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DM86 Local Search Methods – Weekly Notes

Week 2, Spring 2006

Lecture February 9

We continued the general introduction of Local Search methods, emphasizing the existence of different terminologies. We refined the presentation of components such as the Neighborhood Structure and the Step Function. Within this latter component, we pointed out the importance of the Evaluation Function.

We discussed the three basic Perturbative Search procedures

- Uniformed Random Picking
- Uniformed Random Walk
- Iterative Improvement

In particular, related with Iterative Improvement we defined the pivoting rules: best and first improvement, and the concept of local optimality. As general ideas to escape from local optima we mentioned the combination of intensification and diversification.

Finally we reviewed the results of Complexity Theory applied to Local Search algorithms.

We then started considering the basic procedures of Local Search algorithms more in detail. To this aim we focused on the Traveling Salesman Problem and described the following Construction Heuristics:

- Heuristics that grow fragments
  - Nearest neighbor
  - Greedy heuristic on edges (multiple fragment heuristic)
  - Greedy heuristic on vertices (Quick Borüvka)
- Heuristics that grow tours
  - Insertion heuristics
    - nearest addition
    - cheapest addition
    - farthest addition
    - random addition
  - Savings heuristics (Clark Wright)
- Heuristics based on trees
  - Christofides

We concluded the lecture with a remark on Software Development and the Extreme Programming rules (links are given in the section Literature). Finally, we review a framework for the design of Local Search algorithms.

Exercises

Exercise 1

Implement basic versions of some of the above mentioned construction heuristics for TSP.

Test the algorithms on the following instances of the TSPLIB obtainable from the web site of the 8th DIMACS Implementation Challenge on TSP `http://www.research.att.com/~dsj/chtsp/index.html` (optimal values between parentheses):

- `pcb1173` (56892),
- `u2319` (234256),
- `pr2392` (378032),
- `pcb3038` (137694),
- `fnl4461` (182566),
- `rl5915` (565530),
- `pla7397` (23260728)

Address the following questions:

- Are there deterministic heuristics? Do ties in the construction process occur in any of the tested instances? (In affirmative case, resolve them by random decisions.)
- From a sample of 30 runs of the heuristics that you implemented, which is the median and average percent deviation of the tour found over the optimal tour length?
- From a sample of 30 runs of the heuristics that you implemented, which is the median and average computation time?
- How do the values found in the previous two points compare to the known values available at the DIMACS challenge web page?

Finally, for an instance at choice, plot the histogram and boxplot of the tour length distribution obtained by a sample of 50 runs.
[Note: from the section Course Material, code is available for reading the instances and computing the tour length.]

Exercise 2

Download the **R** Reference Card `http://cran.r-project.org/doc/contrib/Short-refcard.pdf` and learn the basics **R** functions. Try the command `demo()`, and with some of the graphical functions in the Reference Card, the command `example(name.function)`