* オートエンコーダ　中間層：1000次元

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| Epoch 398/400  8/8 [==============================] - 1s 107ms/step - loss: 6.5895e-04 - accuracy: 0.8978 - val\_loss: 0.0071 - val\_accuracy: 0.8121  Epoch 399/400  8/8 [==============================] - 1s 107ms/step - loss: 6.5630e-04 - accuracy: 0.8978 - val\_loss: 0.0071 - val\_accuracy: 0.8136  Epoch 400/400  8/8 [==============================] - 1s 97ms/step - loss: 6.5899e-04 - accuracy: 0.8979 - val\_loss: 0.0071 - val\_accuracy: 0.8135  Model: "model\_2"  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Layer (type) Output Shape Param #  =================================================================  encoder\_input (InputLayer) [(None, 256, 256, 3)] 0  encoder\_conv\_0 (Conv2D) (None, 256, 256, 3) 84  leaky\_re\_lu (LeakyReLU) (None, 256, 256, 3) 0  encoder\_conv\_0\_1 (Conv2D) (None, 128, 128, 16) 448  leaky\_re\_lu\_1 (LeakyReLU) (None, 128, 128, 16) 0  encoder\_conv\_1 (Conv2D) (None, 64, 64, 32) 4640  leaky\_re\_lu\_2 (LeakyReLU) (None, 64, 64, 32) 0  encoder\_conv\_3 (Conv2D) (None, 32, 32, 64) 18496  leaky\_re\_lu\_3 (LeakyReLU) (None, 32, 32, 64) 0  flatten (Flatten) (None, 65536) 0  encoder\_output (Dense) (None, 1000) 65537000  model\_1 (Functional) (None, 256, 256, 3) 65661987  =================================================================  Total params: 131,222,655  Trainable params: 131,222,655  Non-trainable params: 0  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  WARNING:absl:Found untraced functions such as \_jit\_compiled\_convolution\_op, \_jit\_compiled\_convolution\_op, \_jit\_compiled\_convolution\_op, \_jit\_compiled\_convolution\_op, \_jit\_compiled\_convolution\_op while saving (showing 5 of 8). These functions will not be directly callable after loading. |

* クラスタリング結果

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| 精度算出方法  予測された正解ラベルのデータ数/予測ラベルのデータ数  予測された正解ラベルのデータ数/100(正解ラベルのデータ数) |

* 次元数：1000
* 検証データ：各ラベル100枚

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| --- |
| ============  label 0 = 0.23316062176165803  label 0 = 0.45  label 1 = 0.18652849740932642  label 1 = 0.36  label 2 = 0.23834196891191708  label 2 = 0.46  label 3 = 0.34196891191709844  label 3 = 0.66  ============  label 0 = 0.024390243902439025  label 0 = 0.02  label 1 = 0.43902439024390244  label 1 = 0.36  label 2 = 0.524390243902439  label 2 = 0.43  label 3 = 0.012195121951219513  label 3 = 0.01  ============  label 0 = 0.25  label 0 = 0.06  label 1 = 0.4166666666666667  label 1 = 0.1  none  label 3 = 0.3333333333333333  label 3 = 0.08  ============  label 0 = 0.46534653465346537  label 0 = 0.47  label 1 = 0.1782178217821782  label 1 = 0.18  label 2 = 0.10891089108910891  label 2 = 0.11  label 3 = 0.24752475247524752  label 3 = 0.25  ============ |

* オートエンコーダ　中間層：500次元

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| 8/8 [==============================] - 1s 94ms/step - loss: 7.9219e-04 - accuracy: 0.8924 - val\_loss: 0.0096 - val\_accuracy: 0.7154  Epoch 398/400  8/8 [==============================] - 1s 95ms/step - loss: 8.2637e-04 - accuracy: 0.8898 - val\_loss: 0.0094 - val\_accuracy: 0.7027  Epoch 399/400  8/8 [==============================] - 1s 91ms/step - loss: 8.7954e-04 - accuracy: 0.8709 - val\_loss: 0.0097 - val\_accuracy: 0.7082  Epoch 400/400  8/8 [==============================] - 1s 91ms/step - loss: 8.8357e-04 - accuracy: 0.8740 - val\_loss: 0.0097 - val\_accuracy: 0.6964  Model: "model\_2"  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Layer (type) Output Shape Param #  =================================================================  encoder\_input (InputLayer) [(None, 256, 256, 3)] 0  encoder\_conv\_0 (Conv2D) (None, 256, 256, 3) 84  leaky\_re\_lu (LeakyReLU) (None, 256, 256, 3) 0  encoder\_conv\_0\_1 (Conv2D) (None, 128, 128, 16) 448  leaky\_re\_lu\_1 (LeakyReLU) (None, 128, 128, 16) 0  encoder\_conv\_1 (Conv2D) (None, 64, 64, 32) 4640  leaky\_re\_lu\_2 (LeakyReLU) (None, 64, 64, 32) 0  encoder\_conv\_3 (Conv2D) (None, 32, 32, 64) 18496  leaky\_re\_lu\_3 (LeakyReLU) (None, 32, 32, 64) 0  flatten (Flatten) (None, 65536) 0  encoder\_output (Dense) (None, 500) 32768500  model\_1 (Functional) (None, 256, 256, 3) 32893987  =================================================================  Total params: 65,686,155  Trainable params: 65,686,155  Non-trainable params: 0  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  WARNING:absl:Found untraced functions such as \_jit\_compiled\_convolution\_op, \_jit\_compiled\_convolution\_op, \_jit\_compiled\_convolution\_op, \_jit\_compiled\_convolution\_op, \_jit\_compiled\_convolution\_op while saving (showing 5 of 8). These functions will not be directly callable after loading. |

クラスタリング結果

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| ============  none  label 1 = 0.23809523809523808  label 1 = 0.05  label 2 = 0.7619047619047619  label 2 = 0.16  none  ============  label 0 = 0.028985507246376812  label 0 = 0.02  label 1 = 0.5362318840579711  label 1 = 0.37  label 2 = 0.42028985507246375  label 2 = 0.29  label 3 = 0.014492753623188406  label 3 = 0.01  ============  label 0 = 0.4430379746835443  label 0 = 0.35  label 1 = 0.27848101265822783  label 1 = 0.22  label 2 = 0.08860759493670886  label 2 = 0.07  label 3 = 0.189873417721519  label 3 = 0.15  ============  label 0 = 0.2727272727272727  label 0 = 0.63  label 1 = 0.15584415584415584  label 1 = 0.36  label 2 = 0.2077922077922078  label 2 = 0.48  label 3 = 0.36363636363636365  label 3 = 0.84  ============ |

* オートエンコーダ　中間層：100次元

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| Epoch 397/400  8/8 [==============================] - 1s 89ms/step - loss: 0.0014 - accuracy: 0.8207 - val\_loss: 0.0117 - val\_accuracy: 0.7014  Epoch 398/400  8/8 [==============================] - 1s 90ms/step - loss: 0.0014 - accuracy: 0.8126 - val\_loss: 0.0114 - val\_accuracy: 0.7041  Epoch 399/400  8/8 [==============================] - 1s 85ms/step - loss: 0.0014 - accuracy: 0.8126 - val\_loss: 0.0116 - val\_accuracy: 0.7110  Epoch 400/400  8/8 [==============================] - 1s 85ms/step - loss: 0.0016 - accuracy: 0.8047 - val\_loss: 0.0115 - val\_accuracy: 0.7011  Model: "model\_2"  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Layer (type) Output Shape Param #  =================================================================  encoder\_input (InputLayer) [(None, 256, 256, 3)] 0  encoder\_conv\_0 (Conv2D) (None, 256, 256, 3) 84  leaky\_re\_lu (LeakyReLU) (None, 256, 256, 3) 0  encoder\_conv\_0\_1 (Conv2D) (None, 128, 128, 16) 448  leaky\_re\_lu\_1 (LeakyReLU) (None, 128, 128, 16) 0  encoder\_conv\_1 (Conv2D) (None, 64, 64, 32) 4640  leaky\_re\_lu\_2 (LeakyReLU) (None, 64, 64, 32) 0  encoder\_conv\_3 (Conv2D) (None, 32, 32, 64) 18496  leaky\_re\_lu\_3 (LeakyReLU) (None, 32, 32, 64) 0  flatten (Flatten) (None, 65536) 0  encoder\_output (Dense) (None, 100) 6553700  model\_1 (Functional) (None, 256, 256, 3) 6679587  =================================================================  Total params: 13,256,955  Trainable params: 13,256,955  Non-trainable params: 0  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  WARNING:absl:Found untraced functions such as \_jit\_compiled\_convolution\_op, \_jit\_compiled\_convolution\_op, \_jit\_compiled\_convolution\_op, \_jit\_compiled\_convolution\_op, \_jit\_compiled\_convolution\_op while saving (showing 5 of 8). These functions will not be directly callable after loading. |

クラスタリング結果

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| ============  label 0 = 0.3076923076923077  label 0 = 0.08  label 1 = 0.38461538461538464  label 1 = 0.1  none  label 3 = 0.3076923076923077  label 3 = 0.08  ============  label 0 = 0.024691358024691357  label 0 = 0.02  label 1 = 0.43209876543209874  label 1 = 0.35  label 2 = 0.5308641975308642  label 2 = 0.43  label 3 = 0.012345679012345678  label 3 = 0.01  ============  label 0 = 0.21693121693121692  label 0 = 0.41  label 1 = 0.19576719576719576  label 1 = 0.37  label 2 = 0.23809523809523808  label 2 = 0.45  label 3 = 0.3492063492063492  label 3 = 0.66  ============  label 0 = 0.47115384615384615  label 0 = 0.49  label 1 = 0.17307692307692307  label 1 = 0.18  label 2 = 0.11538461538461539  label 2 = 0.12  label 3 = 0.2403846153846154  label 3 = 0.25  ============ |

* オートエンコーダ　中間層：1000次元 →メトリックラーニングによる距離の埋め込み

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| Epoch 998/1000  64/64 [==============================] - 0s 2ms/step - loss: 0.0215  Epoch 999/1000  64/64 [==============================] - 0s 2ms/step - loss: 0.0184  Epoch 1000/1000  64/64 [==============================] - 0s 2ms/step - loss: 0.0156  Model: "embedding\_model"  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Layer (type) Output Shape Param #  =================================================================  input\_1 (InputLayer) [(None, 1000)] 0  dense (Dense) (None, 1000) 1001000  tf.math.l2\_normalize (TFOpL (None, 1000) 0  ambda)  =================================================================  Total params: 1,001,000  Trainable params: 1,001,000  Non-trainable params: 0  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

クラスタリング結果

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| ============  label 0 = 0.21428571428571427  label 0 = 0.21  label 1 = 0.23469387755102042  label 1 = 0.23  label 2 = 0.20408163265306123  label 2 = 0.2  label 3 = 0.3469387755102041  label 3 = 0.34  ============  label 0 = 0.1625  label 0 = 0.13  label 1 = 0.1375  label 1 = 0.11  label 2 = 0.4  label 2 = 0.32  label 3 = 0.3  label 3 = 0.24  ============  label 0 = 0.06666666666666667  label 0 = 0.08  label 1 = 0.475  label 1 = 0.57  label 2 = 0.30833333333333335  label 2 = 0.37  label 3 = 0.15  label 3 = 0.18  ============  label 0 = 0.5686274509803921  label 0 = 0.58  label 1 = 0.08823529411764706  label 1 = 0.09  label 2 = 0.10784313725490197  label 2 = 0.11  label 3 = 0.23529411764705882  label 3 = 0.24  ============ |

* オートエンコーダ　中間層：500次元 →メトリックラーニングによる距離の埋め込み

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| --- |
| Epoch 998/1000  64/64 [==============================] - 0s 2ms/step - loss: 0.0167  Epoch 999/1000  64/64 [==============================] - 0s 2ms/step - loss: 0.0289  Epoch 1000/1000  64/64 [==============================] - 0s 2ms/step - loss: 0.0162  Model: "embedding\_model"  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Layer (type) Output Shape Param #  =================================================================  input\_1 (InputLayer) [(None, 500)] 0  dense (Dense) (None, 500) 250500  tf.math.l2\_normalize (TFOpL (None, 500) 0  ambda)  =================================================================  Total params: 250,500  Trainable params: 250,500  Non-trainable params: 0  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

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| ============  label 0 = 0.0625  label 0 = 0.04  label 1 = 0.3125  label 1 = 0.2  label 2 = 0.40625  label 2 = 0.26  label 3 = 0.21875  label 3 = 0.14  ============  label 0 = 0.5307692307692308  label 0 = 0.69  label 1 = 0.08461538461538462  label 1 = 0.11  label 2 = 0.14615384615384616  label 2 = 0.19  label 3 = 0.23846153846153847  label 3 = 0.31  ============  label 0 = 0.13953488372093023  label 0 = 0.12  label 1 = 0.1744186046511628  label 1 = 0.15  label 2 = 0.2558139534883721  label 2 = 0.22  label 3 = 0.43023255813953487  label 3 = 0.37  ============  label 0 = 0.125  label 0 = 0.15  label 1 = 0.45  label 1 = 0.54  label 2 = 0.275  label 2 = 0.33  label 3 = 0.15  label 3 = 0.18  ============ |

* オートエンコーダ　中間層：100次元 →メトリックラーニングによる距離の埋め込み

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| Epoch 998/1000  64/64 [==============================] - 0s 2ms/step - loss: 0.8176  Epoch 999/1000  64/64 [==============================] - 0s 2ms/step - loss: 0.7795  Epoch 1000/1000  64/64 [==============================] - 0s 2ms/step - loss: 0.7049  Model: "embedding\_model"  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Layer (type) Output Shape Param #  =================================================================  input\_1 (InputLayer) [(None, 100)] 0  dense (Dense) (None, 100) 10100  tf.math.l2\_normalize (TFOpL (None, 100) 0  ambda)  =================================================================  Total params: 10,100  Trainable params: 10,100  Non-trainable params: 0  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

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| ============  label 0 = 0.5777777777777777  label 0 = 0.26  label 1 = 0.06666666666666667  label 1 = 0.03  label 2 = 0.022222222222222223  label 2 = 0.01  label 3 = 0.3333333333333333  label 3 = 0.15  ============  label 0 = 0.10743801652892562  label 0 = 0.13  label 1 = 0.2809917355371901  label 1 = 0.34  label 2 = 0.21487603305785125  label 2 = 0.26  label 3 = 0.39669421487603307  label 3 = 0.48  ============  label 0 = 0.05921052631578947  label 0 = 0.09  label 1 = 0.3684210526315789  label 1 = 0.56  label 2 = 0.4473684210526316  label 2 = 0.68  label 3 = 0.125  label 3 = 0.19  ============  label 0 = 0.6341463414634146  label 0 = 0.52  label 1 = 0.08536585365853659  label 1 = 0.07  label 2 = 0.06097560975609756  label 2 = 0.05  label 3 = 0.21951219512195122  label 3 = 0.18  ============ |

* VQVAE　中間層：64,64,16次元 距離学習ニューラルネットワーク：1000次元

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| ============  label 0 = 1.0  label 0 = 0.39  none  none  none  ============  label 0 = 1.0  label 0 = 0.35  none  none  none  ============  label 0 = 1.0  label 0 = 0.19  none  none  none  ============  label 0 = 1.0  label 0 = 0.23  none  none  none  ============ |

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* AE中間層1000 ，ML中間層：1000　畳み込み層から抽出：32\*32\*64

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| ============  label 0 = 0.8157894736842105  label 0 = 0.62  label 1 = 0.09210526315789473  label 1 = 0.07  label 2 = 0.09210526315789473  label 2 = 0.07  none  ============  label 0 = 0.13392857142857142  label 0 = 0.15  label 1 = 0.5267857142857143  label 1 = 0.59  label 2 = 0.32142857142857145  label 2 = 0.36  label 3 = 0.017857142857142856  label 3 = 0.02  ============  label 0 = 0.09016393442622951  label 0 = 0.11  label 1 = 0.09836065573770492  label 1 = 0.12  label 2 = 0.01639344262295082  label 2 = 0.02  label 3 = 0.7950819672131147  label 3 = 0.97  ============  label 0 = 0.13333333333333333  label 0 = 0.12  label 1 = 0.24444444444444444  label 1 = 0.22  label 2 = 0.6111111111111112  label 2 = 0.55  label 3 = 0.011111111111111112  label 3 = 0.01  ============ |

* AE\_500 CML500

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| ============  label 0 = 0.85  label 0 = 0.68  label 1 = 0.0875  label 1 = 0.07  label 2 = 0.05  label 2 = 0.04  label 3 = 0.0125  label 3 = 0.01  ============  label 0 = 0.08333333333333333  label 0 = 0.09  label 1 = 0.12962962962962962  label 1 = 0.14  label 2 = 0.7685185185185185  label 2 = 0.83  label 3 = 0.018518518518518517  label 3 = 0.02  ============  label 0 = 0.11965811965811966  label 0 = 0.14  label 1 = 0.008547008547008548  label 1 = 0.01  label 2 = 0.06837606837606838  label 2 = 0.08  label 3 = 0.8034188034188035  label 3 = 0.94  ============  label 0 = 0.09473684210526316  label 0 = 0.09  label 1 = 0.8210526315789474  label 1 = 0.78  label 2 = 0.05263157894736842  label 2 = 0.05  label 3 = 0.031578947368421054  label 3 = 0.03  ============ |

* AE中間層100 ，ML中間層：100　畳み込み層から抽出：32\*32\*64

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| \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Layer (type) Output Shape Param #  =================================================================  encoder\_input (InputLayer) [(None, 256, 256, 3)] 0  encoder\_conv\_0 (Conv2D) (None, 256, 256, 3) 84  leaky\_re\_lu (LeakyReLU) (None, 256, 256, 3) 0  encoder\_conv\_0\_1 (Conv2D) (None, 128, 128, 16) 448  leaky\_re\_lu\_1 (LeakyReLU) (None, 128, 128, 16) 0  encoder\_conv\_1 (Conv2D) (None, 64, 64, 32) 4640  leaky\_re\_lu\_2 (LeakyReLU) (None, 64, 64, 32) 0  encoder\_conv\_3 (Conv2D) (None, 32, 32, 64) 18496  leaky\_re\_lu\_3 (LeakyReLU) (None, 32, 32, 64) 0  flatten (Flatten) (None, 65536) 0  encoder\_output (Dense) (None, 100) 6553700  model\_1 (Functional) (None, 256, 256, 3) 6679587  =================================================================  Total params: 13,256,955  Trainable params: 13,256,955  Non-trainable params: 0  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Model: "embedding\_model"  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Layer (type) Output Shape Param #  =================================================================  input\_1 (InputLayer) [(None, 32, 32, 64)] 0  conv2d (Conv2D) (None, 15, 15, 16) 9232  conv2d\_1 (Conv2D) (None, 7, 7, 32) 4640  global\_average\_pooling2d (G (None, 32) 0  lobalAveragePooling2D)  dense (Dense) (None, 100) 3300  tf.math.l2\_normalize (TFOpL (None, 100) 0  ambda)  =================================================================  Total params: 17,172  Trainable params: 17,172  Non-trainable params: 0  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

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| ============  label 0 = 0.125  label 0 = 0.16  label 1 = 0.046875  label 1 = 0.06  label 2 = 0.1015625  label 2 = 0.13  label 3 = 0.7265625  label 3 = 0.93  ============  label 0 = 0.868421052631579  label 0 = 0.66  label 1 = 0.09210526315789473  label 1 = 0.07  label 2 = 0.02631578947368421  label 2 = 0.02  label 3 = 0.013157894736842105  label 3 = 0.01  ============  label 0 = 0.08139534883720931  label 0 = 0.07  label 1 = 0.1744186046511628  label 1 = 0.15  label 2 = 0.7093023255813954  label 2 = 0.61  label 3 = 0.03488372093023256  label 3 = 0.03  ============  label 0 = 0.1  label 0 = 0.11  label 1 = 0.6545454545454545  label 1 = 0.72  label 2 = 0.21818181818181817  label 2 = 0.24  label 3 = 0.02727272727272727  label 3 = 0.03  ============ |

* オートエンコーダのFlatten（ベクトル）を中間層3層の距離学習NNに適用した場合

３層の構造

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| dense (Dense) (None, 3000) 196611000  dense\_1 (Dense) (None, 2000) 6002000  dense\_2 (Dense) (None, 1000) 2001000 |

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| 1000 | Model: "model\_2"  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Layer (type) Output Shape Param #  =================================================================  encoder\_input (InputLayer) [(None, 256, 256, 3)] 0  encoder\_conv\_0 (Conv2D) (None, 256, 256, 3) 84  leaky\_re\_lu (LeakyReLU) (None, 256, 256, 3) 0  encoder\_conv\_0\_1 (Conv2D) (None, 128, 128, 16) 448  leaky\_re\_lu\_1 (LeakyReLU) (None, 128, 128, 16) 0  encoder\_conv\_1 (Conv2D) (None, 64, 64, 32) 4640  leaky\_re\_lu\_2 (LeakyReLU) (None, 64, 64, 32) 0  encoder\_conv\_3 (Conv2D) (None, 32, 32, 64) 18496  leaky\_re\_lu\_3 (LeakyReLU) (None, 32, 32, 64) 0  flatten (Flatten) (None, 65536) 0  encoder\_output (Dense) (None, 1000) 65537000  model\_1 (Functional) (None, 256, 256, 3) 65661987  =================================================================  Total params: 131,222,655  Trainable params: 131,222,655  Non-trainable params: 0  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Model: "embedding\_model"  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Layer (type) Output Shape Param #  =================================================================  input\_1 (InputLayer) [(None, 65536)] 0  dense (Dense) (None, 3000) 196611000  dense\_1 (Dense) (None, 2000) 6002000  dense\_2 (Dense) (None, 1000) 2001000  tf.math.l2\_normalize (TFOpL (None, 1000) 0  ambda)  =================================================================  Total params: 204,614,000  Trainable params: 204,614,000  Non-trainable params: 0  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | ============  label 0 = 0.09016393442622951  label 0 = 0.11  label 1 = 0.48360655737704916  label 1 = 0.59  label 2 = 0.36065573770491804  label 2 = 0.44  label 3 = 0.06557377049180328  label 3 = 0.08  ============  label 0 = 0.7033898305084746  label 0 = 0.83  label 1 = 0.0847457627118644  label 1 = 0.1  label 2 = 0.07627118644067797  label 2 = 0.09  label 3 = 0.13559322033898305  label 3 = 0.16  ============  label 0 = 0.023255813953488372  label 0 = 0.02  label 1 = 0.12790697674418605  label 1 = 0.11  label 2 = 0.03488372093023256  label 2 = 0.03  label 3 = 0.813953488372093  label 3 = 0.7  ============  label 0 = 0.05405405405405406  label 0 = 0.04  label 1 = 0.2702702702702703  label 1 = 0.2  label 2 = 0.5945945945945946  label 2 = 0.44  label 3 = 0.08108108108108109  label 3 = 0.06  ============ |
| 500 | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Layer (type) Output Shape Param #  =================================================================  encoder\_input (InputLayer) [(None, 256, 256, 3)] 0  encoder\_conv\_0 (Conv2D) (None, 256, 256, 3) 84  leaky\_re\_lu (LeakyReLU) (None, 256, 256, 3) 0  encoder\_conv\_0\_1 (Conv2D) (None, 128, 128, 16) 448  leaky\_re\_lu\_1 (LeakyReLU) (None, 128, 128, 16) 0  encoder\_conv\_1 (Conv2D) (None, 64, 64, 32) 4640  leaky\_re\_lu\_2 (LeakyReLU) (None, 64, 64, 32) 0  encoder\_conv\_3 (Conv2D) (None, 32, 32, 64) 18496  leaky\_re\_lu\_3 (LeakyReLU) (None, 32, 32, 64) 0  flatten (Flatten) (None, 65536) 0  encoder\_output (Dense) (None, 500) 32768500  model\_1 (Functional) (None, 256, 256, 3) 32893987  =================================================================  Total params: 65,686,155  Trainable params: 65,686,155  Non-trainable params: 0  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Model: "embedding\_model"  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Layer (type) Output Shape Param #  =================================================================  input\_1 (InputLayer) [(None, 65536)] 0  dense (Dense) (None, 1500) 98305500  dense\_1 (Dense) (None, 1000) 1501000  dense\_2 (Dense) (None, 500) 500500  tf.math.l2\_normalize (TFOpL (None, 500) 0  ambda)  =================================================================  Total params: 100,307,000  Trainable params: 100,307,000  Non-trainable params: 0  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | ============  label 0 = 0.8690476190476191  label 0 = 0.73  label 1 = 0.08333333333333333  label 1 = 0.07  label 2 = 0.011904761904761904  label 2 = 0.01  label 3 = 0.03571428571428571  label 3 = 0.03  ============  label 0 = 0.08411214953271028  label 0 = 0.09  label 1 = 0.08411214953271028  label 1 = 0.09  label 2 = 0.1308411214953271  label 2 = 0.14  label 3 = 0.7009345794392523  label 3 = 0.75  ============  label 0 = 0.06666666666666667  label 0 = 0.05  label 1 = 0.18666666666666668  label 1 = 0.14  label 2 = 0.6666666666666666  label 2 = 0.5  label 3 = 0.08  label 3 = 0.06  ============  label 0 = 0.09701492537313433  label 0 = 0.13  label 1 = 0.5223880597014925  label 1 = 0.7  label 2 = 0.26119402985074625  label 2 = 0.35  label 3 = 0.11940298507462686  label 3 = 0.16  ============ |
| 100 | Model: "model\_2"  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Layer (type) Output Shape Param #  =================================================================  encoder\_input (InputLayer) [(None, 256, 256, 3)] 0  encoder\_conv\_0 (Conv2D) (None, 256, 256, 3) 84  leaky\_re\_lu (LeakyReLU) (None, 256, 256, 3) 0  encoder\_conv\_0\_1 (Conv2D) (None, 128, 128, 16) 448  leaky\_re\_lu\_1 (LeakyReLU) (None, 128, 128, 16) 0  encoder\_conv\_1 (Conv2D) (None, 64, 64, 32) 4640  leaky\_re\_lu\_2 (LeakyReLU) (None, 64, 64, 32) 0  encoder\_conv\_3 (Conv2D) (None, 32, 32, 64) 18496  leaky\_re\_lu\_3 (LeakyReLU) (None, 32, 32, 64) 0  flatten (Flatten) (None, 65536) 0  encoder\_output (Dense) (None, 100) 6553700  model\_1 (Functional) (None, 256, 256, 3) 6679587  =================================================================  Total params: 13,256,955  Trainable params: 13,256,955  Non-trainable params: 0  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Model: "embedding\_model"  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Layer (type) Output Shape Param #  =================================================================  input\_1 (InputLayer) [(None, 65536)] 0  dense (Dense) (None, 300) 19661100  dense\_1 (Dense) (None, 200) 60200  dense\_2 (Dense) (None, 100) 20100  tf.math.l2\_normalize (TFOpL (None, 100) 0  ambda)  =================================================================  Total params: 19,741,400  Trainable params: 19,741,400  Non-trainable params: 0  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | ============  label 0 = 0.058823529411764705  label 0 = 0.07  label 1 = 0.5630252100840336  label 1 = 0.67  label 2 = 0.3025210084033613  label 2 = 0.36  label 3 = 0.07563025210084033  label 3 = 0.09  ============  label 0 = 0.06451612903225806  label 0 = 0.06  label 1 = 0.10752688172043011  label 1 = 0.1  label 2 = 0.13978494623655913  label 2 = 0.13  label 3 = 0.6881720430107527  label 3 = 0.64  ============  label 0 = 0.6842105263157895  label 0 = 0.78  label 1 = 0.11403508771929824  label 1 = 0.13  label 2 = 0.05263157894736842  label 2 = 0.06  label 3 = 0.14912280701754385  label 3 = 0.17  ============  label 0 = 0.12162162162162163  label 0 = 0.09  label 1 = 0.13513513513513514  label 1 = 0.1  label 2 = 0.6081081081081081  label 2 = 0.45  label 3 = 0.13513513513513514  label 3 = 0.1  ============ |

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|  | 1000 | 500 | 100 |
| 平均再現率 | 0.64 | 0.68 | 0.63 |
| 平均適合率 | 0.64 | 0.67 | 0.63 |