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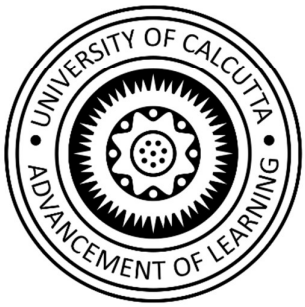


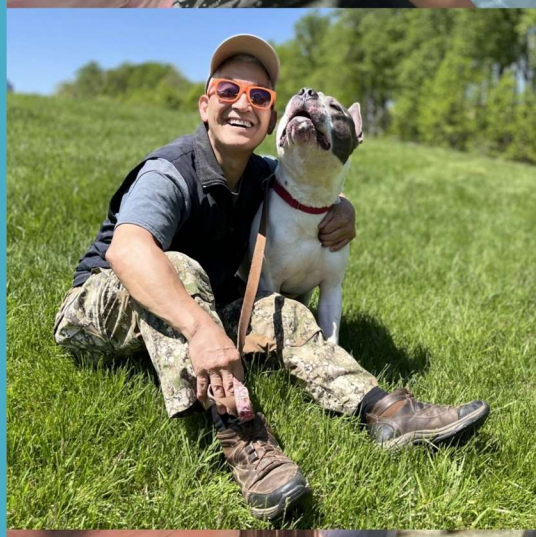
Final Semester Project - 2024

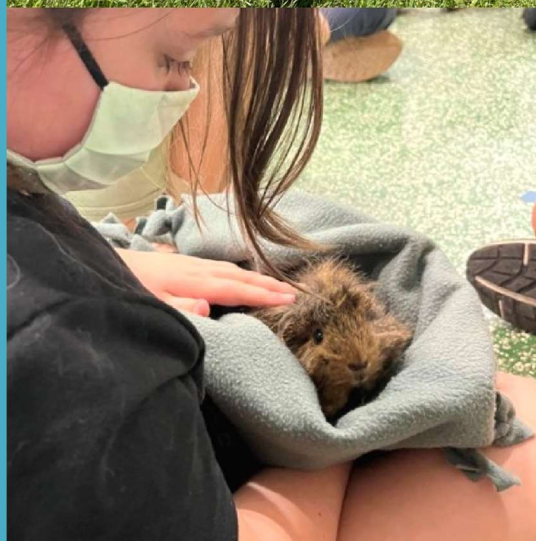
College code-544

Semester:	**VI**
Stream:	**B.Sc.**
Category:	**HONS**
Subject:	**STSA**
Paper:	**DSE-B2**
Topic:	**Austin Animal Shelter Intakes & Outcomes Analysis**
C.U. Registration Number:	**544-1111-0428-21**
C.U. Roll Number:	**213544-21-0075**
Date of Examination:	**29.07.24**

Austin

Animal Shelter Intakes & Outcomes Analysis





Project Verification Form

Title of the Project	Analysis of Austin Animal Shelter Intakes & Outcomes
Commencement Date	27.03.24
Completion Date	26.07.24
Project Supervisor	Mr. Nilkanta Mukherjee, Dr. Junaid Khan, Ms. Suptapa Biswas, Ms. Riddhi Das Majumder.
Organization/Institution where the Project was accomplished	Vivekanda College Thakurpukur, 269, Diamond Harbour Road, Thakurpukur Kolkata – 700063

Project Description

This project delves into the comprehensive analysis of animal intake and outcome trends at the Austin Animal Shelter, spanning from 2013 to 2024. The goal of this analysis is to understand patterns and factors influencing the shelter's operations, particularly focusing on adoptions and euthanasia of dogs and cats.

Key Analyses and Findings:

1. **Animal Intake Trends (2013-2024):**
   - Examined the yearly and seasonal trends in animal intakes over the specified period.
   - Identified patterns such as peak intake periods and fluctuations in different animal types.
2. **Adoption Analysis Using Logistic Regression:**
   - Performed logistic regression to analyze the likelihood of adoption for dogs and cats.
   - Identified significant predictors of adoption success, including animal characteristics and shelter practices.
3. **Euthanasia Analysis Using Logistic Regression:**
   - Utilized logistic regression to study factors associated with the euthanasia of dogs and cats.
   - Determined key variables that contribute to the likelihood of euthanasia, helping to pinpoint areas for potential intervention.
4. **Chi-Square Tests of Association:**
   - Conducted chi-square tests to explore the association between animal type (dog, cat) and adoption outcomes.
   - Assessed the statistical significance of these associations to understand if certain animal types have higher adoption rates.

Conclusion:

This project provides a detailed statistical analysis of the operations at the Austin Animal Shelter, with a focus on improving animal outcomes. The findings can help inform policy decisions, enhance adoption strategies, and ultimately contribute to better management of the shelter's animal population.

Submitted by: -	**Project Supervisor Details: -**
Name: Reevu Thapa	Name: Mr. Nilkanta Mukherjee, Dr. Junaid Khan, Ms. Suptapa Biswas, Ms. Riddhi Das Majumder.
Roll No: 213544-21-0075	Designation: Department Teachers
Registration No: 544-1111-0428-21	

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ABSTRACT

Animal adoption is a critical component of animal welfare efforts, providing homes for countless animals while alleviating the burden on shelters and rescue organizations. Animal shelters and rescue organizations hold the responsibility for catering to the needs of the animals that are abandoned or given up by their owners. However, despite widespread awareness campaigns and advocacy efforts, adoption rates vary significantly across different regions and demographics. Understanding the factors influencing adoption can enhance targeted interventions to increase adoption rates and improve outcomes for animals in need.

This study employs statistical analysis techniques to explore the dynamics of animal adoption, using a comprehensive dataset from animal adoption centers in Austin, Texas between years 2013 and 2024 encompassing animal type & breed, animal age, adoption records and socio-economic indicators.
Through Logistic regression analysis and data visualization, the study identifies key factors influencing adoption rates, including age, breed and behavioral traits of animals.

The findings reveal patterns in adoption trends, highlighting the influence of individual animal characteristics. For instance, certain breeds may experience higher adoption rates, while older animals and those with specific behavioral issues may face challenges in finding homes. Also, the data set enable us to make conclusions about why certain animals are euthanized.

By explaining these patterns, this study provides valuable insights for animal welfare organizations, policymakers, and advocates seeking to optimize adoption strategies and address barriers to adoption. Targeted interventions, such as promotional campaigns tailored to specific demographics or behavioral training programs for shelter animals, can be developed to enhance adoption outcomes and promote responsible pet ownership.

INTRODUCTION

Animal adoption has seen a solid trend in the society for decades. We have come very far with the way we manage abandoned animals and strays to rehabilitate them. While organizations like the Blue Cross of India (BCI) have operated since the year 1959, with the advancement of technology, we now have the system of online pet adoption where databases of pets taken in by numerous rescue groups and animal shelters are maintained and are openly available for access and utilization by the public. Further, a lot of innovative work has being going into the field of animal welfare.

A good example of this is BCI receiving the Proggy Award from PETA for its interactive computer programs which serve as an alternate to animal dissection. An important parameter to discuss when we talk about animal welfare is the question of how people deal with unwanted pets. Euthanasia is a controversial option with an open debate on whether putting an animal down is humane in comparison to having it caged and imprisoned for long periods of time. Some people euthanize pets because of fatal and irrecoverable injuries or illnesses. Others do so even for treatable health problems that they either are unable to financially provide for or are not willing to. Without doubt, many veterinarians consider euthanasia to be a completely unethical procedure. Some other people let go of their pets, into the wild perhaps, or abandon them with the hope that they will be able to care for themselves or that someone will find or adopt them. In reality, most of these pets that are released by their owners perish to harsh weather, hunger, traffic or easily treatable health issues. In addition to this, homes cannot be always found in adoption centers and unless the center has a no-kill policy, excess animals are also euthanized to make room for new pets. It was estimated by The Humane Society of the US, that every year, 2.4 million adoptable, healthy dogs and cats are euthanized in the United States of America because of unavailability of homes.

Objectives:

- Animal intake trend analysis
- Animal adoption analysis Using Logistic Regression
- Euthanasia analysis using Logistic Regression
- Analysis of association between animal type (dog, cat) and adoption outcomes.

Analysis of Intake Types in Austin Animal Shelter (2013 – 2024)

Understanding the distribution of animal intake types in shelters is crucial for developing effective management strategies and improving animal welfare. This analysis categorizes shelter intakes into six primary types: "Stray," "Owner Surrender," "Public Assist," "Abandoned," "Euthanasia Request," and "Wildlife." Each category represents distinct pathways through which animals enter shelters, and each has unique implications for shelter operations and resource allocation.

- **Stray:** These are animals found without an apparent owner, often roaming the streets or public spaces. Stray animals are typically brought to shelters by animal control officers or concerned citizens.
- **Owner Surrender:** These are pets relinquished by their owners for various reasons, such as behavioral issues, financial constraints, or changes in living situations. Owner surrenders can be planned or occur in emergencies.
- **Public Assist:** This category includes animals brought to shelters by the public for reasons other than straying or surrender, such as found pets that the public cannot keep temporarily or animals needing immediate medical attention.
- **Abandoned:** These are animals left in public places or at shelter premises without any information or intention to reclaim them. Abandonment often reflects severe owner neglect or inability to care for the pet.
- **Euthanasia Request:** Some animals are brought to shelters by their owners specifically for euthanasia due to severe illness, old age, or behavioral issues that the owners cannot manage.
- **Wildlife:** Shelters sometimes receive wildlife, which may be injured, orphaned, or displaced. Handling wildlife intake requires specialized care and coordination with wildlife rehabilitation centers.

Distribution of Animal Intake Types in the Shelter

Intake Type	No. of Intakes
Abandoned	1505
Euthanasia Request	260
Owner Surrender	33267
Public Assist	9611
Stray	110168
Wildlife	6119
Grand Total	**160930**

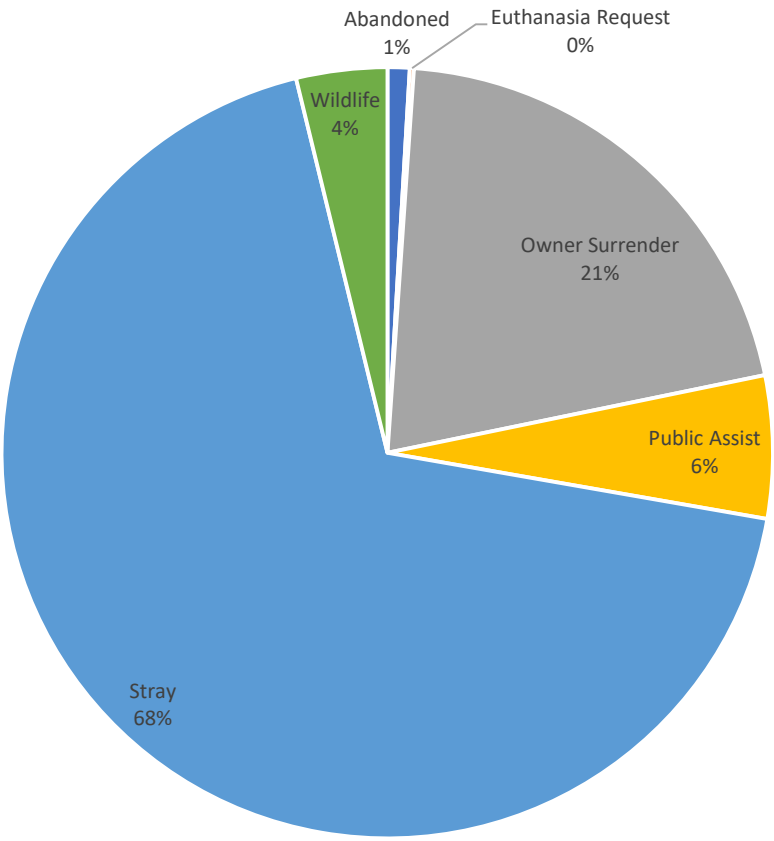


Fig.1 Distribution of Intake Type

The distribution of animal intake types in the analyzed shelter reveals several key insights:

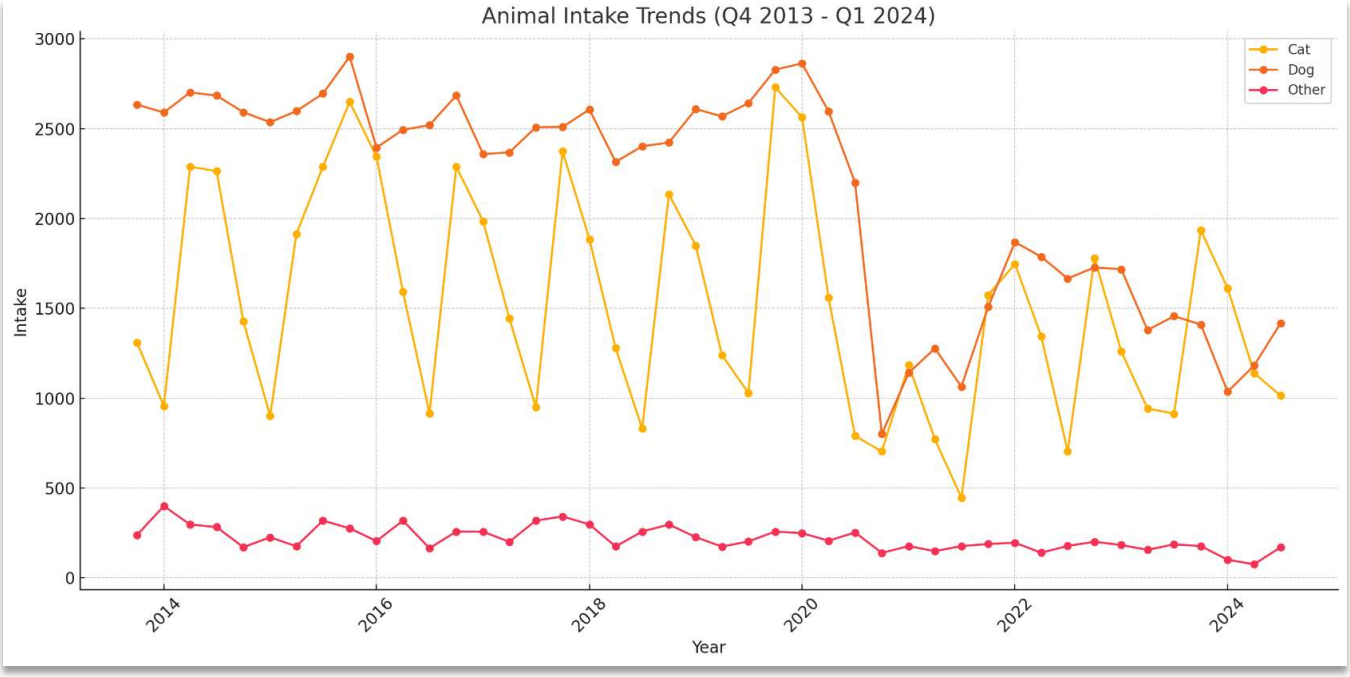
1. **High Stray Intake:** The significant proportion of strays (68%) indicates a prevalent issue of roaming animals in the community. This suggests a need for enhanced stray animal management strategies, including targeted spay/neuter programs, public education on responsible pet ownership, and community-based initiatives to reduce stray populations.
2. **Owner Surrenders:** While owner surrenders (21%) constitute a substantial portion of intakes, they are notably lower than stray intakes. This could indicate that owner surrender rates are relatively controlled, with owners seeking alternative solutions for their pets rather than relinquishing them to shelters.
3. **Limited Wildlife Intake:** Wildlife intake (4%) comprises a smaller proportion of shelter intakes, indicating that the shelter primarily serves domestic animals.
4. **Abandonment:** The minimal proportion of abandoned animals (1%) suggests that deliberate abandonment is relatively rare in the community. However, even a small percentage warrants attention and may indicate cases of severe neglect or owner distress requiring intervention and support services.
5. **Public Assist:** Public assist cases (6%) represent instances where community members seek shelter assistance for animals in need. These cases may include found pets, injured animals, or individuals unable to care for animals temporarily.

Strengthening community outreach and support networks can enhance the capacity to address such cases effectively.

6. **Negligible Euthanasia Requests:** The near absence of euthanasia requests reflects a positive trend in pet owner responsibility and the effectiveness of alternative solutions for managing end-of-life care or behavioral challenges in pets.

Analysis of Animal Intake Trends (2013 Q4 – 2024 Q1)

In this analysis, we present a time series plot illustrating the intake of three types of animals—dogs, cats, and others—into shelter. The data spans from the fourth quarter of 2013 to the first quarter of 2024. The x-axis represents the time period divided into quarterly intervals, providing a detailed view of trends and patterns over a decade. The y-axis indicates the number of animals taken in, allowing for a comparative analysis of intake rates among dogs, cats, and other animals. This visualization aims to identify any seasonal trends, significant changes over time, and potential factors influencing the intake rates of different animal types. By examining this data, we can gain insights into animal population dynamics, resource allocation needs, and the effectiveness of policies and programs related to animal welfare.



Dogs

- The intake of dogs shows a relatively stable trend with some fluctuations.
- There's a noticeable peak around Q4 2019 and another around Q1 2020.

- A slight decline is observed after 2020, but intake levels remain relatively high compared to cats and other animals.

Cats

- The intake of cats shows significant fluctuations over the years.
- There are sharp increases and decreases, indicating a more volatile trend compared to dogs.
- Peaks can be observed around Q2 2015, Q4 2015, and Q4 2019.
- There's a noticeable dip in Q4 2020, similar to the trend observed in dogs.

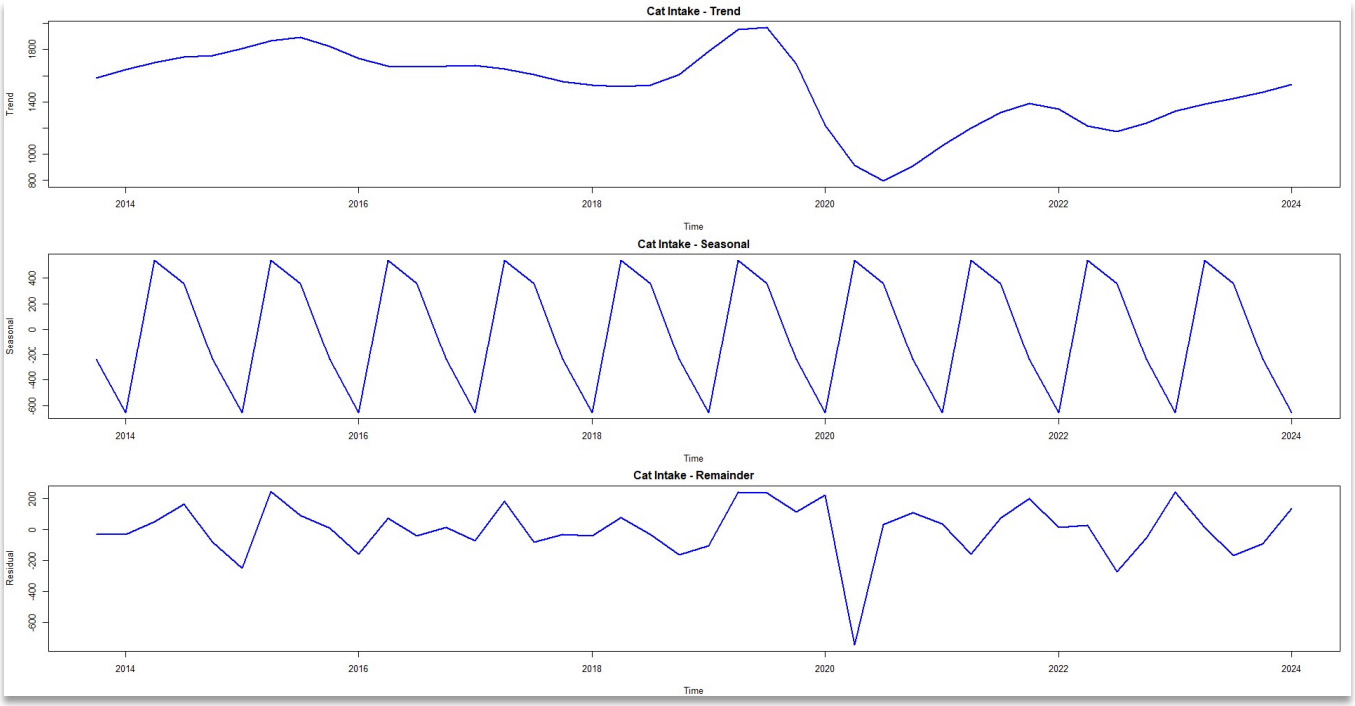
Other Animals

- The intake of other animals remains relatively low and stable compared to cats and dogs.
- There are minor fluctuations, but no significant peaks or troughs.
- The trend shows consistency over the years with slight variations.

Seasonal Decomposition of Animal Intake

The seasonal decomposition of the animal intake data provides a clearer view of the underlying trend, seasonal patterns, and residuals for each animal type.

Cats



Trend:

1. **2013-2016**: The cat intake shows a gradual increase, indicating a steady rise in the number of cats being taken in during this period.
2. **2016-2018**: There is a slight fluctuation but the overall trend remains relatively stable, with minor increases and decreases.
3. **2018-2019**: The trend shows a significant increase, peaking around early 2019. This could indicate a substantial rise in cat intake during this time.
4. **2019-2021**: A sharp decline is observed, reaching the lowest point around early 2021. This dramatic drop could be due to various factors such as policy changes, external events, or changes in data recording.
5. **2021-2023**: The intake starts to increase again, showing a recovery from the previous decline. There are minor fluctuations, but the overall trend is upward.
6. **2023-2024**: The trend continues to rise steadily, suggesting a consistent increase in cat intake.

In summary, the trend shows periods of growth, decline, and recovery in cat intake over the years, with notable peaks and troughs that could be linked to specific events or changes in circumstances.

Seasonal:

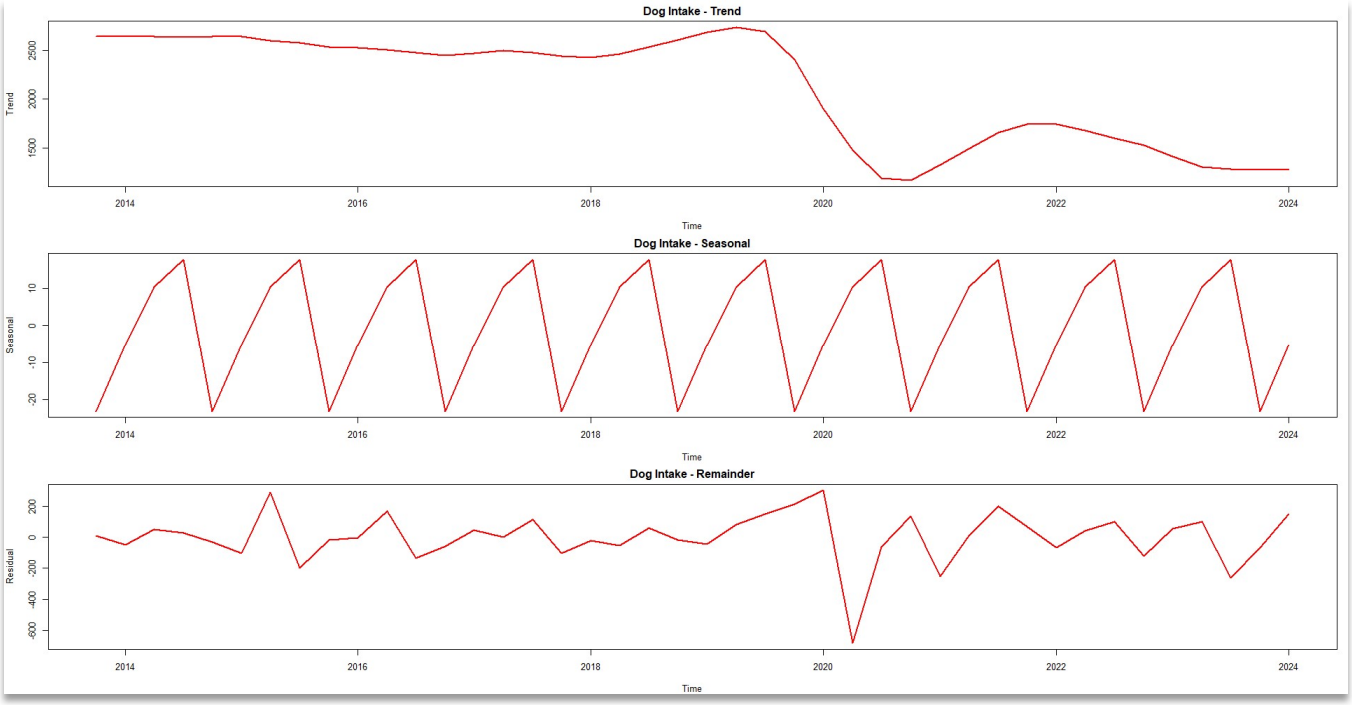
The curve shows a clear repeating pattern every year, indicating a strong seasonal component in the cat intake data.

Every year in Q1 (Jan – Mar) the curve starts low & begin to rise & reaches peak at the beginning of the Q2 (April – Jun) & then starts decline. In Q3 (July – Sep) the declination continues & reach a trough middle or end of the period. In Q4 (Oct – Dec) after reaching trough it again starts to increase.

Residual:

The residual (or remainder) component curve depicts the irregular variations in the cat intake data after removing the trend and seasonal components. The most notable feature in the residual component is the sharp drop around 2020, which might indicate an external event or anomaly that significantly impacted cat intake during that period. This outlier is well outside the usual range of fluctuations observed in other periods. The presence of random noise and irregular fluctuations indicates that there are factors affecting cat intake that are not captured by the trend or seasonal components. These could include unexpected events, policy changes, or other irregular influences.

Dogs



Trend:

1. **2014 to 2019**: The dog intake remains relatively stable with minor fluctuations.
2. **2019 to 2020**: There is a noticeable increase in dog intake, reaching a peak.
3. **2020 to 2021**: A significant decline is observed, suggesting a sharp drop in dog intake.
4. **2021 to 2022**: After the decline, there is a recovery with intake numbers rising again.
5. **2022 to 2024**: The intake numbers decrease gradually and then stabilize towards the end of the period.

The significant dip around 2020-2021 could be due to an external factor such as the COVID-19 pandemic, which might have affected the intake process. The stabilization towards the end suggests that the intake rates have settled to a new norm.

Seasonal:

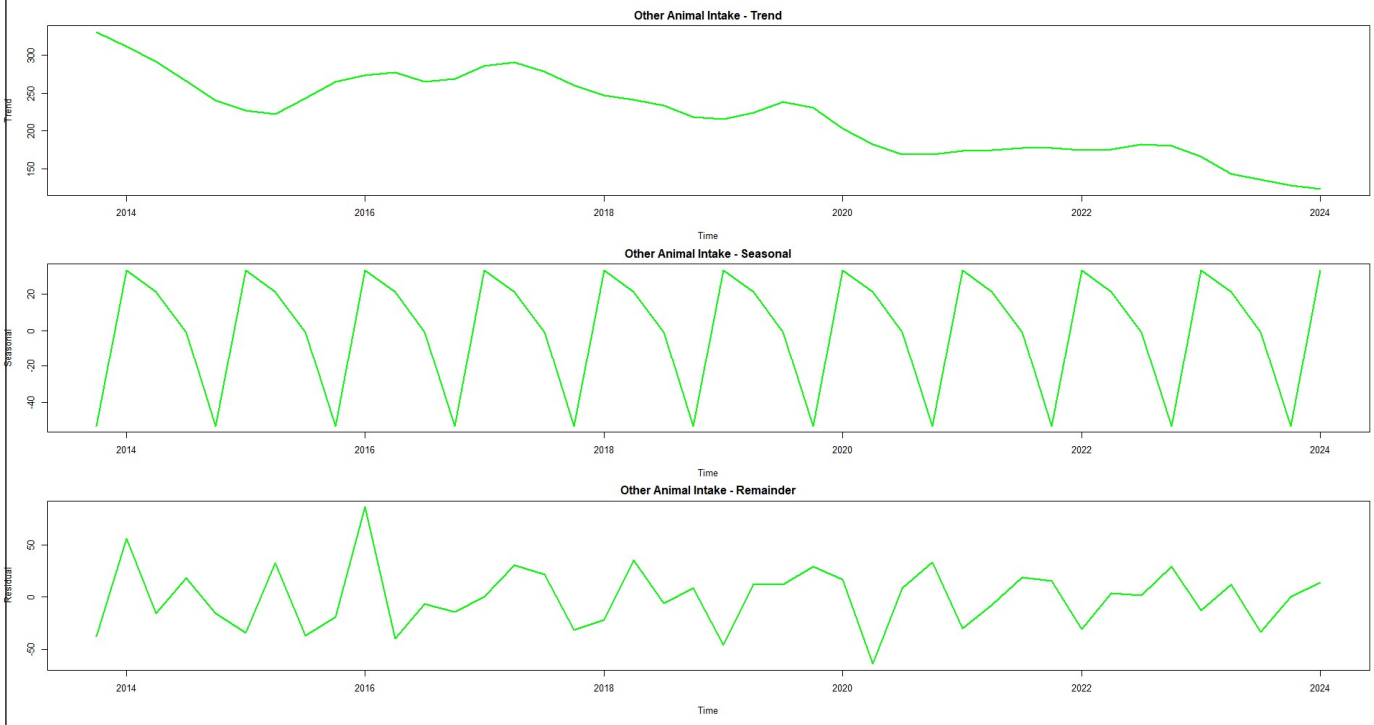
Each year, there is a peak in dog intake followed by a trough. This consistent annual pattern suggests that dog intake is influenced by seasonal factors. For example, intake might be higher during specific months due to factors like breeding seasons, holidays, or weather conditions.

Residual:

The residuals show less variability compared to cats. **Major Anomaly around 2020**: A significant dip is observed around 2020, aligning with the previous trend analysis. This could

be due to an extraordinary event such as the COVID-19 pandemic, which may have impacted dog intake numbers significantly. After the major dip, the residuals show increased variability but tend to stabilize, suggesting a return to normalcy with some fluctuations.

Other Animals



• **Trend**: The trend for other animals shows a slight increase until around 2016, followed by a relatively stable period with minor fluctuations. The overall trend indicates some stability in the intake numbers of other animals.

• **Seasonal**: The seasonal pattern for other animals is present but not as strong or consistent as in cats. This might be due to the diverse nature of animals categorized under "other."

• **Residual**: The residuals show significant variability, indicating that there are many fluctuations not explained by the trend or seasonal components. This could be due to the diverse species included in this category, each with different influencing factors.

Forecasting of Animal Intake by Exponential Smoothing method

Exponential smoothing is a widely used forecasting method for time series data that applies weighted averages of past observations to predict future values. The weights decrease exponentially as the observations get older, giving more importance to recent observations.

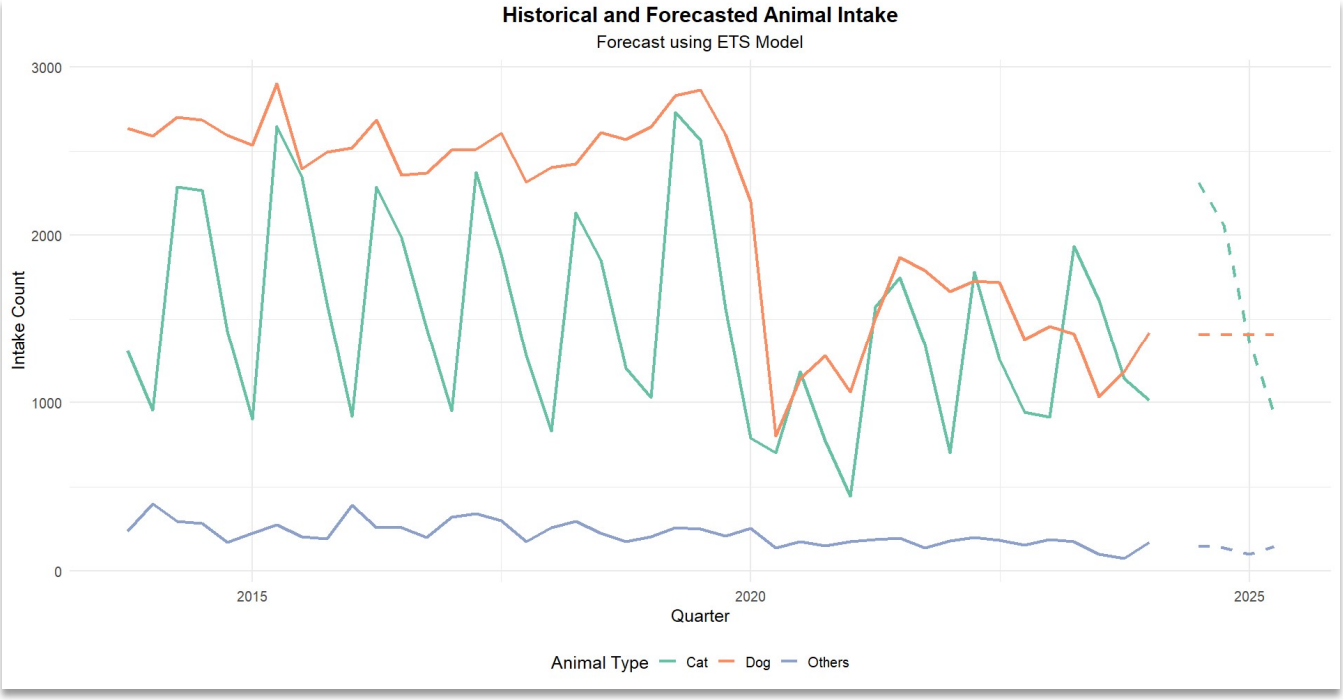
Types of Exponential Smoothing Methods:

1. **Simple Exponential Smoothing (SES)**: Suitable for time series without trend or seasonality. It uses a single smoothing parameter to forecast future values based on the past values.
2. **Holt's Linear Trend Model**: An extension of SES that accounts for a linear trend in the data. It uses two smoothing parameters: one for the level and another for the trend component.
3. **Holt-Winters Seasonal Model**: Further extends Holt's model to handle seasonality in the data. It uses three smoothing parameters: one for the level, one for the trend, and one for the seasonal component.

The `ets` function in R automatically selects the best-fitting model based on the characteristics of the data using an information criterion such as AIC (Akaike Information Criterion). It ensures that the chosen model captures the underlying patterns in the data effectively.

Forecasted Values

Quarter	Cat Forecast	Dog Forecast	Others Forecast
2024 Q3	2311.7912	1407.236	152.2711
2024 Q4	2057.5025	1407.236	137.1958
2024 Q1	1353.7707	1407.236	102.0234
2025 Q2	938.0209	1407.236	146.4728



The forecasted values for animal intake from the second 2024 Q3 to 2025 Q12 reveal several key insights:

Cats:

The intake of cats shows a declining trend over the forecast period. From 2311.7912 in Q3 2024, the intake decreases to 938.0209 by Q2 2025. This significant reduction might indicate seasonal effects, changes in stray populations, or successful adoption and spay/neuter programs.

Dogs:

The forecasted intake for dogs remains constant at 1407.236 across all quarters. This consistency suggests a stable intake rate for dogs, potentially due to steady demand for dog adoptions or consistent numbers of strays and surrenders.

Others:

The intake of other animals (neither cats nor dogs) also shows a decreasing trend, although less dramatically than cats. From 152.2711 in Q3 2024, it drops to 146.47 by Q2 2025.

Logistic Regression Analysis of Dog Age on Adoption Likelihood

Logistic regression is a statistical method used to model the probability of a binary outcome based on one or more predictor variables. In the context of animal shelters, logistic regression can be employed to predict the likelihood of an animal being adopted or not adopted based on various factors. This analysis focuses on using logistic regression with the response variable "adopted" (coded as 1 for adopted and 0 for not adopted) and two explanatory variables: "dog age"

Literature Review

Studies exploring the factors influencing pet adoption rates and outcomes provide valuable insights into the role of dog age and gender in adoption decisions.

- **Mondelli et al. (2004)** conducted a study on factors affecting the length of stay of shelter dogs, finding that younger dogs tend to be adopted more quickly than older dogs. This suggests that age is a significant predictor of adoption likelihood, with puppies and younger dogs being more desirable to potential adopters.
- **Wells & Hepper (2000)** investigated the influence of puppy-like characteristics (e.g., size, facial features) on the perceived attractiveness of dogs in shelters. Their findings suggest that dogs displaying puppy-like traits are more likely to be adopted, highlighting the importance of age-related factors in adoption decisions.
- **Kwan & Bain (2013)** analyzed adoption outcomes for shelter dogs and found that younger age was associated with higher adoption rates and shorter lengths of stay in shelters. Additionally, they identified a "sweet spot" for dog age, where puppies and young adult dogs were most likely to be adopted.
- **Protopopova & Wynne (2014)** examined the impact of dog age and appearance on adoption outcomes, revealing that younger dogs and those with certain physical characteristics (e.g., smaller size, attractive coat color) were more likely to be adopted. Age emerged as a significant predictor of adoption success, with younger dogs having higher odds of adoption.

Binary Logistic Regression: Outcome Type versus Age upon Outcome

Model

$$\text{logit}(P(\text{adopted} \mid \text{age upon outcome})) = \log\left(\frac{P(\text{adopted}|\text{age upon outcome})}{1-P(\text{adopted}|\text{age upon outcome})}\right) = \beta_0 + \beta_1 \cdot \text{age upon outcome}$$

Coefficients

Term	Coef	SE Coef	Z-Value	P-Value	VIF
Constant	0.38732	0.00912	42.47	0.000	

Age upon Outcome	-0.012602	0.000216	-58.34	0.000	1.00

Interpretation of the coefficients:

Constant (Intercept): The intercept represents the log odds of the outcome variable when all predictor variables are zero. In this case, it indicates the log odds of the outcome variable when the age upon outcome is zero. The intercept is highly significant ($p < 0.001$), indicating that it significantly contributes to the model.

Age upon Outcome: The coefficient represents the change in the log odds of the outcome variable for a one-unit increase in the age upon outcome. In this case, a one-month increase in the age upon outcome is associated with a decrease of approximately 0.012602 units in the log odds of the outcome variable. The coefficient is highly significant ($p < 0.001$), indicating that age upon outcome is a significant predictor of the outcome variable, after accounting for other variables in the model.

Odds Ratios for Continuous Predictors

	Odds Ratio	95% CI
Age upon Outcome	0.9875	(0.9871, 0.9879)

Interpretation:

- **Odds Ratio:**

  The odds ratio of 0.9872 means that for each one-month increase in age, the odds of the outcome (e.g., adoption) decrease by a factor of 0.9872. This indicates that older dogs have slightly lower odds of being adopted compared to younger dogs.

- **95% Confidence Interval:**

  The 95% confidence interval for the odds ratio is between 0.9867 and 0.9876. This narrow range indicates a high level of precision in the estimated odds ratio.

  Since the entire confidence interval is below 1, it confirms that the relationship between age and the outcome is statistically significant.

Model Summary

Deviance R-Sq	Deviance R-Sq(adj)	AIC	AICc	BIC	Area Under ROC Curve
3.17%	3.17%	119364.07	119364.07	119382.86	0.6161

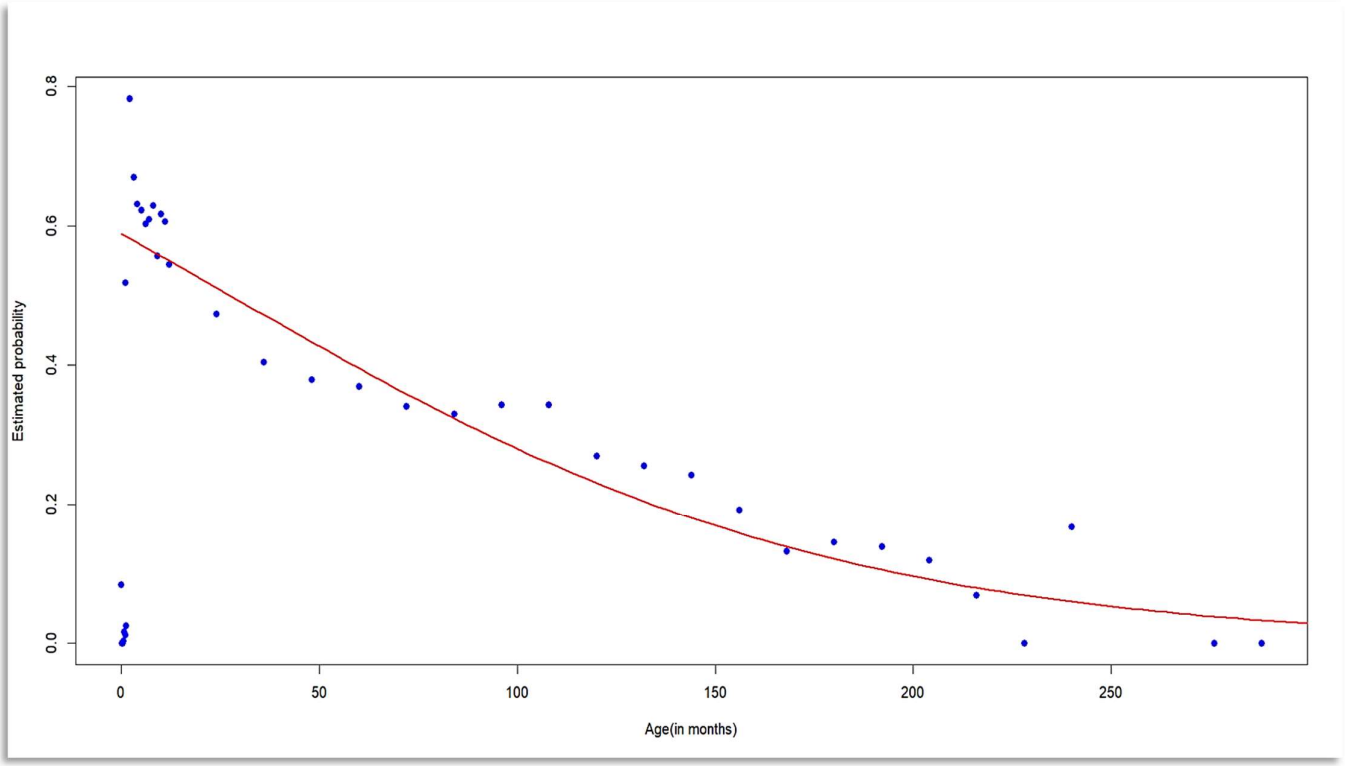
Interpretation:

- **R-Squared (R-Sq):** The R-Squared value of 3.17% indicates that approximately 3.17% of the variability in the response variable (e.g., adoption outcome) is explained by the predictors included in the logistic regression model. This relatively low R-Squared value suggests that a large proportion of the variability in the outcome remains unexplained by the model.

- **Adjusted R-Squared (R-Sq(adj)):** The Adjusted R-Squared also being 3.17% confirms that the model's explanatory power is not inflated by the number of predictors. It is adjusted for the number of predictors in the model and thus provides a more accurate measure of the goodness of fit for models with multiple predictors.

Analysis of Observed Proportion of Adoptions by Age and Estimated Probabilities from the Logistic Regression Model

In this analysis, we plot the age of dogs in months on the x-axis and the estimated probability of adoption on the y-axis. The plot demonstrates how the likelihood of adoption changes with the age of the dogs, based on the logistic regression model's predictions.



Observations:

1. **Trend in Adoption Probability:**

   The red curve shows a clear downward trend, indicating that the probability of adoption decreases as the age of the dogs increases.

   This trend is consistent with the negative coefficient for age in the logistic regression model, confirming that older dogs have lower chances of being adopted.

2. **Observed Proportions:**

   The blue dots represent the observed proportions of adoptions at each age.

At younger ages (0-50 months), the observed proportions of adoption are relatively high, some variability.

As age increases beyond 50 months, the observed proportions of adoption decrease, aligning closely with the estimated probabilities from the logistic regression model.

3. **Model Fit:**

   The red curve closely follows the pattern of the observed data points, suggesting that the logistic regression model provides a reasonable fit to the data.

   There is some variability in the observed proportions, especially at younger ages, but the overall trend is captured well by the model.

4. **Age-Specific Insights:**

   For very young dogs (0-10 months), the probability of adoption is highest, often above 0.5 (50%).

   For middle-aged dogs (50-150 months), the probability of adoption declines more gradually.

   For older dogs (150-250 months), the probability of adoption drops significantly, often below 0.1 (10%).

Adoption Strategies:

- Shelters may need to develop specific strategies to promote the adoption of older dogs, given their lower probabilities of being adopted.
- Potential adopters could be educated about the benefits of adopting older dogs to help improve their adoption rates.

Logistic Regression Analysis of Dog Age & Dog Gender on Adoption Likelihood

Logistic regression is a statistical method used to model the probability of a binary outcome based on one or more predictor variables. In the context of animal shelters, logistic regression can be employed to predict the likelihood of an animal being adopted or not adopted based on various factors. This analysis focuses on using logistic regression with the response variable "adopted" (coded as 1 for adopted and 0 for not adopted) and two explanatory variables: "dog age" and "dog gender."

Literature Review

Studies exploring the factors influencing pet adoption rates and outcomes provide valuable insights into the role of dog age and gender in adoption decisions.

- **Barnard et al. (2018)** investigated the influence of dog gender on adoption outcomes, finding that female dogs were adopted more quickly than male dogs. This suggests that gender is another important predictor of adoption likelihood, with female dogs being more desirable to potential adopters.

These studies collectively underscore the importance of both dog age and gender as predictors of adoption outcomes in animal shelters. Logistic regression analysis can further elucidate the relationship between these factors and adoption likelihood, helping shelters tailor their adoption strategies to improve outcomes for shelter dogs.

Binary Logistic Regression: Outcome Type versus Age upon Outcome, Sex upon Outcome

Coefficients

Term	Coef	SE Coef	Z-Value	P-Value
Constant	0.4897	0.0118	41.59	0.000
Age upon Outcome	-0.012921	0.000218	-59.38	0.000
Sex upon Outcome				
Male	-0.1431	0.0138	-10.35	0.000

Interpretation of Coefficients:

• **Age upon Outcome:** The coefficient for age is negative (-0.012921), indicating that older dogs are less likely to be adopted. For each additional month of age, the log-odds of adoption

decrease by approximately 0.0129. This relationship is statistically significant (P-Value < 0.001).

• **Sex upon Outcome (Male):** The coefficient for male dogs is negative (-0.1431), indicating that male dogs are less likely to be adopted compared to female dogs. Male dogs have a lower log-odds of adoption by approximately 0.1431 compared to female dogs. This relationship is statistically significant (P-Value < 0.001).

Odds Ratios for Continuous Predictors

	Odds Ratio	95% CI
Age upon Outcome	0.9872	(0.9867, 0.9876)

Interpretation:

The odds ratio for age upon outcome is 0.9872, indicating that for each additional month of age, the odds of adoption decrease by about 1.28% (since $1-0.9872=0.01281$ - $0.9872 = 0.01281-0.9872=0.0128$). The 95% confidence interval suggests that this effect is statistically significant, indicating a reliable estimate of the odds ratio.

Odds Ratios for Categorical Predictors

Level A	Level B	Odds Ratio	95% CI
Sex upon Outcome			
Male	Female	0.8667	(0.8435, 0.8905)

Odds ratio for level A relative to level B

Interpretation:

Male dogs have 0.8667 times the odds of being adopted compared to female dogs. In other words, male dogs have about 13.33% lower odds of being adopted than female dogs. The 95% confidence interval indicates that this difference is statistically significant, with a high level of confidence.

Odds Ratio for Male Relative to Female:

- Odds Ratio for Male Relative to Female $= \frac{1}{0.8667} \approx 1.1526$
- **95% CI:** (1.1222, 1.1846)

Model Summary

Deviance R-Sq	Deviance R-Sq(adj)	AIC	AICc	BIC	Area Under ROC Curve
3.44%	3.43%	118145.29	118145.29	118173.45	0.6233

Logistic Regression Analysis of Dog Age, Gender, and Breed Group on Adoption Likelihood

Literature Review

Studies have shown that dog breed significantly impacts adoption outcomes:

- **Protopopova et al. (2012)** found that certain breeds, especially those perceived as more attractive or popular, tend to be adopted more quickly.
- **Diesel et al. (2007)** highlighted that breed-specific characteristics, such as temperament and size, influence adopter preferences and consequently adoption rates.
- **Brown et al. (2013)** indicated that breed perceptions play a crucial role in adoption decisions, with mixed breeds sometimes facing longer stays in shelters compared to purebreds.

Previously, we examined how dog age and gender influence adoption likelihood. To enhance the model's predictive power, we now introduce an additional predictor: dog group. Various studies have shown that breed characteristics, including temperament, size, and public perception, significantly affect an adopter's decision. This analysis includes several breed groups, each with unique traits that influence their likelihood of adoption. Here is a brief overview of each breed group considered in the analysis:

1. **Herding Group:**

   Herding dogs are known for their intelligence, agility, and strong work ethic. They are often perceived as active and trainable, making them appealing to adopters looking for a versatile companion. Popular breeds in this group include Border Collies and Australian Shepherds.

2. **Hound Group:**

   Hound dogs are renowned for their exceptional hunting and tracking abilities. They can be either scent hounds or sight hounds, with breeds such as Beagles and Greyhounds being well-known examples. Their strong prey drive and sometimes independent nature can influence adoption preferences.

3. **Non-Sporting Group:**

   The non-sporting group is a diverse category that includes breeds with varying sizes, appearances, and temperaments. Breeds like Bulldogs and Dalmatians fall into this group. Their unique characteristics and sometimes specialized care needs can affect their adoption rates.

4. **Sporting Group:**

   Sporting dogs are typically active, friendly, and eager to please. They are often used in hunting and other outdoor activities. Breeds such as Labradors and Golden Retrievers are common in this group. Their popularity and generally pleasant disposition often lead to higher adoption rates.

5. **Terrier Group:**

   Terriers are energetic and feisty dogs known for their determination and bold personalities. Breeds like Jack Russell Terriers and Bull Terriers are part of this group. Their high energy levels and strong-willed nature can impact their desirability to potential adopters.

6. **Toy Group:**

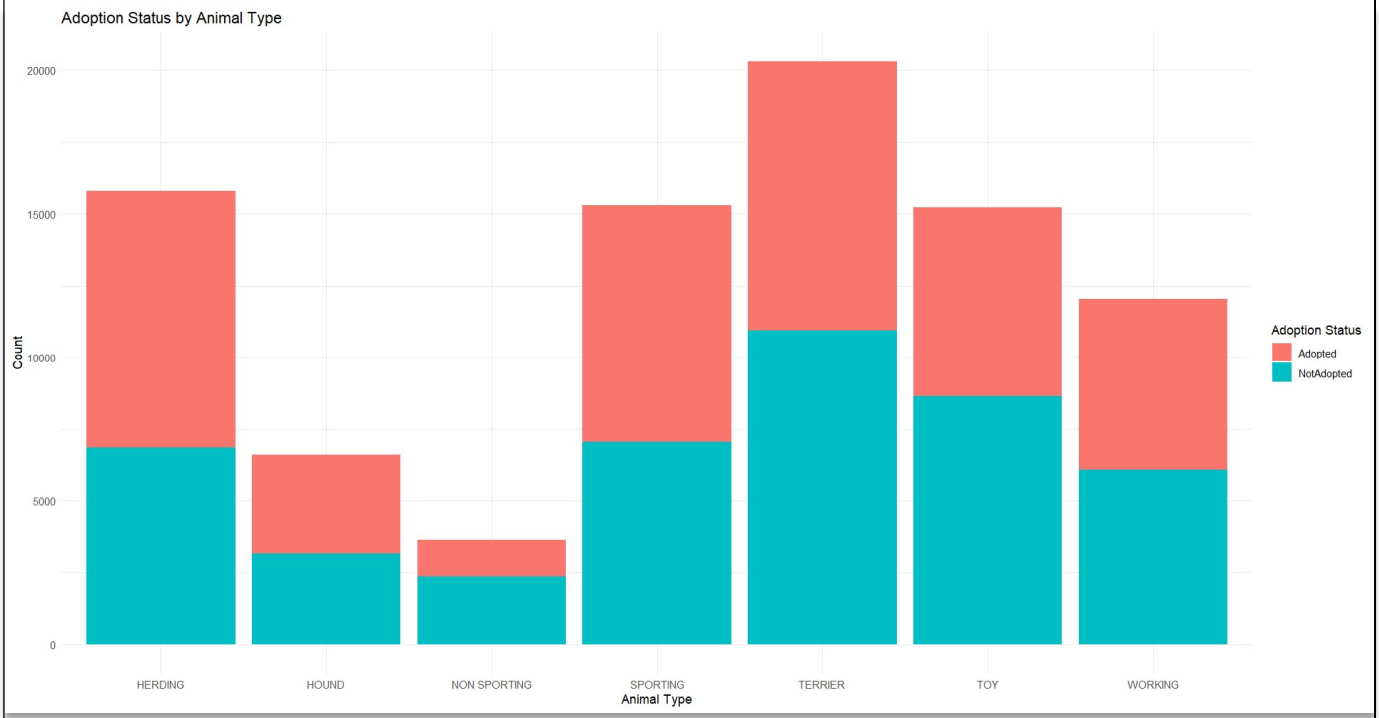
   Toy dogs are small in size but often big in personality. They are bred primarily for companionship and include breeds like Chihuahuas and Pomeranians. Their small size makes them suitable for apartment living, but their delicate nature can be a consideration for adopters.

7. **Working Group:**

   Working dogs are strong and intelligent, often bred for specific tasks such as guarding, pulling, or rescue operations. Breeds like Rottweilers and Siberian Huskies are part of this group. Their size and strength can be both an attraction and a challenge for potential adopters.

Distribution of Adoption Outcomes Across Breed Groups

Before diving into the binary logistic regression analysis, it's beneficial to visually explore the adoption outcomes within each breed group through a bar plot. This plot will provide a clear understanding of the distribution of adopted and not adopted dogs across different breed categories.



Distribution of Adoption Outcomes Across Breed Groups

Observations:

Animal Type	% Not Adopted	% Adopted
HERDING	43.31%	56.69%
HOUND	47.72%	52.28%
NON-SPORTING	65.06%	34.94%
SPORTING	45.97%	54.03%
TERRIER	53.81%	46.19%
TOY	56.69%	43.31%
WORKING	50.43%	49.57%

- **Most Adopted Groups**: TERRIER and SPORTING have the highest adoption counts, indicating they are the most popular among adopters.
- **Least Adopted Groups**: HERDING and HOUND have the highest not adopted counts, showing they are less favored for adoption.
- **Balanced Adoption Status**: TOY animals have a relatively balanced adoption status, with adopted and not adopted counts being close.
- **Low Presence Groups**: NON-SPORTING animals have the lowest total counts, suggesting either lower availability or lower popularity in the adoption lists.

Binary Logistic Regression: Outcome Type versus Age upon Outcome, Sex upon Outcome, Group

Model

$$\text{logit}(P(\text{adopted} \mid \text{age}, \text{gender}, \text{breed group})) = \log\left(\frac{P(\text{adopted}|\text{age},\text{gender},\text{breed group})}{1-P(\text{adopted}|\text{age},\text{gender},\text{breed group})}\right) = \beta_0 + \beta_1 \cdot \text{age} + \beta_2 \cdot \text{gender} + \beta_3 \cdot \text{breed group}$$

Coefficients

Term	Coef	SE Coef	Z-Value	P-Value
Constant	0.7072	0.0188	37.60	0.000
Age upon Outcome	-0.012281	0.000219	-56.17	0.000
Sex upon Outcome				
Male	-0.1383	0.0139	-9.95	0.000
Group				
HOUND	-0.1158	0.0303	-3.82	0.000
NON SPORTING	-0.5687	0.0423	-13.46	0.000
SPORTING	-0.1021	0.0235	-4.35	0.000
TERRIER	-0.3573	0.0219	-16.35	0.000
TOY	-0.8450	0.0347	-24.34	0.000
WORKING	-0.2475	0.0214	-11.56	0.000

Odds Ratios for Continuous Predictors

	Odds Ratio	95% CI
Age upon Outcome	0.9878	(0.9874, 0.9882)

Odds Ratios for Categorical Predictors

Level A	Level B	Odds Ratio	95% CI
Sex upon Outcome			
Male	Female	0.8708	(0.8474, 0.8949)
Group			
HOUND	HERDING	0.8907	(0.8393, 0.9452)
NON SPORTING	HERDING	0.5663	(0.5213, 0.6152)
SPORTING	HERDING	0.9030	(0.8624, 0.9455)
TERRIER	HERDING	0.6996	(0.6703, 0.7302)
TOY	HERDING	0.4296	(0.4013, 0.4598)
WORKING	HERDING	0.7808	(0.7487, 0.8142)
NON SPORTING	HOUND	0.6358	(0.5805, 0.6963)
SPORTING	HOUND	1.0138	(0.9551, 1.0761)
TERRIER	HOUND	0.7855	(0.7418, 0.8317)
TOY	HOUND	0.4823	(0.4462, 0.5213)
WORKING	HOUND	0.8766	(0.8284, 0.9276)
SPORTING	NON SPORTING	1.5945	(1.4676, 1.7325)
TERRIER	NON SPORTING	1.2354	(1.1391, 1.3399)
TOY	NON SPORTING	0.7586	(0.6887, 0.8356)
WORKING	NON SPORTING	1.3788	(1.2720, 1.4946)
TERRIER	SPORTING	0.7748	(0.7421, 0.8089)
TOY	SPORTING	0.4757	(0.4444, 0.5093)
WORKING	SPORTING	0.8647	(0.8289, 0.9020)
TOY	TERRIER	0.6140	(0.5748, 0.6559)
WORKING	TERRIER	1.1160	(1.0737, 1.1601)
WORKING	TOY	1.8176	(1.7025, 1.9404)

Odds ratio for level A relative to level B

Model Summary

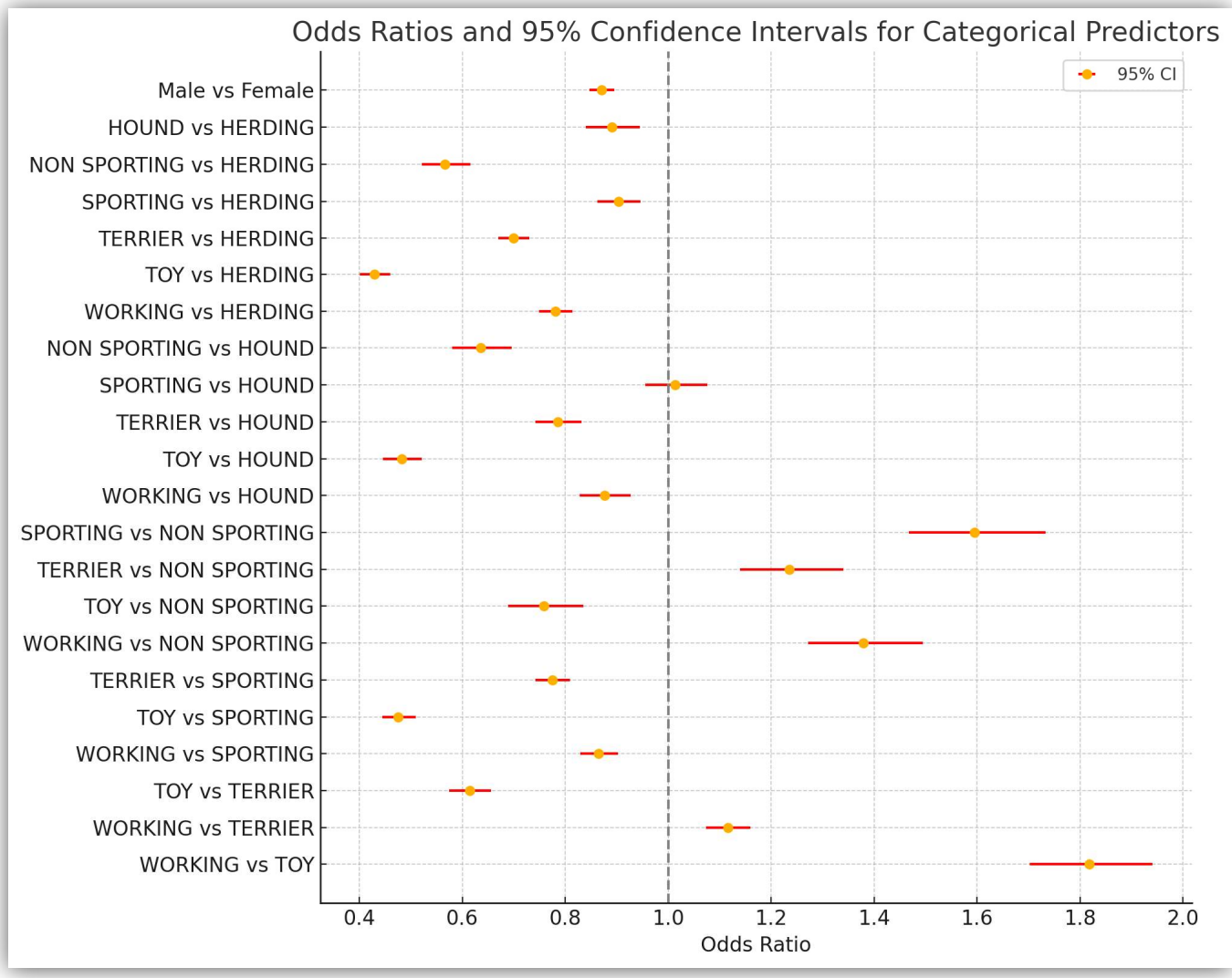
Deviance R-Sq	Deviance R-Sq(adj)	AIC	AICc	BIC	Area Under ROC Curve
4.13%	4.13%	117272.72	117272.72	117357.21	0.6367

Percentage Differences in Dog Adoption Likelihood Based on Sex and Breed Group

- Male dogs are approximately 12.92% less likely to be adopted compared to female dogs.
- Hound dogs are approximately 10.93% less likely to be adopted compared to herding dogs.
- Non-sporting dogs are approximately 43.37% less likely to be adopted compared to herding dogs.
- Sporting dogs are approximately 9.70% less likely to be adopted compared to herding dogs.

- Terrier dogs are approximately 30.04% less likely to be adopted compared to herding dogs.
- Toy dogs are approximately 57.04% less likely to be adopted compared to herding dogs.
- Working dogs are approximately 21.92% less likely to be adopted compared to herding dogs.
- Non-sporting dogs are approximately 36.42% less likely to be adopted compared to hound dogs.
- Sporting dogs have similar odds of being adopted as hound dogs (+1.38%).
- Terrier dogs are approximately 21.45% less likely to be adopted compared to hound dogs.
- Toy dogs are approximately 51.77% less likely to be adopted compared to hound dogs.
- Working dogs are approximately 12.34% less likely to be adopted compared to hound dogs.
- Sporting dogs are approximately 59.45% more likely to be adopted compared to non-sporting dogs.
- Terrier dogs are approximately 23.54% more likely to be adopted compared to non-sporting dogs.
- Toy dogs are approximately 24.14% less likely to be adopted compared to non-sporting dogs.
- Working dogs are approximately 37.88% more likely to be adopted compared to non-sporting dogs.
- Terrier dogs are approximately 22.52% less likely to be adopted compared to sporting dogs.
- Toy dogs are approximately 52.43% less likely to be adopted compared to sporting dogs.
- Working dogs are approximately 13.53% less likely to be adopted compared to sporting dogs.
- Toy dogs are approximately 38.60% less likely to be adopted compared to terrier dogs.
- Working dogs are approximately 11.60% more likely to be adopted compared to terrier dogs.
- Working dogs are approximately 81.67% more likely to be adopted compared to Toy dogs.

Visualization of Odds Ratio & 95% confidence intervals



The plot displays the odds ratios and their 95% confidence intervals for various comparisons between cat breed groups. Here are the key points:

Odds Ratios: Represented by yellow dots, these values indicate the relative odds of an event occurring in one breed group compared to another.

95% Confidence Intervals: Represented by horizontal lines, these intervals show the range within which the true odds ratio is likely to fall 95% of the time.

Null Effect Line: The grey dashed vertical line at 1 represents the null effect, where there is no difference in odds between the two groups being compared.

Observations:

Here are some key insights from the interpretation of the percentage differences in dog adoption likelihood based on sex and breed group:

Statistical Significance: Most confidence intervals do not include 1, indicating statistically significant differences between the compared groups.

- **Herding Dogs:** Dogs in the herding group appear to have higher adoption rates compared to other groups, with hound and non-sporting breeds being notably less likely to be adopted.

- **Sporting Dogs:** Sporting dogs have a higher likelihood of adoption compared to non-sporting and terrier breeds.

- **Toy Dogs:** Toy dogs have the lowest likelihood of adoption across all breed groups, being approximately 57.04% less likely to be adopted compared to herding dogs.

- **Working Dogs:** Working dogs demonstrate mixed adoption likelihoods depending on the comparison group. They are notably less likely to be adopted compared to herding dogs but show higher adoption rates compared to non-sporting, terrier, and toy breeds.

- **Terrier Dogs:** Terrier dogs generally show lower adoption rates compared to herding and sporting breeds but have higher adoption rates compared to non-sporting and toy groups.

Strategic Adoption Efforts: Shelters and rescue organizations may need to implement targeted adoption strategies based on sex and breed group, focusing on increasing the adoption rates of male dogs and breeds with lower overall adoption rates, such as toy and non-sporting breeds.

Logistic Regression Analysis of Cat Age on Adoption Likelihood

Binary Logistic Regression: Outcome Type versus Age upon Outcome

Coefficients

Term	Coef	SE Coef	Z-Value	P-Value	VIF
Constant	0.11028	0.00905	12.18	0.000	
Age upon Outcome	-0.005097	0.000269	-18.97	0.000	1.00

Interpretation:

1. **Constant (Intercept):**

   The constant coefficient of 0.11028 represents the log-odds of a cat being adopted when the age is zero (newborn cats).

   A positive intercept indicates that the baseline probability of adoption is above 0.5 for very young cats.

2. **Age upon Outcome:**

   The coefficient for "Age upon Outcome" is -0.005097.

   This negative coefficient indicates that as the age of the cat increases, the likelihood of adoption decreases.

   The magnitude of the coefficient suggests that for each additional month in age, the log-odds of adoption decrease by 0.005097.

3. **Significance:**

   The p-value for "Age upon Outcome" is 0.000, which is highly significant. This indicates that the age of the cat is a significant predictor of adoption probability.

Odds Ratios for Continuous Predictors

	Odds Ratio	95% CI
Age upon Outcome	0.9949	(0.9944, 0.9954)

Interpretation:

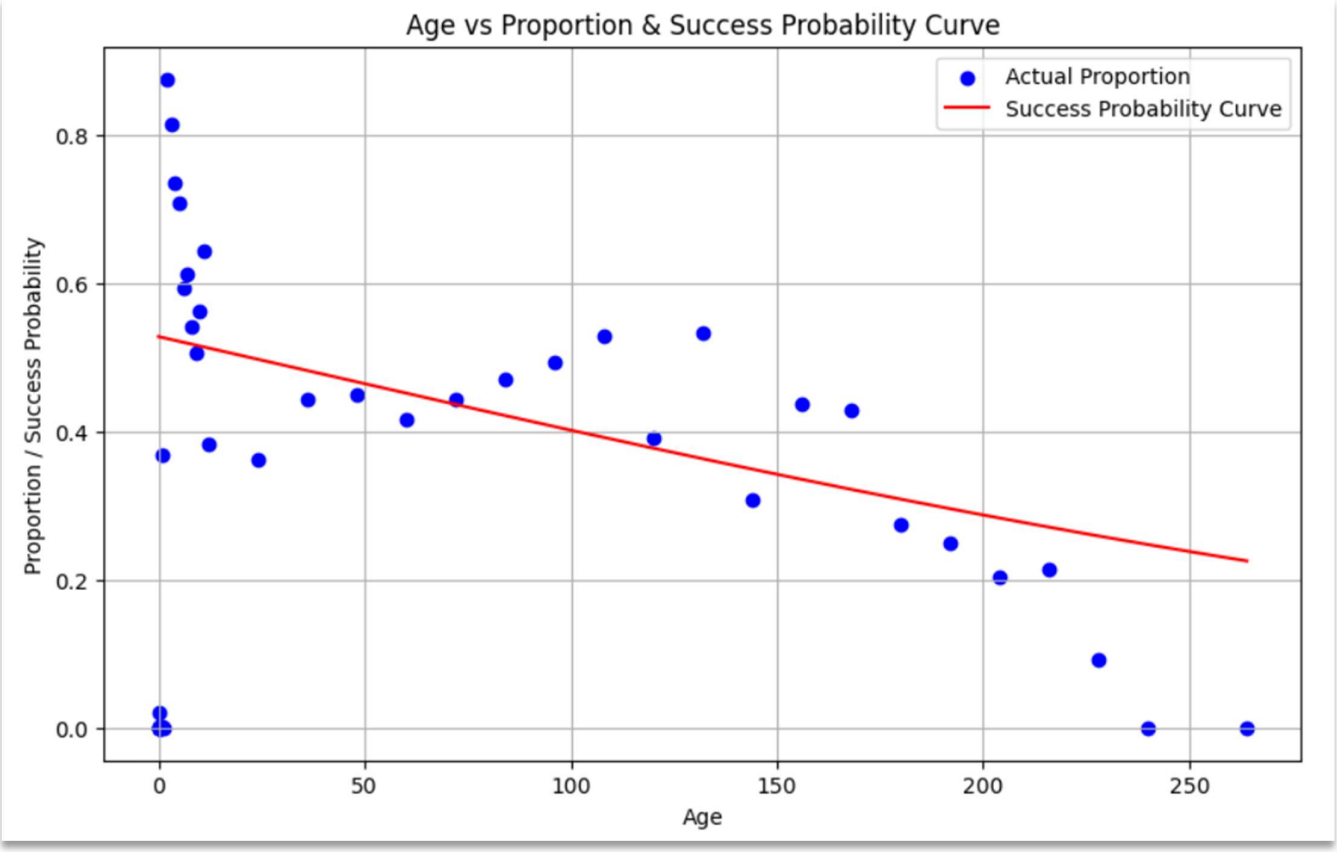
- The odds ratio for "Age upon Outcome" is 0.9949.
- This means that for each additional month of age, the odds of a cat being adopted decrease by approximately 0.51% (calculated as (1 - 0.9949) * 100).
- The 95% confidence interval for this odds ratio is (0.9944, 0.9954), indicating a narrow range and reinforcing the precision of this estimate.
- Since the entire confidence interval is below 1, it confirms that increased age consistently reduces the likelihood of adoption.

Model Summary

Deviance R-Sq	Deviance R-Sq(adj)	AIC	AICc	BIC	Area Under ROC Curve
0.43%	0.43%	86789.72	86789.72	86807.82	0.4558

Analysis of Observed Proportion of Adoptions by Age and Estimated Probabilities of adoption from the Logistic Regression Model

In this analysis, we plot the age of dogs in months on the x-axis and the estimated probability of adoption on the y-axis. The plot demonstrates how the likelihood of adoption changes with the age of the dogs, based on the logistic regression model's predictions.



Observations:

Age Distribution and Adoption Success Probability:

Young Cats (0-50 months): The adoption success probability is quite high, with several points above 0.6, and some even close to 0.8. The red line starts relatively high, indicating a strong likelihood of young cats being adopted.

Middle-Aged Cats (50-150 months): There is a gradual decline in the success probability as age increases. The blue points start to spread more along the y-axis, but the overall trend shows a decrease.

Older Cats (150+ months): The probability of adoption decreases significantly. The red line continues to decline, and the blue points show lower proportions, indicating that older cats have a much lower success rate for adoption.

Model Fit: The red line (success probability curve) indicates a negative linear trend, showing that as age increases, the probability of adoption decreases. The fit appears to capture the general downward trend, though there is noticeable variability in the data points.

Logistic Regression Analysis of Cat Age, Gender, and Breed Groups on Adoption Likelihood

Description of Cat Breed Groups

- **Domestic Shorthair**: This group encompasses cats of mixed ancestry with short coats. Domestic Shorthairs are known for their diverse appearance and robust health. They often exhibit a wide range of colors and patterns.

- **Domestic Mediumhair**: Similar to Domestic Shorthairs, Domestic Mediumhairs have mixed ancestry but sport medium-length coats. They share the same variability in appearance as Domestic Shorthairs but with slightly longer fur.

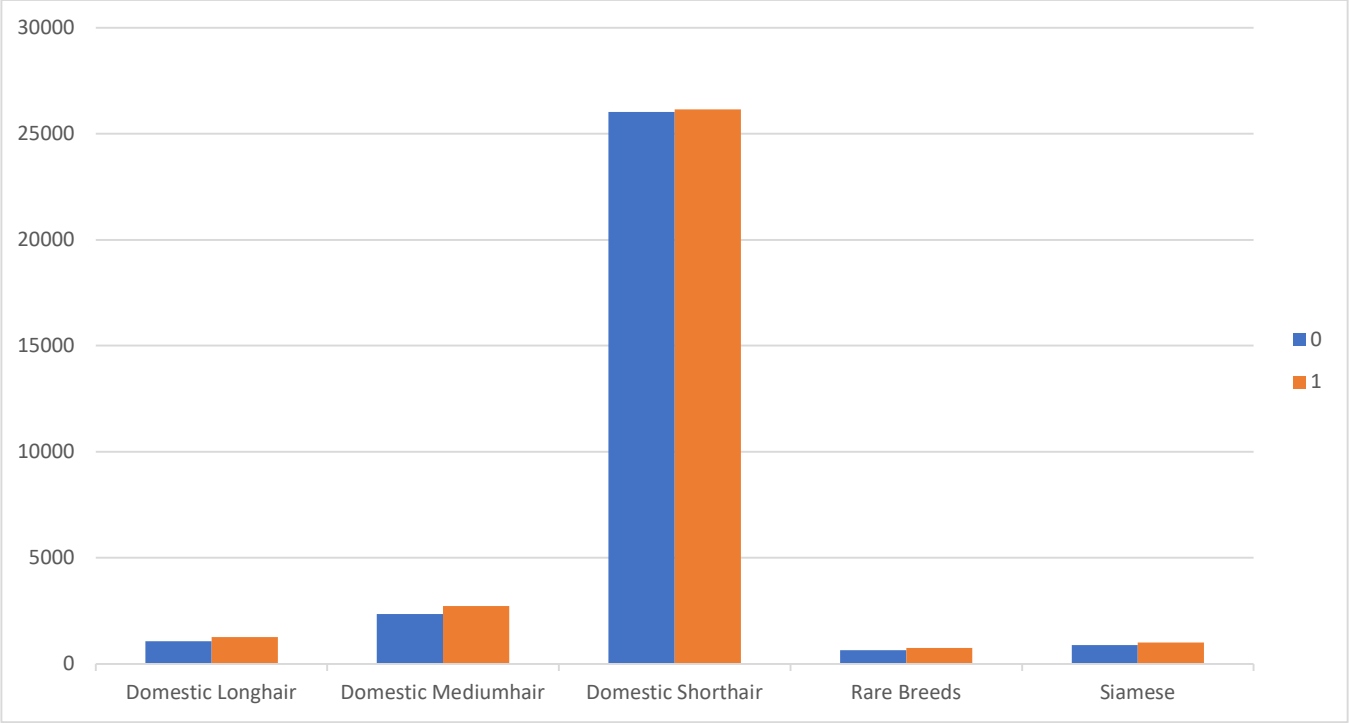
- **Domestic Longhair**: These cats also have mixed ancestry but feature long, flowing coats. Domestic Longhairs are known for their striking appearance and often require regular grooming to maintain their coats.

- **Siamese**: Siamese cats are a distinct breed known for their sleek bodies, striking blue almond-shaped eyes, and pointed coloration (darker colors on their ears, face, paws, and tail). They are vocal, social, and highly intelligent cats.

- **Rare Breeds**: This group encompasses breeds that are less common or less standardized compared to popular breeds like Siamese. Examples might include breeds like the Maine Coon, Bengal, Ragdoll, or Scottish Fold. Each rare breed possesses unique characteristics, often with distinct physical traits, temperaments, or health considerations.

Distribution of Adoption Outcomes Across Breed Groups

Before diving into the binary logistic regression analysis, it's beneficial to visually explore the adoption outcomes within each breed group through a bar plot. This plot will provide a clear understanding of the distribution of adopted and not adopted cats across different breed categories.



Distribution of Adoption Outcomes Across Breed Groups

Observations:

Domestic Shorthair: This breed group shows the highest number of cats, both adopted and not adopted, with both numbers being significantly higher than those for other breeds. The number of not adopted cats is slightly higher than the number of adopted cats in this group.

Domestic Longhair and Domestic Mediumhair: These groups have a moderate number of cats, with the number of adopted cats being slightly higher than the number of not adopted cats in both cases.

Rare Breeds and Siamese: Both these groups have a relatively low number of cats. The number of adopted cats is slightly higher than the number of not adopted cats for Siamese, whereas for Rare Breeds, the numbers are very close, with a very slight edge to adopted cats.

Logistic Regression Analysis of Dog Age, Gender, and Group on Adoption Likelihood

Binary Logistic Regression: Outcome Type versus Age upon Outcome, Sex upon Outcome, Breed Group

Coefficients

Term	Coef	SE Coef	Z-Value	P-Value	VIF
Constant	0.5044	0.0449	11.22	0.000	
Age upon Outcome	-0.007082	0.000278	-25.44	0.000	1.02
Sex upon Outcome					
Male	-0.0427	0.0167	-2.55	0.011	1.00
Group					
Domestic Mediumhair	-0.0736	0.0524	-1.40	0.160	2.92
Domestic Shorthair	-0.2018	0.0444	-4.54	0.000	4.03
Rare Breeds	-0.0223	0.0702	-0.32	0.751	1.57
Siamese	-0.1018	0.0643	-1.58	0.114	1.77

Odds Ratios for Continuous Predictors

	Odds Ratio	95% CI
Age upon Outcome	0.9929	(0.9924, 0.9935)

Odds Ratios for Categorical Predictors

Level A	Level B	Odds Ratio	95% CI
Sex upon Outcome			
Male	Female	0.9582	(0.9272, 0.9901)
Group			
Domestic Mediumhair	Domestic Longhair	0.9291	(0.8384, 1.0295)
Domestic Shorthair	Domestic Longhair	0.8172	(0.7491, 0.8916)
Rare Breeds	Domestic Longhair	0.9780	(0.8523, 1.1222)
Siamese	Domestic Longhair	0.9032	(0.7962, 1.0246)
Domestic Shorthair	Domestic Mediumhair	0.8796	(0.8281, 0.9343)
Rare Breeds	Domestic Mediumhair	1.0526	(0.9307, 1.1906)
Siamese	Domestic Mediumhair	0.9721	(0.8712, 1.0848)
Rare Breeds	Domestic Shorthair	1.1967	(1.0715, 1.3365)
Siamese	Domestic Shorthair	1.1052	(1.0049, 1.2155)
Siamese	Rare Breeds	0.9235	(0.8003, 1.0658)

Odds ratio for level A relative to level B

Percentage Differences in Cat Adoption Likelihood Based on Sex and Breed Group

Sex upon Outcome:

- **Male vs. Female:**

  Male cats have a 4.18% lower likelihood of being adopted compared to female cats.

Group:

- **Domestic Mediumhair vs. Domestic Longhair:**

  Domestic Mediumhair cats have a 7.09% lower likelihood of being adopted compared to Domestic Longhair cats.

- **Domestic Shorthair vs. Domestic Longhair:**

  Domestic Shorthair cats have an 18.28% lower likelihood of being adopted compared to Domestic Longhair cats.

- **Rare Breeds vs. Domestic Longhair:**

  Rare Breeds cats have a 2.20% lower likelihood of being adopted compared to Domestic Longhair cats.

- **Siamese vs. Domestic Longhair:**

  Siamese cats have a 9.68% lower likelihood of being adopted compared to Domestic Longhair cats.

- **Domestic Shorthair vs. Domestic Mediumhair:**

  Domestic Shorthair cats have a 12.04% lower likelihood of being adopted compared to Domestic Mediumhair cats.

- **Rare Breeds vs. Domestic Mediumhair:**

  Rare Breeds cats have a 5.26% higher likelihood of being adopted compared to Domestic Mediumhair cats.

- **Siamese vs. Domestic Mediumhair:**

  Siamese cats have a 2.79% lower likelihood of being adopted compared to Domestic Mediumhair cats.

- **Rare Breeds vs. Domestic Shorthair:**

  Rare Breeds cats have a 19.67% higher likelihood of being adopted compared to Domestic Shorthair cats.

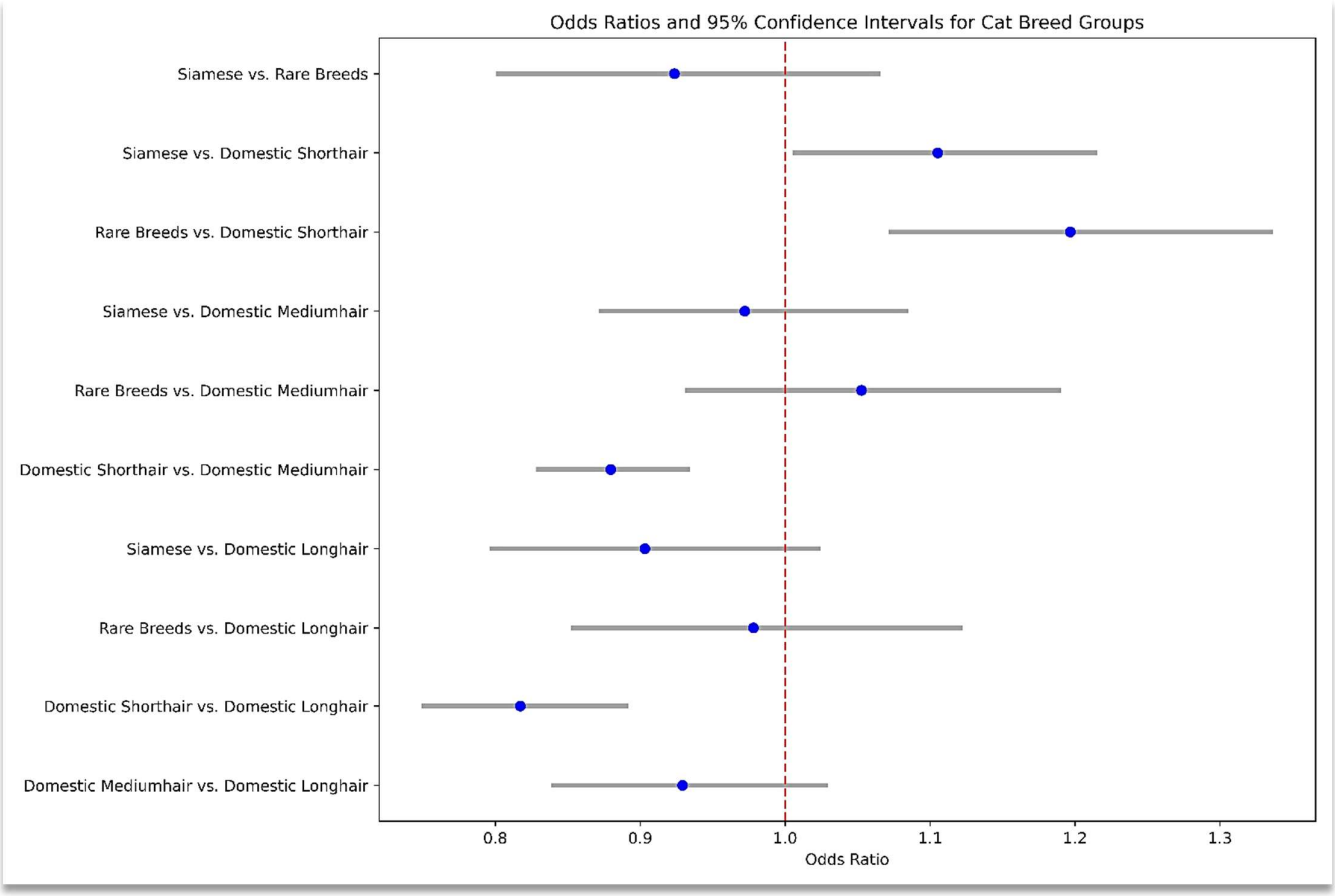
- **Siamese vs. Domestic Shorthair:**

Siamese cats have a 10.52% higher likelihood of being adopted compared to Domestic Shorthair cats.

- **Siamese vs. Rare Breeds:**

Siamese cats have a 7.65% lower likelihood of being adopted compared to Rare Breeds cats.

Visualization of Odds Ratio & 95% confidence intervals



The plot displays the odds ratios and their 95% confidence intervals for various comparisons between cat breed groups. Here are the key points:

Odds Ratios: Represented by blue dots, these values indicate the relative odds of an event occurring in one breed group compared to another.

95% Confidence Intervals: Represented by horizontal lines, these intervals show the range within which the true odds ratio is likely to fall 95% of the time.

Null Effect Line: The red dashed vertical line at 1 represents the null effect, where there is no difference in odds between the two groups being compared.

Conclusion:

Most comparisons show no significant difference in odds between the breed groups, as indicated by confidence intervals crossing the null effect line. The only significant difference is observed in the comparison between Rare Breeds and Domestic Shorthair, where the confidence interval does not cross the null effect line.

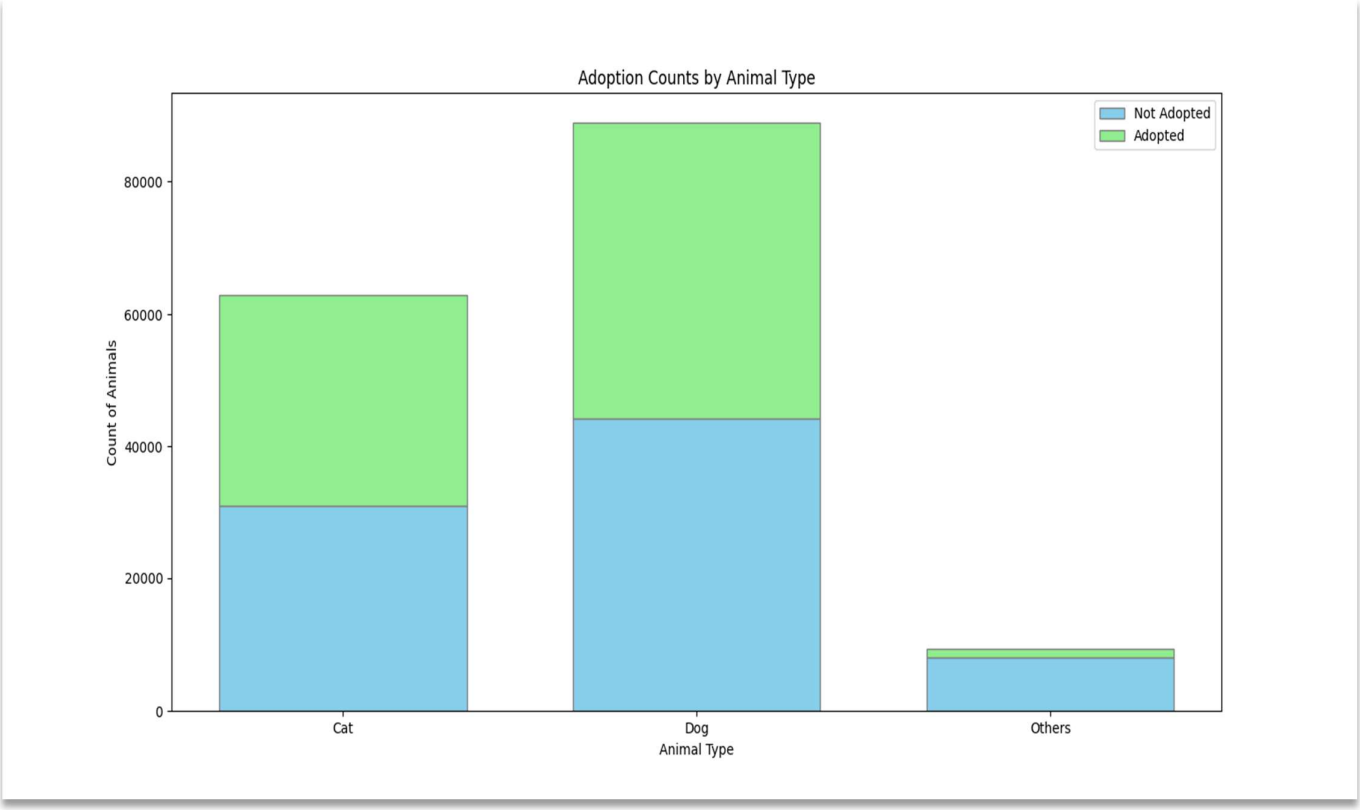
Despite the Domestic Shorthair group having a higher number of adoptions due to its larger population, the Rare Breeds group exhibits a higher adoption probability, indicating that a larger proportion of available cats in this group are being adopted.

Adoption Strategies for Cats

Based on the above analysis, the following adoption strategies can be recommended to increase the adoption rates of less preferred groups:

- **Domestic Shorthair Cats:** Since these cats have the lowest adoption likelihood, shelters can create campaigns to highlight their unique qualities and dispel any negative perceptions.
- Since male cats are slightly less likely to be adopted, shelters can focus on promoting the benefits and lovable traits of male cats.

Adoption Trends by Animal Type



Insights:

Adoption Rates:

- **Cats**: 54.6% of the total cats are adopted.
- **Dogs**: 50.7% of the total dogs are adopted.
- **Others**: 49.0% of the total other animals are adopted.

General Trend:

- Dogs have the highest total numbers in both adoption and non-adoption categories.
- Cats have a higher overall adoption rate compared to dogs and other animals.

CLAIM: Dogs, Cats & Other animals have equal probability of being adopted!

The χ^2 test of independence (or association)

Formulation:

Null Hypothesis (H_0):

$$H_0 : P(\text{Adoption Outcome} \mid \text{Animal Type}) = P(\text{Adoption Outcome})$$

This indicates that the probability of an adoption outcome is independent of the animal type.

Alternative Hypothesis (H_1):

$$H_1 : P(\text{Adoption Outcome} \mid \text{Animal Type}) \neq P(\text{Adoption Outcome})$$

This indicates that the probability of an adoption outcome is dependent on the animal type.

Test Statistics:

For the chi-square test of association, the test statistic is calculated using the following formula:

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

where:

- O_i represents the observed frequency for the ith category.
- E_i represents the expected frequency for the ith category, calculated under the assumption that the null hypothesis is true.

Degrees of Freedom

The degrees of freedom (df) for the test is given by:

$$\mathrm{df} = (r - 1) \times (c - 1)$$

where:

- r is the number of rows (categories of the first variable, animal type).
- c is the number of columns (categories of the second variable, adoption outcome).

Tabulated Statistics: Outcome Type, Animal Type

Rows: Outcome Type Columns: Animal Type

	Cat	Dog	Others	All
Not Adopted	31001	44130	8063	83194
	32483	45934	4777	
Adopted	31884	44797	1185	77866
	30402	42993	4471	
Missing	9	19	7	*
All	62885	88927	9248	161060

Cell Contents
Count
Expected count

Chi-Square Test

	Chi-Square	DF	P-Value
Pearson	4961.941	2	0.000
Likelihood Ratio	5580.787	2	0.000

Given that the p-value < 0.01, we reject the null hypothesis, indicating a significant association between animal type and adoption outcome.

Conclusion:

- **Rejecting the Null Hypothesis**: There is sufficient evidence to conclude that there is a significant association between the type of animal (Cat, Dog, Others) and their adoption outcome (Adopted, Not Adopted).
- **Interpretation**: The likelihood of an animal being adopted, not adopted is dependent on the type of animal. This means that the type of animal influences its adoption outcome.

Animal Euthanasia

Animal euthanasia refers to the act of humanely ending the life of an animal to alleviate suffering or for other compassionate reasons. This procedure is typically performed by veterinarians using methods that cause minimal pain and distress. Euthanasia is considered a last resort when an animal's quality of life is severely compromised due to illness, injury, or behavioral issues that cannot be resolved. It is a complex and sensitive topic, often necessitated in shelters and veterinary practices.

Literature Review on Factors Influencing Animal Euthanasia

1. Health Status

- **Terminal Illnesses**: Chronic or terminal diseases such as cancer, severe organ failure, and advanced stages of infectious diseases are leading reasons for euthanasia. Studies highlight the importance of quality-of-life assessments in making these decisions (Patronek et al., 1996).
- **Injuries**: Severe, irreversible injuries from accidents or abuse often led to euthanasia when the animal's pain cannot be adequately managed.

2. Behavioral Issues

- **Aggression**: Aggressive behavior, especially when it poses a danger to humans or other animals, is a common factor. This can be due to poor socialization, trauma, or inherent temperament (Marder & Duxbury, 2008).
- **Fear and Anxiety**: Animals with severe, unmanageable anxiety or fear, which leads to a poor quality of life, may also be euthanized (Duxbury et al., 2003).

3. Overpopulation

- **Shelter Capacity**: Overcrowded shelters may resort to euthanasia when they exceed their capacity to care for animals. This is a significant issue, particularly in regions with high stray populations (Scarlett et al., 2002).
- **Adoptability**: Animals that are less likely to be adopted due to age, breed, or health issues are at higher risk in overburdened shelters (Patronek et al., 1995).

4. Resource Limitations

- **Financial Constraints**: Limited funding and resources in shelters and rescue organizations can lead to euthanasia when there are insufficient means to provide adequate care (Clancy & Rowan, 2003).
- **Medical Resources**: Lack of access to advanced medical treatments or veterinary care can result in euthanasia for treatable conditions (Lord et al., 2006).

Predicting Euthanasia in Dogs: Logistic Regression Analysis Using Age as a Predictor

Literature Review

Age and Euthanasia Rates:

- A study by Salman et al. (2000) found that older animals are more likely to be euthanized in shelters compared to younger ones. This is often due to the increased prevalence of health problems and lower adoption demand for older animals.
- Kass et al. (2001) reported similar findings, highlighting that age is a significant factor in euthanasia decisions.

Binary Logistic Regression: Outcome Type versus Age upon Outcome

Model

$$\text{logit}(P(\text{euthanasia} \mid \text{age upon outcome})) = \log\left(\frac{P(\text{euthanasia}|\text{age upon outcome})}{1-P(\text{euthanasia}|\text{age upon outcome})}\right) = \beta_0 + \beta_1 \cdot \text{age upon outcome}$$

Coefficients

Term	Coef	SE Coef	Z-Value	P-Value	VIF
Constant	-4.2311	0.0318	-133.07	0.000	
Age upon Outcome	0.012314	0.000433	28.44	0.000	1.00

Interpretation of the coefficients:

1. **Constant Coefficient (-4.2311)**:

- The constant coefficient represents the log-odds of the baseline category (e.g., euthanasia) when the predictor variable (dog age) is zero.
- In this case, the negative coefficient suggests that as the age of the dog approaches zero, the log-odds of euthanasia decrease significantly.
- The Z-value (-133.07) and associated P-value (0.000) indicate that the constant coefficient is statistically significant, implying that the baseline log-odds of euthanasia are significantly different from zero.

2. **Age upon Outcome Coefficient (0.012314)**:

- The coefficient for "Age upon Outcome" represents the change in log-odds of the response variable (euthanasia) for a one-unit increase in dog age.
- The positive coefficient indicates that as the age of the dog increases, the log-odds of euthanasia also increase.

- The Z-value (28.44) and associated P-value (0.000) suggest that the coefficient for dog age is statistically significant, implying that dog age has a significant effect on the likelihood of euthanasia.

Odds Ratios for Continuous Predictors

	Odds Ratio	95% CI
Age upon Outcome	1.0124	(1.0115, 1.0132)

Interpretation:

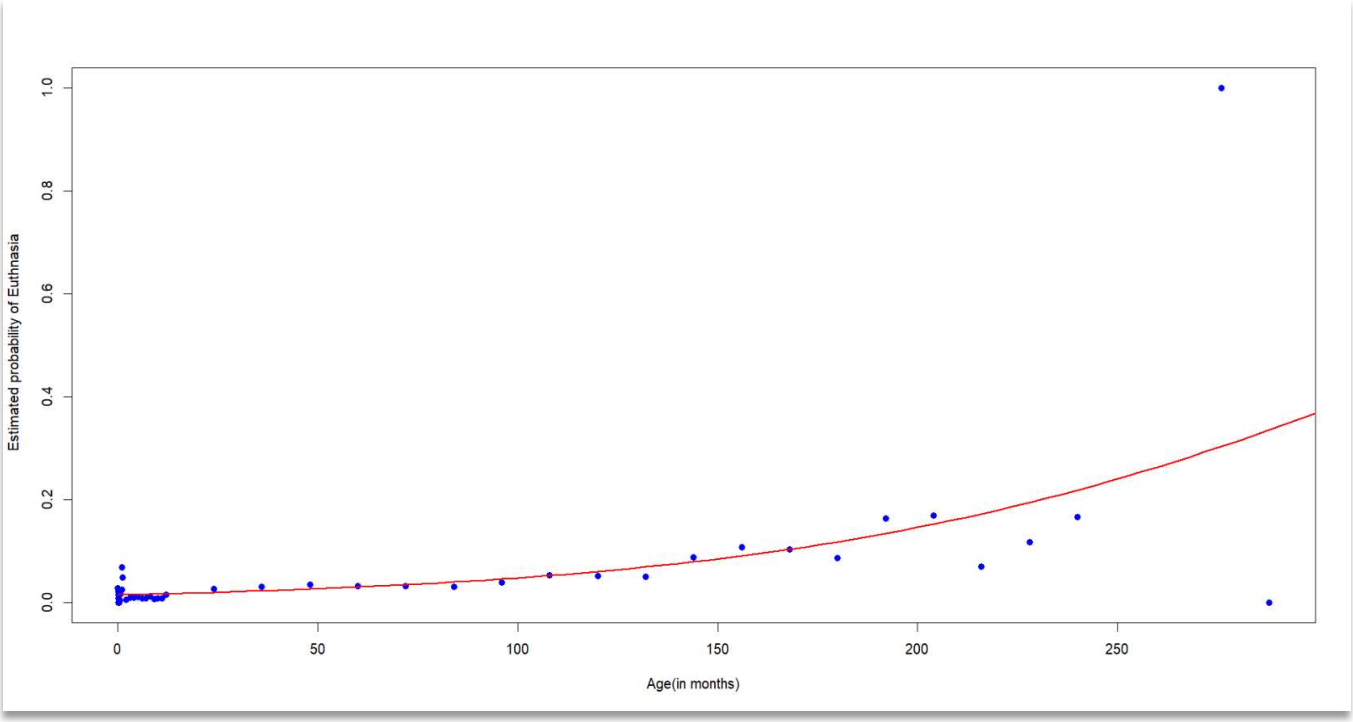
1. **Odds Ratio (1.0124)**:
   - The odds ratio represents the change in odds of the response variable (euthanasia) for a one-unit increase in the predictor variable (dog age).
   - In this case, an odds ratio of 1.0124 indicates that for each additional year of age in a dog, the odds of euthanasia increase by approximately 1.24%.
2. **95% Confidence Interval (CI)**:
   - The 95% confidence interval provides a range of values within which we are 95% confident that the true odds ratio lies.
   - The interval (1.0115, 1.0132) suggests that we can be reasonably confident that the true increase in odds of euthanasia for each additional year of age falls within this range.

Model Summary

Deviance R-Sq	Deviance R-Sq(adj)	AIC	AICc	BIC	Area Under ROC Curve
3.37%	3.36%	19015.20	19015.20	19033.99	0.6603

Analysis of Observed Proportion of Euthanasia by Age and Estimated Probabilities of euthanasia of Dogs from the Logistic Regression Model

In this analysis, we plot the age of dogs in months on the x-axis and the estimated probability of adoption on the y-axis. The plot demonstrates how the likelihood of euthanasia changes with the age of the dogs, based on the logistic regression model's predictions.



Age Distribution and Probability of Euthanasia:

Young Dogs (0-50 months): The probability of euthanasia is very low. The scatter plot points are clustered near zero on the y-axis, indicating that younger dogs have a low euthanasia rate.

Middle-Aged Dogs (50-150 months): There is a slight increase in the probability of euthanasia, but it remains relatively low. The red curve (logistic regression fit) starts to increase gradually, suggesting a slow rise in the risk as age increases.

Older Dogs (150+ months): The probability of euthanasia increases more noticeably. The red curve shows a steeper ascent, indicating that older dogs have a higher estimated probability of euthanasia. Scatter plot points are more spread out and higher on the y-axis, reflecting a higher proportion of euthanized dogs in this age range.

Model Fit: The logistic regression curve fits the data well, capturing the trend that the probability of euthanasia increases with age.

Predicting Euthanasia in Cats: Logistic Regression Analysis Using Age as a Predictor

Binary Logistic Regression: Outcome Type versus Age upon Outcome

Model

$$\text{logit}(P(\text{euthanasia} \mid \text{age upon outcome})) = \log\left(\frac{P(\text{euthanasia}|\text{age upon outcome})}{1-P(\text{euthanasia}|\text{age upon outcome})}\right) = \beta_0 + \beta_1 \cdot \text{age upon outcome}$$

Coefficients

Term	Coef	SE Coef	Z-Value	P-Value	VIF
Constant	-3.5581	0.0255	-139.56	0.000	
Age upon Outcome	0.013064	0.000410	31.89	0.000	1.00

Odds Ratios for Continuous Predictors

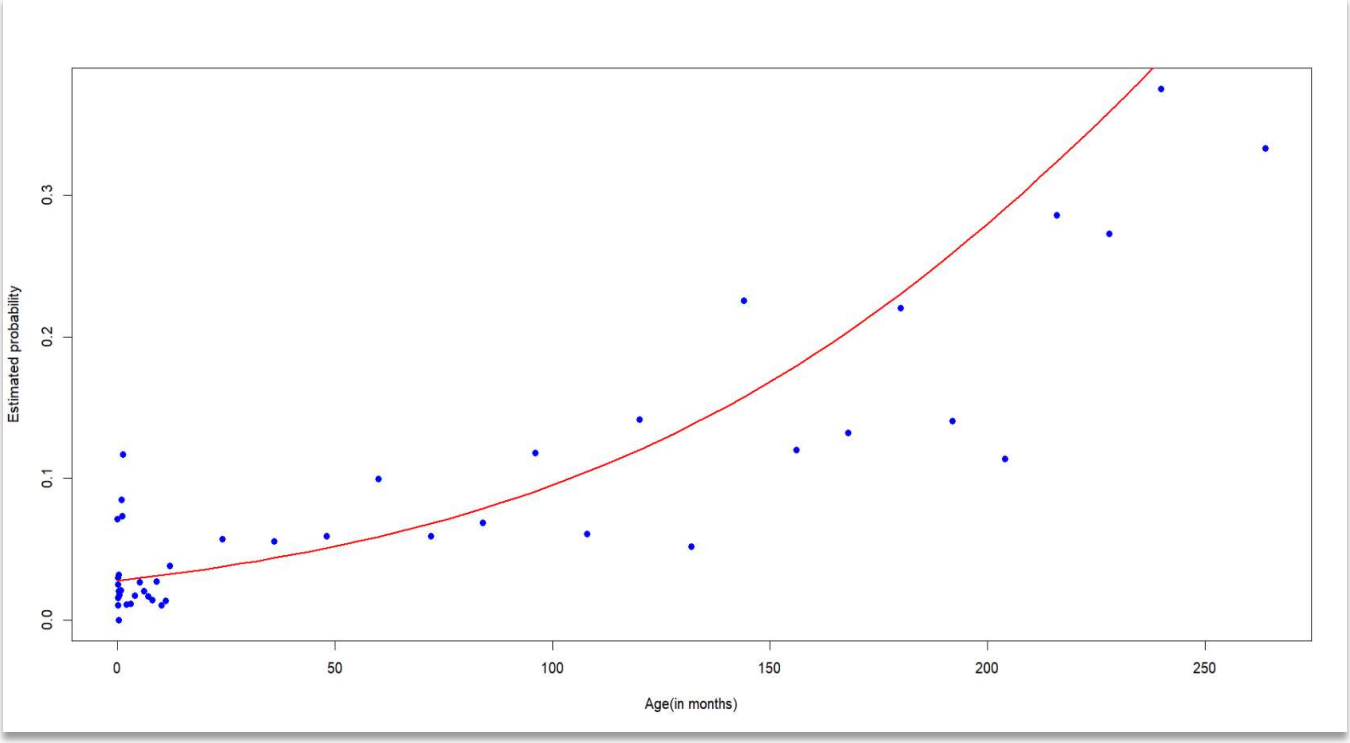
	Odds Ratio	95% CI
Age upon Outcome	1.0132	(1.0123, 1.0140)

Model Summary

Deviance R-Sq	Deviance R-Sq(adj)	AIC	AICc	BIC	Area Under ROC Curve
3.89%	3.89%	19413.27	19413.27	19431.37	0.6248

Analysis of Observed Proportion of Euthanasia by Age and Estimated Probabilities of euthanasia of Cats from the Logistic Regression Model

In this analysis, we plot the age of cats in months on the x-axis and the estimated probability of adoption on the y-axis. The plot demonstrates how the likelihood of euthanasia changes with the age of the dogs, based on the logistic regression model's predictions.



Observations:

- In the lower age range (0-50 months), there are many points with low estimated probabilities, indicating lower euthanasia rates.
- As age increases, the scatter points tend to be higher, particularly after 100 months, showing higher euthanasia rates for older cats , it becomes more pronounced after 150 months.

Model Fitting

The red logistic regression curve fits the general trend of the data points well, with the probability of euthanasia rising as the cats' age increases. While the model fits the data well, there is some scatter around the red curve, indicating variability not explained by age alone. Other factors might also influence euthanasia probability.

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