MachineLearnAthon - Microlecture Hyperparameter Tuning

Recorded by Lara Kuhlmann

MachineLearnAthon
A project Co-funded by the Erasmus+ programme of the European Union

Learning outcomes of today

After successfully completing this micro-lecture, you are able to….

- Understand the role and importance of hyperparameters in machine learning models
- Apply basic hyperparameter tuning techniques
- Understand the principles behind advanced methods

Agenda for today

- Hyperparameters
- Hyperparameter tuning
- Grid Search
- Random Search
- Hyperband optimization

Hyperparameters

- Hyperparameters are inputs to a machine learning algorithm that govern how the algorithm's perfomances generalizes to new, unseen data.[1]
- Are not learned from data, unlike model parameters
- Examples: learning rates, amount of regularization

[1] Li et al. 2018

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Hyperparameter tuning

- Hyperparameter tuning is the process of determining optimal hyperparameters to measure performance of a machine learning model.[1]
- Goal: Find the highest possible model performance through a few sequential queries.[2]
- Challenge: Complexity increases with the number of hyperparameters and their interactions.[3]
- Tuning methods: Manual adjustment, Automated Algorithms

[1] Gerouani & Bouneffa. 2024
[2] Nguyen. 2019
[3] Sievert et al. 2019; Li et al. 2018

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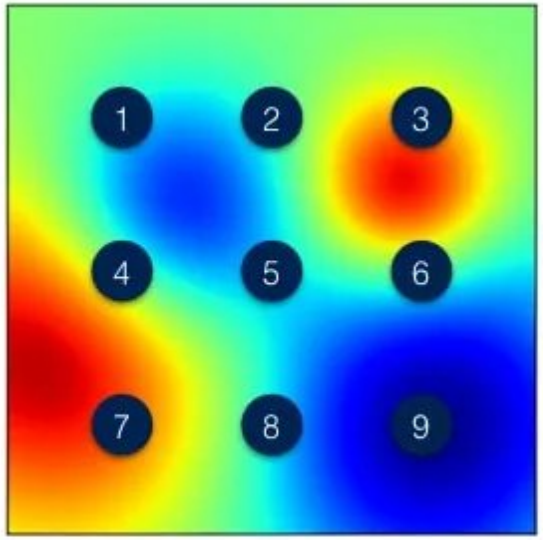
Grid Search

- Methods: Systematic search through all combinations in a given parameter range.[1]
- Advantages: Easy to implement and to understand.[2]
- Disadvantages: High computing effort, inefficient with large search spaces.[3]

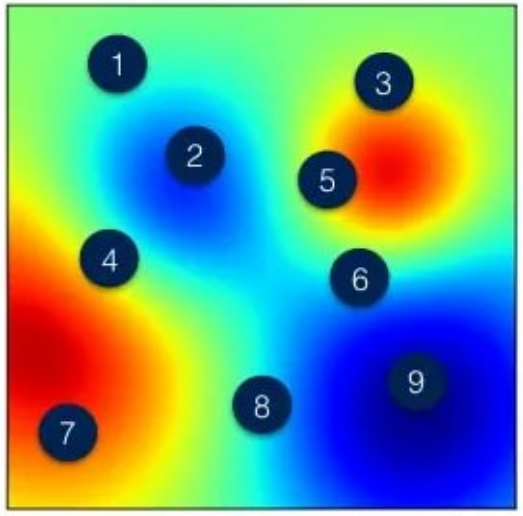


Grid Search

[1] Raschka et al. 2020
[2][3] Juilian & Devipriya. 2024
Iimg:https://pub.aimind.so/understanding-hyperparameter-optimization-techniques-4a39d0494612

Random Search

- Methods: Random selection and evaluation of configurations within the parameter range.[1]
- Advantages: Flexible and fault-tolerant, experiments can be stopped or supplemented at any time.[2]
- Disadvantages: No complete overview of the entire parameter range.[3]



Random Search

[1] Raschka et al. 2020
[2] Bergstra & Bengio. 2012
[3] Juilian & Devipriya. 2024
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Hyperband Optimization

- Principle:
  - Exploration vs. exploitation: Hyperband tests many different configurations (exploration), with the most promising ones being pursued further (exploitation).[1]
  - Successive Halving: Several configurations receive certain resources at the beginning, weak configurations are gradually sorted out, better configurations receive more resources.[2]
- Functionality:
  - Generation of multiple, random configurations of the hyperparameters.[1]
  - Distributes a fixed amount of resources to the configurations.[2]
  - Each configuration is trained and evaluated for a certain number of iterations.[3]
  - Weak configurations are aborted at an early stage to save resources.[3]
  - Successful configurations are further optimized.[3]
  - Finally, the power of the individual brackets is averaged to give a total power.[2]

[1] Raschka et al. 2020
[2] Li et al. 2018
[3] Sievert et al. 2019
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Recap this lecture

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