Outline for Master thesis: "Studies on approximations of Spanning Trees with Low Crossing Number"

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1. Introduction
   a) Definiton of a Spanning Tree with Low Crossing Number
      - Example graph in the plane
      - Crossing distance
      - Equivalence relation on line set
      - Worst case crossing number
   b) Motivation
      - LP Solving
      - Clarkson algorithm
      - Multiplicative weights update method
   c) Known facts
      - Generalization to d dimensions
      - Variations of crossing numbers
        - Spanning crossing number (minimum crossing number)
        - Stabbing number
   d) Own Constribution
   e) Similiar problems
      - Perfect matching
      - Triangulations of minimum total length (*non* Steiner ones)
      - Relative crossing number
      - Overall small crossing number

2. Analysis of the complexity
    - Overview of NP-Hardness
    - Finding optimum
    - Integer Program with exponential constraints
3. Approximation approaches
    a) LP relaxation by Fekete
        - Planarity heuristics
        - Iterative rounding scheme
    b) Multiplicative weights update scheme
        - Approximation algorithm
        - Used facts: crossing distance, crossing disk
    c) General iterative, LP-based approximation scheme by Sariel
        - LP formulation with bounded VC dimensions
        - Listing of generic approximation algorithm
        - Randomized rounding scheme
        - Tailoring to d dimensions and planar case
        - Deterministic rounding in the plane
    d) Challenges
        - Self crossing edges in approximation
        - Computing spanning tree within connected components
        - ...
4. New iterative, LP-based Approximation scheme
    - Sariel's approach revisited
    - LP formulation with connected components
    - Rounding scheme
    - Listing of the algorithm
5. Results
    a) Computational studies
        - Problem sets (Grid, Uniform distribution, high dimensional data sets, ...)
        - Implementation details
        - Hardware
    b) Observations on experiments

- Pros and Cons of different approximation schemes
- Comparison with Fekete's technical report

c) Proven facts

6. Conclusion