GEOG 490/590: LOCATION-AWARE SYSTEMS

Instructor: Hedda R. Schmidtke
Lecture: 2 x 1-hour lecture/week
Labs: 1 x 2-hour lecture/week

READINGS

A. Ahmed, L. Hong, and A. J. Smola. Hierarchical geographical modeling of user locations from social media posts. In *Proceedings of the 22nd international conference on World Wide Web*, pages 25–36. International World Wide Web Conferences Steering Committee, 2013.
F. Chang, J. Dean, S. Ghemawat, W. C. Hsieh, D. A. Wallach, M. Burrows, T. Chandra, A. Fikes, and R. E. Gruber. Bigtable: A distributed storage system for structured data. *ACM Transactions on Computer Systems (TOCS)*, 26 (2): 4, 2008.
S. Elwood and A. Leszczynski. Privacy, reconsidered: New representations, data practices, and the geoweb. *Geoforum*, 42 (1): 6–15, 2011.
N. Eagle and A. Pentland. Reality mining: sensing complex social systems. *Personal and ubiquitous computing*, 10 (4): 255–268, 2006.
C. Goranson, S. Thihalolipavan, and N. di Tada. Vgi and public health: Possibilities and pitfalls. In *Crowdsourcing geographic knowledge*, pages 329–340. Springer, 2013.
A. Gupta, F. Yang, J. Govig, A. Kirsch, K. Chan, K. Lai, S. Wu, S. G. Dhoot, A. R. Kumar, A. Agiwal, et al. Mesa: Geo-replicated, near real-time, scalable data warehousing. *Proceedings of the VLDB Endowment*, 7 (12): 1259–1270, 2014.
H. Karl and A. Willig. *Protocols and architectures for wireless sensor networks*. John Wiley & Sons, 2007.
M. Langheinrich. Privacy by design - principles of privacy-aware ubiquitous systems. In G. D. Abowd, B. Brumitt, and S. Shafer, editors, *Ubiquitous Computing*, pages 273–291, Heidelberg, 2001. Springer.
H. Lieberman and T. Selker. Out of context: Computer systems that adapt to, and learn from, context. *IBM systems journal*, 39 (3.4): 617–632, 2000.
M. P. Peterson. *Mapping in the Cloud*. Guilford Press, 2014.
T. Sakaki, M. Okazaki, and Y. Matsuo. Earthquake shakes twitter users: real-time event detection by social sensors. In *Proceedings of the 19th international conference on World wide web*, pages 851–860. ACM, 2010.
A. Schmidt, K. A. Aidoo, A. Takaluoma, U. Tuomela, K. V. Laerhoven, and W. V. de Velde. Advanced interaction in context. In *Handheld and Ubiquitous Computing*, pages 89–101, 1999.
W. Stallings. *Wireless communications & networks*. Pearson Education, 2005.
M. Wernke, P. Skvortsov, F. Dürr, and K. Rothermel. A classification of location privacy attacks and approaches. *Personal and Ubiquitous Computing*, 18 (1): 163–175, 2014.
All readings will be posted on Canvas.

COURSE DESCRIPTION

Location-aware systems are the foundation of today's easy access to geospatial information for everyone. A smart phone that knows where you are can provide you with an appropriate map of your surroundings without searching. Location-awareness also allows your phone to access location based services, e.g. for finding restaurants or shops in the vicinity. Location based services may also feed advertisements to your phone directing you at shops or special opportunities nearby. Geofencing applications may even reach out to you as you pass by a store or restaurant with targeted offers. Moreover, location-aware social networking apps allow you to connect with people around you or to track your friends' or children's locations. The collected geospatial movement information about a growing number of users world-wide poses up to now unknown potential for analysis of massive geospatial data about human behavior. All these are exciting technological developments, but there are also many challenges and caveats, the most obvious being

privacy and the potential for abuse of spatial data for criminal purposes, such as burglary when the house owners are on vacation.
This course, on the one hand, introduces the technical fundamentals of location-aware systems including the smart phone technology making location-awareness possible, the spatial models and data structures developed to manage locations as part of a computer network, and the operation and structure of location-based services as supported by GI systems; on the other hand, it discusses ethical challenges of the different technologies, in particular how to protect user privacy both technically and legally.

EXPECTED LEARNING OUTCOMES

After successfully completing the course students

- Understand all steps of how a location-aware application works: how location information is obtained, potentially sent to a location based service and transported through a network, potentially anonymized or obfuscated, translated into a query, and finally answered.
- Are able to critically evaluate location-aware technologies as to their potential, importance, and risks, and to develop alternatives that minimize risks.
- Gain an overview of recent widely used location-aware systems or services enhanced with location-awareness
- Understand the scientific usage of data from these services for geographic purposes
- Are able to develop a location-aware smart phone application

Students with sufficient technical background can additionally gain experience in programming a location-aware smart phone application as part of their final project.

ESTIMATED STUDENT WORKLOAD

The course contains lectures, reading assigments, and in-class activities/quizzes, as well as lab assignments, including a final project. Students spend two hours in lectures and two hours in labs. Each lecture consists of 30 mins of presentation by the instructor and 20 mins of in-class activities. Presentations are interleaved with in-class activities, in order to allow students to actively engage with concepts and to make theoretical material tangible with hands-on experience. In-class activities include short quizzes, discussion group exercises, and computational excercises using location-aware systems components.
Assignments deepen the practical part of the learning experience enabling students to apply the presented concepts so as to reach learning objectives. Assignments practice the main steps for developing a location-aware system and give hands-on experience with components of such a system, as well as techniques for assessing its risks and developing alternatives. In the final project, students will combine all the knowledge and methods learned previously to write their own location-aware system, which obtains data from a social media stream, connects users over a network, and provides information to users that addresses their location-dependent information needs in a manner that allows users to protect their privacy and safety.Students are expected to spend about eight hours per week on assignments and the final project: two hours in labs and on average six hours outside of classroom. Another two hours outside of classroom are required for course readings.

GRADING

GEOG 490
Examinations (30%): mid term (10%), final (20%)
Final project (30%)
Lab assignments (30%): four lab assignments
In-class activities (10%)

GEOG 590

The criteria for 590 students differ mainly in the requirements for the final project, which needs to be described in a short research paper (5-10 pages), and the requirement for a literature review (discussion of 5-10 scientific articles discussing a topic from the lectures at more depth). The distribution schema for GEOG 590 students is:

Examinations (22.5%): mid term (7.5%), final (15%)
Literature review (10%)
Final project (40%): project (300 points = 22.5%), write-up & method (200 points = 15%)
Lab assignments (22.5%): four lab assignments
In-class activities (7.5%)
Work of graduate students will not be evaluated by the graduate student teaching fellow.

GRADING RUBRIC

Grading criteria follow http://gradeculture.uoregon.edu:

A+ Only used when a student's performance significantly exceeds all requirements and expectations for the class. Typically very few to no students receive this grade.

A Excellent grasp of material and strong performance across the board, or exceptional performance in one aspect of the course offsetting somewhat less strong performance in another. Typically no more than a quarter of the students in a class receive this grade, fewer in lower-division classes.

B Good grasp of material and good performance on most components of the course. Typically this is the most common grade.

C Satisfactory grasp of material and/or performance on significant aspects of the class.

D Subpar grasp of material and/or performance on significant aspects of the class.

F Unacceptable grasp of material and/or performance on significant aspects of the class.

The following expectations regarding point ranges are applied:

Grading in basic activities, such as examinations and lab assignments, evaluates in how far an answer reflects that the question with its background was understood and solved following the methods to be applied in the specific answer. Grading of advanced activities with higher degrees of freedom, such as advanced labs, the final project, or literature reviews, additionally evaluates the suitability of the choices made, e.g. the final project plan, the method chosen for analysis, the choice of articles selected for review. Students should make sure that they seek guidance early for these tasks so as to actively discuss alternatives and should justify their choices in write-ups.

COURSE SCHEDULE AND ASSIGNMENTS

WEEK 1

Lecture 1
INTRODUCTION & OVERVIEW,
Reading: Peterson (2014), Chapter 19, pp. 361-375
Lecture 2
WHAT ARE LOCATION-AWARE SYSTEMS?,
Reading: Peterson (2014), Chapter 20, pp. 376-386
Lab 1
Me on My Map

WEEK 2

Lecture 3
SMART PHONES AS SENSING SYSTEMS,
Reading: Schmidt et al. (1999)
Lecture 4
IMPLICIT INTERACTION,
Reading: Lieberman and Selker (2000)
Lab 2
Apps that Use Location Data

WEEK 3

Lecture5
COMMUNICATION NETWORKS,
Reading: Stallings (2005), Chapter 3 pp. 46-68
Lecture 6
NETWORK PROTOCOLS,
Reading: Stallings (2005), Chapter 4 pp. 69-94
Lab 3
Introduction: Network Trace

WEEK 4

Lecture 7
THE SPATIAL INTERNET & GOOGLE'S BIG TABLE,
Reading: Chang et al. (2008)
Lecture 8
THE SPATIAL INTERNET & MARKETING,
Reading: Gupta et al. (2014)
Lab 4
Work session: Network Trace

WEEK 5

Lecture 9
SOCIAL MEDIA AND LOCATION,
Reading: Sakaki et al. (2010)
Lecture 10
Midterm,
Lab 5
Introduction: Analysing Spatial Data from Twitter

WEEK 6

Lecture 11
LOCATIONS FROM SOCIAL MEDIA,
Reading: Ahmed et al. (2013)
Lecture 12
ANALYSIS OF LOCATION-BASED DATA,
Reading: Eagle and Pentland (2006)
Lab 6
Work session: Analysing Spatial Data from Twitter

WEEK 7

Lecture 13
LOCATION PRIVACY BY DESIGN,
Reading: Langheinrich (2001)
Lecture 14
PRIVACY AND THE GEOWEB,
Reading: Elwood and Leszczynski (2011)
Lab 7 Introduction: Final Project

WEEK 8

Lecture 15
LOCATION PRIVACY ATTACKS,
Reading: Wernke et al. (2014)
Lecture 16
LOCATION-BASED DATA FOR PUBLIC HEALTH
Reading: Goranson (2013)
Lab 8 Work session: Final Project

WEEK 9

Lecture 17
LOCALIZATION TECHNIQUE PRINCIPLES,
Reading: Karl and Willig (2007), Chapter 9.1-9.3 pp. 231-240
Lecture 18
LOCALIZATION TECHNIQUE PROTOCOLS,
Reading: Karl and Willig (2007), Chapter 9.4-9.8 pp. 240-250
Lab 9
Work session: Final Project

WEEK 10

Lecture 19
Presentations,
Reading: project handouts
Lecture 20
Presentations,
Reading: project handouts
Lab 10
Work session: Final Project

WEEK 11

Final Exam