

CSci 5980-001: From GPS and Google Earth to Spatial Computing

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Credits: 3

Class Time & Place: Tu,Th: 4-515pm, 3-125 KHKH

Class Webpage: <http://www.cs.umn.edu/~shekhar/5980/>

To Register: Computer Science in 4-192 Keller Hall.

Pre-requisites: CSci 1902 (required), CSci 2011
(preferred) or equivalent.

Text: GIS: A Computing Perspective, M. Worboys et al.
CRC Press. 2004.

Supplement: R. Ferraro et al., Location Aware Applications,
Manning, 2011 (isbn 978-1-935182-33-7).

Long Title: Spatial Computing: How are GPS, Location-based Social Networks, Geo-Social Media and Cell-phone based Location Based Services transforming computing?



Motivation: Spatial Computing is a set of ideas and technologies that transform our lives by understanding the physical world, knowing and communicating our relation to places in that world, and navigating through those places. The transformational potential of Spatial Computing is already evident. From Google Maps to consumer GPS devices, our society has benefitted immensely from spatial technology. We've reached the point where a hiker in Yellowstone, a schoolgirl in DC, a biker in Minneapolis, and a taxi driver in Manhattan know precisely where they are, nearby points of interest, and how to reach their destinations. Groups of friends can form impromptu events via "check-in" models used by Facebook and foursquare. Scientists use GPS to track endangered species to better understand behavior and farmers use GPS for precision agriculture to increase crop yields while reducing costs. Google Earth is being used in classrooms to teach children about their neighborhoods and the world in a fun and interactive way. Augmented reality applications are providing real-time place labeling in the physical world and providing people detailed information about major landmarks nearby.

Hands-on Labs: Four labs will allow for hands-on development with real systems and applications: developing Android/iPhone applications, mining GPS data from Twitter feeds, developing plugins for Google Earth with KML, etc.



Check-in

Topics: This course introduces the fundamental ideas underlying the geo-spatial services, systems, and sciences. These include mathematical concepts (e.g. Euclidean space, topology of space, network space), geo-information models (e.g. field-based, object-based), representations (e.g. discretized, spaghetti, tessellation, Voronoi diagram), algorithms (e.g. metric and Euclidean, topological, set-based, triangulation, graph-based), data-structures and access methods (e.g. space filling curves, quad-trees, R-tree), analysis (e.g. spatial query languages, spatial statistics, spatial data mining), architectures (e.g. location sensor, location based services), interfaces (e.g. cartography, Geo-visualization), reasoning (e.g. data quality, approaches to uncertainty), and time (e.g. valid time, events and processes).

Required Work: Course has a set of four assignments and two examinations. The weighting scheme used for grading is: Midterm exam. - 25%, Final exam. - 25%, Assignments including a project - 40%, Class participation - 10%. Examinations will emphasize problem solving and critical thinking. Assignments will include pen-and-paper problems and computer based laboratory experiments/projects to reinforce concepts uncovered in the classroom. Class participation includes spatial-news presenting and active group learning. Participants will take turn to review current spatial news and present selected news items in the class. During active learning, participants will work in small groups on exercises provided in the class meeting. After this, a randomly chosen group will be invited to summarize the discussion in his/her group. Other groups in the class may critique constructively.

Career Opportunities: Major computer science employers looking for geospatial knowledge and skills include ESRI, Facebook, Google, IBM, Microsoft, Nokia, Oracle, Yahoo, and many government agencies related to public health, public safety, transportation, etc. As per a recent article in the Nature magazine “the US Department of Labor identified geo-technology as one of the three most important emerging and evolving fields, along with nanotechnology and biotechnology. Job opportunities are growing and diversifying as geospatial technologies prove their value in ever more areas.”

Auxiliary Information: Representing geo-spatial information services include *virtual globes* (e.g., Google Earth), *location based services* (Google Maps), *location-based social networks* (e.g., foursquare), *enterprise consulting* (e.g. IBM smarter planet). Representative application programming interfaces include HTML 5 Geolocation API , Google Maps API , Bing Maps API , Yahoo Maps Web Services , Flickr Flickr Maps , Twitter location API.

Non-intuitive geo-spatial concepts include map projections, scale, auto-correlation, heterogeneity and non-stationarity etc. First two impact computation of spatial distance, area, direction, shortest paths etc. Spatial (and temporal) autocorrelation violates the omni-present independence assumption in traditional statistical and data mining methods. Non-stationarity violates assumptions underlying dynamic programming, a popular algorithm design paradigm in Computer Science. This course will also explore these concepts particularly in context of the gap between traditional Computer Science (CS) paradigms and the computational needs of spatial domains. We will examine current approaches to address these new challenges possibly via talks from prominent geospatial thinkers at our university.



Source: Google Earth