Jeff Killeen, Jon Ice, Jonathan Nix

November 17, 2014

Project Alpha

Needs to be changed…

- The CSV does not provide any information on prerequisites so the Course Relation in the ERD needs to be changed
- Occupancy for rooms are not mentioned, must be changed in schema
- Currently the application only lets the user change a class to a specific time and building: We need to add features that shows the best possible locations to move a class
- Password hashing needs to be added to our login

Design

Executive Summary: Karen, a degree plan specialist at ACU, was in need of an application that would ease in the process of taking students from a scheduled class and moving them into another timeslot. After she had moved a class, Karen also needed a way to view the possible conflicts students may have with this change. This application is intended to assist in the rescheduling of classes by finding the best possible timeslots for a scheduled class that has the least amount of serious conflicts.

Requirements:

Date Given	Summary
9/24/2014	User should be able to change the time (and possibly) location of a course
9/24/2014	List students who have conflicts after a class has been changed
9/24/2014	Rank the severity of each conflict by the student's classification and if the class is a required prerequisite
9/24/2014	User should be able to login to application. It needs to be secure as the information that is being used is confidential.
9/24/2014	Data that is used to display schedule must be taken from banner.
9/24/2014	Be able to search a class by CRN. Each class must have a unique CRN.

Work Breakdown Structure

Jeff Killeen: Project Lead. Has more knowledge and experience in the development of web applications and working with Ruby and HTML. Project Lead will provide direction and assistance where it is needed.

Jon David Ice: Backend developer. The business logic and database access of our application will be handled in this area with the help of Ruby and MongoDB.

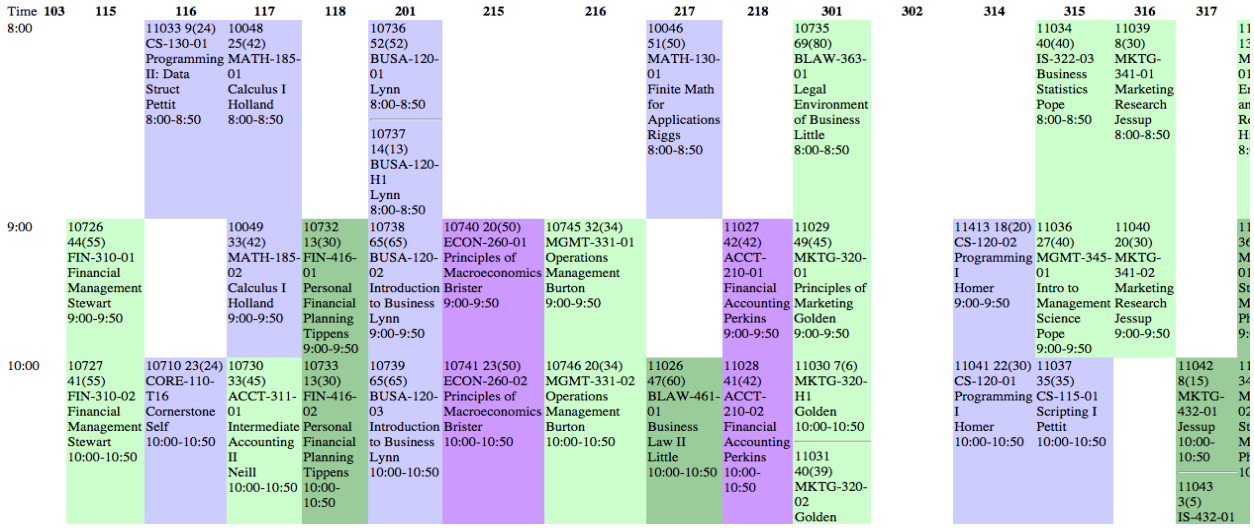
Jonathan Nix: Frontend developer. The views of the application will be handled in this area. The frontend developer will be in charge of making the webpages responsive with HTML, CSS, and Javascript with some help from other libraries such has Twitter Bootstrap.

Project scope

Detailed design by activity

Functionality of Application

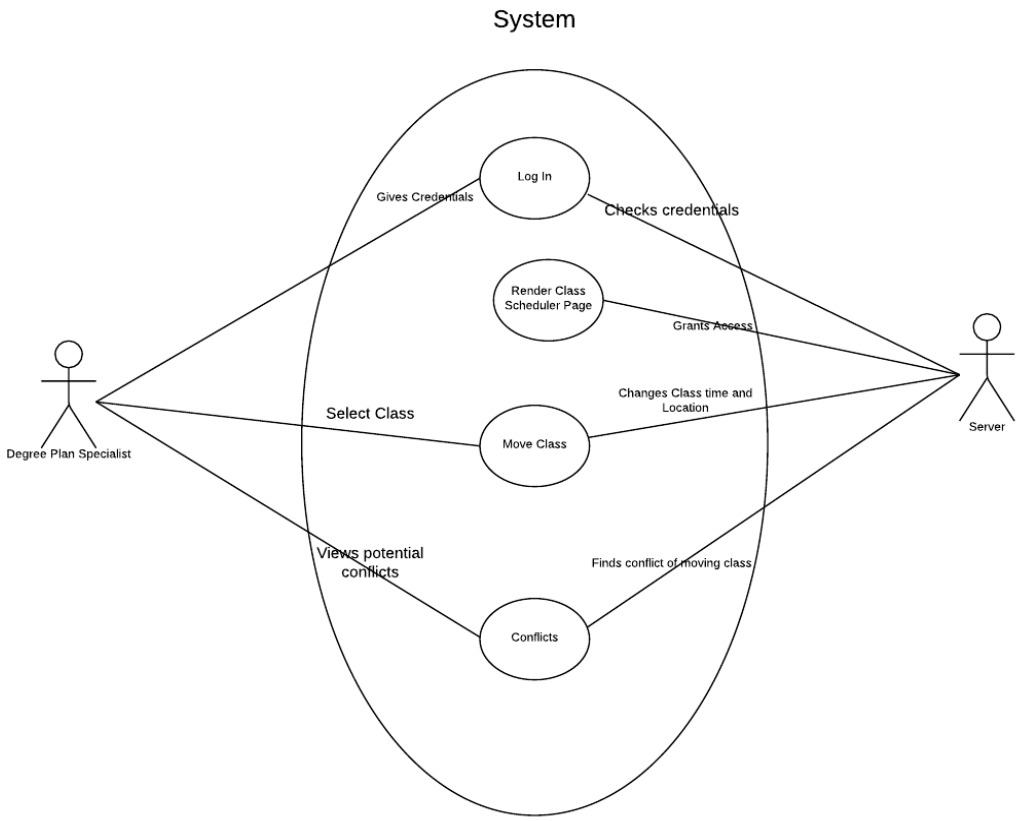
1) It will start off by prompting the user for a user name and password. (see security)
2) Once logged in, the user will be prompted with a drop down box to select a building. This will generate the class schedule calendar for that building. The picture below is an example of what the user will see.



Time	103	115	116	117	118	201	215	216	217	218	301	302	314	315	316	317
8:00			11033 9(24) CS-130-01 Programming II: Data Struct Pettit 8:00-8:50	10048 25(42) MATH-185-01 Calculus I Holland 8:00-8:50		10736 52(52) BUSA-120-01 Lynn 8:00-8:50 10737 14(13) BUSA-120-H1 Lynn 8:00-8:50			10046 51(50) MATH-130-01 Finite Math for Applications Riggs 8:00-8:50		10735 69(80) BLAW-363-01 Legal Environment of Business Little 8:00-8:50			11034 40(40) IS-322-03 Business Statistics Pope 8:00-8:50	11039 8(30) MKTG-341-01 Marketing Research Jessup 8:00-8:50	
9:00		10726 44(55) FIN-310-01 Financial Management Stewart 9:00-9:50		10049 33(42) MATH-185-02 Calculus I Holland 9:00-9:50	10732 13(30) FIN-416-01 Personal Financial Planning Tippens 9:00-9:50	10738 65(65) BUSA-120-02 Introduction to Business Lynn 9:00-9:50	10740 20(50) ECON-260-01 Principles of Macroeconomics Brister 9:00-9:50	10745 32(34) MGMT-331-01 Operations Management Burton 9:00-9:50		11027 42(42) ACCT-210-01 Financial Accounting Perkins 9:00-9:50	11029 49(45) MKTG-320-01 Principles of Marketing Golden 9:00-9:50		11413 18(20) CS-120-02 Programming I Homer 9:00-9:50	11036 27(40) MGMT-345-01 Intro to Management Science Pope 9:00-9:50	11040 20(30) MKTG-341-02 Marketing Research Jessup 9:00-9:50	
10:00		10727 41(55) FIN-310-02 Financial Management Stewart 10:00-10:50	10710 23(24) CORE-110-T16 Cornerstone Self 10:00-10:50	10730 33(45) ACCT-311-01 Intermediate Accounting II Neill 10:00-10:50	10733 13(30) FIN-416-02 Personal Financial Planning Tippens 10:00-10:50	10739 65(65) BUSA-120-03 Introduction to Business Lynn 10:00-10:50	10741 23(50) ECON-260-02 Principles of Macroeconomics Brister 10:00-10:50	10746 20(34) MGMT-331-02 Operations Management Burton 10:00-10:50	11026 47(60) BLAW-461-01 Business Law II Little 10:00-10:50	11028 41(42) ACCT-210-02 Financial Accounting Perkins 10:00-10:50	11030 7(6) MKTG-320-H1 Golden 10:00-10:50 11031 40(39) MKTG-320-02 Golden		11041 22(30) CS-120-01 Programming I Homer 10:00-10:50	11037 35(35) CS-115-01 Scripting I Pettit 10:00-10:50		11042 8(15) MKTG-432-01 Jessup 10:00-10:50 11043 3(5) IS-432-01	

3) The user will be asked which class they would like to reschedule. They will enter the CRN, Time, Day, and Room of the class and click “submit”.
4) Two representations of data will be generated.
   a) The calendar’s empty spaces will be populated with the number of students in the class that moving the class to that room and time slot affects.
   b) There will be a list of all the possible room and time slots to move the class ordered by increasing number of affected students.
5) Clicking on a field in the calendar or list will take the user to a page that gives a list of the students in the class, their classification, and which class the schedule change conflicts with.
6) Clicking on a specific student will display their current schedule for the user to figure out whether the conflict can be dealt with or not.

Use Case Diagram:



Architecture

In our application, we are going to base our implementation around the MVC design pattern. Using this design pattern will allow us to separate the logic so that there is no confusion on what each part of the application does and it will also allow the different layers of our application to communicate with one another.

Our application is initially set up using the Sinatra web framework. This means that the controller or business logic of our web application will be handled by Ruby. Component-based software engineering will be made easier for us thanks to Ruby's assortment of gems that have been made to speed up the web development process e.g. BCrypt gem, which can be used to hash and salt a password; or Pony, which will make it easy to email specific users of our site.

For the views aspect of our MVC design, we will be using embedded ruby files, or ERB for short. ERB will allow us to execute Ruby code on our previously existing HTML pages so that they will become much more dynamic.

Finally for our model, we will be making use of the Mongoid gem in Ruby, which allows us to wrap classes created in Ruby into Documents that will be used in MongoDB. The Mongoid gem lets us write code that appears to be written in Ruby that is easily translatable into MongoDB. MongoDB was chosen for the project because it is designed to be fast and scalable so that users will get minimum wait time for their queries.

Database

As mentioned above, we will be using MongoDB for the database for our web application. One helpful thing that MongoDB does is that it allows our entities to hold embedded documents. This means that we can easily see the information stored between one entity and another.

For our database, we will have multiple entities for our application. All of the entities have components that coincide with one another, expect for the User entity, which is primarily used for interaction with the site. The ERD listed below helps describes the relationships between our entities.

With the Mongoid gem, we are able to create classes in Ruby that can be translated into documents in Mongoid. The following classes will be created:

User: The User class is the only class that does not have a relation with any of the other entities. The User class will be used to keep track of users logged into the system.

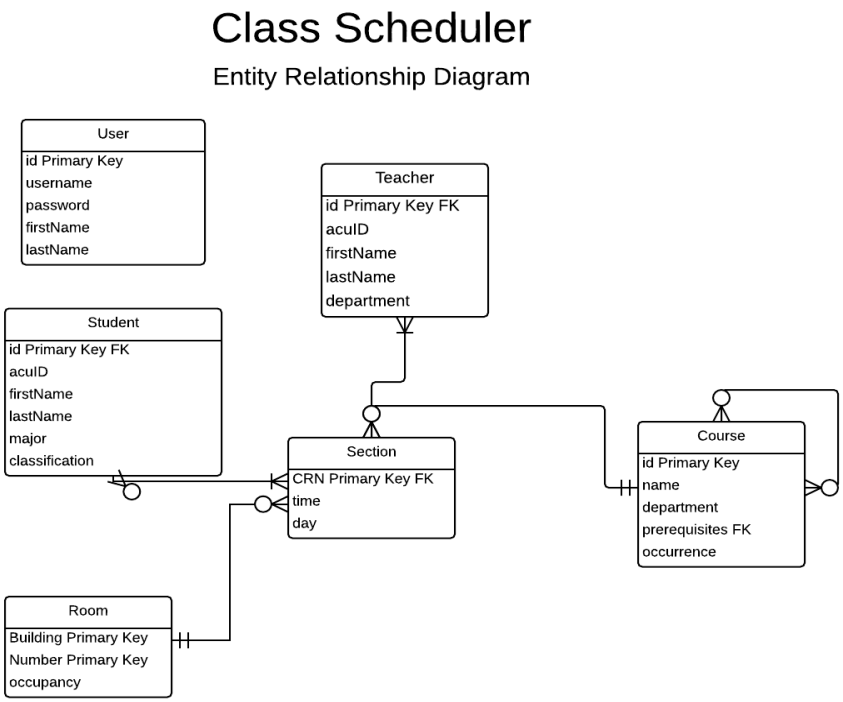
Teacher: A Teacher will have zero to multiple Sections. An important distinction to make is that a Teacher does not teach a Course but a Section. This will allow us to distinguish the different times a Teacher might be teaching a class.

Course: A Course will have a name, a department, and prerequisites, which will be a many-to-many relationship to itself. A course can have many sections or no sections at all, if it is not being taught that semester.

Section: A Section will have a unique CRN, with a certain date and time of the week. A section will belong to a Room.

Student: A Student will be enrolled in multiple sections. The student will need to take certain Sections that will correspond with a Course needed for graduation. The student's classification will determine the severity of changing a course within our application.

Room: A Room will have a building attribute and a room attribute to distinguish between other rooms. A Room can be home to many Sections and a Section must belong to some room. The occupancy attribute of the Room will determine the amount of Students allowed to enroll into a certain section.



Security

We want to make sure that only people who are authorized are able to use the application because they will be viewing confidential information. To ensure this, we will prompt with a form for their username and password. Once they submit the form, we will check their username to see if it already exists in our database. Then, if their password exists, we will hash their password with a salt and compare the salted password with the one stored in our database. Once both components match up, we will allow access to the user for our application.

Glossary

ACU ID- Both teachers and students have an ACU ID. This describes the unique ID that is used to identify a teacher or student.

Building- Each section has a building. This describes which building the section takes place in.

Course- A course is implemented by any number of specific sections

Classification- Each student has a classification. This describes the student's current standing at the university (e.g. Sophomore, Junior, Senior).

CRN- Each section has a CRN. This describes the unique number used to identify a section.

Day- Each section has a day. This describes which days the section is on.

Department- Each teacher has a department. This describes the department that the teacher belongs to.

First Name- Both teachers and students have a first name.

ID- Both teachers and students have ID's. This describes the unique number used to identify a teacher or student.

Last Name- Both teachers and students have a last name.

Major- Each student has a major. This describes what type of degree plan the student is currently on.

Name- Each course has a name. This describes what the content of the course is about to the user.

Occupancy- Each section has an occupancy attribute. This describes how many students are in a section and how many students can be in that section.

Occurrence- Each course has an occurrence attribute. This describes how often a course is offered by the school.

Password- A user has a password. Their password is used for security purposes and allows the user to access the application.

Prerequisites- Each course has a prerequisite. This describes which courses need to be taken in order for a student to take the course in question. This could be zero or more.

Room- Each section will be taught in a room

Room Number- Each section has a room number. This describes which room the section takes place in.

Section- A section is an instance of a course.

Student- A student is enrolled in any number of specific sections.

Teacher- A teacher teaches any number of specific sections.

User- A user is able to access the application via their username and password. They use the application to assist in rescheduling a specific section.

Username- A user has a username. The username is used for security purposes and, coupled with the password, allows the user to access the application.

Specification

Product Overview

This product is intended to assist users in the rescheduling of specific sections.

Requirements

Priority Definitions

1. This requirement is a "must have" for the product to function.
2. This requirement will make the product much more efficient, but is not necessary for it to function. It is still highly imperative.
3. This requirement is a luxury and is not necessarily needed. Functional Requirements

Functional Requirements

Function	Priority	Date Reviewed	Approved by
The system should provide all information available via Banner regarding the rescheduling of the section in question for the user to view.	1	8/12/14	Jonathan Nix
The system should provide the optimal solutions for rescheduling a section.	3	8/12/14	Jonathan Nix
The system should provide information in order of relevancy. The user determines relevancy and chooses which information they want to view.	2	8/12/04	Jonathan Nix

User Interface Requirements

The user interface should…
- Provide a user login screen.
- Provide prompts for the user to input current section information. Instructions on what input to give and what to do to run the application should be clear.
- Provide output as information in a table format. This will look like the already existing room times' table.

- Provide output as information in a list format. An example of this is displayed below the same existing room times' table.

Usability
The product should…
- Be easy to learn and understand. Clear instructions will be provided on each page regarding how and where to give input and how to view different output. (See User Interface)
- Only be useable by authorized personnel. (See security)

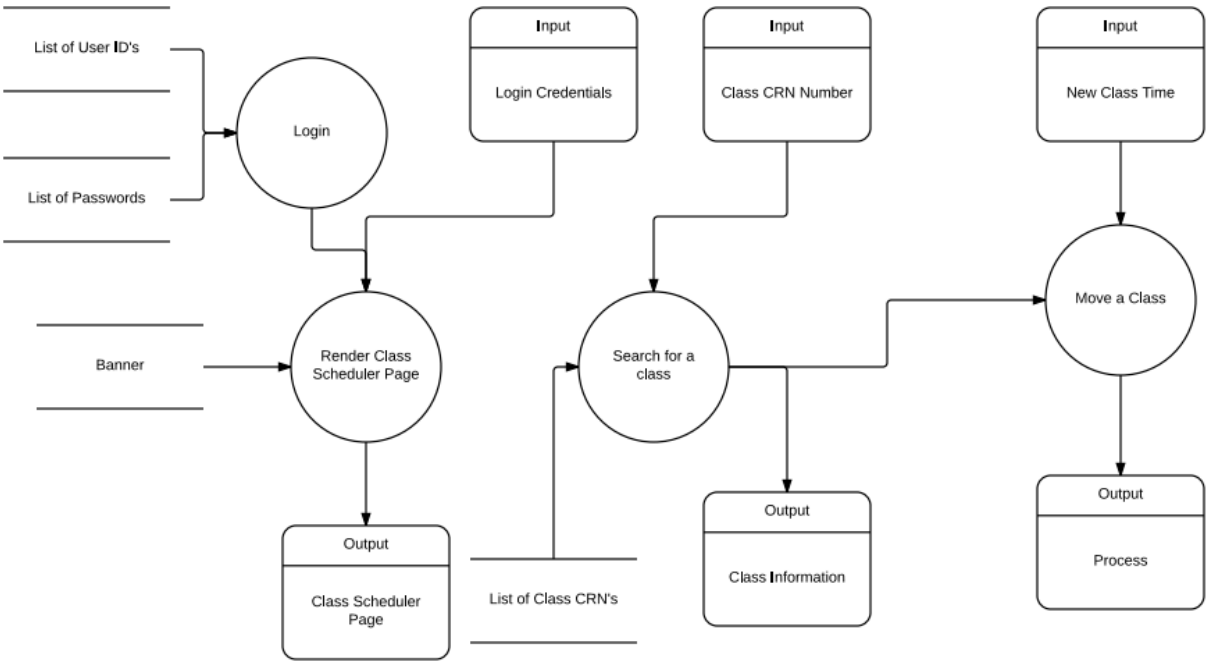
Performance
The product should…
- Be able to support multiple users at once.
- Be able provide correct feedback within an average of 5 seconds.

Manageability/Maintainability
The product should…
- Have access to Banner and download information each night.
- Run on multiple at least two servers so that if one fails, the system can remain operational
- Have embedded Ruby files that allows our system to be more easily maintained.

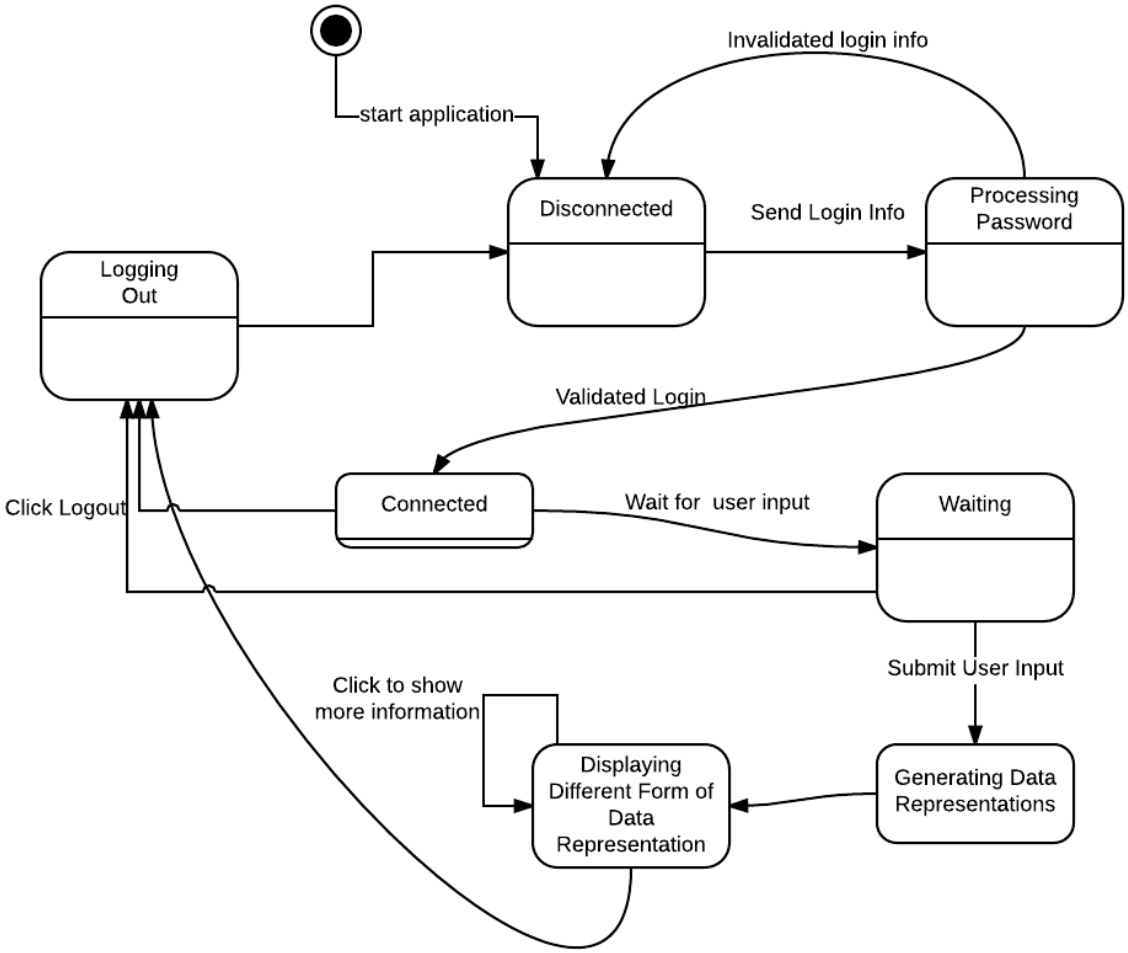
System Interface
- Our system will use MongoDB.
- Our system will use the testing framework, Cucumber.
- Our system will use Sinatra.

Logic and Algebraic Specifications
We felt that there was no need to describe our specifications in this way. After analyzing the different processes that our web application goes through, we saw that the addition of these descriptive specifications would only complicate our document. We felt that our previous specifications were sufficient in describing the workings of the application. The Algebraic specifications seems to be only relevant if our application heavily relied on using object oriented concepts, but we did not specify any objects oriented concepts in our design.

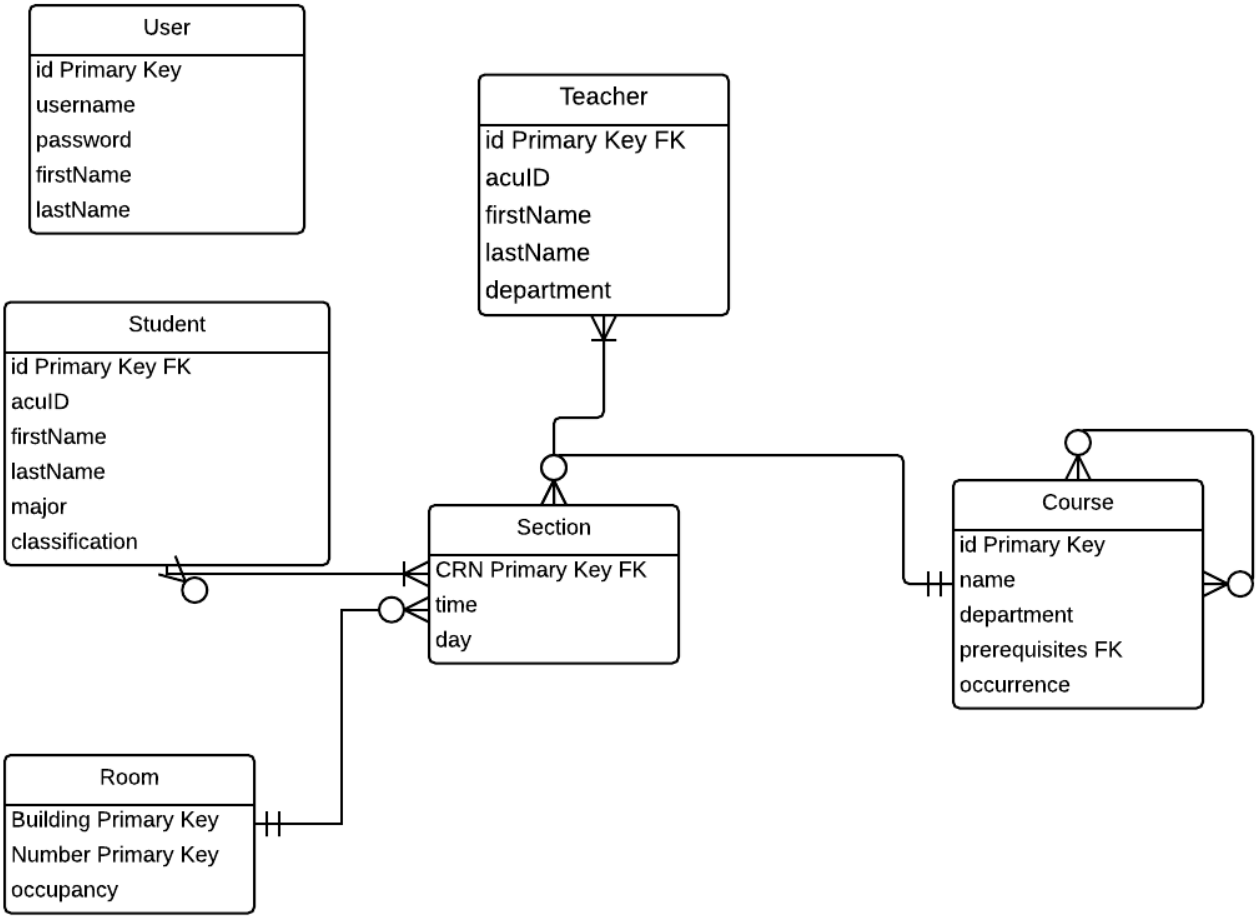
DFD


List of User IDs
List of Passwords
Login
Input
Login Credentials
Input
Class CRN Number
Input
New Class Time
Banner
Render Class Scheduler Page
Search for a class
Move a Class
Output
Class Scheduler Page
List of Class CRN's
Output
Class Information
Output
Process

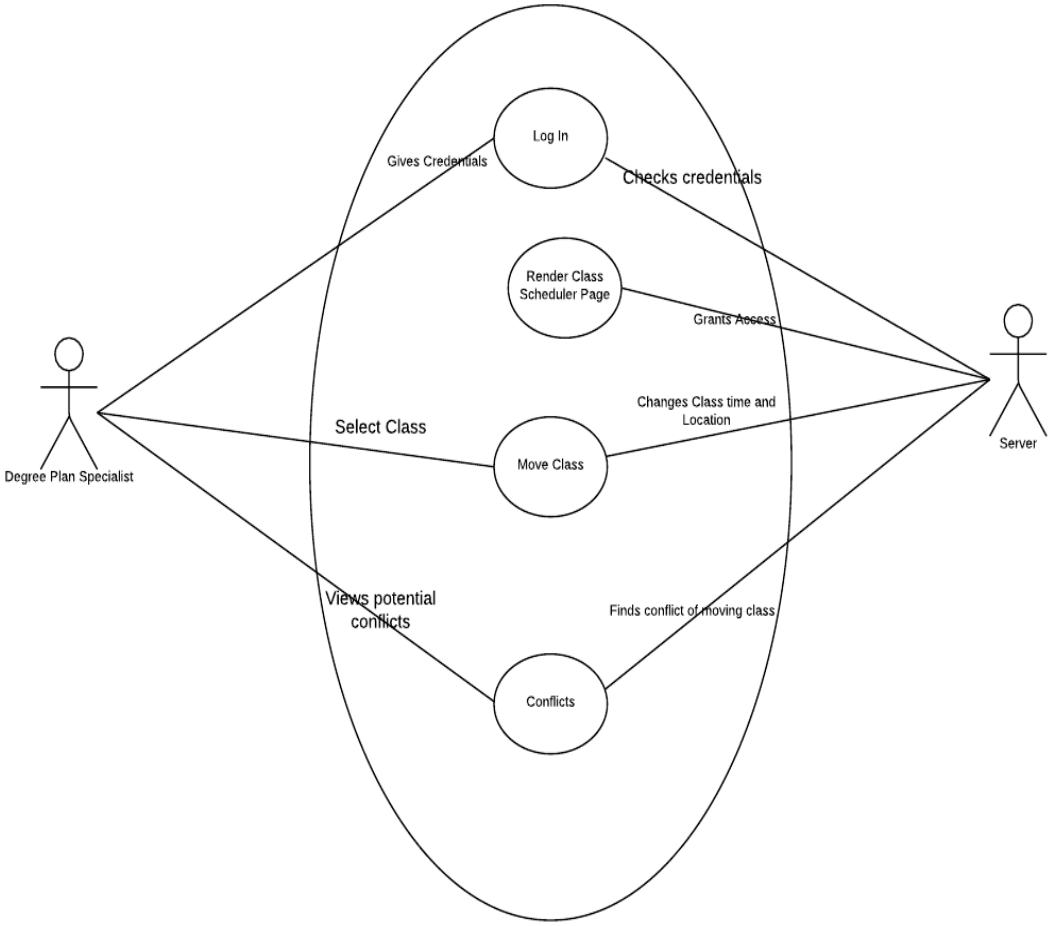
State Machine



Entity Relationship Diagram



Use Case Diagram (UML)



Verification

Testing in the Small

White box testing: Currently we do not have the information to start our white box testing. However, we plan on doing the following types of coverage once we receive the necessary information.

Statement Coverage: We need to be able to hit every part of our code with our tests so that any possible errors can be addressed.

Edge Coverage: We will create a control flow diagram for our code when we have written it. It is important that we write tests that traverse each edge of the diagram at least once to catch as many errors as possible.

Condition Coverage: An enhancement of Edge coverage, we will make sure that our tests catch even more errors. To do this, we will create tests that result in all possible values of the constituents of compound conditionals at least once. This simply means that given a conditional such as “if A and B”, we will create tests that address each combination of A and B where A and B can either be true or false.

Black box testing:

In black box testing, we are checking to see if a specific part of a program does what it is intended to do. This will be done through our cucumber tests in our project. By taking a test driven development approach, we can write tests that say how the features of our application should work and then we can actually code our features to make our tests pass. This type of testing is testing driven by logic specification.

When we have modules written, we will use other black-box techniques such as decision table based testing and a cause-effect graph.

Testing in the Large:

There are three main aspects to testing in the large.

Modularity Testing: Based on how we decide to implement our code, we will test each module using white and black-box techniques. We will also identify which modules depend on one another to operate properly.

We currently have one feature with one scenario written as a cucumber test. The feature is logging in and the scenario is that the input is a valid username and password. The application will access the database for information, so it expects the database to be structured a certain way.

Integration Testing: As we continue to add modules, we will test to see if the new modules integrate well with the previously tested modules.

We will use a top-down approach for integration testing. This will allow us to view the application in a more abstract sense in terms of what features it has and then push down to subsets of those features.

System Testing: Once we have a finished prototype, we will test the entire system.

We will use overload and robustness testing to figure out the limits of our application. However we will not worry about testing for regression because this is just a semester-long project that will be, for the most part, out of our hands when we are finished. If we were required to be in charge of this application and adding new features as they were requested, we would be more concerned with testing for regression.

Analysis

Code Walk-Throughs: We will have several scheduled opportunities to go through our code and trace it by hand to find any logic errors that have occurred in the process of writing the code. When these errors are found they will be documented and dealt with appropriately.

Code Inspections: Similar to the code walk-throughs, we will have several code inspections to look through our code with the specific intent of looking for common errors in the code. If these are found then they will be documented and dealt with appropriately.

Correctness Proofs: We will not be using correctness proofs on our project and are instead focusing on testing using the Cucumber framework. We believe that this will be sufficient in providing feedback on the functionality of our system and feel that using correctness proofs would be more detrimental than helpful for the following reasons:

- would be longer and more complex than the programs it is intended to prove.
- overwhelms the designers with more details than could easily be dispensed with if they use an informal analysis.
- Even if mathematical certainty of the correctness of a program can be achieved, we cannot rely on it in an absolute way because there could be a failure in the implementation of the language (the compiler) or even in the hardware.

Symbolic Execution

Symbolic execution allows us to combine the techniques of analytical testing and experimental testing. We won't need to use symbolic execution in our testing.

Model Checking

For model checking, we already have a basic finite state machine. We will use it in our testing to see if our application does fulfill each property that we have specified. If not, we will have a counterexample, or a test case that cause the application to break.

Debugging

Debugging is technically not a verification activity, but it still goes hand in hand with our other testing approaches. A failure is a behavior that does not match the product specifications. It is difficult to find certain failures in a project because the failure can be determined by multiple errors. In order to debug our project, we have a few precautions in place. Using Sinatra, we can see if there is a certain action that breaks our system; we are immediately notified with the

specific error on our web page. From there, we can go through our code and see what line caused the error. If we reach a failure that greatly affects the features of our application, then we will need to reevaluate the coding of those features and have our tests address that change.

Verifying Other Software Properties

Performance: For the scope of our project, we will not be using formal performance analysis technique such as worst-case runtime simply because taking into the intent of our application, unless the product performs notably in an unreasonable time, formal analysis is unnecessary.

Reliability: As with performance, it is unnecessary for our application to have extensive formal reliability testing that would be more extraneous than helpful and thus we will measure reliability with very basic level probability statistics such as how many times out of 10 tests does it return a correct result.

Subjective Qualities: Considering the scope and intent of our project, the measurements of subjective qualities in our application such as a program's complexity will be left to the developers' internal discretion. It is not necessary for us to use complex theories to validate these qualities in our project because its small scope allows the developers to gauge these using human intuition and still be able to use accurate metrics for these qualities.