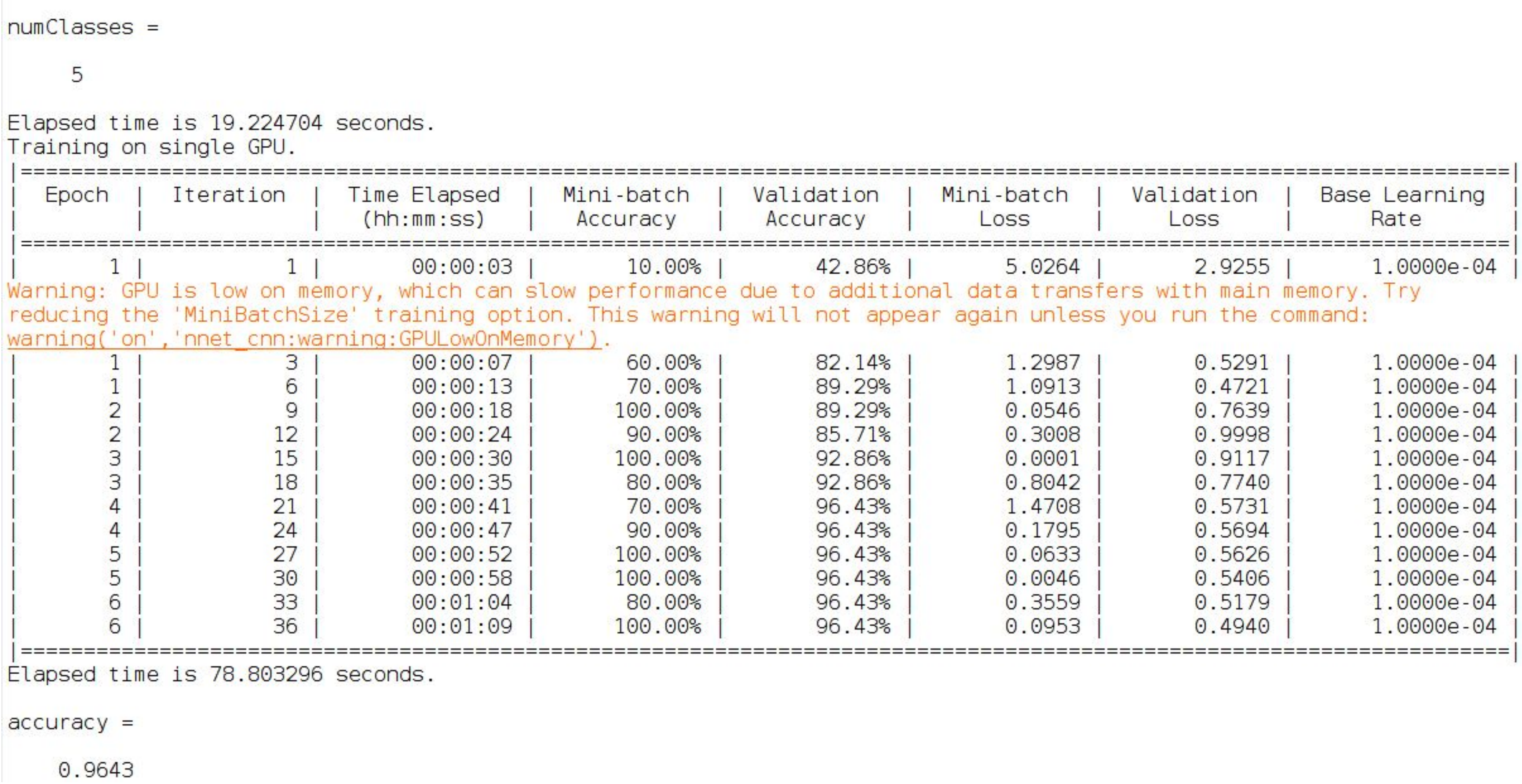


# Accuracy after preprocessing methods



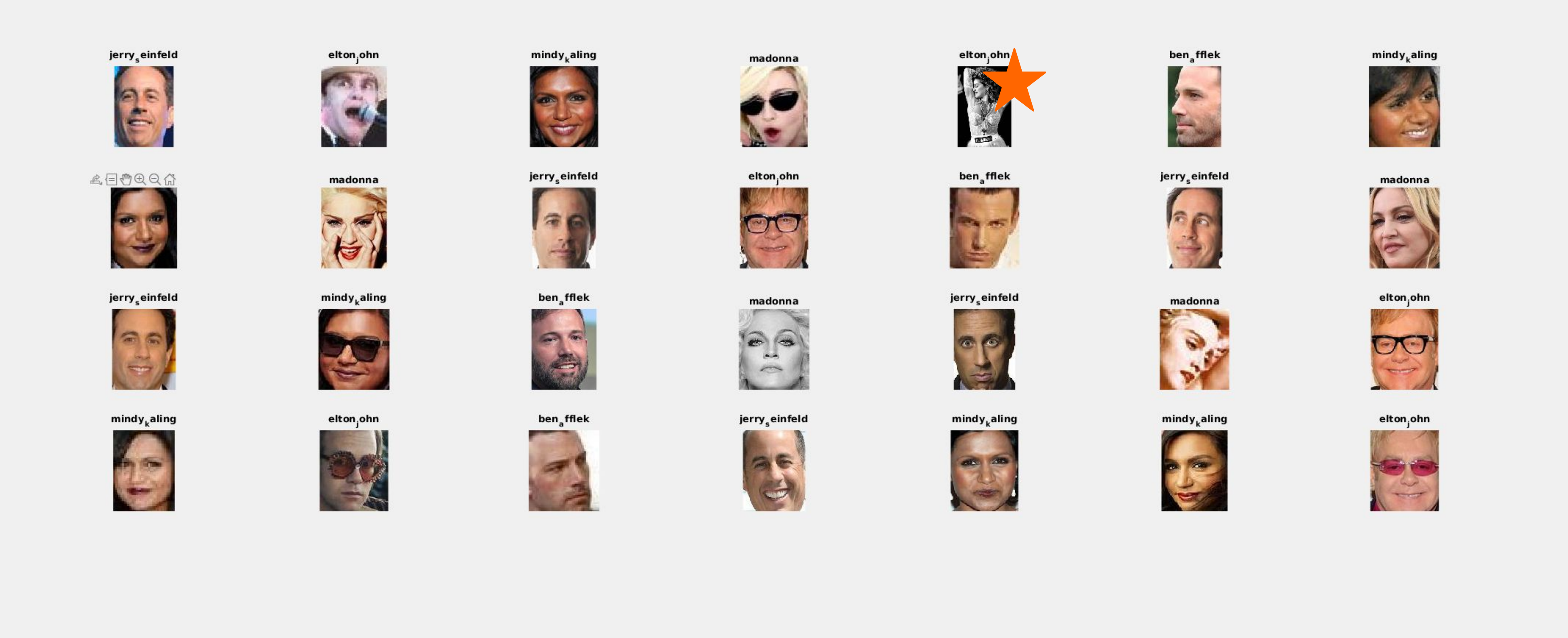
| | |
|---|---|
| **Results** | |
| Validation accuracy: | 96.43% |
| Training finished: | Reached final iteration |
| **Training Time** | |
| Start time: | 14-Dec-2020 14:14:33 |
| Elapsed time: | 1 min 10 sec |
| **Training Cycle** | |
| Epoch: | 6 of 6 |
| Iteration: | 36 of 36 |
| Iterations per epoch: | 6 |
| Maximum iterations: | 36 |
| **Validation** | |
| Frequency: | 3 iterations |
| **Other Information** | |
| Hardware resource: | Single GPU |
| Learning rate schedule: | Constant |
| Learning rate: | 0.0001 |

# Train and validation process



```
numClasses =

     5

Elapsed time is 19.224704 seconds.
Training on single GPU.
|======================================================================================================|
|  Epoch  |  Iteration  |  Time Elapsed  |  Mini-batch  |  Validation  |  Mini-batch  |  Validation  |  Base Learning  |
|         |             |   (hh:mm:ss)   |   Accuracy   |   Accuracy   |     Loss     |     Loss     |      Rate       |
|======================================================================================================|
|       1 |           1 |       00:00:03 |       10.00% |       42.86% |       5.0264 |       2.9255 |      1.0000e-04 |
Warning: GPU is low on memory, which can slow performance due to additional data transfers with main memory. Try
reducing the 'MiniBatchSize' training option. This warning will not appear again unless you run the command:
warning('on','nnet_cnn:warning:GPULowOnMemory').
|       1 |           3 |       00:00:07 |       60.00% |       82.14% |       1.2987 |       0.5291 |      1.0000e-04 |
|       1 |           6 |       00:00:13 |       70.00% |       89.29% |       1.0913 |       0.4721 |      1.0000e-04 |
|       2 |           9 |       00:00:18 |      100.00% |       89.29% |       0.0546 |       0.7639 |      1.0000e-04 |
|       2 |          12 |       00:00:24 |       90.00% |       85.71% |       0.3008 |       0.9998 |      1.0000e-04 |
|       3 |          15 |       00:00:30 |      100.00% |       92.86% |       0.0001 |       0.9117 |      1.0000e-04 |
|       3 |          18 |       00:00:35 |       80.00% |       92.86% |       0.8042 |       0.7740 |      1.0000e-04 |
|       4 |          21 |       00:00:41 |       70.00% |       96.43% |       1.4708 |       0.5731 |      1.0000e-04 |
|       4 |          24 |       00:00:47 |       90.00% |       96.43% |       0.1795 |       0.5694 |      1.0000e-04 |
|       5 |          27 |       00:00:52 |      100.00% |       96.43% |       0.0633 |       0.5626 |      1.0000e-04 |
|       5 |          30 |       00:00:58 |      100.00% |       96.43% |       0.0046 |       0.5406 |      1.0000e-04 |
|       6 |          33 |       00:01:04 |       80.00% |       96.43% |       0.3559 |       0.5179 |      1.0000e-04 |
|       6 |          36 |       00:01:09 |      100.00% |       96.43% |       0.0953 |       0.4940 |      1.0000e-04 |
|======================================================================================================|
Elapsed time is 78.803296 seconds.

accuracy =

    0.9643
```

# Face recognition of 28 validation images


jerry$_s$einfeld
elton$_j$ohn
mindy$_k$aling
madonna
elton$_j$ohn
ben$_a$fflek
mindy$_k$aling
madonna
jerry$_s$einfeld
elton$_j$ohn
ben$_a$fflek
jerry$_s$einfeld
madonna
jerry$_s$einfeld
mindy$_k$aling
ben$_a$fflek
madonna
jerry$_s$einfeld
madonna
elton$_j$ohn
mindy$_k$aling
elton$_j$ohn
ben$_a$fflek
jerry$_s$einfeld
mindy$_k$aling
mindy$_k$aling
elton$_j$ohn