*Determination of geographical origin*

For construction of classifiers, feature selection coupled with supervised machine learning algorithms were introduced. Fig 4 showed relative importance of the features computed by Relief algorithm on training set where higher relative importance implies higher contribution to the classifications. With the information provided by Relief, forward selection was implemented with grid search to find the optimal classifiers. Started with 48% mean cross-validation accuracy for RF and 63% accuracy for SVM, the SVM only outperformed RF within top two features during training process and eventually showed similar results. The performances were boosting with more features included and both algorithms reached 100% training accuracy rapidly with only 4 features (Al, Rb, B and Na), when optimal hyperparameters were selected. Then the optimal classifiers were validated on testing set. The validation results could be found in table 2, where kappa coefficient is a statistic for testing interrater reliability (citations). Both classifiers showed perfect classification results for all types of GI rice in testing set as well. The result is suggesting the information provided by these 4 elements has significant differentiation power to make the classification. (I do feel like we should add new radar plots)

However, the rationale behind the differentiation power of the four elements are not fully understood yet. The accumulation of elements in rice involves multiple factors (genotype, geographical conditions, meteorological characteristics, etc..). The soil in northwest is known for being more fertile than other regions in China (citation) and rich in trace metal elements; WC rice from Heilongjiang province is higher in Rubidium concentration indeed. Interestingly, PJ-1 and PJ-2 grew in the same province, implying they grow in a similar environment. Nonetheless, they show very different profiles of aluminum and sodium, indicating other factors must play prominent roles as well. A more comprehensive metadata would be helpful to better understand the origin of these high discrimination power.