



PROJECT IMPLEMENTATION

HYPER-PARAMETER OPTIMIZATION
OF MACHINE LEARNING

Outline

- Introduction
- Hyperparameter Optimization motivation
- Hyper-parameters in Machine Learning Models
- Hyperparameter optimization Techniques
- Applying Optimization Techniques to Machine Learning Algorithms
- Implementation
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INTRODUCTION

What is the hyper-parameters?

What is hyper-parameter optimization?

Aim: To automate the hyper-parameters tuning process to get optimal model architecture of ML models



Hyper-parameter optimization motivation

In machine learning we distinguish:

Model parameters: can be initialized and updated in data learning process.

Model hyper-parameters: set by the user before training not changed during fitting data.

Parameters are learned by applying Gradient descent to optimization problem. But not for hyperparameters. **Why?**



Hyper-parameters in Machine Learning Models

Hyper-parameters in **supervised learning**

Hyper-parameters depends on the ML models.
SVM, KNN, CNN, Lasso and Ridge regression.



• Hyperparameter optimization Techniques

We need to use optimization techniques to get optimal hyper-parameters for the model.

There are many different methods:

- Babysitting
- **Grid search**
- Random forest
- Bayesian optimization
- Particle swarm optimization
- Genetic algorithm,...



- # Hyperparameter optimization Techniques

Grid Search

Grid search define a search space as grid of hyperparameters values and evaluate every position in the grid by finding the combinations.

For eg: 6 hyperparameters, each has 10 values, we must try 10^6 combinations

Take time!!!



Grid Search con't

Scikit-learn python source ML libraries provide technique to tune hyperparameters one is “GridSearchCV” which can be implemented to detect the optimal hyper-parameters using the GS algorithm Calculate performance using cross validation. the optimal hyper-parameter combination in the defined search space with its performance score will be returned.



- Applying Optimization Techniques to Machine Learning Algorithms

ML algorithms can be classified by the characteristics of their hyper-parameter configurations.

Appropriate optimization algorithms can be chosen to optimize the hyper-parameters based on these characteristics.



Implementation

- Data:
 - Breast cancer wisconsin (Diagnostic) data set
- Tasks:
 - Classification problem
- H.P.O Algorithms to ML models:
 - Grid Search t applied to:
 - Support Vector Machine
 - K-Nearest Neighbors
 - Logistic Regression



Results

ML Models	Score	Run-time(s)
Logistic Regression	96.9%	0.05
K-Nearest Neighbors	95.2%	0.04
Support Vector Machine	96.4%	9.04

Performance evaluation of applying HPO methods to the ML classifier on the Breast cancer dataset: **Defaults Hyper-parameters**



Results con't

ML Models	Score	Run-time(s)
Logistic Regression	97.7%	1.44
K-Nearest Neighbors	95.9%	2.83
Support Vector Machine	99.4%	1.52

Performance evaluation of applying HPO methods to the ML classifier on the Breast cancer dataset: **Grid Search**



Conclusion

To apply ML models to practical problems, their hyper-parameters need to be tuned to fit specific datasets.

- Manually tuning hyper-parameters is extremely computationally expensive.
- We need to optimize hyper-parameters by an automatic process.
- I did on Grid search as hyperparameter optimization method and is only efficient with categorical HPs.
- Further work: Bayesian Optimization and Genetic Algorithm.

