



THE PAWSOME CLASSIFIER

Image Classification of 120 Dog
Breeds

Christopher Gozali

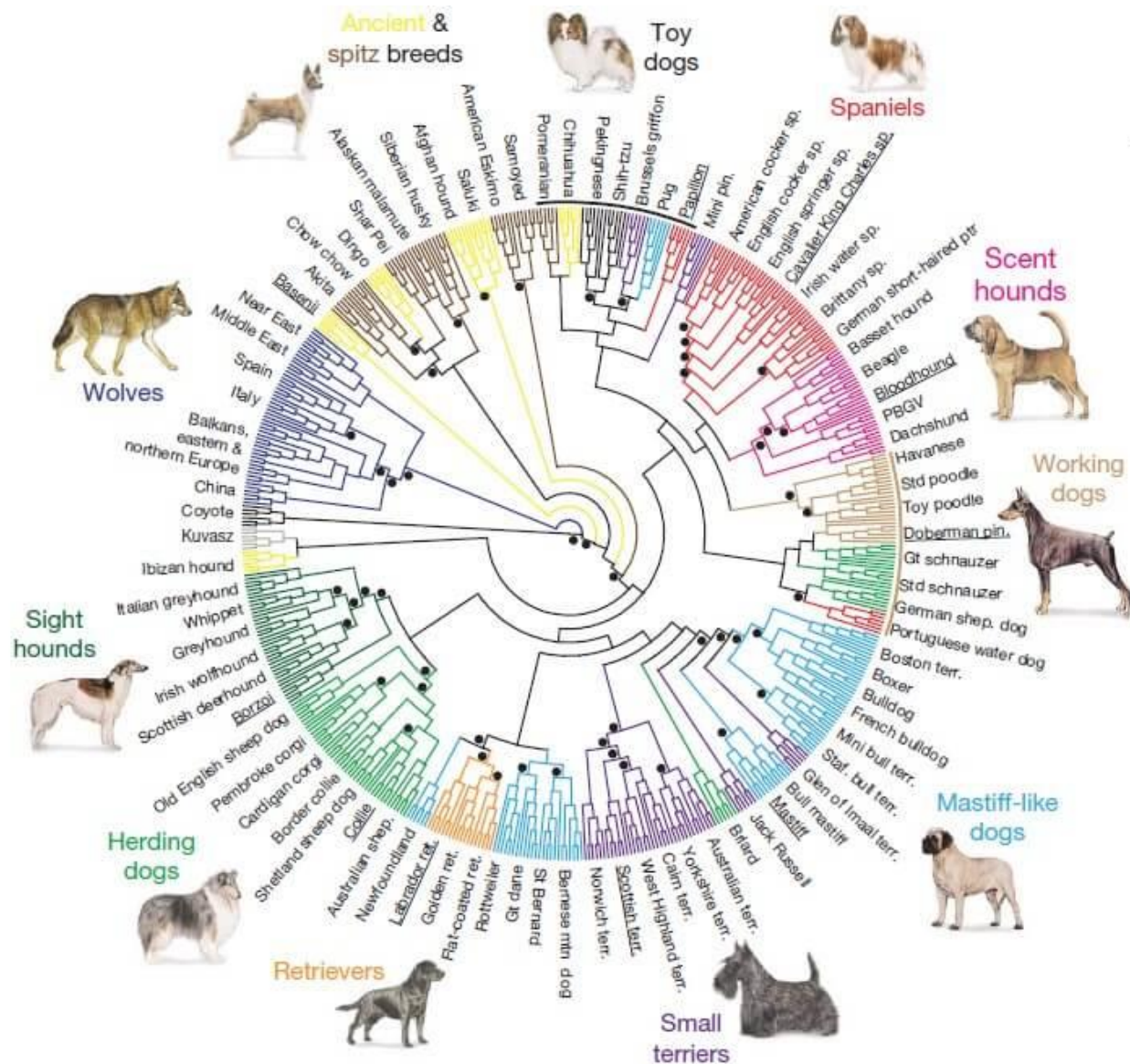


Project Overview

"Man's best friend"

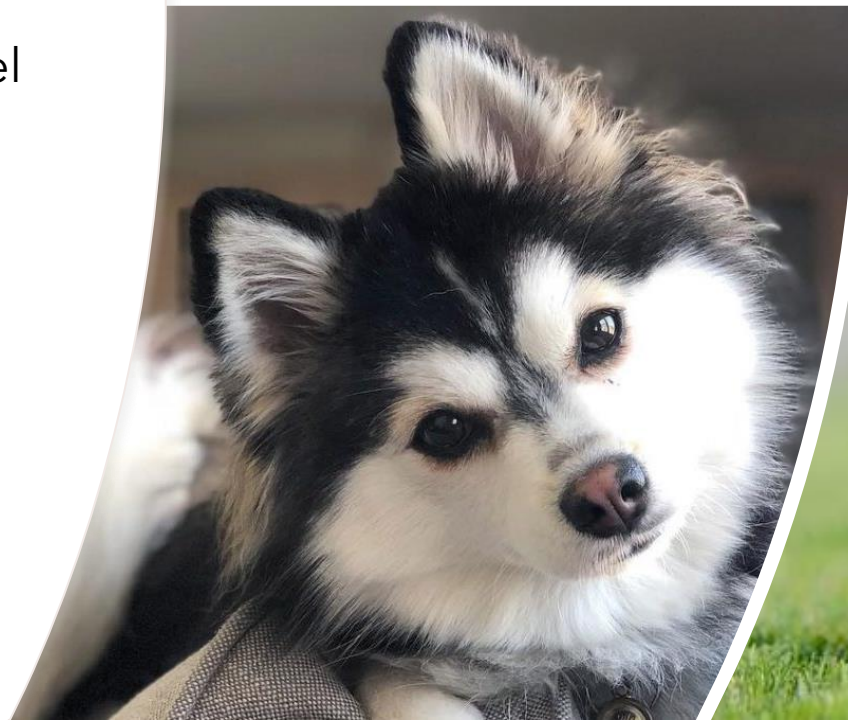
History of dog breeds

- 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

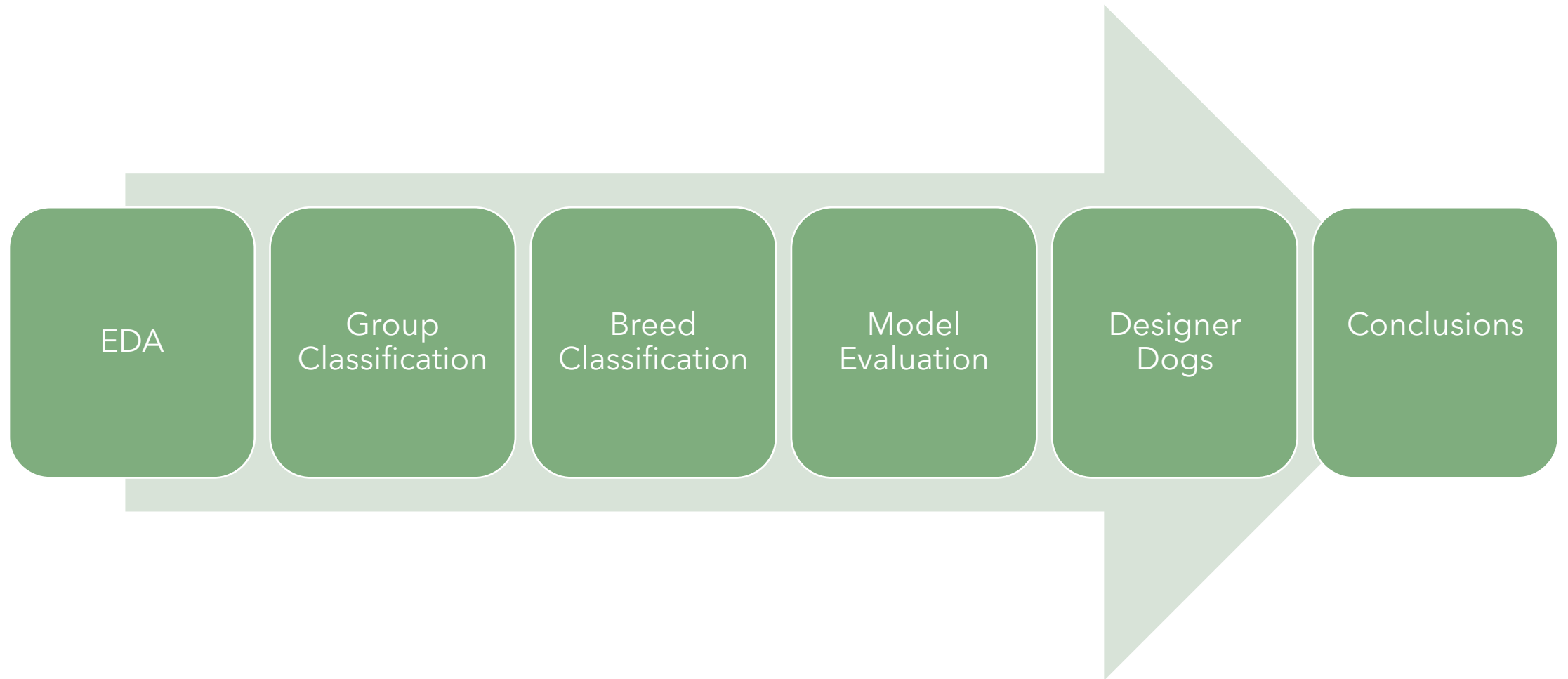
- Intentionally crossing dog pedigrees to create offspring with mixed appearance/characteristics
- Not recognized as “pure breeds” by kennel clubs.



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



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

Sample Training Images

Terriers



Pinscher/Schnauzers



Sample Training Images

Companion/Toy



Bull



Sample Training Images

Primal



Spitz/Nordic



Sample Training Images

Pastoral/Stock



Guardian/Pastoral/Mountain



Sample Training Images

Sighthounds



Scenthounds



Sample Training Images

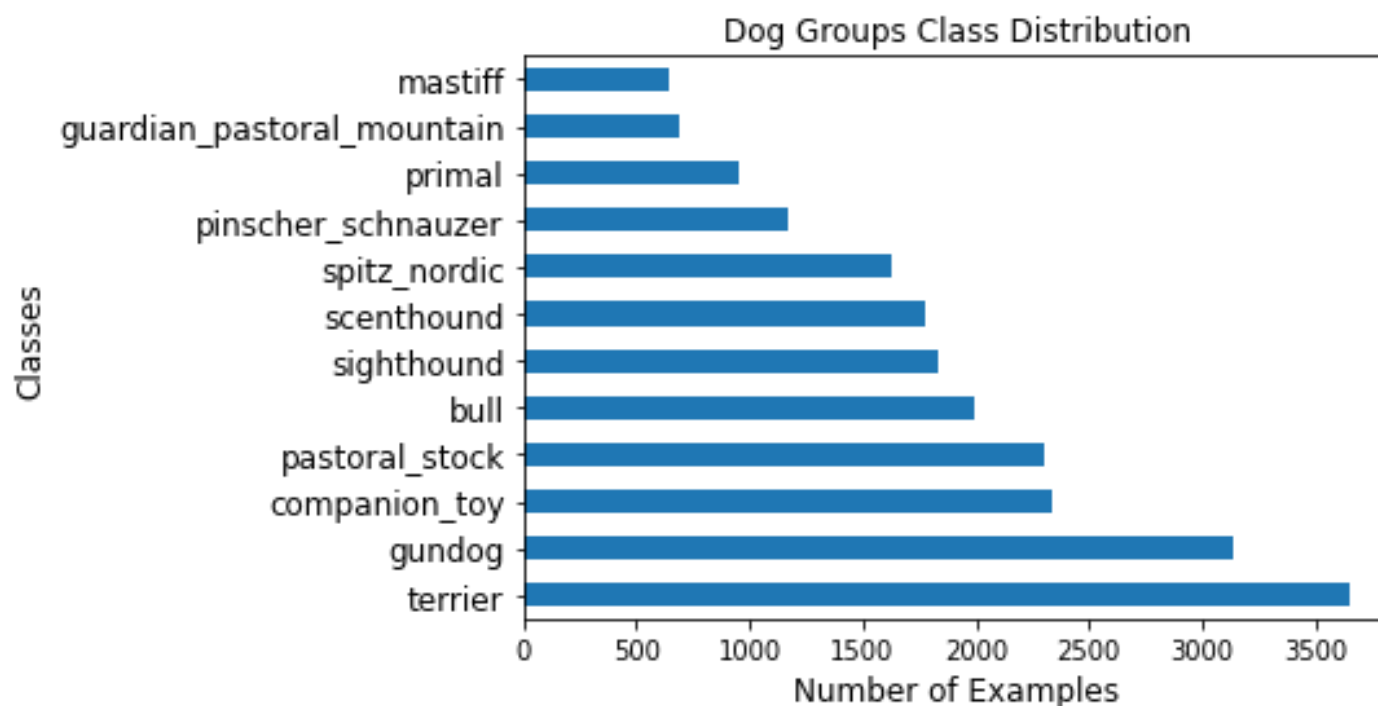
Mastiff



Gundog



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

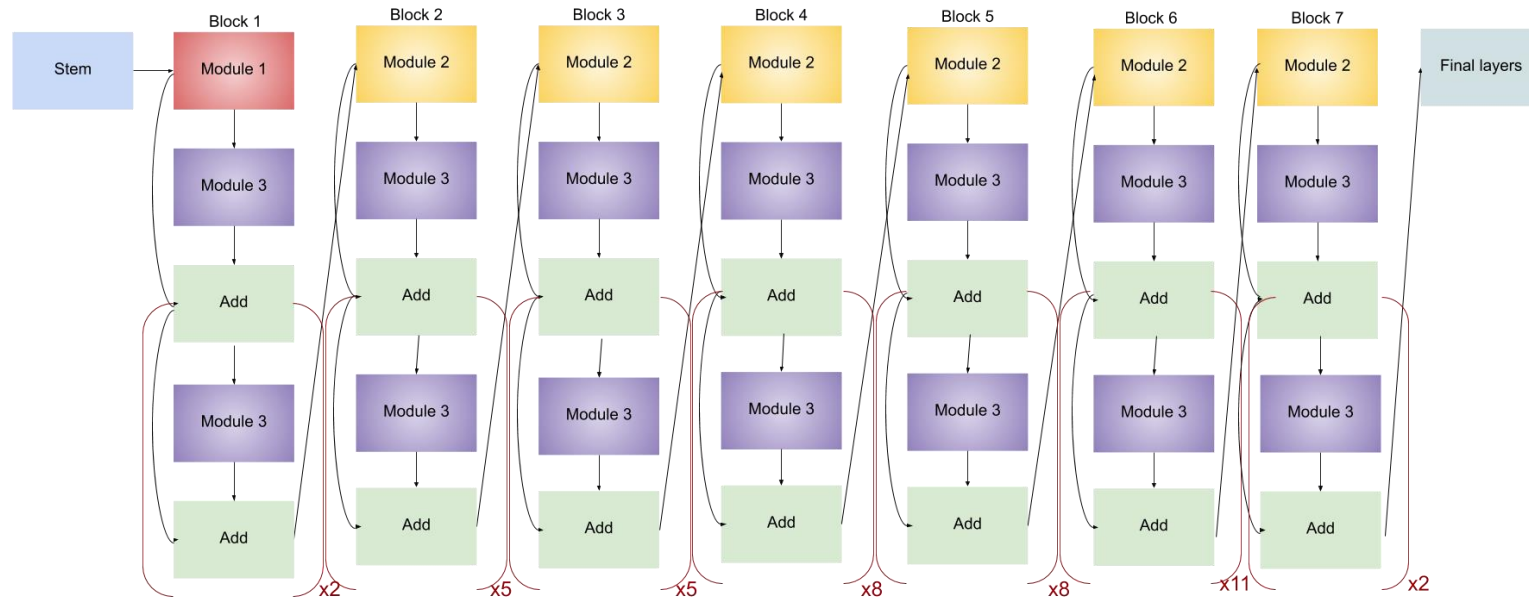
Group Classification

- 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

01

Unfreeze block 7
of base model

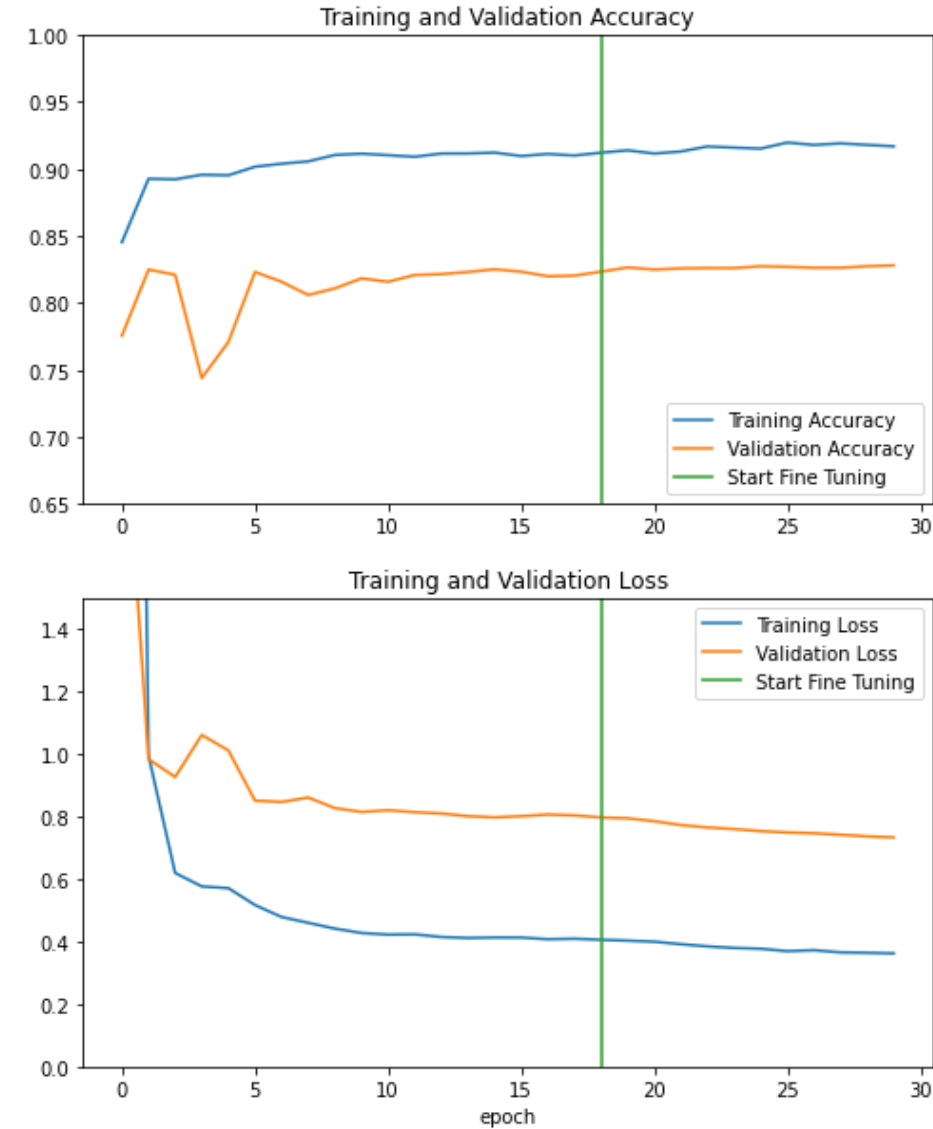
02

Keep batch
normalization
layers frozen

03

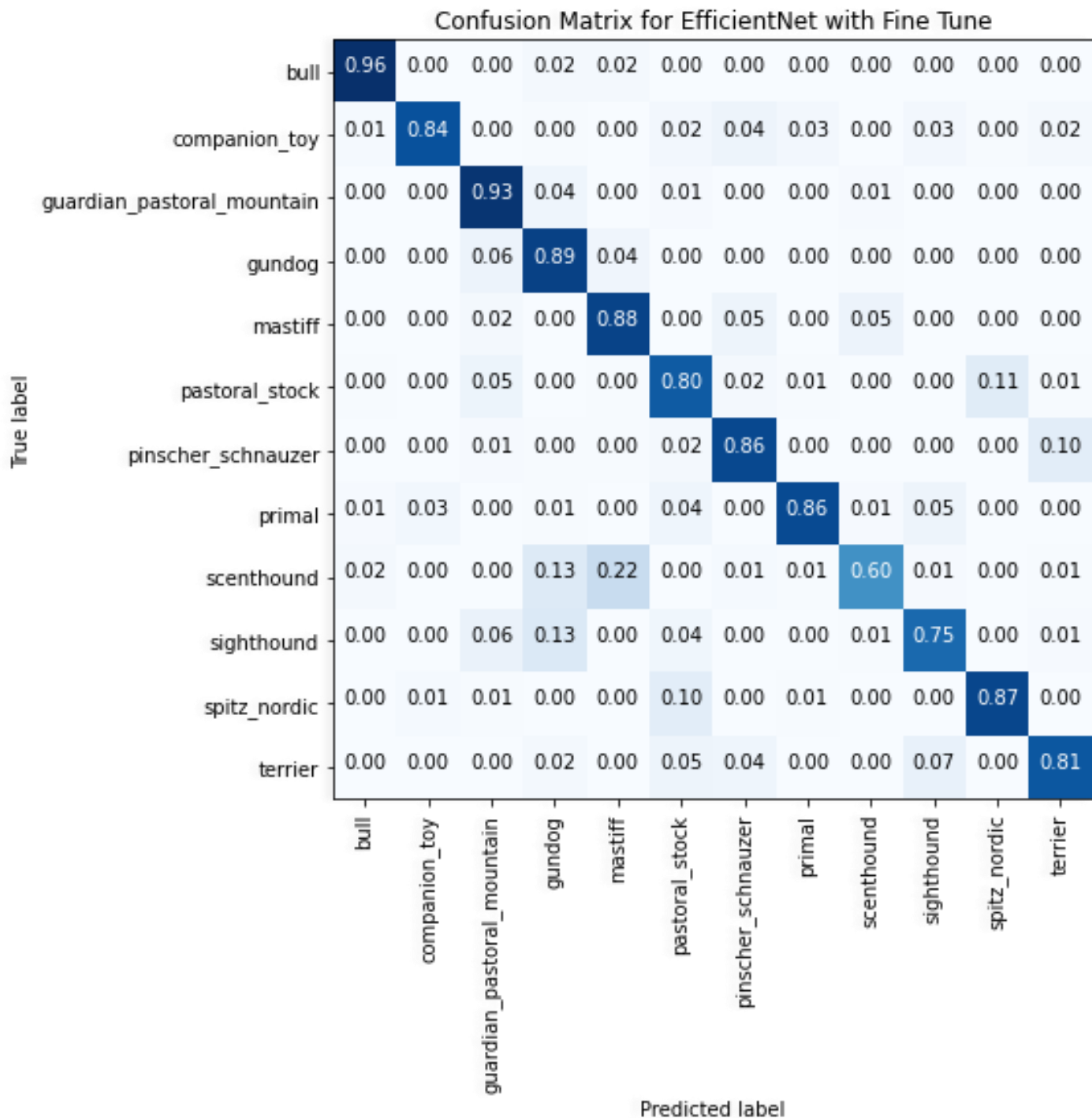
Reduce learning
rate by factor of
10 and retrain for
another 10
epochs

Group Classification - Evaluation



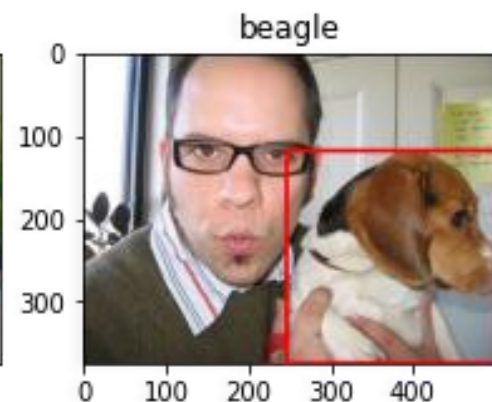
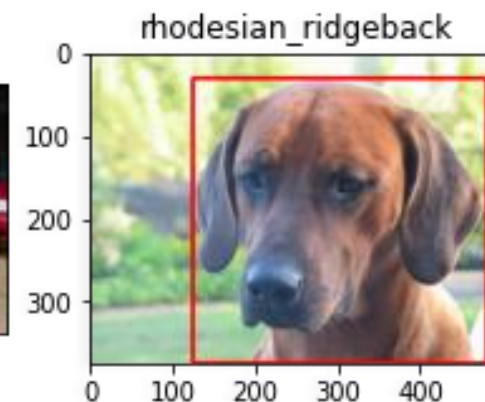
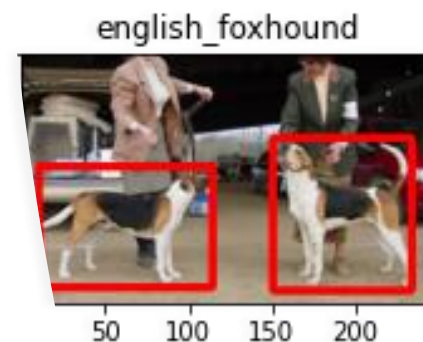
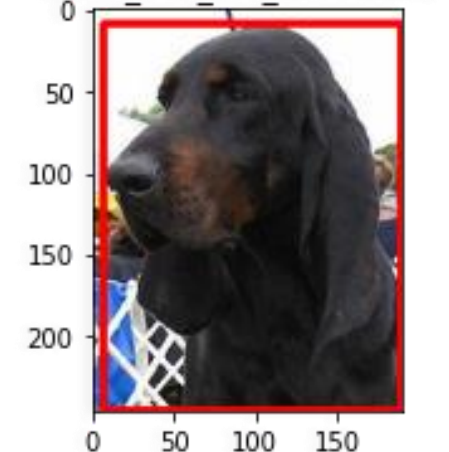
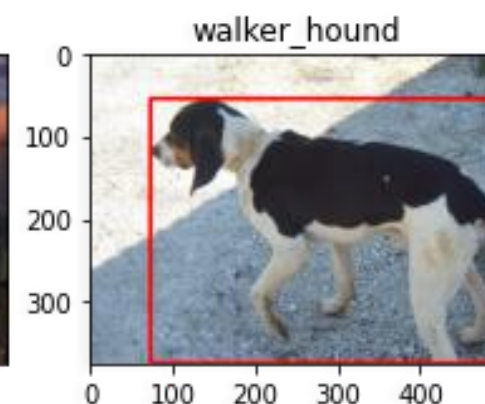
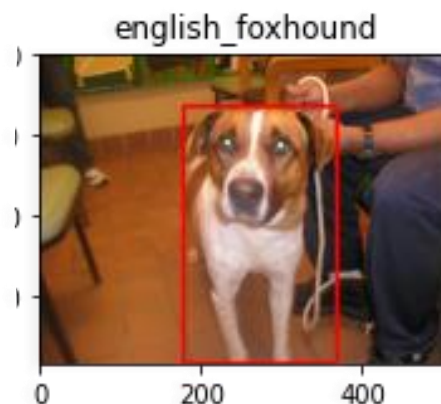
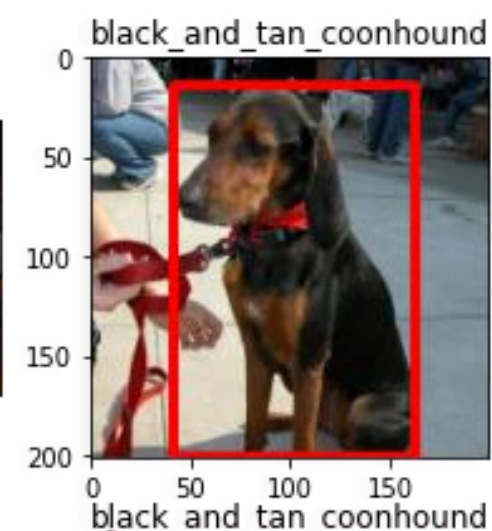
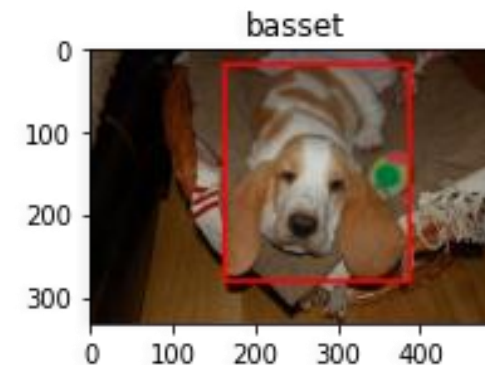
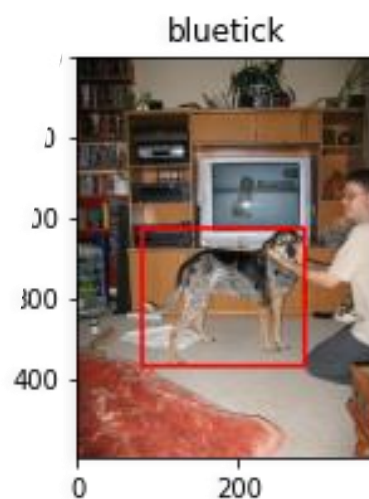
Group Classification - Evaluation

- Validation Accuracy: **82.5%**
- Top accuracies
 - Bull (96%)
 - Guardian/pastoral/mountain (93%)
 - Gundog (89%)
- Lowest accuracies
 - Scenthound (60%)
 - Sighthound (75%)

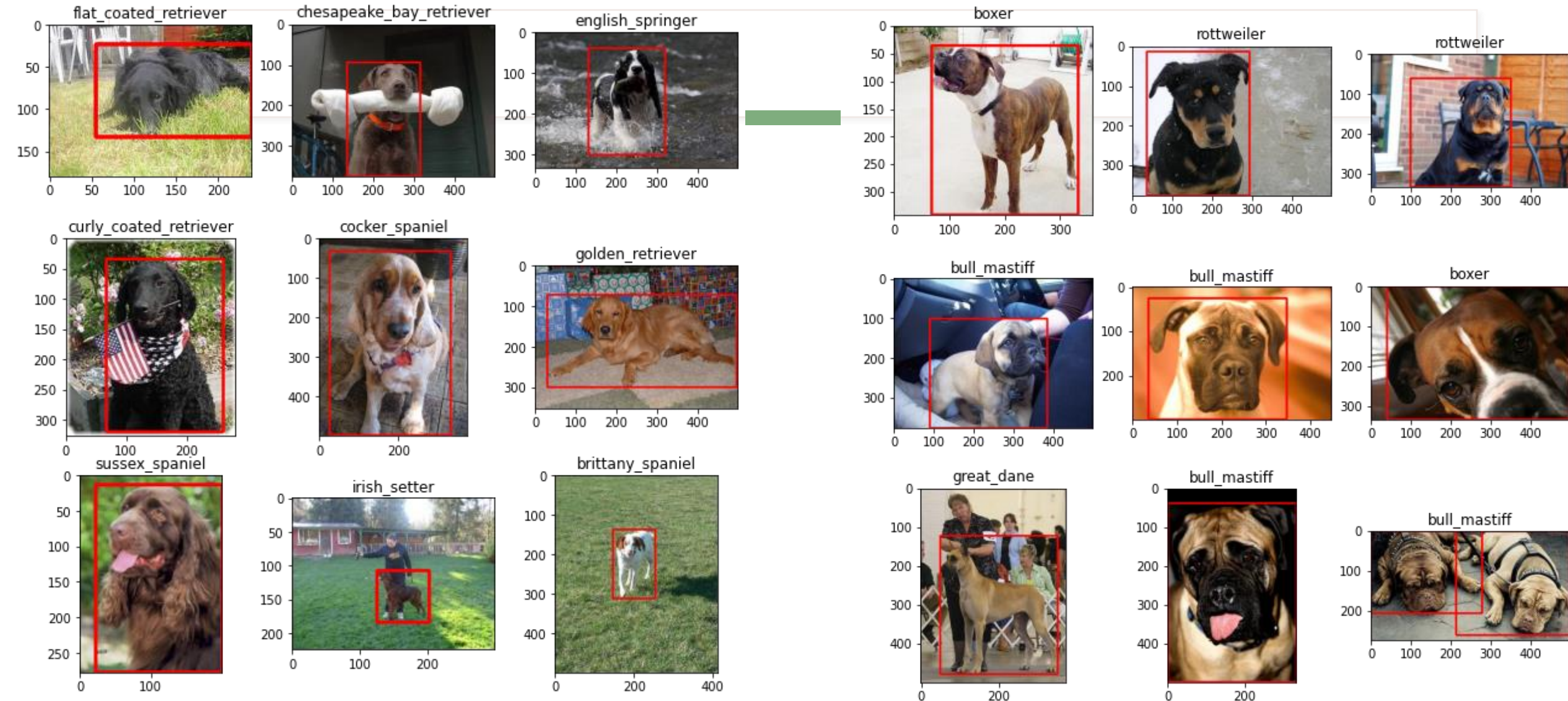


Group Classification - Misclassification Analysis

- 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

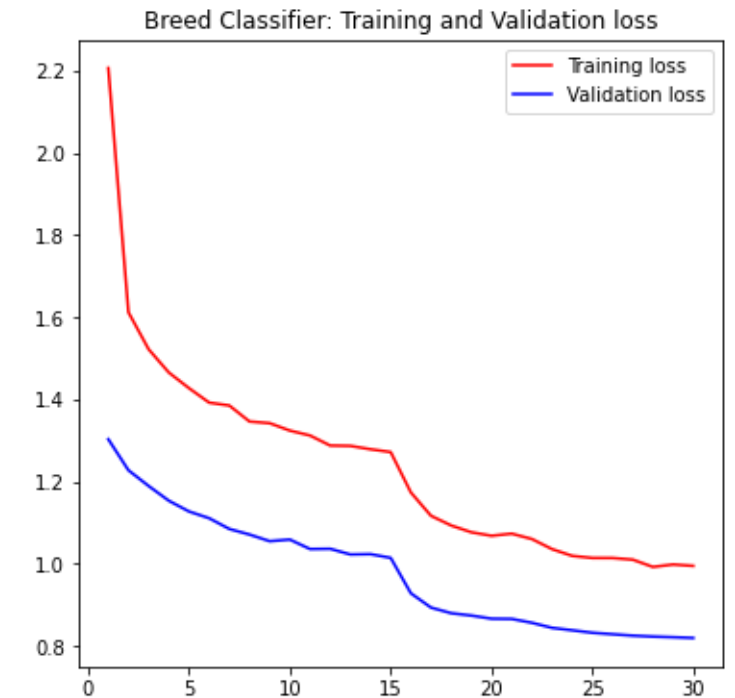
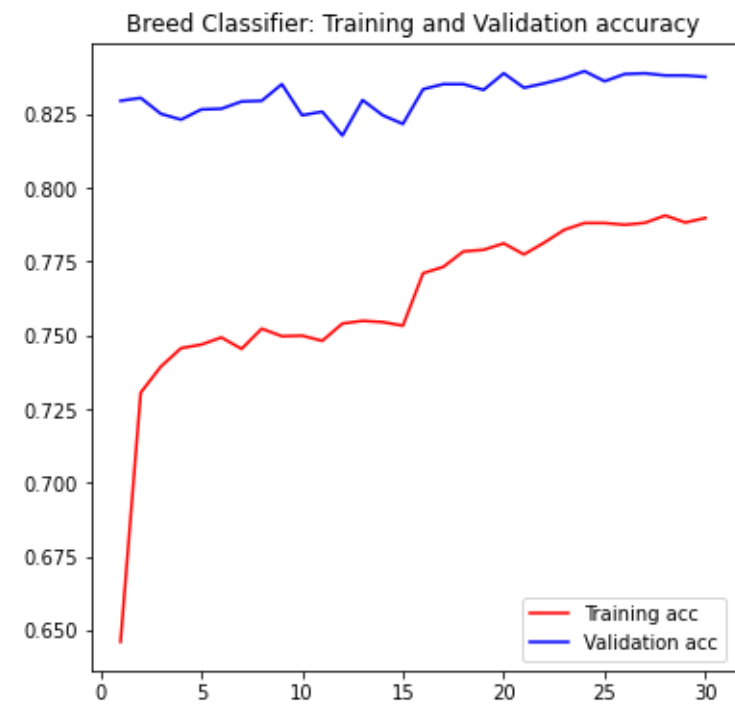
Replace
prediction layer
to output 120
instead of 12

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%

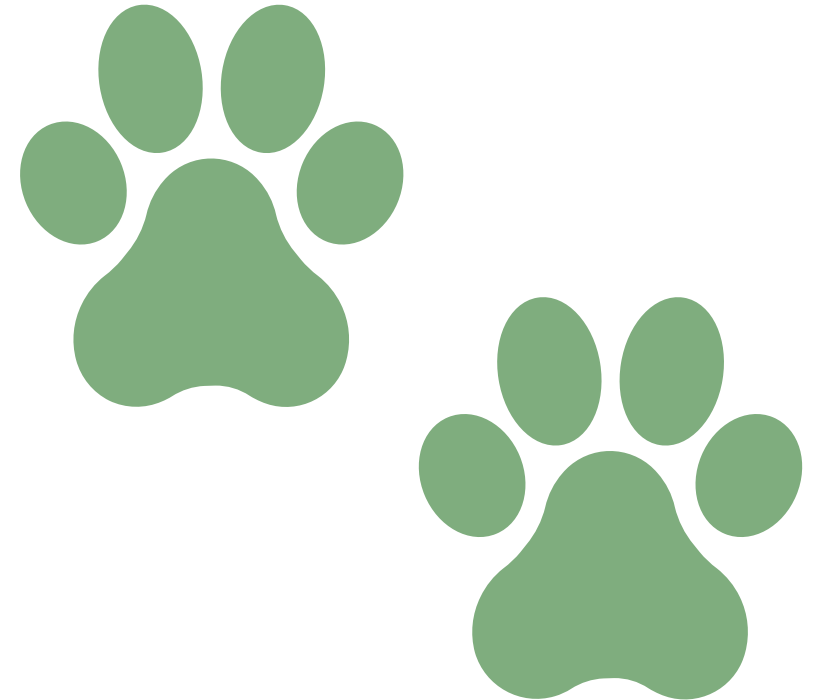


Chorkie = Chihuahua + Yorkshire Terrier

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

Conclusions

- Dog group classifier
 - Validation accuracy: 82.5%
- 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

