Boosting I

Shrinkage, Subsampling, Tuning for Gradient Boosting

Shrinkage, Subsampling, Tuning

Shrinkage

- Additional tweak in Gradient boosting
- Slow down learning rate to avoid overfitting
- Learning rate is controlled by λ
    - $f_m(x) = f_{m-1}(x) + \lambda \sum_{j=1}^{J_m} \gamma_{jm} I(x \in R_{jm})$

Subsampling

- Optional add-on in Gradient boosting
- Use a random sample (w/o replacement) of pseudo-residuals in each step
- Can be introduced to improve performance and speed
    - "Stochastic gradient boosting"

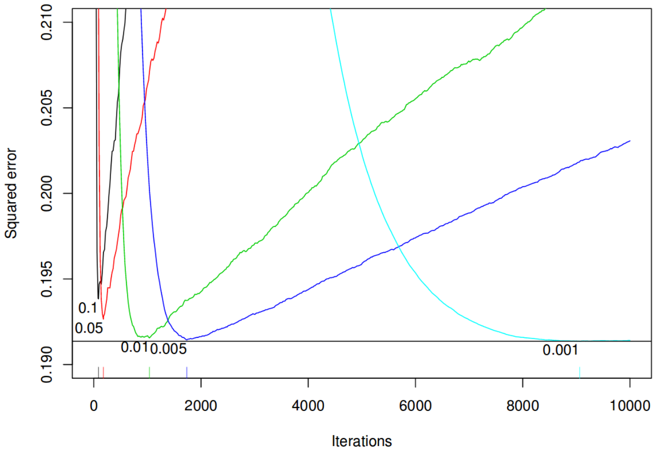
Shrinkage, Subsampling, Tuning

Tuning Gradient Boosting Machines

- Number of trees M
  - Number of “iterations”
  - Overfitting can occur for large M
- Interaction depth D
  - Number of splits for each tree
  - Boosting stumps: $D = 1$
- Shrinkage parameter λ
  - e.g. $\lambda = 0.01$, $\lambda = 0.001$
  - Smaller λ needs larger M
- ...

Shrinkage, Subsampling, Tuning

Figure: Performance by number of iterations and shrinkage[1]



[1] Source: Ridgeway 2018

Summary

- Boosting sequentially combines multiple models into a powerful ensemble
- Similar to random forests, boosting is a “general purpose” approach
- A lot of different flavors exist
- Specific implementations can be compared in a large train and tune loop
- Drawbacks: Low interpretability and (often) high computational costs

Software Resources

Resources for R

- AdaBoost: `fastAdaboost`
  - AdaBoost implementation with C++ backend
- Standard package for Gradient Boosting: `gbm`
  - Implementation and extensions of AdaBoost and GBM (Ridgeway 2018)

References

Friedman, J. (2001). Greedy Function Approximation: A Gradient Boosting Machine. *The Annals of Statistics, 29*(5), 1189–1232.

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Ridgeway, G. (2018). *Generalized Boosted Models: A guide to the gbm package.* `https://cran.r-project.org/web/packages/gbm/vignettes/gbm.pdf`.

Schapire, R. E. and Freund, Y. (2012). *Boosting: Foundations and Algorithms*. Cambridge, MA: MIT Press.