Lab on Metaheuristic Methods: Simulated Annealing and Genetic Algorithms

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1 Questions for Students

1. **Formulation for VRP:** Suppose that you are given 11 demand points with known demand for each point and the co-ordinates of each demand point being given. [**R**] Now write a mathematical formulation for the problem to minimize the total distance travelled by vehicles if you have infinite number of vehicles and capacity of each vehicle is 100 units. All the vehicles must start from the depot and return back to the depot after serving the demand points.

   You have to use the benchmark dataset Augerat, 1995 (A-n32-k5) (http://vrp.atd-lab.inf.puc-rio.br/index.php/en/)for the problem. Use 11 initial demand points for this problem.

2. **Reporting the solution time and quality:** Now repeat the same problem above for 11, 12 and 13 demand points (including depot) and report the solution times for each case.

   Solve the same using any one of simulated annealing or genetic algorithm and compare solution time of the exact method with that of the meta heuristics.

   [**R**] What will be the tentative solution time if we solve this exact method formulation using a solver for 32 demand points ?

3. **Simulated Annealing :** Now, Use simulated annealing to solve the same problem on complete A-n32-k5 and A-n80-k10 datasets from the benchmark dataset. Report the solution time and the percentage gap from the optimal.

   Try diffrent cooling schedules and initial temperatures to obtain the best result. plot a chart showing the best result obtained against initial

temperature. [**R**] What is the effect of temperature on the overall behaviour of the algorithm ?

4. **Genetic Algorithm :** Solve the same problem using genetic algorithm on the same two datasets. Report the solution time and quality. Also you can choose any selection method (not necessary roulette wheel) of your choice for the candidate selection.

5. **OR Tools:** Now import google OR Tools and use it to solve the VRP on the given two datasets and compare the solution with that of simulated Annealing and Genetic Algorithm.

   [**R**]If OR Tools performs better, what might have been the reason ?

2 Conclusion

This lab provides a comprehensive introduction to metaheuristic methods with simulated annealing and genetic algorithms. The lab is structured to give you both theoretical background and practical experience in coding these algorithms. Use the provided Python dry-run examples as a starting point to explore further optimizations and enhancements.

3 Readings

You can find definitions, short description and dry run code for simulated annealing and genetic algorithm in the file attached with the (link.) or copy paste the link in your browser: https://l1nk.dev/i5DtN