

# **CS225: Spatial Computing**

## **Course Outline**

Instructor: Amr Magdy

Computer Science and Engineering

[www.cs.ucr.edu/~amr/](http://www.cs.ucr.edu/~amr/)

# Welcome to CS 225

- › **Instructor:** Amr Magdy  
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**(Include [CS225] in the subject – no spaces)**

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- › **TA:** Mayur Patil Office hours: TBA

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- › Course Website: <https://www.cs.ucr.edu/~amr/#teaching>



# 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

# 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%)
  - ▶ Mini-topics 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%)
  - extra credit up to 10% for exceptional ideas and above-average quality ideas
- Outline of project deliverables
- 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

# Paper Reviews and Presentations



- ▶ Two review assignment (7.5%)
  - ▶ Summarization of paper research elements
  - ▶ Paper critique
- ▶ Mini-topics presentations (10%)
  - ▶ Group-based topic preparations (titles and tentative outlines provided).
  - ▶ 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



## › Literature Surveys

1. Scalable Techniques for *Kriging Spatial Interpolation*
2. Spatial operations using *doubly connected edge lists* (DCELs).
3. Spatial Applications on *Multi-scale Geographically Weighted Regression* (MGWR)

# Suggested Projects



- **Spatial Applications (Real use cases in UCR)**
  - **Irrigation status app**
    - Purpose: Display status of irrigation blocks, record duration of irrigation events and technicians responsible.
    - Core functionality
      - App will display on web map:
        - Irrigation blocks currently being irrigated.
        - Date/time of next scheduled irrigation by block of blocks not being irrigated.
        - Irrigation technician responsible for Irrigation.
        - Record date and time of irrigation started and ended by block; calculate duration.

# Suggested Projects



- **Spatial Applications (Real use cases in UCR)**
  - **Pesticide application app**
    - Purpose: Display where pesticides have been and will be applied and records pesticide applications.
    - Core functionality
      - App will display on web map:
        - Locations that have been treated with a pesticide, include name if selected.
        - Locations currently under REI,
        - Locations scheduled for pesticide application, include name if selected.
        - Tentative date/time of scheduled applications.
        - Record pesticide applications by treatment block, include pesticide name and treatment end date/time.



# Suggested Projects

- › ESRI GeoAI tools
  - › **ArcGIS and Microsoft AI: Scalable GeoAI in the Cloud**
    - › [https://www.youtube.com/watch?v=m7GqaC5\\_fFU](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](#)

# Credits

- › Prof. Shashi Shekhar course
  - › <http://www.spatial.cs.umn.edu/Courses/Spring18/8715/index.php>