Design and Analysis of Heuristics

TENTATIVE COURSE OUTLINE

Week	Topic
1.	Introduction – course requirements, why heuristics? Intro to complexity theory
2.	More on complexity theory including techniques for proving NP-completeness and bounds on algorithms
3.	Basic heuristic constructs – greedy algorithms, improvement algorithms and algorithms for common problems (e.g., TSP and location problems)
4.	Worst case analysis of heuristics
5.	Genetic Algorithms
6.	Tabu Search
7.	Simulated Annealing and Ant Algorithms
8.	Testing heuristics
9.	Additional topics of interest and student project presentations
10.	Additional topics of interest and student project presentations

COURSE REQUIREMENTS

There will be **two major programming assignments** in the course. The **first** will be an assignment in which each student will be given the same problem. Students will have to write a heuristic algorithm for solving the problem. The algorithms will then be tested on a common dataset (that will not be disclosed except in broad terms) until after the algorithms are coded. Grades will be based in large part on the quality of the solutions obtained and the solution time required. For example, students may have to write an algorithm to solve the traveling salesman problem. You will be told in advance what the maximum size of the problem will be and the format in which the data will be stored. Your job will be to write an algorithm that solves the problem as well as possible.

The **second major programming assignment** will be of your own choice. You are to choose a problem of interest to you, demonstrate why the problem needs to be solved using a heuristic and then write and code an appropriate algorithm for the problem.

In both cases, you will be required to write a brief report (5-10 pages) outlining the problem, the algorithm, and the testing that you have done on the algorithm.

In addition to the programming assignments, **you will be required to present a variety of papers** on different subjects related to the course. Students not presenting a paper will be required to write a short (1-2 page) critique of the paper(s) along the lines of a referee report. This is to be handed in before the class discussion of the paper.

Finally, we ***may*** have a small number of short assignments related to material in the class.

The bulk of your grade will be based on the two programming assignments and your presentations and class participation during the other student presentations.

INSTRUCTOR

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Daskin
office hours: M W, 3-5; T 9-11 or **any other time** by appointment. I am serious about the **any other time** part. It is quite possible that these hours will not be convenient for some of you, so please just send me an e-mail to set up an appointment if you need/want to see me!

SELECTED REFERENCES

Complexity Theory:

Garey, M. R. and D. S. Johnson, 1979, Computers and Intractability: A Guide to the Theory of NP-Completeness, W. H. Freeman and Company, NY.

Genetic Algorithms:

Gen, M. and R. Cheng, 1997, Genetic Algorithms and Engineering Design, John Wiley and Sons, NY

Goldberg, D., 1989, Genetic Algorithms in Search, Optimization and Machine Learning, Addison-Wesley, Reading, MA.

Haupt, R. L. and S. E. Haupt, 1998, Practical Genetic Algorithms, John Wiley and Sons, Inc., NY.

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Tabu Search:

Glover, F., 1989, "Tabu Search — Part I," *ORSA Journal on Computing*, **1**:3, pp. 190-206.

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Glover, F. and M. Laguna, 1997, Tabu Search, Kluwer Academic Publishers, Boston, MA

Ant Algorithms:

Bonabeau, E. and G. Theraulaz, 2000, "Swarm Smarts," *Scientific American*, **282**:3 (March 2000), pp. 72-79.

OTHER REFERENCES

Genetic Algorithms:

Chu, P. C. and J. E. Beasley, 1997, "A Genetic Algorithm for the Generalised Assignment Problem," *Computers and Operations Research*, **24**:1, pp. 17-23.

Levine, D., 1996, "Application of a Hybrid Genetic Algorithm to Airline Crew Scheduling," *Computers and Operations Research*, **23**:6, pp. 547-558.

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Holland, J. H., 1992, "Genetic Algorithms," *Scientific American*, **July**, pp. 66-72.

Tabu Search:

Brandao, J. and A. Mercer, 1997, "A tabu search algorithm for the multi-trip vehicle routing and scheduling problem," *European Journal of Operational Research*, **100**, pp. 180-191.

Gendreau, M., Laporte, G., and F Semet, 1998, "A tabu search heuristic for the undirected selective travelling salesman problem," *European Journal of Operational Research*, **106**, pp. 539-545.

Gendron, B., Potvin, J.-Y., and P. Sariano, 1999, "Tabu search with exact neighbor evaluation for multicommodity location with balancing requirements," *INFOR*, **37**:3, pp. 255-269.

Glover, F., 1998, "Tabu Search — Wellsprings and Challenges," *European Journal of Operational Research*, **106**, pp. 221-225.

Rego, C., 1998, "A Subpath Ejection Method for the Vehicle Routing Algorithm," *Management Science*, **44**:10, pp. 1447-1459.

Rolland, E., Schilling, D. A., and J. R. Current, 1996, "An efficient tabu search procedure for the p-Median problem," *European Journal of Operational Research*, **96**, pp. 329-342.

Sun, M., Araonson, J. E., McKeown, P. G. and D. Drinka, 1998, "A tabu search heuristic procedure for the fixed charge transportation problem," *European Journal of Operational Research*, **106**, pp. 441-456.

Tuzun, D. and L I. Burke, 1999, "A two-phase tabu search approach to the location routing problem," *European Journal of Operational Research*, **116**, pp. 87-99.

Other Heuristics:

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Golden, B., Bodin, L., Doyle, T. and W. Stewart, Jr., 1980, "Approximate Traveling Salesman Algorithms," *Operations Research*, **28**:3, part II, pp. 694-711.

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NU DISABILITY POLICY

http://www.northwestern.edu/disability/policies/syllabus.html

To be eligible for disability-related services; students must have a visibly obvious or documented disability as defined by the Americans with Disabilities Act of 1990 (ADA) and Section ,504 of the Rehabilitation Act of 1973. Under the ADA and Section 504, a person has a disability if he/she has a physical or mental impairment that substantially limits one or more major life activities such as walking, standing, seeing, speaking, hearing, sitting, breathing, and/or taking care of oneself.

SSD is the designated office at Northwestern University that obtains and files disability-related documents, certifies eligibility for services, determines reasonable accommodations, and develops plans for the provision of such accommodations. Students with disabilities are also offered auxiliary services, including assessment, library and lab assistants, notetakers, tutoring, assistive/adaptive technology, academic, psycho/social support, and mentorship.

Certifying Eligibility for Services

When appropriate, SSD requests disability-related documents from the appropriate licensed professional to certify a student as having a disability and to determine reasonable accommodations. Students who suspect that they have a disability, and have not received a formal assessment, may be referred to on-campus (Counseling and Psychological Services, Department of Communication Sciences and Disorders) or off-campus resources for an evaluation. Pending receipt of documentation, SSD reserves the right to deny services or accommodations.