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1 حذف جميع البيانات المرتبطة لتسهيل عملية الربط من جديد#
2
3 %reset -sf
4
5

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1 ربط كولا ب ب الريدف#
2 from google.colab import drive
3 drive.mount('/content/drive')

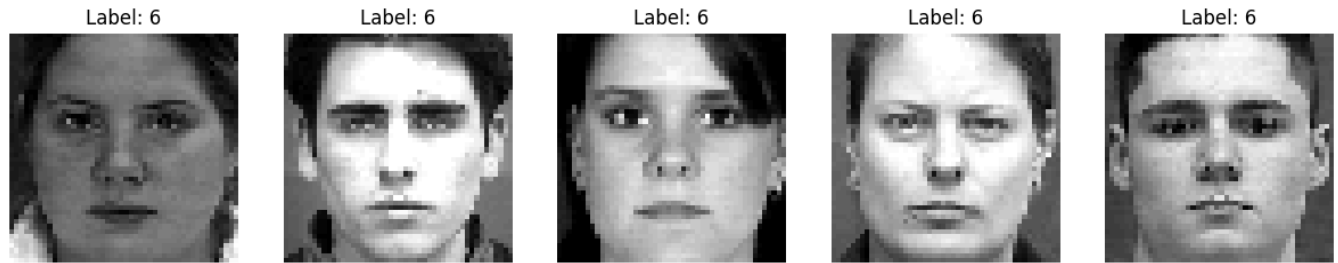
```

Mounted at /content/drive

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1 استيراد الحزم الأساسية#
2 import pandas as pd
3 import numpy as np
4 import matplotlib.pyplot as plt
5
6 # تحميل ملفات CSV
7 csv_path = '/content/drive/MyDrive/Datasets/CK+/ckextended.csv'
8
9 # دالة تحسين جودة الصورة (تباين + تنعيم + حدة + تكبير)
10 df_ck = pd.read_csv(csv_path)
11
12 # دالة لعرض عينات الصور بعد تحسينها
13 def display_ck_images(df, num_samples=5):
14     plt.figure(figsize=(15,5))
15     for i in range(num_samples):
16         pixel_values = [int(p) for p in df.iloc[i]['pixels'].split()]
17         image = np.array(pixel_values).reshape(48, 48)
18         label = df.iloc[i]['emotion']
19 # رسم الصورة
20         plt.subplot(1, num_samples, i+1)
21         plt.imshow(image, cmap='gray')
22         plt.title(f'Label: {label}')
23         plt.axis('off')
24     plt.show()
25 # استدعاء الدالة لعرض أول 5 صور بعد تحسينها
26 display_ck_images(df_ck, num_samples=5)
27

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1  # استدعاء الدالة لعرض أول 5 صور بعد تحسينها
2  import cv2
3
4  # إلى صورة CSV تحويل أول صورة في RGB و Grayscale
5  pixel_values = [int(p) for p in df_ck.iloc[0]['pixels'].split()]
6  image_48 = np.array(pixel_values, dtype='uint8').reshape(48, 48)
7
8  # RGB تحويل إلى 3 قنوات لتصبح
9  image_rgb = cv2.cvtColor(image_48, cv2.COLOR_GRAY2RGB)
10
11 # 128 إلى إعادة الحجم إلى 128x128
12 image_rgb_resized = cv2.resize(image_rgb, (128,128))
13 image_gray = cv2.cvtColor(image_rgb_resized, cv2.COLOR_RGB2GRAY)
14
15 # تجهيز الشكل لعرض صورتين جنباً إلى جنب
16
17 plt.subplot(1,2,1)
18 plt.imshow(image_rgb_resized)
19 plt.title("RGB Image Resized")
20 plt.axis("off")
21
22 plt.subplot(1,2,2)
23 plt.imshow(image_gray, cmap='gray')
24 plt.title("Grayscale Image")
25 plt.axis("off")
26 # عرض الشكل النهائي بالصور
27
28 plt.show()
29 # طباعة أبعاد الصورة الملونة بعد التصغير
30
31 print(f"Dimensions of RGB Image: {image_rgb_resized.shape}")
32

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RGB Image Resized



Grayscale Image



Dimensions of RGB Image: (128, 128, 3)

```

1 import pandas as pd
2 import numpy as np
3 import matplotlib.pyplot as plt
4 import cv2
5
6 # تحميل ملف CSV
7 csv_path = '/content/drive/MyDrive/Datasets/CK+/ckextended.csv'
8 df_ck = pd.read_csv(csv_path)
9
10 # تحسين الصورة (تباين وحدة) مع التأكد من القناة الواحدة والنوع
11 def enhance_image(image):
12     # وقناة واحدة uint8 تأكيد التحويل إلى
13     if len(image.shape) == 3:
14         image = cv2.cvtColor(image, cv2.COLOR_RGB2GRAY)
15     image = image.astype('uint8')
16
17     image_enhanced = cv2.equalizeHist(image)
18     gaussian = cv2.GaussianBlur(image_enhanced, (9,9), 10.0)
19     image_sharp = cv2.addWeighted(image_enhanced, 1.5, gaussian, -0.5, 0)
20     return image_sharp
21
22 # عرض الصور مع اظهار مربعات البكسل
23 def display_ck_images(df, num_samples=5):
24     plt.figure(figsize=(20,5))
25     for i in range(num_samples):
26         pixel_values = [int(p) for p in df.iloc[i]['pixels'].split()]
27         image = np.array(pixel_values).reshape(48, 48).astype('uint8')
28
29         # تحسين الصورة
30         image = enhance_image(image)
31

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32     label = df.iloc[i]['emotion']
33
34     plt.subplot(1, num_samples, i+1)
35     plt.imshow(image, cmap='gray', interpolation='nearest') # البكسل واضح
36     plt.title(f'Label: {label}', fontsize=12)
37     plt.axis('off')
38
39     plt.tight_layout()
40     plt.show()
41
42 # استدعاء الدالة
43 display_ck_images(df_ck, num_samples=5)
44

```



```

1 import pandas as pd
2 import numpy as np
3 import matplotlib.pyplot as plt
4 import cv2
5
6 # تحميل البيانات
7 csv_path = '/content/drive/MyDrive/Datasets/CK+/ckextended.csv'
8 df_ck = pd.read_csv(csv_path)
9
10 # حدة + تكبير + تحسين الصورة: CLAHE
11 def enhance_image(image):
12     image = image.astype('uint8')
13
14     # تحسين التباين باستخدام CLAHE
15     clahe = cv2.createCLAHE(clipLimit=2.0, tileGridSize=(8,8))
16     image_clahe = clahe.apply(image)
17
18     # تعزيز الحواف: Laplacian filter
19     laplacian = cv2.Laplacian(image_clahe, cv2.CV_8U)
20     enhanced = cv2.addWeighted(image_clahe, 1.5, laplacian, -0.5, 0)
21
22     # تكبير الصورة حتى تظهر التفاصيل
23     enhanced_resized = cv2.resize(enhanced, (192,192), interpolation=cv2.INTER
24

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25     return enhanced_resized
26
27 # عرض الصور مع تفاصيل واضحة ومربعات بكسل كبيرة
28 def display_ck_images(df, num_samples=5):
29     plt.figure(figsize=(20,5))
30     for i in range(num_samples):
31         pixel_values = [int(p) for p in df.iloc[i]['pixels'].split()]
32         image = np.array(pixel_values).reshape(48, 48).astype('uint8')
33
34         # تحسين الصورة وتكبيرها
35         enhanced_image = enhance_image(image)
36         label = df.iloc[i]['emotion']
37
38         plt.subplot(1, num_samples, i+1)
39         plt.imshow(enhanced_image, cmap='gray', interpolation='nearest')
40         plt.title(f'Label: {label}', fontsize=12)
41         plt.axis('off')
42
43     plt.tight_layout()
44     plt.show()
45
46 # عرض الصور المحسنة
47 display_ck_images(df_ck, num_samples=5)
48

```



```

1 import pandas as pd
2 import numpy as np
3 import matplotlib.pyplot as plt
4 import cv2
5
6 # تحميل البيانات
7 csv_path = '/content/drive/MyDrive/Datasets/CK+/ckextended.csv'
8 df_ck = pd.read_csv(csv_path)
9
10 def enhance_image(image):
11     image = image.astype('uint8')
12
13     # تحسين التباين باستخدام CLAHE

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14 clahe = cv2.createCLAHE(clipLimit=2.0, tileGridSize=(8,8))
15 image_clahe = clahe.apply(image)
16
17 # تحسين الحدة باستخدام unsharp masking
18 gaussian = cv2.GaussianBlur(image_clahe, (0,0), sigmaX=1.0)
19 image_sharp = cv2.addWeighted(image_clahe, 1.5, gaussian, -0.5, 0)
20
21 return image_sharp
22
23 def display_ck_images(df, num_samples=5):
24     plt.figure(figsize=(20,5))
25     for i in range(num_samples):
26         pixel_values = [int(p) for p in df.iloc[i]['pixels'].split()]
27         image = np.array(pixel_values).reshape(48, 48).astype('uint8')
28
29         # تحسين الصورة
30         enhanced_image = enhance_image(image)
31         label = df.iloc[i]['emotion']
32
33         plt.subplot(1, num_samples, i+1)
34         plt.imshow(enhanced_image, cmap='gray', interpolation='bicubic') #
35         plt.title(f'Label: {label}', fontsize=12)
36         plt.axis('off')
37
38     plt.tight_layout()
39     plt.show()
40
41 # عرض الصور المحسنة بمظهر ناعم
42 display_ck_images(df_ck, num_samples=5)
43

```



```

1 import pandas as pd
2 import numpy as np
3 import matplotlib.pyplot as plt
4 import cv2
5
6 # تحميل البيانات
7 csv_path = '/content/drive/MyDrive/Datasets/CK+/ckextended.csv'

```

```

8 df_ck = pd.read_csv(csv_path)
9
10 def enhance_image(image):
11     image = image.astype('uint8')
12
13     # تحسين التباين باستخدام CLAHE
14     clahe = cv2.createCLAHE(clipLimit=2.0, tileGridSize=(8,8))
15     image_clahe = clahe.apply(image)
16
17     # لتنعيم الضوضاء مع الحفاظ على الحواف Bilateral فلتير
18     bilateral = cv2.bilateralFilter(image_clahe, d=9, sigmaColor=75, sigmaSp
19
20     # حدة مع Unsharp Mask
21     gaussian = cv2.GaussianBlur(bilateral, (0,0), sigmaX=1.5)
22     image_sharp = cv2.addWeighted(bilateral, 1.7, gaussian, -0.7, 0)
23
24     # بوضوح عالي 256x256 تكبير الصورة إلى 256
25     image_resized = cv2.resize(image_sharp, (256,256), interpolation=cv2.INT
26
27     return image_resized
28
29 def display_ck_images(df, num_samples=5):
30     plt.figure(figsize=(25,5))
31     for i in range(num_samples):
32         pixel_values = [int(p) for p in df.iloc[i]['pixels'].split()]
33         image = np.array(pixel_values).reshape(48, 48).astype('uint8')
34
35         # تحسين الصورة وتكبيرها
36         enhanced_image = enhance_image(image)
37         label = df.iloc[i]['emotion']
38
39         plt.subplot(1, num_samples, i+1)
40         plt.imshow(enhanced_image, cmap='gray')
41         plt.title(f'Label: {label}', fontsize=14)
42         plt.axis('off')
43
44     plt.tight_layout()
45     plt.show()
46
47 # عرض الصور المحسنة بجودة فائقة
48 display_ck_images(df_ck, num_samples=5)
49
50

```



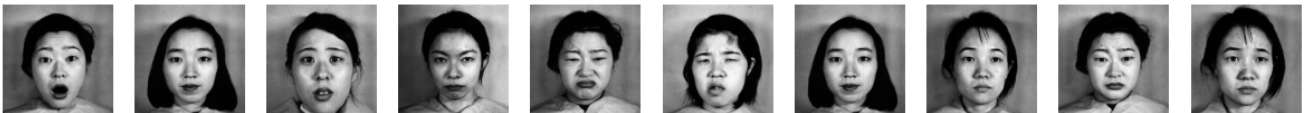
```

1 import os
2 from PIL import Image
3 import matplotlib.pyplot as plt
4 # تحديد مسار مجلد صور قاعدة بيانات JAFFE
5
6 jaffe_path = '/content/drive/MyDrive/Datasets/jaffe'
7     # صورة المرور على أول
8
9 def display_jaffe_samples(directory, num_samples=5):
10     images = [f for f in os.listdir(directory) if f.endswith('.tiff')]
11     plt.figure(figsize=(15,5))
12     for i, img_name in enumerate(images[:num_samples]):
13         img_path = os.path.join(directory, img_name)
14         img = Image.open(img_path)
15         plt.subplot(1, num_samples, i+1)
16         plt.imshow(img, cmap='gray')
17         plt.title(img_name)
18         plt.axis('off')
19     plt.show()
20 # استدعاء الدالة لعرض أول 10 صور من قاعدة بيانات JAFFE
21
22 display_jaffe_samples(jaffe_path, num_samples=10)
23

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```

1 import os
2 from PIL import Image
3 import torch
4 from torch.utils.data import Dataset, DataLoader
5 from torchvision import transforms
6
7 jaffe_path = '/content/drive/MyDrive/Datasets/jaffe'
8
9 # إنشاء قاموس لتحويل كل Index إلى رقم label
10 class JaffeDataset(Dataset):

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10 class JaffeDataset(Dataset):
11     def __init__(self, root_dir, transform=None):
12         self.root_dir = root_dir
13         self.image_files = [f for f in os.listdir(root_dir) if f.endswith('.')]
14         self.transform = transform
15         self.labels = [self.get_label(f) for f in self.image_files]
16         self.labels_idx = [self.labels.index(label) for label in self.labels]
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34 #4. تحميل الصور والتسميات JaffeDataset تعريف كلاس
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```

38     transforms.Resize((128,128)),
39     transforms.ToTensor()
40 ])
41 # تحميل البيانات داخل DataLoader
42
43 jaffe_dataset = JaffeDataset(jaffe_path, transform=transform)
44 jaffe_loader = DataLoader(jaffe_dataset, batch_size=8, shuffle=True)
45

```

```

1 import pandas as pd
2 import numpy as np
3
4 csv_path = '/content/drive/MyDrive/Datasets/CK+/ckextended.csv'
5 df_ck = pd.read_csv(csv_path)
6
7 class CKPlusDataset(Dataset):
8     def __init__(self, dataframe, transform=None):
9         self.df = dataframe
10        self.transform = transform
11
12    def __len__(self):
13        return len(self.df)
14
15    def __getitem__(self, idx):
16        pixel_values = [int(p) for p in self.df.iloc[idx]['pixels']].
17        image = np.array(pixel_values, dtype='uint8').reshape(48, 48)
18        image = cv2.cvtColor(image, cv2.COLOR_GRAY2RGB)
19        image = cv2.resize(image, (128,128))
20        image = Image.fromarray(image)
21        label = self.df.iloc[idx]['emotion']
22        if self.transform:
23            image = self.transform(image)
24        return image, label
25
26 ck_dataset = CKPlusDataset(df_ck, transform=transform)
27 ck_loader = DataLoader(ck_dataset, batch_size=8, shuffle=True)
28

```

```

1 from torchvision import models
2 import torch.nn as nn
3 # تحديد الجهاز المناسب للتدريب (GPU أو CPU):
4
5
6 device = torch.device('cuda' if torch.cuda.is_available() else 'cpu')
7
8 num_classes_jaffe = len(set(jaffe_dataset.labels))

```

```

8 num_classes_jaff = len(set(jaffe_dataset_loader.labels))
9 num_classes_ck = df_ck['emotion'].nunique()
10
11 # تعديل الطبقة النهائية لتناسب مع عدد الفئات في MobileNetV2 تحميل
12
13 model = models.mobilenet_v2(pretrained=False)
14 model.classifier[1] = nn.Linear(model.last_channel, num_classes_jaff)
15 model = model.to(device)
16
17 # (Optimizer) والمُحسِّن (Loss Function) تعريف دالة الخسارة:
18
19 criterion = nn.CrossEntropyLoss()
20 optimizer = torch.optim.Adam(model.parameters(), lr=0.001)
21

```

→ /usr/local/lib/python3.11/dist-packages/torchvision/models/_utils.py:208: UserWarning: 1
warnings.warn(
/usr/local/lib/python3.11/dist-packages/torchvision/models/_utils.py:223: UserWarning: 1
warnings.warn(msg)

```

1 # # (Dropout و BatchNorm) تفعيل وضع التدريب
2
3
4 epochs = 45
5 for epoch in range(epochs):
6     model.train()
7     running_loss, correct = 0.0, 0
8     for inputs, labels in jaffe_loader:
9         inputs, labels = inputs.to(device), labels.to(device)
10        optimizer.zero_grad()
11        outputs = model(inputs)
12        loss = criterion(outputs, labels)
13        loss.backward()
14        optimizer.step()
15        _, preds = torch.max(outputs, 1)
16        correct += torch.sum(preds == labels.data)
17        running_loss += loss.item() * inputs.size(0)
18        # حساب دقة وخسارة العنصر
19    epoch_acc = correct.double() / len(jaffe_dataset)
20    print(f'JAFPE Epoch {epoch+1}: Accuracy={epoch_acc:.4f}, Loss={running_l
21

```

→ JAFPE Epoch 1: Accuracy=0.0423, Loss=3.5417
JAFPE Epoch 2: Accuracy=0.0516, Loss=3.3005
JAFPE Epoch 3: Accuracy=0.0986, Loss=2.9897
JAFPE Epoch 4: Accuracy=0.1033, Loss=2.9613
JAFPE Epoch 5: Accuracy=0.1596, Loss=2.7834
JAFPE Epoch 6: Accuracy=0.1737, Loss=2.6625

```
JAFFE Epoch 7: Accuracy=0.1362, Loss=2.6883
JAFFE Epoch 8: Accuracy=0.2066, Loss=2.4317
JAFFE Epoch 9: Accuracy=0.2582, Loss=2.1691
JAFFE Epoch 10: Accuracy=0.2441, Loss=2.1952
JAFFE Epoch 11: Accuracy=0.3474, Loss=1.8670
JAFFE Epoch 12: Accuracy=0.3756, Loss=1.7576
JAFFE Epoch 13: Accuracy=0.4038, Loss=1.5630
JAFFE Epoch 14: Accuracy=0.4085, Loss=1.6606
JAFFE Epoch 15: Accuracy=0.3991, Loss=1.7367
JAFFE Epoch 16: Accuracy=0.4883, Loss=1.4560
JAFFE Epoch 17: Accuracy=0.4977, Loss=1.3735
JAFFE Epoch 18: Accuracy=0.4178, Loss=1.5723
JAFFE Epoch 19: Accuracy=0.4742, Loss=1.4081
JAFFE Epoch 20: Accuracy=0.5211, Loss=1.3671
JAFFE Epoch 21: Accuracy=0.5540, Loss=1.1800
JAFFE Epoch 22: Accuracy=0.5117, Loss=1.2430
JAFFE Epoch 23: Accuracy=0.5352, Loss=1.2044
JAFFE Epoch 24: Accuracy=0.5540, Loss=1.2814
JAFFE Epoch 25: Accuracy=0.4742, Loss=1.4862
JAFFE Epoch 26: Accuracy=0.6103, Loss=1.1323
JAFFE Epoch 27: Accuracy=0.6573, Loss=0.9348
JAFFE Epoch 28: Accuracy=0.6526, Loss=0.9306
JAFFE Epoch 29: Accuracy=0.7512, Loss=0.7311
JAFFE Epoch 30: Accuracy=0.8028, Loss=0.6713
JAFFE Epoch 31: Accuracy=0.8075, Loss=0.5672
JAFFE Epoch 32: Accuracy=0.8216, Loss=0.5730
JAFFE Epoch 33: Accuracy=0.7840, Loss=0.6516
JAFFE Epoch 34: Accuracy=0.7746, Loss=0.7408
JAFFE Epoch 35: Accuracy=0.7277, Loss=0.7825
JAFFE Epoch 36: Accuracy=0.6995, Loss=1.0116
JAFFE Epoch 37: Accuracy=0.7606, Loss=0.6436
JAFFE Epoch 38: Accuracy=0.8310, Loss=0.5471
JAFFE Epoch 39: Accuracy=0.8028, Loss=0.5352
JAFFE Epoch 40: Accuracy=0.8451, Loss=0.4537
JAFFE Epoch 41: Accuracy=0.7746, Loss=0.6057
JAFFE Epoch 42: Accuracy=0.8451, Loss=0.5341
JAFFE Epoch 43: Accuracy=0.7840, Loss=0.5357
JAFFE Epoch 44: Accuracy=0.7653, Loss=0.6762
JAFFE Epoch 45: Accuracy=0.7887, Loss=0.6162
```

```
1 model.classifier[1] = nn.Linear(model.last_channel, num_classes_ck)
2 model = model.to(device)
3
4 for epoch in range(190):
5     model.train()
6     running_loss, correct = 0.0, 0
7     for inputs, labels in ck_loader:
8         inputs, labels = inputs.to(device), labels.to(device)
9         optimizer.zero_grad()
10        outputs = model(inputs)
11        loss = criterion(outputs, labels)
12        loss.backward()
```

```
13     optimizer.step()
14     _, preds = torch.max(outputs, 1)
15     correct += torch.sum(preds == labels.data)
16     running_loss += loss.item() * inputs.size(0)
17
18     epoch_acc = correct.double() / len(ck_dataset)
19     print(f'CK+ Epoch {epoch+1}: Accuracy={epoch_acc:.4f}, Loss={running_loss:.4f}')
20
```



```

CK+ Epoch 178: Accuracy=1.0000, Loss=0.0003
CK+ Epoch 179: Accuracy=1.0000, Loss=0.0003
CK+ Epoch 180: Accuracy=1.0000, Loss=0.0002
CK+ Epoch 181: Accuracy=1.0000, Loss=0.0002
CK+ Epoch 182: Accuracy=1.0000, Loss=0.0002
CK+ Epoch 183: Accuracy=1.0000, Loss=0.0003
CK+ Epoch 184: Accuracy=1.0000, Loss=0.0002
CK+ Epoch 185: Accuracy=1.0000, Loss=0.0002
CK+ Epoch 186: Accuracy=1.0000, Loss=0.0003
CK+ Epoch 187: Accuracy=1.0000, Loss=0.0002
CK+ Epoch 188: Accuracy=1.0000, Loss=0.0002
CK+ Epoch 189: Accuracy=1.0000, Loss=0.0002
CK+ Epoch 190: Accuracy=1.0000, Loss=0.0001

```

```

1 from google.colab import drive
2 drive.mount('/content/drive')
3
4 import cv2
5 import numpy as np
6 import matplotlib.pyplot as plt
7 from PIL import Image
8

```



Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.mount()

```

1 import cv2
2 import matplotlib.pyplot as plt
3 import numpy as np
4
5 # عدّل حسب مجلدك مسار الصورة من Google Drive
6 image_path = '/content/drive/MyDrive/Datasets/jaffe/NM.NE3.94.tiff'
7
8 # تحميل الصورة
9 image = cv2.imread(image_path, cv2.IMREAD_GRAYSCALE) # بالياً رمادية jaffe الصور في
10
11 # التحقق من التحميل
12 if isinstance(image, np.ndarray):
13     # تغيير الحجم
14     resized_image = cv2.resize(image, (128, 128), interpolation=cv2.INTER_CUBIC)
15
16 # عرض الصورة الأصلية والمعدّلة
17 plt.figure(figsize=(10,5), dpi=150)
18
19 plt.subplot(1, 2, 1)
20 plt.imshow(image, cmap='gray')
21 plt.title("Original")
22 plt.axis('off')
23

```

```
24 plt.subplot(1, 2, 2)
25 plt.imshow(resized_image, cmap='gray')
26 plt.title("Resized")
27 plt.axis('off')
28
29 plt.show()
30 else:
31     print("❌ لم يتم تحميل الصورة. تأكد من المسار.")
32
```



Original

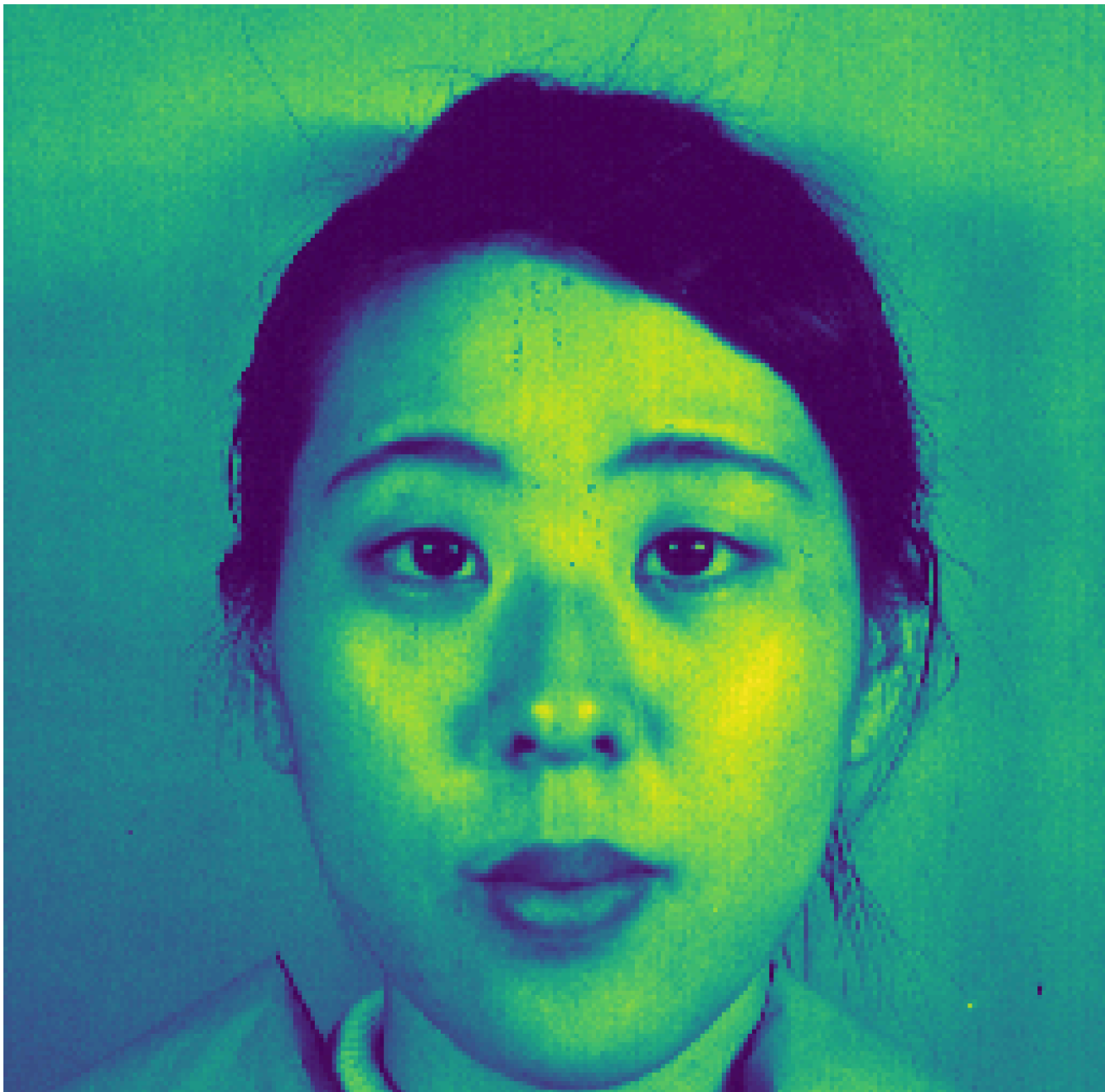


Resized



Double-click (or enter) to edit

```
1 plt.figure(figsize=(10,10), dpi=200) # dpi = dots per inch
2 plt.imshow(image)
3 plt.axis('off')
4 plt.show()
5
```



```
1 gray_image = cv2.imread('/content/drive/MyDrive/Datasets/jaffe/KA.AN1.39.tif')
2
3
4
5
6
7
8
9 csv_path = '/content/drive/MyDrive/Datasets/CK+/ckextended.csv'
10
```

```

11 #لربط البيانات مع التحويل المطلوب CKPlusDataset يتم إنشاء كائن من كلاس#.
12 class CKPlusDataset(Dataset):
13     def __init__(self, dataframe, transform=None):
14         self.df = dataframe
15         self.transform = transform
16
17     def __len__(self):
18         return len(self.df)
19
20     def __getitem__(self, idx):
21         pixel_values = [int(p) for p in self.df.iloc[idx]['pixels'].split()]
22         image = np.array(pixel_values, dtype='uint8').reshape(48, 48)
23         image = cv2.cvtColor(image, cv2.COLOR_GRAY2RGB)
24         image = cv2.resize(image, (128,128))
25         image = Image.fromarray(image)
26         label = self.df.iloc[idx]['emotion']
27         if self.transform:
28             image = self.transform(image)
29         return image, label
30
31 df_ck = pd.read_csv(csv_path)
32
33 transform = transforms.Compose([
34     transforms.ToTensor()
35 ])
36
37 ck_dataset = CKPlusDataset(df_ck, transform=transform)
38 ck_loader = DataLoader(ck_dataset, batch_size=8, shuffle=True)
39 #عدد الأصناف (المشاعر) في قاعدة البيانات
40 num_classes_ck = df_ck['emotion'].nunique()
41

```

```

1 jaffe_path = '/content/drive/MyDrive/Datasets/jaffe'
2
3 class JaffeDataset(Dataset):
4     def __init__(self, root_dir, transform=None):
5         self.root_dir = root_dir
6         self.image_files = [f for f in os.listdir(root_dir) if f.endswith(".
7         self.transform = transform
8         self.labels = [self.get_label(f) for f in self.image_files]
9         self.label_map = {label: idx for idx, label in enumerate(sorted(set(
10         self.labels_idx = [self.label_map[label] for label in self.labels]
11
12     def get_label(self, filename):
13         return filename.split('.')[1] # AN, HA, etc.
14

```

```

15     def __len__(self):
16         return len(self.image_files)
17
18     def __getitem__(self, idx):
19         img_path = os.path.join(self.root_dir, self.image_files[idx])
20         image = Image.open(img_path).convert('RGB')
21         if self.transform:
22             image = self.transform(image)
23         label = self.labels_idx[idx]
24         return image, label
25
26 jaffe_dataset = JaffeDataset(jaffe_path, transform=transform)
27 jaffe_loader = DataLoader(jaffe_dataset, batch_size=8, shuffle=True)
28 num_classes_jaffe = len(set(jaffe_dataset.labels))
29

```

```

1 import torch
2 import torch.nn as nn
3
4 class SimpleCNN(nn.Module):
5     def __init__(self, num_classes):
6         super(SimpleCNN, self).__init__()
7         self.model = nn.Sequential(
8             nn.Conv2d(3, 32, kernel_size=3, stride=1, padding=1),
9             nn.ReLU(),
10            nn.MaxPool2d(2),
11
12            nn.Conv2d(32, 64, kernel_size=3, stride=1, padding=1),
13            nn.ReLU(),
14            nn.MaxPool2d(2),
15
16            nn.Conv2d(64, 128, kernel_size=3, stride=1, padding=1),
17            nn.ReLU(),
18            nn.MaxPool2d(2),
19
20            nn.Flatten(),
21            nn.Linear(128 * 16 * 16, 128),
22            nn.ReLU(),
23            nn.Dropout(0.5),
24            nn.Linear(128, num_classes)
25        )
26
27     def forward(self, x):
28         return self.model(x)
29

```

```

1 from torchvision import models
2
3 def get_mobilenetv2(num_classes):
4     model = models.mobilenet_v2(pretrained=False)
5     model.classifier[1] = nn.Linear(model.last_channel, num_classes)
6     return model
7

1 # استيراد المكتبات اللازمة
2 import torch
3 import torch.nn as nn
4 from torchvision import models
5 import matplotlib.pyplot as plt
6
7 # (إن وُجد GPU) تحديد الجهاز
8 device = torch.device('cuda' if torch.cuda.is_available() else 'cpu')
9
10 # (JAFPE مثلاً 7 مشاعر في) وتعديله لعدد الأصناف MobileNetV2 تحميل نموذج
11 def get_mobilenetv2(num_classes):
12     model = models.mobilenet_v2(weights=None) # بدون أوزان مُسبقة
13     model.classifier[1] = nn.Linear(model.last_channel, num_classes) # الأخيرة
14     return model
15
16 # إعداد النموذج والوظائف المساعدة
17 model = get_mobilenetv2(num_classes_jaffe)
18 model = model.to(device)
19 optimizer = torch.optim.Adam(model.parameters(), lr=0.001)
20 criterion = nn.CrossEntropyLoss()
21
22 # عدد الدورات التدريبية
23 epochs = 45
24 train_losses, train_accs = [], []
25
26 # التدريب
27 for epoch in range(epochs):
28     model.train() # وضع النموذج في طور التدريب
29     running_loss = 0.0
30     correct = 0
31     total = 0
32
33     # حلقة على دفعات البيانات
34     for inputs, labels in jaffe_loader:
35         inputs, labels = inputs.to(device), labels.to(device)
36
37         optimizer.zero_grad()

```

```

38     outputs = model(inputs)
39     loss = criterion(outputs, labels)
40     loss.backward()
41     optimizer.step()
42
43     running_loss += loss.item()
44
45     _, preds = torch.max(outputs, 1)
46     correct += (preds == labels).sum().item()
47     total += labels.size(0)
48
49     # حساب متوسط الخسارة والدقة لكل epoch
50     epoch_loss = running_loss / len(jaffe_loader)
51     epoch_acc = correct / total
52
53     # ✅ تسجيل القيم في القوائم
54     train_losses.append(epoch_loss)
55     train_accs.append(epoch_acc)
56
57     print(f"Epoch {epoch+1}/{epochs}: Loss={epoch_loss:.4f}, Accuracy={epoch.
58

```



```

Epoch 1/45: Loss=3.5622, Accuracy=0.0188
Epoch 2/45: Loss=3.3827, Accuracy=0.0329
Epoch 3/45: Loss=3.2723, Accuracy=0.0798
Epoch 4/45: Loss=3.2139, Accuracy=0.0563
Epoch 5/45: Loss=3.0694, Accuracy=0.0657
Epoch 6/45: Loss=2.8080, Accuracy=0.1174
Epoch 7/45: Loss=2.7637, Accuracy=0.1127
Epoch 8/45: Loss=2.6086, Accuracy=0.1127
Epoch 9/45: Loss=2.4761, Accuracy=0.2066
Epoch 10/45: Loss=2.3182, Accuracy=0.1643
Epoch 11/45: Loss=2.0756, Accuracy=0.2582
Epoch 12/45: Loss=1.9031, Accuracy=0.3286
Epoch 13/45: Loss=2.2427, Accuracy=0.2254
Epoch 14/45: Loss=1.9603, Accuracy=0.2770
Epoch 15/45: Loss=1.8481, Accuracy=0.3099
Epoch 16/45: Loss=1.6083, Accuracy=0.4178
Epoch 17/45: Loss=1.5744, Accuracy=0.4507
Epoch 18/45: Loss=1.6038, Accuracy=0.3521
Epoch 19/45: Loss=1.5139, Accuracy=0.3709
Epoch 20/45: Loss=1.4631, Accuracy=0.4507
Epoch 21/45: Loss=1.4383, Accuracy=0.4507
Epoch 22/45: Loss=1.3299, Accuracy=0.4930
Epoch 23/45: Loss=1.3188, Accuracy=0.5305
Epoch 24/45: Loss=1.1270, Accuracy=0.5587
Epoch 25/45: Loss=1.1413, Accuracy=0.5915
Epoch 26/45: Loss=1.1572, Accuracy=0.5915
Epoch 27/45: Loss=1.1535, Accuracy=0.5493
Epoch 28/45: Loss=0.9995, Accuracy=0.6291
Epoch 29/45: Loss=1.1437, Accuracy=0.6150
Epoch 30/45: Loss=1.0887, Accuracy=0.5822

```

```
Epoch 31/45: Loss=0.9217, Accuracy=0.6667
Epoch 32/45: Loss=0.9046, Accuracy=0.6854
Epoch 33/45: Loss=0.7393, Accuracy=0.7606
Epoch 34/45: Loss=0.5281, Accuracy=0.7840
Epoch 35/45: Loss=0.6364, Accuracy=0.7840
Epoch 36/45: Loss=0.6972, Accuracy=0.7559
Epoch 37/45: Loss=0.7486, Accuracy=0.7324
Epoch 38/45: Loss=1.0619, Accuracy=0.6291
Epoch 39/45: Loss=0.8483, Accuracy=0.6995
Epoch 40/45: Loss=0.7011, Accuracy=0.7700
Epoch 41/45: Loss=0.5599, Accuracy=0.8169
Epoch 42/45: Loss=0.5617, Accuracy=0.7887
Epoch 43/45: Loss=0.6037, Accuracy=0.7653
Epoch 44/45: Loss=0.5118, Accuracy=0.8310
Epoch 45/45: Loss=0.4166, Accuracy=0.8592
```

```
1 import torch, torch.nn as nn, torch.optim as optim
2 from torchvision import models
3
4 device = torch.device('cuda' if torch.cuda.is_available() else 'cpu')
5
6 num_classes = len(full_dataset_jaffe.classes)
7 model = models.mobilenet_v2(weights=models.MobileNet_V2_Weights.IMAGENET1K_V1)
8 model.classifier[1] = nn.Linear(model.last_channel, num_classes)
9 model = model.to(device)
10
11 criterion = nn.CrossEntropyLoss()
12 optimizer = optim.AdamW(model.parameters(), lr=1e-3)
13
14 epochs = 45
15 train_losses, train_accs = [], []
16 val_losses, val_accs = [], []
17
18 for epoch in range(epochs):
19     # ---- TRAIN ----
20     model.train()
21     running_loss, correct, total = 0.0, 0, 0
22     for x, y in train_loader:
23         x, y = x.to(device), y.to(device)
24         optimizer.zero_grad()
25         out = model(x)
26         loss = criterion(out, y)
27         loss.backward()
28         optimizer.step()
29
30     running_loss += loss.item() * x.size(0)
31     correct += (out.argmax(1) == y).sum().item()
32     total += x.size(0)
```

```

33
34     epoch_loss = running_loss / total
35     epoch_acc  = correct / total
36     train_losses.append(epoch_loss)
37     train_accs.append(epoch_acc)
38
39     # ---- VALIDATION ----
40     model.eval()
41     v_loss, v_correct, v_total = 0.0, 0, 0
42     with torch.no_grad():
43         for x, y in val_loader:
44             x, y = x.to(device), y.to(device)
45             out = model(x)
46             loss = criterion(out, y)
47             v_loss += loss.item() * x.size(0)
48             v_correct += (out.argmax(1) == y).sum().item()
49             v_total += x.size(0)
50
51     val_loss = v_loss / v_total
52     val_acc  = v_correct / v_total
53     val_losses.append(val_loss)
54     val_accs.append(val_acc)
55
56     print(f"Epoch {epoch+1}/{epochs}: "
57           f"Train Loss={epoch_loss:.4f} Acc={epoch_acc:.4f} | "
58           f"Val Loss={val_loss:.4f} Acc={val_acc:.4f}")
59

```



```

-----
NameError                                Traceback (most recent call last)
/tmp/ipython-input-1671935070.py in <cell line: 0>()
      4 device = torch.device('cuda' if torch.cuda.is_available() else 'cpu')
      5
----> 6 num_classes = len(full_dataset_jaffe.classes)
      7 model = models.mobilenet_v2(weights=models.MobileNet_V2_Weights.IMAGENET1K_V1)
      8 model.classifier[1] = nn.Linear(model.last_channel, num_classes)

NameError: name 'full_dataset_jaffe' is not defined

```

Next steps: [Explain error](#)

```

1 import matplotlib.pyplot as plt
2
3 plt.figure(figsize=(8,5))
4 plt.plot(train_accs, label="Training Accuracy")
5 plt.plot(val_accs, label="Validation Accuracy")

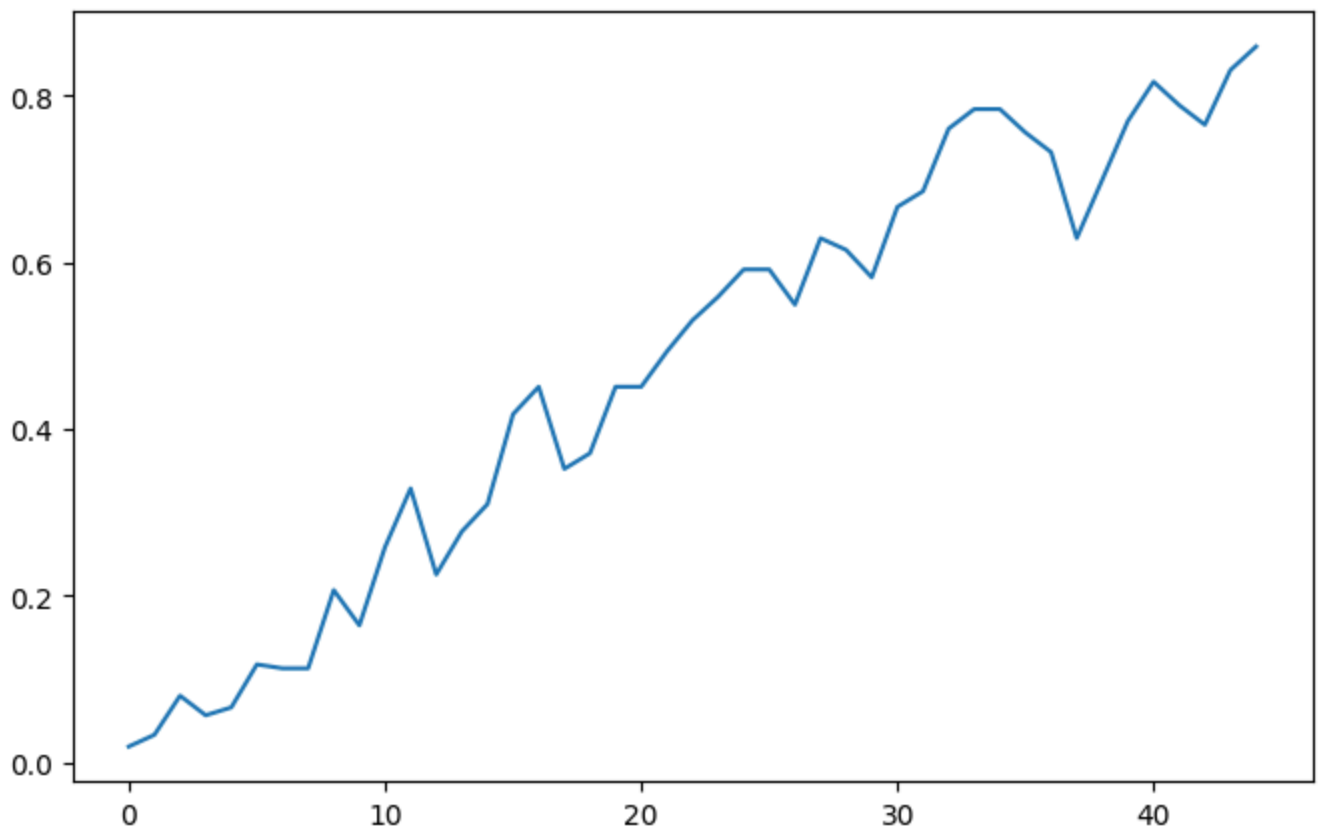
```

```
6 plt.title("JAFPE - Training vs Validation Accuracy")
7 plt.xlabel("Epoch"); plt.ylabel("Accuracy")
8 plt.legend(); plt.grid(True); plt.show()
9
```



```
-----
NameError                                Traceback (most recent call last)
/tmp/ipython-input-1069374777.py in <cell line: 0>()
      3 plt.figure(figsize=(8,5))
      4 plt.plot(train_accs, label="Training Accuracy")
----> 5 plt.plot(val_accs, label="Validation Accuracy")
      6 plt.title("JAFPE - Training vs Validation Accuracy")
      7 plt.xlabel("Epoch"); plt.ylabel("Accuracy")
```

NameError: name 'val_accs' is not defined



Next steps: [Explain error](#)

1 Start coding or [generate](#) with AI.

1 Start coding or [generate](#) with AI.

1 Start coding or [generate](#) with AI.

1 Start coding or [generate](#) with AI.

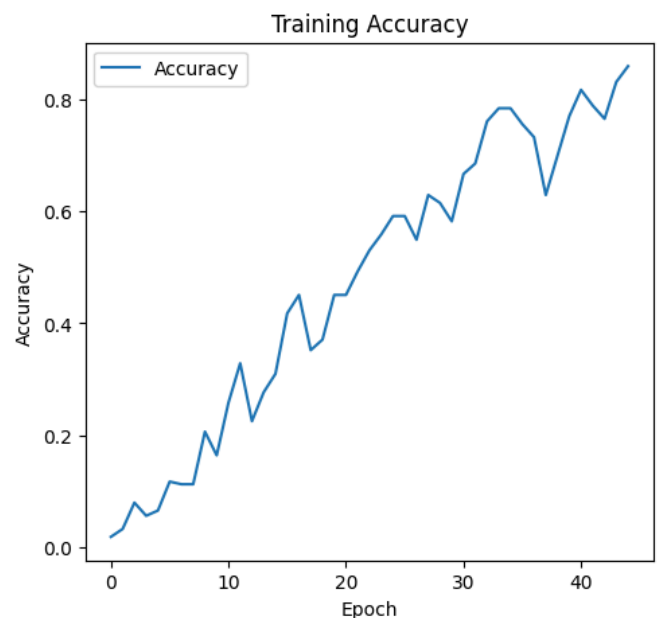
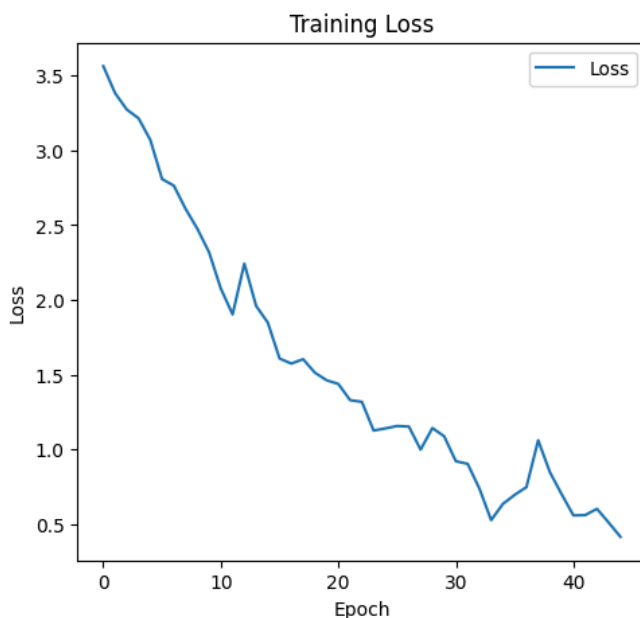
1 Start coding or generate with AI.

1 Start coding or generate with AI.

```

1 import matplotlib.pyplot as plt
2
3 plt.figure(figsize=(12,5))
4
5 plt.subplot(1,2,1)
6 plt.plot(train_losses, label='Loss')
7 plt.title('Training Loss')
8 plt.xlabel('Epoch')
9 plt.ylabel('Loss')
10 plt.legend()
11
12 plt.subplot(1,2,2)
13 plt.plot(train_accs, label='Accuracy')
14 plt.title('Training Accuracy')
15 plt.xlabel('Epoch')
16 plt.ylabel('Accuracy')
17 plt.legend()
18
19 plt.show()
20

```



```

1 import pandas as pd
2 import numpy as np
3 import torch
4 from torch.utils.data import Dataset

```

```

5 from PIL import Image
6 from torchvision import transforms
7
8 class CKPlusFromCSV(Dataset):
9     def __init__(self, csv_file, usage="Training", transform=None):
10         self.data = pd.read_csv(csv_file)
11         self.data = self.data[self.data["Usage"] == usage].reset_index()
12         self.transform = transform
13
14     def __len__(self):
15         return len(self.data)
16
17     def __getitem__(self, idx):
18         pixels = np.array(self.data.loc[idx, "pixels"].split(), dtype=np.uint8)
19         img = pixels.reshape(48, 48) # CK+ 48x48 غالباً حجم صور
20         img = Image.fromarray(img)
21
22         label = int(self.data.loc[idx, "emotion"])
23         if self.transform:
24             img = self.transform(img)
25         return img, label
26
27 # ===== التحويلات =====
28 transform_ck = transforms.Compose([
29     transforms.Grayscale(num_output_channels=3), # تحويل لثلاث قنوات
30     transforms.Resize((224, 224)),
31     transforms.ToTensor()
32 ])
33
34 # ===== تحميل الداتاسيت =====
35 csv_path = "/content/drive/MyDrive/Datasets/CK+/ckextended.csv"
36 full_dataset_ck = CKPlusFromCSV(csv_file=csv_path, usage="Training",
37
38 print(f"عدد العينات: {len(full_dataset_ck)}")
39

```

عدد العينات: 734

```

1 from torch.utils.data import random_split, DataLoader
2 import torch, torch.nn as nn, torch.optim as optim
3 from torchvision.models import resnet18, ResNet18_Weights
4
5 device = torch.device('cuda' if torch.cuda.is_available() else 'cpu')
6
7 # 1) DataLoaders ثم إرجاع الـ Train/Val دالة تقسيم الداتا إلى
8 def make_loaders(dataset, batch_size=64, val_ratio=0.15, seed=42):

```

```

9     val_len = int(len(dataset) * val_ratio)
10    train_len = len(dataset) - val_len
11    train_ds, val_ds = random_split(
12        dataset, [train_len, val_len],
13        generator=torch.Generator().manual_seed(seed)
14    )
15    train_loader = DataLoader(train_ds, batch_size=batch_size, shuffle=True,
16    val_loader = DataLoader(val_ds, batch_size=batch_size, shuffle=False)
17    return train_ds, val_ds, train_loader, val_loader
18
19 # 2) إنشاء اللودرز لـ CK+
20 train_ds_ck, val_ds_ck, train_loader_ck, val_loader_ck = make_loaders(full_d
21
22 # 3) عدد الأصناف
23 if hasattr(full_dataset_ck, "classes"):
24     num_classes_ck = len(full_dataset_ck.classes)
25 elif hasattr(full_dataset_ck, "data"):
26     num_classes_ck = int(full_dataset_ck.data["emotion"].nunique())
27 else:
28     # احتياطي: استخراج الليبلات من خلال المرور مرة واحدة
29     labels = [full_dataset_ck[i][1] for i in range(len(full_dataset_ck))]
30     num_classes_ck = len(set(labels))
31
32 # 4) Loss الموديل + الأوبتامايرز والـ
33 model_ck = resnet18(weights=ResNet18_Weights.DEFAULT)
34 model_ck.fc = nn.Linear(model_ck.fc.in_features, num_classes_ck)
35 model_ck = model_ck.to(device)
36
37 criterion = nn.CrossEntropyLoss()
38 optimizer_ck = optim.Adam(model_ck.parameters(), lr=1e-3)
39
40 # 5) التدريب مع حفظ التاريخ
41 epochs = 20
42 train_acc_history_ck, val_acc_history_ck = [], []
43
44 for epoch in range(1, epochs+1):
45     # --- TRAIN ---
46     model_ck.train()
47     tr_corr = tr_cnt = 0
48     for x, y in train_loader_ck:
49         x, y = x.to(device), y.to(device)
50         optimizer_ck.zero_grad()
51         out = model_ck(x)
52         loss = criterion(out, y)
53         loss.backward()
54         optimizer_ck.step()

```

```

55
56     tr_corr += (out.argmax(1) == y).sum().item()
57     tr_cnt  += x.size(0)
58
59     train_acc = tr_corr / tr_cnt
60     train_acc_history_ck.append(train_acc)
61
62     # --- VAL ---
63     model_ck.eval()
64     va_corr = va_cnt = 0
65     with torch.no_grad():
66         for x, y in val_loader_ck:
67             x, y = x.to(device), y.to(device)
68             out = model_ck(x)
69             va_corr += (out.argmax(1) == y).sum().item()
70             va_cnt  += x.size(0)
71
72     val_acc = va_corr / va_cnt
73     val_acc_history_ck.append(val_acc)
74
75     print(f"Epoch {epoch}/{epochs} | Train Acc {train_acc:.4f} | Val Acc {va
76

```



Downloading: "<https://download.pytorch.org/models/resnet18-f37072fd.pth>" to /root/.cache
 100%|██████████| 44.7M/44.7M [00:00<00:00, 132MB/s]

```

Epoch 1/20 | Train Acc 0.6506 | Val Acc 0.6545
Epoch 2/20 | Train Acc 0.9295 | Val Acc 0.8727
Epoch 3/20 | Train Acc 0.9696 | Val Acc 0.9000
Epoch 4/20 | Train Acc 0.9840 | Val Acc 0.8727
Epoch 5/20 | Train Acc 0.9792 | Val Acc 0.8364
Epoch 6/20 | Train Acc 0.9776 | Val Acc 0.8455
Epoch 7/20 | Train Acc 0.9872 | Val Acc 0.9364
Epoch 8/20 | Train Acc 0.9904 | Val Acc 0.9000
Epoch 9/20 | Train Acc 0.9888 | Val Acc 0.8727
Epoch 10/20 | Train Acc 0.9920 | Val Acc 0.9273
Epoch 11/20 | Train Acc 0.9920 | Val Acc 0.9091
Epoch 12/20 | Train Acc 0.9968 | Val Acc 0.8818
Epoch 13/20 | Train Acc 1.0000 | Val Acc 0.9364
Epoch 14/20 | Train Acc 1.0000 | Val Acc 0.9545
Epoch 15/20 | Train Acc 1.0000 | Val Acc 0.9455
Epoch 16/20 | Train Acc 1.0000 | Val Acc 0.9455
Epoch 17/20 | Train Acc 1.0000 | Val Acc 0.9455
Epoch 18/20 | Train Acc 1.0000 | Val Acc 0.9455
Epoch 19/20 | Train Acc 1.0000 | Val Acc 0.9455
Epoch 20/20 | Train Acc 1.0000 | Val Acc 0.9455

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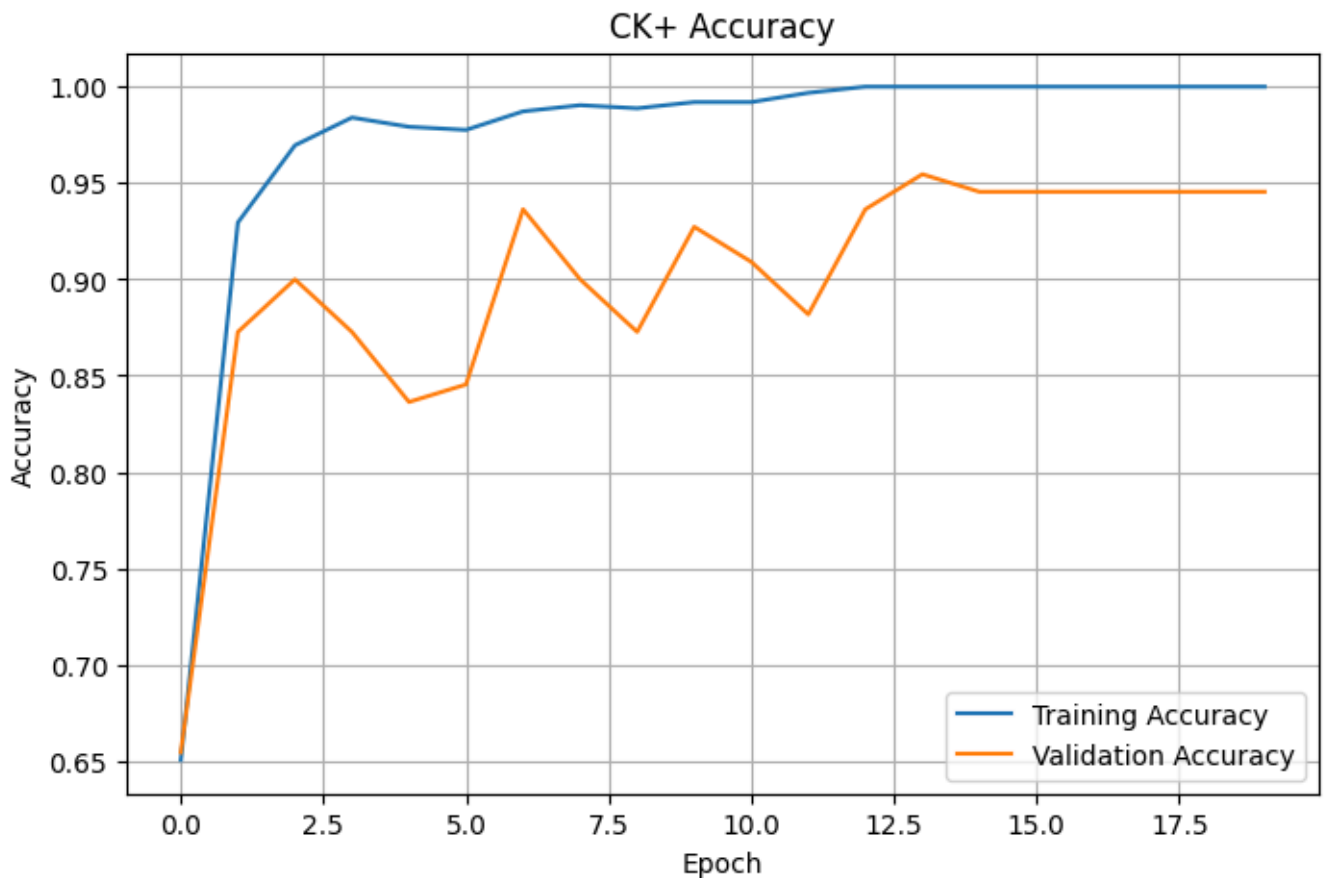
1 import matplotlib.pyplot as plt
2
3 plt.figure(figsize=(8,5))

```

```

4 plt.plot(train_acc_history_ck, label='Training Accuracy')
5 plt.plot(val_acc_history_ck, label='Validation Accuracy')
6 plt.xlabel('Epoch'); plt.ylabel('Accuracy'); plt.title('CK+ Accuracy')
7 plt.legend(); plt.grid(True); plt.show()
8

```



```

1 import torch, os
2
3 device = torch.device('cuda' if torch.cuda.is_available() else 'cpu')
4 torch.backends.cudnn.benchmark = True
5 if hasattr(torch, "set_float32_matmul_precision"):
6     torch.set_float32_matmul_precision('high')
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```

11
12     # لتسريع التشغيل اللاحق pt. كاش إلى
13     if cache_pt_path and os.path.isfile(cache_pt_path):
14         data = torch.load(cache_pt_path)
15         self.images = data["images"]      # uint8 [N,48,48]
16         self.labels = data["labels"]      # long  [N]
17     else:
18         # __getitem__ (بدل كل) مرة واحدة pixels فك الـ
19         px = df["pixels"].apply(lambda s: np.fromstring(s, sep=' ', dtype=
20         self.images = np.stack([p.reshape(48,48) for p in px], axis=0)
21         self.labels = df["emotion"].astype(np.int64).to_numpy()
22         self.images = torch.from_numpy(self.images)      # uint8
23         self.labels = torch.from_numpy(self.labels)      # long
24         if cache_pt_path:
25             torch.save({"images": self.images, "labels": self.labels}, c
26
27     def __len__(self): return len(self.labels)
28
29     def __getitem__(self, idx):
30         img = Image.fromarray(self.images[idx].numpy(), mode='L') # PIL(L)
31         if self.transform: img = self.transform(img)                # -> 3x22
32         return img, self.labels[idx].item()
33

```

```

1 from torch.utils.data import DataLoader, random_split
2 from torchvision import datasets, transforms
3 from torchvision.models import resnet18, ResNet18_Weights
4 import torch.nn as nn, torch.optim as optim
5 import matplotlib.pyplot as plt, random
6
7 IMAGENET_MEAN = (0.485, 0.456, 0.406)
8 IMAGENET_STD  = (0.229, 0.224, 0.225)
9 COMMON_TF = transforms.Compose([
10     transforms.Grayscale(3),
11     transforms.Resize((224,224)),
12     transforms.ToTensor(),
13     transforms.Normalize(IMAGENET_MEAN, IMAGENET_STD),
14 ])
15
16 def cap_per_class_indices(targets, per_class=500):
17     from collections import defaultdict
18     d=defaultdict(list)
19     for i,y in enumerate(targets): d[y].append(i)
20     sel=[]
21     for y,ix in d.items():
22         k = min(per_class, len(ix))

```

```

23     sel.extend(random.sample(ix, k))
24     random.shuffle(sel)
25     return sel
26
27 def make_loaders(dataset, batch_size=64, val_ratio=0.15, seed=42):
28     v = int(len(dataset)*val_ratio); t = len(dataset)-v
29     tr, va = random_split(dataset, [t, v], generator=torch.Generator().manual_seed(seed))
30     loader_kwargs = dict(num_workers=2, pin_memory=True, persistent_workers=True)
31     return tr, va, DataLoader(tr, batch_size=batch_size, **loader_kwargs), DataLoader(va, batch_size=batch_size, **loader_kwargs)
32
33 def build_model(num_classes, freeze_backbone=True):
34     m = resnet18(weights=ResNet18_Weights.DEFAULT).to(device)
35     if freeze_backbone:
36         for p in m.layer1.parameters(): p.requires_grad = False
37         for p in m.layer2.parameters(): p.requires_grad = False
38         for p in m.layer3.parameters(): p.requires_grad = False
39     m.fc = nn.Linear(m.fc.in_features, num_classes).to(device)
40     if hasattr(torch, "compile"):
41         try: m = torch.compile(m)
42         except: pass
43     return m
44
45 def train_fast(model, train_loader, val_loader, epochs=12, lr=1e-3, patience=10):
46     crit = nn.CrossEntropyLoss()
47     opt = optim.AdamW([p for p in model.parameters() if p.requires_grad], lr=lr)
48     scaler = torch.cuda.amp.GradScaler(enabled=(device.type=='cuda'))
49     best_val, bad = float('inf'), 0
50     train_hist, val_hist = [], []
51
52     for ep in range(1, epochs+1):
53         # ---- Train (AMP) ----
54         model.train(); tr_corr=tr_cnt=0; tr_loss_sum=0.0
55         for x,y in train_loader:
56             x,y = x.to(device, non_blocking=True), y.to(device, non_blocking=True)
57             opt.zero_grad(set_to_none=True)
58             with torch.cuda.amp.autocast(enabled=(device.type=='cuda')):
59                 out = model(x)
60                 loss = crit(out,y)
61                 scaler.scale(loss).backward()
62                 scaler.step(opt)
63                 scaler.update()
64                 tr_loss_sum += loss.item()*x.size(0)
65                 tr_corr += (out.argmax(1)==y).sum().item()
66                 tr_cnt += x.size(0)
67         train_acc = tr_corr/tr_cnt; train_hist.append(train_acc)
68

```

```

69     # ---- Val ----
70     model.eval(); va_corr=va_cnt=0; va_loss_sum=0.0
71     with torch.no_grad(), torch.cuda.amp.autocast(enabled=(device.type==
72         for x,y in val_loader:
73             x,y = x.to(device, non_blocking=True), y.to(device, non_bloc
74             out = model(x); loss = crit(out,y)
75             va_loss_sum += loss.item()*x.size(0)
76             va_corr += (out.argmax(1)==y).sum().item()
77             va_cnt += x.size(0)
78     val_loss = va_loss_sum/va_cnt; val_acc = va_corr/va_cnt; val_hist.ap
79
80     print(f"Epoch {ep}/{epochs} | Train Acc {train_acc:.4f} | Val Acc {v
81
82     # Early Stopping
83     if val_loss < best_val - 1e-4:
84         best_val = val_loss; bad = 0
85         best_state = {k:v.detach().cpu().clone() for k,v in model.state_
86     else:
87         bad += 1
88         if bad >= patience:
89             print(f"Early stop @ epoch {ep}")
90             break
91
92     # Load best
93     model.load_state_dict(best_state, strict=True)
94     return train_hist, val_hist
95

```

```

1 from torchvision import datasets
2
3 # FER-2013
4 FER_DIR = "/content/drive/MyDrive/Datasets/FER-2013/train" # عدّل المسار
5 if os.path.isdir(FER_DIR):
6     fer_full = datasets.ImageFolder(FER_DIR, transform=COMMON_TF)
7     # تخفيض العينة (مثلاً 500 لكل فئة)
8     fer_targets = fer_full.targets
9     fer_idx = cap_per_class_indices(fer_targets, per_class=500)
10    from torch.utils.data import Subset
11    fer_ds = Subset(fer_full, fer_idx)
12
13    trF, vaF, trL_F, vaL_F = make_loaders(fer_ds, batch_size=64, val_ratio=0
14    model_fer = build_model(num_classes=len(fer_full.classes), freeze_backbo
15    hist_trF, hist_vaF = train_fast(model_fer, trL_F, vaL_F, epochs=12, lr=1
16
17 # JAFFE
18 JAFFE_DIR = "/content/drive/MyDrive/Datasets/JAFFE" # عدّل المسار

```

```

19 if os.path.isdir(JAFFE_DIR):
20     jaffe_full = datasets.ImageFolder(JAFFE_DIR, transform=COMMON_TF)
21     # غالبًا صغير، لكن تستطيع تقليل لو رغبت
22     trJ, vaJ, trL_J, vaL_J = make_loaders(jaffe_full, batch_size=64, val_rat
23     model_jaffe = build_model(num_classes=len(jaffe_full.classes), freeze_ba
24     hist_trJ, hist_vaJ = train_fast(model_jaffe, trL_J, vaL_J, epochs=12, lr
25

```

```

➡ /tmp/ipython-input-169423696.py:48: FutureWarning: `torch.cuda.amp.GradScaler(args...)`
    scaler = torch.cuda.amp.GradScaler(enabled=(device.type=='cuda'))
/tmp/ipython-input-169423696.py:58: FutureWarning: `torch.cuda.amp.autocast(args...)` is
    with torch.cuda.amp.autocast(enabled=(device.type=='cuda')):
No CUDA runtime is found, using CUDA_HOME='/usr/local/cuda'
/tmp/ipython-input-169423696.py:58: FutureWarning: `torch.cuda.amp.autocast(args...)` is
    with torch.cuda.amp.autocast(enabled=(device.type=='cuda')):
/tmp/ipython-input-169423696.py:71: FutureWarning: `torch.cuda.amp.autocast(args...)` is
    with torch.no_grad(), torch.cuda.amp.autocast(enabled=(device.type=='cuda')):
Epoch 1/12 | Train Acc 0.3629 | Val Acc 0.4665 | Val Loss 1.3862
/tmp/ipython-input-169423696.py:58: FutureWarning: `torch.cuda.amp.autocast(args...)` is
    with torch.cuda.amp.autocast(enabled=(device.type=='cuda')):
/tmp/ipython-input-169423696.py:71: FutureWarning: `torch.cuda.amp.autocast(args...)` is
    with torch.no_grad(), torch.cuda.amp.autocast(enabled=(device.type=='cuda')):
Epoch 2/12 | Train Acc 0.6229 | Val Acc 0.4193 | Val Loss 1.7564
Epoch 3/12 | Train Acc 0.7792 | Val Acc 0.4232 | Val Loss 2.1252
Epoch 4/12 | Train Acc 0.8759 | Val Acc 0.4154 | Val Loss 2.4618
Early stop @ epoch 4

```

```

1 CK_CSV = "/content/drive/MyDrive/Datasets/CK+/ckextended.csv" # عدل المسار
2 if os.path.isfile(CK_CSV):
3     ck_ds = CKPlusFast(CK_CSV, usage="Training", transform=COMMON_TF,
4                        cache_pt_path="/content/ck_train_cache.pt")
5     trC, vaC, trL_C, vaL_C = make_loaders(ck_ds, batch_size=64, val_ratio=0.
6     # تقدير عدد الأصناف
7     try:
8         n_cls_ck = int(pd.read_csv(CK_CSV).query("Usage=='Training'")["emoti
9     except:
10         labels_ck = [ck_ds[i][1] for i in range(len(ck_ds))]
11         n_cls_ck = len(set(labels_ck))
12         model_ck = build_model(num_classes=n_cls_ck, freeze_backbone=True)
13         hist_trC, hist_vaC = train_fast(model_ck, trL_C, vaL_C, epochs=12, lr=1e
14

```

```

➡ /tmp/ipython-input-169423696.py:48: FutureWarning: `torch.cuda.amp.GradScaler(args...)`
    scaler = torch.cuda.amp.GradScaler(enabled=(device.type=='cuda'))
/tmp/ipython-input-415479120.py:30: DeprecationWarning: 'mode' parameter is deprecated a
    img = Image.fromarray(self.images[idx].numpy(), mode='L') # PIL(L)
/tmp/ipython-input-415479120.py:30: DeprecationWarning: 'mode' parameter is deprecated a
    img = Image.fromarray(self.images[idx].numpy(), mode='L') # PIL(L)
/tmp/ipython-input-169423696.py:58: FutureWarning: `torch.cuda.amp.autocast(args...)` is
    with torch.cuda.amp.autocast(enabled=(device.type=='cuda')):

```

```

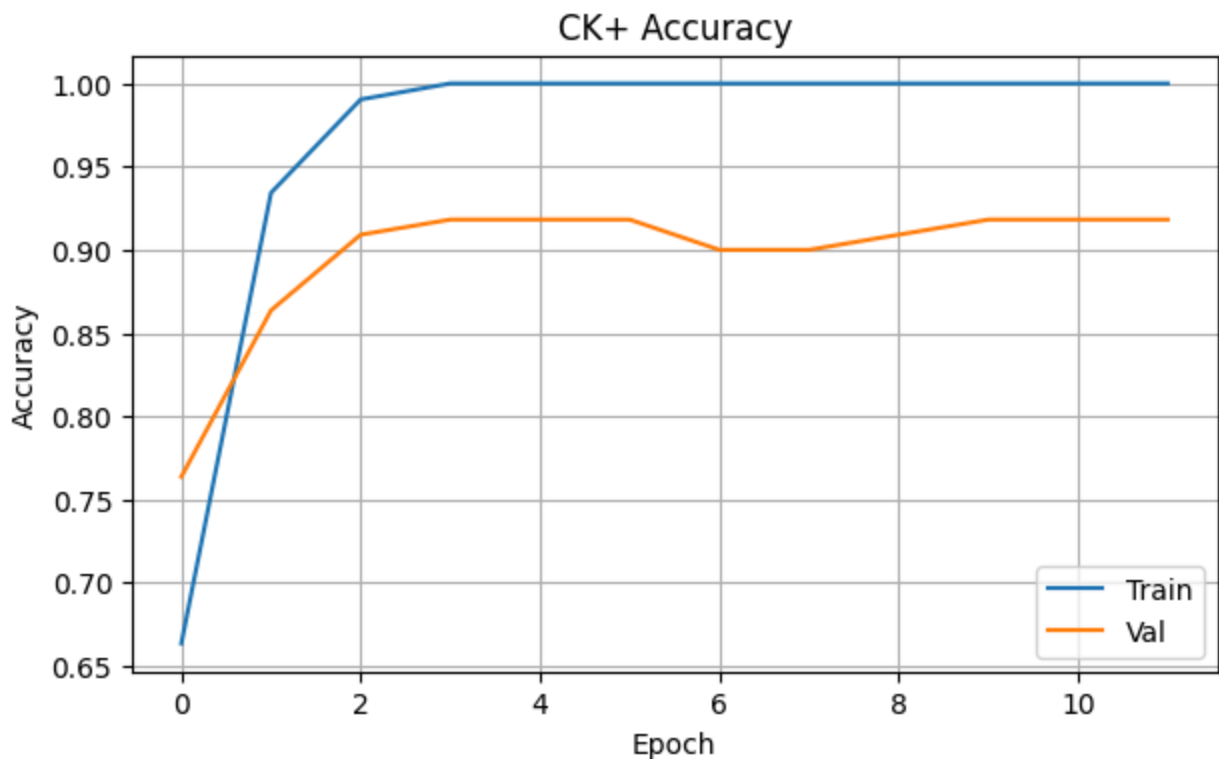
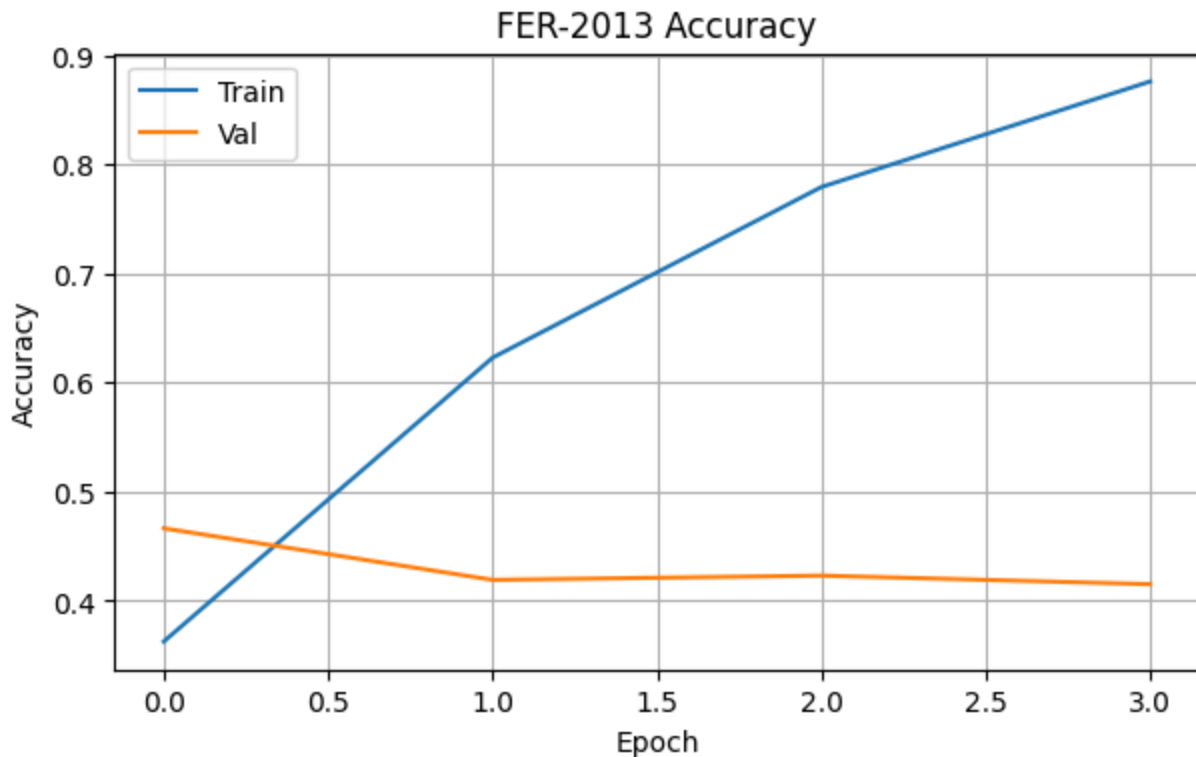
/tmp/ipython-input-169423696.py:58: FutureWarning: `torch.cuda.amp.autocast(args...)` is
  with torch.cuda.amp.autocast(enabled=(device.type=='cuda'))):
/tmp/ipython-input-169423696.py:71: FutureWarning: `torch.cuda.amp.autocast(args...)` is
  with torch.no_grad(), torch.cuda.amp.autocast(enabled=(device.type=='cuda'))):
/tmp/ipython-input-415479120.py:30: DeprecationWarning: 'mode' parameter is deprecated a
  img = Image.fromarray(self.images[idx].numpy(), mode='L') # PIL(L)
/tmp/ipython-input-415479120.py:30: DeprecationWarning: 'mode' parameter is deprecated a
  img = Image.fromarray(self.images[idx].numpy(), mode='L') # PIL(L)
Epoch 1/12 | Train Acc 0.6635 | Val Acc 0.7636 | Val Loss 1.0532
/tmp/ipython-input-169423696.py:58: FutureWarning: `torch.cuda.amp.autocast(args...)` is
  with torch.cuda.amp.autocast(enabled=(device.type=='cuda'))):
/tmp/ipython-input-169423696.py:71: FutureWarning: `torch.cuda.amp.autocast(args...)` is
  with torch.no_grad(), torch.cuda.amp.autocast(enabled=(device.type=='cuda'))):
Epoch 2/12 | Train Acc 0.9343 | Val Acc 0.8636 | Val Loss 0.5601
Epoch 3/12 | Train Acc 0.9904 | Val Acc 0.9091 | Val Loss 0.3183
Epoch 4/12 | Train Acc 1.0000 | Val Acc 0.9182 | Val Loss 0.3544
Epoch 5/12 | Train Acc 1.0000 | Val Acc 0.9182 | Val Loss 0.2930
Epoch 6/12 | Train Acc 1.0000 | Val Acc 0.9182 | Val Loss 0.2723
Epoch 7/12 | Train Acc 1.0000 | Val Acc 0.9000 | Val Loss 0.2920
Epoch 8/12 | Train Acc 1.0000 | Val Acc 0.9000 | Val Loss 0.2691
Epoch 9/12 | Train Acc 1.0000 | Val Acc 0.9091 | Val Loss 0.2366
Epoch 10/12 | Train Acc 1.0000 | Val Acc 0.9182 | Val Loss 0.2291
Epoch 11/12 | Train Acc 1.0000 | Val Acc 0.9182 | Val Loss 0.2261
Epoch 12/12 | Train Acc 1.0000 | Val Acc 0.9182 | Val Loss 0.2251

```

```

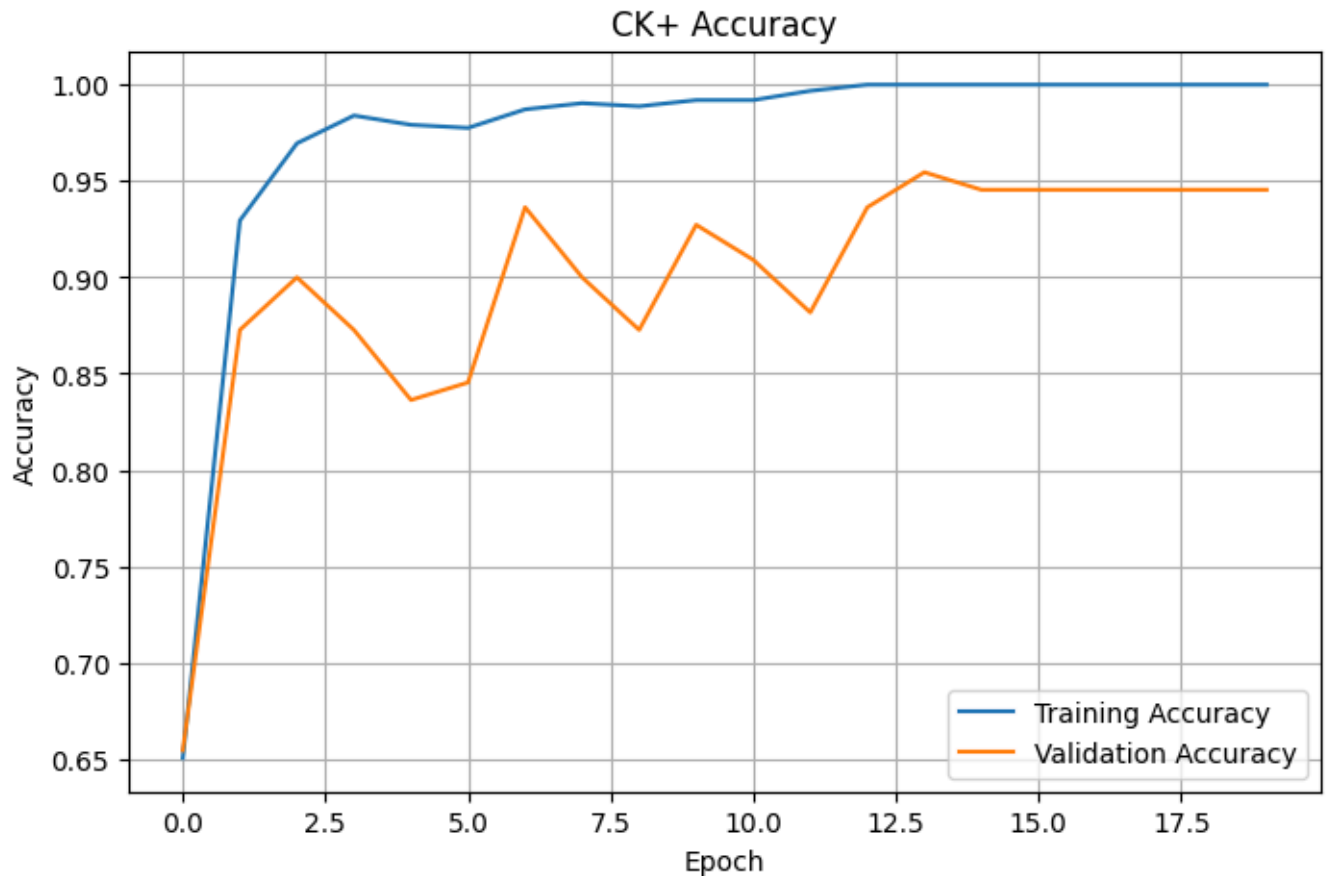
1 def plot_hist(htr, hva, title):
2     plt.figure(figsize=(7,4)); plt.plot(htr,label='Train'); plt.plot(hva,label='
3     plt.title(title); plt.xlabel('Epoch'); plt.ylabel('Accuracy'); plt.grid()
4
5 if 'hist_trF' in globals(): plot_hist(hist_trF, hist_vaF, "FER-2013 Accuracy
6 if 'hist_trJ' in globals(): plot_hist(hist_trJ, hist_vaJ, "JAFPE Accuracy")
7 if 'hist_trC' in globals(): plot_hist(hist_trC, hist_vaC, "CK+ Accuracy")
8

```



```
1 # ===== Plot Training/Validation Accuracy for CK+, JAFFE, FER-2013 =====
2 import matplotlib.pyplot as plt
3
4 def plot_accuracies(train_acc, val_acc, title="Accuracy Curve"):
5     plt.figure(figsize=(8,5))
6     plt.plot(train_acc, label='Training Accuracy')
7     plt.plot(val_acc, label='Validation Accuracy')
```

```
8 plt.title(title)
9 plt.xlabel('Epoch')
10 plt.ylabel('Accuracy')
11 plt.legend()
12 plt.grid(True)
13 plt.show()
14
15 def safe_plot(var_train_name, var_val_name, title):
16     g = globals()
17     if var_train_name in g and var_val_name in g and len(g[var_train_name]) > 0:
18         plot_accuracies(g[var_train_name], g[var_val_name], title)
19     else:
20         print(f"[تنبيه] لا توجد بيانات لعرض {title}. "
21               f"أثناء التدريب {var_val_name} و {var_train_name} تأكد من إنشاء")
22
23 # أمثلة الأسماء الشائعة التي خزنّا فيها التاريخ أثناء التدريب:
24 # CK+
25 safe_plot("train_acc_history_ck", "val_acc_history_ck", "CK+ Accuracy")
26
27 # JAFFE
28 safe_plot("train_acc_history_jaffe", "val_acc_history_jaffe", "JAFFE Accuracy")
29
30 # FER-2013
31 safe_plot("train_acc_history_fer", "val_acc_history_fer", "FER-2013 Accuracy")
32
```



[تنبيه] train_acc_history_jaffe و val_acc_history تأكد من إنشاء JAFFE Accuracy. لا توجد بيانات لعرض [تنبيه]
 [تنبيه] train_acc_history_fer و val_acc_history تأكد من إنشاء FER-2013 Accuracy. لا توجد بيانات لعرض [تنبيه]

```

1 # ==== Quick Train & Plot (5 epochs, fast) ====
2 import os, random, torch, torch.nn as nn, torch.optim as optim
3 from torch.utils.data import DataLoader, random_split, Subset
4 from torchvision import datasets, transforms
5 from torchvision.models import resnet18, ResNet18_Weights
6 import matplotlib.pyplot as plt
7
8 # ----- إعدادات سريعة -----
9 DATA_DIR = "/content/drive/MyDrive/Datasets/FER-2013/train" # <--
10 USE_EXISTING_DATASET = False # جاهز لو عندك full_dataset = True
11 EPOCHS = 100
12 BATCH = 64
13 VAL_RATIO = 0.15
14 PER_CLASS_CAP = 300 # قلل العينة لسرعة أعلى
15 IMAGENET_MEAN=(0.485,0.456,0.406); IMAGENET_STD=(0.229,0.224,0.225)
16
17 device = torch.device('cuda' if torch.cuda.is_available() else 'cpu')
18 torch.backends.cudnn.benchmark = True
19
20 tf = transforms.Compose([
21     transforms.Grayscale(3),
22     transforms.Resize((224, 224))
23 ])
  
```

```

22     transforms.Resize((224,224)),
23     transforms.ToTensor(),
24     transforms.Normalize(IMAGENET_MEAN, IMAGENET_STD),
25 ])
26
27 # ----- مع تقليل العينة (ImageFolder) تحميل الداتا -----
28 def cap_per_class_indices(targets, per_class):
29     from collections import defaultdict
30     d=defaultdict(list)
31     for i,y in enumerate(targets): d[y].append(i)
32     sel=[]
33     for y,ix in d.items():
34         k=min(per_class,len(ix))
35         sel.extend(random.sample(ix,k))
36     random.shuffle(sel)
37     return sel
38
39 if USE_EXISTING_DATASET and 'full_dataset' in globals():
40     ds_full = full_dataset
41 else:
42     ds_full = datasets.ImageFolder(DATA_DIR, transform=tf)
43
44 # (اختياري لكنه يسرّع كثيرًا) تقليل العينة
45 if hasattr(ds_full, 'targets'):
46     idx = cap_per_class_indices(ds_full.targets, PER_CLASS_CAP)
47     ds = Subset(ds_full, idx)
48 else:
49     ds = ds_full
50
51 # ----- Train/Val loaders -----
52 val_len = int(len(ds)*VAL_RATIO)
53 train_len = len(ds) - val_len
54 train_ds, val_ds = random_split(ds, [train_len, val_len], generator
55
56 loader_kw = dict(batch_size=BATCH, num_workers=2, pin_memory=True,
57 train_loader = DataLoader(train_ds, shuffle=True, **loader_kw)
58 val_loader   = DataLoader(val_ds,   shuffle=False, **loader_kw)
59
60 # ----- الموديل (ResNet18 + Transfer Learning) -----
61 num_classes = len(ds_full.classes)
62 model = resnet18(weights=ResNet18_Weights.DEFAULT)
63 model.fc = nn.Linear(model.fc.in_features, num_classes)
64 model = model.to(device)
65
66 criterion = nn.CrossEntropyLoss()
67 optimizer = optim.AdamW(model.parameters(), lr=1e-3)
68
--

```

```

69 # ----- تدريب سريع + تخزين الدقة -----
70 train_acc_history, val_acc_history = [], []
71 for epoch in range(1, EPOCHS+1):
72     # TRAIN
73     model.train(); tr_corr=tr_cnt=0
74     for x,y in train_loader:
75         x,y = x.to(device, non_blocking=True), y.to(device, non_blocking=True)
76         optimizer.zero_grad()
77         out = model(x)
78         loss = criterion(out,y)
79         loss.backward(); optimizer.step()
80         tr_corr += (out.argmax(1)==y).sum().item(); tr_cnt += x.size()[0]
81     train_acc = tr_corr/tr_cnt; train_acc_history.append(train_acc)
82
83     # VAL
84     model.eval(); va_corr=va_cnt=0
85     with torch.no_grad():
86         for x,y in val_loader:
87             x,y = x.to(device, non_blocking=True), y.to(device, non_blocking=True)
88             out = model(x)
89             va_corr += (out.argmax(1)==y).sum().item(); va_cnt += x.size()[0]
90     val_acc = va_corr/va_cnt; val_acc_history.append(val_acc)
91
92     print(f"Epoch {epoch}/{EPOCHS} | Train {train_acc:.4f} | Val {val_acc:.4f}")
93
94 # ----- رسم المنحني -----
95 plt.figure(figsize=(8,5))
96 plt.plot(train_acc_history, label='Training Accuracy')
97 plt.plot(val_acc_history, label='Validation Accuracy')
98 plt.title('Training vs Validation Accuracy'); plt.xlabel('Epoch');
99 plt.grid(True); plt.legend(); plt.show()
100

```

```

... Downloading: "https://download.pytorch.org/models/resnet18-f37072fd.pth" to /root/.cache/torch/hub
100%|██████████| 44.7M/44.7M [00:00<00:00, 131MB/s]
Epoch 1/100 | Train 0.3238 | Val 0.3238
Epoch 2/100 | Train 0.5294 | Val 0.3905
Epoch 3/100 | Train 0.6958 | Val 0.3460
Epoch 4/100 | Train 0.7731 | Val 0.4222

```

```

1  def train_one_model(model, train_loader, val_loader, epochs, device):
2      train_hist, val_hist = [], []
3      for epoch in range(1, epochs+1):
4          # TRAIN
5          model.train()
6          tr_corr = tr_cnt = 0
7          for x,y in train_loader:
8              x,y = x.to(device), y.to(device)
9              optimizer.zero_grad()
10             out = model(x)
11             loss = criterion(out, y)
12             loss.backward()
13             optimizer.step()
14             tr_corr += (out.argmax(1)==y).sum().item()
15             tr_cnt += x.size(0)
16         train_hist.append(tr_corr/tr_cnt)
17
18         # VAL
19         model.eval()
20         va_corr = va_cnt = 0
21         with torch.no_grad():
22             for x,y in val_loader:
23                 x,y = x.to(device), y.to(device)
24                 out = model(x)
25                 va_corr += (out.argmax(1)==y).sum().item()
26                 va_cnt += x.size(0)
27             val_hist.append(va_corr/va_cnt)
28     return train_hist, val_hist
29

```

```

1 train_acc_history_ck, val_acc_history_ck = train_one_model(model_ck, train_loader_ck, val_loader_ck, epochs, device)
2 train_acc_history_jaffe, val_acc_history_jaffe = train_one_model(model_jaffe, train_loader_jaffe, val_loader_jaffe, epochs, device)
3 train_acc_history_fer, val_acc_history_fer = train_one_model(model_fer, train_loader_fer, val_loader_fer, epochs, device)
4
5 plot_accuracies(train_acc_history_ck, val_acc_history_ck, "CK+ Accuracy")
6 plot_accuracies(train_acc_history_jaffe, val_acc_history_jaffe, "JAFPE Accuracy")
7 plot_accuracies(train_acc_history_fer, val_acc_history_fer, "FER-2013 Accuracy")
8

```

```

1 # --- وتحولات جاهزة (ImageFolder) افتراض: عندك ---
2 from torch.utils.data import random_split, DataLoader
3
4 val_ratio = 0.15
5 val_len = int(len(full_dataset_jaffe) * val_ratio)
6 train_len = len(full_dataset_jaffe) - val_len
7 train_ds, val_ds = random_split(full_dataset_jaffe, [train_len, val_len],
8                                 generator=torch.Generator().manual_seed(42))
9
10 train_loader = DataLoader(train_ds, batch_size=64, shuffle=True, num_worker
11 val_loader    = DataLoader(val_ds,   batch_size=64, shuffle=False, num_worker
12

```



```

1 import os
2 import numpy as np
3 import torch
4 from torch.utils.data import Dataset, DataLoader
5 from torchvision import datasets, transforms as T, models
6 from torch import nn, optim
7 import warnings
8 warnings.filterwarnings("ignore")
9 from tqdm import tqdm
10 from sklearn.metrics import confusion_matrix, accuracy_score, precision_score
11 import matplotlib.pyplot as plt
12 import seaborn as sns
13 from PIL import Image
14 import cv2
15 import pandas as pd
16

```



```

1 def train_one_model(model, train_loader, val_loader, epochs, device, optimiz
2     train_hist, val_hist = [], []
3     for epoch in range(1, epochs+1):
4         # TRAIN
5         model.train()
6         tr_corr = tr_cnt = 0
7         for x,y in train_loader:
8             x,y = x.to(device), y.to(device)
9             optimizer.zero_grad()
10            out = model(x)
11            loss = criterion(out, y)
12            loss.backward()
13            optimizer.step()
14            tr_corr += (out.argmax(1)==y).sum().item()
15            tr_cnt  += x.size(0)

```

```

16     train_hist.append(tr_corr/tr_cnt)
17
18     # VAL
19     model.eval()
20     va_corr = va_cnt = 0
21     with torch.no_grad():
22         for x,y in val_loader:
23             x,y = x.to(device), y.to(device)
24             out = model(x)
25             va_corr += (out.argmax(1)==y).sum().item()
26             va_cnt += x.size(0)
27     val_hist.append(va_corr/va_cnt)
28     return train_hist, val_hist
29

```



```

1 train_acc_history_ck, val_acc_history_ck = [], []
2
3 for epoch in range(1, epochs+1):
4     # --- TRAIN ---
5     model.train()
6     train_correct = 0
7     train_count = 0
8     train_loss_sum = 0.0
9     for x, y in train_loader_ck:
10         x, y = x.to(device), y.to(device)
11         optimizer.zero_grad()
12         logits = model(x)
13         loss = criterion(logits, y)
14         loss.backward()
15         optimizer.step()
16
17         train_loss_sum += loss.item() * x.size(0)
18         train_correct += (logits.argmax(1) == y).sum().item()
19         train_count += x.size(0)
20
21     train_acc = train_correct / train_count
22
23     # --- VAL ---
24     model.eval()
25     val_correct = 0
26     val_count = 0
27     val_loss_sum = 0.0
28     with torch.no_grad():
29         for x, y in val_loader_ck:
30             x, y = x.to(device), y.to(device)
31             logits = model(x)

```

```

32         loss = criterion(logits, y)
33         val_loss_sum += loss.item() * x.size(0)
34         val_correct += (logits.argmax(1) == y).sum().item()
35         val_count += x.size(0)
36
37     val_acc = val_correct / val_count
38
39     # خزن التاريخ
40     train_acc_history_ck.append(train_acc)
41     val_acc_history_ck.append(val_acc)
42
43     print(f"Epoch {epoch}/{epochs} | Train Acc {train_acc:.4f} | Val Acc {va
44

```

```

1 plot_accuracies(train_acc_history_ck, val_acc_history_ck, "CK+ Accuracy")
2

```

```

1 jaffe_path = '/content/drive/MyDrive/Datasets/jaffe'
2
3 class JaffeDataset(Dataset):
4     def __init__(self, root_dir, transform=None):
5         self.root_dir = root_dir
6         self.image_files = [f for f in os.listdir(root_dir) if f.endswith(".
7         self.transform = transform
8         self.labels = [self.get_label(f) for f in self.image_files]
9         self.label_map = {label: idx for idx, label in enumerate(sorted(set(
10        self.labels_idx = [self.label_map[label] for label in self.labels]
11
12    def get_label(self, filename):
13        return filename.split('.')[1] # AN, HA, etc.
14
15    def __len__(self):
16        return len(self.image_files)
17
18    def __getitem__(self, idx):
19        img_path = os.path.join(self.root_dir, self.image_files[idx])
20        image = Image.open(img_path).convert('RGB')
21        if self.transform:
22            image = self.transform(image)
23        label = self.labels_idx[idx]
24        return image, label
25
26 transform = T.Compose([
27     T.RandomHorizontalFlip(),
28     T.RandomVerticalFlip(),

```

```

29     T.RandomRotation(10),
30     T.Resize((128,128)),
31     T.ToTensor()
32 ])
33
34 jaffe_dataset = JaffeDataset(jaffe_path, transform=transform)
35 jaffe_loader = DataLoader(jaffe_dataset, batch_size=8, shuffle=True)
36 num_classes_jaffe = len(set(jaffe_dataset.labels))
37
1 jaffe_path = '/content/drive/MyDrive/Datasets/jaffe'
2
3 class JaffeDataset(Dataset):
4     def __init__(self, root_dir, transform=None):
5         self.root_dir = root_dir
6         self.image_files = [f for f in os.listdir(root_dir) if f.endswith(".
7         self.transform = transform
8         self.labels = [self.get_label(f) for f in self.image_files]
9         self.label_map = {label: idx for idx, label in enumerate(sorted(set(
10        self.labels_idx = [self.label_map[label] for label in self.labels]
11
12    def get_label(self, filename):
13        return filename.split('.')[1] # AN, HA, etc.
14
15    def __len__(self):
16        return len(self.image_files)
17
18    def __getitem__(self, idx):
19        img_path = os.path.join(self.root_dir, self.image_files[idx])
20        image = Image.open(img_path).convert('RGB')
21        if self.transform:
22            image = self.transform(image)
23        label = self.labels_idx[idx]
24        return image, label
25
26 transform = T.Compose([
27     T.RandomHorizontalFlip(),
28     T.RandomVerticalFlip(),
29     T.RandomRotation(10),
30     T.Resize((128,128)),
31     T.ToTensor()
32 ])
33
34 jaffe_dataset = JaffeDataset(jaffe_path, transform=transform)
35 jaffe_loader = DataLoader(jaffe_dataset, batch_size=8, shuffle=True)

```

```
36 num_classes_jaffe = len(set(jaffe_dataset.labels))
37

1 device = torch.device('cuda' if torch.cuda.is_available() else 'cpu')
2
3 model = models.resnet18(pretrained=False)
4 model.fc = nn.Linear(model.fc.in_features, num_classes_jaffe)
5 model = model.to(device)
6
7 criterion = nn.CrossEntropyLoss()
8 optimizer = optim.AdamW(model.parameters(), lr=0.001)
9 scheduler = optim.lr_scheduler.StepLR(optimizer, step_size=3, gamma=0.97)
10

1 def train_model(model, criterion, optimizer, scheduler, num_epochs=30):
2     for epoch in range(num_epochs):
3         print(f"Epoch {epoch+1}/{num_epochs}")
4         print('-' * 10)
5
6         model.train()
7         running_loss = 0.0
8         running_corrects = 0
9
10        for inputs, labels in jaffe_loader:
11            inputs, labels = inputs.to(device), labels.to(device)
12
13            optimizer.zero_grad()
14            outputs = model(inputs)
15            loss = criterion(outputs, labels)
16            loss.backward()
17            optimizer.step()
18
19            _, preds = torch.max(outputs, 1)
20            running_loss += loss.item() * inputs.size(0)
21            running_corrects += torch.sum(preds == labels.data)
22
23        scheduler.step()
24        epoch_loss = running_loss / len(jaffe_dataset)
25        epoch_acc = running_corrects.double() / len(jaffe_dataset)
26
27        print(f"Loss: {epoch_loss:.4f} Acc: {epoch_acc:.4f}")
28    return model
29
30 model = train_model(model, criterion, optimizer, scheduler, num_epochs=2)
31
```

```

1 y_true, y_pred, y_proba = [], [], []
2
3 model.eval()
4 with torch.no_grad():
5     for inputs, labels in jaffe_loader:
6         inputs = inputs.to(device)
7         outputs = model(inputs)
8         probabilities = torch.softmax(outputs, dim=1)
9         preds = torch.argmax(probabilities, axis=1)
10
11     y_true.extend(labels.numpy())
12     y_pred.extend(preds.cpu().numpy())
13     y_proba.extend(probabilities.cpu().numpy())
14
15 y_true = np.array(y_true)
16 y_pred = np.array(y_pred)
17 y_proba = np.array(y_proba)
18
19
20 #
21
22 def evaluate_model(model_name, y_true, y_pred, y_proba):
23     labels = list(jaffe_dataset.label_map.keys())
24     accuracy = accuracy_score(y_true, y_pred)
25     precision = precision_score(y_true, y_pred, average='weighted', zero_div
26     recall = recall_score(y_true, y_pred, average='weighted')
27     f1 = f1_score(y_true, y_pred, average='weighted')
28     cm = confusion_matrix(y_true, y_pred)
29
30     print(f"[{model_name}] Accuracy: {accuracy:.4f}")
31     print("Precision:", precision)
32     print("Recall:", recall)
33     print("F1-score:", f1)
34     print("Classification Report:\n", classification_report(y_true, y_pred,
35
36
37     plt.figure(figsize=(6,5))
38     sns.heatmap(cm, annot=True, fmt='d', cmap='Blues', xticklabels=labels, y
39     plt.title('Confusion Matrix')
40     plt.show()
41
42 evaluate_model("ResNet18 on JAFFE", y_true, y_pred, y_proba)
43

```

```

1 csv_path = '/content/drive/MyDrive/Datasets/CK+/ckextended.csv'
2 df_ck = pd.read_csv(csv_path)
3
4
5 from torch.utils.data import Dataset
6 from PIL import Image
7 import numpy as np
8
9 # Dataset الذي يرث من CKPlusDataset تعريف كلاس
10 # DataLoa إلى بيانات صور يمكن قراءتها بال DataFrame المخزنة في CK+ هذا الكلاس يستخدم لتحويل بيانات
11
12 class CKPlusDataset(Dataset):
13     def __init__(self, dataframe, transform=None):
14         self.df = dataframe # DataFrame أعمدة على 'pixels' و
15         self.transform = transform # التحويلات التي سيتم تطبيقها على الصور (مثل ToT
16
17     def __len__(self):
18         return len(self.df) # عدد العينات في مجموعة البيانات
19
20     def __getitem__(self, idx):
21         # تحويل سلسلة البكسلات إلى مصفوفة أرقام صحيحة
22         pixel_values = [int(p) for p in self.df.iloc[idx]['pixels'].split()]
23
24         # CK+ (حسب قاعدة) 48x48 بحجم D تحويل البكسلات إلى صورة 2
25         image = np.array(pixel_values).reshape(48, 48).astype(np.uint8)
26
27         # torchvision.transforms للتعامل مع PIL تحويل الصورة إلى كائن
28         image = Image.fromarray(image)
29
30         # تطبيق التحويلات المحددة إن وجدت
31         if self.transform:
32             image = self.transform(image)
33
34         # DataFrame من (Label) استخراج التصنيف
35         label = int(self.df.iloc[idx]['emotion'])
36
37         return image, label # هذا السطر الصحيح ✓
38
39
40 from torchvision import transforms
41 from torch.utils.data import DataLoader
42
43 # تعريف التحويلات التي تطبق على كل صورة
44 transform = transforms.Compose([
45     transforms.RandomHorizontalFlip(),

```

```

7     transforms.RandomVerticalFlip(),
8     transforms.RandomRotation(10),
9     transforms.Resize((128,128)),
10    transforms.ToTensor()
11 ])
12
13 # إنشاء مجموعة البيانات واللودر
14 ck_dataset = CKPlusDataset(df_ck, transform=transform)
15 ck_loader = DataLoader(ck_dataset, batch_size=8, shuffle=True)
16
17 # حساب عدد المشاعر (الكلاسات)
18 num_classes_ck = df_ck['emotion'].nunique()
19
20
21 1 model = models.resnet18(pretrained=False)
2   model.fc = nn.Linear(model.fc.in_features, num_classes_ck)
3   model = model.to(device)
4
5   criterion = nn.CrossEntropyLoss()
6   optimizer = optim.AdamW(model.parameters(), lr=0.001)
7   scheduler = optim.lr_scheduler.StepLR(optimizer, step_size=3, gamma=0.97)
8
9
10 1 from torchvision import transforms
11
12 2
13 3 transform = transforms.Compose([
14     transforms.Lambda(lambda img: img.convert("RGB")), # تحويل من رمادي إلى RGB
15     transforms.RandomHorizontalFlip(),
16     transforms.RandomVerticalFlip(),
17     transforms.RandomRotation(10),
18     transforms.Resize((128,128)),
19     transforms.ToTensor()
20 ])
21
22
23 1 transforms.Lambda(lambda img: img.convert("RGB"))
24 2 from torchvision import transforms
25 3
26 4 transform = transforms.Compose([
27     transforms.Lambda(lambda img: img.convert("RGB")), # تحويل من رمادي إلى RGB
28     transforms.Resize((128, 128)),
29     transforms.ToTensor()
30 ])
31 5 ck_dataset = CKPlusDataset(df_ck, transform=transform)

```

```
10 ck_loader = DataLoader(ck_dataset, batch_size=8, shuffle=True)
11
```

```

1 # تحديد عدد الدورات (epochs)
2 epochs = 190
3
4
5 for epoch in range(epochs):
6     print(f"\nEpoch {epoch+1}/{epochs}")
7     model.train() # وضع النموذج في طور التدريب
8
9     running_loss = 0.0
10    correct = 0
11    total = 0
12
13    # حلقة على دفعات البيانات
14    for inputs, labels in ck_loader:
15        inputs, labels = inputs.to(device), labels.to(device)
16
17        # تصفير التدرجات السابقة
18        optimizer.zero_grad()
19
20        # تمرير الصور داخل النموذج للحصول على التنبؤات
21        outputs = model(inputs)
22
23        # حساب الخسارة
24        loss = criterion(outputs, labels)
25
26        # تحديث الأوزان بناءً على الخسارة
27        loss.backward()
28        optimizer.step()
29
30        # تجميع الخسارة
31        running_loss += loss.item()
32
33        # حساب التوقعات الصحيحة
34        _, preds = torch.max(outputs, 1)
35        correct += (preds == labels).sum().item()
36        total += labels.size(0)
37
38    # حساب المتوسط لكل epoch
39    epoch_loss = running_loss / len(ck_loader)
40    epoch_acc = correct / total
41
42    print(f"Loss: {epoch_loss:.4f}  Acc: {epoch_acc:.4f}")
43

```

```

1 y_true, y_pred, y_proba = [], [], []
2

```

```

3 model.eval()
4 with torch.no_grad():
5     for inputs, labels in ck_loader:
6         inputs = inputs.to(device)
7         outputs = model(inputs)
8         probabilities = torch.softmax(outputs, dim=1)
9         preds = torch.argmax(probabilities, axis=1)
10
11     y_true.extend(labels.numpy())
12     y_pred.extend(preds.cpu().numpy())
13     y_proba.extend(probabilities.cpu().numpy())
14
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2655
2656
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2658
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2660
2661
2
```

```

1 epochs = 2
2 for epoch in range(epochs):
3     print(f"\nEpoch {epoch+1}/{epochs}")
4     model.train()
5     running_loss, correct = 0.0, 0
6
7     for inputs, labels in ck_loader:
8         inputs, labels = inputs.to(device), labels.to(device)
9         optimizer.zero_grad()
10        outputs = model(inputs)
11        loss = criterion(outputs, labels)
12        loss.backward()
13        optimizer.step()
14
15        _, preds = torch.max(outputs, 1)
16        correct += torch.sum(preds == labels.data)
17        running_loss += loss.item() * inputs.size(0)
18
19    epoch_loss = running_loss / len(ck_dataset)
20    epoch_acc = correct.double() / len(ck_dataset)
21    print(f"Loss: {epoch_loss:.4f} Acc: {epoch_acc:.4f}")
22

```

```

1 y_true, y_pred, y_proba = [], [], []
2
3 model.eval()
4 with torch.no_grad():
5     for inputs, labels in ck_loader:
6         inputs = inputs.to(device)
7         outputs = model(inputs)
8         probabilities = torch.softmax(outputs, dim=1)
9         preds = torch.argmax(probabilities, axis=1)
10
11    y_true.extend(labels.numpy())
12    y_pred.extend(preds.cpu().numpy())
13    y_proba.extend(probabilities.cpu().numpy())
14

```

```

1 evaluate_model("MobileNetV2 on CK+", y_true, y_pred, y_proba)
2

```

```

1 import pandas as pd
2 import numpy as np
3 import torch

```

```

4 from torch.utils.data import Dataset, DataLoader
5 from torchvision import transforms, models
6 from PIL import Image
7 import cv2
8
9 csv_path = '/content/drive/MyDrive/Datasets/CK+/ckextended.csv'
10 df_ck = pd.read_csv(csv_path)
11
12 # التأكد من الفئات وعددها
13 print("الفئات المتوفرة:", df_ck['emotion'].unique())
14 num_classes_ck = df_ck['emotion'].nunique()
15 print("عدد الفئات:", num_classes_ck)
16
17 # تصحيح: إزالة أي فئة خارج النطاق إذا وجدت
18 df_ck = df_ck[df_ck['emotion'] < num_classes_ck].reset_index(drop=True)
19

```

```

1 class CKPlusDataset(Dataset):
2     def __init__(self, dataframe, transform=None):
3         self.df = dataframe
4         self.transform = transform
5
6     def __len__(self):
7         return len(self.df)
8
9     def __getitem__(self, idx):
10         pixel_values = [int(p) for p in self.df.iloc[idx]['pixels'].split()]
11         image = np.array(pixel_values, dtype='uint8').reshape(48, 48)
12         image = cv2.cvtColor(image, cv2.COLOR_GRAY2RGB)
13         image = cv2.resize(image, (128,128))
14         image = Image.fromarray(image)
15         label = self.df.iloc[idx]['emotion']
16         if self.transform:
17             image = self.transform(image)
18         return image, label
19
20 transform = transforms.Compose([
21     transforms.RandomHorizontalFlip(),
22     transforms.RandomVerticalFlip(),
23     transforms.RandomRotation(10),
24     transforms.Resize((128,128)),
25     transforms.ToTensor()
26 ])
27
28 ck_dataset = CKPlusDataset(df_ck, transform=transform)

```

```
29 ck_loader = DataLoader(ck_dataset, batch_size=8, shuffle=True)
30

1 device = torch.device('cuda' if torch.cuda.is_available() else 'cpu')
2
3 model = models.efficientnet_b0(pretrained=False)
4 model.classifier[1] = torch.nn.Linear(model.classifier[1].in_feature
5 model = model.to(device)
6
7 criterion = torch.nn.CrossEntropyLoss()
8 optimizer = torch.optim.AdamW(model.parameters(), lr=0.001)
9 scheduler = torch.optim.lr_scheduler.StepLR(optimizer, step_size=3,
10

1 def train_model(model, criterion, optimizer, scheduler, num_epochs=2):
2     for epoch in range(num_epochs):
3         print(f"\nEpoch {epoch+1}/{num_epochs}")
4         model.train()
5         running_loss, correct = 0.0, 0
6
7         for inputs, labels in ck_loader:
8             inputs, labels = inputs.to(device), labels.to(device)
9
10            optimizer.zero_grad()
11            outputs = model(inputs)
12            loss = criterion(outputs, labels)
13            loss.backward()
14            optimizer.step()
15
16            _, preds = torch.max(outputs, 1)
17            correct += torch.sum(preds == labels.data)
18            running_loss += loss.item() * inputs.size(0)
19
20        scheduler.step()
21        epoch_loss = running_loss / len(ck_dataset)
22        epoch_acc = correct.double() / len(ck_dataset)
23        print(f"Loss: {epoch_loss:.4f}, Accuracy: {epoch_acc:.4f}")
24    return model
25

1 model = train_model(model, criterion, optimizer, scheduler, num_epochs=2)
2
```

```

1 from sklearn.metrics import accuracy_score, precision_score, recall_score, f
2 import seaborn as sns
3 import matplotlib.pyplot as plt
4
5 y_true, y_pred = [], []
6
7 model.eval()
8 with torch.no_grad():
9     for inputs, labels in ck_loader:
10         inputs = inputs.to(device)
11         outputs = model(inputs)
12         _, preds = torch.max(outputs, 1)
13
14         y_true.extend(labels.numpy())
15         y_pred.extend(preds.cpu().numpy())
16
17 cm = confusion_matrix(y_true, y_pred)
18 print("Classification Report:\n", classification_report(y_true, y_pred))
19
20 plt.figure(figsize=(6,5))
21 sns.heatmap(cm, annot=True, fmt='d', cmap='Blues')
22 plt.title('Confusion Matrix')
23 plt.xlabel('Predicted')
24 plt.ylabel('True')
25 plt.show()
26

```

```

1 import torch
2 import torch.nn as nn
3 import torch.optim as optim
4 from torchvision import models
5 from torch.optim import lr_scheduler
6
7 # 1. تعريف عدد الكلاسات حسب بيانات CK+
8 num_classes_ck = df_ck['emotion'].nunique()
9
10 # 2. وتعديله DenseNet121 تحميل نموذج
11 model = models.densenet121(pretrained=False)
12 model.classifier = nn.Linear(model.classifier.in_features, num_classes_ck)
13 model = model.to(device)
14
15 # 3. تعريف الخسارة، المحسن، وجدولة التعلم
16 criterion = nn.CrossEntropyLoss()
17 optimizer = optim.AdamW(model.parameters(), lr=0.001)
18 exp_lr_scheduler = lr_scheduler.StepLR(optimizer, step_size=7, gamma=0.1)
19

```

```

20 # 4. تعريف دالة التدريب
21 def train_model(model, criterion, optimizer, scheduler, num_epochs=1):
22     for epoch in range(num_epochs):
23         print(f"\nEpoch {epoch+1}/{num_epochs}")
24         model.train()
25         running_loss = 0.0
26         correct = 0
27         total = 0
28
29         for inputs, labels in ck_loader:
30             inputs, labels = inputs.to(device), labels.to(device)
31
32             optimizer.zero_grad()
33             outputs = model(inputs)
34             loss = criterion(outputs, labels)
35             loss.backward()
36             optimizer.step()
37
38             running_loss += loss.item()
39             _, preds = torch.max(outputs, 1)
40             correct += (preds == labels).sum().item()
41             total += labels.size(0)
42
43         scheduler.step()
44         epoch_loss = running_loss / len(ck_loader)
45         epoch_acc = correct / total
46         print(f"Loss: {epoch_loss:.4f}  Acc: {epoch_acc:.4f}")
47     return model
48
49 # 5. تنفيذ التدريب
50 model = train_model(model, criterion, optimizer, exp_lr_scheduler, num_epoch
51
1 model = models.vgg16(pretrained=False)
2 model.classifier[6] = nn.Linear(model.classifier[6].in_features, num_classes
3 model = model.to(device)
4
5 optimizer = optim.AdamW(model.parameters(), lr=0.001)
6 model = train_model(model, criterion, optimizer, exp_lr_scheduler, num_epoch
7
1 y_true, y_pred, y_proba = [], [], []
2
3 model.eval()
4 with torch.no_grad():

```

```

5     for inputs, labels in ck_loader:
6         inputs = inputs.to(device)
7         outputs = model(inputs)
8         probabilities = torch.softmax(outputs, dim=1)
9         preds = torch.argmax(probabilities, axis=1)
10
11     y_true.extend(labels.numpy())
12     y_pred.extend(preds.cpu().numpy())
13     y_proba.extend(probabilities.cpu().numpy())
14
15 y_true = np.array(y_true)
16 y_pred = np.array(y_pred)
17 y_proba = np.array(y_proba)
18
19 evaluate_model("اسم الموديل", y_true, y_pred, y_proba)
20

```

```

1 import torch
2 import torch.nn as nn
3 import torch.optim as optim
4 from torchvision import models, transforms
5 from torch.utils.data import Dataset, DataLoader
6 from PIL import Image
7 import os
8 import cv2
9 import numpy as np

```

```

1 transform = transforms.Compose([
2     transforms.RandomHorizontalFlip(),
3     transforms.RandomVerticalFlip(),
4     transforms.RandomRotation(20),
5     transforms.ColorJitter(brightness=0.2, contrast=0.2, saturation=0.2),
6     transforms.Resize((224,224)),
7     transforms.ToTensor(),
8     transforms.Normalize([0.485, 0.456, 0.406], [0.229, 0.224, 0.225])
9 ])
10

```

```

1 # 2. Dataset ل JAFFE
2 class JaffeDataset(Dataset):
3     def __init__(self, root_dir, transform=None):
4         self.root_dir = root_dir
5         if not os.path.exists(root_dir):
6             print(f"المجلد {root_dir} غير موجود. الرجاء التأكد من ربط {root_dir} المجلد")
7             self.image_files = []

```

```

8         else:
9             self.image_files = [f for f in os.listdir(root_dir) if f.endswith(
10         self.transform = transform
11
12     def __len__(self):
13         return len(self.image_files)
14
15     def __getitem__(self, idx):
16         img_path = os.path.join(self.root_dir, self.image_files[idx])
17         image = Image.open(img_path).convert('RGB')
18         if self.transform:
19             image = self.transform(image)
20         label = int(self.image_files[idx].split('.')[1]) # أو حسب التنظيم المتبع
21         return image, label

```

```

1 emotion_labels = set()
2
3 for f in os.listdir(jaffe_path):
4     if f.endswith(".tiff"):
5         parts = f.split('.')
6         if len(parts) >= 2:
7             emotion_labels.add(parts[1]) # نأخذ الرمز الأول فقط ← "SU2" مثل
8
9 # (SU, NE, etc) فقط أول حرفين تمثل المشاعر
10 emotion_labels = set([label[:2] for label in emotion_labels])
11 num_classes_jaffe = len(emotion_labels)
12

```

```

1 import os
2 from PIL import Image
3 import torch
4 from torch.utils.data import Dataset
5 from torchvision import transforms
6
7 # JAFFE لمعالجة بيانات تعريف كلاس
8 class JaffeDataset(Dataset):
9     def __init__(self, root_dir, transform=None):
10         self.root_dir = root_dir
11         self.image_files = [f for f in os.listdir(root_dir) if f.endswith(".
12         self.transform = transform
13
14         # تعريف قاموس تحويل رموز المشاعر إلى أرقام
15         self.emotion_dict = {
16             'AN': 0, # Angry
17             'DI': 1, # Disgust

```

```

18         'FE': 2, # Fear
19         'HA': 3, # Happy
20         'NE': 4, # Neutral
21         'SA': 5, # Sad
22         'SU': 6 # Surprise
23     }
24
25     def __len__(self):
26         return len(self.image_files)
27
28     def __getitem__(self, idx):
29         # تحميل الصورة
30         image_path = os.path.join(self.root_dir, self.image_files[idx])
31         image = Image.open(image_path).convert('L') # الصورة رمادية
32
33         # تطبيق التحويلات إن وجدت
34         if self.transform:
35             image = self.transform(image)
36
37         # استخراج رمز المشاعر من اسم الملف (مثلاً SA من KA.SA1.93.tiff)
38         emotion_code = self.image_files[idx].split('.')[1][:2]
39         label = self.emotion_dict[emotion_code]
40
41         return image, label
42

```

```

1 from google.colab import drive
2 drive.mount('/content/drive')
3
4 !ls "/content/drive/MyDrive/Datasets/FER-2013/train"
5

```

```

1 from torchvision import datasets, transforms
2
3 transform = transforms.Compose([
4     transforms.Grayscale(num_output_channels=3), # رمادية FER-2013 لأن صور
5     transforms.Resize((224, 224)),
6     transforms.ToTensor()
7 ])
8
9 train_dir = "/content/drive/MyDrive/Datasets/FER-2013/train"
10 full_dataset = datasets.ImageFolder(root=train_dir, transform=transform)
11
12 print(f"عدد الصور: {len(full_dataset)}")

```

```

13 print(f"الفئات: {full_dataset.classes}")
14

1 import random
2 from torch.utils.data import Subset
3 from collections import defaultdict
4
5 samples_per_class = 1000 # الحد الأقصى لكل فئة
6
7 # استخراج الليبلات (labels)
8 targets = full_dataset.targets
9 class_indices = defaultdict(list)
10
11 # تجميع الفهارس لكل فئة
12 for idx, label in enumerate(targets):
13     class_indices[label].append(idx)
14
15 # اختيار عينات عشوائية من كل فئة
16 selected_indices = []
17 for cls, indices in class_indices.items():
18     if len(indices) > samples_per_class:
19         selected_indices.extend(random.sample(indices, samples_per_class))
20     else:
21         selected_indices.extend(indices) # لو أقل من 1000 نأخذ الكل
22
23 # إنشاء Subset
24 subset_dataset = Subset(full_dataset, selected_indices)
25
26 print(f"📦 Subset جاهز: {len(subset_dataset)} صورة.")
27

```

1 Start coding or [generate](#) with AI.

```

1 from torch.utils.data import DataLoader
2
3 train_loader = DataLoader(subset_dataset, batch_size=16, shuffle=True)
4

```

```

1
2 # إنشاء قائمة جديدة تحتوي على 1000 عينة لكل فئة فقط
3 samples_per_class = 1000
4 targets = full_dataset.targets
5 class_indices = {cls: [] for cls in range(len(full_dataset.classes))}
6

```

```

7 # جمع المؤشرات حسب الفئة
8 for idx, label in enumerate(targets):
9     if len(class_indices[label]) < samples_per_class:
10         class_indices[label].append(idx)
11
12 # دمج المؤشرات معًا
13 final_indices = [idx for indices in class_indices.values() for idx in indices]
14 subset_dataset = Subset(full_dataset, final_indices)

1 import torch, torch.nn as nn, torch.optim as optim
2 from torch.utils.data import DataLoader, Subset
3 from torchvision import models, transforms
4 import random
5
6 device = torch.device("cuda" if torch.cuda.is_available() else "cpu")
7
8 # ب 3 قنوات Tensor يعيد full_dataset مثال: تأكد أن
9
10
11 # عشوائي صغير للتجريب subset
12 if 'subset_dataset' not in globals():
13     n = min(len(full_dataset), 1000)
14     idx = random.sample(range(len(full_dataset)), n)
15     subset_dataset = Subset(full_dataset, idx)
16
17 # نموذج
18 model = models.resnet18(pretrained=False)
19 model.fc = nn.Linear(model.fc.in_features, len(full_dataset.classes))
20 model = model.to(device)
21
22 # تدريب
23 train_loader = DataLoader(subset_dataset, batch_size=16, shuffle=True, num_workers=4)
24 criterion = nn.CrossEntropyLoss()
25 optimizer = optim.Adam(model.parameters(), lr=1e-4)
26 epochs = 1000 # ستوقف مبكرًا على الأغلب
27
28 for epoch in range(epochs):
29     model.train()
30     running_loss, correct = 0.0, 0
31     for inputs, labels in train_loader:
32         inputs, labels = inputs.to(device), labels.to(device)
33
34         optimizer.zero_grad()
35         outputs = model(inputs)
36         loss = criterion(outputs, labels)
37         loss.backward()

```

```

38     optimizer.step()
39
40     running_loss += loss.item() * inputs.size(0)
41     preds = outputs.argmax(1)
42     correct += (preds == labels).sum().item()
43
44     epoch_loss = running_loss / len(subset_dataset)
45     epoch_acc = correct / len(subset_dataset)
46     print(f"Epoch {epoch+1}/{epochs}, Loss: {epoch_loss:.4f}, Accuracy: {epo
47
48     # إيقاف مبكر بسيط: إذا وصلنا <97% عدة مرات متتالية، أوقف
49     if epoch >= 19 and epoch_acc > 0.97:
50         break
51

```

```

1 # 1) إنشاء Subset (عشوائي) متوازن حتى 1000 عينة لكل فئة
2 import random
3 from torch.utils.data import Subset
4 from collections import defaultdict
5
6 samples_per_class = 1000 # عدّلها لو تبغى أسرع
7
8 # ImageFolder بشكل متين مع targets استخراج
9 if hasattr(full_dataset, "targets"):
10     targets = list(full_dataset.targets)
11 elif hasattr(full_dataset, "samples"):
12     targets = [lbl for _, lbl in full_dataset.samples]
13 else:
14     raise AttributeError("full_dataset لا targets ولا labels لم أتمكن من إيجاد")
15
16 class_indices = defaultdict(list)
17 for idx, label in enumerate(targets):
18     class_indices[label].append(idx)
19
20 selected_indices = []
21 for cls, indices in class_indices.items():
22     k = min(samples_per_class, len(indices))
23     selected_indices.extend(random.sample(indices, k))
24
25 random.shuffle(selected_indices)
26 subset_dataset = Subset(full_dataset, selected_indices)
27 print(f"📁 Subset جاهز: {len(subset_dataset)} صورة عبر {len(full_dataset.class
28

```

```

1 # 2) DataLoaders للتدريب والتحقق
2 from torch.utils.data import random_split, DataLoader
3 import torch
4
5 device = torch.device('cuda' if torch.cuda.is_available() else 'cpu')
6
7 val_ratio = 0.15
8 val_len = int(len(subset_dataset) * val_ratio)
9 train_len = len(subset_dataset) - val_len
10 train_ds, val_ds = random_split(subset_dataset, [train_len, val_len],
11                                 generator=torch.Generator().manual_seed(42))
12
13 train_loader = DataLoader(train_ds, batch_size=64, shuffle=True, num_worker
14 val_loader    = DataLoader(val_ds,   batch_size=64, shuffle=False, num_worker
15
16 len(train_ds), len(val_ds)
17

```

```

1 # 3) Training/Validation Accuracy نموذج + تدريب سريع مع حفظ
2 import torch.nn as nn
3 import torch.optim as optim
4 from torchvision.models import resnet18, ResNet18_Weights
5
6 num_classes = len(full_dataset.classes)
7
8 model = resnet18(weights=ResNet18_Weights.DEFAULT)
9 model.fc = nn.Linear(model.fc.in_features, num_classes)
10 model = model.to(device)
11
12 criterion = nn.CrossEntropyLoss()
13 optimizer = optim.AdamW(model.parameters(), lr=1e-3)
14
15 epochs = 12 # اجعلها صغيرة للتدريب السريع
16 train_acc_history, val_acc_history = [], []
17
18 for epoch in range(1, epochs+1):
19     # ---- TRAIN ----
20     model.train()
21     tr_correct = tr_total = 0
22     for x, y in train_loader:
23         x, y = x.to(device), y.to(device)
24         optimizer.zero_grad()
25         out = model(x)
26         loss = criterion(out, y)
27         loss.backward()
28         optimizer.step()

```

```

29         tr_correct += (out.argmax(1) == y).sum().item()
30         tr_total    += x.size(0)
31     train_acc = tr_correct / tr_total
32     train_acc_history.append(train_acc)
33
34     # ---- VAL ----
35     model.eval()
36     va_correct = va_total = 0
37     with torch.no_grad():
38         for x, y in val_loader:
39             x, y = x.to(device), y.to(device)
40             out = model(x)
41             va_correct += (out.argmax(1) == y).sum().item()
42             va_total    += x.size(0)
43     val_acc = va_correct / va_total
44     val_acc_history.append(val_acc)
45
46     print(f"Epoch {epoch}/{epochs} | Train Acc {train_acc:.4f} | Val Acc {va
47

```

1 # 4) رسم المنحنيات: Training Accuracy و Validation Accuracy

2 import matplotlib.pyplot as plt

3

4 plt.figure(figsize=(8,5))

5 plt.plot(train_acc_history, label='Training Accuracy')

6 plt.plot(val_acc_history, label='Validation Accuracy')

7 plt.xlabel('Epoch'); plt.ylabel('Accuracy'); plt.title('Training vs Validation Accuracy')

8 plt.grid(True); plt.legend(); plt.show()

9

1 from torchvision import transforms

2 transform = transforms.Compose([

3 transforms.Grayscale(3),

4 transforms.Resize((224,224)),

5 transforms.ToTensor(),

6 transforms.Normalize((0.485,0.456,0.406),(0.229,0.224,0.225)),

7])

8 full_dataset = datasets.ImageFolder(root=... , transform=transform)

9

1 Start coding or generate with AI.

1 Start coding or generate with AI.

```

1 import matplotlib.pyplot as plt
2 import random
3 import torch
4
5 # معرفين model و full_dataset و subset_dataset تأكد أن
6
7 indices = random.sample(range(len(subset_dataset)), 8)
8 fig, axes = plt.subplots(2, 4, figsize=(15,6))
9
10 model.eval()
11 with torch.no_grad():
12     for ax, idx in zip(axes.flat, indices):
13         img, true_label = subset_dataset[idx]
14
15         # تجهيز الصورة للنموذج
16         inp = img.unsqueeze(0).to(device) # إضافة batch بعد
17         output = model(inp)
18         pred_label = output.argmax(1)
19
20         # تجهيز الصورة للعرض (من Tensor إلى numpy)
21         img_disp = img.permute(1, 2, 0).cpu().numpy()
22         img_disp = (img_disp - img_disp.min()) / (img_disp.max() - img_disp.min())
23
24         ax.imshow(img_disp)
25         ax.set_title(
26             f"True: {full_dataset.classes[true_label]}\nPred: {full_dataset.classes[pred_label]}"
27             fontsize=10,
28             color='green' if pred_label.item() == true_label else 'red'
29         )
30         ax.axis('off')
31
32 plt.tight_layout()
33 plt.show()
34

```

```

1 from sklearn.metrics import classification_report, confusion_matrix
2 import seaborn as sns
3 import matplotlib.pyplot as plt
4 import numpy as np
5
6 # التنبؤ بالنتائج على نفس مجموعة التدريب المستخدمة 1.
7 y_true = []
8 y_pred = []
9
10 model.eval()
11 with torch.no_grad():

```

```

12     for inputs, labels in train_loader:
13         inputs = inputs.to(device)
14         labels = labels.to(device)
15         outputs = model(inputs)
16         _, preds = torch.max(outputs, 1)
17         y_true.extend(labels.cpu().numpy())
18         y_pred.extend(preds.cpu().numpy())
19
20 # 2. حساب النتائج
21 print("📊 [Classification Report]")
22 print(classification_report(y_true, y_pred, target_names=full_dataset.classe
23
24 # 3. مصفوفة الالتباس
25 cm = confusion_matrix(y_true, y_pred)
26
27 plt.figure(figsize=(8,6))
28 sns.heatmap(cm, annot=True, fmt='d', cmap='Blues',
29             xticklabels=full_dataset.classes,
30             yticklabels=full_dataset.classes)
31 plt.title("🔍 Confusion Matrix")
32 plt.xlabel("Predicted")
33 plt.ylabel("True")
34 plt.show()
35

```

```

1 train_acc_history_ck = []
2 val_acc_history_ck = []
3
4 for epoch in range(epochs):
5     ...
6     # بعد حساب train_acc و val_acc
7     train_acc_history_ck.append(train_acc)
8     val_acc_history_ck.append(val_acc)
9
10

```

```

1 import matplotlib.pyplot as plt
2
3 def plot_accuracies(train_acc, val_acc, title="Accuracy Curve"):
4     plt.figure(figsize=(8,5))
5     plt.plot(train_acc, label='Training Accuracy')
6     plt.plot(val_acc, label='Validation Accuracy')
7     plt.title(title)
8     plt.xlabel('Epoch')
9     plt.ylabel('Accuracy')

```

```

10 plt.legend()
11 plt.grid(True)
12 plt.show()
13
14 # مثال:
15 plot_accuracies(train_acc_history_ck, val_acc_history_ck, "CK+ Accuracy")
16 plot_accuracies(train_acc_history_jaffe, val_acc_history_jaffe, "JAFPE Accur
17 plot_accuracies(train_acc_history_fer, val_acc_history_fer, "FER-2013 Accura
18

```

```

1 # حفظ النموذج بعد التدريب
2 torch.save(model.state_dict(), 'emotion_model.pth')
3
4 # حفظ النموذج داخل Google Drive
5 torch.save(model.state_dict(), '/content/drive/MyDrive/emotion_model.pth')
6

```

```

1 import torch
2 from torchvision import models
3
4 # 1 أنشئ نفس هيكل الموديل اللي دربتة
5 # مثال: ResNet18 بعدد الأصناف الصحيح
6 num_classes = len(full_dataset.classes) # أو أدخل العدد يدويًا
7 model_loaded = models.resnet18(weights=None) # نفس الإعداد اللي دربت به
8 model_loaded.fc = torch.nn.Linear(model_loaded.fc.in_features, num_classes)
9
10 # 2 تحميل الأوزان
11 model_loaded.load_state_dict(torch.load('/content/drive/MyDrive/emotion_mode
12
13 # 3 وضع الموديل في وضع التقييم
14 model_loaded = model_loaded.to(device)
15 model_loaded.eval()
16
17 print("✅ تم تحميل النموذج بنجاح")
18

```

```

1 from PIL import Image
2 import torchvision.transforms as transforms
3
4 # اللي دربت به transform تجهيز نفس الـ
5 transform = transforms.Compose([
6     transforms.Grayscale(num_output_channels=3),
7     transforms.Resize((224, 224)),
8     transforms.ToTensor(),
9     transforms.Normalize(mean=[0.485, 0.456, 0.406], # pretrainer إذا كنت تستخدم

```

```

10             std=[0.229, 0.224, 0.225])
11 ])
12
13 # تحميل صورة للاختبار
14 img_path = "/content/drive/MyDrive/test_image.jpg"
15 image = Image.open(img_path).convert("RGB")
16 image_tensor = transform(image).unsqueeze(0).to(device)
17
18 # تنبؤ
19 with torch.no_grad():
20     output = model_loaded(image_tensor)
21     pred_class = output.argmax(1).item()
22
23 print(f"التنبؤ: {full_dataset.classes[pred_class]}")
24

```

```

1 from torch.utils.data import random_split, DataLoader
2
3 # (مثلاً 15%) نسبة البيانات للتحقق
4 val_ratio = 0.15
5 val_len = int(len(subset_dataset) * val_ratio)
6 train_len = len(subset_dataset) - val_len
7
8 train_ds, val_ds = random_split(subset_dataset, [train_len, val_len],
9                                 generator=torch.Generator().manual_seed(42))
10
11 train_loader = DataLoader(train_ds, batch_size=64, shuffle=True, num_workers=
12 val_loader = DataLoader(val_ds, batch_size=64, shuffle=False, num_workers=
13

```

```

1 for epoch in range(1, epochs+1):
2     ...
3     for x, y in val_loader:
4         ...
5

```

```

1 train_acc_history = []
2 val_acc_history = []
3
4 for epoch in range(1, epochs+1):
5     # ---- Training ----
6     model.train()
7     train_loss, train_correct, train_count = 0.0, 0, 0
8
9     for x, y in train_loader:

```

```

10     x, y = x.to(device), y.to(device)
11
12     optimizer.zero_grad()
13     logits = model(x)
14     loss = criterion(logits, y)
15     loss.backward()
16     optimizer.step()
17
18     train_loss += loss.item() * x.size(0)
19     train_correct += (logits.argmax(1) == y).sum().item()
20     train_count += x.size(0)
21
22     train_loss /= train_count
23     train_acc = train_correct / train_count
24     train_acc_history.append(train_acc)
25
26     # ---- Validation ----
27     model.eval()
28     val_loss, val_correct, val_count = 0.0, 0, 0
29
30     with torch.no_grad():
31         for x, y in val_loader:
32             x, y = x.to(device), y.to(device)
33             logits = model(x)
34             loss = criterion(logits, y)
35
36             val_loss += loss.item() * x.size(0)
37             val_correct += (logits.argmax(1) == y).sum().item()
38             val_count += x.size(0)
39
40     val_loss /= val_count
41     val_acc = val_correct / val_count
42     val_acc_history.append(val_acc)
43
44     print(f"Epoch {epoch}/{epochs} | "
45           f"Train Loss: {train_loss:.4f} Acc: {train_acc:.4f} | "
46           f"Val Loss: {val_loss:.4f} Acc: {val_acc:.4f}")
47

```

```

1 import matplotlib.pyplot as plt
2
3 plt.figure(figsize=(8,5))
4 plt.plot(train_acc_history, label="Train Accuracy")
5 plt.plot(val_acc_history, label="Validation Accuracy")
6 plt.xlabel("Epoch")
7 plt.ylabel("Accuracy")

```

```

8 plt.title("Training vs Validation Accuracy")
9 plt.legend()
10 plt.grid(True)
11 plt.show()
12

```

```

1 # مسار مجلد test
2 test_dir = '/content/drive/MyDrive/Datasets/FER-2013'
3
4 # تحميل بيانات test
5 test_dataset = datasets.ImageFolder(root=test_dir, transform=transform)
6 test_loader = DataLoader(test_dataset, batch_size=16, shuffle=False)
7
8 # اختبار النموذج
9 model.eval()
10 correct, total = 0, 0
11 with torch.no_grad():
12     for inputs, labels in test_loader:
13         inputs, labels = inputs.to(device), labels.to(device)
14         outputs = model(inputs)
15         _, preds = torch.max(outputs, 1)
16         total += labels.size(0)
17         correct += (preds == labels).sum().item()
18
19 print(f"✅ Test Accuracy: {100 * correct / total:.2f}%")
20

```

```

1 import os
2 from PIL import Image
3 import torch
4 import torch.nn as nn
5 import torch.optim as optim
6 from torch.utils.data import Dataset, DataLoader
7 from torchvision import transforms, models
8 import matplotlib.pyplot as plt
9
10 # 1. لصور Dataset كلاس JAFFE
11 class JaffeDataset(Dataset):
12     def __init__(self, root_dir, transform=None):
13         self.root_dir = root_dir
14         self.image_files = [f for f in os.listdir(root_dir) if f.endswith(".")]
15         self.transform = transform
16         self.emotion_dict = {
17             'AN': 0, 'DI': 1, 'FE': 2,
18             'HA': 3, 'NE': 4, 'SA': 5, 'SU': 6

```

```

19         }
20
21     def __len__(self):
22         return len(self.image_files)
23
24     def __getitem__(self, idx):
25         image_path = os.path.join(self.root_dir, self.image_files[idx])
26         image = Image.open(image_path).convert('L') # رمادية
27
28         if self.transform:
29             image = self.transform(image)
30
31         emotion_code = self.image_files[idx].split('.')[1][:2]
32         label = self.emotion_dict[emotion_code]
33
34         return image, label
35
36 # 2. التحويلات المناسبة (تحويل من رمادي إلى RGB)
37 transform = transforms.Compose([
38     transforms.Lambda(lambda img: img.convert("RGB")),
39     transforms.Resize((128, 128)),
40     transforms.ToTensor()
41 ])
42
43 # 3. تحميل البيانات
44 jaffe_path = '/content/drive/MyDrive/Datasets/jaffe'
45 jaffe_dataset = JaffeDataset(jaffe_path, transform=transform)
46 jaffe_loader = DataLoader(jaffe_dataset, batch_size=8, shuffle=False)
47
48 # 4. عدد الفئات (7 مشاعر)
49 num_classes = 7
50 device = torch.device("cuda" if torch.cuda.is_available() else "cpu")
51
52 # 5. تحميل النماذج وتعديل طبقات الإخراج
53 resnet = models.resnet18(pretrained=True)
54 resnet.fc = nn.Linear(resnet.fc.in_features, num_classes)
55 resnet = resnet.to(device)
56
57 mobilenet = models.mobilenet_v2(pretrained=True)
58 mobilenet.classifier[1] = nn.Linear(mobilenet.classifier[1].in_features, num
59 mobilenet = mobilenet.to(device)
60
61 # 6. دالة التقييم
62 def evaluate_model(model, dataloader, device):
63     model.eval()
64     correct = 0

```

```

65     total = 0
66     with torch.no_grad():
67         for inputs, labels in dataloader:
68             inputs, labels = inputs.to(device), labels.to(device)
69             outputs = model(inputs)
70             _, preds = torch.max(outputs, 1)
71             correct += (preds == labels).sum().item()
72             total += labels.size(0)
73     accuracy = 100 * correct / total
74     return accuracy
75
76 # 7. حساب الدقة لكل نموذج (قد تكون قليلة إذا لم يتم تدريبهم)
77 resnet_acc = evaluate_model(resnet, jaffe_loader, device)
78 mobilenet_acc = evaluate_model(mobilenet, jaffe_loader, device)
79
80 # 8. عرض النتائج
81 print(f"✅ ResNet18 Accuracy: {resnet_acc:.2f}%")
82 print(f"✅ MobileNetV2 Accuracy: {mobilenet_acc:.2f}%")
83
84 # 9. رسم بياني للمقارنة
85 results = {
86     'ResNet18': resnet_acc,
87     'MobileNetV2': mobilenet_acc
88 }
89
90 plt.bar(results.keys(), results.values())
91 plt.ylabel("Accuracy (%)")
92 plt.title("Model Comparison on JAFFE")
93 plt.ylim(0, 100)
94 plt.show()
95

```

```

1 import os
2 from PIL import Image
3 import torch
4 import torch.nn as nn
5 import torch.optim as optim
6 from torch.utils.data import Dataset, DataLoader
7 from torchvision import transforms, models, datasets
8 import matplotlib.pyplot as plt
9
10 # 1. لصور Dataset كلاس JAFFE
11 class JaffeDataset(Dataset):
12     def __init__(self, root_dir, transform=None):
13         self.root_dir = root_dir
14         self.image_files = [f for f in os.listdir(root_dir) if f.endswith(".

```

```

15     self.transform = transform
16     self.emotion_dict = {
17         'AN': 0, 'DI': 1, 'FE': 2,
18         'HA': 3, 'NE': 4, 'SA': 5, 'SU': 6
19     }
20
21     def __len__(self):
22         return len(self.image_files)
23
24     def __getitem__(self, idx):
25         image_path = os.path.join(self.root_dir, self.image_files[idx])
26         image = Image.open(image_path).convert('L') # رمادية
27         if self.transform:
28             image = self.transform(image)
29         emotion_code = self.image_files[idx].split('.')[1][:2]
30         label = self.emotion_dict[emotion_code]
31         return image, label
32
33 # 2. إعداد التحويلات
34 transform = transforms.Compose([
35     transforms.Lambda(lambda img: img.convert("RGB")),
36     transforms.Resize((128, 128)),
37     transforms.ToTensor()
38 ])
39
40 # 3. تحميل بيانات JAFFE
41 jaffe_path = '/content/drive/MyDrive/Datasets/jaffe'
42 jaffe_dataset = JaffeDataset(jaffe_path, transform=transform)
43 jaffe_loader = DataLoader(jaffe_dataset, batch_size=8, shuffle=False)
44
45 # 4. مدرب مسبقاً + تعديل الطبقة الأخيرة ResNet18 تحميل نموذج
46 num_classes = 7
47 device = torch.device("cuda" if torch.cuda.is_available() else "cpu")
48
49 resnet = models.resnet18(pretrained=True)
50 resnet.fc = nn.Linear(resnet.fc.in_features, num_classes)
51 resnet = resnet.to(device)
52
53 # 5. دالة تقييم الدقة
54 def evaluate_model(model, dataloader, device):
55     model.eval()
56     correct, total = 0, 0
57     with torch.no_grad():
58         for inputs, labels in dataloader:
59             inputs, labels = inputs.to(device), labels.to(device)
60             outputs = model(inputs)

```

```

61         _, preds = torch.max(outputs, 1)
62         correct += (preds == labels).sum().item()
63         total += labels.size(0)
64     return 100 * correct / total
65
66 # 6. JAFFE تقييم النموذج على
67 acc_jaffe = evaluate_model(resnet, jaffe_loader, device)
68 print(f"✅ JAFFE Accuracy: {acc_jaffe:.2f}%")
69
70 # 7. FER-2013/test تقييم النموذج على
71 test_dir = '/content/drive/MyDrive/Datasets/FER-2013/test'
72 test_dataset = datasets.ImageFolder(root=test_dir, transform=transform)
73 test_loader = DataLoader(test_dataset, batch_size=16, shuffle=False)
74
75 acc_fer = evaluate_model(resnet, test_loader, device)
76 print(f"✅ FER-2013 Test Accuracy: {acc_fer:.2f}%")
77
78 # 8. عرض النتائج في رسم بياني
79 results = {
80     'JAFFE': acc_jaffe,
81     'FER-2013': acc_fer
82 }
83
84 plt.bar(results.keys(), results.values())
85 plt.ylabel("Accuracy (%)")
86 plt.title("Model Accuracy Comparison")
87 plt.ylim(0, 100)
88 plt.show()
89
90
91 1 # مثال: آخر 2 بلوك في) فك تجميد بعض الطبقات فقط
92 2 for name, param in model.named_parameters():
93 3     if "layer4" in name or "fc" in name:
94 4         param.requires_grad = True
95 5     else:
96 6         param.requires_grad = False
97 7
98 8 # منخفض learning rate إعادة التدريب بـ
99 9 optimizer = optim.Adam(filter(lambda p: p.requires_grad, model.parameters()))
100 10
101
102 1 transform = transforms.Compose([
103 2     transforms.RandomHorizontalFlip(),
104 3     transforms.RandomRotation(20),
105 4     transforms.ColorJitter(brightness=0.3, contrast=0.3),

```

```

5     transforms.Resize((128, 128)),
6     transforms.ToTensor()
7 ])
8

1 from sklearn.model_selection import train_test_split
2
3 # تقسيم يدوي للفهرس
4 indices = list(range(len(full_dataset)))
5 train_idx, val_idx = train_test_split(indices, test_size=0.2, stratify=target)
6
7 train_set = Subset(full_dataset, train_idx)
8 val_set = Subset(full_dataset, val_idx)
9
10 train_loader = DataLoader(train_set, batch_size=16, shuffle=True)
11 val_loader = DataLoader(val_set, batch_size=16, shuffle=False)
12

1 from torchvision import models
2 import torch.nn as nn
3
4 # عدد المشاعر
5 num_classes = len(full_dataset.classes) # حسب السياق أو test_dataset.classes
6
7 # تحميل النماذج المدربة مسبقاً
8 resnet = models.resnet18(pretrained=True)
9 mobilenet = models.mobilenet_v2(pretrained=True)
10
11 # تعديل الطبقة الأخيرة لتناسب مع عدد المشاعر
12 resnet.fc = nn.Linear(resnet.fc.in_features, num_classes)
13 mobilenet.classifier[1] = nn.Linear(mobilenet.classifier[1].in_features, num_classes)
14

1 from torchvision import transforms
2
3 transform = transforms.Compose([
4     transforms.RandomHorizontalFlip(),
5     transforms.RandomRotation(20),
6     transforms.RandomResizedCrop(128, scale=(0.8, 1.0)),
7     transforms.ColorJitter(brightness=0.2, contrast=0.2),
8     transforms.ToTensor(),
9 ])
10

```

```

1 from torchvision.models import efficientnet_b0
2 model = efficientnet_b0(pretrained=True)
3 model.classifier[1] = nn.Linear(model.classifier[1].in_features, num_classes)
4

1 for name, param in model.named_parameters():
2     param.requires_grad = "classifier" in name or "fc" in name
3

1 scheduler = torch.optim.lr_scheduler.StepLR(optimizer, step_size=5, gamma=0.1)
2

1 from sklearn.metrics import classification_report
2 print(classification_report(y_true, y_pred, target_names=full_dataset.class_names))
3

1 # تقييم النموذج على بيانات التحقق أو التدريب
2 correct = 0
3 total = 0
4 model.eval()
5
6 with torch.no_grad():
7     for inputs, labels in train_loader: # أو test_loader
8         inputs, labels = inputs.to(device), labels.to(device)
9         outputs = model(inputs)
10        _, preds = torch.max(outputs, 1)
11        correct += (preds == labels).sum().item()
12        total += labels.size(0)
13
14 accuracy = 100 * correct / total
15 print(f"✅ Final Accuracy: {accuracy:.2f}%")
16

1 # إنشاء قائمتين لتخزين نتائج التدريب
2
3 train_losses = []
4 train_accuracies = []
5
6 for epoch in range(epochs):
7     model.train()
8     running_loss = 0.0
9     correct = 0
10    total = 0
11    # من بيانات التدريب (batch) تمرير كل دفعة بيانات

```

```

12
13     for inputs, labels in train_loader:
14         inputs, labels = inputs.to(device), labels.to(device)
15         optimizer.zero_grad()
16         outputs = model(inputs)
17         loss = criterion(outputs, labels)
18         loss.backward()
19         optimizer.step()
20
21         _, preds = torch.max(outputs, 1)
22         correct += torch.sum(preds == labels).item()
23         total += labels.size(0)
24         running_loss += loss.item()
25     # حساب متوسط الخسارة والدقة لهذا الـ epoch
26
27     epoch_loss = running_loss / len(train_loader)
28     epoch_acc = correct / total
29     train_losses.append(epoch_loss)
30     train_accuracies.append(epoch_acc)
31
32     # طباعة النتائج
33
34     print(f"Epoch {epoch+1}/{epochs}, Loss: {epoch_loss:.4f}, Accuracy: {epoch_acc:.4f}")
35

```

```

1 import matplotlib.pyplot as plt
2
3 epochs_range = range(1, epochs + 1)
4 plt.figure(figsize=(12, 5))
5
6 # Loss Curve
7 plt.subplot(1, 2, 1)
8 plt.plot(epochs_range, train_losses, marker='o')
9 plt.title('Training Loss')
10 plt.xlabel('Epoch')
11 plt.ylabel('Loss')
12
13 # Accuracy Curve
14 plt.subplot(1, 2, 2)
15 plt.plot(epochs_range, train_accuracies, marker='o')
16 plt.title('Training Accuracy')
17 plt.xlabel('Epoch')
18 plt.ylabel('Accuracy')
19
20 plt.tight_layout()

```

```

21 plt.show()
22

1 import random
2 # عينة عشوائية من 8 صور
3 indices = random.sample(range(len(subset_dataset)), 8)
4 fig, axes = plt.subplots(2, 4, figsize=(15,6))
5 # نأكد أن النموذج في وضع التقييم
6 model.eval()
7 with torch.no_grad():
8     for i, idx in enumerate(indices):
9         image, true_label = subset_dataset[idx]
10        img_input = image.unsqueeze(0).to(device)
11        output = model(img_input)
12        _, pred_label = torch.max(output, 1)
13
14        ax = axes[i // 4, i % 4]
15        ax.imshow(image.permute(1, 2, 0)) # تحويل إلى HWC
16        ax.axis('off')
17        ax.set_title(
18            f"True: {full_dataset.classes[true_label]}\nPred: {full_dataset.
19            color='green' if pred_label.item() == true_label else 'red'
20        )
21        # عرض التسمية الحقيقية والمتوقعة
22 plt.tight_layout()
23 plt.show()
24

```

```

1 # ✅ Cell 1: تحميل المكتبات الأساسية
2 import os
3 import random
4 import numpy as np
5 import pandas as pd
6 from PIL import Image
7 import torch
8 import torch.nn as nn
9 import torch.optim as optim
10 from torch.utils.data import Dataset, DataLoader, Subset
11 from torchvision import transforms, models
12 from sklearn.model_selection import StratifiedKFold
13 import matplotlib.pyplot as plt
14 from tqdm import tqdm
15 import warnings
16 warnings.filterwarnings("ignore")
17 device = torch.device("cuda" if torch.cuda.is_available() else "cpu")

```

```
18 print("Using device:", device)
19
```

```
1 #  Cell 2: Augmentation + Preprocessing (متوافقة مع ViT)
2 transform = transforms.Compose([
3     transforms.Resize((224, 224)), #  مطلوب ViT-B_16
4     transforms.RandomHorizontalFlip(),
5     transforms.RandomRotation(10),
6     transforms.ColorJitter(brightness=0.2, contrast=0.2),
7     transforms.ToTensor()
8 ])
9
```

```
1 #  Cell 3 (مصححة): لقاعدة Dataset كلاس JAFFE
2 class JaffeDataset(Dataset):
3     def __init__(self, root_dir, transform=None):
4         self.root_dir = root_dir
5         self.image_files = [f for f in os.listdir(root_dir) if f.endswith(".
6         self.label_map = {'AN':0, 'DI':1, 'FE':2, 'HA':3, 'NE':4, 'SA':5, 'SI
7         self.labels = [self.get_label(f) for f in self.image_files]
8         self.transform = transform
9
10    def get_label(self, filename):
11        code = filename.split('.')[1][:2]
12        return self.label_map.get(code, 0)
13
14    def __len__(self):
15        return len(self.image_files)
16
17    def __getitem__(self, idx):
18        img_path = os.path.join(self.root_dir, self.image_files[idx])
19        image = Image.open(img_path).convert("RGB")
20        label = self.labels[idx]
21        if self.transform:
22            image = self.transform(image)
23        return image, label
24
25
```

```
1 #  Cell 4: تحميل نموذج Vision Transformer وتعديله حسب عدد الفئات
2 from torchvision.models import vit_b_16
3
4 def get_vit_model(num_classes):
5     model = vit_b_16(pretrained=True)
6     model.heads.head = nn.Linear(model.heads.head.in_features, num_classes)
```

```

7     return model.to(device)
8
1 # ✅ Cell 5: تدريب النموذج باستخدام K-Fold Cross Validation
2 def train_kfold(dataset, k=5, epochs=3, batch_size=8, lr=1e-4):
3     skf = StratifiedKFold(n_splits=k, shuffle=True, random_state=42)
4     labels = dataset.labels
5     fold accuracies = []
6
7     for fold, (train_idx, val_idx) in enumerate(skf.split(np.zeros(len(label
8         print(f"\n🔄 Fold {fold+1}/{k}")
9
10        train_subset = Subset(dataset, train_idx)
11        val_subset = Subset(dataset, val_idx)
12
13        train_loader = DataLoader(train_subset, batch_size=batch_size, shuff
14        val_loader = DataLoader(val_subset, batch_size=batch_size, shuffle=F
15
16        model = get_vit_model(num_classes=7)
17        optimizer = optim.Adam(model.parameters(), lr=lr)
18        criterion = nn.CrossEntropyLoss()
19
20        for epoch in range(epochs):
21            model.train()
22            running_loss, correct, total = 0.0, 0, 0
23
24            for inputs, labels in train_loader:
25                inputs, labels = inputs.to(device), labels.to(device)
26                optimizer.zero_grad()
27                outputs = model(inputs)
28                loss = criterion(outputs, labels)
29                loss.backward()
30                optimizer.step()
31                running_loss += loss.item()
32                _, preds = torch.max(outputs, 1)
33                correct += (preds == labels).sum().item()
34                total += labels.size(0)
35
36            train_acc = 100 * correct / total
37            print(f" Epoch {epoch+1}/{epochs} - Loss: {running_loss:.4f} - ,
38
39        # Evaluation on validation set
40        model.eval()
41        correct, total = 0, 0
42        with torch.no_grad():
43            for inputs, labels in val_loader:

```

```

44         inputs, labels = inputs.to(device), labels.to(device)
45         outputs = model(inputs)
46         _, preds = torch.max(outputs, 1)
47         correct += (preds == labels).sum().item()
48         total += labels.size(0)
49     val_acc = 100 * correct / total
50     fold accuracies.append(val_acc)
51     print(f"✅ Fold {fold+1} Validation Accuracy: {val_acc:.2f}%")
52
53     avg_acc = sum(fold accuracies) / len(fold accuracies)
54     print(f"\n🇸🇦 متوسط الدقة بعد {k}-Fold: {avg_acc:.2f}%")
55     return fold accuracies
56

```

```

1 # ✅ Cell 6: تشغيل Cross-Validation قاعدة JAFFE
2 jaffe_path = '/content/drive/MyDrive/Datasets/jaffe'
3 jaffe_dataset = JaffeDataset(jaffe_path, transform=transform)
4 fold_scores = train_kfold(jaffe_dataset, k=5, epochs=3)
5

```

```

1 # ✅ Cell CK+: لقاعدة Dataset كلاس CK+
2 class CKPlusDataset(Dataset):
3     def __init__(self, dataframe, transform=None):
4         self.df = dataframe
5         self.transform = transform
6
7     def __len__(self):
8         return len(self.df)
9
10    def __getitem__(self, idx):
11        pixels = [int(p) for p in self.df.iloc[idx]['pixels'].split()]
12        image = np.array(pixels).reshape(48, 48).astype(np.uint8)
13        image = Image.fromarray(image).convert("RGB") # تأكد من RGB
14        if self.transform:
15            image = self.transform(image)
16        label = int(self.df.iloc[idx]['emotion'])
17        return image, label
18

```

1 Start coding or [generate](#) with AI.

```

1 # ✅ Cell CK+: التحويل (transform) لـ ViT المناسب
2 transform = transforms.Compose([
3     transforms.Resize((224, 224)),

```

```

4     transforms.ToTensor()
5 ])
6

1 from sklearn.model_selection import StratifiedKFold
2 import torch
3 import torch.nn as nn
4 import torch.optim as optim
5 from torch.utils.data import DataLoader
6 from torchvision import models
7
8 def train_kfold(dataset, k=5, epochs=3, batch_size=8, lr=1e-4):
9     skf = StratifiedKFold(n_splits=k, shuffle=True, random_state=42)
10
11     # استخرج الليلات من الداتاست (dataset.labels افترض أنها موجودة في)
12     labels = dataset.labels
13     fold accuracies = []
14
15     for fold, (train_idx, val_idx) in enumerate(skf.split(X=range(len(labels)))):
16         print(f"\n🔄 Fold {fold+1}/{k}")
17
18         # تقسيم البيانات
19         train_subset = torch.utils.data.Subset(dataset, train_idx)
20         val_subset = torch.utils.data.Subset(dataset, val_idx)
21
22         train_loader = DataLoader(train_subset, batch_size=batch_size, shuffle=True)
23         val_loader = DataLoader(val_subset, batch_size=batch_size, shuffle=False)
24
25         # عدد الأصناف
26         num_classes = len(set(labels))
27
28         # مدرب مسبقاً Vision Transformer تحميل نموذج
29         model = models.vit_b_16(weights="IMAGENET1K_V1")
30         in_features = model.heads[0].in_features # حل المشكلة هنا ✅
31         model.heads = nn.Linear(in_features, num_classes)
32         model = model.to(device)
33
34         # تهيئة دوال التدريب
35         criterion = nn.CrossEntropyLoss()
36         optimizer = optim.Adam(model.parameters(), lr=lr)
37
38         # التدريب
39         for epoch in range(epochs):
40             model.train()
41             for inputs, targets in train_loader:
42                 inputs, targets = inputs.to(device), targets.to(device)

```

```
43         optimizer.zero_grad()
44         outputs = model(inputs)
45         loss = criterion(outputs, targets)
46         loss.backward()
47         optimizer.step()
48
49     # التقييم
50     model.eval()
51     correct, total = 0, 0
52     with torch.no_grad():
53         for inputs, targets in val_loader:
54             inputs, targets = inputs.to(device), targets.to(device)
55             outputs = model(inputs)
56             _, preds = torch.max(outputs, 1)
57             correct += (preds == targets).sum().item()
58             total += targets.size(0)
59 ~
```