

Animal Shelter ML

Vyas, Atharva

MMA – McGill University

**Project Proposal:** Enhancing Animal Shelter Efficiency through Machine Learning

**Problem Statement:**  
Animal shelters face growing challenges in managing limited resources, ensuring high adoption rates, and preparing for fluctuating intake volumes. With over 5.4 million stray animals in the U.S. as of 2024 and inconsistent adoption trends post-COVID, shelters are often operating on tight budgets from donations or public funds and thus struggle to respond proactively. A data-driven approach is needed to optimise resource allocation, improve adoption outcomes, and support financial planning.

**Goals and Scope:**  
This project aims to apply machine learning and statistical modelling to enhance decision-making for animal shelters by focusing on three key areas:

1. Adoption Likelihood Prediction:
   * Build classification models (e.g., logistic regression, random forests, XGBoost) to predict each animal’s probability of adoption within a given timeframe.
   * Use model interpretation tools like SHAP to identify which features (age, breed, health status, intake condition) drive outcomes.
2. Adopter-Pet Matchmaking and Segmentation:
   * Apply clustering (e.g., K-Means, GMM) on adopter demographics and pet traits to segment adopter types and animal profiles.
3. Seasonal Intake Forecasting:
   * Use time series models (e.g., ARIMA, Prophet) to forecast future animal intakes by species, time of year, and location.
4. Budget Optimisation and Financial Management (Stretch-goal):
   * Simulate budgetary trade-offs using scenario-based modelling (e.g., fee changes vs. adoption volume vs. medical cost).
   * Formulate a linear programming model to optimise spending on high-risk animals (e.g., extended stay, medical cases) for maximum adoption return on investment.
5. Communicating Insights:
   * Design an interactive dashboard with forecast visualisations, adoption likelihood heatmaps, and adopter-pet compatibility tools to support decision-making by shelter staff and non-technical stakeholders.

**Data Sources:**  
Primary data will be drawn from publicly available intake/outcome datasets from:

* [Austin Animal Center (Texas)](https://data.austintexas.gov/Health-and-Community-Services/Austin-Animal-Center-Outcomes/9t4d-g238/about_data)
* [Sonoma County Animal Services (California)](https://data.sonomacounty.ca.gov/Government/Animal-Shelter-Intake-and-Outcome/924a-vesw/about_data)
* [San Jose Animal Care Services (California)](https://data.sanjoseca.gov/dataset/animal-shelter-intake-and-outcomes)
* [Long Beach Animal Care Services (California)](https://data.longbeach.gov/explore/dataset/animal-shelter-intakes-and-outcomes/table/?disjunctive.animal_type&disjunctive.primary_color&disjunctive.sex&disjunctive.intake_cond&disjunctive.intake_type&disjunctive.reason&disjunctive.outcome_type&disjunctive.outcome_subtype&disjunctive.intake_is_dead&disjunctive.outcome_is_dead)

Additional datasets are being requested from national aggregators (e.g., [Shelter Animals Count](https://www.shelteranimalscount.org/)) and local shelters to incorporate anonymised adopter demographics under appropriate data use agreements.

**References**

Best Friends Animal Society. (2022). How data helps save lives. <https://bestfriends.org/data>

Brown, W. P., Davidson, J. P., & Zuefle, M. E. (2013). Effects of phenotypic characteristics on the length of stay of dogs at two no kill animal shelters. Journal of Applied Animal Welfare Science, 16(1), 2–18. <https://doi.org/10.1080/10888705.2013.740967>

Dowling-Guyer, S., Marder, A. R., & D’Arpino, S. S. (2011). Behavioral traits detected in shelter dogs by a behavior evaluation. Applied Animal Behaviour Science, 130(3-4), 107–114. <https://doi.org/10.1016/j.applanim.2010.12.004>

Miller, D. D., Staats, S. R., Partlo, C., & Rada, K. (1996). Factors associated with the decision to surrender a pet to an animal shelter. Journal of the American Veterinary Medical Association, 209(4), 738–742. <https://www.avma.org>

Normando, S., Stefanini, C., Meers, L., Adamelli, S., Coultis, D., & Bono, G. (2006). Some factors influencing adoption of sheltered dogs. Anthrozoös, 19(3), 211–224. <https://doi.org/10.2752/089279306785415556>

Patronek, G. J., Glickman, L. T., Beck, A. M., McCabe, G. P., & Ecker, C. (1996). Risk factors for relinquishment of dogs to an animal shelter. Journal of the American Veterinary Medical Association, 209(3), 572–581. <https://www.avma.org>

Protopopova, A., & Gunter, L. M. (2017). Adoption and relinquishment interventions at the animal shelter: A review. Animal Welfare, 26(1), 35–48. <https://doi.org/10.7120/09627286.26.1.035>

Shelter Animals Count. (2024). National database of shelter statistics. <https://www.shelteranimalscount.org>

Weiss, E., Miller, K., Mohan-Gibbons, H., & Vela, C. (2012). Why did you choose this pet?: Adopters and pet selection preferences in five animal shelters in the United States. Animals, 2(2), 144–159. <https://doi.org/10.3390/ani2020144>