

Investigating an Automated Greenhouse Monitoring System for Temperature and Humidity and Using Applied Machine Learning Techniques on the Data Tracked.



1. Project Scope & Objectives

The proposed project aims to monitor and record the temperature and humidity in a greenhouse environment, using applied machine learning techniques to analyse the collected data. The goal is to ensure optimal conditions for crop growth by continuously tracking and displaying relevant statistics through an application, which in turn allows for the adjustment of the greenhouse climate, leading to better crop quality.

Objectives:

- Improve crop quality
- Grow interest in sustainable agriculture
- Accessible for those with varying levels of experience and physical capability
- Contribute to the advancement of smart gardening technologies

2. Constraints and Limitations

The application will focus on delivering core functionalities essential to its purpose. Due to time constraints, the implementation will prioritize functionality over visual design, resulting in a [minimalistic user interface](#).

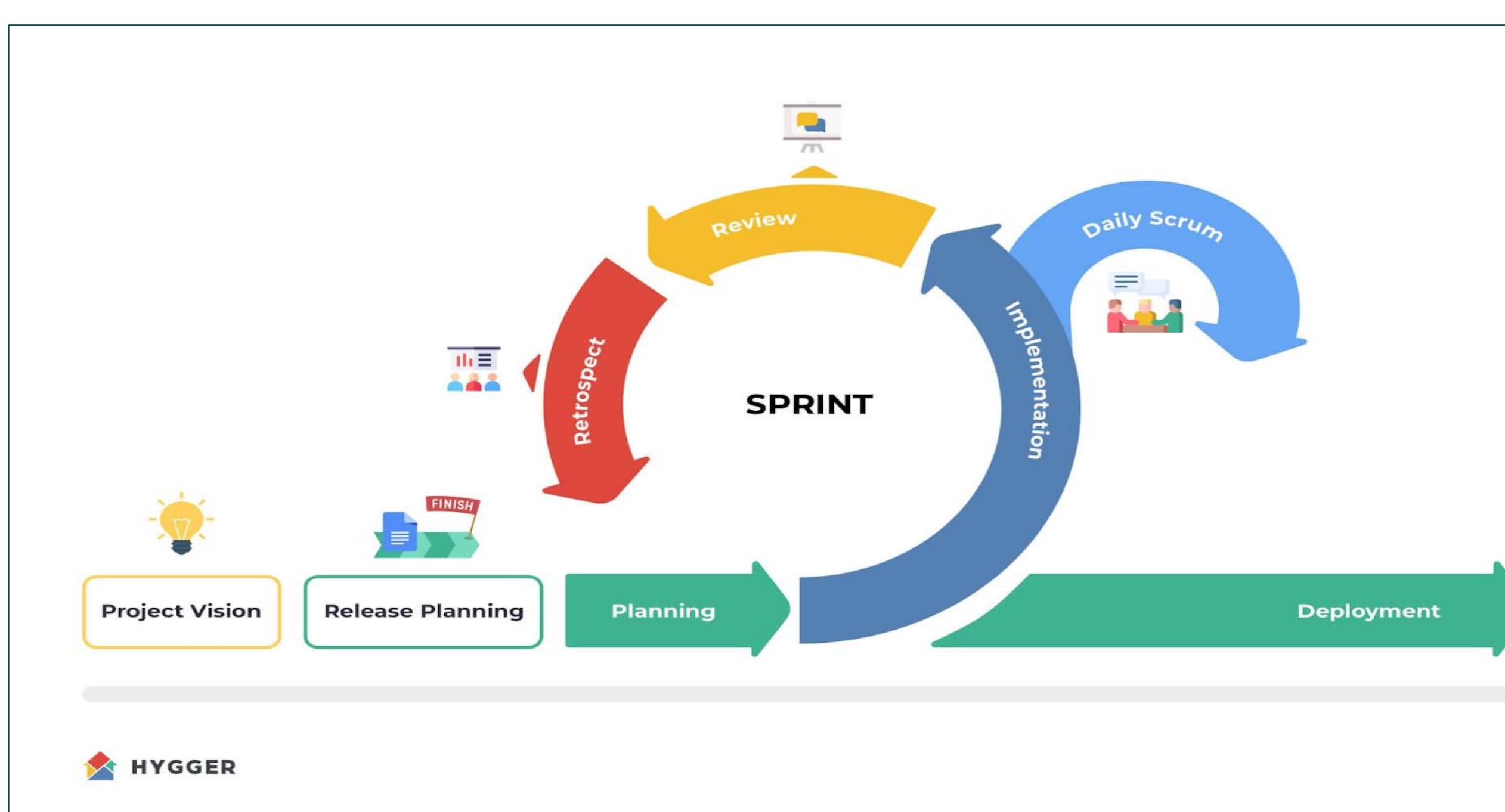
Moreover, the [data used for training with applied machine learning techniques will be sourced from Kaggle](#). If time allows, a custom dataset will be generated using data collected from my personal greenhouse using the project.

3. Methodology

The development of the proposed project is a [personal scrum agile methodology](#), which applies the scrum practices to an individual person project.

Reason:

- Gives a clear set of goals in each given scrum period/cycle
- More flexible development cycle as it promotes adaptability



4. Research & Analysis

The ELEGOO Arduino Mega 2560 Most Complete Starter Kit Tutorial (2024) was utilized to understand the [capabilities of the Arduino platform and its components](#), including sensors, displays, and breadboards, essential for developing a greenhouse monitoring system. Besides that, extensive research on the project topic included reviewing articles, blogs, books, and [academic literature on automated greenhouses, monitoring methods, and smart farming practices](#). This analysis highlighted the significance of temperature and humidity as critical variables and their impact on the environment and crop health, providing a solid foundation for defining the project scope and ensuring the feasibility of the proposed approach.

Areas of Investigation:

1. Arduino Platform and Components
2. Understanding Temperature and Humidity Dynamics
3. Integration of Smart Farming Technologies
4. Data Collection and Analysis
5. User Interface (UI) Development

5. Hardware & Software



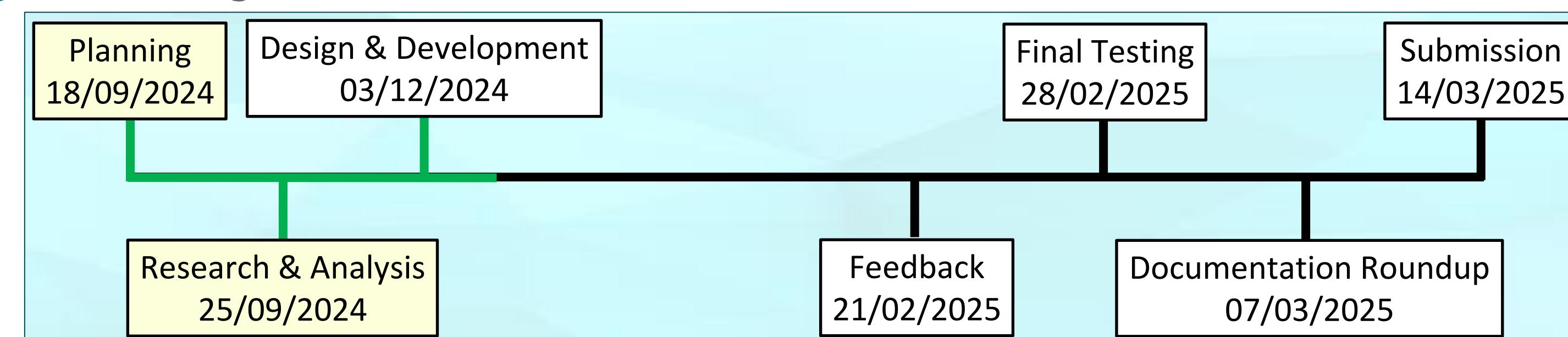
Arduino: Serves as the platform for hardware implementation, enabling interaction with physical components and managing its logic.

Python: Used for developing the application's UI, ensuring seamless interaction with the dataset received from the hardware.

R: Facilitates data analysis and the application of machine learning techniques to train and evaluate the model.

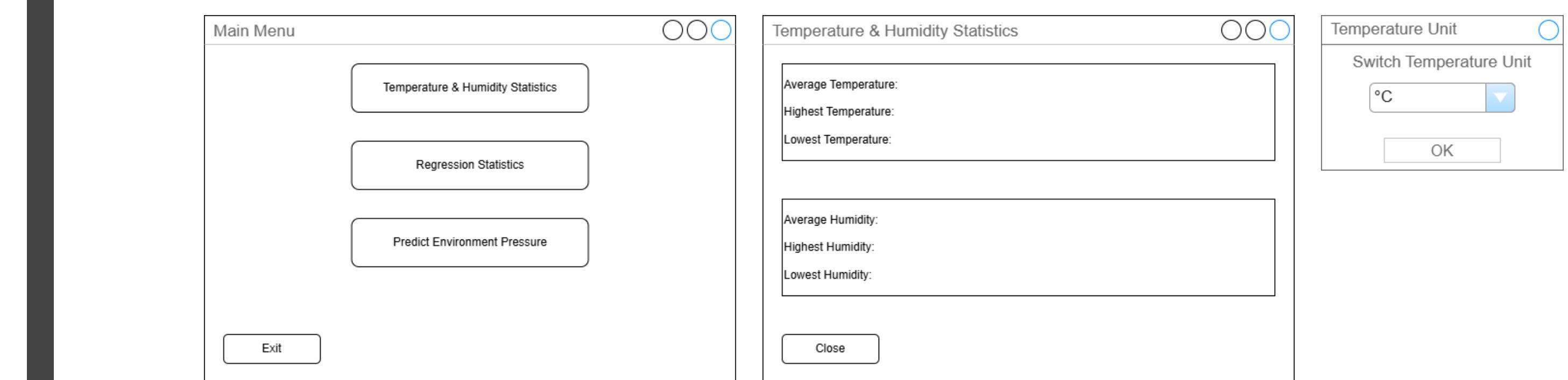
Microsoft Word: Documents project progress in following the planned methodology, ensuring clear and organized reporting.

6. Project Timeline



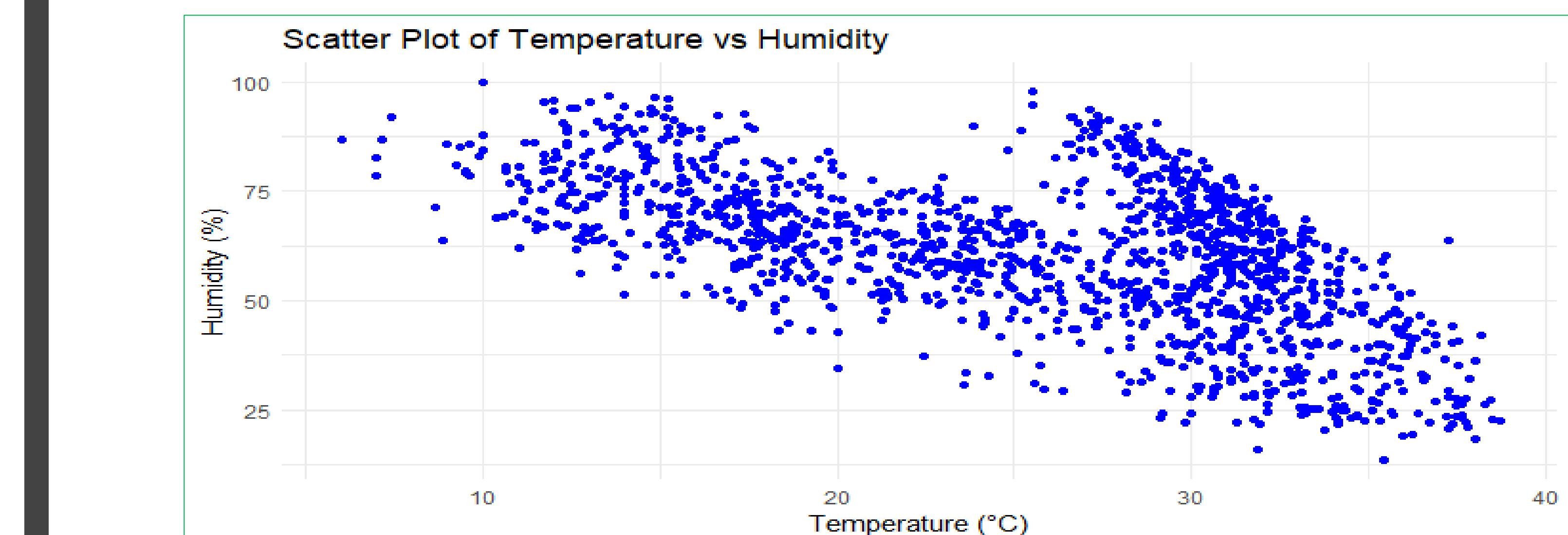
7. Project Design

The application design [prioritizes user-friendliness and simplicity](#) to ensure accessibility for individuals with varying levels of technological experience. The main menu is [intuitively organized](#), presenting clear options alongside an exit button. Key data, such as the "Average Temperature," is [displayed in a straightforward and easily understandable manner](#). Moreover, an option to switch the unit of measurement is also introduced, allowing users to choose between Celsius, Fahrenheit and Kelvin, ensuring the application is [suitable and accessible for everyone, regardless of measurement preferences](#).



8. Analytics & Data Visuals

The scatter plot below is from the dataset "Daily climate in Delhi. ARIMA with TimeSeries." from Kaggle, which is plotted using R. This dataset will be used to [train and predict the atmospheric pressure of an environment](#), according to temperature and humidity.



9. Progress & Next Steps

Progress:

Following the completion of project planning and research analysis, the documentation process has begun, accompanied by the creation of multiple drafts for the UI design. Additionally, efforts are underway to visualize data using R by generating relevant and informative graphs.

Next Steps:

- Research and decide on a suitable applied machine learning method to be used for training data
- Plan and design Arduino hardware layout to be used as the monitoring device

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Issues & Considerations

| Ethical Insights | Though the proposed project is mostly a personal work and does not involve others, it is paramount that some form of consent should be requested for a commercial release, especially for the data to be used for applied machine learning on the application. Measures that could be taken to ensure this is by having a confirmation pop-up implemented at the start of the application, informing users that any data they provide is given voluntarily and may be used for the purposes of the application, including applied machine learning. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| Legal Aspects | The project will strictly adhere to all relevant legal and institutional guidelines to ensure compliance throughout its development and implementation. In alignment with the General Data Protection Regulation (GDPR), any data collected, processed, or stored will be handled responsibly and securely, safeguarding user privacy and maintaining transparency. Additionally, an ethics review will be conducted to confirm that all ethical standards are met, ensuring the project upholds principles of fairness, accountability, and respect for individuals' rights. This proactive approach reinforces the commitment to maintaining the highest legal and ethical standards. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Social Impact | This problem is relevant to the growing interest in sustainable agriculture and the increasing use of technology to enhance agricultural practices. As more individuals and communities seek to grow their own food, the demand for efficient and user-friendly solutions to manage home greenhouses is on the rise. By developing a system that automates temperature and humidity monitoring while also displaying relevant statistics on the data collected through applied machine learning, I aim to provide a practical solution that not only assists my guardian but can also benefit others in similar situations, or those who want something more than a simple greenhouse monitoring system. Thus, this project will contribute to the advancement of smart gardening technologies, encouraging more people to engage in sustainable practices while making greenhouse management more accessible for those with varying levels of experience and physical capability. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Risk Assessment | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <table border="1"> <thead> <tr> <th rowspan="2">Ref</th> <th colspan="3">The Risk</th> <th colspan="3">Inherent Risk Assessment</th> <th colspan="3">Reducing The Risk [Planned controls shown in GREEN]</th> <th colspan="3">Residual Risk Assessment</th> <th rowspan="2">Overall Risk Score Key:</th> </tr> <tr> <th>#</th> <th>Risk Cause and Event</th> <th>Risk Consequences</th> <th>Risk Owner</th> <th>Probability</th> <th>Impact</th> <th>Score</th> <th>Control Measures (In place and planned)</th> <th>Date / In place</th> <th>Probability</th> <th>Impact</th> <th>Score</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Stock of Arduino Hardware: Shortage of Arduino hardware components due to supply chain issues or increased demand</td> <td> <ul style="list-style-type: none"> • Delay in project progress • Increased cost </td> <td>Supplier</td> <td>2</td> <td>5</td> <td>10</td> <td> A. Consider bulk purchasing of hardware for stockpiling B. 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| Security Measures | To ensure data privacy, any collected information will be anonymized. Transparency will be maintained by clearly communicating what data is being collected, how it will be used, and the rights of users to withdraw consent or request data deletion at any time. Additionally, only the data necessary for the functionality of the system will be collected, minimizing the risk of misuse. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Inclusive Equality | Promotes inclusive equality in greenhouse management by making the process more accessible to individuals with varying levels of experience and physical capability. The system's user-friendly interface ensures that even users with limited technical expertise can easily interpret key metrics such as temperature and humidity. Additionally, automation reduces the need for manual labour, making it a valuable tool for individuals with physical limitations. By providing real-time insights and predictive analysis through machine learning, the system empowers users to make informed decisions without requiring extensive agricultural or technical knowledge, ensuring that greenhouse management is accessible to everyone, regardless of their background or abilities. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Career Skills | This project provided me with the opportunity to investigate a real-world problem and apply the skills I have gained from the modules studied throughout my degree, including applied machine learning, agile development, and application development using object-oriented programming with appropriate design patterns. Furthermore, my interest in integrating Arduino into projects, which has not been part of my formal coursework, motivated me to explore this technology independently. Taking on this challenge allowed me to expand my skill set, combining the theoretical knowledge acquired during my studies with practical problem-solving using Arduino, further enhancing my technical and career-oriented capabilities. Moreover, with the application of the Scrum methodology and progress documentation, I have developed valuable skills such as iterative problem-solving, task prioritization, time management, and adaptability, all of which are highly relevant and transferable to future career endeavours. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

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