DM811

Heuristics for Combinatorial Optimization

Lecture 4

Construction Heuristics and Metaheuristics

Class Exercise

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Outline

Construction Heuristics

Construction heuristics specific for TSP

- Heuristics that Grow Fragments
  - Nearest neighborhood heuristics
  - Double-Ended Nearest Neighbor heuristic
  - Multiple Fragment heuristic (aka, greedy heuristic)
- Heuristics that Grow Tours
  - Nearest Addition
  - Farthest Addition
  - Random Addition
  - Clarke-Wright savings heuristic
  - Nearest Insertion
  - Farthest Insertion
  - Random Insertion
- Heuristics based on Trees
  - Minimum spanning tree heuristic
  - Christofides' heuristics
  - Fast recursive partitioning heuristic

Construction Heuristics for TSP

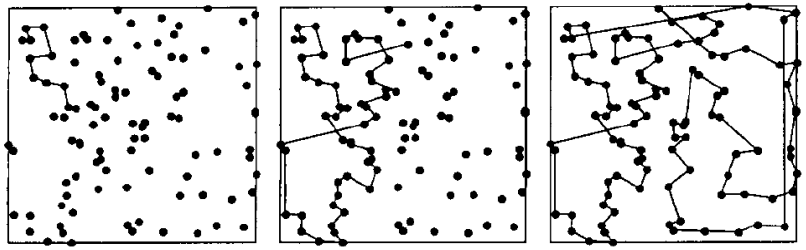

Figure 1. The Nearest Neighbor heuristic.

Construction Heuristics for TSP

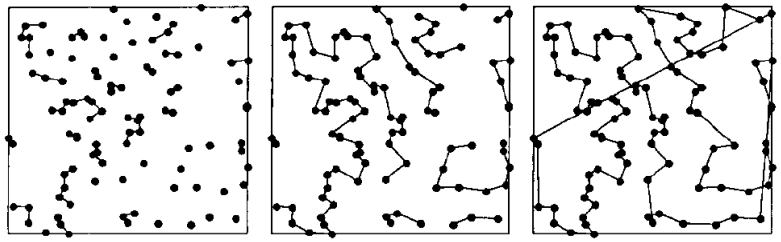

Figure 5. The Multiple Fragment heuristic.

Construction Heuristics for TSP

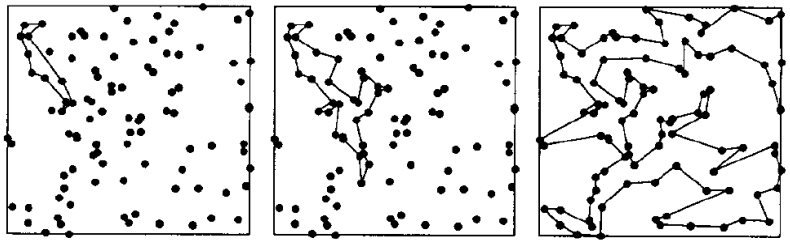

Figure 8. The Nearest Addition heuristic.

Construction Heuristics for TSP

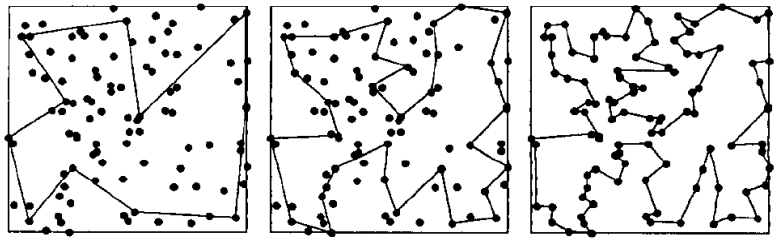

Figure 11. The Farthest Addition heuristic.

Construction Heuristics for TSP

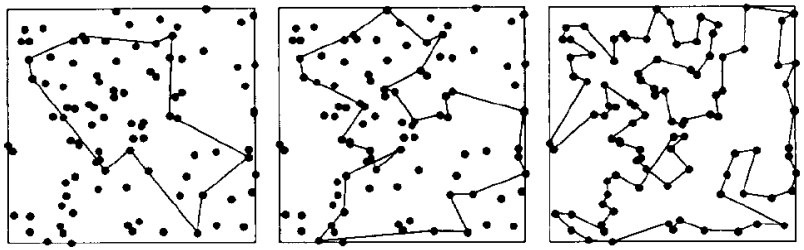

Figure 14. The Random Addition heuristic.

Construction Heuristics for TSP

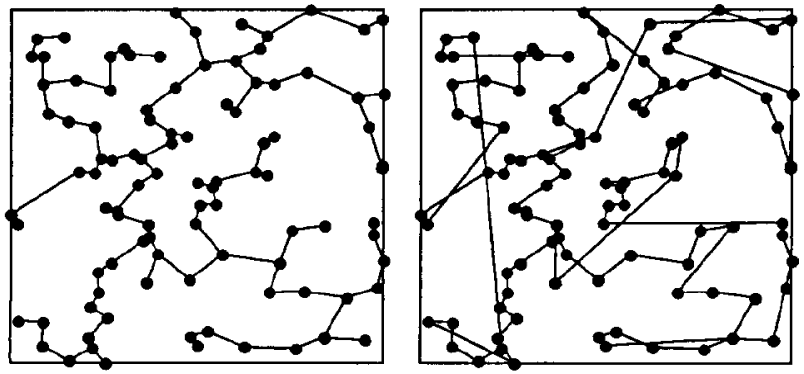

Figure 18. The Minimum Spanning Tree heuristic.

Construction Heuristics for TSP

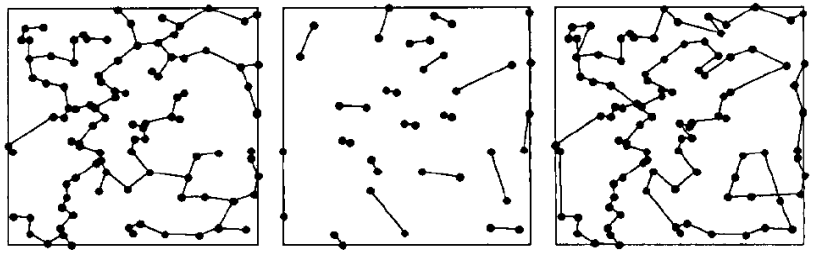

Figure 19. Christofides' heuristic.

Complete Algorithms and Lower Bounds

- Branch & cut algorithms (Concorde: http://www.tsp.gatech.edu/)
  - cutting planes + branching
  - use LP-relaxation for lower bounding schemes
  - effective heuristics for upper bounds

Solution times with Concorde

Instance	No. nodes	CPU time (secs)
att532	7	109.52
rat783	1	37.88
pcb1173	19	468.27
fl1577	7	6705.04
d2105	169	11179253.91
pr2392	1	116.86
rl5934	205	588936.85
usa13509	9539	ca. 4 years
d15112	164569	ca. 22 years
s24978	167263	84.8 CPU years

- Lower bounds: (within less than one percent of optimum for random Euclidean, up to two percent for TSPLIB instances)