Animal Outcome Analysis

Austin Animal Center

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Introduction

Municipal Animal Shelter

- Located in the city of Austin, Texas
- Founded in 2011

Mission

- Improve animal welfare by:
  - Reuniting owners with lost pets
  - Fostering & adopting out animals into permanent homes
  - Providing a temporary home and medical care to lost or surrendered dogs and cats
  - Trap-Neuter-Return Program
  - Educating and providing resources to people to prevent animals from being surrendered

AUSTIN ANIMAL CENTER
ANIMAL SERVICES

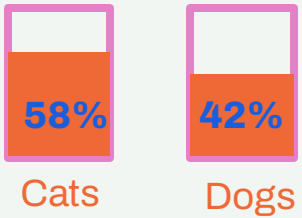
Motivation

6,300,000

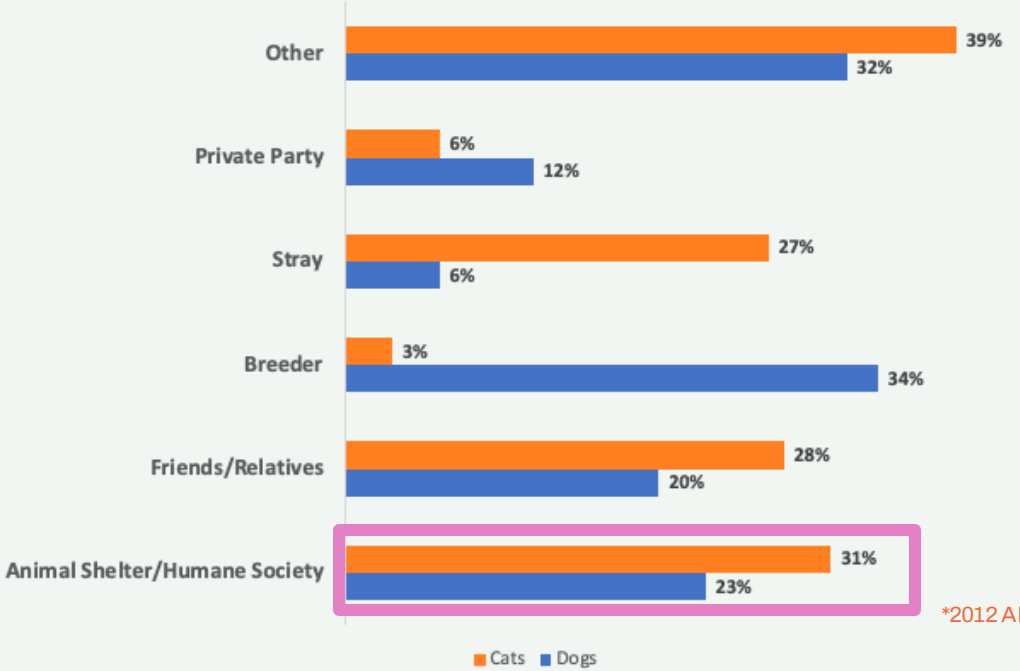
Animals surrendered each year to shelters in the U.S.

920,000

Animals euthanized



Most Common Ways Animals Obtained as Pets



*2012 APPA Study

- Most common way of adopting a dog or cat is *not* through a shelter

https://www.aspca.org/helping-people-pets/shelter-intake-and-surrender/pet-statistics

Potential Project Impact

Identify factors that influence the live release rate of cats and dogs

- Models can be used to predict the likelihood of a cat or dog being adopted, euthanized, etc. based on their color, breed, age, etc.

Analyze trends in the dataset

- Staff more members during popular adoption days
- Strategically place animals that are less likely to be adopted (based on breed, color, age, etc.) to more visible areas, put bigger signs next to cage, or feature them more on social media

Exploratory Data Analysis

Kaggle hosted a competition in 2016 with the goal of improving the outcomes (adopted, died, euthanized, returned to owner, transferred) for cats and dogs at the Austin Animal Center

* Data collected from October 2013-March 2016

Two data sets provided

Train Data

26,730 observations

Test Data

11,457 observations

Random 70/30 train test split

Pie chart of outcome type, live release rate

Exploratory Data Analysis

Snippet of Training Dataset

	A	B	C	D	E	F	G	H	I	J
1	**AnimalID**	**Name**	**DateTime**	**OutcomeType**	**OutcomeSubtype**	**AnimalType**	**SexuponOutcome**	**AgeuponOutcome**	**Breed**	**Color**
2	A671945	Hambone	2/12/14 18:22	Return_to_owner		Dog	Neutered Male	1 year	Shetland Sheepdog Mix	Brown/White
3	A656520	Emily	10/13/13 12:44	Euthanasia	Suffering	Cat	Spayed Female	1 year	Domestic Shorthair Mix	Cream Tabby
4	A686464	Pearce	1/31/15 12:28	Adoption	Foster	Dog	Neutered Male	2 years	Pit Bull Mix	Blue/White
5	A683430		7/11/14 19:09	Transfer	Partner	Cat	Intact Male	3 weeks	Domestic Shorthair Mix	Blue Cream
6	A667013		11/15/13 12:52	Transfer	Partner	Dog	Neutered Male	2 years	Lhasa Apso/Miniature Poodle	Tan
7	A677334	Elsa	4/25/14 13:04	Transfer	Partner	Dog	Intact Female	1 month	airn Terrier/Chihuahua Shortha	Black/Tan
8	A699218	Jimmy	3/28/15 13:11	Transfer	Partner	Cat	Intact Male	3 weeks	Domestic Shorthair Mix	Blue Tabby
9	A701489		4/30/15 17:02	Transfer	Partner	Cat	Unknown	3 weeks	Domestic Shorthair Mix	Brown Tabby
10	A671784	Lucy	2/4/14 17:17	Adoption		Dog	Spayed Female	5 months	American Pit Bull Terrier Mix	Red/White
11	A677747		5/3/14 7:48	Adoption	Offsite	Dog	Spayed Female	1 year	Cairn Terrier	White
12	A668402		12/5/13 15:50	Transfer	SCRP	Cat	Unknown	2 years	Domestic Shorthair Mix	Black
13	A666320		11/4/13 14:48	Adoption		Dog	Spayed Female	2 years	Miniature Schnauzer Mix	Silver
14	A684601	Rocket	2/3/16 11:27	Adoption	Foster	Dog	Neutered Male	4 years	Pit Bull Mix	Brown
15	A704702	Scooter	6/8/15 16:30	Return_to_owner		Dog	Neutered Male	2 years	Yorkshire Terrier Mix	Black/Red
16	A688584	Preston	11/25/15 15:00	Return_to_owner		Dog	Neutered Male	1 year	Great Pyrenees Mix	White/Cream
17	A678825	Oliver	7/12/14 12:10	Adoption	Foster	Cat	Neutered Male	3 months	Domestic Shorthair Mix	Orange Tabby/White
18	A678050		5/3/14 16:15	Transfer	Partner	Cat	Intact Male	3 weeks	Domestic Shorthair Mix	Brown Tabby
19	A680028		6/7/14 12:54	Transfer	Partner	Dog	Intact Female	2 weeks	Pit Bull Mix	Brown/White
20	A679010	Chrissy	5/17/14 11:32	Transfer	Partner	Cat	Intact Female	2 years	Angora Mix	White

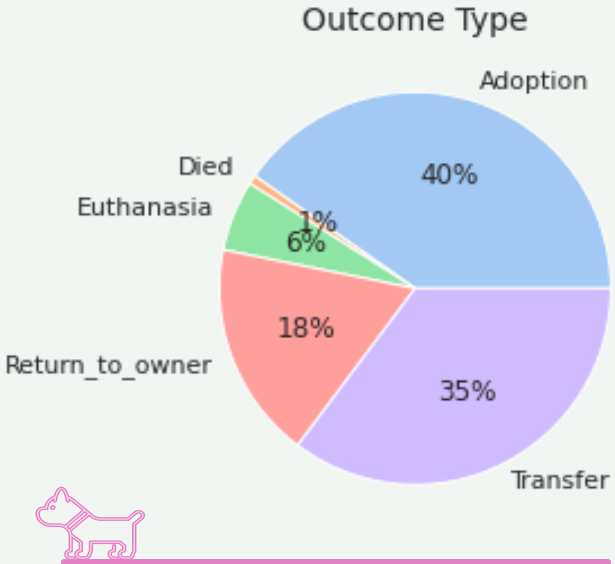
Exploratory Data Analysis

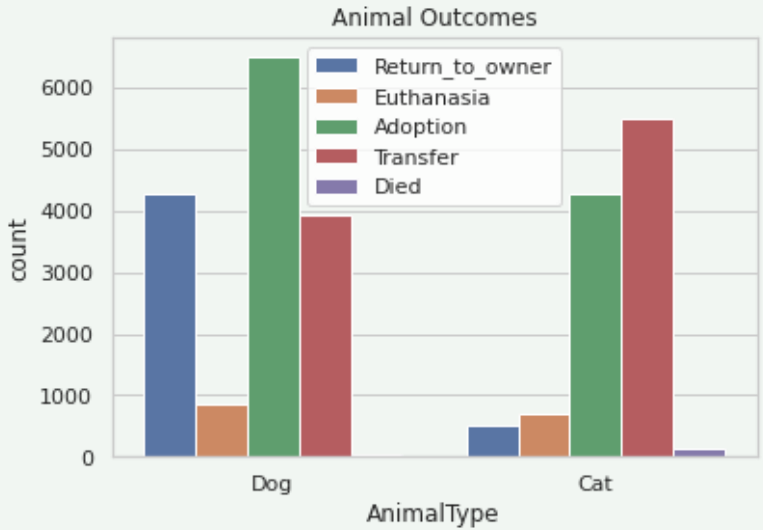
Variable	Variable Description
Animal ID	Unique animal identifier
Animal Name	Name of animal
Date Time	Date and time animal left shelter
Outcome Type	Adoption, death, euthanasia, return to owner, or transfer
Outcome Sub Type	Adopted through foster, partner transfer, etc.
Animal Type	Either cat or dog
Sex Upon Outcome	Neutered male, spayed female, intact male or female
Age Upon Outcome	Age upon outcome
Breed	Animal breed
Color	Animal color

Y var. →

Exploratory Data Analysis

Train Data

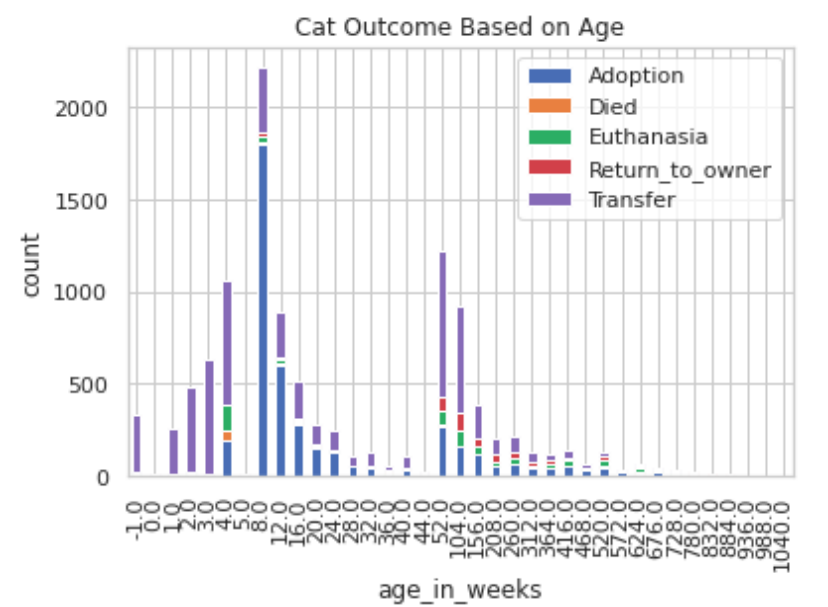


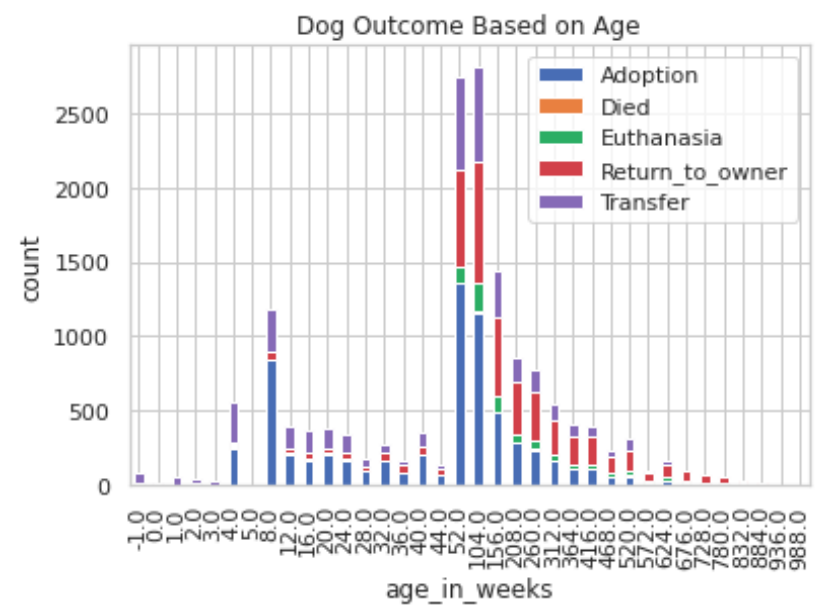


93.4% Live Release Rate

Exploratory Data Analysis

Train Data



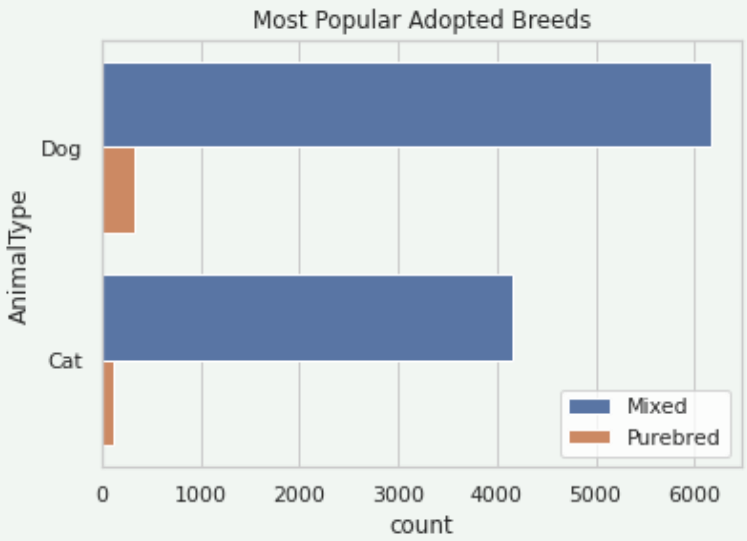


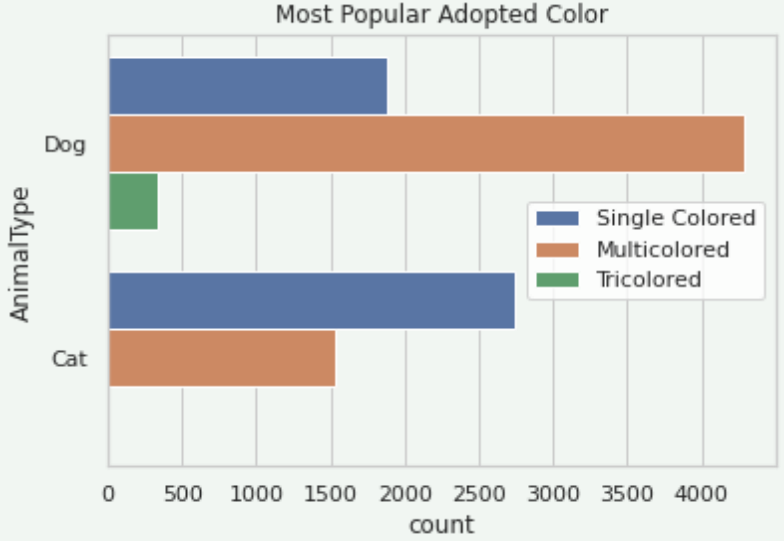
- Kittens (ages 8-24 weeks) more likely to be adopted
- Newborns (days – 4 weeks) more likely to be transferred
- Older animals less likely to be adopted

- Dogs (ages 8-156 weeks) more likely to be adopted
- Dogs 52 weeks and older have a higher chance of returning to owner

Exploratory Data Analysis

Train Data



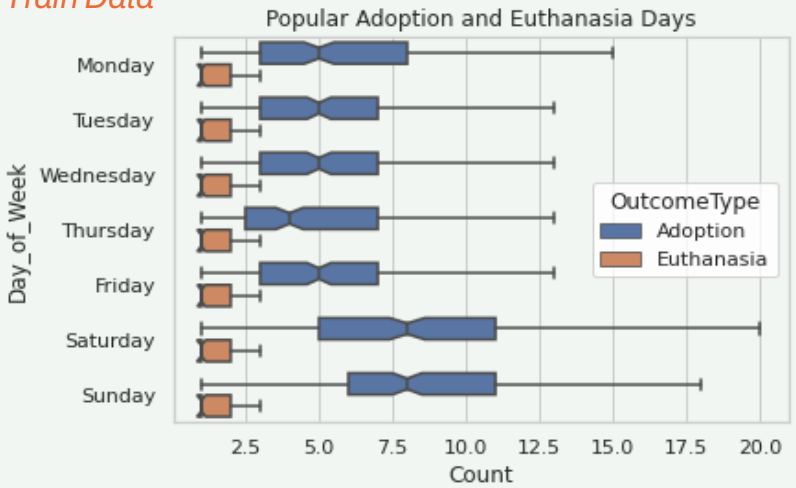


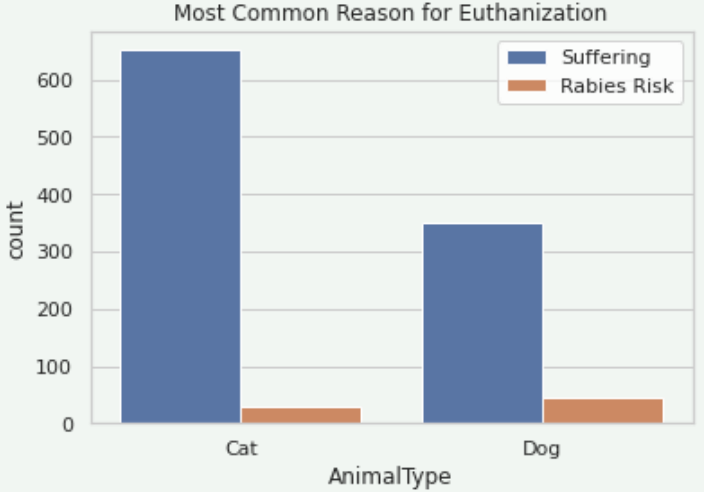
- Mixed dogs and cats more likely to be adopted, but may be a result of not many purebreds coming into shelters

- Multi-colored dogs get more adopted
- Single colored cats get more adopted

Exploratory Data Analysis

Train Data



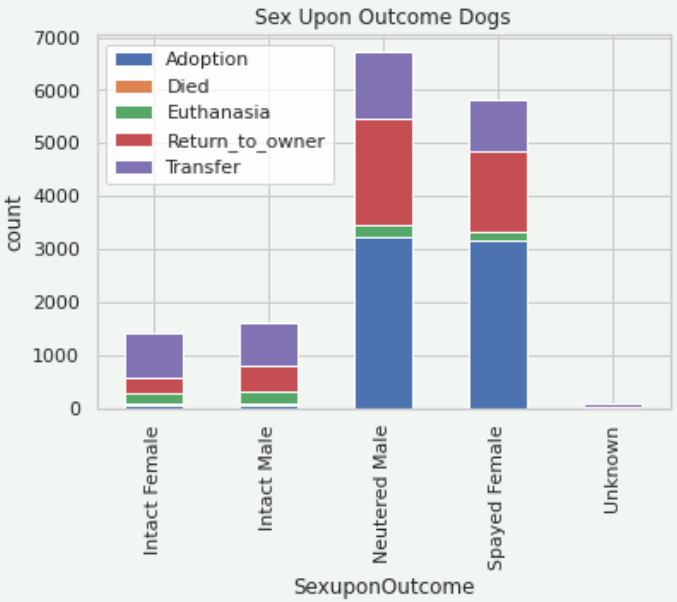


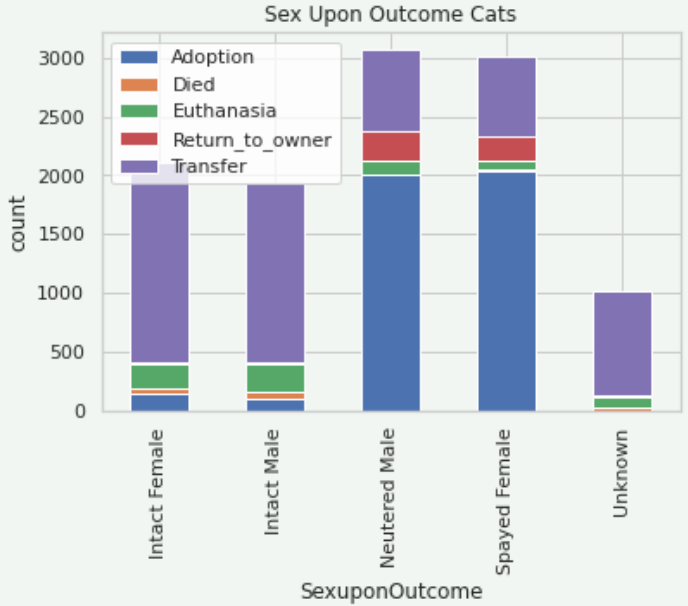
- Notches represent a 95% confidence interval around the median
- Adoption: There is some overlap, *but* some days do not overlap. In this case, we reject the null hypothesis and conclude that there is a relationship with day of week and adoption counts
- Saturday & Sunday popular days to adopt
- Euthanasia: There does not seem to be a relationship with euthanasia and day of week

- Suffering is one of the main reasons animals are put down
- Cats seem to display higher suffering counts than dogs

Exploratory Data Analysis

Train Data





- Neutered and spayed dogs have a higher chance of being adopted or returned to owner

- Cats that are not fixed are more likely transferred
- Neutered and spayed cats more likely to be adopted

Data Cleaning

Breed
Shetland Sheepdog Mix
Beagle
Lhasa Apso/Miniature Poodle
Cairn Terrier/Chihuahua Shorthair
Cairn Terrier

Breed_type
Mix
Purebred
Mix
Mix
Purebred

SexuponOutcome
Neutered Male
Spayed Female
Intact Male

Is_male
True
False
True

Is_neutered
True
True
False

Color
Tan
Orange Tabby/White
Tricolor

Color_num
1
2
3

AgeuponOutcome
1 year
3 weeks
4 months

Age_in_weeks
52
3
12

Predictive Task

Can we use an animal's features to predict the outcome?

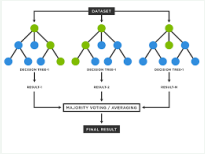
- Possible Outcomes:
  Adoption, Died, Euthanasia,
  Return to Owner, or Transfer (to a different facility or partner organization)

- A multi-class classification problem

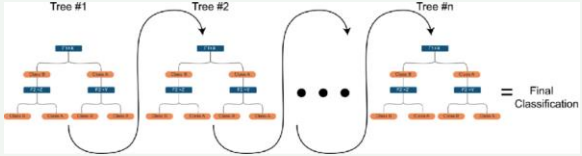
- Imbalanced data set

Select Predictive Models

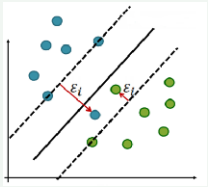
Random Forest for Classification: this model creates an ensemble of decision trees that is used in classification tasks



eXtreme Gradient Boosting (XGBoost): a version of gradient boosting that utilizes clever penalization of trees and proportional shrinking of leaf nodes to enhance its predictive capacity over standard boosting methods

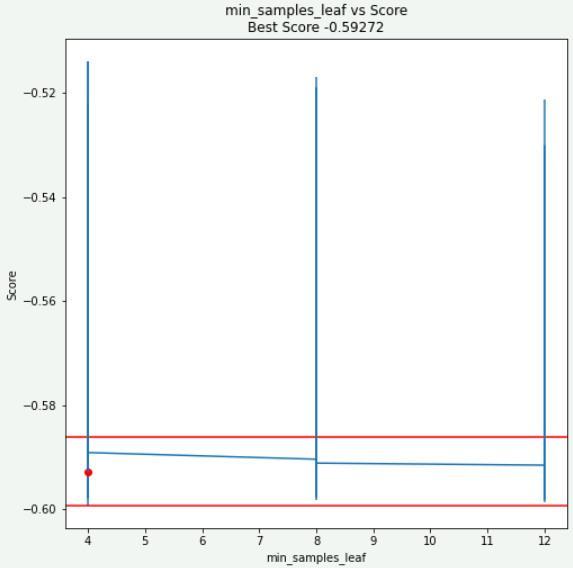


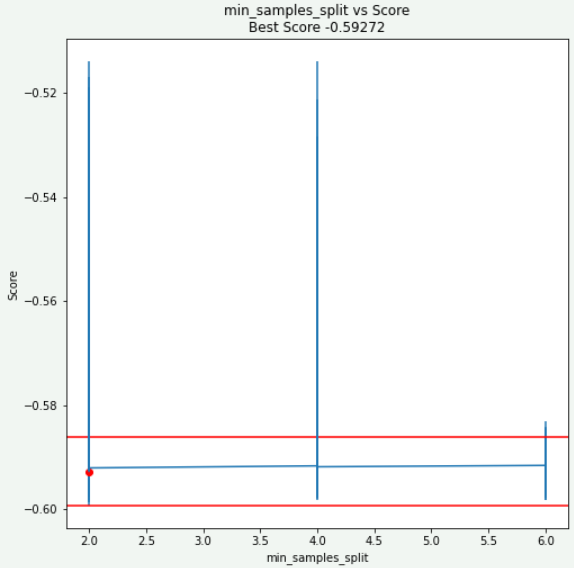
Linear SVC: a support vector machine (SVM) designed for multi-class classification tasks. This model works be drawing a linear decision boundary in multi-dimensional space

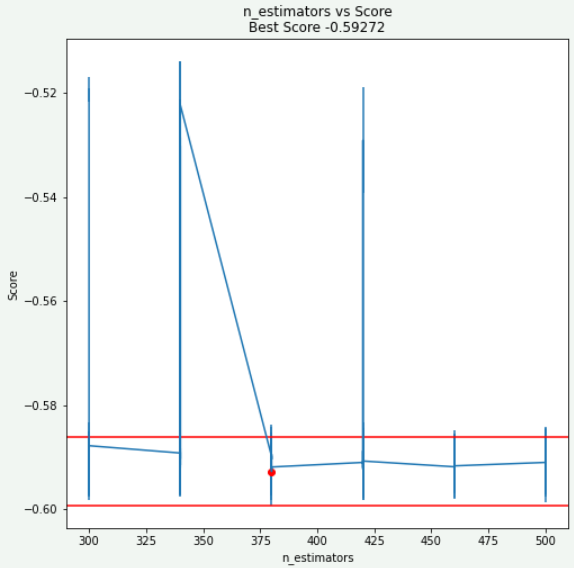


Random Forest: Grid Search Results

The following are the scores corresponding with the param values from the grid search cross validation of the Random Forest model. The optimal param value indicated with the red dot.

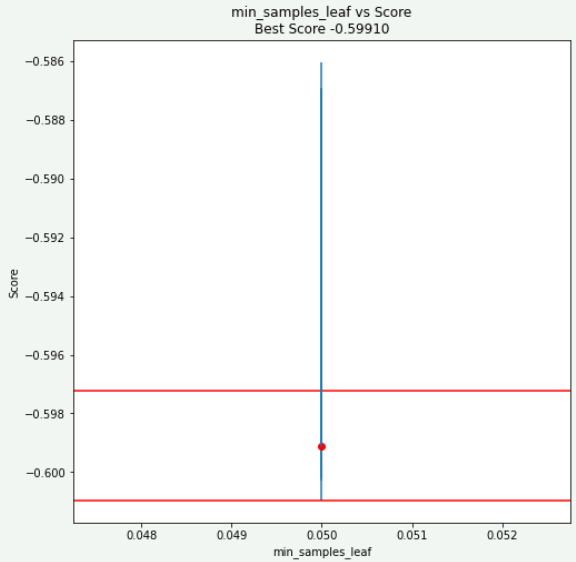


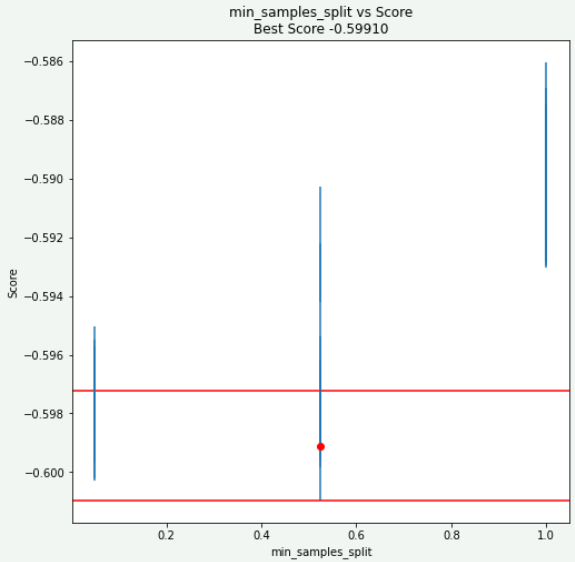


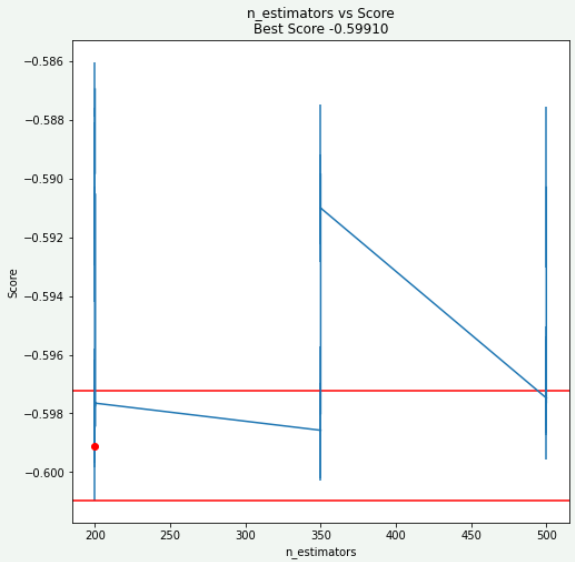


XGBoosting: Grid Search Results

The following are the scores corresponding with the param values from the grid search cross validation of the XGBoosting model. The optimal param value indicated with the red dot.

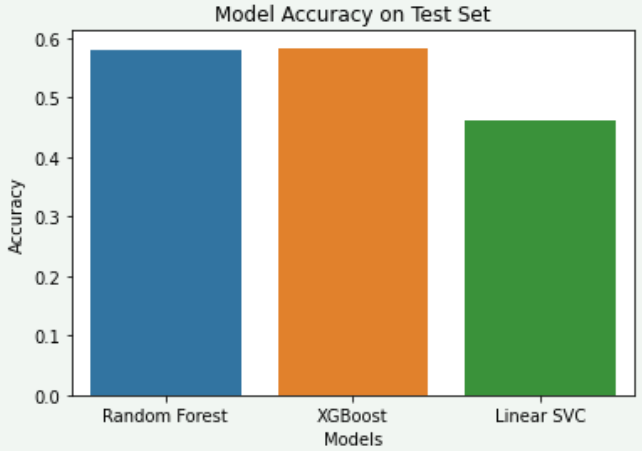






Test Set Performance

- **XGBoost** was the **top-performing** model, with an Accuracy score of 0.584
- Best-tuned XGBoost & Random Forest had similar levels of performance (acc. 0.584 vs 0.580)
- XGBoost & Random Forest models showed enhanced performance over Linear SVC Model



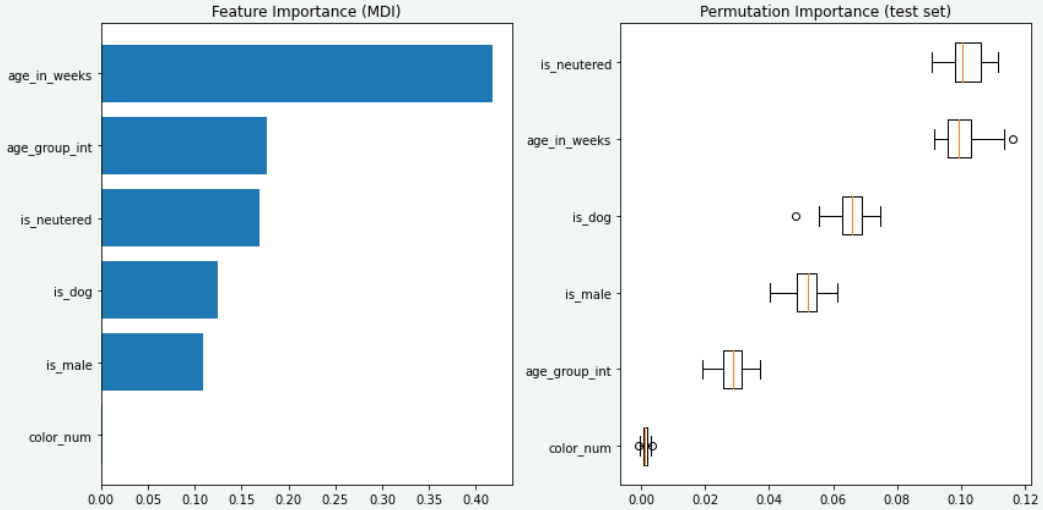
Feature Importance

Our Model indicates the importance of age in predicting outcomes

- Age in weeks & Age Group are the top-2 features (as measured by MDI). Together, they account for 42% & 18% of the decrease in node impurity

Retrained Model Relies on *Is Neutered* & *Age in Weeks*

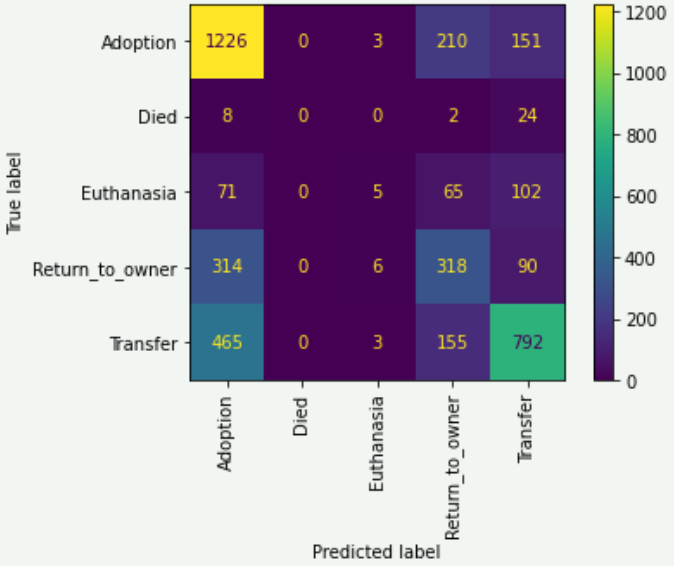
- Top-2 features when model is repeatedly re-trained on the test set
- Approx. 0.11 permutation importance each. Suggests the model does poorly when either feature is dropped from the model.



Feature Importance (left) & Permutation Importance (right). Feature Importance is measured via Mean Increase in Impurity (MDI). Permutation Importance is generated by repeated sampling of the test set over n = 50 iterations.

Observations from the Confusion Matrix

- The final model was good at predicting adoption & transfer outcomes
- Poor performance predicting Died, Euthanasia, & Return to Owner
- Adoption was most often misclassified as Transfer or Return to Owner
- Died was misclassified as Transfer or Adoption



Confusion Matrix of Actual vs Predicted Classes over the Test set

Conclusion

- Ensemble models performed better
- XGBoost was the top-performing predictive model. It relied heavily on age and neutered status of the animal to achieve 58% accuracy on the classification task
- Based on the EDA, younger aged, neutered, and mixed animals have higher adoption counts
- Popular days of the week to adopt an animal is on a Saturday or Sunday