Route-Constrained Family Shopping Optimization

Design Document

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Executive Summary

Development Standards & Practices Used

- Agile
- Version Control

Summary of Requirements

- A route to drive
- Mobile and desktop application
- Database full of store locations and items with their prices
- Optimized by user spending and distance
- Multiple users

Applicable Courses from Iowa State University

- Software Engineering 185: Into to Problem Solving I
- Computer Engineering 186: Intro to Problem solving II
- Computer Science 227: Intro to Object Oriented Programming
- Computer Science 228: Intro to Data Structures
- Computer Science 309: Software Development Practices
- Computer Science 319: Software Construction and User Interface
- Computer Science 327: Advanced Programming Techniques
- Software Engineering 329: Software Project Management
- Software Engineering 339: Software Architecture and Design
- Computer Science 363: Intro to Database Management Systems

New Skills/Knowledge acquired that was not taught in

- Web api
- Kotlin
- React

Table of Contents **3**

List of figures/tables/symbols/definitions (Work In progress)

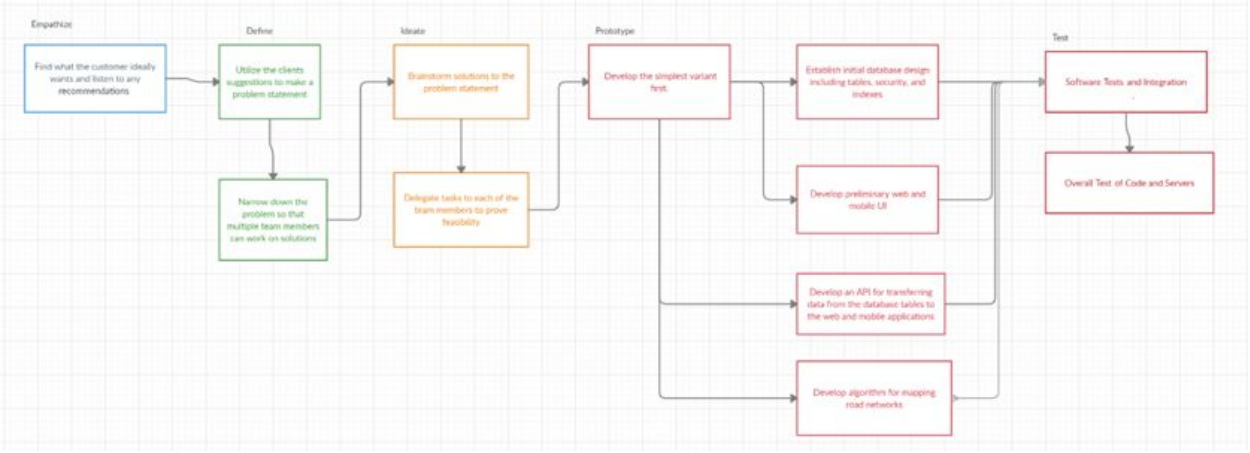


Figure 1 Design process Diagram

1 INTRODUCTION

1.1 ACKNOWLEDGEMENT

The Route-Constrained Family Shopping Optimization team would like to thank both our advisors, Professor Goce Trajcevski and Ashfaq Khokhar for meeting with us on a weekly basis and helping guide us through the design process of this project. We would also like to thank the Iowa State University College of Engineering for giving our team access to professional guidance, resources and experts.

1.2 PROBLEM AND PROJECT STATEMENT

The goal of this project is to design and implement an application for both mobile and desktop that would help families coordinate and optimize their shopping routes. Families will also be able to add constraints to further customize their shopping route by including things like the family's starting location, the prices of the items, the distance from the store, and others. The application will then generate the optimal shopping route for that family.

The problem will involve constructing algorithms to determine the optimal shopping paths, getting data for item prices and store locations, and the constraints. The solution for both mobile and desktop will be the same. In the application, users can join a group with their family members so everyone can see the starting locations of each family member in the group as well as the family's current shopping list. To make the route, the application will check the family's shopping list to find items within the family's maximum distance they are willing to travel, and pick the store that has the items with the best price, thus optimizing spending. Through a map system the route would be shown and take into account the distance constraint. With all of this the application will output an optimized route for all family members.

1.3 OPERATIONAL ENVIRONMENT

Since this project will have a mobile and desktop application, the physical environment will depend on which platform the user is currently accessing. On the cyber side, we would use online systems and local systems to create the application and keep it maintained.

1.4 REQUIREMENTS

Constraints

- Radius of the map of stores and locations
- The time it takes to travel to different stores
- Starting the trip from home vs. varying locations
- Start time of the trip

Functional Requirements

- Store location accuracy
- Outputting the closest store with desired items with respect to distance/time to travel
- Output fastest travel time to any given store at desired start time

1.5 INTENDED USERS AND USES

The main user for this application is a family who wants to minimize their distance traveled and money spent while shopping. Users will make an account and join a group with their family members. Once in a group, users can see the family's current shopping list, and add or remove items from the list. Users will also be able to see the current location of other members in their group. Each family member would be able to input their location and have that factor into creating the optimal shopping route for each family member. The final result is a route that is optimized on spending and the constraint of distance for each family member for efficient shopping.

1.6 ASSUMPTIONS AND LIMITATIONS

Assumptions:

- The customer must create an account to be routed to stores
- The customer has a phone or PC to access this application
- The customer has access to an internet connection.
- Maximum number of users is unknown however the project can be scaled to accommodate more users.

Limitations:

- This application will only work inside of the United States
- Routes and Maps will be generated by TomTom API
- Loading times will be determined by the quality of the users internet connection.

1.7 EXPECTED END PRODUCT AND DELIVERABLES

The final expected end product for this project will be made available at the end of the second semester.

The deliverables for the first semester will be as follows:

1. **September 10th:** Identify data models and data sources to be used.
    - This deliverable will include the our main data structure to be used in the database. It will also include populating our database from store APIs.
2. **October 10th:** Finalize the plan for the different variants of the problem/solution.
    - This deliverable will include identifying and enumeration of the different problem cases. Then developing the solutions to each of these variants.
3. **October 25th:** Finalize the selection of development platforms and provide architecture design with preliminary UI.
    - This deliverable will include a final decision of our development platform choice and the initial UI design ideas.
4. **November 10th:** Finalize the algorithmic solutions; device use-cases and test-cases; develop test-plans; provide basic UI functionality.
    - This deliverable will include a decision on algorithmic decisions for distance and time constraints. It will also include our use-cases, test-cases, and initial functionality of the UI.
5. **November 20th:** Finalize and submit the design document; prepare presentation.
    - This deliverable will include a completed design document, as well as a completed presentation for the first semester deliverables.

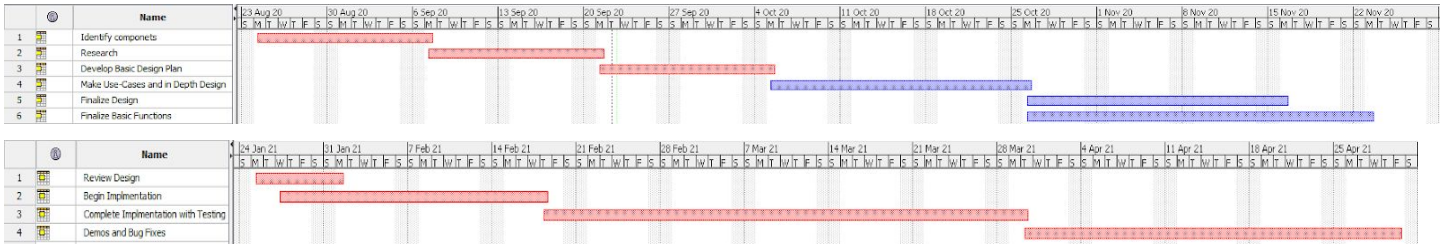
The deliverables for the second semester will be as follows:

1. **January 25th:** Revise the design; assign development roles.
    - This deliverable will include revisions to the project to refine the design. Development roles will be assigned for each individual.
2. **February 15th:** Complete unit testing; begin integration testing.
    - This deliverable will include the end of unit testing and integration testing will begin.
3. **March 5th:** Provide alpha-version and an implemented scenario.
    - This deliverable will include the first build of the project and be able to do the most basic scenario that was created.
4. **March 20th:** Finalize the revisions; release beta-version; run another set of end-user testing of functionalities.
    - This deliverable will include more revisions that will be final with a second build of the project. More testing will also be done.
5. **April 5th:** Finalize the user-manual, prepare for public release.
    - Not yet defined.

6. **April 15th:** Deploy the final version at Github; start the final report and presentation preparation.
    - This deliverable will include the final build of the project and the beginning of the final report/presentation.
7. **April 30th:** Final presentation and demo; submit final report.
    - This deliverable will include the final presentation, a demo of the working product, and the final report for the project.

2. SPECIFICATION AND ANALYSIS

2.1 TASK DECOMPOSITION



1. Identify Components
    a. In this stage, we would be talking with our client and start determining preliminary design. This would also include finding all the requirements and a general timeline when things should be done.
2. Research
    a. For this stage we would start researching components that would be a part of the solution. This would include researching getting item data from the stores, getting the road network information from an area, and the distance from stores to stores. Development environments that would work well with the ending product.
3. Develop Basic Design Plan
    a. Make a dynamic timeline
    b. Define a concrete solution.
    c. Cost and risk analysis.
    d. Determine end users and preliminary look of end product.
    e. Discuss and revise preliminary design with clients.
4. Make Use-Cases and In-Depth Design
    a. Make scenarios for each step of design.
    b. Build design for each component of our solution.

5. Finalize Design
    a. Set in stone the design of each component.
    b. Create a component diagram that shows how each component is connected to each other.
6. Finalize Basic Function
    a. Get a basic application working on either Android or desktop
    b. Be able to interact with the application with buttons or text boxes.
    c. Iterate through each scenario and build the required component functionality for each.
7. Review Design
    a. After the winter break review the design in order to refresh our minds.
    b. Add any details that we might have missed.
8. Begin Implementation
    a. Work with the basic functioning application.
    b. Make databases for the data that is going to be needed.
    c. Connect those pieces of data to be shown on the screen.
    d. Begin working out the algorithms for the route generation.
9. Complete Implementation with Testing
    a. Complete algorithms with simple inputs.
    b. Use the data being pulled in to interact with the algorithms.
    c. Design a better looking and functioning UI.
    d. Start testing the application for integration and unit testing.
10. Demos and Bug Fixes
    a. Get a working product that can be demoed.
    b. Fix any bugs that appear while testing and demoing the product.

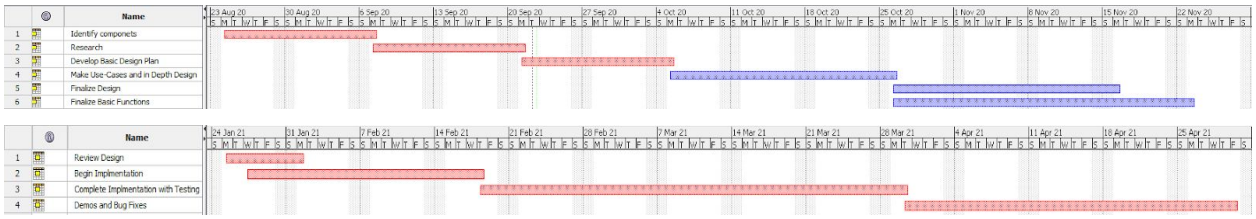
2.2 RISKS AND RISK MANAGEMENT/MITIGATION

Task/Component	Risk	Risk Probability	Risk Mitigation
Identify Components	Component is not identified or a component is incorrectly identified. Not all requirements are gathered	0.7	Meet with Client again to firmly establish requirements and components
Research	Information found is false or Information not available	0.6	Compare research results with multiple credible sources.
Develop Basic Design Plan	Preliminary design is not what the client asked for.	0.6	Meet with Client again to firmly establish requirements and components
Making Use Cases and in Depth Design	Scenarios do not correctly reflect how the end user will use the application	0.4	None
Finalize Design	Component Diagram incorrectly shows how each component is connected to one another	0.7	Meet with team and remake component diagram to make sure that each component is correctly connected
Finalize Basic Function	Scenarios were incorrectly formed on false requirements	0.2	None
Review Design	Design Document is missing information	0.8	Add any details missed in the design
Begin Implementation	Databases and Server cannot be accessed by the Web Application	0.5	None
Complete Implementation with Testing	Testing reveals bugs in code or implementation incomplete	0.6	Fix bugs and meet with whole team to fix issues regarding implementation
Demos and Bug Fixes	A bug is encountered that cannot be fixed	0.3	None

2.3 PROJECT PROPOSED MILESTONES,METRICS, AND EVALUATION CRITERIA

For the first semester our milestones are: Design document version 1, version 2, version3 and the final design presentation. The evaluation criteria for those documents will be the grading rubric and grades we receive for them. For the second semester our milestones will be the different levels of functionality for our project. Single user multiple stores, single family multiple stores, multiple starting times, travel_distance vs. travel_time, and Scalability. These milestones can be measured by their functionality and if they work. Another milestone will be the completion of the web application and mobile application which will be measured again by their completeness and functionality. One way to do this is to get test users and get feedback throughout the development process to get a continuous stream of feedback and evaluation criteria.

2.4 PROJECT TIMELINE/SCHEDULE



See Section 2.1 for a detailed description of each task associated in the Gantt chart.

2.5 PROJECT TRACKING PROCEDURES

Our team is planning on using Trello for project tracking and management and will be using GitHub for the file tracking and collaboration. We will also be using discord to conduct team meetings and communication which will also be used to keep track of meeting notes, assignment deadlines, and important information/announcements we want to have pinned.

2.6 PERSONNEL EFFORT REQUIREMENTS

Task	Effort Requirement (Person hours)
Identify Components	3
Research	12
Develop Basic Design Plan	30
Making Use Cases and in Depth Design	60
Finalize Design	36
Finalize Basic Function	30
Review Design	30
Begin Implementation	24
Complete Implementation with Testing	300
Demos and Bug Fixes	90
Total	615

2.7 OTHER RESOURCE REQUIREMENTS

There are no physical parts and materials needed to complete this project. The work will be completed on various coding platforms.

2.8 FINANCIAL REQUIREMENTS

The OpenStreetMap API that will be utilized will cost $0 for every 50,000 requests per month. The team will most likely stay within this 50,000 request limit, so the API will have no cost to the team. Hosting a server for the web and mobile application will cost between $40-$70 a month. Publishing the application on the Android store is a $25 one time payment. In total, the total cost for this project will not exceed $120.

3. STATEMENT OF WORK

3.1 PREVIOUS AND LITERATURE

3.2 TECHNOLOGY CONSIDERATIONS

3.3 TASK DECOMPOSITION

3.4 POSSIBLE RISKS AND RISK MANAGEMENT

3.5 PROJECT PROPOSED MILESTONES AND EVALUATION CRITERIA

3.6 PROJECT TRACKING PROCEDURES

3.7 EXPECTED RESULTS AND VALIDATION

4. PROJECT TIMELINE, ESTIMATED RESOURCES, AND CHALLENGES

4.1 PROJECT TIMELINE

4.2 FEASIBILITY ASSESSMENT

6.1 CONCLUSION

6.2 REFERENCES

6.3 APPENDICES