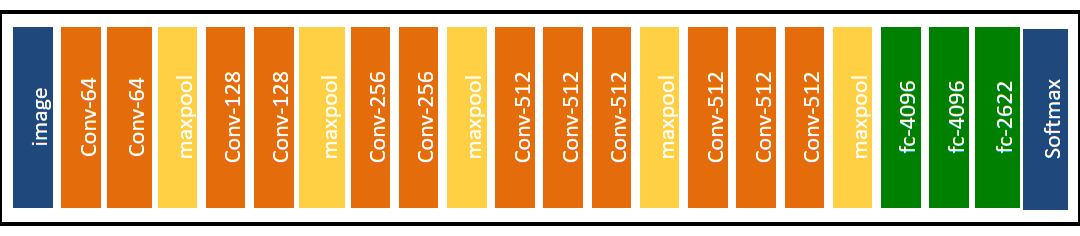
**Training model**

Tuần này sẽ thực hiện việc training model với tập dữ liệu datasets được tạo ra ở tuần trước.

Model phổ biến dùng cho việc nhận diện khuôn mặt là VGG-faces.

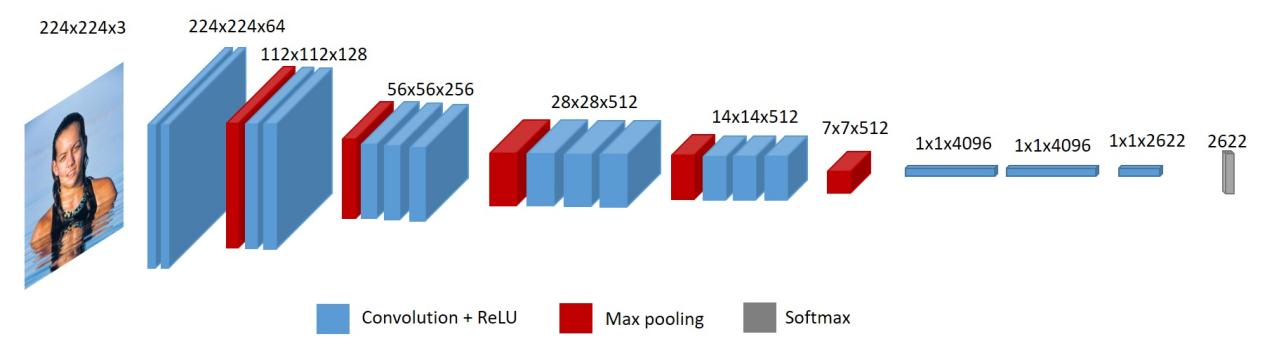
VGG được viết tắt là Visual Geometry Group, VGG-Face được ra đời năm 2015, model dựa trên mạng tích chập CNN để phát triên một mô hình nhận dạng khuôn mặt chuẩn.

Kiến trúc của model VGG-Face là:



Kiến trúc chia là 6 block khác nhau, và cứ sao mỗi lớp Maxpolling sẽ hình thành một block, trong một block có ít nhất 2 lớp tích chập và một lớp maxpooling, riêng block cuối cùng thì bao gồm các lớp fully-connected network và lớp dense với activation function là softmax.

Để có thể hình dung rõ hơn về mô hình ta nhìn hình ảnh sau:



Ban đầu từ một tấm ảnh có dimension là 3, sẽ được qua từng lớp tích chập chiều thứ 3 của tấp ảnh tăng lên từ 3 sang 64, việc tăng số lượng lớp cho chiều thứ 3 giúp việc trích xuất và học dữ liệu thu được trở nên nhiều hơn tăng độ chính xác. Sau đó ta đưa kết quả vào lớp maxpooling, ở lớp này sẽ giúp tăng cường ảnh để việc trích xuất trở nên tốt hơn bằng cách làm kích thước của ảnh nhỏ lại. Nhắc lại, lớp Maxpooling chỉ có tác dụng tăng cường ảnh, không hỗ trợ việc học dữ liệu của model. Cứ trải quả quá trình lặp lại như thế, rồi đưa qua lớp fully-connected để cập nhật các trọng số sau quá trình học, từ đó đúc kết lại chỉ còn một vector một chiều với các giá trị được tính toán sau khi qua hàm activation function là softmax. Hàm loss function được dùng là Cross-entropy loss.

**Xây dựng model**

Đầu tiên ta thử dùng model VGG-face có sắn trong thư viện tensorflow để train model.

Ứng dụng phương pháp transfer learning, ta có thể sử dụng model đã được thiết kế sắn và dùng thêm từ đó dùng thêm vài lớp để xuất ra output

pre\_trained\_model = VGG16(input\_shape=input\_shape, include\_top=False, weights=None)

last\_layer = pre\_trained\_model.get\_layer('block5\_pool')

last\_output = last\_layer.output

x = GlobalMaxPooling2D()(last\_output)

x = Dense(512, activation='relu')(x)

x = Dropout(0.8)(x)

x = Dense(10, activation='softmax')(x)

Tuy nhiên kết quả thực thi trong 20 epochs đầu là:

Epoch 1/20

6/6 [==============================] - 226s 43s/step - loss: 2.7975 - accuracy: 0.0774 - val\_loss: 2.3061 - val\_accuracy: 0.1045

Epoch 2/20

6/6 [==============================] - 195s 32s/step - loss: 2.3011 - accuracy: 0.1310 - val\_loss: 2.3022 - val\_accuracy: 0.0821

Epoch 3/20

6/6 [==============================] - 188s 31s/step - loss: 2.3038 - accuracy: 0.1071 - val\_loss: 2.3080 - val\_accuracy: 0.0970

Epoch 4/20

6/6 [==============================] - 202s 33s/step - loss: 2.2956 - accuracy: 0.1250 - val\_loss: 2.3061 - val\_accuracy: 0.0970

Epoch 5/20

6/6 [==============================] - 196s 32s/step - loss: 2.2976 - accuracy: 0.1250 - val\_loss: 2.3045 - val\_accuracy: 0.0970

Epoch 6/20

6/6 [==============================] - 191s 32s/step - loss: 2.3038 - accuracy: 0.0774 - val\_loss: 2.3069 - val\_accuracy: 0.0896

Epoch 7/20

6/6 [==============================] - 140s 22s/step - loss: 2.3012 - accuracy: 0.1250 - val\_loss: 2.3024 - val\_accuracy: 0.0896

Epoch 8/20

6/6 [==============================] - 82s 14s/step - loss: 2.2992 - accuracy: 0.1250 - val\_loss: 2.3027 - val\_accuracy: 0.0896

Epoch 9/20

6/6 [==============================] - 75s 12s/step - loss: 2.2929 - accuracy: 0.1607 - val\_loss: 2.3107 - val\_accuracy: 0.0896

Epoch 10/20

6/6 [==============================] - 72s 12s/step - loss: 2.3081 - accuracy: 0.1131 - val\_loss: 2.3045 - val\_accuracy: 0.0896

Epoch 11/20

6/6 [==============================] - 76s 13s/step - loss: 2.2963 - accuracy: 0.1250 - val\_loss: 2.3029 - val\_accuracy: 0.0896

Epoch 12/20

6/6 [==============================] - 71s 12s/step - loss: 2.2919 - accuracy: 0.1369 - val\_loss: 2.3042 - val\_accuracy: 0.0896

Epoch 13/20

6/6 [==============================] - 76s 13s/step - loss: 2.3039 - accuracy: 0.1131 - val\_loss: 2.3015 - val\_accuracy: 0.0896

Epoch 14/20

6/6 [==============================] - 76s 13s/step - loss: 2.2749 - accuracy: 0.1190 - val\_loss: 2.2802 - val\_accuracy: 0.0896

Epoch 15/20

6/6 [==============================] - 75s 14s/step - loss: 2.2365 - accuracy: 0.1131 - val\_loss: 2.2405 - val\_accuracy: 0.0896

Epoch 16/20

6/6 [==============================] - 77s 13s/step - loss: 2.2503 - accuracy: 0.1607 - val\_loss: 2.2565 - val\_accuracy: 0.0896

Epoch 17/20

6/6 [==============================] - 91s 16s/step - loss: 2.2635 - accuracy: 0.1250 - val\_loss: 2.2781 - val\_accuracy: 0.0896

Epoch 18/20

6/6 [==============================] - 92s 15s/step - loss: 2.2150 - accuracy: 0.1310 - val\_loss: 2.2351 - val\_accuracy: 0.0896

Epoch 19/20

6/6 [==============================] - 85s 14s/step - loss: 2.2249 - accuracy: 0.1012 - val\_loss: 2.2830 - val\_accuracy: 0.0896

Epoch 20/20

6/6 [==============================] - 80s 13s/step - loss: 2.2828 - accuracy: 0.1369 - val\_loss: 2.3045 - val\_accuracy: 0.0896

Độ chính xác chỉ nằm trong khoảng từ 10% đến 13%, độ chính xác khá thấp. Sau vài lần hiệu chính kích thước của sổ trượt kernel từ (3, 3) thành (5, 5), hay hiệu chỉnh số lượng lớp kernel trong mỗi lớp convolution hay số lớp hidden trong lớp dense(lớp fully-connected) thì kết quả cũng vẫn không có cải biến.

Lý do dẫn đến việc có độ chính xác thấp như vậy là do mô hình được xây dựng quá phức tạp trong khi lượng dữ liệu để training khá nhỏ chỉ có vài trăm mà thôi.

Cách để giải quyết tình huống này là giảm độ phức tạp của thuật toán, giảm kích thước mô hình bằng cách giảm số lớp kernel trong lớp convolution. Không chỉ thể, ta có thể tăng thêm dữ liệu để làm tăng độ chính xác của model.

Và thay vì ta tăng thêm dữ liệu để train thì do lượng dữ liệu quá huấn luyện quá ít nên ta sẽ train với nhiều epochs để độ chính xác có thể tăng cao hơn.

Bên cạnh đó ta có thể giảm regulation, bằng cách dừng dropout để làm giảm một số node trong lớp hidden, tuy nhiên với cách này nếu giảm quá đà sẽ dẫn đến độ chính xác không thể tăng mà ngược lại càng giảm. Đã thử và thấy kết quả cũng không khả thi.

Và xây dựng lại model:

model = Sequential()

model.add(Conv2D(16, kernel\_size=3,input\_shape=input\_shape, activation='relu'))

model.add(Conv2D(16, kernel\_size=3, activation='relu'))

model.add(MaxPooling2D(pool\_size=(2, 2)))

model.add(Conv2D(32, kernel\_size=3, activation='relu'))

model.add(Conv2D(32, kernel\_size=3, activation='relu'))

model.add(MaxPooling2D(pool\_size=(2, 2)))

model.add(Conv2D(64, kernel\_size=3, activation='relu'))

model.add(MaxPooling2D(pool\_size=(2, 2)))

model.add(Flatten())

model.add(Dense(64, activation='relu'))

model.add(Dense(10, activation='softmax'))

**Train model**

model.compile(loss='categorical\_crossentropy', optimizer='adam', metrics=['accuracy'])

model.summary()

print('Start Training')

model.fit(train\_data\_generator, epochs=epochs, validation\_data=valid\_data\_generator)

model.save("my\_model1.h5")

Số lượng epochs là: 200

Kết quả:

5/5 [==============================] - 9s 2s/step - loss: 2.3531 - accuracy: 0.0968 - val\_loss: 2.3012 - val\_accuracy: 0.1000

Epoch 2/200

5/5 [==============================] - 8s 2s/step - loss: 2.3040 - accuracy: 0.1290 - val\_loss: 2.2963 - val\_accuracy: 0.1000

Epoch 3/200

5/5 [==============================] - 9s 2s/step - loss: 2.2694 - accuracy: 0.1290 - val\_loss: 2.2653 - val\_accuracy: 0.1000

Epoch 4/200

5/5 [==============================] - 8s 2s/step - loss: 2.2320 - accuracy: 0.1290 - val\_loss: 2.1990 - val\_accuracy: 0.1000

Epoch 5/200

5/5 [==============================] - 8s 2s/step - loss: 2.1816 - accuracy: 0.2129 - val\_loss: 2.1150 - val\_accuracy: 0.1000

Epoch 6/200

5/5 [==============================] - 9s 2s/step - loss: 2.1271 - accuracy: 0.2387 - val\_loss: 2.0813 - val\_accuracy: 0.3000

Epoch 7/200

5/5 [==============================] - 15s 3s/step - loss: 2.0826 - accuracy: 0.2258 - val\_loss: 2.1295 - val\_accuracy: 0.2000

Epoch 8/200

5/5 [==============================] - 10s 2s/step - loss: 2.0664 - accuracy: 0.2258 - val\_loss: 2.1153 - val\_accuracy: 0.2000

Epoch 9/200

5/5 [==============================] - 10s 2s/step - loss: 2.0586 - accuracy: 0.2194 - val\_loss: 2.0524 - val\_accuracy: 0.2000

Epoch 10/200

5/5 [==============================] - 10s 2s/step - loss: 2.0140 - accuracy: 0.2258 - val\_loss: 1.9835 - val\_accuracy: 0.2000

Epoch 11/200

5/5 [==============================] - 10s 2s/step - loss: 1.9776 - accuracy: 0.2194 - val\_loss: 1.9461 - val\_accuracy: 0.3000

Epoch 12/200

5/5 [==============================] - 10s 2s/step - loss: 1.9646 - accuracy: 0.2774 - val\_loss: 2.0186 - val\_accuracy: 0.3000

Epoch 13/200

5/5 [==============================] - 9s 2s/step - loss: 1.9460 - accuracy: 0.2516 - val\_loss: 2.0647 - val\_accuracy: 0.2000

Epoch 14/200

5/5 [==============================] - 9s 2s/step - loss: 1.9604 - accuracy: 0.2710 - val\_loss: 1.9482 - val\_accuracy: 0.3000

Epoch 15/200

5/5 [==============================] - 10s 2s/step - loss: 1.9231 - accuracy: 0.2903 - val\_loss: 1.9703 - val\_accuracy: 0.2000

Epoch 16/200

5/5 [==============================] - 10s 2s/step - loss: 1.9022 - accuracy: 0.3097 - val\_loss: 2.3453 - val\_accuracy: 0.2000

Epoch 17/200

5/5 [==============================] - 9s 2s/step - loss: 1.9373 - accuracy: 0.2710 - val\_loss: 1.8659 - val\_accuracy: 0.2000

Epoch 18/200

5/5 [==============================] - 10s 2s/step - loss: 1.8967 - accuracy: 0.2839 - val\_loss: 1.9066 - val\_accuracy: 0.2000

Epoch 19/200

5/5 [==============================] - 8s 2s/step - loss: 1.8431 - accuracy: 0.3290 - val\_loss: 2.1311 - val\_accuracy: 0.2000

Epoch 20/200

5/5 [==============================] - 8s 2s/step - loss: 1.8823 - accuracy: 0.2968 - val\_loss: 1.9511 - val\_accuracy: 0.3000

Epoch 21/200

5/5 [==============================] - 8s 2s/step - loss: 1.8299 - accuracy: 0.2839 - val\_loss: 1.8530 - val\_accuracy: 0.4000

Epoch 22/200

5/5 [==============================] - 9s 2s/step - loss: 1.9290 - accuracy: 0.2516 - val\_loss: 1.8053 - val\_accuracy: 0.3000

Epoch 23/200

5/5 [==============================] - 8s 2s/step - loss: 1.7840 - accuracy: 0.3548 - val\_loss: 1.9670 - val\_accuracy: 0.3000

Epoch 24/200

5/5 [==============================] - 8s 2s/step - loss: 1.7817 - accuracy: 0.3742 - val\_loss: 1.7652 - val\_accuracy: 0.2000

Epoch 25/200

5/5 [==============================] - 8s 2s/step - loss: 1.7383 - accuracy: 0.3613 - val\_loss: 1.9983 - val\_accuracy: 0.2000

Epoch 26/200

5/5 [==============================] - 8s 2s/step - loss: 1.7219 - accuracy: 0.3355 - val\_loss: 1.9863 - val\_accuracy: 0.2000

Epoch 27/200

5/5 [==============================] - 8s 2s/step - loss: 1.7116 - accuracy: 0.3806 - val\_loss: 2.1823 - val\_accuracy: 0.2000

Epoch 28/200

5/5 [==============================] - 9s 2s/step - loss: 1.7741 - accuracy: 0.3484 - val\_loss: 1.7155 - val\_accuracy: 0.2000

Epoch 29/200

5/5 [==============================] - 9s 2s/step - loss: 1.7336 - accuracy: 0.3548 - val\_loss: 2.3347 - val\_accuracy: 0.2000

Epoch 30/200

5/5 [==============================] - 8s 2s/step - loss: 1.7050 - accuracy: 0.3613 - val\_loss: 1.9897 - val\_accuracy: 0.2000

Epoch 31/200

5/5 [==============================] - 8s 2s/step - loss: 1.6998 - accuracy: 0.4065 - val\_loss: 2.2774 - val\_accuracy: 0.2000

Epoch 32/200

5/5 [==============================] - 8s 2s/step - loss: 1.7134 - accuracy: 0.3742 - val\_loss: 1.8967 - val\_accuracy: 0.2000

Epoch 33/200

5/5 [==============================] - 8s 2s/step - loss: 1.7558 - accuracy: 0.3677 - val\_loss: 2.0270 - val\_accuracy: 0.3000

Epoch 34/200

5/5 [==============================] - 8s 2s/step - loss: 1.7229 - accuracy: 0.4000 - val\_loss: 2.1269 - val\_accuracy: 0.3000

Epoch 35/200

5/5 [==============================] - 9s 2s/step - loss: 1.6798 - accuracy: 0.3806 - val\_loss: 1.7817 - val\_accuracy: 0.3000

Epoch 36/200

5/5 [==============================] - 9s 2s/step - loss: 1.6968 - accuracy: 0.3742 - val\_loss: 2.0674 - val\_accuracy: 0.1000

Epoch 37/200

5/5 [==============================] - 8s 2s/step - loss: 1.6809 - accuracy: 0.3613 - val\_loss: 1.6794 - val\_accuracy: 0.4000

Epoch 38/200

5/5 [==============================] - 8s 2s/step - loss: 1.7060 - accuracy: 0.3935 - val\_loss: 2.0076 - val\_accuracy: 0.3000

Epoch 39/200

5/5 [==============================] - 8s 2s/step - loss: 1.6338 - accuracy: 0.4000 - val\_loss: 1.7402 - val\_accuracy: 0.3000

Epoch 40/200

5/5 [==============================] - 8s 2s/step - loss: 1.5578 - accuracy: 0.3935 - val\_loss: 2.2568 - val\_accuracy: 0.3000

Epoch 41/200

5/5 [==============================] - 8s 2s/step - loss: 1.6359 - accuracy: 0.3677 - val\_loss: 1.7013 - val\_accuracy: 0.4000

Epoch 42/200

5/5 [==============================] - 9s 2s/step - loss: 1.6064 - accuracy: 0.4065 - val\_loss: 2.5161 - val\_accuracy: 0.4000

Epoch 43/200

5/5 [==============================] - 8s 2s/step - loss: 1.5503 - accuracy: 0.4129 - val\_loss: 1.9580 - val\_accuracy: 0.4000

Epoch 44/200

5/5 [==============================] - 8s 2s/step - loss: 1.6161 - accuracy: 0.3935 - val\_loss: 2.0810 - val\_accuracy: 0.2000

Epoch 45/200

5/5 [==============================] - 8s 2s/step - loss: 1.5490 - accuracy: 0.3871 - val\_loss: 2.0722 - val\_accuracy: 0.2000

Epoch 46/200

5/5 [==============================] - 8s 2s/step - loss: 1.5716 - accuracy: 0.4065 - val\_loss: 1.8786 - val\_accuracy: 0.5000

Epoch 47/200

5/5 [==============================] - 8s 2s/step - loss: 1.5755 - accuracy: 0.4129 - val\_loss: 1.9996 - val\_accuracy: 0.3000

Epoch 48/200

5/5 [==============================] - 8s 2s/step - loss: 1.5803 - accuracy: 0.3806 - val\_loss: 2.3429 - val\_accuracy: 0.4000

Epoch 49/200

5/5 [==============================] - 8s 2s/step - loss: 1.5232 - accuracy: 0.4323 - val\_loss: 1.7822 - val\_accuracy: 0.3000

Epoch 50/200

5/5 [==============================] - 8s 2s/step - loss: 1.5287 - accuracy: 0.4968 - val\_loss: 1.9807 - val\_accuracy: 0.2000

Epoch 51/200

5/5 [==============================] - 9s 2s/step - loss: 1.5302 - accuracy: 0.4452 - val\_loss: 2.1231 - val\_accuracy: 0.3000

Epoch 52/200

5/5 [==============================] - 8s 2s/step - loss: 1.4496 - accuracy: 0.5161 - val\_loss: 2.0687 - val\_accuracy: 0.3000

Epoch 53/200

5/5 [==============================] - 8s 2s/step - loss: 1.5365 - accuracy: 0.4452 - val\_loss: 2.1725 - val\_accuracy: 0.2000

Epoch 54/200

5/5 [==============================] - 8s 2s/step - loss: 1.5108 - accuracy: 0.4645 - val\_loss: 1.6779 - val\_accuracy: 0.5000

Epoch 55/200

5/5 [==============================] - 8s 2s/step - loss: 1.4795 - accuracy: 0.5097 - val\_loss: 2.0694 - val\_accuracy: 0.2000

Epoch 56/200

5/5 [==============================] - 8s 2s/step - loss: 1.4432 - accuracy: 0.4581 - val\_loss: 2.9649 - val\_accuracy: 0.4000

Epoch 57/200

5/5 [==============================] - 8s 2s/step - loss: 1.4623 - accuracy: 0.4645 - val\_loss: 2.0188 - val\_accuracy: 0.2000

Epoch 58/200

5/5 [==============================] - 9s 2s/step - loss: 1.4887 - accuracy: 0.4645 - val\_loss: 1.6585 - val\_accuracy: 0.6000

Epoch 59/200

5/5 [==============================] - 8s 2s/step - loss: 1.4672 - accuracy: 0.4581 - val\_loss: 1.4923 - val\_accuracy: 0.5000

Epoch 60/200

5/5 [==============================] - 8s 2s/step - loss: 1.4209 - accuracy: 0.5032 - val\_loss: 1.5098 - val\_accuracy: 0.4000

Epoch 61/200

5/5 [==============================] - 8s 2s/step - loss: 1.4255 - accuracy: 0.4645 - val\_loss: 1.5814 - val\_accuracy: 0.5000

Epoch 62/200

5/5 [==============================] - 8s 2s/step - loss: 1.4514 - accuracy: 0.4968 - val\_loss: 1.7758 - val\_accuracy: 0.4000

Epoch 63/200

5/5 [==============================] - 8s 2s/step - loss: 1.4147 - accuracy: 0.5032 - val\_loss: 1.3593 - val\_accuracy: 0.5000

Epoch 64/200

5/5 [==============================] - 8s 2s/step - loss: 1.4315 - accuracy: 0.4258 - val\_loss: 1.9365 - val\_accuracy: 0.3000

Epoch 65/200

5/5 [==============================] - 8s 2s/step - loss: 1.4308 - accuracy: 0.4903 - val\_loss: 1.8256 - val\_accuracy: 0.4000

Epoch 66/200

5/5 [==============================] - 8s 2s/step - loss: 1.3890 - accuracy: 0.4839 - val\_loss: 1.9670 - val\_accuracy: 0.4000

Epoch 67/200

5/5 [==============================] - 9s 2s/step - loss: 1.6383 - accuracy: 0.4581 - val\_loss: 2.0504 - val\_accuracy: 0.2000

Epoch 68/200

5/5 [==============================] - 8s 2s/step - loss: 1.4256 - accuracy: 0.4645 - val\_loss: 1.9743 - val\_accuracy: 0.4000

Epoch 69/200

5/5 [==============================] - 9s 2s/step - loss: 1.4126 - accuracy: 0.5226 - val\_loss: 1.7424 - val\_accuracy: 0.4000

Epoch 70/200

5/5 [==============================] - 8s 2s/step - loss: 1.3812 - accuracy: 0.4839 - val\_loss: 2.5784 - val\_accuracy: 0.2000

Epoch 71/200

5/5 [==============================] - 8s 2s/step - loss: 1.4741 - accuracy: 0.4581 - val\_loss: 2.0401 - val\_accuracy: 0.5000

Epoch 72/200

5/5 [==============================] - 8s 2s/step - loss: 1.3769 - accuracy: 0.4774 - val\_loss: 1.1791 - val\_accuracy: 0.7000

Epoch 73/200

5/5 [==============================] - 8s 2s/step - loss: 1.4117 - accuracy: 0.5032 - val\_loss: 1.5120 - val\_accuracy: 0.5000

Epoch 74/200

5/5 [==============================] - 8s 2s/step - loss: 1.3287 - accuracy: 0.4968 - val\_loss: 1.2462 - val\_accuracy: 0.5000

Epoch 75/200

5/5 [==============================] - 8s 2s/step - loss: 1.2846 - accuracy: 0.5290 - val\_loss: 1.9042 - val\_accuracy: 0.4000

Epoch 76/200

5/5 [==============================] - 8s 2s/step - loss: 1.4304 - accuracy: 0.4710 - val\_loss: 1.7251 - val\_accuracy: 0.4000

Epoch 77/200

5/5 [==============================] - 8s 2s/step - loss: 1.3499 - accuracy: 0.4968 - val\_loss: 1.7438 - val\_accuracy: 0.5000

Epoch 78/200

5/5 [==============================] - 8s 2s/step - loss: 1.2507 - accuracy: 0.5484 - val\_loss: 1.3645 - val\_accuracy: 0.6000

Epoch 79/200

5/5 [==============================] - 9s 2s/step - loss: 1.4630 - accuracy: 0.4710 - val\_loss: 1.4707 - val\_accuracy: 0.5000

Epoch 80/200

5/5 [==============================] - 10s 2s/step - loss: 1.2796 - accuracy: 0.5419 - val\_loss: 1.3593 - val\_accuracy: 0.4000

Epoch 81/200

5/5 [==============================] - 9s 2s/step - loss: 1.2409 - accuracy: 0.4903 - val\_loss: 1.9668 - val\_accuracy: 0.5000

Epoch 82/200

5/5 [==============================] - 10s 2s/step - loss: 1.3191 - accuracy: 0.5355 - val\_loss: 1.6267 - val\_accuracy: 0.5000

Epoch 83/200

5/5 [==============================] - 9s 2s/step - loss: 1.2742 - accuracy: 0.5290 - val\_loss: 1.6339 - val\_accuracy: 0.4000

Epoch 84/200

5/5 [==============================] - 10s 2s/step - loss: 1.2263 - accuracy: 0.5871 - val\_loss: 1.7165 - val\_accuracy: 0.5000

Epoch 85/200

5/5 [==============================] - 10s 2s/step - loss: 1.2104 - accuracy: 0.5871 - val\_loss: 1.4991 - val\_accuracy: 0.5000

Epoch 86/200

5/5 [==============================] - 8s 2s/step - loss: 1.2218 - accuracy: 0.6000 - val\_loss: 1.6262 - val\_accuracy: 0.5000

Epoch 87/200

5/5 [==============================] - 8s 2s/step - loss: 1.1385 - accuracy: 0.5806 - val\_loss: 1.3575 - val\_accuracy: 0.7000

Epoch 88/200

5/5 [==============================] - 9s 2s/step - loss: 1.3634 - accuracy: 0.5548 - val\_loss: 1.7768 - val\_accuracy: 0.3000

Epoch 89/200

5/5 [==============================] - 9s 2s/step - loss: 1.4060 - accuracy: 0.5226 - val\_loss: 2.2678 - val\_accuracy: 0.4000

Epoch 90/200

5/5 [==============================] - 9s 2s/step - loss: 1.3802 - accuracy: 0.4452 - val\_loss: 1.9668 - val\_accuracy: 0.2000

Epoch 91/200

5/5 [==============================] - 9s 2s/step - loss: 1.2433 - accuracy: 0.5290 - val\_loss: 1.6216 - val\_accuracy: 0.5000

Epoch 92/200

5/5 [==============================] - 8s 2s/step - loss: 1.2763 - accuracy: 0.5355 - val\_loss: 1.7134 - val\_accuracy: 0.4000

Epoch 93/200

5/5 [==============================] - 8s 2s/step - loss: 1.2266 - accuracy: 0.5871 - val\_loss: 1.3866 - val\_accuracy: 0.6000

Epoch 94/200

5/5 [==============================] - 8s 2s/step - loss: 1.2842 - accuracy: 0.5548 - val\_loss: 1.4319 - val\_accuracy: 0.6000

Epoch 95/200

5/5 [==============================] - 8s 2s/step - loss: 1.2147 - accuracy: 0.6194 - val\_loss: 1.9415 - val\_accuracy: 0.4000

Epoch 96/200

5/5 [==============================] - 9s 2s/step - loss: 1.2353 - accuracy: 0.5548 - val\_loss: 1.6425 - val\_accuracy: 0.4000

Epoch 97/200

5/5 [==============================] - 9s 2s/step - loss: 1.2491 - accuracy: 0.5742 - val\_loss: 1.5849 - val\_accuracy: 0.6000

Epoch 98/200

5/5 [==============================] - 10s 2s/step - loss: 1.1041 - accuracy: 0.6065 - val\_loss: 1.0877 - val\_accuracy: 0.7000

Epoch 99/200

5/5 [==============================] - 11s 2s/step - loss: 1.1539 - accuracy: 0.6129 - val\_loss: 1.6728 - val\_accuracy: 0.6000

Epoch 100/200

5/5 [==============================] - 10s 2s/step - loss: 1.1271 - accuracy: 0.5871 - val\_loss: 1.2721 - val\_accuracy: 0.5000

Epoch 101/200

5/5 [==============================] - 9s 2s/step - loss: 1.1561 - accuracy: 0.5677 - val\_loss: 1.4103 - val\_accuracy: 0.5000

Epoch 102/200

5/5 [==============================] - 9s 2s/step - loss: 1.1886 - accuracy: 0.5484 - val\_loss: 1.3984 - val\_accuracy: 0.5000

Epoch 103/200

5/5 [==============================] - 9s 2s/step - loss: 1.1617 - accuracy: 0.5548 - val\_loss: 1.4254 - val\_accuracy: 0.5000

Epoch 104/200

5/5 [==============================] - 10s 2s/step - loss: 1.2462 - accuracy: 0.5290 - val\_loss: 1.8261 - val\_accuracy: 0.4000

Epoch 105/200

5/5 [==============================] - 9s 2s/step - loss: 1.2799 - accuracy: 0.5548 - val\_loss: 2.1371 - val\_accuracy: 0.4000

Epoch 106/200

5/5 [==============================] - 9s 2s/step - loss: 1.1831 - accuracy: 0.5871 - val\_loss: 1.8175 - val\_accuracy: 0.4000

Epoch 107/200

5/5 [==============================] - 9s 2s/step - loss: 1.2607 - accuracy: 0.5548 - val\_loss: 1.7163 - val\_accuracy: 0.4000

Epoch 108/200

5/5 [==============================] - 8s 2s/step - loss: 1.2523 - accuracy: 0.5613 - val\_loss: 1.6417 - val\_accuracy: 0.5000

Epoch 109/200

5/5 [==============================] - 10s 2s/step - loss: 1.1198 - accuracy: 0.6194 - val\_loss: 1.8724 - val\_accuracy: 0.4000

Epoch 110/200

5/5 [==============================] - 11s 2s/step - loss: 1.1117 - accuracy: 0.6194 - val\_loss: 1.2292 - val\_accuracy: 0.5000

Epoch 111/200

5/5 [==============================] - 8s 2s/step - loss: 1.1200 - accuracy: 0.5935 - val\_loss: 1.4514 - val\_accuracy: 0.4000

Epoch 112/200

5/5 [==============================] - 9s 2s/step - loss: 1.1405 - accuracy: 0.5806 - val\_loss: 1.4869 - val\_accuracy: 0.3000

Epoch 113/200

5/5 [==============================] - 9s 2s/step - loss: 0.9890 - accuracy: 0.6903 - val\_loss: 1.4399 - val\_accuracy: 0.5000

Epoch 114/200

5/5 [==============================] - 8s 2s/step - loss: 0.9946 - accuracy: 0.6323 - val\_loss: 1.6412 - val\_accuracy: 0.4000

Epoch 115/200

5/5 [==============================] - 9s 2s/step - loss: 1.0214 - accuracy: 0.6194 - val\_loss: 1.9116 - val\_accuracy: 0.5000

Epoch 116/200

5/5 [==============================] - 9s 2s/step - loss: 1.0957 - accuracy: 0.6000 - val\_loss: 2.1557 - val\_accuracy: 0.4000

Epoch 117/200

5/5 [==============================] - 9s 2s/step - loss: 0.9864 - accuracy: 0.6581 - val\_loss: 1.6656 - val\_accuracy: 0.4000

Epoch 118/200

5/5 [==============================] - 9s 2s/step - loss: 1.1378 - accuracy: 0.6581 - val\_loss: 1.3407 - val\_accuracy: 0.6000

Epoch 119/200

5/5 [==============================] - 9s 2s/step - loss: 1.1463 - accuracy: 0.5677 - val\_loss: 1.3891 - val\_accuracy: 0.4000

Epoch 120/200

5/5 [==============================] - 9s 2s/step - loss: 1.1445 - accuracy: 0.6065 - val\_loss: 0.9133 - val\_accuracy: 0.6000

Epoch 121/200

5/5 [==============================] - 8s 2s/step - loss: 1.1272 - accuracy: 0.5935 - val\_loss: 0.9631 - val\_accuracy: 0.6000

Epoch 122/200

5/5 [==============================] - 9s 2s/step - loss: 1.0214 - accuracy: 0.6710 - val\_loss: 2.1768 - val\_accuracy: 0.4000

Epoch 123/200

5/5 [==============================] - 9s 2s/step - loss: 1.0818 - accuracy: 0.6452 - val\_loss: 1.4231 - val\_accuracy: 0.4000

Epoch 124/200

5/5 [==============================] - 9s 2s/step - loss: 1.0242 - accuracy: 0.6710 - val\_loss: 1.7942 - val\_accuracy: 0.5000

Epoch 125/200

5/5 [==============================] - 9s 2s/step - loss: 1.0349 - accuracy: 0.6000 - val\_loss: 1.0633 - val\_accuracy: 0.6000

Epoch 126/200

5/5 [==============================] - 9s 2s/step - loss: 0.9862 - accuracy: 0.6452 - val\_loss: 1.3955 - val\_accuracy: 0.7000

Epoch 127/200

5/5 [==============================] - 8s 2s/step - loss: 1.0331 - accuracy: 0.6129 - val\_loss: 2.0010 - val\_accuracy: 0.4000

Epoch 128/200

5/5 [==============================] - 8s 2s/step - loss: 0.9662 - accuracy: 0.6903 - val\_loss: 1.6580 - val\_accuracy: 0.5000

Epoch 129/200

5/5 [==============================] - 8s 2s/step - loss: 0.9737 - accuracy: 0.6968 - val\_loss: 1.1490 - val\_accuracy: 0.4000

Epoch 130/200

5/5 [==============================] - 9s 2s/step - loss: 0.9569 - accuracy: 0.6387 - val\_loss: 1.6193 - val\_accuracy: 0.4000

Epoch 131/200

5/5 [==============================] - 9s 2s/step - loss: 0.9619 - accuracy: 0.6516 - val\_loss: 1.1039 - val\_accuracy: 0.6000

Epoch 132/200

5/5 [==============================] - 9s 2s/step - loss: 1.0174 - accuracy: 0.6387 - val\_loss: 1.0932 - val\_accuracy: 0.5000

Epoch 133/200

5/5 [==============================] - 8s 2s/step - loss: 0.8956 - accuracy: 0.6710 - val\_loss: 1.5602 - val\_accuracy: 0.5000

Epoch 134/200

5/5 [==============================] - 9s 2s/step - loss: 1.0171 - accuracy: 0.5742 - val\_loss: 1.6248 - val\_accuracy: 0.4000

Epoch 135/200

5/5 [==============================] - 9s 2s/step - loss: 0.9315 - accuracy: 0.6516 - val\_loss: 1.7490 - val\_accuracy: 0.6000

Epoch 136/200

5/5 [==============================] - 9s 2s/step - loss: 1.1360 - accuracy: 0.6387 - val\_loss: 1.0578 - val\_accuracy: 0.7000

Epoch 137/200

5/5 [==============================] - 9s 2s/step - loss: 0.9774 - accuracy: 0.6323 - val\_loss: 1.2735 - val\_accuracy: 0.5000

Epoch 138/200

5/5 [==============================] - 9s 2s/step - loss: 0.9326 - accuracy: 0.6968 - val\_loss: 1.6457 - val\_accuracy: 0.3000

Epoch 139/200

5/5 [==============================] - 8s 2s/step - loss: 1.0061 - accuracy: 0.6903 - val\_loss: 1.4862 - val\_accuracy: 0.6000

Epoch 140/200

5/5 [==============================] - 9s 2s/step - loss: 0.8536 - accuracy: 0.7032 - val\_loss: 1.3235 - val\_accuracy: 0.4000

Epoch 141/200

5/5 [==============================] - 9s 2s/step - loss: 0.9297 - accuracy: 0.6194 - val\_loss: 1.3097 - val\_accuracy: 0.8000

Epoch 142/200

5/5 [==============================] - 9s 2s/step - loss: 0.8675 - accuracy: 0.6710 - val\_loss: 1.2794 - val\_accuracy: 0.6000

Epoch 143/200

5/5 [==============================] - 8s 2s/step - loss: 0.9087 - accuracy: 0.6516 - val\_loss: 1.9049 - val\_accuracy: 0.5000

Epoch 144/200

5/5 [==============================] - 9s 2s/step - loss: 0.8455 - accuracy: 0.6839 - val\_loss: 1.4071 - val\_accuracy: 0.4000

Epoch 145/200

5/5 [==============================] - 9s 2s/step - loss: 1.1109 - accuracy: 0.6258 - val\_loss: 1.2506 - val\_accuracy: 0.5000

Epoch 146/200

5/5 [==============================] - 8s 2s/step - loss: 1.1548 - accuracy: 0.5742 - val\_loss: 1.1665 - val\_accuracy: 0.5000

Epoch 147/200

5/5 [==============================] - 9s 2s/step - loss: 1.0791 - accuracy: 0.6000 - val\_loss: 1.7269 - val\_accuracy: 0.3000

Epoch 148/200

5/5 [==============================] - 8s 2s/step - loss: 0.9631 - accuracy: 0.6452 - val\_loss: 2.3594 - val\_accuracy: 0.3000

Epoch 149/200

5/5 [==============================] - 9s 2s/step - loss: 1.0531 - accuracy: 0.6000 - val\_loss: 1.4254 - val\_accuracy: 0.6000

Epoch 150/200

5/5 [==============================] - 9s 2s/step - loss: 0.9649 - accuracy: 0.6452 - val\_loss: 1.1167 - val\_accuracy: 0.5000

Epoch 151/200

5/5 [==============================] - 8s 2s/step - loss: 1.0167 - accuracy: 0.6065 - val\_loss: 2.5027 - val\_accuracy: 0.5000

Epoch 152/200

5/5 [==============================] - 8s 2s/step - loss: 1.0915 - accuracy: 0.6258 - val\_loss: 0.9648 - val\_accuracy: 0.6000

Epoch 153/200

5/5 [==============================] - 8s 2s/step - loss: 1.0473 - accuracy: 0.6323 - val\_loss: 1.3391 - val\_accuracy: 0.6000

Epoch 154/200

5/5 [==============================] - 9s 2s/step - loss: 1.0457 - accuracy: 0.6323 - val\_loss: 1.4447 - val\_accuracy: 0.6000

Epoch 155/200

5/5 [==============================] - 9s 2s/step - loss: 0.9259 - accuracy: 0.6452 - val\_loss: 1.3063 - val\_accuracy: 0.6000

Epoch 156/200

5/5 [==============================] - 9s 2s/step - loss: 0.8818 - accuracy: 0.6968 - val\_loss: 1.1509 - val\_accuracy: 0.6000

Epoch 157/200

5/5 [==============================] - 10s 2s/step - loss: 0.8612 - accuracy: 0.6710 - val\_loss: 0.8491 - val\_accuracy: 0.7000

Epoch 158/200

5/5 [==============================] - 8s 2s/step - loss: 0.9025 - accuracy: 0.6710 - val\_loss: 1.1950 - val\_accuracy: 0.7000

Epoch 159/200

5/5 [==============================] - 8s 2s/step - loss: 0.8225 - accuracy: 0.6839 - val\_loss: 1.3141 - val\_accuracy: 0.6000

Epoch 160/200

5/5 [==============================] - 8s 2s/step - loss: 0.9105 - accuracy: 0.7032 - val\_loss: 1.1149 - val\_accuracy: 0.6000

Epoch 161/200

5/5 [==============================] - 8s 2s/step - loss: 0.8228 - accuracy: 0.7032 - val\_loss: 1.4620 - val\_accuracy: 0.4000

Epoch 162/200

5/5 [==============================] - 8s 2s/step - loss: 0.8729 - accuracy: 0.6645 - val\_loss: 0.9099 - val\_accuracy: 0.5000

Epoch 163/200

5/5 [==============================] - 9s 2s/step - loss: 0.8845 - accuracy: 0.7032 - val\_loss: 1.5322 - val\_accuracy: 0.7000

Epoch 164/200

5/5 [==============================] - 10s 2s/step - loss: 0.9390 - accuracy: 0.6774 - val\_loss: 1.5164 - val\_accuracy: 0.6000

Epoch 165/200

5/5 [==============================] - 9s 2s/step - loss: 0.8004 - accuracy: 0.7097 - val\_loss: 1.1817 - val\_accuracy: 0.5000

Epoch 166/200

5/5 [==============================] - 8s 2s/step - loss: 0.8663 - accuracy: 0.7226 - val\_loss: 1.1187 - val\_accuracy: 0.7000

Epoch 167/200

5/5 [==============================] - 8s 2s/step - loss: 0.8693 - accuracy: 0.6774 - val\_loss: 1.7047 - val\_accuracy: 0.4000

Epoch 168/200

5/5 [==============================] - 9s 2s/step - loss: 0.8928 - accuracy: 0.7032 - val\_loss: 1.3183 - val\_accuracy: 0.4000

Epoch 169/200

5/5 [==============================] - 9s 2s/step - loss: 0.8058 - accuracy: 0.7290 - val\_loss: 0.8447 - val\_accuracy: 0.8000

Epoch 170/200

5/5 [==============================] - 9s 2s/step - loss: 0.7917 - accuracy: 0.7484 - val\_loss: 1.4077 - val\_accuracy: 0.6000

Epoch 171/200

5/5 [==============================] - 9s 2s/step - loss: 0.8590 - accuracy: 0.7290 - val\_loss: 1.1314 - val\_accuracy: 0.6000

Epoch 172/200

5/5 [==============================] - 9s 2s/step - loss: 0.9183 - accuracy: 0.6903 - val\_loss: 2.1571 - val\_accuracy: 0.5000

Epoch 173/200

5/5 [==============================] - 9s 2s/step - loss: 0.7486 - accuracy: 0.7548 - val\_loss: 1.1778 - val\_accuracy: 0.6000

Epoch 174/200

5/5 [==============================] - 9s 2s/step - loss: 0.8149 - accuracy: 0.7097 - val\_loss: 1.4283 - val\_accuracy: 0.7000

Epoch 175/200

5/5 [==============================] - 10s 2s/step - loss: 0.8030 - accuracy: 0.7097 - val\_loss: 0.9804 - val\_accuracy: 0.8000

Epoch 176/200

5/5 [==============================] - 9s 2s/step - loss: 0.8523 - accuracy: 0.7032 - val\_loss: 0.8119 - val\_accuracy: 0.7000

Epoch 177/200

5/5 [==============================] - 10s 2s/step - loss: 0.8054 - accuracy: 0.6903 - val\_loss: 1.3271 - val\_accuracy: 0.7000

Epoch 178/200

5/5 [==============================] - 8s 2s/step - loss: 0.7725 - accuracy: 0.7419 - val\_loss: 1.2235 - val\_accuracy: 0.6000

Epoch 179/200

5/5 [==============================] - 8s 2s/step - loss: 0.7897 - accuracy: 0.7290 - val\_loss: 1.3707 - val\_accuracy: 0.5000

Epoch 180/200

5/5 [==============================] - 8s 2s/step - loss: 0.6934 - accuracy: 0.7613 - val\_loss: 1.4323 - val\_accuracy: 0.6000

Epoch 181/200

5/5 [==============================] - 8s 2s/step - loss: 0.7423 - accuracy: 0.7161 - val\_loss: 1.2599 - val\_accuracy: 0.7000

Epoch 182/200

5/5 [==============================] - 8s 2s/step - loss: 0.7479 - accuracy: 0.7548 - val\_loss: 1.8569 - val\_accuracy: 0.4000

Epoch 183/200

5/5 [==============================] - 8s 2s/step - loss: 0.7217 - accuracy: 0.7742 - val\_loss: 1.2835 - val\_accuracy: 0.5000

Epoch 184/200

5/5 [==============================] - 9s 2s/step - loss: 0.6963 - accuracy: 0.7806 - val\_loss: 0.7349 - val\_accuracy: 0.7000

Epoch 185/200

5/5 [==============================] - 9s 2s/step - loss: 0.7456 - accuracy: 0.7290 - val\_loss: 1.9935 - val\_accuracy: 0.4000

Epoch 186/200

5/5 [==============================] - 9s 2s/step - loss: 0.8214 - accuracy: 0.7161 - val\_loss: 1.0645 - val\_accuracy: 0.5000

Epoch 187/200

5/5 [==============================] - 9s 2s/step - loss: 0.8643 - accuracy: 0.6839 - val\_loss: 1.5490 - val\_accuracy: 0.5000

Epoch 188/200

5/5 [==============================] - 8s 2s/step - loss: 0.8402 - accuracy: 0.6903 - val\_loss: 1.4580 - val\_accuracy: 0.6000

Epoch 189/200

5/5 [==============================] - 8s 2s/step - loss: 0.7916 - accuracy: 0.7097 - val\_loss: 2.5109 - val\_accuracy: 0.3000

Epoch 190/200

5/5 [==============================] - 8s 2s/step - loss: 0.6952 - accuracy: 0.7742 - val\_loss: 1.5360 - val\_accuracy: 0.5000

Epoch 191/200

5/5 [==============================] - 8s 2s/step - loss: 0.7152 - accuracy: 0.7290 - val\_loss: 0.9236 - val\_accuracy: 0.6000

Epoch 192/200

5/5 [==============================] - 8s 2s/step - loss: 0.7521 - accuracy: 0.7419 - val\_loss: 1.2796 - val\_accuracy: 0.4000

Epoch 193/200

5/5 [==============================] - 8s 2s/step - loss: 0.7821 - accuracy: 0.7032 - val\_loss: 1.2357 - val\_accuracy: 0.7000

Epoch 194/200

5/5 [==============================] - 8s 2s/step - loss: 0.7817 - accuracy: 0.7161 - val\_loss: 1.2862 - val\_accuracy: 0.4000

Epoch 195/200

5/5 [==============================] - 8s 2s/step - loss: 0.6605 - accuracy: 0.7742 - val\_loss: 1.1535 - val\_accuracy: 0.7000

Epoch 196/200

5/5 [==============================] - 8s 2s/step - loss: 0.8319 - accuracy: 0.7097 - val\_loss: 0.9167 - val\_accuracy: 0.8000

Epoch 197/200

5/5 [==============================] - 8s 2s/step - loss: 0.9131 - accuracy: 0.7097 - val\_loss: 1.3376 - val\_accuracy: 0.6000

Epoch 198/200

5/5 [==============================] - 8s 2s/step - loss: 0.7875 - accuracy: 0.7484 - val\_loss: 1.8305 - val\_accuracy: 0.5000

Epoch 199/200

5/5 [==============================] - 8s 2s/step - loss: 0.7413 - accuracy: 0.7032 - val\_loss: 2.2711 - val\_accuracy: 0.4000

Epoch 200/200

5/5 [==============================] - 8s 2s/step - loss: 0.7288 - accuracy: 0.7419 - val\_loss: 1.1346 - val\_accuracy: 0.7000

Độ chính xác đạt được đến cao nhất là 78%

**Test kết quả.**

Bảng thực nghiệm kết quả

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Lần 1 | Lần 2 | Lần 3 | Lần 4 | Lần 5 |
| Albert Einstein | ☑ |  |  |  |  |
| Alexander Fleming |  |  |  |  |  |
| Dmitri Mendeleev |  |  |  |  |  |
| Galileo Galilei |  |  |  |  |  |
| Issac Newton |  |  |  |  |  |
| Marie Curie |  |  |  |  |  |
| Michael Faraday |  |  |  |  |  |
| Nicola Tesla |  |  |  |  |  |
| Otto Hahn |  |  |  |  |  |
| Thomas Edison |  |  |  |  |  |