Impact of Nationwide Income and Education Level on Euthanasia in Animal Shelters

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Abstract

- Animal welfare has changed significantly in the past few decades whereas animal euthanasia rates in shelters have been in a steep decline [1]. When examining these euthanasia rates countrywide, it is still obvious that some areas perform much better than others [2], [3].
- We attempt to understand the causes for whether or not an animal arriving at the shelter gets adopted, which can lead to their eventual euthanasia.
- Through the analysis of the surrounding neighborhoods of the shelters, we can determine whether the demographic composition and income distribution has an effect on whether an animal shelter chooses to perform euthanasia.
- We use exploratory data analysis and implement a Linear Regression model that could help to predict the euthanasia rate based on community demographics.

Background

- Each year approximately 3-4 million animals are euthanized in shelters with many factors cited as contributing to euthanasia [4].
- Using data provided by Shelter Animal Count [1] and the US Census [5][6], we were provided with the opportunity to analyze the effects of income and education on the euthanasia rates across the United States.
- For determination of the effect of education and income on euthanasia rates, we employed several data analytics techniques for visualization of our set of features in comparison to euthanasia rates. This allowed us to determine which features were correlated to euthanasia rates.
- Additionally, we used Multiple Linear Regression to predict on our given dataset and determine the expected values for low and high income and education.

Problem Motivation

Through the identification of euthanasia factors, further actions can be taken to reduce unnecessary euthanasia procedures and save animal lives. We attempt to look at the median household income and the highest level of education as possible socioeconomic factors affecting the likelihood of euthanasia.

This research is important because:

- There is still a lot that can be done to reduce euthanasia rates across the country. As shown in Figure 1, various hotspots exist across the United States for euthanasia rates. For example in Hawaii, 28% of animals entering the shelter system were euthanized in 2020 [1][7].
- Median household income hotspots tend to be nonexistent in comparison to euthanasia hotspots.
- If we know the factors affecting euthanasia we could work on a better solution such as transferring animals to other shelters with better regional characteristics [8].

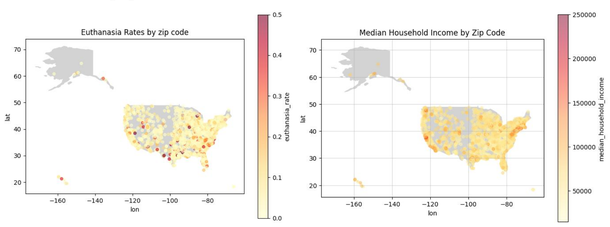

Figure 1. Euthanasia Rates and Median Household Income by Zip Code

Approach

To compute euthanasia rates based on income and education data, three different datasets were used. Our euthanasia and shelter data was taken from the Shelter Animal Count database. Our income and education data was taken from the US Census database. Lastly, to merge these datasets by zip code a ZCTA to Zip Code crosswalk database was used.

- Initially, cleaning and preprocessing of data were performed to remove missing values using MySQL.
- Data imputation was used to replace missing income values with the averages of the remaining values.
- Using the crosswalk database from ZCTA to Zip Codes we then joined the shelter data with Census income and education data.
- Animal Shelter Database contained data from 2015 to 2023. In order to analyze the possible correlation, data from 2020 was used to match the Census data.
- Exploratory data analysis in Tableau and Python was performed.
- Based on the findings, a Multiple Linear Regression model was created to predict euthanasia rates based on education level and household median income

Evaluation

Once data had been collected and merged allowing for our feature set to be ordered by zip codes, we began analysis on the correlation between euthanasia rates and our various other features. As shown in Figure 2, the following features are correlated:

- Features with significant negative correlation
  - adoption rate and transferred rate
  - adoption rate and euthanasia rate
  - transfer rate and completion of bachelor degree
  - rate of completion of high school and rate of completion of other schooling
- Features with significant positive correlation
  - transfer rate and intake rate
  - adoption rate and completion of bachelors degree rate

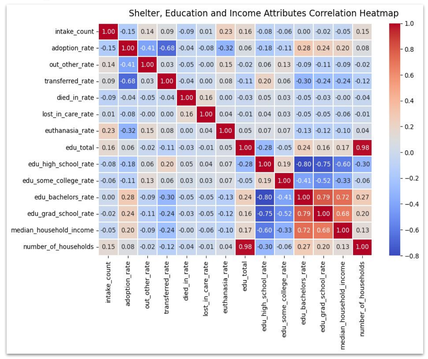

Figure 2. Merged Dataset Features Heatmap

Using this knowledge, we decided to look at transfer count to further determine the effect it had on euthanasia rates. Figure 3 and Figure 4 provides this analysis.

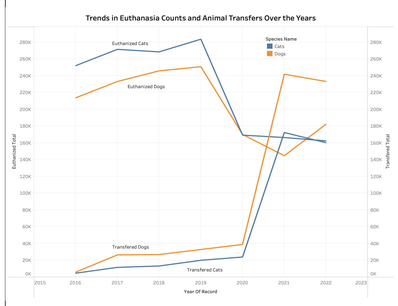

Figure 3. Trends in Euthanasia Counts and Animal Transfers Over the Years

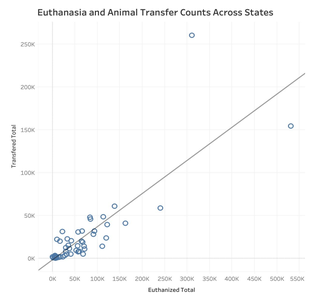

Figure 4. Correlation between state counts for euthanasia and transfers across the US

Figure 3 demonstrates trends in total euthanasia counts and animal transfers over the years for cats and dogs. It can be observed that euthanasia counts dropped significantly in 2020 for both species. Furthermore, there is a sharp increase in animal transfers in the following year. Evidently, there are far more dogs than cats included in the transfer programs.

Results

Initially, we performed linear regression on the individual components against euthanasia rates. These results are shown in Figure 5.

- Noticeably, intake rate and euthanasia rate appear to be correlated
- Otherwise, no significant individual correlations

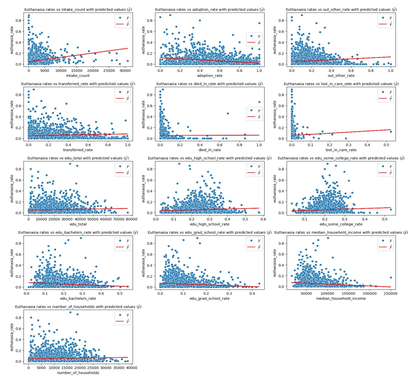

Figure 5. Individual Linear Regression against Euthanasia Rates

We then performed multiple linear regression to account for the possibility that multiple features may have an effect on predictions of euthanasia rates.
Results:

- MSE: 0.00493, RMSE: 0.0702
- Average value vs predicted for euthanasia rates with income below 50000: 0.0642/0.0665
- Average value vs predicted for euthanasia rates with income above 70000: 0.0344/0.0429
- Average value vs predicted for euthanasia rates with low education level(50% of population have not completed high school): 0.0662/0.0918
- Average value vs predicted for euthanasia rates with high education level (50% of population have at least some college experience): 0.0383/0.04354

Conclusion

Overall, it has been shown that euthanasia rates are correlated to higher education and income. This is given by the results of the multiple linear regression in comparison to the average value results.

- As income increases as shown in our results (income above 70000 vs below 50000), our euthanasia rates decrease. Our predicted model values decrease as well for multiple linear regression.
- As education increases (50% of population have at least some college experience vs 50% of population have not completed high school), euthanasia rates decrease as well. Our predicted model values decrease as well for multiple linear regression.

We have shown that increased euthanasia rates are associated to both income and education for United States animal shelters. These results give shelters insight into how locational characteristics may affect the need to euthanize animals, and hopefully guide them to transfer animals to better locations before euthanizing.

References

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