

COMS4111-02, Fall'16

Project 1, Part 3

(worth 50% of overall Project 1 grade)

- Due: Wednesday November 09 3pm
- Note: If you follow the Web Front-End Option, you cannot use grace late days

Your Team

You will do Part 3 of Project 1 with the same team as for Part 1. If your team partner dropped the class and you did **not** submit a contingency plan for this with your Part 1 submission, then unfortunately you will still have to complete the whole project by yourself. If your team partner dropped the class and you did submit a contingency plan for this with your Part 1 submission, then you are welcome to switch to this reduced version of your project.

Overview of Part 3 of Project 1

As you recall from [Part 1](#), you had two options for Part 3 of the project: you could either follow the **Web Front-End Option** or the **Expanded-Design Option**. If you stated in Part 1 that you would follow the Expanded-Design Option, it is OK for you to change your mind now and follow the Web Front-End Option for Part 3; however, if you did not submit a plan for the Expanded-Design Option when you submitted Part 1 of the project, then you do not have a choice now and you will have to follow the Web Front-End Option.

Important notes:

- You cannot use grace days for the Web Front-End Option; you can use grace days as usual for the Expanded-Design Option.
- You should make sure that you loaded sufficient data into your database to show off all functionality of your application.
- You can make (hopefully small) changes to the SQL schema that you created in Part 2. If for some strange reason you feel the need to make any radical changes, please check with your project mentor ahead of time to avoid any last-minute surprises.

Web Front-End Option

If you are following the Web Front-End option, you will finish building the application that you proposed in Part 1, on top of the database that you created in Part 2. For the final evaluation of Project 1, you will need to submit your code for your application and a README file on CourseWorks by **Wednesday November 09 at 3 p.m.** (see below for further instructions). Also, both team members will **meet with your project mentor on Thursday November 10 or Friday November 11**. Your project mentor will contact you shortly to schedule a 15-minute meeting for one of those days. Your implementation will be on Python using Flask, and should satisfy these requirements:

- Your application must execute SQL query strings on the provided staff database. You **cannot use an Object-Relational Mapper, or ORM**. An important goal of this project is that you practice writing and debugging SQL queries as part of your application, so tools that attempt to make this "too easy" are not permitted.
- Your application must provide a way to view or interact with all the entities and relationships in your final E/R diagram.
- Your application's web interface does not need to be beautiful or sophisticated. Plain text pages are acceptable. You will not get additional credit for fancy interfaces, as this is not the focus of our course.
- In general, you can use any third-party libraries you want **except for ORMs or other libraries that simplify database access, which are not allowed**. If you are unsure if a library is permitted, ask your project mentor.

The following resources may be helpful for learning both Python and Flask:

- [Java to Python Cheatsheet](#)
- [Python tutorial](#)
- [Learn Python The Hard Way](#)
- [Flask documentation](#)
- [Flask tutorial](#)
- [Jinja template documentation](#)
- [Jinja tutorial](#)

Getting Started

Your job is to implement your proposed web application. To help you out, we have provided a bare-bones Flask web application, `server.py`, [available here](#). It provides code that connects to a database URL, and a default index page. Take a look at the comments in `server.py` to see how to use or modify the server. You will need to connect to your database from Part 2. Please read all these directions, and get the example server we provide running. Once you get it running you should edit it to talk to your own database that you created in Part 2, and start working on your custom logic.

A Short Introduction to SQLAlchemy

We use a Python package called SQLAlchemy to simplify our work for connecting to the database. For example, `server.py` contains the following code to load useful functions from the package:

```
from sqlalchemy import *
```

SQLAlchemy is able to connect to many different types of DBMSes, including SQLite, PostgreSQL, MySQL, and Oracle. Each such DBMS is called an "engine." The `create_engine()` function sets up the configuration to the specific DBMS we want to connect to:

```
engine = create_engine(DATABASEURI)
```

Given an engine, we can then connect to it (this is similar to how `psql` connects to the staff database):

```
conn = engine.connect()
```

At this point, the `conn` connection object can be used to execute queries to the database. This is basically what `psql` is doing under the covers:

```
cursor = conn.execute("select 1")
```

The `execute` function takes a SQL query string as input and returns a `cursor` object. You can think of this as an iterator over the result relation. This means you can run `select *` on a million-row table and not run out of memory. Instead of receiving the entire result at once, this object lets you treat the result as an iterator and call `next()` on it, or loop through it. [See the SQLAlchemy documentation for a detailed description](#).

```
# this fetches the first row if called right after
# the execute function above. It also moves the
# iterator to the next result row.
record = cursor.fetchone()

# this will fetch the next record, or None if
# there are no more results.
second_record = cursor.fetchone()

# this loops through the results of the cursor one by one
for row in cursor:
    print list(row)
```

The above description is a way to directly write and run SQL queries as strings, and directly manipulate the result relations. SQLAlchemy also includes an [Object Relational Mapper](#) that provides an interface that hides SQL query strings and result sets from you. **In this project, you will directly write and run SQL queries, and cannot use any ORM functionality.**

Working with a Version Control System

Since you are working collaboratively with your teammate, we **strongly encourage** you to use a version control system for your code such as git on [BitBucket](#). BitBucket is a web-based hosting service for version control systems such as git. Nowadays the most popular platform for git hosting is GitHub, but since it does not offer free private repositories, we recommend BitBucket for this course. If you have access to private repositories on GitHub and would like to use it, please feel free to do so (GitHub offers [free student developer packs](#) that includes 5 private repos, but it can take a bit of time for them to process your request and it does not always go through). We will only be providing instructions on setting up your workflow with BitBucket on this page.

We cover below the basics of git and BitBucket. With this setup, you can code on your own desktop, commit and push your changes to the BitBucket repository, and then pull the updated changes on your Azure virtual machine. You can also code without your teammate being in the same room, and your teammate will be aware of the changes after "pulling" the code from BitBucket. Conversely, your teammate will also be able to contribute to the same code repository, so you can both work collaboratively. Please follow these steps to get started with git and BitBucket:

1. [Register an account](#) on BitBucket. You will need to provide/verify your email address and provide a username. There is no requirement on what email or username you use here. Your teammate should also register for a different account, so that you both have access to the code repository.
2. Once your account is created, log into BitBucket. Create a repository by clicking "Repositories" on the top navigation bar, and then clicking "create repository" in the drop-down menu.
3. Give your repository a name, such as "w4111-proj1". From here on we will use <projectname> to denote the name that you chose in this step for your project. Make sure that you select "This is a private repository" for access level, and that the repository type is "Git".
4. In the repository interface, go to "Settings" on the left navigation bar, and go to the "Access management" tab. Here you can give your teammate access to the repository using the username or email of your teammate's BitBucket account, and selecting "Admin" access on the drop-down menu.
5. We are done with the BitBucket web interface. Now start your Azure virtual machine (recall [our instructions for Part 2](#)), ssh into it, and run the following commands:

```
# download and extract our skeleton Flask web application
cd ~
wget http://www.cs.columbia.edu/~biliris/4111/index.htm/projects/Proj1-3/webserver.tar
tar xf webserver.tar
mv webserver <projectname>
cd <projectname>
# configure your git environment
git config --global user.name "<your full name>"
git config --global user.email "<email you used to register for BitBucket>"
# initialize git repository, and push the skeleton files up to the server
# here <username> denotes your bitbucket username
git init
git remote add origin https://<username>@bitbucket.org/<username>/<projectname>.git
git add --all
git commit -m "initial commit"
git push -u origin master # you will be prompted for your username and password here
```

You have now created a local git repository, made your first commit, and pushed the files contained in webserver.tar onto BitBucket. Your usual workflow after these initial steps will be a bit different than this, as described in the next step.

6. Your workflow with git will typically comprise the following steps:
 1. Pull your changes from the BitBucket repository so that your code is up-to-date: **git pull**. Note that this step is necessary because, when working on a project with a teammate, your teammate may have updated and pushed the code while you were not working on the project, so you should always pull the changes before beginning to work on a new revision.
 2. Work on the project, make some changes locally, and test them.
 3. See what git thinks you have changed: **git status**
 4. Add any modified files to the next "commit." For example, if you modified files server.py and README, then run: **git add server.py README**
 5. Commit your changes (locally) with an appropriate commit message: **git commit -m "added feature X"**
 6. Push your changes to the BitBucket server: **git push**
7. Step 5 is more or less all you need to get started if you were working on this project alone. However, you are working as a two-person team, and you might even be using different computers to do your coding. (It's cumbersome to develop your code directly on Azure, and it's much more convenient to use your desktop or laptop for writing the code and then "pull" the code into your Azure account using git, as discussed in the "Running Your Application..." section below.) So if you carried out Step 5 above for your team, then your teammate will need to perform the following steps to get a copy of the code on his/her desktop or laptop. Similarly, you will have to perform the steps below for any new computer that you want to use to continue developing your code:

```
# configure your git environment, as in step 5
git config --global user.name "<your full name>"
git config --global user.email "<email you used to register for BitBucket>"

# clone (i.e., download) the repository onto your local machine
# use the username of the owner of the repository here
git clone https://<username>@bitbucket.org/<username>/<projectname>.git

# you're done setting up. you can now continue as in step 6
```

git provide many other powerful functions that we haven't talked about. For more information, you can refer to [this tutorial](#), and documentation on that website. Typically if you encounter a problem with git, you can do a quick search with the error message and get a lot of helpful information online. Feel free to also come to office hours with any of your questions about git and BitBucket.

Running Your Application on Your Azure Virtual Machine

Once you have developed (a preliminary version of) your web application, you will deploy it to your Azure virtual machine.

- One time setup: [Follow our directions to make a port accessible to the Internet so anyone can access your application](#).
- 1. Write down the IP of your virtual machine.
- 2. ssh to your virtual machine and [enter the "test" virtual environment you created in Part 2 of the project](#).
- 3. Make sure you have committed and pushed all the latest changes to your code to your BitBucket repository. (See Step 6 above.)
- 4. Copy the latest version of your code to the Azure virtual machine by running **git pull** on your virtual machine.
- 5. Run the Python server with the defaults parameters, which will listen for requests on port 8111. Run with **--help** if you need help:

```
cd <projectname> (<projectname> is the name of your repository and directory that you created in Step 5 above.)
python server.py
```

- 6. Go to `http://<IP ADDRESS>:8111/` in your browser to check that it worked.
You will need this URL when presenting the project to your mentor.

What to Submit and When

If you are following the Web Front-End Option, you will need to **submit your code for your application and a README file on CourseWorks by Wednesday November 09 at 3 p.m.** You cannot use grace late days with the Web Front-End Option, so this is a hard deadline. Here are the instructions for your electronic submission:

- Create a directory named `<UNI>-proj1-3`, where you should replace `<UNI>` with the UNI of one of the teammates. For example, if the UNI is ab2264, then the directory should be named `ab2264-proj1-3`.
- Copy all the Python source code files into the `<UNI>-proj1-3` directory, and include all the other files that are necessary for your program to run.
- Tar and gzip the `<UNI>-proj1-3` directory, to generate a single file `<UNI>-proj1-3.tar.gz`, which is the first file that you will submit.
- Login to Courseworks and **submit the file `<UNI>-proj1-3.tar.gz`** to the "Project 1.3" assignment.
- Separately, **submit an uncompressed README file** with the following information:
 - The PostgreSQL account where your database on our server resides. (This should be the same database that you used for Part 2, but we need you to confirm that we should check that database.)
 - The URL of your web application.
 - A description of the parts of your original proposal in Part 1 that you implemented, the parts you did not (which hopefully is nothing or something very small), and possibly new features that were not included in the proposal and that you implemented anyway. If you did not implement some part of the proposal in Part 1, explain why.
 - Briefly describe two of the web pages that require (what you consider) the most interesting database operations in terms of what the pages are used for, how the page is related to the database operations (e.g., inputs on the page are used in such and such way to produce database operations that do such and such), and why you think they are interesting.

1) daily todo
lists — five
closest patients
2) ??

In summary, you need to submit on CourseWorks exactly two files: (1) your `<UNI>-proj1-3.tar.gz` file with your code and (2) your uncompressed README file. You need to submit these two files by **Wednesday November 09 at 3 p.m.** and you **cannot use any grace late days** for this submission.

Additionally, **both teammates in each team will meet together with their project mentor on either Thursday November 10 or Friday November 11.** Your project mentor will email you shortly to schedule a 15' meeting for either day. (If you haven't received an email from your project mentor by Friday March 25 please contact your mentor immediately after that day.) During the meeting with your project mentor, you will show your mentor your application using a regular web browser:

- You should have your application up and running so that you and your project mentor can access it over the web simply by typing a URL in a regular browser. Your project mentor will be running Chrome.
- Your project mentor should be able to interact with your application and access the functionality that you specified in Part 1, over the database that you created for Part 2.
- The project mentor might ask to look at your code during your meeting.
- Your web interface does not need to be fancy. (See Grading below.) However, you should not force users to type SQL. The less your web site looks like it is interacting with a relational database, the better. At the very least, the user should be completely shielded from having to type anything resembling SQL. Most interactions should involve some sort of input values in addition to the user

pressing a Submit button. Whenever possible, input values should be specified using menus, radio buttons, checkboxes, scrollers, etc. Text input boxes may also be appropriate.

- Sophisticated error handling is not necessary; however your web site definitely **should not "lock up"** (i.e., crash or become blocked) regardless of how the user chooses to interact with it.
- Your database should contain (at least) the data that you entered for Part 2. You can, of course, add extra tuples to your tables if you want to make interaction with your application more interesting and revealing.
- Your grade will suffer considerably if your application is not running properly when you access it from your project mentor's machine. It is your responsibility to ensure that your application is up and running when you meet with your project mentor.
- You should have a number of **example interactions prepared** so that you can use your meeting time efficiently. The more you can impress your project mentor during the 15-minute meeting, the better your grade is likely to be, so come to the meeting prepared.

Grading for Web Front-End Option

Your grade for Part 3 of Project 1 will be a function of how well your application (which should be up and running) matches your specification that you submitted as Part 1, of how well you have incorporated any feedback that your project mentor has given you, and of how well you have followed the guidelines above. Your grade will not be influenced by how fancy the web-based user interface to your application is. It is sufficient and perfectly fine for this interface to be plain and simple as long as it supports the functionality that you indicated earlier, following the guidelines above about not having to type SQL commands, not "locking up" on unexpected input, etc.

Expanded-Design Option

If you are following the Expanded-Design Option, you need to follow the expansion plans that you outlined in Part 1, and:

1. **Extend your E/R diagram** from Part 1 to include the entity sets and relationship sets—and all associated real-world constraints—for your expanded design.
2. **Extend your SQL schema** from Part 2 of your database on our PostgreSQL server to include the mapping of all new entity sets and relationship sets, following the directions in Part 2 of the project on how to specify constraints in your expanded SQL design.
3. **Add tuples** to your new tables on our PostgreSQL server, following the guidelines on the number of tuples from Part 2 of the project.

What to Submit and When

You will submit this part of the project electronically on CourseWorks directly, along the lines of what you did for Part 2. The deadline is **Wednesday November 09 at 3 p.m.** You can use grace late days as usual for this part of the project if you are following the Expanded-Design Option. Just as for Parts 1 and 2, you should submit your project exactly once per team. You should submit a **single (uncompressed) file** containing:

1. The name and UNI of both teammates.
2. The PostgreSQL account where your database on our server resides. (This should be the same database that you used for Part 2, but we need you to confirm that we should check that database.)
3. A textual description of your extensions on the database design, explaining which entity sets and relationship sets are new, and how you mapped them to SQL statements.
4. Your new, complete E/R diagram, including all of your entity sets and relationship sets, both from Part 1 and the new ones from Part 3.
5. The CREATE TABLE statements and any other elements of the full database that you created on your PostgreSQL database. (We will of course also check the schema directly on the database server, but we need as well the statements as part of your submission file.) You should include all of your tables, not just the new ones for Part 3.
6. As in Part 2 of this project, three "interesting" SQL queries over your expanded database, with a sentence or two per query explaining what the query is supposed to compute. Each of these queries should involve at least one of the new tables that you added for Part 3. Submit well formed queries that run without problems, so please make sure that you have tested your queries by running them on your database exactly as submitted (use copy and paste).

Grading for Expanded Design Option

Your grade for Part 3 of Project 1 will be a function of how well you have incorporated any feedback that your project mentor has given you, and the following factors:

1. **Quality of your expanded E/R diagram:** We will evaluate how well your expanded E/R diagram implements your plans for the Expanded-Design Option from Part 1, and how well your expanded E/R diagram models your application, including how well you modeled any relevant real-world constraints.

2. **Quality of your expanded SQL schema and implementation on PostgreSQL:** We will evaluate how well you mapped your expanded E/R diagram, including constraints, into a SQL schema on PostgreSQL, using the techniques that we covered in class.
 3. **Quality of your expanded constraint handling:** We will evaluate how well you managed to capture real-world constraints of your expanded design through primary key, foreign key, unique, and attribute- and tuple-based CHECK constraints.
 4. **Your three SQL statements:** Are they reasonably interesting for your application and do they use the requested SQL features?
 5. **Quality of the expanded real-world (or at least realistic) data** that you loaded into the expanded database on PostgreSQL.
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Important note: So that you don't exhaust your monthly Azure credits --and also to avoid wasting energy-- make sure to turn off your virtual machine on Azure whenever you are not using it, by following the (very simple) ["Stopping Your Virtual Machine" instructions available at the bottom of the instructions page here](#).
