Term Papers

First Draft due: Nov 18th **Final paper due: Dec 15th**

This document contains suggestions for term paper topics. *With my permission*, you are welcome to pick a topic not among those suggested below.

1. In a DISC 2006 paper by Kuhn, Moscibroda, Nieberg, and Wattenhofer (see ref [10]), a class of graphs called *growth bounded graphs* are defined. These generalize UBGs in doubling metric spaces. In other words, every UBG in a doubling metric space is a growth bounded graph. Kuhn and coauthors present a distributed, deterministic $O(\log \Delta \log^* n)$-round MIS algorithm for growth bounded graphs. As usual, here Δ is the maximum vertex degree and n is the number of vertices in the graph. Whether this time complexity can be reduced to $O(\log^* n)$ rounds is an open question. I would like your paper to focus on how to solve this open question. Describe possible approaches and evaluate these approaches. In some cases, you might be able to present counterexamples for your approaches and in other cases, you might be able to present conjectures whose truth would make the approach go through. You should also consider subclasses of growth bounded graphs for which some of your approaches are successful.

2. In class, we discussed the network decomposition algorithm due to Awerbuch, Goldberg, Luby, and Plotkin (see ref [1]). Recall that this deterministic algorithm yielded an $(n^{O(f(n))}, n^{O(f(n))})$-decomposition in $O(f(n))$ rounds, where $f(n) = \sqrt{\frac{\log \log n}{\log n}}$. Improving deterministic network decomposition is considered an important issue because of the connection to deterministic MIS and deterministic $(\Delta+1)$-coloring. Consider possible ways of designing improved network decomposition algorithms. There is an improvement due Panconesi and Srinivasan ("Improved distributed algorithms for coloring and network decomposition problems," STOC 1992) and in this paper $f(n) = 1/\sqrt{\log n}$. Study this paper to get ideas. Describe any fundamental bottle-necks that an improved network decomposition algorithm may have to deal with. We now know how to construct an $(O(1), O(1))$-network decomposition of UBGs in doubling metric spaces in $O(\log^* n)$ rounds (Kuhn, Moscibroda, Wattenhofer, PODC 2005, ref [11]). Are there other interesting network classes on which we might be able to get improved network decomposition?

3. In class, we studied the Kuhn-Wattenhofer proof (PODC 2006, ref [13]) showing a lower bound on the number of colors used by a deterministic 1-round distributed coloring algorithm. The crux of this paper is an argument that shows a certain lower bound on the chromatic number of the neighborhood graph $\mathcal{N}_1(m, \Delta)$. Are there other, possibly simpler, approaches to obtaining a lower bound on the chromatic number of $\mathcal{N}_1(m, \Delta)$? There are a number of results in classical graph theory (see Doug West's book, for examples) that may be useful in deriving lower bounds on the chromatic number. This would of course depend on what properties the neighborhood graph has. It would be helpful to derive non-trivial structural properties of the neighborhood graph.

4. In this class, we have not spent any time on distributed edge coloring algorithms. It is known via the Gupta-Vizing Theorem that a graph with maximum degree Δ can always be $(\Delta + 1)$-edge coloreed. There are distributed algorithms that come close to achieving this bound in polylogarithmic number of rounds. Survey the state of affairs in the area of distributed edge coloring. Describe key algorithmic ideas and key analysis techniques. To get started you might want to study the following papers by Allesandro Panconesi: (1) Marathe, Panconesi, Risinger: An experimental study of a simple, distributed edge-coloring algorithm, *ACM Journal of Experimental Algorithms* 9: (2004). (2) Dubhashi, Grable, Panconesi: Near-Optimal, Distributed Edge Colouring via the Nibble Method. *Theor. Comput. Sci.* 203(2): 225-251 (1998).

5. The models for wireless networks that we have thus far considered in class may be unrealistic due to the fact that these models ignore collisions and interference of wireless signals. One common way of abstracting what happens due to interference is this: let x and y be nodes that simultaneously send out a message; a node z that is a common neighbor of x and y is unable to receive the message from

either x or y due to interference. Survey common models of interference in wireless networks from recent literature. Consider the MIS problem and describe what is known about how to solve MIS in these models of computation. You should evaluate MIS algorithms in these models according to their time complexity and whether randomization was used or not.
