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# CIS 450/550: Database and Information Systems

## Course Project Guidelines

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# A. OVERVIEW

## 1. Description

**The goal of this project is to identify at least two large, overlapping datasets of interest, import and integrate them into a SQL relational database, then create a web-enabled application of your own choosing over the database. You will work in teams of four, and you can use any SQL database technology and any web-development stack.**

The objective of this project is to assess whether you're able to apply the concepts you're learning about in this course to solve unstructured problems with limited hands-on guidance. Specifically, the project will require you to practice:

- wrangling and cleaning data,
- performing entity resolution (ER),
- designing schema,
- writing SQL queries,
- choosing database indexes,
- designing a web application,
- optimizing SQL queries.

If you use this as an opportunity to build something you're proud of, you are welcome to use the final product to demonstrate your skills to potential employers.

We also want you to enjoy completing the project. This is one of the most open-ended projects in the Penn computer science curriculum. You can build just about any game, application, or website you want, as long as it's built on top of a SQL database and has multiple distinct pages. For example, past students have built trading card games, recipe recommendation platforms, and many other interesting apps. So we encourage you to have fun with it and be creative. Check out the resources section for more inspiration.

In this document, you will find deliverables you'll produce while completing the project, each project milestone described in detail, the grading criteria and several sources of extra credit, and several resources that might benefit you, including dataset sources, descriptions of past students' projects, and links to useful tools.

You will also be assigned a TA as a project mentor, who will be your primary point-of-contact on staff for questions about your project. You may also post your questions relating to this project on Piazza. Good luck and have fun!

## 2. Deliverables

The table below provides a brief description of each deliverable you'll need to submit to complete the project. Please see the milestone section for more detailed instructions.

**Check Canvas module Project Information and Tutorials for past project examples and video overviews of the project goals and expectations.**

*\*Milestone deliverables due dates are tentative and subject to change\**

Deliverable	Description	Milestone
<b>Project Proposal</b>	A 1-2 page document that identifies the datasets you will use, gives a rough idea of what your application may do, and demonstrates you have performed some basic descriptive analysis on the data	Milestone 1 (Oct. 11)
<b>Project Outline</b>	A 2-3 page document that describes what your application will do, explains its significance, and gives the schema your database will implement	Milestone 2 (Oct. 29)
<b>Database Population</b>	A 3NF- or BCNF-normalized MySQL database hosted on AWS RDS that contains all your data	Milestone 3 (Nov. 12)
<b>SQL Queries</b>	A list of SQL queries that can run on your database with short explanations of what each query is supposed to do	Milestone 3 (Nov. 12)
<b>Mentor Meeting and API done</b>	An informal Zoom meeting with your project mentor where you demonstrate that you have implemented some basic functionality of your application, backend API should be done and testable.	Milestone 4
<b>Final Report</b>	A 6-10 page document that thoroughly describes the problem you tried to solve, your application functionality, your database design, your query optimization efforts, etc.	Milestone 5 (Dec. 14)
<b>Application Code</b>	A zip file that contains your application code, a list of dependencies, instructions for building the app and any code you wrote to populate the database or wrangle data	Milestone 5 (Dec. 14)
<b>Application Demo</b>	A 2-4 minute screen-captured video that demonstrates your application's main functionalities and includes narration from at least one group member.	Milestone 5 (Dec. 14)
<b>Final Demo</b>	A video conference call with your project mentor, another TA, and the professor where you demonstrate functionality of your application. We use this to test edge cases and ensure your video demo wasn't heavily edited.	(Dec. 11-14)

## B. MILESTONES AND FINAL PRESENTATION

### 1. Milestone 1 - Project Proposal (Oct. 11)

Develop an initial idea.

The initial step is to select your teammates, then brainstorm ideas applications and search for datasets. Remember your application must have several distinct pages and a SQL database with at least several tables. Your datasets must be:

1. **Large** -- As a rule of thumb, your final database should contain on the order of *tens of thousands* of instances or *more* (depending on the size of each instance).
2. **Overlapping** -- Your application will need to include queries that require information from both datasets. This means the datasets need to be related and probably need to contain references to the same entities.

**Before finalizing your dataset choices, you should conduct some basic exploratory analysis (EDA).** Poke around, compute summary statistics, and try to get a sense of how clean, large, and complete the data is. These factors will affect how difficult it will be to clean/pre-process the data, create and query a database, and perform entity resolution later. We provide an introduction to Pandas--a Python library for data analysis-- in [this tutorial](#) and demonstrate how to perform EDA with Pandas in [this tutorial](#).

**Next, write your project proposal. The project proposal should contain the following:**

1. A List of group members, email addresses, and GitHub usernames
2. A Description of application/website idea
3. For each dataset you've chosen:
  - a. A 1-2 sentence description of the dataset
  - b. A link to where you found the dataset
  - c. If you're scraping the data, a description of how you will scrape it
  - d. If you're not scraping the data:
    - i. relevant size statistics (e.g. For a table, mb/gb, number of rows, and number of attributes. For a graph, mb, number of nodes, and number of edges)
    - ii. summary statistics of several attributes (e.g. report mean, standard deviation)
4. A list of at least 5 queries (in natural language) you could write for your datasets. Some of these should require complex SQL (aggregations, subqueries, joins, etc.)

**Milestone 1 Submission Instructions:** One member should upload the proposal as PDF to Gradescope and add the other three members of the group to the submission as teammates.

**Based on your project proposal, we will assign each group a TA who will serve as your project mentor for the remainder of the semester.** Your project mentor will email your group with feedback on your proposal. One person should add every group member and your project mentor (see Piazza for GitHub info) to a private GitHub repository before the next milestone.

## 2. Milestone 2 - Project Outline (Oct. 29)

Detailed functionality description and schema design, and initial set up.

**In this phase, you will set up your version control environment, explain your project idea in more detail, and assign responsibilities to each group member.**

**First, make sure to create a GitHub repository and share it with your Project Mentor.**

During development, you will use the repository to share code and perform version control. Your project mentor will also use the repository during grading to review the quality of your code and ensure you haven't plagiarized any of it.

**Next, write your project outline. The outline should contain the following:**

1. Motivation for the idea/description of the problem the application solves
2. List of features you will definitely implement in the application
3. List of features you might implement in the application, given enough time
4. List of pages the application will have and a 1-2 sentence description of each page.  
We expect that the functionality of each page will be meaningfully different than the functionality of the other pages.
5. Relational schema as an ER diagram
6. SQL DDL for creating the database
7. Explanation of how you will clean and pre-process the data. [This tutorial](#) demonstrates how to do simple pre-processing in Python.
8. List of technologies you will use. You must use some kind of SQL database. We recommend using MySQL or Oracle specifically because you will use MySQL in HW2, and we will provide guidance for setting up a MySQL database. Some groups in the past have had issues with MySQL, but Oracle is another option.
9. Description of what each group member will be responsible for

**Milestone 2 Submission Instructions:** One group member should upload the project outline to Gradescope as a PDF and add all other group members to the submission as teammates.

**IMPORTANT NOTE ABOUT AWS:** Each group member should have applied for AWS Educate, which grants \$100 in usage credits. \$100 should be enough to complete the project. But if you exceed this amount through carelessness, you will be responsible for overages. You should not publicly share your id and password or put them somewhere that they can be compromised. We had an incident a few years ago where hackers used a group's AWS Keys to deploy several EC2 instances, which generated a bill of more than \$100.

### 3. Milestone 3 - Database Population/SQL Queries (Nov. 12)

Pre-process your data, perform entity resolution, populate the database, and write queries.

Now that you have a schema, clean your data, perform entity resolution as needed (make sure your ER diagram is connected), create a database and populate it with your data. You may find the following resources useful for performing these steps (check Canvas):

1. [Processing Tutorial](#) - Interactive Google Colab notebook that demonstrates pre-processing and entity resolution techniques in Python
2. **AWS Database Set-up Tutorial** - Video segment that demonstrates how to set-up a remote MySQL database using AWS Relational Database Service (RDS).
3. **Database Connection Tutorial** - Video segment that demonstrates how to access a remote MySQL database using the command line or MySQL Workbench
4. **MySQL Workbench Tutorials** - 3 video segments that demonstrate how to create schema, create tables, and populate tables in a remote db with MySQL Workbench

Next, create a .txt file containing the following:

1. **Queries** -- A list of at least 6 small queries and at least 4 big SQL queries for your database that your application may execute. Ensure that your queries are **complex** (e.g. multiple subqueries, joins, aggregations, etc.). A complex query finds interesting insights about your given data set rather than just aggregating and displaying data.
2. **Descriptions** -- A 1-2 sentence description of what each query is supposed to do
3. **Credentials** -- Instructions and guest credentials for accessing the database

**Milestone 3 Submission Instructions:** One group member should upload the .txt file of SQL queries to Gradescope and add all other group members to the submission as teammates.

**Now, begin building your application!** Here are a few recommendations for getting started:

1. **Use the code from HW2 as a starting point.** Feel free to copy and paste it into your project directory just as long as you mention that you used it, in your final report.
2. **Before building anything, make sure you can retrieve data from your database and display it on a webpage.** This requires setting up a server, connecting it to your database, and creating one route that queries your database then sends the data to the web client. You shouldn't need to write much code for any of these steps, but if you're not familiar with web-development, putting all the pieces together can be challenging. Once you've done it once, it's easy to replicate and modify for your different features. Reach out to your project mentor early if you struggle with this step.

## **4. Milestone 4 - Mentor Meeting & API**

details to come

## **5. Milestone 5 - Final Report, Demo Video, and Code (Dec. 14)**

details to come

## **6. Live Demo (Dec. 11-14)**

details to come



## C. GRADING

### 1. Criteria

The project will be graded out of 100 points. The seven following criteria will be used to evaluate your work. The exact rubric will be released.

**1. Milestones** - (Was each milestone completed on time with clear effort?)

**2. Technical Quality** - (Does the application solve a non-trivial problem or answer non-trivial questions? Is the application robust and functional? Are the queries complex? Is the database designed well? Is the schema normalized? Was entity resolution and data cleaning performed correctly? Does the application perform interesting joins between data from different sources?)

**3. Scope** - (Does the application implement a sufficient number of features? Does the application have multiple pages? Does each page interact with a database? Are the datasets large?)

**4. Presentation and Report** - (Is the final report written using clear and concise language and correct grammar? Is the final report well-organized and easy to read? Does the final report make use of charts and tables when appropriate? During the video demo, is the narrator easier to hear and understand? Is the information presented accurate?)

**5. Optimization** - (Did the developers attempt to optimize their more complex queries using relevant optimization techniques (e.g. improving the query, caching, indexing)? Does the final report provide reasonable, correct explanations for why each optimization failed or succeeded? Does the final report include relevant and accurate pre and post optimization timings?)

**6. Look and feel** - (Is the application visually appealing? Is the user interface easy to use? Does the application make use of data visualizations and images when appropriate and feasible?)

**7. Group Dynamics - [Manual Deductions From Final Project Grade]** (Did all members of the team contribute to the project? Were all members of the team given the opportunity to contribute to the project? Did team members work cooperatively and support each other? As an individual, did you complete your fair share of the work? As an individual, did you fully complete the tasks assigned to you by the group in a timely manner? As an individual, did you communicate with your group members regarding your ability to meet internal deadlines, as necessary?)

## 2. Awards

The instructors will nominate and vote on several projects to receive awards at the end of the semester. Each project that wins at least one award will receive an extra credit feature. Additional points will not be awarded for receiving multiple nominations or wins. You may obtain a final score greater than 100 with this extra credit.

The following awards will be distributed:

1. Best all-around application
2. Most beautiful application
3. Most technically complex application

## D. RESOURCES

### 1. Dataset Resources

We've compiled a list of datasets and dataset aggregators to help jumpstart your search for data. But don't feel compelled to choose something off this list. This is just the tip of the iceberg. There's a lot more data out there!

#### Dataset Aggregators

1. [Wikidata](#)
2. [DBpedia](#)
3. [World Bank Open Data](#)
4. [Tableau datasets](#)
5. [sqlbelle's list of datasets and dataset aggregators](#)
6. [AwesomeData's list of public datasets](#)
7. [fivethirtyeight datasets](#)
8. [OpenDataPhilly](#)
9. [NYC OpenData](#)
10. [Zillow Datasets](#)
11. [AWS Datasets](#)
12. [Google Cloud Datasets](#)
13. [Reddit Datasets](#)
14. [Buzzfeed Datasets](#)
15. [Data.world](#)
16. [Kaggle](#)
17. [Federal Government Datasets](#)
18. [UCI ML Repository](#)
19. [Academic Torrents](#)
20. [WorldData.AI](#)

#### Knowledge Bases

1. [World Factbook](#)
2. [Wikipedia](#)
3. [Greatest Sporting Nation](#)
4. [Summer Olympics Medals](#)

#### Datasets

1. [OpenFlights](#)
2. [Yelp](#)
3. [NYC Taxis](#)

## 2. Example projects

The list below gives a few examples of projects people have done in the past in this course. We hope these help inspire your group and give you a better idea of what we're looking for. You can use the datasets, but must develop your own original application over the datasets using your own code.

### World Bank database Factbook

The data made available by [WorldBank](#) presents the most current and accurate global development data available, and it includes national, regional and global estimates. A group of students used this data to make an application that displayed development data for selected countries/regions in interactive visualizations.

### World Travel Guide

A group used travel datasets like [Google's](#) to build an interface that lets users see information about places they could travel to, based on their travel preferences and needs.

### Soccer Fantasy League

A group used this [soccer dataset](#) along with data scraped from ESPN to build a Soccer fantasy league. They built interfaces that let users draft their own teams and implemented an account system to save teams and expose different features to different kinds of users.

### Olympics App

A group used the Summer Olympics dataset augmented with data from the WorldBank to create an application that helped people learn more about each country, while viewing how well that country has performed at the Olympics historically.

### Bike Rental Routes

A group developed a web-app that allowed people to find routes between two points in NYC using a combination of bike, subway and walking. Platforms such as Google Maps assume that the user either owns their own bike or has none at all. This project used [Citi Bike database](#) JSON and combined that with [subway stations database](#) of New York City and calculated the shortest distance using a combination of all three, allowing the user to pick up a Citi Bike and drop it off during the journey.

### 3. Useful Tools

We've compiled a list of software tools that you may find helpful for scraping, cleaning, and ingesting data or making your demo video. If you know of some convenient tool we didn't include, please let us know on Piazza!

#### Content Extractors

1. [Apache Tika](#) -- Extracts metadata and text from word documents, PDF, powerpoints, and many other types of files
2. [Jackson Project](#) -- Efficient, easy-to-use JSON parser for Java
3. [Trail](#) -- XML Parser for Java
4. [jsoup](#) -- HTML parser for Java
5. [Selenium for Python](#) -- A Python library for automating interactions with a web browser to perform web scraping or application testing
6. [Beautiful Soup](#) -- A Python library for extracting data from HTML and XML files

#### Data cleaning and exploration tools

1. [Pandas](#) -- A Python library for data analysis that provides DataFrame, a convenient data structure for storing and processing large amounts of data
2. [Dora](#) -- A Python library for cleaning data and performing exploratory analysis
3. [JupyterLab](#) -- Software that enables you to work with Jupyter notebooks -- documents that contain live runnable Python code and display code output inline. Useful for data exploration, cleaning, and pre-processing
4. [Google Colab](#) -- An online version of JupyterLab that allows Google-Drive-style collaboration

#### Screen Recording Software

1. [ScreenRec](#) -- Free screen recording software for Mac, Windows, and Linux
2. [Open Broadcaster Software](#) -- Free screen recording software for Mac, Windows, and Linux

#### Database Software

1. [MongoDB Atlas](#) -- Cloud database hosting service for MongoDB with 512 MB of free storage
2. [MongoDB Compass](#) -- GUI for MongoDB
3. [MySQL Workbench](#) -- GUI for MySQL

## E. PLAGIARISM POLICY

**You can refer to the web or any other resource for ideas, but you are STRICTLY NOT ALLOWED to use other people's code directly.** If you would like to use some code or snippets, please consult your project mentor and obtain permission before you do so.

Please make sure that you cite the original author/source if you are approved to use it. If you are caught violating this policy, you will receive a 0 for the final project and/or the class, and we will refer your case to the Office of Student Conduct (OSC), which may take further disciplinary action.