


Heuristic Algorithms for the Traveling Salesman Problem




This Hypercard stack was prepared by:
Dennis L. Bricker,
Dept. of Industrial Engineering,
University of Iowa,
Iowa City, Iowa 52242
e-mail: dbricker@icaen.uiowa.edu

Most heuristics are of one of two types:

 ***Construction Heuristics***

*Add one arc after another to a tour,
until the tour includes all nodes.*

 ***Improvement Heuristics***

*Given an initial tour, find an improved
tour*

Examples

Construction Heuristics

- ➡ Nearest Neighbor Algorithm
- ➡ Nearest Insertion Algorithm
- ➡ Farthest Insertion Algorithm
- ➡ Space-filling Curve Algorithm



Improvement Heuristics

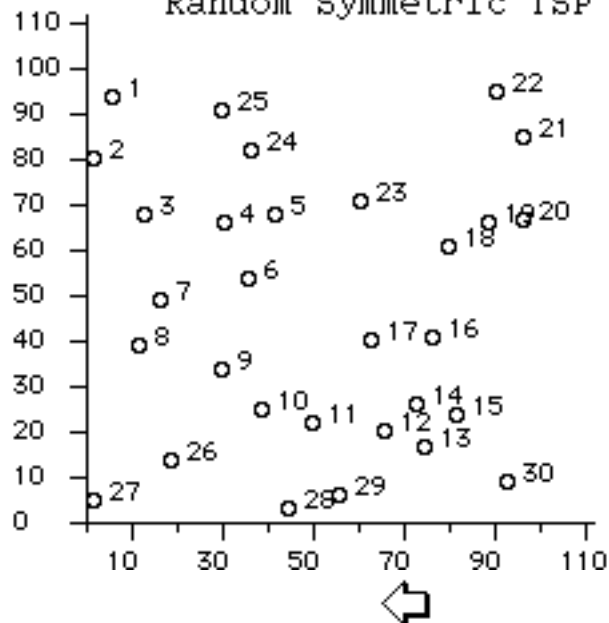
☞ Exchange Algorithm

☞ Simulated Annealing

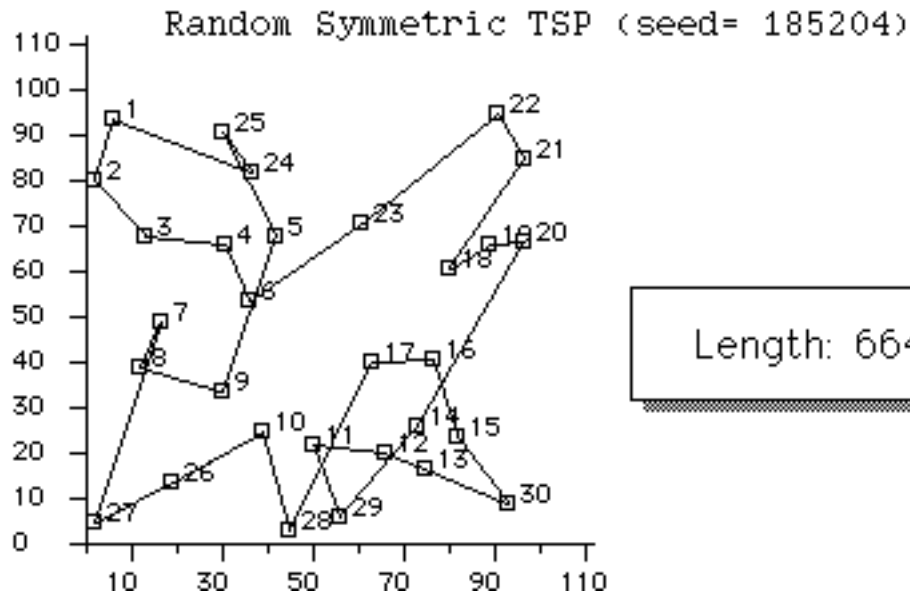


Example**30 CITIES**

Random Symmetric TSP (seed= 185204)

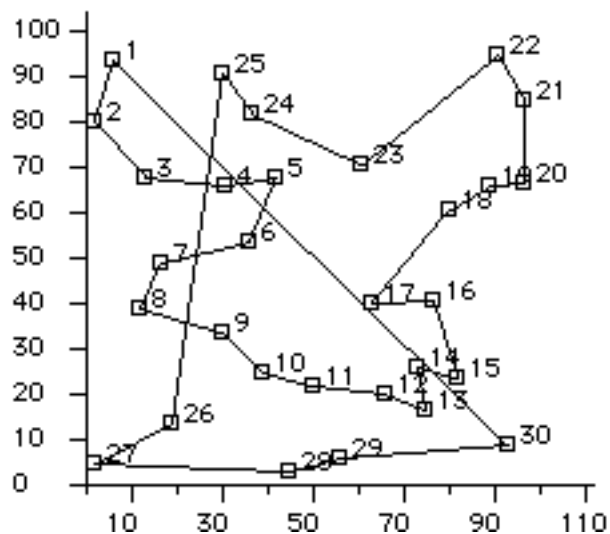


Spacefilling Curve Heuristic



Nearest Neighbor Heuristic

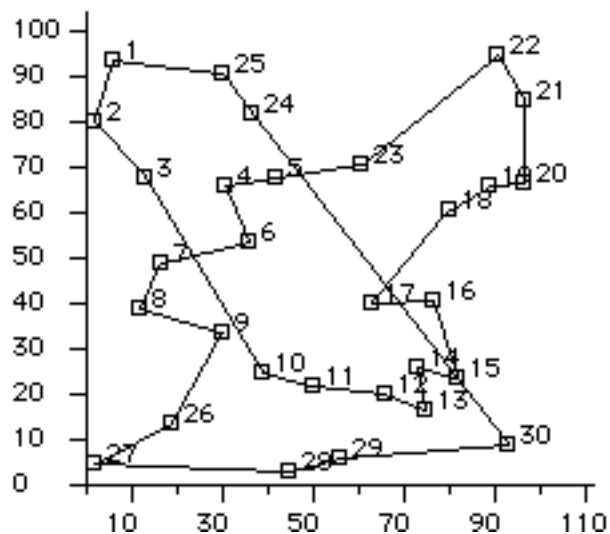
Random Symmetric TSP (seed= 185204)



Starting Node: #1
Length: 684

Nearest Neighbor Heuristic

Random Symmetric TSP (seed= 185204)

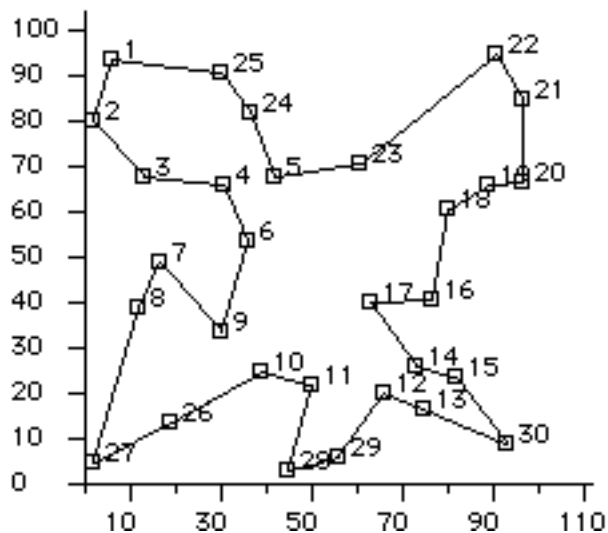


Starting Node: #10

Length: 633

Farthest Insertion Heuristic

Random Symmetric TSP (seed= 185204)

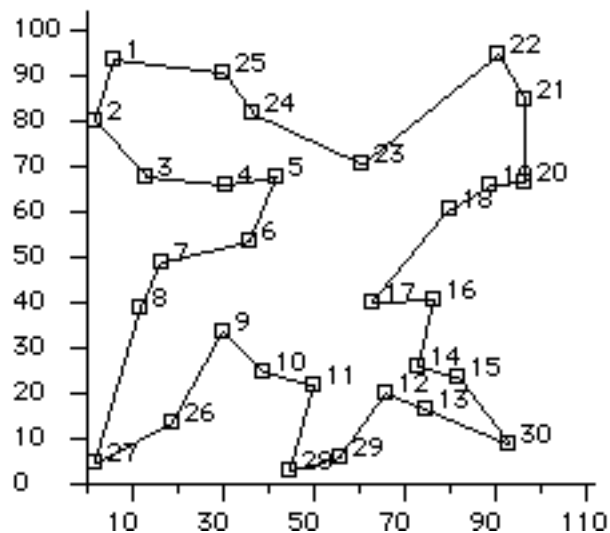


Starting Node: #1

Length: 513

Farthest Insertion Heuristic

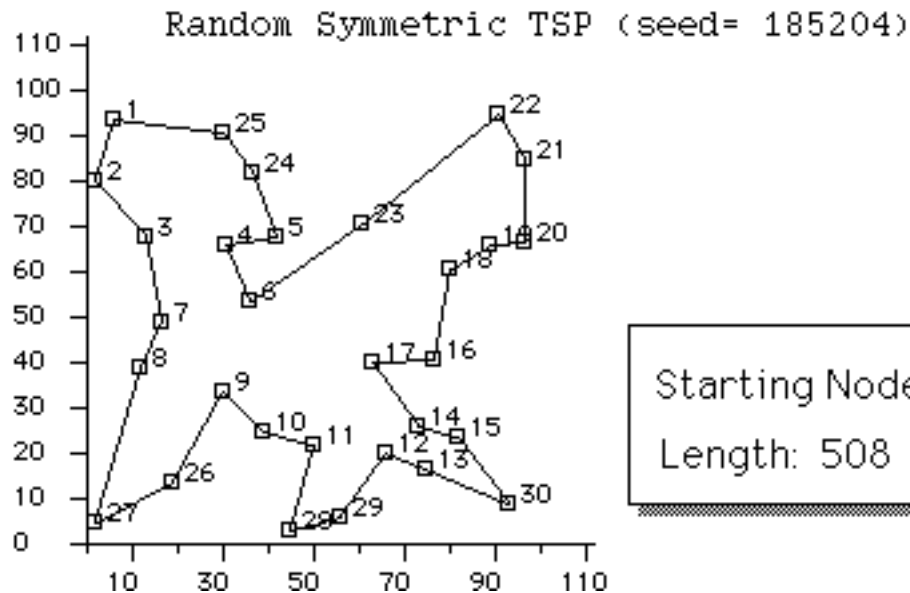
Random Symmetric TSP (seed= 185204)



Starting Node: #10

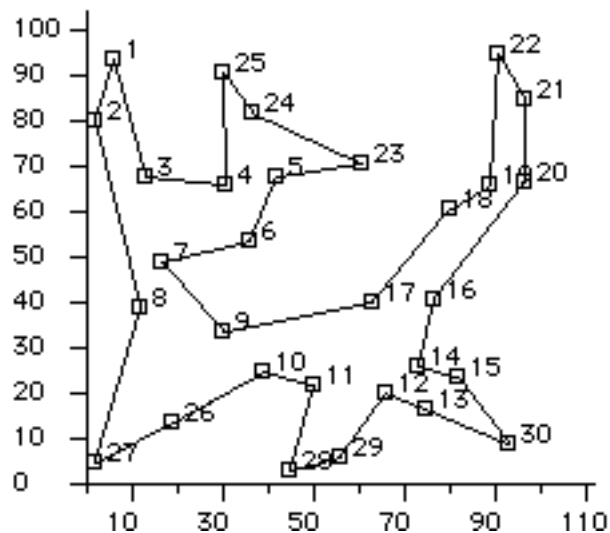
Length: 516

Farthest Insertion Heuristic



Nearest Insertion Heuristic

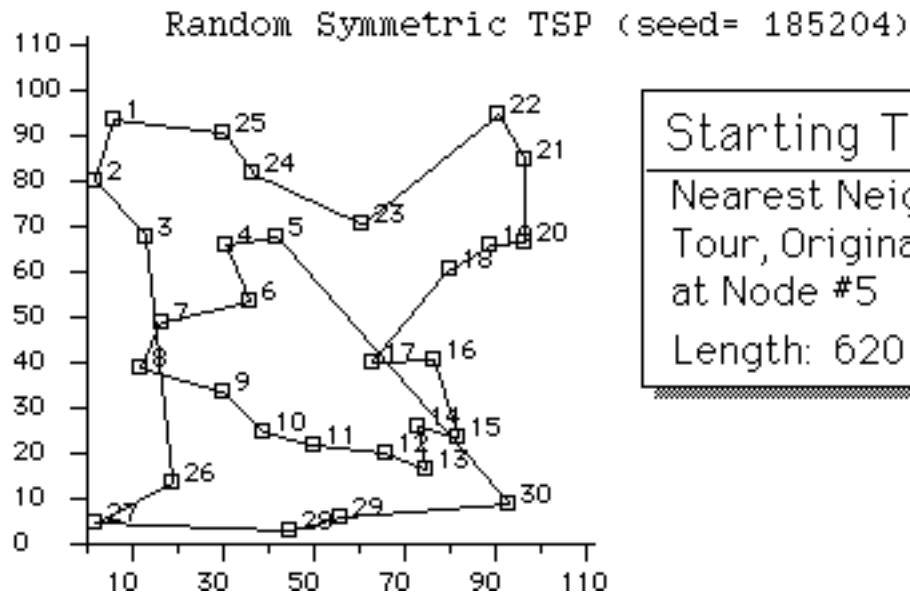
Random Symmetric TSP (seed= 185204)



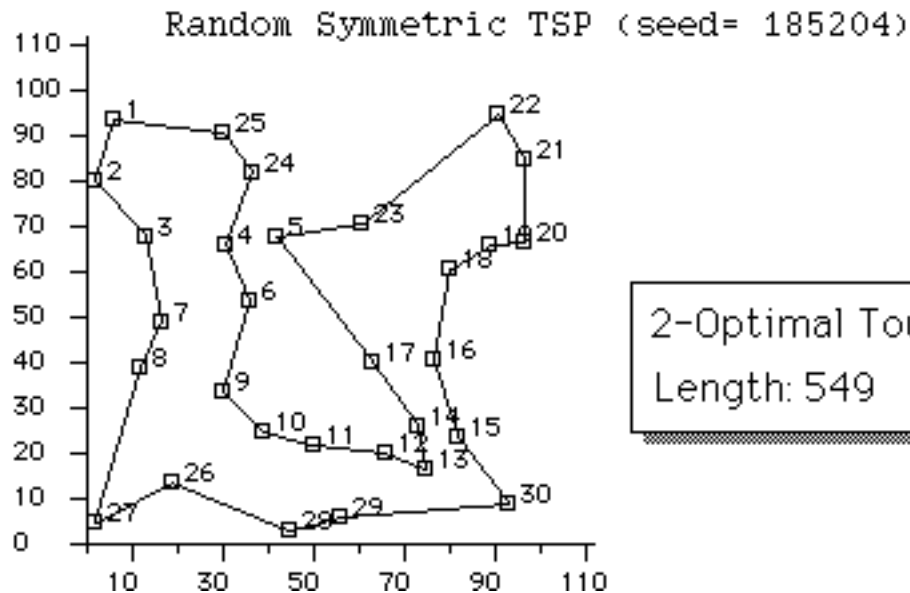
Starting Node: #10

Length: 610

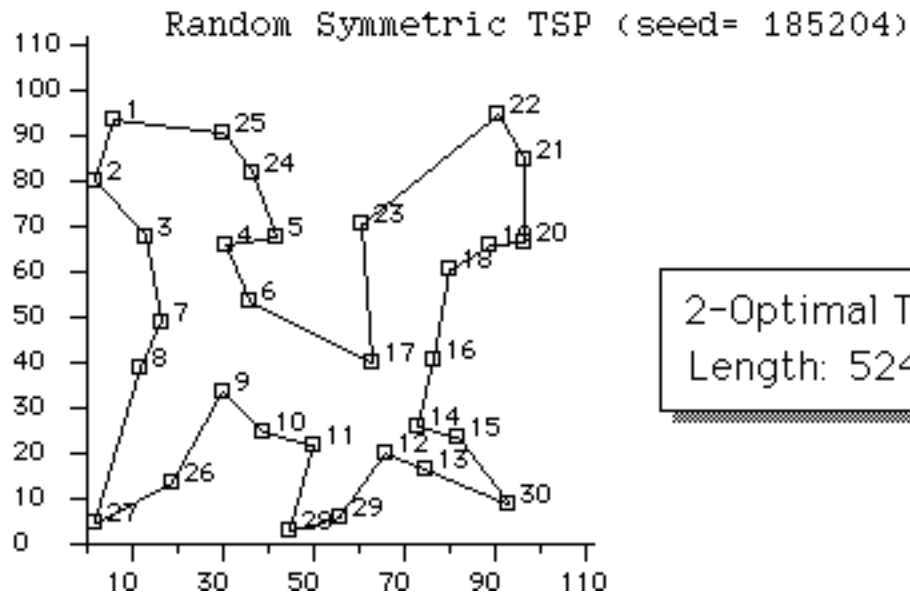
Lin's 2-Opt Heuristic

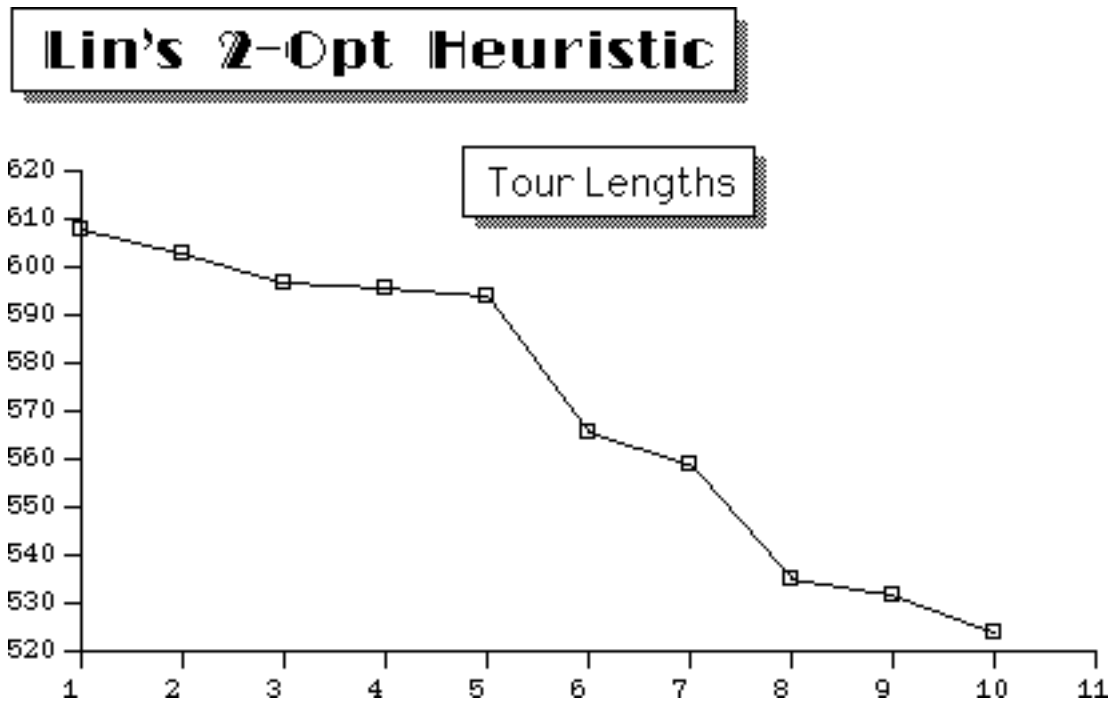


Lin's 2-Opt Heuristic

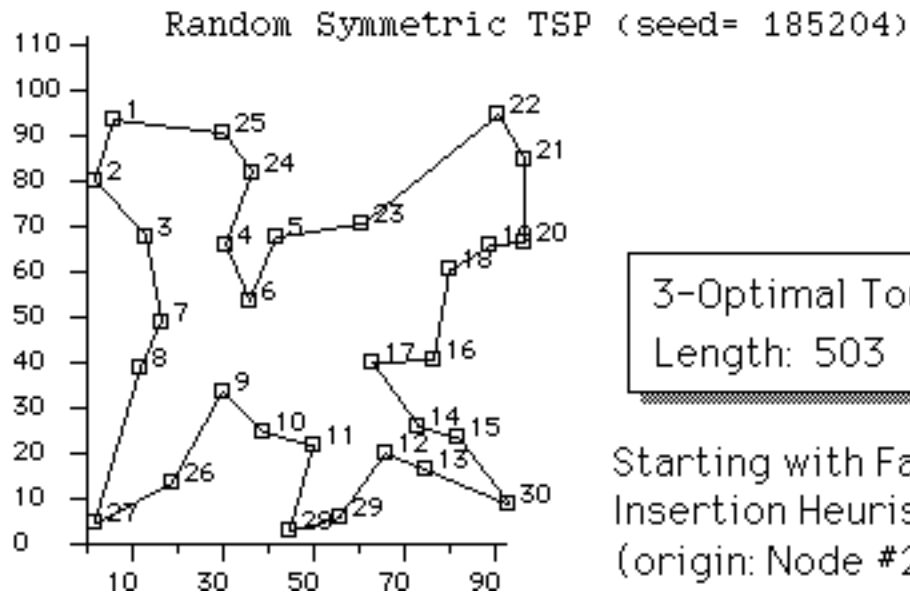


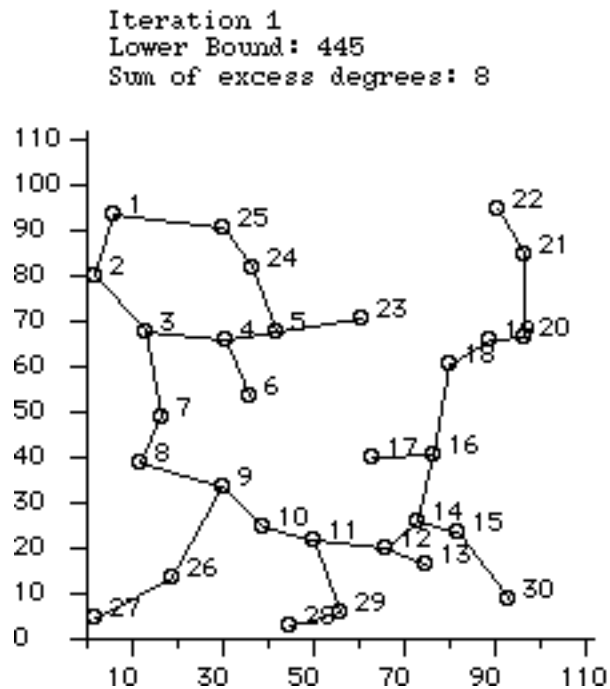
Lin's 2-Opt Heuristic



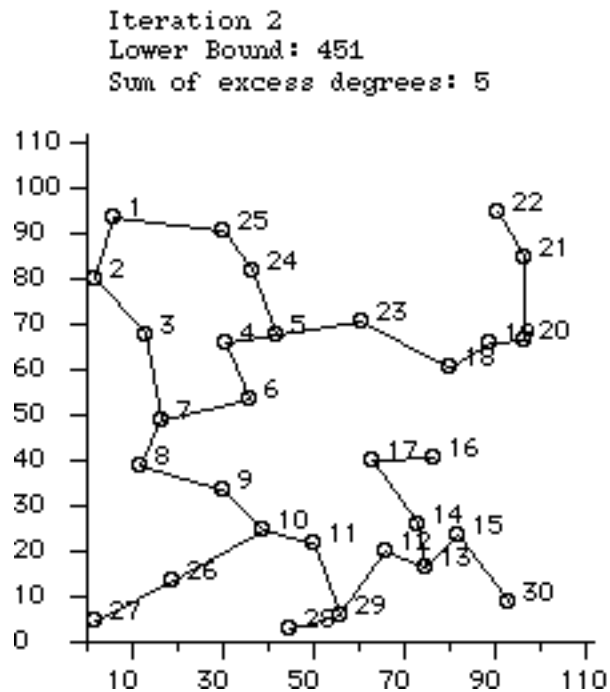


Lin's 3-Opt Heuristic



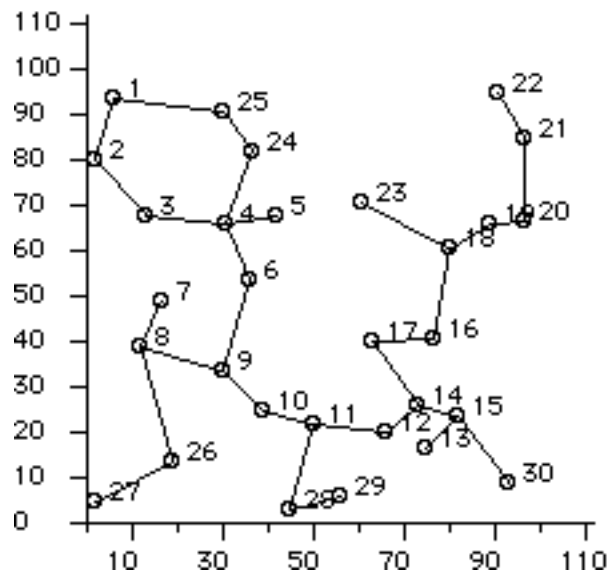


Vertex Penalty Method



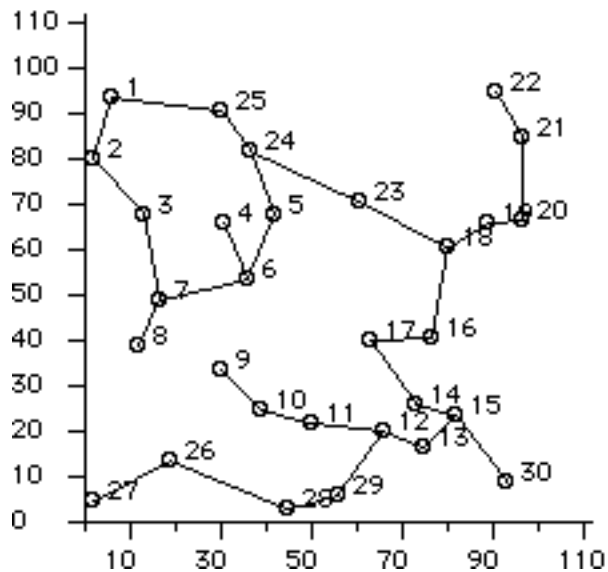
Vertex Penalty Method

Iteration 3
Lower Bound: 452.7
Sum of excess degrees: 8



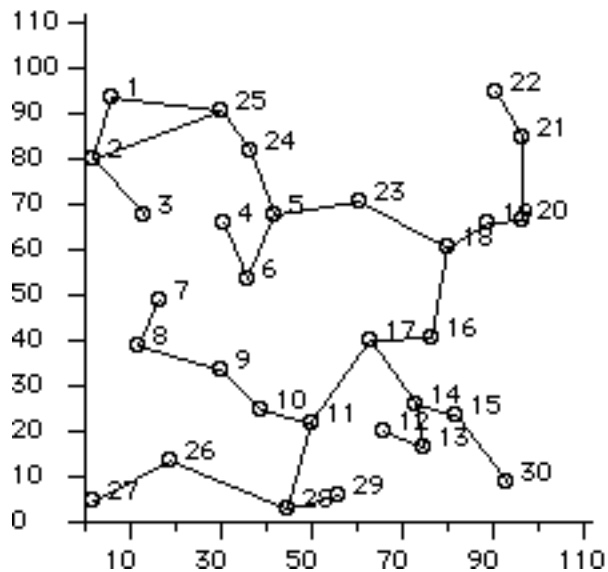
**Vertex
Penalty
Method**

Iteration 4
Lower Bound: 463.545
Sum of excess degrees: 6



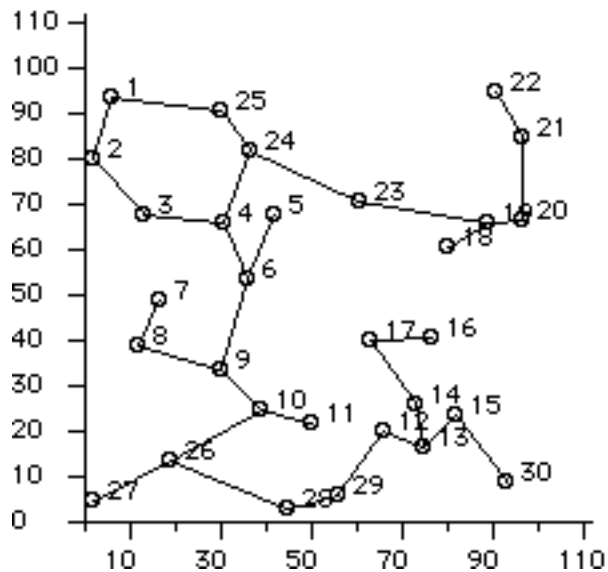
**Vertex
Penalty
Method**

Iteration 5
Lower Bound: 472.0270833
Sum of excess degrees: 8



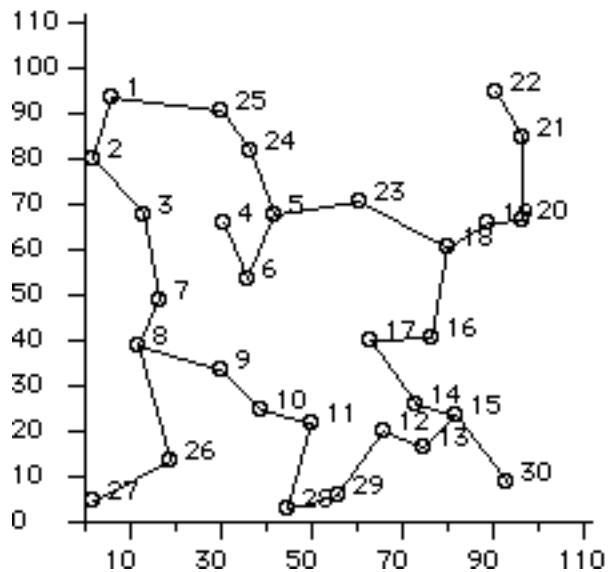
**Vertex
Penalty
Method**

Iteration 6
Lower Bound: 475.0825781
Sum of excess degrees: 8



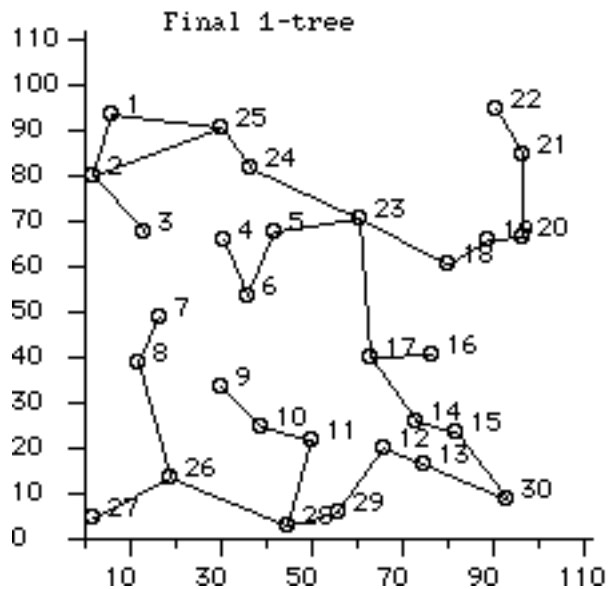
**Vertex
Penalty
Method**

Iteration 7
Lower Bound: 477.417609
Sum of excess degrees: 4



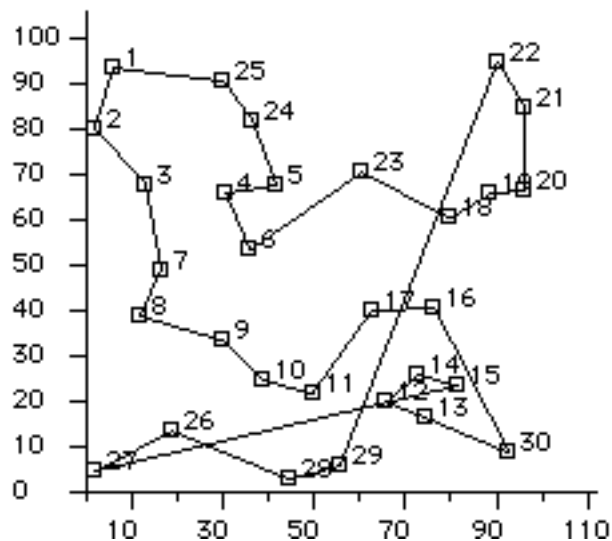
**Vertex
Penalty
Method**

Vertex Penalty Method



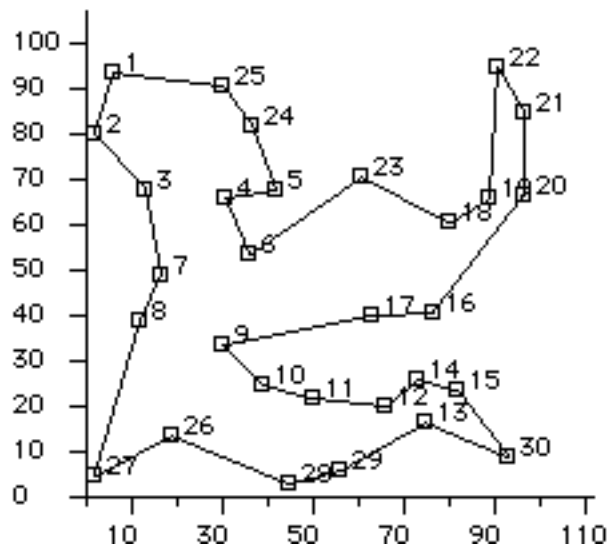
Iteration	Lower Bound	Excess Degree	at Nodes				Vertex Penalty			
1	445	8	3	4	5	9	11	12	14	16
2	446	7	5	6	7	10	13			
3	445	10	2	8	14	15	18	24	25	26 29
4	469	5	4	7	12	15	28			
5	462	7	9	11	13	17	23			
6	467	7	6	8	9	14	16	18	29	
7	473	8	3	5	10	11	19			
8	480	7	2	10	18	24	25	26		
9	489	6	3	4	8	19	29			
10	485	5	5	6	7	18	28			
11	485	7	2	19	20	23	24	25	29	
12	496	4	3	8	17	20				
13	498	5	5	10	12	15	16			
14	499	5	6	7	9	11	13			
15	497	5	2	23	24	25	28			
16	495	5	3	4	10	12				
17	499	3	5	11	17					
18	494	7	2	6	7	15	16	25	26	
19	496	5	8	13	23	24	29			
20	497	5	3	4	14	26				

2-Exchange Heuristic



Nearest Neighbor
Tour, originating
at Node #15
Length: 632

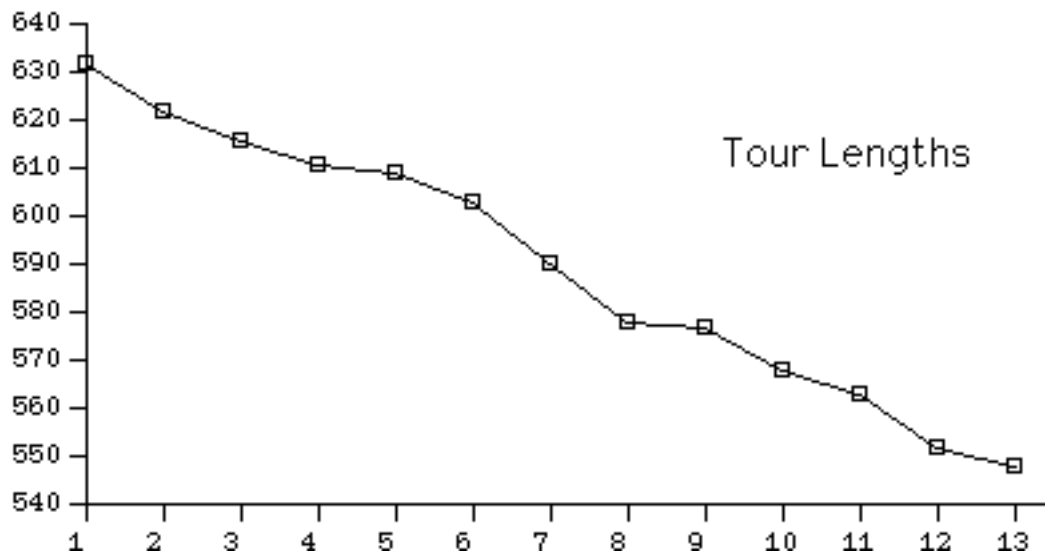
2-Exchange Heuristic



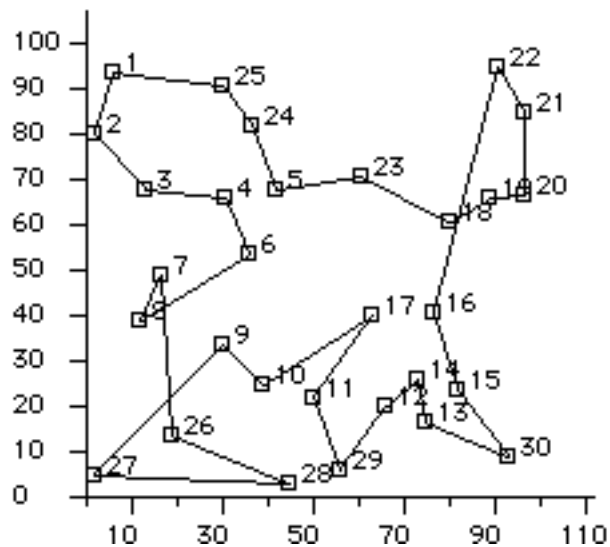
2-Optimal Tour
Length: 548

(Starting search
with Nearest
Neighbor Tour
originating at #15)

2-Exchange Heuristic



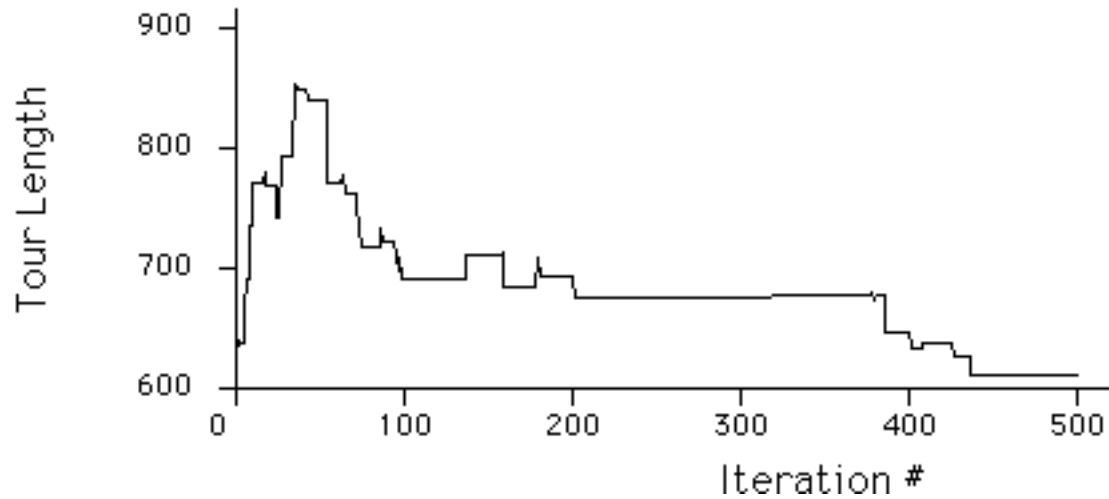
Simulated Annealing



Final Tour
Length: 613

(Beginning with
tour of length 632)

Simulated Annealing



Simulated Annealing

