



Class 7 - Analyzing and Plotting Results

Guiding Genetic Algorithms with Language Models for Combinatorial Optimization

MISE Research Program - July 2025



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Genetic Algorithms



Genetic Algorithm for Truck Packing

State: A list of N distinct integers from 1 to N (i.e., a permutation of $1, \dots, N$), which correspond to an assignment of packages to trucks through the first-fit algorithm

Score function of a state: Size of the list produced by the first-fit algorithm

Crossover: Note that we can't just use the one-point crossover method since it leads to duplicates, so:

- Pick two cut positions $a < b$ on the lists
- Child inherits the slice from the first parent between the cuts
- Fill the remaining blanks by scanning the second parent from the right-hand cut onward inserting each item that isn't already in the child, in that order

Mutation: A random swap of two elements in the list that corresponds to a state



Implementation

[See code demo](#)

Parameter Tuning



Making our Code Better

Code that isn't measured can't be improved

We need to collect statistics on our code to understand where improvements can be made

While the algorithm runs, we can keep track of per-iteration metrics

A fixed seed makes experiments reproducible -> `random.seed(seed)`

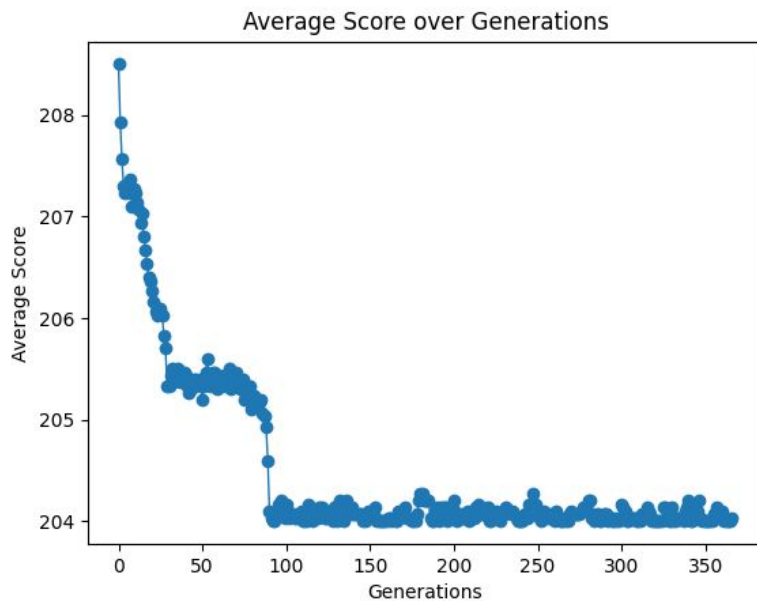
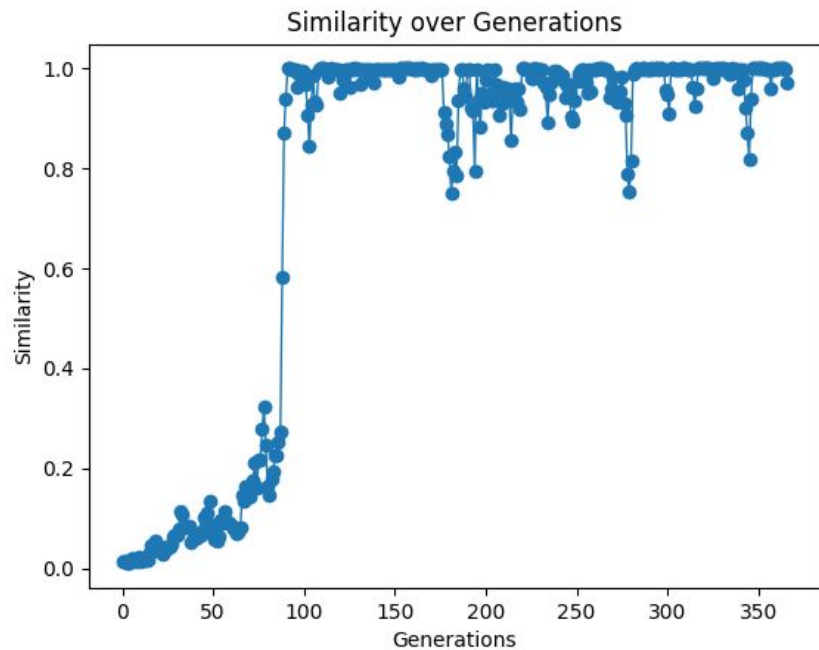
Setting a seed gives the pseudo-random generator a fixed starting state, so every call to `random` produces the same sequence of numbers in every run.



Genetic Algorithms Common Pitfalls

- **Premature convergence:** diversity collapses early (e.g., too low mutation, weak crossover), so the population gets stuck in a local optimum
- **Excessive evaluation cost:** when the fitness function is expensive, population-wide evaluation becomes a runtime bottleneck
- **Too strong elitism or no replacement strategy:** keeping only the very best can kill diversity
- **Fitness plateaus with sparse gradients:** if large parts of the search space share identical fitness (e.g., many ties), selection pressure drops and the GA drifts randomly

Code Demo





What's next?

Next class tomorrow/friday (3pm)

No assignment sheet today, study the code from the class, which will be on the website

Challenge: try to run the GA code from today to get better than 42 and 204 on the hard samples

Class 8: Problem Focus: Conveyor Diverter Routing