Galaxies' Redshift Estimates

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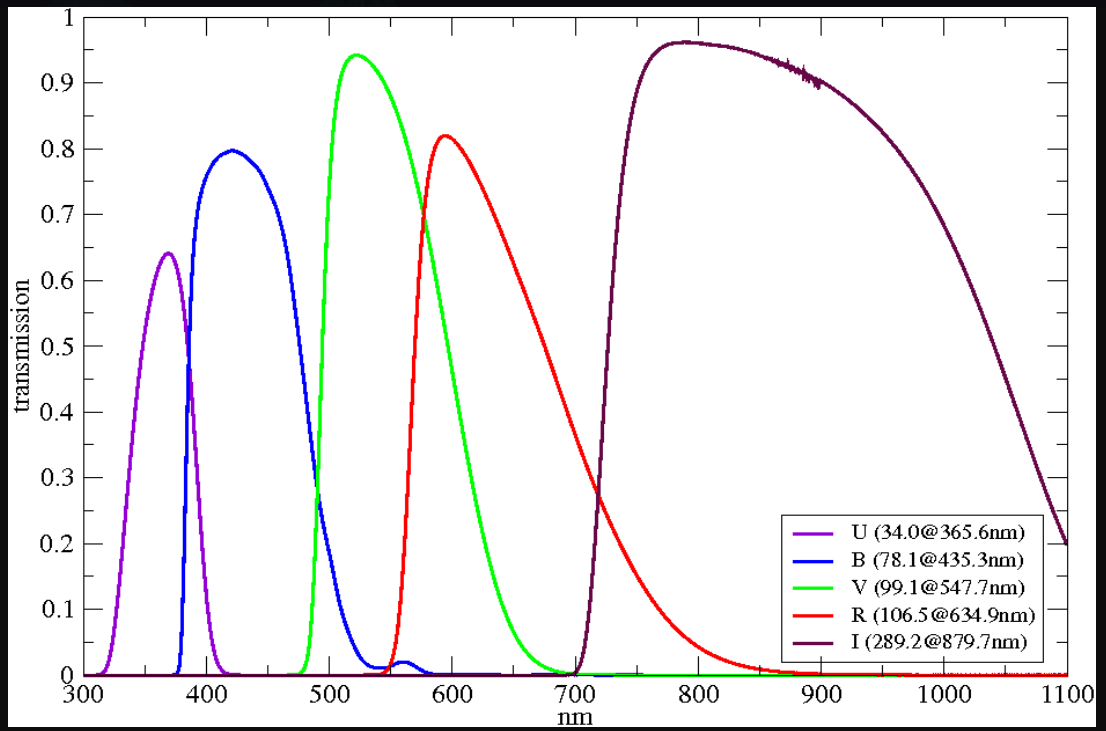
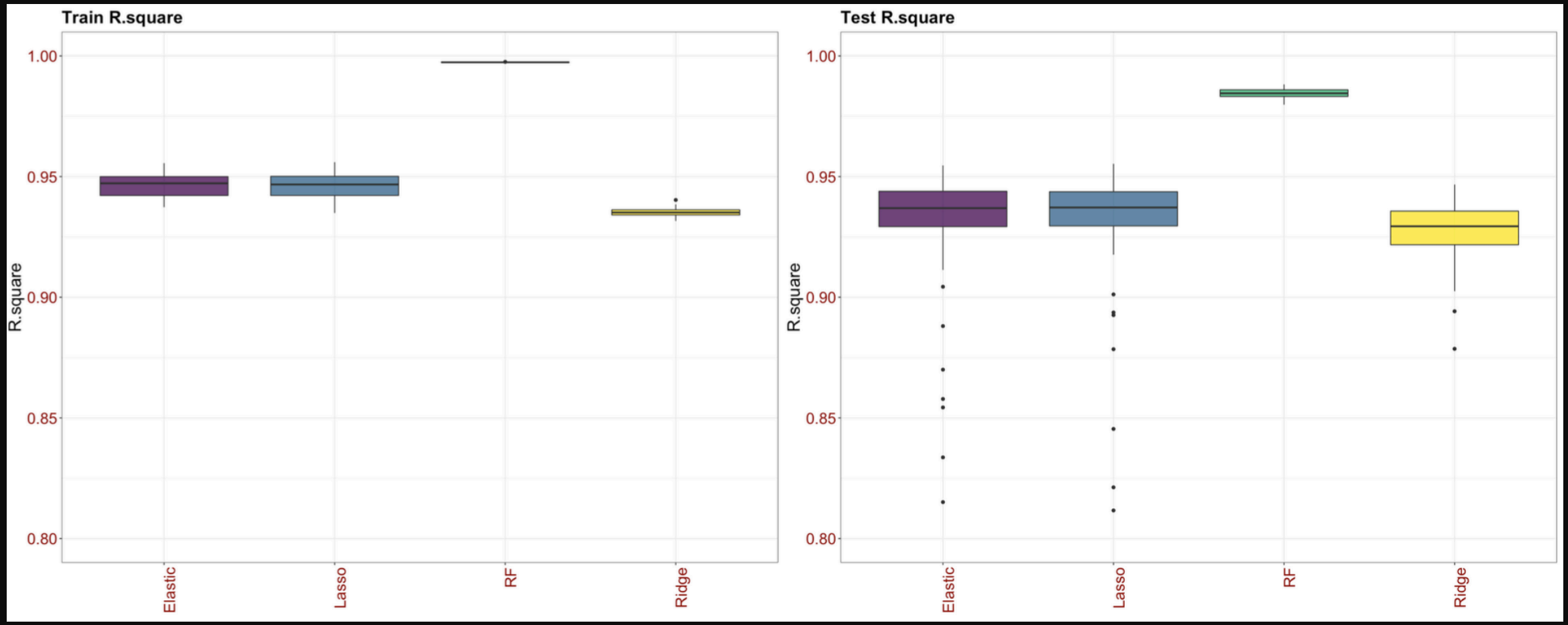
IMAGE SOURCE: HTTPS://WWW.ESO.ORG/PUBLIC/IMAGES/POTW1830A/

INTRODUCTION

- → The target variable is photometric estimates of redshift, a measure of distance from us to an object.
- → The predictors variables are mainly the measurements and errors of brightness of color bands of galaxies.
- → n = 3438, number of galaxies samples (after removing missing values)
- → p = 60 (number of predictors)
- → We will be able to predict the velocity of a galaxy based on the brightness of color bands of a galaxy



R2

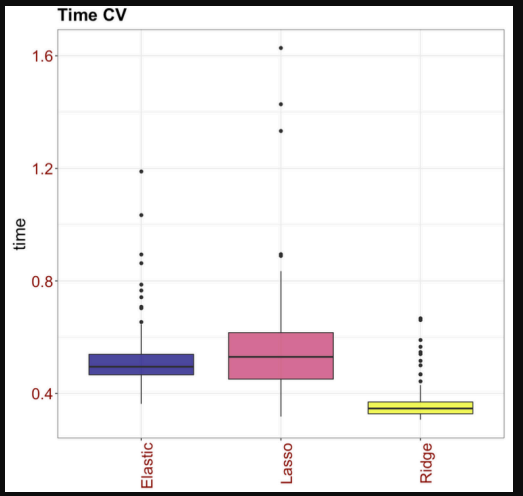


→ Random Forest has the best train R-square and test R-square, while Ridge is the lowest on both train and test set.

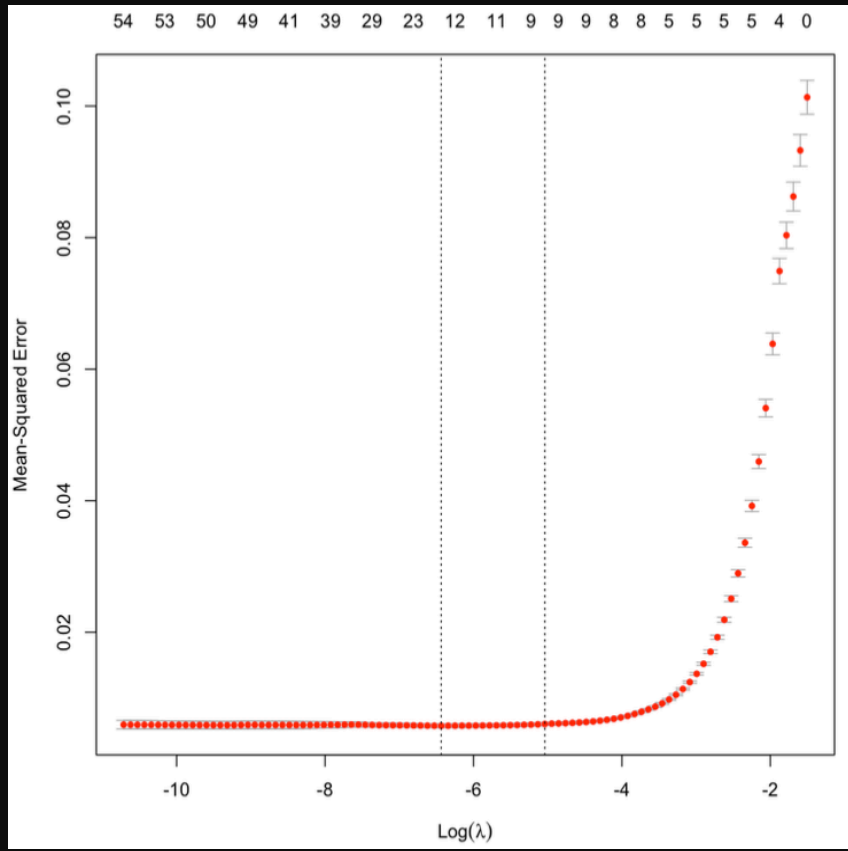
→ Test R-square values are lower and more spread on all models

10-FOLD CV CURVE

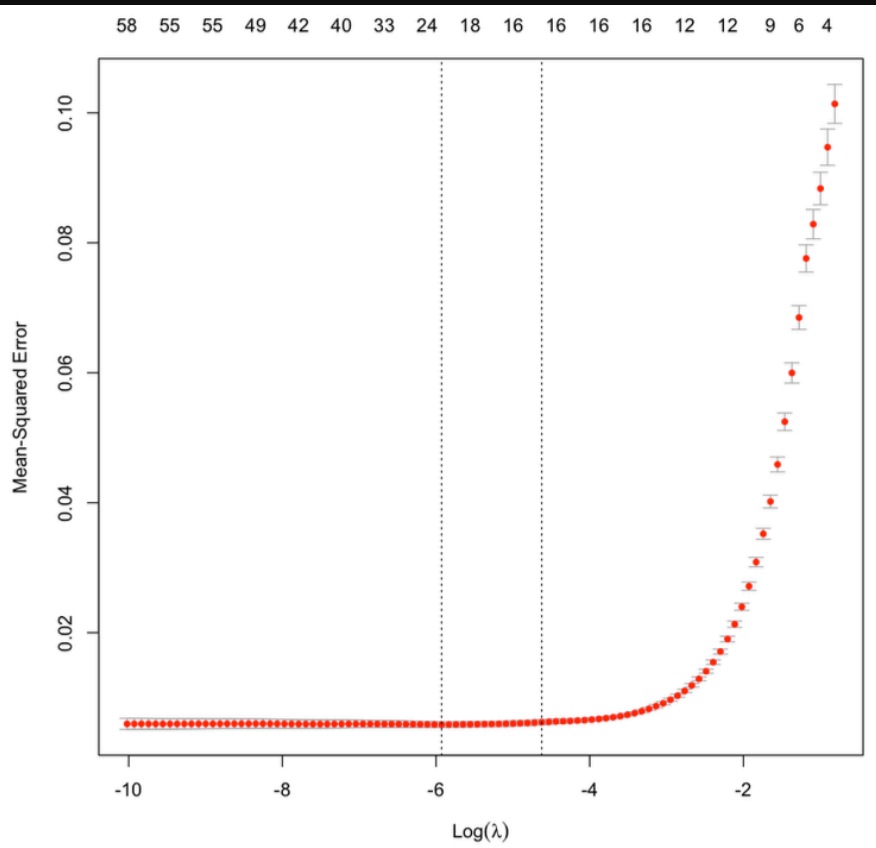
- → Optimized Lasso has around 12 non-zero coefficients
- → Optimized ElasticNet has around 22-23 non-zero coefficients
- → As expected, Optimized Ridge has maintained all predictors coefficients



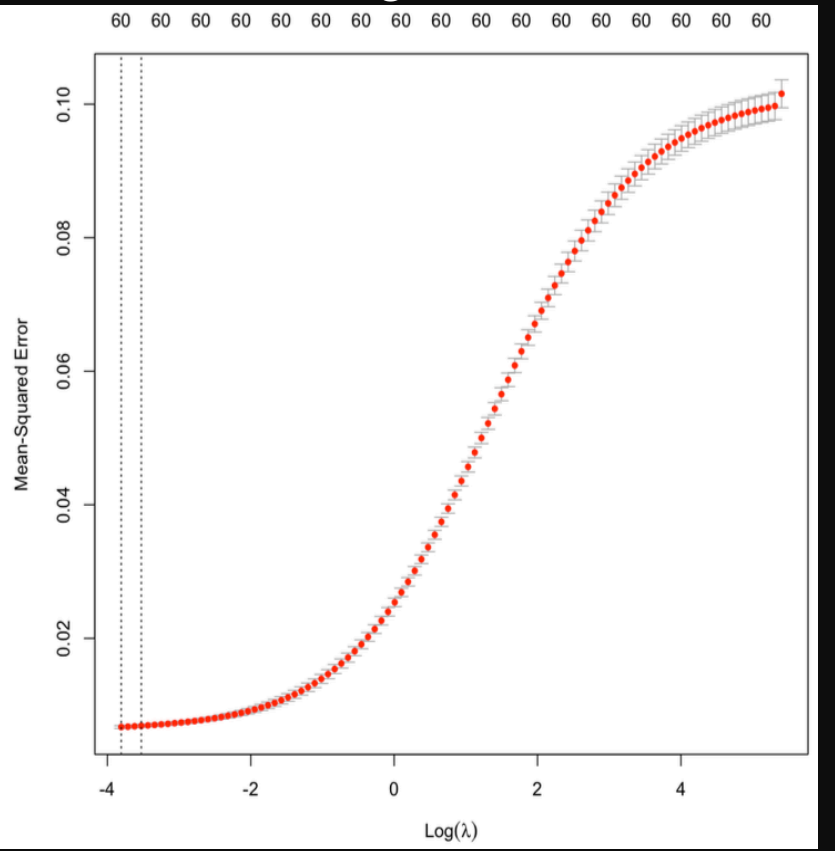
LASSO



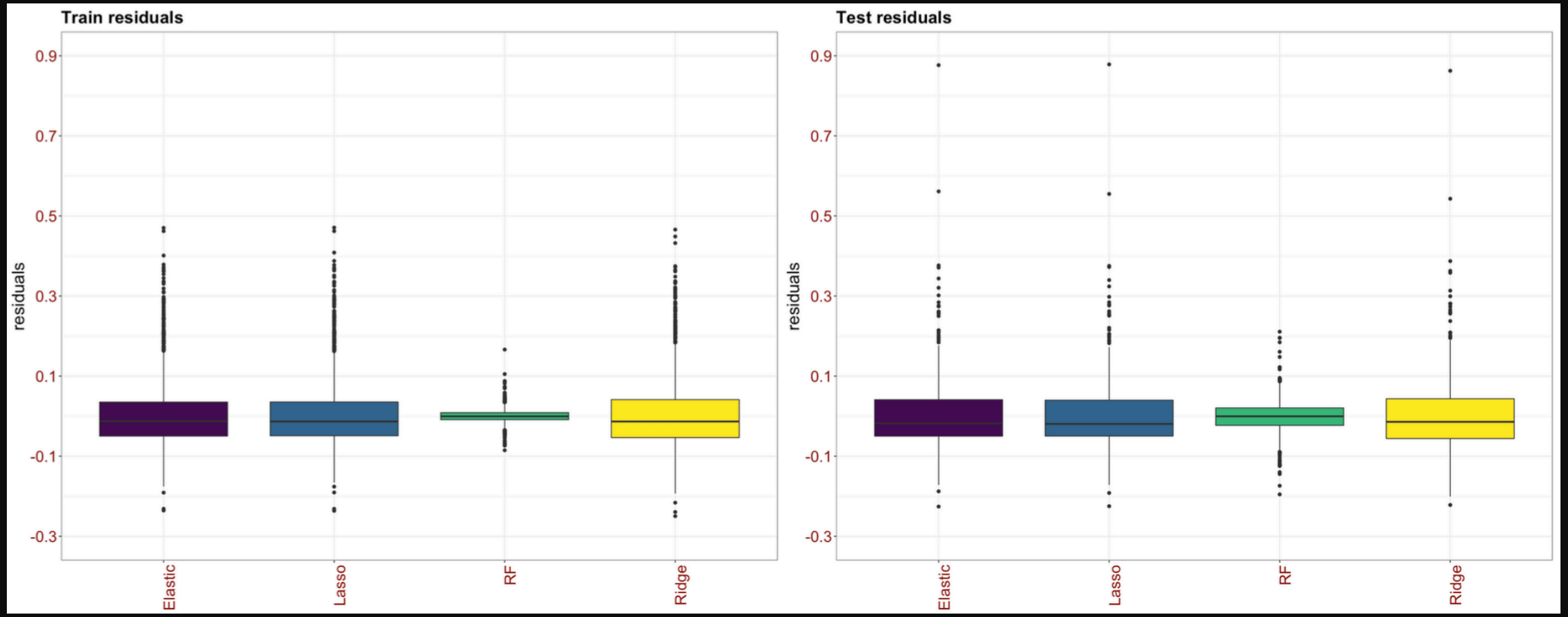
Elastic Net



Ridge



RESIDUALS



→ Train size is 2750 and test size is 688.

→ Random Forest has smallest spread while all constrained models have larger spread.

→ Extreme residual outliers are detected on test set of all 3 constrained models.

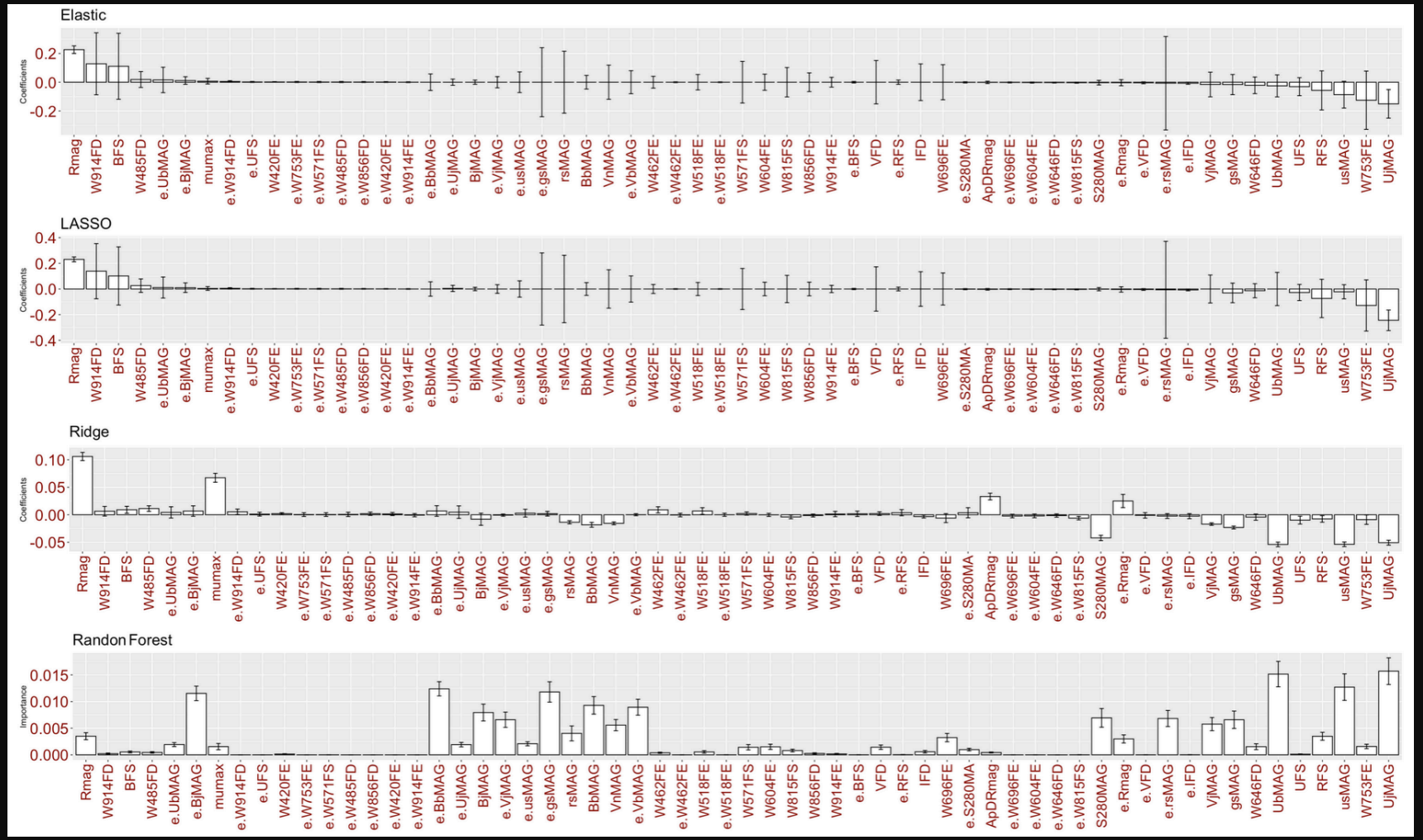
Performance

- → There is a trade off between time and model performance comparing between 3 constrained linear models and RF.
- → Lasso takes longest time to run but does not perform much better than Elastic Net.
- → Ridge is fastest, but its score is less comparable.

Models	90% test R2	Time (s)
Lasso	(0.92183, 0.947541)	0.623
ElasticNet	(0.91962, 0.948475)	0.595
Ridge	(0.91070, 0.93855)	**0.409**
RF	**(0.98144, 0.98680)**	39.352

Coefficients (100 Bootstrap Samples)

- → All linear models have similar feature importance: UjMAG (Johnson U luminosity) and Rmag (red band magnitude) are the two largest coefficients in 3 linear models.
- → With Random Forest, it is UjMAG (Johnson U luminosity) and UbMAG (Bessell U luminosity)
- → Lasso and Elastic Net seem to have similar coefficients magnitudes.
- → All linear models have more spread in features importance than Random Forest.
- → Some features in Elastic Net and Lasso have very wide standard deviation.
- → Based on Elastic Net and Lasso model, when holding other predictors constant, redshift is predicted to increase by 0.25 if red band magnitude goes up by 1; it is the opposite with ultra-violet luminosity.



Conclusion:

- → There is not a big difference between train and test R-squared, train and test residuals which proves that all our predictive models have good performance.
- → Even though RF takes longest time to run, it is still the best model considering its 90% test R-squared.
- → The features importance between RF and linear models are different, there must be some non-linear relationship between the predictors and response variable so that RF can achieve significantly better score than the linear models.
- → There is a positive linear relationship between redshift and red band magnitude; negative linear relationship between redshift and ultra-violet luminosity.