UNIVERSITY OF CALIFORNIA
UC RIVERSIDE

CS225: Spatial Computing

Course Outline

Instructor: Amr Magdy
Computer Science and Engineering
www.cs.ucr.edu/~amr/

Welcome to CS 225

- **Instructor**: Amr Magdy
  Office: Tomas Rivera Library, 159B
  http://www.cs.ucr.edu/~amr/
  Email: amr@cs.ucr.edu
  (**Include [CS225] in the subject**)
- Office hours [tentative]:
  Tue: 11:00 - 12:00 PM (asynchronous)
  Thu: 11:00 - 12:00 PM (in-person & online)
- **TA**: Yunfan Kang Email: ykang040@ucr.edu
  Office hours: TBA
- Course Website: https://www.cs.ucr.edu/~amr/#teaching
- Slack: https://join.slack.com/t/cs225spatialcomputing/shared_invite/zt-w383vtth-gKO09aodAvNi9cleoJME1w

Course Content

- Introduction to Spatial Computing
- Spatial Relationships and Data Models
- Spatial Data Storage and Indexing
- Spatial Query Processing
- Spatial Networks
- Geo-visualization
- Spatial Data Mining
- Trends and Innovations in Spatial Applications

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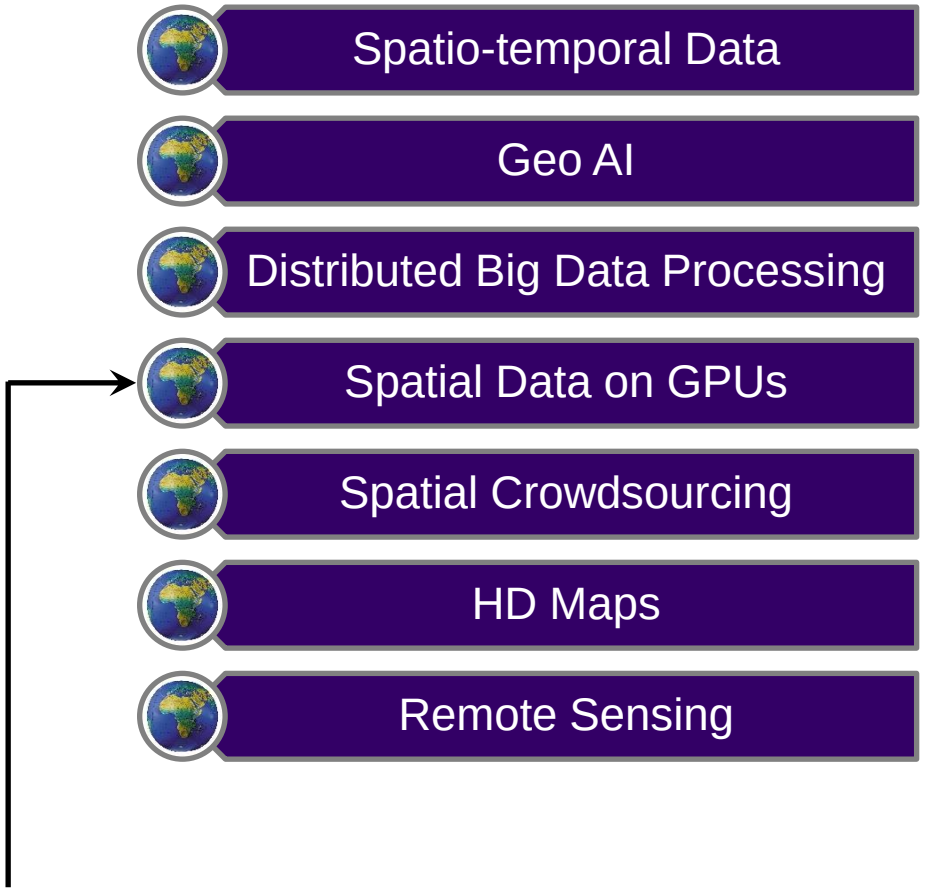

Course Content

- Course Research Elements:
  - "Introduction to Research" lecture
  - Surveying the literature methodology
  - Paper reviews practice
  - Presenting research papers
  - Writing technical papers (survey and/or final report)
  - Project stages
    (identifying idea, literature survey, tackling the problem, and documenting the results)
  - Lecture contents on new trends on spatial-related research

Grading and Policies

- Course work
  - Project (65%)
  - Hands-on on spatial technologies (7.5%)
  - Class participation (Evaluating others) (5%)
  - Paper reviews (7.5%)
  - Presentations (10%)
  - Final exam (5%)
- Delivery policies:
  - Groups of 3-4 students required for the project.
  - Delivery instructions and policies announced per assignment.
- Cheating is not allowed and will be reported
  - If you are using any external source, you must cite it and clarify what exactly got out of it.
  - You are expected to understand any source you use.

Project: Grade Breakdown

- Idea Proposal (with potential revision cycles) (5%)
  - Project description, outline of project deliverables, and timeline
  - extra credit up to 10% for exceptional ideas and above-average quality ideas
- Literature survey (10%)
- Project deliverables (35%)
- Final report, presentation, and discussion (15%)

Project: Categories

- Novel Research
  - Preliminary investigation for a novel research idea
- Literature Survey Paper
  - Surveying the literature of a certain spatial topic
- Literature Experimental Evaluation
  - Experimentally compare major techniques of a certain spatial topic
- Vision Analysis
  - Track the advances in topics of a vision report (e.g., CCC Spatial Computing 2020 Workshop)
- Interdisciplinary project
  - Apply spatial computing technologies to a non-CS field
- Spatial Application
  - Apply spatial technologies to a real use case.

Project: Deliverables and Assessment

- Novel Research
  - Clearly identifying and presenting the research elements
  - Preliminary solution idea
  - Preliminary evaluation results
- Literature Survey Paper
  - Comprehensive list of papers
  - Literature classification/taxonomy
  - Manuscript quality (writing, figures, organization,...etc)
- Literature Experimental Evaluation
  - Long and short lists of papers
  - Evaluation outline and corresponding implementations from the short list (or a subset)
  - Evaluation results

Project: Deliverables and Assessment

- Vision Analysis
  - Itemized analysis of the vision report
  - Quality of surveying work on each topic
- Interdisciplinary Project
  - Clear problem definition and importance
  - Survey of related work
  - Quality of the main deliverable, e.g., script, program, etc
- Spatial application
  - Quality of the delivered software modules

Project: Joint CS225 & CS226 projects

- You can share project groups between CS 225 (Spatial Computing) and CS 226 (Big Data Management), given:
  - You work on one project with double in size, this gives opportunity to focus on one big project for the two courses.
  - At least three group members must be taking the two courses.
  - The project proposal must explicitly emphasize the spatial component and the big data component.
  - The project proposal must explicitly emphasize how the project size would be different if it belongs to only one course.
  - Two separate reports must be submitted, one for each course. Each report focuses on the relevant component for its course.

Project: Joint CS225 & CS226 projects

- Example joint projects:
  - **Satellite imagery analysis**: use large satellite images datasets in any societal application
  - **Contact tracing for epidemics control**: use spatial trajectory data to trace contacts to patients of COVID-like epidemics
  - **Smart cities**: Use publicly open data, e.g., traffic, crimes, ... etc, to query and visualize data at the city, county, or state level.
  - **Analyze social media** data to detect patterns or trends in geographical regions.

Paper Reviews and Presentations

- Two review assignment (7.5%)
  - Summarization of paper research elements
  - Paper critique

- Presentations (10%)
  - Papers are presented in groups, different from project groups.
  - Each group member must present.
  - Involve presenting research papers as well as relevant articles.
  - Open for new title suggestions.

Hands-on on Spatial Technologies

- Any spatial technology is fine, check instructor approval
- Any reasonable-sized hands-on is fine as well
- Candidate technologies
  - Spatial Databases
    - PostGIS, Oracle Spatial, SpatiaLite, MonetDB/GIS, etc
  - GIS Software
    - ArcGIS, QGIS, etc
  - Maps
    - Google Maps, Bing Maps, ESRI Maps, etc
  - ESRI Story Maps
  - Big Spatial Data Systems
    - Simba, SpatialHadoop, GeoSpark, SpatialSpark, etc
  - GeoSpatial Analysis Tools
    - PySAL, GeoPandas, Fiona, Shapely, GeoDa, SSN & STARS, SP and SF R packages, OGR GDAL

Final Exam

- Lectures content

Sample Survey Papers

- In-Memory Big Data Management and Processing: A Survey. Hao Zhang, Gang Chen, Beng Chin Ooi, Kian-Lee Tan, and Meihui Zhang. TKDE, vol. 27, no. 7.

- A survey of top-k query processing techniques in relational database systems. Ihab F. Ilyas, George Beskales, Mohamed A. Soliman. ACM Computing Surveys (CSUR), Vol. 40, Issue 4, No. 11, Oc. 2008.

- Crowdsourced Data Management: A Survey. Guoliang Li, Jiannan Wang, Yudian Zheng, Michael J. Franklin. TKDE, vol. 28, issue 9.

Suggested Projects

- **Spatial Applications**
  - Mobile-based contact tracing for UCR community
- **Vision Analysis**
  - Analyzing the vision of CCC Spatial Computing 2020 Workshop
- **Literature Surveys**
  1. Blockchain-based Spatial Applications
  2. Network-based Spatial Statistics
  3. Crowdsourcing LiDAR Data Applications
  4. Spatial operations using *doubly connected edge lists* (DCELs).
  5. Spatial Data Science Applications

Suggested Projects

- ESRI GeoAI tools
  - **ArcGIS and Microsoft AI: Scalable GeoAI in the Cloud**
    - https://www.youtube.com/watch?v=m7GqaC5_fFU
  - **Geo Artificial Intelligence**
    - GeoAI medium blogs
    - GeoAI Demonstration Gallery
  - **Geospatial Data Science**
    - Spatial Analysis and Data Science
    - R-ArcGIS Bridge
    - Bridging Into New Realms: R-ArcGIS Bridge and Microsoft R
    - R Notebooks in ArcGIS Pro for Spatial Data Science
    - ArcGIS API for Python – A powerful python library for spatial analysis, mapping and GIS

Suggested Projects

- ESRI GeoAI tools
  - Online Lessons:
    - Use Deep Learning to Assess Palm Tree Health
    - Extracting Information using Image classification
    - Downscale Climate Data with Machine Learning
    - Predict Seagrass Habitats with Machine Learning
    - Identify and Ecological Niche for African Buffalo (with R-ArcGIS Bridge)
    - Analyze Crime using Statistics and R-ArcGIS Bridge
    - Analyzing violet crime using hot spot analysis and space time cube

R'GeoSpatial Student Club

R'GEOSPATIAL

WHAT'S GIS?

GIS stands for Geographic Information system. The software is used for both gathering and visualizing data. The most common example that is applicable to our lives is Google maps. Whenever you look up directions or try to figure out where you are, that's the byproduct of GIS.

GOAL OF THE CLUB:

R'geospatial is a relatively new club on campus that aims to show the utility and transferability of GIS skills to students' careers. The club will cover how to use the software and also how it applies to your major and future professional endeavors.

If interested, please add us on Highlanderlink and feel free to reach out to us if you have any questions!

Credits

- Prof. Shashi Shekhar course
  - http://www.spatial.cs.umn.edu/Courses/Spring18/8715/index.php
  - http://www.spatial.cs.umn.edu/Courses/Fall21/5715/index.php