Airfoil Self-Noise prediction

SCS3253 - Machine Learning Project - Group I

Agenda

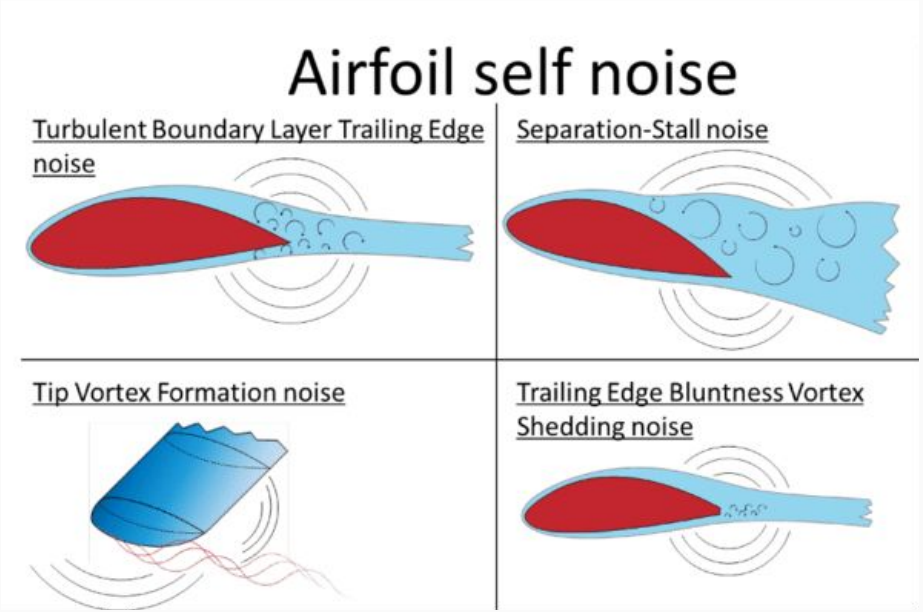
- Introduction
- Exploration
- Scikit-learn Models
- Neural network Models
- Summary

Airfoil Self-Noise Dataset

Airfoil Self-Noise Data Set

The NASA data set comprises different size NACA 0012 airfoils at various wind tunnel speeds and angles of attack.

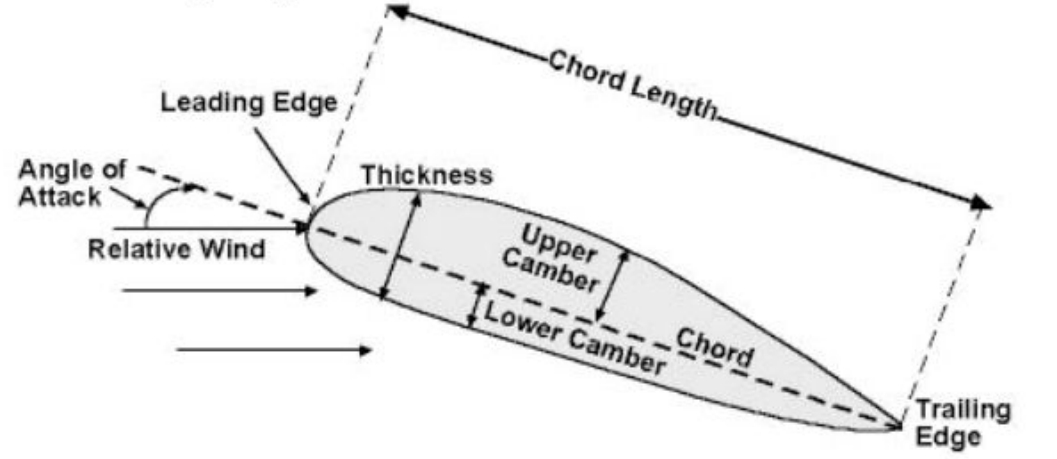
The span of the airfoil and the observer position were the same in all of the experiments.



https://www.researchgate.net/figure/leftSketch-of-airfoil-self-noise-mechanisms-right-methodology-of-the-IBPM-model_fig2_308841044

Airfoil Self-Noise Data Set

The NASA data set was obtained from a series of aerodynamic and acoustic tests of two and three-dimensional airfoil blade sections.



https://www.researchgate.net/figure/leftSketch-of-airfoil-self-noise-mechanisms-right-methodology-of-the-IBPM-model_fig2_308841044

Objective

- Investigating the associations among all features and target.
- Practicing data preprocessing.
- Searching for the better fitting model.

Exploration

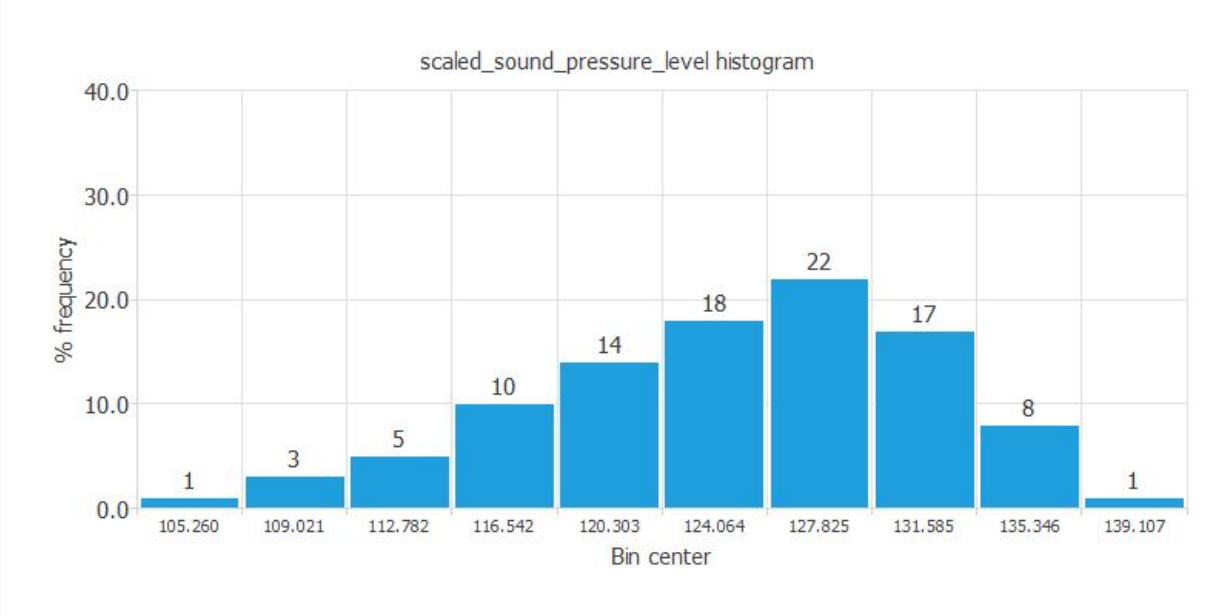
Attributes

There are 5 features and 1 target

The target is scaled sound pressure level, in decibels.

Attribute Information:
1. Frequency, in Hertz.
2. The angle of attack, in degrees.
3. Chord length, in meters.
4. Free-stream velocity, in meters per second.
5. Suction side displacement thickness, in meters.
6. Scaled sound pressure level, in decibels.

Exploration - target

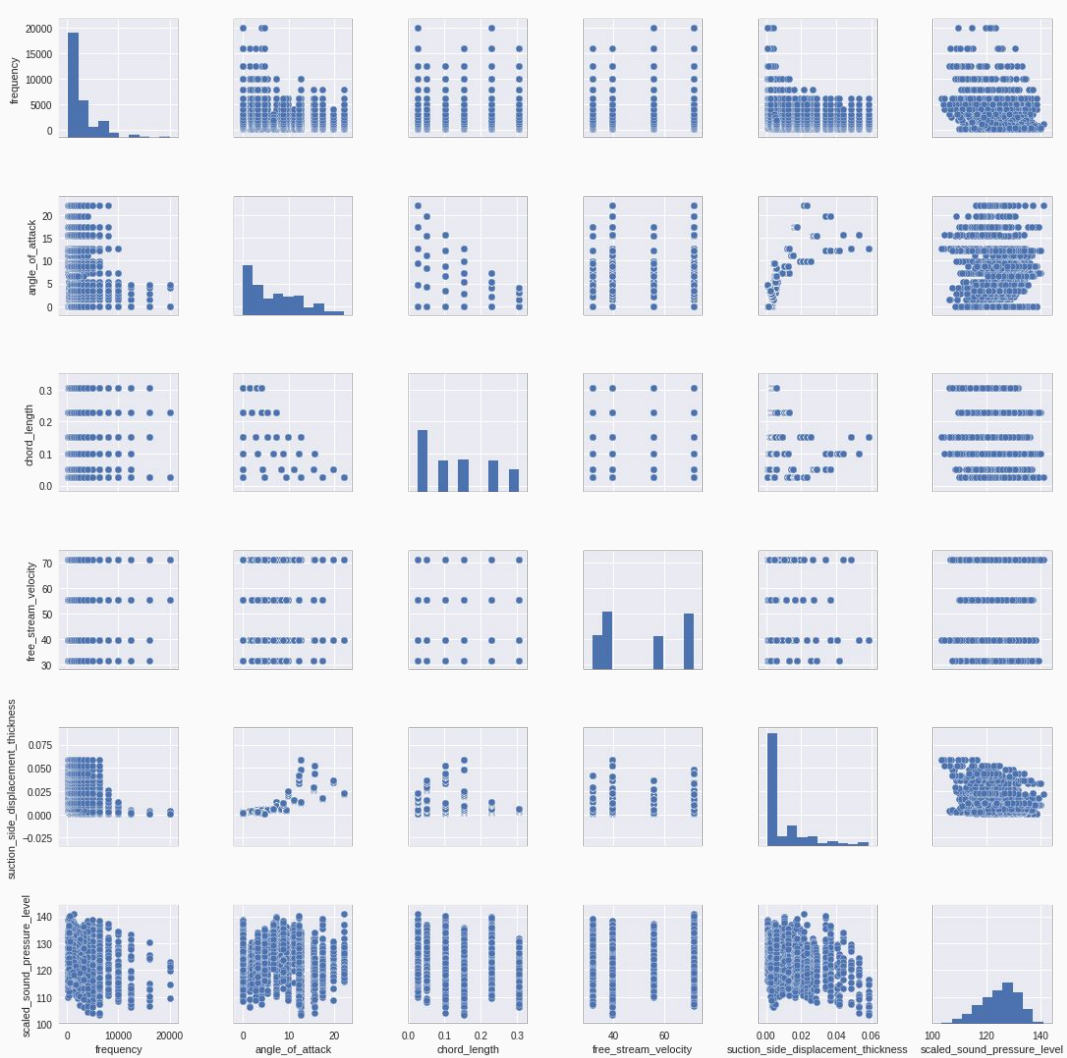


https://www.neuraldesigner.com/learning/examples/airfoil-self-noise-prediction#ModelSelection

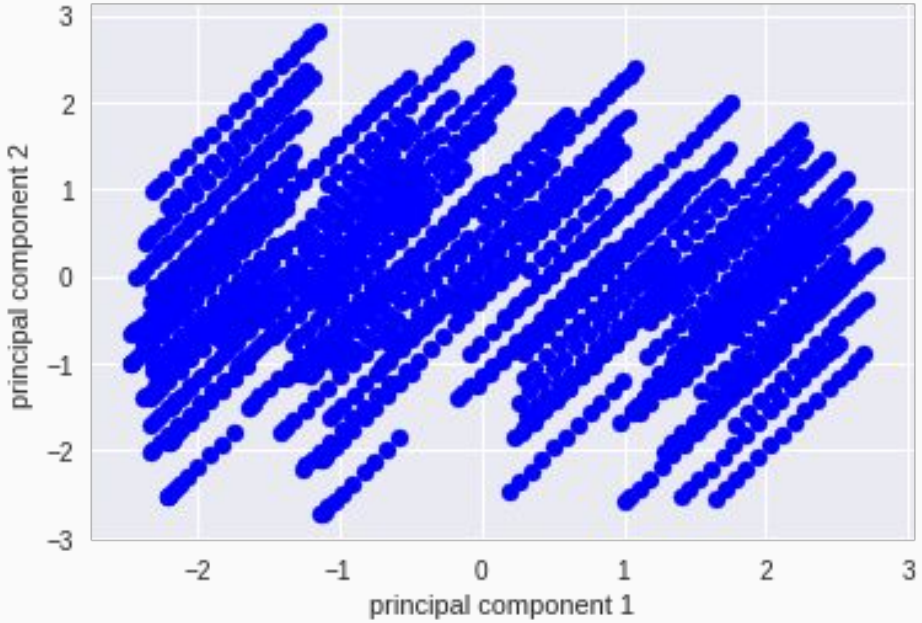
Exploration - features

There are 5 features and 1 target

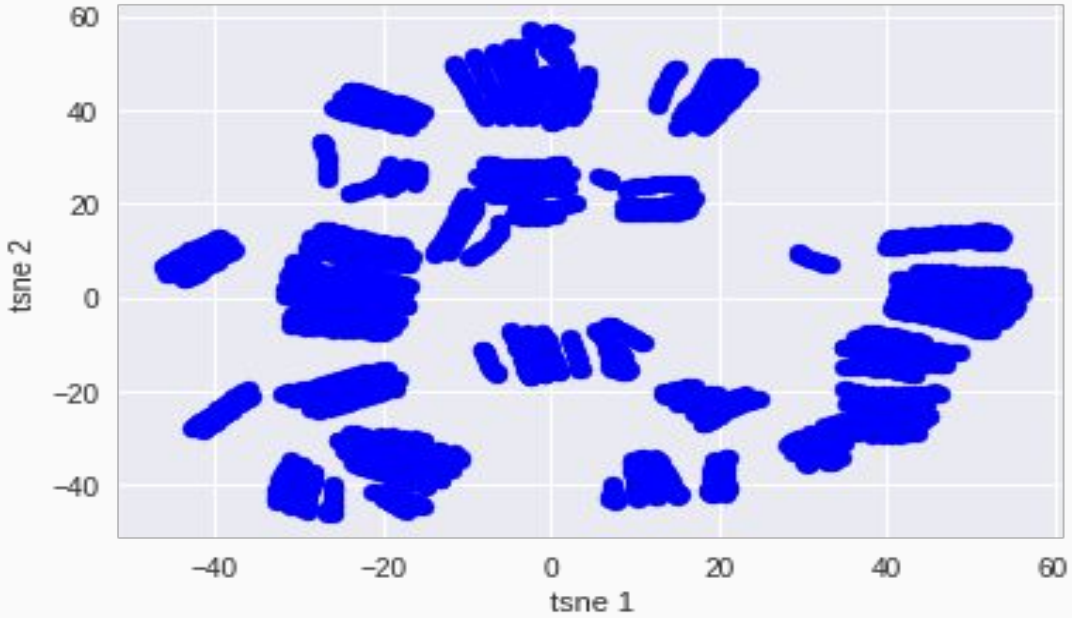
The target is scaled sound pressure level, in decibels.



Dimensionality reduction - PCA



Dimensionality reduction - T-SNE



Model Selection

Transformations and tuning

- Quantile transformer: This method transforms the features to follow a uniform or a normal distribution.
- Max Abs scaler: Scale each feature by its maximum absolute value.
- Standard scaler: Standardize features by removing the mean and scaling to unit variance.
- GridSearchCV: Exhaustive search over specified parameter values for an estimator.

Model Selection

- Lasso
- Linear regression
- Bayesian Ridge
- Ridge
- ElasticNet
- SVR
- Neural network

GitHub

GitHub page and project

To the code

Results

Results

Model	R2 score	MSE score
Neural network	88.92%	5.40
SVR	79.81%	9.85
BayesianRidge	45.68%	26.52
LinearRegression	45.68%	26.53
Ridge	45.68%	26.52
ElasticNet	45.55%	26.59
Lasso	45.55%	26.59

88%

The best accuracy using a neural network

Conclusions & Recommendations

- Epsilon-Support Vector Regression (SVR)

  R square score = 0.80

- Neural Network model is predicting well the entire range of sound level data

  R square score = 0.88

Thank you