A HyFlex Module for the Quadratic Assignment Problem*

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1 Problem Formulation

Given a set of n facilities F, a set of n locations L, $d : L \times L \to \mathbb{R}$ a function specifying the distance between each pair of locations and $f : F \times F \to \mathbb{R}$ a function specifying the flow between each pair of facilities. Find an assignment of facilities to distinct locations that minimizes the sum of the distances multiplied by the corresponding flows. The search space S consists of all bijections $F \to L$. The cost function is $c(s) = \sum_{x,y \in F} f(x, y)d(s(x), s(y))$. This domain provides 10 benchmark instances, taken from the QAPLIB library [2]. The properties and best known solution qualities (f_{prev}) of these instances, are summarized in Table 1.

Table 1: Instances provided in the QAP domain

index	**name**	**n**	$\boldsymbol{f_{prev}}$
0	sko100a	100	152002
1	sko100b	100	153890
2	sko100c	100	147862
3	sko100d	100	149576
4	tai100a	100	21052466
5	tai100b	100	1185996137
6	tai150b	150	441786736
7	tai256c	256	43849646
8	tho150	150	7620628
9	wil100	100	273038

2 Solution Initialisation

Assigns facilities to locations, uniformly at random.

*This description is an extract from [1]

3 Low Level Heuristics

3.1 Local search heuristics

0. SWAPFIRSTII: Iteratively swaps the locations of 2 random facilities, improving the solution.

1. SWAPBESTII: Iteratively swaps the locations of the 2 facilities, improving the solution most.

Both local-search heuristics terminate at a local optimum.

3.2 Mutational heuristics

2. SWAPRANDOM: Swaps the locations of 2 random facilities, repeated $\lceil 5\alpha \rceil$ times.

3. SWAPBEST: Swaps the locations of the 2 facilities, resulting in the best solution quality. This operation is repeated $\lceil 1000\alpha^3 \rceil$ times or until an improving solution is found. Within a single application the same pair of facilities are never swapped twice.

3.3 Ruin-Recreate heuristics

4. RREASSIGN: Unassigns $\lceil \frac{\alpha n}{2} \rceil$ facilities and reassigns them uniformly at random.

5. GREEDYREASSIGNF: First unassigns $\lceil \alpha n \rceil$ facilities. Next re-assigns facilities x to a location, in order of decreasing sum of flows $\sum_{y \in F} f(x,y) + f(y,x)$, minimizing the cost of the partial assignment $c(s') = \sum_{x,y \in F'} f(x,y) d(s(x), s(y))$, with $F' \subset F$ the assigned facilities.

6. GREEDYREASSIGNL: As 5, but instead free locations x are re-assigned to facilities in order of decreasing sum of distances $\sum_{y \in L} d(x,y) + d(y,x)$.

3.4 Crossover heuristics

The domain provides the 2 classic permutation crossover operations, shown to perform best on QAP in [3].

7. PMX: Partially Matched Crossover.

8. OX: Order Crossover.

References

[1] Steven Adriaensen, Gabriela Ochoa, and Ann Nowé. A benchmark set extension and comparative study for the hyflex framework. In *Evolutionary Computation (CEC), 2015 IEEE Congress on*. IEEE, 2015.

[2] Rainer E Burkard, Stefan E Karisch, and Franz Rendl. Qaplib–a quadratic assignment problem library. *Journal of Global optimization*, 10(4):391–403, 1997.

[3] KC Chan and H Tansri. A study of genetic crossover operations on the facilities layout problem. *Computers & Industrial Engineering*, 26(3):537–550, 1994.