An Evaluation of Machine Learning Algorithms for Classification of Shelter Animal Outcomes

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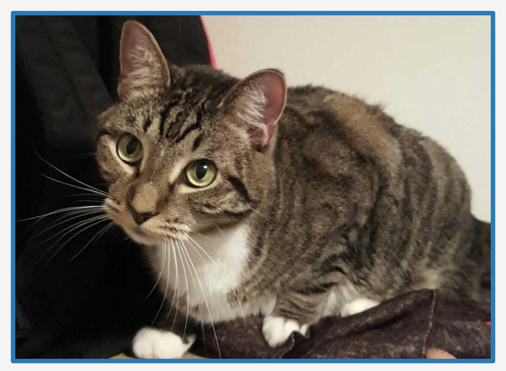
Introduction

Background



- Every year, **animal shelters** across the U.S. give approximately **7.6 million animals** a chance at finding a forever home and starting a new life [1].
- **Certain attributes** of the animals recorded at shelter intake may **affect their outcomes**.
- Shelters can **focus their efforts** on animals who are less likely to be adopted if they know the animal is at risk of having a **negative outcome**.

Goals

- Develop a system utilizing **machine learning** algorithms to **predict the outcomes** of animals brought to shelters based on recorded attributes.
- Determine **which attributes** carry the **most significance** in classifying outcomes.

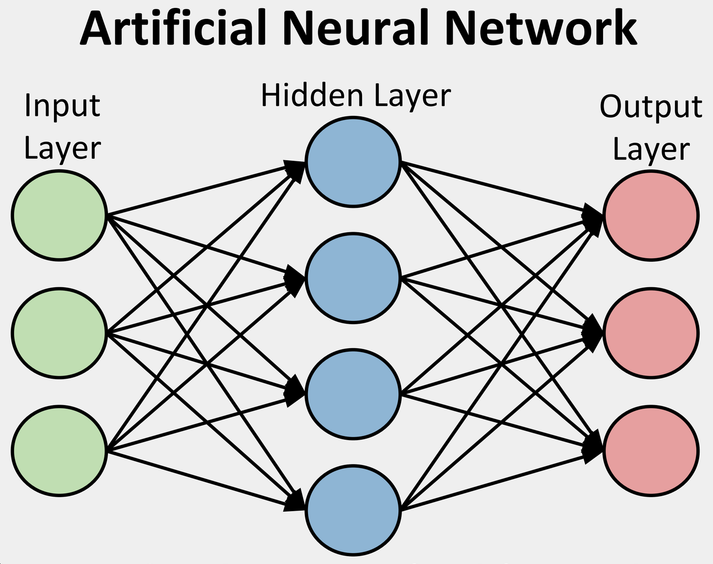
Approach

Data

- Data taken from Austin Animal Center from October, 2013, to March, 2016.
- **Attributes:** Name, Animal Type, Sex, Intactness, Age, Breed, Color, Date/Time
- **Possible Outcomes:** Adoption, Return to Owner, Transfer, Euthanasia, Died
- **Number of Animals in Training Set:** 26729
- **Number of Animals in Testing Set:** 11456

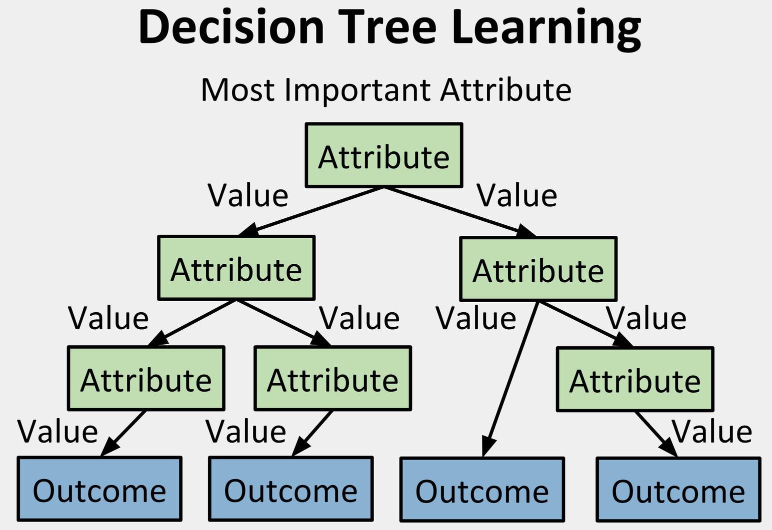
Classification

Artificial Neural Network



- **Weighted neurons** feed forward signals through hidden layers when weights surpass a **threshold** in an **activation function** [2], [3]
- Output layer: **outcomes**
- **Parameterized**
- Relatively **slow**
- **Complex** structure

Decision Tree Learning

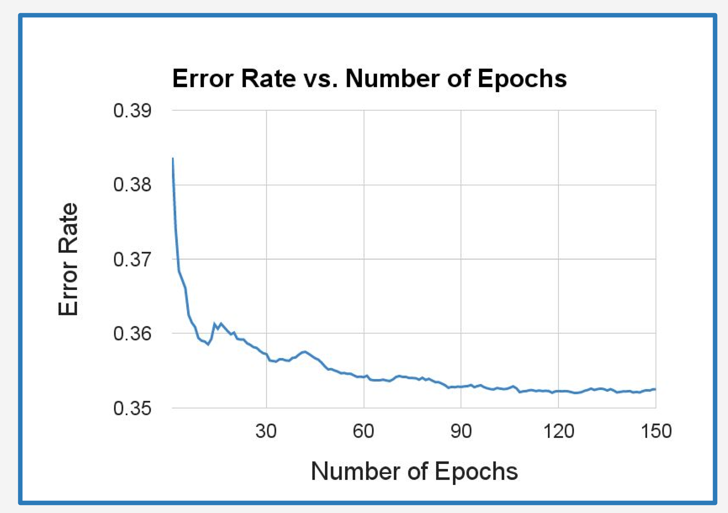


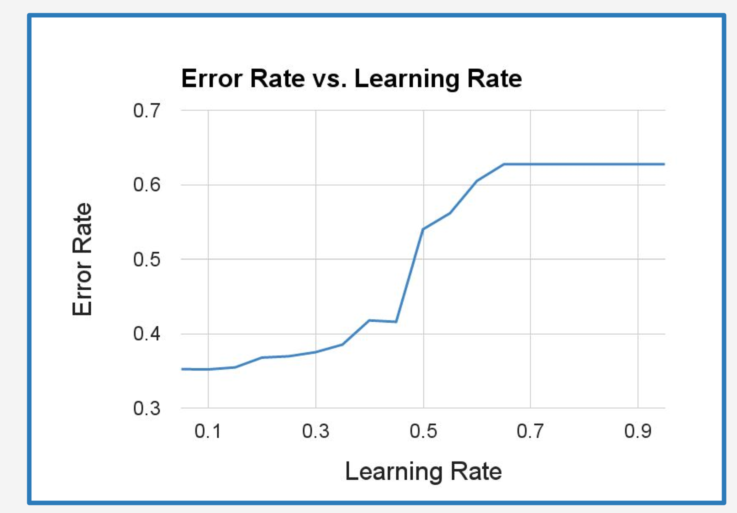
- **Splits instances** by **most important attribute** until all instances have **same classification** [2], [3]
- Most important attribute determined by **information gain** calculation
- **Not Parameterized**
- Relatively **fast**
- **Simple** structure

Results

Artificial Neural Network Parameterization

- By altering the **learning rate** and **number of epochs** for the neural network, we can observe changes in the **total error** for classification of the training set.

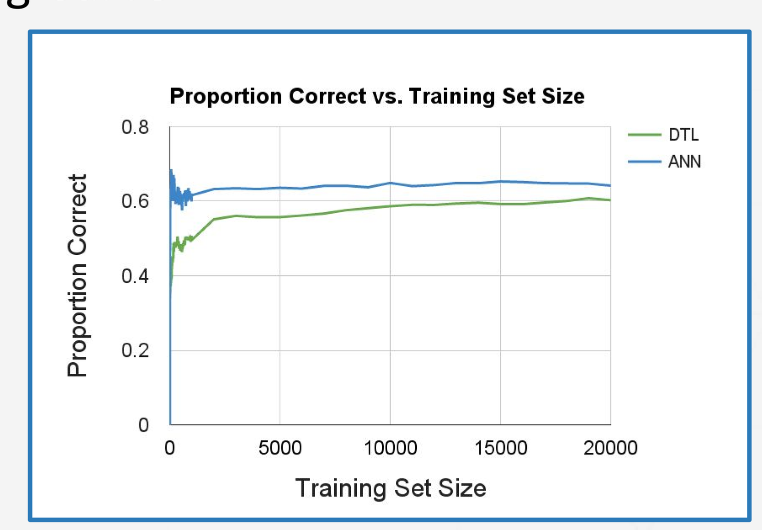




- Increasing the **number of epochs** leads to a **lower error rate** for the ANN.
- Increasing the **learning rate** to a point leads to a **higher error rate** for the ANN.

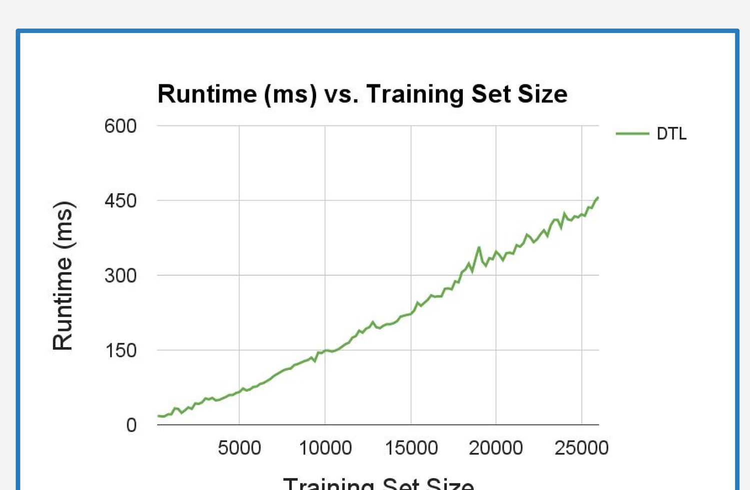
Artificial Neural Network (ANN) vs. Decision Tree Learning (DTL)

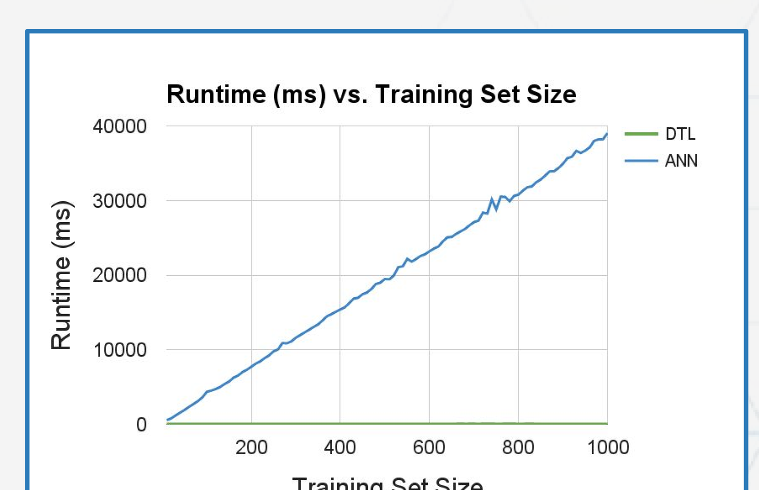
Learning Curve



- The **ANN outperforms** the DTL in terms of **accuracy**.
- The DTL's accuracy grows at a **slower initial rate**, but reaches a higher accuracy given **more examples**.

Runtime

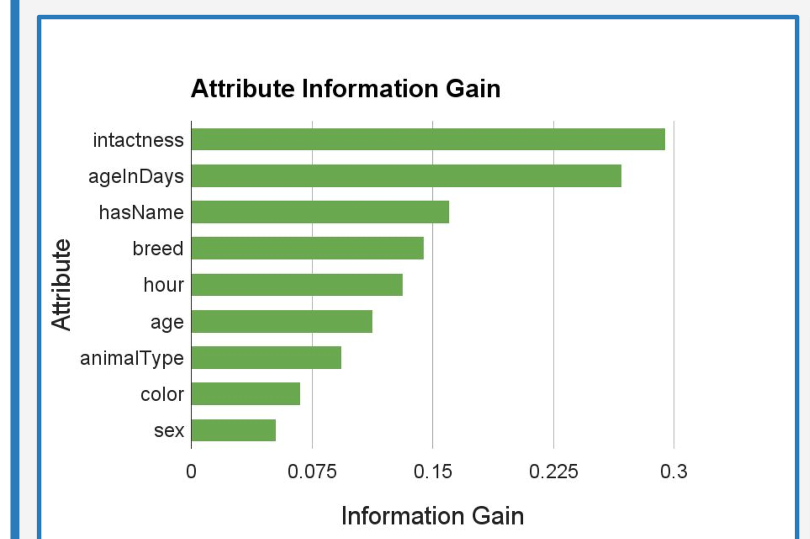


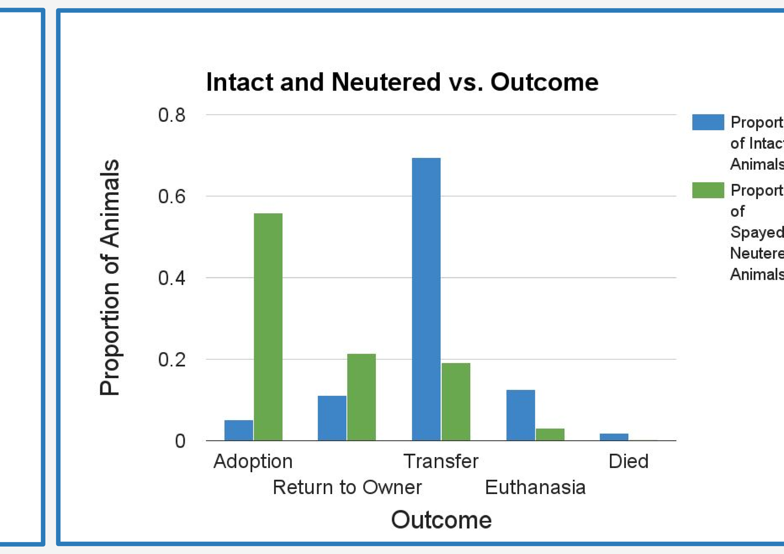


- Given many examples, the **DTL's runtime increases slightly**.
- However, the **ANN's runtime grows** at a much **faster** rate.

Results (cont.)

- By ranking the attributes by their **information gain**, we can see which **attributes** give the **most insight** into the final outcome.





- **Spayed/neutered** animals have **higher adoption** and **lower euthanization** rates.

Conclusion

Discussion

- The **ANN** classifies a **higher percentage of correct instances** than the DTL, but takes a **much longer time** to run (no free lunch).
- Given a greater number of **examples**, both algorithms **improve** in **accuracy**, though the runtime increases significantly for the ANN.
- Some **attributes** of the animals **do not matter much** (sex, color), while some make a **big difference** (intactness, ageInDays) in determining the outcomes.
- Some attributes cannot be controlled, but **adoption rates** may **increase** by **spaying/neutering** the shelter animals and giving each one a **name**.

Future Directions

Add decision tree **pruning** to combat overfitting issues	Implement **GUI** for viewing visualizations of attributes/outcomes	Test **other algorithms**, such as Naive Bayes, and compare results

References

1. **ASPCA**. Pet Statistics. http://www.aspca.org/animal-homelessness, 2016.
2. **M. Aly.** Survey on Multiclass Classification Methods. 2005.
3. **S. Russell and P. Norvig.** Artificial Intelligence A Modern Approach, 3rd Edition. 2010.

Acknowledgements

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