AIIC 2024 AWARDS

OPTIMISING CLASSIFICATION OF CONGESTIVE HEART FAILURE USING FEATURE WEIGHT IMPORTANCE CORRELATION

University of Warwick

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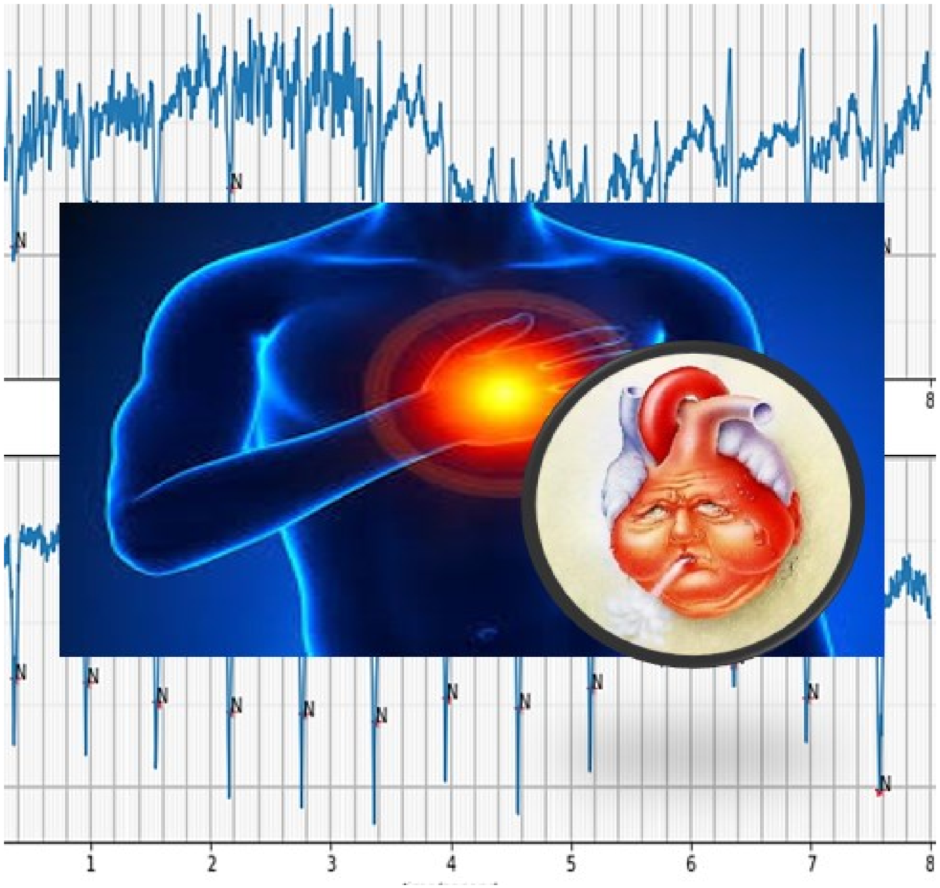

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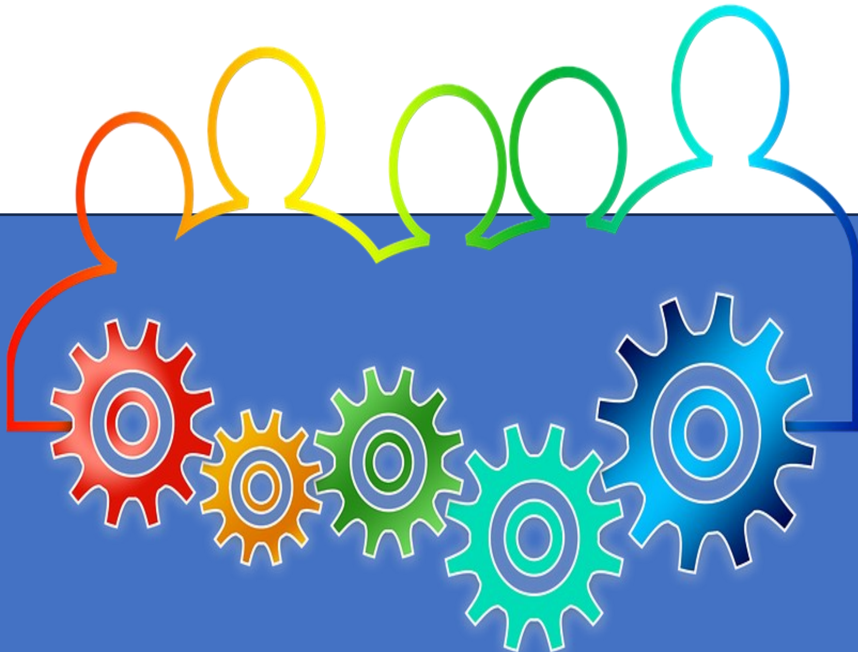

The Team

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Description

Feature engineering pipeline

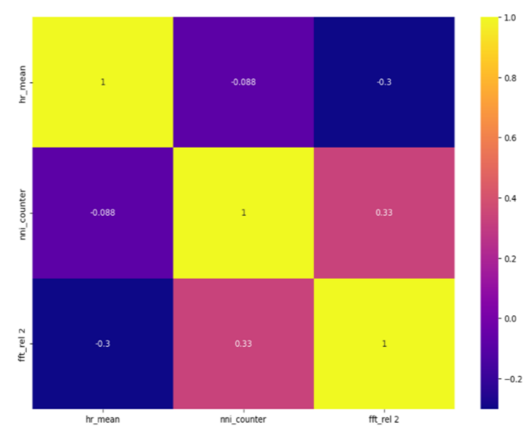
1. Selection of 10 most important features according to 14 different classifiers.
2. Pooling of selected features and importance score for further analysis.
3. Weight appropriation to features based on frequency of occurrence and mean importance score.
4. Features subjected to correlation analysis in an iterative manner and values examined using heat maps.
5. Features with correlation values greater than the selected CIT knocked off.

Frequency table of selected classifiers

SUMMARY REPORT

S/N	Feature name	Frequency of occurrence	Average importance score across classifiers	S/N	Feature name	Frequency of occurrence	Average importance score across classifiers
1.	hr_mean	8	4.0542	**17.**	**nni_min**	1	0.037009
2.	nni_mean	7	1.6348	**18.**	**hr_std**	1	0.048487
3.	nni_counter	5	2.8315	**19.**	**pnn20**	1	0.013626
4.	nni_max	4	0.0389	**20.**	**fft_peak 0**	1	9
5.	fft_rel 2	3	2.3525	**21.**	**lomb_abs 0**	1	7
6.	hr_max	3	1.4047	**22.**	**ar_rel 1**	1	2
7.	tri_index	3	1.0068	**23.**	**sd_ratio**	1	0.032949
8.	lomb_total	3	0.6920	**24.**	**sdnn**	1	0.066783
9.	lomb_log 1	3	0.0476	**25.**	**ar_abs 2**	1	0.033391
10.	fft_norm 0	3	0.0428	**26.**	**lomb_norm 1**	1	0.011130
11.	fft_rel 0	3	0.0376	**27.**	**pnn50**	1	0.010881
12.	hr_min	2	0.0479	**28.**	**lomb_abs 1**	1	0.005974
13.	fft_norm 1	2	0.1159	**29.**	**nni_diff_max**	1	0.005093
14.	fft_peak 1	2	0.0372	**30.**	**ar_rel 2**	1	0.04
15.	sdann	2	0.0153	**31.**	**sdsd**	1	0.028307
16.	ar_norm 0	2	0.0264	**32.**	**dfa_alpha1**	1	0.026311

Resultant heat map for correlation values ≤ ±0.40



Resultant heatmap after applying correlation iteration threshold (CIT) of ≤0.40

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Objectives and recipients of the work

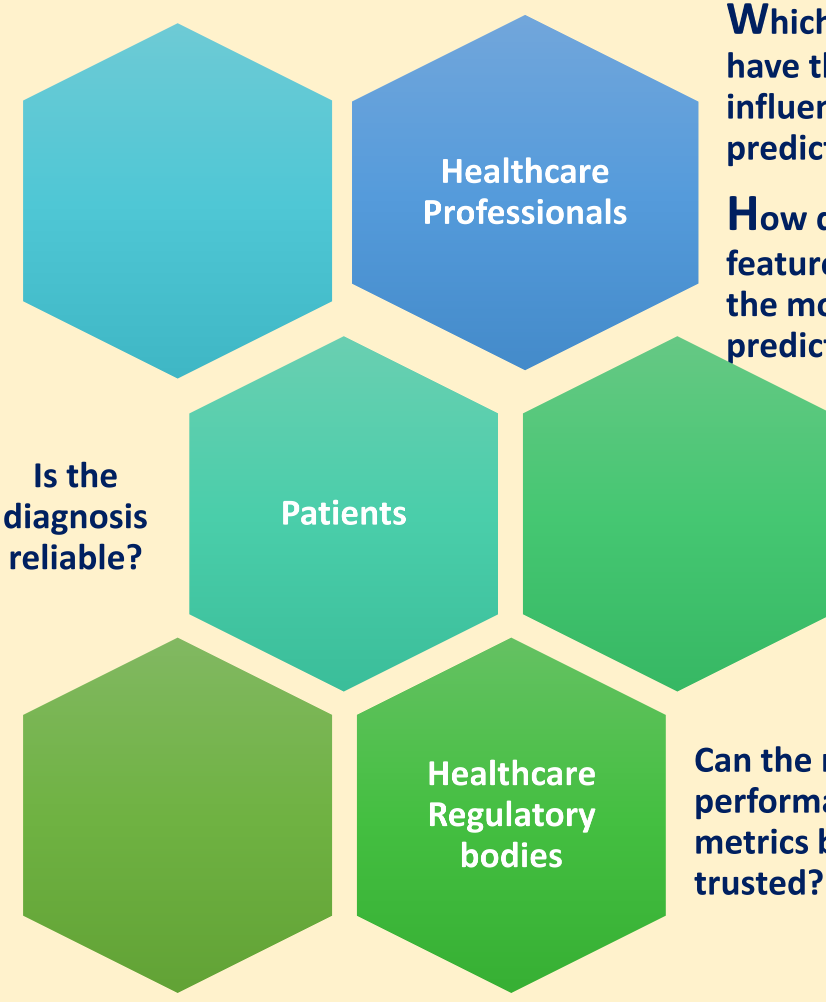
Objectives:

- To develop a novel method for selecting the optimal set of input features for classifying the presence of congestive heart failure (CHF) using long-term ECG data.
- To ensure model transparency and trustworthiness by building interpretability and explainability into the model .

Which features have the greatest influence on the predicted results?

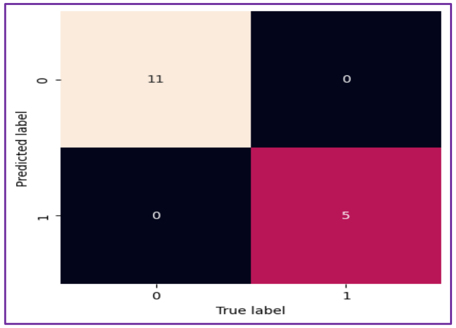
How do different features impact the model’s prediction?

Is the diagnosis reliable?



Can the model performance metrics be trusted?

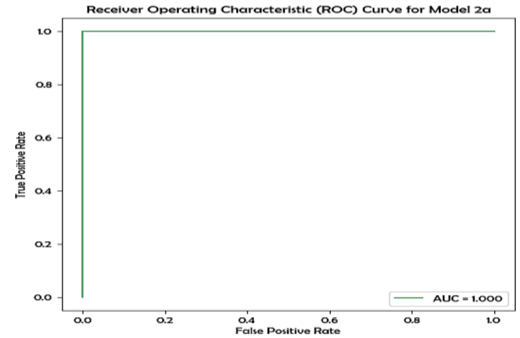
Results



RMS: 0.0

	precision	recall	f1-score	support
0	1.00	1.00	1.00	11
1	1.00	1.00	1.00	5
accuracy			1.00	16
macro avg	1.00	1.00	1.00	16
weighted avg	1.00	1.00	1.00	16

Accuracy: 1.0



Best performing model – implemented with feature weight importance correlation (FWIC): (a) Confusion matrix; (b) performance metrics; (c) ROC AUC

Accuracy: 1.00
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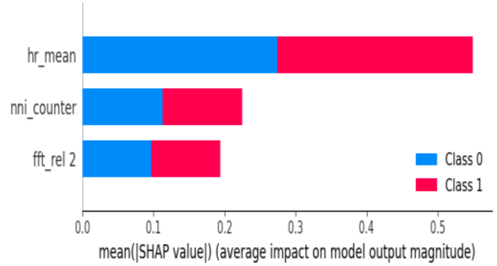
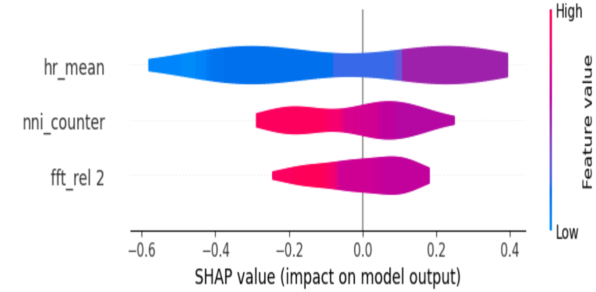
	precision	recall	f1-score	support
Normal	1.00	1.00	1.00	8
CHF	1.00	1.00	1.00	8
accuracy			1.00	16
macro avg	1.00	1.00	1.00	16
weighted avg	1.00	1.00	1.00	16

Accuracy: 0.94
Accuracy: 1.00
Accuracy: 0.88
Accuracy: 1.00
Accuracy: 1.00
Accuracy: 1.00
Accuracy: 1.00
Accuracy: 1.00
Accuracy: 0.94
Accuracy: 1.00

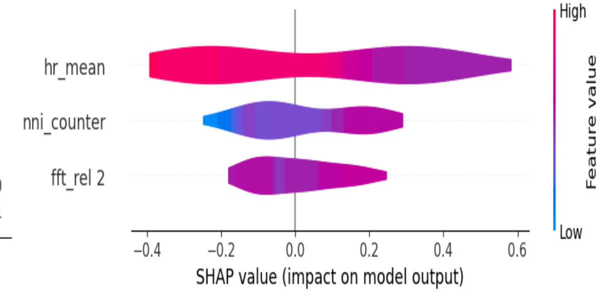
Accuracy of best model (left) tested under data imbalance condition compared to that of 2nd best model using 10-fold stratified shuffle split cross-validation. Same performance metrics. Best model outputs 100% accuracy.



Bar plot of global feature importances.



Class 0 – Normal patients (strat. data)



Class 1 – CHF patients (strat. data)

Violin plots: Positive SHAP values in a plot indicate that the input feature has a positive impact on the prediction and vice versa.

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