**Deep Artificial Neural Network Optimization - Project Report**

Course: Computational Intelligence for Optimization

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1. **Introduction**
   1. **Objective of the project**

The objective is the optimization of the weights of the 64.000 connection in the given artificial neural network using optimization algorithms discussed during the semester. In the end, the artificial neural network should be able to recognize unseen handwritten digits.

This goal should be achieved by benchmarking different algorithms and parameters (especially variations of the Genetic Algorithm).

* 1. **Way of proceeding**

The procedure throughout the project was the following:

Test other algo-rithms

Research

Get best baseline para-meters

Fine tuning of best solution

Test selection methods

Test crossover methods

Test mutation methods

Test different GA´s

1. **Research**

During the research the following methods and algorithms were found and implemented and/or tested:

|  |  |  |
| --- | --- | --- |
| **Genetic Algorithm** | **Selection** | Tournament selection |
| Roulette-Wheel selection |
| Rank selection |
| Boltzmann selection |
| Random selection |
| Best selection |
| **Crossover** | One-point crossover |
| Two-point crossover |
| Uniform-swap |
| Arithmetic crossover |
| Random crossover |
| **Mutation** | Ball mutation |
| Ball mutation with boundaries |
| Random member mutation |
| Swap mutation |
| Decreasing mutation rate |
| **Other** | Elitism |
| Worst removal |
| Mating pool |
| Measuring phenotype/genotype |
| Two populations |
| **Particle Swarm Optimization** |  |  |
| **Simulated Annealing?** |  |  |
| **Hill Climbing?** |  |  |

1. **Exploration of Parameters of the given Algorithms**

The first step in order to optimize the network, is to explore and test different parameters on the existing algorithms.

The given neural network using the genetic algorithm was tested with 5 different seeds by changing the parameters in every combination (get more specific) in order to get a benchmark for the baseline.

The following charts illustrate the impact of the change of each parameters (rest unchanged) on the unseen accuracy:

(4-5 Charts (maybe some that represent different seeds& mean)

Describe benchmark values

* 1. **Hill Climbing**
  2. **Simulated Annealing**
  3. **Genetic Algorithm**

1. **Selection methods**
2. **Crossover methods**
3. **Mutation methods**
4. **Other**
5. **Analysis of Combinations**
6. **Fine Tuning**
7. **Conclusion**
8. **References**