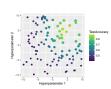
# Introduction to Machine Learning

# Hyperparameter Tuning - Basic Techniques



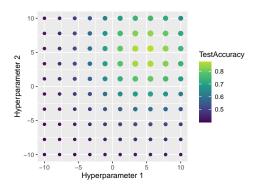
#### Learning goals

- Understand the idea of grid search
- Understand the idea of random search
- Be able to discuss advantages and disadvantages of the two methods

## **GRID SEARCH**

- Simple technique which is still quite popular, tries all HP combinations on a multi-dimensional discretized grid
- For each hyperparameter a finite set of candidates is predefined
- Then, we simply search all possible combinations in arbitrary order

Grid search over 10x10 points



# **GRID SEARCH**

## **Advantages**

- Very easy to implement
- All parameter types possible
- Parallelizing computation is trivial

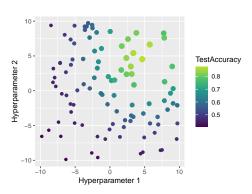
## **Disadvantages**

- Scales badly: combinatorial explosion
- Inefficient: searches large irrelevant areas
- Arbitrary: which values / discretization?

# **RANDOM SEARCH**

- Small variation of grid search
- Uniformly sample from the region-of-interest

Random search over 100 points



# RANDOM SEARCH

# **Advantages**

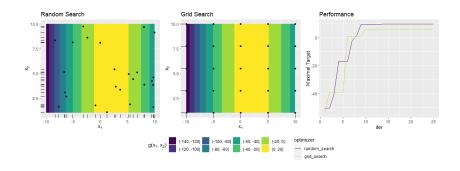
- Like grid search: very easy to implement, all parameter types possible, trivial parallelization
- Anytime algorithm: can stop the search whenever our budget for computation is exhausted, or continue until we reach our performance goal.
- No discretization: each individual parameter is tried with a different value every time

# **Disadvantages**

- Inefficient: many evaluations in areas with low likelihood for improvement
- Scales badly: high-dimensional hyperparameter spaces need lots of samples to cover.

## RANDOM SEARCH VS. GRID SEARCH

We consider a maximization problem on the function  $f(x_1, x_2) = g(x_1) + h(x_2) \approx g(x_1)$ , i.e. in order to maximize the target,  $x_1$  should be the parameter to focus on.



 $\Rightarrow$  In this setting, random search is more superior as we get a better coverage for the parameter  $x_1$  in comparison with grid search, where we only discover 5 distinct values for  $x_1$ .

# **TUNING EXAMPLE**

Tuning random forest with grid search/random search and 5CV on the sonar data set for AUC:

Hyperparameter	Туре	Min	Max
num.trees	integer	3	500
mtry	integer	5	50
min.node.size	integer	10	100

