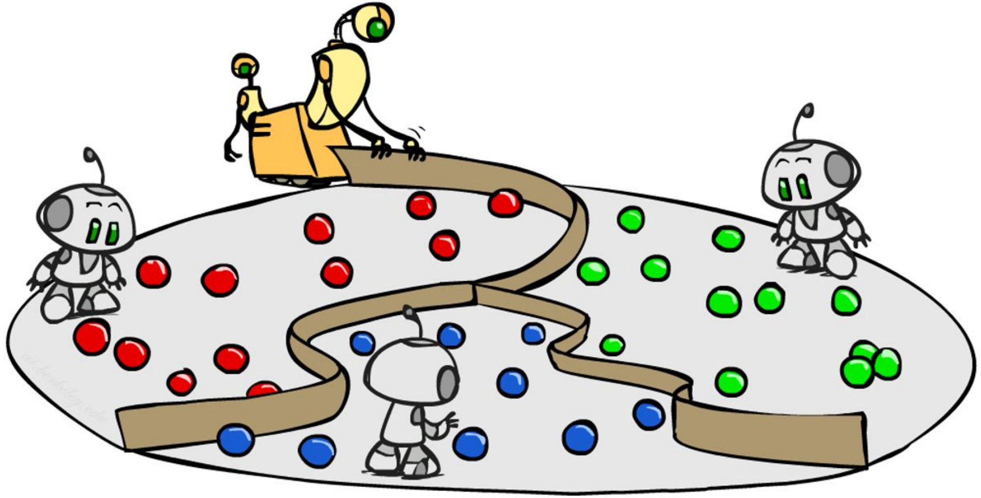
CS-ELEC1A: Advanced Intelligent Systems

Lab Exercise #3



Exploring CNNs Through Image Classification

Dataset: https://drive.google.com/file/d/1L06DBRaeyfwnw61cpUuGwhwDIyUYy8Qq/view?usp=share_link

Task: You have a dataset containing hair images with 3 different types: **Wavy**, **Curly**, and **Straight** Hair. Your task is to **create a CNN** that can **classify** whether or not a person has wavy, curly, and straight hair.

Requirements:

1. Preprocess the Data
2. Create a Train and Test Split
3. Create a Convolutional Neural Network using Keras
4. Experiment on Various Elements
5. Discussion and Analysis of Experiments

Submission:

1. Code
2. Write-up of Activity (from Step #1 to Step #5)
   a. Must be in 2-column format (either in MS Word or LaTeX
   b. File must be in PDF

Part 1: Checking the Dataset

Image Checking: Check if all files are valid

```
from pathlib import Path
import imghdr
import os

data_dir = "hair_types"
image_extensions = [".png", ".jpg"]  # add there all your images file extensions

img_type_accepted_by_tf = ["bmp", "gif", "jpeg", "png"]
for filepath in Path(data_dir).rglob("*"):
    if filepath.suffix.lower() in image_extensions:
        img_type = imghdr.what(filepath)
        if img_type is None:
            print(f"{filepath} is not an image")
            os.remove(filepath)
        elif img_type not in img_type_accepted_by_tf:
            print(f"{filepath} is a {img_type}, not accepted by TensorFlow")
            os.remove(filepath)
```

Part 2: Using a DataLoader for Data Loading

```
import tensorflow as tf
from tensorflow import keras
from tensorflow.keras import layers

image_size = (64, 64)
batch_size = 32

train_ds = tf.keras.preprocessing.image_dataset_from_directory(
    "hair_types",
    validation_split=0.2,
    subset="training",
    seed=1337,
    image_size=image_size,
    batch_size=batch_size,
    labels='inferred',
    label_mode='categorical'
)
val_ds = tf.keras.preprocessing.image_dataset_from_directory(
    "hair_types",
    validation_split=0.2,
    subset="validation",
    seed=1337,
    image_size=image_size,
    batch_size=batch_size,
    labels='inferred',
    label_mode='categorical'
)
```

Part 3: Visualizing the Data

```
import matplotlib.pyplot as plt
import numpy as np

plt.figure(figsize=(10, 10))
for images, labels in train_ds.take(1):
    for i in range(9):
        ax = plt.subplot(3, 3, i + 1)
        plt.imshow(images[i].numpy().astype("uint8"))
        plt.title(int(np.argmax(labels[i])))
        plt.axis("off")
plt.show()
```

Part 4: Sample Model

```
import tensorflow as tf
from tensorflow import keras
from tensorflow.keras import layers
from keras.models import Sequential
from keras.layers import Dense

model = Sequential()
model.add(keras.Input(shape=image_size + (3,))) # 64, 64, 3
model.add(layers.Rescaling(1.0 / 255))

model.add(layers.Conv2D(filters=4, kernel_size=16, strides=1, padding='valid', dilation_rate=1))
model.add(layers.Activation("relu"))

model.add(layers.Conv2D(filters=8, kernel_size=8, strides=1, padding='valid', dilation_rate=1))
model.add(layers.Activation("relu"))

model.add(layers.Conv2D(filters=16, kernel_size=4, strides=1, padding='valid', dilation_rate=1))
model.add(layers.Activation("relu"))

model.add(layers.GlobalAveragePooling2D())
model.add(layers.Dense(64))
model.add(layers.Activation("relu"))
model.add(layers.Dense(3))
model.add(layers.Activation("softmax"))

tf.keras.utils.plot_model(model, to_file='model_test.png', show_shapes=True)

epochs = 50

model.compile(
    optimizer=keras.optimizers.Adam(1e-3),
    loss="categorical_crossentropy",
    metrics=["accuracy"],
)
```

Part 5: Predictions for Images

```
img = keras.preprocessing.image.load_img(

"hair_types/Curly_Hair/02dac897d1dec9ba8c057a11d041ada8--layered-natural-hair-natural-black-hai
rstyles.jpg", target_size=image_size
)
img_array = keras.preprocessing.image.img_to_array(img)
img_array = tf.expand_dims(img_array, 0)  # Create batch axis

predictions = model.predict(img_array)
print(
    "This image is %.2f percent curly hair, %.2f percent straight hair, and %.2f percent wavy
hair."
    % tuple(predictions[0])
)
```

What You Need To Do

Possible Things To Experiment On:

- Other Preprocessing Methods for Images
- Adding Max Pooling
- Changing Number of Filters
- Changing Kernel Size
- Changing Learning Rate
- etc…

For the Write-Up:

- Tell Story from Loading the Data to Insights
- Insights on Experiments:
    - Effects on Changing ____ with Respect to Performance
    - Effects of Doing ____ on Qualitative Errors