Using Machine Learning for Image Classification to Monitor Island-Spotted Skunk Populations

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Introduction

- The island-spotted skunk is a small carnivore, weighing less than 2 pounds, and is endemic to Santa Cruz and Santa Rosa, the two largest California Channel Islands. Known for its distinctive black-and-white striped coat and unique adaptations to the isolated environment of the Channel Islands make it a notable species.
- Drawing from past generations of Data Science Lab Interns, I aim to improve the current image classification model which classifies birds, skunks, foxes, and empty species frames in terms of loss and accuracy by starting fresh for the purpose of estimating the current population density and habitat distribution of the island-spotted skunk on Santa Cruz Island.
- In contributing to this focus of machine learning and fulfilling my role as an intern, this end-product of the model will help in the conservation and management of the island's ecosystem.

Methods

1. NVIDIA Jetson Nano

2. Libraries, Packages & Models

TensorFlow Lite · Keras · NumPy · matplotlib

3. Google Colab

```python
model = tf.keras.Sequential(
    [
        tf.keras.layers.Rescaling(1./255),
        tf.keras.layers.Conv2D(32, 4, activation="relu"),
        tf.keras.layers.MaxPooling2D(),
        tf.keras.layers.Conv2D(32, 4, activation="relu"),
        tf.keras.layers.MaxPooling2D(),
        tf.keras.layers.Conv2D(32, 4, activation="relu"),
        tf.keras.layers.MaxPooling2D(),
        tf.keras.layers.Flatten(),
        tf.keras.layers.Dense(128, activation="relu"),
        tf.keras.layers.Dense(4)
    ]
)
```

4. Mamba & Camera Traps

Mamba

- Will use this model to process approximately 1 million camera trap images that have been collected since 2017 with the UCSB-Smithsonian Scholar Camera Traps on Santa Cruz Island.

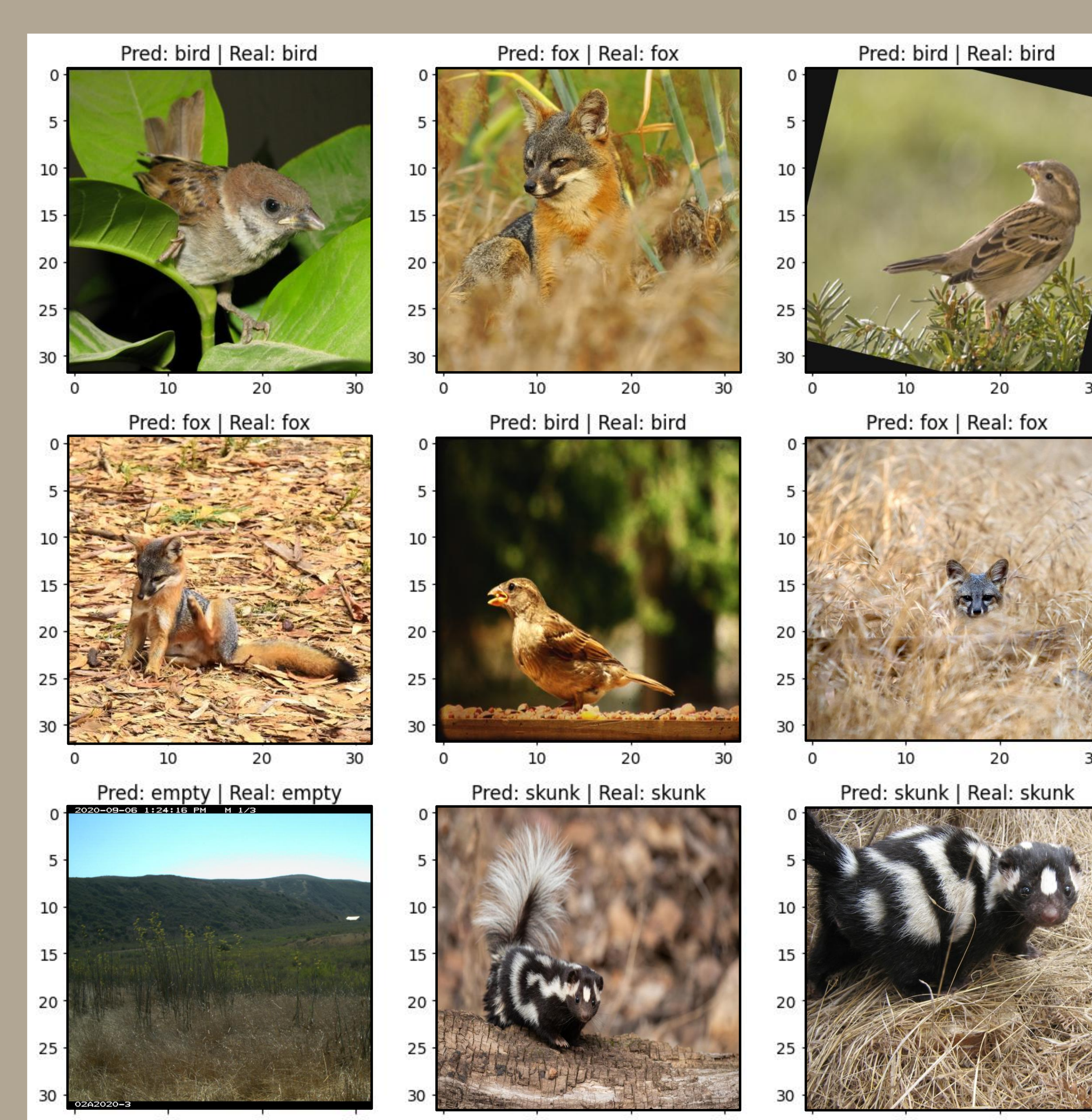
Results

```python
model.fit(
    train_ds,
    validation_data = val_ds,
    epochs = 14
)
```

```
Epoch 1/14
75/75 ━━━━━━━━━━━━━━━━━━━━ 15s 174ms/step - accuracy: 0.4342 - loss: 1.2464 - val_accuracy: 0.5665 - val_loss: 0.9886
Epoch 2/14
75/75 ━━━━━━━━━━━━━━━━━━━━ 15s 199ms/step - accuracy: 0.6255 - loss: 0.9108 - val_accuracy: 0.7133 - val_loss: 0.7864
Epoch 3/14
75/75 ━━━━━━━━━━━━━━━━━━━━ 19s 178ms/step - accuracy: 0.6913 - loss: 0.7220 - val_accuracy: 0.7018 - val_loss: 0.6843
Epoch 4/14
75/75 ━━━━━━━━━━━━━━━━━━━━ 20s 176ms/step - accuracy: 0.7114 - loss: 0.6522 - val_accuracy: 0.7271 - val_loss: 0.6596
Epoch 5/14
75/75 ━━━━━━━━━━━━━━━━━━━━ 21s 183ms/step - accuracy: 0.7294 - loss: 0.5822 - val_accuracy: 0.7844 - val_loss: 0.5618
Epoch 6/14
75/75 ━━━━━━━━━━━━━━━━━━━━ 12s 160ms/step - accuracy: 0.7774 - loss: 0.5315 - val_accuracy: 0.8234 - val_loss: 0.4833
Epoch 7/14
75/75 ━━━━━━━━━━━━━━━━━━━━ 22s 174ms/step - accuracy: 0.8348 - loss: 0.4467 - val_accuracy: 0.7936 - val_loss: 0.4940
Epoch 8/14
75/75 ━━━━━━━━━━━━━━━━━━━━ 19s 154ms/step - accuracy: 0.8337 - loss: 0.4056 - val_accuracy: 0.8693 - val_loss: 0.3445
Epoch 9/14
75/75 ━━━━━━━━━━━━━━━━━━━━ 13s 176ms/step - accuracy: 0.8741 - loss: 0.3193 - val_accuracy: 0.8761 - val_loss: 0.2943
Epoch 10/14
75/75 ━━━━━━━━━━━━━━━━━━━━ 20s 171ms/step - accuracy: 0.9006 - loss: 0.2668 - val_accuracy: 0.8693 - val_loss: 0.2975
Epoch 11/14
75/75 ━━━━━━━━━━━━━━━━━━━━ 21s 179ms/step - accuracy: 0.9106 - loss: 0.2363 - val_accuracy: 0.9220 - val_loss: 0.2092
Epoch 12/14
75/75 ━━━━━━━━━━━━━━━━━━━━ 19s 158ms/step - accuracy: 0.9277 - loss: 0.2007 - val_accuracy: 0.9358 - val_loss: 0.2018
Epoch 13/14
75/75 ━━━━━━━━━━━━━━━━━━━━ 22s 176ms/step - accuracy: 0.9406 - loss: 0.1631 - val_accuracy: 0.9404 - val_loss: 0.1667
Epoch 14/14
75/75 ━━━━━━━━━━━━━━━━━━━━ 23s 212ms/step - accuracy: 0.9505 - loss: 0.1540 - val_accuracy: 0.9312 - val_loss: 0.1665
<keras.src.callbacks.history.History at 0x7831e88eee60>
```

```python
model.evaluate(test_ds)
```

```
45/45 ━━━━━━━━━━━━━━━━━━━━ 8s 173ms/step - accuracy: 0.9475 - loss: 0.1328
[0.14506796002388, 0.9428251385688782]
```



Conclusions

Model Achieved High Accuracy in Species Classification

- The model achieved approximately 95% accuracy in classifying skunks, foxes, birds, and empty species frames. This performance was consistent even when tested on an unseen validation and test datasets, showing its ability to handle varying image factors like texture, angle, rotation and brightness.

Model's Impact on Advancing Machine Learning in Wildlife Research and Ecosystem Studies

- The successful implementation of this image classification model demonstrates the effectiveness of machine learning techniques in handling complex wildlife datasets.

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