In [2]:
```
%pip install tensorflow==2.11.0 numpy==1.23.5 pandas matplotlib scikit-learn ten
```

```
Requirement already satisfied: tensorflow==2.11.0 in c:\users\erikt\appdata\local
\programs\python\python310\lib\site-packages (2.11.0)Note: you may need to restar
t the kernel to use updated packages.
```

```
WARNING: You are using pip version 21.3.1; however, version 25.1.1 is available.
```

```
Requirement already satisfied: numpy==1.23.5 in c:\users\erikt\appdata\local\prog
rams\python\python310\lib\site-packages (1.23.5)
Requirement already satisfied: pandas in c:\users\erikt\appdata\local\programs\py
thon\python310\lib\site-packages (2.2.3)
Requirement already satisfied: matplotlib in c:\users\erikt\appdata\local\program
s\python\python310\lib\site-packages (3.10.3)
Requirement already satisfied: scikit-learn in c:\users\erikt\appdata\local\progr
ams\python\python310\lib\site-packages (1.6.1)
Requirement already satisfied: tensorflowjs==3.18.0 in c:\users\erikt\appdata\loc
al\programs\python\python310\lib\site-packages (3.18.0)
Requirement already satisfied: tensorflow-intel==2.11.0 in c:\users\erikt\appdata
\local\programs\python\python310\lib\site-packages (from tensorflow==2.11.0) (2.1
1.0)
Requirement already satisfied: packaging~=20.9 in c:\users\erikt\appdata\local\pr
ograms\python\python310\lib\site-packages (from tensorflowjs==3.18.0) (20.9)
Requirement already satisfied: tensorflow-hub<0.13,>=0.7.0 in c:\users\erikt\appd
ata\local\programs\python\python310\lib\site-packages (from tensorflowjs==3.18.0)
(0.12.0)
Requirement already satisfied: six<2,>=1.12.0 in c:\users\erikt\appdata\roaming\p
ython\python310\site-packages (from tensorflowjs==3.18.0) (1.17.0)
Requirement already satisfied: google-pasta>=0.1.1 in c:\users\erikt\appdata\loca
l\programs\python\python310\lib\site-packages (from tensorflow-intel==2.11.0->ten
sorflow==2.11.0) (0.2.0)
Requirement already satisfied: gast<=0.4.0,>=0.2.1 in c:\users\erikt\appdata\loca
l\programs\python\python310\lib\site-packages (from tensorflow-intel==2.11.0->ten
sorflow==2.11.0) (0.4.0)
Requirement already satisfied: grpcio<2.0,>=1.24.3 in c:\users\erikt\appdata\loca
l\programs\python\python310\lib\site-packages (from tensorflow-intel==2.11.0->ten
sorflow==2.11.0) (1.71.0)
Requirement already satisfied: keras<2.12,>=2.11.0 in c:\users\erikt\appdata\loca
l\programs\python\python310\lib\site-packages (from tensorflow-intel==2.11.0->ten
sorflow==2.11.0) (2.11.0)
Requirement already satisfied: protobuf<3.20,>=3.9.2 in c:\users\erikt\appdata\lo
cal\programs\python\python310\lib\site-packages (from tensorflow-intel==2.11.0->t
ensorflow==2.11.0) (3.19.6)
Requirement already satisfied: setuptools in c:\users\erikt\appdata\local\program
s\python\python310\lib\site-packages (from tensorflow-intel==2.11.0->tensorflow==
2.11.0) (57.4.0)
Requirement already satisfied: tensorflow-io-gcs-filesystem>=0.23.1 in c:\users\e
rikt\appdata\local\programs\python\python310\lib\site-packages (from tensorflow-i
ntel==2.11.0->tensorflow==2.11.0) (0.31.0)
Requirement already satisfied: tensorflow-estimator<2.12,>=2.11.0 in c:\users\eri
kt\appdata\local\programs\python\python310\lib\site-packages (from tensorflow-int
el==2.11.0->tensorflow==2.11.0) (2.11.0)
Requirement already satisfied: opt-einsum>=2.3.2 in c:\users\erikt\appdata\local
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orflow==2.11.0) (3.4.0)
Requirement already satisfied: h5py>=2.9.0 in c:\users\erikt\appdata\local\progra
ms\python\python310\lib\site-packages (from tensorflow-intel==2.11.0->tensorflow=
=2.11.0) (3.13.0)
Requirement already satisfied: absl-py>=1.0.0 in c:\users\erikt\appdata\local\pro
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ow==2.11.0) (2.3.0)
Requirement already satisfied: wrapt>=1.11.0 in c:\users\erikt\appdata\local\prog
rams\python\python310\lib\site-packages (from tensorflow-intel==2.11.0->tensorflo
w==2.11.0) (1.17.2)
Requirement already satisfied: flatbuffers>=2.0 in c:\users\erikt\appdata\local\p
rograms\python\python310\lib\site-packages (from tensorflow-intel==2.11.0->tensor
flow==2.11.0) (25.2.10)
Requirement already satisfied: termcolor>=1.1.0 in c:\users\erikt\appdata\local\p
```

```
rograms\python\python310\lib\site-packages (from tensorflow-intel==2.11.0->tensor
flow==2.11.0) (3.1.0)
Requirement already satisfied: tensorboard<2.12,>=2.11 in c:\users\erikt\appdata
\local\programs\python\python310\lib\site-packages (from tensorflow-intel==2.11.0
->tensorflow==2.11.0) (2.11.2)
Requirement already satisfied: typing-extensions>=3.6.6 in c:\users\erikt\appdata
\roaming\python\python310\site-packages (from tensorflow-intel==2.11.0->tensorflo
w==2.11.0) (4.13.2)
Requirement already satisfied: libclang>=13.0.0 in c:\users\erikt\appdata\local\p
rograms\python\python310\lib\site-packages (from tensorflow-intel==2.11.0->tensor
flow==2.11.0) (18.1.1)
Requirement already satisfied: astunparse>=1.6.0 in c:\users\erikt\appdata\local
\programs\python\python310\lib\site-packages (from tensorflow-intel==2.11.0->tens
orflow==2.11.0) (1.6.3)
Requirement already satisfied: pytz>=2020.1 in c:\users\erikt\appdata\local\progr
ams\python\python310\lib\site-packages (from pandas) (2025.2)
Requirement already satisfied: python-dateutil>=2.8.2 in c:\users\erikt\appdata\r
oaming\python\python310\site-packages (from pandas) (2.9.0.post0)
Requirement already satisfied: tzdata>=2022.7 in c:\users\erikt\appdata\local\pro
grams\python\python310\lib\site-packages (from pandas) (2025.2)
Requirement already satisfied: pyparsing>=2.3.1 in c:\users\erikt\appdata\local\p
rograms\python\python310\lib\site-packages (from matplotlib) (3.2.3)
Requirement already satisfied: contourpy>=1.0.1 in c:\users\erikt\appdata\local\p
rograms\python\python310\lib\site-packages (from matplotlib) (1.3.2)
Requirement already satisfied: fonttools>=4.22.0 in c:\users\erikt\appdata\local
\programs\python\python310\lib\site-packages (from matplotlib) (4.58.1)
Requirement already satisfied: pillow>=8 in c:\users\erikt\appdata\local\programs
\python\python310\lib\site-packages (from matplotlib) (11.2.1)
Requirement already satisfied: kiwisolver>=1.3.1 in c:\users\erikt\appdata\local
\programs\python\python310\lib\site-packages (from matplotlib) (1.4.8)
Requirement already satisfied: cycler>=0.10 in c:\users\erikt\appdata\local\progr
ams\python\python310\lib\site-packages (from matplotlib) (0.12.1)
Requirement already satisfied: threadpoolctl>=3.1.0 in c:\users\erikt\appdata\loc
al\programs\python\python310\lib\site-packages (from scikit-learn) (3.6.0)
Requirement already satisfied: joblib>=1.2.0 in c:\users\erikt\appdata\local\prog
rams\python\python310\lib\site-packages (from scikit-learn) (1.5.1)
Requirement already satisfied: scipy>=1.6.0 in c:\users\erikt\appdata\local\progr
ams\python\python310\lib\site-packages (from scikit-learn) (1.15.3)
Requirement already satisfied: wheel<1.0,>=0.23.0 in c:\users\erikt\appdata\local
\programs\python\python310\lib\site-packages (from astunparse>=1.6.0->tensorflow-
intel==2.11.0->tensorflow==2.11.0) (0.45.1)
Requirement already satisfied: tensorboard-data-server<0.7.0,>=0.6.0 in c:\users
\erikt\appdata\local\programs\python\python310\lib\site-packages (from tensorboar
d<2.12,>=2.11->tensorflow-intel==2.11.0->tensorflow==2.11.0) (0.6.1)
Requirement already satisfied: tensorboard-plugin-wit>=1.6.0 in c:\users\erikt\ap
pdata\local\programs\python\python310\lib\site-packages (from tensorboard<2.12,>=
2.11->tensorflow-intel==2.11.0->tensorflow==2.11.0) (1.8.1)
Requirement already satisfied: werkzeug>=1.0.1 in c:\users\erikt\appdata\local\pr
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ow-intel==2.11.0->tensorflow==2.11.0) (3.1.3)
Requirement already satisfied: google-auth-oauthlib<0.5,>=0.4.1 in c:\users\erikt
\appdata\local\programs\python\python310\lib\site-packages (from tensorboard<2.1
2,>=2.11->tensorflow-intel==2.11.0->tensorflow==2.11.0) (0.4.6)
Requirement already satisfied: markdown>=2.6.8 in c:\users\erikt\appdata\local\pr
ograms\python\python310\lib\site-packages (from tensorboard<2.12,>=2.11->tensorfl
ow-intel==2.11.0->tensorflow==2.11.0) (3.8)
Requirement already satisfied: google-auth<3,>=1.6.3 in c:\users\erikt\appdata\lo
cal\programs\python\python310\lib\site-packages (from tensorboard<2.12,>=2.11->te
nsorflow-intel==2.11.0->tensorflow==2.11.0) (2.40.2)
Requirement already satisfied: requests<3,>=2.21.0 in c:\users\erikt\appdata\loca
```

```
l\programs\python\python310\lib\site-packages (from tensorboard<2.12,>=2.11->tens
orflow-intel==2.11.0->tensorflow==2.11.0) (2.26.0)
Requirement already satisfied: pyasn1-modules>=0.2.1 in c:\users\erikt\appdata\lo
cal\programs\python\python310\lib\site-packages (from google-auth<3,>=1.6.3->tens
orboard<2.12,>=2.11->tensorflow-intel==2.11.0->tensorflow==2.11.0) (0.4.2)
Requirement already satisfied: cachetools<6.0,>=2.0.0 in c:\users\erikt\appdata\l
ocal\programs\python\python310\lib\site-packages (from google-auth<3,>=1.6.3->ten
sorboard<2.12,>=2.11->tensorflow-intel==2.11.0->tensorflow==2.11.0) (5.5.2)
Requirement already satisfied: rsa<5,>=3.1.4 in c:\users\erikt\appdata\local\prog
rams\python\python310\lib\site-packages (from google-auth<3,>=1.6.3->tensorboard<
2.12,>=2.11->tensorflow-intel==2.11.0->tensorflow==2.11.0) (4.9.1)
Requirement already satisfied: requests-oauthlib>=0.7.0 in c:\users\erikt\appdata
\local\programs\python\python310\lib\site-packages (from google-auth-oauthlib<0.
5,>=0.4.1->tensorboard<2.12,>=2.11->tensorflow-intel==2.11.0->tensorflow==2.11.0)
(2.0.0)
Requirement already satisfied: charset-normalizer~=2.0.0 in c:\users\erikt\appdat
a\local\programs\python\python310\lib\site-packages (from requests<3,>=2.21.0->te
nsorboard<2.12,>=2.11->tensorflow-intel==2.11.0->tensorflow==2.11.0) (2.0.7)
Requirement already satisfied: certifi>=2017.4.17 in c:\users\erikt\appdata\local
\programs\python\python310\lib\site-packages (from requests<3,>=2.21.0->tensorboa
rd<2.12,>=2.11->tensorflow-intel==2.11.0->tensorflow==2.11.0) (2021.10.8)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in c:\users\erikt\appdata\lo
cal\programs\python\python310\lib\site-packages (from requests<3,>=2.21.0->tensor
board<2.12,>=2.11->tensorflow-intel==2.11.0->tensorflow==2.11.0) (1.26.7)
Requirement already satisfied: idna<4,>=2.5 in c:\users\erikt\appdata\local\progr
ams\python\python310\lib\site-packages (from requests<3,>=2.21.0->tensorboard<2.1
2,>=2.11->tensorflow-intel==2.11.0->tensorflow==2.11.0) (3.3)
Requirement already satisfied: MarkupSafe>=2.1.1 in c:\users\erikt\appdata\local
\programs\python\python310\lib\site-packages (from werkzeug>=1.0.1->tensorboard<
2.12,>=2.11->tensorflow-intel==2.11.0->tensorflow==2.11.0) (3.0.2)
Requirement already satisfied: pyasn1<0.7.0,>=0.6.1 in c:\users\erikt\appdata\loc
al\programs\python\python310\lib\site-packages (from pyasn1-modules>=0.2.1->googl
e-auth<3,>=1.6.3->tensorboard<2.12,>=2.11->tensorflow-intel==2.11.0->tensorflow==
2.11.0) (0.6.1)
Requirement already satisfied: oauthlib>=3.0.0 in c:\users\erikt\appdata\local\pr
ograms\python\python310\lib\site-packages (from requests-oauthlib>=0.7.0->google-
auth-oauthlib<0.5,>=0.4.1->tensorboard<2.12,>=2.11->tensorflow-intel==2.11.0->ten
sorflow==2.11.0) (3.2.2)
```

```
You should consider upgrading via the 'c:\Users\erikt\AppData\Local\Programs\Pyth
on\Python310\python.exe -m pip install --upgrade pip' command.
```

In [ ]:

```python
import tensorflow as tf
import numpy as np
import matplotlib.pyplot as plt
from sklearn.model_selection import train_test_split

# Asegúrate de estar usando las versiones correctas en tu entorno de VS Code
# pip install tensorflow==2.11.0 numpy==1.23.5 matplotlib scikit-learn tensorflo

print(f"TensorFlow version: {tf.__version__}")
print(f"NumPy version: {np.__version__}")

# 1. Generación del Conjunto de Datos directamente en el código
# Generar al menos 1000 temperaturas [cite: 4]
num_samples = 1000
# Rango de temperaturas Fahrenheit (puedes ajustarlo según necesites)
fahrenheit_input = np.linspace(-50, 150, num_samples, dtype=float)
# Fórmula de conversión: C = (F - 32) * 5/9
celsius_output = (fahrenheit_input - 32) * 5/9
```

```
print(f"Generadas {len(fahrenheit_input)} muestras de temperatura.")
print("Ejemplo de datos generados:")
for i in range(5):
    print(f"{fahrenheit_input[i]:.2f}°F -> {celsius_output[i]:.2f}°C")

# 2. División de Datos [cite: 5]
# 80% entrenamiento, 20% prueba inicial [cite: 5]
X_train_full, X_test, y_train_full, y_test = train_test_split(
    fahrenheit_input, celsius_output, test_size=0.2, random_state=42
)
# De los datos de entrenamiento, 5% para validación [cite: 5]
# (0.05 del total es 0.05 / 0.8 = 0.0625 de la porción de entrenamiento)
X_train, X_val, y_train, y_val = train_test_split(
    X_train_full, y_train_full, test_size=0.0625, random_state=42
)

print(f"Muestras de entrenamiento: {len(X_train)}")
print(f"Muestras de validación: {len(X_val)}")
print(f"Muestras de prueba: {len(X_test)}")

# 3. Definición del Modelo
# Para Fahrenheit a Celsius, una capa densa suele ser suficiente.
modelo = tf.keras.Sequential([
    tf.keras.layers.Dense(units=1, input_shape=[1])
])

modelo.summary()

# 4. Compilación del Modelo
modelo.compile(
    optimizer=tf.keras.optimizers.Adam(0.01), # Puedes ajustar la tasa de aprend
    loss='mean_squared_error', # Error Cuadrático Medio
    metrics=['mae'] # Mean Absolute Error (Error Absoluto Medio)
)

# 5. Entrenamiento del Modelo
print("\nComenzando entrenamiento...")
historial = modelo.fit(
    X_train.reshape(-1, 1), y_train, # Asegúrate de que X_train tenga la forma c
    epochs=100, # Ajusta las épocas según sea necesario
    verbose=1,
    validation_data=(X_val.reshape(-1, 1), y_val) # Y X_val también
)
print("Modelo entrenado!")

# 6. Evaluación y Gráficas de pérdida y "precisión" (MAE en este caso) [cite: 6]
plt.figure(figsize=(12, 5))

plt.subplot(1, 2, 1)
plt.plot(historial.history['loss'], label='Pérdida de Entrenamiento')
plt.plot(historial.history['val_loss'], label='Pérdida de Validación')
plt.title('Pérdida del Modelo (MSE)')
plt.xlabel('Épocas')
plt.ylabel('Error Cuadrático Medio')
plt.legend()
plt.grid(True)

plt.subplot(1, 2, 2)
plt.plot(historial.history['mae'], label='MAE de Entrenamiento')
plt.plot(historial.history['val_mae'], label='MAE de Validación')
```

```
plt.title('Error Absoluto Medio del Modelo')
plt.xlabel('Épocas')
plt.ylabel('Error Absoluto Medio')
plt.legend()
plt.grid(True)

plt.tight_layout()
plt.show()

# Evaluar en el conjunto de prueba
print("\nEvaluación en el conjunto de prueba:")
loss, mae = modelo.evaluate(X_test.reshape(-1, 1), y_test, verbose=0)
print(f"Pérdida en prueba (MSE): {loss}")
print(f"Error Absoluto Medio en prueba (MAE): {mae}")

# Hacer una predicción de ejemplo
print("\nEjemplo de predicción:")
temp_f_ejemplo = np.array([32.0, 0.0, 100.0, 212.0])
predicciones_c = modelo.predict(temp_f_ejemplo)
for i, temp_f in enumerate(temp_f_ejemplo):
    real_c = (temp_f - 32) * 5/9
    print(f"Predicción para {temp_f}°F: {predicciones_c[i][0]:.2f}°C (Real: {rea


# 7. Exportación del Modelo a formato H5 [cite: 3]
model_filename = 'fahrenheit_a_celsius.h5'
modelo.save(model_filename)
print(f"Modelo guardado como {model_filename}")

# 8. Comandos para la conversión a TensorFlow.js (ejecutar en la terminal) [cite
# Asegúrate de tener tensorflowjs==3.18.0 instalado en tu entorno:
# pip install tensorflowjs==3.18.0

# Crear carpeta donde se colocarán los archivos resultantes (si no existe):
# (En la terminal)
# mkdir -p carpeta_salida_f2c

# Realizar la exportación a la carpeta de salida:
# (En la terminal)
# tensorflowjs_converter --input_format keras fahrenheit_a_celsius.h5 carpeta_sa
print("\nPara convertir el modelo a TensorFlow.js, ejecuta los siguientes comand
print("1. pip install tensorflowjs==3.18.0 (si aún no lo has hecho)")
print("2. mkdir -p carpeta_salida_f2c")
print(f"3. tensorflowjs_converter --input_format keras {model_filename} carpeta_
```

```
TensorFlow version: 2.11.0
NumPy version: 1.23.5
Generadas 1000 muestras de temperatura.
Ejemplo de datos generados:
-50.00°F -> -45.56°C
-49.80°F -> -45.44°C
-49.60°F -> -45.33°C
-49.40°F -> -45.22°C
-49.20°F -> -45.11°C
Muestras de entrenamiento: 750
Muestras de validación: 50
Muestras de prueba: 200
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense (Dense)               (None, 1)                 2

=================================================================
Total params: 2
Trainable params: 2
Non-trainable params: 0
_________________________________________________________________

Comenzando entrenamiento...
Epoch 1/100
24/24 [==============================] - 0s 7ms/step - loss: 4204.9746 - mae: 53.
3471 - val_loss: 2707.5505 - val_mae: 43.1054
Epoch 2/100
24/24 [==============================] - 0s 2ms/step - loss: 2337.7715 - mae: 40.
5927 - val_loss: 1462.2019 - val_mae: 32.8287
Epoch 3/100
24/24 [==============================] - 0s 2ms/step - loss: 1197.6951 - mae: 30.
6527 - val_loss: 733.6707 - val_mae: 25.1316
Epoch 4/100
24/24 [==============================] - 0s 2ms/step - loss: 588.9411 - mae: 23.0
552 - val_loss: 388.1166 - val_mae: 19.4530
Epoch 5/100
24/24 [==============================] - 0s 2ms/step - loss: 312.1282 - mae: 17.5
440 - val_loss: 243.3388 - val_mae: 15.5043
Epoch 6/100
24/24 [==============================] - 0s 2ms/step - loss: 206.0321 - mae: 13.9
029 - val_loss: 191.9087 - val_mae: 13.0248
Epoch 7/100
24/24 [==============================] - 0s 2ms/step - loss: 171.3251 - mae: 11.6
967 - val_loss: 175.3632 - val_mae: 11.5994
Epoch 8/100
24/24 [==============================] - 0s 2ms/step - loss: 160.6785 - mae: 10.6
130 - val_loss: 170.0278 - val_mae: 11.0255
Epoch 9/100
24/24 [==============================] - 0s 2ms/step - loss: 157.1975 - mae: 10.3
158 - val_loss: 167.3655 - val_mae: 10.7813
Epoch 10/100
24/24 [==============================] - 0s 2ms/step - loss: 155.1755 - mae: 10.2
061 - val_loss: 165.3676 - val_mae: 10.6708
Epoch 11/100
24/24 [==============================] - 0s 2ms/step - loss: 153.4324 - mae: 10.1
386 - val_loss: 163.4525 - val_mae: 10.5955
Epoch 12/100
24/24 [==============================] - 0s 2ms/step - loss: 151.6488 - mae: 10.0
```

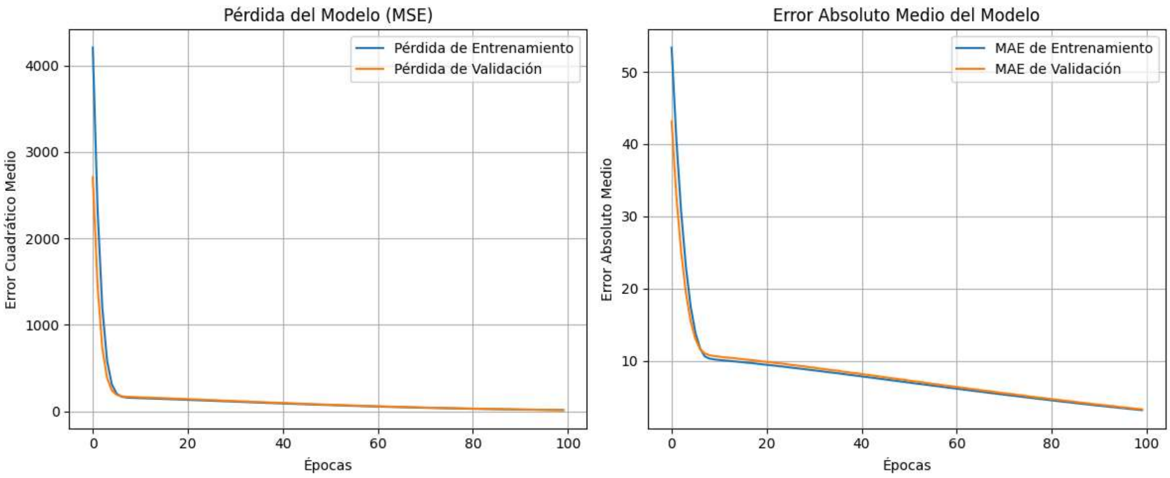
```
706 - val_loss: 161.4868 - val_mae: 10.4976
Epoch 13/100
24/24 [==============================] - 0s 2ms/step - loss: 149.8398 - mae: 10.0
098 - val_loss: 159.5154 - val_mae: 10.4485
Epoch 14/100
24/24 [==============================] - 0s 2ms/step - loss: 147.9763 - mae: 9.94
97 - val_loss: 157.5093 - val_mae: 10.3891
Epoch 15/100
24/24 [==============================] - 0s 2ms/step - loss: 146.0749 - mae: 9.88
57 - val_loss: 155.4309 - val_mae: 10.3111
Epoch 16/100
24/24 [==============================] - 0s 2ms/step - loss: 144.1462 - mae: 9.81
87 - val_loss: 153.3132 - val_mae: 10.2355
Epoch 17/100
24/24 [==============================] - 0s 2ms/step - loss: 142.1705 - mae: 9.75
25 - val_loss: 151.2071 - val_mae: 10.1693
Epoch 18/100
24/24 [==============================] - 0s 2ms/step - loss: 140.2587 - mae: 9.69
44 - val_loss: 149.0398 - val_mae: 10.1094
Epoch 19/100
24/24 [==============================] - 0s 2ms/step - loss: 138.1164 - mae: 9.61
35 - val_loss: 146.8637 - val_mae: 10.0289
Epoch 20/100
24/24 [==============================] - 0s 2ms/step - loss: 136.0968 - mae: 9.53
83 - val_loss: 144.6123 - val_mae: 9.9318
Epoch 21/100
24/24 [==============================] - 0s 2ms/step - loss: 134.0244 - mae: 9.46
49 - val_loss: 142.4849 - val_mae: 9.8718
Epoch 22/100
24/24 [==============================] - 0s 2ms/step - loss: 131.9790 - mae: 9.39
64 - val_loss: 140.2162 - val_mae: 9.8066
Epoch 23/100
24/24 [==============================] - 0s 2ms/step - loss: 129.8842 - mae: 9.32
11 - val_loss: 137.9886 - val_mae: 9.7117
Epoch 24/100
24/24 [==============================] - 0s 2ms/step - loss: 127.8305 - mae: 9.25
08 - val_loss: 135.7564 - val_mae: 9.6564
Epoch 25/100
24/24 [==============================] - 0s 2ms/step - loss: 125.6832 - mae: 9.17
44 - val_loss: 133.4924 - val_mae: 9.5737
Epoch 26/100
24/24 [==============================] - 0s 2ms/step - loss: 123.6197 - mae: 9.08
81 - val_loss: 131.2165 - val_mae: 9.4656
Epoch 27/100
24/24 [==============================] - 0s 2ms/step - loss: 121.4929 - mae: 9.01
15 - val_loss: 128.9307 - val_mae: 9.3875
Epoch 28/100
24/24 [==============================] - 0s 2ms/step - loss: 119.3607 - mae: 8.93
45 - val_loss: 126.6918 - val_mae: 9.3204
Epoch 29/100
24/24 [==============================] - 0s 2ms/step - loss: 117.2273 - mae: 8.85
88 - val_loss: 124.4181 - val_mae: 9.2375
Epoch 30/100
24/24 [==============================] - 0s 2ms/step - loss: 115.1191 - mae: 8.77
31 - val_loss: 122.1380 - val_mae: 9.1222
Epoch 31/100
24/24 [==============================] - 0s 2ms/step - loss: 113.0721 - mae: 8.69
81 - val_loss: 119.9193 - val_mae: 9.0846
Epoch 32/100
24/24 [==============================] - 0s 2ms/step - loss: 110.8877 - mae: 8.61
```

```
29 - val_loss: 117.6157 - val_mae: 8.9594
Epoch 33/100
24/24 [==============================] - 0s 2ms/step - loss: 108.7891 - mae: 8.52
79 - val_loss: 115.4054 - val_mae: 8.8884
Epoch 34/100
24/24 [==============================] - 0s 2ms/step - loss: 106.7085 - mae: 8.44
76 - val_loss: 113.1450 - val_mae: 8.7936
Epoch 35/100
24/24 [==============================] - 0s 2ms/step - loss: 104.6249 - mae: 8.36
36 - val_loss: 110.9474 - val_mae: 8.7099
Epoch 36/100
24/24 [==============================] - 0s 2ms/step - loss: 102.6278 - mae: 8.29
40 - val_loss: 108.6922 - val_mae: 8.6509
Epoch 37/100
24/24 [==============================] - 0s 2ms/step - loss: 100.4325 - mae: 8.19
61 - val_loss: 106.4436 - val_mae: 8.5165
Epoch 38/100
24/24 [==============================] - 0s 2ms/step - loss: 98.4077 - mae: 8.110
3 - val_loss: 104.2500 - val_mae: 8.4452
Epoch 39/100
24/24 [==============================] - 0s 2ms/step - loss: 96.3434 - mae: 8.028
9 - val_loss: 102.0905 - val_mae: 8.3535
Epoch 40/100
24/24 [==============================] - 0s 2ms/step - loss: 94.3324 - mae: 7.947
6 - val_loss: 99.9733 - val_mae: 8.2909
Epoch 41/100
24/24 [==============================] - 0s 2ms/step - loss: 92.3364 - mae: 7.858
9 - val_loss: 97.7889 - val_mae: 8.1754
Epoch 42/100
24/24 [==============================] - 0s 2ms/step - loss: 90.3158 - mae: 7.772
1 - val_loss: 95.6810 - val_mae: 8.1016
Epoch 43/100
24/24 [==============================] - 0s 2ms/step - loss: 88.3501 - mae: 7.689
2 - val_loss: 93.5666 - val_mae: 8.0039
Epoch 44/100
24/24 [==============================] - 0s 2ms/step - loss: 86.3781 - mae: 7.605
8 - val_loss: 91.4697 - val_mae: 7.9228
Epoch 45/100
24/24 [==============================] - 0s 2ms/step - loss: 84.4025 - mae: 7.516
1 - val_loss: 89.3783 - val_mae: 7.8305
Epoch 46/100
24/24 [==============================] - 0s 2ms/step - loss: 82.4972 - mae: 7.436
1 - val_loss: 87.3039 - val_mae: 7.7332
Epoch 47/100
24/24 [==============================] - 0s 2ms/step - loss: 80.5867 - mae: 7.338
4 - val_loss: 85.2533 - val_mae: 7.6302
Epoch 48/100
24/24 [==============================] - 0s 2ms/step - loss: 78.7106 - mae: 7.260
7 - val_loss: 83.2973 - val_mae: 7.5589
Epoch 49/100
24/24 [==============================] - 0s 2ms/step - loss: 76.8822 - mae: 7.169
4 - val_loss: 81.3117 - val_mae: 7.4492
Epoch 50/100
24/24 [==============================] - 0s 2ms/step - loss: 75.0778 - mae: 7.087
3 - val_loss: 79.4046 - val_mae: 7.3895
Epoch 51/100
24/24 [==============================] - 0s 2ms/step - loss: 73.2385 - mae: 7.000
5 - val_loss: 77.4566 - val_mae: 7.2737
Epoch 52/100
24/24 [==============================] - 0s 2ms/step - loss: 71.4709 - mae: 6.909
```

```
0 - val_loss: 75.5614 - val_mae: 7.1699
Epoch 53/100
24/24 [==============================] - 0s 2ms/step - loss: 69.7007 - mae: 6.829
2 - val_loss: 73.7481 - val_mae: 7.1236
Epoch 54/100
24/24 [==============================] - 0s 2ms/step - loss: 67.9675 - mae: 6.745
6 - val_loss: 71.8544 - val_mae: 7.0218
Epoch 55/100
24/24 [==============================] - 0s 2ms/step - loss: 66.2555 - mae: 6.662
1 - val_loss: 69.9901 - val_mae: 6.9190
Epoch 56/100
24/24 [==============================] - 0s 2ms/step - loss: 64.5562 - mae: 6.566
6 - val_loss: 68.2231 - val_mae: 6.8095
Epoch 57/100
24/24 [==============================] - 0s 2ms/step - loss: 62.9603 - mae: 6.492
4 - val_loss: 66.4528 - val_mae: 6.7539
Epoch 58/100
24/24 [==============================] - 0s 2ms/step - loss: 61.2625 - mae: 6.403
0 - val_loss: 64.7112 - val_mae: 6.6421
Epoch 59/100
24/24 [==============================] - 0s 2ms/step - loss: 59.6841 - mae: 6.313
4 - val_loss: 63.0000 - val_mae: 6.5510
Epoch 60/100
24/24 [==============================] - 0s 2ms/step - loss: 58.0859 - mae: 6.236
6 - val_loss: 61.3465 - val_mae: 6.4861
Epoch 61/100
24/24 [==============================] - 0s 2ms/step - loss: 56.5378 - mae: 6.153
0 - val_loss: 59.7201 - val_mae: 6.3960
Epoch 62/100
24/24 [==============================] - 0s 2ms/step - loss: 55.0409 - mae: 6.063
8 - val_loss: 58.0759 - val_mae: 6.2964
Epoch 63/100
24/24 [==============================] - 0s 2ms/step - loss: 53.5238 - mae: 5.985
7 - val_loss: 56.4966 - val_mae: 6.2332
Epoch 64/100
24/24 [==============================] - 0s 2ms/step - loss: 52.0416 - mae: 5.899
5 - val_loss: 54.9144 - val_mae: 6.1126
Epoch 65/100
24/24 [==============================] - 0s 2ms/step - loss: 50.5723 - mae: 5.815
7 - val_loss: 53.4176 - val_mae: 6.0591
Epoch 66/100
24/24 [==============================] - 0s 2ms/step - loss: 49.1960 - mae: 5.746
8 - val_loss: 51.8689 - val_mae: 5.9509
Epoch 67/100
24/24 [==============================] - 0s 2ms/step - loss: 47.7664 - mae: 5.652
4 - val_loss: 50.3810 - val_mae: 5.8668
Epoch 68/100
24/24 [==============================] - 0s 2ms/step - loss: 46.3808 - mae: 5.568
9 - val_loss: 48.9312 - val_mae: 5.7984
Epoch 69/100
24/24 [==============================] - 0s 2ms/step - loss: 45.0494 - mae: 5.494
0 - val_loss: 47.4739 - val_mae: 5.7031
Epoch 70/100
24/24 [==============================] - 0s 2ms/step - loss: 43.7140 - mae: 5.408
4 - val_loss: 46.0877 - val_mae: 5.6089
Epoch 71/100
24/24 [==============================] - 0s 2ms/step - loss: 42.4201 - mae: 5.321
6 - val_loss: 44.7313 - val_mae: 5.5255
Epoch 72/100
24/24 [==============================] - 0s 2ms/step - loss: 41.1602 - mae: 5.244
```

```
4 - val_loss: 43.3889 - val_mae: 5.4542
Epoch 73/100
24/24 [==============================] - 0s 2ms/step - loss: 39.9205 - mae: 5.176
2 - val_loss: 42.0558 - val_mae: 5.3788
Epoch 74/100
24/24 [==============================] - 0s 2ms/step - loss: 38.6904 - mae: 5.085
7 - val_loss: 40.7724 - val_mae: 5.2707
Epoch 75/100
24/24 [==============================] - 0s 2ms/step - loss: 37.5135 - mae: 5.010
1 - val_loss: 39.5195 - val_mae: 5.2168
Epoch 76/100
24/24 [==============================] - 0s 2ms/step - loss: 36.3272 - mae: 4.929
9 - val_loss: 38.2575 - val_mae: 5.1073
Epoch 77/100
24/24 [==============================] - 0s 2ms/step - loss: 35.1861 - mae: 4.852
8 - val_loss: 37.0500 - val_mae: 5.0355
Epoch 78/100
24/24 [==============================] - 0s 2ms/step - loss: 34.0583 - mae: 4.770
0 - val_loss: 35.8496 - val_mae: 4.9399
Epoch 79/100
24/24 [==============================] - 0s 2ms/step - loss: 32.9645 - mae: 4.699
1 - val_loss: 34.7069 - val_mae: 4.8793
Epoch 80/100
24/24 [==============================] - 0s 2ms/step - loss: 31.9051 - mae: 4.626
1 - val_loss: 33.5439 - val_mae: 4.7974
Epoch 81/100
24/24 [==============================] - 0s 2ms/step - loss: 30.8506 - mae: 4.542
9 - val_loss: 32.4169 - val_mae: 4.6987
Epoch 82/100
24/24 [==============================] - 0s 2ms/step - loss: 29.8069 - mae: 4.464
5 - val_loss: 31.3529 - val_mae: 4.6259
Epoch 83/100
24/24 [==============================] - 0s 2ms/step - loss: 28.8071 - mae: 4.387
7 - val_loss: 30.2968 - val_mae: 4.5645
Epoch 84/100
24/24 [==============================] - 0s 2ms/step - loss: 27.8209 - mae: 4.318
3 - val_loss: 29.2635 - val_mae: 4.4807
Epoch 85/100
24/24 [==============================] - 0s 2ms/step - loss: 26.8722 - mae: 4.240
3 - val_loss: 28.2553 - val_mae: 4.4030
Epoch 86/100
24/24 [==============================] - 0s 2ms/step - loss: 25.9443 - mae: 4.164
8 - val_loss: 27.2880 - val_mae: 4.3245
Epoch 87/100
24/24 [==============================] - 0s 2ms/step - loss: 25.0474 - mae: 4.097
8 - val_loss: 26.3174 - val_mae: 4.2405
Epoch 88/100
24/24 [==============================] - 0s 2ms/step - loss: 24.1540 - mae: 4.020
7 - val_loss: 25.3674 - val_mae: 4.1644
Epoch 89/100
24/24 [==============================] - 0s 2ms/step - loss: 23.2883 - mae: 3.949
5 - val_loss: 24.4549 - val_mae: 4.0936
Epoch 90/100
24/24 [==============================] - 0s 2ms/step - loss: 22.4397 - mae: 3.870
9 - val_loss: 23.5641 - val_mae: 4.0063
Epoch 91/100
24/24 [==============================] - 0s 2ms/step - loss: 21.6245 - mae: 3.801
9 - val_loss: 22.7289 - val_mae: 3.9510
Epoch 92/100
24/24 [==============================] - 0s 2ms/step - loss: 20.8509 - mae: 3.745
```

```
2 - val_loss: 21.8540 - val_mae: 3.8684
Epoch 93/100
24/24 [==============================] - 0s 2ms/step - loss: 20.0671 - mae: 3.656
4 - val_loss: 21.0490 - val_mae: 3.7983
Epoch 94/100
24/24 [==============================] - 0s 2ms/step - loss: 19.3104 - mae: 3.602
7 - val_loss: 20.2568 - val_mae: 3.7411
Epoch 95/100
24/24 [==============================] - 0s 2ms/step - loss: 18.5744 - mae: 3.521
7 - val_loss: 19.4664 - val_mae: 3.6480
Epoch 96/100
24/24 [==============================] - 0s 2ms/step - loss: 17.8560 - mae: 3.461
7 - val_loss: 18.7087 - val_mae: 3.5711
Epoch 97/100
24/24 [==============================] - 0s 2ms/step - loss: 17.1623 - mae: 3.384
9 - val_loss: 18.0028 - val_mae: 3.5128
Epoch 98/100
24/24 [==============================] - 0s 2ms/step - loss: 16.4911 - mae: 3.321
5 - val_loss: 17.2946 - val_mae: 3.4372
Epoch 99/100
24/24 [==============================] - 0s 2ms/step - loss: 15.8504 - mae: 3.260
1 - val_loss: 16.5910 - val_mae: 3.3629
Epoch 100/100
24/24 [==============================] - 0s 2ms/step - loss: 15.2103 - mae: 3.192
2 - val_loss: 15.9314 - val_mae: 3.3112
Modelo entrenado!
```



```
Evaluación en el conjunto de prueba:
Pérdida en prueba (MSE): 14.257917404174805
Error Absoluto Medio en prueba (MAE): 3.101583480834961

Ejemplo de predicción:
1/1 [==============================] - 0s 58ms/step
Predicción para 32.0°F: 3.71°C (Real: 0.00°C)
Predicción para 0.0°F: -12.69°C (Real: -17.78°C)
Predicción para 100.0°F: 38.55°C (Real: 37.78°C)
Predicción para 212.0°F: 95.95°C (Real: 100.00°C)
Modelo guardado como fahrenheit_a_celsius.h5

Para convertir el modelo a TensorFlow.js, ejecuta los siguientes comandos en tu t
erminal:
1. pip install tensorflowjs==3.18.0 (si aún no lo has hecho)
2. mkdir -p carpeta_salida_f2c
3. tensorflowjs_converter --input_format keras fahrenheit_a_celsius.h5 carpeta_sa
lida_f2c
1/1 [==============================] - 0s 58ms/step
Predicción para 32.0°F: 3.71°C (Real: 0.00°C)
Predicción para 0.0°F: -12.69°C (Real: -17.78°C)
Predicción para 100.0°F: 38.55°C (Real: 37.78°C)
Predicción para 212.0°F: 95.95°C (Real: 100.00°C)
Modelo guardado como fahrenheit_a_celsius.h5

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2. mkdir -p carpeta_salida_f2c
3. tensorflowjs_converter --input_format keras fahrenheit_a_celsius.h5 carpeta_sa
lida_f2c
```

In [ ]:

```python
import tensorflow as tf
import numpy as np
import matplotlib.pyplot as plt
import os

# --- 1. CONFIGURACIÓN Y PREPARACIÓN DEL DATASET ---

# IMPORTANTE: Actualiza esta ruta a donde hayas descomprimido el dataset de flor
# Ejemplo: 'C:/Users/TuUsuario/Downloads/flowers' o './flowers' si está en la mi
dataset_path = 'ruta/a/tu/carpeta/flowers' # <--- CAMBIA ESTO

if not os.path.isdir(dataset_path):
    print(f"Error: La ruta del dataset '{dataset_path}' no existe o no es un dir
    print("Por favor, descarga y descomprime el dataset y actualiza la variable
    exit()

# Parámetros para la carga de imágenes y el modelo
IMG_HEIGHT = 180
IMG_WIDTH = 180
BATCH_SIZE = 32

# Cargar datos de entrenamiento (80%) y validación (20%)
print("Cargando datasets...")
try:
    train_dataset = tf.keras.utils.image_dataset_from_directory(
        dataset_path,
        validation_split=0.2,
        subset="training",
```

```
        seed=123, # Semilla para reproducibilidad
        image_size=(IMG_HEIGHT, IMG_WIDTH),
        batch_size=BATCH_SIZE
    )

    validation_dataset = tf.keras.utils.image_dataset_from_directory(
        dataset_path,
        validation_split=0.2,
        subset="validation",
        seed=123, # Misma semilla para asegurar que no haya solapamiento
        image_size=(IMG_HEIGHT, IMG_WIDTH),
        batch_size=BATCH_SIZE
    )
except Exception as e:
    print(f"Error al cargar el dataset desde '{dataset_path}': {e}")
    print("Asegúrate de que la ruta es correcta y la carpeta 'flowers' contiene
    exit()

class_names = train_dataset.class_names
num_classes = len(class_names)
print("Nombres de las clases encontradas:", class_names)
print(f"Número de clases: {num_classes}")

# Normalización de Píxeles
normalization_layer = tf.keras.layers.Rescaling(1./255)
train_dataset_normalized = train_dataset.map(lambda x, y: (normalization_layer(x
validation_dataset_normalized = validation_dataset.map(lambda x, y: (normalizati

# Optimización del Rendimiento del Dataset
AUTOTUNE = tf.data.AUTOTUNE
train_dataset_final = train_dataset_normalized.cache().prefetch(buffer_size=AUTC
validation_dataset_final = validation_dataset_normalized.cache().prefetch(buffer

# Aumento de Datos (Data Augmentation)
data_augmentation = tf.keras.Sequential([
    tf.keras.layers.RandomFlip("horizontal_and_vertical", input_shape=(IMG_HEIGH
    tf.keras.layers.RandomRotation(0.2),
    tf.keras.layers.RandomZoom(0.2),
    tf.keras.layers.RandomContrast(0.2), # Añadido para más robustez
])

# --- 2. IMPLEMENTACIÓN DEL MODELO CNN (PARA ENTRENAMIENTO) ---
print("\nDefiniendo el modelo CNN para entrenamiento...")
training_model = tf.keras.Sequential([
    data_augmentation, # Capa de aumento de datos

    tf.keras.layers.Conv2D(32, (3, 3), padding='same', activation='relu'),
    tf.keras.layers.MaxPooling2D((2, 2)),

    tf.keras.layers.Conv2D(64, (3, 3), padding='same', activation='relu'),
    tf.keras.layers.MaxPooling2D((2, 2)),

    tf.keras.layers.Conv2D(128, (3, 3), padding='same', activation='relu'),
    tf.keras.layers.MaxPooling2D((2, 2)),

    # Opcional: Una capa convolucional más para mayor profundidad si es necesari
    # tf.keras.layers.Conv2D(256, (3, 3), padding='same', activation='relu'),
    # tf.keras.layers.MaxPooling2D((2, 2)),

    tf.keras.layers.Flatten(), # Aplanar para capas densas
```

```
    # Capa densa con regularización (Dropout y BatchNormalization)
    tf.keras.layers.Dense(512, activation='relu'), # Regularizador L2 eliminado
    tf.keras.layers.BatchNormalization(),
    tf.keras.layers.Dropout(0.5),

    tf.keras.layers.Dense(num_classes, activation='softmax') # Capa de salida
])

# Compilar el modelo de entrenamiento
print("Compilando el modelo de entrenamiento...")
training_model.compile(
    optimizer=tf.keras.optimizers.Adam(learning_rate=0.0005), # Tasa de aprendiz
    loss='sparse_categorical_crossentropy',
    metrics=['accuracy']
)

# Imprimir resumen del modelo (si es posible antes de entrenar)
try:
    training_model.summary()
except Exception as e:
    print(f"No se pudo mostrar training_model.summary() aún (se mostrará después


# --- 3. ENTRENAMIENTO DEL MODELO ---
epochs = 3 # Número reducido de épocas para pruebas rápidas
print(f"\nComenzando entrenamiento por {epochs} épocas...")

# Callbacks
early_stopping = tf.keras.callbacks.EarlyStopping(monitor='val_loss', patience=3
reduce_lr = tf.keras.callbacks.ReduceLROnPlateau(monitor='val_loss', factor=0.2,

history = training_model.fit(
    train_dataset_final,
    validation_data=validation_dataset_final,
    epochs=epochs,
    callbacks=[early_stopping, reduce_lr]
)

if not training_model.built: # Si summary no se pudo mostrar antes
    training_model.summary()

print("\nEntrenamiento completado.")

# Graficar resultados (precisión y pérdida)
print("Generando gráficas de entrenamiento...")
print("Claves disponibles en history.history:", history.history.keys())

acc = history.history.get('accuracy', [])
val_acc = history.history.get('val_accuracy', [])
loss = history.history.get('loss', [])
val_loss = history.history.get('val_loss', [])

actual_epochs = len(acc)

if actual_epochs > 0:
    plt.figure(figsize=(12, 5))

    plt.subplot(1, 2, 1)
    plt.plot(range(actual_epochs), acc, label='Precisión de Entrenamiento')
```

```
    if val_acc:
        plt.plot(range(actual_epochs), val_acc, label='Precisión de Validación')
    plt.legend(loc='lower right')
    plt.title('Precisión de Entrenamiento y Validación')
    plt.xlabel('Épocas')
    plt.ylabel('Precisión')
    plt.grid(True)

    plt.subplot(1, 2, 2)
    plt.plot(range(actual_epochs), loss, label='Pérdida de Entrenamiento')
    if val_loss:
        plt.plot(range(actual_epochs), val_loss, label='Pérdida de Validación')
    plt.legend(loc='upper right')
    plt.title('Pérdida de Entrenamiento y Validación')
    plt.xlabel('Épocas')
    plt.ylabel('Pérdida')
    plt.grid(True)

    plt.tight_layout()
    plt.show()
else:
    print("No hay suficientes datos en el historial para generar las gráficas.")

# Evaluar el modelo de entrenamiento
if validation_dataset_final and val_acc:
    print("\nEvaluando el modelo de entrenamiento con los datos de validación fi
    val_loss_final, val_acc_final = training_model.evaluate(validation_dataset_f
    print(f"Pérdida final en validación (entrenamiento): {val_loss_final:.4f}")
    print(f"Precisión final en validación (entrenamiento): {val_acc_final*100:.2
else:
    print("\nNo se evaluó el modelo de entrenamiento en datos de validación.")

# --- 4. CREACIÓN Y EXPORTACIÓN DEL MODELO PARA INFERENCIA ---
print("\nCreando un modelo para inferencia (sin la capa de aumento de datos)..."

inference_model = tf.keras.Sequential()
inference_model.add(tf.keras.Input(shape=(IMG_HEIGHT, IMG_WIDTH, 3), name="input

# Añadir todas las capas del modelo entrenado, EXCEPTO la primera (data_augmenta
for layer in training_model.layers[1:]:
    inference_model.add(layer)

print("Resumen del modelo de inferencia:")
inference_model.summary()

print("\nExportando el modelo de inferencia...")
inference_model_path_h5 = 'inference_modelo_flores_cnn.h5'
inference_model.save(inference_model_path_h5)
print(f"Modelo de inferencia guardado en formato H5 en: {inference_model_path_h5

print("\n--- Comandos para la conversión a TensorFlow.js (ejecutar en la termina
print("Asegúrate de tener tensorflowjs==3.18.0 instalado (`pip install tensorflo
print("Crea una carpeta de salida, ej: 'mkdir carpeta_salida_tfjs_flores'.")
print(f"\nComando de conversión para el modelo H5 de INFERENCIA (desde el archiv
print(f"tensorflowjs_converter --input_format keras {inference_model_path_h5} ca
print("-----------------------------------------------------------------------

print("\nScript de Python completado.")
```

```
Error: La ruta del dataset 'ruta/a/tu/carpeta/flowers' no existe o no es un direc
torio.
Por favor, descarga y descomprime el dataset y actualiza la variable 'dataset_pat
h'.
Cargando datasets...
Error al cargar el dataset desde 'ruta/a/tu/carpeta/flowers': Could not find dire
ctory ruta/a/tu/carpeta/flowers
Asegúrate de que la ruta es correcta y la carpeta 'flowers' contiene las subcarpe
tas de las clases (daisy, dandelion, etc.).
Nombres de las clases encontradas: ['test', 'train']
Número de clases: 2
WARNING:tensorflow:Using a while_loop for converting RngReadAndSkip cause there i
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Definiendo el modelo CNN para entrenamiento...
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```
Compilando el modelo de entrenamiento...
Model: "sequential_9"
_________________________________________________________________
 Layer (type)                Output Shape              Param #   
=================================================================
 sequential_8 (Sequential)   (None, 180, 180, 3)       0         
                                                                 
 conv2d_11 (Conv2D)          (None, 180, 180, 32)      896       
                                                                 
 max_pooling2d_11 (MaxPoolin  (None, 90, 90, 32)       0         
 g2D)                                                            
                                                                 
 conv2d_12 (Conv2D)          (None, 90, 90, 64)        18496     
                                                                 
 max_pooling2d_12 (MaxPoolin  (None, 45, 45, 64)       0         
 g2D)                                                            
                                                                 
 conv2d_13 (Conv2D)          (None, 45, 45, 128)       73856     
                                                                 
 max_pooling2d_13 (MaxPoolin  (None, 22, 22, 128)      0         
 g2D)                                                            
                                                                 
 flatten_3 (Flatten)         (None, 61952)             0         
                                                                 
 dense_7 (Dense)             (None, 512)               31719936  
                                                                 
 batch_normalization_3 (Batc  (None, 512)              2048      
 hNormalization)                                                 
                                                                 
 dropout_3 (Dropout)         (None, 512)               0         
                                                                 
 dense_8 (Dense)             (None, 2)                 1026      
                                                                 
=================================================================
Total params: 31,816,258
Trainable params: 31,815,234
Non-trainable params: 1,024
_________________________________________________________________

Comenzando entrenamiento por 3 épocas...
Epoch 1/3
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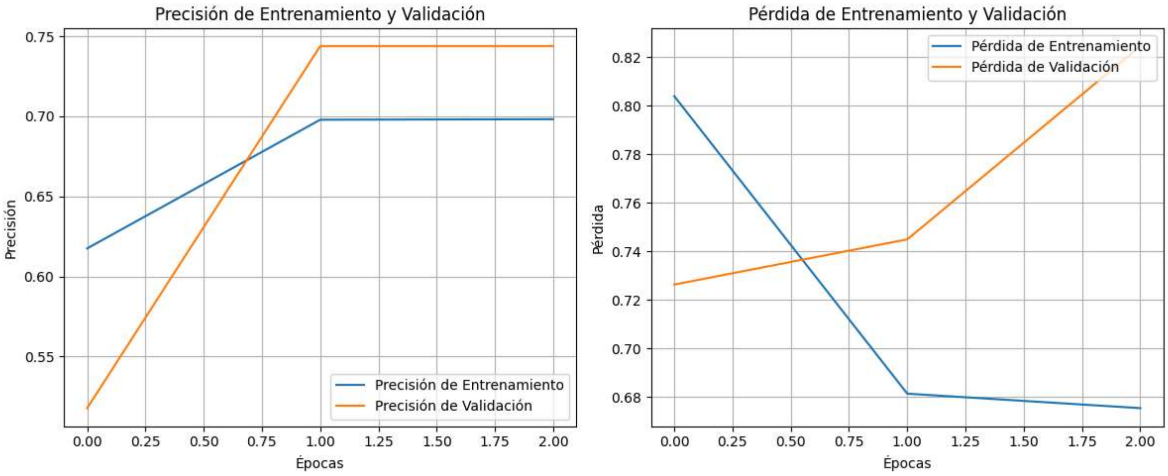
```
92/92 [==============================] - 72s 742ms/step - loss: 0.8039 - accurac
y: 0.6175 - val_loss: 0.7263 - val_accuracy: 0.5177 - lr: 5.0000e-04
Epoch 2/3
92/92 [==============================] - 67s 724ms/step - loss: 0.6814 - accurac
y: 0.6979 - val_loss: 0.7449 - val_accuracy: 0.7439 - lr: 5.0000e-04
Epoch 3/3
92/92 [==============================] - 74s 810ms/step - loss: 0.6755 - accurac
y: 0.6982 - val_loss: 0.8245 - val_accuracy: 0.7439 - lr: 5.0000e-04

Entrenamiento completado.
Generando gráficas de entrenamiento...
Claves disponibles en history.history: dict_keys(['loss', 'accuracy', 'val_loss',
'val_accuracy', 'lr'])
```



```
Evaluando el modelo de entrenamiento con los datos de validación finales:
Pérdida final en validación (entrenamiento): 0.8245
Precisión final en validación (entrenamiento): 74.39%

Creando un modelo para inferencia (sin la capa de aumento de datos)...
Resumen del modelo de inferencia:
Model: "sequential_10"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_11 (Conv2D)          (None, 180, 180, 32)      896

 max_pooling2d_11 (MaxPoolin  (None, 90, 90, 32)       0
 g2D)

 conv2d_12 (Conv2D)          (None, 90, 90, 64)        18496

 max_pooling2d_12 (MaxPoolin  (None, 45, 45, 64)       0
 g2D)

 conv2d_13 (Conv2D)          (None, 45, 45, 128)       73856

 max_pooling2d_13 (MaxPoolin  (None, 22, 22, 128)      0
 g2D)

 flatten_3 (Flatten)         (None, 61952)             0

 dense_7 (Dense)             (None, 512)               31719936

 batch_normalization_3 (Batc  (None, 512)              2048
 hNormalization)

 dropout_3 (Dropout)         (None, 512)               0

 dense_8 (Dense)             (None, 2)                 1026

=================================================================
Total params: 31,816,258
Trainable params: 31,815,234
Non-trainable params: 1,024
_________________________________________________________________

Exportando el modelo de inferencia...
WARNING:tensorflow:Compiled the loaded model, but the compiled metrics have yet t
o be built. `model.compile_metrics` will be empty until you train or evaluate the
model.
WARNING:tensorflow:Compiled the loaded model, but the compiled metrics have yet t
o be built. `model.compile_metrics` will be empty until you train or evaluate the
model.
```

```
Modelo de inferencia guardado en formato H5 en: inference_modelo_flores_cnn.h5

--- Comandos para la conversión a TensorFlow.js (ejecutar en la terminal) ---
Asegúrate de tener tensorflowjs==3.18.0 instalado (`pip install tensorflowjs==3.18.0`).
Crea una carpeta de salida, ej: 'mkdir carpeta_salida_tfjs_flores'.

Comando de conversión para el modelo H5 de INFERENCIA (desde el archivo 'inference_modelo_flores_cnn.h5'):
tensorflowjs_converter --input_format keras inference_modelo_flores_cnn.h5 carpeta_salida_tfjs_flores
--------------------------------------------------------------------------------

Script de Python completado.
```

```
The Kernel crashed while executing code in the current cell or a previous cell.

Please review the code in the cell(s) to identify a possible cause of the failure.

Click <a href='https://aka.ms/vscodeJupyterKernelCrash'>here</a> for more info.

View Jupyter <a href='command:jupyter.viewOutput'>log</a> for further details.
```