CS F364
Design & Analysis of Algorithms

Algorithm Design: Greedy Technique

Spanning Trees vs. Steiner Trees

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Steiner Trees

- Recall: Given a computer network modeled as an graph:
  - Shortest paths minimize the cost of communication per source-destination pair.
  - Spanning trees form the (optimal) broadcast path
- Multicast Communication:
  - Within a network a subset of nodes are destinations.
  - How do you minimize the cumulative weight of the multicast path?
    - Observation: The subset may not form a connected component.

Steiner Trees

- Given G=(V,E,w), w : E --> Z^+ and a subset S of V, a minimal Steiner tree T is the tree of minimum total weight that connects all vertices in S.
  - Special cases:
    - |S|=1, |S|=2, |S|=|V|
  - When 2 < |S| < |V|
    - A spanning tree including only nodes of S may not exist
    - Even if a spanning tree exists for S, the MST for S may not be a minimal Steiner tree.
      - Why?

STEINER TREES

- Vertices in V \ S that are used in constructing a Steiner tree for S are referred to as **Steiner vertices.**
- No known polynomial time algorithm exists for solving the Minimal Steiner Tree problem:
  - Special case: a constant number of Steiner vertices are given.
    - i.e. Given G= (V,E,w), a subset S of V, a subset T of V-S, such that |T|=k, k is a constant,
    - find a tree of minimum total weight that connects all nodes in S but may include any vertex in S U T.

MINIMUM STEINER TREES

- Exercise:
  - Provide an intuitive explanation of why the
    - *Minimum Steiner Tree problem is harder to solve than the Minimum Spanning Tree problem.*
  - Write an algorithm for the special case in the previous slide.
    - Analyze the algorithm for time complexity.