

MACHINE LEARNING IMPROVES THE ACCURACY OF KIDNEY TRANSPLANT OUTCOME PREDICTIVE MODELS

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INTRODUCTION

Prediction tools have been developed to predict transplant outcomes. The majority of these models are based on regression analysis. More recently models using individual machine learning (ML) algorithms have been published, but 'ensemble' ML methods (combination of individual algorithms) have not been used to predict kidney transplant outcomes.

AIM

In this study we used Super Learning, an 'ensemble' of ML algorithms to develop a kidney transplant prediction model.

METHOD

Data of 14629 adult patients, from the UK Transplant Registry, who underwent deceased donor kidney transplantation from 1st January 2006 to 31st December 2015 were analyzed. Pediatric donor and multiorgan transplants were excluded.

The Super Learner package in R was used to develop models to predict 1 year graft survival (GS) and delayed graft function (DGF). Using cross-validation, the performance of different ML models (logistic regression, elastic net and lasso regression, Bayesian regression, random forest, gradient boosting) was evaluated. An 'ensemble' model was built using the combination of the previous algorithms.

RESULTS

The AUC predicting the **1 year GS** for logistic regression with all 65 predictors was 0.617, and 0.624 with reduced number of predictors selected. Random forest had a similar AUC of 0.61 and gradient boosting had 0.6. From the individual algorithms used the lasso regression gave the best performance with an AUC of 0.635 whereas the AUC of the 'ensemble' Super Learner model was 0.642

For **DGF** the Super Learner gave a prediction with an AUC of 0.643, similar to the one reached by lasso regression (AUC=0.637) and Bayesian logistic regression (0.627). The AUC for the conventional logistic regression was 0.633.

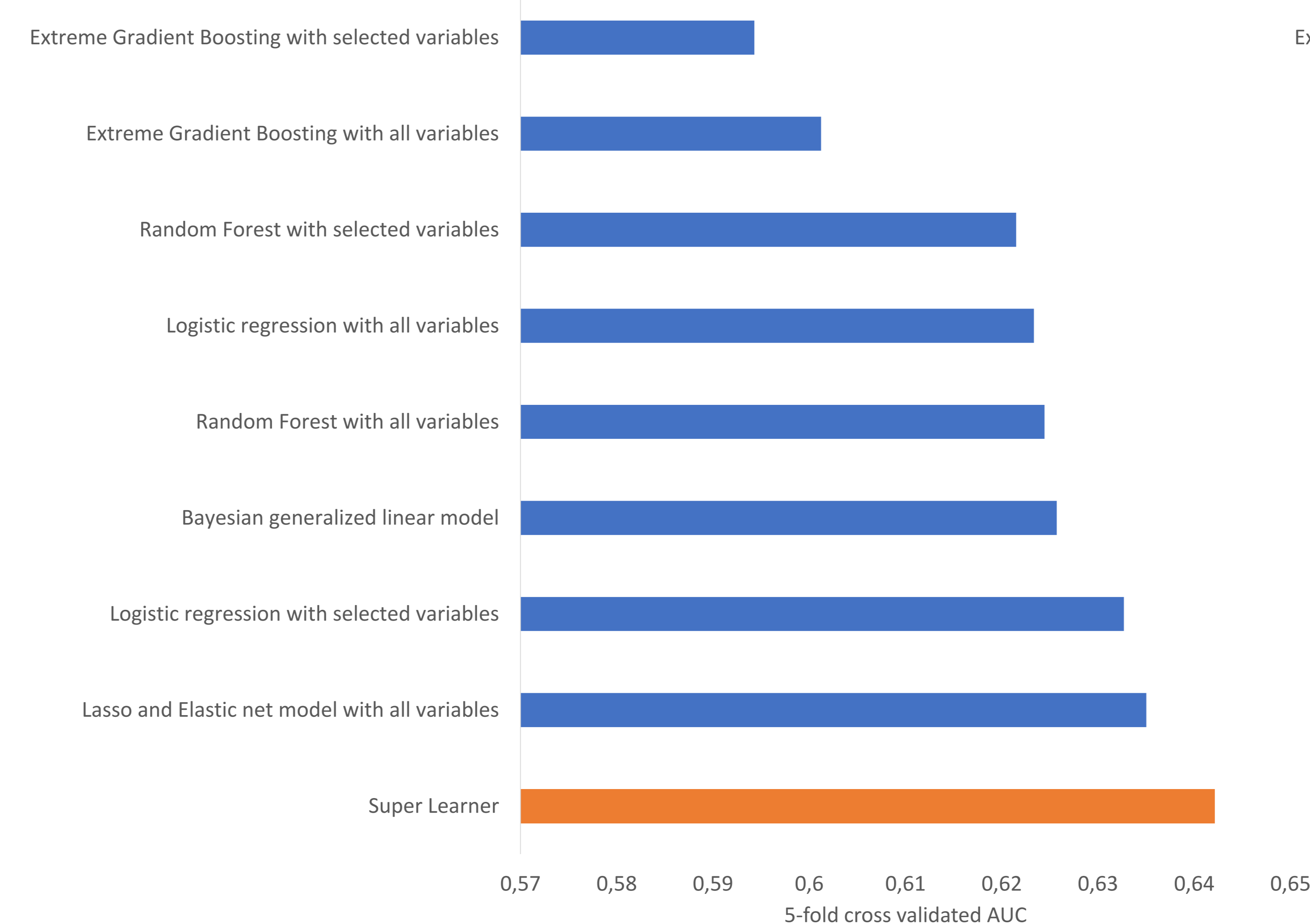


Fig 1. Performance of different models predicting 1 year Graft Survival

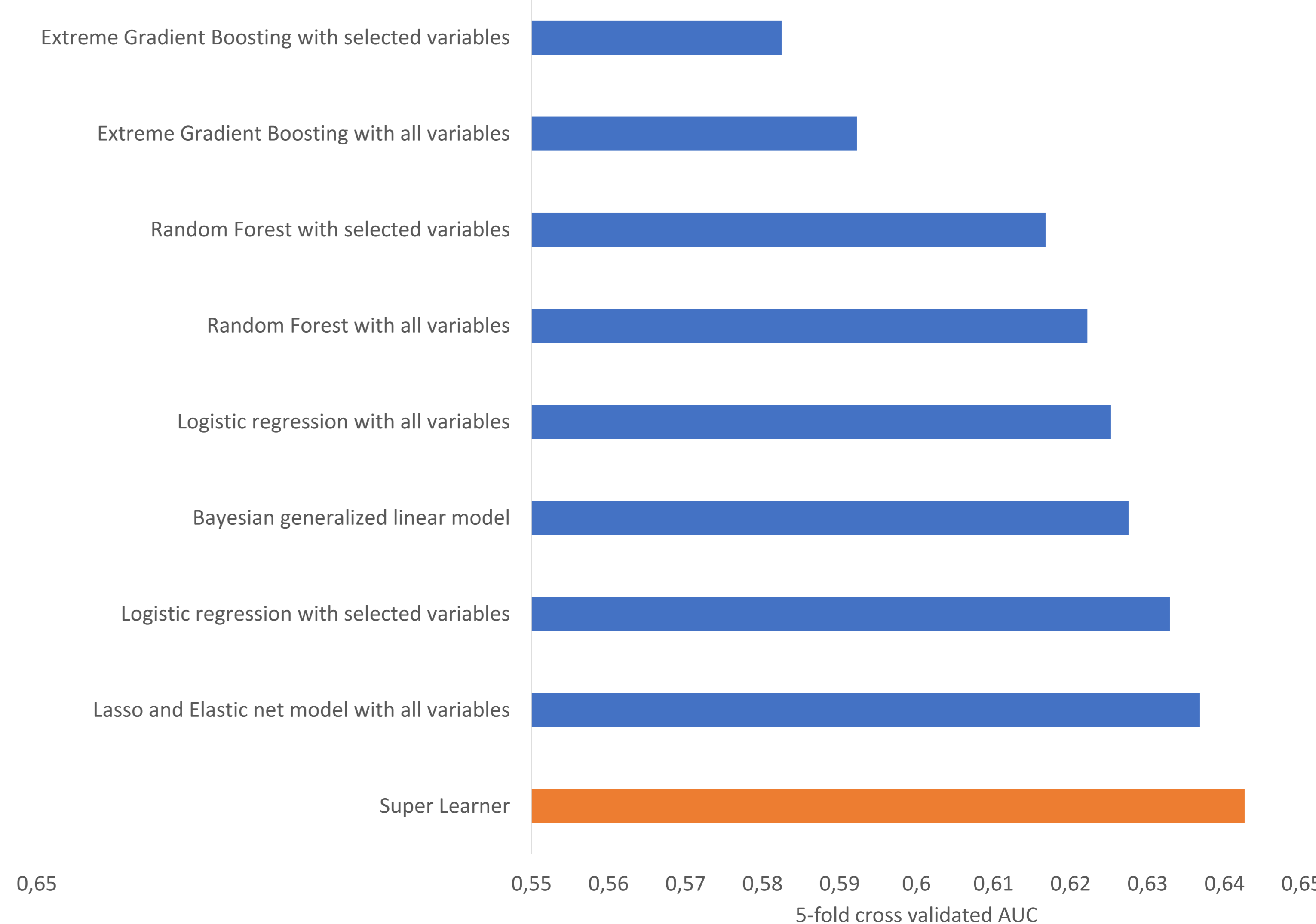


Fig 2. Performance of different models predicting DGF

CONCLUSIONS

The Super Learner ensemble machine learning algorithm outperformed the traditional logistic regression in predicting both the DGF and 1 year graft survival, despite the performance of random forest and gradient boosting models were worse compared to logistic regression.

The hyperparameters were kept at their default values, but hyperparameter tuning could potentially improve the performance of these algorithms.

The careful selection of the individual models to build the ensemble Super Learner model could also help improving the overall performance.

This is the first study when ensemble Super Learner model was used to predict kidney transplant outcomes on a large national registry data.

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