Branch & Bound Algorithms for the Traveling Salesman Problem

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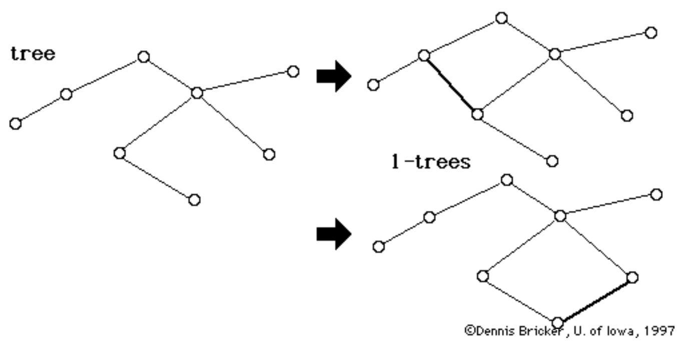
A TSP tour has the properties:

- it is a ***connected*** subgraph of the network
- the degree of every node is 2

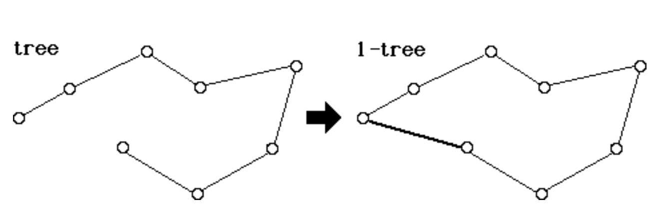
The solution of the ***Assignment Problem*** satisfies the second property, but not always the first.
The solution of the ***minimum spanning 1-tree*** problem satisfies the first property, but not always the second.

1-Tree

A 1-tree is constructed by adding a single edge to a tree.



Note that a tour is a 1-tree:



$$\text{Minimize} \sum_{i=1}^{n} \sum_{j=1}^{n} d_{ij} X_{ij}$$

subject to

$$\left.\begin{aligned} \sum_{i=1}^{n} X_{ij} = 1 \ \forall\ j=1,\ldots n \\ \sum_{j=1}^{n} X_{ij} = 1 \ \forall\ i=1,\ldots n \end{aligned}\right\} \textit{Assignment constraints}$$

$$X \in \mathfrak{T} \qquad \textit{= set of all 1-trees}$$

If either the assignment or the 1-tree constraints are relaxed, the resulting problem (which is easy to solve) provides a lower bound on the length of the optimal tour.

☞ Relaxation of 1-tree constraints

☞ Relaxation of Assignment constraints