Capstone project:
Database & AI initiative biomedical research
(Spring 2027)

Course Description and Objectives:

This course is designed to familiarize students with biomedical research, with a particular focus on AI-driven studies impacting biomarker discovery and drug repositioning in complex diseases.

The students will learn the basics of data processing and relational database construction.

The students will follow the state-of-the-art techniques in processing the multi-omics data and enhance their understanding of the frontiers of bioinformatics algorithms, tackling biomedical questions, such as the stratification of the patients and identifying potential cohort-specific oncogenes and treatments.

This course will introduce the Engineering College's master students who are interested in pursuing careers in bioinformatics or data science, equipping them with the skills needed to conduct bioinformatics research using state-of-the-art technologies.

Expected learning outcomes:

Following successful completion of the course, students will be able to:

- Analyze the available literature on oncogene discovery, AI initiative techniques and applications in bioinformatics research.
- Design experiments to investigate biomedical research using bioinformatics approaches.
- Understand the design of database(s) for bioinformatics research.
- Understand the common AI techniques and how it facilitates biomedical studies.
- Be able to understand and review the literature and design experiments to carry out studies in biomarker discovery and drug discovery of complex diseases.
- Develop a knowledge base for the application of AI techniques.

Reading Assignments: Both classical and current research and review scientific articles and book chapters will be used as reading materials. These will be selected from websites (PubMed, Google Scholar), Scientific journals, and books. All required reading will be posted on Canvas.

Hands-on experience: To familiarize yourself with relational database management system (RDBMS), this course will incorporate the Oracle database and user interface programming using Oracle Academy Application Express associated with the academic Oracle Cloud account. For the programming session, Python or R with Jupyter notebook instances will be employed and deployed on the Easley high-performance computing (HPC) clusters associated with your AU account.

Office Hours: Anytime by email appointment. Every Monday, we will have a 30-minute short meeting to report progress and obstacles that need to be solved.

Pre-requisites: The class is targeted at master students enrolled in the AU Engineering College.

Grading criteria:

The course meets once every week on Thursday for two and a half hours. Participation in class discussion accounts is very important and highly encouraged. Participation includes an active discussion by asking

pertinent questions. Students will also be asked to do two presentations. Students will select their research topics for presentations.

Participation: 150 points

- 10 points per class * 15 (including the weekly meeting and interactive discussions)

Progress Report: 350 points

- 100 points per presentation. (2 times) 200 points in total.
- 25 points per presentation. (6 times) 150 points

Final Presentation: 500 points

- 200 points for the final presentation
- 150 points for the final report
- 150 points for codes submitted to GitHub

Bonus:

- 20 points for the team lead
- 10 points for each ad hoc assignment or competition

Miscellaneous Deductions:

- 10 points per missed for Presentation Day attendance
- Lack of class participation/missed assignments Professor's discretion (max of 50 points)

Grading:

- A - 90-100%
- B – 80<90%
- C – 70<80%
- D – 60<70%
- F < 60%

Bonus award with incentives: The best scientific award and the best collaboration award will be selected according to the evaluation board of internal and external faculties. The winner group and individual will receive gift cards.

Class Attendance: Students are expected to attend all classes and participate in the discussion.

Classroom and Schedule:

1. a) Day: Thursday from Jan 7 – Apr 29, 2027 (no class on Mar 11, Spring Break; Apr 29 falls in the final exam period)
2. b) Time: 1:00 pm - 3:00 pm

3. c) Location: Walker 4207 - Conference Room

Policies

All policies set forth in the Student Policy Handbook apply to this course.

(http://www.auburn.edu/student_info/student_policies/).

Students should be especially familiar with the following sections of the Handbook:

Academic Honesty:

https://sites.auburn.edu/admin/universitypolicies/Policies/AcademicHonestyCode.pdf

Class Attendance:

https://sites.auburn.edu/admin/universitypolicies/Policies/PolicyonClassAttendance.pdf

Classroom Behavior:

https://sites.auburn.edu/admin/universitypolicies/Policies/PolicyonClassroomBehavior.pdf

Make-Up Policy: Arrangements to make up missed presentations due to properly authorized excused absences must be initiated by the student within one week of the end of the period of the excused absences. Except in unusual circumstances, such as the continued absence of the student or the advent of university holidays, the presentation will take place within two weeks from the time that the student initiates arrangements for it.

Disability Accommodations: Students who need accommodations are asked to electronically submit their approved accommodations through AU Access and to arrange a meeting during the first week of classes, or as soon as possible if accommodations are needed immediately. To set up this meeting, please contact the coordinators me by e-mail. If you have not established accommodations through the Office of Accessibility, but need accommodations, make an appointment with the Office of Accessibility, 1228 Haley Center, 844-2096(V/TT)

Course coordinator:

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	Content	Activity
1 Jan 7	Introduction	Review papers and form groups
2 Jan 14	Select research topics	Discuss papers and narrow down the topics
3 Jan 21	Refinement and extension of topic selection	Identify the codes and study design
4 Jan 28	Early project initiation	Reading and discussing potential
5 Feb 4	Address challenges and reevaluate potential projects	Reading and discussing potential
6 Feb 11	The last day for the project commencement	Reading and discussing potential
7 Feb 18	Progress discussion	Data collection and method discussion
8 Feb 25	Progress discussion	Tool selection and trial study
9 Mar 4	Present journal paper group 1 first round	Submit the reading report and discuss it in class
10 Mar 11	Spring Break	
11 Mar 18	Present journal paper group 2 first round	Submit the reading report and discuss it in class
12 Mar 25	Progress discussion	Mid-term progress review and follow up study design
13 Apr 1	Progress discussion	Progress review and potential extension
14 Apr 8	Present journal paper group 1 second round	Submit the reading report and discuss it in class
15 Apr 15	Present journal paper group 2 second round	Submit the reading report and discuss it in class

16 Apr 22	Final presentation of the project report	Present project results and submit the final codes to GitHub
17 Apr 29	Announcement of the winning team and celebration	Review of the course and summary

Participation: 150 points

- 10 points per class * 15 (including the weekly meeting and interactive discussions)

Participation Instruction:

- Participants and interactive discussion.

Progress Report: 350 points

- 100 points per presentation. (2 times) 200 points in total.
- 25 points per presentation. (6 times) 150 points

Progress Report Instruction:

- Prepare a concise report both prior to and during the presentation.
- Actively engage by asking questions and providing constructive comments on the presentation.
- Evaluate both the journal papers and the presenters through a structured rating system.

Presentation Instruction:

Content and Relevance (30%)

- Clarity and accuracy in presenting the research question, objectives, and key findings.
- Inclusion of relevant background information, methodologies, and results.
- Alignment of the content with the project's goals and scope.

Methodology and Analysis (20%)

- Appropriateness and rigor of the methods used.
- Depth and accuracy of data analysis.
- Clear explanation of procedures, workflows, and any tools or software applied.

Structure and Organization (15%)

- Logical flow of sections, including introduction, methods, results, discussion, and conclusion.
- Proper use of headings, subheadings, and transitions to enhance readability.
- Consistency in formatting and adherence to guidelines.

Clarity and Presentation (15%)

- Quality of writing, including grammar, spelling, and vocabulary.
- Effective use of visuals (e.g., charts, tables, and figures) to support and enhance the text.
- Conciseness and clarity in conveying ideas and results.

Critical Thinking and Interpretation (15%)

- Depth of insight and originality in discussing the implications of the results.
- Ability to identify limitations and propose future directions.
- Relevance and quality of conclusions drawn from the findings.

Citations and References (5%)

- Proper citation of sources in text and in the reference section.
- Use of appropriate and credible references.
- Consistency in citation style and adherence to specified guidelines.

Final Presentation: 500 points

- 200 points for the final presentation
- 150 points for the final report
- 150 points for codes submitted to GitHub

Overall Instruction:

- Clearly present the key results and major methodologies of the project, ensuring clarity and precision.
- Provide detailed explanations of the concepts supported by appropriate figures, workflows, and visual aids.
- Structure the content in a logical and cohesive manner for seamless understanding.
- Demonstrate strong presentation skills, including clear communication, confident delivery, and active audience engagement.
- Respond thoughtfully and accurately to questions from both students and instructors, showcasing a deep understanding of the work.

Final presentation instruction:

Functionality and Accuracy (30%)

- The code performs as intended and meets the project requirements.
- Accuracy and correctness of the outputs in alignment with the expected results.
- All features and functionalities outlined in the project description are implemented.

Code Quality and Readability (20%)

- Clear and consistent coding style (e.g., indentation, naming conventions, and structure).
- Adequate and meaningful comments to explain key sections and logic.
- Proper use of modularity, such as functions and classes, to improve maintainability.

Documentation (20%)

- A well-written README file that includes:
    - Project description and objectives.
    - Setup instructions, dependencies, and usage examples.
- Inline comments explaining complex code segments.
- Proper documentation of APIs, functions, or workflows used in the project.

Version Control and Collaboration (15%)

- Effective use of GitHub features, such as branches, commits, and pull requests.
- Clear, descriptive commit messages that summarize changes.
- Proper use of GitHub issues, labels, or discussions for tracking bugs and enhancements.

Error Handling and Robustness (10%)

- Appropriate error handling to prevent crashes and unexpected behavior.
- Validation of inputs and outputs to ensure reliability.
- Resilience to edge cases and stress testing.

Innovation and Optimization (5%)

- Use of innovative approaches or techniques to solve the problem.
- Code optimization for performance and efficiency, including time and space complexity.