ISyE 8852 (ISyE 7xxx)

Freight Transportation Systems

Fall 2007

Syllabus

Instructor: Alan L. Erera
Office: Groseclose 220A
Office hours: TBA
e-mail: Alan.Erera@isye.gatech.edu
Phone: (404) 385-0358
Fax: (404) 894-2301

Class Location: 303 Groseclose
Class Times: Monday, Wednesday 9:35–10:55
Course Website: http://t-square.gatech.edu

Description:
This course is designed for Ph.D. students in the Supply Chain Engineering program, and is to be completed prior to sitting for the comprehensive examination. The focus of the course will be the application of operations research to the analysis of freight transportation and logistics systems, and will provide research-level treatment of problems in

- vehicle routing and scheduling;
- transportation resource management; and
- service network design

Analytical techniques and methods to be used will include

- discrete optimization;
- local search heuristics and meta-heuristics;
- dynamic programming and approximate dynamic programming; and
- continuous approximation

As a technical elective, this course may be appropriate for Masters students with appropriate background in both operations research tools and logistics application problems.

Objectives:

- to develop an understanding of state-of-the-art freight transportation and logistics systems operations research;
- to develop skill in applying a variety of techniques to solve logistics problems.

Prerequisites:

- Linear and discrete (network and integer) optimization (ISyE 6661 and 6662, or equivalents);
- Stochastic modeling (ISyE 6761, or equivalent);
- Some programming experience

Required Texts:

- Simchi-Levi, David; Chen, Xin; and Bramel, Julien. *The Logic of Logistics*, 2nd edition, Springer, 2005.
- Course scribe notes

Reference Texts:

- Ghiani, Gianpaolo; Laporte, Gilbert; and Musmanno, Roberto. *Introduction to Logistics Systems Planning and Control*, Wiley-Interscience, 2004.
- Daganzo, Carlos, *Logistics Systems Analysis*, Fourth Edition, Springer, 2005.

Course Format:

Our study will be guided primarily by important research papers drawn from the literature, and will be augmented with material in the Simchi-Levi text. Some material covered will also be sourced from the reference texts.

Student responsibilities in the course will include: (1) a course computational project; (2) an in-class final examination, and (3) one to two weeks of scribe note-taking in LaTeX of lectures. Homework problems may also be assigned periodically. Each of these responsibilities is designed to help students prepare for future Ph.D. study work. The computational project will provide experience in implementing operations research techniques to solve freight transportation problems, a key component of virtually all Ph.D. research in this area. The final examination will allow practice on questions similar to those to be found on the comprehensive examination.

Additional information on the detailed schedule of course topics will be distributed at the first lecture.

Grading: Grades will be assigned according to the following formula:

- Class Participation, Scribing, and Homework: 1/3
- Course Project: 1/3
- Final Examination: 1/3

Academic Honor Code:

It is your responsibility to familiarize yourself with the Georgia Tech Honor Code. Specifically, you must do your own work in all homeworks, projects, and exams; when homework or projects are specifically assigned to groups, you may and should work with the other members of your group.

ISyE 8852

Topics in Logistics: Freight Transportation Systems

Fall 2007

Course Topics and References

Description:

Reading and reference material for this course will come primarily from published research papers, from the text by Simchi-Levi et al., and from a set of course notes that I have developed. The following is an approximate guide to the topics in this course, along with the references that we will cover (in various degrees of depth) for each topic.

Topics and References

SHORT-HAUL TRANSPORTATION

1. *Single-vehicle routing: worst-case analysis*: Simchi-Levi et al. (2005), chapter 3.1, 3.3, 5.4-5.5
2. *Single-vehicle routing: local search, Lin-Kernighan*: Johnson and McGeoch (1997), chapter 1, 2, 3.1-3.3; Helsgaun (2000)
3. *Bin-packing: worst-case analysis*: Simchi-Levi et al. (2005), chapter 3.2
4. *Vehicle routing problem: savings, insertion, local search*: Simchi-Levi et al. (2005), chapter 13.2, 14.1-14.3
5. *Vehicle routing problem: tabu search*: Gendreau et al. (1992); Gendreau et al. (1994); and Toth and Vigo (2003)
6. *Split-delivery vehicle routing*: Archetti et al. (2006)
7. *Vehicle routing problem with time windows: local search, variable neighborhood search*: Savelsbergh (1990); Bräysy (2003)
8. *Vehicle routing problem with time windows: set partitioning*: Desrochers et al. (1992)
9. *Dynamic vehicle routing*: Ausiello et al. (2001); Angelelli et al. (2007); Larsen (2001)
10. *Stochastic vehicle routing: fixed routes*: Bertsimas (1992); Ak and Erera (2007)
11. *Stochastic and dynamic vehicle routing: scenario-based planning*: Bent and Hentenryck (2004)
12. *Inventory routing*: Bertazzi and Speranza (2002)

LONG-HAUL TRANSPORTATION

1. *Dynamic resource assignment*: Yang et al. (2004)
2. *Dynamic assignment under stochastic demand*: Cheung and Powell (1996); Godfrey and Powell (2002)
3. *Service network design: overview*: Crainic (2000)
4. *Service network design: less-than-truckload transportation*: Powell (1986)
5. *Service network design: express package*: Kim et al. (1999); Armacost et al. (2002)

References

Ak, A. and Erera, A. 2007. A paired-vehicle recourse strategy for the vehicle routing problem with stochastic demands. *Transportation Science*, 41:222–237.

Angelelli, E., Speranza, M., and Savelsbergh, M. 2007. Competitive analysis for dynamic multiperiod uncapacitated routing problems. *Networks*, 49:308–317.

Archetti, C., Savelsbergh, M., and Speranza, M. 2006. Worst-case analysis of split delivery routing problems. *Transportation Science*, 40:226–234.

Armacost, A., Barnhart, C., and Ware, K. 2002. Composite variable formulations for express shipment service network design. *Transportation Science*, 36:1–20.

Ausiello, G., Feuerstein, E., Leonardi, S., Stougie, L., and Talamo, M. 2001. Algorithms for the on-line travelling salesman. *Algorithmica*, 29:560–581.

Bent, R. and Hentenryck, P. V. 2004. Scenario-based planning for partially dynamic vehicle routing with stochastic customers. *Operations Research*, 52:977–987.

Bertazzi, L. and Speranza, M. 2002. Continuous and discrete shipping strategies for the single link problem. *Transportation Science*, 36:314–325.

Bertsimas, D. 1992. A vehicle routing problem with stochastic demand. *Operations Research*, 40:574–585.

Bräysy, O. 2003. A reactive variable neighborhood search for the vehicle-routing problem with time windows. *INFORMS Journal on Computing*, 15:347–368.

Cheung, R. and Powell, W. 1996. An algorithm for multistage dynamic networks with random arc capacities, with an application to dynamic fleet management. *Operations Research*, 44:951–963.

Crainic, T. 2000. Service network design in freight transportation. *European Journal of Operational Research*, 122:272–288.

Desrochers, M., Desrosiers, J., and Solomon, M. 1992. A new optimization algorithm for the vehicle routing problem with time windows. *Operations Research*, 40:342–354.

Gendreau, M., Hertz, A., and Laporte, G. 1992. New insertion and post-optimization procedures for the traveling salesman problem. *Operations Research*, 40:1086–1094.

Gendreau, M., Hertz, A., and Laporte, G. 1994. A tabu search heuristic for the vehicle routing problem. *Management Science*, 40:1276–1290.

Godfrey, G. and Powell, W. 2002. An adaptive dynamic programming algorithm for single-period fleet management problems I: Single period travel times. *Transportation Science*, 36:21–39.

Helsgaun, K. 2000. An effective implementation of the lin-kernighan travelling salesman heuristic. *European Journal of Operational Research*, 126:106–130.

Johnson, D. and McGeoch, L. 1997. The Traveling Salesman Problem: A Case Study in Local Optimization. In Aarts, E. and Lenstra, J., editors, *Local Search in Combinatorial Optimization*, pages 215–310. John Wiley and Sons, London.

Kim, D., Barnhart, C., Ware, K., and Reinhardt, G. 1999. Multimodal express package delivery: a service network design application. *Transportation Science*, 33:391–407.

Larsen, A. 2001. *The Dynamic Vehicle Routing Problem.* PhD thesis, Department of Mathematical Modeling, Technical University of Denmark, Copenhagen, Denmark.

Powell, W. 1986. A local improvement heuristic for the design of less-than-truckload motor carrier networks. *Transportation Science*, 20:246–257.

Savelsbergh, M. 1990. An efficient implementation of local search for constrained routing problems. *European Journal of Operational Research*, 47:75–85.

Simchi-Levi, D., Chen, X., and Bramel, J. 2005. *The Logic of Logistics: Theory, Algorithms, and Applications for Logistics and Supply Chain Management.* Springer, New York.

Toth, P. and Vigo, D. 2003. The granular tabu search and its application to the vehicle-routing problem. *INFORMS Journal on Computing*, 15:333–346.

Yang, J., Jaillet, P., and Mahmassani, H. 2004. Real-time multivehicle truckload pickup and delivery problems. *Transportation Science*, 38:135–148.