Second Semester Project Plan

Panther Carpooling & Parking: Improving On-Campus Traffic and Parking

Team Members

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Client

Name: Dr. Phillip Chan –pkc@cs.fit.edu

Affiliation: Florida Tech

Date(s) of Meeting(s) with the Client

Project Plan Meeting:

September 3rd, 2024

Goal and Motivation

The goal of this project is to help alleviate parking and traffic problems at the Florida Institute of Technology by creating an application for students to use to find and create carpooling groups based on the students location and class schedule. This is one of the biggest concerns among Florida Tech students, as the limited number of parking spots and traffic problems directly impact students' ability to arrive to class on time and the amount of gas they expend while trying to find a parking spot. With this application, we can help reduce the number of vehicles on campus and improve the parking lot issues that exist every day at Florida Tech. By carpooling, students can save on gas money, save time in their mornings, and reduce their carbon footprint.

Approach (Key Features of the System)

- **Receive Recommended Groups Based on User Profile:** Using students' profile and preference information, the application will give users carpooling group recommendations. Recommendations will be based on users' proximity to each other to minimize distance driven, similarity in class schedule between users, and their vehicle capacity. In addition, preferences the user sets in their profile are considered to ensure a clean, comfortable, and safe ride.

- **Stay Informed about your Trip:** Drivers can view an efficient route to pick up riders that are part of the group. Riders can view the drivers live location to ensure the riders know when the driver is arriving and an estimate on when they will be arriving at Florida Tech. Riders will be sent a picture of the driver and a picture of the driver's vehicle to ensure they get into the correct car. Riders and drivers can provide feedback on their group to create a safe community for carpooling at Florida Tech.
- **Customize User Preferences in their Profile:** The application enables users to customize their preferences. Users can specify their cleanliness preferences regarding eating, drinking and smoking in the car. User safety preferences can be set by setting gender-specific preferences on who they'd like in their carpool groups. Users can set comfort preferences such as music choice. These customizations will be saved in the users profile for easy accessibility.
- **Connect to Other FIT Students**: Florida Tech Students can connect to nearby students with similar schedules and preferences. Users can talk one-on-one with group leaders, and after joining a group users can use the app's group messaging feature to chat with their group. Groups can also organize public meeting spots for carpooling trips.

Algorithms and Tools

- Google Maps API is used to provide real time map data. Map data used to gather distance data between users which we use to generate the most ideal group for a user to join. Map data is also used to display where the driver for a carpool group currently is in real time and to provide the driver a link to google maps with a route created for their pickup/drop off points and final destination.
- .NET Blazor Web Application Framework is used to make interactive client interfaces that are integrated tightly with the backend code. This was chosen because we are able to use C# in the frontend and backend which allowed for consistency across the project and streamlined the development process. Blazor uses a WebSocket connection to send real time changes between the client and server without having to render the page again, this allows for a better user experience.
- Group Matching Algorithm is used to recommend groups to a user of carpooling groups that meet their profile preferences and are close geographically. The inputs to the algorithm are the number of seats available in the driver's car, the range of arrival/departure times to/from campus, user locations and user preferences. We have come up with matrices on how to compare the non-numeric values which can be seen below.

Group Matching Algorithm:

The group-matching algorithm assigns a group a score for three different metrics: Location, Schedule and Preferences. Once those three are calculated, the group

matching algorithms weighs their scores and adds them together to compute a total score.

When recommending groups, the algorithm will order groups by computing their scores with the user added among their members. Lower scores will appear higher on the list.

Location:

The group-matching algorithm computes a Traveling Salesman Problem algorithm, using the distances between the group members (measured in trip duration) as the input. Outputs the total duration of the trip in minutes.

Schedule:

The group-matching algorithm computes the range of arrival and departure times between group members. It takes the arrival and departure times of each group member as inputs, and outputs the largest difference between arrival times + the largest difference between departure times in minutes.

Preferences:

The group-matching algorithm computes the number of conflicting preference settings between group members. It takes the preference settings of each group member as an array, and outputs the number of times two group members had conflicting settings.

Novel Features/Functionalities

- Schedule-Based Carpool Matching: Unique algorithm to match users not just based on location but also on their daily/weekly class schedules.
- Integrated Communication System: Enables in-app messaging among users and within carpool groups, enhancing coordination and flexibility.

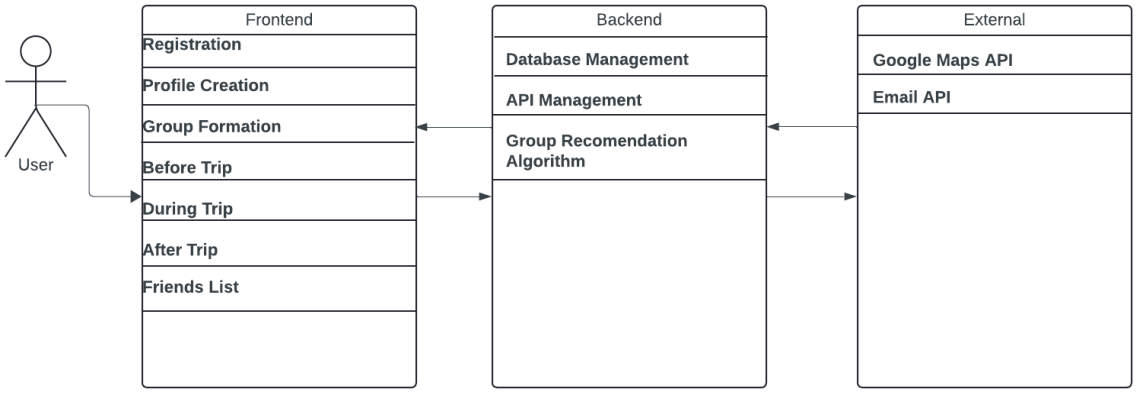
Technical Challenges

Three technical challenges that standout during the planning phase of our project are to implement an authentication system into a web application, developing an algorithm to match users together based on location and schedule, and to restrict user access to specific web pages in the application based on their role.

Design (System Architecture Diagram)

- Components/modules of the software system
    - Registration
    - User Information and Group Preferences
    - Schedule Calendar
    - Rider View
    - Driver View
    - Group Interface
    - Friends List

    - View User Details
    - Account Management
- Interfacing with different types of users (Drivers/Riders)
    - Setting up user profile and preferences
        - Drivers must enter Vehicle Information (make and model, number of functional seatbelts, image of vehicle) and preferences for their vehicle
    - Carpool Trip Pages
        - Rider Page: Provides the driver a list of the pickup locations for the current trip as well as a link to generate directions that will open in google maps if the application is installed or go to the google maps webpage if it is not.
        - Driver Page: Provides the rider a google maps view of where the driver is located.



Description

Frontend:
Profile Creation and Registration: User sets preferences, basic information, vehicle information, and schedule
Group Formation: Accept or decline recommendations and manage groups
Before/During/After Trip: Rider confirmation that they need a ride, Driver receives a navigation route, Rider can view drivers live location, both Riders and Drivers can provide feedback on the carpool ride
Backend:
Database Management: Take updates from the frontend and ensure they are in the database
All Database operations are defined in methods for retrieval and updates
API Management: Handle GoogleAPI and Email API keys to keep them secure and methods to handle interactions to the API
Group Recommendation Algorithm: Called by the frontend, this will provide a list of groups a user should join based on their profile information

External:
Google Maps API: Used for displaying the drivers location and for generating directions for the driver
Email API: Used to confirm the user is signing up using an FIT email and to send email confirmation

Evaluation

- Recommendation Accuracy: Accuracy of the group recommendations is the most important metric for this application. Groups must meet users preferences and there must be an efficient route between all the users that avoids redundant driving.
- User Survey: To ensure our user interface efficiently displays information and is self explanatory for users, we will use a user survey to get feedback about each part of the carpool process. This will allow us to evaluate how users respond to the flow between pages as well the visual appeal of the site.
- User Timing Test: The last form of evaluation we will use is timing new users on how long their profile creation takes to complete. This will give insight into how efficiently we laid out the information and how navigable the system is for new users.

Progress Summary

Module/feature	Completion %	To do
User Profile and Preferences	85%	-Max Driver distance -Viewing another user's profile -Long and Short views
Creating Group Recommendations and Forming Groups	60%	-Integrate Algorithm -Modify to fit mobile view -Add group interface functionality
Friends	25%	-Add backend functionality on adding removing and viewing friends
Before Trip Actions	90%	-Determining driver algorithm -Prompt users to confirm

		rides -Allow riders and drivers to cancel rides
During Trip Actions	95%	-Link to Florida Tech Safe
After Trip Actions	10%	-Implement user rating system

Milestone 4 (Sep 30)

- Group Recommendation with difference scenarios; Same time different location clusters; Could increase from 8 -> 16; 4 location clusters North - East - West - South of campus
- Develop and test long and short views for user profiles
- Finding Friends, Add and Remove Friends
- Interface for entering ratings and reviews
- Integrate accept and deny group recommendations into the database; Once they decline show more recommendations if available
- Rider confirmation, cancel; Section 3.5.1 of Requirement Document; Know the Driver 3.5.2 of Requirement Driver document

Milestone 5 (Oct 28)

- Research, develop and test alternatives to using Google Distance Matrix API due to high cost of the service
- Develop and test a home page that displays the user's upcoming trips
- Develop and test a group management page
- Develop and test a communication page for messaging and sending confirmations for trips
- Integrate a shortcut to the Florida Tech Safe website

Milestone 6 (Nov 25)

- Implement, test, and demo account email confirmation during account registration
- Test/demo of the entire system
- Conduct evaluation and analyze results
- Create user/developer manual
- Create demo video

Task Matrix for Milestone 4

Task	Austin	Jason	Jacqueline	Hunter

Group Recommendation with difference scenarios; Same time different location clusters; Could increase from 8 -> 16; 4 location clusters North - East - West - South of campus	25%	25%	25%	25%
Develop and Test long and short views for user profiles	25%	25%	25%	25%
Finding Friends, Add and Remove Friends	25%	25%	25%	25%
Interface for entering ratings and reviews	25%	25%	25%	25%
Integrate accept and deny group recommendations into the database; Once they decline show more recommendations if available	25%	25%	25%	25%
Rider confirmation, cancel; Section 3.5.1 of Requirement Document; Know the Driver 3.5.2 of Requirement Driver document	25%	25%	25%	25%

Description of each planned task for Milestone 4:

Task 1: This task has a strong focus on implementing different scenarios to test the group recommendation algorithm. Through this task, the algorithm will be exposed to these tests and will allow us to optimize based on these situations.

Task 2: Task 2 focuses on user privacy and readability. With a short view, other users can be exposed to other users in a concise manner, while maintaining privacy. The focus on the short view is basic information such as name and reviews. The long view(or personal view) will include more information such as driver/rider statistics.

Task 3: Extending Task 2, Task 3 focuses on the ability to leave each rider/drive a review and a rating. This will be connected to the database and will be updated and presented in the users profile.

Task 4: This would involve inserting database entries when groups are created and allow group members to modify and delete the group as needed. We have already created the user interface for this section but will need to integrate this interface to our site database along with the additional recommendations for new groups for the user to join.

Task 5: The rider cancel and confirmation page will prompt the user before their trip if they are going to be part of the carpooling trip on that specific day. This ensures drivers are not wasting time or waiting on riders that won't be using the service on that day.

Approval from Faculty Advisor

"I have discussed with the team and approved this project plan. I will evaluate the progress and assign a grade for each of the three milestones."

Signature: _____ Date: _____