

COMP 4560 Industrial Project Proposal

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Abstract

The Canadian Grain Commission manages a vast amount of data every year. This project aims to help visualize this data in an efficient and user-friendly way. The focus is on creating a visual tool that enables users to upload various data sets and generate engaging visualizations.

Core features include presenting scientific data through multiple visualization techniques, such as mapping multiple data points, a dynamic legend system to enhance data interpretation, and incorporating interactive elements to explore trends over time. Emphasizing creativity and adaptability, this project seeks to transform raw data into comprehensive geographical maps for the Canadian Grain Commission.

Background

Courses Completed

- COMP 3010: Distributed Computing
- COMP 3020: Human-Computer Interaction I
- COMP 3030: Automata Theory and Formal Languages
- COMP 3190: Introduction to Artificial Intelligence
- COMP 3350: Software Engineering I
- COMP 3370: Computer Organization
- COMP 3380: Databases Concepts and Usage
- COMP 4180: Intelligent Mobile Robotics
- COMP 4190: Artificial Intelligence 2
- COMP 4360: Machine Learning
- COMP 4380: Database Implementation
- COMP 4820: Bioinformatics
- COMP 4620: Professional Practices in Computer Science

Ajay Nair

- Experience in software development following traditional software engineering principles and agile methodologies.
- Experience in project management and client relations.
- Experience in database management.
- Experience in UX/UI development following the User-Centered Design Cycle.
- Experience in Object Oriented Programming.
- Experience in data cleaning and analysis in an academic research setting.

Ishraq Md Nazrul

- Experience in Linux server setup, maintenance, and development, along with experience in Windows and macOS.
- Experience in PERN stack, HTML, JavaScript, CSS for web development, and Android app development.
- Experience in user-centered design using Figma and in multiple scripting languages, including Bash.
- Experience in AI/ML model development, bioinformatics and biology algorithms, and building AI-powered small-scale robots.
- Experience with the Unity game engine for game projects and developed IoT devices for real-time motion detection with display attachments.
- Experience in network configuration and management (CCNA, A+ courses) and experienced in database technologies.
- Experience in modern languages like Rust for low level system apps and experience in formal languages and automata theory for computability and complexity analysis.

Logan Doran

- Extensive C# and Java experience in industry and project work.
- Experience with MSSQL, and sqlite.
- Experience designing interfaces under usability principles.
- Experience in data cleaning, data visualization, and data analysis in an industry context.
- Experience in Object Oriented Programming.

Tahmina Sadia Mahmud Rodshi

- Experience in designing user interfaces under usability principles.
- Extensive Python, Java, C and C# experience in project work.
- Experience in implementing front-end web applications using React.
- Experience with Postgresql and database implementations.
- Experience with project planning and management.
- Experience with Agile methodologies in software development.
- Experience in managing and maintaining databases.

Problem Statement

The Canadian Grain Commission (CGC) lacks an efficient tool for visualizing complex agricultural data on geographical maps, resulting in inefficiencies in data presentation. Currently, creating maps is a time-consuming process with difficult reproducibility.

Our project aims to streamline the creation of agricultural visualization tools and provide the CGC with a dedicated platform that assists in the efficient and creative representation of their data. By establishing a robust visual tool, we hope to enhance the interpretation and accessibility of crucial agricultural information.

Methodology and Timeline

The first step of the project is to use a public GitHub repository to set up a collaborative environment. This repository will serve as the main hub for monitoring tasks, managing active dev tasks, and organizing deliverables. The configuration of each development environment will be tailored to the specific needs of the project for managing agricultural data, with an emphasis on database and platform choices.

The implementation of an Agile development technique will be paired with a user-centered design. This strategy makes it possible to make adaptable and flexible adjustments in response to frequent input, ensuring that the tool is in line with the requirements and experiences of non-technical users. To serve a varied user base, important elements like web accessibility standards and user-friendly interfaces will be given priority.

A well-structured relational database on disk and on memory will be the core of our application, enabling seamless user interaction with agricultural data. These tables will support efficient data storage, integration, and retrieval, allowing for efficient query capabilities while ensuring data accuracy and security. As the project progresses, we will adapt the database schema to handle all forms of data that a user could want to upload to the application.

Time-series and geographic data management will be accomplished through the use of libraries that are tailored to handle and process geospatial data efficiently. Preprocessing and normalization of data will also be done as part of backend development. To reduce edge cases and facilitate data management, this step is essential as it entails cleaning, converting and standardizing data formats.

The development of the user interface will prioritize usability for non-technical users with an added option for an Advanced Mode for users needing extra statistics and information. The intuitiveness of the interface will be verified through usability testing and prototyping. There will be plenty of customization choices, including dynamic style options that enable users to change visualization elements like color schemes and intensity and careful considerations will be made to comply with the Web Content Accessibility Guidelines.

The system's architecture will have security and privacy in mind when in development to ensure a robust toolset in production. The system will be continuously monitored, and tests will be implemented to ensure proper safety of user data and proper integration of the system. Maintenance will be done throughout the term to ensure everything is updated and complies with proper licensing when using external libraries.

There will be clear and comprehensive user manuals available, aimed at non-technical consumers. The architecture and data processing of the system will be described in detail in the technical documentation. The tool's general usability will be improved by

providing users with assistance in addressing frequent issues through a troubleshooting guide and FAQ area.

The project will be polished at the last stage, making sure every feature functions as it should. The system will be more versatile and portable thanks to containerization, which will be accomplished via Docker. Frequent check-ins with Sean from Canadian Grain Commission and Professor Robert Guderian will guarantee ongoing development in response to input. The product will be ready for use, guaranteeing simple incorporation into current systems and usability for the intended audience.

The following is the detail of the timeline:

Timeline:

| Combined Project Tasks | |
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| Tasks | Tentative Completion Dates |
| Infrastructure and Environment Setup: <ul style="list-style-type: none"> • Discuss architecture. • Setup individual environments. • Setup CI/CD and Containerization. • Generate Issues for user stories and features. • Split up dev tasks. • Discuss potential platforms to develop application. • Set up Development database. | January 25, 2024 |
| Check in with Sean and Robert Guderian | January 27, 2024 |
| Milestone 1: <ul style="list-style-type: none"> • Set up the map interface, including geographical regions (provinces and agricultural zones). • Develop data upload functionality. • Implement basic data visualization with initial color customization. • Add download functionality for visualized data maps in a single file format as photo format. | February 6, 2024 |
| Check in with Sean and Robert Guderian | February 7, 2024 |

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| <p>Milestone 2:</p> <ul style="list-style-type: none"> • Preprocessing of data and Outlier Detection. <ul style="list-style-type: none"> – Outlier data detection in terms of GIS. • Implement feature to upload multiple data sets. • Implement Observational View for multiple data sets. <ul style="list-style-type: none"> – Two main options: Overlay or Side by side comparison • Searching and modifying Map: <ul style="list-style-type: none"> – Implementing a feature to allow users to view changes occurring in cities or municipalities by focusing on a subset of a city. – Implement a feature to allow users to modify colors to preferred color choices. • Implement advanced numerical filtering options for combined datasets (this is dependent on dataset that is uploaded) <ul style="list-style-type: none"> – Ability to filter results based on fields that are present in the dataset. | February 25, 2024 |
| Check in with Sean and Robert Guderian | March 10, 2024 |
| <p>Milestone 3:</p> <ul style="list-style-type: none"> • Enhance data export options, supporting multiple file formats. • Implement history feature to track changes made to files. <ul style="list-style-type: none"> – Incorporate undo/redo feature for region coloring • Matrix/Album of images of how the trend would change: <ul style="list-style-type: none"> – Add feature to view the data with clips – use sliders to show the change over time. | March 10 , 2024 |
| Check in with Sean and Robert Guderian | March 11, 2024 |

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| <ul style="list-style-type: none"> • Conduct Unit, Integration Tests for the application with more complicated datasets to ensure proper functionality | March 20, 2024 |
| Check in with Sean and Robert Guderian | March 22, 2024 |
| <ul style="list-style-type: none"> • Create a guide that walks the user through the process of interacting with the application for users without a technical background. • Outline an index with a description of the project and provide brief summaries of each feature that the application offers. • Additionally, assemble a comprehensive instruction manual detailing the steps necessary to configure the environment for running the application. | March 30, 2024 |
| Check in with Sean and Robert Guderian | April 1, 2024 |
| <ul style="list-style-type: none"> • A final document outlining final tasks completed over the course of the project. • Prepare and compile final presentation slides and discussing potential improvement to be made to the application. • Decide who will present which parts of the projects. | TBD |

Infrastructure, facilities and expert personnel requirements

To ensure the success of this project, we would need access to the data collected and held by the Canadian Grain Commission. Additionally, we would require insights and support from an HCI professional, specifically Dr. Patrick Dubois, to ensure a proper user-designed approach. These insights will prove beneficial when we require guidance on decisions outside of our areas of expertise. We have also discussed potential development-focused support from Sean through a colleague from the Canadian Grain Commission.

We are planning to communicate and establish a connection with Sean's co-worker over email. We are expected to require additional resources such as the Linux lab, and potential Geographic Information System (GIS) experts such as Dr. David Walker from the Riddell Faculty of Environment, Earth, and Resources within the university. However, should we encounter issues in accessing any of these resources we will investigate

alternatives such as graduate students in GIS-focused areas of research.

Outcome and Deliverables

Shrink Goals

- Streamlined feature for uploading data.
- Normalized database filled with raw spatial data.
- Scripts and modules for handling and cleaning inconsistent data.
- User-friendly interface emphasizing web accessibility standards.
- Data visualization using heatmaps.
- Timelapse feature with an interactive slider for dynamic data representation.
- Basic options for exporting files.
- Flexible and interactive legend for user personalization.
- Technical documentation of system configuration, usage and functionalities.
- Importable libraries to process and manage time-series and geographic data.
- Basic data privacy and security measures in system architecture.
- Automatically adaptable or manually adjustable color filtering and customization.

Expected Goals

- Agile development model with user-centered design for adaptable adjustments.
- Additional functional testing and database query optimization.
- Scripts and modules for identifying outliers and managing missing data.
- Further map interactivity for multiple data set uploads, overlay or side-by-side comparison, and matrix, album or images.
- Further compatibility and support for multiple data formats.
- Further security and privacy measures in system architecture.
- Additional export options including the ability to export static and dynamic visual representation of data.
- Further functionality enabling users to select and explore subsets of the data.
- Supplemental documentation including a troubleshooting guide and Frequently Asked Questions (FAQs) section detailing the system's use case scenarios.

Stretch Goals

- User interface with responsive website design and further improved user experience.
- Versatile and portable system using Docker containerization.
- Enhance user interface with logging or history system to monitor changes in data.
- Further download capabilities including various map file formats.
- Advanced user interface with both Easy and Advanced modes to accommodate users of varying proficiency.
- Further research and explore potential integration of AI technologies for advanced data processing and analysis.
- Customizable dashboard for observational view options:
 - Personalized data visualization.
 - Map customization options for a more tailored user experience.