CS.5200
Database Management Systems

Term: Summer 2 2024
Instructor: Prof. Schedlbauer
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Phone: via Teams
Office: Virtual on Teams
Hours: See Canvas & By Appointment
Room: See Registrar

> Students are expected to be familiar and fully understand all policies and rules set forth in this syllabus. Failure to properly read the syllabus is not a valid excuse for missed work, submissions, or information.

Course Description

This course presents the database design process practiced when creating a relational database; it also presents the relational database management system's architecture as well as the fundamental ACID properties of a relational database management system. Extended entity-relationship models will be generated and represented using the Unified Modeling Language (UML) notation. SQL will be studied in detail. Relational algebra and its relationship to the SQL language will be presented. Advanced topics include triggers, stored procedures, indexing, and fundamentals of transactions, concurrency and recovery. The course will also include an introduction to NoSQL databases and provide students the opportunity to compare SQL to NoSQL. Students will define a database project that includes the design and implementation of a database as well as an application for interacting with the database.

Prerequisites

While the course does not have specific prerequisites, students are expected to have reasonably strong experience in programming in at least one modern programming language such as C++, Java, Python, Visual Basic, or R. The actual programming language used in the course is set by the instructor and is commonly R. Some understanding of key concepts in computer science at the undergraduate level, including computer systems, operating systems, multi-threaded programming, networking, discrete mathematics, data structures, and algorithms, is presumed.

Learning Outcomes

Upon completion of this course, the learner will be able to:

- create an operational relational database from an analysis of a domain
- express a data model using UML and ERD
- write complex relational queries in SQL
- construct analytical databases using star and snowflake schemas
- abstract queries with relational algebra and domain relational calculus
- build client/server applications using embedded SQL combined with stored procedures and triggers
- understand the architecture of database engines including query planning and execution
- define data storage infrastructures, including RAID
- explain data storage solutions using partioning, sharding, and distribution
- manage concurrent access to data using transactions and concurrency control protocols

Required Texts

The textbook for this course is *Introduction to Database Systems by ITL Education Solutions Limited, Pearson India , November 2008, ISBN: 9788131731925*. This textbook is available at no cost to matriculated students at all Northeastern Campuses through the O'Reilly Learning portal. For more information on how to access the textbook, see Course Resources, Text Book, Tools on Canvas.

The materials are supplemented and augmented with numerous videos, pre-recorded lessons, demonstrations, code walks, and thoughtfully curated external content.

Office & Tutoring Hours

Office and tutoring hours as well as information about teaching assistants and tutors are listed on Canvas.

Schedule & Agenda

1. Database Systems, Use, and Organization
2. Domain and Data Modeling
3. Relational Database Design & Normalization
4. Realizing a Relational Database Schema
5. Data Retrieval with SQL
6. App Dev with Stored Procedures and Triggers
7. Practicum I
8. Query Abstraction with Relational Algebra and Calculus
9. Query Processing and Indexing
10. Concurrency, Transactions, and Recovery
11. Database Architectures & NoSQL
12. Data Warehousing and OLAP
13. Practicum II

Learning Assessment

Achievement of learning outcomes will be assessed and graded through:

- Assignments (50%)
- Practicums (45%)
- Practicum Reviews (5%)

The two lowest assignment grades are dropped. All graded items within a category are weighted equally.

Practicums are small projects that require substantial individual effort (about 15-20 hours) and a dedicated week is provided for each practicum. The practicums are required and must be submitted. The one-on-one reviews with a grader are required. Failing to demo or failing to appear for a scheduled review of a practicum will result in a 0 for the practicum.

Any request for late submission, special considerations, or exceptions can generally, out of fairness and equity, not be considered. Of course, if there unusual circumstances for extended absence from a course, your adviser or WeCare should contact us.

Mark your calendar with due dates as soon as a module is published and set reminders. Be particularly mindful of due times (AM versus PM) and time zones (all due times are ET/Boston Time although your configuration of Canvas may be for a different time zone).

When completing assignments, you may use any material you wish from the course, web, slides, readings, lessons, *etc.*, but you may not work with anyone or engage a third party (web site, tutoring service, someone else, *etc.*) unless explicitly stated in the assignment instructions. If you use any code or materials in an assignment, include a reference to the material. Any violation of these rules is serious and will result in a F for the course, a referral to OSCCR and the Khoury Academic Integrity Committee, and potential expulsion from the program and the University.

Grading

The course requires a 70% overall score to pass the course with an additional requirement that the average of all practicums is at least 70%. In other words, you cannot pass the course without getting a passing grade on the practicums.

Learning Methodology

For each module, students are expected to:

- Review each module's learning objectives
- Complete all assigned readings
- Complete all lessons and activities
- Participate in any required discussions or group activities
- Complete and submit any and all graded work by the due date
- Complete any ungraded practice exercises
- Participate in any recitation sessions or view the recording

Required Time

A typical 4-credit graduate course in the Khoury College of Computer Sciences requires an average of 12-15 hours of work per week. Over a 14 week semester that amounts to about 200 hours of work which includes attending lectures and recitations, completing readings, learning activities, assignments, group discussions, case studies, practicums, among other work. Less prepared students or those with less programming experience will require additional time each week. If the course is presented over an eight-week compressed summer session, the work increases to double the number of hours per week. If you cannot make that commitment, please reconsider your plans.

If you plan to travel during the term, schedule interviews, or attend private functions, you are still responsible to submit all work on time – be sure to manage your schedule and work ahead.

Students who succeed take their studying seriously. They are less likely to say, "Oh, I'm done. I just need to Google the assignment solution. I don't need to read the material." That strategy may have worked for some of you before, but it rarely works in Khoury or at Northeastern.

Use of AI Assistants

We understand that there are numerous resources available to assist you. In fact, we encourage that you use resources on the web and AI Assistants such as Copilot, Bard, ChatGPT, among others. While you may use AI assistants as needed we require that you let us know which ones you used and for what and that you add clear acknowledgments in your code. Furthermore, you are responsible for knowing how your code works and you must be able to explain any code you copied or borrowed. So, while you may use assistants for inspiration and to get you started, you must learn from what you copied and you must understand what you copied.

Social Network Connections

I do not connect with students on any social network but may consider connecting on select networks once the student has graduated.

Recommendations

Recommendations for coop, employment, or further studies (MS or PhD program) are meaningful and I would like to help when I can. However, I cannot provide a recommendation unless you have come to at least five office hours so that I can get to know you, you have earned at least an A- in the course, and you discussed your project or at least the last practicum with me. Should you wish to ask me for a recommendation letter or reference, please check with me well ahead of time, and email me your CV, resume, and other supporting documents, in addition to reminding me when we spoke, what you did as a project, and during which term you took a course with me.

Grading Scale

Score	Letter	GPA	Qualitative Meaning
95% and above	A	4.0	Outstanding and exemplary work without flaws
90% - 94.9%	A-	3.7	Excellent work with only a few but very minor flaws
87% - 89.9%	B+	3.3	Very good work with a several minor but immaterial flaws
84% - 86.9%	B	3.0	Good and solid work having only immaterial flaws
80% - 83.9%	B-	2.7	Reasonably good work but significant flaws
77% - 79.9%	C+	2.3	Adequate work; some significant flaws
73% - 76.9%	C	2.0	Adequate work; several significant flaws
70% - 72.9%	C-	1.7	Barely adequate work; several significant flaws
Less than 70%	F	0.0	Inadequate with significant flaws

Participation

Interaction occurs primarily through the University's Microsoft Teams platform, although any graded peer group discussions are on Canvas. As part of each module, students are expected to:

- Complete all lessons and assigned work on time and within guidelines
- Be professional, courteous, and respectful in all communication
- Post their questions in the designated Teams channel
- Read all messages posted to Teams and Canvas daily
- Respond or comment on other students' posts
- Join the live recitation sessions or watch the recording

> *Copying from the web or third parties without citation on any graded item is an academic integrity violations and results in a grade of 0 and a potential referral to OSCCR.*

Posts, questions, or responses on Teams are not graded and direct copying even without citation is allowed – but for those posts only.

Code of Conduct

As a student in this course, students are expected conduct themselves at all times in a professional and respectful manner towards fellow students, instructors, teaching assistants, observers, graders, and anyone within or outside the course, College, University, and the community-at-large.

Specifically, students agree to:

- be speak in a respectful manner to instructors, teaching assistants, and graders
- resolve disputes over grades in a civil and constructive manner
- regard grades as a reflection of their mastery of the material, their commitment to timely submission or work, and the degree of mastery of the subject, and not as a token that is negotiated
- do all work on their own and to be students in the strictest sense of the word, *i.e.*, one who studies and is an attentive and systematic observer
- not disparage others
- do all work in a timely fashion and when assigned
- to carefully read all assigned and provided material, study all lessons, and complete all graded and ungraded assignments, practices, laboratories, practicums, projects, reflections, quizzes, examinations, and any other exercises
- use inclusive language and avoid actions that could be perceived as discriminatory or offensive
- embrace and respect the diversity of the class, which includes but is not limited to race, gender, age, sexual orientation, primary language, and cultural background
- attend all classes, recitations, except in cases of illness or emergencies, or to view recordings of the same as soon as being made available
- refrain from recording classes, recitations, chats, emails, or interactions, or sharing course materials without explicit permission by the instructor
- respond to surveys and polls, including any and all course evaluations

Egregious violations of the code of conduct may result in disciplinary actions, including reporting to University or College disciplinary committees and notation on the student's academic record. Violations pertaining to learning may result in a reduction in scores or course grade.

Communication

Communication between instructor, teaching assistants, and students is in English and is through

- E-mail via the Canvas distribution list
- Announcements posted on Canvas
- Notes and clarifications posted on Teams
- Private chats on Teams

Students are responsible for joining the class group on Teams and for ensuring that all email addresses are properly configured. Missing an email that is sent to *Spam* or not enrolling in Teams is not an excuse for any missed work or information.

You must check your Teams messages daily. We recommend that you install the Teams up on your mobile devices (phone, tablet) and turn on notifications so that you do not miss important messages or announcements.

To contact the instructor and the teaching assistant use Microsoft Teams as that ensures that communication is delivered and does not accidentally get filtered into "spam" or "junk" folders.

Office Hours and Assistance

Office hours are times where students can seek individual assistance from the instructor and the teaching assistants.

The times of all office hours for the instructor and the teaching assistants are published on Canvas. Use the office hours of teaching assistants to get help on assignments and with programming questions.

For individual help or questions on matters regarding the materials or assignments that cannot be answered by the teaching assistants or that cannot be answered as a post on Teams, visit the instructor during office hours.

Assistance should first be sought by posting on Teams so that the answer is available to everyone. I answer questions posted on Teams in the morning and in the late afternoon, Monday through Friday, and Saturday morning. I cannot be available Sundays and Holidays.

Note that office hours are for you to get clarification on material and specific questions on assignments, but please do not ask me or the teaching assistants to review your assignment prior to submission, *i.e.*, a "pre-grading".

To contact the instructor and the teaching assistant use Microsoft Teams as that ensures that communication is delivered and does not accidentally get filtered into "spam" or "junk" folders. Use Teams and do not email me or the Teaching Assistants.

Submission of Work

To receive full credit, all work for the course is expected to be completed by 11:59pm ET (Boston Time) on the due date and must be submitted via Canvas. To foster fairness, all deadlines and due dates are to be strictly observed. Any graded work that is submitted after the due date is accepted with a 2.5% penalty for each day late until the solution is published or discussed in class, or until a date and time set by the instructor.

Submissions via email, as attachments to Canvas comments, Canvas Inbox messages, Teams, or through any manner other than via the Canvas assignment submission mechanism cannot be accepted under any circumstances. Any submissions received this way are not graded.

When submitting, attach all required files or documents along with explanatory comments. Once an item has been graded, students will be able to view the grade and feedback via the grade book. Multiple submissions are accepted but only the last submission will be considered. After submission, check that your submission was successful.

All work is expected to be done in a professional and timely manner and must be written in English free of grammatical and spelling errors or a reduction in points will result. Using any third party material, ideas, or direct quotes must be properly cited. Anything directly copied must be placed in quotes and must be cited using either APA or MLA formats.

Be sure to frequently backup your work onto a cloud drive (OneDrive, Google Drive, Dropbox, S3, or similar; all students have a subscription for cloud storage on OneDrive and Google Drive through the University). You may not backup to a public GitHub repository. Alternatively, email your work and associated files to yourself frequently. Not meeting a deadline when work is lost because it was not backed up is not an acceptable excuse.

Be sure to have an alternative way to complete assignments in case of computer failure, *e.g.*, borrow a computer, get a loaner from the University (Library or your Department), use a public computer on campus, use a secondary computer such as a ChromeBook, use *posit.cloud*, use *repl.it*, or a virtual machine on Azure, Google Cloud, or AWS,

or similar.

Late Submissions

Work submitted past the date when solutions are published cannot be accepted, even when the student registered for the class after the start of the term. While late submissions will not receive credit, a student may requested that they be graded for feedback.

Any requests for extensions cannot, out of fairness to all students, be considered. All due dates are set so that there is sufficient time to complete the work. Additionally, there is time for late submission and some assignments are “dropped” which allows for travel, work, illness, personal issues, and other circumstances.

Grading Disputes

If there is a material grading dispute, the student must contact the Grader who graded the work before contacting the instructor. When making any request for a revision of a grade, the student must clearly specify why the item was graded incorrectly, point to a correct solution, and state why their solution is correct.

Re-Grade Requests

A student may request a re-grading of a graded item by the instructor if (a) the student contacted the Grader first and the dispute cannot be resolved, and (b) the student provides a clear description as to why their solution is correct and that the loss of points is material.

Regrade requests must be made within 72 hours of the graded item’s grade being published on Canvas. Regrade requests must be made via Teams directly to the instructor and only after disputes have been addressed through the Grader first. The re-grade request must be accompanied with a detailed explanation of why the assigned grade is incorrect and all correspondence with the Grader. The points in dispute must be material. In a re-grade, the instructor will not consider any prior grading of an item and will grade the item anew which may significantly increase or reduce the grade. The grade given after a re-grade is non-disputable and will replace any prior grades.

Accommodations

If you require any special considerations to support your learning, visit the DRC. Should the DRC approve accommodations, provide the instructor with a letter so that appropriate adjustments can be made as long as they are feasible and do not affect other students negatively. Unfortunately, we cannot provide any special accommodations unless there is a letter from the DRC. We do require that you provide us with 24 hour notification if you need extended time for a quiz, an assignment, or the final exam; an email to the instructor with a message on Teams is sufficient. Extensions past the date at which solutions are published or discussed cannot be accommodated.

Academic Integrity Policy

The University views academic dishonesty as one of the most serious offenses that a student can commit and imposes appropriate punitive sanctions on violators. Here are some examples of academic dishonesty. While this is not an all-inclusive list, we hope this will help you to understand some of the things instructors look for.

> Any incident of academic misconduct will result in a 0 for the graded item, a report to OSCCR, a report to the applicable Academic Integrity Committee, and a two-letter reduction in the final course grade or an F if it is on the final exam or especially egregious.

While you may discuss your assignments with others in the current class, we require that all of your work submitted for grading be your own (unless specifically stated otherwise, *e.g.*, group work) and not copied in whole or in part from anyone (including AI or AI Assistants).

Students are expected to read and understand the Northeastern University Academic Honesty Policy (https://osccr.sites.northeastern.edu/academic-integrity-policy/).

In general, unauthorized collaboration is any collaboration that has not been specifically authorized.

The following is excerpted from the University's policy on academic integrity; the complete policy is available in the Student Handbook.

- **Cheating** – intentionally using or attempting to use unauthorized materials, information or study aids in an academic exercise, or paying a third party, person, or firm to produce or edit work for the student
- **Fabrication** – intentional and unauthorized falsification, misrepresentation, or invention of any data, or citation in an academic exercise
- **Plagiarism** – intentionally representing the words, ideas, or data of another as one's own in any academic exercise without quotation and without providing proper citation; that includes the use of online posts, blogs, and prior term's submissions or solutions
- **Unauthorized collaboration** – instances when students submit individual academic works that are substantially similar to one another; while several students may have the same source material, the analysis, interpretation, and reporting of the data must be each individual's independent work.
- **Participation in academically dishonest activities** – any action taken by a student with the intent of gaining an unfair advantage, including but not limited to copying work, submitting someone else's work, or submitting previously published solutions
- **Reusing Work** – submitting work submitted for credit or a grade in another course in the current or a prior term or at this or another institution
- **Facilitating academic dishonesty** – intentionally or knowingly helping or attempting to violate any provision of this policy; sending files to another student; allowing a student to use your own computer
- **Impersonation** – working on behalf of another students or allowing someone else to represent a student online, in discussion groups, in classes or sessions, or exams
- **Sharing** – sharing – whether for profit or not – materials, assignments, solutions, exams, exam question on sharing sites, including but not limited to CourseHero, Quora, and Chegg
- **Sharing of URL** – sharing of classroom URLS (*e.g.*, Zoom or Teams meetings) with anyone not currently enrolled in the course
- **Unannounced recording of conversations** – fully or partially recording audio, video, or chats in discussions, channels, or any online forum

- **Sharing of recordings or posts** – sharing portions or excerpts of any class recordings, posts, or other class communication with anyone not presently enrolled in the class
- **Sharing of login credentials** – sharing of username and/or password to allow anyone other than the students with those credentials to access any course resources
- **Misconduct** - any misconduct that is counter to the values of Northeastern University, *e.g.*, social gatherings during a pandemic, not using masks in areas where required, use of inappropriate language or activities
- **AI Assistants** - any use of AI Assistants, where allowed and not specifically prohibited, must be acknowledged and you are responsible for ensuring the accuracy of any AI generated content. Directly copying answers generated by AI is not allowed.

Make certain that you are completely familiar with all policies, rules, and guidelines for this course. If in doubt, ask your instructor.
