CS 785 Algorithms for Enabling Responsible Data Management (Fall 2025)

Instructor: Senjuti Basu Roy
Location: CKB 207
Class sessions: Tuesday and Thursday, 1 pm – 2:20 pm
Instructor Office: GITC 4302
Office Hours: Tuesday and Thursday, (11:50 am – 12:50 pm /by appointment (**email:** senjutib@njit.edu)

Class canvas website: https://njit.instructure.com/courses/56159

Zoom link: https://njit-edu.zoom.us/j/97007295531?pwd=E7WPQnLj8b9S1mdnYPbX7JkfSC03Gy.1

Course Overview: Welcome. This course introduces students to the design and analysis of algorithms for responsible data management. It focuses on core algorithmic principles while addressing issues of fairness, privacy, transparency, and accountability in data-driven systems. Topics include responsible data collection and preprocessing, algorithms for fairness-aware query processing, privacy-preserving data analytics, explainability in data management, and trade-offs between accuracy and ethical constraints. The course combines theoretical foundations and course projects, preparing students to conduct independent research at the intersection of algorithms, data management, and responsible AI.

The **primary objectives** of the course are:

- **Develop foundational understanding** of algorithmic techniques for data management, including indexing, query processing, and optimization, in the context of responsible and ethical use.

- **Analyze trade-offs** between efficiency, fairness, privacy, transparency, and accountability in the design of data management algorithms.

- **Apply algorithmic frameworks** to real world datasets involving fairness-aware processing , and explainable data systems.

 Critically evaluate research literature at the intersection of algorithms, data management, and responsible AI, identifying open challenges and opportunities.

 Design and propose original research contributions that advance responsible data management practices in theory or application.

The **outcomes** of the course are:

Upon successful completion of the course, students are able to:

 D**emonstrate proficiency** in applying algorithmic methods to responsibly manage large-scale data while balancing efficiency and ethical constraints.

 Design and implement algorithms that incorporate fairness, privacy, and transparency requirements into data management tasks.

 Critically assess the strengths and limitations of existing approaches in responsible data management through analysis of current research.

 Communicate research contributions effectively through written reports and oral presentations targeted to both technical and interdisciplinary audiences.

 Formulate and pursue independent research questions that advance the state of knowledge in responsible data management and its applications.

Prerequisite: Students are expected to have prior graduate-level coursework in **algorithms** (e.g., complexity analysis, graph algorithms, optimization) and **database systems** (e.g., query processing, indexing, transaction management). Familiarity with concepts in **probability, statistics, and linear algebra** is required. Background knowledge in **machine learning** or **responsible AI** (fairness, privacy, interpretability) is recommended but not mandatory. Programming proficiency in at least one high-level language (e.g., Python, Java, or C++) is assumed.

Texts: No text book is needed.

Additional Readings: Reading materials will be provided by the instructors

Course deliverables/grading policies:

Assignment name	Grade
Paper presentation	2-3 paper presentations 30%
Midterm project + presentation	30%
Final project+ presentation	30%
Class participation	10%

Submissions are due by midnight. Submissions more than 6 hours late will be penalized 20% and no submissions will be accepted 24 hours after the due date. **No late submission will be accepted for the final project**

Midterm project: The midterm project is a research-oriented assignment where students will study, implement, and evaluate an existing work. Each student will work individually -

1. **Identify a research paper** at the intersection of algorithms, data management, and responsible AI
2. **Design and implement at least one core algorithmic solution**
3. **Evaluate the solution** using at least two real datasets
4. **Prepare a report and presentation** summarizing the research question, methodology, findings, and directions for future work.

Final Project. The final project allows students to demonstrate mastery of course concepts by conducting an in-depth investigation into an area of responsible data management. Students may choose one of three formats:

Survey Paper – Provide a comprehensive review of the state of the art in a focused area (e.g., fairness in query processing, differential privacy in databases, explainability in data systems). The paper should identify key methods, open challenges, and future research directions.

Experimental Analysis Paper – Implement and evaluate existing algorithms related to responsible data management. Students should design experiments, use real or synthetic datasets, and provide critical analysis of scalability, accuracy, fairness, privacy, or efficiency trade-offs.

Research Paper – Students may propose a novel problem in responsible data management and develop an original algorithmic approach or framework to address it. Contributions can take the form of theoretical results, prototype implementations, or hybrid methods, supported by either empirical experiments or formal analysis.

Deliverables:
A project proposal (2–3 pages) outlining the topic and plan.
A final written report in research paper format (10–15 pages).
A short in-class presentation summarizing the project.
Projects are expected to be of publishable quality, with scope appropriate for a doctoral-level course.

*I reserve the right to make small adjustments to grade weights, or to add small assignments as the need arises.
Class Schedule: (may change)

Week	**Activity**	**Topic**
1	**Instructor presentation**	**General premise of fairness, explainability, – listing key papers**

2	**Midterm project proposal**	
3	**Student 1, Student 2**	
4	**Student 3, Student 4**	
5	**Student 5, Student 6**	
6	**Midterm project presentation (20 min per student)**	
7	**Instructor presentation**	**Fairness in light of generative AI**
8	**Student 6, Student 5**	
9	**Student 4, Student 3**	
10	**Student 2, Student 1**	
11	**Instructor presentation**	**Privacy, Accountability**
12	**Final Project Proposal**	
13	**Instructor presentation**	**Emerging topics**
14	**Instructor presentation**	**Emerging topics**
15	**Midterm project presentation (20 min per student)**	

Grading Scale
A: 93% and above; B+: 86%-92.9%; B: 78%-85.9%; C+: 70%-77.9%; C: 60%-69.9%; F: Below 60%.

Academic Integrity *Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the code of Academic Integrity policy that is found at: NJIT Academic Integrity Code.*

Please note that it is my professional obligation and responsibility to

report any academic misconduct to the Office of the Dean of Students. Any student found in violation of the code by cheating, plagiarizing, or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Office of the Dean of Students at dos@njit.edu."

Generative AI: Allowed, with Conditions and Citation/Acknowledgment

Student use of artificial intelligence (AI) is permitted the final project only. It is not permitted to be used in the following class presentation and final project. Additionally, if and when students use AI in this course, the AI must be cited as is shown within the *NJIT Library AI citation page* for AI. If you have any questions or concerns about AI technology use in this class, please reach out to me prior to submitting any assignments.

Student Absences for Religious Observations: NJIT is committed to supporting students who observe religious holidays. Students must notify the instructor in writing of any conflicts between course requirements and religious observances by the end of the second week of classes, and no later than two weeks prior to the anticipated absence. Reasonable accommodations will be provided to allow completion of missed work (assignments, exams, quizzes, or other coursework) within the term. Students will not be penalized for properly documented absences, and confidentiality will be maintained. For questions or additional guidance, please contact the Office of Inclusive Excellence at **inclusiveexcellence@njit.edu**