



OPTIMISATION METHODS & ALGORITHMS WORKGROUP GROUP 3

STSP SOLVED BY HYBRID METAHEURISTICS

173428 Ghio Luca
177145 Martello Hillary
207006 Miano Sebastiano
171370 De Lucia Riccardo Roberto

OUR META-HEURISTICS

➤ STSP

- Symmetric distance matrix (Euclidean Distance)
- I: #numbers

➤ GENERAL APPROACH: HYBRID META-HEURISTICS

- Genetic Algorithm plus Tabu Search
- At each iteration:
 - I. GA first generates one offspring, then two sons are chosen
 - II. Tabu Search is employed on both the two sons in order to improve them
 - Tabu Search employs both INTENSIFICATION and DIVERSIFICATION techniques to get better solutions

BASIC BLOCKS

➤ Solution Representation

- Ordered List of Customers
- OF Evaluation
 - Full and Incremental

➤ Offspring generation for the GA

- Crossover randomly chosen at each iteration among different ones

➤ Neighbourhood generation for the TS

- 2-opt moves in INTENSIFICATION phase
 - Basic Concept: two edges, let's say A-B & D-E, are replaced by A-D & B-E
- Special 2-opt move in DIVERSIFICATION phase
 - This move deletes the two most frequent non consecutive edges and applies a 2-opt move on them

GA BASIC BLOCKS (CONT.)

- **Initial Solution**
 - Nearest City approach
- **Crossover**
 - SCX, ERX, PMX, OX
- **Killing policy**
 - The two worst sons of each offspring are killed, and replaced by the two ones modified with the Tabu Search
- **Fitness Function for min problems**
 - $1/\text{fitness}$ function
- **Evolution of the population**
 - Pseudo-probabilistic approach (the behaviour is fixed according to the specific seed which is used)

TS BASIC BLOCKS (CONT.)

➤ **Aspiration Criteria**

- Standard: solution extracted from the neighbourhood is globally improving

➤ **Tabu List**

- Reactive Tabu List

Tabu List with variable tenure (starting from 7)

Tenure increased for non-improving iterations ($\min(\text{MAX_TENURE}, \text{current tenure}+2)$)

Tenure decreased for new best solution found ($\max(7, 0.75 * \text{current tenure})$)

➤ **Tabu Move**

- Attribute: deleted edges considered in the move

➤ **Backtrack**

- It happens if the max number of non-improving iterations is performed consequently
An old best solution is set and slightly modified to generate new neighbours
The number of maximum non-improving iterations decreases as the search goes deep in the tree

PARAMETERS TUNING

➤ GA

- Max Generations: 100
- Population Size: 100
- Crossover Probability: 0.8
- Random Selection chance: 10
It lets occasionally select sons for the Tabu exploration which are not the best of the offspring
- Chromosome mutation probability: 0.15
Sometimes new sons can be modified again after the crossover, before selecting the individuals for the Tabu Search

➤ TS

- Max Iterations for each search: 700
- Max non-improving iterations: 400
- Min non-improving iterations: 100
- Neighbourhood size: $n*(n-1)/2$
- Max Tenure: number of customers/2

RESULTS

Istanze	Best (%)	Mean (%)	Time
berlin52	0,00	0,00	2
eil51	0,00	0,00	2
eli76	0,00	0,00	5
pr152	0,00	0,10	23
pr1002	3,07	3,37	301
rat195	0,04	0,39	39
Mean	0,52	0,64	62

➤ Note

- The previous results for each instance are to be intended as a mean value, due to the non-completely deterministic approach of the meta-heuristics, which depends on the seed
- **Very efficient for small problems, still accurate for bigger instances**