Introduction to Machine Learning

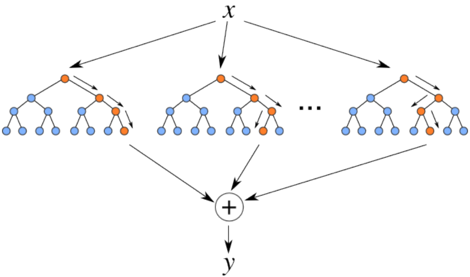
Random Forest: Introduction

compstat-lmu.github.io/lecture_i2ml

RANDOM FORESTS

Modification of bagging for trees proposed by Breiman (2001):

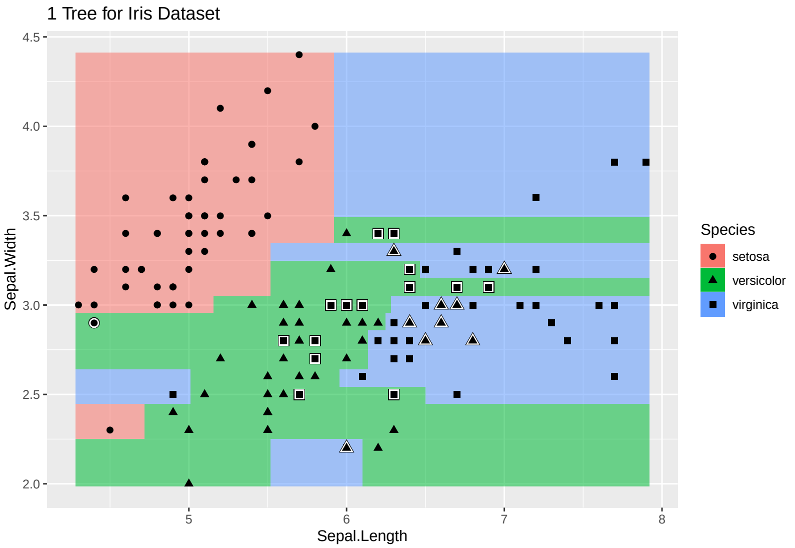
- Tree baselearners on bootstrap samples of the data
- Uses **decorrelated** trees by randomizing splits (see below)
- Tree baselearners are usually fully expanded, without aggressive early stopping or pruning, to **increase variance of the ensemble**



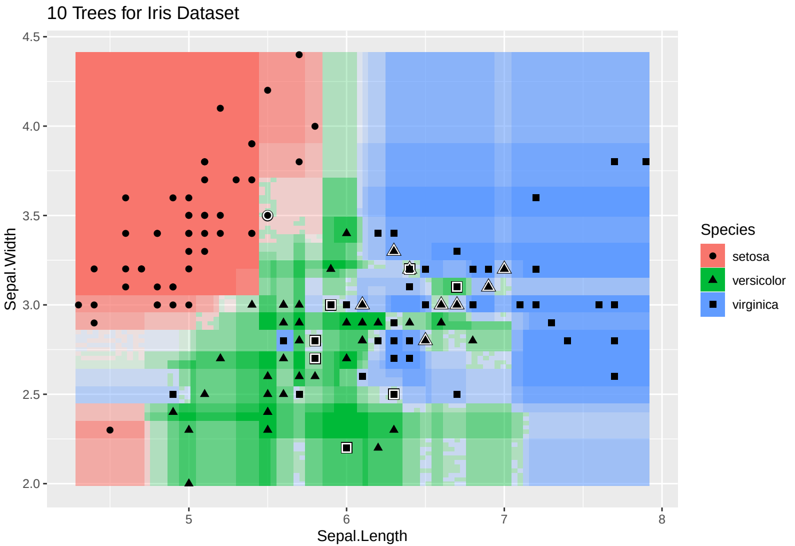
RANDOM FEATURE SAMPLING

- From our analysis of bagging risk we can see that decorrelating trees improves the ensemble
- Simple randomized approach:
  At each node of each tree, randomly draw mtry $\leq p$ candidate features to consider for splitting. Recommended values:
  - Classification: mtry $= \lfloor \sqrt{p} \rfloor$
  - Regression: mtry $= \lfloor p/3 \rfloor$

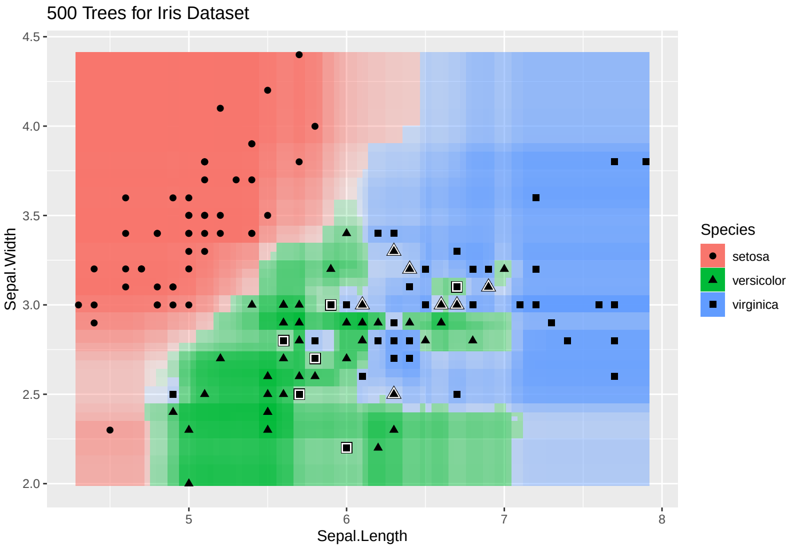
EFFECT OF ENSEMBLE SIZE



EFFECT OF ENSEMBLE SIZE

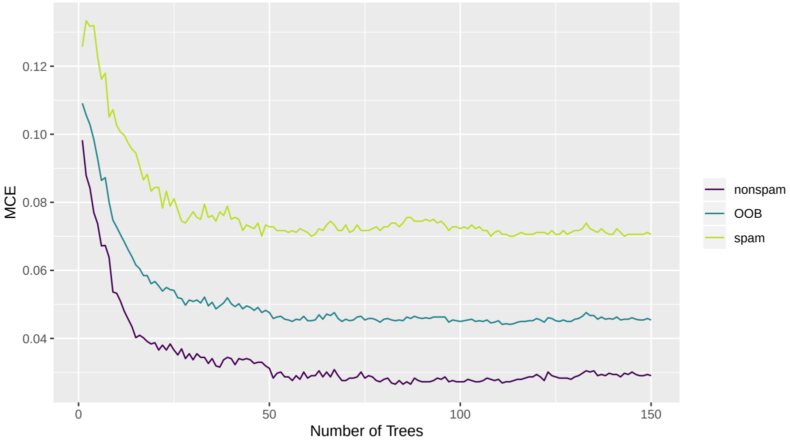


EFFECT OF ENSEMBLE SIZE

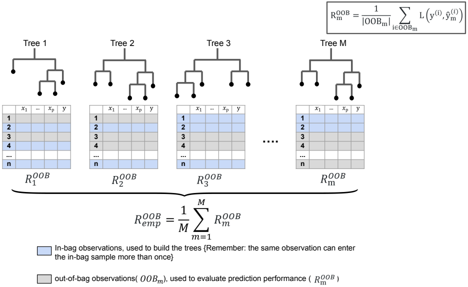


OUT-OF-BAG ERROR ESTIMATE

With the RF it is possible to obtain unbiased estimates of generalization error directly during training, based on the out-of-bag observations for each tree:



OUT-OF-BAG ERROR ESTIMATE



- OOB size: $P(\text{not drawn}) = \left(1 - \frac{1}{n}\right)^n \overset{n \to \infty}{\longrightarrow} \frac{1}{e} \approx 0.37$
- Predict all observations with trees that didn't use it for training and compute average loss of these predictions
- Similar to 3-CV, can be used for a quick model selection