

Traveling Salesman Game

Andrej Lonek
Ústav matematiky



Thesis Goals

- Study the Traveling Salesman Problem
- Explore fundamental concepts of cooperative game theory
- Analyze fair cost-sharing methods among agents
- Apply these methods in practice using:
 - Custom implementations
 - Existing libraries

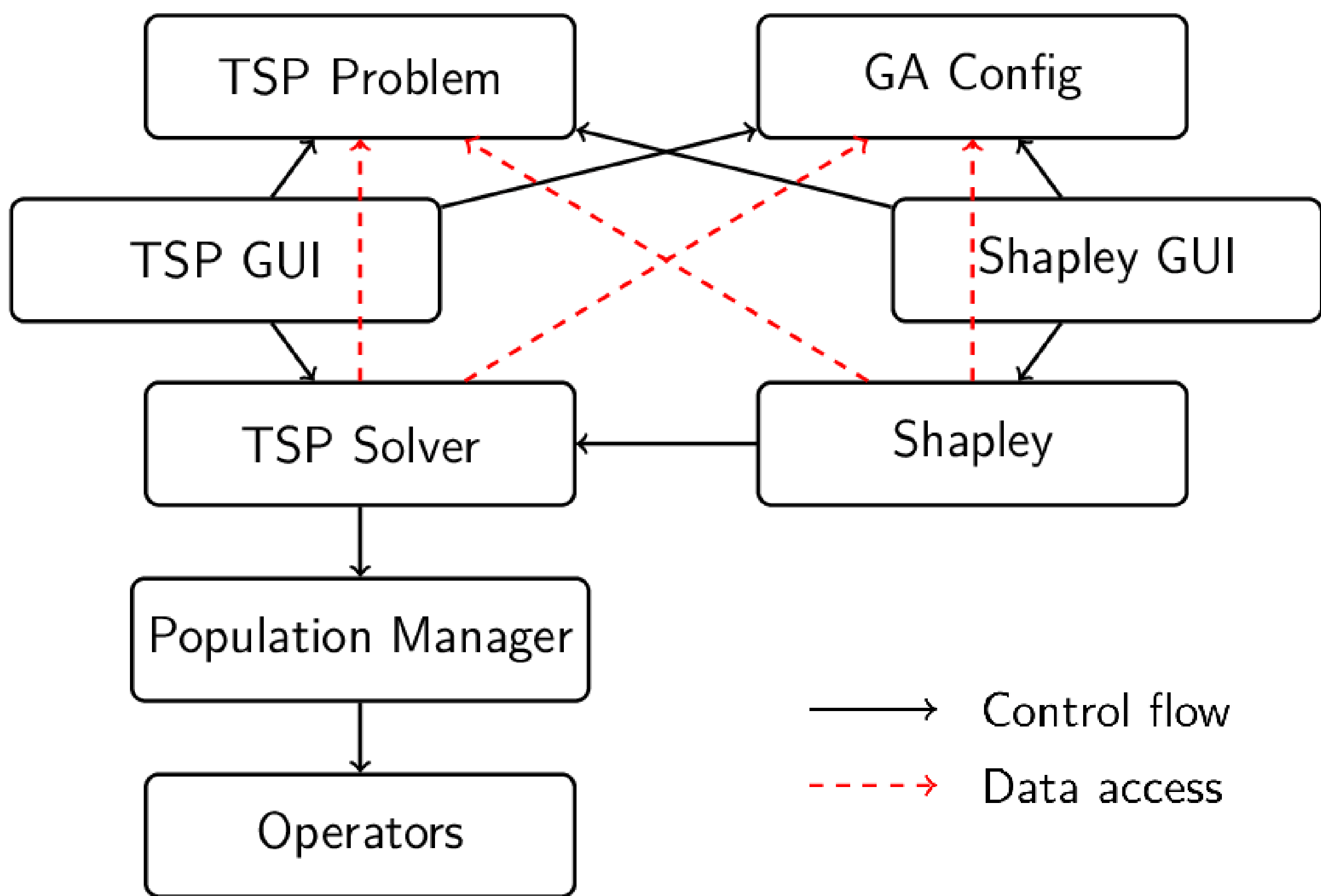
Informal formulation of TSP

Given a set of cities and pairwise distances between them, determine the shortest possible route that visits each city exactly once and returns to the original city.

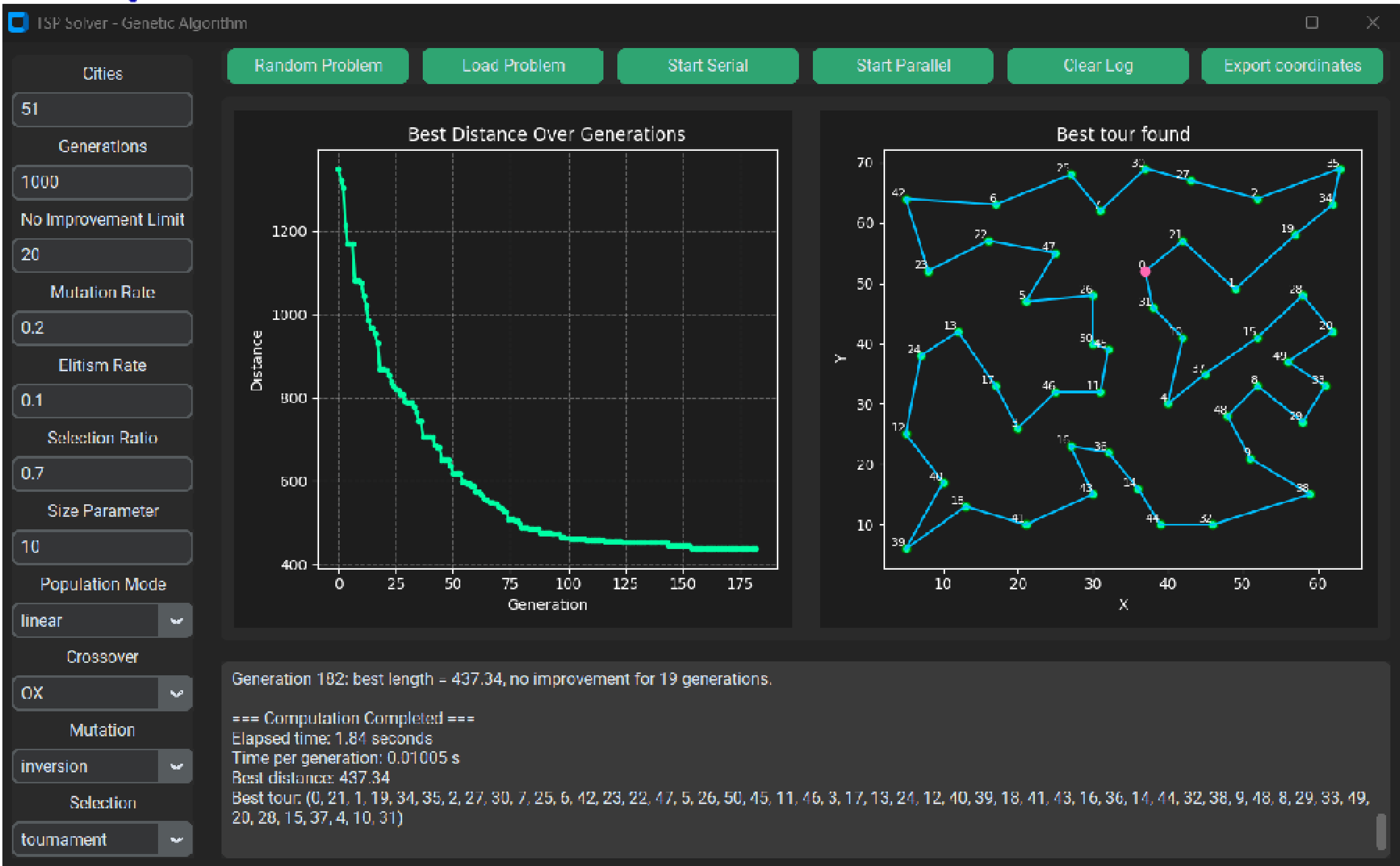
Algorithm Genetic Algorithm

- 1: **BEGIN**
- 2: Initialize population with random candidate solutions
- 3: Evaluate each candidate
- 4: **repeat**
- 5: Select parents
- 6: Recombine pairs of parents
- 7: Mutate the resulting offspring
- 8: Evaluate new candidates
- 9: Select individuals for the next generation
- 10: **until** termination condition is satisfied
- 11: **END**

Combined Architecture: TSP GA + Shapley app

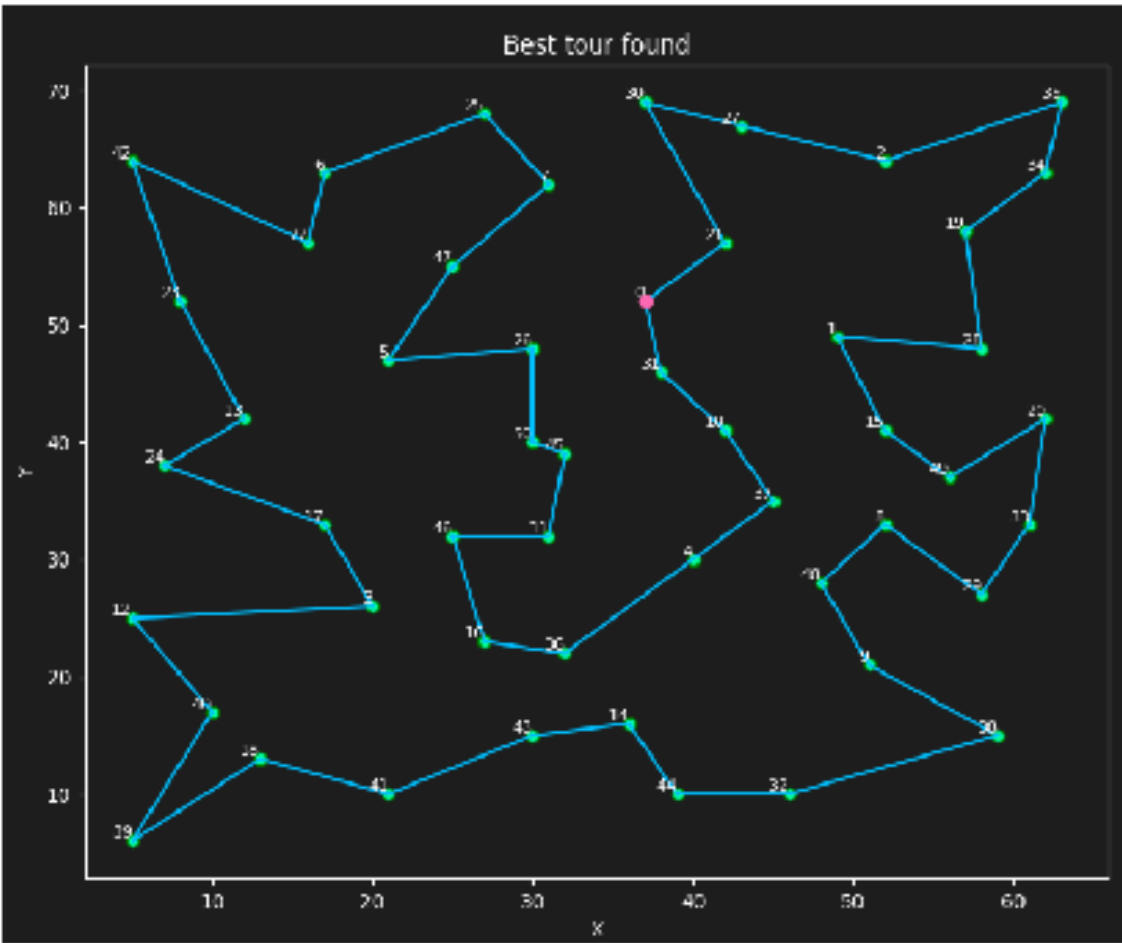


Graphical Interface for TSP GA

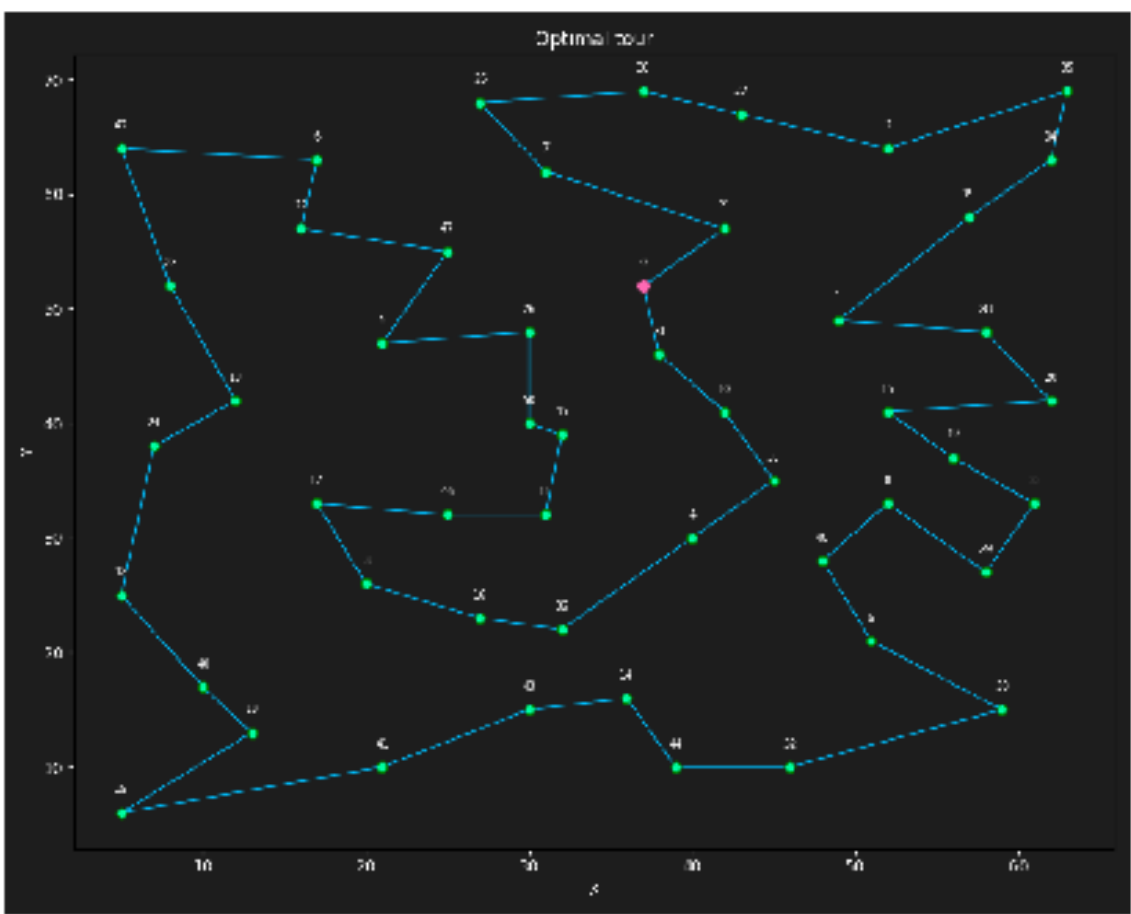


Top GA Configurations - ei151

Xover	Sel.	Mut Rate	Sel Rate	Elit Rate	Mean Length	+Opt. (%)	Time (s)
OX	tournament	0.20	0.7	0.10	454.44	6.68	2.48
OX	tournament	0.20	0.8	0.15	455.76	6.99	2.31
OX	tournament	0.15	0.7	0.05	455.95	7.03	2.68



GA tour length = 438.52



Optimal tour length = 426.0

Shapley Value Approximation Results

Evaluation Strategy (100 Samples per Worker, 11 workers, 30 runs)

15-city Benchmark:

- Coalition costs estimated via Genetic Algorithm for all subsets with $|S| > 9$.

True Shapley Values:

1: 13.518, 2: 3.986, 3: 4.477, 4: 2.987, 5: 8.272, 6: 9.818, 7: 7.404, 8: 3.057, 9: 14.319, 10: 4.451, 11: 5.130, 12: 8.257, 13: 7.270, 14: 6.659

15-city Metric	Single-thread		Parallel	
	Mean	Std Dev	Mean	Std Dev
MAE	0.7257	0.1650	0.2210	0.0496
MSE	0.9422	0.4317	0.0868	0.0386
RMSE	0.9458	0.2180	0.2878	0.0632
Max Error	2.1298	0.6488	0.6552	0.1819
Percent Error	10.9%	2.4%	3.3%	0.7%
Elapsed Time (s)	—	—	32.438	1.380