**Normal\_vs\_Cataract**

**DenseNet121**

Model: "sequential"

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Layer (type) Output Shape Param #

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

densenet121 (Functional) (None, 1000) 8062504

flatten (Flatten) (None, 1000) 0

dropout (Dropout) (None, 1000) 0

batch\_normalization (BatchN (None, 1000) 4000

ormalization)

dense (Dense) (None, 4) 4004

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

Total params: 8,070,508

Trainable params: 6,004

Non-trainable params: 8,064,504

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Epoch 1/100

/usr/local/lib/python3.10/dist-packages/keras/backend.py:5612: UserWarning: "`sparse\_categorical\_crossentropy` received `from\_logits=True`, but the `output` argument was produced by a Softmax activation and thus does not represent logits. Was this intended?

output, from\_logits = \_get\_logits(

24/24 [==============================] - 37s 776ms/step - loss: 1.0797 - accuracy: 0.6387 - val\_loss: 0.8329 - val\_accuracy: 0.8099

Epoch 2/100

24/24 [==============================] - 20s 762ms/step - loss: 0.6367 - accuracy: 0.8053 - val\_loss: 0.6734 - val\_accuracy: 0.5391

Epoch 3/100

24/24 [==============================] - 20s 755ms/step - loss: 0.5446 - accuracy: 0.8073 - val\_loss: 0.6474 - val\_accuracy: 0.7630

Epoch 4/100

24/24 [==============================] - 20s 755ms/step - loss: 0.4944 - accuracy: 0.8346 - val\_loss: 0.6225 - val\_accuracy: 0.8984

Epoch 5/100

24/24 [==============================] - 19s 742ms/step - loss: 0.4559 - accuracy: 0.8535 - val\_loss: 0.6047 - val\_accuracy: 0.7422

Epoch 6/100

24/24 [==============================] - 20s 754ms/step - loss: 0.4325 - accuracy: 0.8542 - val\_loss: 0.6007 - val\_accuracy: 0.7344

Epoch 7/100

24/24 [==============================] - 19s 732ms/step - loss: 0.4091 - accuracy: 0.8516 - val\_loss: 0.5646 - val\_accuracy: 0.8906

Epoch 8/100

24/24 [==============================] - 19s 731ms/step - loss: 0.3946 - accuracy: 0.8607 - val\_loss: 0.5520 - val\_accuracy: 0.8672

Epoch 9/100

24/24 [==============================] - 20s 752ms/step - loss: 0.3834 - accuracy: 0.8574 - val\_loss: 0.5222 - val\_accuracy: 0.8646

Epoch 10/100

24/24 [==============================] - 19s 739ms/step - loss: 0.3690 - accuracy: 0.8509 - val\_loss: 0.5116 - val\_accuracy: 0.8490

Epoch 11/100

24/24 [==============================] - 20s 749ms/step - loss: 0.3558 - accuracy: 0.8607 - val\_loss: 0.4821 - val\_accuracy: 0.8880

Epoch 12/100

24/24 [==============================] - 19s 746ms/step - loss: 0.3389 - accuracy: 0.8763 - val\_loss: 0.4566 - val\_accuracy: 0.8776

Epoch 13/100

24/24 [==============================] - 20s 762ms/step - loss: 0.3526 - accuracy: 0.8516 - val\_loss: 0.4526 - val\_accuracy: 0.8698

Epoch 14/100

24/24 [==============================] - 19s 740ms/step - loss: 0.3449 - accuracy: 0.8659 - val\_loss: 0.4265 - val\_accuracy: 0.8932

Epoch 15/100

24/24 [==============================] - 20s 754ms/step - loss: 0.3271 - accuracy: 0.8717 - val\_loss: 0.4135 - val\_accuracy: 0.8958

Epoch 16/100

24/24 [==============================] - 19s 731ms/step - loss: 0.3297 - accuracy: 0.8594 - val\_loss: 0.4015 - val\_accuracy: 0.8802

Epoch 17/100

24/24 [==============================] - 20s 752ms/step - loss: 0.3125 - accuracy: 0.8737 - val\_loss: 0.3868 - val\_accuracy: 0.8854

Epoch 18/100

24/24 [==============================] - 19s 748ms/step - loss: 0.3184 - accuracy: 0.8711 - val\_loss: 0.3639 - val\_accuracy: 0.8984

Epoch 19/100

24/24 [==============================] - 20s 745ms/step - loss: 0.3137 - accuracy: 0.8730 - val\_loss: 0.3378 - val\_accuracy: 0.9115

Epoch 20/100

24/24 [==============================] - 19s 736ms/step - loss: 0.3112 - accuracy: 0.8717 - val\_loss: 0.3259 - val\_accuracy: 0.8984

Epoch 21/100

24/24 [==============================] - 20s 755ms/step - loss: 0.2974 - accuracy: 0.8835 - val\_loss: 0.3527 - val\_accuracy: 0.8802

Epoch 22/100

24/24 [==============================] - 19s 746ms/step - loss: 0.2983 - accuracy: 0.8828 - val\_loss: 0.3224 - val\_accuracy: 0.8880

Epoch 23/100

24/24 [==============================] - 20s 746ms/step - loss: 0.3001 - accuracy: 0.8841 - val\_loss: 0.3104 - val\_accuracy: 0.8854

Epoch 24/100

24/24 [==============================] - 19s 744ms/step - loss: 0.2935 - accuracy: 0.8750 - val\_loss: 0.2991 - val\_accuracy: 0.8984

Epoch 25/100

24/24 [==============================] - 19s 739ms/step - loss: 0.2979 - accuracy: 0.8698 - val\_loss: 0.2834 - val\_accuracy: 0.9010

Epoch 26/100

24/24 [==============================] - 20s 760ms/step - loss: 0.2725 - accuracy: 0.8893 - val\_loss: 0.2922 - val\_accuracy: 0.9036

Epoch 27/100

24/24 [==============================] - 19s 743ms/step - loss: 0.2737 - accuracy: 0.8900 - val\_loss: 0.2567 - val\_accuracy: 0.9089

Epoch 28/100

24/24 [==============================] - 20s 754ms/step - loss: 0.2739 - accuracy: 0.8952 - val\_loss: 0.2590 - val\_accuracy: 0.9089

Epoch 29/100

24/24 [==============================] - 19s 739ms/step - loss: 0.2890 - accuracy: 0.8841 - val\_loss: 0.2628 - val\_accuracy: 0.9115

Epoch 30/100

24/24 [==============================] - 20s 758ms/step - loss: 0.2767 - accuracy: 0.8822 - val\_loss: 0.2723 - val\_accuracy: 0.8906

Epoch 31/100

24/24 [==============================] - 19s 734ms/step - loss: 0.2797 - accuracy: 0.8906 - val\_loss: 0.2412 - val\_accuracy: 0.9115

Epoch 32/100

24/24 [==============================] - 20s 747ms/step - loss: 0.2836 - accuracy: 0.8887 - val\_loss: 0.2143 - val\_accuracy: 0.9245

Epoch 33/100

24/24 [==============================] - 19s 739ms/step - loss: 0.2641 - accuracy: 0.8913 - val\_loss: 0.2311 - val\_accuracy: 0.9245

Epoch 34/100

24/24 [==============================] - 19s 738ms/step - loss: 0.2783 - accuracy: 0.8802 - val\_loss: 0.2556 - val\_accuracy: 0.8984

Epoch 35/100

24/24 [==============================] - 19s 741ms/step - loss: 0.2709 - accuracy: 0.8835 - val\_loss: 0.2410 - val\_accuracy: 0.9167

Epoch 36/100

24/24 [==============================] - 19s 726ms/step - loss: 0.2638 - accuracy: 0.8939 - val\_loss: 0.2036 - val\_accuracy: 0.9297

Epoch 37/100

24/24 [==============================] - 19s 739ms/step - loss: 0.2709 - accuracy: 0.8939 - val\_loss: 0.2192 - val\_accuracy: 0.9245

Epoch 38/100

24/24 [==============================] - 19s 734ms/step - loss: 0.2632 - accuracy: 0.8945 - val\_loss: 0.2162 - val\_accuracy: 0.9323

Epoch 39/100

24/24 [==============================] - 19s 748ms/step - loss: 0.2608 - accuracy: 0.8978 - val\_loss: 0.2289 - val\_accuracy: 0.9245

Epoch 40/100

24/24 [==============================] - 20s 738ms/step - loss: 0.2512 - accuracy: 0.8997 - val\_loss: 0.2125 - val\_accuracy: 0.9323

Epoch 41/100

24/24 [==============================] - 20s 750ms/step - loss: 0.2625 - accuracy: 0.8945 - val\_loss: 0.1941 - val\_accuracy: 0.9193

Epoch 42/100

24/24 [==============================] - 20s 749ms/step - loss: 0.2501 - accuracy: 0.8906 - val\_loss: 0.1818 - val\_accuracy: 0.9505

Epoch 43/100

24/24 [==============================] - 20s 768ms/step - loss: 0.2784 - accuracy: 0.8848 - val\_loss: 0.2032 - val\_accuracy: 0.9115

Epoch 44/100

24/24 [==============================] - 19s 740ms/step - loss: 0.2614 - accuracy: 0.8887 - val\_loss: 0.2309 - val\_accuracy: 0.9219

Epoch 45/100

24/24 [==============================] - 20s 756ms/step - loss: 0.2622 - accuracy: 0.8900 - val\_loss: 0.1855 - val\_accuracy: 0.9349

Epoch 46/100

24/24 [==============================] - 20s 756ms/step - loss: 0.2559 - accuracy: 0.9010 - val\_loss: 0.2039 - val\_accuracy: 0.9245

Epoch 47/100

24/24 [==============================] - 20s 766ms/step - loss: 0.2535 - accuracy: 0.9010 - val\_loss: 0.1998 - val\_accuracy: 0.9401

Epoch 48/100

24/24 [==============================] - 20s 754ms/step - loss: 0.2645 - accuracy: 0.8978 - val\_loss: 0.2573 - val\_accuracy: 0.9036

Epoch 49/100

24/24 [==============================] - 20s 762ms/step - loss: 0.2527 - accuracy: 0.8965 - val\_loss: 0.2270 - val\_accuracy: 0.9453

Epoch 50/100

24/24 [==============================] - 20s 754ms/step - loss: 0.2513 - accuracy: 0.9030 - val\_loss: 0.2164 - val\_accuracy: 0.9271

Epoch 51/100

24/24 [==============================] - 20s 747ms/step - loss: 0.2518 - accuracy: 0.8984 - val\_loss: 0.2181 - val\_accuracy: 0.9323

Epoch 52/100

24/24 [==============================] - 19s 745ms/step - loss: 0.2506 - accuracy: 0.8997 - val\_loss: 0.2154 - val\_accuracy: 0.9297

Epoch 53/100

24/24 [==============================] - 20s 748ms/step - loss: 0.2438 - accuracy: 0.8991 - val\_loss: 0.2176 - val\_accuracy: 0.9115

Epoch 54/100

24/24 [==============================] - 20s 754ms/step - loss: 0.2442 - accuracy: 0.9010 - val\_loss: 0.2108 - val\_accuracy: 0.9453

Epoch 55/100

24/24 [==============================] - 20s 750ms/step - loss: 0.2440 - accuracy: 0.8945 - val\_loss: 0.1694 - val\_accuracy: 0.9349

Epoch 56/100

24/24 [==============================] - 20s 749ms/step - loss: 0.2491 - accuracy: 0.9030 - val\_loss: 0.2075 - val\_accuracy: 0.9271

Epoch 57/100

24/24 [==============================] - 19s 745ms/step - loss: 0.2512 - accuracy: 0.8971 - val\_loss: 0.1781 - val\_accuracy: 0.9401

Epoch 58/100

24/24 [==============================] - 20s 773ms/step - loss: 0.2464 - accuracy: 0.9049 - val\_loss: 0.1885 - val\_accuracy: 0.9427

Epoch 59/100

24/24 [==============================] - 20s 754ms/step - loss: 0.2442 - accuracy: 0.9004 - val\_loss: 0.2034 - val\_accuracy: 0.9297

Epoch 60/100

24/24 [==============================] - 19s 743ms/step - loss: 0.2405 - accuracy: 0.9069 - val\_loss: 0.1793 - val\_accuracy: 0.9271

Epoch 61/100

24/24 [==============================] - 20s 752ms/step - loss: 0.2612 - accuracy: 0.9017 - val\_loss: 0.2055 - val\_accuracy: 0.9323

Epoch 62/100

24/24 [==============================] - 20s 747ms/step - loss: 0.2434 - accuracy: 0.9010 - val\_loss: 0.1715 - val\_accuracy: 0.9297

Epoch 63/100

24/24 [==============================] - 19s 741ms/step - loss: 0.2541 - accuracy: 0.8971 - val\_loss: 0.2172 - val\_accuracy: 0.9401

Epoch 64/100

24/24 [==============================] - 20s 749ms/step - loss: 0.2443 - accuracy: 0.8978 - val\_loss: 0.2082 - val\_accuracy: 0.9323

Epoch 65/100

24/24 [==============================] - 20s 751ms/step - loss: 0.2385 - accuracy: 0.8991 - val\_loss: 0.1880 - val\_accuracy: 0.9323

Epoch 66/100

24/24 [==============================] - 19s 740ms/step - loss: 0.2523 - accuracy: 0.8971 - val\_loss: 0.1911 - val\_accuracy: 0.9349

Epoch 67/100

24/24 [==============================] - 20s 749ms/step - loss: 0.2358 - accuracy: 0.9160 - val\_loss: 0.1918 - val\_accuracy: 0.9401

Epoch 68/100

24/24 [==============================] - 19s 745ms/step - loss: 0.2537 - accuracy: 0.8952 - val\_loss: 0.2020 - val\_accuracy: 0.9323

Epoch 69/100

24/24 [==============================] - 20s 759ms/step - loss: 0.2217 - accuracy: 0.9082 - val\_loss: 0.1986 - val\_accuracy: 0.9193

Epoch 70/100

24/24 [==============================] - 20s 753ms/step - loss: 0.2408 - accuracy: 0.9049 - val\_loss: 0.1896 - val\_accuracy: 0.9349

Epoch 71/100

24/24 [==============================] - 20s 754ms/step - loss: 0.2473 - accuracy: 0.9095 - val\_loss: 0.1746 - val\_accuracy: 0.9557

Epoch 72/100

24/24 [==============================] - 19s 739ms/step - loss: 0.2393 - accuracy: 0.9049 - val\_loss: 0.1613 - val\_accuracy: 0.9297

Epoch 73/100

24/24 [==============================] - 20s 749ms/step - loss: 0.2375 - accuracy: 0.9056 - val\_loss: 0.1799 - val\_accuracy: 0.9401

Epoch 74/100

24/24 [==============================] - 19s 748ms/step - loss: 0.2460 - accuracy: 0.8926 - val\_loss: 0.1521 - val\_accuracy: 0.9427

Epoch 75/100

24/24 [==============================] - 20s 740ms/step - loss: 0.2501 - accuracy: 0.8900 - val\_loss: 0.2167 - val\_accuracy: 0.9401

Epoch 76/100

24/24 [==============================] - 19s 736ms/step - loss: 0.2339 - accuracy: 0.9069 - val\_loss: 0.1624 - val\_accuracy: 0.9349

Epoch 77/100

24/24 [==============================] - 20s 738ms/step - loss: 0.2288 - accuracy: 0.9043 - val\_loss: 0.1728 - val\_accuracy: 0.9479

Epoch 78/100

24/24 [==============================] - 19s 738ms/step - loss: 0.2260 - accuracy: 0.9030 - val\_loss: 0.2258 - val\_accuracy: 0.9193

Epoch 79/100

24/24 [==============================] - 20s 741ms/step - loss: 0.2467 - accuracy: 0.9049 - val\_loss: 0.1939 - val\_accuracy: 0.9141

Epoch 80/100

24/24 [==============================] - 20s 748ms/step - loss: 0.2297 - accuracy: 0.9049 - val\_loss: 0.1761 - val\_accuracy: 0.9557

Epoch 81/100

24/24 [==============================] - 19s 737ms/step - loss: 0.2232 - accuracy: 0.9160 - val\_loss: 0.1800 - val\_accuracy: 0.9219

Epoch 82/100

24/24 [==============================] - 20s 751ms/step - loss: 0.2481 - accuracy: 0.8991 - val\_loss: 0.2080 - val\_accuracy: 0.9219

Epoch 83/100

24/24 [==============================] - 19s 742ms/step - loss: 0.2385 - accuracy: 0.8997 - val\_loss: 0.1992 - val\_accuracy: 0.9453

Epoch 84/100

24/24 [==============================] - 20s 756ms/step - loss: 0.2510 - accuracy: 0.9036 - val\_loss: 0.1509 - val\_accuracy: 0.9609

Epoch 85/100

24/24 [==============================] - 19s 737ms/step - loss: 0.2306 - accuracy: 0.8991 - val\_loss: 0.2130 - val\_accuracy: 0.9323

Epoch 86/100

24/24 [==============================] - 20s 762ms/step - loss: 0.2300 - accuracy: 0.9062 - val\_loss: 0.1873 - val\_accuracy: 0.9375

Epoch 87/100

24/24 [==============================] - 19s 746ms/step - loss: 0.2265 - accuracy: 0.9030 - val\_loss: 0.2078 - val\_accuracy: 0.9401

Epoch 88/100

24/24 [==============================] - 20s 755ms/step - loss: 0.2363 - accuracy: 0.9036 - val\_loss: 0.1630 - val\_accuracy: 0.9297

Epoch 89/100

24/24 [==============================] - 19s 742ms/step - loss: 0.2062 - accuracy: 0.9212 - val\_loss: 0.2118 - val\_accuracy: 0.9219

Epoch 90/100

24/24 [==============================] - 20s 749ms/step - loss: 0.2275 - accuracy: 0.9102 - val\_loss: 0.2087 - val\_accuracy: 0.9271

Epoch 91/100

24/24 [==============================] - 19s 740ms/step - loss: 0.2423 - accuracy: 0.9010 - val\_loss: 0.1870 - val\_accuracy: 0.9453

Epoch 92/100

24/24 [==============================] - 20s 735ms/step - loss: 0.2527 - accuracy: 0.8971 - val\_loss: 0.1813 - val\_accuracy: 0.9323

Epoch 93/100

24/24 [==============================] - 19s 744ms/step - loss: 0.2264 - accuracy: 0.9115 - val\_loss: 0.1944 - val\_accuracy: 0.9245

Epoch 94/100

24/24 [==============================] - 20s 738ms/step - loss: 0.2334 - accuracy: 0.9115 - val\_loss: 0.2091 - val\_accuracy: 0.9297

Epoch 95/100

24/24 [==============================] - 20s 750ms/step - loss: 0.2289 - accuracy: 0.9147 - val\_loss: 0.1988 - val\_accuracy: 0.9323

Epoch 96/100

24/24 [==============================] - 19s 744ms/step - loss: 0.2209 - accuracy: 0.9115 - val\_loss: 0.1635 - val\_accuracy: 0.9427

Epoch 97/100

24/24 [==============================] - 19s 749ms/step - loss: 0.2243 - accuracy: 0.9186 - val\_loss: 0.2024 - val\_accuracy: 0.9245

Epoch 98/100

24/24 [==============================] - 19s 741ms/step - loss: 0.2296 - accuracy: 0.9062 - val\_loss: 0.1818 - val\_accuracy: 0.9531

Epoch 99/100

24/24 [==============================] - 20s 759ms/step - loss: 0.2186 - accuracy: 0.9173 - val\_loss: 0.1822 - val\_accuracy: 0.9271

Epoch 100/100

24/24 [==============================] - 19s 742ms/step - loss: 0.2431 - accuracy: 0.9049 - val\_loss: 0.1615 - val\_accuracy: 0.9375

A graph of loss and accuracy

Description automatically generated with low confidence

A picture containing text, screenshot, display, diagram

Description automatically generated

**Resnet50**

Model: "sequential"

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Layer (type) Output Shape Param #

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

resnet50 (Functional) (None, 1000) 25636712

flatten (Flatten) (None, 1000) 0

dropout (Dropout) (None, 1000) 0

batch\_normalization (BatchN (None, 1000) 4000

ormalization)

dense (Dense) (None, 4) 4004

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

Total params: 25,644,716

Trainable params: 6,004

Non-trainable params: 25,638,712

Epoch 1/100

/usr/local/lib/python3.10/dist-packages/keras/backend.py:5612: UserWarning: "`sparse\_categorical\_crossentropy` received `from\_logits=True`, but the `output` argument was produced by a Softmax activation and thus does not represent logits. Was this intended?

output, from\_logits = \_get\_logits(

24/24 [==============================] - 27s 721ms/step - loss: 1.1299 - accuracy: 0.4961 - val\_loss: 0.8553 - val\_accuracy: 0.5182

Epoch 2/100

24/24 [==============================] - 20s 753ms/step - loss: 0.7566 - accuracy: 0.5182 - val\_loss: 0.7084 - val\_accuracy: 0.5339

Epoch 3/100

24/24 [==============================] - 20s 764ms/step - loss: 0.7062 - accuracy: 0.4941 - val\_loss: 0.6996 - val\_accuracy: 0.5104

Epoch 4/100

24/24 [==============================] - 20s 779ms/step - loss: 0.6990 - accuracy: 0.5234 - val\_loss: 0.6973 - val\_accuracy: 0.4557

Epoch 5/100

24/24 [==============================] - 20s 754ms/step - loss: 0.6965 - accuracy: 0.5137 - val\_loss: 0.6951 - val\_accuracy: 0.5286

Epoch 6/100

24/24 [==============================] - 20s 766ms/step - loss: 0.6989 - accuracy: 0.4948 - val\_loss: 0.7043 - val\_accuracy: 0.4948

Epoch 7/100

24/24 [==============================] - 19s 740ms/step - loss: 0.6947 - accuracy: 0.5020 - val\_loss: 0.6952 - val\_accuracy: 0.4870

Epoch 8/100

24/24 [==============================] - 20s 756ms/step - loss: 0.6913 - accuracy: 0.5397 - val\_loss: 0.6946 - val\_accuracy: 0.4896

Epoch 9/100

24/24 [==============================] - 19s 739ms/step - loss: 0.6931 - accuracy: 0.5273 - val\_loss: 0.6960 - val\_accuracy: 0.4974

Epoch 10/100

24/24 [==============================] - 20s 749ms/step - loss: 0.6921 - accuracy: 0.5182 - val\_loss: 0.7000 - val\_accuracy: 0.4974

Epoch 11/100

24/24 [==============================] - 19s 744ms/step - loss: 0.6896 - accuracy: 0.5293 - val\_loss: 0.6937 - val\_accuracy: 0.4948

Epoch 12/100

24/24 [==============================] - 20s 748ms/step - loss: 0.6913 - accuracy: 0.5319 - val\_loss: 0.6889 - val\_accuracy: 0.5469

Epoch 13/100

24/24 [==============================] - 19s 744ms/step - loss: 0.6904 - accuracy: 0.5365 - val\_loss: 0.6938 - val\_accuracy: 0.4974

Epoch 14/100

24/24 [==============================] - 20s 748ms/step - loss: 0.6940 - accuracy: 0.5104 - val\_loss: 0.6941 - val\_accuracy: 0.4766

Epoch 15/100

24/24 [==============================] - 20s 748ms/step - loss: 0.6936 - accuracy: 0.5208 - val\_loss: 0.6941 - val\_accuracy: 0.4714

Epoch 16/100

24/24 [==============================] - 20s 750ms/step - loss: 0.6909 - accuracy: 0.5312 - val\_loss: 0.6943 - val\_accuracy: 0.4766

Epoch 17/100

24/24 [==============================] - 20s 778ms/step - loss: 0.6942 - accuracy: 0.5098 - val\_loss: 0.6903 - val\_accuracy: 0.5443

Epoch 18/100

24/24 [==============================] - 20s 752ms/step - loss: 0.6913 - accuracy: 0.5208 - val\_loss: 0.6920 - val\_accuracy: 0.5286

Epoch 19/100

24/24 [==============================] - 20s 772ms/step - loss: 0.6877 - accuracy: 0.5547 - val\_loss: 0.6895 - val\_accuracy: 0.5365

Epoch 20/100

24/24 [==============================] - 20s 748ms/step - loss: 0.6910 - accuracy: 0.5332 - val\_loss: 0.6905 - val\_accuracy: 0.5365

Epoch 21/100

24/24 [==============================] - 20s 762ms/step - loss: 0.6869 - accuracy: 0.5352 - val\_loss: 0.6933 - val\_accuracy: 0.5208

Epoch 22/100

24/24 [==============================] - 20s 756ms/step - loss: 0.6894 - accuracy: 0.5280 - val\_loss: 0.6913 - val\_accuracy: 0.5130

Epoch 23/100

24/24 [==============================] - 20s 747ms/step - loss: 0.6859 - accuracy: 0.5573 - val\_loss: 0.6902 - val\_accuracy: 0.6016

Epoch 24/100

24/24 [==============================] - 19s 744ms/step - loss: 0.6867 - accuracy: 0.5456 - val\_loss: 0.6862 - val\_accuracy: 0.5651

Epoch 25/100

24/24 [==============================] - 20s 751ms/step - loss: 0.6871 - accuracy: 0.5469 - val\_loss: 0.6897 - val\_accuracy: 0.5182

Epoch 26/100

24/24 [==============================] - 20s 749ms/step - loss: 0.6890 - accuracy: 0.5306 - val\_loss: 0.6872 - val\_accuracy: 0.5417

Epoch 27/100

24/24 [==============================] - 20s 748ms/step - loss: 0.6862 - accuracy: 0.5586 - val\_loss: 0.6895 - val\_accuracy: 0.5156

Epoch 28/100

24/24 [==============================] - 20s 758ms/step - loss: 0.6863 - accuracy: 0.5482 - val\_loss: 0.6875 - val\_accuracy: 0.4974

Epoch 29/100

24/24 [==============================] - 20s 756ms/step - loss: 0.6848 - accuracy: 0.5339 - val\_loss: 0.6869 - val\_accuracy: 0.5521

Epoch 30/100

24/24 [==============================] - 20s 779ms/step - loss: 0.6873 - accuracy: 0.5397 - val\_loss: 0.6948 - val\_accuracy: 0.5052

Epoch 31/100

24/24 [==============================] - 20s 762ms/step - loss: 0.6879 - accuracy: 0.5254 - val\_loss: 0.6879 - val\_accuracy: 0.5156

Epoch 32/100

24/24 [==============================] - 20s 765ms/step - loss: 0.6868 - accuracy: 0.5404 - val\_loss: 0.6819 - val\_accuracy: 0.5599

Epoch 33/100

24/24 [==============================] - 20s 753ms/step - loss: 0.6905 - accuracy: 0.5378 - val\_loss: 0.6851 - val\_accuracy: 0.5312

Epoch 34/100

24/24 [==============================] - 20s 756ms/step - loss: 0.6891 - accuracy: 0.5358 - val\_loss: 0.6852 - val\_accuracy: 0.5339

Epoch 35/100

24/24 [==============================] - 20s 759ms/step - loss: 0.6884 - accuracy: 0.5260 - val\_loss: 0.6857 - val\_accuracy: 0.6354

Epoch 36/100

24/24 [==============================] - 20s 752ms/step - loss: 0.6824 - accuracy: 0.5638 - val\_loss: 0.6808 - val\_accuracy: 0.5990

Epoch 37/100

24/24 [==============================] - 20s 769ms/step - loss: 0.6852 - accuracy: 0.5501 - val\_loss: 0.6850 - val\_accuracy: 0.5729

Epoch 38/100

24/24 [==============================] - 20s 755ms/step - loss: 0.6853 - accuracy: 0.5592 - val\_loss: 0.6825 - val\_accuracy: 0.5547

Epoch 39/100

24/24 [==============================] - 20s 764ms/step - loss: 0.6894 - accuracy: 0.5319 - val\_loss: 0.6840 - val\_accuracy: 0.6042

Epoch 40/100

24/24 [==============================] - 20s 756ms/step - loss: 0.6890 - accuracy: 0.5345 - val\_loss: 0.6807 - val\_accuracy: 0.6667

Epoch 41/100

24/24 [==============================] - 20s 761ms/step - loss: 0.6837 - accuracy: 0.5723 - val\_loss: 0.6864 - val\_accuracy: 0.5365

Epoch 42/100

24/24 [==============================] - 20s 754ms/step - loss: 0.6837 - accuracy: 0.5560 - val\_loss: 0.6805 - val\_accuracy: 0.5234

Epoch 43/100

24/24 [==============================] - 21s 753ms/step - loss: 0.6817 - accuracy: 0.5612 - val\_loss: 0.6779 - val\_accuracy: 0.5729

Epoch 44/100

24/24 [==============================] - 20s 760ms/step - loss: 0.6878 - accuracy: 0.5514 - val\_loss: 0.6846 - val\_accuracy: 0.5365

Epoch 45/100

24/24 [==============================] - 20s 748ms/step - loss: 0.6828 - accuracy: 0.5618 - val\_loss: 0.6814 - val\_accuracy: 0.5964

Epoch 46/100

24/24 [==============================] - 20s 771ms/step - loss: 0.6836 - accuracy: 0.5651 - val\_loss: 0.6844 - val\_accuracy: 0.5339

Epoch 47/100

24/24 [==============================] - 20s 754ms/step - loss: 0.6854 - accuracy: 0.5495 - val\_loss: 0.6841 - val\_accuracy: 0.4479

Epoch 48/100

24/24 [==============================] - 20s 771ms/step - loss: 0.6858 - accuracy: 0.5534 - val\_loss: 0.6923 - val\_accuracy: 0.4818

Epoch 49/100

24/24 [==============================] - 20s 747ms/step - loss: 0.6840 - accuracy: 0.5703 - val\_loss: 0.6877 - val\_accuracy: 0.4661

Epoch 50/100

24/24 [==============================] - 20s 757ms/step - loss: 0.6871 - accuracy: 0.5475 - val\_loss: 0.6795 - val\_accuracy: 0.5964

Epoch 51/100

24/24 [==============================] - 20s 749ms/step - loss: 0.6896 - accuracy: 0.5391 - val\_loss: 0.6851 - val\_accuracy: 0.5807

Epoch 52/100

24/24 [==============================] - 20s 749ms/step - loss: 0.6893 - accuracy: 0.5391 - val\_loss: 0.6774 - val\_accuracy: 0.5000

Epoch 53/100

24/24 [==============================] - 20s 752ms/step - loss: 0.6831 - accuracy: 0.5625 - val\_loss: 0.6794 - val\_accuracy: 0.5573

Epoch 54/100

24/24 [==============================] - 20s 747ms/step - loss: 0.6861 - accuracy: 0.5241 - val\_loss: 0.6810 - val\_accuracy: 0.5911

Epoch 55/100

24/24 [==============================] - 20s 765ms/step - loss: 0.6852 - accuracy: 0.5540 - val\_loss: 0.6780 - val\_accuracy: 0.5729

Epoch 56/100

24/24 [==============================] - 20s 747ms/step - loss: 0.6789 - accuracy: 0.5553 - val\_loss: 0.6788 - val\_accuracy: 0.5859

Epoch 57/100

24/24 [==============================] - 20s 767ms/step - loss: 0.6793 - accuracy: 0.5729 - val\_loss: 0.6853 - val\_accuracy: 0.5339

Epoch 58/100

24/24 [==============================] - 20s 757ms/step - loss: 0.6841 - accuracy: 0.5436 - val\_loss: 0.6818 - val\_accuracy: 0.4896

Epoch 59/100

24/24 [==============================] - 20s 764ms/step - loss: 0.6821 - accuracy: 0.5547 - val\_loss: 0.6793 - val\_accuracy: 0.6667

Epoch 60/100

24/24 [==============================] - 20s 755ms/step - loss: 0.6819 - accuracy: 0.5710 - val\_loss: 0.6810 - val\_accuracy: 0.5651

Epoch 61/100

24/24 [==============================] - 20s 758ms/step - loss: 0.6843 - accuracy: 0.5462 - val\_loss: 0.6766 - val\_accuracy: 0.6016

Epoch 62/100

24/24 [==============================] - 19s 745ms/step - loss: 0.6795 - accuracy: 0.5664 - val\_loss: 0.6839 - val\_accuracy: 0.5234

Epoch 63/100

24/24 [==============================] - 20s 755ms/step - loss: 0.6887 - accuracy: 0.5423 - val\_loss: 0.6795 - val\_accuracy: 0.6120

Epoch 64/100

24/24 [==============================] - 20s 761ms/step - loss: 0.6818 - accuracy: 0.5573 - val\_loss: 0.6799 - val\_accuracy: 0.5781

Epoch 65/100

24/24 [==============================] - 20s 757ms/step - loss: 0.6860 - accuracy: 0.5456 - val\_loss: 0.6781 - val\_accuracy: 0.6354

Epoch 66/100

24/24 [==============================] - 20s 769ms/step - loss: 0.6826 - accuracy: 0.5645 - val\_loss: 0.6826 - val\_accuracy: 0.5339

Epoch 67/100

24/24 [==============================] - 19s 744ms/step - loss: 0.6808 - accuracy: 0.5664 - val\_loss: 0.6747 - val\_accuracy: 0.6432

Epoch 68/100

24/24 [==============================] - 21s 789ms/step - loss: 0.6825 - accuracy: 0.5592 - val\_loss: 0.6798 - val\_accuracy: 0.6250

Epoch 69/100

24/24 [==============================] - 20s 752ms/step - loss: 0.6842 - accuracy: 0.5417 - val\_loss: 0.6786 - val\_accuracy: 0.6432

Epoch 70/100

24/24 [==============================] - 20s 759ms/step - loss: 0.6863 - accuracy: 0.5384 - val\_loss: 0.6787 - val\_accuracy: 0.6328

Epoch 71/100

24/24 [==============================] - 19s 740ms/step - loss: 0.6829 - accuracy: 0.5527 - val\_loss: 0.6752 - val\_accuracy: 0.5859

Epoch 72/100

24/24 [==============================] - 20s 757ms/step - loss: 0.6765 - accuracy: 0.5840 - val\_loss: 0.6765 - val\_accuracy: 0.5885

Epoch 73/100

24/24 [==============================] - 20s 762ms/step - loss: 0.6802 - accuracy: 0.5586 - val\_loss: 0.6799 - val\_accuracy: 0.5000

Epoch 74/100

24/24 [==============================] - 20s 752ms/step - loss: 0.6821 - accuracy: 0.5605 - val\_loss: 0.6719 - val\_accuracy: 0.6380

Epoch 75/100

24/24 [==============================] - 20s 764ms/step - loss: 0.6871 - accuracy: 0.5273 - val\_loss: 0.6776 - val\_accuracy: 0.6615

Epoch 76/100

24/24 [==============================] - 20s 757ms/step - loss: 0.6822 - accuracy: 0.5658 - val\_loss: 0.6777 - val\_accuracy: 0.5964

Epoch 77/100

24/24 [==============================] - 20s 765ms/step - loss: 0.6800 - accuracy: 0.5586 - val\_loss: 0.6806 - val\_accuracy: 0.5495

Epoch 78/100

24/24 [==============================] - 20s 758ms/step - loss: 0.6833 - accuracy: 0.5540 - val\_loss: 0.6778 - val\_accuracy: 0.6484

Epoch 79/100

24/24 [==============================] - 20s 777ms/step - loss: 0.6826 - accuracy: 0.5521 - val\_loss: 0.6759 - val\_accuracy: 0.6094

Epoch 80/100

24/24 [==============================] - 20s 760ms/step - loss: 0.6858 - accuracy: 0.5430 - val\_loss: 0.6737 - val\_accuracy: 0.5573

Epoch 81/100

24/24 [==============================] - 21s 777ms/step - loss: 0.6758 - accuracy: 0.5814 - val\_loss: 0.6784 - val\_accuracy: 0.6380

Epoch 82/100

24/24 [==============================] - 20s 768ms/step - loss: 0.6872 - accuracy: 0.5462 - val\_loss: 0.6815 - val\_accuracy: 0.5573

Epoch 83/100

24/24 [==============================] - 20s 764ms/step - loss: 0.6806 - accuracy: 0.5690 - val\_loss: 0.6843 - val\_accuracy: 0.5234

Epoch 84/100

24/24 [==============================] - 20s 775ms/step - loss: 0.6848 - accuracy: 0.5553 - val\_loss: 0.6772 - val\_accuracy: 0.6068

Epoch 85/100

24/24 [==============================] - 20s 758ms/step - loss: 0.6843 - accuracy: 0.5566 - val\_loss: 0.6788 - val\_accuracy: 0.5104

Epoch 86/100

24/24 [==============================] - 20s 780ms/step - loss: 0.6803 - accuracy: 0.5677 - val\_loss: 0.6742 - val\_accuracy: 0.5938

Epoch 87/100

24/24 [==============================] - 20s 763ms/step - loss: 0.6749 - accuracy: 0.5794 - val\_loss: 0.6733 - val\_accuracy: 0.5469

Epoch 88/100

24/24 [==============================] - 20s 768ms/step - loss: 0.6888 - accuracy: 0.5430 - val\_loss: 0.6767 - val\_accuracy: 0.6094

Epoch 89/100

24/24 [==============================] - 20s 753ms/step - loss: 0.6779 - accuracy: 0.5892 - val\_loss: 0.6737 - val\_accuracy: 0.5677

Epoch 90/100

24/24 [==============================] - 20s 764ms/step - loss: 0.6859 - accuracy: 0.5514 - val\_loss: 0.6775 - val\_accuracy: 0.5781

Epoch 91/100

24/24 [==============================] - 20s 770ms/step - loss: 0.6836 - accuracy: 0.5625 - val\_loss: 0.6747 - val\_accuracy: 0.6510

Epoch 92/100

24/24 [==============================] - 20s 767ms/step - loss: 0.6840 - accuracy: 0.5501 - val\_loss: 0.6748 - val\_accuracy: 0.6667

Epoch 93/100

24/24 [==============================] - 21s 794ms/step - loss: 0.6823 - accuracy: 0.5716 - val\_loss: 0.6745 - val\_accuracy: 0.6536

Epoch 94/100

24/24 [==============================] - 20s 751ms/step - loss: 0.6780 - accuracy: 0.5775 - val\_loss: 0.6847 - val\_accuracy: 0.5260

Epoch 95/100

24/24 [==============================] - 20s 760ms/step - loss: 0.6844 - accuracy: 0.5573 - val\_loss: 0.6788 - val\_accuracy: 0.5547

Epoch 96/100

24/24 [==============================] - 19s 749ms/step - loss: 0.6806 - accuracy: 0.5645 - val\_loss: 0.6776 - val\_accuracy: 0.5729

Epoch 97/100

24/24 [==============================] - 20s 754ms/step - loss: 0.6827 - accuracy: 0.5501 - val\_loss: 0.6755 - val\_accuracy: 0.5573

Epoch 98/100

24/24 [==============================] - 20s 747ms/step - loss: 0.6881 - accuracy: 0.5391 - val\_loss: 0.6772 - val\_accuracy: 0.5938

Epoch 99/100

24/24 [==============================] - 20s 756ms/step - loss: 0.6834 - accuracy: 0.5592 - val\_loss: 0.6741 - val\_accuracy: 0.5911

Epoch 100/100

24/24 [==============================] - 20s 768ms/step - loss: 0.6804 - accuracy: 0.5618 - val\_loss: 0.6794 - val\_accuracy: 0.5495

A picture containing text, screenshot, plot, line

Description automatically generated

A picture containing text, diagram, line, plot

Description automatically generated

**FirstUpdate**

Found 2112 images belonging to 2 classes.

Found 2112 images belonging to 2 classes.

Downloading data from <https://storage.googleapis.com/tensorflow/keras-applications/vgg16/vgg16_weights_tf_dim_ordering_tf_kernels_notop.h5>

58889256/58889256 [==============================] - 2s 0us/step

Epoch 1/100

33/33 [==============================] - 80s 2s/step - loss: 1.4533 - accuracy: 0.4285 - val\_loss: 0.8995 - val\_accuracy: 0.7079

Epoch 2/100

33/33 [==============================] - 60s 2s/step - loss: 0.8543 - accuracy: 0.6761 - val\_loss: 0.6012 - val\_accuracy: 0.9200

Epoch 3/100

33/33 [==============================] - 60s 2s/step - loss: 0.6345 - accuracy: 0.7723 - val\_loss: 0.5588 - val\_accuracy: 0.9200

Epoch 4/100

33/33 [==============================] - 59s 2s/step - loss: 0.5028 - accuracy: 0.8499 - val\_loss: 0.4725 - val\_accuracy: 0.9342

Epoch 5/100

33/33 [==============================] - 59s 2s/step - loss: 0.4680 - accuracy: 0.8594 - val\_loss: 0.4178 - val\_accuracy: 0.9366

Epoch 6/100

33/33 [==============================] - 60s 2s/step - loss: 0.4250 - accuracy: 0.8849 - val\_loss: 0.3881 - val\_accuracy: 0.9280

Epoch 7/100

33/33 [==============================] - 59s 2s/step - loss: 0.4156 - accuracy: 0.8849 - val\_loss: 0.4262 - val\_accuracy: 0.9342

Epoch 8/100

33/33 [==============================] - 59s 2s/step - loss: 0.3771 - accuracy: 0.9001 - val\_loss: 0.3465 - val\_accuracy: 0.9451

Epoch 9/100

33/33 [==============================] - 58s 2s/step - loss: 0.3557 - accuracy: 0.9001 - val\_loss: 0.3105 - val\_accuracy: 0.9432

Epoch 10/100

33/33 [==============================] - 59s 2s/step - loss: 0.3392 - accuracy: 0.9053 - val\_loss: 0.2673 - val\_accuracy: 0.9489

Epoch 11/100

33/33 [==============================] - 59s 2s/step - loss: 0.3153 - accuracy: 0.9205 - val\_loss: 0.2437 - val\_accuracy: 0.9493

Epoch 12/100

33/33 [==============================] - 59s 2s/step - loss: 0.3025 - accuracy: 0.9261 - val\_loss: 0.2630 - val\_accuracy: 0.9508

Epoch 13/100

33/33 [==============================] - 58s 2s/step - loss: 0.3078 - accuracy: 0.9162 - val\_loss: 0.2459 - val\_accuracy: 0.9569

Epoch 14/100

33/33 [==============================] - 59s 2s/step - loss: 0.2746 - accuracy: 0.9323 - val\_loss: 0.2308 - val\_accuracy: 0.9493

Epoch 15/100

33/33 [==============================] - 59s 2s/step - loss: 0.2696 - accuracy: 0.9370 - val\_loss: 0.2724 - val\_accuracy: 0.9271

Epoch 16/100

33/33 [==============================] - 59s 2s/step - loss: 0.2556 - accuracy: 0.9380 - val\_loss: 0.2345 - val\_accuracy: 0.9522

Epoch 17/100

33/33 [==============================] - 59s 2s/step - loss: 0.2608 - accuracy: 0.9366 - val\_loss: 0.1892 - val\_accuracy: 0.9588

Epoch 18/100

33/33 [==============================] - 59s 2s/step - loss: 0.2382 - accuracy: 0.9413 - val\_loss: 0.2617 - val\_accuracy: 0.9190

Epoch 19/100

33/33 [==============================] - 59s 2s/step - loss: 0.2387 - accuracy: 0.9408 - val\_loss: 0.1721 - val\_accuracy: 0.9593

Epoch 20/100

33/33 [==============================] - 59s 2s/step - loss: 0.2286 - accuracy: 0.9484 - val\_loss: 0.1671 - val\_accuracy: 0.9612

Epoch 21/100

33/33 [==============================] - 60s 2s/step - loss: 0.2311 - accuracy: 0.9451 - val\_loss: 0.1725 - val\_accuracy: 0.9550

Epoch 22/100

33/33 [==============================] - 59s 2s/step - loss: 0.2010 - accuracy: 0.9470 - val\_loss: 0.1739 - val\_accuracy: 0.9669

Epoch 23/100

33/33 [==============================] - 58s 2s/step - loss: 0.1963 - accuracy: 0.9579 - val\_loss: 0.1757 - val\_accuracy: 0.9650

Epoch 24/100

33/33 [==============================] - 59s 2s/step - loss: 0.2010 - accuracy: 0.9527 - val\_loss: 0.1414 - val\_accuracy: 0.9697

Epoch 25/100

33/33 [==============================] - 60s 2s/step - loss: 0.2063 - accuracy: 0.9545 - val\_loss: 0.1393 - val\_accuracy: 0.9688

Epoch 26/100

33/33 [==============================] - 59s 2s/step - loss: 0.1987 - accuracy: 0.9503 - val\_loss: 0.1633 - val\_accuracy: 0.9650

Epoch 27/100

33/33 [==============================] - 58s 2s/step - loss: 0.1793 - accuracy: 0.9593 - val\_loss: 0.1319 - val\_accuracy: 0.9669

Epoch 28/100

33/33 [==============================] - 59s 2s/step - loss: 0.1902 - accuracy: 0.9564 - val\_loss: 0.1177 - val\_accuracy: 0.9697

Epoch 29/100

33/33 [==============================] - 58s 2s/step - loss: 0.1943 - accuracy: 0.9560 - val\_loss: 0.1467 - val\_accuracy: 0.9635

Epoch 30/100

33/33 [==============================] - 59s 2s/step - loss: 0.1610 - accuracy: 0.9602 - val\_loss: 0.3319 - val\_accuracy: 0.8745

Epoch 31/100

33/33 [==============================] - 59s 2s/step - loss: 0.1905 - accuracy: 0.9512 - val\_loss: 0.1831 - val\_accuracy: 0.9455

Epoch 32/100

33/33 [==============================] - 59s 2s/step - loss: 0.1720 - accuracy: 0.9602 - val\_loss: 0.1478 - val\_accuracy: 0.9602

Epoch 33/100

33/33 [==============================] - 58s 2s/step - loss: 0.1816 - accuracy: 0.9531 - val\_loss: 0.2226 - val\_accuracy: 0.9233

Epoch 34/100

33/33 [==============================] - 58s 2s/step - loss: 0.1467 - accuracy: 0.9621 - val\_loss: 0.1680 - val\_accuracy: 0.9422

Epoch 35/100

33/33 [==============================] - 59s 2s/step - loss: 0.1570 - accuracy: 0.9645 - val\_loss: 0.1069 - val\_accuracy: 0.9768

Epoch 36/100

33/33 [==============================] - 58s 2s/step - loss: 0.1513 - accuracy: 0.9612 - val\_loss: 0.1034 - val\_accuracy: 0.9792

Epoch 37/100

33/33 [==============================] - 59s 2s/step - loss: 0.1501 - accuracy: 0.9612 - val\_loss: 0.1114 - val\_accuracy: 0.9730

Epoch 38/100

33/33 [==============================] - 58s 2s/step - loss: 0.1522 - accuracy: 0.9678 - val\_loss: 0.1734 - val\_accuracy: 0.9389

Epoch 39/100

33/33 [==============================] - 59s 2s/step - loss: 0.1413 - accuracy: 0.9669 - val\_loss: 0.1298 - val\_accuracy: 0.9626

Epoch 40/100

33/33 [==============================] - 58s 2s/step - loss: 0.1379 - accuracy: 0.9702 - val\_loss: 0.1167 - val\_accuracy: 0.9664

Epoch 41/100

33/33 [==============================] - 59s 2s/step - loss: 0.1355 - accuracy: 0.9673 - val\_loss: 0.0838 - val\_accuracy: 0.9820

Epoch 42/100

33/33 [==============================] - 59s 2s/step - loss: 0.1366 - accuracy: 0.9659 - val\_loss: 0.1070 - val\_accuracy: 0.9711

Epoch 43/100

33/33 [==============================] - 58s 2s/step - loss: 0.1225 - accuracy: 0.9740 - val\_loss: 0.1788 - val\_accuracy: 0.9285

Epoch 44/100

33/33 [==============================] - 59s 2s/step - loss: 0.1358 - accuracy: 0.9683 - val\_loss: 0.1788 - val\_accuracy: 0.9361

Epoch 45/100

33/33 [==============================] - 60s 2s/step - loss: 0.1298 - accuracy: 0.9654 - val\_loss: 0.2331 - val\_accuracy: 0.9119

Epoch 46/100

33/33 [==============================] - 58s 2s/step - loss: 0.1280 - accuracy: 0.9673 - val\_loss: 0.1613 - val\_accuracy: 0.9394

Epoch 47/100

33/33 [==============================] - 58s 2s/step - loss: 0.1231 - accuracy: 0.9735 - val\_loss: 0.2494 - val\_accuracy: 0.8963

Epoch 48/100

33/33 [==============================] - 58s 2s/step - loss: 0.1212 - accuracy: 0.9721 - val\_loss: 0.1124 - val\_accuracy: 0.9640

Epoch 49/100

33/33 [==============================] - 58s 2s/step - loss: 0.1287 - accuracy: 0.9683 - val\_loss: 0.1999 - val\_accuracy: 0.9271

Epoch 50/100

33/33 [==============================] - 58s 2s/step - loss: 0.1139 - accuracy: 0.9735 - val\_loss: 0.2863 - val\_accuracy: 0.8902

Epoch 51/100

33/33 [==============================] - 58s 2s/step - loss: 0.1193 - accuracy: 0.9692 - val\_loss: 0.1429 - val\_accuracy: 0.9437

Epoch 52/100

33/33 [==============================] - 58s 2s/step - loss: 0.1133 - accuracy: 0.9721 - val\_loss: 0.2083 - val\_accuracy: 0.9152

Epoch 53/100

33/33 [==============================] - 59s 2s/step - loss: 0.1379 - accuracy: 0.9659 - val\_loss: 0.2057 - val\_accuracy: 0.9129

Epoch 54/100

33/33 [==============================] - 58s 2s/step - loss: 0.0985 - accuracy: 0.9787 - val\_loss: 0.0814 - val\_accuracy: 0.9759

Epoch 55/100

33/33 [==============================] - 58s 2s/step - loss: 0.1012 - accuracy: 0.9773 - val\_loss: 0.0712 - val\_accuracy: 0.9801

Epoch 56/100

33/33 [==============================] - 60s 2s/step - loss: 0.1146 - accuracy: 0.9725 - val\_loss: 0.0734 - val\_accuracy: 0.9853

Epoch 57/100

33/33 [==============================] - 58s 2s/step - loss: 0.1012 - accuracy: 0.9773 - val\_loss: 0.2261 - val\_accuracy: 0.9105

Epoch 58/100

33/33 [==============================] - 58s 2s/step - loss: 0.1088 - accuracy: 0.9735 - val\_loss: 0.0612 - val\_accuracy: 0.9853

Epoch 59/100

33/33 [==============================] - 58s 2s/step - loss: 0.1202 - accuracy: 0.9688 - val\_loss: 0.0920 - val\_accuracy: 0.9697

Epoch 60/100

33/33 [==============================] - 58s 2s/step - loss: 0.1139 - accuracy: 0.9716 - val\_loss: 0.0597 - val\_accuracy: 0.9863

Epoch 61/100

33/33 [==============================] - 58s 2s/step - loss: 0.0938 - accuracy: 0.9787 - val\_loss: 0.1578 - val\_accuracy: 0.9389

Epoch 62/100

33/33 [==============================] - 58s 2s/step - loss: 0.1214 - accuracy: 0.9716 - val\_loss: 0.2866 - val\_accuracy: 0.8925

Epoch 63/100

33/33 [==============================] - 58s 2s/step - loss: 0.1059 - accuracy: 0.9754 - val\_loss: 0.2726 - val\_accuracy: 0.8944

Epoch 64/100

33/33 [==============================] - 59s 2s/step - loss: 0.0912 - accuracy: 0.9801 - val\_loss: 0.0702 - val\_accuracy: 0.9839

Epoch 65/100

33/33 [==============================] - 59s 2s/step - loss: 0.1027 - accuracy: 0.9721 - val\_loss: 0.0593 - val\_accuracy: 0.9848

Epoch 66/100

33/33 [==============================] - 59s 2s/step - loss: 0.0919 - accuracy: 0.9806 - val\_loss: 0.0830 - val\_accuracy: 0.9725

Epoch 67/100

33/33 [==============================] - 59s 2s/step - loss: 0.0858 - accuracy: 0.9782 - val\_loss: 0.1131 - val\_accuracy: 0.9607

Epoch 68/100

33/33 [==============================] - 58s 2s/step - loss: 0.0889 - accuracy: 0.9759 - val\_loss: 0.0526 - val\_accuracy: 0.9877

Epoch 69/100

33/33 [==============================] - 60s 2s/step - loss: 0.0871 - accuracy: 0.9792 - val\_loss: 0.0675 - val\_accuracy: 0.9820

Epoch 70/100

33/33 [==============================] - 59s 2s/step - loss: 0.1060 - accuracy: 0.9740 - val\_loss: 0.3070 - val\_accuracy: 0.8835

Epoch 71/100

33/33 [==============================] - 60s 2s/step - loss: 0.0988 - accuracy: 0.9725 - val\_loss: 0.0477 - val\_accuracy: 0.9896

Epoch 72/100

33/33 [==============================] - 59s 2s/step - loss: 0.0809 - accuracy: 0.9811 - val\_loss: 0.0999 - val\_accuracy: 0.9621

Epoch 73/100

33/33 [==============================] - 58s 2s/step - loss: 0.0786 - accuracy: 0.9830 - val\_loss: 0.0514 - val\_accuracy: 0.9853

Epoch 74/100

33/33 [==============================] - 58s 2s/step - loss: 0.0890 - accuracy: 0.9801 - val\_loss: 0.0551 - val\_accuracy: 0.9910

Epoch 75/100

33/33 [==============================] - 58s 2s/step - loss: 0.0784 - accuracy: 0.9815 - val\_loss: 0.0810 - val\_accuracy: 0.9725

Epoch 76/100

33/33 [==============================] - 59s 2s/step - loss: 0.0836 - accuracy: 0.9806 - val\_loss: 0.0719 - val\_accuracy: 0.9763

Epoch 77/100

33/33 [==============================] - 58s 2s/step - loss: 0.0822 - accuracy: 0.9830 - val\_loss: 0.1135 - val\_accuracy: 0.9560

Epoch 78/100

33/33 [==============================] - 58s 2s/step - loss: 0.0832 - accuracy: 0.9792 - val\_loss: 0.1729 - val\_accuracy: 0.9356

Epoch 79/100

33/33 [==============================] - 58s 2s/step - loss: 0.0757 - accuracy: 0.9815 - val\_loss: 0.1309 - val\_accuracy: 0.9479

Epoch 80/100

33/33 [==============================] - 58s 2s/step - loss: 0.0847 - accuracy: 0.9806 - val\_loss: 0.1427 - val\_accuracy: 0.9455

Epoch 81/100

33/33 [==============================] - 58s 2s/step - loss: 0.0823 - accuracy: 0.9796 - val\_loss: 0.0858 - val\_accuracy: 0.9688

Epoch 82/100

33/33 [==============================] - 59s 2s/step - loss: 0.0851 - accuracy: 0.9825 - val\_loss: 0.4145 - val\_accuracy: 0.8636

Epoch 83/100

33/33 [==============================] - 58s 2s/step - loss: 0.0737 - accuracy: 0.9806 - val\_loss: 0.0722 - val\_accuracy: 0.9815

Epoch 84/100

33/33 [==============================] - 58s 2s/step - loss: 0.0654 - accuracy: 0.9848 - val\_loss: 0.3091 - val\_accuracy: 0.8873

Epoch 85/100

33/33 [==============================] - 59s 2s/step - loss: 0.0761 - accuracy: 0.9811 - val\_loss: 0.0439 - val\_accuracy: 0.9915

Epoch 86/100

33/33 [==============================] - 58s 2s/step - loss: 0.0768 - accuracy: 0.9815 - val\_loss: 0.1625 - val\_accuracy: 0.9332

Epoch 87/100

33/33 [==============================] - 58s 2s/step - loss: 0.0706 - accuracy: 0.9839 - val\_loss: 0.0581 - val\_accuracy: 0.9806

Epoch 88/100

33/33 [==============================] - 58s 2s/step - loss: 0.0671 - accuracy: 0.9839 - val\_loss: 0.0367 - val\_accuracy: 0.9938

Epoch 89/100

33/33 [==============================] - 58s 2s/step - loss: 0.0754 - accuracy: 0.9782 - val\_loss: 0.1399 - val\_accuracy: 0.9470

Epoch 90/100

33/33 [==============================] - 58s 2s/step - loss: 0.0642 - accuracy: 0.9830 - val\_loss: 0.0580 - val\_accuracy: 0.9815

Epoch 91/100

33/33 [==============================] - 58s 2s/step - loss: 0.0556 - accuracy: 0.9891 - val\_loss: 0.0629 - val\_accuracy: 0.9792

Epoch 92/100

33/33 [==============================] - 59s 2s/step - loss: 0.0657 - accuracy: 0.9820 - val\_loss: 0.0741 - val\_accuracy: 0.9725

Epoch 93/100

33/33 [==============================] - 57s 2s/step - loss: 0.0603 - accuracy: 0.9848 - val\_loss: 0.0579 - val\_accuracy: 0.9825

Epoch 94/100

33/33 [==============================] - 58s 2s/step - loss: 0.0605 - accuracy: 0.9863 - val\_loss: 0.0336 - val\_accuracy: 0.9924

Epoch 95/100

33/33 [==============================] - 59s 2s/step - loss: 0.0682 - accuracy: 0.9830 - val\_loss: 0.1499 - val\_accuracy: 0.9470

Epoch 96/100

33/33 [==============================] - 59s 2s/step - loss: 0.0649 - accuracy: 0.9863 - val\_loss: 0.0919 - val\_accuracy: 0.9621

Epoch 97/100

33/33 [==============================] - 58s 2s/step - loss: 0.0808 - accuracy: 0.9754 - val\_loss: 0.0370 - val\_accuracy: 0.9896

Epoch 98/100

33/33 [==============================] - 58s 2s/step - loss: 0.0702 - accuracy: 0.9801 - val\_loss: 0.0665 - val\_accuracy: 0.9801

Epoch 99/100

33/33 [==============================] - 58s 2s/step - loss: 0.0932 - accuracy: 0.9754 - val\_loss: 0.0699 - val\_accuracy: 0.9782

Epoch 100/100

33/33 [==============================] - 58s 2s/step - loss: 0.0643 - accuracy: 0.9834 - val\_loss: 0.0396 - val\_accuracy: 0.9891

33/33 [==============================] - 20s 599ms/step - loss: 0.0396 - accuracy: 0.9891

Validation accuracy: 0.9891098737716675

33/33 [==============================] - 20s 596ms/step

**A picture containing text, screenshot, diagram, font

Description automatically generated**

Classification Report:

precision recall f1-score support

0 1.00 0.98 0.99 1038

1 0.98 1.00 0.99 1074

accuracy 0.99 2112

macro avg 0.99 0.99 0.99 2112

weighted avg 0.99 0.99 0.99 2112

**A picture containing text, screenshot, plot, diagram

Description automatically generated**

**A picture containing text, screenshot, diagram, plot

Description automatically generated**

Overall Accuracy: 0.9891098484848485

Class: 0

Sensitivity: 0.9816955684007708

Specificity: 0.9962756052141527

Recall: 0.9816955684007708

Precision: 0.9960899315738025

F1-score: 0.9888403687530326

Class: 1

Sensitivity: 0.9962756052141527

Specificity: 0.9816955684007708

Recall: 0.9962756052141527

Precision: 0.9825528007346189

F1-score: 0.9893666204345817

A picture containing text, screenshot, display, rectangle

Description automatically generated

**Normal\_Vs\_DiabeticRetinopathy**

**DenseNet121**

Model: "sequential"

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Layer (type) Output Shape Param #

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

densenet121 (Functional) (None, 1000) 8062504

flatten (Flatten) (None, 1000) 0

dropout (Dropout) (None, 1000) 0

batch\_normalization (BatchN (None, 1000) 4000

ormalization)

dense (Dense) (None, 4) 4004

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

Total params: 8,070,508

Trainable params: 6,004

Non-trainable params: 8,064,504

Epoch 1/100

/usr/local/lib/python3.10/dist-packages/keras/backend.py:5612: UserWarning: "`sparse\_categorical\_crossentropy` received `from\_logits=True`, but the `output` argument was produced by a Softmax activation and thus does not represent logits. Was this intended?

output, from\_logits = \_get\_logits(

25/25 [==============================] - 29s 446ms/step - loss: 1.1147 - accuracy: 0.5119 - val\_loss: 0.8365 - val\_accuracy: 0.5246

Epoch 2/100

25/25 [==============================] - 9s 346ms/step - loss: 0.6962 - accuracy: 0.6812 - val\_loss: 0.7016 - val\_accuracy: 0.6741

Epoch 3/100

25/25 [==============================] - 10s 350ms/step - loss: 0.6183 - accuracy: 0.7212 - val\_loss: 0.6922 - val\_accuracy: 0.5089

Epoch 4/100

25/25 [==============================] - 10s 356ms/step - loss: 0.5852 - accuracy: 0.7425 - val\_loss: 0.6802 - val\_accuracy: 0.5558

Epoch 5/100

25/25 [==============================] - 10s 362ms/step - loss: 0.5660 - accuracy: 0.7412 - val\_loss: 0.6774 - val\_accuracy: 0.5022

Epoch 6/100

25/25 [==============================] - 9s 351ms/step - loss: 0.5534 - accuracy: 0.7412 - val\_loss: 0.6785 - val\_accuracy: 0.5134

Epoch 7/100

25/25 [==============================] - 9s 346ms/step - loss: 0.5446 - accuracy: 0.7500 - val\_loss: 0.6638 - val\_accuracy: 0.6830

Epoch 8/100

25/25 [==============================] - 10s 366ms/step - loss: 0.5243 - accuracy: 0.7600 - val\_loss: 0.6567 - val\_accuracy: 0.7188

Epoch 9/100

25/25 [==============================] - 9s 349ms/step - loss: 0.5153 - accuracy: 0.7706 - val\_loss: 0.6544 - val\_accuracy: 0.6496

Epoch 10/100

25/25 [==============================] - 10s 347ms/step - loss: 0.4997 - accuracy: 0.7794 - val\_loss: 0.6360 - val\_accuracy: 0.7232

Epoch 11/100

25/25 [==============================] - 9s 351ms/step - loss: 0.5015 - accuracy: 0.7706 - val\_loss: 0.6325 - val\_accuracy: 0.6295

Epoch 12/100

25/25 [==============================] - 10s 371ms/step - loss: 0.4881 - accuracy: 0.7825 - val\_loss: 0.6184 - val\_accuracy: 0.7254

Epoch 13/100

25/25 [==============================] - 9s 348ms/step - loss: 0.4851 - accuracy: 0.7950 - val\_loss: 0.6020 - val\_accuracy: 0.7790

Epoch 14/100

25/25 [==============================] - 9s 344ms/step - loss: 0.4757 - accuracy: 0.7819 - val\_loss: 0.5957 - val\_accuracy: 0.7344

Epoch 15/100

25/25 [==============================] - 10s 358ms/step - loss: 0.4732 - accuracy: 0.7825 - val\_loss: 0.5855 - val\_accuracy: 0.6652

Epoch 16/100

25/25 [==============================] - 10s 368ms/step - loss: 0.4770 - accuracy: 0.7875 - val\_loss: 0.5688 - val\_accuracy: 0.7835

Epoch 17/100

25/25 [==============================] - 9s 350ms/step - loss: 0.4716 - accuracy: 0.7919 - val\_loss: 0.5561 - val\_accuracy: 0.8125

Epoch 18/100

25/25 [==============================] - 10s 347ms/step - loss: 0.4619 - accuracy: 0.7869 - val\_loss: 0.5565 - val\_accuracy: 0.7098

Epoch 19/100

25/25 [==============================] - 10s 367ms/step - loss: 0.4633 - accuracy: 0.7856 - val\_loss: 0.5516 - val\_accuracy: 0.7902

Epoch 20/100

25/25 [==============================] - 10s 380ms/step - loss: 0.4569 - accuracy: 0.7956 - val\_loss: 0.5184 - val\_accuracy: 0.8058

Epoch 21/100

25/25 [==============================] - 9s 345ms/step - loss: 0.4565 - accuracy: 0.7869 - val\_loss: 0.4984 - val\_accuracy: 0.7969

Epoch 22/100

25/25 [==============================] - 10s 356ms/step - loss: 0.4517 - accuracy: 0.7906 - val\_loss: 0.4975 - val\_accuracy: 0.7902

Epoch 23/100

25/25 [==============================] - 10s 361ms/step - loss: 0.4458 - accuracy: 0.8075 - val\_loss: 0.4983 - val\_accuracy: 0.8080

Epoch 24/100

25/25 [==============================] - 9s 355ms/step - loss: 0.4497 - accuracy: 0.8012 - val\_loss: 0.4653 - val\_accuracy: 0.8326

Epoch 25/100

25/25 [==============================] - 10s 349ms/step - loss: 0.4477 - accuracy: 0.8031 - val\_loss: 0.4765 - val\_accuracy: 0.8103

Epoch 26/100

25/25 [==============================] - 10s 357ms/step - loss: 0.4412 - accuracy: 0.7962 - val\_loss: 0.4495 - val\_accuracy: 0.8326

Epoch 27/100

25/25 [==============================] - 10s 379ms/step - loss: 0.4331 - accuracy: 0.8125 - val\_loss: 0.4684 - val\_accuracy: 0.7991

Epoch 28/100

25/25 [==============================] - 9s 351ms/step - loss: 0.4400 - accuracy: 0.8094 - val\_loss: 0.4429 - val\_accuracy: 0.8192

Epoch 29/100

25/25 [==============================] - 10s 345ms/step - loss: 0.4450 - accuracy: 0.8031 - val\_loss: 0.4367 - val\_accuracy: 0.8393

Epoch 30/100

25/25 [==============================] - 9s 354ms/step - loss: 0.4232 - accuracy: 0.8075 - val\_loss: 0.4516 - val\_accuracy: 0.7879

Epoch 31/100

25/25 [==============================] - 10s 376ms/step - loss: 0.4279 - accuracy: 0.8044 - val\_loss: 0.4337 - val\_accuracy: 0.8192

Epoch 32/100

25/25 [==============================] - 9s 351ms/step - loss: 0.4270 - accuracy: 0.8075 - val\_loss: 0.4221 - val\_accuracy: 0.8214

Epoch 33/100

25/25 [==============================] - 10s 353ms/step - loss: 0.4233 - accuracy: 0.8031 - val\_loss: 0.4149 - val\_accuracy: 0.8125

Epoch 34/100

25/25 [==============================] - 10s 357ms/step - loss: 0.4417 - accuracy: 0.7987 - val\_loss: 0.4128 - val\_accuracy: 0.8170

Epoch 35/100

25/25 [==============================] - 10s 383ms/step - loss: 0.4245 - accuracy: 0.8138 - val\_loss: 0.3995 - val\_accuracy: 0.8281

Epoch 36/100

25/25 [==============================] - 9s 353ms/step - loss: 0.4247 - accuracy: 0.8100 - val\_loss: 0.4010 - val\_accuracy: 0.8371

Epoch 37/100

25/25 [==============================] - 10s 358ms/step - loss: 0.4219 - accuracy: 0.8188 - val\_loss: 0.4096 - val\_accuracy: 0.8371

Epoch 38/100

25/25 [==============================] - 10s 370ms/step - loss: 0.4195 - accuracy: 0.8112 - val\_loss: 0.4096 - val\_accuracy: 0.8013

Epoch 39/100

25/25 [==============================] - 10s 377ms/step - loss: 0.4215 - accuracy: 0.8138 - val\_loss: 0.3982 - val\_accuracy: 0.8348

Epoch 40/100

25/25 [==============================] - 9s 353ms/step - loss: 0.4127 - accuracy: 0.8200 - val\_loss: 0.4066 - val\_accuracy: 0.8348

Epoch 41/100

25/25 [==============================] - 10s 352ms/step - loss: 0.4021 - accuracy: 0.8200 - val\_loss: 0.3902 - val\_accuracy: 0.8393

Epoch 42/100

25/25 [==============================] - 10s 366ms/step - loss: 0.4035 - accuracy: 0.8213 - val\_loss: 0.3835 - val\_accuracy: 0.8527

Epoch 43/100

25/25 [==============================] - 10s 370ms/step - loss: 0.4044 - accuracy: 0.8256 - val\_loss: 0.4067 - val\_accuracy: 0.8259

Epoch 44/100

25/25 [==============================] - 9s 347ms/step - loss: 0.4037 - accuracy: 0.8150 - val\_loss: 0.3786 - val\_accuracy: 0.8393

Epoch 45/100

25/25 [==============================] - 10s 353ms/step - loss: 0.4149 - accuracy: 0.8075 - val\_loss: 0.4091 - val\_accuracy: 0.8438

Epoch 46/100

25/25 [==============================] - 10s 373ms/step - loss: 0.4113 - accuracy: 0.8163 - val\_loss: 0.4254 - val\_accuracy: 0.8036

Epoch 47/100

25/25 [==============================] - 10s 359ms/step - loss: 0.4119 - accuracy: 0.8163 - val\_loss: 0.4044 - val\_accuracy: 0.8371

Epoch 48/100

25/25 [==============================] - 10s 355ms/step - loss: 0.4238 - accuracy: 0.7969 - val\_loss: 0.4179 - val\_accuracy: 0.8214

Epoch 49/100

25/25 [==============================] - 9s 354ms/step - loss: 0.4164 - accuracy: 0.8119 - val\_loss: 0.3687 - val\_accuracy: 0.8460

Epoch 50/100

25/25 [==============================] - 10s 371ms/step - loss: 0.4174 - accuracy: 0.8138 - val\_loss: 0.4085 - val\_accuracy: 0.8103

Epoch 51/100

25/25 [==============================] - 10s 379ms/step - loss: 0.4132 - accuracy: 0.8125 - val\_loss: 0.4102 - val\_accuracy: 0.8348

Epoch 52/100

25/25 [==============================] - 10s 356ms/step - loss: 0.3992 - accuracy: 0.8131 - val\_loss: 0.3936 - val\_accuracy: 0.8080

Epoch 53/100

25/25 [==============================] - 10s 362ms/step - loss: 0.3963 - accuracy: 0.8263 - val\_loss: 0.3367 - val\_accuracy: 0.8549

Epoch 54/100

25/25 [==============================] - 10s 374ms/step - loss: 0.4046 - accuracy: 0.8138 - val\_loss: 0.3776 - val\_accuracy: 0.8192

Epoch 55/100

25/25 [==============================] - 10s 364ms/step - loss: 0.4055 - accuracy: 0.8219 - val\_loss: 0.3816 - val\_accuracy: 0.8594

Epoch 56/100

25/25 [==============================] - 10s 358ms/step - loss: 0.4015 - accuracy: 0.8181 - val\_loss: 0.3728 - val\_accuracy: 0.8705

Epoch 57/100

25/25 [==============================] - 10s 363ms/step - loss: 0.4056 - accuracy: 0.8150 - val\_loss: 0.3922 - val\_accuracy: 0.8103

Epoch 58/100

25/25 [==============================] - 10s 379ms/step - loss: 0.4025 - accuracy: 0.8125 - val\_loss: 0.4016 - val\_accuracy: 0.8125

Epoch 59/100

25/25 [==============================] - 10s 363ms/step - loss: 0.4159 - accuracy: 0.7981 - val\_loss: 0.3653 - val\_accuracy: 0.8415

Epoch 60/100

25/25 [==============================] - 10s 355ms/step - loss: 0.3970 - accuracy: 0.8094 - val\_loss: 0.3722 - val\_accuracy: 0.8393

Epoch 61/100

25/25 [==============================] - 9s 353ms/step - loss: 0.3963 - accuracy: 0.8263 - val\_loss: 0.4031 - val\_accuracy: 0.8527

Epoch 62/100

25/25 [==============================] - 10s 373ms/step - loss: 0.4106 - accuracy: 0.7987 - val\_loss: 0.4055 - val\_accuracy: 0.8393

Epoch 63/100

25/25 [==============================] - 10s 359ms/step - loss: 0.3985 - accuracy: 0.8094 - val\_loss: 0.3770 - val\_accuracy: 0.8438

Epoch 64/100

25/25 [==============================] - 10s 353ms/step - loss: 0.3980 - accuracy: 0.8112 - val\_loss: 0.3996 - val\_accuracy: 0.8281

Epoch 65/100

25/25 [==============================] - 9s 352ms/step - loss: 0.3851 - accuracy: 0.8319 - val\_loss: 0.3855 - val\_accuracy: 0.8527

Epoch 66/100

25/25 [==============================] - 10s 377ms/step - loss: 0.4086 - accuracy: 0.8169 - val\_loss: 0.3949 - val\_accuracy: 0.8393

Epoch 67/100

25/25 [==============================] - 10s 359ms/step - loss: 0.3945 - accuracy: 0.8200 - val\_loss: 0.3762 - val\_accuracy: 0.8616

Epoch 68/100

25/25 [==============================] - 10s 346ms/step - loss: 0.4123 - accuracy: 0.8087 - val\_loss: 0.4074 - val\_accuracy: 0.8192

Epoch 69/100

25/25 [==============================] - 10s 385ms/step - loss: 0.3876 - accuracy: 0.8338 - val\_loss: 0.3560 - val\_accuracy: 0.8750

Epoch 70/100

25/25 [==============================] - 10s 374ms/step - loss: 0.3994 - accuracy: 0.8150 - val\_loss: 0.3988 - val\_accuracy: 0.8125

Epoch 71/100

25/25 [==============================] - 10s 363ms/step - loss: 0.4045 - accuracy: 0.8075 - val\_loss: 0.3933 - val\_accuracy: 0.8326

Epoch 72/100

25/25 [==============================] - 10s 354ms/step - loss: 0.4032 - accuracy: 0.8119 - val\_loss: 0.3666 - val\_accuracy: 0.8281

Epoch 73/100

25/25 [==============================] - 10s 358ms/step - loss: 0.3865 - accuracy: 0.8244 - val\_loss: 0.4001 - val\_accuracy: 0.8259

Epoch 74/100

25/25 [==============================] - 10s 385ms/step - loss: 0.3910 - accuracy: 0.8144 - val\_loss: 0.3882 - val\_accuracy: 0.8571

Epoch 75/100

25/25 [==============================] - 10s 376ms/step - loss: 0.4070 - accuracy: 0.8131 - val\_loss: 0.3546 - val\_accuracy: 0.8438

Epoch 76/100

25/25 [==============================] - 10s 350ms/step - loss: 0.3923 - accuracy: 0.8219 - val\_loss: 0.3845 - val\_accuracy: 0.8326

Epoch 77/100

25/25 [==============================] - 10s 356ms/step - loss: 0.3822 - accuracy: 0.8331 - val\_loss: 0.3499 - val\_accuracy: 0.8438

Epoch 78/100

25/25 [==============================] - 10s 375ms/step - loss: 0.3959 - accuracy: 0.8206 - val\_loss: 0.3509 - val\_accuracy: 0.8705

Epoch 79/100

25/25 [==============================] - 10s 357ms/step - loss: 0.3791 - accuracy: 0.8256 - val\_loss: 0.3136 - val\_accuracy: 0.8795

Epoch 80/100

25/25 [==============================] - 10s 362ms/step - loss: 0.4152 - accuracy: 0.8081 - val\_loss: 0.3917 - val\_accuracy: 0.8460

Epoch 81/100

25/25 [==============================] - 10s 360ms/step - loss: 0.4004 - accuracy: 0.8213 - val\_loss: 0.3728 - val\_accuracy: 0.8460

Epoch 82/100

25/25 [==============================] - 10s 387ms/step - loss: 0.3768 - accuracy: 0.8394 - val\_loss: 0.3447 - val\_accuracy: 0.8616

Epoch 83/100

25/25 [==============================] - 10s 357ms/step - loss: 0.4006 - accuracy: 0.8175 - val\_loss: 0.3837 - val\_accuracy: 0.8371

Epoch 84/100

25/25 [==============================] - 10s 359ms/step - loss: 0.3911 - accuracy: 0.8300 - val\_loss: 0.3831 - val\_accuracy: 0.8482

Epoch 85/100

25/25 [==============================] - 10s 362ms/step - loss: 0.3948 - accuracy: 0.8194 - val\_loss: 0.3780 - val\_accuracy: 0.8438

Epoch 86/100

25/25 [==============================] - 10s 387ms/step - loss: 0.4040 - accuracy: 0.8069 - val\_loss: 0.3596 - val\_accuracy: 0.8527

Epoch 87/100

25/25 [==============================] - 10s 370ms/step - loss: 0.3948 - accuracy: 0.8131 - val\_loss: 0.3953 - val\_accuracy: 0.8304

Epoch 88/100

25/25 [==============================] - 10s 359ms/step - loss: 0.3995 - accuracy: 0.8163 - val\_loss: 0.3791 - val\_accuracy: 0.8549

Epoch 89/100

25/25 [==============================] - 10s 360ms/step - loss: 0.3873 - accuracy: 0.8238 - val\_loss: 0.3387 - val\_accuracy: 0.8504

Epoch 90/100

25/25 [==============================] - 10s 384ms/step - loss: 0.3735 - accuracy: 0.8331 - val\_loss: 0.3232 - val\_accuracy: 0.8683

Epoch 91/100

25/25 [==============================] - 9s 356ms/step - loss: 0.3921 - accuracy: 0.8294 - val\_loss: 0.3977 - val\_accuracy: 0.8147

Epoch 92/100

25/25 [==============================] - 10s 350ms/step - loss: 0.3774 - accuracy: 0.8281 - val\_loss: 0.3605 - val\_accuracy: 0.8571

Epoch 93/100

25/25 [==============================] - 9s 354ms/step - loss: 0.3827 - accuracy: 0.8181 - val\_loss: 0.4051 - val\_accuracy: 0.8259

Epoch 94/100

25/25 [==============================] - 10s 383ms/step - loss: 0.3940 - accuracy: 0.8181 - val\_loss: 0.3835 - val\_accuracy: 0.8638

Epoch 95/100

25/25 [==============================] - 10s 356ms/step - loss: 0.3753 - accuracy: 0.8244 - val\_loss: 0.3529 - val\_accuracy: 0.8638

Epoch 96/100

25/25 [==============================] - 10s 357ms/step - loss: 0.3798 - accuracy: 0.8331 - val\_loss: 0.3785 - val\_accuracy: 0.8460

Epoch 97/100

25/25 [==============================] - 9s 349ms/step - loss: 0.3699 - accuracy: 0.8350 - val\_loss: 0.3963 - val\_accuracy: 0.8304

Epoch 98/100

25/25 [==============================] - 10s 378ms/step - loss: 0.3773 - accuracy: 0.8244 - val\_loss: 0.3776 - val\_accuracy: 0.8393

Epoch 99/100

25/25 [==============================] - 9s 348ms/step - loss: 0.3785 - accuracy: 0.8306 - val\_loss: 0.3668 - val\_accuracy: 0.8393

Epoch 100/100

25/25 [==============================] - 10s 359ms/step - loss: 0.3896 - accuracy: 0.8181 - val\_loss: 0.3779 - val\_accuracy: 0.8326

**A graph of loss and accuracy

Description automatically generated with low confidence**

**A picture containing text, diagram, screenshot, line

Description automatically generated**

**ResNet50**

Model: "sequential\_1"

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Layer (type) Output Shape Param #

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

resnet50 (Functional) (None, 1000) 25636712

flatten\_1 (Flatten) (None, 1000) 0

dropout\_1 (Dropout) (None, 1000) 0

batch\_normalization\_1 (Batc (None, 1000) 4000

hNormalization)

dense\_1 (Dense) (None, 4) 4004

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

Total params: 25,644,716

Trainable params: 6,004

Non-trainable params: 25,638,712

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Epoch 1/100

/usr/local/lib/python3.10/dist-packages/keras/backend.py:5612: UserWarning: "`sparse\_categorical\_crossentropy` received `from\_logits=True`, but the `output` argument was produced by a Softmax activation and thus does not represent logits. Was this intended?

output, from\_logits = \_get\_logits(

25/25 [==============================] - 17s 412ms/step - loss: 1.1089 - accuracy: 0.4831 - val\_loss: 0.8255 - val\_accuracy: 0.5045

Epoch 2/100

25/25 [==============================] - 10s 357ms/step - loss: 0.7448 - accuracy: 0.4988 - val\_loss: 0.7089 - val\_accuracy: 0.4844

Epoch 3/100

25/25 [==============================] - 10s 359ms/step - loss: 0.7035 - accuracy: 0.4963 - val\_loss: 0.7011 - val\_accuracy: 0.4978

Epoch 4/100

25/25 [==============================] - 10s 369ms/step - loss: 0.6983 - accuracy: 0.5231 - val\_loss: 0.6949 - val\_accuracy: 0.5312

Epoch 5/100

25/25 [==============================] - 10s 376ms/step - loss: 0.6971 - accuracy: 0.4994 - val\_loss: 0.6946 - val\_accuracy: 0.5246

Epoch 6/100

25/25 [==============================] - 9s 355ms/step - loss: 0.6938 - accuracy: 0.5213 - val\_loss: 0.7000 - val\_accuracy: 0.4933

Epoch 7/100

25/25 [==============================] - 10s 363ms/step - loss: 0.6970 - accuracy: 0.5106 - val\_loss: 0.6969 - val\_accuracy: 0.5000

Epoch 8/100

25/25 [==============================] - 10s 372ms/step - loss: 0.6913 - accuracy: 0.5275 - val\_loss: 0.6946 - val\_accuracy: 0.5089

Epoch 9/100

25/25 [==============================] - 10s 379ms/step - loss: 0.6923 - accuracy: 0.5394 - val\_loss: 0.6939 - val\_accuracy: 0.5424

Epoch 10/100

25/25 [==============================] - 10s 361ms/step - loss: 0.6945 - accuracy: 0.5069 - val\_loss: 0.6934 - val\_accuracy: 0.5089

Epoch 11/100

25/25 [==============================] - 10s 363ms/step - loss: 0.6934 - accuracy: 0.5156 - val\_loss: 0.6935 - val\_accuracy: 0.4933

Epoch 12/100

25/25 [==============================] - 10s 366ms/step - loss: 0.6894 - accuracy: 0.5462 - val\_loss: 0.6931 - val\_accuracy: 0.5089

Epoch 13/100

25/25 [==============================] - 10s 370ms/step - loss: 0.6914 - accuracy: 0.5337 - val\_loss: 0.6989 - val\_accuracy: 0.4799

Epoch 14/100

25/25 [==============================] - 9s 353ms/step - loss: 0.6944 - accuracy: 0.5225 - val\_loss: 0.6931 - val\_accuracy: 0.4911

Epoch 15/100

25/25 [==============================] - 10s 356ms/step - loss: 0.6912 - accuracy: 0.5369 - val\_loss: 0.6923 - val\_accuracy: 0.5201

Epoch 16/100

25/25 [==============================] - 10s 372ms/step - loss: 0.6866 - accuracy: 0.5512 - val\_loss: 0.6929 - val\_accuracy: 0.5089

Epoch 17/100

25/25 [==============================] - 10s 388ms/step - loss: 0.6879 - accuracy: 0.5437 - val\_loss: 0.6944 - val\_accuracy: 0.4955

Epoch 18/100

25/25 [==============================] - 10s 359ms/step - loss: 0.6886 - accuracy: 0.5369 - val\_loss: 0.6944 - val\_accuracy: 0.5067

Epoch 19/100

25/25 [==============================] - 10s 362ms/step - loss: 0.6885 - accuracy: 0.5281 - val\_loss: 0.6913 - val\_accuracy: 0.5022

Epoch 20/100

25/25 [==============================] - 10s 373ms/step - loss: 0.6970 - accuracy: 0.5337 - val\_loss: 0.6901 - val\_accuracy: 0.6942

Epoch 21/100

25/25 [==============================] - 10s 378ms/step - loss: 0.6877 - accuracy: 0.5462 - val\_loss: 0.6920 - val\_accuracy: 0.5045

Epoch 22/100

25/25 [==============================] - 10s 357ms/step - loss: 0.6908 - accuracy: 0.5175 - val\_loss: 0.6894 - val\_accuracy: 0.5156

Epoch 23/100

25/25 [==============================] - 10s 361ms/step - loss: 0.6900 - accuracy: 0.5256 - val\_loss: 0.6888 - val\_accuracy: 0.5179

Epoch 24/100

25/25 [==============================] - 10s 369ms/step - loss: 0.6863 - accuracy: 0.5562 - val\_loss: 0.6883 - val\_accuracy: 0.5201

Epoch 25/100

25/25 [==============================] - 10s 369ms/step - loss: 0.6925 - accuracy: 0.5294 - val\_loss: 0.6880 - val\_accuracy: 0.5379

Epoch 26/100

25/25 [==============================] - 10s 361ms/step - loss: 0.6920 - accuracy: 0.5188 - val\_loss: 0.6873 - val\_accuracy: 0.6004

Epoch 27/100

25/25 [==============================] - 10s 357ms/step - loss: 0.6858 - accuracy: 0.5519 - val\_loss: 0.6903 - val\_accuracy: 0.5000

Epoch 28/100

25/25 [==============================] - 10s 367ms/step - loss: 0.6893 - accuracy: 0.5500 - val\_loss: 0.6882 - val\_accuracy: 0.5558

Epoch 29/100

25/25 [==============================] - 10s 374ms/step - loss: 0.6904 - accuracy: 0.5138 - val\_loss: 0.6878 - val\_accuracy: 0.5647

Epoch 30/100

25/25 [==============================] - 10s 363ms/step - loss: 0.6881 - accuracy: 0.5362 - val\_loss: 0.6885 - val\_accuracy: 0.5312

Epoch 31/100

25/25 [==============================] - 10s 364ms/step - loss: 0.6903 - accuracy: 0.5387 - val\_loss: 0.6844 - val\_accuracy: 0.5446

Epoch 32/100

25/25 [==============================] - 10s 373ms/step - loss: 0.6896 - accuracy: 0.5206 - val\_loss: 0.6841 - val\_accuracy: 0.5848

Epoch 33/100

25/25 [==============================] - 10s 376ms/step - loss: 0.6884 - accuracy: 0.5400 - val\_loss: 0.6868 - val\_accuracy: 0.5201

Epoch 34/100

25/25 [==============================] - 10s 360ms/step - loss: 0.6900 - accuracy: 0.5387 - val\_loss: 0.6888 - val\_accuracy: 0.5045

Epoch 35/100

25/25 [==============================] - 10s 364ms/step - loss: 0.6880 - accuracy: 0.5469 - val\_loss: 0.6844 - val\_accuracy: 0.7411

Epoch 36/100

25/25 [==============================] - 10s 371ms/step - loss: 0.6887 - accuracy: 0.5537 - val\_loss: 0.6883 - val\_accuracy: 0.4866

Epoch 37/100

25/25 [==============================] - 10s 373ms/step - loss: 0.6885 - accuracy: 0.5475 - val\_loss: 0.6834 - val\_accuracy: 0.5424

Epoch 38/100

25/25 [==============================] - 10s 360ms/step - loss: 0.6867 - accuracy: 0.5462 - val\_loss: 0.6875 - val\_accuracy: 0.4955

Epoch 39/100

25/25 [==============================] - 10s 357ms/step - loss: 0.6880 - accuracy: 0.5475 - val\_loss: 0.6852 - val\_accuracy: 0.5446

Epoch 40/100

25/25 [==============================] - 10s 364ms/step - loss: 0.6907 - accuracy: 0.5238 - val\_loss: 0.6818 - val\_accuracy: 0.5469

Epoch 41/100

25/25 [==============================] - 10s 381ms/step - loss: 0.6879 - accuracy: 0.5337 - val\_loss: 0.6832 - val\_accuracy: 0.5871

Epoch 42/100

25/25 [==============================] - 10s 356ms/step - loss: 0.6844 - accuracy: 0.5500 - val\_loss: 0.6829 - val\_accuracy: 0.4978

Epoch 43/100

25/25 [==============================] - 10s 363ms/step - loss: 0.6872 - accuracy: 0.5325 - val\_loss: 0.6827 - val\_accuracy: 0.6205

Epoch 44/100

25/25 [==============================] - 10s 365ms/step - loss: 0.6921 - accuracy: 0.5269 - val\_loss: 0.6902 - val\_accuracy: 0.5045

Epoch 45/100

25/25 [==============================] - 10s 377ms/step - loss: 0.6894 - accuracy: 0.5512 - val\_loss: 0.6841 - val\_accuracy: 0.5246

Epoch 46/100

25/25 [==============================] - 9s 354ms/step - loss: 0.6886 - accuracy: 0.5362 - val\_loss: 0.6838 - val\_accuracy: 0.7232

Epoch 47/100

25/25 [==============================] - 10s 361ms/step - loss: 0.6846 - accuracy: 0.5688 - val\_loss: 0.6816 - val\_accuracy: 0.6272

Epoch 48/100

25/25 [==============================] - 10s 364ms/step - loss: 0.6905 - accuracy: 0.5425 - val\_loss: 0.6809 - val\_accuracy: 0.5000

Epoch 49/100

25/25 [==============================] - 10s 385ms/step - loss: 0.6862 - accuracy: 0.5550 - val\_loss: 0.6877 - val\_accuracy: 0.4665

Epoch 50/100

25/25 [==============================] - 10s 363ms/step - loss: 0.6867 - accuracy: 0.5556 - val\_loss: 0.6852 - val\_accuracy: 0.5022

Epoch 51/100

25/25 [==============================] - 10s 362ms/step - loss: 0.6931 - accuracy: 0.5306 - val\_loss: 0.6870 - val\_accuracy: 0.4844

Epoch 52/100

25/25 [==============================] - 10s 369ms/step - loss: 0.6849 - accuracy: 0.5481 - val\_loss: 0.6810 - val\_accuracy: 0.7254

Epoch 53/100

25/25 [==============================] - 10s 388ms/step - loss: 0.6916 - accuracy: 0.5306 - val\_loss: 0.6810 - val\_accuracy: 0.5402

Epoch 54/100

25/25 [==============================] - 10s 382ms/step - loss: 0.6871 - accuracy: 0.5494 - val\_loss: 0.6846 - val\_accuracy: 0.4844

Epoch 55/100

25/25 [==============================] - 10s 361ms/step - loss: 0.6876 - accuracy: 0.5381 - val\_loss: 0.6923 - val\_accuracy: 0.4732

Epoch 56/100

25/25 [==============================] - 10s 364ms/step - loss: 0.6844 - accuracy: 0.5556 - val\_loss: 0.6809 - val\_accuracy: 0.5848

Epoch 57/100

25/25 [==============================] - 10s 381ms/step - loss: 0.6860 - accuracy: 0.5537 - val\_loss: 0.6803 - val\_accuracy: 0.6875

Epoch 58/100

25/25 [==============================] - 10s 365ms/step - loss: 0.6863 - accuracy: 0.5587 - val\_loss: 0.6818 - val\_accuracy: 0.5312

Epoch 59/100

25/25 [==============================] - 10s 356ms/step - loss: 0.6899 - accuracy: 0.5400 - val\_loss: 0.6825 - val\_accuracy: 0.5826

Epoch 60/100

25/25 [==============================] - 10s 364ms/step - loss: 0.6865 - accuracy: 0.5450 - val\_loss: 0.6814 - val\_accuracy: 0.7188

Epoch 61/100

25/25 [==============================] - 10s 384ms/step - loss: 0.6908 - accuracy: 0.5369 - val\_loss: 0.6848 - val\_accuracy: 0.4621

Epoch 62/100

25/25 [==============================] - 10s 369ms/step - loss: 0.6867 - accuracy: 0.5381 - val\_loss: 0.6863 - val\_accuracy: 0.5045

Epoch 63/100

25/25 [==============================] - 10s 366ms/step - loss: 0.6916 - accuracy: 0.5325 - val\_loss: 0.6802 - val\_accuracy: 0.5513

Epoch 64/100

25/25 [==============================] - 10s 360ms/step - loss: 0.6817 - accuracy: 0.5788 - val\_loss: 0.6817 - val\_accuracy: 0.6562

Epoch 65/100

25/25 [==============================] - 10s 385ms/step - loss: 0.6850 - accuracy: 0.5494 - val\_loss: 0.6815 - val\_accuracy: 0.6696

Epoch 66/100

25/25 [==============================] - 10s 374ms/step - loss: 0.6873 - accuracy: 0.5350 - val\_loss: 0.6806 - val\_accuracy: 0.6763

Epoch 67/100

25/25 [==============================] - 10s 362ms/step - loss: 0.6846 - accuracy: 0.5600 - val\_loss: 0.6818 - val\_accuracy: 0.7098

Epoch 68/100

25/25 [==============================] - 10s 364ms/step - loss: 0.6875 - accuracy: 0.5487 - val\_loss: 0.6809 - val\_accuracy: 0.7143

Epoch 69/100

25/25 [==============================] - 10s 379ms/step - loss: 0.6903 - accuracy: 0.5325 - val\_loss: 0.6813 - val\_accuracy: 0.6183

Epoch 70/100

25/25 [==============================] - 10s 369ms/step - loss: 0.6850 - accuracy: 0.5375 - val\_loss: 0.6928 - val\_accuracy: 0.4978

Epoch 71/100

25/25 [==============================] - 10s 360ms/step - loss: 0.6834 - accuracy: 0.5594 - val\_loss: 0.6818 - val\_accuracy: 0.7009

Epoch 72/100

25/25 [==============================] - 10s 365ms/step - loss: 0.6847 - accuracy: 0.5688 - val\_loss: 0.6795 - val\_accuracy: 0.6205

Epoch 73/100

25/25 [==============================] - 10s 369ms/step - loss: 0.6868 - accuracy: 0.5425 - val\_loss: 0.6818 - val\_accuracy: 0.6138

Epoch 74/100

25/25 [==============================] - 10s 376ms/step - loss: 0.6849 - accuracy: 0.5506 - val\_loss: 0.6798 - val\_accuracy: 0.6920

Epoch 75/100

25/25 [==============================] - 10s 362ms/step - loss: 0.6855 - accuracy: 0.5362 - val\_loss: 0.6810 - val\_accuracy: 0.7411

Epoch 76/100

25/25 [==============================] - 10s 362ms/step - loss: 0.6845 - accuracy: 0.5400 - val\_loss: 0.6831 - val\_accuracy: 0.5469

Epoch 77/100

25/25 [==============================] - 10s 372ms/step - loss: 0.6859 - accuracy: 0.5375 - val\_loss: 0.6810 - val\_accuracy: 0.7277

Epoch 78/100

25/25 [==============================] - 10s 373ms/step - loss: 0.6879 - accuracy: 0.5375 - val\_loss: 0.6812 - val\_accuracy: 0.5000

Epoch 79/100

25/25 [==============================] - 10s 358ms/step - loss: 0.6852 - accuracy: 0.5600 - val\_loss: 0.6889 - val\_accuracy: 0.4955

Epoch 80/100

25/25 [==============================] - 10s 355ms/step - loss: 0.6872 - accuracy: 0.5544 - val\_loss: 0.6745 - val\_accuracy: 0.5625

Epoch 81/100

25/25 [==============================] - 10s 375ms/step - loss: 0.6842 - accuracy: 0.5437 - val\_loss: 0.6815 - val\_accuracy: 0.7321

Epoch 82/100

25/25 [==============================] - 10s 376ms/step - loss: 0.6871 - accuracy: 0.5444 - val\_loss: 0.6800 - val\_accuracy: 0.6853

Epoch 83/100

25/25 [==============================] - 10s 361ms/step - loss: 0.6829 - accuracy: 0.5475 - val\_loss: 0.6791 - val\_accuracy: 0.6607

Epoch 84/100

25/25 [==============================] - 10s 365ms/step - loss: 0.6848 - accuracy: 0.5600 - val\_loss: 0.6789 - val\_accuracy: 0.5960

Epoch 85/100

25/25 [==============================] - 10s 379ms/step - loss: 0.6832 - accuracy: 0.5525 - val\_loss: 0.6818 - val\_accuracy: 0.5268

Epoch 86/100

25/25 [==============================] - 10s 376ms/step - loss: 0.6871 - accuracy: 0.5494 - val\_loss: 0.6800 - val\_accuracy: 0.5759

Epoch 87/100

25/25 [==============================] - 10s 361ms/step - loss: 0.6874 - accuracy: 0.5525 - val\_loss: 0.6807 - val\_accuracy: 0.7433

Epoch 88/100

25/25 [==============================] - 10s 365ms/step - loss: 0.6858 - accuracy: 0.5612 - val\_loss: 0.6789 - val\_accuracy: 0.7277

Epoch 89/100

25/25 [==============================] - 10s 371ms/step - loss: 0.6888 - accuracy: 0.5400 - val\_loss: 0.6808 - val\_accuracy: 0.5960

Epoch 90/100

25/25 [==============================] - 10s 384ms/step - loss: 0.6850 - accuracy: 0.5462 - val\_loss: 0.6850 - val\_accuracy: 0.4821

Epoch 91/100

25/25 [==============================] - 10s 380ms/step - loss: 0.6854 - accuracy: 0.5531 - val\_loss: 0.6845 - val\_accuracy: 0.4911

Epoch 92/100

25/25 [==============================] - 10s 361ms/step - loss: 0.6919 - accuracy: 0.5306 - val\_loss: 0.6819 - val\_accuracy: 0.5647

Epoch 93/100

25/25 [==============================] - 10s 357ms/step - loss: 0.6835 - accuracy: 0.5481 - val\_loss: 0.6804 - val\_accuracy: 0.6830

Epoch 94/100

25/25 [==============================] - 10s 388ms/step - loss: 0.6838 - accuracy: 0.5475 - val\_loss: 0.6775 - val\_accuracy: 0.6228

Epoch 95/100

25/25 [==============================] - 10s 361ms/step - loss: 0.6880 - accuracy: 0.5381 - val\_loss: 0.6803 - val\_accuracy: 0.7098

Epoch 96/100

25/25 [==============================] - 10s 360ms/step - loss: 0.6844 - accuracy: 0.5638 - val\_loss: 0.6810 - val\_accuracy: 0.6830

Epoch 97/100

25/25 [==============================] - 10s 365ms/step - loss: 0.6788 - accuracy: 0.5800 - val\_loss: 0.6800 - val\_accuracy: 0.7433

Epoch 98/100

25/25 [==============================] - 10s 385ms/step - loss: 0.6855 - accuracy: 0.5569 - val\_loss: 0.6792 - val\_accuracy: 0.6384

Epoch 99/100

25/25 [==============================] - 10s 360ms/step - loss: 0.6875 - accuracy: 0.5487 - val\_loss: 0.6779 - val\_accuracy: 0.5692

Epoch 100/100

25/25 [==============================] - 10s 356ms/step - loss: 0.6870 - accuracy: 0.5487 - val\_loss: 0.6847 - val\_accuracy: 0.4866

**A picture containing text, screenshot, plot, line

Description automatically generated**

**A picture containing text, diagram, line, plot

Description automatically generated**

**FirstUpdate**

Epoch 1/100

34/34 [==============================] - 59s 1s/step - loss: 1.4170 - accuracy: 0.4487 - val\_loss: 1.7798 - val\_accuracy: 0.0000e+00

Epoch 2/100

34/34 [==============================] - 47s 1s/step - loss: 1.0226 - accuracy: 0.6213 - val\_loss: 1.3291 - val\_accuracy: 0.5565

Epoch 3/100

34/34 [==============================] - 48s 1s/step - loss: 0.8383 - accuracy: 0.7059 - val\_loss: 1.0938 - val\_accuracy: 0.6526

Epoch 4/100

34/34 [==============================] - 48s 1s/step - loss: 0.7316 - accuracy: 0.7509 - val\_loss: 0.8342 - val\_accuracy: 0.7477

Epoch 5/100

34/34 [==============================] - 48s 1s/step - loss: 0.6161 - accuracy: 0.7863 - val\_loss: 0.6577 - val\_accuracy: 0.8621

Epoch 6/100

34/34 [==============================] - 48s 1s/step - loss: 0.4806 - accuracy: 0.8421 - val\_loss: 0.5182 - val\_accuracy: 0.9136

Epoch 7/100

34/34 [==============================] - 49s 1s/step - loss: 0.4466 - accuracy: 0.8577 - val\_loss: 0.4376 - val\_accuracy: 0.9044

Epoch 8/100

34/34 [==============================] - 48s 1s/step - loss: 0.4065 - accuracy: 0.8728 - val\_loss: 0.3926 - val\_accuracy: 0.9095

Epoch 9/100

34/34 [==============================] - 49s 1s/step - loss: 0.3484 - accuracy: 0.8983 - val\_loss: 0.3828 - val\_accuracy: 0.9012

Epoch 10/100

34/34 [==============================] - 48s 1s/step - loss: 0.3451 - accuracy: 0.9083 - val\_loss: 0.4227 - val\_accuracy: 0.8773

Epoch 11/100

34/34 [==============================] - 48s 1s/step - loss: 0.2872 - accuracy: 0.9215 - val\_loss: 0.4291 - val\_accuracy: 0.8741

Epoch 12/100

34/34 [==============================] - 48s 1s/step - loss: 0.2878 - accuracy: 0.9262 - val\_loss: 0.3605 - val\_accuracy: 0.9026

Epoch 13/100

34/34 [==============================] - 48s 1s/step - loss: 0.2829 - accuracy: 0.9296 - val\_loss: 0.2762 - val\_accuracy: 0.9370

Epoch 14/100

34/34 [==============================] - 48s 1s/step - loss: 0.2799 - accuracy: 0.9229 - val\_loss: 0.2697 - val\_accuracy: 0.9177

Epoch 15/100

34/34 [==============================] - 48s 1s/step - loss: 0.2429 - accuracy: 0.9395 - val\_loss: 0.3300 - val\_accuracy: 0.9007

Epoch 16/100

34/34 [==============================] - 49s 1s/step - loss: 0.2363 - accuracy: 0.9456 - val\_loss: 0.3986 - val\_accuracy: 0.8791

Epoch 17/100

34/34 [==============================] - 49s 1s/step - loss: 0.2010 - accuracy: 0.9593 - val\_loss: 0.4690 - val\_accuracy: 0.8562

Epoch 18/100

34/34 [==============================] - 49s 1s/step - loss: 0.2315 - accuracy: 0.9481 - val\_loss: 0.3046 - val\_accuracy: 0.9062

Epoch 19/100

34/34 [==============================] - 48s 1s/step - loss: 0.1984 - accuracy: 0.9650 - val\_loss: 0.4183 - val\_accuracy: 0.8759

Epoch 20/100

34/34 [==============================] - 48s 1s/step - loss: 0.2526 - accuracy: 0.9414 - val\_loss: 0.2846 - val\_accuracy: 0.9173

Epoch 21/100

34/34 [==============================] - 48s 1s/step - loss: 0.2098 - accuracy: 0.9541 - val\_loss: 0.2610 - val\_accuracy: 0.9297

Epoch 22/100

34/34 [==============================] - 48s 1s/step - loss: 0.2208 - accuracy: 0.9579 - val\_loss: 0.3434 - val\_accuracy: 0.8943

Epoch 23/100

34/34 [==============================] - 48s 1s/step - loss: 0.2104 - accuracy: 0.9586 - val\_loss: 0.4143 - val\_accuracy: 0.8727

Epoch 24/100

34/34 [==============================] - 48s 1s/step - loss: 0.1908 - accuracy: 0.9598 - val\_loss: 0.5179 - val\_accuracy: 0.8392

Epoch 25/100

34/34 [==============================] - 48s 1s/step - loss: 0.1848 - accuracy: 0.9589 - val\_loss: 0.4414 - val\_accuracy: 0.8594

Epoch 26/100

34/34 [==============================] - 48s 1s/step - loss: 0.1900 - accuracy: 0.9574 - val\_loss: 0.3740 - val\_accuracy: 0.8828

Epoch 27/100

34/34 [==============================] - 48s 1s/step - loss: 0.1965 - accuracy: 0.9622 - val\_loss: 0.4458 - val\_accuracy: 0.8580

Epoch 28/100

34/34 [==============================] - 49s 1s/step - loss: 0.1969 - accuracy: 0.9565 - val\_loss: 0.3219 - val\_accuracy: 0.8957

Epoch 29/100

34/34 [==============================] - 49s 1s/step - loss: 0.2083 - accuracy: 0.9485 - val\_loss: 0.4805 - val\_accuracy: 0.8529

Epoch 30/100

34/34 [==============================] - 49s 1s/step - loss: 0.1976 - accuracy: 0.9570 - val\_loss: 0.3701 - val\_accuracy: 0.8842

Epoch 31/100

34/34 [==============================] - 48s 1s/step - loss: 0.2099 - accuracy: 0.9551 - val\_loss: 0.3868 - val\_accuracy: 0.8851

Epoch 32/100

34/34 [==============================] - 49s 1s/step - loss: 0.1977 - accuracy: 0.9579 - val\_loss: 0.3795 - val\_accuracy: 0.8874

Epoch 33/100

34/34 [==============================] - 48s 1s/step - loss: 0.2081 - accuracy: 0.9589 - val\_loss: 0.4784 - val\_accuracy: 0.8658

Epoch 34/100

34/34 [==============================] - 48s 1s/step - loss: 0.1638 - accuracy: 0.9664 - val\_loss: 0.3908 - val\_accuracy: 0.8842

Epoch 35/100

34/34 [==============================] - 47s 1s/step - loss: 0.1643 - accuracy: 0.9683 - val\_loss: 0.4198 - val\_accuracy: 0.8824

Epoch 36/100

34/34 [==============================] - 48s 1s/step - loss: 0.1656 - accuracy: 0.9617 - val\_loss: 0.3626 - val\_accuracy: 0.8952

Epoch 37/100

34/34 [==============================] - 48s 1s/step - loss: 0.1814 - accuracy: 0.9608 - val\_loss: 0.5350 - val\_accuracy: 0.8470

Epoch 38/100

34/34 [==============================] - 49s 1s/step - loss: 0.1641 - accuracy: 0.9697 - val\_loss: 0.4612 - val\_accuracy: 0.8525

Epoch 39/100

34/34 [==============================] - 50s 1s/step - loss: 0.1591 - accuracy: 0.9674 - val\_loss: 0.4332 - val\_accuracy: 0.8686

Epoch 40/100

34/34 [==============================] - 48s 1s/step - loss: 0.1472 - accuracy: 0.9702 - val\_loss: 0.3665 - val\_accuracy: 0.8819

Epoch 41/100

34/34 [==============================] - 49s 1s/step - loss: 0.1520 - accuracy: 0.9650 - val\_loss: 0.4777 - val\_accuracy: 0.8539

Epoch 42/100

34/34 [==============================] - 48s 1s/step - loss: 0.1238 - accuracy: 0.9778 - val\_loss: 0.5255 - val\_accuracy: 0.8456

Epoch 43/100

34/34 [==============================] - 47s 1s/step - loss: 0.1514 - accuracy: 0.9716 - val\_loss: 0.3438 - val\_accuracy: 0.8957

Epoch 44/100

34/34 [==============================] - 48s 1s/step - loss: 0.1546 - accuracy: 0.9669 - val\_loss: 0.3721 - val\_accuracy: 0.8879

Epoch 45/100

34/34 [==============================] - 48s 1s/step - loss: 0.1320 - accuracy: 0.9688 - val\_loss: 0.3880 - val\_accuracy: 0.8856

Epoch 46/100

34/34 [==============================] - 48s 1s/step - loss: 0.1454 - accuracy: 0.9721 - val\_loss: 0.5132 - val\_accuracy: 0.8529

Epoch 47/100

34/34 [==============================] - 48s 1s/step - loss: 0.1505 - accuracy: 0.9707 - val\_loss: 0.4089 - val\_accuracy: 0.8755

Epoch 48/100

34/34 [==============================] - 48s 1s/step - loss: 0.1349 - accuracy: 0.9764 - val\_loss: 0.4677 - val\_accuracy: 0.8603

Epoch 49/100

34/34 [==============================] - 48s 1s/step - loss: 0.1430 - accuracy: 0.9735 - val\_loss: 0.5092 - val\_accuracy: 0.8529

Epoch 50/100

34/34 [==============================] - 49s 1s/step - loss: 0.1435 - accuracy: 0.9721 - val\_loss: 0.5915 - val\_accuracy: 0.8415

Epoch 51/100

34/34 [==============================] - 48s 1s/step - loss: 0.1491 - accuracy: 0.9693 - val\_loss: 0.2816 - val\_accuracy: 0.9150

Epoch 52/100

34/34 [==============================] - 48s 1s/step - loss: 0.1446 - accuracy: 0.9683 - val\_loss: 0.3433 - val\_accuracy: 0.8897

Epoch 53/100

34/34 [==============================] - 48s 1s/step - loss: 0.1216 - accuracy: 0.9764 - val\_loss: 0.4901 - val\_accuracy: 0.8516

Epoch 54/100

34/34 [==============================] - 48s 1s/step - loss: 0.1317 - accuracy: 0.9726 - val\_loss: 0.3428 - val\_accuracy: 0.8906

Epoch 55/100

34/34 [==============================] - 48s 1s/step - loss: 0.1434 - accuracy: 0.9721 - val\_loss: 0.3022 - val\_accuracy: 0.9049

Epoch 56/100

34/34 [==============================] - 49s 1s/step - loss: 0.1437 - accuracy: 0.9721 - val\_loss: 0.3855 - val\_accuracy: 0.8814

Epoch 57/100

34/34 [==============================] - 49s 1s/step - loss: 0.1199 - accuracy: 0.9778 - val\_loss: 0.3097 - val\_accuracy: 0.9062

Epoch 58/100

34/34 [==============================] - 49s 1s/step - loss: 0.1104 - accuracy: 0.9801 - val\_loss: 0.5322 - val\_accuracy: 0.8594

Epoch 59/100

34/34 [==============================] - 48s 1s/step - loss: 0.1082 - accuracy: 0.9797 - val\_loss: 0.3726 - val\_accuracy: 0.8915

Epoch 60/100

34/34 [==============================] - 48s 1s/step - loss: 0.1300 - accuracy: 0.9749 - val\_loss: 0.3531 - val\_accuracy: 0.8934

Epoch 61/100

34/34 [==============================] - 48s 1s/step - loss: 0.1196 - accuracy: 0.9773 - val\_loss: 0.3150 - val\_accuracy: 0.8984

Epoch 62/100

34/34 [==============================] - 48s 1s/step - loss: 0.0999 - accuracy: 0.9835 - val\_loss: 0.4008 - val\_accuracy: 0.8828

Epoch 63/100

34/34 [==============================] - 47s 1s/step - loss: 0.1177 - accuracy: 0.9764 - val\_loss: 0.3936 - val\_accuracy: 0.8787

Epoch 64/100

34/34 [==============================] - 48s 1s/step - loss: 0.1341 - accuracy: 0.9740 - val\_loss: 0.4508 - val\_accuracy: 0.8594

Epoch 65/100

34/34 [==============================] - 47s 1s/step - loss: 0.0987 - accuracy: 0.9830 - val\_loss: 0.3370 - val\_accuracy: 0.8961

Epoch 66/100

34/34 [==============================] - 49s 1s/step - loss: 0.1214 - accuracy: 0.9759 - val\_loss: 0.3868 - val\_accuracy: 0.8828

Epoch 67/100

34/34 [==============================] - 48s 1s/step - loss: 0.1455 - accuracy: 0.9726 - val\_loss: 0.4726 - val\_accuracy: 0.8543

Epoch 68/100

34/34 [==============================] - 49s 1s/step - loss: 0.1216 - accuracy: 0.9773 - val\_loss: 0.3530 - val\_accuracy: 0.8842

Epoch 69/100

34/34 [==============================] - 49s 1s/step - loss: 0.1202 - accuracy: 0.9745 - val\_loss: 0.5113 - val\_accuracy: 0.8566

Epoch 70/100

34/34 [==============================] - 49s 1s/step - loss: 0.1202 - accuracy: 0.9773 - val\_loss: 0.3112 - val\_accuracy: 0.9035

Epoch 71/100

34/34 [==============================] - 48s 1s/step - loss: 0.1204 - accuracy: 0.9759 - val\_loss: 0.1559 - val\_accuracy: 0.9527

Epoch 72/100

34/34 [==============================] - 48s 1s/step - loss: 0.1220 - accuracy: 0.9749 - val\_loss: 0.3300 - val\_accuracy: 0.9040

Epoch 73/100

34/34 [==============================] - 48s 1s/step - loss: 0.1323 - accuracy: 0.9768 - val\_loss: 0.1972 - val\_accuracy: 0.9522

Epoch 74/100

34/34 [==============================] - 48s 1s/step - loss: 0.1139 - accuracy: 0.9792 - val\_loss: 0.2616 - val\_accuracy: 0.9187

Epoch 75/100

34/34 [==============================] - 49s 1s/step - loss: 0.1371 - accuracy: 0.9702 - val\_loss: 0.3334 - val\_accuracy: 0.8980

Epoch 76/100

34/34 [==============================] - 49s 1s/step - loss: 0.1260 - accuracy: 0.9773 - val\_loss: 0.4347 - val\_accuracy: 0.8750

Epoch 77/100

34/34 [==============================] - 49s 1s/step - loss: 0.1073 - accuracy: 0.9764 - val\_loss: 0.4012 - val\_accuracy: 0.8824

Epoch 78/100

34/34 [==============================] - 49s 1s/step - loss: 0.1224 - accuracy: 0.9764 - val\_loss: 0.2573 - val\_accuracy: 0.9104

Epoch 79/100

34/34 [==============================] - 49s 1s/step - loss: 0.1083 - accuracy: 0.9816 - val\_loss: 0.4261 - val\_accuracy: 0.8750

Epoch 80/100

34/34 [==============================] - 49s 1s/step - loss: 0.1228 - accuracy: 0.9745 - val\_loss: 0.2809 - val\_accuracy: 0.9085

Epoch 81/100

34/34 [==============================] - 48s 1s/step - loss: 0.1093 - accuracy: 0.9835 - val\_loss: 0.5026 - val\_accuracy: 0.8603

Epoch 82/100

34/34 [==============================] - 48s 1s/step - loss: 0.1320 - accuracy: 0.9768 - val\_loss: 0.2143 - val\_accuracy: 0.9154

Epoch 83/100

34/34 [==============================] - 48s 1s/step - loss: 0.1143 - accuracy: 0.9735 - val\_loss: 0.3623 - val\_accuracy: 0.8828

Epoch 84/100

34/34 [==============================] - 48s 1s/step - loss: 0.1053 - accuracy: 0.9787 - val\_loss: 1.1115 - val\_accuracy: 0.7858

Epoch 85/100

34/34 [==============================] - 49s 1s/step - loss: 0.1319 - accuracy: 0.9735 - val\_loss: 0.6913 - val\_accuracy: 0.8318

Epoch 86/100

34/34 [==============================] - 49s 1s/step - loss: 0.1072 - accuracy: 0.9830 - val\_loss: 0.1981 - val\_accuracy: 0.9288

Epoch 87/100

34/34 [==============================] - 49s 1s/step - loss: 0.0963 - accuracy: 0.9844 - val\_loss: 0.2351 - val\_accuracy: 0.9187

Epoch 88/100

34/34 [==============================] - 49s 1s/step - loss: 0.0931 - accuracy: 0.9811 - val\_loss: 0.2848 - val\_accuracy: 0.9099

Epoch 89/100

34/34 [==============================] - 49s 1s/step - loss: 0.0941 - accuracy: 0.9801 - val\_loss: 0.3988 - val\_accuracy: 0.8874

Epoch 90/100

34/34 [==============================] - 48s 1s/step - loss: 0.1134 - accuracy: 0.9778 - val\_loss: 0.2767 - val\_accuracy: 0.9099

Epoch 91/100

34/34 [==============================] - 49s 1s/step - loss: 0.1075 - accuracy: 0.9830 - val\_loss: 0.6313 - val\_accuracy: 0.8511

Epoch 92/100

34/34 [==============================] - 50s 1s/step - loss: 0.0872 - accuracy: 0.9835 - val\_loss: 0.3797 - val\_accuracy: 0.8998

Epoch 93/100

34/34 [==============================] - 49s 1s/step - loss: 0.0928 - accuracy: 0.9844 - val\_loss: 0.3049 - val\_accuracy: 0.9104

Epoch 94/100

34/34 [==============================] - 49s 1s/step - loss: 0.0871 - accuracy: 0.9787 - val\_loss: 0.2869 - val\_accuracy: 0.9141

Epoch 95/100

34/34 [==============================] - 49s 1s/step - loss: 0.0864 - accuracy: 0.9858 - val\_loss: 0.2110 - val\_accuracy: 0.9297

Epoch 96/100

34/34 [==============================] - 50s 1s/step - loss: 0.0866 - accuracy: 0.9820 - val\_loss: 0.3707 - val\_accuracy: 0.8934

Epoch 97/100

34/34 [==============================] - 49s 1s/step - loss: 0.0928 - accuracy: 0.9825 - val\_loss: 0.3005 - val\_accuracy: 0.9067

Epoch 98/100

34/34 [==============================] - 54s 2s/step - loss: 0.1032 - accuracy: 0.9816 - val\_loss: 0.4900 - val\_accuracy: 0.8644

Epoch 99/100

34/34 [==============================] - 49s 1s/step - loss: 0.0904 - accuracy: 0.9835 - val\_loss: 0.7952 - val\_accuracy: 0.8139

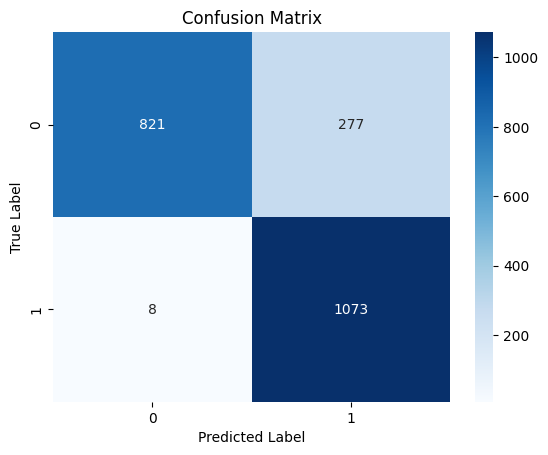
Epoch 100/100

34/34 [==============================] - 50s 1s/step - loss: 0.1285 - accuracy: 0.9721 - val\_loss: 0.4346 - val\_accuracy: 0.8690

35/35 [==============================] - 16s 441ms/step - loss: 0.4340 - accuracy: 0.8692

Validation accuracy: 0.8692060708999634

35/35 [==============================] - 15s 411ms/step

****

Classification Report:

precision recall f1-score support

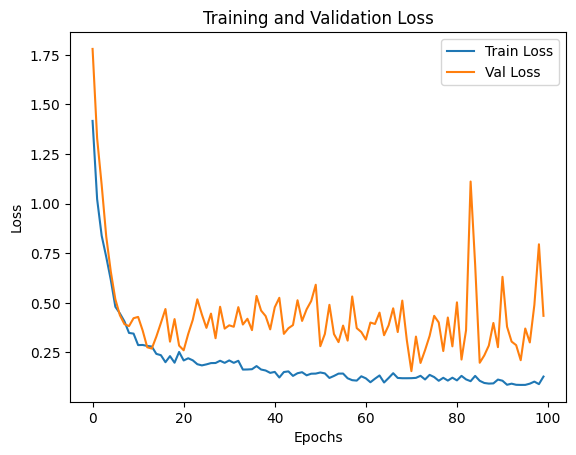
0 0.99 0.75 0.85 1098

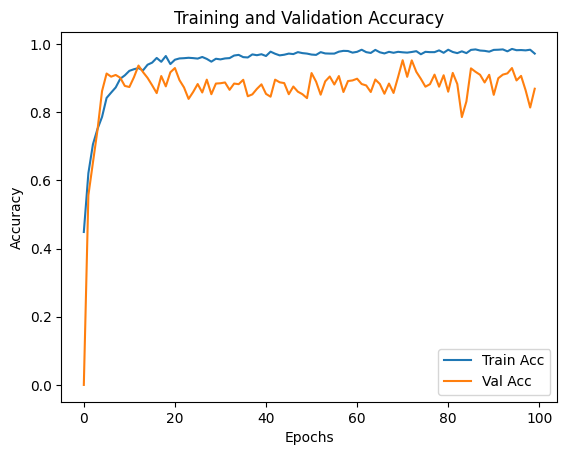
1 0.79 0.99 0.88 1081

accuracy 0.87 2179

macro avg 0.89 0.87 0.87 2179

weighted avg 0.89 0.87 0.87 2179

****

****

Overall Accuracy: 0.8692060578246902

Class: 0

Sensitivity: 0.7477231329690346

Specificity: 0.9925994449583718

Recall: 0.7477231329690346

Precision: 0.9903498190591074

F1-score: 0.8521017125064867

Class: 1

Sensitivity: 0.9925994449583718

Specificity: 0.7477231329690346

Recall: 0.9925994449583718

Precision: 0.7948148148148149

F1-score: 0.8827642945290005

**A picture containing text, screenshot, display, line

Description automatically generated**

**Normal\_\_Vs\_Glaucoma**

Model: "sequential\_2"

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Layer (type) Output Shape Param #

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

densenet121 (Functional) (None, 1000) 8062504

flatten\_4 (Flatten) (None, 1000) 0

dropout\_6 (Dropout) (None, 1000) 0

batch\_normalization\_6 (Batc (None, 1000) 4000

hNormalization)

dense\_8 (Dense) (None, 4) 4004

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

Total params: 8,070,508

Trainable params: 6,004

Non-trainable params: 8,064,504

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Epoch 1/100

/usr/local/lib/python3.10/dist-packages/keras/backend.py:5612: UserWarning: "`sparse\_categorical\_crossentropy` received `from\_logits=True`, but the `output` argument was produced by a Softmax activation and thus does not represent logits. Was this intended?

output, from\_logits = \_get\_logits(

24/24 [==============================] - 27s 796ms/step - loss: 1.1059 - accuracy: 0.5514 - val\_loss: 0.8396 - val\_accuracy: 0.6172

Epoch 2/100

24/24 [==============================] - 19s 723ms/step - loss: 0.6900 - accuracy: 0.7142 - val\_loss: 0.6961 - val\_accuracy: 0.5443

Epoch 3/100

24/24 [==============================] - 19s 725ms/step - loss: 0.6128 - accuracy: 0.7227 - val\_loss: 0.6706 - val\_accuracy: 0.6250

Epoch 4/100

24/24 [==============================] - 19s 710ms/step - loss: 0.5871 - accuracy: 0.7292 - val\_loss: 0.6677 - val\_accuracy: 0.7214

Epoch 5/100

24/24 [==============================] - 19s 729ms/step - loss: 0.5671 - accuracy: 0.7448 - val\_loss: 0.6562 - val\_accuracy: 0.7266

Epoch 6/100

24/24 [==============================] - 19s 719ms/step - loss: 0.5558 - accuracy: 0.7513 - val\_loss: 0.6428 - val\_accuracy: 0.7630

Epoch 7/100

24/24 [==============================] - 19s 730ms/step - loss: 0.5356 - accuracy: 0.7546 - val\_loss: 0.6341 - val\_accuracy: 0.7161

Epoch 8/100

24/24 [==============================] - 19s 722ms/step - loss: 0.5287 - accuracy: 0.7604 - val\_loss: 0.6267 - val\_accuracy: 0.7604

Epoch 9/100

24/24 [==============================] - 19s 733ms/step - loss: 0.5179 - accuracy: 0.7669 - val\_loss: 0.6183 - val\_accuracy: 0.7396

Epoch 10/100

24/24 [==============================] - 19s 718ms/step - loss: 0.5233 - accuracy: 0.7611 - val\_loss: 0.6117 - val\_accuracy: 0.7500

Epoch 11/100

24/24 [==============================] - 20s 734ms/step - loss: 0.5189 - accuracy: 0.7624 - val\_loss: 0.6062 - val\_accuracy: 0.7604

Epoch 12/100

24/24 [==============================] - 19s 721ms/step - loss: 0.5025 - accuracy: 0.7767 - val\_loss: 0.5978 - val\_accuracy: 0.7578

Epoch 13/100

24/24 [==============================] - 19s 727ms/step - loss: 0.4969 - accuracy: 0.7715 - val\_loss: 0.5805 - val\_accuracy: 0.7370

Epoch 14/100

24/24 [==============================] - 19s 721ms/step - loss: 0.4956 - accuracy: 0.7773 - val\_loss: 0.5814 - val\_accuracy: 0.7578

Epoch 15/100

24/24 [==============================] - 19s 718ms/step - loss: 0.4993 - accuracy: 0.7611 - val\_loss: 0.5514 - val\_accuracy: 0.8177

Epoch 16/100

24/24 [==============================] - 19s 717ms/step - loss: 0.5013 - accuracy: 0.7617 - val\_loss: 0.5411 - val\_accuracy: 0.7734

Epoch 17/100

24/24 [==============================] - 20s 724ms/step - loss: 0.4947 - accuracy: 0.7728 - val\_loss: 0.5491 - val\_accuracy: 0.7630

Epoch 18/100

24/24 [==============================] - 19s 715ms/step - loss: 0.5090 - accuracy: 0.7520 - val\_loss: 0.5516 - val\_accuracy: 0.7604

Epoch 19/100

24/24 [==============================] - 19s 720ms/step - loss: 0.4824 - accuracy: 0.7826 - val\_loss: 0.5299 - val\_accuracy: 0.7786

Epoch 20/100

24/24 [==============================] - 19s 715ms/step - loss: 0.4892 - accuracy: 0.7741 - val\_loss: 0.5318 - val\_accuracy: 0.7865

Epoch 21/100

24/24 [==============================] - 19s 726ms/step - loss: 0.4843 - accuracy: 0.7812 - val\_loss: 0.5232 - val\_accuracy: 0.7891

Epoch 22/100

24/24 [==============================] - 20s 732ms/step - loss: 0.4784 - accuracy: 0.7760 - val\_loss: 0.4891 - val\_accuracy: 0.8151

Epoch 23/100

24/24 [==============================] - 19s 715ms/step - loss: 0.4801 - accuracy: 0.7832 - val\_loss: 0.4925 - val\_accuracy: 0.8151

Epoch 24/100

24/24 [==============================] - 20s 742ms/step - loss: 0.4870 - accuracy: 0.7767 - val\_loss: 0.4856 - val\_accuracy: 0.7917

Epoch 25/100

24/24 [==============================] - 19s 712ms/step - loss: 0.4795 - accuracy: 0.7741 - val\_loss: 0.4651 - val\_accuracy: 0.8073

Epoch 26/100

24/24 [==============================] - 19s 734ms/step - loss: 0.4730 - accuracy: 0.7760 - val\_loss: 0.4738 - val\_accuracy: 0.7969

Epoch 27/100

24/24 [==============================] - 19s 726ms/step - loss: 0.4864 - accuracy: 0.7702 - val\_loss: 0.4619 - val\_accuracy: 0.8229

Epoch 28/100

24/24 [==============================] - 20s 737ms/step - loss: 0.4746 - accuracy: 0.7832 - val\_loss: 0.4563 - val\_accuracy: 0.8047

Epoch 29/100

24/24 [==============================] - 19s 719ms/step - loss: 0.4656 - accuracy: 0.7793 - val\_loss: 0.4497 - val\_accuracy: 0.8151

Epoch 30/100

24/24 [==============================] - 20s 736ms/step - loss: 0.4602 - accuracy: 0.7806 - val\_loss: 0.4393 - val\_accuracy: 0.8281

Epoch 31/100

24/24 [==============================] - 19s 716ms/step - loss: 0.4712 - accuracy: 0.7858 - val\_loss: 0.4306 - val\_accuracy: 0.8073

Epoch 32/100

24/24 [==============================] - 19s 718ms/step - loss: 0.4647 - accuracy: 0.7832 - val\_loss: 0.4099 - val\_accuracy: 0.8281

Epoch 33/100

24/24 [==============================] - 20s 735ms/step - loss: 0.4513 - accuracy: 0.7969 - val\_loss: 0.4205 - val\_accuracy: 0.8203

Epoch 34/100

24/24 [==============================] - 20s 728ms/step - loss: 0.4616 - accuracy: 0.7852 - val\_loss: 0.4257 - val\_accuracy: 0.8177

Epoch 35/100

24/24 [==============================] - 19s 732ms/step - loss: 0.4637 - accuracy: 0.7832 - val\_loss: 0.4414 - val\_accuracy: 0.8203

Epoch 36/100

24/24 [==============================] - 19s 725ms/step - loss: 0.4622 - accuracy: 0.7923 - val\_loss: 0.3939 - val\_accuracy: 0.8255

Epoch 37/100

24/24 [==============================] - 19s 714ms/step - loss: 0.4640 - accuracy: 0.7891 - val\_loss: 0.4014 - val\_accuracy: 0.8490

Epoch 38/100

24/24 [==============================] - 19s 719ms/step - loss: 0.4575 - accuracy: 0.7897 - val\_loss: 0.3975 - val\_accuracy: 0.8177

Epoch 39/100

24/24 [==============================] - 19s 728ms/step - loss: 0.4591 - accuracy: 0.7943 - val\_loss: 0.4072 - val\_accuracy: 0.8333

Epoch 40/100

24/24 [==============================] - 19s 725ms/step - loss: 0.4497 - accuracy: 0.8001 - val\_loss: 0.3775 - val\_accuracy: 0.8385

Epoch 41/100

24/24 [==============================] - 19s 735ms/step - loss: 0.4852 - accuracy: 0.7728 - val\_loss: 0.4133 - val\_accuracy: 0.8385

Epoch 42/100

24/24 [==============================] - 19s 713ms/step - loss: 0.4630 - accuracy: 0.7936 - val\_loss: 0.4170 - val\_accuracy: 0.8073

Epoch 43/100

24/24 [==============================] - 19s 732ms/step - loss: 0.4786 - accuracy: 0.7734 - val\_loss: 0.4435 - val\_accuracy: 0.7891

Epoch 44/100

24/24 [==============================] - 20s 742ms/step - loss: 0.4635 - accuracy: 0.7878 - val\_loss: 0.4139 - val\_accuracy: 0.8281

Epoch 45/100

24/24 [==============================] - 19s 721ms/step - loss: 0.4524 - accuracy: 0.7936 - val\_loss: 0.4098 - val\_accuracy: 0.8177

Epoch 46/100

24/24 [==============================] - 19s 717ms/step - loss: 0.4445 - accuracy: 0.7982 - val\_loss: 0.3733 - val\_accuracy: 0.8672

Epoch 47/100

24/24 [==============================] - 19s 717ms/step - loss: 0.4537 - accuracy: 0.7949 - val\_loss: 0.4157 - val\_accuracy: 0.8073

Epoch 48/100

24/24 [==============================] - 19s 721ms/step - loss: 0.4473 - accuracy: 0.7962 - val\_loss: 0.3767 - val\_accuracy: 0.8464

Epoch 49/100

24/24 [==============================] - 20s 725ms/step - loss: 0.4607 - accuracy: 0.7904 - val\_loss: 0.4026 - val\_accuracy: 0.8151

Epoch 50/100

24/24 [==============================] - 19s 722ms/step - loss: 0.4608 - accuracy: 0.7962 - val\_loss: 0.3950 - val\_accuracy: 0.8281

Epoch 51/100

24/24 [==============================] - 19s 718ms/step - loss: 0.4572 - accuracy: 0.7826 - val\_loss: 0.4152 - val\_accuracy: 0.8099

Epoch 52/100

24/24 [==============================] - 19s 733ms/step - loss: 0.4714 - accuracy: 0.7676 - val\_loss: 0.3960 - val\_accuracy: 0.8542

Epoch 53/100

24/24 [==============================] - 19s 720ms/step - loss: 0.4321 - accuracy: 0.8079 - val\_loss: 0.4313 - val\_accuracy: 0.8047

Epoch 54/100

24/24 [==============================] - 19s 736ms/step - loss: 0.4469 - accuracy: 0.8047 - val\_loss: 0.4033 - val\_accuracy: 0.8203

Epoch 55/100

24/24 [==============================] - 20s 737ms/step - loss: 0.4550 - accuracy: 0.7897 - val\_loss: 0.3899 - val\_accuracy: 0.8255

Epoch 56/100

24/24 [==============================] - 19s 733ms/step - loss: 0.4574 - accuracy: 0.7956 - val\_loss: 0.3927 - val\_accuracy: 0.8229

Epoch 57/100

24/24 [==============================] - 19s 722ms/step - loss: 0.4512 - accuracy: 0.7943 - val\_loss: 0.4055 - val\_accuracy: 0.8151

Epoch 58/100

24/24 [==============================] - 19s 734ms/step - loss: 0.4501 - accuracy: 0.7936 - val\_loss: 0.4039 - val\_accuracy: 0.8177

Epoch 59/100

24/24 [==============================] - 19s 716ms/step - loss: 0.4342 - accuracy: 0.8066 - val\_loss: 0.3943 - val\_accuracy: 0.8255

Epoch 60/100

24/24 [==============================] - 19s 731ms/step - loss: 0.4413 - accuracy: 0.8099 - val\_loss: 0.3934 - val\_accuracy: 0.8281

Epoch 61/100

24/24 [==============================] - 19s 712ms/step - loss: 0.4475 - accuracy: 0.7891 - val\_loss: 0.3921 - val\_accuracy: 0.8099

Epoch 62/100

24/24 [==============================] - 20s 729ms/step - loss: 0.4770 - accuracy: 0.7780 - val\_loss: 0.3841 - val\_accuracy: 0.8490

Epoch 63/100

24/24 [==============================] - 19s 722ms/step - loss: 0.4486 - accuracy: 0.7793 - val\_loss: 0.3994 - val\_accuracy: 0.8281

Epoch 64/100

24/24 [==============================] - 19s 718ms/step - loss: 0.4464 - accuracy: 0.7956 - val\_loss: 0.4051 - val\_accuracy: 0.8125

Epoch 65/100

24/24 [==============================] - 19s 719ms/step - loss: 0.4373 - accuracy: 0.8040 - val\_loss: 0.3853 - val\_accuracy: 0.8281

Epoch 66/100

24/24 [==============================] - 20s 747ms/step - loss: 0.4376 - accuracy: 0.7923 - val\_loss: 0.4077 - val\_accuracy: 0.7995

Epoch 67/100

24/24 [==============================] - 19s 714ms/step - loss: 0.4438 - accuracy: 0.7936 - val\_loss: 0.3951 - val\_accuracy: 0.8177

Epoch 68/100

24/24 [==============================] - 19s 721ms/step - loss: 0.4364 - accuracy: 0.7988 - val\_loss: 0.4024 - val\_accuracy: 0.8177

Epoch 69/100

24/24 [==============================] - 19s 726ms/step - loss: 0.4420 - accuracy: 0.7910 - val\_loss: 0.3858 - val\_accuracy: 0.8255

Epoch 70/100

24/24 [==============================] - 19s 725ms/step - loss: 0.4536 - accuracy: 0.7995 - val\_loss: 0.3625 - val\_accuracy: 0.8438

Epoch 71/100

24/24 [==============================] - 19s 733ms/step - loss: 0.4338 - accuracy: 0.7995 - val\_loss: 0.3922 - val\_accuracy: 0.8281

Epoch 72/100

24/24 [==============================] - 19s 719ms/step - loss: 0.4437 - accuracy: 0.7845 - val\_loss: 0.3968 - val\_accuracy: 0.8125

Epoch 73/100

24/24 [==============================] - 20s 737ms/step - loss: 0.4535 - accuracy: 0.7910 - val\_loss: 0.3914 - val\_accuracy: 0.8307

Epoch 74/100

24/24 [==============================] - 19s 715ms/step - loss: 0.4335 - accuracy: 0.8027 - val\_loss: 0.3943 - val\_accuracy: 0.8177

Epoch 75/100

24/24 [==============================] - 19s 727ms/step - loss: 0.4451 - accuracy: 0.7884 - val\_loss: 0.4071 - val\_accuracy: 0.8151

Epoch 76/100

24/24 [==============================] - 19s 713ms/step - loss: 0.4236 - accuracy: 0.8099 - val\_loss: 0.3829 - val\_accuracy: 0.8307

Epoch 77/100

24/24 [==============================] - 20s 751ms/step - loss: 0.4345 - accuracy: 0.8014 - val\_loss: 0.4105 - val\_accuracy: 0.8151

Epoch 78/100

24/24 [==============================] - 19s 722ms/step - loss: 0.4410 - accuracy: 0.7975 - val\_loss: 0.3931 - val\_accuracy: 0.8281

Epoch 79/100

24/24 [==============================] - 20s 734ms/step - loss: 0.4420 - accuracy: 0.7962 - val\_loss: 0.3931 - val\_accuracy: 0.8359

Epoch 80/100

24/24 [==============================] - 19s 714ms/step - loss: 0.4335 - accuracy: 0.8014 - val\_loss: 0.3890 - val\_accuracy: 0.8438

Epoch 81/100

24/24 [==============================] - 20s 725ms/step - loss: 0.4396 - accuracy: 0.8014 - val\_loss: 0.3977 - val\_accuracy: 0.8229

Epoch 82/100

24/24 [==============================] - 20s 733ms/step - loss: 0.4385 - accuracy: 0.7982 - val\_loss: 0.4058 - val\_accuracy: 0.8255

Epoch 83/100

24/24 [==============================] - 19s 713ms/step - loss: 0.4338 - accuracy: 0.8112 - val\_loss: 0.4162 - val\_accuracy: 0.8125

Epoch 84/100

24/24 [==============================] - 19s 713ms/step - loss: 0.4514 - accuracy: 0.7969 - val\_loss: 0.4109 - val\_accuracy: 0.8359

Epoch 85/100

24/24 [==============================] - 19s 721ms/step - loss: 0.4517 - accuracy: 0.7962 - val\_loss: 0.3839 - val\_accuracy: 0.8255

Epoch 86/100

24/24 [==============================] - 19s 719ms/step - loss: 0.4242 - accuracy: 0.8079 - val\_loss: 0.3706 - val\_accuracy: 0.8333

Epoch 87/100

24/24 [==============================] - 19s 720ms/step - loss: 0.4397 - accuracy: 0.7975 - val\_loss: 0.3860 - val\_accuracy: 0.8281

Epoch 88/100

24/24 [==============================] - 19s 726ms/step - loss: 0.4278 - accuracy: 0.8040 - val\_loss: 0.3918 - val\_accuracy: 0.8438

Epoch 89/100

24/24 [==============================] - 19s 722ms/step - loss: 0.4567 - accuracy: 0.7871 - val\_loss: 0.3830 - val\_accuracy: 0.8229

Epoch 90/100

24/24 [==============================] - 20s 737ms/step - loss: 0.4378 - accuracy: 0.8001 - val\_loss: 0.4011 - val\_accuracy: 0.8125

Epoch 91/100

24/24 [==============================] - 19s 705ms/step - loss: 0.4495 - accuracy: 0.7891 - val\_loss: 0.3962 - val\_accuracy: 0.8047

Epoch 92/100

24/24 [==============================] - 19s 729ms/step - loss: 0.4368 - accuracy: 0.8014 - val\_loss: 0.3927 - val\_accuracy: 0.8073

Epoch 93/100

24/24 [==============================] - 19s 722ms/step - loss: 0.4399 - accuracy: 0.7975 - val\_loss: 0.3793 - val\_accuracy: 0.8359

Epoch 94/100

24/24 [==============================] - 19s 734ms/step - loss: 0.4423 - accuracy: 0.7923 - val\_loss: 0.3827 - val\_accuracy: 0.8307

Epoch 95/100

24/24 [==============================] - 19s 716ms/step - loss: 0.4269 - accuracy: 0.8118 - val\_loss: 0.4074 - val\_accuracy: 0.8099

Epoch 96/100

24/24 [==============================] - 20s 730ms/step - loss: 0.4330 - accuracy: 0.8066 - val\_loss: 0.3710 - val\_accuracy: 0.8229

Epoch 97/100

24/24 [==============================] - 19s 714ms/step - loss: 0.4379 - accuracy: 0.7995 - val\_loss: 0.3684 - val\_accuracy: 0.8359

Epoch 98/100

24/24 [==============================] - 20s 730ms/step - loss: 0.4309 - accuracy: 0.8014 - val\_loss: 0.4022 - val\_accuracy: 0.8255

Epoch 99/100

24/24 [==============================] - 19s 716ms/step - loss: 0.4294 - accuracy: 0.8092 - val\_loss: 0.4152 - val\_accuracy: 0.7917

Epoch 100/100

24/24 [==============================] - 20s 734ms/step - loss: 0.4451 - accuracy: 0.8040 - val\_loss: 0.3906 - val\_accuracy: 0.8385

**A graph of loss and accuracy

Description automatically generated with low confidence**

**A picture containing text, diagram, screenshot, line

Description automatically generated**

**Resnet50**

Model: "sequential\_3"

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Layer (type) Output Shape Param #

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

resnet50 (Functional) (None, 1000) 25636712

flatten\_5 (Flatten) (None, 1000) 0

dropout\_7 (Dropout) (None, 1000) 0

batch\_normalization\_7 (Batc (None, 1000) 4000

hNormalization)

dense\_9 (Dense) (None, 4) 4004

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

Total params: 25,644,716

Trainable params: 6,004

Non-trainable params: 25,638,712

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Epoch 1/100

/usr/local/lib/python3.10/dist-packages/keras/backend.py:5612: UserWarning: "`sparse\_categorical\_crossentropy` received `from\_logits=True`, but the `output` argument was produced by a Softmax activation and thus does not represent logits. Was this intended?

output, from\_logits = \_get\_logits(

24/24 [==============================] - 23s 757ms/step - loss: 1.1312 - accuracy: 0.4818 - val\_loss: 0.8489 - val\_accuracy: 0.5234

Epoch 2/100

24/24 [==============================] - 20s 732ms/step - loss: 0.7553 - accuracy: 0.4993 - val\_loss: 0.7093 - val\_accuracy: 0.5182

Epoch 3/100

24/24 [==============================] - 20s 758ms/step - loss: 0.7056 - accuracy: 0.4987 - val\_loss: 0.6993 - val\_accuracy: 0.5130

Epoch 4/100

24/24 [==============================] - 19s 729ms/step - loss: 0.7015 - accuracy: 0.4974 - val\_loss: 0.6978 - val\_accuracy: 0.4818

Epoch 5/100

24/24 [==============================] - 20s 735ms/step - loss: 0.6955 - accuracy: 0.5241 - val\_loss: 0.6950 - val\_accuracy: 0.5260

Epoch 6/100

24/24 [==============================] - 19s 721ms/step - loss: 0.6971 - accuracy: 0.5111 - val\_loss: 0.7004 - val\_accuracy: 0.4948

Epoch 7/100

24/24 [==============================] - 20s 726ms/step - loss: 0.6955 - accuracy: 0.5124 - val\_loss: 0.6906 - val\_accuracy: 0.5469

Epoch 8/100

24/24 [==============================] - 19s 724ms/step - loss: 0.6936 - accuracy: 0.5326 - val\_loss: 0.6935 - val\_accuracy: 0.5260

Epoch 9/100

24/24 [==============================] - 19s 716ms/step - loss: 0.6924 - accuracy: 0.5436 - val\_loss: 0.6955 - val\_accuracy: 0.4635

Epoch 10/100

24/24 [==============================] - 19s 718ms/step - loss: 0.6970 - accuracy: 0.4844 - val\_loss: 0.6933 - val\_accuracy: 0.5312

Epoch 11/100

24/24 [==============================] - 19s 728ms/step - loss: 0.6929 - accuracy: 0.5312 - val\_loss: 0.6948 - val\_accuracy: 0.4922

Epoch 12/100

24/24 [==============================] - 19s 734ms/step - loss: 0.6962 - accuracy: 0.5143 - val\_loss: 0.6947 - val\_accuracy: 0.4661

Epoch 13/100

24/24 [==============================] - 19s 720ms/step - loss: 0.6928 - accuracy: 0.5182 - val\_loss: 0.6977 - val\_accuracy: 0.5156

Epoch 14/100

24/24 [==============================] - 20s 767ms/step - loss: 0.6927 - accuracy: 0.5404 - val\_loss: 0.6964 - val\_accuracy: 0.5052

Epoch 15/100

24/24 [==============================] - 19s 723ms/step - loss: 0.6960 - accuracy: 0.5156 - val\_loss: 0.6987 - val\_accuracy: 0.4792

Epoch 16/100

24/24 [==============================] - 20s 735ms/step - loss: 0.6953 - accuracy: 0.5130 - val\_loss: 0.6925 - val\_accuracy: 0.5130

Epoch 17/100

24/24 [==============================] - 19s 729ms/step - loss: 0.6957 - accuracy: 0.5085 - val\_loss: 0.6936 - val\_accuracy: 0.5026

Epoch 18/100

24/24 [==============================] - 20s 732ms/step - loss: 0.6941 - accuracy: 0.5072 - val\_loss: 0.6969 - val\_accuracy: 0.4818

Epoch 19/100

24/24 [==============================] - 19s 719ms/step - loss: 0.6907 - accuracy: 0.5404 - val\_loss: 0.6864 - val\_accuracy: 0.5573

Epoch 20/100

24/24 [==============================] - 20s 726ms/step - loss: 0.6960 - accuracy: 0.5046 - val\_loss: 0.6926 - val\_accuracy: 0.5130

Epoch 21/100

24/24 [==============================] - 19s 722ms/step - loss: 0.6919 - accuracy: 0.5163 - val\_loss: 0.6977 - val\_accuracy: 0.4922

Epoch 22/100

24/24 [==============================] - 19s 718ms/step - loss: 0.6921 - accuracy: 0.5221 - val\_loss: 0.6919 - val\_accuracy: 0.5104

Epoch 23/100

24/24 [==============================] - 19s 729ms/step - loss: 0.6917 - accuracy: 0.5156 - val\_loss: 0.6909 - val\_accuracy: 0.5521

Epoch 24/100

24/24 [==============================] - 20s 723ms/step - loss: 0.6887 - accuracy: 0.5365 - val\_loss: 0.6911 - val\_accuracy: 0.5156

Epoch 25/100

24/24 [==============================] - 19s 730ms/step - loss: 0.6943 - accuracy: 0.5228 - val\_loss: 0.6922 - val\_accuracy: 0.5104

Epoch 26/100

24/24 [==============================] - 20s 733ms/step - loss: 0.6927 - accuracy: 0.5195 - val\_loss: 0.6867 - val\_accuracy: 0.5469

Epoch 27/100

24/24 [==============================] - 19s 733ms/step - loss: 0.6945 - accuracy: 0.5169 - val\_loss: 0.6956 - val\_accuracy: 0.5339

Epoch 28/100

24/24 [==============================] - 19s 724ms/step - loss: 0.7005 - accuracy: 0.4922 - val\_loss: 0.6918 - val\_accuracy: 0.4922

Epoch 29/100

24/24 [==============================] - 20s 744ms/step - loss: 0.6916 - accuracy: 0.5306 - val\_loss: 0.6898 - val\_accuracy: 0.5130

Epoch 30/100

24/24 [==============================] - 19s 723ms/step - loss: 0.6941 - accuracy: 0.5228 - val\_loss: 0.6883 - val\_accuracy: 0.7031

Epoch 31/100

24/24 [==============================] - 20s 743ms/step - loss: 0.6892 - accuracy: 0.5312 - val\_loss: 0.6900 - val\_accuracy: 0.5052

Epoch 32/100

24/24 [==============================] - 19s 736ms/step - loss: 0.6894 - accuracy: 0.5378 - val\_loss: 0.6900 - val\_accuracy: 0.5104

Epoch 33/100

24/24 [==============================] - 20s 727ms/step - loss: 0.6892 - accuracy: 0.5326 - val\_loss: 0.6915 - val\_accuracy: 0.4766

Epoch 34/100

24/24 [==============================] - 19s 718ms/step - loss: 0.6916 - accuracy: 0.5267 - val\_loss: 0.6860 - val\_accuracy: 0.5312

Epoch 35/100

24/24 [==============================] - 20s 730ms/step - loss: 0.6895 - accuracy: 0.5352 - val\_loss: 0.6874 - val\_accuracy: 0.5078

Epoch 36/100

24/24 [==============================] - 19s 718ms/step - loss: 0.6934 - accuracy: 0.5052 - val\_loss: 0.6865 - val\_accuracy: 0.5208

Epoch 37/100

24/24 [==============================] - 20s 737ms/step - loss: 0.6939 - accuracy: 0.5208 - val\_loss: 0.6881 - val\_accuracy: 0.6016

Epoch 38/100

24/24 [==============================] - 19s 732ms/step - loss: 0.6894 - accuracy: 0.5306 - val\_loss: 0.6892 - val\_accuracy: 0.4974

Epoch 39/100

24/24 [==============================] - 19s 721ms/step - loss: 0.6911 - accuracy: 0.5273 - val\_loss: 0.6852 - val\_accuracy: 0.6198

Epoch 40/100

24/24 [==============================] - 19s 720ms/step - loss: 0.6954 - accuracy: 0.5026 - val\_loss: 0.6861 - val\_accuracy: 0.5911

Epoch 41/100

24/24 [==============================] - 19s 725ms/step - loss: 0.6916 - accuracy: 0.5247 - val\_loss: 0.6875 - val\_accuracy: 0.5078

Epoch 42/100

24/24 [==============================] - 20s 736ms/step - loss: 0.6879 - accuracy: 0.5397 - val\_loss: 0.6949 - val\_accuracy: 0.4844

Epoch 43/100

24/24 [==============================] - 19s 726ms/step - loss: 0.6915 - accuracy: 0.5247 - val\_loss: 0.6880 - val\_accuracy: 0.5104

Epoch 44/100

24/24 [==============================] - 20s 747ms/step - loss: 0.6898 - accuracy: 0.5241 - val\_loss: 0.6845 - val\_accuracy: 0.6693

Epoch 45/100

24/24 [==============================] - 19s 723ms/step - loss: 0.6918 - accuracy: 0.5234 - val\_loss: 0.6866 - val\_accuracy: 0.5208

Epoch 46/100

24/24 [==============================] - 20s 742ms/step - loss: 0.6916 - accuracy: 0.5156 - val\_loss: 0.6843 - val\_accuracy: 0.5391

Epoch 47/100

24/24 [==============================] - 20s 742ms/step - loss: 0.6912 - accuracy: 0.5312 - val\_loss: 0.6829 - val\_accuracy: 0.5599

Epoch 48/100

24/24 [==============================] - 21s 764ms/step - loss: 0.6888 - accuracy: 0.5534 - val\_loss: 0.6878 - val\_accuracy: 0.5156

Epoch 49/100

24/24 [==============================] - 20s 752ms/step - loss: 0.6976 - accuracy: 0.4954 - val\_loss: 0.6872 - val\_accuracy: 0.5130

Epoch 50/100

24/24 [==============================] - 20s 758ms/step - loss: 0.6903 - accuracy: 0.5332 - val\_loss: 0.6835 - val\_accuracy: 0.5833

Epoch 51/100

24/24 [==============================] - 20s 774ms/step - loss: 0.6883 - accuracy: 0.5410 - val\_loss: 0.6842 - val\_accuracy: 0.5833

Epoch 52/100

24/24 [==============================] - 20s 752ms/step - loss: 0.6904 - accuracy: 0.5299 - val\_loss: 0.6877 - val\_accuracy: 0.5104

Epoch 53/100

24/24 [==============================] - 21s 781ms/step - loss: 0.6911 - accuracy: 0.5117 - val\_loss: 0.6876 - val\_accuracy: 0.5000

Epoch 54/100

24/24 [==============================] - 20s 748ms/step - loss: 0.6914 - accuracy: 0.5273 - val\_loss: 0.6857 - val\_accuracy: 0.6823

Epoch 55/100

24/24 [==============================] - 20s 756ms/step - loss: 0.6927 - accuracy: 0.5098 - val\_loss: 0.6857 - val\_accuracy: 0.6667

Epoch 56/100

24/24 [==============================] - 20s 765ms/step - loss: 0.6860 - accuracy: 0.5443 - val\_loss: 0.6856 - val\_accuracy: 0.5104

Epoch 57/100

24/24 [==============================] - 21s 779ms/step - loss: 0.6881 - accuracy: 0.5553 - val\_loss: 0.6847 - val\_accuracy: 0.5938

Epoch 58/100

24/24 [==============================] - 20s 766ms/step - loss: 0.6919 - accuracy: 0.5326 - val\_loss: 0.6846 - val\_accuracy: 0.6328

Epoch 59/100

24/24 [==============================] - 20s 741ms/step - loss: 0.6873 - accuracy: 0.5508 - val\_loss: 0.6872 - val\_accuracy: 0.5573

Epoch 60/100

24/24 [==============================] - 20s 740ms/step - loss: 0.6885 - accuracy: 0.5436 - val\_loss: 0.6850 - val\_accuracy: 0.6068

Epoch 61/100

24/24 [==============================] - 19s 731ms/step - loss: 0.6875 - accuracy: 0.5404 - val\_loss: 0.6875 - val\_accuracy: 0.5052

Epoch 62/100

24/24 [==============================] - 20s 748ms/step - loss: 0.6887 - accuracy: 0.5404 - val\_loss: 0.6829 - val\_accuracy: 0.5521

Epoch 63/100

24/24 [==============================] - 20s 733ms/step - loss: 0.6891 - accuracy: 0.5456 - val\_loss: 0.6889 - val\_accuracy: 0.5104

Epoch 64/100

24/24 [==============================] - 20s 743ms/step - loss: 0.6880 - accuracy: 0.5449 - val\_loss: 0.6835 - val\_accuracy: 0.5547

Epoch 65/100

24/24 [==============================] - 20s 741ms/step - loss: 0.6891 - accuracy: 0.5319 - val\_loss: 0.6865 - val\_accuracy: 0.5885

Epoch 66/100

24/24 [==============================] - 20s 732ms/step - loss: 0.6893 - accuracy: 0.5397 - val\_loss: 0.6863 - val\_accuracy: 0.5365

Epoch 67/100

24/24 [==============================] - 19s 722ms/step - loss: 0.6918 - accuracy: 0.5143 - val\_loss: 0.6815 - val\_accuracy: 0.5964

Epoch 68/100

24/24 [==============================] - 20s 735ms/step - loss: 0.6849 - accuracy: 0.5651 - val\_loss: 0.6849 - val\_accuracy: 0.5729

Epoch 69/100

24/24 [==============================] - 20s 746ms/step - loss: 0.6887 - accuracy: 0.5326 - val\_loss: 0.6787 - val\_accuracy: 0.5625

Epoch 70/100

24/24 [==============================] - 20s 730ms/step - loss: 0.6897 - accuracy: 0.5241 - val\_loss: 0.6811 - val\_accuracy: 0.6146

Epoch 71/100

24/24 [==============================] - 20s 746ms/step - loss: 0.6896 - accuracy: 0.5423 - val\_loss: 0.6834 - val\_accuracy: 0.6536

Epoch 72/100

24/24 [==============================] - 19s 727ms/step - loss: 0.6932 - accuracy: 0.5339 - val\_loss: 0.6824 - val\_accuracy: 0.6068

Epoch 73/100

24/24 [==============================] - 20s 744ms/step - loss: 0.6863 - accuracy: 0.5540 - val\_loss: 0.6804 - val\_accuracy: 0.5469

Epoch 74/100

24/24 [==============================] - 19s 735ms/step - loss: 0.6909 - accuracy: 0.5417 - val\_loss: 0.6844 - val\_accuracy: 0.5625

Epoch 75/100

24/24 [==============================] - 20s 750ms/step - loss: 0.6901 - accuracy: 0.5378 - val\_loss: 0.6822 - val\_accuracy: 0.7292

Epoch 76/100

24/24 [==============================] - 19s 733ms/step - loss: 0.6859 - accuracy: 0.5527 - val\_loss: 0.6834 - val\_accuracy: 0.5859

Epoch 77/100

24/24 [==============================] - 20s 740ms/step - loss: 0.6877 - accuracy: 0.5417 - val\_loss: 0.6849 - val\_accuracy: 0.5182

Epoch 78/100

24/24 [==============================] - 19s 735ms/step - loss: 0.6880 - accuracy: 0.5228 - val\_loss: 0.6830 - val\_accuracy: 0.6328

Epoch 79/100

24/24 [==============================] - 20s 740ms/step - loss: 0.6871 - accuracy: 0.5371 - val\_loss: 0.6845 - val\_accuracy: 0.5208

Epoch 80/100

24/24 [==============================] - 20s 755ms/step - loss: 0.6909 - accuracy: 0.5260 - val\_loss: 0.6858 - val\_accuracy: 0.5521

Epoch 81/100

24/24 [==============================] - 19s 731ms/step - loss: 0.6911 - accuracy: 0.5410 - val\_loss: 0.6817 - val\_accuracy: 0.6458

Epoch 82/100

24/24 [==============================] - 20s 755ms/step - loss: 0.6852 - accuracy: 0.5573 - val\_loss: 0.6854 - val\_accuracy: 0.5156

Epoch 83/100

24/24 [==============================] - 20s 740ms/step - loss: 0.6875 - accuracy: 0.5469 - val\_loss: 0.6867 - val\_accuracy: 0.5104

Epoch 84/100

24/24 [==============================] - 20s 752ms/step - loss: 0.6915 - accuracy: 0.5384 - val\_loss: 0.6819 - val\_accuracy: 0.5286

Epoch 85/100

24/24 [==============================] - 20s 753ms/step - loss: 0.6851 - accuracy: 0.5378 - val\_loss: 0.6836 - val\_accuracy: 0.6328

Epoch 86/100

24/24 [==============================] - 20s 738ms/step - loss: 0.6870 - accuracy: 0.5358 - val\_loss: 0.6840 - val\_accuracy: 0.6510

Epoch 87/100

24/24 [==============================] - 20s 745ms/step - loss: 0.6895 - accuracy: 0.5488 - val\_loss: 0.6832 - val\_accuracy: 0.5677

Epoch 88/100

24/24 [==============================] - 20s 752ms/step - loss: 0.6870 - accuracy: 0.5417 - val\_loss: 0.6847 - val\_accuracy: 0.5651

Epoch 89/100

24/24 [==============================] - 20s 756ms/step - loss: 0.6869 - accuracy: 0.5469 - val\_loss: 0.6847 - val\_accuracy: 0.5052

Epoch 90/100

24/24 [==============================] - 20s 743ms/step - loss: 0.6904 - accuracy: 0.5319 - val\_loss: 0.6876 - val\_accuracy: 0.5078

Epoch 91/100

24/24 [==============================] - 20s 775ms/step - loss: 0.6908 - accuracy: 0.5306 - val\_loss: 0.6932 - val\_accuracy: 0.5156

Epoch 92/100

24/24 [==============================] - 19s 726ms/step - loss: 0.6915 - accuracy: 0.5273 - val\_loss: 0.6922 - val\_accuracy: 0.4922

Epoch 93/100

24/24 [==============================] - 20s 740ms/step - loss: 0.6908 - accuracy: 0.5319 - val\_loss: 0.6839 - val\_accuracy: 0.5807

Epoch 94/100

24/24 [==============================] - 20s 738ms/step - loss: 0.6874 - accuracy: 0.5456 - val\_loss: 0.6835 - val\_accuracy: 0.5859

Epoch 95/100

24/24 [==============================] - 20s 727ms/step - loss: 0.6871 - accuracy: 0.5378 - val\_loss: 0.6794 - val\_accuracy: 0.6120

Epoch 96/100

24/24 [==============================] - 19s 727ms/step - loss: 0.6858 - accuracy: 0.5540 - val\_loss: 0.6788 - val\_accuracy: 0.6120

Epoch 97/100

24/24 [==============================] - 20s 728ms/step - loss: 0.6855 - accuracy: 0.5547 - val\_loss: 0.6810 - val\_accuracy: 0.6432

Epoch 98/100

24/24 [==============================] - 19s 725ms/step - loss: 0.6843 - accuracy: 0.5534 - val\_loss: 0.6796 - val\_accuracy: 0.5469

Epoch 99/100

24/24 [==============================] - 20s 734ms/step - loss: 0.6874 - accuracy: 0.5553 - val\_loss: 0.6836 - val\_accuracy: 0.5234

Epoch 100/100

24/24 [==============================] - 20s 747ms/step - loss: 0.6893 - accuracy: 0.5410 - val\_loss: 0.6849 - val\_accuracy: 0.5104

**A graph of loss and accuracy

Description automatically generated with low confidence**

**A picture containing text, diagram, line, plot

Description automatically generated**

**FirstUpdate**

Found 2112 images belonging to 2 classes.

Found 2112 images belonging to 2 classes.

Downloading data from <https://storage.googleapis.com/tensorflow/keras-applications/vgg16/vgg16_weights_tf_dim_ordering_tf_kernels_notop.h5>

58889256/58889256 [==============================] - 0s 0us/step

Epoch 1/100

33/33 [==============================] - 316s 9s/step - loss: 1.3210 - accuracy: 0.4583 - val\_loss: 0.8450 - val\_accuracy: 0.9034

Epoch 2/100

33/33 [==============================] - 64s 2s/step - loss: 0.8000 - accuracy: 0.7088 - val\_loss: 0.6445 - val\_accuracy: 0.9067

Epoch 3/100

33/33 [==============================] - 63s 2s/step - loss: 0.6248 - accuracy: 0.7917 - val\_loss: 0.5218 - val\_accuracy: 0.9205

Epoch 4/100

33/33 [==============================] - 63s 2s/step - loss: 0.5182 - accuracy: 0.8442 - val\_loss: 0.4167 - val\_accuracy: 0.9223

Epoch 5/100

33/33 [==============================] - 66s 2s/step - loss: 0.4708 - accuracy: 0.8646 - val\_loss: 0.4311 - val\_accuracy: 0.9223

Epoch 6/100

33/33 [==============================] - 64s 2s/step - loss: 0.4346 - accuracy: 0.8840 - val\_loss: 0.3688 - val\_accuracy: 0.9304

Epoch 7/100

33/33 [==============================] - 65s 2s/step - loss: 0.4037 - accuracy: 0.8916 - val\_loss: 0.3512 - val\_accuracy: 0.9389

Epoch 8/100

33/33 [==============================] - 66s 2s/step - loss: 0.3788 - accuracy: 0.8977 - val\_loss: 0.2931 - val\_accuracy: 0.9441

Epoch 9/100

33/33 [==============================] - 66s 2s/step - loss: 0.3591 - accuracy: 0.9058 - val\_loss: 0.2968 - val\_accuracy: 0.9375

Epoch 10/100

33/33 [==============================] - 65s 2s/step - loss: 0.3355 - accuracy: 0.9195 - val\_loss: 0.2789 - val\_accuracy: 0.9484

Epoch 11/100

33/33 [==============================] - 65s 2s/step - loss: 0.3128 - accuracy: 0.9195 - val\_loss: 0.3107 - val\_accuracy: 0.9332

Epoch 12/100

33/33 [==============================] - 64s 2s/step - loss: 0.3044 - accuracy: 0.9261 - val\_loss: 0.2635 - val\_accuracy: 0.9446

Epoch 13/100

33/33 [==============================] - 64s 2s/step - loss: 0.3029 - accuracy: 0.9195 - val\_loss: 0.2325 - val\_accuracy: 0.9503

Epoch 14/100

33/33 [==============================] - 66s 2s/step - loss: 0.2815 - accuracy: 0.9276 - val\_loss: 0.2369 - val\_accuracy: 0.9474

Epoch 15/100

33/33 [==============================] - 64s 2s/step - loss: 0.2652 - accuracy: 0.9375 - val\_loss: 0.2284 - val\_accuracy: 0.9493

Epoch 16/100

33/33 [==============================] - 64s 2s/step - loss: 0.2506 - accuracy: 0.9384 - val\_loss: 0.2356 - val\_accuracy: 0.9479

Epoch 17/100

33/33 [==============================] - 66s 2s/step - loss: 0.2564 - accuracy: 0.9375 - val\_loss: 0.2201 - val\_accuracy: 0.9531

Epoch 18/100

33/33 [==============================] - 66s 2s/step - loss: 0.2407 - accuracy: 0.9384 - val\_loss: 0.2050 - val\_accuracy: 0.9555

Epoch 19/100

33/33 [==============================] - 64s 2s/step - loss: 0.2319 - accuracy: 0.9470 - val\_loss: 0.2190 - val\_accuracy: 0.9484

Epoch 20/100

33/33 [==============================] - 64s 2s/step - loss: 0.2430 - accuracy: 0.9347 - val\_loss: 0.2349 - val\_accuracy: 0.9328

Epoch 21/100

33/33 [==============================] - 63s 2s/step - loss: 0.2262 - accuracy: 0.9413 - val\_loss: 0.1595 - val\_accuracy: 0.9669

Epoch 22/100

33/33 [==============================] - 65s 2s/step - loss: 0.2021 - accuracy: 0.9517 - val\_loss: 0.1757 - val\_accuracy: 0.9598

Epoch 23/100

33/33 [==============================] - 65s 2s/step - loss: 0.1898 - accuracy: 0.9527 - val\_loss: 0.1546 - val\_accuracy: 0.9669

Epoch 24/100

33/33 [==============================] - 64s 2s/step - loss: 0.2038 - accuracy: 0.9470 - val\_loss: 0.1368 - val\_accuracy: 0.9697

Epoch 25/100

33/33 [==============================] - 64s 2s/step - loss: 0.2099 - accuracy: 0.9427 - val\_loss: 0.1560 - val\_accuracy: 0.9640

Epoch 26/100

33/33 [==============================] - 63s 2s/step - loss: 0.1798 - accuracy: 0.9602 - val\_loss: 0.1281 - val\_accuracy: 0.9721

Epoch 27/100

33/33 [==============================] - 64s 2s/step - loss: 0.1745 - accuracy: 0.9612 - val\_loss: 0.1440 - val\_accuracy: 0.9673

Epoch 28/100

33/33 [==============================] - 64s 2s/step - loss: 0.1784 - accuracy: 0.9607 - val\_loss: 0.1482 - val\_accuracy: 0.9574

Epoch 29/100

33/33 [==============================] - 64s 2s/step - loss: 0.1799 - accuracy: 0.9574 - val\_loss: 0.1757 - val\_accuracy: 0.9437

Epoch 30/100

33/33 [==============================] - 64s 2s/step - loss: 0.1777 - accuracy: 0.9569 - val\_loss: 0.1396 - val\_accuracy: 0.9635

Epoch 31/100

33/33 [==============================] - 64s 2s/step - loss: 0.1774 - accuracy: 0.9583 - val\_loss: 0.1639 - val\_accuracy: 0.9550

Epoch 32/100

33/33 [==============================] - 63s 2s/step - loss: 0.1625 - accuracy: 0.9635 - val\_loss: 0.1204 - val\_accuracy: 0.9711

Epoch 33/100

33/33 [==============================] - 64s 2s/step - loss: 0.1725 - accuracy: 0.9579 - val\_loss: 0.1201 - val\_accuracy: 0.9725

Epoch 34/100

33/33 [==============================] - 64s 2s/step - loss: 0.1539 - accuracy: 0.9669 - val\_loss: 0.1522 - val\_accuracy: 0.9508

Epoch 35/100

33/33 [==============================] - 65s 2s/step - loss: 0.1528 - accuracy: 0.9640 - val\_loss: 0.1150 - val\_accuracy: 0.9735

Epoch 36/100

33/33 [==============================] - 64s 2s/step - loss: 0.1483 - accuracy: 0.9659 - val\_loss: 0.1234 - val\_accuracy: 0.9725

Epoch 37/100

33/33 [==============================] - 64s 2s/step - loss: 0.1439 - accuracy: 0.9664 - val\_loss: 0.1779 - val\_accuracy: 0.9422

Epoch 38/100

33/33 [==============================] - 64s 2s/step - loss: 0.1467 - accuracy: 0.9640 - val\_loss: 0.0991 - val\_accuracy: 0.9763

Epoch 39/100

33/33 [==============================] - 64s 2s/step - loss: 0.1400 - accuracy: 0.9706 - val\_loss: 0.0966 - val\_accuracy: 0.9787

Epoch 40/100

33/33 [==============================] - 64s 2s/step - loss: 0.1367 - accuracy: 0.9692 - val\_loss: 0.1565 - val\_accuracy: 0.9408

Epoch 41/100

33/33 [==============================] - 64s 2s/step - loss: 0.1467 - accuracy: 0.9612 - val\_loss: 0.2053 - val\_accuracy: 0.9214

Epoch 42/100

33/33 [==============================] - 64s 2s/step - loss: 0.1289 - accuracy: 0.9683 - val\_loss: 0.0973 - val\_accuracy: 0.9768

Epoch 43/100

33/33 [==============================] - 64s 2s/step - loss: 0.1234 - accuracy: 0.9697 - val\_loss: 0.1637 - val\_accuracy: 0.9394

Epoch 44/100

33/33 [==============================] - 65s 2s/step - loss: 0.1322 - accuracy: 0.9706 - val\_loss: 0.1965 - val\_accuracy: 0.9318

Epoch 45/100

33/33 [==============================] - 65s 2s/step - loss: 0.1268 - accuracy: 0.9740 - val\_loss: 0.0902 - val\_accuracy: 0.9777

Epoch 46/100

33/33 [==============================] - 64s 2s/step - loss: 0.1264 - accuracy: 0.9702 - val\_loss: 0.0809 - val\_accuracy: 0.9811

Epoch 47/100

33/33 [==============================] - 66s 2s/step - loss: 0.1275 - accuracy: 0.9716 - val\_loss: 0.1305 - val\_accuracy: 0.9517

Epoch 48/100

33/33 [==============================] - 65s 2s/step - loss: 0.1171 - accuracy: 0.9768 - val\_loss: 0.2377 - val\_accuracy: 0.9176

Epoch 49/100

33/33 [==============================] - 67s 2s/step - loss: 0.1244 - accuracy: 0.9730 - val\_loss: 0.1782 - val\_accuracy: 0.9408

Epoch 50/100

33/33 [==============================] - 66s 2s/step - loss: 0.1033 - accuracy: 0.9759 - val\_loss: 0.1090 - val\_accuracy: 0.9678

Epoch 51/100

33/33 [==============================] - 65s 2s/step - loss: 0.0996 - accuracy: 0.9759 - val\_loss: 0.1586 - val\_accuracy: 0.9446

Epoch 52/100

33/33 [==============================] - 64s 2s/step - loss: 0.1037 - accuracy: 0.9773 - val\_loss: 0.1000 - val\_accuracy: 0.9702

Epoch 53/100

33/33 [==============================] - 66s 2s/step - loss: 0.1391 - accuracy: 0.9635 - val\_loss: 0.1067 - val\_accuracy: 0.9683

Epoch 54/100

33/33 [==============================] - 64s 2s/step - loss: 0.1035 - accuracy: 0.9773 - val\_loss: 0.0775 - val\_accuracy: 0.9825

Epoch 55/100

33/33 [==============================] - 65s 2s/step - loss: 0.1123 - accuracy: 0.9749 - val\_loss: 0.2143 - val\_accuracy: 0.9228

Epoch 56/100

33/33 [==============================] - 65s 2s/step - loss: 0.1011 - accuracy: 0.9782 - val\_loss: 0.1140 - val\_accuracy: 0.9645

Epoch 57/100

33/33 [==============================] - 65s 2s/step - loss: 0.0978 - accuracy: 0.9777 - val\_loss: 0.2004 - val\_accuracy: 0.9247

Epoch 58/100

33/33 [==============================] - 65s 2s/step - loss: 0.1129 - accuracy: 0.9716 - val\_loss: 0.1579 - val\_accuracy: 0.9422

Epoch 59/100

33/33 [==============================] - 65s 2s/step - loss: 0.1209 - accuracy: 0.9697 - val\_loss: 0.3165 - val\_accuracy: 0.8930

Epoch 60/100

33/33 [==============================] - 63s 2s/step - loss: 0.1120 - accuracy: 0.9744 - val\_loss: 0.1426 - val\_accuracy: 0.9484

Epoch 61/100

33/33 [==============================] - 65s 2s/step - loss: 0.1066 - accuracy: 0.9754 - val\_loss: 0.0656 - val\_accuracy: 0.9844

Epoch 62/100

33/33 [==============================] - 64s 2s/step - loss: 0.1196 - accuracy: 0.9683 - val\_loss: 0.1485 - val\_accuracy: 0.9446

Epoch 63/100

33/33 [==============================] - 64s 2s/step - loss: 0.0944 - accuracy: 0.9768 - val\_loss: 0.3232 - val\_accuracy: 0.8892

Epoch 64/100

33/33 [==============================] - 65s 2s/step - loss: 0.0932 - accuracy: 0.9782 - val\_loss: 0.0634 - val\_accuracy: 0.9839

Epoch 65/100

33/33 [==============================] - 66s 2s/step - loss: 0.0842 - accuracy: 0.9801 - val\_loss: 0.0938 - val\_accuracy: 0.9702

Epoch 66/100

33/33 [==============================] - 65s 2s/step - loss: 0.0863 - accuracy: 0.9787 - val\_loss: 0.2047 - val\_accuracy: 0.9313

Epoch 67/100

33/33 [==============================] - 63s 2s/step - loss: 0.0875 - accuracy: 0.9787 - val\_loss: 0.0797 - val\_accuracy: 0.9721

Epoch 68/100

33/33 [==============================] - 63s 2s/step - loss: 0.0919 - accuracy: 0.9792 - val\_loss: 0.1876 - val\_accuracy: 0.9280

Epoch 69/100

33/33 [==============================] - 64s 2s/step - loss: 0.0883 - accuracy: 0.9777 - val\_loss: 0.0932 - val\_accuracy: 0.9683

Epoch 70/100

33/33 [==============================] - 62s 2s/step - loss: 0.1012 - accuracy: 0.9754 - val\_loss: 0.0981 - val\_accuracy: 0.9669

Epoch 71/100

33/33 [==============================] - 63s 2s/step - loss: 0.0865 - accuracy: 0.9777 - val\_loss: 0.0521 - val\_accuracy: 0.9901

Epoch 72/100

33/33 [==============================] - 64s 2s/step - loss: 0.0782 - accuracy: 0.9839 - val\_loss: 0.0511 - val\_accuracy: 0.9901

Epoch 73/100

33/33 [==============================] - 65s 2s/step - loss: 0.0756 - accuracy: 0.9811 - val\_loss: 0.1145 - val\_accuracy: 0.9574

Epoch 74/100

33/33 [==============================] - 64s 2s/step - loss: 0.0860 - accuracy: 0.9796 - val\_loss: 0.1306 - val\_accuracy: 0.9503

Epoch 75/100

33/33 [==============================] - 63s 2s/step - loss: 0.0714 - accuracy: 0.9830 - val\_loss: 0.0831 - val\_accuracy: 0.9740

Epoch 76/100

33/33 [==============================] - 63s 2s/step - loss: 0.0779 - accuracy: 0.9811 - val\_loss: 0.0551 - val\_accuracy: 0.9848

Epoch 77/100

33/33 [==============================] - 63s 2s/step - loss: 0.0919 - accuracy: 0.9796 - val\_loss: 0.1661 - val\_accuracy: 0.9389

Epoch 78/100

33/33 [==============================] - 64s 2s/step - loss: 0.0841 - accuracy: 0.9834 - val\_loss: 0.0899 - val\_accuracy: 0.9683

Epoch 79/100

33/33 [==============================] - 64s 2s/step - loss: 0.0794 - accuracy: 0.9815 - val\_loss: 0.0466 - val\_accuracy: 0.9891

Epoch 80/100

33/33 [==============================] - 64s 2s/step - loss: 0.0816 - accuracy: 0.9801 - val\_loss: 0.0999 - val\_accuracy: 0.9616

Epoch 81/100

33/33 [==============================] - 64s 2s/step - loss: 0.0779 - accuracy: 0.9796 - val\_loss: 0.0930 - val\_accuracy: 0.9706

Epoch 82/100

33/33 [==============================] - 63s 2s/step - loss: 0.0806 - accuracy: 0.9773 - val\_loss: 0.0453 - val\_accuracy: 0.9886

Epoch 83/100

33/33 [==============================] - 64s 2s/step - loss: 0.0793 - accuracy: 0.9834 - val\_loss: 0.4546 - val\_accuracy: 0.8362

Epoch 84/100

33/33 [==============================] - 64s 2s/step - loss: 0.0729 - accuracy: 0.9825 - val\_loss: 0.1126 - val\_accuracy: 0.9564

Epoch 85/100

33/33 [==============================] - 63s 2s/step - loss: 0.0735 - accuracy: 0.9839 - val\_loss: 0.0557 - val\_accuracy: 0.9834

Epoch 86/100

33/33 [==============================] - 63s 2s/step - loss: 0.0688 - accuracy: 0.9825 - val\_loss: 0.1701 - val\_accuracy: 0.9361

Epoch 87/100

33/33 [==============================] - 63s 2s/step - loss: 0.0653 - accuracy: 0.9853 - val\_loss: 0.1391 - val\_accuracy: 0.9399

Epoch 88/100

33/33 [==============================] - 65s 2s/step - loss: 0.0657 - accuracy: 0.9820 - val\_loss: 0.1141 - val\_accuracy: 0.9569

Epoch 89/100

33/33 [==============================] - 65s 2s/step - loss: 0.0683 - accuracy: 0.9820 - val\_loss: 0.1005 - val\_accuracy: 0.9645

Epoch 90/100

33/33 [==============================] - 64s 2s/step - loss: 0.0629 - accuracy: 0.9858 - val\_loss: 0.0477 - val\_accuracy: 0.9839

Epoch 91/100

33/33 [==============================] - 63s 2s/step - loss: 0.0610 - accuracy: 0.9853 - val\_loss: 0.1679 - val\_accuracy: 0.9323

Epoch 92/100

33/33 [==============================] - 64s 2s/step - loss: 0.0643 - accuracy: 0.9834 - val\_loss: 0.0370 - val\_accuracy: 0.9901

Epoch 93/100

33/33 [==============================] - 63s 2s/step - loss: 0.0661 - accuracy: 0.9844 - val\_loss: 0.0577 - val\_accuracy: 0.9806

Epoch 94/100

33/33 [==============================] - 63s 2s/step - loss: 0.0631 - accuracy: 0.9863 - val\_loss: 0.0278 - val\_accuracy: 0.9938

Epoch 95/100

33/33 [==============================] - 63s 2s/step - loss: 0.0686 - accuracy: 0.9830 - val\_loss: 0.0635 - val\_accuracy: 0.9759

Epoch 96/100

33/33 [==============================] - 64s 2s/step - loss: 0.0627 - accuracy: 0.9848 - val\_loss: 0.2038 - val\_accuracy: 0.9228

Epoch 97/100

33/33 [==============================] - 64s 2s/step - loss: 0.0704 - accuracy: 0.9830 - val\_loss: 0.5413 - val\_accuracy: 0.8385

Epoch 98/100

33/33 [==============================] - 63s 2s/step - loss: 0.0675 - accuracy: 0.9844 - val\_loss: 0.0333 - val\_accuracy: 0.9953

Epoch 99/100

33/33 [==============================] - 63s 2s/step - loss: 0.0761 - accuracy: 0.9796 - val\_loss: 0.2139 - val\_accuracy: 0.9209

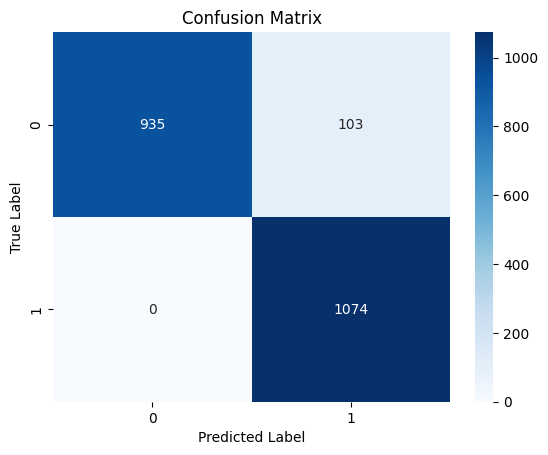
Epoch 100/100

33/33 [==============================] - 63s 2s/step - loss: 0.0594 - accuracy: 0.9877 - val\_loss: 0.1155 - val\_accuracy: 0.9512

33/33 [==============================] - 22s 657ms/step - loss: 0.1155 - accuracy: 0.9512

Validation accuracy: 0.951231062412262

33/33 [==============================] - 21s 622ms/step

****

Classification Report:

precision recall f1-score support

0 1.00 0.90 0.95 1038

1 0.91 1.00 0.95 1074

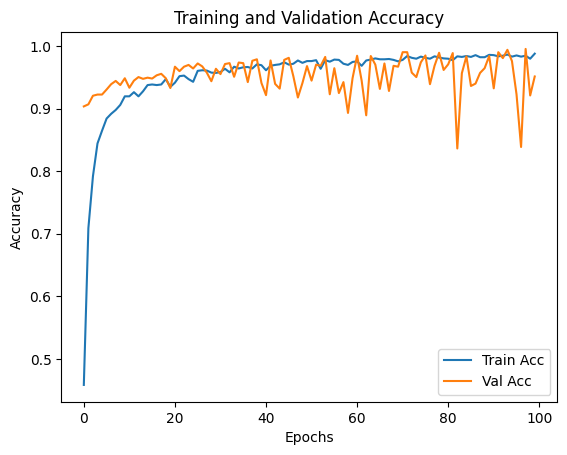
accuracy 0.95 2112

macro avg 0.96 0.95 0.95 2112

weighted avg 0.96 0.95 0.95 2112

**A picture containing text, screenshot, plot, diagram

Description automatically generated**

****

Overall Accuracy: 0.9512310606060606

Class: 0

Sensitivity: 0.9007707129094412

Specificity: 1.0

Recall: 0.9007707129094412

Precision: 1.0

F1-score: 0.9477952356817029

Class: 1

Sensitivity: 1.0

Specificity: 0.9007707129094412

Recall: 1.0

Precision: 0.9124893797790994

F1-score: 0.9542425588627277

**A picture containing text, screenshot, display, rectangle

Description automatically generated**