Course Proposal Form

Please refer to the Electronic Course Authorization System's (ECAS) Web-based forms for more detailed information about how to complete all fields.

* = **Required field**

Category

*Institution: *UMNTC – Twin Cities*

*Effective Term: *Spring 2014*

*Subject: *CSCI*

*Course Number: *5715*

*Department: *Computer Science and Engineering*

*College: *College of Science and Engineering*

*Career: *UGRD*

*Effective Status [Active/Inactive]: *Active*

General

*Course Title Short: *Spatial Computing*

*Course Title Long: *From GPS and Virtual Globes to Spatial Computing*

***Max-Min Credits for Course**

Maximum credits: 3

Minimum credits: 3

*Catalog Description: *This course introduces mathematical concepts (e.g., topology), geo-information, representations (e.g., tessellation), algorithms (e.g. Euclidean, graph-based), data-structures and access methods (e.g., R-tree), analysis (e.g., spatial data mining), architectures (e.g., location based services), interfaces (e.g., Geo-visualization), reasoning (e.g., location uncertainty), and time (e.g., processes).*

*Print in Catalog? [Y/N]: *Y*

*Grading Basis: Student Option

Delivery Mode(s): *Classroom*

*Years most frequently offered: *Every other year*

*Terms most frequently offered: *Spring*

*Component 1: Lecture

*Component 1 has final exam [Y/N]: *Y*

*Auto-Enroll Course [Y/N]: *N*

*Graded Component: *Lecture*

Prerequisites for Catalog: Familiarity with Java, C++, or Python

Consent Requirement: No required consent

Enforced Prerequisites: *001186 - Exclude fr or soph 5000 level courses*

Student Learning Outcomes (Twin Cities courses only – effective Fall 2010)

At least 1 outcome must be selected.

Students in this course:

Can identify, define, and solve problems [Y/N]: Y

*Please explain briefly how this outcome will be addressed in the course. Give brief examples of class work related to the outcome.

Spatial computing introduces new challenges to familiar computer science ideas. This course will use labs, homework assignments, and exams to ask the students to solve various computer science problems with a spatial twist. For example, students will need to identify which spatial concepts (e.g., auto-correlation) might be useful for a specific problem, construct a solution, design appropriate algorithms that incorporate spatial components, and verify the correctness of the solution.

*How will you assess the students' learning related to this outcome? Give brief examples of how class work related to the outcome will be evaluated.

This SLO will be assessed through labs, homework, quizzes, in-class exercises, and a semester project. Each of these types of students' work is problem-based; solving open-ended spatial computing problems where the students must first identify, define, and/or clarify what the problem is before solving it, and explain the solution they propose.

Syllabus

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.

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, vornoi 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). We will also explore spatial ideas and questions in other computing areas.

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.

Schedule

Week	Topic
1	Introduction to Spatial Computing
2	Database Concepts
3	Spatial Concepts
4	Models of Geospatial Information
5	Representations of Spatial Data (e.g., raster, vector, graph)
6	Algorithms (e.g., geometric, topological, graph-based)
7	Data Structures (e.g., spaghetti, node-arc-area)
8	Midterms
9	Access Methods (e.g., Quad-tree, R-Tree)
10	Architectures (e.g., location-based services)
11	Interfaces (e.g., cartography, geo-visualization)
12	Spatial Reasoning, Uncertainty
13	Spatio-temporal
14	Spatial Data Mining
15	Finals

Geo-spatial information science includes relevant branches of computer sciences (e.g. spatial databases, spatial data mining, computational geometry, computational cartography), mathematics (e.g. topology, geometry, graph theory, spatial statistics), physical sciences (e.g. geodesy and geophysics), and social sciences (e.g spatial cognition), etc. Web-based resources include Encyclopedia of GIS , Proceedings of the ACM SIG-Spatial Conf. on GIS , Proceedings of the Intl. Symposium on Spatial and Temporal Databases , IEEE Transactions on Knowledge and Data Eng. , and GeoInformatica: An International Journal on Advances in Computer Science for GIS. 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.