COMP 4340 – Graph Algorithms 1

Calendar Description: Spanning trees, connectivity, planar graphs, directed graphs, networks, colouring problems and tours are studied and their applications to computer science will be highlighted.
Prerequisite: COMP 3170
This course is a prerequisite for: COMP 4220.

Outline

1) Basic concepts of graph theory (1.5 weeks)
   Vertices, edges, complete graphs, complements, graph isomorphism, self-complementary graphs, paths, walks, adjacency matrices, adjacency lists.
2) Bipartite graphs, Line graphs, Moore graphs, Euler tours (1.5 weeks)
   Use of Breadth-First Search (BFS) to test if a graph is bipartite, Euler tour algorithms, Moore graphs as computer networks.
3) Network Flows (2 weeks)
   The Ford-Fulkerson algorithm, the Max-Flow-Min-Cut theorem, commodity networks, the Edmonds-Karp algorithm, the use of shortest augmenting paths (BFS).
4) Hamilton Cycles (2 weeks)
   The cross-over algorithm, exhaustive search algorithms, the Hamilton closure, the Bondy-Chvatal theorem, the Travelling Salesman Problem, Christofides' algorithm, the nature of NP-complete problems.
5) Trees (1.5 weeks)
   Spanning trees, fundamental cycles, Read's tree-encoding and decoding algorithms, Prufer sequences, Cayley's theorem, the Matrix-Tree theorem.
6) Connectivity (1 week)
   K-connectivity, the use of the Depth-First Search (DFS) to find 2-connected components, Menger's theorems.
7) Digraphs (1 week)
   Activity graphs, topological order, use of the DFS to find strong components, tournaments.
8) Planarity (1.5 weeks)
   Jordan curves, graph embeddings, the planar dual, Kuratowski's theorem, graph minors, the Hopcroft-Tarjan algorithm, Whitney's theorem.
9) Graph Embeddings (1 week)
   Introduction to graph embeddings on the sphere, projective plane, torus, and Klein bottle, genus, the Robertson-Seymour theorem.

Text: Kocay and Kreher, *Graphs, Algorithms, and Optimization*, CRC Press, 2005