CP6542: Transportation and GIS

Georgia Institute of Technology, Spring 2014
M/W 9:05 – 10:25pm
Rm. 359, Architecture West
Instructor: Tim Welch
Office Hours: Wednesdays 2:00-4:00 or by appt.
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OVERVIEW This course covers the applications of GIS and emerging spatial technologies to transportation. Its primary goal is to help students understand the basic principles of geographical information science for transportation, and to equip students with the state-of-the-practice computing technology for transportation planning in a GIS environment.

The course is appropriate for those with transportation experience and interested in learning practical implementation of transportation modeling in the GIS environment. It is also appropriate for those with a GIS background and interested in gaining experience in problems specific to transportation. The learning objectives of this course are to:

1) Understand transportation GIS fundamentals, including network, route and path, etc. 2) Increase proficiency in Transportation GIS routine operations such as data conversion, matrix operation, and topology building; 3) Become experienced in applying GIS to travel demand modeling and logistics analysis; 4) Explore creatively the applications of GIS to transportation analytical tasks, for example, accessibility modeling, urban mobility performance, health impact assessment or those specific to students' own areas of study and interest.

Evaluation The course will be structured as a combined lecture-lab course. You are expected to have read all assigned readings ahead of time, and be prepared to actively participate in class discussions. Students will be evaluated on three sets of tasks: (1) class participation (2) three lab projects; and (3) a final course project. The formal requirements of the class are as follows:

Class Attendance and Discussion Participation **(10%):**
Class sessions will consist of lecture material, discussion and in some cases, hands-on lab work. Students are expected to come to each class well prepared to discuss and evaluate the assigned reading material.

Three Lab Projects **(45%):**
Through the completion of three lab assignments, students will gain first hand knowledge of the use and operation of GIS in transportation. Each lab will consist of (1) one day working on a guided example problem; (2) one day to work with the class instructor's supervision on a specific problem; and (3)

additional out of class time to complete the special problem on complete a breif lab write-up/memo.

Class Project **(5% Presentation, 40% Project):**
The final class requirement is a team-based project that applies the knowledge learned in the class to a real world problem. Topics will be selected by groups from a list provided by the instructor as the beginning of the semester. Students will be provided full details of the project guidelines and expectations on the class. Five percent of the total course grade will be a formal presentation to the class.

Please note that all written assignments (unless otherwise noted) are to be submitted through the "Assignments" tab in T-Square. Late submissions will be discounted a letter grade a day. It is the student's responsibility to ensure that assignments submitted through T-Square are successfully uploaded into the system. Also note that the grading percentages presented above may be adjusted by the instructor in response to an insufficient effort on any assignment.

The Institute policy regarding student plagiarism will be strictly enforced. It is expected that all students have a thorough understanding of the various forms of plagiarism and that questions pertaining to this policy will be resolved before the submission of any assignment. For a description of proper attribution, please see the "Academic and Professional Writing Guide," available through the resources tab in T-Square. Any student found to violate the policy on plagiarism will receive a failing grade for the assignment and will be subject to disciplinary action as outlined within the Institute's Honor Code.

Students with disabilities needing academic accommodation should provide documentation to the Access Disabled Assistance Program for Tech Students (http://www.adapts.gatech.edu/) and bring an ADAPTS accommodation letter to the instructor indicating the nature of accommodations required. This should be done within the first week of class or as soon as possible after a new disability condition arises. All effort will be made to provide reasonable accommodation.

TEXTS All readings will be available as PDF files on T-Square. No textbook purchase is required.

Optional Textbook: Harvey J. Miller and Shih-Lung Shaw (2001), Geographic Information Systems for Transportation: Principles and Applications, Oxford University Press. ['GIS-T' in the syllabus]

I. NETWORK ANALYSIS

Week 1: Course Overview; Course Introduction

Introduction to Transport GIS:

Chapter 1 in GIS-T

Nyerges, T. L. (2004). GIS inUrban-Regional Transportation Planning. In Hanson, S. (Ed). 2004. The Urban Transportation Planning Process. The Geography of Urban Transportation. New York: Guilford Press

Week 2: No Class: TRB

No Readings

Week 3: Transportation Data and Databases

Transportation Data:

Chapter 4 in GIS-T

Data Modeling and Database Design:

Chapter 2 in GIS-T

Week 4: Path Analysis

Graph Theory:

Chapter 3, pages 53-54 in GIS-T

Dijkstra, E. W. (1959). A note on two problems in connexion with graphs. *Numerische mathematik*, *1*(1), 269-271.

Least-cost (shortest path) analysis:

Chapter 5 pages 130-157 in GIS-T

[SKIM] Gallo, G., & Pallottino, S. (1988). Shortest path algorithms. *Annals of Operations Research*, *13*(1), 1-79.

Zhan, F. B., & Noon, C. E. (1998). Shortest path algorithms: an evaluation using real road networks. Transportation Science, 32(1), 65-73.

Week 5: Movement on the network

Flow Modeling and The Classic Transportation Problem:

Chapter 6, pages 172-198 in GIS-T

Accessibility Modeling:

Chapter 8, pages 247-281 in GIS-T

Week 6: LAB 1

Regional Accessibility and Freight Movement

II. LOCATION, ROUTING AND DATA MODELING

Week 7: Vector and Object-based Models

The network model:

Chapter 3, pages 55-61 in GIS-T

Kansky, K. J. (1963). Structure of transportation networks: relationships between network geometry and regional characteristics.

Linear Referencing:

Chapter 3, pages 62-76 in GIS-T

Week 8: Routing

Routing Systems:

Chapter 3, pages 77-84 in GIS-T

Vehicle Routing and Arc Routing:

Chapter 5, pages 158-170 in GIS-T

Week 9: Location-allocation Modeling

Linear/Integer Programming & Matrix Algebra Basics:

de Dios Ortúzar, J., & Willumsen, L. G. (2001). *Modelling transport* (Vol. 7). Chichester: Wiley. Chapter 2.

Facility Location & P-median:

Chapter 6, pages 199-213 in GIS-T
Chapter 11, pages 383-395 in GIS-T

Week 10: Lab 2

The vehicle routing problem

Week 11: Spring Break

No Class

III. STATE OF THE PRACTICE AND EMERGING TECHNOLOGIES

Week 12: Agency GIS Use

Guest Speaker 1: *ARC GIS Data Management and Use*

Guest Speaker 2: *GDOT GIS Data Management and Use*

Week 13: Public Map Data & Crowdsourcing

Google Maps API:

Chow, T. E. (2008). The potential of maps APIs for Internet GIS applications. *Transactions in GIS*, *12*(2), 179-191.

Miller, C. C. (2006). A beast in the field: The Google Maps mashup as GIS/2. *Cartographica: The International Journal for Geographic Information and Geovisualization*, *41*(3), 187-199.

Open Streets:

Haklay, M., & Weber, P. (2008). Openstreetmap: User-generated street maps. *Pervasive Computing, IEEE*, *7*(4), 12-18.

Chilton, S. (2009, November). Crowdsourcing is radically changing the geodata landscape: Case study of OpenStreetMap. In *24th International Cartographic Conference, Chile*.

Week 14: Dig Data

GPS data:

Mintsis, G., Basbas, S., Papaioannou, P., Taxiltaris, C., & Tziavos, I. N. (2004). Applications of GPS technology in the land transportation system. *European Journal of Operational Research*, *152*(2), 399-409.

[SKIM] Czerniak, R. J., & Genrich, R. L. (2002). *Collecting, processing, and integrating GPS data into GIS* (Vol. 301). Transportation Research Board.

Transit Feeds:

Guest Speaker: ARC, Transit Feeds

Week 15: Lab 3

Working with and programming for open data

Week 16: Final Project Presentations

No Readings