



# THE PAWSOME CLASSIFIER

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Image Classification of 120 Dog  
Breeds

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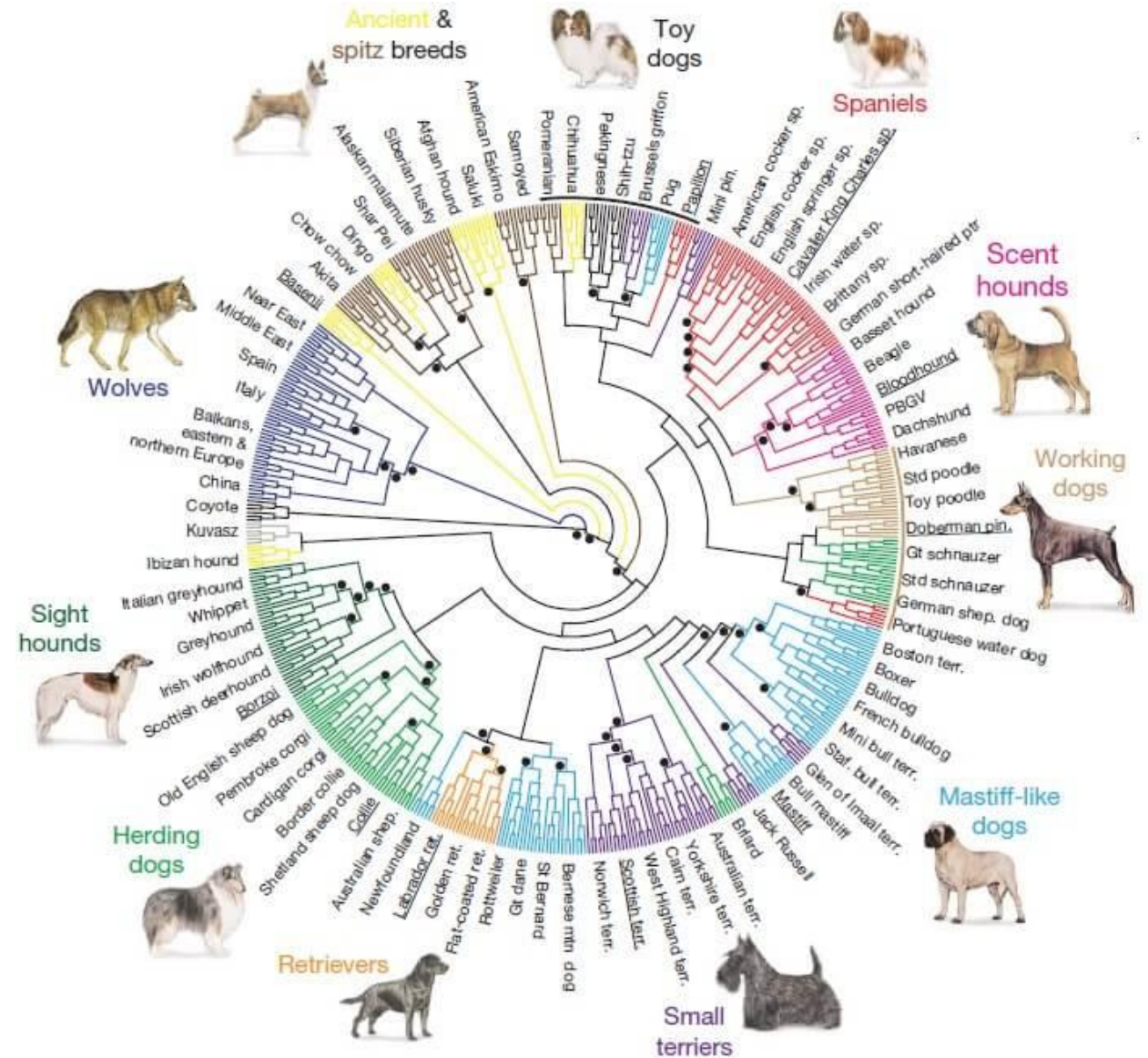
# Project Overview

"Man's best friend"



# History of dog breeds

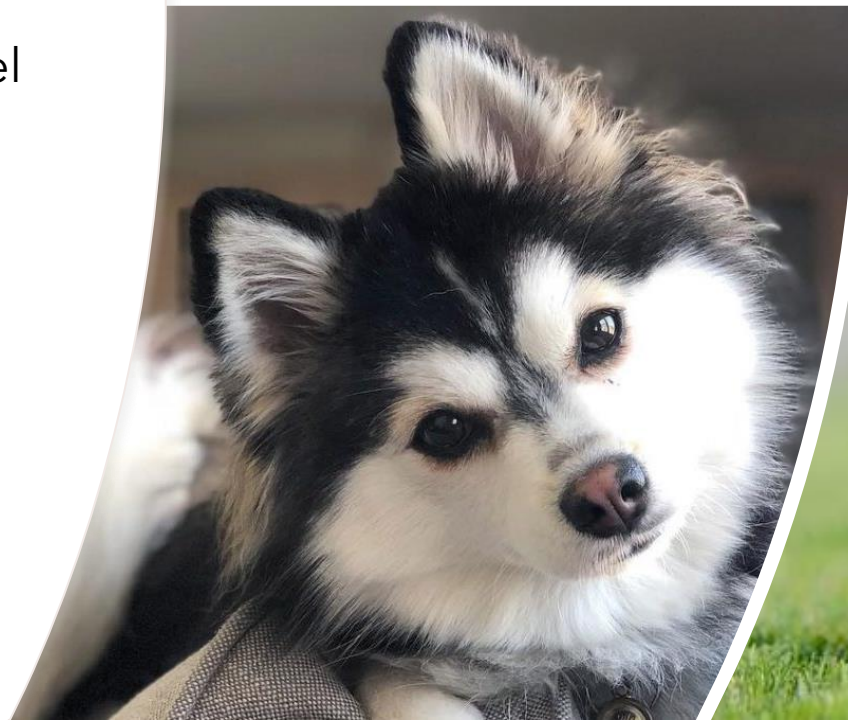
- Today's "pure bred" dogs (pedigree) are a product of **selective breeding** by humans
- Dogs bred to optimize their ability to perform specific functions:
  - Hunting
  - Tracking
  - Guarding
  - Herding
  - Sports
  - War
- Dog pedigrees are documented and registered by **Kennel Clubs**.



# Designer Dogs

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- Intentionally crossing dog pedigrees to create offspring with mixed appearance/characteristics
- Not recognized as “pure breeds” by kennel clubs.

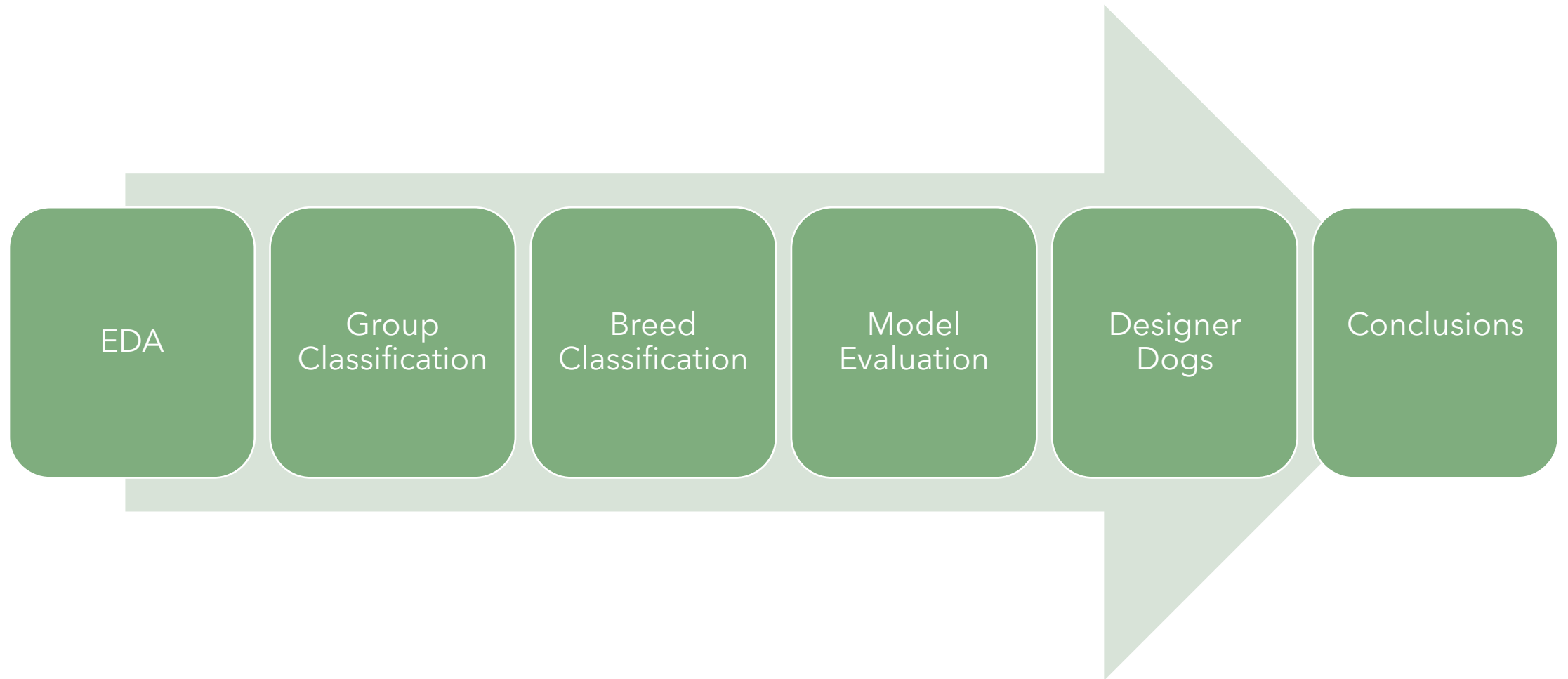


# Problem Statement

- Personal motivations
- Construct a machine-learning model for image classification of:
  - Dogs by Kennel Club groupings
  - Dogs by breed
  - Stretch goal: Designer dogs prediction

# Project Flowchart

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# EDA - Dataset Summary

Dataset	Number of Images	Number of Classes	Used in
Stanford Dogs Dataset (Kaggle)	20,580	12 / 120	Model training and validation
Unseen Dataset (Kaggle)	550	55	Evaluating model performance
Designer Dogs (From web)	20	10	Predicting mixed breeds

Note: Stanford Dogs Dataset contains bounding boxes for dogs in images.



## EDA - 12 Dog Groups (Continental Kennel Club)

- Terrier
- Pinscher/Schnauzer
- Companion/toy
- Sighthound
- Scenthound
- Gundog
- Primal
- Spitz/Nordic
- Pastoral/Stock
- Guardian/Pastoral/Mountain
- Mastiff
- Bull



# EDA - 12 Dog Groups

Group	Key characteristics	Fun Fact
<b>Terrier</b>	Small. Used for hunting vermin	<i>Terrier</i> in French means “burrow”
<b>Pinscher/Schnauzer</b>	Schnauzers have beard and feathery eyebrows	Pinschers and Schnauzers look quite different but share common ancestry with German Pinscher.
<b>Companion/Toy</b>	Small. Easy to carry	Bred for ladies/children
<b>Sighthound</b>	Lean bodied, long legs, deep ribcage	Built for the chase
<b>Scenthound</b>	Large nasal cavities, drooping ears	Built for endurance and tracking
<b>Gundog</b>	Drooping ears	Used for hunting birds
<b>Primal</b>	“wild” looking	Ancient breeds
<b>Spitz/Nordic</b>	Thick coats, curled tails	Essential for arctic people survival
<b>Pastoral/Stock</b>	Intelligent, muscular	Work with grazing livestock
<b>Guardian/Pastoral/Mountain</b>	Large, thick coat	Can endure tough mountain conditions
<b>Mastiff</b>	Large, muscular, aggressive	Used as war dogs / blood sports
<b>Bull</b>	Characteristic flat head shape	Used for bull-baiting

# Sample Training Images

**Terriers**



**Pinscher/Schnauzers**



# Sample Training Images

**Companion/Toy**



**Gundog**





# Sample Training Images

**Sighthounds**



**Scenthounds**



# Sample Training Images

**Primal**



**Spitz/Nordic**





# Sample Training Images

**Pastoral/Stock**



**Guardian/Pastoral/Mountain**





# Sample Training Images

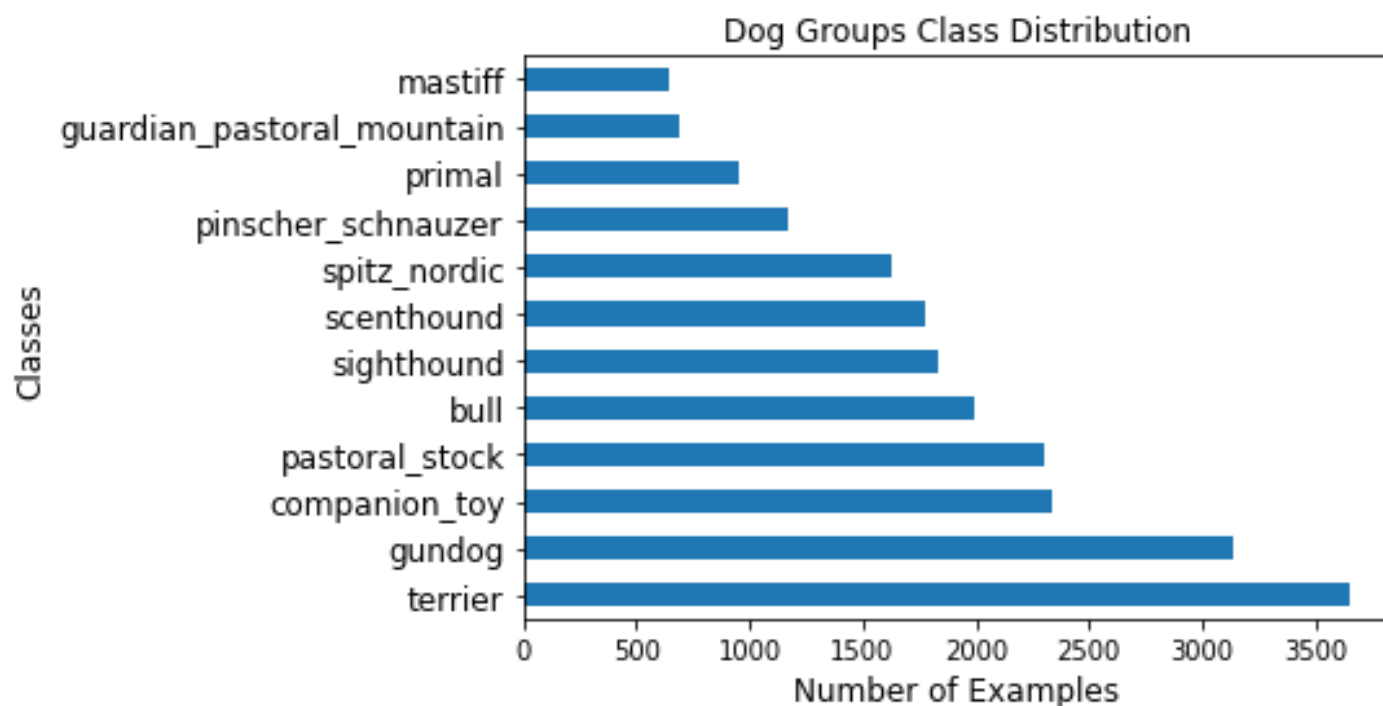
**Mastiff**



**Bull**



# EDA - 12 Dog Groups



- Uneven class distribution
- Baseline Accuracy (random rate classification): **10.26%**

# Modelling Process Overview

## Base Model Selection

- EfficientNet
- VGG-16
- Xception
- MobileNet

## Group Classification

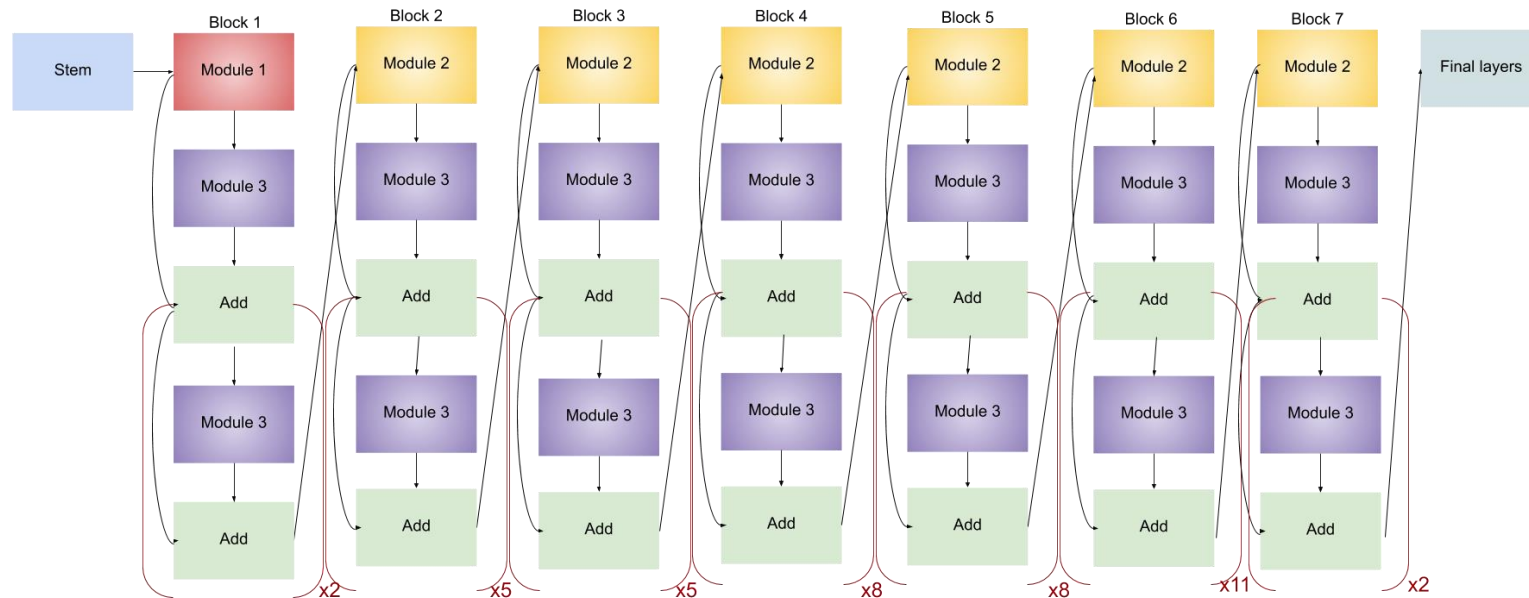
- Transfer Learning and Fine Tuning

## Breed Classification

- Transfer Learning and re-training



# Base Model: EfficientNet B7



- 67% validation accuracy without tuning
- Other base models could not achieve more than 40% validation accuracy
- Model architecture: stem + 7 blocks + top layers

# Group Classification - Model Summary

- Model architecture:
  - Base model - EfficientNet B7 (excluding top layers)
  - Global Average Pooling 2D - 2560 nodes
  - Dense layer - 1280 nodes, relu activation
  - Dropout layer - 50%
  - Prediction layer - 12 nodes, softmax activation

# Group Classification - Tuning

## Callbacks

- ReduceLROnPlateau- Adam optimizer
- Checkpoint - save weights for best validation accuracy
- Early Stopping

## Regularization

- L2 kernel regularizer
- Dropout - 50%
- Image augmentation - random rotations, horizontal flips and random shifts



# Group Classification - Fine tuning

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01

Unfreeze block 7  
of base model

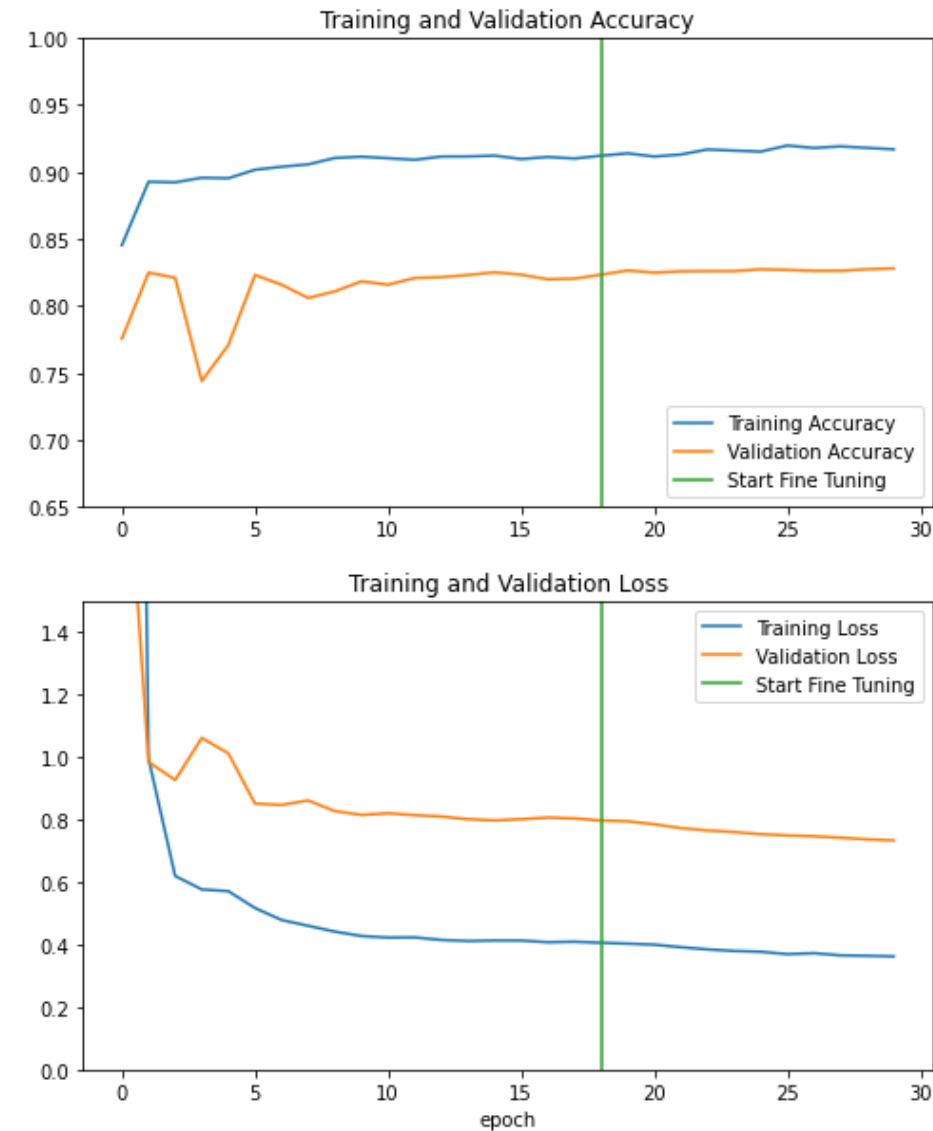
02

Keep batch  
normalization  
layers frozen

03

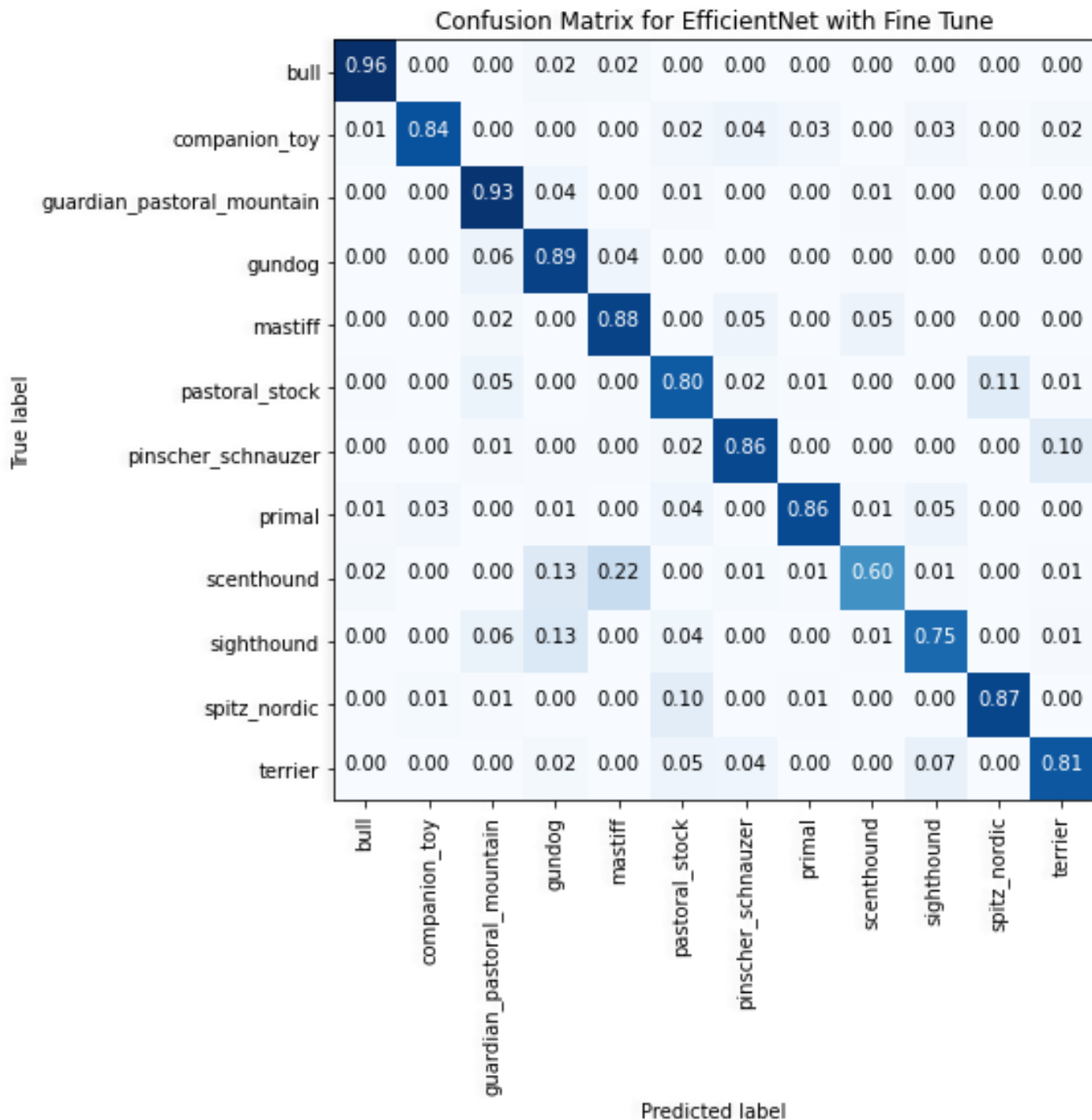
Reduce learning  
rate by factor of  
10 and retrain for  
another 10  
epochs

# Group Classification - Evaluation



# Group Classification - Evaluation

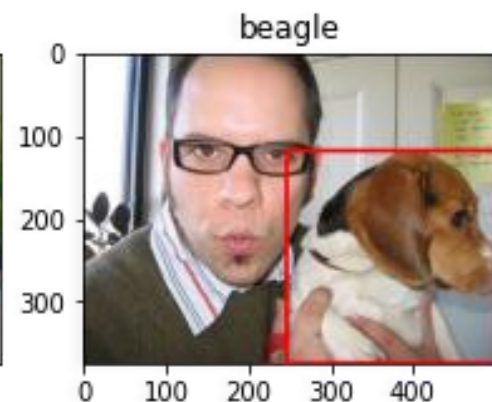
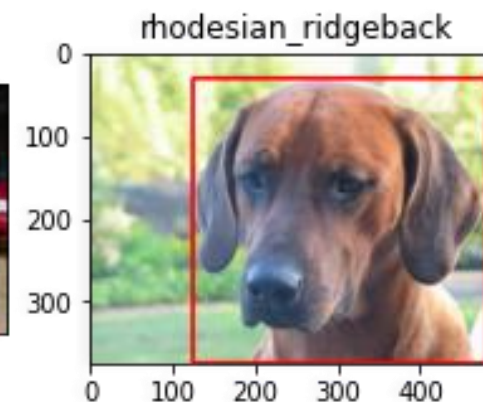
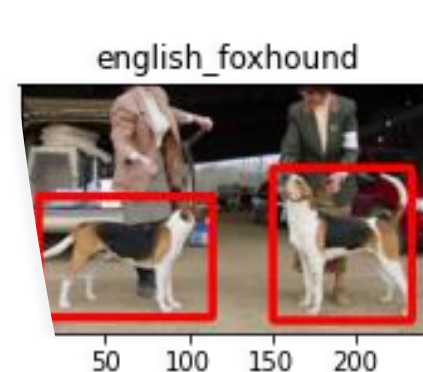
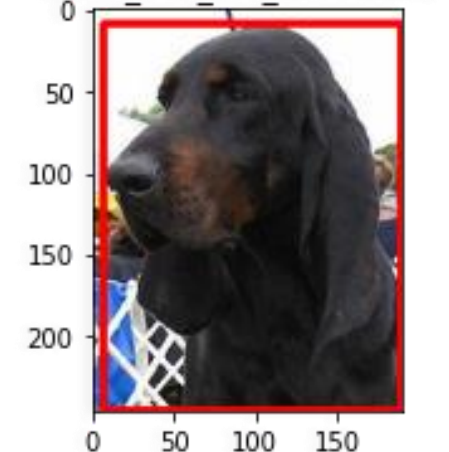
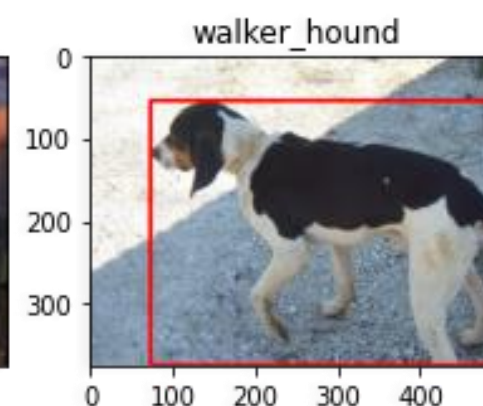
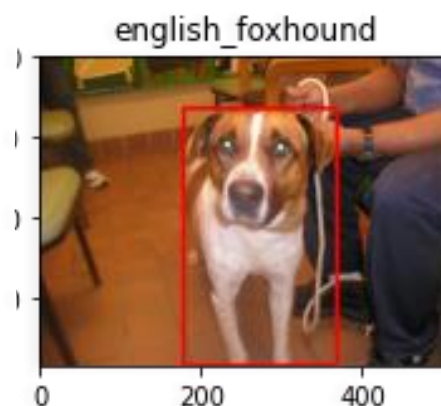
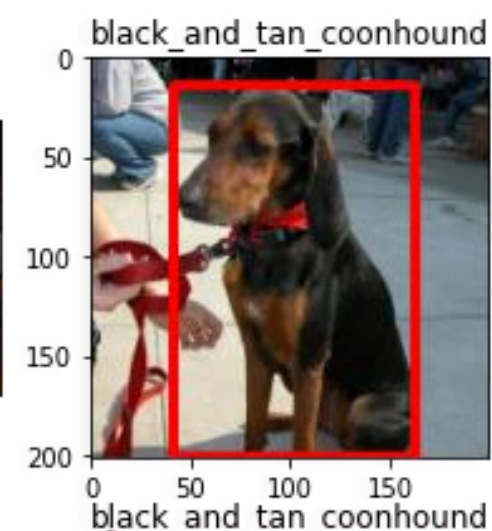
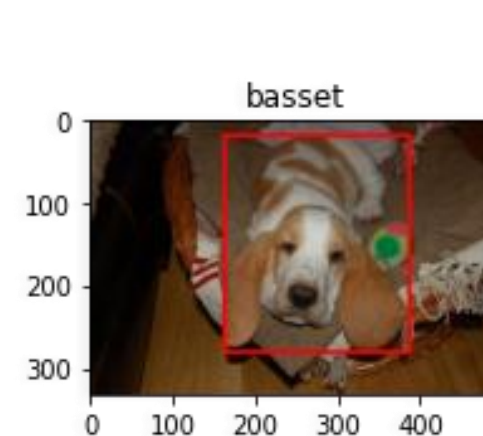
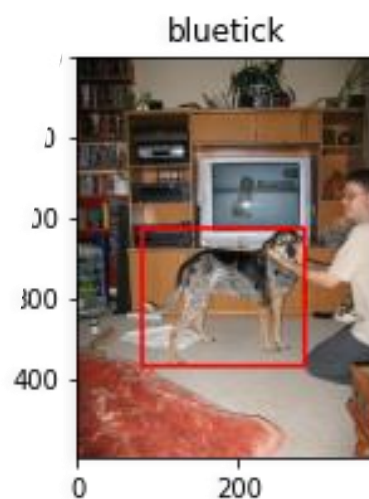
- Validation Accuracy: **82.8%**
- Top accuracies
  - Bull (96%)
  - Guardian/pastoral/mountain (93%)
  - Gundog (89%)
- Lowest accuracies
  - Scenthound (60%)
  - Sighthound (75%)



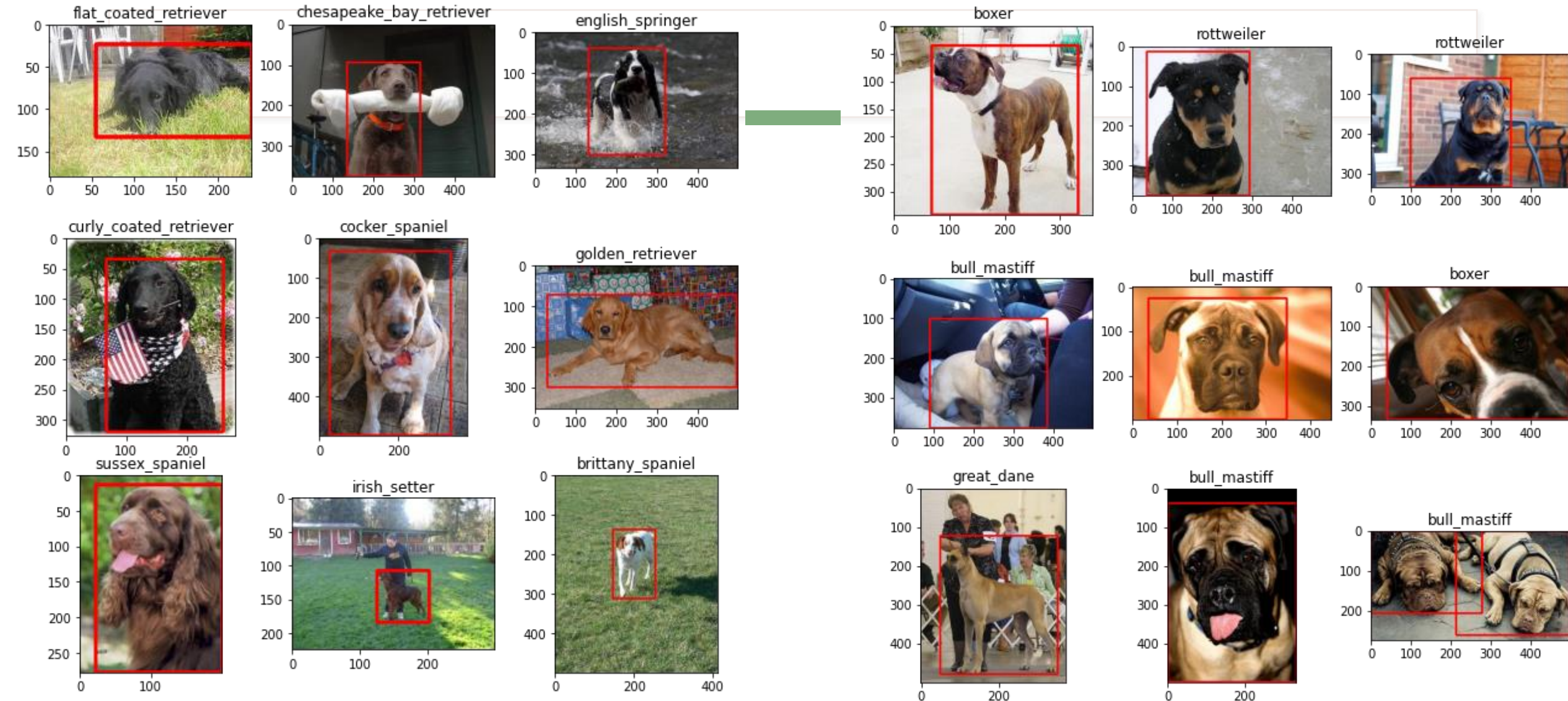


# Group Classification - Misclassification Analysis

- Model is quite bad at predicting scenthounds
- Misclassified as:
  - Mastiffs (22%) - broad snout
  - Gundogs (13%) - large droopy ears



# Group Classification - Misclassification Analysis



# Breed Classification

01

Freeze base  
model

02

Replace  
prediction layer  
to output 120  
instead of 12

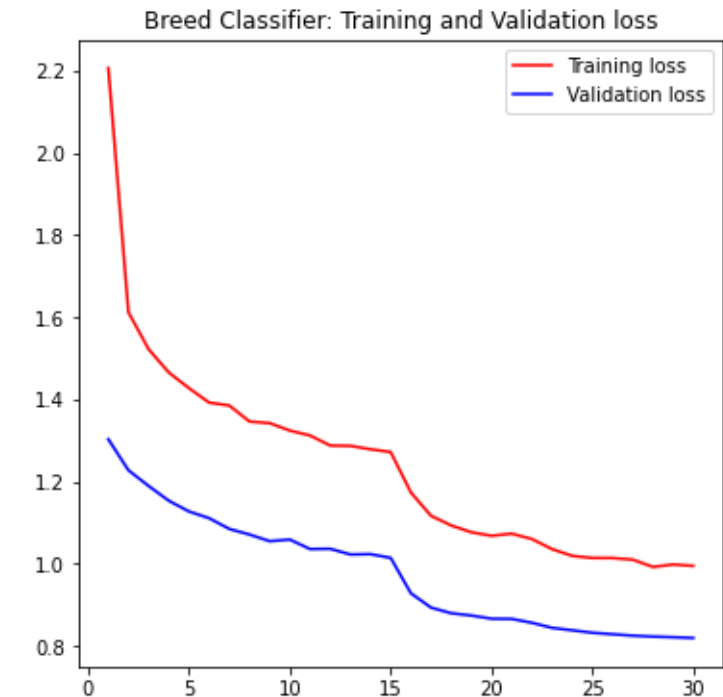
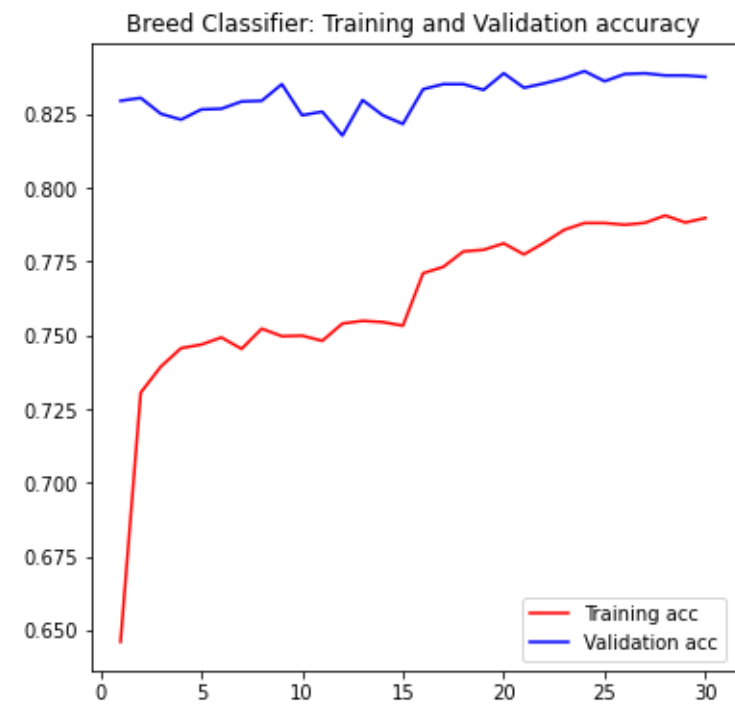
03

Train model for  
30 epochs



# Breed Classification - Evaluation

Validation Accuracy: **84.0%**



# Breed Classification Evaluation

- Accuracy on unseen data - **92.0%**
- Many misclassifications were the same type of dog but different size variant. For example:
  - Predicted - giant\_schnauzer, Actual: standard\_schnauzer
  - Predicted - miniature/toy poodle, actual: standard\_poodle
- Unseen dataset contains only 55 out of 120 labels

# Designer Dogs Prediction



**Pomsky = Pomeranian + Siberian husky**

- **21.9% Pomeranian**
- 17.6% Shetland Sheepdog
- 10.6% Malamute



**Chug = Chihuahua + Pug**

- **91.2% Pug**
- 2.7% Pekingese
- 2.1% Brabancon griffon



# Designer Dogs Prediction



**Goldendoodle = Golden Retriever + Poodle**

- **Golden Retriever 35.2%**
- Cocker Spaniel 17.1%
- **Standard Poodle 16%**



**Schnoodle = Schnauzer + Poodle**

- 40% Kerry Blue Terrier
- 21.2% Bouvier Des Flandres
- **6.6% Miniature Schnauzer**

# Designer Dogs Prediction



**Shihpoo = Shih Tzu + Poodle**

- Lhasa 53.5%
- **Shih Tzu 29%**
- Tibetan Terrier 11.1%



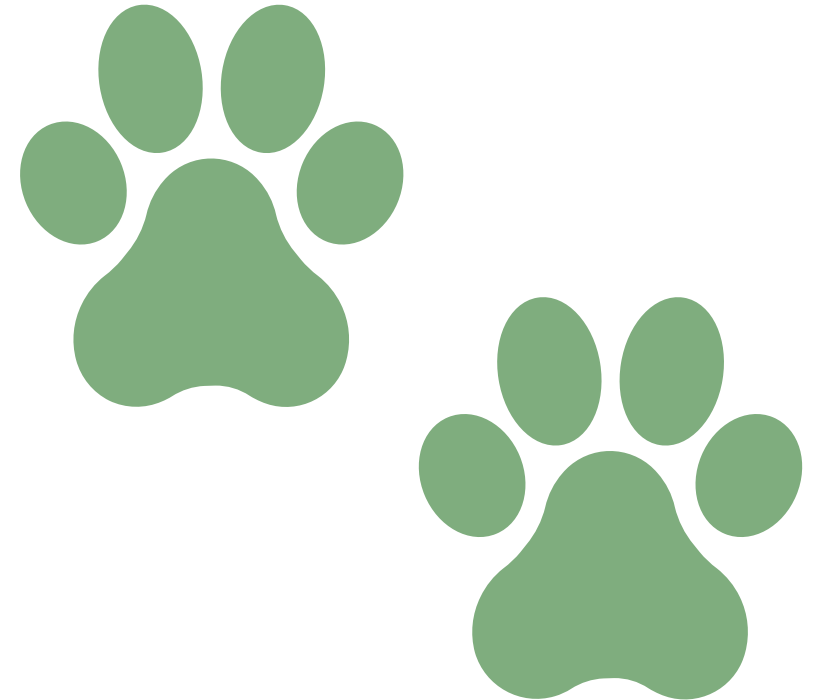
**Chorkie = Chihuahua + Yorkshire Terrier**

- **Chihuahua 81.7%**
- Papillon 5.7%
- Toy terrier 3.5%

# Conclusions

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- Dog group classifier
  - Validation accuracy: 82%
- Dog breed classifier
  - Validation accuracy: 84%
  - Unseen data accuracy: 92%
- Designer dogs
  - Can predict at least 1 parent breed
  - Overfit to pure breeds
- Given the data, computer vision can be better than human vision!





# Conclusions - Use cases

Train models to recognize dog groupings for a specific kennel club

Can be used by kennel clubs to assess how closely a dog matches their ideal breed standard

Can be used to recognize possible parentage for mixed breed dogs

# Future Work



Introduce model for object detection



Include more breeds



Model can be adapted to recognize different breeds for another animal e.g. cats



Model can be adapted to categorize newly discovered species into family groupings.

**THANK YOU**

