cv_pipeline

May 12, 2025

1 Building an E2E Computer Vision ML Pipeline with Amazon Rekognition

Author: Yi-Hsuan Kuo It's a complete computer vision pipeline, including: - Dataset preparation and storage. - Model training using Amazon Rekognition Custom Labels. - Testing the trained model on unseen data. - Performing inference using manual interaction with the Rekognition API.

1.1 Dataset Description and Labeling Process

The dataset used in this project was collected manually from https://www.pexels.com/.
Two categories were selected for classification: Ccat and dog. For each category, 20 representative images were downloaded, resulting in a total of 40 images in the dataset.

To prepare the data for training, all images were uploaded to an Amazon S3 bucket created specifically for this project. The images were then labeled using the Amazon Rekognition Custom Labels interface. Each image was manually assigned to one of the three classes based on its content. The labeling process ensured that all classes had an equal number of images to maintain balance during training.

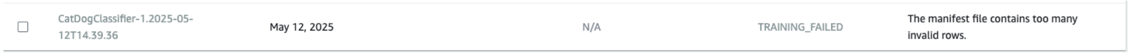
[1]:

```
# Examine image shape
import os
from PIL import Image

def check_image_shapes(folder_path):
    shapes = {}
    for file_name in os.listdir(folder_path):
        if file_name.lower().endswith(('.jpg', '.jpeg', '.png')):
            file_path = os.path.join(folder_path, file_name)
            try:
                with Image.open(file_path) as img:
                    shapes[file_name] = img.size[::-1] + ((len(img.
 ↪getbands())),)
                    # img.size gives (width, height), we reverse to (height,␣
 ↪width)
            except Exception as e:
                shapes[file_name] = f"Error: {e}"
    return shapes
```

```python
folder = 'data/dog'
shapes = check_image_shapes(folder)

for name, shape in shapes.items():
    print(f"{name}: {shape}")


folder = 'data/cat'
shapes = check_image_shapes(folder)

for name, shape in shapes.items():
    print(f"{name}: {shape}")
```

```
dog20.jpg: (3456, 5184, 3)
dog1.jpg: (3888, 5184, 3)
dog7.jpg: (3456, 5184, 3)
dog19.jpg: (5176, 4000, 3)
dog5.jpg: (3306, 2888, 3)
dog14.jpg: (2560, 1707, 3)
dog16.jpg: (4150, 3456, 3)
dog17.jpg: (3648, 5004, 3)
dog18.jpg: (2592, 3872, 3)
dog8.jpg: (4000, 6000, 3)
dog11.jpg: (1843, 3276, 3)
dog12.jpg: (3456, 5184, 3)
dog10.jpg: (3456, 5184, 3)
dog3.jpg: (1365, 2048, 3)
dog13.jpg: (6000, 4000, 3)
dog6.jpg: (3456, 4608, 3)
dog2.jpg: (6306, 4204, 3)
dog15.jpg: (2000, 3000, 3)
dog9.jpg: (5184, 3456, 3)
dog4.jpg: (4032, 3024, 3)
cat10.jpg: (3010, 4896, 3)
cat5.jpg: (2304, 3456, 3)
cat12.jpg: (1944, 2592, 3)
cat13.jpg: (3200, 4800, 3)
cat2.jpg: (3560, 5360, 3)
cat14.jpg: (3696, 2765, 3)
cat1.jpg: (2592, 3888, 3)
cat19.jpg: (4016, 6016, 3)
cat18.jpg: (6016, 4000, 3)
cat4.jpg: (1704, 2557, 3)
cat20.jpg: (1728, 2480, 3)
cat3.jpg: (2657, 1771, 3)
cat17.jpg: (3072, 4608, 3)
cat8.jpg: (3266, 4899, 3)
```

```
cat11.jpg: (2916, 5184, 3)
cat16.jpg: (4000, 6000, 3)
cat9.jpg: (2667, 4000, 3)
cat6.jpg: (3602, 5403, 3)
cat15.jpg: (4523, 3096, 3)
cat7.jpg: (3601, 5700, 3)
```



□	CatDogClassifier-1.2025-05-12T14.39.36	May 12, 2025	N/A	TRAINING_FAILED	The manifest file contains too many invalid rows.

We found while we train models using original pictures, there's an error message: "The manifest file contains too many invalid rows.". Therefore, we clean images first.

[2]:
```python
from PIL import Image
import os

def clean_images(input_folder, output_folder):
    os.makedirs(output_folder, exist_ok=True)
    for filename in os.listdir(input_folder):
        if filename.lower().endswith(('.jpg', '.jpeg', '.png')):
            try:
                img = Image.open(os.path.join(input_folder, filename))
                img = img.convert("RGB")
                img = img.resize((400, 400))
                img.save(os.path.join(output_folder, filename), format='JPEG')
            except Exception as e:
                print(f"Failed to process {filename}: {e}")
```

[3]:
```python
clean_images("data/cat", "cleaned_data/cat")
clean_images("data/dog", "cleaned_data/dog")
```

1.2 Upload cleaned data to S3

[4]:
```python
import boto3

BUCKET = "rekog-cv-iris"
s3 = boto3.client('s3')
s3.create_bucket(Bucket=BUCKET)
```

[4]:
```
{'ResponseMetadata': {'RequestId': 'FOM1QM13TGH1XS6J',
  'HostId': 'CUdFNGpIeAjvbymm/VGu/lhjUX6Nkr+J/biYWXzqs9ReMkpvVWro7xudEYwROG2HvY4
iC7V2vKQQZZTvLCO88qhAfKnmKGgai3ElsqOd0As=',
  'HTTPStatusCode': 200,
  'HTTPHeaders': {'x-amz-id-2': 'CUdFNGpIeAjvbymm/VGu/lhjUX6Nkr+J/biYWXzqs9ReMkp
vVWro7xudEYwROG2HvY4iC7V2vKQQZZTvLCO88qhAfKnmKGgai3ElsqOd0As=',
   'x-amz-request-id': 'FOM1QM13TGH1XS6J',
   'date': 'Tue, 13 May 2025 03:08:26 GMT',
   'location': '/rekog-cv-iris',
   'content-length': '0',
   'server': 'AmazonS3'},
  'RetryAttempts': 0},
 'Location': '/rekog-cv-iris'}
```

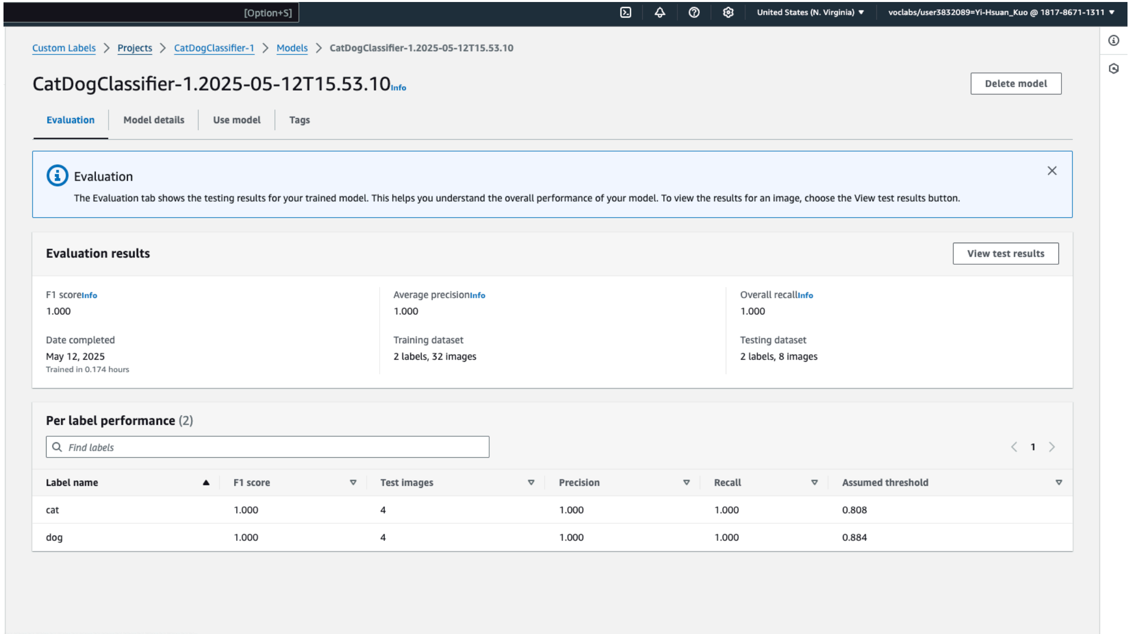
[5]:
```python
import os
from pathlib import Path

def upload_images(local_folder, s3_prefix):
    for file_name in Path(local_folder).glob("*.jpg"):
        s3.upload_file(str(file_name), BUCKET, f"{s3_prefix}/{file_name.name}")

upload_images("cleaned_data/cat", "cleaned_data/cat")
upload_images("cleaned_data/dog", "cleaned_data/dog")
print("upload successfully")
```

```
upload successfully
```

1.3 Model Training

The model was trained using the Amazon Rekognition Custom Labels user interface. After uploading and labeling the dataset, we initiated the training process directly through the Rekognition console. The training pipeline automatically split the dataset into a training set and a test set (approximately 80/20 split).

No hyperparameter tuning was required, as Rekognition handles the optimization internally. The training process was completed in approximately 11 minutes (0.174 hours), as shown in the training summary. After training, the model was evaluated using a built-in test set, and the performance metrics—precision, recall, and F1 score—were all reported as 1.000, indicating perfect classification on the test set.


[Option+S]
United States (N. Virginia) ▼
voclabs/user3832089=Yi-Hsuan_Kuo @ 1817-8671-1311 ▼
Custom Labels > Projects > CatDogClassifier-1 > Models > CatDogClassifier-1.2025-05-12T15.53.10
Delete model
Evaluation
Model details
Use model
Tags
View test results
Find labels
1

CatDogClassifier-1.2025-05-12T15.53.10 Info

Evaluation

The Evaluation tab shows the testing results for your trained model. This helps you understand the overall performance of your model. To view the results for an image, choose the View test results button.

Evaluation results

F1 score Info: 1.000
Average precision Info: 1.000
Overall recall Info: 1.000
Date completed: May 12, 2025
Trained in 0.174 hours
Training dataset: 2 labels, 32 images
Testing dataset: 2 labels, 8 images

Per label performance (2)

Label name ▲	F1 score ▽	Test images ▽	Precision ▽	Recall ▽	Assumed threshold ▽
cat	1.000	4	1.000	1.000	0.808
dog	1.000	4	1.000	1.000	0.884

2 PathB Using Python to Build Rekognition Custom Labels Training Pipeline - Failed

Despite using cleaned and correctly structured images, Rekognition marked all images as Error in the console.

[6]:
```
# make manifest, that is, make train dataset and labeled it from S3 using␣
 ↪python code instead of AWS console
import os
import json

def generate_manifest(data_dir, s3_bucket, s3_prefix, output_manifest):
    manifest_lines = []
    label_map = {'cat': 'cat', 'dog': 'dog'}

    for label_folder in os.listdir(data_dir):
        folder_path = os.path.join(data_dir, label_folder)
        if os.path.isdir(folder_path) and label_folder in label_map:
            for file in os.listdir(folder_path):
                if file.lower().endswith(('.jpg', '.jpeg', '.png')):
                    s3_uri = f"s3://{s3_bucket}/{s3_prefix}/{label_folder}/
 ↪{file}"
                    line = {
                        "source-ref": s3_uri,
                        "class-label": label_map[label_folder],
                        "class-label-metadata": {
                            "type": "groundtruth/image-classification",
                            "class-name": label_map[label_folder],
                            "human-annotated": "yes",
                            "creation-date": "2025-05-12T00:00:00"
                        }
                    }
                    manifest_lines.append(json.dumps(line))

    with open(output_manifest, 'w') as f:
        f.write("\n".join(manifest_lines))

    print(f"Manifest file created with {len(manifest_lines)} entries.")
```

[7]:
```
# Auto-generating the .manifest File
generate_manifest(
    data_dir='cleaned_data',
    s3_bucket='rekog-cv-iris',
    s3_prefix='cleaned_data',
    output_manifest='cleanedcatdog.manifest'
)
```

```
Manifest file created with 40 entries.
```

[8]:

```python
# upload manifest to S3
s3_prefix='manifest'
file_name = "cleaned2catdog.manifest"
s3.upload_file(file_name, BUCKET, f"{s3_prefix}/{file_name}")
```

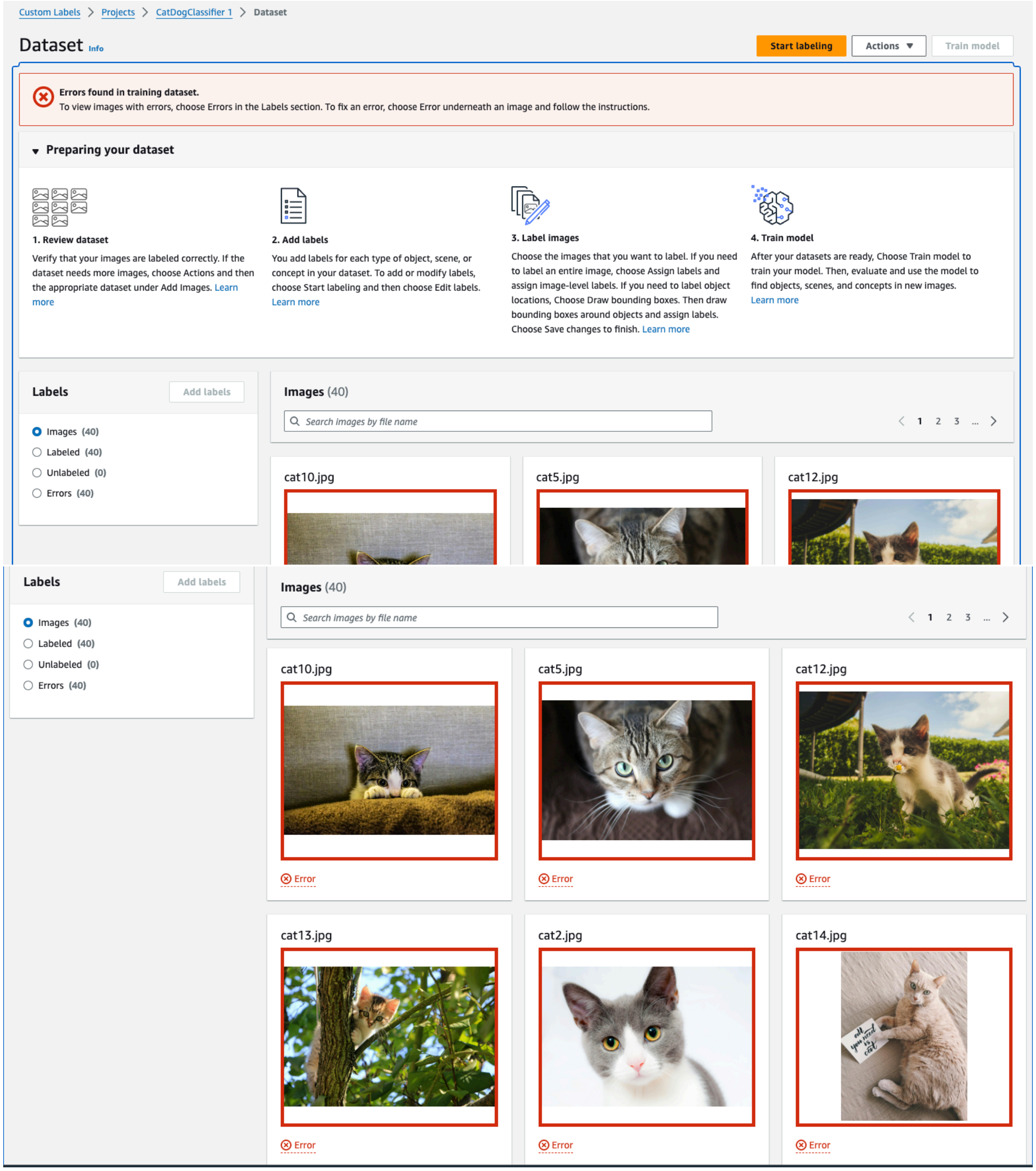
[9]:

```python
# Creating Dataset and Training Model via boto3
import boto3
import time

rekognition = boto3.client('rekognition')

project_arn = 'arn:aws:rekognition:us-east-1:181786711311:project/
  ↪CatDogClassifier-1/1747078729884'
manifest_bucket = 'rekog-cv-iris'
manifest_key = 'manifest/cleanedcatdog.manifest'
output_prefix = 'output/'
version_name = 'v1'
```

[12]:

```python
#   Training Dataset
train_response = rekognition.create_dataset(
    DatasetType='TRAIN',
    ProjectArn=project_arn,
    DatasetSource={
        'GroundTruthManifest': {
            'S3Object': {
                'Bucket': manifest_bucket,
                'Name': manifest_key
            }
        }
    }
)
print("Training dataset created.")

#dataset_arn = train_response['DatasetArn']
```

```
Training dataset created.
```



Custom Labels > Projects > CatDogClassifier 1 > Dataset

Dataset Info

Errors found in training dataset.
To view images with errors, choose Errors in the Labels section. To fix an error, choose Error underneath an image and follow the instructions.

▼ Preparing your dataset

1. Review dataset
Verify that your images are labeled correctly. If the dataset needs more images, choose Actions and then the appropriate dataset under Add images. Learn more

2. Add labels
You add labels for each type of object, scene, or concept in your dataset. To add or modify labels, choose Start labeling and then choose Edit labels. Learn more

3. Label images
Choose the images that you want to label. If you need to label an entire image, choose Assign labels and assign image-level labels. If you need to label object locations, Choose Draw bounding boxes. Then draw bounding boxes around objects and assign labels. Choose Save changes to finish. Learn more

4. Train model
After your datasets are ready, Choose Train model to train your model. Then, evaluate and use the model to find objects, scenes, and concepts in new images.
Learn more

Labels Add labels

● Images (40)
○ Labeled (40)
○ Unlabeled (0)
○ Errors (40)

Images (40)

Search images by file name

< 1 2 3 ... >

cat10.jpg

cat5.jpg

cat12.jpg

Labels Add labels

● Images (40)
○ Labeled (40)
○ Unlabeled (0)
○ Errors (40)

Images (40)

Search images by file name

< 1 2 3 ... >

cat10.jpg
Error

cat5.jpg
Error

cat12.jpg
Error

cat13.jpg
Error

cat2.jpg
Error

cat14.jpg
Error

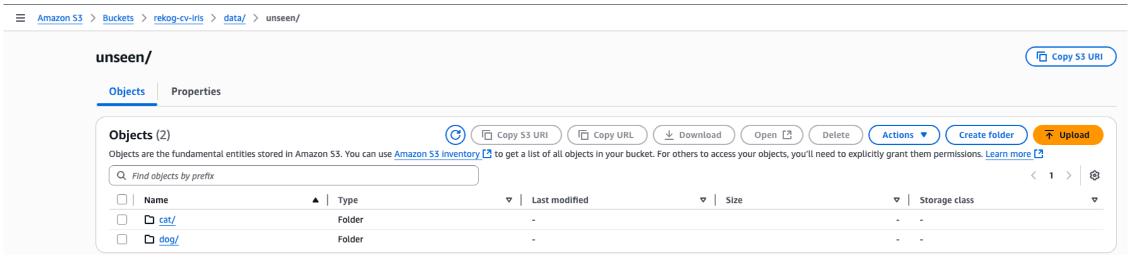
2.1 Model testing

To evaluate the model's performance beyond the built-in test set, we also collected additional unseen data from the internet. Specifically, 6 new images were gathered for each class (12 images total) that were not included in the training or built-in evaluation set. These images were later used during the inference stage by calling the Rekognition API through the AWS SDK (boto3), allowing us to simulate real-world predictions and assess the model's generalization ability.

The inference workflow involved starting the trained model using start_project_version(), sending each image to the model via detect_custom_labels(), and stopping the model afterward with stop_project_version() to avoid unnecessary costs. The predictions were collected and compared to the true labels to compute accuracy.

[48]:
```python
upload_images("data/unseen/cat", "data/unseen/cat")
upload_images("data/unseen/dog", "data/unseen/dog")
print("upload unseen successfully")
```

```
upload unseen successfully
```



Amazon S3 > Buckets > rekog-cv-iris > data/ > unseen/

unseen/

Objects (2)

Objects are the fundamental entities stored in Amazon S3. You can use Amazon S3 inventory to get a list of all objects in your bucket. For others to access your objects, you'll need to explicitly grant them permissions. Learn more

□	Name	Type	Last modified	Size	Storage class
□	cat/	Folder	-	-	-
□	dog/	Folder	-	-	-

[15]:
```python
# Initialize Rekognition client
client = boto3.client("rekognition", region_name="us-east-1")

# activate model
client.start_project_version(
    ProjectVersionArn='arn:aws:rekognition:us-east-1:181786711311:project/
 ↪CatDogClassifier-1/version/CatDogClassifier-1.2025-05-12T15.53.10/
 ↪1747083190902',
    MinInferenceUnits=1
)
```

[15]:
```
{'Status': 'STARTING',
 'ResponseMetadata': {'RequestId': 'daf736d9-94b9-42fe-82a2-56fde8b097cc',
  'HTTPStatusCode': 200,
  'HTTPHeaders': {'x-amzn-requestid': 'daf736d9-94b9-42fe-82a2-56fde8b097cc',
   'content-type': 'application/x-amz-json-1.1',
   'content-length': '21',
   'date': 'Tue, 13 May 2025 03:11:38 GMT'},
  'RetryAttempts': 0}}
```

[17]:
```python
# Initialize Rekognition client
client = boto3.client("rekognition", region_name="us-east-1")

# activate model
client.start_project_version(
    ProjectVersionArn='arn:aws:rekognition:us-east-1:181786711311:project/
 ↪CatDogClassifier-1/version/CatDogClassifier-1.2025-05-12T15.53.10/
 ↪1747083190902',
    MinInferenceUnits=1
)
```

[17]:
```
{'Status': 'STARTING',
 'ResponseMetadata': {'RequestId': 'c3196d61-a151-43d7-bae2-1117534816f1',
  'HTTPStatusCode': 200,
  'HTTPHeaders': {'x-amzn-requestid': 'c3196d61-a151-43d7-bae2-1117534816f1',
   'content-type': 'application/x-amz-json-1.1',
   'content-length': '21',
   'date': 'Tue, 13 May 2025 03:11:47 GMT'},
  'RetryAttempts': 0}}
```

[20]:

```python
import boto3
import pandas as pd


PROJECT_VERSION_ARN = "arn:aws:rekognition:us-east-1:181786711311:project/
  ↪CatDogClassifier-1/version/CatDogClassifier-1.2025-05-12T15.53.10/
  ↪1747083190902"

S3_BUCKET = "rekog-cv-iris"

# Test images and ground truth labels
test_images = [
    # cat
    {"s3_key": "data/unseen/cat/img01.jpg",  "true_label": "cat"},
    {"s3_key": "data/unseen/cat/img02.jpg",  "true_label": "cat"},
    {"s3_key": "data/unseen/cat/img03.jpg",  "true_label": "cat"},
    {"s3_key": "data/unseen/cat/img04.jpg",  "true_label": "cat"},
    {"s3_key": "data/unseen/cat/img05.jpg",  "true_label": "cat"},
    {"s3_key": "data/unseen/cat/img06.jpg",  "true_label": "cat"},


    # dog
    {"s3_key": "data/unseen/dog/img01.jpg", "true_label": "dog"},
    {"s3_key": "data/unseen/dog/img02.jpg", "true_label": "dog"},
    {"s3_key": "data/unseen/dog/img03.jpg", "true_label": "dog"},
    {"s3_key": "data/unseen/dog/img04.jpg", "true_label": "dog"},
    {"s3_key": "data/unseen/dog/img05.jpg", "true_label": "dog"},
    {"s3_key": "data/unseen/dog/img06.jpg", "true_label": "dog"}
]




# Function to call inference
def predict_label(s3_key):
    response = client.detect_custom_labels(
        ProjectVersionArn=PROJECT_VERSION_ARN,
        Image={"S3Object": {"Bucket": S3_BUCKET, "Name": s3_key}}
    )
    if response["CustomLabels"]:
        return response["CustomLabels"][0]["Name"]
    else:
        return "Unknown"

# Run inference and collect results
results = []
for item in test_images:
    predicted = predict_label(item["s3_key"])
    results.append({
        "Image": item["s3_key"],
        "TrueLabel": item["true_label"],
        "PredictedLabel": predicted
    })

# Convert to DataFrame
df = pd.DataFrame(results)

# Show result table
print(df)

# Calculate accuracy
accuracy = (df["TrueLabel"] == df["PredictedLabel"]).mean()
print(f"\n Accuracy on test set: {accuracy:.2%}")
```

```
---------------------------------------------------------------------------
ImageTooLargeException                    Traceback (most recent call last)
Cell In[20], line 45
     43 results = []
     44 for item in test_images:
---> 45     predicted = predict_label(item["s3_key"])
     46     results.append({
     47         "Image": item["s3_key"],
     48         "TrueLabel": item["true_label"],
     49         "PredictedLabel": predicted
     50     })
     52 # Convert to DataFrame

Cell In[20], line 33, in predict_label(s3_key)
     32 def predict_label(s3_key):
---> 33     response = client.detect_custom_labels(
     34         ProjectVersionArn=PROJECT_VERSION_ARN,
     35         Image={"S3Object": {"Bucket": S3_BUCKET, "Name": s3_key}}
     36     )
     37     if response["CustomLabels"]:
     38         return response["CustomLabels"][0]["Name"]
```

```
File ~/anaconda3/envs/python3/lib/python3.10/site-packages/botocore/client.py:
  ↪570, in ClientCreator._create_api_method.<locals>._api_call(self, *args,␣
  ↪**kwargs)
    566     raise TypeError(
    567         f"{py_operation_name}() only accepts keyword arguments."
    568     )
    569 # The "self" in this scope is referring to the BaseClient.
--> 570 return self._make_api_call(operation_name, kwargs)

File ~/anaconda3/envs/python3/lib/python3.10/site-packages/botocore/context.py:
  ↪123, in with_current_context.<locals>.decorator.<locals>.wrapper(*args,␣
  ↪**kwargs)
    121 if hook:
    122     hook()
--> 123 return func(*args, **kwargs)

File ~/anaconda3/envs/python3/lib/python3.10/site-packages/botocore/client.py:
  ↪1031, in BaseClient._make_api_call(self, operation_name, api_params)
   1027     error_code = error_info.get("QueryErrorCode") or error_info.get(
   1028         "Code"
   1029     )
   1030     error_class = self.exceptions.from_code(error_code)
-> 1031     raise error_class(parsed_response, operation_name)
   1032 else:
   1033     return parsed_response

ImageTooLargeException: An error occurred (ImageTooLargeException) when calling␣
  ↪the DetectCustomLabels operation: Image size is too large
```

2.2 We found unseen image size is too large, so we need to clean unseen image first.

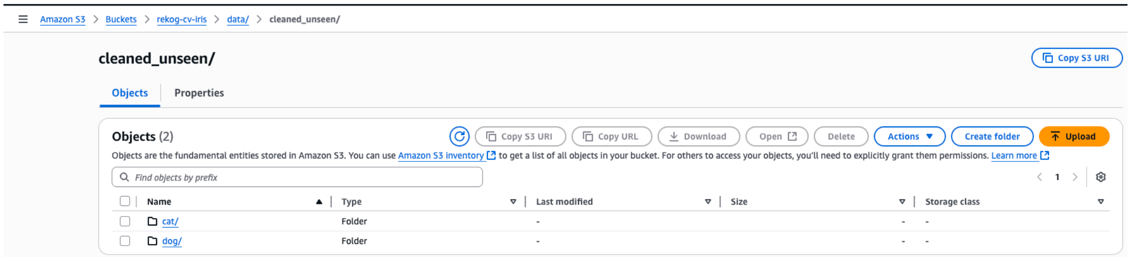
[53]:

```
clean_images("data/unseen/cat", "cleaned_unseen/cat")
clean_images("data/unseen/dog", "cleaned_unseen/dog")
```

[54]:

```
upload_images("cleaned_unseen/cat", "data/cleaned_unseen/cat")
upload_images("cleaned_unseen/dog", "data/cleaned_unseen/dog")
print("upload unseen successfully")
```

```
upload unseen successfully
```



cleaned_unseen/

Objects (2)

Objects are the fundamental entities stored in Amazon S3. You can use Amazon S3 inventory to get a list of all objects in your bucket. For others to access your objects, you'll need to explicitly grant them permissions. Learn more

□	Name	Type	Last modified	Size	Storage class
□	cat/	Folder	-	-	-
□	dog/	Folder	-	-	-

[14]:

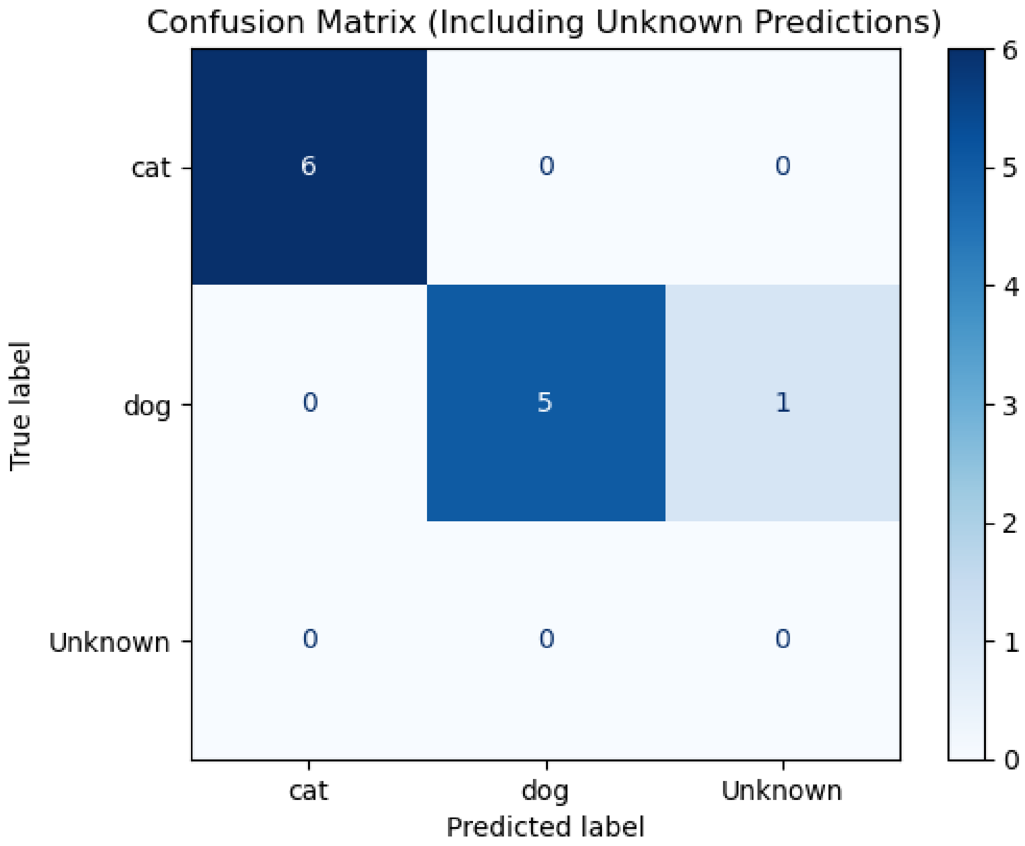
```python
import boto3
import pandas as pd


PROJECT_VERSION_ARN = "arn:aws:rekognition:us-east-1:181786711311:project/
 ↪CatDogClassifier-1/version/CatDogClassifier-1.2025-05-12T15.53.10/
 ↪1747083190902"

S3_BUCKET = "rekog-cv-iris"

# Test images and ground truth labels
test_images = [
    # cat
    {"s3_key": "data/cleaned_unseen/cat/img01.jpg",  "true_label": "cat"},
    {"s3_key": "data/cleaned_unseen/cat/img02.jpg",  "true_label": "cat"},
    {"s3_key": "data/cleaned_unseen/cat/img03.jpg",  "true_label": "cat"},
    {"s3_key": "data/cleaned_unseen/cat/img04.jpg",  "true_label": "cat"},
    {"s3_key": "data/cleaned_unseen/cat/img05.jpg",  "true_label": "cat"},
    {"s3_key": "data/cleaned_unseen/cat/img06.jpg",  "true_label": "cat"},


    # dog
    {"s3_key": "data/cleaned_unseen/dog/img01.jpg", "true_label": "dog"},
    {"s3_key": "data/cleaned_unseen/dog/img02.jpg", "true_label": "dog"},
    {"s3_key": "data/cleaned_unseen/dog/img03.jpg", "true_label": "dog"},
    {"s3_key": "data/cleaned_unseen/dog/img04.jpg", "true_label": "dog"},
    {"s3_key": "data/cleaned_unseen/dog/img05.jpg", "true_label": "dog"},
    {"s3_key": "data/cleaned_unseen/dog/img06.jpg", "true_label": "dog"}
]




# Function to call inference
def predict_label(s3_key):
    response = client.detect_custom_labels(
        ProjectVersionArn=PROJECT_VERSION_ARN,
        Image={"S3Object": {"Bucket": S3_BUCKET, "Name": s3_key}}
    )
    if response["CustomLabels"]:
        top_label = response["CustomLabels"][0]
        return top_label["Name"], top_label["Confidence"]
    else:
        return "Unknown", 0.0


# Run inference and collect results
results = []
```

```python
for item in test_images:
    label, confidence = predict_label(item["s3_key"])
    results.append({
        "Image": item["s3_key"],
        "TrueLabel": item["true_label"],
        "PredictedLabel": label,
        "Confidence": round(confidence, 2)
    })

# Convert to DataFrame
df = pd.DataFrame(results)

# Show result table
print(df)

# Calculate accuracy
accuracy = (df["TrueLabel"] == df["PredictedLabel"]).mean()
print(f"\n Accuracy on test set: {accuracy:.2%}")
```

```
---------------------------------------------------------------------------
ResourceNotReadyException                 Traceback (most recent call last)
Cell In[14], line 47
     45 results = []
     46 for item in test_images:
---> 47     label, confidence = predict_label(item["s3_key"])
     48     results.append({
     49         "Image": item["s3_key"],
     50         "TrueLabel": item["true_label"],
     51         "PredictedLabel": label,
     52         "Confidence": round(confidence, 2)
     53     })
     55 # Convert to DataFrame

Cell In[14], line 33, in predict_label(s3_key)
     32 def predict_label(s3_key):
---> 33     response = client.detect_custom_labels(
     34         ProjectVersionArn=PROJECT_VERSION_ARN,
     35         Image={"S3Object": {"Bucket": S3_BUCKET, "Name": s3_key}}
     36     )
     37     if response["CustomLabels"]:
     38         top_label = response["CustomLabels"][0]

File ~/anaconda3/envs/python3/lib/python3.10/site-packages/botocore/client.py:
  ↪570, in ClientCreator._create_api_method.<locals>._api_call(self, *args,␣
  ↪**kwargs)
    566     raise TypeError(
    567         f"{py_operation_name}() only accepts keyword arguments."
    568     )
    569 # The "self" in this scope is referring to the BaseClient.
--> 570 return self._make_api_call(operation_name, kwargs)

File ~/anaconda3/envs/python3/lib/python3.10/site-packages/botocore/context.py:
 ↪123, in with_current_context.<locals>.decorator.<locals>.wrapper(*args,␣
 ↪**kwargs)
    121 if hook:
    122     hook()
--> 123 return func(*args, **kwargs)

File ~/anaconda3/envs/python3/lib/python3.10/site-packages/botocore/client.py:
 ↪1031, in BaseClient._make_api_call(self, operation_name, api_params)
   1027     error_code = error_info.get("QueryErrorCode") or error_info.get(
   1028         "Code"
   1029     )
   1030     error_class = self.exceptions.from_code(error_code)
-> 1031     raise error_class(parsed_response, operation_name)
   1032 else:
   1033     return parsed_response

ResourceNotReadyException: An error occurred (ResourceNotReadyException) when␣
 ↪calling the DetectCustomLabels operation: ProjectVersion arn:aws:rekognition:
 ↪us-east-1:181786711311:project/CatDogClassifier-1/version/CatDogClassifier-1.
 ↪2025-05-12T15.53.10/1747083190902 is not ready
```

[57]:

```python
import matplotlib.pyplot as plt
from sklearn.metrics import confusion_matrix, ConfusionMatrixDisplay

labels = ["cat", "dog", "Unknown"]
cm = confusion_matrix(df["TrueLabel"], df["PredictedLabel"], labels=labels)

disp = ConfusionMatrixDisplay(confusion_matrix=cm, display_labels=labels)
disp.plot(cmap=plt.cm.Blues)
plt.title("Confusion Matrix (Including Unknown Predictions)")
plt.show()
```



2.2.1 Interpretation of “Unknown” Predictions

In some test cases, the model returned no predicted label, which we recorded as “Unknown”. This usually occurs when the model is uncertain or the image is too different from the training distribution.

By including “Unknown” in the confusion matrix, we can better understand how often the model fails to classify unfamiliar images.

In our test set of 12 images, only one image was predicted as “Unknown”, giving us a 91.67% accuracy overall.

[68]:
```
#stop model
client.stop_project_version(ProjectVersionArn='arn:aws:rekognition:us-east-1:
 ↪181786711311:project/CatDogClassifier-1/version/CatDogClassifier-1.
 ↪2025-05-12T15.53.10/1747083190902')
```

[68]:
```
{'Status': 'STOPPING',
 'ResponseMetadata': {'RequestId': '3484209c-f549-41b6-a9d5-b81137eb0348',
  'HTTPStatusCode': 200,
  'HTTPHeaders': {'x-amzn-requestid': '3484209c-f549-41b6-a9d5-b81137eb0348',
   'content-type': 'application/x-amz-json-1.1',
   'content-length': '21',
   'date': 'Mon, 12 May 2025 21:56:42 GMT'},
  'RetryAttempts': 0}}
```

2.3 Qualitative Error Analysis: Why Was This Image Predicted as "Unknown"?

1. Low Contrast Between Subject and Background The dog has a black and white coat, and the background is also grayscale (concrete, shadowed). This low-contrast setting may have made it harder for the model to detect edges and features.
2. Pose and Composition The dog's face is turned slightly to the side, and its ears are pointed upright. These features may loosely resemble a cat, especially if the model is relying on ear shape, fur pattern, or face symmetry.
3. Facial Similarity to Cat Features Husky dogs in particular have sharp eyes and triangular ears — traits that may confuse a model trained only on domestic, short-haired dogs and common cats.

[69]:
```python
unknowns = df[df["PredictedLabel"] == "Unknown"]
print(unknowns)
```

```
                              Image TrueLabel PredictedLabel  Confidence
6  data/cleaned_unseen/dog/img01.jpg       dog        Unknown         0.0
```

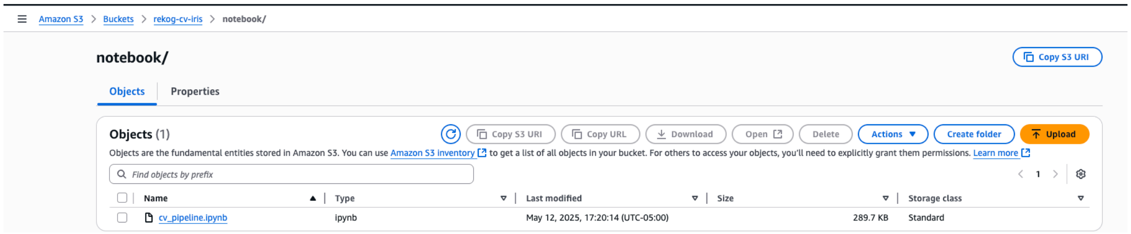
[72]:
```python
Image.open("cleaned_unseen/dog/img01.jpg")
```

[72]:

2.4 upload notebook and report to S3

```
[ ]: # upload notebook and screenshots to S3
     s3_prefix='notebook'
     file_name = "cv_pipeline.ipynb"
     s3.upload_file(file_name, BUCKET, f"{s3_prefix}/{file_name}")
```

```
[82]: def upload_f(local_folder, s3_prefix):
          for file_name in Path(local_folder).glob("*"):
              s3.upload_file(str(file_name), BUCKET, f"{s3_prefix}/{file_name.name}")
      upload_f('screenshots', "screenshots")
```

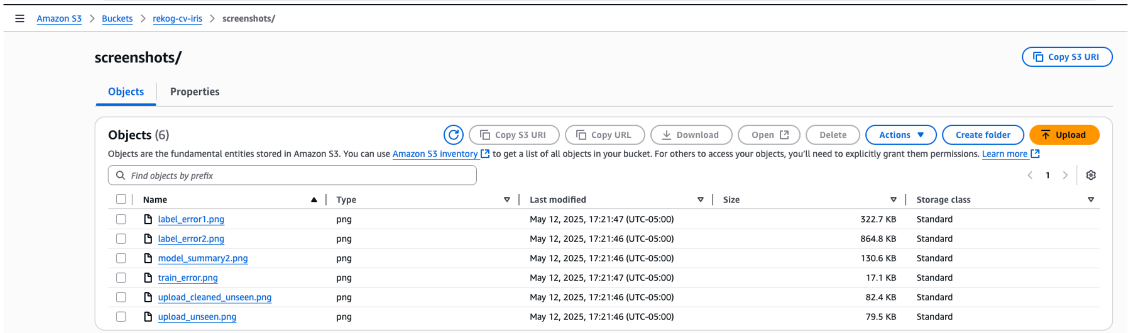


notebook/

Objects (1)

Objects are the fundamental entities stored in Amazon S3. You can use Amazon S3 inventory to get a list of all objects in your bucket. For others to access your objects, you'll need to explicitly grant them permissions. Learn more

□	Name ▲	Type	Last modified	Size	Storage class
□	cv_pipeline.ipynb	ipynb	May 12, 2025, 17:20:14 (UTC-05:00)	289.7 KB	Standard



screenshots/

Objects (6)

Objects are the fundamental entities stored in Amazon S3. You can use Amazon S3 inventory to get a list of all objects in your bucket. For others to access your objects, you'll need to explicitly grant them permissions. Learn more

□	Name ▲	Type	Last modified	Size	Storage class
□	label_error1.png	png	May 12, 2025, 17:21:47 (UTC-05:00)	322.7 KB	Standard
□	label_error2.png	png	May 12, 2025, 17:21:46 (UTC-05:00)	864.8 KB	Standard
□	model_summary2.png	png	May 12, 2025, 17:21:46 (UTC-05:00)	130.6 KB	Standard
□	train_error.png	png	May 12, 2025, 17:21:47 (UTC-05:00)	17.1 KB	Standard
□	upload_cleaned_unseen.png	png	May 12, 2025, 17:21:46 (UTC-05:00)	82.4 KB	Standard
□	upload_unseen.png	png	May 12, 2025, 17:21:46 (UTC-05:00)	79.5 KB	Standard