Course title: **Algorithmic Graph Theory**
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Syllabus:
We will give an overview of a selection of topics in structural and algorithmic graph theory. The following is the list of topics that we expect to cover:

- **Review of basic notions in graph theory, algorithms and complexity.** Basic graph theoretic definitions. Graph representations. Classes P and NP, NP-hardness, polynomial reductions, 2-SAT problem, 3-SAT problem.
- **Graph colorings.** Chromatic number, upper and lower bounds. Greedy algorithm and its analysis. The Four Color Theorem. Hadwiger's Conjecture. Brooks' Theorem. Edge colorings and Vizing's Theorem. List colorings. Galvin's Theorem. Algorithmic aspects of graph coloring. NP-completeness of the problem of computing the chromatic number. Applications in scheduling.
- **Approximation algorithms for graph problems.** Approximation algorithm for vertex cover problem. Approximation algorithms for the metric traveling salesman problem.
- **Perfect graphs and their subclasses.** Basic theory and examples of hereditary graph classes. Perfect graphs and their properties. Cographs. Split graphs and threshold graphs. Chordal graphs. Interval graphs. Efficient algorithms for various problems based on structural properties of graphs in these classes.
- **Further examples of tractable problems.** Polynomial time algorithm for the maximum cut problem in planar graphs. Polynomial time algorithm for the 3-coloring problem on graphs with small dominating sets. The independent set problem: Matching techniques. Method of augmenting graphs. Decomposition by clique separators. Modular decomposition. Bounded tree-width, bounded clique-width. Applications of these methods, both individually and combined.

References:
The course is based on several sources (books and research articles). The following is a list of some relevant literature:

- T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein, Introduction to Algorithms, second edition. McGraw-Hill, 2001.
- M. R. Garey, D. S. Johnson, Computers and Intractability: A guide to the theory of NP-Completeness, 1979.
- M. C. Golumbic. Algorithmic Graph Theory and Perfect Graphs, Volume 57 in the series Annals of Discrete Mathematics. North Holland, second edition, 2004.
- A. Brandstädt, V. B. Le, J. P. Spinrad. Graph Classes: A Survey. SIAM, 1999.
- V. V. Vazirani. Approximation Algorithms, Springer-Verlag, 2001.
- J. A. Bondy, U. S. R. Murty. Graph Theory, North-Holland, Springer-Verlag, 2008.
- B. Korte, J. Vygen. Combinatorial Optimization. Theory and Algorithms, Volume 21 in the series Algorithms and Combinatorics, Springer-Verlag, druga izdaja, 2002.
- R. Diestel, Graph Theory. Springer, 2006.
- A. Schrijver, Combinatorial Optimization, Springer, 2003.

Grading:
Based on a take home final exam.