A Proposal to Predict Cat Breeds

Proposed by:

Rachel Tumulak

Domain Background

Image classification is the process of identifying through computer vision the visual content of an image. There are a lot of applications image classification can be used for such as face recognition, self-driving cars, automatic vacuum cleaner and a lot more. Common to these applications include identifying an object. An example is identifying whether a human face is in a picture or not to recognize face of a human. For a self-driving car to be able to drive automatically, it needs to identify stoplights, signs, and humans to drive safely. Vacuum cleaners need to identify if an object is a dirt and needs to be cleaned, or a wall to change its direction.

There are a wide range of species in the world, human with a curious mind sometimes just wants to know what specie that is. In each specie there are a lot more classifications. An example would be animals. There are a lot of animals in the world that some even look similar. Tigers, lions, leopards have common features and they belong in the Cat family. There are also domestic cats which are separated in terms of its breed. For a human to detect what breed a cat would be is challenging due to many factors. A cat breed can be identified through behavior, body type, face, and ear shape, vocal, color, fur, markings and patterns, body size and mannerism. In an image one can only focus on what can be seen namely body type, face and ear shape, color, fur, markings and patterns, and body size.

Machine learning, as a subset of artificial intelligence, provides system the ability to learn and improve automatically through experience. Image classification is one the topics in machine learning and a common deep learning algorithm that is being used to analyze visual imagery is Convolutional Neural Network or CNN.

Problem Statement

This project aims to build a machine learning pipeline that will identify an estimate of a feline's breed. The most identifiable characteristic in a feline is its coat color, pattern, and length. It is likely to be classified into three groups – domestic short hair, medium hair, and long hair. However, there are other more things to consider. Identifying a cat by coat pattern and color, take the following as an example:

		
Tortoiseshell	Torbie	Calico

These cats are Tabby cat patterning having a blend of two distinct colors—with one dominant collar and are characterized by having an "M" on their forehead. However, they all have different breeds.

"Pointed" cats based on color are cats that have lighter color bodies and dark color extremities which includes face, ear, tail, and inguinal areas in male. Siamese are the most common type of cat to have these characteristics but there are a lot more breeds that exhibit the same type of coloration. In this case they're all Siamese but with different shades and body shapes.

				
Seal Point	Lilac Point	Red Point	Cream Point	Blue Point
Light body and dark brown accents	Cream body, gray highlighting, and blue eyes	Cream body with apricot highlighting	Cream body coloring with minor shading in similar color on the points	Dark faces, dark paws, and blue eyes

Another pointed cat based on pattern are lynx point, orange stripping, and gray-black stripping. This can be exhibited by Tabby cats.

		
Tabby Point	Red Tabby	Seal Tabby Point

Cats can also be identified by ear type and face shape. This tells a lot about cat breeds, there are apple narrow shaped faces like in Siamese. A big, blocky, or round head for Persian. Lynx tips and tufts ears for Norwegian Forest Cat and Maine Coon. Curls and folded ears for American curl and Scottish fold.

Datasets and Inputs

- unbalanced dataset of images representing 67 different cat breeds

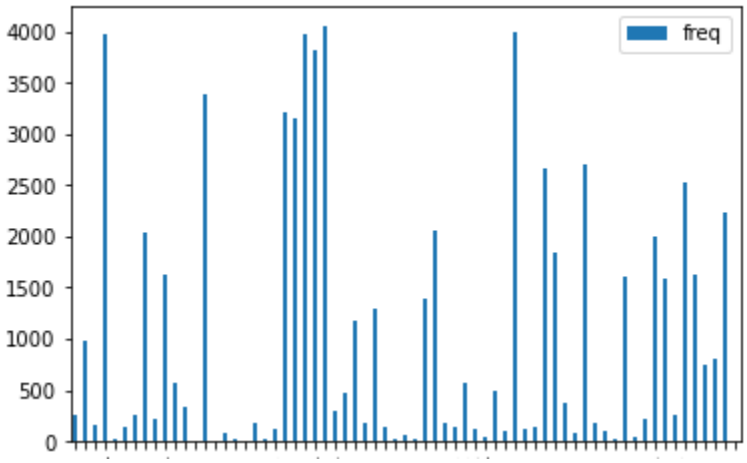


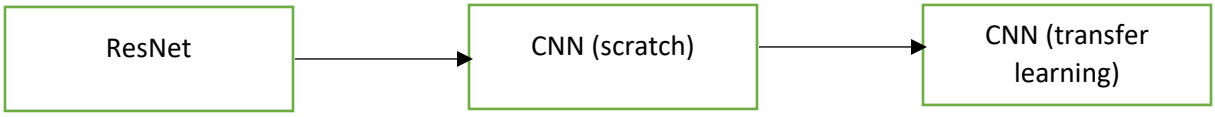
Figure A. Distribution of cat breeds

- there are 126606 total cat images
    - 1/10 of the total images are to be used for testing
    - 1/10 of the total images are to be used for validation
    - 8/10 of the total images are to be used for training
- For training the images will be transformed:
    - Random rotation
    - Random resize
- All datasets are resized to fit the model
- The dataset was made available by - https://www.kaggle.com/ma7555/cat-breeds-dataset:
    - PetFinder API
    - aschleg: petpy
    - ma7555: https://github.com/ma7555/petpy/blob/new/notebooks/03-Download%20Pure%20Breeds%20Cat%20Images%20with%20petpy%20for%20Deep%20Neural%20Network%20training%20-%20multiprocessing.ipynb

Solution Statement

A proposed solution to this problem is to undergo two approaches of Convolutional Neural Network.

1. **Traditional**. I will then construct a Convolutional Neural Network from scratch that will identify cat breeds.
2. **Transfer Learning.** I will use an existing CNN model that has been trained and use its knowledge for training the newer model.



To discuss the flow, first I will use ResNet pretrained model to detect if a cat exists in a picture. All images will be transformed into randomly rotated and resized for training. I will build a convolutional neural network from scratch to predict the breed of the cat. To improve the model, I will use an existing CNN model that has been trained, ResNet, and use its knowledge for training the newer model.

According to the observations of researchers, in convolutional neural network, the deeper the better. However, even if the models tend to become more capable after some depth the performance degrades. When the network goes too deep, calculating the gradients from a loss function shrinks to zero after several application of the chain rule. Which results to no learning performed. ResNets solves this problem by allowing the gradients to directly flow through the skip connections backwards from the later layers to initial filters.

Benchmark Model

For this project, CNN from scratch will serve as a baseline for the performance of my actual model.

Convolutional Neural Network

Computer vision is to allow computers to perceive images just as humans can see. There are many advancements towards this agenda, and it is primary based on Convolutional Neural Network. ConvNet or CNN takes images, distinguish learnable weights and biases to various objects that will enable it to differentiate one object to another. Its architect is based that of a neuron in the human brain where each neuron is respond to stimuli in a restricted region of the visual field – Receptive Field. A collection overlap to cover the entire visual area. Therefore, convnet can successfully capture Spatial and Temporal dependencies in an image through an application of relevant filters. By reducing the number of parameters involved and reusability of weights the network performs better since it can be trained to understand sophisticated images.

Evaluation Metrics

To evaluate the model, I will use F1 score to determine model performance. F1 score is the weighted average of the precision and recall. Where an F1 score reaches its best value at 1 and worst score at 0. The relative contribution of precision and recall to the F1 score are equal.

$$f1\ score = 2\ \times \frac{precision\ \times recall}{precision + recall}$$

Project Design

The project will undergo the following procedures for its pipeline

1. Import Datasets
    a. Import the datasets that will be used for the project
2. Use a pretrained model ResNet34
    a. Use a pre-trained model that will detect if a cat exists in a picture
3. Create a CNN to Classify Cat Breeds (Scratch)
    a. Build a model from scratch to classify cat breeds
4. Create a CNN to Classify Cat Breeds (Transfer Learning)
    a. Improve the model by using transfer learning
5. Algorithm
    a. Detect if there exist a cat in a picture
    b. If none identify the closest cat breed of the picture
    c. If there is identify the cat breed

Resources

https://pethelpful.com/cats/How-to-Determine-Your-Cats-BreedsMixed-Breeds-to-Purebreds

https://towardsdatascience.com/a-comprehensive-hands-on-guide-to-transfer-learning-with-real-world-applications-in-deep-learning-212bf3b2f27a

https://towardsdatascience.com/dog-breed-prediction-using-cnns-and-transfer-learning-22d8ed0b16c5

https://siameseofday.com/siamese-cat-colors-chart/