Vocal analysis as a screening for Parkinson's disease

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Parkinson’s disease (PD)

Neurodegenerative disease

Dopamine cells die, which results in too little dopamine

Host of different symptoms, motoric, cognitive

Voice is affected

Vocal characteristics Parkinson’s patients

Lower pitch

Lower volume

Monotone speaking patterns

More unstable in pitch (jitter)

More unstable in volume (shimmer)

Statistical goals

Predict PD or not, with:

- Multiple linear regression model (mRLM)
- Logistic regression

H0: The predictions based on a regression model are no better than chance.
HA: The predictions based on a regression model are better than chance.

Dataset 1 analysis

32 people

24 PD patients, 8 healthy controls

~20 variables

- Pitch
- Volume
- Jitter
- Shimmer

6 measurements per person

Dataset 1 analysis

Normalization to Z-scores

Multicollinearity -> Variance Inflation Factor

High VIF scores (>10), not illogical

Does not affect predictive power

Multiple Linear Regression Model (MLRM)

Low F-statistic (0.9937)

High p-value (0.542) -> statistically insignificant

Probably due to dataset

Dataset 2

252 people

188 PD patients

64 healthy controls

754 variables

Multiple Linear Regression Model (MLRM)

F-statistic: 3.440

P-value: 0.000524 < 0.05

Statistically significant!

Multiple Linear Regression Model (MLRM)

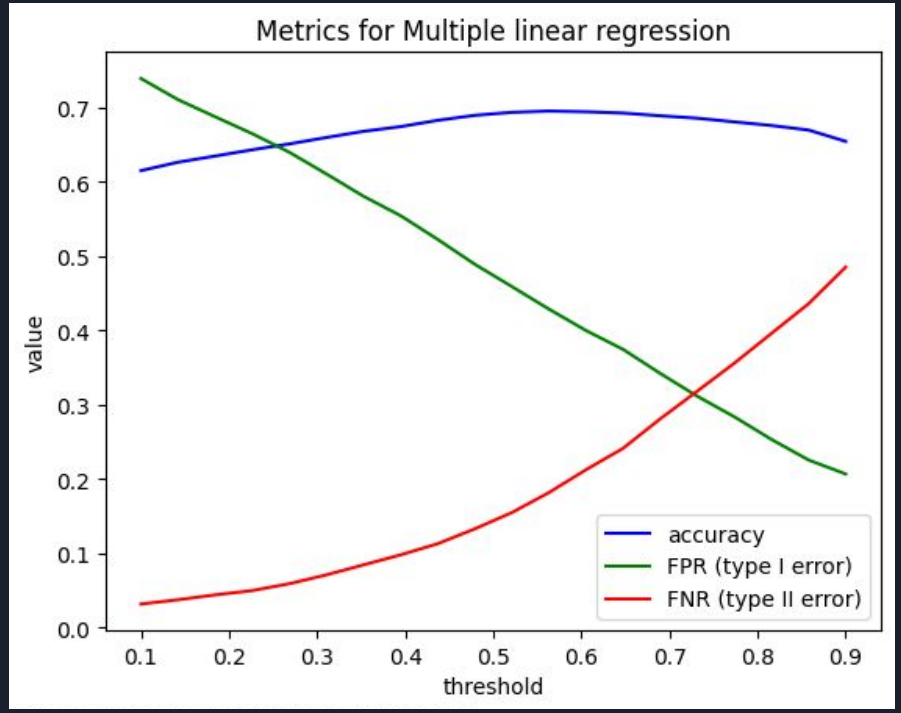
Let’s test it!

60 (training) / 40 (test)

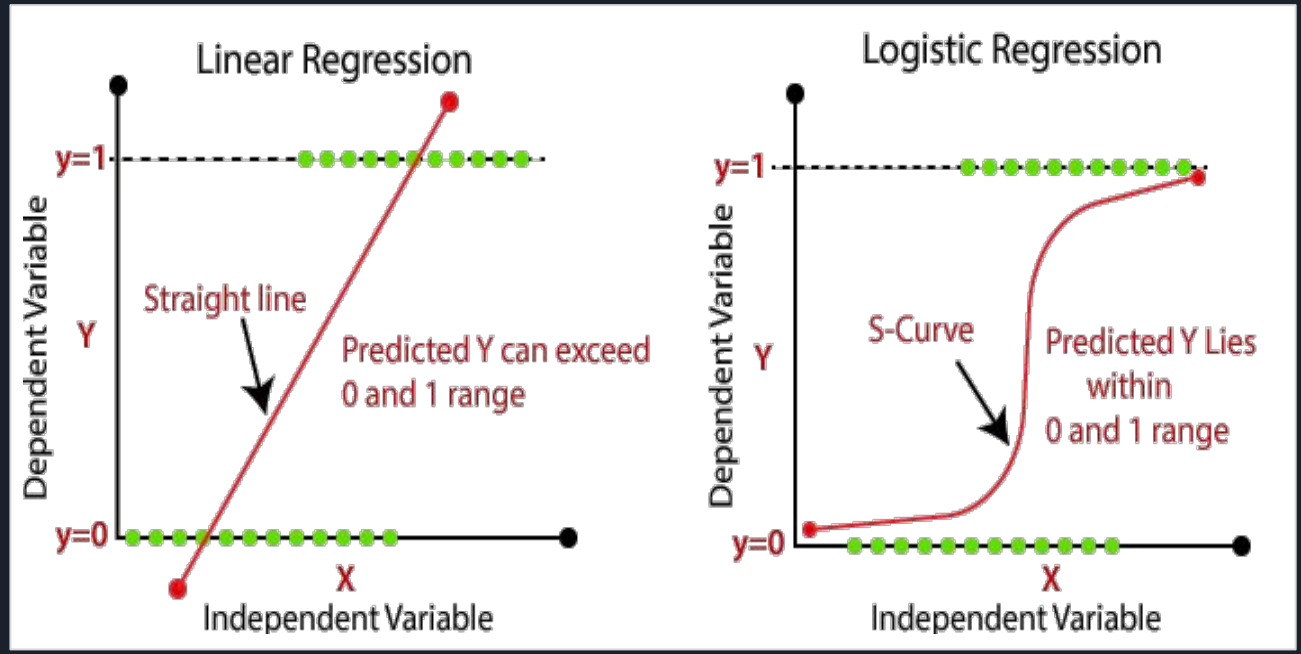
Equal amount of patients and controls in the test set

Classification using a threshold

Multiple Linear Regression Model (MLRM)



MLRM vs Multiple Logistic regression

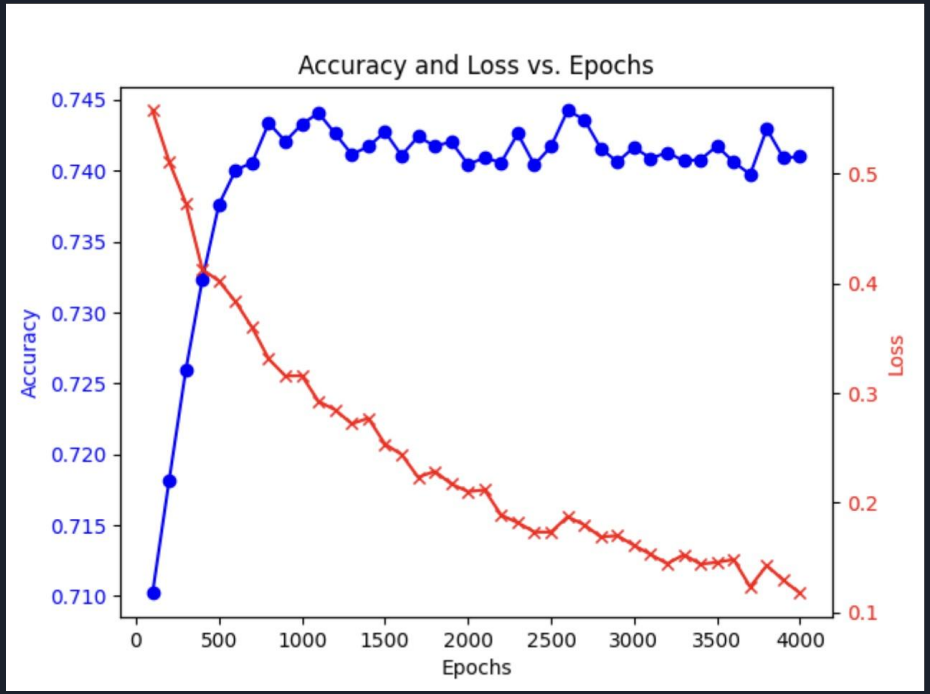


Initial results: loss function

Demonstrative figure, with lower learning rate

Epochs: times every datapoint is processed

Loss goes down, but prediction accuracy plateaus



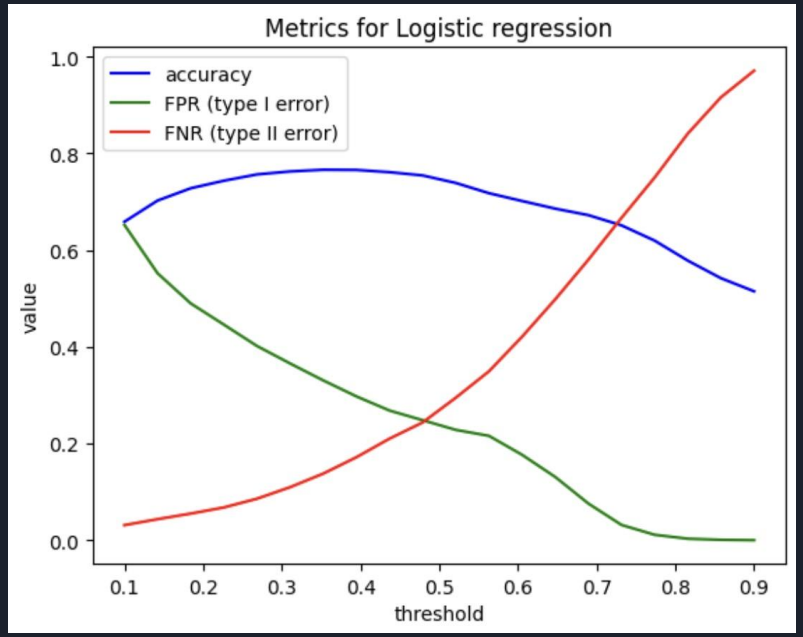
Multiple Logistic regression

Improvement over MLRM

~75% prediction accuracy

Dependent on threshold

Influences accuracy, but false negatives are also important to avoid (screening)



Elastic net regularisation

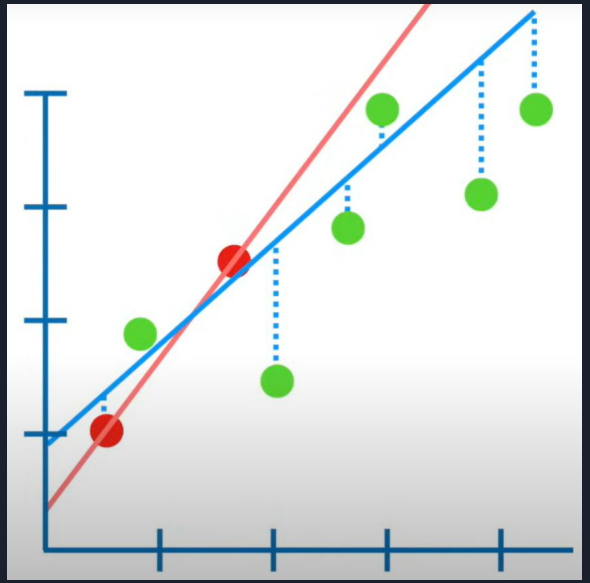
To eliminate variables that do not add to prediction

Lasso (L1): reduce weight, possibly to 0

Ridge (L2): reduce weight with penalty, not to 0

Optimal elastic net parameters:

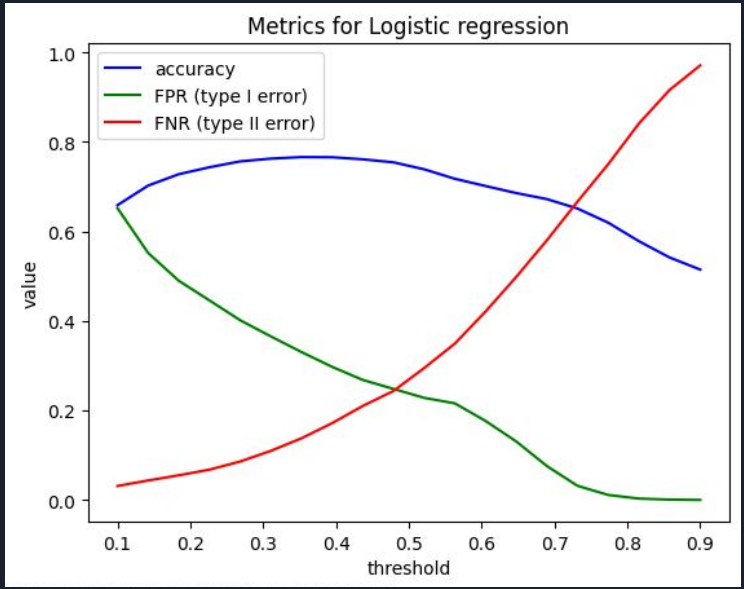
- L1 ratio: 0.1 (mostly ridge)
- alpha: 0.3

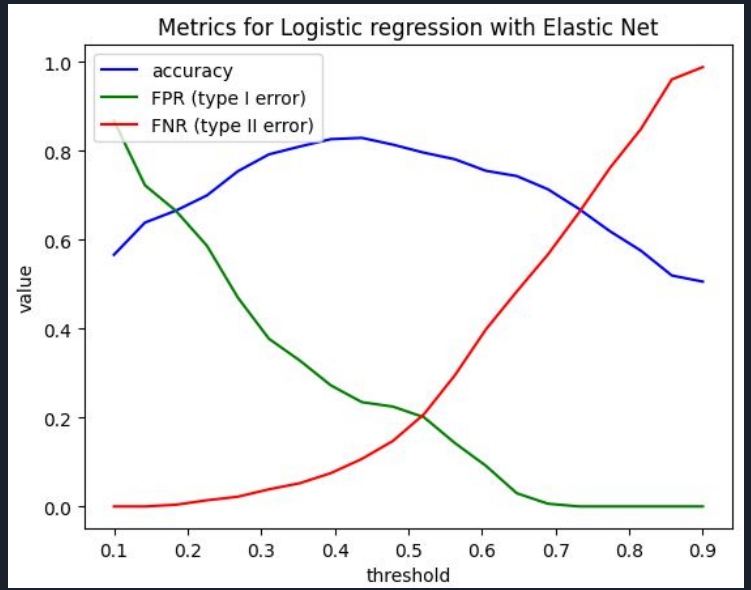


Results after elastic net

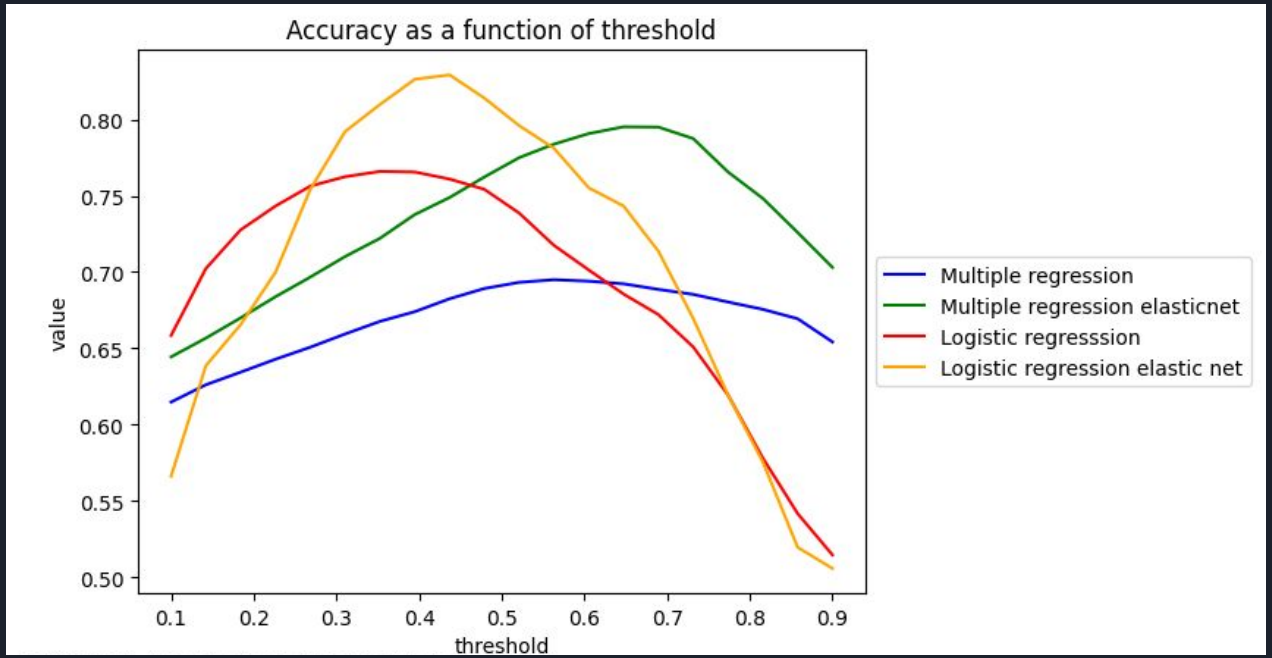
Slightly higher prediction accuracy with 79 variables when threshold is near 0.5

Accuracy is highers around a threshold of 0.4, which also has considerably lower false negatives

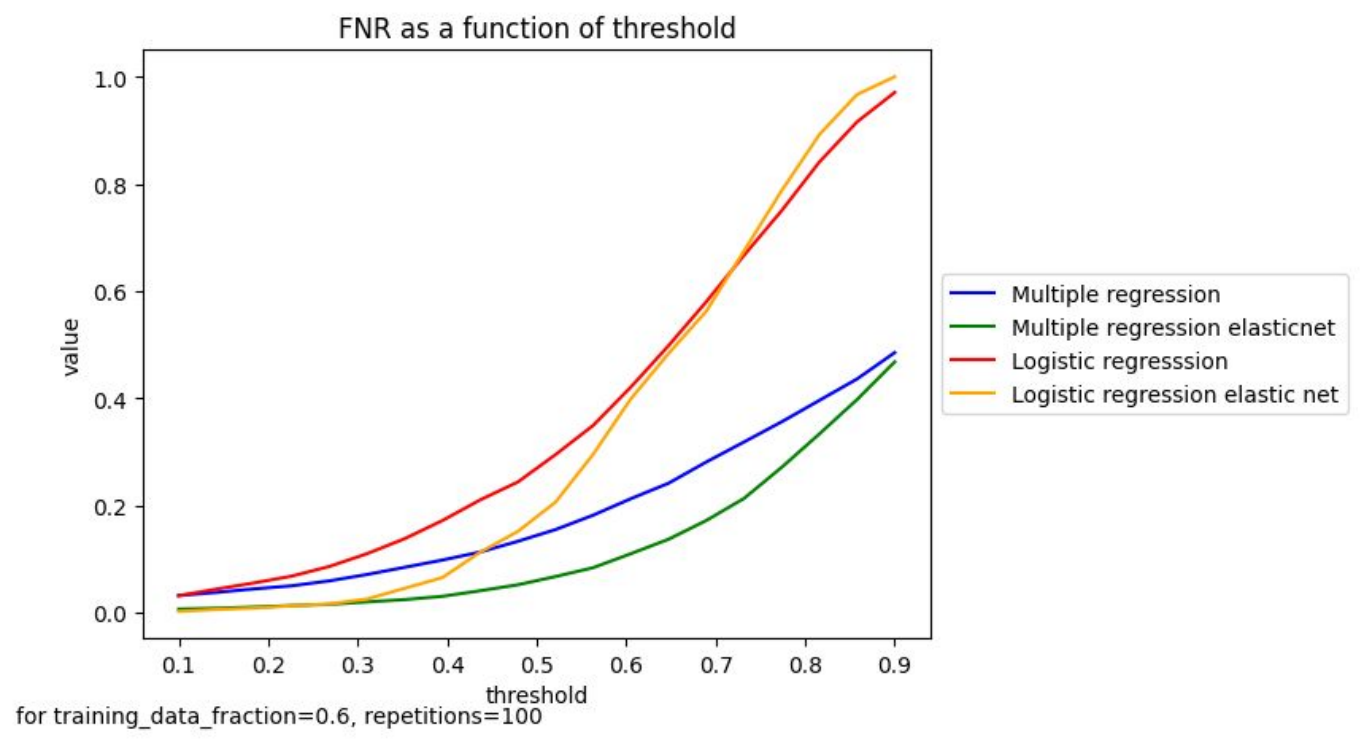




Which method to choose?



Which method to choose?



Limitations to our method

Only ~83% accuracy

Still several false negatives

The current model would be expensive

Real world: much less PD patients

Conclusion

Prediction is possible

Could be a cheap way to screen for Parkinson’s if further researched

Cannot substitute actual diagnostics, but possibly valuable as screening

Questions?