Social Network Analysis and Visualization Support for the Analysis of Music Collaborations

CSC 2310 – Fall 2022

Abstract

In 1927, a group of country music artists were called by Ralph Peer to record old-time music. The Bristol Sessions have been touted as the "Big Bang" of Country Music and had a big impact on the future of the genre. While country music scholars have studied the sessions extensively, the sessions have become popularized with the release of the Ken Burns Country Music documentary in 2019. In this project, we will use the Discogs API to gather and use data about artists to perform a graph-based social network analysis to visualize and synthesize new insights about the artists that recorded and collaborated on the recordings of the original Bristol Sessions.

Data is critical for making both short-term and long-term decisions. Data scientists are often called upon to create tools for providing insight into the knowledge embedded in data by fusing information from various sources into a single cogent collection of information. For instance, consider the following example taken from the Discogs (api.discogs.com) API:


```
{
  "name": "Jimmie Rodgers",
  "id": 269365,
  "resource_url": "https://api.discogs.com/artists/269365",
  "uri": "https://www.discogs.com/artist/269365-Jimmie-Rodgers",
  "releases_url": "https://api.discogs.com/artists/269365/releases",
  "realname": "James Charles Rodgers",
  "profile":
      "American country singer, guitarist and songwriter (born
      September 08, 1897 in Meridian, Mississippi - died May 26, 1933
      in New York City, New York).\r\nIn the early 20th century known
      most widely for his rhythmic yodeling. Among the first country
      music superstars and pioneers, Rodgers was also known as The
      Singing Brakeman, The Blue Yodeler, and The Father of Country
      Music.\r\nInducted into Songwriters Hall of Fame in
      1970.\r\nInducted into Rock And Roll Hall of Fame in 1986 (Early
      Influence). \r\nInducted into Country Music Hall of Fame in
      1961.\r\n\r\n[b]Note! Please be careful when assigning credits to
      this artist.[/b] Other artists with a same or similar name exist
      (list not complete):\r\n- [a=Jimmy Rogers] - Chicago blues singer
      and guitarist\r\n- [a=Jimmie Rogers] - multi-instrumentalist
      (flute, didgeridoo, jew's harp ...)\r\n- [a=Jimmie Rogers (2)] -
      rock n' roll songwriter\r\n- [a=Jimmie Rodgers (2)] - folk/pop
      singer (born 1933)",
  "data_quality": "Correct"
}
```


From this and other associated information, enough data can be acquired that can be used to identify all of the artists that collaborated with an artist (a 1st-order degree of separation) and the artists that collaborated with the 1st-order artists (i.e., the 2nd-order degree of separation from the original artist. By doing some elementary data mining, the data can be assembled to form a graph depicting the extent of the collaborations between different artists, as shown in Figure 1.

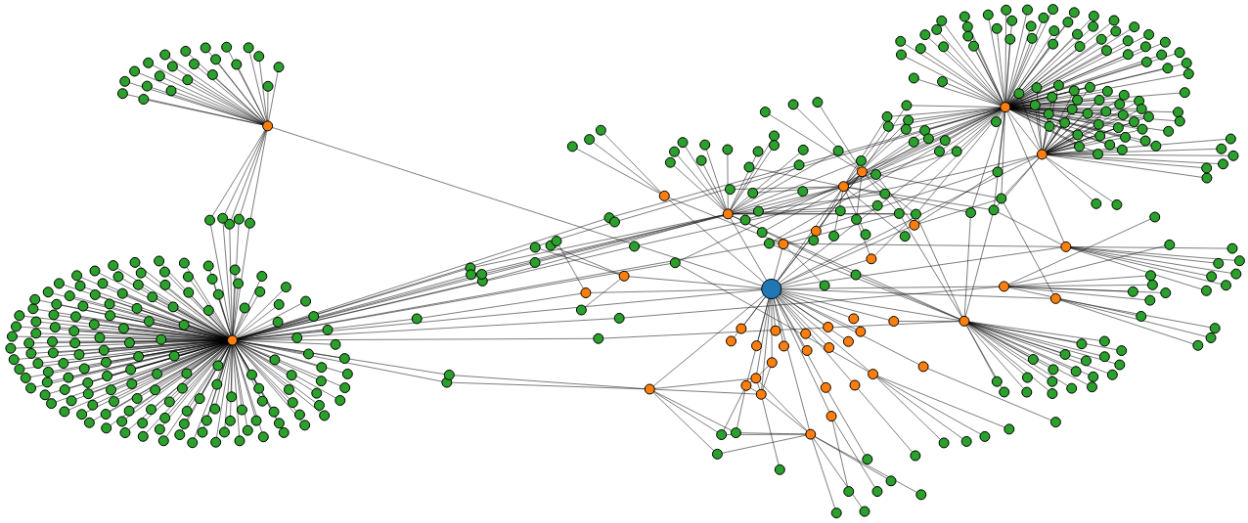


Figure 1 Collaboration Graph of Jimmie Rodgers

As you begin the brainstorming process, recall that as a "developer" you have biases, and that you need to try adopt the mindset of different kinds of users. You may want to ask yourself questions such as:

- Who are the users?
- Should a user be able to add or modify data? Which type of users can do this?
- How will they use this system? What should the screen designs be to make using the system easy?
- What should a user be able to learn from the display of the data?
- Are there specific analyses that can be performed to identify interesting relationships?
- Are there other data sets that may be of interest?
- How should we incorporate color, sizes, and other visual features to convey information about artists?
- What other information should we display? What does each type of user need to see and do?

In this iteration, you will be doing the following:

- Brainstorm the potential features of the system – for instance, some users might want to add information expand the graph by clicking on a node.
- Specify user stories for each of the user types based on your problem analysis using the user story format of "As a <user>, I want <feature>, so that <reason>".

As you go through this activity, you should attempt, as much as possible, to avoid thinking about how any of this is going to be implemented. ***The most important aspect of this activity is identifying all of the possible features for this system (noting that identification of all of the possible features does not mean you will have to implement all of the features).***

Project Phases

The project will be conducted in two major phases: *concept-initiate* and *iteration-construction*. In the *concept-initiate* phase you will identify project requirements, create models, and prep your development environment to support your implementation activities. In the *iteration-construction* phase of the project you will iteratively develop software for the project by adding support according to the requirements developed during the *concept-initiate* phase. The schedule of the phases of the project and the individual iterations contained therein are defined below:

Date (Midnight)	Phase	Description
September 9	Concept Initiate 0	User stories
September 23	Concept Initiate 1	Use case diagrams
October 7	Concept Initiate 2	Initial Design
October 21	Iteration 0	Project environment setup and initial execution demonstration
November 4	Iteration 1	Graph Visualization
November 18	Iteration 2	Graph Algorithms
December 2	Iteration 3	Delivery

Concept Initiate 0

User Stories

In the initial phase of the project, you will create user stories based on the description provided while also generating ideas of other potential features for such a system. The user stories that you create should be specified in the following form:

As a <user type>, I want <desired feature>, so that <outcome>

You must also include, with each user story, a description of how you would expect to be able to observe this behavior in the system. Your source of information for the user stories you will identify are given in the description provided above as well as any discussion sessions we conduct in class. You may also reach out to faculty or other students to generate ideas on potential stories. **However, the work you turn in must be your own. You may not copy other students' user stories, descriptions, or other similar work products.**

A template for your user stories is provided below.

User Story Template

Use the following user story template for *concept-initiate 0*. Replicate this as many times as is necessary.

User Story Name: <Short phrase for the user story>	
As a:	<user type>
I want:	<feature>
So that:	<outcome or reason>
Description	<description of how the user story / feature would be observed and tested in the system>

Submission

Submit your user stories as a PDF document only. *Microsoft Word, LibreOffice, or any other native word processing format will not be accepted.*

Rubric

Completeness: You will be graded on the completeness of your turn-in. In particular, you must analyze the description and attempt to identify as many features as you can that are relevant for the project. Note, there is no upper bound on the number of user stories you can define, but there is a lower bound **that *will not* be specified**.

Correctness: You will be graded based on your adherence to the format of the user story template and on the accuracy of the user stories with respect to relevance to the described project, including your description of how you might expect to observe the user story / feature in the system.

Points: The assignment is worth 20 project points.

Concept Initiate 1

Use Case Diagrams

In our initial step on this project, we did some work to try to identify user stories for the *Dashboard* system. A baseline set of 23 user stories has been uploaded to the course iLearn site and should be used as a starting point for completing the next activity in the project. You must add additional user stories from your own set produced from the set you created for Concept Initiate 0. For Concept Initiate 1, you will be creating use case diagrams for the *Bristol Social Network* system. The baseline user stories fall into a few categories:

- *Analysis* – Stories that are related to interpretation of graph information
- *Data* – Stories that are related to managing data
- *Interaction* – Stories that are related to the use of the application

As you did in Laboratory 2, you will use GenMyModel to create your use case diagram(s) for the Dashboard system. The user stories that you will use for creating the use cases in the diagram are included as an attachment to the assignment in iLearn. Some things to note about these user stories:

- There are 23 base user stories specified in the reference set across 3 different user types in the baseline set. You must add your own additional user stories (at least 5-10)
- User stories may differ by users with the same feature. These should be represented by different users in the diagram linked to a common use case.
- The use case diagram should be partitioned according to the feature categories specified above. Additional stories may result in additional categories that you should name, if appropriate.

Submission

For your turn-in, you should export the model to an image and copy and paste the image to word or some other word processing suite and generate a PDF. The due date is found in the table found in the Project Phases section found earlier in the document.

Rubric

Completeness: You will be graded on the completeness of your turn-in. In particular, your submission must at the very least include the user stories provided in the baseline set. However, it is also expected that you will include other stories in your diagram.

Correctness: You will be graded on the correctness of your use case diagrams. In particular, your submission must correctly represent use cases, actors (both interactive and external actors), and partitioning of the stories into appropriate subsystems by category.

Points: The assignment is worth 25 project points.

User Story Name: Annotate	
Category: Analysis	
As a:	Analyst
I want:	annotate graphs with notes
So that:	I can add information about an artist
Description	Allows a user to take notes about a given artist

User Story Name: Degree	
Category: Analysis	
As a:	Analyst
I want:	generate vertex degree information
So that:	I can find important nodes in the graph
Description	https://networkx.org/documentation/stable/reference/algorithms/centrality.html

User Story Name: In-Degree	
Category: Analysis	
As a:	Analyst
I want:	generate vertex in-degree
So that:	I can find important nodes in the graph
Description	https://networkx.org/documentation/stable/reference/algorithms/centrality.html

User Story Name: Out-Degree	
Category: Analysis	
As a:	Analyst
I want:	generate vertex out-degree
So that:	I can find important nodes in the graph
Description	https://networkx.org/documentation/stable/reference/algorithms/centrality.html

User Story Name: Centrality measures	
Category: Analysis	
As a:	Analyst
I want:	generate centrality measures
So that:	I can find important nodes in the graph
Description	https://networkx.org/documentation/stable/reference/algorithms/centrality.html

User Story Name: Select nodes	
Category: Analysis	
As a:	Analyst
I want:	select multiple nodes in the graph
So that:	I can analyze whether groups of nodes are special
Description	Need to be able to select multiple nodes (drag a box?)

User Story Name: Upload new data	
Category: Data	
As a:	Data archivist
I want:	upload new data on the fly
So that:	I can add new information to the site on-the-fly
Description	By right clicking a leaf node

User Story Name: Batch upload new data	
Category: Data	
As a:	Data archivist
I want:	batch upload data
So that:	I can add a large amount of data using a file upload
Description	Upload multiple artists at a time

User Story Name: Export	
Category: Data	
As a:	Data archivist
I want:	export to csv
So that:	I can use the data in other tools
Description	Need to define what the export format will be

User Story Name: Select artist	
Category: Interaction	
As a:	User
I want:	select a single artist
So that:	I can build a graph based on that artist's collaborations
Description	Build a graph using just one selected artist

User Story Name: Select multiple artists	
Category: Interaction	
As a:	User
I want:	select multiple artists
So that:	I can build a graph based on multiple artist's collaborators
Description	Build a graph using multiple artists; Need to differentiate between different people

User Story Name: Color nodes	
Category: Interaction	
As a:	User
I want:	view nodes using different colors
So that:	I can differentiate between the role someone had in a recording
Description	Colors determine distance from the originally selected artist

User Story Name: Info on hover	
Category: Interaction	
As a:	User
I want:	see artist info when I hover over a node
So that:	I can see relevant information about the artist on demand
Description	Hover to see artist info

User Story Name: Save	
Category: Save	
As a:	User
I want:	save graphs
So that:	I can share a graph with another user
Description	Save graphs so I we don't have to generate them multiple times

User Story Name: Download	
Category: Save	
As a:	User
I want:	download graphs
So that:	I can put them into other documents
Description	pdf, png, etc.; should be split into different stories by type

User Story Name: Clear graph	
Category: Interaction	
As a:	User
I want:	clear the graph
So that:	I can start a new analysis
Description	Start work over

User Story Name: Move nodes	
Category: Interaction	
As a:	User
I want:	move nodes on the graph
So that:	I can make the graph more understandable
Description	Requires an ability to manipulate the graph

User Story Name: Name graph	
Category: Interaction	
As a:	User
I want:	name a graph
So that:	I can provide context to the graph that was generated
Description	Add a name of the artist or group of artists to the interface

User Story Name: Set defaults	
Category: Interaction	
As a:	User
I want:	configure features
So that:	I can determine default features in a graph
Description	color, size, shape of nodes

User Story Name: Artist info in list	
Category: Interaction	
As a:	User
I want:	see artist info in the selection list
So that:	I can differentiate between artists in the main list
Description	Add extra info into the selection list?

User Story Name: Hide nodes	
Category: Interaction	
As a:	User
I want:	hide nodes in the graph
So that:	I can clear some clutter
Description	Collapse leaf nodes in the graph

User Story Name: Generate graph in tab	
Category: Interaction	
As a:	User
I want:	generate graphs in new tabs
So that:	I can generate multiple graphs at once
Description	Allows a user to create multiple views at once

User Story Name: List of saved graphs	
Category: Data	
As a:	User
I want:	see a list of graphs generated thus far
So that:	I can go back to previous work
Description	Would require saving graphs in a database

Concept Initiate 2

Class Diagrams

In the last iteration, we worked with a number of use-cases for the Bristol Project. As implied by the project description, the primary goal of the application is to manage the collaborations between different artists (regardless of the genre to which they are associated). A *possible* use case diagram solution from the core set of user stories identified for last iteration is shown in Figure 2.

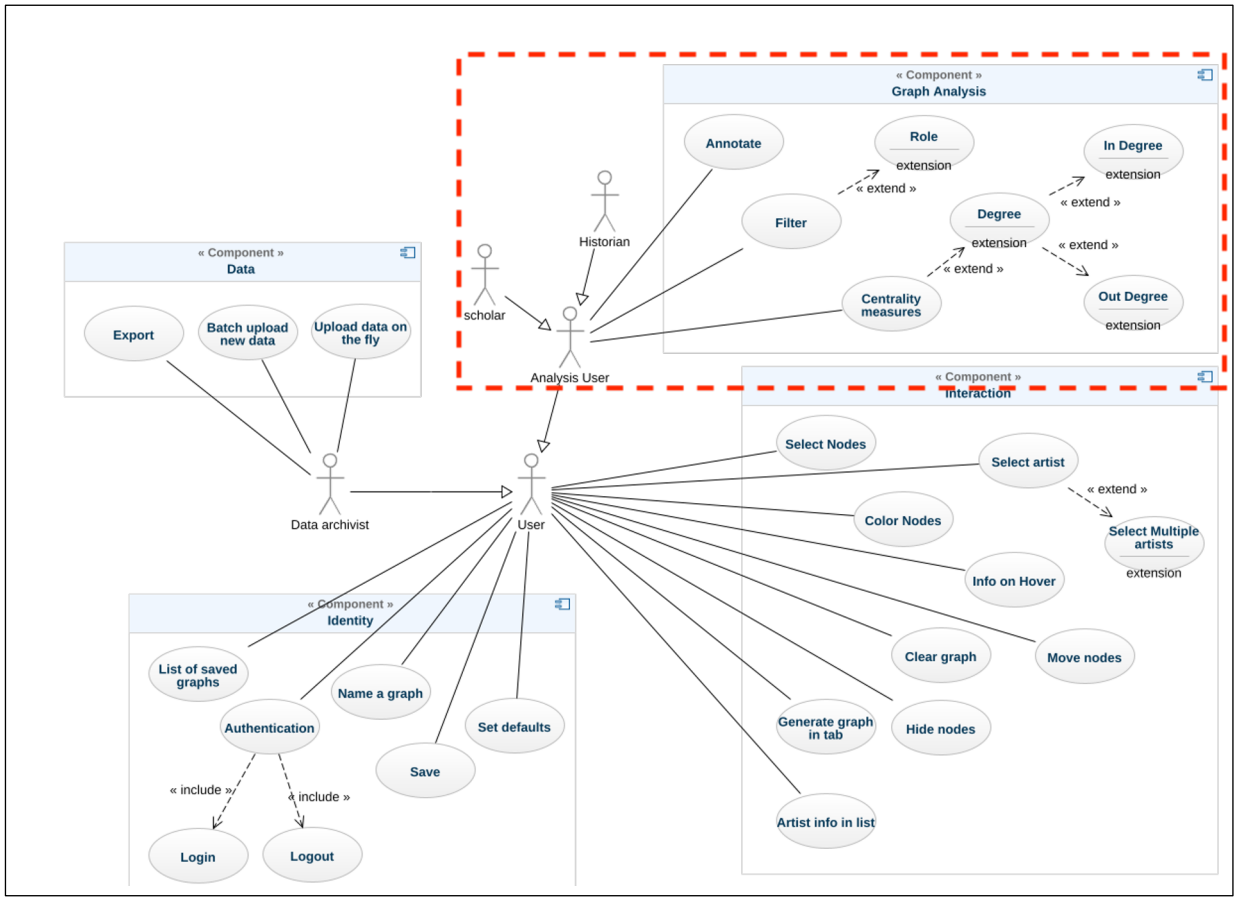


Figure 2 Use Case Diagram for Bristol Project

One of the primary aspects of this system is the analysis of graphs in order to better understand the collaborations between different recording artists. The user stories in the upper right-hand corner of the diagram (in the inset in Figure 2 and shown in Figure 3) provide details on these particular features. In particular, these features point to the need for an *ArtistGraph* class, which can be used to represent *Artists* as *nodes*, and the relationships (i.e., *collaborations*) between them as *edges* in a *Graph*. That is, an *ArtistGraph* is a *Graph.*

According to the diagram, other desired features include the ability to indicate what *role* an artist had on a recording, the number of collaborations an artist had with others (either as a primary artist via an "out-degree", or as a supporting artist via an "in-degree"), and different metrics for a graph such as degree centrality, betweenness centrality, and closeness centrality.

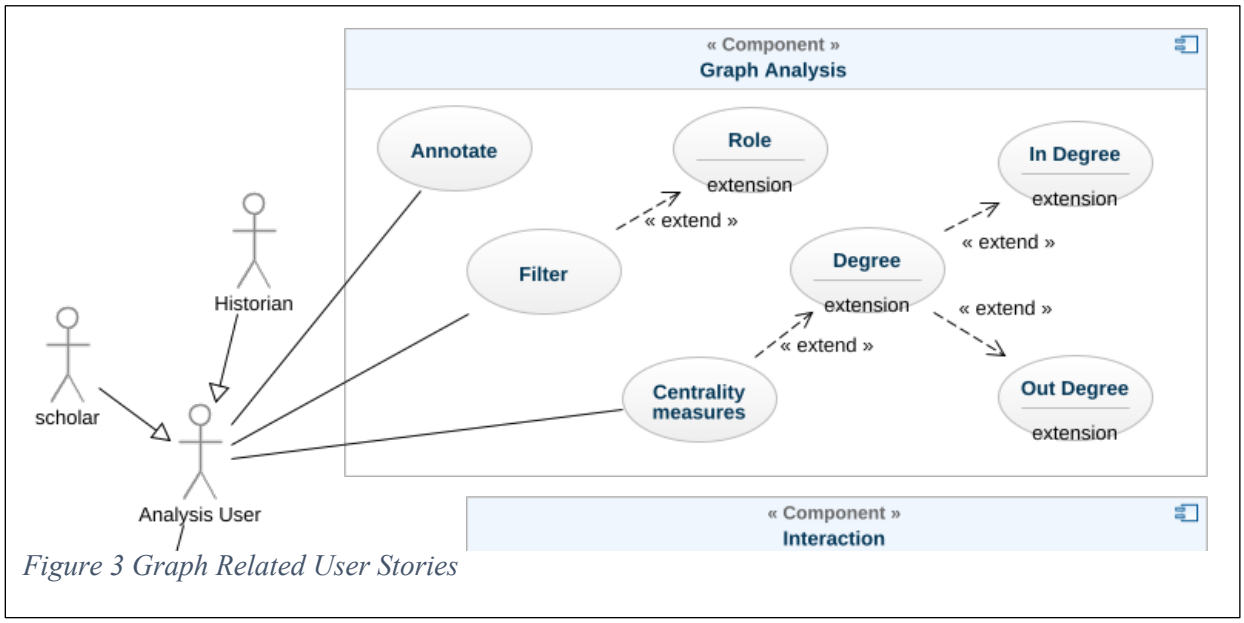
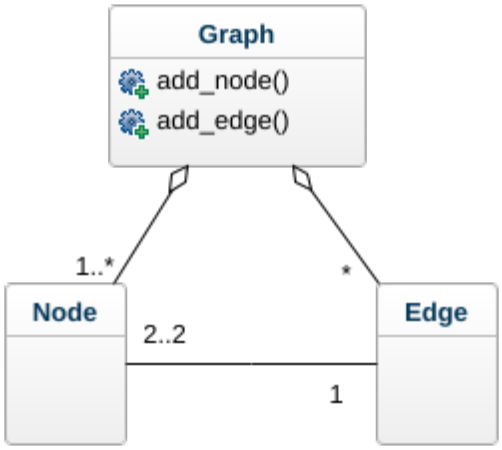


Figure 3 Graph Related User Stories

Data Analysis

The following class diagram shows a *Graph* class as a collection of *Node* and *Edge* objects. The diagram depicts an edge as a relationship between two nodes. Through the use of inheritance, aggregation, composition, and association, you will create a model depicting the major concepts needed to analyze artists and their collaborations.



In this iteration you will be creating a class diagram to model the major classes for the Bristol Project. The core classes that you should include are:

- Graph
- Node
- Edge
- ArtistGraph

Other classes, however, also exist that you will have to identify by analyzing some of the data available to populate the graphs. In particular, you should analyze the following sample data related to Jimmie Rodgers available from the Discogs API:

- Artist Data: https://api.discogs.com/artists/269365
  - The data for an artist provides a listing of associated attributes including the name, artist id, profile, and other information
  - The artist data also includes a link to a list of releases related to the artist: for instance, for Jimmie Rodgers, the list can be found here: https://api.discogs.com/artists/269365/releases;
- Release Data: https://api.discogs.com/releases/11530368
  - The data for an individual release provides a release id, the year of the release, and information about *Tracks* (i.e., individual songs) including the artists that performed on the track.

In this iteration, you are to create a class diagram that identifies all of the classes, their relationships (e.g., **inheritance**, **composition**, **aggregation**, **association**), the **multiplicities** of the relationships (e.g., 1-1, 1..*, etc.) and **potential attributes** and (non-constructor, non-getter, and non-setter) **methods**.

To help simplify the modeling, it is suggested that you create modeling diagrams as follows:

- Relationships: Create a model that shows the classes and their relationships. Omit the use of attributes and methods on this diagram and focus only on the relationships
- Class information: Create one or more models that omit the relationships but show the attributes and methods of each class. This should include any parameters used for methods.

Submission

Use the https://app.genmymodel.com system to create your models. Export your model to a PNG and submit as a PDF to iLearn. Videos are available online on the different modeling notations for UML.

Rubric

Completeness: You will be graded on the completeness of your submission, most notably the inclusion of classes described above as well as on the identification of implicit and derived classes that arise from a thorough analysis of the problem.

Correctness: You will be graded on the correctness of the class specifications you have created including correct capture of the relationships between the classes and the specification of attributes and methods that arise from a thorough analysis of the problem.

Points: The assignment is worth 30 project points.

Iteration 0

Architecture

In the last iteration, you analyzed the data related to artists and their collaborators. The model you created is an important part of understanding the relationship between artists and the collaborations they had with other artists. For the initial iteration of the implementation you will be creating a number of classes as part of a standard 3-tier architecture involving a *UI* layer, an *App* layer, and a *Data* layer as depicted in Figure 4.

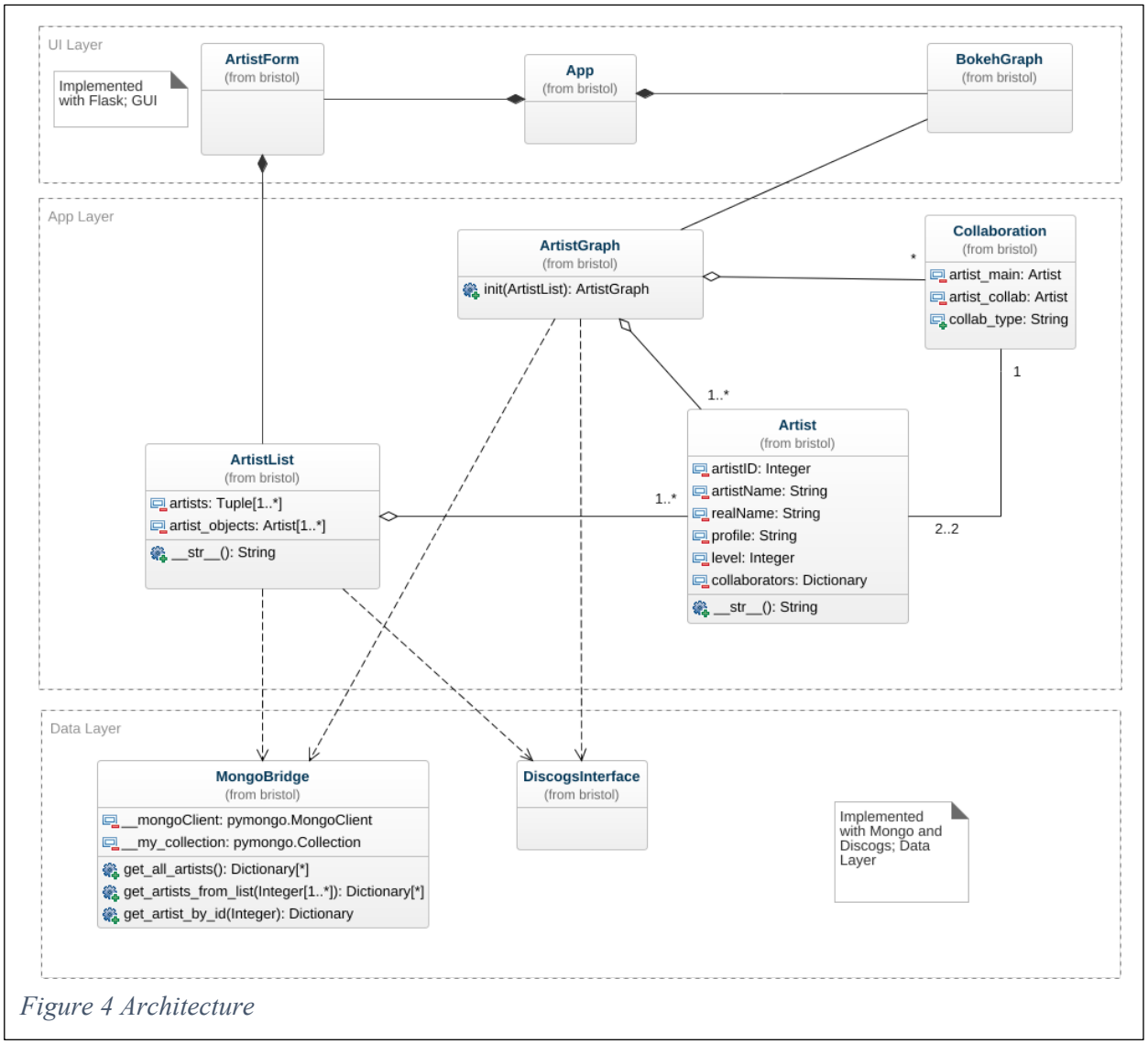


Figure 4 Architecture

As shown in the architecture, each layer is responsible for different aspects of the implementation, including interactions with the user in the UI layer, the modeling of the data as a graph in the App layer, and access to the data in the Data layer. The architecture depicts a handful of classes that you will either implement or use as part of creating the solution, or are planned as part of later iterations. In this first iteration the focus is on getting the basic application up and running, implementing some support classes, and creating a bridge between the application and its data source (i.e., a mongo database).

The application itself runs using the Flask web development framework for python. The application works as follows:

1. The App object instantiates an ArtistForm object, which populates the UI with a list of the names of Bristol artists using an ArtistList object.
2. The ArtistList object receives a list of integers corresponding to Artist IDs, which it uses to retrieve a dictionary of data for an artist using the MongoBridge.
3. The MongoBridge object is an interface to a MongoDB instance; it makes the call to MongoDB using the pymongo library.
4. When a user selects one or more artists using the ArtistForm object, the App object will display:
    - A list of the selected artists as "artist name (artist id)" (as shown in Figure 5)
    - Eventually, the app will display a graph showing artists and their related collaborators

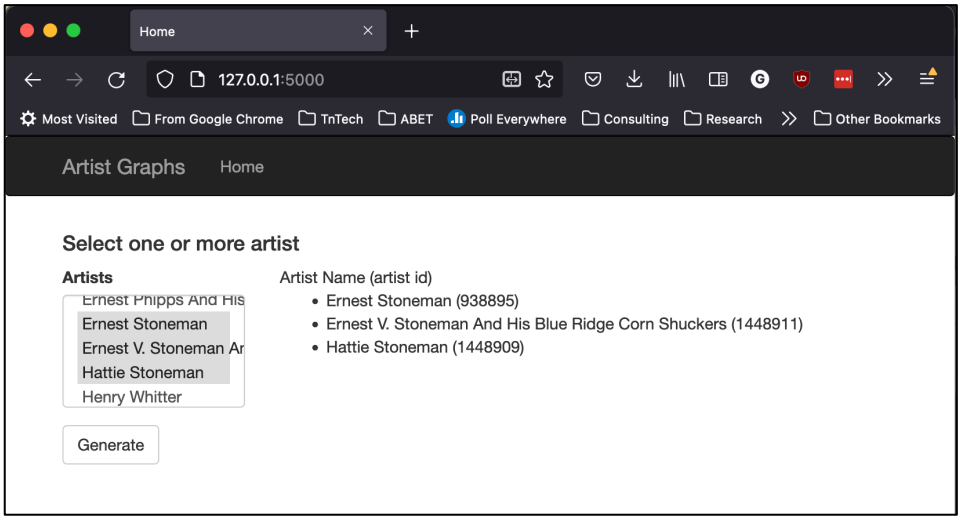


Figure 5 Interface

Implementation

This section describes the setup and coding for the iteration.

Setup

Begin by cloning the project repository:

https://gitlab.csc.tntech.edu/csc2310-fa22-students/*yourid*/*yourid*-artistgraph_0.git

replacing *yourid* with your userid. ***It is recommended that you create a new directory, cd into that directory, and then clone the repo at that location.*** The repository has the structure shown in Figure 6 with the applayer, datalayer, and guilayer corresponding to the architecture layers. **When doing your work, edit the files in these directories *directly***. Specifically, do not copy these files into other directories or to other locations other than where they were downloaded using the clone command.

Your ability to clone, modify, stage, commit, and push your solution back to gitlab will be assessed in this iteration of the project.

Once you have cloned the project, you must setup the venv environment by issuing the following command:

```
pip3 install -r requirements.txt
```

This will ensure that all of the libraries needed for the project are available in your environment.

Coding

In this iteration you will be implementing three classes shown in the architecture diagram found in Figure 4. All of the source files that you will need have been pre-populated in the project repository and contain stubs for all of the methods that you must implement. You may add other methods but you must not change the signature of any of the methods already stubbed in the provided source files. Each of the methods has been documented. *It is highly recommended that you implement the classes in the order listed below. In particular,* ArtistList *depends on a functioning* MongoBridge *class.*

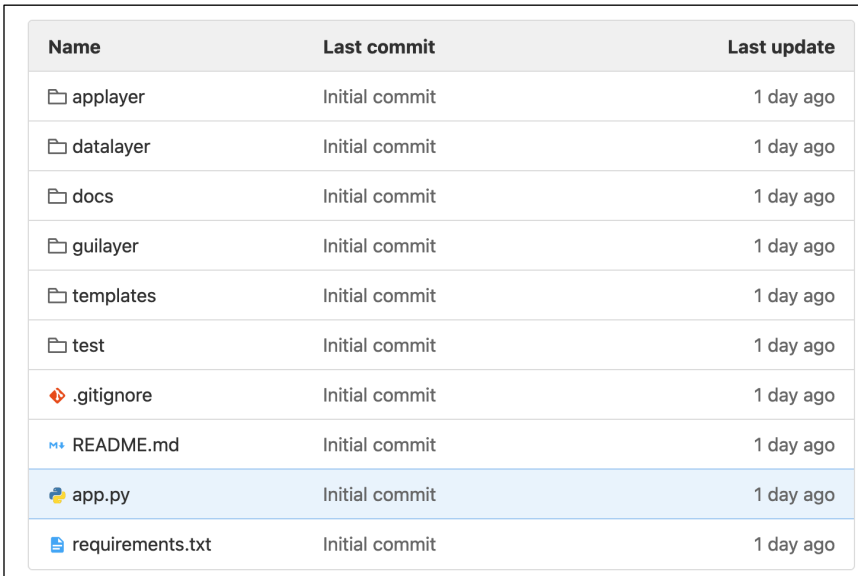


Figure 6 Repo Structure

Artist

The Artist class contains basic information regarding an artist as well as a dictionary of their related collaborators. The class implements a getter for all of the attributes except level, for which it also implements a setter. The class also implements a __str()__ operation, which is used to print the object in the form "artistName (artistID)".

MongoBridge

The MongoBridge class is an interface to the MongoDB instance containing the data for the application. The class reads data from the database and returns a list of dictionaries containing the raw data found in the database collections. To begin, you should import the data found in the datalayer/Artists.json file into a Mongo database called "**BristolData**" into a collection called "**Artists**" using the same approach used in Lab 01:

```
mongoimport --db BristolData --collection Artists --type json --jsonArray --uri mongodb://localhost:27017 --file /path/to/Artists.json
```

Note that you must startup docker as you did in Lab 01. To access the data from a mongo server, you must first instantiate a mongo client and establish a connection to a collection in a database, as follows:

```
mongoClient = pymongo.MongoClient("mongodb://localhost:27017/")
myCollection = mongoClient["BristolData"]["Artists"]
```

To retrieve an individual record from the database you must specify a filter and issue a find command, as follows, which will search the database for the record with artistID = 938895:

```
afilter = {"artistID": 938895}
a = myCollection.find_one(afilter)
```

Variable a will either contain a single record or None.

A variant of the find method will return all records found in a collection but must be explicitly iterated through in order to "download" the records:

```
result: List[dict] = []
artists = myCollection.find()
for a in artists:
   result.append(a)
```

As such, the result variable will contain all records.

ArtistList

The ArtistList class is used to support displaying a list of artists. The artists attribute is a ***sorted*** list of tuples in the form:

(artistID, artistName)

For example:

(269365, "Jimmie Rodgers")

The artist_objects attribute is simply a list of Artist objects. The class implements getters for the two attributes as well as a __str()__ operation, which is used to print the individual Artist objects in a comma delimited list.

This class is responsible for connecting to the mongo server using the MongoBridge class. It will also instantiate individual Artist objects, saving them in the artist_objects attribute list.

Test Files

The test directory contains three test files:

- test_artist.py
- test_mongobridge.py
- test_artistlist.py

These files contain the core tests using unittest for the Artist, ArtistList, and MongoBridge classes, respectively. It is suggested that you fully employ the TDD approach by using these test files as your guide for implementing the project. Also, make note that you should implement the classes in the order of Artist, MongoBridge, and then ArtistList.

You should not make modifications to the test files except to add your own tests. Changing the nature of how tests are executed for each of the individual methods may affect the fidelity of your implementation.

You are required to create your own tests.

Execution

The application has been configured to allow for unittest, debugging, and system tests. While the system can be executed by PyCharm, your system should also be executable via the terminal using the following command: **python3 -m flask run.** The application will not run correctly until all of the code has been written.

Submission

The schedule for the project has shifted slightly as shown below:

Date (Midnight)	Phase	Description
September 9	Concept Initiate 0	User stories
September 23	Concept Initiate 1	Use case diagrams
October 7	Concept Initiate 2	Initial Design
~~**October 21**~~ **Mon Oct 31**	Iteration 0	Project environment setup and initial execution demonstration
~~**November 4**~~ **November 11**	Iteration 1	Graph Visualization
~~**November 18**~~ **December 2**	Iteration 2	Graph Algorithms and Delivery

Upon completion of your code, you should commit and push to gitlab using the following commands:

```
git commit -m “Completed Solution”
git push -u origin master
```

Rubric

The primary concerns for evaluation are the following:

- Implementation for the Artist, MongoBridge, and ArtistList classes must address the features described in the comments of the provided source files and associated tests. You will be evaluated on the quality of the code and the execution.
- You are required to create your own tests in addition to the provided set. The tests you create for the application must pass as you have specified.

- Supplied tests for Artist, MongoBridge, and ArtistList must pass as specified in the associated test files.
- Proper use of git: You will be assessed on your ability to clone, modify, stage, commit, and push your solution back to gitlab. DO NOT submit your files to iLearn. No files submitted to iLearn will be accepted.
- The application must run when issuing the python3 -m flask run command in the terminal.

Points: This assignment is worth 40 points

Tips

Historically, this iteration has tended to be overwhelming. Here are some tips:

- Start early; there is a lot of information to consume. Starting early will help you with comprehension
- Focus on one task at a time: implement the classes in the order suggested and focus on the individual methods as specified in the source file comments
- Use the unittest tests as your guide for implementing the methods; create your own tests as appropriate in order to break down the implementation task into smaller chunks