Artificial neural networks and deep learning

Hands-on project Units 1 and 2: Building an artificial neural network

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1. Introducción

El problema a resolver en esta práctica es el de clasificar jugadores de futbol en función a su calidad general como jugador basándose en sus habilidades. Para ello, se utiliza una red de neuronas artificial. El modelo neuronal se ha implementado en Python con Keras y Tensorflow en Google Collab.

El dataset inicial contiene 18207 datos y 89 atributos sobre las habilidades de futbol de los jugadores. Este dataset se limpia usando el notebook *PreparingFootballPlayersDataset.ipynb*. Tras la limpieza, el nuevo dataset contiene 17 atributos que han sido seleccionados porque tiene un valor de correlación mayor que 0.4 en valor absoluto con la puntuación global. Los atributos son: Crossing, Heading Accuracy, Short Passing, Volleys, Dribbling, Curve, Free Kick Accuracy, Long Passing, Ball Control, Reactions, Shot Power, Stamina, Long Shots, Aggression, Positioning, Vision, and Composure. En la entrada, va a haber 16122 datos con 17 columnas (los 17 atributos) con valores entre -1 y 1, y en la salida, dará la puntuación global del jugador. En función de esta puntuación, los jugadores se clasifican en cuatro categorías; *Poor* con puntuación global entre [46, 62], *Intermediate* con puntuación global entre [63, 66], *Good* con puntuación global entre [67, 71] y *Excellent* con puntuación global entre [72, 94].

En la *figura 1*, se puede observar el formato de los atributos de entrada. Se ve como hay 17 columnas, cada una correspondiente a un atributo y que los valores de los datos de entrada varían entre -1 y 1.

Crossing	HeadingAccuracy	ShortPassing	Volleys	Dribbling	Curve	FKAccuracy	LongPassing	BallControl	Reactions	ShotPower	Stamina	LongShots	Aggression	Positioning	Vision	Composure
0.487805	-0.164557	0.260274	0.450	0.301205	0.445783	0.380952	0.297297	0.267606	0.173333	0.432099	0.188406	0.325301	0.268293	0.166667	0.121951	0.027027
0.536585	-0.367089	0.397260	0.300	0.469880	0.397590	0.166667	-0.378378	0.408451	0.306667	0.259259	-0.246377	0.036145	-0.634146	0.404762	0.414634	0.324324
-0.146341	-0.215190	0.041096	-0.350	-0.108434	-0.156627	-0.357143	0.000000	-0.154930	-0.040000	-0.234568	0.246377	-0.277108	-0.048780	0.047619	-0.024390	-0.135135
-0.317073	0.037975	0.260274	-0.025	0.132530	0.228916	-0.142857	0.270270	0.042254	0.146667	0.308642	0.826087	0.108434	0.268293	0.119048	0.121951	0.135135
0.195122	0.139241	0.123288	0.575	0.301205	-0.084337	-0.214286	-0.135135	0.239437	0.173333	0.506173	-0.101449	0.204819	-0.073171	0.428571	0.195122	0.351351
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
-0.560976	0.341772	-0.150685	-0.750	-0.325301	-0.566265	-0.642857	-0.513514	-0.408451	0.253333	-0.283951	0.246377	-0.542169	0.512195	-0.714286	-0.560976	0.081081
0.414634	-0.139241	0.506849	0.200	0.421687	0.590361	0.619048	0.324324	0.352113	0.253333	0.481481	0.101449	0.397590	-0.024390	0.285714	0.439024	0.216216
0.341463	0.063291	0.041096	-0.450	0.060241	0.084337	-0.190476	0.027027	-0.014085	0.093333	0.012346	0.536232	-0.253012	0.512195	0.119048	-0.439024	-0.162162
0.609756	0.443038	0.561644	0.925	0.542169	0.493976	0.642857	0.513514	0.521127	0.573333	0.679012	0.826087	0.710843	0.609756	0.690476	0.560976	0.540541
-0.390244	0.443038	-0.068493	-0.025	0.060241	-0.180723	-0.238095	-0.567568	0.014085	-0.066667	0.160494	-0.188406	0.132530	-0.390244	0.190476	-0.024390	-0.189189

Figura 1. Atributos de entrada.

En la *figura 2*, se puede observar los datos de salida. Estos datos están en codificación *One-hot*, todas columnas tienen valor 0 a excepción de una en el que el valor es 1 y denota a que categoría pertenece el jugador.

Poor:[46.0, 62.0]	Interm:[63.0, 66.0]	Good:[67.0, 71.0]	Excel:[72.0, 94.0]
0.0	0.0	1.0	0.0
0.0	0.0	0.0	1.0
1.0	0.0	0.0	0.0
0.0	1.0	0.0	0.0
0.0	0.0	1.0	0.0
...	...	...	...
0.0	0.0	1.0	0.0
0.0	0.0	1.0	0.0
0.0	1.0	0.0	0.0
0.0	0.0	0.0	1.0
0.0	1.0	0.0	0.0

Figura 2. Datos de salida.

De los datos del dataset limpio, el 80% se utilizarán para el entrenamiento de la red, el 10% para calibrar los hiperparámetros y el 10% restante para test finales para determinar la fiabilidad de la red, por tanto, quedan:

- 12897 datos para **entrenamiento**
- 1612 datos para el **test de desarrollo**
- 1613 datos para **test final**

2. Proceso de diseño

Una vez sabemos los datos con los que vamos a tratar en este problema y cuál es el objetivo de este, vamos a pasar a comentar el proceso de diseño que hemos seguido para la construcción de la red neuronal que nos resuelva dicho problema.

En primer lugar, he de comentar que vamos el seguir el proceso de diseño comentado en clase, ilustrado en la *figura 3*. Este diagrama consiste en primer lugar alcanzar un valor de bias relativamente bajo para después pasar a reducir la varianza, lo que probablemente cause que el bias vuelva a incrementar y se tenga que reducir. Este proceso se sigue de forma iterativa hasta que alcancemos una red neuronal que satisfaga nuestras condiciones.

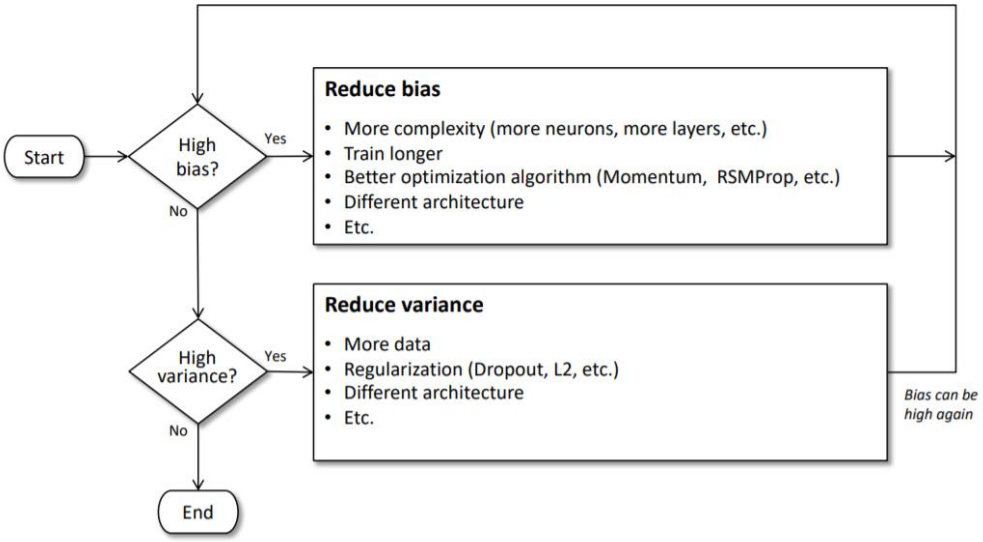

Figura 3. Proceso de diseño de una red neuronal. Tema 2.5. "Regularization", UPM. (2021). M. Molina.

En el caso de las condiciones, lo que se desea es una arquitectura neuronal que sea capaz de realizar un trabajo similar al de un humano. Para el caso de nuestro problema, hemos asumido un error humano del 10%. Este valor está basado en la creencia de que, dado un humano y presentándole las 17 características de un jugador en concreto, nos parece razonable que 1 de cada 10 veces se falle en la clasificación de este jugador.

Con el objetivo de que el proceso de diseño sea replicable, establecemos una semilla de la siguiente forma: *random.seed(10)*.

Pasando ya al proceso al proceso de diseño como tal, la primera arquitectura con la que decidimos comenzar fue una un tanto sencilla, como lo es una arquitectura neuronal con dos capas ocultas, compuestas de 25 neuronas cada una. Además, estas capas tendrán como función de activación una *sigmoidal*. En cuanto al resto de hiperparámetros, estableceremos el número de épocas a 10, el valor de *learning_rate* a 0.1, pues no podemos empezar con algo muy bajo ya que tenemos pocas épocas, y el *batch_size* a 128, pues este debe de ser una potencia de dos y además consideramos que es un valor adecuado teniendo en cuenta el número de casos de entrenamiento de los que disponemos.

Ya teniendo clara la forma que tiene la red neuronal inicial y el valor de sus parámetros, veamos los resultados que obtiene:

```
loss=0.838, categorical_accuracy=0.625, val_loss=0.827, val_categorical_accuracy=0.638
```

Como era de esperar, tanto el valor de *accuracy* en entrenamiento (0.625) como en validación (0.638) es bajo, pues la red es muy simple.

Viendo esto, pasamos a realizar nuestra primera modificación, que tiene como objetivo reducir el bias. Esta modificación consiste en aumentar la complejidad de la arquitectura neuronal, pues ahora constará de tres capas ocultas con 75, 50 y 25 neuronas, respectivamente. Veamos los nuevos resultados:

```
loss=1.26, categorical_accuracy=0.472, val_loss=1.22, val_categorical_accuracy=0.537
```

Seguimos teniendo un bias elevado, de hecho, aún más elevado que antes, puesto que hemos aumentado la complejidad de la red neuronal, pero las funciones de activación siguen siendo "básicas" y el número de épocas parece no ser suficiente. Por tanto, lo siguiente que hicimos fue cambiar la función de activación *sigmoidal* por una *ReLU* (en todas las capas ocultas). Estos son los resultados:

```
loss=0.46, categorical_accuracy=0.796, val_loss=0.427, val_categorical_accuracy=0.821
```

En este caso sí que hemos conseguido reducir drásticamente el bias, pues como hemos visto en teoría, la función de activación ReLU nos aporta una serie de ventajas frente a otras como la sigmoidal o tangente hiperbólica. Ahora, haremos la otra modificación que consideramos más necesaria, aumentar el número de épocas a 100, pues probablemente sean insuficientes. Los resultados obtenidos son los siguientes:

```
loss=0.37, categorical_accuracy=0.839, val_loss=0.43, val_categorical_accuracy=0.823
```

Como era de esperar el bias ha sido reducido pues le hemos dado más tiempo a la red neuronal para aprender. Aun así, la red parece necesitar algo más de tiempo para aprender, pues los valores de *accuracy* no oscilan, sino que no hacen más que incrementar, lo cual es una señal de que necesitamos un mayor número de épocas. En este caso empleamos 500 épocas y estos son los resultados:

```
loss=0.169, categorical_accuracy=0.933, val_loss=0.967, val_categorical_accuracy=0.765
```

De nuevo, hemos reducimos el bias de la red, que ahora tiene un valor negativo, pues el error humano que estamos teniendo en cuenta es incluso mayor que el cometido por la red en entrenamiento. Además, hemos observado que durante el paso de las épocas los valores de *accuracy* ya no crecían de forma lineal y constante como en el caso anterior, sino que se percibían ciertas oscilaciones, lo que indica que subir más las épocas sin realizar cambios previos no tendría mucho sentido.

A lo que hemos de prestar intención es al valor de bias, pues al ser negativo y teniendo en cuenta el proceso de diseño de la figura 3, debemos de pasar ahora a reducir el valor de la varianza del modelo.

Para conseguir esto, lo que hicimos fue introducir a nuestra red un regularizador ya que este permitirá que los pesos de la red (w) no crezcan demasiado y por tanto no se ajusten en exceso (sobreentrenen) a los datos de entrada. En concreto, el regularizador que empleamos es L2 con un factor de regularización (λ) de 0.001 (en todas las capas ocultas y en la capa de salida). Decidimos emplear este y no L1 por su capacidad de lograr mantener los pesos más pequeños, ya que penaliza con estos al cuadrado. Los resultados que obtuvimos fueron los siguientes:

```
loss=0.477, categorical_accuracy=0.816, val_loss=0.473, val_categorical_accuracy=0.832
```

En efecto, el introducir un regularizador hizo que la red no se ajustara tanto a los datos de entrenamiento y por tanto consiguiera generalizar de una mejor forma, lo que lleva a unos mejores resultados sobre los datos de desarrollo (menor varianza), con el inconveniente de que el bias aumenta.

Una vez llegamos a estos resultados, estuvimos realizando una serie de pruebas para ver si conseguíamos reducir el bias sin perder mucha varianza o, al contrario, reducir varianza sin que afectara demasiado al bias. Estas pruebas se compusieron principalmente de cambiar la arquitectura neuronal, tanto número de capas ocultas como de neuronas en esas capas, así como cambiar el número de épocas.

Haciendo esto, observamos que la medida de *accuracy* producía oscilaciones, es decir, a partir de una arquitectura neuronal lo suficientemente compleja como para tratar el problema, las modificaciones que añadíamos no mejoraban los resultados, pues siempre se oscilaba en torno al 82% de precisión en los datos de desarrollo. Por tanto, lo que decidimos fue mantener la arquitectura neuronal que se ha comentado anteriormente y realizamos una serie de pruebas sobre la misma, variando diferentes parámetros con el objetivo de tratar de superar este último valor de *accuracy*, 83.2%.

La primera de las pruebas que hicimos se corresponde con el uso de optimizadores alternativos al que habíamos venido utilizando hasta este momento, con el objetivo de mejorar el bias consiguiendo una precisión mayor con los datos de entrenamiento. Este uso alternativo se fundamenta en el hecho comentado en la asignatura que destaca que cada uno de estos optimizadores puede resultar ser mejor que otro dependiendo del problema que se quiere afrontar. Los optimizadores alternativos que consideramos fueron *Adam*, *SGD* con la variación de *Nesterov* (*NAG*) y *RMSprop*.

Para el primero de los optimizadores, *Adam*, establecimos los hiperparámetros con los valores predefinidos que concreta la librería *Keras* (0.9 para el *momentum decay* y 0.999 para el *scaling decay*) sin alterar la tasa de aprendizaje y se obtuvieron los resultados que se muestran a continuación:

```
loss=0.559, categorical_accuracy=0.776, val_loss=0.545, val_categorical_accuracy=0.806
```

Se puede observar que el uso de este optimizador empeora la precisión con respecto a los datos de entrenamiento, no consiguiendo mejorar el bias que era lo que se buscaba, por lo que descartamos su uso de forma inmediata.

El siguiente optimizador con el que probamos fue *NAG*. De nuevo, no se varió el valor de la tasa de aprendizaje y el valor del factor *momentum* se estableció en 0.9 como se aconseja en la asignatura. Los resultados obtenidos fueron en la línea del optimizador anterior

```
loss=0.508, categorical_accuracy=0.805, val_loss=0.529, val_categorical_accuracy=0.803
```

Donde podemos ver que, si bien el bias mejora ligeramente con respecto a *Adam*, no lo consigue hacer con respecto a los mejores resultados obtenidos hasta el momento. Así que, al no poder reducir el bias, descartamos el uso de este optimizador en pruebas futuras.

El tercero de los optimizadores que comprobamos para la mejora del bias es *RMSprop*. Como viene siendo habitual, el valor de la tasa de aprendizaje se mantiene como hasta ahora y el valor para el *decay rate* se establece en 0.9.

```
loss=0.727, categorical_accuracy=0.72, val_loss=0.753, val_categorical_accuracy=0.731
```

Se puede ver que, de los tres optimizadores con los que se ha experimentado, es el que peor desempeño realiza y el que más bias genera, que es lo contrario a lo que se quería conseguir. Es por ello que, en las posteriores etapas de la experimentación realizada, se volverá al optimizador original SGD.

Las pruebas que se han llevado a cabo a continuación tienen que ver con el uso de funciones de activación diferentes a *ReLU* en las capas ocultas. Esta experimentación no tiene como objetivo reducir el *bias* o la varianza en concreto, sino intentar mejorar el rendimiento general de la red neuronal construida, tratando así con el problema de *vanishing gradient* que podría estar dándose, ya que la red converge rápidamente y el valor de precisión con los datos de entrenamiento se estanca fácilmente. Esto podría deberse también por los datos que se proporcionan en la práctica, pero consideramos que es una prueba con la que no se tiene nada que perder y existe un potencial beneficio general en el desempeño de la red neuronal.

Al igual que con las pruebas anteriores, se van a considerar tres funciones de activación alternativas diferentes; *ELU*, *Leaky ReLU* y *SeLU*. Los resultados se muestran a continuación y cada listado de valores se corresponde con las funciones de activación que tenemos en cuenta respectivamente:

```
loss=0.494, categorical_accuracy=0.808, val_loss=0.479, val_categorical_accuracy=0.829
```

```
loss=0.482, categorical_accuracy=0.814, val_loss=0.516, val_categorical_accuracy=0.81
```

```
loss=0.477, categorical_accuracy=0.816, val_loss=0.472, val_categorical_accuracy=0.829
```

Lo más destacable de los resultados obtenidos es que se obtienen unas métricas muy similares a las obtenidas con la función de activación *ReLU* y apenas tienen impacto en el bias y la varianza, por lo que decidimos no cambiar la función *ReLU* por ninguna de las nombradas.

La siguiente prueba tiene que ver con la experimentación de distintos valores para la tasa de aprendizaje. Con esto lo que se pretende es comprobar qué valor resulta más efectivo para que la red neuronal aprenda de forma consistente y razonablemente rápido sin que se escape demasiado de los óptimos donde cae. Así que probamos con los valores 0.01, y 0.001. Para este último valor realizamos una prueba adicional aumentando el número de épocas a 1000 para que, aunque la red se entrenara lentamente, tuviera margen suficiente de mejora. Los resultados obtenidos son los siguientes, para cada prueba respectivamente:

```
loss=0.471, categorical_accuracy=0.83, val_loss=0.473, val_categorical_accuracy=0.837
```

```
loss=0.595, categorical_accuracy=0.799, val_loss=0.585, val_categorical_accuracy=0.819
```

```
loss=0.553, categorical_accuracy=0.812, val_loss=0.548, val_categorical_accuracy=0.822
```

Existen dos hechos destacables en los resultados obtenidos. El primero es que, para el valor de 0.01 se ha conseguido mejorar tanto el bias como la varianza, ligeramente, pero de forma suficientemente sustancial para establecerlo como nuevo valor para la tasa de aprendizaje. El segundo hecho destacable es que la prueba con más épocas y un valor más bajo para la tasa de aprendizaje no arroja mejores resultados, por lo que se va a mantener el número de épocas en 500. Además, durante el entrenamiento, el valor de precisión para los datos de entrenamiento y validación iba oscilando mucho, pero no mejoraba.

Continuamos la experimentación modificando el tamaño de *batch* con un valor superior e inferior a 128, que es el que veníamos manejando hasta ahora. Con esta idea, al igual que con la prueba anterior, lo que se pretende es mejorar el modelo de manera global, debido al estancamiento que se comentó al inicio de estas pruebas. Los tamaños de *batch* escogidos son 64 y 256 (potencia de 2, por temas de memoria caché) y se obtuvieron los siguientes resultados, respectivamente:

```
loss=0.456, categorical_accuracy=0.831, val_loss=0.473, val_categorical_accuracy=0.829
```

```
loss=0.502, categorical_accuracy=0.822, val_loss=0.503, val_categorical_accuracy=0.831
```

Se puede comprobar que no se obtiene una mejora sustancial del bias o la varianza y concluimos que lo mejor es no alterar este valor, pues con un tamaño de 128 es con el que se ha obtenido un mejor desempeño en el modelo.

Llegados a este punto, una mejora en el bias implica un empeoramiento de la varianza, por lo que no tiene sentido intentar reducirlo nuevamente. Aun a sabiendas que de muy probablemente habíamos alcanzado un buen modelo para la práctica, decidimos seguir probando introduciendo la técnica *dropout* en las capas ocultas. Los resultados obtenidos con probabilidades del 10% y del 20% respectivamente se muestran a continuación:

```
loss=0.519, categorical_accuracy=0.806, val_loss=0.492, val_categorical_accuracy=0.828
```

```
loss=0.554, categorical_accuracy=0.794, val_loss=0.506, val_categorical_accuracy=0.829
```

Como se ve, la varianza empeora y también lo hace la precisión con los datos de entrenamiento, así que descartamos su uso, no sin antes realizar una última prueba introduciendo normalización de batch junto a dropout y L2 (una combinación de 3 regularizadores distintos) con los siguientes resultados obtenidos:

```
loss=0.542, categorical_accuracy=0.784, val_loss=0.48, val_categorical_accuracy=0.821
```

Que apenas aportan algo nuevo al resto de pruebas y se descartó su uso por esa razón.

3. Resultados finales

3.1. Hiperparámetros y modelo final

En esta sección se va a comentar los hiperparámetros que se han utilizado para el modelo final, así como este modelo.

En el modelo final, se ha utilizado una red neuronal con tres capas ocultas, en las que hay 75, 50 y 25 neuronas respectivamente. Como valor de learning rate, α, se ha utilizado 0.01.

En las capas ocultas, la función de activación que se utiliza es la ReLU. Para la salida, se utiliza una función de activación Softmax.

En el entrenamiento, se han utilizado 500 épocas y un tamaño de mini-batch de 128.

A continuación, se muestra el modelo final:

```
# MODELO
n_neurons_per_hidden_layer = [75, 50, 25]
learning_rate = 0.01

model = keras.Sequential(name="my_model")

model.add(keras.layers.InputLayer(input_shape=(INPUTS,)))
for neurons in n_neurons_per_hidden_layer:
  model.add(keras.layers.Dense(neurons, activation="relu",
            kernel_regularizer=keras.regularizers.l2(0.001)))
model.add(keras.layers.Dense(OUTPUTS, activation="softmax",
          kernel_regularizer=keras.regularizers.l2(0.001)))

model.compile(loss=tf.keras.losses.categorical_crossentropy,
              optimizer=tf.keras.optimizers.SGD(learning_rate=learn
ing_rate),
              metrics=["categorical_accuracy"])

# ENTRENAMIENTO
n_epochs = 500
batch_size = 128
start_time = time.perf_counter()

history = model.fit(x_train, t_train,
                    batch_size = batch_size,
                    epochs=n_epochs,
                    verbose = 1,
                    validation_data = (x_dev, t_dev))
```

3.2. Pérdida y accuracy durante el entrenamiento

La siguiente gráfica (*figura 4*), muestra la evolución de la pérdida y la precisión a lo largo del entrenamiento. En esta se puede observar como con el paso de las épocas nuestro modelo va aprendiendo poco a poco, aunque en las épocas finales este aprendizaje no sea tan notable. Además, se puede apreciar como no estamos sobreentrenando la red, pues tanto para el valor de pérdida, como para el de precisión, las diferencias entre estas métricas en sus respectivos resultados de entrenamiento y desarrollo son mínimas (esto se puede apreciar visualmente, pues la línea roja y naranja, que representan la precisión en entrenamiento y desarrollo, respectivamente, están muy juntas, al igual que sucede con las líneas verde y azul).

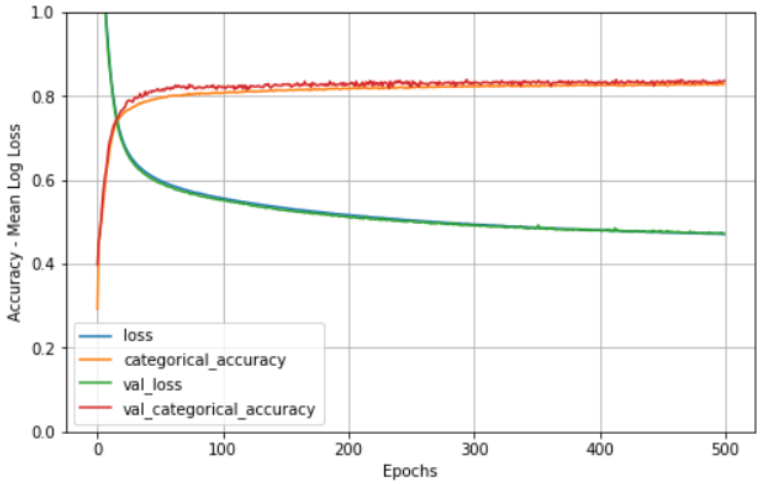

Figura 4. Evolución del accuracy y loss durante el entrenamiento.

El proceso de entrenamiento completo, en el que se muestran los valores de la pérdida (*log loss*) y de precisión (*accuracy*) así como el tiempo de computación para cada época puede encontrase en el anexo.

3.3. Resultados del conjunto de test final

La siguiente tabla (*tabla 1*), muestra la matriz de confusión obtenida con el modelo final. Esta matriz es obtenida durante el test final, comparando los resultados predichos por la red con los resultados objetivo o reales.

		Clase predicha				
		Poor	**Interm**	**Good**	**Excel**	Total
Clase real	**Poor**	364	54	2	0	420
	Interm	56	303	56	0	415
	Good	2	55	337	35	429
	Excel	6	0	38	305	349
	Total	428	412	433	340	1613

Tabla 1. Matriz de confusión.

En cada fila, se muestra cuantas veces se ha predicho cada clase para una clase real determinada. Es decir, la fila *Interm* – columna *Good*, indica el número de veces que, siendo la clase real *Interm*, se ha predicho la clase *Good*. Por ejemplo, en la fila 1, para los casos en los que la clase real es *Poor*, se ha predicho 364 veces *Poor*, 54 *Interm*, 2 *Good* y ninguna *Excel*.

Por lo tanto, en esta matriz los valores de la diagonal principal son número de aciertos y el resto son fallos. Si sumamos los números de la diagonal principal obtenemos 1309, el número total de aciertos, y 304 es el número de fallos (fallos = 1613-1309). Por tanto, obtenemos que el *accuracy* sobre los datos del subconjunto de test es de un 81.15% (*accuracy* = 1309/1613).

La tabla que se muestra a continuación (*tabla 2*), muestra un desglose de los valores *precisión*, *recall*, *f1-score* y *support* para cada clase.

	Precision	**recall**	**f1-score**	**support**
Poor	0.88	0.86	0.87	420
Interm	0.74	0.73	0.73	415
Good	0.78	0.79	0.78	429
Excel	0.90	0.87	0.89	349
micro avg	0.82	0.81	0.81	1613
macro avg	0.82	0.81	0.82	1613
weighted avg	0.82	0.81	0.82	1613
samples avg	0.81	0.81	0.81	1613

Tabla 2. Classification report.

Precision (*true positive* rate) es la proporción de observaciones correctamente predichas para una clase, frente a todas las veces que esta clase ha sido predicha. Por ejemplo, en la *tabla 1* se puede ver que la clase *Good* ha sido predicha correctamente 337 veces (valor de *Good* en la diagonal principal), frente a las 433 veces que ha sido predicha en total (suma de los valores de la columna *Good*). Por lo tanto, el valor de *precision* para la clase *Good* es de 0.78 (*precision* = 337/433).

Recall (*sensitivity*) es la fracción de observaciones correctamente predichas de una clase. Es decir, la proporción de observaciones correctamente predichas, frente a todas las observaciones que tienen realmente esa clase. Por ejemplo, en la *tabla 1* se puede ver que la clase *Good* ha sido predicha correctamente 337 veces (valor de *Good* en la diagonal principal), frente a las 429 observaciones en las que esta es la clase real (suma de los valores de la fila *Good*). Por lo tanto, el valor de *recall* para la clase *Good* es de 0.79 (*recall* = 337/429).

F1-score es la media ponderada entre los valores de *precision* y *recall*. Puede llegar a ser más útil que el *accuracy*, sobretodo cuando la distribución entre clases no es homogénea. El *accuracy* es mejor si *precision* y *recall* tienen costes similares. El *F1-score* se ha calculado de la siguiente forma:

$$F1 - score = \frac{2 \cdot (Precision \cdot Recall)}{Precision + Recall}$$

Así que, por ejemplo, para la clase *Good*, obtenemos un *F1-score* de 0.78.

El valor *support* es cuantas observaciones reales hay de cada clase.

Para calcular los valores de *micro average* se suma todos los dividendos y divisores de cada métrica para cada clase y obtiene el cociente global. Por ejemplo, en *recall* tenemos que los dividendos-divisores de cada clase son: 364/420 *Poor*, 303/415 *Interm*, 337/429 *Good* y 305/349 *Excell*. Por tanto, el valor de *micro average* de esta métrica será 0.81 ($\frac{364+303+337+305}{420+415+429+349} = \frac{1309}{1613}$).

Para el *macro average*, se realiza una media de todas las métricas, dando igual importancia a todas las clases. Por ejemplo, en *recall* tenemos que los valores de esta métrica para cada clase son: 0.86 *Poor*, 0.73 *Interm*, 0.79 *Good* y 0.87 *Excell*. Por tanto, el valor de *macro average* de esta métrica será 0.81 ($\frac{0.86+0.73+0.79+0.87}{4}$).

En *weighted average*, se realiza la media ponderada de las métricas, en las que cada clase tiene un peso en función del número de observaciones de esa clase en los datos reales. Por ejemplo, en *recall* tenemos que los valores de esta métrica y las observaciones reales para cada clase son: 0.86 – 420 *Poor*, 0.73 – 415 *Interm*, 0.79 – 429 *Good* y 0.87 – 349 *Excell*. Por tanto, el valor de *weighted average* de esta métrica será 0.81 ($\frac{0.86 \cdot 420+0.73 \cdot 415+0.79 \cdot 429+0.87 \cdot 349}{4}$).

Para *samples average*, calcula la métrica directamente de los valores totales. Por ejemplo, para *precision*, hay un total de 1309 valores acertados frente a las 1613 observaciones totales, por lo que el *samples average* de *precision* será 0.81 (1309/1613).

4. Conclusiones

Hemos observado que los mejores resultados se obtienen usando tres capas ocultas con 75, 50 y 25 neuronas ocultas en cada una de ellas y con un learning rate de 0.01.

Tras varias pruebas, creemos que no es posible superar el 84% de *accuracy* en el desarrollo, pues hemos trabajado con una amplia cantidad de modelos y ninguno supera esta medida, es más, todos acaban oscilando en ese valor. Esto creemos que puede venir dado por dos motivos, el primer es por la complejidad del problema, pues no es trivial y el segundo sería el preprocesado de datos que se realizó, pues se eliminaron una gran cantidad de atributos que, aunque su correlación con la variable de salida fuera inferior a los que utilizamos en este problema, seguramente siguen siendo relevantes. Por tanto, formas de mejorar estos resultados podrían ser la de emplear una mayor cantidad de atributos (parámetros de entrada) o aumentar el número de datos.

Se puede observar como la red neuronal tiene unos mejores resultados a la hora de predecir las clases extremos (*Poor* y *Excellent*) y peor para los intermedios (*Intermediate* y *Good*), siendo esto lo común también si empleáramos esta tarea a un humano, pues es más fácil simplificar e ir a los extremos, que diferenciar entre si un jugador es intermedio o bueno, pues la línea que separa estos conceptos es más compleja. Aun así, se obtienen buenas métricas en general.

ANEXO

Este anexo contiene el proceso de aprendizaje completo, época a época, del modelo final comentado en el apartado 3.

```
Epoch 1/500
101/101 [==============================] - 1s 4ms/step - loss: 1.4882 - categorical_accuracy: 0.2923 - val_loss: 1.4579 - val_categorical_accuracy: 0.3983
Epoch 2/500
101/101 [==============================] - 0s 2ms/step - loss: 1.4141 - categorical_accuracy: 0.4514 - val_loss: 1.3759 - val_categorical_accuracy: 0.4516
Epoch 3/500
101/101 [==============================] - 0s 2ms/step - loss: 1.3218 - categorical_accuracy: 0.4809 - val_loss: 1.2806 - val_categorical_accuracy: 0.4721
Epoch 4/500
101/101 [==============================] - 0s 2ms/step - loss: 1.2298 - categorical_accuracy: 0.5027 - val_loss: 1.1962 - val_categorical_accuracy: 0.5056
Epoch 5/500
101/101 [==============================] - 0s 2ms/step - loss: 1.1532 - categorical_accuracy: 0.5299 - val_loss: 1.1259 - val_categorical_accuracy: 0.5484
Epoch 6/500
101/101 [==============================] - 0s 2ms/step - loss: 1.0889 - categorical_accuracy: 0.5579 - val_loss: 1.0657 - val_categorical_accuracy: 0.5837
Epoch 7/500
101/101 [==============================] - 0s 3ms/step - loss: 1.0325 - categorical_accuracy: 0.5870 - val_loss: 1.0130 - val_categorical_accuracy: 0.6086
Epoch 8/500
101/101 [==============================] - 0s 2ms/step - loss: 0.9828 - categorical_accuracy: 0.6156 - val_loss: 0.9665 - val_categorical_accuracy: 0.6247
Epoch 9/500
101/101 [==============================] - 0s 2ms/step - loss: 0.9395 - categorical_accuracy: 0.6387 - val_loss: 0.9261 - val_categorical_accuracy: 0.6532
Epoch 10/500
101/101 [==============================] - 0s 2ms/step - loss: 0.9018 - categorical_accuracy: 0.6586 - val_loss: 0.8906 - val_categorical_accuracy: 0.6799
Epoch 11/500
101/101 [==============================] - 0s 2ms/step - loss: 0.8688 - categorical_accuracy: 0.6785 - val_loss: 0.8582 - val_categorical_accuracy: 0.6960
Epoch 12/500
101/101 [==============================] - 0s 2ms/step - loss: 0.8394 - categorical_accuracy: 0.6939 - val_loss: 0.8302 - val_categorical_accuracy: 0.7060
Epoch 13/500
101/101 [==============================] - 0s 2ms/step - loss: 0.8135 - categorical_accuracy: 0.7075 - val_loss: 0.8046 - val_categorical_accuracy: 0.7196
Epoch 14/500
101/101 [==============================] - 0s 2ms/step - loss: 0.7909 - categorical_accuracy: 0.7192 - val_loss: 0.7825 - val_categorical_accuracy: 0.7301
Epoch 15/500
101/101 [==============================] - 0s 2ms/step - loss: 0.7710 - categorical_accuracy: 0.7299 - val_loss: 0.7632 - val_categorical_accuracy: 0.7364
Epoch 16/500
101/101 [==============================] - 0s 2ms/step - loss: 0.7537 - categorical_accuracy: 0.7333 - val_loss: 0.7459 - val_categorical_accuracy: 0.7444
Epoch 17/500
101/101 [==============================] - 0s 2ms/step - loss: 0.7386 - categorical_accuracy: 0.7393 - val_loss: 0.7311 - val_categorical_accuracy: 0.7488
Epoch 18/500
101/101 [==============================] - 0s 2ms/step - loss: 0.7253 - categorical_accuracy: 0.7458 - val_loss: 0.7180 - val_categorical_accuracy: 0.7525
Epoch 19/500
101/101 [==============================] - 0s 2ms/step - loss: 0.7138 - categorical_accuracy: 0.7509 - val_loss: 0.7064 - val_categorical_accuracy: 0.7605
Epoch 20/500
101/101 [==============================] - 0s 2ms/step - loss: 0.7038 - categorical_accuracy: 0.7535 - val_loss: 0.6966 - val_categorical_accuracy: 0.7655
Epoch 21/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6947 - categorical_accuracy: 0.7575 - val_loss: 0.6883 - val_categorical_accuracy: 0.7667
Epoch 22/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6867 - categorical_accuracy: 0.7602 - val_loss: 0.6807 - val_categorical_accuracy: 0.7717
Epoch 23/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6797 - categorical_accuracy: 0.7627 - val_loss: 0.6737 - val_categorical_accuracy: 0.7742
Epoch 24/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6735 - categorical_accuracy: 0.7648 - val_loss: 0.6671 - val_categorical_accuracy: 0.7835
Epoch 25/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6678 - categorical_accuracy: 0.7665 - val_loss: 0.6609 - val_categorical_accuracy: 0.7885
Epoch 26/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6625 - categorical_accuracy: 0.7689 - val_loss: 0.6552 - val_categorical_accuracy: 0.7897
Epoch 27/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6577 - categorical_accuracy: 0.7687 - val_loss: 0.6504 - val_categorical_accuracy: 0.7891
Epoch 28/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6533 - categorical_accuracy: 0.7711 - val_loss: 0.6463 - val_categorical_accuracy: 0.7885
Epoch 29/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6490 - categorical_accuracy: 0.7739 - val_loss: 0.6425 - val_categorical_accuracy: 0.7860
Epoch 30/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6455 - categorical_accuracy: 0.7747 - val_loss: 0.6381 - val_categorical_accuracy: 0.7922
Epoch 31/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6421 - categorical_accuracy: 0.7758 - val_loss: 0.6344 - val_categorical_accuracy: 0.7971
Epoch 32/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6385 - categorical_accuracy: 0.7782 - val_loss: 0.6309 - val_categorical_accuracy: 0.7959
Epoch 33/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6353 - categorical_accuracy: 0.7803 - val_loss: 0.6280 - val_categorical_accuracy: 0.7953
Epoch 34/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6325 - categorical_accuracy: 0.7810 - val_loss: 0.6251 - val_categorical_accuracy: 0.7990
Epoch 35/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6297 - categorical_accuracy: 0.7841 - val_loss: 0.6238 - val_categorical_accuracy: 0.8058
Epoch 36/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6270 - categorical_accuracy: 0.7823 - val_loss: 0.6203 - val_categorical_accuracy: 0.7978
Epoch 37/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6248 - categorical_accuracy: 0.7851 - val_loss: 0.6180 - val_categorical_accuracy: 0.7984
Epoch 38/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6220 - categorical_accuracy: 0.7868 - val_loss: 0.6151 - val_categorical_accuracy: 0.8021
Epoch 39/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6199 - categorical_accuracy: 0.7861 - val_loss: 0.6138 - val_categorical_accuracy: 0.8108
Epoch 40/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6178 - categorical_accuracy: 0.7875 - val_loss: 0.6112 - val_categorical_accuracy: 0.8033
Epoch 41/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6157 - categorical_accuracy: 0.7883 - val_loss: 0.6087 - val_categorical_accuracy: 0.8071
Epoch 42/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6136 - categorical_accuracy: 0.7893 - val_loss: 0.6065 - val_categorical_accuracy: 0.8096
Epoch 43/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6116 - categorical_accuracy: 0.7898 - val_loss: 0.6048 - val_categorical_accuracy: 0.8114
Epoch 44/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6102 - categorical_accuracy: 0.7916 - val_loss: 0.6037 - val_categorical_accuracy: 0.8089
Epoch 45/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6080 - categorical_accuracy: 0.7925 - val_loss: 0.6017 - val_categorical_accuracy: 0.8133
Epoch 46/500
```

```
101/101 [==============================] - 0s 2ms/step - loss: 0.6067 - categorical_accuracy: 0.7911 - val_loss: 0.6008 - val_categorical_accuracy: 0.8114
Epoch 47/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6048 - categorical_accuracy: 0.7931 - val_loss: 0.5978 - val_categorical_accuracy: 0.8127
Epoch 48/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6030 - categorical_accuracy: 0.7943 - val_loss: 0.5960 - val_categorical_accuracy: 0.8151
Epoch 49/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6015 - categorical_accuracy: 0.7942 - val_loss: 0.5951 - val_categorical_accuracy: 0.8170
Epoch 50/500
101/101 [==============================] - 0s 2ms/step - loss: 0.6003 - categorical_accuracy: 0.7956 - val_loss: 0.5943 - val_categorical_accuracy: 0.8127
Epoch 51/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5985 - categorical_accuracy: 0.7971 - val_loss: 0.5917 - val_categorical_accuracy: 0.8145
Epoch 52/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5971 - categorical_accuracy: 0.7955 - val_loss: 0.5926 - val_categorical_accuracy: 0.8127
Epoch 53/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5961 - categorical_accuracy: 0.7972 - val_loss: 0.5904 - val_categorical_accuracy: 0.8170
Epoch 54/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5947 - categorical_accuracy: 0.7976 - val_loss: 0.5888 - val_categorical_accuracy: 0.8133
Epoch 55/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5934 - categorical_accuracy: 0.7982 - val_loss: 0.5869 - val_categorical_accuracy: 0.8158
Epoch 56/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5921 - categorical_accuracy: 0.7970 - val_loss: 0.5854 - val_categorical_accuracy: 0.8201
Epoch 57/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5910 - categorical_accuracy: 0.7993 - val_loss: 0.5847 - val_categorical_accuracy: 0.8182
Epoch 58/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5898 - categorical_accuracy: 0.8010 - val_loss: 0.5837 - val_categorical_accuracy: 0.8195
Epoch 59/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5882 - categorical_accuracy: 0.7996 - val_loss: 0.5843 - val_categorical_accuracy: 0.8164
Epoch 60/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5873 - categorical_accuracy: 0.8013 - val_loss: 0.5825 - val_categorical_accuracy: 0.8207
Epoch 61/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5863 - categorical_accuracy: 0.8010 - val_loss: 0.5808 - val_categorical_accuracy: 0.8182
Epoch 62/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5851 - categorical_accuracy: 0.8009 - val_loss: 0.5798 - val_categorical_accuracy: 0.8213
Epoch 63/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5844 - categorical_accuracy: 0.8016 - val_loss: 0.5774 - val_categorical_accuracy: 0.8257
Epoch 64/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5835 - categorical_accuracy: 0.8017 - val_loss: 0.5769 - val_categorical_accuracy: 0.8213
Epoch 65/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5822 - categorical_accuracy: 0.8007 - val_loss: 0.5760 - val_categorical_accuracy: 0.8244
Epoch 66/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5813 - categorical_accuracy: 0.8010 - val_loss: 0.5751 - val_categorical_accuracy: 0.8251
Epoch 67/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5805 - categorical_accuracy: 0.8021 - val_loss: 0.5747 - val_categorical_accuracy: 0.8213
Epoch 68/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5796 - categorical_accuracy: 0.8016 - val_loss: 0.5737 - val_categorical_accuracy: 0.8207
Epoch 69/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5783 - categorical_accuracy: 0.8035 - val_loss: 0.5725 - val_categorical_accuracy: 0.8232
Epoch 70/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5777 - categorical_accuracy: 0.8014 - val_loss: 0.5713 - val_categorical_accuracy: 0.8232
Epoch 71/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5771 - categorical_accuracy: 0.8034 - val_loss: 0.5715 - val_categorical_accuracy: 0.8189
Epoch 72/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5757 - categorical_accuracy: 0.8046 - val_loss: 0.5712 - val_categorical_accuracy: 0.8201
Epoch 73/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5750 - categorical_accuracy: 0.8027 - val_loss: 0.5709 - val_categorical_accuracy: 0.8182
Epoch 74/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5742 - categorical_accuracy: 0.8061 - val_loss: 0.5677 - val_categorical_accuracy: 0.8275
Epoch 75/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5736 - categorical_accuracy: 0.8041 - val_loss: 0.5673 - val_categorical_accuracy: 0.8226
Epoch 76/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5725 - categorical_accuracy: 0.8038 - val_loss: 0.5663 - val_categorical_accuracy: 0.8257
Epoch 77/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5720 - categorical_accuracy: 0.8057 - val_loss: 0.5669 - val_categorical_accuracy: 0.8226
Epoch 78/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5707 - categorical_accuracy: 0.8045 - val_loss: 0.5667 - val_categorical_accuracy: 0.8189
Epoch 79/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5703 - categorical_accuracy: 0.8052 - val_loss: 0.5657 - val_categorical_accuracy: 0.8182
Epoch 80/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5696 - categorical_accuracy: 0.8070 - val_loss: 0.5641 - val_categorical_accuracy: 0.8201
Epoch 81/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5691 - categorical_accuracy: 0.8060 - val_loss: 0.5645 - val_categorical_accuracy: 0.8201
Epoch 82/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5683 - categorical_accuracy: 0.8045 - val_loss: 0.5621 - val_categorical_accuracy: 0.8226
Epoch 83/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5676 - categorical_accuracy: 0.8076 - val_loss: 0.5619 - val_categorical_accuracy: 0.8207
Epoch 84/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5672 - categorical_accuracy: 0.8061 - val_loss: 0.5609 - val_categorical_accuracy: 0.8195
Epoch 85/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5660 - categorical_accuracy: 0.8069 - val_loss: 0.5602 - val_categorical_accuracy: 0.8201
Epoch 86/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5651 - categorical_accuracy: 0.8062 - val_loss: 0.5626 - val_categorical_accuracy: 0.8201
Epoch 87/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5650 - categorical_accuracy: 0.8055 - val_loss: 0.5587 - val_categorical_accuracy: 0.8207
Epoch 88/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5643 - categorical_accuracy: 0.8066 - val_loss: 0.5583 - val_categorical_accuracy: 0.8244
Epoch 89/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5637 - categorical_accuracy: 0.8059 - val_loss: 0.5583 - val_categorical_accuracy: 0.8213
Epoch 90/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5628 - categorical_accuracy: 0.8068 - val_loss: 0.5579 - val_categorical_accuracy: 0.8213
Epoch 91/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5622 - categorical_accuracy: 0.8058 - val_loss: 0.5572 - val_categorical_accuracy: 0.8238
Epoch 92/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5613 - categorical_accuracy: 0.8077 - val_loss: 0.5562 - val_categorical_accuracy: 0.8213
Epoch 93/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5611 - categorical_accuracy: 0.8079 - val_loss: 0.5553 - val_categorical_accuracy: 0.8263
Epoch 94/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5605 - categorical_accuracy: 0.8065 - val_loss: 0.5557 - val_categorical_accuracy: 0.8207
Epoch 95/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5592 - categorical_accuracy: 0.8080 - val_loss: 0.5543 - val_categorical_accuracy: 0.8213
Epoch 96/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5590 - categorical_accuracy: 0.8083 - val_loss: 0.5551 - val_categorical_accuracy: 0.8164
```

```
Epoch 97/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5587 - categorical_accuracy: 0.8069 - val_loss: 0.5534 - val_categorical_accuracy: 0.8238
Epoch 98/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5583 - categorical_accuracy: 0.8072 - val_loss: 0.5526 - val_categorical_accuracy: 0.8232
Epoch 99/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5575 - categorical_accuracy: 0.8073 - val_loss: 0.5532 - val_categorical_accuracy: 0.8232
Epoch 100/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5570 - categorical_accuracy: 0.8076 - val_loss: 0.5522 - val_categorical_accuracy: 0.8201
Epoch 101/500
101/101 [==============================] - 0s 3ms/step - loss: 0.5560 - categorical_accuracy: 0.8084 - val_loss: 0.5521 - val_categorical_accuracy: 0.8220
Epoch 102/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5560 - categorical_accuracy: 0.8080 - val_loss: 0.5512 - val_categorical_accuracy: 0.8226
Epoch 103/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5549 - categorical_accuracy: 0.8092 - val_loss: 0.5516 - val_categorical_accuracy: 0.8182
Epoch 104/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5548 - categorical_accuracy: 0.8096 - val_loss: 0.5498 - val_categorical_accuracy: 0.8220
Epoch 105/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5542 - categorical_accuracy: 0.8082 - val_loss: 0.5494 - val_categorical_accuracy: 0.8238
Epoch 106/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5532 - categorical_accuracy: 0.8104 - val_loss: 0.5488 - val_categorical_accuracy: 0.8232
Epoch 107/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5532 - categorical_accuracy: 0.8090 - val_loss: 0.5481 - val_categorical_accuracy: 0.8213
Epoch 108/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5527 - categorical_accuracy: 0.8094 - val_loss: 0.5477 - val_categorical_accuracy: 0.8220
Epoch 109/500
101/101 [==============================] - 0s 3ms/step - loss: 0.5519 - categorical_accuracy: 0.8094 - val_loss: 0.5471 - val_categorical_accuracy: 0.8244
Epoch 110/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5512 - categorical_accuracy: 0.8091 - val_loss: 0.5479 - val_categorical_accuracy: 0.8164
Epoch 111/500
101/101 [==============================] - 0s 3ms/step - loss: 0.5508 - categorical_accuracy: 0.8084 - val_loss: 0.5460 - val_categorical_accuracy: 0.8226
Epoch 112/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5503 - categorical_accuracy: 0.8086 - val_loss: 0.5469 - val_categorical_accuracy: 0.8182
Epoch 113/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5500 - categorical_accuracy: 0.8085 - val_loss: 0.5459 - val_categorical_accuracy: 0.8232
Epoch 114/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5493 - categorical_accuracy: 0.8094 - val_loss: 0.5443 - val_categorical_accuracy: 0.8257
Epoch 115/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5484 - categorical_accuracy: 0.8106 - val_loss: 0.5447 - val_categorical_accuracy: 0.8213
Epoch 116/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5483 - categorical_accuracy: 0.8096 - val_loss: 0.5438 - val_categorical_accuracy: 0.8257
Epoch 117/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5480 - categorical_accuracy: 0.8104 - val_loss: 0.5458 - val_categorical_accuracy: 0.8170
Epoch 118/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5475 - categorical_accuracy: 0.8103 - val_loss: 0.5423 - val_categorical_accuracy: 0.8251
Epoch 119/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5471 - categorical_accuracy: 0.8114 - val_loss: 0.5441 - val_categorical_accuracy: 0.8251
Epoch 120/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5465 - categorical_accuracy: 0.8103 - val_loss: 0.5432 - val_categorical_accuracy: 0.8151
Epoch 121/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5461 - categorical_accuracy: 0.8120 - val_loss: 0.5413 - val_categorical_accuracy: 0.8220
Epoch 122/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5459 - categorical_accuracy: 0.8112 - val_loss: 0.5414 - val_categorical_accuracy: 0.8182
Epoch 123/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5449 - categorical_accuracy: 0.8111 - val_loss: 0.5395 - val_categorical_accuracy: 0.8251
Epoch 124/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5446 - categorical_accuracy: 0.8107 - val_loss: 0.5390 - val_categorical_accuracy: 0.8238
Epoch 125/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5440 - categorical_accuracy: 0.8109 - val_loss: 0.5382 - val_categorical_accuracy: 0.8238
Epoch 126/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5437 - categorical_accuracy: 0.8119 - val_loss: 0.5382 - val_categorical_accuracy: 0.8226
Epoch 127/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5432 - categorical_accuracy: 0.8103 - val_loss: 0.5390 - val_categorical_accuracy: 0.8226
Epoch 128/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5427 - categorical_accuracy: 0.8111 - val_loss: 0.5372 - val_categorical_accuracy: 0.8232
Epoch 129/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5422 - categorical_accuracy: 0.8117 - val_loss: 0.5364 - val_categorical_accuracy: 0.8251
Epoch 130/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5418 - categorical_accuracy: 0.8113 - val_loss: 0.5363 - val_categorical_accuracy: 0.8232
Epoch 131/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5413 - categorical_accuracy: 0.8119 - val_loss: 0.5363 - val_categorical_accuracy: 0.8213
Epoch 132/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5409 - categorical_accuracy: 0.8111 - val_loss: 0.5362 - val_categorical_accuracy: 0.8220
Epoch 133/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5405 - categorical_accuracy: 0.8116 - val_loss: 0.5356 - val_categorical_accuracy: 0.8207
Epoch 134/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5404 - categorical_accuracy: 0.8114 - val_loss: 0.5340 - val_categorical_accuracy: 0.8263
Epoch 135/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5395 - categorical_accuracy: 0.8121 - val_loss: 0.5338 - val_categorical_accuracy: 0.8282
Epoch 136/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5392 - categorical_accuracy: 0.8124 - val_loss: 0.5337 - val_categorical_accuracy: 0.8257
Epoch 137/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5389 - categorical_accuracy: 0.8120 - val_loss: 0.5347 - val_categorical_accuracy: 0.8294
Epoch 138/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5384 - categorical_accuracy: 0.8138 - val_loss: 0.5340 - val_categorical_accuracy: 0.8226
Epoch 139/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5379 - categorical_accuracy: 0.8140 - val_loss: 0.5342 - val_categorical_accuracy: 0.8195
Epoch 140/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5374 - categorical_accuracy: 0.8136 - val_loss: 0.5331 - val_categorical_accuracy: 0.8220
Epoch 141/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5372 - categorical_accuracy: 0.8115 - val_loss: 0.5311 - val_categorical_accuracy: 0.8263
Epoch 142/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5367 - categorical_accuracy: 0.8130 - val_loss: 0.5309 - val_categorical_accuracy: 0.8257
Epoch 143/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5363 - categorical_accuracy: 0.8158 - val_loss: 0.5324 - val_categorical_accuracy: 0.8282
Epoch 144/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5359 - categorical_accuracy: 0.8137 - val_loss: 0.5298 - val_categorical_accuracy: 0.8263
Epoch 145/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5356 - categorical_accuracy: 0.8145 - val_loss: 0.5291 - val_categorical_accuracy: 0.8251
Epoch 146/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5347 - categorical_accuracy: 0.8147 - val_loss: 0.5285 - val_categorical_accuracy: 0.8257
Epoch 147/500
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101/101 [==============================] - 0s 2ms/step - loss: 0.5346 - categorical_accuracy: 0.8145 - val_loss: 0.5290 - val_categorical_accuracy: 0.8257
Epoch 148/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5347 - categorical_accuracy: 0.8138 - val_loss: 0.5282 - val_categorical_accuracy: 0.8251
Epoch 149/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5339 - categorical_accuracy: 0.8135 - val_loss: 0.5286 - val_categorical_accuracy: 0.8288
Epoch 150/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5333 - categorical_accuracy: 0.8136 - val_loss: 0.5280 - val_categorical_accuracy: 0.8282
Epoch 151/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5333 - categorical_accuracy: 0.8145 - val_loss: 0.5276 - val_categorical_accuracy: 0.8275
Epoch 152/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5327 - categorical_accuracy: 0.8136 - val_loss: 0.5279 - val_categorical_accuracy: 0.8288
Epoch 153/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5322 - categorical_accuracy: 0.8145 - val_loss: 0.5260 - val_categorical_accuracy: 0.8275
Epoch 154/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5318 - categorical_accuracy: 0.8157 - val_loss: 0.5268 - val_categorical_accuracy: 0.8288
Epoch 155/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5314 - categorical_accuracy: 0.8147 - val_loss: 0.5260 - val_categorical_accuracy: 0.8238
Epoch 156/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5309 - categorical_accuracy: 0.8147 - val_loss: 0.5267 - val_categorical_accuracy: 0.8226
Epoch 157/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5309 - categorical_accuracy: 0.8137 - val_loss: 0.5255 - val_categorical_accuracy: 0.8263
Epoch 158/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5307 - categorical_accuracy: 0.8147 - val_loss: 0.5249 - val_categorical_accuracy: 0.8269
Epoch 159/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5301 - categorical_accuracy: 0.8147 - val_loss: 0.5248 - val_categorical_accuracy: 0.8263
Epoch 160/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5296 - categorical_accuracy: 0.8158 - val_loss: 0.5239 - val_categorical_accuracy: 0.8313
Epoch 161/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5291 - categorical_accuracy: 0.8147 - val_loss: 0.5245 - val_categorical_accuracy: 0.8282
Epoch 162/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5291 - categorical_accuracy: 0.8154 - val_loss: 0.5245 - val_categorical_accuracy: 0.8238
Epoch 163/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5289 - categorical_accuracy: 0.8152 - val_loss: 0.5233 - val_categorical_accuracy: 0.8282
Epoch 164/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5284 - categorical_accuracy: 0.8161 - val_loss: 0.5234 - val_categorical_accuracy: 0.8269
Epoch 165/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5279 - categorical_accuracy: 0.8145 - val_loss: 0.5231 - val_categorical_accuracy: 0.8263
Epoch 166/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5276 - categorical_accuracy: 0.8149 - val_loss: 0.5217 - val_categorical_accuracy: 0.8350
Epoch 167/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5273 - categorical_accuracy: 0.8160 - val_loss: 0.5224 - val_categorical_accuracy: 0.8275
Epoch 168/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5272 - categorical_accuracy: 0.8155 - val_loss: 0.5222 - val_categorical_accuracy: 0.8269
Epoch 169/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5268 - categorical_accuracy: 0.8161 - val_loss: 0.5228 - val_categorical_accuracy: 0.8269
Epoch 170/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5262 - categorical_accuracy: 0.8134 - val_loss: 0.5203 - val_categorical_accuracy: 0.8282
Epoch 171/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5259 - categorical_accuracy: 0.8165 - val_loss: 0.5227 - val_categorical_accuracy: 0.8220
Epoch 172/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5258 - categorical_accuracy: 0.8153 - val_loss: 0.5195 - val_categorical_accuracy: 0.8319
Epoch 173/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5253 - categorical_accuracy: 0.8158 - val_loss: 0.5197 - val_categorical_accuracy: 0.8275
Epoch 174/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5248 - categorical_accuracy: 0.8182 - val_loss: 0.5214 - val_categorical_accuracy: 0.8300
Epoch 175/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5248 - categorical_accuracy: 0.8160 - val_loss: 0.5199 - val_categorical_accuracy: 0.8269
Epoch 176/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5241 - categorical_accuracy: 0.8160 - val_loss: 0.5195 - val_categorical_accuracy: 0.8251
Epoch 177/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5238 - categorical_accuracy: 0.8158 - val_loss: 0.5199 - val_categorical_accuracy: 0.8251
Epoch 178/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5234 - categorical_accuracy: 0.8171 - val_loss: 0.5188 - val_categorical_accuracy: 0.8275
Epoch 179/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5234 - categorical_accuracy: 0.8162 - val_loss: 0.5189 - val_categorical_accuracy: 0.8294
Epoch 180/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5231 - categorical_accuracy: 0.8166 - val_loss: 0.5175 - val_categorical_accuracy: 0.8275
Epoch 181/500
101/101 [==============================] - 0s 3ms/step - loss: 0.5225 - categorical_accuracy: 0.8149 - val_loss: 0.5190 - val_categorical_accuracy: 0.8257
Epoch 182/500
101/101 [==============================] - 0s 3ms/step - loss: 0.5225 - categorical_accuracy: 0.8159 - val_loss: 0.5195 - val_categorical_accuracy: 0.8294
Epoch 183/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5221 - categorical_accuracy: 0.8159 - val_loss: 0.5168 - val_categorical_accuracy: 0.8244
Epoch 184/500
101/101 [==============================] - 0s 3ms/step - loss: 0.5216 - categorical_accuracy: 0.8172 - val_loss: 0.5175 - val_categorical_accuracy: 0.8288
Epoch 185/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5215 - categorical_accuracy: 0.8180 - val_loss: 0.5162 - val_categorical_accuracy: 0.8257
Epoch 186/500
101/101 [==============================] - 0s 3ms/step - loss: 0.5211 - categorical_accuracy: 0.8176 - val_loss: 0.5183 - val_categorical_accuracy: 0.8350
Epoch 187/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5205 - categorical_accuracy: 0.8179 - val_loss: 0.5154 - val_categorical_accuracy: 0.8288
Epoch 188/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5205 - categorical_accuracy: 0.8187 - val_loss: 0.5148 - val_categorical_accuracy: 0.8275
Epoch 189/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5203 - categorical_accuracy: 0.8170 - val_loss: 0.5147 - val_categorical_accuracy: 0.8313
Epoch 190/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5197 - categorical_accuracy: 0.8172 - val_loss: 0.5148 - val_categorical_accuracy: 0.8257
Epoch 191/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5191 - categorical_accuracy: 0.8194 - val_loss: 0.5167 - val_categorical_accuracy: 0.8282
Epoch 192/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5190 - categorical_accuracy: 0.8192 - val_loss: 0.5148 - val_categorical_accuracy: 0.8275
Epoch 193/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5189 - categorical_accuracy: 0.8169 - val_loss: 0.5133 - val_categorical_accuracy: 0.8269
Epoch 194/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5191 - categorical_accuracy: 0.8165 - val_loss: 0.5132 - val_categorical_accuracy: 0.8294
Epoch 195/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5186 - categorical_accuracy: 0.8168 - val_loss: 0.5136 - val_categorical_accuracy: 0.8313
Epoch 196/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5177 - categorical_accuracy: 0.8184 - val_loss: 0.5136 - val_categorical_accuracy: 0.8257
Epoch 197/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5179 - categorical_accuracy: 0.8188 - val_loss: 0.5137 - val_categorical_accuracy: 0.8319
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Epoch 198/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5173 - categorical_accuracy: 0.8184 - val_loss: 0.5128 - val_categorical_accuracy: 0.8257
Epoch 199/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5171 - categorical_accuracy: 0.8177 - val_loss: 0.5121 - val_categorical_accuracy: 0.8300
Epoch 200/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5172 - categorical_accuracy: 0.8178 - val_loss: 0.5116 - val_categorical_accuracy: 0.8269
Epoch 201/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5162 - categorical_accuracy: 0.8176 - val_loss: 0.5128 - val_categorical_accuracy: 0.8288
Epoch 202/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5165 - categorical_accuracy: 0.8197 - val_loss: 0.5106 - val_categorical_accuracy: 0.8294
Epoch 203/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5161 - categorical_accuracy: 0.8183 - val_loss: 0.5104 - val_categorical_accuracy: 0.8325
Epoch 204/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5157 - categorical_accuracy: 0.8183 - val_loss: 0.5102 - val_categorical_accuracy: 0.8288
Epoch 205/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5153 - categorical_accuracy: 0.8196 - val_loss: 0.5122 - val_categorical_accuracy: 0.8306
Epoch 206/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5152 - categorical_accuracy: 0.8191 - val_loss: 0.5114 - val_categorical_accuracy: 0.8244
Epoch 207/500
101/101 [==============================] - 0s 3ms/step - loss: 0.5148 - categorical_accuracy: 0.8182 - val_loss: 0.5094 - val_categorical_accuracy: 0.8350
Epoch 208/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5149 - categorical_accuracy: 0.8180 - val_loss: 0.5100 - val_categorical_accuracy: 0.8263
Epoch 209/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5149 - categorical_accuracy: 0.8186 - val_loss: 0.5095 - val_categorical_accuracy: 0.8238
Epoch 210/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5138 - categorical_accuracy: 0.8202 - val_loss: 0.5085 - val_categorical_accuracy: 0.8275
Epoch 211/500
101/101 [==============================] - 0s 3ms/step - loss: 0.5139 - categorical_accuracy: 0.8183 - val_loss: 0.5091 - val_categorical_accuracy: 0.8263
Epoch 212/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5134 - categorical_accuracy: 0.8200 - val_loss: 0.5083 - val_categorical_accuracy: 0.8331
Epoch 213/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5135 - categorical_accuracy: 0.8207 - val_loss: 0.5081 - val_categorical_accuracy: 0.8263
Epoch 214/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5131 - categorical_accuracy: 0.8190 - val_loss: 0.5090 - val_categorical_accuracy: 0.8238
Epoch 215/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5125 - categorical_accuracy: 0.8193 - val_loss: 0.5127 - val_categorical_accuracy: 0.8337
Epoch 216/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5126 - categorical_accuracy: 0.8195 - val_loss: 0.5088 - val_categorical_accuracy: 0.8300
Epoch 217/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5124 - categorical_accuracy: 0.8185 - val_loss: 0.5075 - val_categorical_accuracy: 0.8282
Epoch 218/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5116 - categorical_accuracy: 0.8176 - val_loss: 0.5075 - val_categorical_accuracy: 0.8362
Epoch 219/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5115 - categorical_accuracy: 0.8196 - val_loss: 0.5061 - val_categorical_accuracy: 0.8344
Epoch 220/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5117 - categorical_accuracy: 0.8196 - val_loss: 0.5074 - val_categorical_accuracy: 0.8251
Epoch 221/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5113 - categorical_accuracy: 0.8201 - val_loss: 0.5072 - val_categorical_accuracy: 0.8344
Epoch 222/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5103 - categorical_accuracy: 0.8193 - val_loss: 0.5062 - val_categorical_accuracy: 0.8269
Epoch 223/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5110 - categorical_accuracy: 0.8197 - val_loss: 0.5063 - val_categorical_accuracy: 0.8306
Epoch 224/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5102 - categorical_accuracy: 0.8200 - val_loss: 0.5072 - val_categorical_accuracy: 0.8319
Epoch 225/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5105 - categorical_accuracy: 0.8178 - val_loss: 0.5061 - val_categorical_accuracy: 0.8257
Epoch 226/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5098 - categorical_accuracy: 0.8194 - val_loss: 0.5044 - val_categorical_accuracy: 0.8306
Epoch 227/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5094 - categorical_accuracy: 0.8186 - val_loss: 0.5047 - val_categorical_accuracy: 0.8337
Epoch 228/500
101/101 [==============================] - 0s 3ms/step - loss: 0.5093 - categorical_accuracy: 0.8199 - val_loss: 0.5099 - val_categorical_accuracy: 0.8238
Epoch 229/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5094 - categorical_accuracy: 0.8181 - val_loss: 0.5047 - val_categorical_accuracy: 0.8319
Epoch 230/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5090 - categorical_accuracy: 0.8193 - val_loss: 0.5054 - val_categorical_accuracy: 0.8331
Epoch 231/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5089 - categorical_accuracy: 0.8206 - val_loss: 0.5047 - val_categorical_accuracy: 0.8313
Epoch 232/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5086 - categorical_accuracy: 0.8212 - val_loss: 0.5038 - val_categorical_accuracy: 0.8300
Epoch 233/500
101/101 [==============================] - 0s 3ms/step - loss: 0.5078 - categorical_accuracy: 0.8207 - val_loss: 0.5074 - val_categorical_accuracy: 0.8189
Epoch 234/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5082 - categorical_accuracy: 0.8185 - val_loss: 0.5053 - val_categorical_accuracy: 0.8350
Epoch 235/500
101/101 [==============================] - 0s 3ms/step - loss: 0.5075 - categorical_accuracy: 0.8210 - val_loss: 0.5033 - val_categorical_accuracy: 0.8306
Epoch 236/500
101/101 [==============================] - 0s 3ms/step - loss: 0.5076 - categorical_accuracy: 0.8200 - val_loss: 0.5033 - val_categorical_accuracy: 0.8232
Epoch 237/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5075 - categorical_accuracy: 0.8203 - val_loss: 0.5028 - val_categorical_accuracy: 0.8325
Epoch 238/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5071 - categorical_accuracy: 0.8191 - val_loss: 0.5024 - val_categorical_accuracy: 0.8344
Epoch 239/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5069 - categorical_accuracy: 0.8198 - val_loss: 0.5024 - val_categorical_accuracy: 0.8313
Epoch 240/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5066 - categorical_accuracy: 0.8200 - val_loss: 0.5038 - val_categorical_accuracy: 0.8362
Epoch 241/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5067 - categorical_accuracy: 0.8214 - val_loss: 0.5020 - val_categorical_accuracy: 0.8337
Epoch 242/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5060 - categorical_accuracy: 0.8207 - val_loss: 0.5029 - val_categorical_accuracy: 0.8368
Epoch 243/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5057 - categorical_accuracy: 0.8220 - val_loss: 0.5012 - val_categorical_accuracy: 0.8313
Epoch 244/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5054 - categorical_accuracy: 0.8204 - val_loss: 0.5021 - val_categorical_accuracy: 0.8294
Epoch 245/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5053 - categorical_accuracy: 0.8194 - val_loss: 0.5008 - val_categorical_accuracy: 0.8325
Epoch 246/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5052 - categorical_accuracy: 0.8212 - val_loss: 0.5010 - val_categorical_accuracy: 0.8313
Epoch 247/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5048 - categorical_accuracy: 0.8191 - val_loss: 0.5010 - val_categorical_accuracy: 0.8350
Epoch 248/500
```

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101/101 [==============================] - 0s 2ms/step - loss: 0.5046 - categorical_accuracy: 0.8207 - val_loss: 0.5005 - val_categorical_accuracy: 0.8288
Epoch 249/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5051 - categorical_accuracy: 0.8191 - val_loss: 0.5024 - val_categorical_accuracy: 0.8344
Epoch 250/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5042 - categorical_accuracy: 0.8208 - val_loss: 0.5028 - val_categorical_accuracy: 0.8238
Epoch 251/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5034 - categorical_accuracy: 0.8220 - val_loss: 0.5014 - val_categorical_accuracy: 0.8220
Epoch 252/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5039 - categorical_accuracy: 0.8207 - val_loss: 0.5020 - val_categorical_accuracy: 0.8356
Epoch 253/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5034 - categorical_accuracy: 0.8203 - val_loss: 0.4994 - val_categorical_accuracy: 0.8306
Epoch 254/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5036 - categorical_accuracy: 0.8213 - val_loss: 0.5001 - val_categorical_accuracy: 0.8319
Epoch 255/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5033 - categorical_accuracy: 0.8213 - val_loss: 0.4990 - val_categorical_accuracy: 0.8263
Epoch 256/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5028 - categorical_accuracy: 0.8226 - val_loss: 0.4992 - val_categorical_accuracy: 0.8282
Epoch 257/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5026 - categorical_accuracy: 0.8222 - val_loss: 0.5000 - val_categorical_accuracy: 0.8226
Epoch 258/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5028 - categorical_accuracy: 0.8211 - val_loss: 0.4981 - val_categorical_accuracy: 0.8350
Epoch 259/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5021 - categorical_accuracy: 0.8207 - val_loss: 0.4999 - val_categorical_accuracy: 0.8319
Epoch 260/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5024 - categorical_accuracy: 0.8214 - val_loss: 0.4997 - val_categorical_accuracy: 0.8300
Epoch 261/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5017 - categorical_accuracy: 0.8210 - val_loss: 0.5005 - val_categorical_accuracy: 0.8300
Epoch 262/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5018 - categorical_accuracy: 0.8207 - val_loss: 0.4982 - val_categorical_accuracy: 0.8294
Epoch 263/500
101/101 [==============================] - 0s 3ms/step - loss: 0.5015 - categorical_accuracy: 0.8216 - val_loss: 0.4976 - val_categorical_accuracy: 0.8300
Epoch 264/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5011 - categorical_accuracy: 0.8214 - val_loss: 0.5010 - val_categorical_accuracy: 0.8257
Epoch 265/500
101/101 [==============================] - 0s 3ms/step - loss: 0.5015 - categorical_accuracy: 0.8226 - val_loss: 0.4971 - val_categorical_accuracy: 0.8306
Epoch 266/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5009 - categorical_accuracy: 0.8216 - val_loss: 0.4962 - val_categorical_accuracy: 0.8313
Epoch 267/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5007 - categorical_accuracy: 0.8220 - val_loss: 0.4964 - val_categorical_accuracy: 0.8325
Epoch 268/500
101/101 [==============================] - 0s 2ms/step - loss: 0.5003 - categorical_accuracy: 0.8216 - val_loss: 0.4969 - val_categorical_accuracy: 0.8325
Epoch 269/500
101/101 [==============================] - 0s 3ms/step - loss: 0.5002 - categorical_accuracy: 0.8210 - val_loss: 0.4967 - val_categorical_accuracy: 0.8325
Epoch 270/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4999 - categorical_accuracy: 0.8231 - val_loss: 0.4961 - val_categorical_accuracy: 0.8306
Epoch 271/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4999 - categorical_accuracy: 0.8216 - val_loss: 0.4961 - val_categorical_accuracy: 0.8319
Epoch 272/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4995 - categorical_accuracy: 0.8239 - val_loss: 0.4996 - val_categorical_accuracy: 0.8263
Epoch 273/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4994 - categorical_accuracy: 0.8221 - val_loss: 0.4974 - val_categorical_accuracy: 0.8344
Epoch 274/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4997 - categorical_accuracy: 0.8217 - val_loss: 0.4965 - val_categorical_accuracy: 0.8319
Epoch 275/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4990 - categorical_accuracy: 0.8238 - val_loss: 0.4956 - val_categorical_accuracy: 0.8294
Epoch 276/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4985 - categorical_accuracy: 0.8224 - val_loss: 0.4962 - val_categorical_accuracy: 0.8288
Epoch 277/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4989 - categorical_accuracy: 0.8225 - val_loss: 0.4958 - val_categorical_accuracy: 0.8306
Epoch 278/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4985 - categorical_accuracy: 0.8229 - val_loss: 0.4954 - val_categorical_accuracy: 0.8325
Epoch 279/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4980 - categorical_accuracy: 0.8220 - val_loss: 0.4952 - val_categorical_accuracy: 0.8325
Epoch 280/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4980 - categorical_accuracy: 0.8227 - val_loss: 0.4946 - val_categorical_accuracy: 0.8319
Epoch 281/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4974 - categorical_accuracy: 0.8229 - val_loss: 0.4950 - val_categorical_accuracy: 0.8337
Epoch 282/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4981 - categorical_accuracy: 0.8222 - val_loss: 0.4966 - val_categorical_accuracy: 0.8306
Epoch 283/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4972 - categorical_accuracy: 0.8221 - val_loss: 0.4975 - val_categorical_accuracy: 0.8275
Epoch 284/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4976 - categorical_accuracy: 0.8221 - val_loss: 0.4936 - val_categorical_accuracy: 0.8344
Epoch 285/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4970 - categorical_accuracy: 0.8231 - val_loss: 0.4938 - val_categorical_accuracy: 0.8325
Epoch 286/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4964 - categorical_accuracy: 0.8231 - val_loss: 0.4977 - val_categorical_accuracy: 0.8226
Epoch 287/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4968 - categorical_accuracy: 0.8229 - val_loss: 0.4941 - val_categorical_accuracy: 0.8319
Epoch 288/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4964 - categorical_accuracy: 0.8229 - val_loss: 0.4940 - val_categorical_accuracy: 0.8306
Epoch 289/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4967 - categorical_accuracy: 0.8231 - val_loss: 0.4927 - val_categorical_accuracy: 0.8313
Epoch 290/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4962 - categorical_accuracy: 0.8226 - val_loss: 0.4936 - val_categorical_accuracy: 0.8319
Epoch 291/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4959 - categorical_accuracy: 0.8225 - val_loss: 0.4920 - val_categorical_accuracy: 0.8325
Epoch 292/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4957 - categorical_accuracy: 0.8227 - val_loss: 0.4922 - val_categorical_accuracy: 0.8282
Epoch 293/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4958 - categorical_accuracy: 0.8227 - val_loss: 0.4927 - val_categorical_accuracy: 0.8325
Epoch 294/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4955 - categorical_accuracy: 0.8238 - val_loss: 0.4927 - val_categorical_accuracy: 0.8337
Epoch 295/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4954 - categorical_accuracy: 0.8227 - val_loss: 0.4953 - val_categorical_accuracy: 0.8393
Epoch 296/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4953 - categorical_accuracy: 0.8221 - val_loss: 0.4915 - val_categorical_accuracy: 0.8319
Epoch 297/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4951 - categorical_accuracy: 0.8242 - val_loss: 0.4919 - val_categorical_accuracy: 0.8306
Epoch 298/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4947 - categorical_accuracy: 0.8235 - val_loss: 0.4926 - val_categorical_accuracy: 0.8331
```

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Epoch 299/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4946 - categorical_accuracy: 0.8226 - val_loss: 0.4916 - val_categorical_accuracy: 0.8294
Epoch 300/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4941 - categorical_accuracy: 0.8238 - val_loss: 0.4930 - val_categorical_accuracy: 0.8325
Epoch 301/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4943 - categorical_accuracy: 0.8225 - val_loss: 0.4906 - val_categorical_accuracy: 0.8306
Epoch 302/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4937 - categorical_accuracy: 0.8245 - val_loss: 0.4923 - val_categorical_accuracy: 0.8337
Epoch 303/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4939 - categorical_accuracy: 0.8232 - val_loss: 0.4912 - val_categorical_accuracy: 0.8319
Epoch 304/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4937 - categorical_accuracy: 0.8233 - val_loss: 0.4928 - val_categorical_accuracy: 0.8319
Epoch 305/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4936 - categorical_accuracy: 0.8228 - val_loss: 0.4900 - val_categorical_accuracy: 0.8306
Epoch 306/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4936 - categorical_accuracy: 0.8235 - val_loss: 0.4910 - val_categorical_accuracy: 0.8275
Epoch 307/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4934 - categorical_accuracy: 0.8239 - val_loss: 0.4903 - val_categorical_accuracy: 0.8306
Epoch 308/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4929 - categorical_accuracy: 0.8234 - val_loss: 0.4911 - val_categorical_accuracy: 0.8337
Epoch 309/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4928 - categorical_accuracy: 0.8234 - val_loss: 0.4913 - val_categorical_accuracy: 0.8325
Epoch 310/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4928 - categorical_accuracy: 0.8234 - val_loss: 0.4907 - val_categorical_accuracy: 0.8325
Epoch 311/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4923 - categorical_accuracy: 0.8252 - val_loss: 0.4896 - val_categorical_accuracy: 0.8337
Epoch 312/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4923 - categorical_accuracy: 0.8243 - val_loss: 0.4910 - val_categorical_accuracy: 0.8325
Epoch 313/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4922 - categorical_accuracy: 0.8228 - val_loss: 0.4889 - val_categorical_accuracy: 0.8306
Epoch 314/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4919 - categorical_accuracy: 0.8241 - val_loss: 0.4891 - val_categorical_accuracy: 0.8319
Epoch 315/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4919 - categorical_accuracy: 0.8246 - val_loss: 0.4883 - val_categorical_accuracy: 0.8300
Epoch 316/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4921 - categorical_accuracy: 0.8231 - val_loss: 0.4888 - val_categorical_accuracy: 0.8344
Epoch 317/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4916 - categorical_accuracy: 0.8228 - val_loss: 0.4911 - val_categorical_accuracy: 0.8319
Epoch 318/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4914 - categorical_accuracy: 0.8243 - val_loss: 0.4886 - val_categorical_accuracy: 0.8344
Epoch 319/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4914 - categorical_accuracy: 0.8250 - val_loss: 0.4885 - val_categorical_accuracy: 0.8331
Epoch 320/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4914 - categorical_accuracy: 0.8238 - val_loss: 0.4897 - val_categorical_accuracy: 0.8344
Epoch 321/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4912 - categorical_accuracy: 0.8226 - val_loss: 0.4906 - val_categorical_accuracy: 0.8294
Epoch 322/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4911 - categorical_accuracy: 0.8241 - val_loss: 0.4878 - val_categorical_accuracy: 0.8325
Epoch 323/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4907 - categorical_accuracy: 0.8255 - val_loss: 0.4896 - val_categorical_accuracy: 0.8368
Epoch 324/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4910 - categorical_accuracy: 0.8231 - val_loss: 0.4881 - val_categorical_accuracy: 0.8325
Epoch 325/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4905 - categorical_accuracy: 0.8238 - val_loss: 0.4873 - val_categorical_accuracy: 0.8313
Epoch 326/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4902 - categorical_accuracy: 0.8260 - val_loss: 0.4868 - val_categorical_accuracy: 0.8325
Epoch 327/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4900 - categorical_accuracy: 0.8249 - val_loss: 0.4876 - val_categorical_accuracy: 0.8331
Epoch 328/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4894 - categorical_accuracy: 0.8253 - val_loss: 0.4866 - val_categorical_accuracy: 0.8300
Epoch 329/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4897 - categorical_accuracy: 0.8250 - val_loss: 0.4883 - val_categorical_accuracy: 0.8337
Epoch 330/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4895 - categorical_accuracy: 0.8239 - val_loss: 0.4877 - val_categorical_accuracy: 0.8344
Epoch 331/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4891 - categorical_accuracy: 0.8238 - val_loss: 0.4902 - val_categorical_accuracy: 0.8275
Epoch 332/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4894 - categorical_accuracy: 0.8233 - val_loss: 0.4876 - val_categorical_accuracy: 0.8350
Epoch 333/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4888 - categorical_accuracy: 0.8255 - val_loss: 0.4865 - val_categorical_accuracy: 0.8313
Epoch 334/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4888 - categorical_accuracy: 0.8234 - val_loss: 0.4863 - val_categorical_accuracy: 0.8337
Epoch 335/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4884 - categorical_accuracy: 0.8247 - val_loss: 0.4873 - val_categorical_accuracy: 0.8337
Epoch 336/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4885 - categorical_accuracy: 0.8248 - val_loss: 0.4871 - val_categorical_accuracy: 0.8294
Epoch 337/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4884 - categorical_accuracy: 0.8241 - val_loss: 0.4865 - val_categorical_accuracy: 0.8337
Epoch 338/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4883 - categorical_accuracy: 0.8261 - val_loss: 0.4906 - val_categorical_accuracy: 0.8238
Epoch 339/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4883 - categorical_accuracy: 0.8239 - val_loss: 0.4866 - val_categorical_accuracy: 0.8344
Epoch 340/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4887 - categorical_accuracy: 0.8236 - val_loss: 0.4857 - val_categorical_accuracy: 0.8313
Epoch 341/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4879 - categorical_accuracy: 0.8232 - val_loss: 0.4862 - val_categorical_accuracy: 0.8362
Epoch 342/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4884 - categorical_accuracy: 0.8245 - val_loss: 0.4849 - val_categorical_accuracy: 0.8350
Epoch 343/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4879 - categorical_accuracy: 0.8252 - val_loss: 0.4841 - val_categorical_accuracy: 0.8319
Epoch 344/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4877 - categorical_accuracy: 0.8238 - val_loss: 0.4853 - val_categorical_accuracy: 0.8331
Epoch 345/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4871 - categorical_accuracy: 0.8244 - val_loss: 0.4841 - val_categorical_accuracy: 0.8337
Epoch 346/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4869 - categorical_accuracy: 0.8245 - val_loss: 0.4857 - val_categorical_accuracy: 0.8294
Epoch 347/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4869 - categorical_accuracy: 0.8248 - val_loss: 0.4872 - val_categorical_accuracy: 0.8337
Epoch 348/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4865 - categorical_accuracy: 0.8236 - val_loss: 0.4851 - val_categorical_accuracy: 0.8350
Epoch 349/500
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101/101 [==============================] - 0s 3ms/step - loss: 0.4868 - categorical_accuracy: 0.8241 - val_loss: 0.4850 - val_categorical_accuracy: 0.8344
Epoch 350/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4869 - categorical_accuracy: 0.8245 - val_loss: 0.4842 - val_categorical_accuracy: 0.8313
Epoch 351/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4865 - categorical_accuracy: 0.8265 - val_loss: 0.4859 - val_categorical_accuracy: 0.8331
Epoch 352/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4859 - categorical_accuracy: 0.8232 - val_loss: 0.4923 - val_categorical_accuracy: 0.8368
Epoch 353/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4865 - categorical_accuracy: 0.8234 - val_loss: 0.4837 - val_categorical_accuracy: 0.8356
Epoch 354/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4861 - categorical_accuracy: 0.8262 - val_loss: 0.4865 - val_categorical_accuracy: 0.8306
Epoch 355/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4863 - categorical_accuracy: 0.8248 - val_loss: 0.4840 - val_categorical_accuracy: 0.8331
Epoch 356/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4863 - categorical_accuracy: 0.8259 - val_loss: 0.4852 - val_categorical_accuracy: 0.8337
Epoch 357/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4863 - categorical_accuracy: 0.8243 - val_loss: 0.4837 - val_categorical_accuracy: 0.8313
Epoch 358/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4854 - categorical_accuracy: 0.8255 - val_loss: 0.4844 - val_categorical_accuracy: 0.8325
Epoch 359/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4853 - categorical_accuracy: 0.8255 - val_loss: 0.4827 - val_categorical_accuracy: 0.8350
Epoch 360/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4851 - categorical_accuracy: 0.8252 - val_loss: 0.4860 - val_categorical_accuracy: 0.8356
Epoch 361/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4852 - categorical_accuracy: 0.8245 - val_loss: 0.4839 - val_categorical_accuracy: 0.8288
Epoch 362/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4852 - categorical_accuracy: 0.8241 - val_loss: 0.4861 - val_categorical_accuracy: 0.8244
Epoch 363/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4853 - categorical_accuracy: 0.8239 - val_loss: 0.4828 - val_categorical_accuracy: 0.8306
Epoch 364/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4848 - categorical_accuracy: 0.8256 - val_loss: 0.4860 - val_categorical_accuracy: 0.8331
Epoch 365/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4848 - categorical_accuracy: 0.8249 - val_loss: 0.4823 - val_categorical_accuracy: 0.8319
Epoch 366/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4843 - categorical_accuracy: 0.8247 - val_loss: 0.4817 - val_categorical_accuracy: 0.8313
Epoch 367/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4848 - categorical_accuracy: 0.8256 - val_loss: 0.4820 - val_categorical_accuracy: 0.8331
Epoch 368/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4841 - categorical_accuracy: 0.8252 - val_loss: 0.4825 - val_categorical_accuracy: 0.8337
Epoch 369/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4841 - categorical_accuracy: 0.8251 - val_loss: 0.4828 - val_categorical_accuracy: 0.8362
Epoch 370/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4839 - categorical_accuracy: 0.8248 - val_loss: 0.4816 - val_categorical_accuracy: 0.8325
Epoch 371/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4836 - categorical_accuracy: 0.8251 - val_loss: 0.4836 - val_categorical_accuracy: 0.8350
Epoch 372/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4839 - categorical_accuracy: 0.8262 - val_loss: 0.4816 - val_categorical_accuracy: 0.8319
Epoch 373/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4835 - categorical_accuracy: 0.8260 - val_loss: 0.4810 - val_categorical_accuracy: 0.8344
Epoch 374/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4837 - categorical_accuracy: 0.8255 - val_loss: 0.4829 - val_categorical_accuracy: 0.8331
Epoch 375/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4836 - categorical_accuracy: 0.8251 - val_loss: 0.4810 - val_categorical_accuracy: 0.8300
Epoch 376/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4834 - categorical_accuracy: 0.8242 - val_loss: 0.4812 - val_categorical_accuracy: 0.8362
Epoch 377/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4832 - categorical_accuracy: 0.8267 - val_loss: 0.4825 - val_categorical_accuracy: 0.8294
Epoch 378/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4831 - categorical_accuracy: 0.8269 - val_loss: 0.4824 - val_categorical_accuracy: 0.8300
Epoch 379/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4836 - categorical_accuracy: 0.8253 - val_loss: 0.4805 - val_categorical_accuracy: 0.8356
Epoch 380/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4830 - categorical_accuracy: 0.8251 - val_loss: 0.4813 - val_categorical_accuracy: 0.8331
Epoch 381/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4826 - categorical_accuracy: 0.8255 - val_loss: 0.4819 - val_categorical_accuracy: 0.8319
Epoch 382/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4831 - categorical_accuracy: 0.8268 - val_loss: 0.4833 - val_categorical_accuracy: 0.8337
Epoch 383/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4823 - categorical_accuracy: 0.8260 - val_loss: 0.4825 - val_categorical_accuracy: 0.8331
Epoch 384/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4820 - categorical_accuracy: 0.8269 - val_loss: 0.4807 - val_categorical_accuracy: 0.8344
Epoch 385/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4821 - categorical_accuracy: 0.8265 - val_loss: 0.4838 - val_categorical_accuracy: 0.8356
Epoch 386/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4822 - categorical_accuracy: 0.8261 - val_loss: 0.4811 - val_categorical_accuracy: 0.8337
Epoch 387/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4818 - categorical_accuracy: 0.8265 - val_loss: 0.4804 - val_categorical_accuracy: 0.8331
Epoch 388/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4819 - categorical_accuracy: 0.8266 - val_loss: 0.4815 - val_categorical_accuracy: 0.8319
Epoch 389/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4820 - categorical_accuracy: 0.8257 - val_loss: 0.4834 - val_categorical_accuracy: 0.8344
Epoch 390/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4814 - categorical_accuracy: 0.8259 - val_loss: 0.4804 - val_categorical_accuracy: 0.8375
Epoch 391/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4815 - categorical_accuracy: 0.8266 - val_loss: 0.4802 - val_categorical_accuracy: 0.8356
Epoch 392/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4812 - categorical_accuracy: 0.8253 - val_loss: 0.4827 - val_categorical_accuracy: 0.8300
Epoch 393/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4811 - categorical_accuracy: 0.8259 - val_loss: 0.4798 - val_categorical_accuracy: 0.8337
Epoch 394/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4812 - categorical_accuracy: 0.8252 - val_loss: 0.4800 - val_categorical_accuracy: 0.8325
Epoch 395/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4808 - categorical_accuracy: 0.8274 - val_loss: 0.4799 - val_categorical_accuracy: 0.8337
Epoch 396/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4809 - categorical_accuracy: 0.8259 - val_loss: 0.4801 - val_categorical_accuracy: 0.8313
Epoch 397/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4808 - categorical_accuracy: 0.8245 - val_loss: 0.4801 - val_categorical_accuracy: 0.8325
Epoch 398/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4807 - categorical_accuracy: 0.8252 - val_loss: 0.4812 - val_categorical_accuracy: 0.8294
Epoch 399/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4805 - categorical_accuracy: 0.8265 - val_loss: 0.4798 - val_categorical_accuracy: 0.8313
```

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Epoch 400/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4803 - categorical_accuracy: 0.8263 - val_loss: 0.4814 - val_categorical_accuracy: 0.8344
Epoch 401/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4803 - categorical_accuracy: 0.8262 - val_loss: 0.4798 - val_categorical_accuracy: 0.8331
Epoch 402/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4804 - categorical_accuracy: 0.8265 - val_loss: 0.4791 - val_categorical_accuracy: 0.8306
Epoch 403/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4799 - categorical_accuracy: 0.8267 - val_loss: 0.4792 - val_categorical_accuracy: 0.8313
Epoch 404/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4798 - categorical_accuracy: 0.8259 - val_loss: 0.4804 - val_categorical_accuracy: 0.8337
Epoch 405/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4801 - categorical_accuracy: 0.8254 - val_loss: 0.4799 - val_categorical_accuracy: 0.8331
Epoch 406/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4800 - categorical_accuracy: 0.8258 - val_loss: 0.4807 - val_categorical_accuracy: 0.8344
Epoch 407/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4794 - categorical_accuracy: 0.8273 - val_loss: 0.4819 - val_categorical_accuracy: 0.8294
Epoch 408/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4796 - categorical_accuracy: 0.8257 - val_loss: 0.4784 - val_categorical_accuracy: 0.8306
Epoch 409/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4795 - categorical_accuracy: 0.8278 - val_loss: 0.4820 - val_categorical_accuracy: 0.8294
Epoch 410/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4796 - categorical_accuracy: 0.8265 - val_loss: 0.4790 - val_categorical_accuracy: 0.8313
Epoch 411/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4795 - categorical_accuracy: 0.8265 - val_loss: 0.4776 - val_categorical_accuracy: 0.8350
Epoch 412/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4792 - categorical_accuracy: 0.8269 - val_loss: 0.4782 - val_categorical_accuracy: 0.8325
Epoch 413/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4789 - categorical_accuracy: 0.8264 - val_loss: 0.4852 - val_categorical_accuracy: 0.8294
Epoch 414/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4792 - categorical_accuracy: 0.8265 - val_loss: 0.4796 - val_categorical_accuracy: 0.8393
Epoch 415/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4789 - categorical_accuracy: 0.8247 - val_loss: 0.4811 - val_categorical_accuracy: 0.8331
Epoch 416/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4788 - categorical_accuracy: 0.8255 - val_loss: 0.4792 - val_categorical_accuracy: 0.8306
Epoch 417/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4788 - categorical_accuracy: 0.8256 - val_loss: 0.4787 - val_categorical_accuracy: 0.8319
Epoch 418/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4786 - categorical_accuracy: 0.8255 - val_loss: 0.4792 - val_categorical_accuracy: 0.8362
Epoch 419/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4788 - categorical_accuracy: 0.8252 - val_loss: 0.4770 - val_categorical_accuracy: 0.8319
Epoch 420/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4786 - categorical_accuracy: 0.8243 - val_loss: 0.4773 - val_categorical_accuracy: 0.8325
Epoch 421/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4787 - categorical_accuracy: 0.8262 - val_loss: 0.4777 - val_categorical_accuracy: 0.8300
Epoch 422/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4778 - categorical_accuracy: 0.8260 - val_loss: 0.4773 - val_categorical_accuracy: 0.8331
Epoch 423/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4782 - categorical_accuracy: 0.8260 - val_loss: 0.4786 - val_categorical_accuracy: 0.8350
Epoch 424/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4777 - categorical_accuracy: 0.8264 - val_loss: 0.4788 - val_categorical_accuracy: 0.8362
Epoch 425/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4781 - categorical_accuracy: 0.8267 - val_loss: 0.4765 - val_categorical_accuracy: 0.8331
Epoch 426/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4775 - categorical_accuracy: 0.8266 - val_loss: 0.4766 - val_categorical_accuracy: 0.8344
Epoch 427/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4775 - categorical_accuracy: 0.8241 - val_loss: 0.4778 - val_categorical_accuracy: 0.8337
Epoch 428/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4774 - categorical_accuracy: 0.8265 - val_loss: 0.4780 - val_categorical_accuracy: 0.8331
Epoch 429/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4782 - categorical_accuracy: 0.8258 - val_loss: 0.4788 - val_categorical_accuracy: 0.8325
Epoch 430/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4777 - categorical_accuracy: 0.8259 - val_loss: 0.4781 - val_categorical_accuracy: 0.8344
Epoch 431/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4772 - categorical_accuracy: 0.8265 - val_loss: 0.4790 - val_categorical_accuracy: 0.8368
Epoch 432/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4773 - categorical_accuracy: 0.8265 - val_loss: 0.4766 - val_categorical_accuracy: 0.8313
Epoch 433/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4773 - categorical_accuracy: 0.8270 - val_loss: 0.4768 - val_categorical_accuracy: 0.8319
Epoch 434/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4772 - categorical_accuracy: 0.8269 - val_loss: 0.4765 - val_categorical_accuracy: 0.8319
Epoch 435/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4766 - categorical_accuracy: 0.8269 - val_loss: 0.4784 - val_categorical_accuracy: 0.8362
Epoch 436/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4769 - categorical_accuracy: 0.8269 - val_loss: 0.4782 - val_categorical_accuracy: 0.8344
Epoch 437/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4770 - categorical_accuracy: 0.8265 - val_loss: 0.4764 - val_categorical_accuracy: 0.8313
Epoch 438/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4764 - categorical_accuracy: 0.8265 - val_loss: 0.4771 - val_categorical_accuracy: 0.8306
Epoch 439/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4760 - categorical_accuracy: 0.8265 - val_loss: 0.4754 - val_categorical_accuracy: 0.8319
Epoch 440/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4760 - categorical_accuracy: 0.8266 - val_loss: 0.4765 - val_categorical_accuracy: 0.8306
Epoch 441/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4763 - categorical_accuracy: 0.8266 - val_loss: 0.4780 - val_categorical_accuracy: 0.8319
Epoch 442/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4759 - categorical_accuracy: 0.8270 - val_loss: 0.4754 - val_categorical_accuracy: 0.8350
Epoch 443/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4762 - categorical_accuracy: 0.8268 - val_loss: 0.4790 - val_categorical_accuracy: 0.8350
Epoch 444/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4755 - categorical_accuracy: 0.8285 - val_loss: 0.4794 - val_categorical_accuracy: 0.8244
Epoch 445/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4761 - categorical_accuracy: 0.8269 - val_loss: 0.4767 - val_categorical_accuracy: 0.8325
Epoch 446/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4757 - categorical_accuracy: 0.8261 - val_loss: 0.4768 - val_categorical_accuracy: 0.8350
Epoch 447/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4758 - categorical_accuracy: 0.8285 - val_loss: 0.4773 - val_categorical_accuracy: 0.8350
Epoch 448/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4753 - categorical_accuracy: 0.8261 - val_loss: 0.4770 - val_categorical_accuracy: 0.8331
Epoch 449/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4757 - categorical_accuracy: 0.8266 - val_loss: 0.4793 - val_categorical_accuracy: 0.8325
Epoch 450/500
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101/101 [==============================] - 0s 2ms/step - loss: 0.4753 - categorical_accuracy: 0.8274 - val_loss: 0.4752 - val_categorical_accuracy: 0.8313
Epoch 451/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4750 - categorical_accuracy: 0.8264 - val_loss: 0.4772 - val_categorical_accuracy: 0.8368
Epoch 452/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4757 - categorical_accuracy: 0.8266 - val_loss: 0.4751 - val_categorical_accuracy: 0.8319
Epoch 453/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4749 - categorical_accuracy: 0.8258 - val_loss: 0.4760 - val_categorical_accuracy: 0.8300
Epoch 454/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4747 - categorical_accuracy: 0.8278 - val_loss: 0.4776 - val_categorical_accuracy: 0.8337
Epoch 455/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4750 - categorical_accuracy: 0.8241 - val_loss: 0.4788 - val_categorical_accuracy: 0.8362
Epoch 456/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4748 - categorical_accuracy: 0.8272 - val_loss: 0.4775 - val_categorical_accuracy: 0.8356
Epoch 457/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4748 - categorical_accuracy: 0.8277 - val_loss: 0.4750 - val_categorical_accuracy: 0.8313
Epoch 458/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4746 - categorical_accuracy: 0.8285 - val_loss: 0.4773 - val_categorical_accuracy: 0.8356
Epoch 459/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4749 - categorical_accuracy: 0.8274 - val_loss: 0.4771 - val_categorical_accuracy: 0.8356
Epoch 460/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4742 - categorical_accuracy: 0.8265 - val_loss: 0.4751 - val_categorical_accuracy: 0.8337
Epoch 461/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4748 - categorical_accuracy: 0.8272 - val_loss: 0.4754 - val_categorical_accuracy: 0.8306
Epoch 462/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4745 - categorical_accuracy: 0.8274 - val_loss: 0.4766 - val_categorical_accuracy: 0.8368
Epoch 463/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4743 - categorical_accuracy: 0.8286 - val_loss: 0.4756 - val_categorical_accuracy: 0.8344
Epoch 464/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4739 - categorical_accuracy: 0.8274 - val_loss: 0.4770 - val_categorical_accuracy: 0.8375
Epoch 465/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4738 - categorical_accuracy: 0.8289 - val_loss: 0.4745 - val_categorical_accuracy: 0.8319
Epoch 466/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4739 - categorical_accuracy: 0.8287 - val_loss: 0.4756 - val_categorical_accuracy: 0.8393
Epoch 467/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4737 - categorical_accuracy: 0.8279 - val_loss: 0.4749 - val_categorical_accuracy: 0.8368
Epoch 468/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4743 - categorical_accuracy: 0.8271 - val_loss: 0.4740 - val_categorical_accuracy: 0.8344
Epoch 469/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4739 - categorical_accuracy: 0.8283 - val_loss: 0.4754 - val_categorical_accuracy: 0.8300
Epoch 470/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4735 - categorical_accuracy: 0.8283 - val_loss: 0.4742 - val_categorical_accuracy: 0.8331
Epoch 471/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4736 - categorical_accuracy: 0.8267 - val_loss: 0.4745 - val_categorical_accuracy: 0.8325
Epoch 472/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4732 - categorical_accuracy: 0.8269 - val_loss: 0.4761 - val_categorical_accuracy: 0.8356
Epoch 473/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4730 - categorical_accuracy: 0.8272 - val_loss: 0.4774 - val_categorical_accuracy: 0.8350
Epoch 474/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4732 - categorical_accuracy: 0.8267 - val_loss: 0.4740 - val_categorical_accuracy: 0.8350
Epoch 475/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4730 - categorical_accuracy: 0.8283 - val_loss: 0.4754 - val_categorical_accuracy: 0.8300
Epoch 476/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4729 - categorical_accuracy: 0.8274 - val_loss: 0.4761 - val_categorical_accuracy: 0.8356
Epoch 477/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4730 - categorical_accuracy: 0.8258 - val_loss: 0.4744 - val_categorical_accuracy: 0.8356
Epoch 478/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4731 - categorical_accuracy: 0.8297 - val_loss: 0.4741 - val_categorical_accuracy: 0.8337
Epoch 479/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4728 - categorical_accuracy: 0.8280 - val_loss: 0.4740 - val_categorical_accuracy: 0.8344
Epoch 480/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4729 - categorical_accuracy: 0.8285 - val_loss: 0.4731 - val_categorical_accuracy: 0.8350
Epoch 481/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4725 - categorical_accuracy: 0.8274 - val_loss: 0.4736 - val_categorical_accuracy: 0.8313
Epoch 482/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4735 - categorical_accuracy: 0.8271 - val_loss: 0.4734 - val_categorical_accuracy: 0.8331
Epoch 483/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4724 - categorical_accuracy: 0.8276 - val_loss: 0.4742 - val_categorical_accuracy: 0.8381
Epoch 484/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4724 - categorical_accuracy: 0.8293 - val_loss: 0.4738 - val_categorical_accuracy: 0.8350
Epoch 485/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4720 - categorical_accuracy: 0.8286 - val_loss: 0.4735 - val_categorical_accuracy: 0.8362
Epoch 486/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4719 - categorical_accuracy: 0.8283 - val_loss: 0.4741 - val_categorical_accuracy: 0.8331
Epoch 487/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4723 - categorical_accuracy: 0.8265 - val_loss: 0.4728 - val_categorical_accuracy: 0.8319
Epoch 488/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4716 - categorical_accuracy: 0.8286 - val_loss: 0.4755 - val_categorical_accuracy: 0.8331
Epoch 489/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4725 - categorical_accuracy: 0.8291 - val_loss: 0.4743 - val_categorical_accuracy: 0.8319
Epoch 490/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4716 - categorical_accuracy: 0.8286 - val_loss: 0.4723 - val_categorical_accuracy: 0.8325
Epoch 491/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4720 - categorical_accuracy: 0.8274 - val_loss: 0.4738 - val_categorical_accuracy: 0.8319
Epoch 492/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4719 - categorical_accuracy: 0.8284 - val_loss: 0.4744 - val_categorical_accuracy: 0.8337
Epoch 493/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4716 - categorical_accuracy: 0.8269 - val_loss: 0.4729 - val_categorical_accuracy: 0.8337
Epoch 494/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4715 - categorical_accuracy: 0.8286 - val_loss: 0.4727 - val_categorical_accuracy: 0.8319
Epoch 495/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4714 - categorical_accuracy: 0.8266 - val_loss: 0.4734 - val_categorical_accuracy: 0.8331
Epoch 496/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4715 - categorical_accuracy: 0.8283 - val_loss: 0.4740 - val_categorical_accuracy: 0.8375
Epoch 497/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4714 - categorical_accuracy: 0.8294 - val_loss: 0.4736 - val_categorical_accuracy: 0.8337
Epoch 498/500
101/101 [==============================] - 0s 2ms/step - loss: 0.4714 - categorical_accuracy: 0.8284 - val_loss: 0.4748 - val_categorical_accuracy: 0.8337
Epoch 499/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4708 - categorical_accuracy: 0.8272 - val_loss: 0.4735 - val_categorical_accuracy: 0.8356
Epoch 500/500
101/101 [==============================] - 0s 3ms/step - loss: 0.4712 - categorical_accuracy: 0.8301 - val_loss: 0.4725 - val_categorical_accuracy: 0.8368
```