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OPEN DATA, EXPLAINABLE AI, DATA SCIENCE AND CONVENTIONAL NITS THE RECIPE FOR NEW MACHINE LEARNING DIAGNOSTIC TESTS ON MASLD

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INTRODUCTION

Metabolic dysfunction-associated steatotic liver disease (MASLD) has a prevalence exceeding 25% in the general population. Non-invasive tests, namely the FIB-4 index, NFS, APRI, and AST/ALT, play a crucial role in differentiating advanced fibrosis stages (F012 vs. F34 in metavir score).

AIM

Developing and optimizing an interpretable machine learning model that employs the aforementioned non-invasive test parameters as features, surpassing their individual performances in diagnosing advanced fibrosis in MASLD patients.

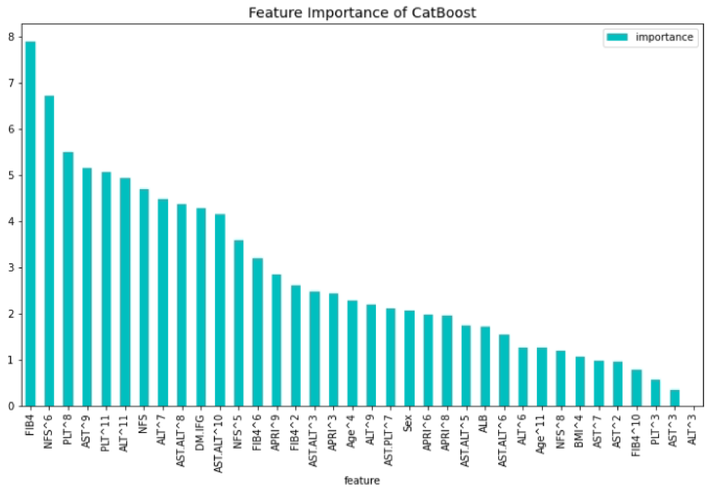
METHOD

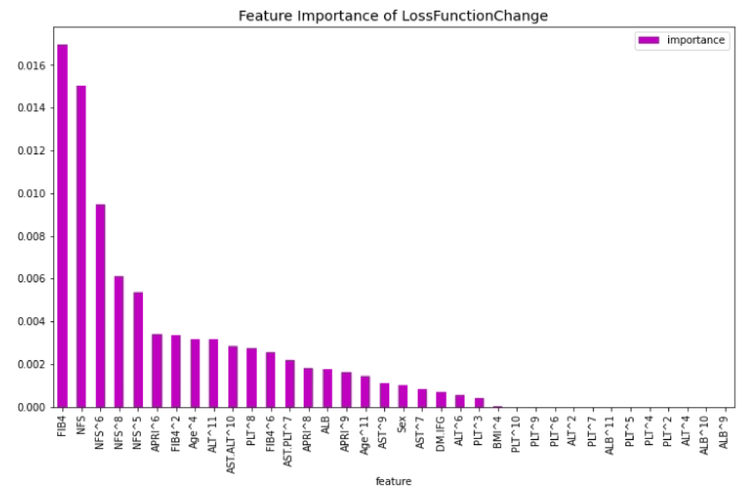
- Open data from two cohorts, China (train) and Malaysia (test), are used, with 540 participants (early/advanced fibrosis: 391/149) and 147 participants (116/31) having liver biopsy-confirmed hepatic fibrosis
- Features: age, sex, BMI, ALB, PLT, AST, ALT, ALT/AST, AST/PLT, presence of diabetes/impaired fasting glycemia (DM.IFG), FIB-4 score, NFS score, APRI score
- The machine learning model is trained, tuned, and validated using the train dataset, followed by testing on the test dataset
- 10-fold cross-validation (10CV) enhances model robustness
- Feature engineering expands feature space by considering power and product combinations of initial features
- Shapley values from explainable artificial intelligence are utilized to understand feature importance in catboost predictions

RESULTS

We conducted a comparative analysis between our catboost model (ML) and the four non-invasive tests (NITs) FIB-4, NFS, APRI, and AST/ALT using specific threshold values for advanced fibrosis, namely 1.30, -1.455, 0.64, and 0.87, respectively. The comparison was performed on identical folds within the 10-fold cross-validation (10CV) framework, with consistent random seed selection.

NIT	Spec. 10CV	Sens. 10CV	ROC-AUC 10CV	F1 10CV	Spec. Test	Sens. Test	ROC-AUC Test	F1 Test
FIB-4	0.8500+/-0.0744	0.4893+/-0.0855	0.6997+/-0.0692	0.5499+/-0.0797	0.9109	0.4783	0.7514	0.5714
NFS	0.8764+/-0.0549	0.4559+/-0.0893	0.7076+/-0.0678	0.5673+/-0.0802	0.9271	0.4706	0.7707	0.5854
APRI	0.8076+/-0.0600	0.4663+/-0.0945	0.6452+/-0.0538	0.4806+/-0.0792	0.8857	0.4524	0.7073	0.5205
AST/ALT	0.7483+/-0.0471	0.3521+/-0.1420	0.5445+/-0.0504	0.2994+/-0.1181	0.8140	0.3889	0.5655	0.2857
ML	**0.8845+/-0.0601**	**0.5903+/-0.0877**	**0.7671+/-0.0632**	**0.6425+/-0.0708**	**0.9434**	**0.6098**	**0.8343**	**0.6944**





CONCLUSIONS

- By utilizing data science with catboost, feature engineering, and the parameters/scores from four NITs, we achieve superior performance and robustness compared to those NITs
- Explainable artificial intelligence identifies the importance of FIB-4, NFS^6, and PLT^8, potentially leading to a novel non-invasive test
- We propose a paradigm shift for classifying MASLD patients into early and advanced fibrosis stages
- Linear cut-off values alone are inadequate, necessitating data science and explainable artificial intelligence to provide insights
- Combining parameters from all four NITs in an interpretable machine learning framework improves outcomes

REFERENCES

Angelakis A. et al. Using FIB-4's parameters an explainable black-box machine learning model outperforms FIB-4 index on the diagnosis of advanced fibrosis of non alcohol related fatty liver disease patients in three cohorts from China, Malaysia and India. Journal of Hepatology *2*2023 vol. 78(S1) | S100–S101, DOI: https://doi.org/10.1016/S0168-8278(23)00435-X

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