

**General hints for code submissions** To make it easier for us and others to understand your solutions please follow these guidelines:

- If available use the template file to create your solution.
- Please add comments so we can understand your solution.
- Please make sure to load all required packages at the beginning of your code.
- Only use relative file paths for `source()`, `load()`, etc.
- Each exercise directory contains a `skeleton` folder where preliminary R files are located.
- Use these R files as a basis for creating your solution which should be contained in a main R file named as the content of the exercise, e.g., `evaluation.R`.
- You can (and sometimes have to) reuse code from previous exercises.
- The points indicate the difficulty of the task.
- If not stated otherwise, we will use exclusively R 4.0 or greater.

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From the lecture you have learned about evolutionary algorithms and simple methods of hyperparameter optimization.

1. **Evolutionary Algorithms** [12 points]

The lecture taught you all about the individual parts of a simple evolutionary Algorithm. Your task is to implement mutation, recombination and selection mechanisms. Specifically:

- (a) Implement **Uniform** and **Gaussian** mutation mechanisms. [3.pt]
- (b) Implement **Uniform crossover** and **Intermediate** recombination mechanisms. [3.pt]
- (c) Implement **Neutral**, **Fitness-proportional** and **Tournament** parent selection mechanisms. [4.pt]
- (d) In each iteration of the EA, create one offspring per selected parent either through recombination or mutation. You can use the `frac_mutants` parameter to trade-off [2.pt]

2. **Basic HPO** [3 points]

Implement a simple HPO method (either grid or random search) to optimize three parameters of your EA. Specifically your method has to handle three categorical parameters (mutation, selection and recombination). Find the optimal parameters for the EA on the Ackley function you have seen in the lecture. We accept to overfit here.