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Metaheuristics for Optimization/Decision Problems

IART 1st Assignment Checkpoint

Work specification

The selected theme of our project was Optimization Problems.

In this case, our goal was to devise a solution for the Hash Code 2017 Final Round problem *Router Placement*, using metaheuristics.

Given a building plan, decide where to put wireless routers and how to connect them to the fiber backbone to maximize coverage and minimize cost.

The score of an attempt is calculated based on the formula:

```
Score = 1000 × Target cells with coverage + Remaining budget

Remaining Budget = Total budget - (Routers × Price of Router + Backbone × Price of Backbone)
```

Input data

The first line contains the following numbers:

- H (1 ≤ H ≤ 1000) - number of rows of the grid
- W (1 ≤ W ≤ 1000) - number of columns of the grid
- R (1 ≤ R ≤ 10) - radius of a router range

The next line contains the following numbers:

- Pb (1 ≤ Pb ≤ 5) - price of connecting one cell to the backbone
- Pr (5 ≤ Pr ≤ 100) - price of one wireless router
- B (1 ≤ B ≤ 10^9) - maximum budget

The next line contains the following numbers:

- br, bc (0 ≤ br < H, 0 ≤ bc < W) - row and column of the initial cell that is already connected to the backbone

Example

```
8 22 3
1 100 220
2 7
----------------------
-########----########-
-#......######......#-
-#..................#-
-#..................#-
-#..................#-
-####################-
----------------------
```

1st line - H=8, W=22, R=3
2nd line - Pb=1, Pr=100, B=220
3rd line - the initial cell connected to backbone is [2, 7]

“-” - Void cells
“#” - Walls
“.” - Target Cells

Related work

- sbrodehl/HashCode
- admirkadriu/router_placment_ga
- *Genetic Algorithms for Efficient Placement of Router Nodes in Wireless Mesh Networks*

Problem formulation

States: Placed routers, target cells, graph representing connected routers with cables

Initial state: No placed routers, all target cells are

Objective test: Can’t place anymore routers (due to budget or space limitations)

Operators: Place router in coordinates i, j

Heuristics/Evaluation functions: Score

Implementation work

The selected language to implement our solution was Python.

There are data structures to represent the problem information, building grid, state and graphs, as well to handle input and output of it.

So far, the Random Hill-Climbing, Steepest Ascent Hill-Climbing and Simulated Annealing optimization techniques have been already implemented.