**Expected Output at the terminal when this machine learning python file starts running:**

I tensorflow/core/platform/cpu\_feature\_guard.cc:193] This TensorFlow binary is optimized with oneAPI Deep Neural Network Library (oneDNN) to use the following CPU instructions in performance-critical operations: SSE4.1 SSE4.2

To enable them in other operations, rebuild TensorFlow with the appropriate compiler flags.

Tensorflow version: 2.10.0

Number of Training Images

7215 happy images

4830 sad images

4097 fear images

3171 surprise images

4965 neutral images

3995 angry images

436 disgust images

Number of Test Images

1774 happy images

1247 sad images

1024 fear images

831 surprise images

1233 neutral images

958 angry images

111 disgust images

Number of Training Images

Found 28709 images belonging to 7 classes.

Number of Test Images

Found 7178 images belonging to 7 classes.

I tensorflow/core/platform/cpu\_feature\_guard.cc:193] This TensorFlow binary is optimized with oneAPI Deep Neural Network Library (oneDNN) to use the following CPU instructions in performance-critical operations: SSE4.1 SSE4.2

To enable them in other operations, rebuild TensorFlow with the appropriate compiler flags.

CNN (Convoluted Neural Network) model

Model: "sequential"

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Layer (type) Output Shape Param #

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conv2d (Conv2D) (None, 48, 48, 64) 640

batch\_normalization (BatchN (None, 48, 48, 64) 256

ormalization)

activation (Activation) (None, 48, 48, 64) 0

max\_pooling2d (MaxPooling2D (None, 24, 24, 64) 0

)

dropout (Dropout) (None, 24, 24, 64) 0

conv2d\_1 (Conv2D) (None, 24, 24, 128) 204928

batch\_normalization\_1 (Batc (None, 24, 24, 128) 512

hNormalization)

activation\_1 (Activation) (None, 24, 24, 128) 0

max\_pooling2d\_1 (MaxPooling (None, 12, 12, 128) 0

2D)

dropout\_1 (Dropout) (None, 12, 12, 128) 0

conv2d\_2 (Conv2D) (None, 12, 12, 512) 590336

batch\_normalization\_2 (Batc (None, 12, 12, 512) 2048

hNormalization)

activation\_2 (Activation) (None, 12, 12, 512) 0

max\_pooling2d\_2 (MaxPooling (None, 6, 6, 512) 0

2D)

dropout\_2 (Dropout) (None, 6, 6, 512) 0

conv2d\_3 (Conv2D) (None, 6, 6, 512) 2359808

batch\_normalization\_3 (Batc (None, 6, 6, 512) 2048

hNormalization)

activation\_3 (Activation) (None, 6, 6, 512) 0

max\_pooling2d\_3 (MaxPooling (None, 3, 3, 512) 0

2D)

dropout\_3 (Dropout) (None, 3, 3, 512) 0

flatten (Flatten) (None, 4608) 0

dense (Dense) (None, 256) 1179904

batch\_normalization\_4 (Batc (None, 256) 1024

hNormalization)

activation\_4 (Activation) (None, 256) 0

dropout\_4 (Dropout) (None, 256) 0

dense\_1 (Dense) (None, 512) 131584

batch\_normalization\_5 (Batc (None, 512) 2048

hNormalization)

activation\_5 (Activation) (None, 512) 0

dropout\_5 (Dropout) (None, 512) 0

dense\_2 (Dense) (None, 7) 3591

=================================================================

Total params: 4,478,727

Trainable params: 4,474,759

Non-trainable params: 3,968

Starting 15 Epoches first, then add on another 5 Epoches (for optimization) for a total of 20 Epoches. (Tried adding 5 more to make up 25 Epoches-> which result in overfitting).

Hence, decided on 20 Epoches for model training.

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Epoch 1/15

accuracy

training (min: 0.296, max: 0.296, cur: 0.296)

validation (min: 0.378, max: 0.378, cur: 0.378)

Loss

training (min: 1.823, max: 1.823, cur: 1.823)

validation (min: 1.617, max: 1.617, cur: 1.617)

Epoch 1: saving model to model\_weights.h5

448/448 [==============================] - 573s 1s/step - loss: 1.8227 - accuracy: 0.2959 - val\_loss: 1.6172 - val\_accuracy: 0.3782 - lr: 5.0000e-04

Epoch 2/15

accuracy

training (min: 0.296, max: 0.423, cur: 0.423)

validation (min: 0.378, max: 0.458, cur: 0.458)

Loss

training (min: 1.498, max: 1.823, cur: 1.498)

validation (min: 1.391, max: 1.617, cur: 1.391)

Epoch 2: saving model to model\_weights.h5

448/448 [==============================] - 602s 1s/step - loss: 1.4977 - accuracy: 0.4227 - val\_loss: 1.3914 - val\_accuracy: 0.4583 - lr: 5.0000e-04

Epoch 3/15

accuracy

training (min: 0.296, max: 0.487, cur: 0.487)

validation (min: 0.378, max: 0.484, cur: 0.484)

Loss

training (min: 1.339, max: 1.823, cur: 1.339)

validation (min: 1.347, max: 1.617, cur: 1.347)

Epoch 3: saving model to model\_weights.h5

448/448 [==============================] - 705s 2s/step - loss: 1.3392 - accuracy: 0.4874 - val\_loss: 1.3472 - val\_accuracy: 0.4837 - lr: 5.0000e-04

Epoch 4/15

accuracy

training (min: 0.296, max: 0.518, cur: 0.518)

validation (min: 0.378, max: 0.525, cur: 0.525)

Loss

training (min: 1.254, max: 1.823, cur: 1.254)

validation (min: 1.213, max: 1.617, cur: 1.213)

Epoch 4: saving model to model\_weights.h5

448/448 [==============================] - 611s 1s/step - loss: 1.2541 - accuracy: 0.5178 - val\_loss: 1.2127 - val\_accuracy: 0.5250 - lr: 5.0000e-04

Epoch 5/15

accuracy

training (min: 0.296, max: 0.541, cur: 0.541)

validation (min: 0.378, max: 0.525, cur: 0.450)

Loss

training (min: 1.200, max: 1.823, cur: 1.200)

validation (min: 1.213, max: 1.617, cur: 1.400)

Epoch 5: saving model to model\_weights.h5

448/448 [==============================] - 654s 1s/step - loss: 1.2000 - accuracy: 0.5411 - val\_loss: 1.3999 - val\_accuracy: 0.4503 - lr: 5.0000e-04

Epoch 6/15

accuracy

training (min: 0.296, max: 0.561, cur: 0.561)

validation (min: 0.378, max: 0.530, cur: 0.530)

Loss

training (min: 1.153, max: 1.823, cur: 1.153)

validation (min: 1.207, max: 1.617, cur: 1.207)

Epoch 6: saving model to model\_weights.h5

448/448 [==============================] - 632s 1s/step - loss: 1.1525 - accuracy: 0.5615 - val\_loss: 1.2074 - val\_accuracy: 0.5301 - lr: 5.0000e-04

Epoch 7/15

accuracy

training (min: 0.296, max: 0.572, cur: 0.572)

validation (min: 0.378, max: 0.592, cur: 0.592)

Loss

training (min: 1.124, max: 1.823, cur: 1.124)

validation (min: 1.082, max: 1.617, cur: 1.082)

Epoch 7: saving model to model\_weights.h5

448/448 [==============================] - 596s 1s/step - loss: 1.1238 - accuracy: 0.5718 - val\_loss: 1.0819 - val\_accuracy: 0.5925 - lr: 5.0000e-04

Epoch 8/15

accuracy

training (min: 0.296, max: 0.586, cur: 0.586)

validation (min: 0.378, max: 0.592, cur: 0.584)

Loss

training (min: 1.091, max: 1.823, cur: 1.091)

validation (min: 1.082, max: 1.617, cur: 1.084)

Epoch 8: saving model to model\_weights.h5

448/448 [==============================] - 608s 1s/step - loss: 1.0906 - accuracy: 0.5857 - val\_loss: 1.0841 - val\_accuracy: 0.5837 - lr: 5.0000e-04

Epoch 9/15

accuracy

training (min: 0.296, max: 0.596, cur: 0.596)

validation (min: 0.378, max: 0.592, cur: 0.577)

Loss

training (min: 1.063, max: 1.823, cur: 1.063)

validation (min: 1.082, max: 1.617, cur: 1.122)

Epoch 9: saving model to model\_weights.h5

448/448 [==============================] - 612s 1s/step - loss: 1.0626 - accuracy: 0.5961 - val\_loss: 1.1221 - val\_accuracy: 0.5767 - lr: 5.0000e-04

Epoch 10/15

accuracy

training (min: 0.296, max: 0.622, cur: 0.622)

validation (min: 0.378, max: 0.623, cur: 0.623)

Loss

training (min: 0.997, max: 1.823, cur: 0.997)

validation (min: 1.010, max: 1.617, cur: 1.010)

Epoch 10: saving model to model\_weights.h5

448/448 [==============================] - 601s 1s/step - loss: 0.9970 - accuracy: 0.6224 - val\_loss: 1.0101 - val\_accuracy: 0.6228 - lr: 5.0000e-05

Epoch 11/15

accuracy

training (min: 0.296, max: 0.630, cur: 0.630)

validation (min: 0.378, max: 0.623, cur: 0.620)

Loss

training (min: 0.974, max: 1.823, cur: 0.974)

validation (min: 1.010, max: 1.617, cur: 1.014)

Epoch 11: saving model to model\_weights.h5

448/448 [==============================] - 1114s 2s/step - loss: 0.9742 - accuracy: 0.6297 - val\_loss: 1.0143 - val\_accuracy: 0.6201 - lr: 5.0000e-05

Epoch 12/15

accuracy

training (min: 0.296, max: 0.636, cur: 0.636)

validation (min: 0.378, max: 0.628, cur: 0.628)

Loss

training (min: 0.963, max: 1.823, cur: 0.963)

validation (min: 0.993, max: 1.617, cur: 0.993)

Epoch 12: saving model to model\_weights.h5

448/448 [==============================] - 542s 1s/step - loss: 0.9632 - accuracy: 0.6362 - val\_loss: 0.9931 - val\_accuracy: 0.6279 - lr: 5.0000e-05

Epoch 13/15

accuracy

training (min: 0.296, max: 0.642, cur: 0.642)

validation (min: 0.378, max: 0.629, cur: 0.629)

Loss

training (min: 0.949, max: 1.823, cur: 0.949)

validation (min: 0.993, max: 1.617, cur: 0.998)

Epoch 13: saving model to model\_weights.h5

448/448 [==============================] - 656s 1s/step - loss: 0.9491 - accuracy: 0.6423 - val\_loss: 0.9975 - val\_accuracy: 0.6292 - lr: 5.0000e-05

Epoch 14/15

accuracy

training (min: 0.296, max: 0.645, cur: 0.645)

validation (min: 0.378, max: 0.636, cur: 0.636)

Loss

training (min: 0.942, max: 1.823, cur: 0.942)

validation (min: 0.991, max: 1.617, cur: 0.991)

Epoch 14: saving model to model\_weights.h5

448/448 [==============================] - 582s 1s/step - loss: 0.9416 - accuracy: 0.6450 - val\_loss: 0.9907 - val\_accuracy: 0.6359 - lr: 5.0000e-05

Epoch 15/15

accuracy

training (min: 0.296, max: 0.648, cur: 0.648)

validation (min: 0.378, max: 0.636, cur: 0.628)

Loss

training (min: 0.935, max: 1.823, cur: 0.935)

validation (min: 0.991, max: 1.617, cur: 1.011)

Epoch 15: saving model to model\_weights.h5

448/448 [==============================] - 639s 1s/step - loss: 0.9347 - accuracy: 0.6479 - val\_loss: 1.0112 - val\_accuracy: 0.6278 - lr: 5.0000e-05

\*Epoch 15 graph (Accuracy of prediction about 62% to 64%)

Chart, line chart

Description automatically generated

**Adding 5 more epoch:**

Epoch 1/5

accuracy

training (min: 0.613, max: 0.613, cur: 0.613)

validation (min: 0.614, max: 0.614, cur: 0.614)

Loss

training (min: 1.020, max: 1.020, cur: 1.020)

validation (min: 1.033, max: 1.033, cur: 1.033)

Epoch 1: saving model to model\_weights.h5

448/448 [==============================] - 626s 1s/step - loss: 1.0198 - accuracy: 0.6131 - val\_loss: 1.0331 - val\_accuracy: 0.6143 - lr: 5.0000e-04

Epoch 2/5

accuracy

training (min: 0.613, max: 0.619, cur: 0.619)

validation (min: 0.578, max: 0.614, cur: 0.578)

Loss

training (min: 1.004, max: 1.020, cur: 1.004)

validation (min: 1.033, max: 1.127, cur: 1.127)

Epoch 2: saving model to model\_weights.h5

448/448 [==============================] - 758s 2s/step - loss: 1.0041 - accuracy: 0.6194 - val\_loss: 1.1266 - val\_accuracy: 0.5783 - lr: 5.0000e-04

Epoch 3/5

accuracy

training (min: 0.613, max: 0.628, cur: 0.628)

validation (min: 0.578, max: 0.614, cur: 0.588)

Loss

training (min: 0.978, max: 1.020, cur: 0.978)

validation (min: 1.033, max: 1.127, cur: 1.086)

Epoch 3: saving model to model\_weights.h5

448/448 [==============================] - 690s 2s/step - loss: 0.9783 - accuracy: 0.6280 - val\_loss: 1.0860 - val\_accuracy: 0.5876 - lr: 5.0000e-04

Epoch 4/5

accuracy

training (min: 0.613, max: 0.657, cur: 0.657)

validation (min: 0.578, max: 0.647, cur: 0.647)

Loss

training (min: 0.910, max: 1.020, cur: 0.910)

validation (min: 0.965, max: 1.127, cur: 0.965)

Epoch 4: saving model to model\_weights.h5

448/448 [==============================] - 768s 2s/step - loss: 0.9097 - accuracy: 0.6574 - val\_loss: 0.9651 - val\_accuracy: 0.6466 - lr: 5.0000e-05

Epoch 5/5

accuracy

training (min: 0.613, max: 0.665, cur: 0.665)

validation (min: 0.578, max: 0.647, cur: 0.647)

Loss

training (min: 0.890, max: 1.020, cur: 0.890)

validation (min: 0.963, max: 1.127, cur: 0.963)

Epoch 5: saving model to model\_weights.h5

448/448 [==============================] - 786s 2s/step - loss: 0.8899 - accuracy: 0.6647 - val\_loss: 0.9634 - val\_accuracy: 0.6472 - lr: 5.0000e-05

\*At total of 20 Epoches: Accuracy of prediction about 64% to 66%

FYI: If add on another 5 more epoch to make up 25 Epoches:

Epoch 1: saving model to model\_weights\_v2.h5

448/448 [==============================] - 703s 2s/step - loss: 0.9480 - accuracy: 0.6419 - val\_loss: 1.1253 - val\_accuracy: 0.5744 - lr: 5.0000e-04

Epoch 2/5

accuracy

training (min: 0.642, max: 0.650, cur: 0.650)

validation (min: 0.574, max: 0.617, cur: 0.617)

Loss

training (min: 0.926, max: 0.948, cur: 0.926)

validation (min: 1.020, max: 1.125, cur: 1.020)

Epoch 2: saving model to model\_weights\_v2.h5

448/448 [==============================] - 865s 2s/step - loss: 0.9264 - accuracy: 0.6501 - val\_loss: 1.0200 - val\_accuracy: 0.6173 - lr: 5.0000e-04

Epoch 3/5

accuracy

training (min: 0.642, max: 0.656, cur: 0.656)

validation (min: 0.574, max: 0.617, cur: 0.613)

Loss

training (min: 0.914, max: 0.948, cur: 0.914)

validation (min: 1.020, max: 1.125, cur: 1.033)

Epoch 3: saving model to model\_weights\_v2.h5

448/448 [==============================] - 704s 2s/step - loss: 0.9140 - accuracy: 0.6562 - val\_loss: 1.0329 - val\_accuracy: 0.6126 - lr: 5.0000e-04

Epoch 4/5

accuracy

training (min: 0.642, max: 0.665, cur: 0.665)

validation (min: 0.574, max: 0.632, cur: 0.632)

Loss

training (min: 0.890, max: 0.948, cur: 0.890)

validation (min: 0.983, max: 1.125, cur: 0.983)

Epoch 4: saving model to model\_weights\_v2.h5

448/448 [==============================] - 687s 2s/step - loss: 0.8901 - accuracy: 0.6648 - val\_loss: 0.9834 - val\_accuracy: 0.6317 - lr: 5.0000e-04

Epoch 5/5

accuracy

training (min: 0.642, max: 0.671, cur: 0.671)

validation (min: 0.574, max: 0.632, cur: 0.586)

Loss

training (min: 0.875, max: 0.948, cur: 0.875)

validation (min: 0.983, max: 1.125, cur: 1.101)

Epoch 5: saving model to model\_weights\_v2.h5

448/448 [==============================] - 769s 2s/step - loss: 0.8748 - accuracy: 0.6711 - val\_loss: 1.1011 - val\_accuracy: 0.5861 - lr: 5.0000e-04

\*At total of 25 Epoches: Accuracy of prediction about 58% to 67%. Validation accuracy dropped.