Acknowledgements

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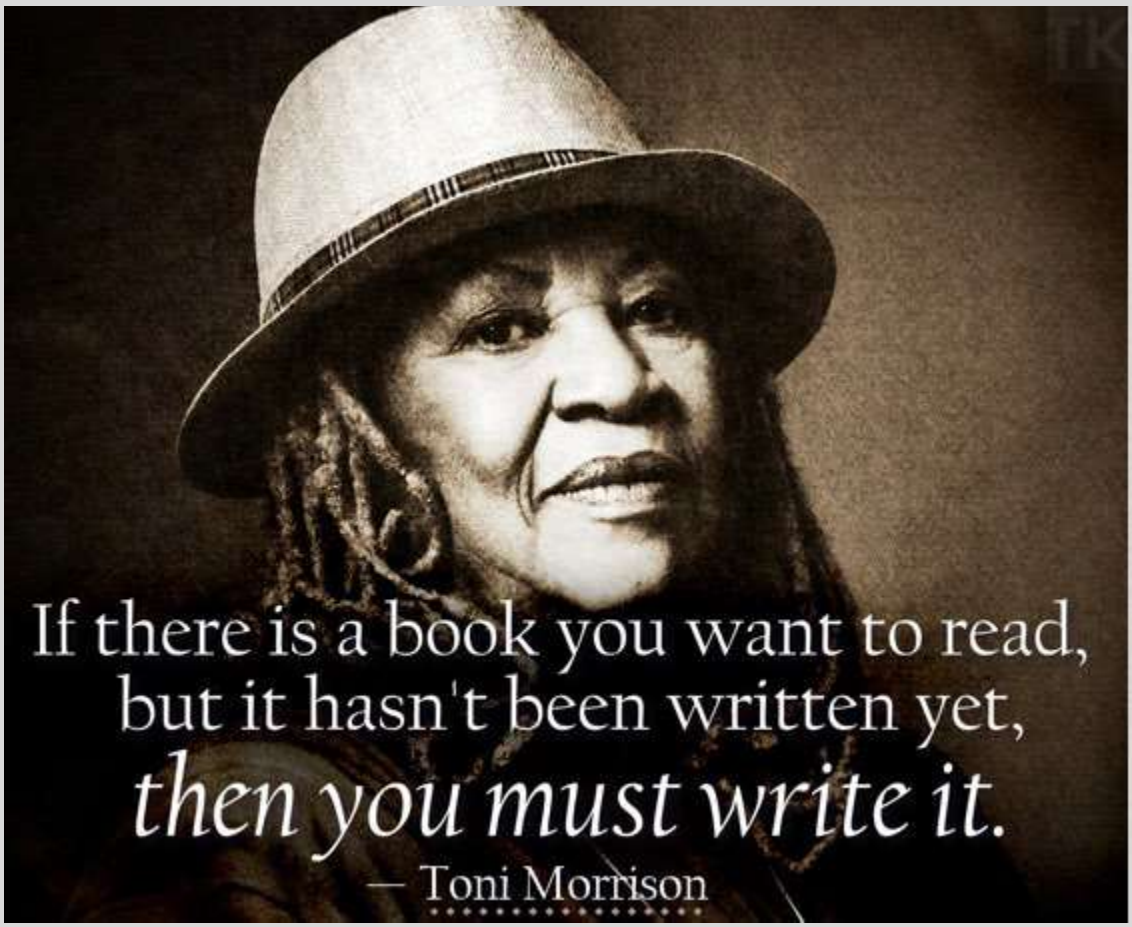


Yes, this is not a book, but you deserve it! And keep those other dreams alive.

Introduction

In Tanzania, the most common form of transportation is minibuses – known as daladalas, followed by three-legged cart cars (bajajis), and walking. With daladalas, private citizens can own a bus and hire both a driver and a conductor who collects the ride fare, assigns seats to passengers, and calls out for stops to passengers coming in and out of the bus. The owner will agree on an expected monthly total with the driver and conductor, and the two workers split any difference thereafter. For instance, if the agreed upon monthly amount is TSH 2,500,000, and the bus makes TSH 4,000,000 for a specific month; the bus owner gets TSH 2,500,000 while the driver and conductor each get TSH 750,000 from the remaining balance.

Dar-es-Salaam daladalas

Line of parked bajajis

Each bus, through their owner, requests to drive a specific route at a given time of day from the local government – the organization responsible for setting up the schedule through accepting and denying bids from owners. Once a route is approved for a bus, it usually stays the same for a long period of time, sometimes, never changing. The government official sets these buses up for runs daily on notebooks and through gentleman's agreements. This way of doing things makes the system inefficient, leaves room for richer owners to request favors and get more favorable routes to boost their income even more, and does not allow for operational procedures to be in place for when a contingency plan is needed. Additionally, quality assurance is not a priority as bad performing drivers, conductors, or even faulty buses can be on the streets without any government official's knowledge.

Proposal

To help streamline this process and ensure that the buses (through drivers), and owners are accounted for properly, a scheduling system is designed where the following functions are essential at the first phase:

- Create a logistics bus scheduling system for a centralized organization. In this case, the organization would be the local government whose job it is to assign time slots for bus owners for their drivers and conductors, and have a full picture of the operation.
- The owner has an account that connects the bus to the driver for scheduling purposes. Since the driver for the owner remains the same in Tanzania, then we can cut out the owner in this transmission of information stage so that the bus drivers can pick from available time slots (in coordination with conductors). With this, the buses can be scheduled to stay on the same route for up to a week.
- The conductor is not assigned as a user because their role does not require any coordination with the local government. In this phase, we assume that the driver and conductor coordinate to decide a schedule, and the driver or admin has the ability to set up a schedule for the specific bus for a desired route and time.
- At this phase, a lot of the scheduling power is being left to the driver. Ideally, if the buses didn't have a specific driver/conductor team, they would both have access to the app/website and be able to pick their schedules as needed. The owner could do this but since the only role they would play is a messenger to the driver and conductor once they know this anyway, it doesn't make sense to have them on this part of the equation.

Business Value

At the base level, having a system for scheduling buses and runs makes the process more efficient than it is now. The owner does not have to be a middle man for scheduling his buses and the driver can directly select options. Now that the drivers will be able to select their schedule autonomously, there is less opportunity for the owner and local government to have side agreements or bribes that benefit some bus owners more than others. Once scheduled, the route is only guaranteed for up to a week. Lastly, there is increased ability of the local officials to coordinate route needs in a more efficient manner, and be aware of any issues e.g. inactive buses, drivers.

Note: The system does not completely eliminate some of these issues. For instance, because the admin (local government user) has the ability to change a driver's schedule, so an owner can still influence their routes through the admin user, but now to a lesser degree. The only reason an admin user has the ability to change schedules is to make sure no route is short on buses. This system also assumes that most drivers have cellphones to be able to use the system. In reality, smart phones are still a novelty in Tanzania, but almost all people who live in the city (where daladalas operate) have some version of a cell phone. To accommodate this user market, the system is designed as a text application.

User Requirements & Functions

There are going to be three types of users in this system – the admin user who is the local government authority in charge of coordinating bus scheduling logistics, the bus owner(s), and the bus drivers assigned to a bus, each of which is connected to a specific owner. The functions for each user is defined below:

Bus Driver

- Sign up for an account using their first and last names, phone number, username and password. The driver gets assigned a bus by the owner who they work for.
- Log into their account to perform a series of functions below depending on whether or not their bus is active or assigned
  - → If the driver does not have an assigned bus, or his/her bus code is deactivated, then the driver is also deactivated and cannot work unless the owner reassigns this driver to another bus
  - → Change their shift up to two days before the run is scheduled to be completed.
  - → Select the time slots for operation based on the bus routes and times available. When times or routes are all filled up, the driver will not be able to see it as an option to select for a schedule run

Bus Owner

- Sign up for an account using their first and last names, phone number, and username and password.
- Log into their account to perform a series of functions below depending on whether or not their account is active based on the admin's rules
  - → Add a bus to their roster of properties and assign a driver to it. The admin has authority to deactivate a bus if they see fit
  - → Assign or reassign a bus to the drivers they have hired

Centralized Organization - Local Government

- This user has the admin role. He is able to sign into the application and has access to change all other user's data
- Get a daily report of each route's need
- Change a driver's route and schedule up to 24 hours in advance if there is a shortage for a specific route
- Activate or deactivate a bus owner's account, or a specific bus. Once a bus is deactivated, the driver cannot sign up for a schedule run. When an owner is deactivated, all the buses under this owner are also deactivated.
- Set and change the route need for a specific route depending on changing metrics for the location and population needs. For example, if during Christmas, the traffic gets denser around in Kristo Mfalme area, the morning need can be changed from 5 to 8 for all routes touching this particular location
- Add new routes if they arise

Program Design

In this section, the program's structure will be illustrated on three levels – user interface design, class structure, and file and database design.

User Interface Design

This is the section of the system that the users interact with to perform their functions. As mentioned earlier, most people have phones but they may not always be smart phones. The bus owners and admin users from the local government are more likely to have smart phones. However, the drivers who make up the majority of users of this application do not. To accommodate this need, this is designed as a text application where users are provided with options to navigate and complete their tasks.

Driver Profile

Below is an example of how the driver what the driver sees, and how they would use the application to execute their functions. To begin, they are able to sign up for an account or log into an existing one.

```
Welcome to Logistics-R-Bus!

1 = Log in
2 = Sign Up: 2

New Account Sign Up:
Please provide the following credentials for a new account:
First Name: Willy
Last Name: Paul
Phone Number: 252525252
Username: willy
Password: ........

Congratulations, Willy! Your account has been created.
```

```
Log in to Logistics-R-Bus:
Username: bkavishe

Password:
```

Once in the system, they can see any messages if an admin user changed their schedule, and a list of options for how to set their schedule.

```
Hello,  Boniface !
T651 JRW
You have no new messages.

For your options, enter:

1 = Set your schedule
0 = Exit:
```

As the user navigates through the system, they are able to exit the system and go back to the log in prompt.

```
For your options, enter:
1 = Set your schedule
0 = Exit: 0
No tasks here! Thanks for using Logistics-R-Bus!
```

The driver has limited actions in the system. They are only able to set a new schedule run, or update an existing one. The rest of their use is dictated by the admin and bus owner.

For navigating these choices, the driver can go through the below progression to select either option.

```
For your options, enter:
1 = Set your schedule
0 = Exit: 1

Schedule Selection (enter number to select)
1 = Add new schedule run(s)
2 = Change current scheduled run(s): 1

Schedule Options: 1 = Weekly, 2 = Daily

Please enter a preferred schedule type:
```

For adding a new schedule run, the driver will pick their preferred schedule type (weekly or daily) and run time based on the available dates and routes. Weekly scheduling is only available from the next Monday while daily scheduling is available for dates at least two days in advance. One is also able to schedule multiple days with daily options. In another phase, they would be able to customize run times and schedule non-consecutive days.

```
Schedule Options: 1 = Weekly, 2 = Daily
Please enter a preferred schedule type: 2

The next day available to schedule is:  Wed, 27 Nov, 2019
Enter "1" to proceed, or "0" to exit: 1

To select preferred run time, enter "AM" (6am-2pm) or "PM" (2pm-10pm): pm

Enter "1" to schedule the next day and same time run or 0 to finish: 1

Enter "1" to schedule the next day and same time run or 0 to finish: 1

Enter "1" to schedule the next day and same time run or 0 to finish: 0

For your availability of 2019-11-27 to 2019-11-29 for PM run(s)
The following routes are available to schedule:
From Location        To Location          Route Code      Drivers Needed
DOU-KCM              Double Road          KCMC            8
DOU-KRI              Double Road          Kristo Mfalme   5
KCM-KRI              KCMC                 Kristo Mfalme   8
KCM-MAI              KCMC                 Mailisita       5
KCM-SHA              KCMC                 Shanti Town     5
```

At this time, a shortcoming for this system is the navigation doesn't allow a user to go back and change their selection for every step unless they log back in. When picking routes however, this is available and a driver can pick a different route on the spot and all inputs are validated to make sure the route entered exists.

```
Please enter the route code for your preferred route: KCM-KI
Error! Enter a route code from the offered options: KCM-KRI
Please enter 1 to confirm route and 0 to pick another route: 0
Please enter the route code for your preferred route: KCM-MAI
Please enter 1 to confirm route and 0 to pick another route: 1
Error! You are already scheduled to drive on 2019-11-27
```

Additionally, if a driver has already scheduled some dates previously, he or she will be notified that they cannot add anything else for that day and redirected to options.

```
Redirecting to driver options...


1 = Set your schedule
0 = Exit:
```

A driver can also update or delete already scheduled runs. They are able to change the date and run time, but not the route scheduled, all with validation. If the update option resembles a run already in the system, the driver will be notified and redirected back to the home page. The user is also able to navigate to delete a scheduled run.

```
Schedule Selection (enter number to select)
1 = Add new schedule run(s)
2 = Change current scheduled run(s): 2

1 = Change scheduled run(s)
2 = Delete scheduled run(s): 1
Note: You can only update runs at least two days from today

Enter 1 to proceed or 0 to add a new run: 1
#  Scheduled For   Route Code      Run Time
1  2019-11-25      DOU-KCM         AM
2  2019-11-26      DOU-KCM         AM
3  2019-11-27      DOU-KCM         PM
4  2019-11-28      DOU-KCM         PM
5  2019-11-29      DOU-KCM         PM
6  2019-12-01      DOU-KCM         PM
Please enter the number of the run you'd like to update: 2
To update the date, Enter Y/N: y

Please enter desired date (YYYY-MM-DD) : 2001
Error! Enter a valid date in form "YYYY-MM-DD": 2019-11-01
Error! The date is invalid or out of scheduling range. Re-enter date in form (YYYY-MM-DD): 2019-11-29
New date:  2019-11-29
To update the run, Enter Y/N: n

Run will remain unchanged for your scheduled run.

Accept new changes? (1 for Yes, 0 for No): 0
Your scheduled run on 2019-11-29 will remain unchanged.

Redirecting to log in...

Enter 1 to log in
0 to Exit:
```

Owner Profile

The owner's access to the system also gives them a log in and looks like the driver's. Once in, they are able to also see options for their specific tasks.

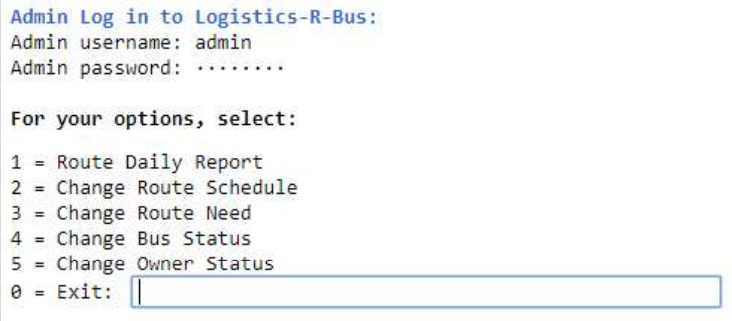
```
Log in to Logistics-R-Bus:
Username: jkavishe
Password: ........

Hello,  Juma !

You have no new messages.

For your options, enter:

1 = Add Buses
2 = Assign Buses
0 = Exit:
```

When an owner is adding a bus, they also have the option to assign it to a driver right then and there. They are also able to do this on their main menu at another time by selecting option 2, seen above. As with the driver, all inputs are checked before accepting entries to sign into the system, and update or insert information into the database.

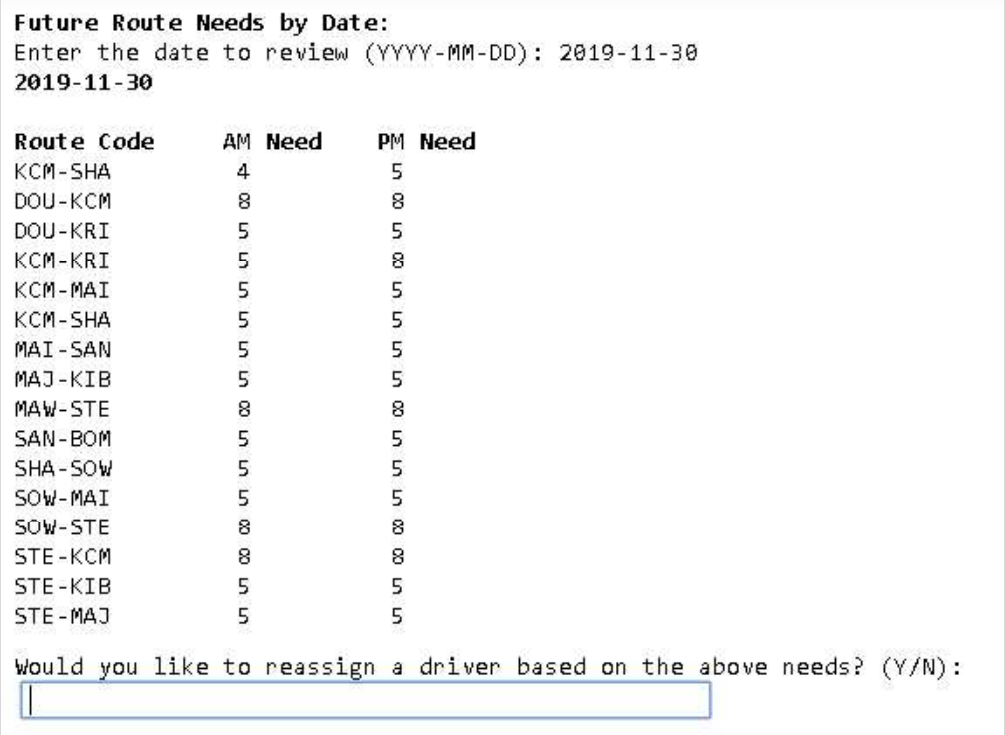
```
For your options, enter:
1 = Add Buses
2 = Assign Buses
0 = Exit: 1

Add a New Bus:
Please provide the bus license plate number (T000 LLL): T2D3F
Invalid format. Please provide the bus license plate number (T000 LLL): TFGH 444
Invalid format. Please provide the bus license plate number (T000 LLL): T444 FGH
Confirm you would like to add bus T444 FGH (Y/N): Y
Bus T444 FGH has been added!

Would you like to assign bus T444 FGH to a driver? (Y/N): Y

Assign Bus to Driver:
Please enter driver's credentials
First Name: Boniface
Last Name: Kavishe

Bus T651 JRW's is now unassigned and is inactive.
Boniface Kavishe has been assigned to bus T444 FGH.

Bus T444 FGH's is now assigned and is active!

Redirecting to log in...

Enter 1 to log in
0 to Exit:
```

Admin Profile

This user has the most access of the system. Unlike the driver and owner accounts, the admin log in is assigned by the organization, therefore the only way one would be able to log in would be through these credentials.



The admin user can navigate using prompts to see a day's report for all route needs. The date at this time has to be at least two days in advance and within a week, because the admin is also not allowed to adjust a driver's schedule less than two days in advance, and cannot schedule them for more than a week after that.



Should the admin user want to schedule drivers to a specific route right away, they are able to do so by specifying above. They can also do this at a later time on the second menu option "Change Route Schedule

The admin can see a list of all available drivers, and will be able to select a driver, and a runtime. Once set, the driver will see a message of this assignment when they log in any date before the scheduled run.

```
Please enter the date for route changes: 2019-11-30
Please enter the route code for your preferred route: KCM-MAI
Please enter 1 to confirm route and 0 to pick another route: 1

Assign Drivers to Routes:
Here is a list of drivers who are active to drive on 2019-11-30:
#     First Name      Last Name       Bus Code
1     Boniface        Kavishe         T651 JRW
2     Maria           Massawe         T995 FOU
3     Subira          Mwinyi          T887 KGY
4     Charles         Mohamed         T814 SPC
5     Juma            Mohamed         T237 HRK
6     Agnes           Kikwete         T970 IEM
190   Ramla           Mkapa           T282 LTW
191   Juma            Mashingia       T596 ESC
192   Charles         Moshi           T879 FPG

Please select the driver you'd like to assign to route KCM-MAI: 190
Please provide the run you'd like to schedule Ramla Mkapa for (AM/PM): PM
Ramla Mkapa has now been assigned to route KCM-MAI on 2019-12-02

Redirecting to log in...

Enter 1 to log in
0 to Exit:
```

The admin also is able to change the number of buses needed for each route depending on the time of day. At this time, there are no metric reports to track changes in need throughout the different seasons of the year. This would be a helpful business planning addition in a later phase of this application.

```
Route Updates:
#     Route Code      Start Location  End Location    AM Need     PM Need
1     DOU-KCM         Double Road     KCMC            8           8
2     DOU-KRI         Double Road     Kristo Mfalme   5           5
3     KCM-KRI         KCMC            Kristo Mfalme   6           6
4     KCM-MAI         KCMC            Mailisita       2           2
5     KCM-SHA         KCMC            Shanti Town     5           5
6     MAI-SAN         Mailisita       Sanya Juu       5           5
7     MAJ-KIB         Majengo         Kiboriloni      5           5
8     MAW-STE         Mawenzi         Stendi          8           8
9     SAN-BOM         Sanya Juu       Boma Ng'ombe    5           5
10    SHA-SOW         Shanti Town     Soweto          5           5
11    SOW-MAI         Soweto          Mailisita       5           5
12    SOW-STE         Soweto          Stendi          8           8
13    STE-KCM         Stendi          KCMC            8           8
14    STE-KIB         Stendi          Kiboriloni      5           5
15    STE-MAJ         Stendi          Majengo         5           5
Please select the # for the route you'd like to update: 4
New Morning Need: 6
New Afternoon Need: 5
Route updated!

Redirecting to log in...

Enter 1 to log in
0 to Exit:
```

Lastly, the admin user can deactivate and update bus and owner statuses respectively. If an owner account is suspended, none of the buses owned by this person will be active. In a later phase, when a bus is suspended, the driver will see this on his messages once he logs in. This was a deliverable that was meant for this first phase but unfortunately wasn't completed.

```
For your options, select:
1 = Route Daily Report
2 = Change Route Schedule
3 = Change Route Need
4 = Deactivate Bus Status
5 = Deactivate Owner Status: 4
Bus Changes:
Please provide the license plate code for the bus (T000 LLL): T105 RDG
Bus Details:  T105 RDG Owner:  Yohanyi Mashingia

Bus T105 RDG's is now unassigned and is inactive.

Redirecting to log in...

Enter 1 to log in
0 to Exit:
```

Bus Deactivation

```
For your options, select:
1 = Route Daily Report
2 = Change Route Schedule
3 = Change Route Need
4 = Deactivate Bus Status
5 = Deactivate Owner Status: 5

Owner Updates:
Enter owner first name: Yohanyi
Enter owner last name: Mashingia
Enter 1 to activate owner
0 to deactivate owner: 1
Update complete: This owner has been activated.

Redirecting to log in...
Enter 1 to log in
0 to Exit: 0
Logistics-R-Bus admin is out of the system
```

Owner Deactivation

Class Structure

For the program, seven classes were defined to interact and store user functions. There are four user classes that match the users and corresponding roles defined earlier. The other three are for objects that the users will interact with.

Admin	User	Owner	Driver	Bus	Route	Schedule
Username	*First Name*	*First Name*	*First Name*	*Bus Code*	*Route Code*	*Schedule ID*
Password	*Last Name*	*Last Name*	*Last Name*	*Bus Owner ID*	*Start Point*	*Schedule Date*
	Username	*Username*	*Username*	*Active*	*End Point*	*Route Code*
	Password	*Password*	*Password*		*AM Need*	*Run Time*
	Phone Number	*Phone Number*	*Phone Number*		*PM Need*	*Bus Code*
		Active	*Assigned Bus*			*Admin*

Table displaying attributes of each class

User Classes

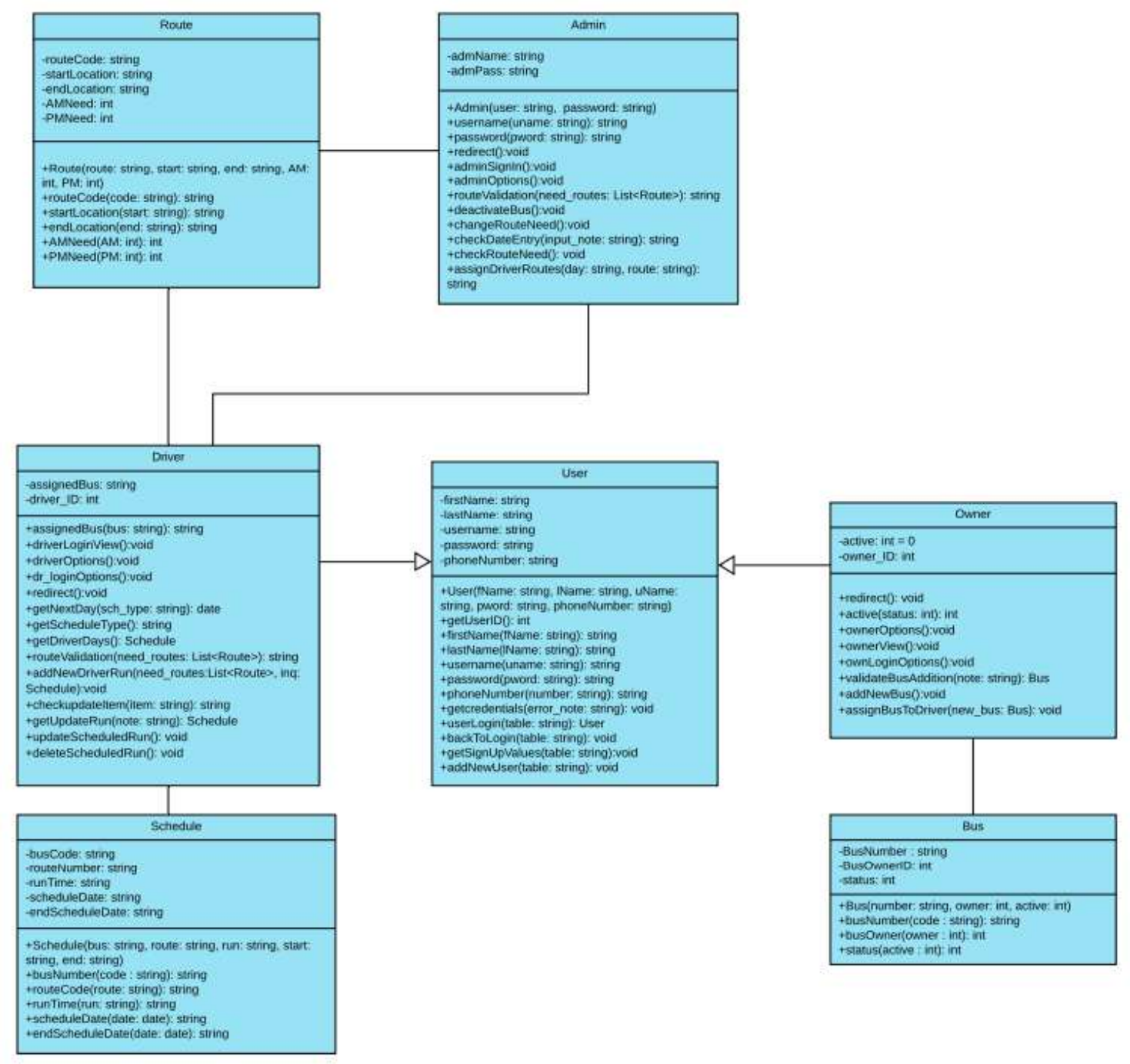
- **Admin:** In this class, the user only has name and access (username and password) attributes. Their methods include ability to change schedules, a
- **User:** This superclass defines a generic person with attributes including first and last names, phone number, and username and password.
- **Owner:** All owner functions not pertaining to the driver like adding a bus, and assigning or reassigning one to a driver, are executable in this subclass, as well as the status attributes that allows the admin to manage the owner account.
- **Driver:** This is a subclass of the user class. In addition to the attributes defined above for a generic user, the driver also has an assigned bus which may or may not be filled in. Moreover, the class has methods allowing drivers to set or change their schedules, and see notifications if their schedule has been changed by an admin user.

Other Classes

- **Bus:** This class defined the bus and stores its plate number also referenced as its code, the bus owner's. Its methods allow the admin to change the status of the bus.
- **Route:** The attributes for this class include the start and end location, for a specific route, the code based on these locations, and the optimal number of buses needed to be scheduled for that route during the morning (6AM – 2PM) and afternoon (2PM – 10PM) runs. It also has methods that allow the admin to add new routes and change the route number of buses depending on need and time of day.
- **Schedule:** This is where each scheduled run is stored with information to show the bus, time of day, date, and route a driver will be on for that day. Its method allow a driver or admin user to schedule a run, view available options, or see the need for a specific route daily.

Class Diagram

Below is an illustration of how the classes interact with each other to perform the user functions outlined in the previous section:



File and Database Design

Database Design

To store the data for our users (drivers and owners) and how they interact with the bus circulation schedule, a MySQL database was used. This database includes five tables which are: *Bus, Route, Schedule, Driver,* and *Owner.*

Below is a summary view of each table with the attributes it stores and their respective data types.

Bus	
Column	Datatype
BusNumber	varchar(20)
BusOwnerID	int(1)
Active	int(1)

Route	
Column	Datatype
RouteCode	varchar(7)
StartLocation	varchar(45)
EndLocation	varchar(45)
MorningNeed	int(11)
AfternoonNeed	int(11)

Schedule	
Column	Datatype
ScheduleID	int(11)
ScheduleDate	date
RouteCode	varchar(7)
BusNumber	varchar(8)
Run	varchar(2)

Driver	
Column	Datatype
DriverID	int(11)
FirstName	varchar(45)
LastName	varchar(45)
Username	varchar(45)
Password	varchar(100)
PhoneNumber	varchar(15)
AssignedBus	varchar(8)

Schedule	
Column	Datatype
OwnerID	int(11)
FirstName	varchar(45)
LastName	varchar(45)
Username	varchar(45)
Password	varchar(100)
PhoneNumber	varchar(15)
Active	int(1)

File Design

It was noted earlier that the admin would be able to access the system with a preset username and password. In this phase, there is no tracking activity framework for the local government to monitor their own usage and access. Therefore there is no information about the admin that needs to be tracked continuously so the username and password are saved to a text file which is read and double checked with the user input when the admin user is trying to log in.

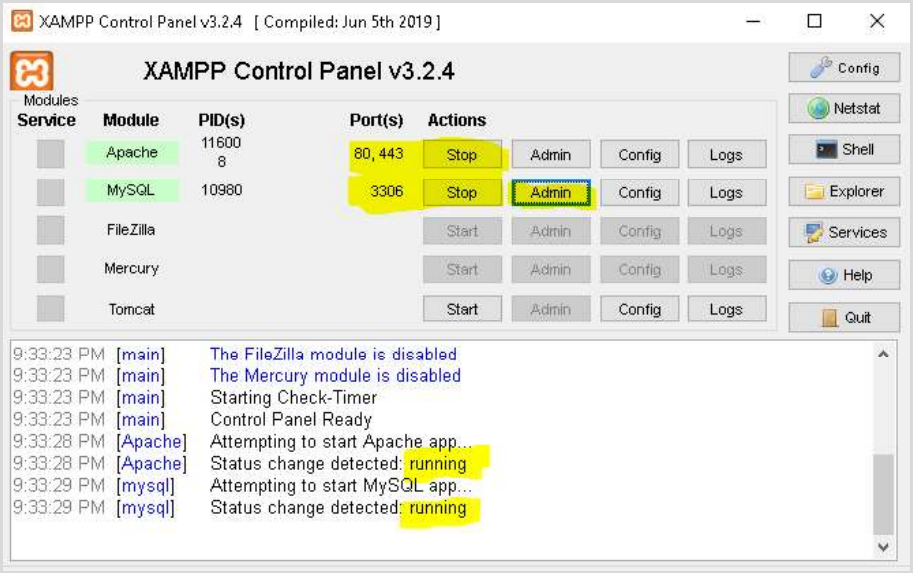
User Manual

Installation

To run this application, the following software is needed:

- Python IDE e.g. Anaconda with Jupyter
  Download link: https://www.anaconda.com/distribution/#download-section
  Once installed, open Anaconda, and launch Jupyter Notebook

- MySQL database infrastructure e.g. XAMPP
  Download link: https://www.apachefriends.org/download.html
  Once installed, click the control application of XAMPP, start both Apache and MySQL, and click Admin to open the database framework on your browser.



The database file "buslogistics.sql" can be imported into the framework and should be ready for access.

Python Application

Open the Jupyter notebook titled Logistics-R-Bus, and press Run. The text prompts will direct the user throughout each profile's options and tasks. As noted earlier, some tasks have navigation back to the home page or log in page, while some do not.

Project Learning Objectives

For this independent study, the goal for me was to learn how to use Python as a programming language. Because it is robust in its use, I wanted to focus on making an application to build on knowledge from other classes. To accomplish this, I used some LinkedIn Learning courses that are available for free to us as UNLV students.

Learning Outcomes

1. Using Python for object oriented programming
2. Understanding and using Python syntax and how it is different from Java, C# syntax
3. Defining methods, different arguments types e.g. args, kwargs, and returning values
4. Defining, using, and traversing object lists, and using logic statements in Python
5. Programming with databases in Python using MySQL
6. Small introduction to using Python for tabulation and quick data analysis using
7. Formatting and using date modules to perform real time querying operations

Additional Objectives

There are some items that I learned but were not prominent or needed in the making of this project. I would like to continue building on them with other classes and improve with some future phases of this same project. These include:

1. Using numpy and pandas libraries to display data. For a future phase, I'd like to increase number of reports that the admin user can generate and display them in table view and graphs. Due to time constraints, there is only one report and its contents are formatted instead of tabulated.
2. Learning Python for data analysis. This includes improving on statistical packages and modules to display metrics and conduct exploratory data analysis e.g. matplotlib, skicitlearn, and seaborn.

Future Project Enhancements

Lastly, there are project specific enhancements that will allow me to learn other uses of Python for programming. These are:

1. Provide admin with a tracking report of how bus drivers are reassigned which also serves as a change log for the owner for his drivers and their bus history.
2. Add driver credentials so that compliance with driving law can be tracked. For example, driver license number and expiration dates can be tracked so that there is a flag and automatic stop of services if a driver's credentials need updating.
3. Route metrics may help the admin understand seasonal changes in need and give them an ability to prepare in advance.
4. Add a conductor profile and a request option so that they can also rotate with the driver between their specific owner's buses if they would like to work with different drivers.