

Course 1-02-322: Database Systems

Semester Project

Project Ideas

Michael J. May

Due October 25

The semester project for the database systems course must be big enough to generate work for the whole semester. Here are a number of project ideas that include an appropriate amount of work. There are four ideas which are more or less fleshed out and seven which are just topic ideas. There are also some projects which were executed by students in previous years. The projects listed below are large and are meant to give a good idea for the scope of a semester project. Students are **not** expected to produce a commercial product, but should show ingenuity in selecting an *interesting and challenging project* to implement.

Students may select one of ideas from the list or take another topic entirely.

Note: Students who choose to use a database topic which they are concurrently working on (or have worked on) as part of an outside job may use the topic on the following conditions (subject to the approval of the instructor):

1. The topic is sufficiently challenging and ambitious
2. There is no substantive information about the work which is secret or may otherwise not be disclosed to the instructor
3. The student(s) complete all of the work on the project themselves, without help from outsiders.

0.1 What you must turn in by October 25

Regardless of choice, students must submit the following information:

1. The name or names of the student(s) working on the team.
2. The topic choice for the team.
3. A short summary (one or two paragraphs) which describe the scope of the intended project and what some of the main features of the project will be.

The last item is meant to be a reality check to ensure that what the team has selected a feasible project.

0.2 Response from the Instructor

I will review all of the project topic submissions and give a response by October 28 by email.

1 Radio Network

Create a database system for managing a cellular radio network. The database will include information about the configuration of the cellular network. The important aspects of the network to record are the radio sites (towers), cellular cells (antennas), and their neighbor relations (connection between two cells).

1.1 Requirements

The following are basic requirements for the cellular radio network system. The students must elaborate on them to make the picture more complete.

1. Support for 2G, 3G, and 4G network technology with different combinations of 5 fields:

For 2G:

- (a) Site name
- (b) Site height
- (c) Antenna type
- (d) Channel
- (e) Identification code

For 3G:

- (a) Site name
- (b) Site height
- (c) Antenna tilt
- (d) Frequency
- (e) Scrambling Code

For 4G;

- (a) Site name
- (b) Site height
- (c) Frequency
- (d) High speed data activated (boolean)
- (e) Video transfer speed

2. Each cell keeps track of the number of successful calls and dropped calls. The ratio between them is used to calculate how efficient the cell is.
3. Support for two different types of sites/cells in each technology.
4. Sites contain multiple cells.
5. Each cell can have up to a certain number of neighbors which are nearby.
6. Cells can be active or inactive, depending on whether they are currently broadcasting.

The database must include prepared queries that enable the users to do the following operations at a minimum:

1. Retrieve cells based on their configuration properties, including between technologies based on common fields.

2. Update information about sites based on any of their fields.
3. Add new sites, checking that no two sites have the same name.
4. Activate or deactivate cells based on any field setting.
5. Add or remove neighbor relations between cells based on any field setting for any technology.

There are at least four levels of users who will want to see the status of the network. They must be given separate views to enforce security requirements and give summaries for a higher level picture of the network.

1. Views for managers to see the status of the network.
2. Views for radio engineers to see subsets of the sites and cells, based on a specific “zone of access” that they have.
3. Views for the CEO to see the progress of the network, its growth, and number of connections.
4. Views for technicians who are to see the status of only specific technologies and sites based on their expertise.

1.2 Reports

The database should automatically generate reports about its status to help the engineers keep it working correctly:

1. Lists of active and inactive cells and sites with inactive cells.
2. Lists of cells with particular configurations.
3. Lists of sites with cells that have different configurations.
4. Lists of cells that have more or less than a certain number of neighbors.
5. Lists of cells that have a successful-to-dropped call ratio less than a certain amount.

2 Library Information System

Create a database to help a college library maintain its book collection, members, fines, and book orders. The important aspects of the system include support for multiple types of resources, including books, CDs, DVDs, magazines, journals, and online service subscriptions. The library has a quarterly budget which is used to purchase new materials and services. The database is used to keep track of the usage of the budget, how it is spent, and how it is allocated. Students, faculty members, and outside readers are allowed to use the library’s resources, but in different ways. The library’s main function, lending materials to readers, is supported as well, tracking which materials are available and when they are due to be returned.

2.1 Requirements

The college library has four types of users who must be supported in the system, with different attributes:

Students Students receive library accounts automatically when they begin their studies at the college. They lose their account when they graduate. Students are allowed to borrow an unlimited number of books or magazines at a time, but are limited to having out 5 CDs or DVDs at a time. Books or magazines can be checked out for 21 days at a time. CDs and DVDs can be checked out for 5 days at a time. Students are allowed access to online resources paid for by the library. Student accounts are closed when they graduate, but not if there are outstanding fees or materials checked out. In anticipation of graduation, students are prevented from borrowing any materials from the library 21 days before their expected graduation date.

Faculty Faculty members receive library accounts when they are hired and lose them when they cease working for the college. Like students, faculty members are allowed to borrow an unlimited number of books or magazines at a time, but are limited to having out 5 CDs or DVDs at a time. Books or magazines can be checked out for 45 days at a time. CDs and DVDs can be checked out for 5 days at a time. Faculty are allowed access to online resources paid for by the library. Faculty accounts are closed when they stop working for the college, but not if there are outstanding fees or materials checked out.

Staff Staff members receive library accounts are hired and lose them when they cease working for the college. Staff members are limited to borrowing 5 books at a time, 5 magazines at a time, and 5 CDs or DVDs at a time. Books or magazines can be checked out for 21 days at a time. CDs and DVDs can be checked out for 5 days at a time. Staff are not allowed access to online resources paid for by the library. Staff accounts are closed when they stop working for the college, but not if there are materials checked out. Outstanding fees are ignored—they are simply deducted from their last pay check.

Outside Readers Outside readers may join the library for a fee and acquire the same rights as staff members in terms of borrowing books, magazines, CDs, and DVDs. Like staff members, they are not allowed access to online resources paid for by the library. Outside reader accounts are closed when the reader informs the college, but not if there are outstanding fees or materials checked out.

The library system must keep track of the following resources which the library provides:

Books Books are kept in the library on shelves, organized by a sorting number. The system must track the book's name, author(s), publisher, publication date, edition, language, and ISBN. The library may have multiple copies of a single book in which case a "copy number" attribute must be kept as well. Books have a price which is the amount that it costs the library to buy a new copy of the book.

Magazines Magazines are kept in the library on shelves, organized by name. The system must track the magazine's name, publisher, and language. The library maintains subscriptions to magazines, so information about the expected expiration of the subscription must be kept as well. Magazines are priced by their subscription per year, the amount that the library pays quarterly to receive the magazine.

CDs and DVDs Music CDs and Video DVDs are kept in the library on shelves, organized by name. The system must track a CD's name, artist, label, release date, and language. The system must track a DVD's name, director, main actor, release date, and language. The library may have multiple copies of a single CD or DVD in which case a "copy number" attribute must be kept as well. CDs and DVDs have a price which is the amount that it costs the library to buy a new copy of the CD or DVD.

Online Resources Online resources are subscription based services that the library purchases for its students and faculty. The system must track an online resource's name, publisher, and URL. Students and faculty members are granted access to the services using their college login ID (not part of the library's database). The library must track the total number of students and faculty members who are granted access to the online resources. Online services have a price which is the price per user that the library must pay per quarter per user.

When users borrow materials from the library, the database is updated to reflect that the material is no longer on the shelf. The material is assigned a due date based on the type of user and the type of material. If the material is not returned on time, a late fee of 10 shekels is added to the user's account balance. If the material is not returned within twice the allotted due date, a replacement fee for the material is added to the user's account balance as follows:

- Books, CDs, DVDs: The full price of the material minus 10 shekels.
- Magazines: Either (A) one quarter of the price of the quarterly subscription or (B) 10 shekels, whichever is larger.

Users can pay their account at any time to reduce their outstanding balance. Once a user has been assigned the replacement fee, the material marked as *lost* and does not count against their maximum borrowing limits for the material type (if any).

The database must include prepared queries that enable users to do the following operations at a minimum:

1. Retrieve a list of books, magazines, CDs, DVDs, or online resource by any of their identifying fields and based on whether they are on the shelf or checked out.
2. Retrieve a list of users who have non-zero account balances.
3. Retrieve a list of items that a user has currently checked out, including or excluding lost items.
4. Retrieve a table of the prices of materials that are lost.
5. Update the checked out/available/lost status for any book, magazine, CD, or DVD in the system by any of the relevant identifying fields.
6. Update a user's account information.
7. Update the account balance of all active users in the system, accruing fees for overdue or lost items.

There are at least three levels of users who will want to see the status of the database. All users are allowed to view the available/checked out/lost status for any book, magazine, CD, or DVD. Additionally, they must be given separate views to enforce their access rights to other parts of the system:

1. Users are allowed to see their account status and balance, their account information, and the items that they have checked out.
2. Library staff are allowed to see the account status and balance for any user and update it. They are also allowed to update the checked out/available/lost status for any material.
3. Library directors are allowed to see the prices for all materials and update them. They can see a summary of the users in the system, how many there are, and what their account balances are.

2.2 Reports

The database should automatically generate reports about its status to help the librarians keep track of their stock:

1. Lists of checked out and lost books.
2. Lists of users with balances on their account.
3. Reports of how much money the library must spend in the quarter to replace all missing materials and cover the costs of all magazine subscriptions and online services (don't take the account balances into the calculation here).
4. Lists of students about to graduate.
5. Lists of new faculty members, students, and staff who have been added to the system recently.

2.3 Gym Membership and Maintenance System

A gym has recreational facilities for people to use, both individually and in organized classes or groups. The gym has a swimming pool, a weight room, and a track which are available for use, but must be maintained. A database for the gym includes information about gym members, guests, classes, class registration, and availability of facilities due to classes or maintenance. The gym offers two kinds of memberships - (A) silver membership which gives access to the pool, weight room, and track and (B) gold membership which also gives access to all classes which take place. Silver members or non-members may also attend classes, but must pay extra for them.

3 Requirements

The gym allows three types of users to use its facilities:

Non-Members Individuals may use the gym's facilities by paying a fixed per visit fee of 10 shekels. Non-members may use the swimming pool, weight room, or track if there is no class going on at the time and they are not under maintenance. Non-members may join classes for a fixed fee of 100 shekels which allows them to attend the class (*i.e.* use the swimming pool, weight room, or track during the class time).

Silver Members Silver members pay a flat monthly fee of 100 shekels. The fee allows them to use the swimming pool, weight room, or track at any time provided that there is not a class going on at the time and they are not under maintenance. Silver members may join classes for a fixed fee of 80 shekels which allows them to attend the class (*i.e.* use the swimming pool, weight room, or track during the class time). Silver members may change their membership to gold at any time for an extra fee of 100 shekels.

Gold Members Gold members pay a flat monthly fee of 200 shekels. The fee allows them to use the swimming pool, weight room, or track at any time provided that there is not a class going on at the time and they are not under maintenance. Gold members may join classes for free which allows them to attend the class (*i.e.* use the swimming pool, weight room, or track during class time).

Classes are scheduled in the gym on a monthly basis. A class includes the following attributes: name, instructor, facility (swimming pool, weight room, track), maximum number of students, minimum number of students, meeting time (start time, end time, day of the month). At the beginning of every month, the classes are renewed, potentially changing time, location, and meeting day. Users can register for classes at any point during the month provided that there is space left in the class. Users can also unregister from a class at any time during the month, freeing up a spot.

All people who use the gym are stored in the database, whether non-members, silver members, or gold members. Each user has an account balance which is updated based on course registration, monthly membership dues, or visits (as appropriate).

Periodically the gym must undergo maintenance. The database should keep track of the schedules for maintenance for the pool, weight room, and track. When maintenance is started and finished, the database should be updated to update its status and record whether scheduled maintenance has been performed.

3.1 Reports

The database should automatically generate the following reports about its status to help gym managers and employees keep track of membership and classes:

1. List of the most popular classes and their attendances.
2. List of all members and non-members.

3. List of all classes that have more or less than a certain number of students.
4. Maintenance records for the past 12 months for the pool, weight room, and track.
5. Total monthly income for the gym, including fees from memberships and classes.

4 Bus Scheduling and Routing System

A city runs its bus system using a database which maintains information about routes, bus types, capacity, and schedules. The bus system include three types of busses: mini-busses for small routes, large busses for regular routes, and coaches for intercity routes. The database maintains information about the busses the city owns, where they are routed, and how their schedules are prepared. The job of the database is to ensure that all busses are used as much as possible and that the maximum number of routes can be supported while staying on schedule.

4.1 Requirements

The city maintains a pool of busses which are of three types:

Mini-Bus A mini-bus can hold a small number of people and is used for short routes or routes with small riderships.

Regular Bus A regular bus can hold twice as many passengers as a mini-bus. It is used for regular routes in the city.

Coach A coach bus holds the same number of passengers as a regular bus, but is used for inter-city routes.

The city has six neighborhoods and a downtown area which must be connected by bus routes. It should be possible to get from each neighborhood to the downtown area and as well as to any other neighborhood. The city is not expected to grow that fast, so the number of neighborhoods may be assumed to be fixed. The number of routes and their paths may change over time, though.

There are four suburbs nearby which run inter-city lines to city. The city's bus service maintains routes between the suburbs and the city, but not between the suburbs. The routes to and from the suburbs can go to any particular neighborhood or directly to downtown.

The route manager's job is to design bus routes that best serve the customers. Each route will maintain a record of the average number of riders per bus on the route over the course of a week. The route manager should be able to enter in information about the weekly average and then use the database to see whether new routes should be added and whether the current bus assigned to the route is sufficient.

The schedule manager's job is to choose times for buses on a route that best fit its length and the expected traffic. The schedule manager will enter information into the database about the starting and ending time for each route over the course of the day. Using the schedule information in the database, the schedule manager can see when busses are being used, sitting idle, or are not being overworked.

4.2 Reports

The database should automatically generate the following reports about its status to help gym managers and employees keep track of membership and classes:

1. A list of the busses currently used by the city and the number of routes that each bus runs.
2. A list of the neighborhoods directly reachable from any particular neighborhood, downtown, or suburb.
3. A list of the schedule for any particular bus or route.
4. The most and least used busses in the city.

5. A list of routes that are very near or very far from capacity on a weekly basis and are therefore candidates for changing their currently assigned bus.

5 Airport Flight Information System

A database to track plane take offs, landings, gates, and maintenance. The database should keep track of when planes are scheduled to take off and land and include functionality to deal with delays and maintenance of planes. There should be reports available to show flight schedules to passengers, pilots, and airport authorities.

6 Travel Agency System

A database for tracking flights, hotels stays, and cruise ship journeys sold as part of a travel package by a travel agency. Customers may purchase flights which have multiple legs and destinations as well as hotel stays. The database must track each passenger with a Passenger Name Record which allows tracking of all flights, hotels, and cruise journeys ordered by the passenger. Additional reporting for the travel agency management is included, showing sales figures and popular combinations of travel packages.

7 Trucking Tracking and Scheduling System

A system to help a trucking company keep track of its fleet of trucks. The trucks can be used for moving goods around, moving people between houses, or making deliveries. The trucking company maintains a staff of drivers to drive the trucks and who have specialized licenses to do particular tasks.

8 Taxi Service Scheduling System

A taxi company offers taxi service within a city, including shared taxis (sherut), special taxis (monit), and bus services (hasaot). The taxi company database must keep track of all of the vehicles in the fleet, all of the drivers, the routes they take, and the income that they generate.

9 Home Equipment Store Management System

A home equipment store stocks a large number of items that it sells to customers. It must keep track of its suppliers, their delivery schedules, and the stock in the store. The home store also offers installation of items and service for the products that it sells. The database should support tracking of inventory, service personnel, customers, suppliers, and service requests.

10 Restaurant Supplies and Service System

A restaurant supplies and service company supplies food, dishes, plastic ware, and cleaning supplies to many restaurants in a city. The database for the company must keep track of the company's stock, its suppliers, its customers, their needs and schedules for delivery. Food products must be handled specially based on their expiration date to ensure that they do not rot.

11 Furniture Factory Management System

A furniture manufacturing company produces chairs, closets, beds, couches, and dining room sets for people's houses. The database for the company must keep track of the types and models of furniture currently produces, the status of the manufacturing line, and the expected date of delivery for orders.

12 Construction Company Management System

A construction company builds houses, stores, and office buildings in a region of the country. The construction company's database must keep track of schedules projects, man power, construction supplies, and the costs of supplies. The construction company manager should be able to tell how busy the staff is, when a new project can be scheduled, and what the cost of producing a new building is to ensure that the company stays profitable.