

Iowa Initiative for Artificial Intelligence

Final Report

Project title:	A model to predict idiopathic pulmonary fibrosis outcomes		
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Date:			
Were specific aims fulfilled:	Y		
Readiness for extramural proposal?	Y		
If yes ... Planned submission date	2023		
Funding agency	NIH		
Grant mechanism	R01		
If no ... Why not? What went wrong?			

Brief summary of accomplished results:

We have developed and validated a Random Forest model to accurately predict idiopathic pulmonary fibrosis (IPF) outcomes (Progression: 1, No progression: 0) using extracted 3D texture features in CT scans of human lung and patients' medical information including patients' characteristics, comorbidities, antifibrotic treatment, treatment duration and so on. The prediction accuracy is 78% in the non-antifibrotic treatment group (sensitivity 0.88, specificity 0.5) and 62% in the antifibrotic drug group (sensitivity 0.87, specificity 0.22).

Research report:

Aims (provided by PI):

To use artificial intelligence (AI) to create a clinical model to predict IPF outcomes.

Data:

A total of 97 IPF patients with compatible imaging protocols were retrospectively reviewed. Patients were predominantly male (70%) with the mean age at 72±8.1 years. Mean FVC and DLCO were 74±17.9% and 50±15.6% predicted, respectively. The majority of patients (45, 46.4%) were classified in GAP stage II, followed by stage I (43, 44.3%). Sixty one patients (63%) received antifibrotic therapy (pirfenidone 30, nintedanib 19, and switch to another drug 12). The mortality rate was 45%. Lung transplantation was performed on 12 patients.

AI/ML Approach:

In this study, supervised machine learning algorithm was implemented for prediction using Python. As many extracted features may be noisy, or highly correlated with each other, Random Forest (RF) algorithm was selected to predict IPF outcomes and performance assessed using 5-

fold-cross-validation. Accuracy and F1-score were calculated to compare performance of different tests.

Experimental methods, validation approach:

Feature extraction

We retrospectively reviewed of patients' characteristics, comorbidities, antifibrotic treatment, treatment duration, GAP stage, transplant status, mortality, and quantitative CT with texture patterns. PFT progression based on forced vital capacity (FVC), diffusion capacity for carbon monoxide (DLCO) decline at 6 months, lung transplantation, and death were the composite outcomes. Three-dimensional Texture patterns were produced by the Adaptive Multiple Feature Method (AMFM). The whole lung region was classified into 7 different parenchymal texture patterns using a Bayes classifier which was trained by the voxel volume-of-interest labeled by experts.

Feature importance

RF model's Feature importance of first 30 features was plotted in descending order for different drug groups.

Results:

Accuracy

The outcome of IPF could be predicted using a combination of clinical and quantitative CT data, and the model performs better in patients who have not started antifibrotic medication with promising accuracy to be a decision-making tool to support the physician in determining the prognosis and preparing the treatment plan.

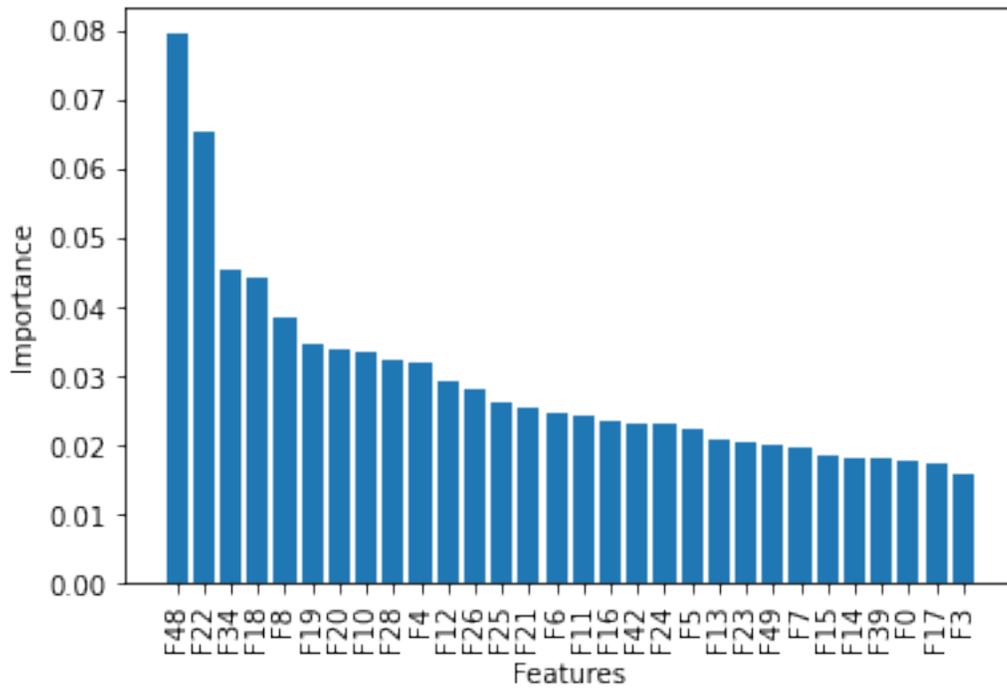
Table 1 Accuracy and F1 score of different drug group

	Accuracy (mean±SD)	F1 score
Drug group	0.62±0.07	0.74
Non-drug group	0.78±0.07	0.85

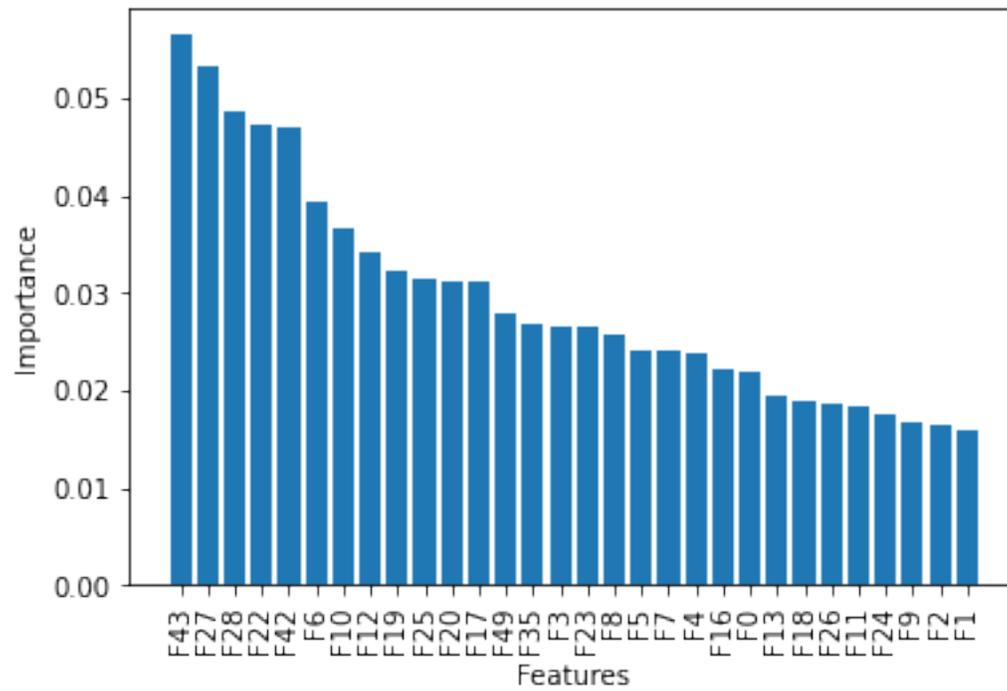
Feature Importance

Random Forest model used 5 cross-validation. Feature importance of each fold was plotted in Figure 1,2 (1: drug group;2: non-drug group). Feature 0-26 were texture features extracted from CT scans. Feature 27-49 were patient information. Overall, all features were useful for prediction. Beside texture features, current age, age at diagnosis, fvc before drug, dlco before drug, bmi, and gender were more important in non-drug group while current age, age at diagnosis, fvc before drug, dlco before drug, bmi, p duration, n duration, >24 month treatment, metabolic syndrome - HTN, DM, and dyslipidemia were more important in drug group.

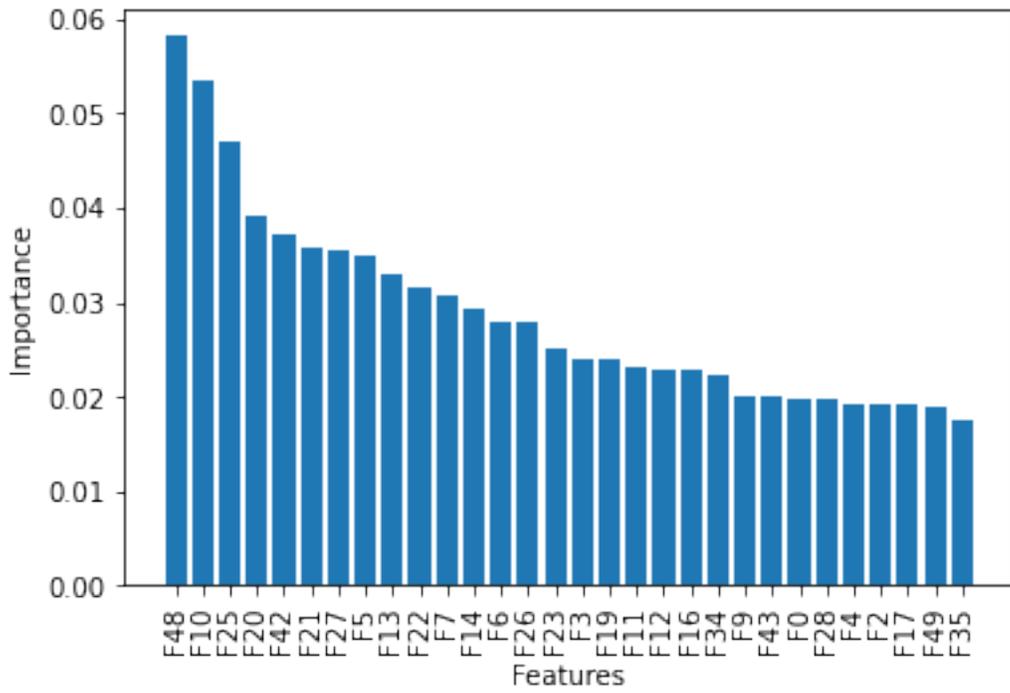
Fold 1



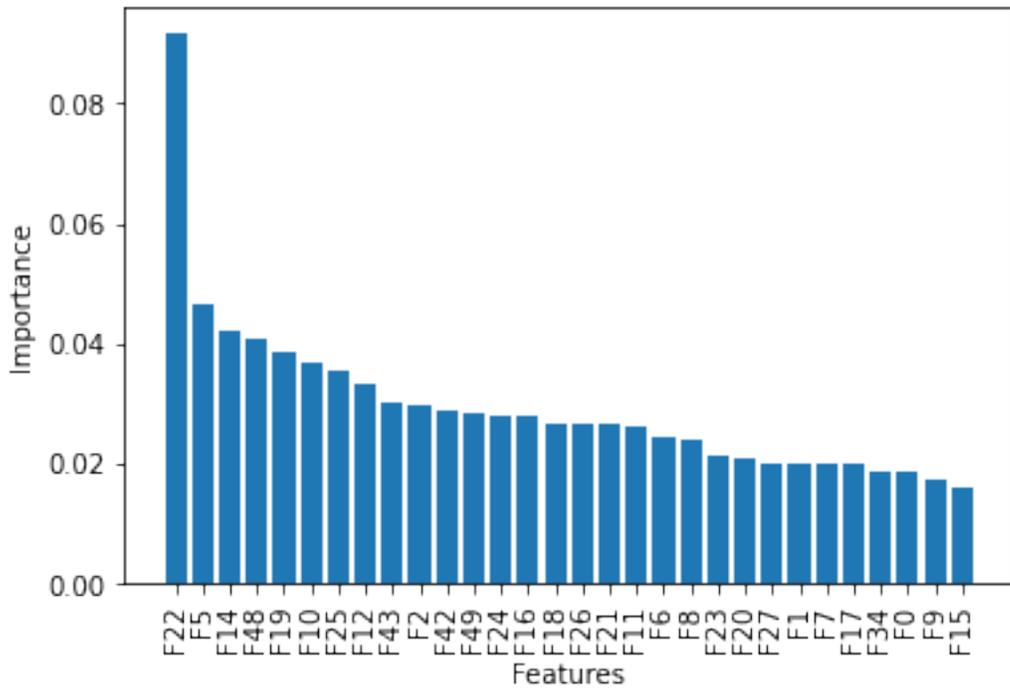
Fold 2



Fold 3



Fold 4



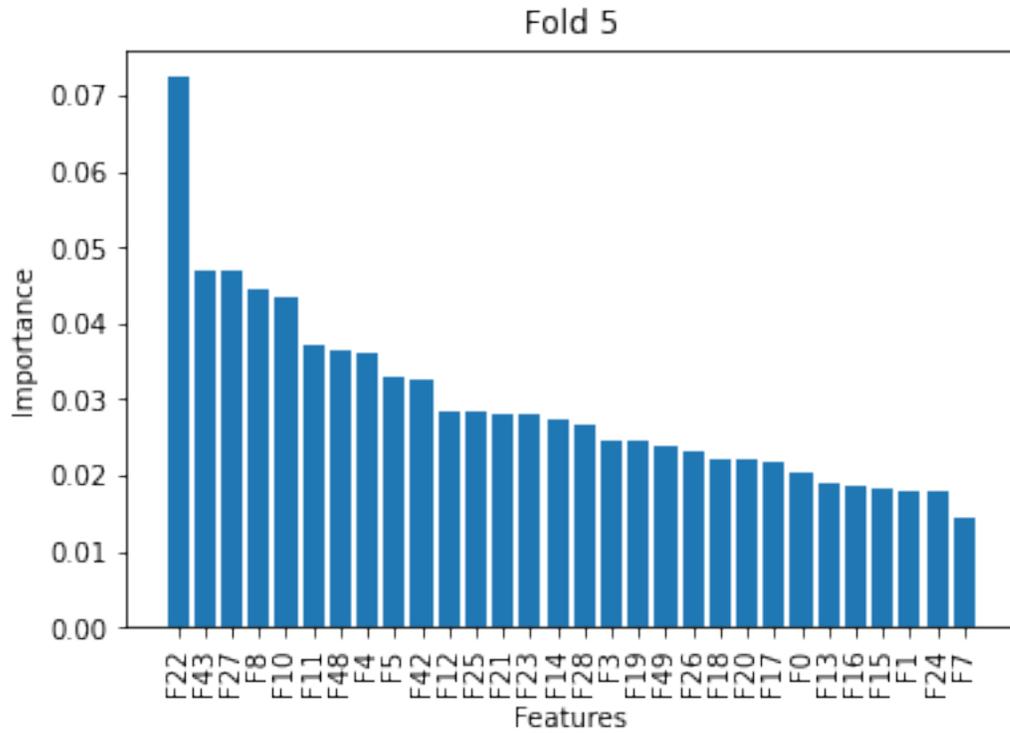
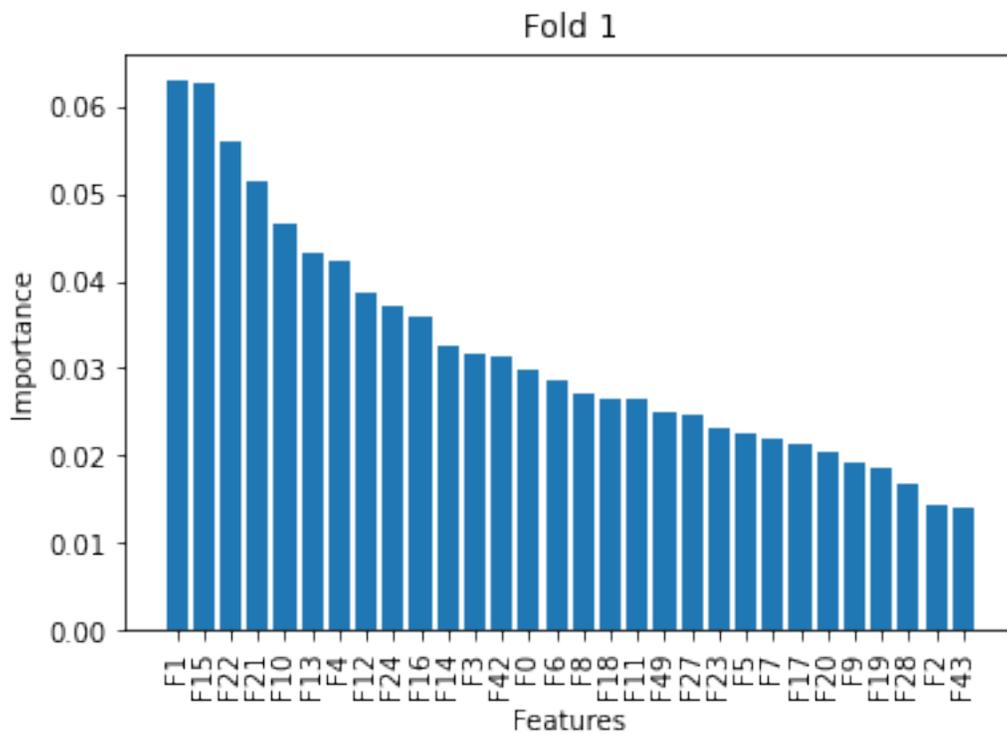
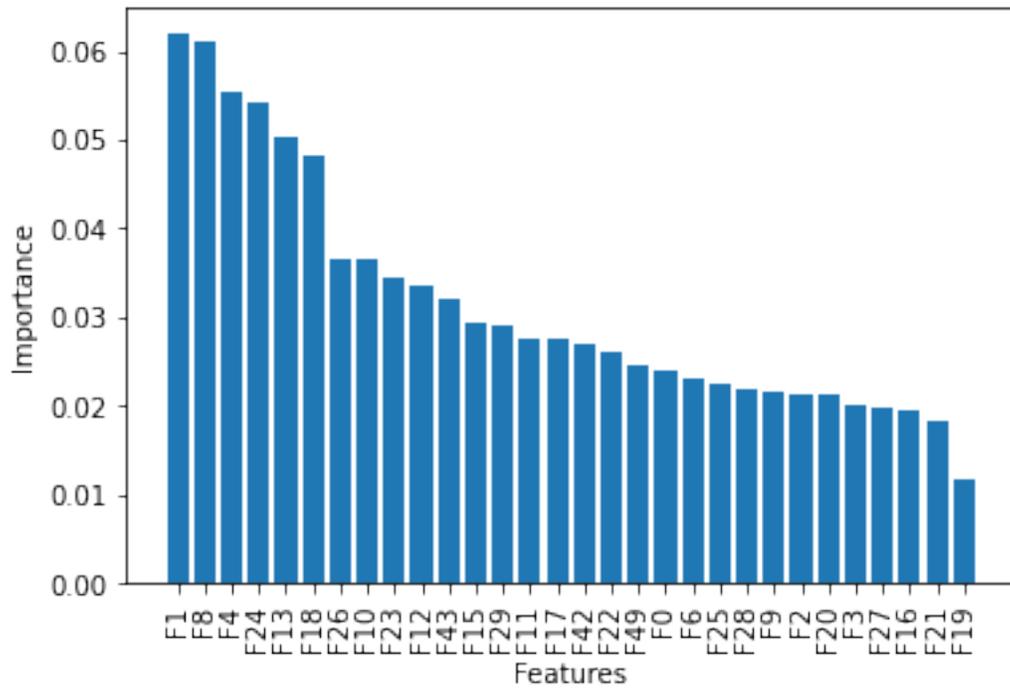


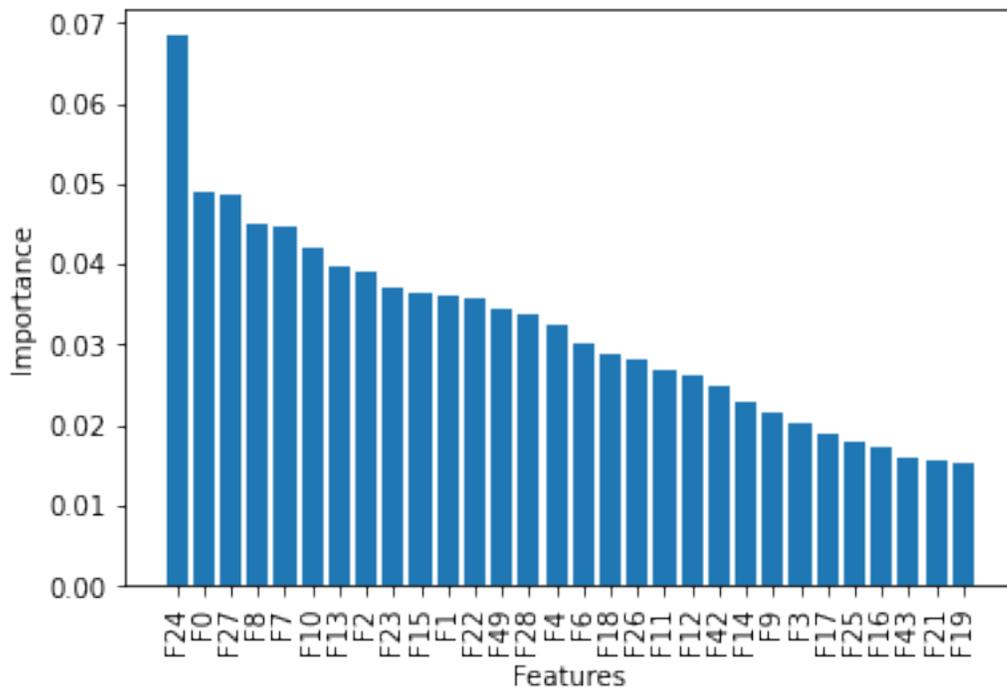
Figure 1 Feature importance of 5 folds cross validation of drug group



Fold 2



Fold 3



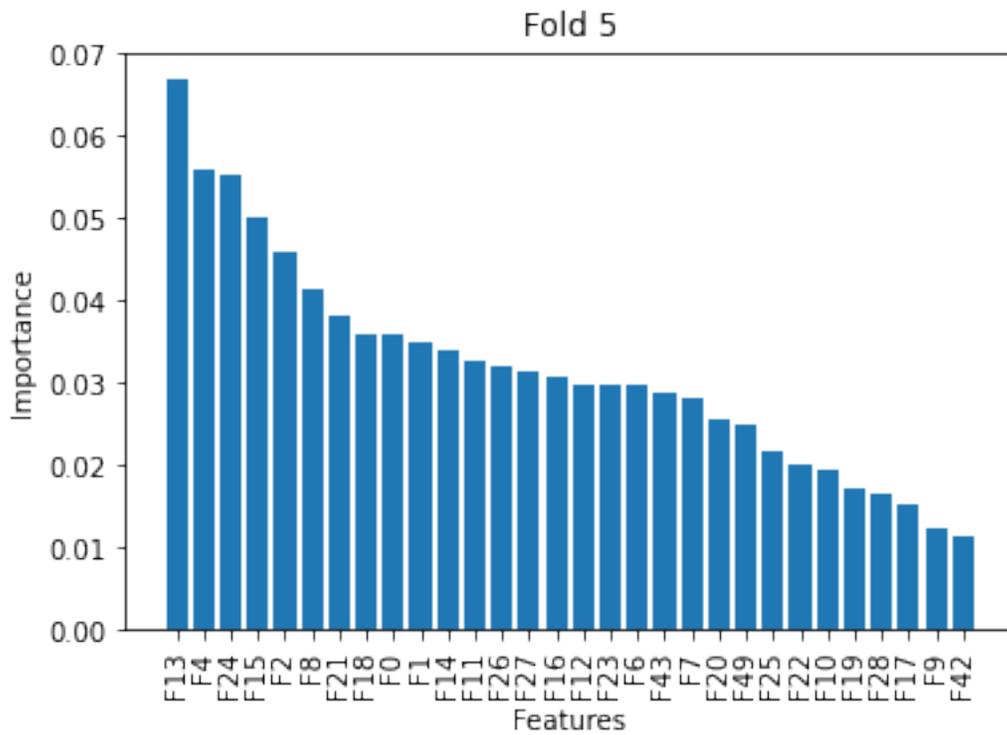
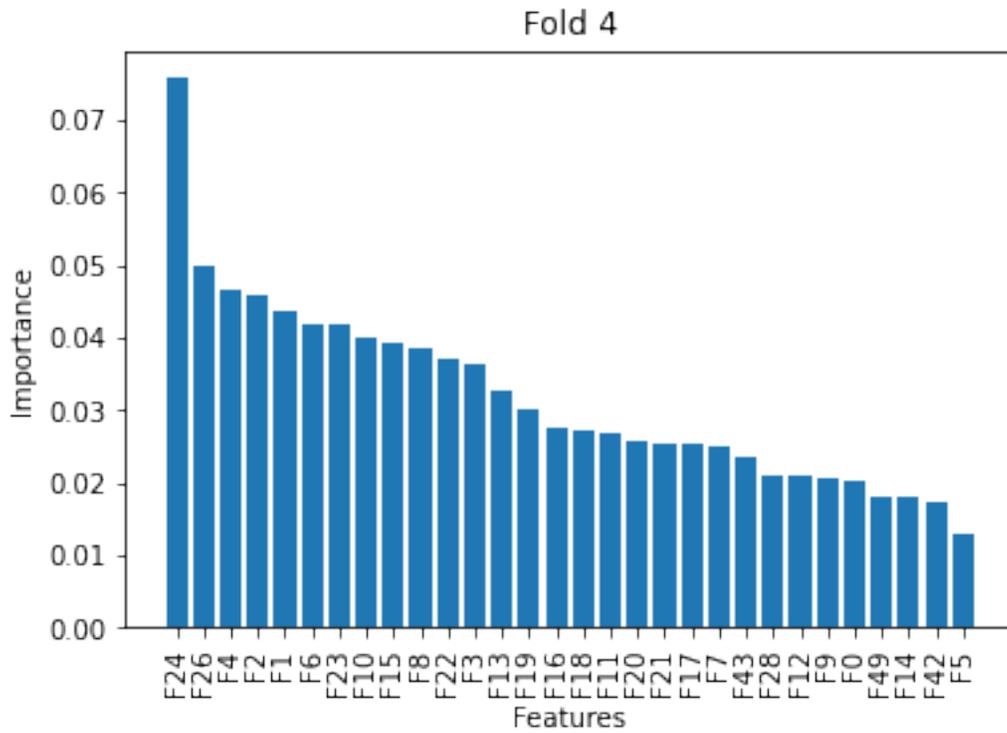


Figure 2 Feature importance of 5 folds cross validation of non-drug group

The findings of this study should be confirmed in a large-scale, prospective study.

Publications resulting from project:

1. A model to predict idiopathic pulmonary fibrosis outcomes, Kamonpun Ussavarungsi MD, Junfeng Guo PhD, Yanan Liu PhD, Archana T. Laroia MD, Joseph M. Reinhardt PhD, Alicia K. Gerke MD, Nabeel Hamzeh MD, Eric A. Hoffman MD, ATS abstract submitted.