Predicting UPDRS score in early-stage Parkinson's Disease based on vocal measurements

Parkinson's disease Case Study

Background

- ❖ Parkinson's disease (PD) is the second most common neurodegenerative disorder that affects movement.
- ❖ Symptoms start gradually, sometimes starting with a barely noticeable tremor in just one hand.
- ❖ Management of PD typically involves the administration of physical examinations applying various empirical tests, including speech and voice tests.
- ❖ The Unified Parkinson Disease Rating Scale (UPDRS) is a rating tool used to gauge the course of Parkinson's disease in patients.
- ❖ Tracking Parkinson's disease symptom progression based on UPDRS assessment requires the patient's presence in clinic, and time-consuming physical examinations by trained medical staff. Thus, symptom monitoring is costly and logistically inconvenient for patient and clinical staff alike, also hindering recruitment for future large-scale clinical trials.

Application / Clinical relevance

An accurate remote monitoring (telemonitoring) tool of PD progression that predicts UPDRS scores could be derived from the analysis of simple, noninvasive speech tests, as demonstrated in Tsanas et al study[1].

https://www.medicalexpo.com/prod/custo-med-gmbh/product-68135-734254.html

https://www.ellines.com/good-news/46361-meleti-anakalupse-tis-rizes-tis-nosou-parkinson-ston-egkefalo

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The Experiment and The Data

Data from Tsanas et al. for identifying predictors of motor and total Unified Parkinson's Disease Rating Scale (UPDRS) score of early-stage Parkinson's patients
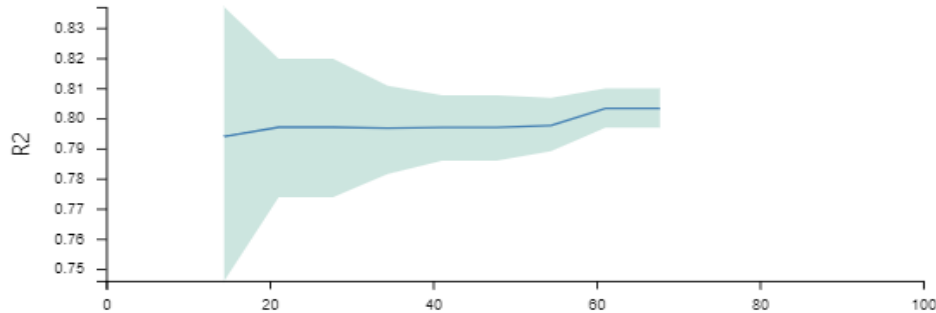
Samples:
5875 PD patients

Potential predictors:
speech signals: 20 measurements
clinical data: age, gender

Target:
Total UPDRS score

Tsanas et al. "Accurate Telemonitoring of Parkinson's Disease Progression by Noninvasive Speech Tests" IEEE TBME (2010) Aprcurate;57(4):884-93. Data available at: https://www.openml.org/d/4531

Running JADBio

❖ Analysis type: Typical
❖ Total time: 00:12:47
❖ 470 models tested

During the Analysis, JADBio

1. Applies AI rules
2. Selects Features
3. Trains regression models
4. Optimizes model selection
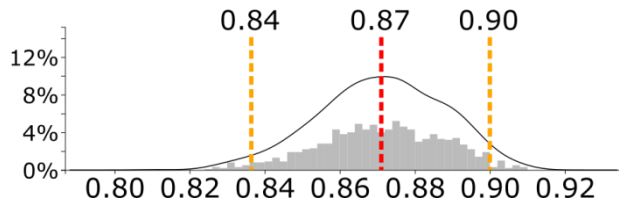5. Estimates model's performance
6. Creates plots

What you get:

✓ Optimal Model
✓ Estimates of Model's performance

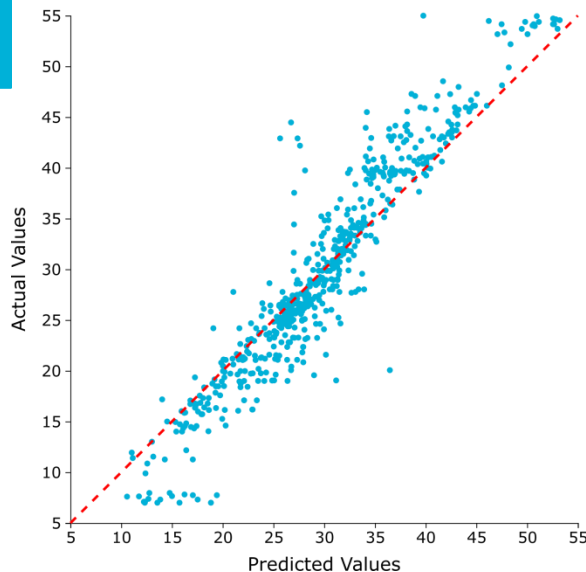# Best performing model: Regression Random Forests

JADBio identifies a Regression Random Forest as the best performing model

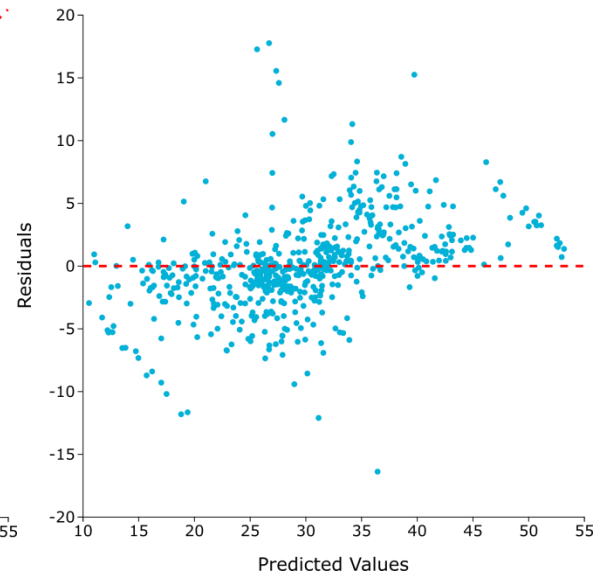95% confidence interval — — Mean performance

R-squared: 0.871 (0.836 – 0.900)

Analysis visualization
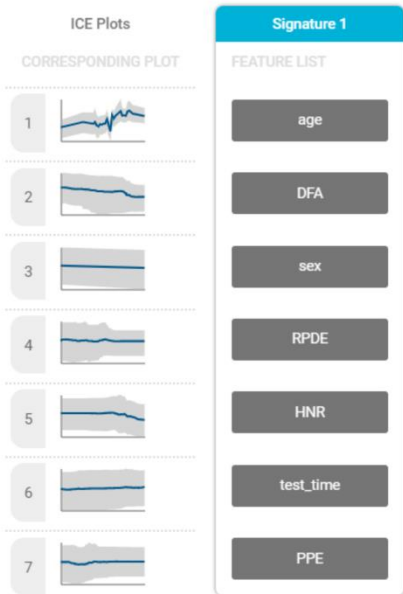
Equivalent signatures

JADBio calculates all relevant biosignatures, that is, minimal-size subsets of variables that are jointly predictive of the outcome of interest.

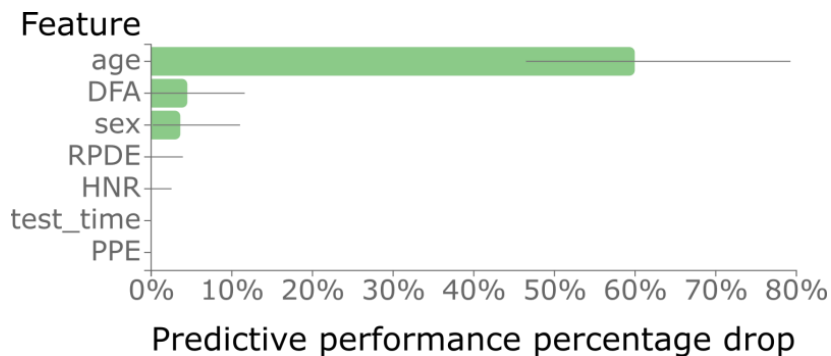For this analysis, 1 signature with seven, out of the total 20 variables, was produced.

Summary

JADBIO selected 7 out of 19 features in the original dataset for the reference signature. In total there is only 1 signature.

Show ICE plots

ICE Plots	Signature 1
CORRESPONDING PLOT	FEATURE LIST
1	age
2	DFA
3	sex
4	RPDE
5	HNR
6	test_time
7	PPE

Feature Importance

JADBio reports the feature importance defined as the percentage drop in predictive performance when the feature is removed from the model. Grey lines indicate 95% confidence intervals.

Apply model

JADBio offers four different methods for model testing:
a) External validation, using another dataset
b) Prediction, using an unlabeled dataset
c) Test, using custom values
d) Export the model and execute outside JADBio

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Conclusion

- ❖ JADBio, applied to Tsanas et al.'s, speech signals and clinical data, produces accurate and simple prognostic/predictive models.

- ❖ Furthermore, JADBio requires no expert knowledge of advanced machine learning techniques.

- ❖ These results show JADBio can produce a predictive model for the prediction of UPDRS score of an early-stage Parkinson's patient in a automated way.

Thank you!

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