```python
from google.colab import drive
drive.mount('/content/drive')
```

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

```python
import numpy as np
import os
import cv2
from tensorflow.keras.applications.resnet50 import ResNet50,
preprocess_input
from sklearn.cluster import KMeans
import matplotlib.pyplot as plt

# Function to load images
def load_images(base_path, image_size):
    ''' The "image_size" parameter is used to resize all the images in
the
    Animals-10 dataset to a specific size before passing them through
the
    Convolutional Neural Network (CNN), specifically the ResNet-50
model.
    The reason for resizing the images is related to the input
expected by the CNN
    architecture. In the case of ResNet-50, the input images must have
a specific
    size (224x224 pixels) to ensure that the model functions properly.
    This requirement is a characteristic of the network's
architecture,
    and many other neural networks also have specific requirements for
input size.
    Resizing the images to a fixed size is a common practice in
computer vision
    tasks as it makes processing more efficient and consistent.
    Additionally, it helps to avoid issues of misalignment or
distortion
    in the images during training and inference.
    '''
    #Initialize two empty lists, one for storing the images and
    #another for storing their corresponding labels.
    images = []
    labels = []
    #This loop iterates over each subdirectory (class) inside the
base_path,
    #where each subdirectory contains images of a specific animal
class.
    for animal_class in os.listdir(base_path):
        class_path = os.path.join(base_path, animal_class) #create a
```

```python
                                  the path to
        #the current animal class subdirectory by
        #joining the base_path with the animal_class subdirectory.
        if os.path.isdir(class_path): #checks if the current item
(animal_class)
        # in the loop is a directory (subdirectory).
        # It is necessary because sometimes there might be other files
or
        # subdirectories inside base_path,
        # and we only want to process animal class subdirectories.
            for image_name in os.listdir(class_path): #iterates over
each image
            #file in the current animal class subdirectory.
                image_path = os.path.join(class_path, image_name)
                image = cv2.imread(image_path) #reads the image from
the
                #image_path using OpenCV's cv2.imread() function.
                #It loads the image as a NumPy array.
                image = cv2.resize(image, image_size) # resizes the
image to the
                #specified image_size. The cv2.resize() function takes
the image
                #and resizes it to the dimensions provided in the
image_size
                #variable. Resizing is done to ensure that all images
have the
                #same size before feeding them into the model.
                images.append(image)
                labels.append(animal_class)
    return np.array(images), np.array(labels)

base_path = "/content/drive/MyDrive/animals10_small/animals10_small"

image_size = (224, 224)

X, y = load_images(base_path, image_size)

# Loading pre-trained resnet50
resnet_model = ResNet50(weights='imagenet', include_top=False,
input_shape=(224, 224, 3))

# Preprocessing of images for ResNet-50 model
X_preprocessed = preprocess_input(X)

# Extracting characteristics
features = resnet_model.predict(X_preprocessed)

Downloading data from https://storage.googleapis.com/tensorflow/keras-
applications/resnet/
resnet50_weights_tf_dim_ordering_tf_kernels_notop.h5
```

```
94765736/94765736 [==============================] - 0s 0us/step
157/157 [==============================] - 96s 603ms/step
```

```python
#Clustering using K-means = 10
# Flatten the features array
num_samples = features.shape[0]
flattened_features = features.reshape(num_samples, -1)

# Perform K-means clustering
num_clusters = 10
kmeans_model = KMeans(n_clusters=num_clusters)
clusters = kmeans_model.fit_predict(flattened_features)
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/cluster/
_kmeans.py:870: FutureWarning: The default value of `n_init` will
change from 10 to 'auto' in 1.4. Set the value of `n_init` explicitly
to suppress the warning
  warnings.warn(
```

```python
def display_clusters(images, labels, cluster_labels, cluster_number):
    cluster_indices = np.where(cluster_labels == cluster_number)[0]
    sample_indices = np.random.choice(cluster_indices, 5,
replace=False)
    plt.figure(figsize=(12, 6))
    for i, idx in enumerate(sample_indices):
        plt.subplot(1, 5, i+1)
        plt.imshow(images[idx])
        plt.title(labels[idx])
        plt.axis('off')
    plt.show()

for cluster_num in range(num_clusters):
    print(f"Cluster {cluster_num}:")
    display_clusters(X, y, clusters, cluster_num)
```
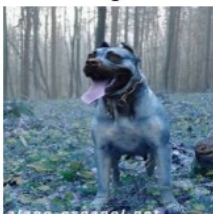
Cluster 0:
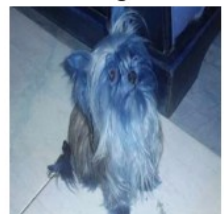
Cluster 1:

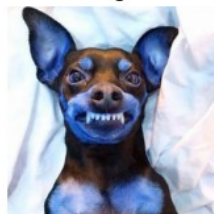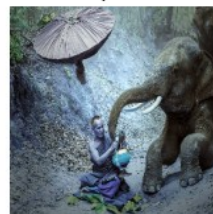| elephant | elephant | elephant | elephant | elephant |

Cluster 2:

| cat | cat | cat | cat | cat |

Cluster 3:

| cow | horse | sheep | sheep | horse |

Cluster 4:

| dogs | squirrel | squirrel | squirrel | squirrel |
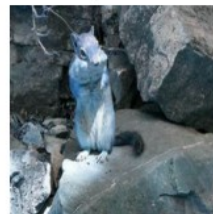
Cluster 5:

sheep	sheep	cow	chicken	sheep

Cluster 6:

spider	spider	spider	spider	spider

Cluster 7:
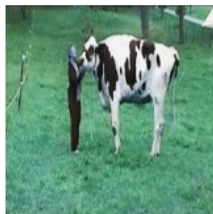
cow	cow	sheep	cow	cow

Cluster 8:
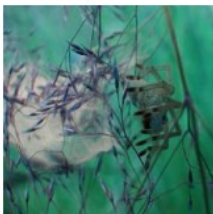
spider	butterfly	butterfly	spider	butterfly
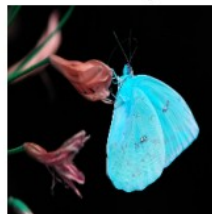
Cluster 9:

chicken   chicken   chicken   chicken   chicken

Question 5

```
pip install openai

Requirement already satisfied: openai in
/usr/local/lib/python3.10/dist-packages (0.27.8)
Requirement already satisfied: requests>=2.20 in
/usr/local/lib/python3.10/dist-packages (from openai) (2.27.1)
Requirement already satisfied: tqdm in /usr/local/lib/python3.10/dist-
packages (from openai) (4.65.0)
Requirement already satisfied: aiohttp in
/usr/local/lib/python3.10/dist-packages (from openai) (3.8.4)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in
/usr/local/lib/python3.10/dist-packages (from requests>=2.20->openai)
(1.26.16)
Requirement already satisfied: certifi>=2017.4.17 in
/usr/local/lib/python3.10/dist-packages (from requests>=2.20->openai)
(2023.5.7)
Requirement already satisfied: charset-normalizer~=2.0.0 in
/usr/local/lib/python3.10/dist-packages (from requests>=2.20->openai)
(2.0.12)
Requirement already satisfied: idna<4,>=2.5 in
/usr/local/lib/python3.10/dist-packages (from requests>=2.20->openai)
(3.4)
Requirement already satisfied: attrs>=17.3.0 in
/usr/local/lib/python3.10/dist-packages (from aiohttp->openai)
(23.1.0)
Requirement already satisfied: multidict<7.0,>=4.5 in
/usr/local/lib/python3.10/dist-packages (from aiohttp->openai) (6.0.4)
Requirement already satisfied: async-timeout<5.0,>=4.0.0a3 in
/usr/local/lib/python3.10/dist-packages (from aiohttp->openai) (4.0.2)
Requirement already satisfied: yarl<2.0,>=1.0 in
/usr/local/lib/python3.10/dist-packages (from aiohttp->openai) (1.9.2)
Requirement already satisfied: frozenlist>=1.1.1 in
/usr/local/lib/python3.10/dist-packages (from aiohttp->openai) (1.4.0)
Requirement already satisfied: aiosignal>=1.1.2 in
/usr/local/lib/python3.10/dist-packages (from aiohttp->openai) (1.3.1)

pip install scikit-llm

Collecting scikit-llm
  Downloading scikit_llm-0.3.0-py3-none-any.whl (36 kB)
```

```
Requirement already satisfied: scikit-learn>=1.1.0 in
/usr/local/lib/python3.10/dist-packages (from scikit-llm) (1.2.2)
Requirement already satisfied: pandas>=1.5.0 in
/usr/local/lib/python3.10/dist-packages (from scikit-llm) (1.5.3)
Requirement already satisfied: openai>=0.27.0 in
/usr/local/lib/python3.10/dist-packages (from scikit-llm) (0.27.8)
Requirement already satisfied: tqdm>=4.60.0 in
/usr/local/lib/python3.10/dist-packages (from scikit-llm) (4.65.0)
Collecting annoy>=1.17.2 (from scikit-llm)
  Downloading annoy-1.17.3.tar.gz (647 kB)
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 647.5/647.5 kB 8.3 MB/s eta
0:00:00
etadata (setup.py) ... >=1.27.0 (from scikit-llm)
  Downloading google_cloud_aiplatform-1.28.1-py2.py3-none-any.whl (2.7
MB)
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 2.7/2.7 MB 15.3 MB/s eta
0:00:00
 scikit-llm)
  Downloading vertexai-0.0.1-py3-none-any.whl (6.0 kB)
Requirement already satisfied: google-api-core[grpc]!=2.0.*,!=2.1.*,!
=2.2.*,!=2.3.*,!=2.4.*,!=2.5.*,!=2.6.*,!=2.7.*,<3.0.0dev,>=1.32.0
in /usr/local/lib/python3.10/dist-packages (from google-cloud-
aiplatform>=1.27.0->scikit-llm) (2.11.1)
Requirement already satisfied: proto-plus<2.0.0dev,>=1.22.0 in
/usr/local/lib/python3.10/dist-packages (from google-cloud-
aiplatform>=1.27.0->scikit-llm) (1.22.3)
Requirement already satisfied: protobuf!=3.20.0,!=3.20.1,!=4.21.0,!
=4.21.1,!=4.21.2,!=4.21.3,!=4.21.4,!=4.21.5,<5.0.0dev,>=3.19.5 in
/usr/local/lib/python3.10/dist-packages (from google-cloud-
aiplatform>=1.27.0->scikit-llm) (3.20.3)
Requirement already satisfied: packaging>=14.3 in
/usr/local/lib/python3.10/dist-packages (from google-cloud-
aiplatform>=1.27.0->scikit-llm) (23.1)
Requirement already satisfied: google-cloud-storage<3.0.0dev,>=1.32.0
in /usr/local/lib/python3.10/dist-packages (from google-cloud-
aiplatform>=1.27.0->scikit-llm) (2.8.0)
Requirement already satisfied: google-cloud-bigquery<4.0.0dev,>=1.15.0
in /usr/local/lib/python3.10/dist-packages (from google-cloud-
aiplatform>=1.27.0->scikit-llm) (3.10.0)
Collecting google-cloud-resource-manager<3.0.0dev,>=1.3.3 (from
google-cloud-aiplatform>=1.27.0->scikit-llm)
  Downloading google_cloud_resource_manager-1.10.2-py2.py3-none-
any.whl (321 kB)
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 321.3/321.3 kB 15.5 MB/s eta
0:00:00
 google-cloud-aiplatform>=1.27.0->scikit-llm)
  Downloading Shapely-1.8.5.post1-cp310-cp310-
manylinux_2_12_x86_64.manylinux2010_x86_64.whl (2.0 MB)
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 2.0/2.0 MB 25.2 MB/s eta
```

```
0:00:00
ent already satisfied: requests>=2.20 in
/usr/local/lib/python3.10/dist-packages (from openai>=0.27.0->scikit-
llm) (2.27.1)
Requirement already satisfied: aiohttp in
/usr/local/lib/python3.10/dist-packages (from openai>=0.27.0->scikit-
llm) (3.8.4)
Requirement already satisfied: python-dateutil>=2.8.1 in
/usr/local/lib/python3.10/dist-packages (from pandas>=1.5.0->scikit-
llm) (2.8.2)
Requirement already satisfied: pytz>=2020.1 in
/usr/local/lib/python3.10/dist-packages (from pandas>=1.5.0->scikit-
llm) (2022.7.1)
Requirement already satisfied: numpy>=1.21.0 in
/usr/local/lib/python3.10/dist-packages (from pandas>=1.5.0->scikit-
llm) (1.25.1)
Requirement already satisfied: scipy>=1.3.2 in
/usr/local/lib/python3.10/dist-packages (from scikit-learn>=1.1.0-
>scikit-llm) (1.11.1)
Requirement already satisfied: joblib>=1.1.1 in
/usr/local/lib/python3.10/dist-packages (from scikit-learn>=1.1.0-
>scikit-llm) (1.3.1)
Requirement already satisfied: threadpoolctl>=2.0.0 in
/usr/local/lib/python3.10/dist-packages (from scikit-learn>=1.1.0-
>scikit-llm) (3.2.0)
Requirement already satisfied: googleapis-common-
protos<2.0.dev0,>=1.56.2 in /usr/local/lib/python3.10/dist-packages
(from google-api-core[grpc]!=2.0.*,!=2.1.*,!=2.2.*,!=2.3.*,!=2.4.*,!
=2.5.*,!=2.6.*,!=2.7.*,<3.0.0dev,>=1.32.0->google-cloud-
aiplatform>=1.27.0->scikit-llm) (1.59.1)
Requirement already satisfied: google-auth<3.0.dev0,>=2.14.1 in
/usr/local/lib/python3.10/dist-packages (from google-api-core[grpc]!
=2.0.*,!=2.1.*,!=2.2.*,!=2.3.*,!=2.4.*,!=2.5.*,!=2.6.*,!
=2.7.*,<3.0.0dev,>=1.32.0->google-cloud-aiplatform>=1.27.0->scikit-
llm) (2.17.3)
Requirement already satisfied: grpcio<2.0dev,>=1.33.2 in
/usr/local/lib/python3.10/dist-packages (from google-api-core[grpc]!
=2.0.*,!=2.1.*,!=2.2.*,!=2.3.*,!=2.4.*,!=2.5.*,!=2.6.*,!
=2.7.*,<3.0.0dev,>=1.32.0->google-cloud-aiplatform>=1.27.0->scikit-
llm) (1.56.0)
Requirement already satisfied: grpcio-status<2.0.dev0,>=1.33.2 in
/usr/local/lib/python3.10/dist-packages (from google-api-core[grpc]!
=2.0.*,!=2.1.*,!=2.2.*,!=2.3.*,!=2.4.*,!=2.5.*,!=2.6.*,!
=2.7.*,<3.0.0dev,>=1.32.0->google-cloud-aiplatform>=1.27.0->scikit-
llm) (1.48.2)
Requirement already satisfied: google-cloud-core<3.0.0dev,>=1.6.0
in /usr/local/lib/python3.10/dist-packages (from google-cloud-
bigquery<4.0.0dev,>=1.15.0->google-cloud-aiplatform>=1.27.0->scikit-
llm) (2.3.3)
```

Requirement already satisfied: google-resumable-media<3.0dev,>=0.6.0 in /usr/local/lib/python3.10/dist-packages (from google-cloud-bigquery<4.0.0dev,>=1.15.0->google-cloud-aiplatform>=1.27.0->scikit-llm) (2.5.0)
Requirement already satisfied: grpc-google-iam-v1<1.0.0dev,>=0.12.4 in /usr/local/lib/python3.10/dist-packages (from google-cloud-resource-manager<3.0.0dev,>=1.3.3->google-cloud-aiplatform>=1.27.0->scikit-llm) (0.12.6)
Requirement already satisfied: six>=1.5 in /usr/local/lib/python3.10/dist-packages (from python-dateutil>=2.8.1->pandas>=1.5.0->scikit-llm) (1.16.0)
Requirement already satisfied: urllib3<1.27,>=1.21.1 in /usr/local/lib/python3.10/dist-packages (from requests>=2.20->openai>=0.27.0->scikit-llm) (1.26.16)
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.10/dist-packages (from requests>=2.20->openai>=0.27.0->scikit-llm) (2023.5.7)
Requirement already satisfied: charset-normalizer~=2.0.0 in /usr/local/lib/python3.10/dist-packages (from requests>=2.20->openai>=0.27.0->scikit-llm) (2.0.12)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.10/dist-packages (from requests>=2.20->openai>=0.27.0->scikit-llm) (3.4)
Requirement already satisfied: attrs>=17.3.0 in /usr/local/lib/python3.10/dist-packages (from aiohttp->openai>=0.27.0->scikit-llm) (23.1.0)
Requirement already satisfied: multidict<7.0,>=4.5 in /usr/local/lib/python3.10/dist-packages (from aiohttp->openai>=0.27.0->scikit-llm) (6.0.4)
Requirement already satisfied: async-timeout<5.0,>=4.0.0a3 in /usr/local/lib/python3.10/dist-packages (from aiohttp->openai>=0.27.0->scikit-llm) (4.0.2)
Requirement already satisfied: yarl<2.0,>=1.0 in /usr/local/lib/python3.10/dist-packages (from aiohttp->openai>=0.27.0->scikit-llm) (1.9.2)
Requirement already satisfied: frozenlist>=1.1.1 in /usr/local/lib/python3.10/dist-packages (from aiohttp->openai>=0.27.0->scikit-llm) (1.4.0)
Requirement already satisfied: aiosignal>=1.1.2 in /usr/local/lib/python3.10/dist-packages (from aiohttp->openai>=0.27.0->scikit-llm) (1.3.1)
Requirement already satisfied: cachetools<6.0,>=2.0.0 in /usr/local/lib/python3.10/dist-packages (from google-auth<3.0.dev0,>=2.14.1->google-api-core[grpc]!=2.0.*,!=2.1.*,!=2.2.*,!=2.3.*,!=2.4.*,!=2.5.*,!=2.6.*,!=2.7.*,<3.0.0dev,>=1.32.0->google-cloud-aiplatform>=1.27.0->scikit-llm) (5.3.1)
Requirement already satisfied: pyasn1-modules>=0.2.1 in /usr/local/lib/python3.10/dist-packages (from google-auth<3.0.dev0,>=2.14.1->google-api-core[grpc]!=2.0.*,!=2.1.*,!=2.2.*,!

```
=2.3.*,!=2.4.*,!=2.5.*,!=2.6.*,!=2.7.*,<3.0.0dev,>=1.32.0->google-
cloud-aiplatform>=1.27.0->scikit-llm) (0.3.0)
Requirement already satisfied: rsa<5,>=3.1.4 in
/usr/local/lib/python3.10/dist-packages (from google-
auth<3.0.dev0,>=2.14.1->google-api-core[grpc]!=2.0.*,!=2.1.*,!=2.2.*,!
=2.3.*,!=2.4.*,!=2.5.*,!=2.6.*,!=2.7.*,<3.0.0dev,>=1.32.0->google-
cloud-aiplatform>=1.27.0->scikit-llm) (4.9)
Requirement already satisfied: google-crc32c<2.0dev,>=1.0 in
/usr/local/lib/python3.10/dist-packages (from google-resumable-
media<3.0dev,>=0.6.0->google-cloud-bigquery<4.0.0dev,>=1.15.0->google-
cloud-aiplatform>=1.27.0->scikit-llm) (1.5.0)
Requirement already satisfied: pyasn1<0.6.0,>=0.4.6 in
/usr/local/lib/python3.10/dist-packages (from pyasn1-modules>=0.2.1-
>google-auth<3.0.dev0,>=2.14.1->google-api-core[grpc]!=2.0.*,!=2.1.*,!
=2.2.*,!=2.3.*,!=2.4.*,!=2.5.*,!=2.6.*,!=2.7.*,<3.0.0dev,>=1.32.0-
>google-cloud-aiplatform>=1.27.0->scikit-llm) (0.5.0)
Building wheels for collected packages: annoy
  Building wheel for annoy (setup.py) ... e=annoy-1.17.3-cp310-cp310-
linux_x86_64.whl size=550735
sha256=bb2dcb6341446514c99a5d529ca36e589f0a0d5b01a8c47a54f7b7a1b5a1eea
c
  Stored in directory:
/root/.cache/pip/wheels/64/8a/da/f714bcf46c5efdcfcac0559e63370c21abe96
1c48e3992465a
Successfully built annoy
Installing collected packages: annoy, vertexai, shapely, google-cloud-
resource-manager, google-cloud-aiplatform, scikit-llm
  Attempting uninstall: shapely
    Found existing installation: shapely 2.0.1
    Uninstalling shapely-2.0.1:
      Successfully uninstalled shapely-2.0.1
Successfully installed annoy-1.17.3 google-cloud-aiplatform-1.28.1
google-cloud-resource-manager-1.10.2 scikit-llm-0.3.0 shapely-
1.8.5.post1 vertexai-0.0.1
```

{"pip_warning":{"packages":["google"]}}

```python
# importing SKLLMConfig to configure OpenAI API (key and Name)
from skllm.config import SKLLMConfig

# Set your OpenAI API key
SKLLMConfig.set_openai_key("sk-
pPXlNlPTYRSFbADYJNfyT3BlbkFJJqApCYUxrWY4foYAuydl")

from skllm import ZeroShotGPTClassifier
from skllm.datasets import get_classification_dataset

X_train, y_train = get_classification_dataset()

classifier = ZeroShotGPTClassifier(openai_model="gpt-3.5-turbo")
```

```
classifier.fit(X_train, y_train)

# Classification test
text = "Greta Gerwig's magnum opus is a brilliantly funny rallying cry
for decency and shredding hypocrisies. There's not a laughless minute
to be had with Robbie and Gosling nailing every gag and emotion with
an equally inspired ensemble."
predicted_sentiment = classifier.predict([text])
print(predicted_sentiment)
```

```
100%|██████████| 1/1 [00:09<00:00,  9.44s/it]

Could not obtain the completion after 3 retries: `RateLimitError ::
You exceeded your current quota, please check your plan and billing
details.`
None
Could not extract the label from the completion: 'NoneType' object is
not subscriptable
['neutral']
```