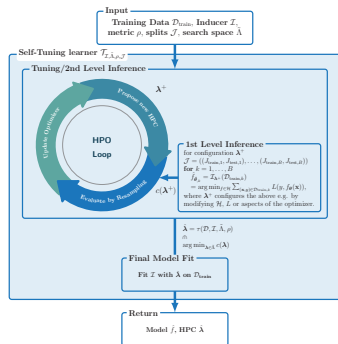
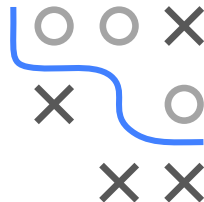


Introduction to Machine Learning

Hyperparameter Tuning

Practical Aspects

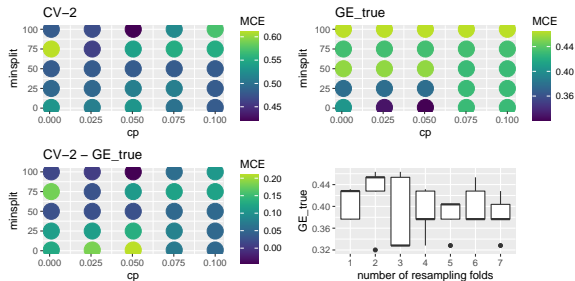
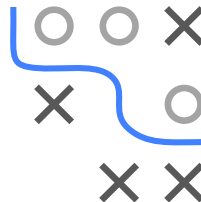


Learning goals

- Understand the possible design choices for HPO
- Know termination criteria of HPO

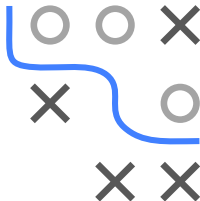
PRACTICAL ASPECTS OF HPO

- Choosing resampling
 - Nr of observations, i.i.d assumption for data sampling process
 - Higher resampling rates likely result in a better model; however they are computationally more expensive



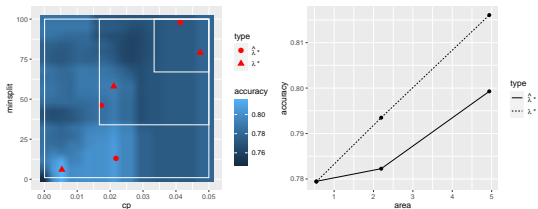
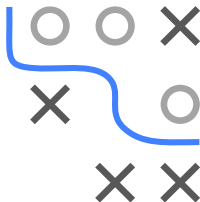
PRACTICAL ASPECTS OF HPO / 2

Tuning a CART on the `spirals` data with a k-fold CV (k=1 means here a 2/3 holdout split) using grid search and estimating the true GE with a very large test set (5 repetitions)



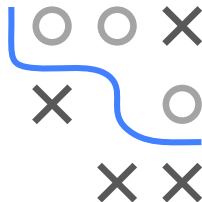
PRACTICAL ASPECTS OF HPO

- Choosing performance measure
 - Desired implications when applying the model in practice
- Choosing a pipeline and search space
 - Numeric HPs of arbitrary size should be tuned on log scale
 - Size of search space results in different trade-offs:
 - too small may miss out well performing HPCs;
 - too large makes optimization more difficult



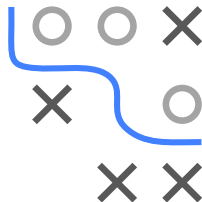
PRACTICAL ASPECTS OF HPO / 2

Tuning `cp` and `minsplit` for a CART on the `titanic` data over 3 increasing rectangular search spaces with random search (candidates number fixed) and comparing the result with the optimal model (found with exhaustive grid search)



PRACTICAL ASPECTS OF HPO

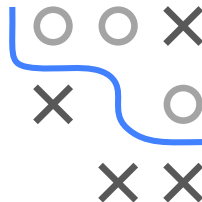
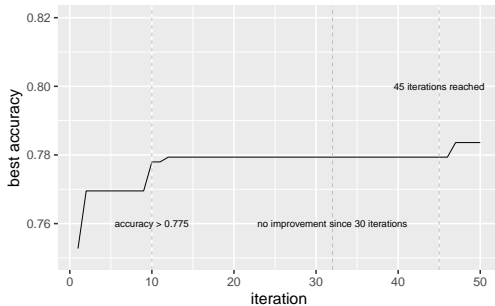
- Choosing HPO algorithm
 - For few HPS (1-3), grid search can be used
 - BO with GPs for upto 10 numeric HPs
 - BO with RFs handle mixed HP spaces
 - Random search and Hyperband work well as long as the “effective” dimension is low
 - EAs are somewhat in-between BO and RS, can handle very complex spaces, but less sample efficient than BO
 - **Also: use something that’s stable and robust! More an aspect of the implementation than the algo!**



PRACTICAL ASPECTS OF HPO

When to terminate HPO

- Specify a certain amount of runtime/budget beforehand
- Set a lower bound regarding \widehat{GE}
- Terminate if performance improvement stagnates



Different stopping points while tuning CART on the `titanic` data depending on which termination criterion is used

PRACTICAL ASPECTS OF HPO

- Warm starts
 - Evaluations (e.g., weight sharing of neural networks)
 - Optimization (initializing with HPCs that worked well before)
- Control of execution
 - Parallelizability of HPO algorithms differs strongly
 - HPO execution can be parallelized at different levels (outer resampling, iteration, evaluation, inner resampling, model fit)

