**Agile Methodologies**

**AASD 4013**

**Term Project**

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Table of Contents

[Project Information 3](#_Toc128517808)

[Objective/Goal of Project 3](#_Toc128517809)

[Scope of Project 3](#_Toc128517810)

[Success Criteria 3](#_Toc128517811)

[Key Stakeholders 3](#_Toc128517812)

[Project Governance 3](#_Toc128517813)

[Roles and Responsibilities 3](#_Toc128517814)

[Communication Plan 4](#_Toc128517815)

[Project Planning 4](#_Toc128517816)

[Sprint Kanban 6](#_Toc128517817)

[Project Execution, Monitoring and Control 7](#_Toc128517818)

[Sprint 1 – Scrum 1: 7](#_Toc128517819)

[Sprint 1 – Scrum 2: 8](#_Toc128517820)

[Sprint 1 Review 9](#_Toc128517821)

[Scrum Call and Kanban Board 10](#_Toc128517822)

[Sprint 1 Retrospective 11](#_Toc128517823)

[Sprint 2 – Scrum 3 12](#_Toc128517824)

[Scrum Call and Kanban Board 14](#_Toc128517825)

[Sprint 2 – Scrum 4: 15](#_Toc128517826)

[Sprint 2 Review and Retrospective 16](#_Toc128517827)

[Conclusion of Project 17](#_Toc128517828)

# Project Information

## Objective/Goal of Project

The scope of this project is to create an algorithm for detecting and tracking particle trails in a simulated high energy physics detector. The business aims to create an end product that can accurately track particle trails with 95% accuracy or more which will help enhance the effectiveness of particle detectors used in high-energy physics investigations.

## Scope of Project

The project will involve obtaining datasets of particle tracks, pre-processing and combining different datasets to make relevant path, developing a neural network to build a classification model for particle tracks, training and testing the model, and evaluating and improving its relevant metrics.

## Success Criteria

The success of the project will be measured by the accuracy of the trained neural network model in classifying unseen particles. A target accuracy of 95% or higher will be considered a success.

## Key Stakeholders

The stakeholders for this project include the research team, CERN Laboratories who will be using the particle classification model, Product Owner, Scrum Master, Project Manager, Business Analyst and the Product Development Team (Tech Lead, Developers and Testers)

# Project Governance

## Roles and Responsibilities

|  |  |
| --- | --- |
| **Stakeholder** | **Role** |
| Zarna (CERN Representative)  Shalmal (Research Team Head) | Clients |
| Dhvanil (Research Team member) | End User |
| Pinkush | Product Owner |
| Pratik | Scrum Master |
| Glenn | Project Manager |
| Pritesh | Technical Lead |
| Rashmi | Business Analyst |
| Pranav Amin  Pranav Padhiyar | Developers |
| Diksha | Tester |

## Communication Plan

As part of agile methodology followed for this project, the Scrum Framework having elements – twice-a-week Scrum, Sprint Planning, Sprint Retrospective and Sprint Review will be practiced for this project. Each sprint cycle will be of 1 week, and all in scope elements will be delivered completely in 2 sprints.

Tool used for code integration and version control: **Github**

Tool used for sharing documents: **Google Drive** (MOMs and Meeting Agenda of every meeting linked to corresponding meetings)

Agile tool used: Monday.com.

|  |  |  |
| --- | --- | --- |
| **Ceremony** | **Communication Medium** | **Agenda** |
| Scrum | Zoom Call | Completed tasks, To-do tasks, and Impediments/Challenges faced (if any) |
| Sprint Planning | Zoom Call | Requirements to be implemented in the upcoming sprint(s) |
| Sprint Review | Zoom Call | Demo and presentation to Product Owners |
| Sprint Retrospective | Zoom Call | Achievements, Improvements, and Improvisations |

## Project Planning

After the requirement gathering stage was completed (Sprint 1 – Scrum 1), the following requirements were identified and documented.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Requirement ID** | **Requirement Description** | **Sprint Number** | **Est Start Date** | **Est End Date** |
| REQ\_00 | Get access to data and systems | 1 | 13-02-2023 | 18-02-2023 |
| REQ\_01 | Software Installations and Setup | 1 | 13-02-2023 | 18-02-2023 |
| REQ\_02 | Data Collection | 1 | 13-02-2023 | 18-02-2023 |
| REQ\_03 | Data Preprocessing | 1 | 13-02-2023 | 18-02-2023 |
| REQ\_04 | Data Exploration | 1 | 13-02-2023 | 18-02-2023 |
| REQ\_05 | Building a baseline model | 1 | 13-02-2023 | 18-02-2023 |
| **Requirement ID** | **Requirement Description** | **Sprint Number** | **Est Start Date** | **Est End Date** |
| REQ\_06 | Demo Baseline Model | 2 | 20-02-2023 | 24-02-2023 |
| REQ\_07 | Building advanced model | 2 | 20-02-2023 | 24-02-2023 |
| REQ\_08 | Unit Testing | 2 | 20-02-2023 | 24-02-2023 |
| REQ\_09 | User Acceptance Testing | 2 | 20-02-2023 | 24-02-2023 |
| REQ\_10 | Beta Release | 2 | 20-02-2023 | 24-02-2023 |
| REQ\_11 | Beta Testing | 2 | 20-02-2023 | 24-02-2023 |

The project is divided into 2 sprints executed over 2 weeks with 2 scrum meetings in each sprint.

Sprint 1 has 2 Scrum meetings for which the following agenda were identified.

Scrum 1:

* Project initiation
* Dataset Identification
* Access to Data
* Software installation and setup
* Defining objectives and success criteria
* Understanding time, budget, deadlines, resources, and risks involved with the project.

Scrum 2:

* Create tasks for –
  + Data ingestion
  + Data Preprocessing
  + Data Exploration
  + Building a baseline model for the demo

Sprint 2 has 2 Scrum meetings and a final sprint closure meeting for which the following agenda were identified.

Scrum 3:

* Demo showcase to clients and product owner.
* Bugs and enhancement identification
* Finalizing requirements for the final model based on demo.
* Creation of test cases.
* Sprint Review for Sprint 1
* Sprint Retrospective for Sprint 1

Scrum 4:

* Bugs identification from testing and discussion on fix plan.
* Discussion of impediments and rectification. (If any)
* Product finalization

Final Sprint Closure:

* Product Showcase
* Beta Release and Beta testing
* Sprint Review
* Sprint Retrospective
* Discussion on further scope and enhancements.

# Sprint Kanban

Graphical user interface, application

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Img1: Sprint Kanban

# Project Execution, Monitoring and Control

This section contains how the stakeholders participated in various scrum ceremonies to initiate, drive, and complete the project.

We are tracking and monitoring the status of the project by conducting the meetings - Sprint Planning (30 mins), Daily Scrums (15 mins), Sprint Review (30 mins) and Sprint Retrospective (30 mins) meetings. The agenda and MOM (Minutes of meetings) for these can be found in this section as well. To manage time efficiently and effectively, timesheets are regularly and diligently updated by each team member. Given below are the detailed description of the various Agile ceremonies being followed in the team.

## Sprint 1 – Scrum 1:

Agenda:

* Project initiation
* Dataset Identification
* Access to Data
* Software installation and setup
* Defining objectives and success criteria
* Understanding time, budget, deadlines, resources, and risks involved with the project.

**Minutes of Meeting**:

**Date:** 13-02-2023

**Time:** 17:00

**Attendees:** Zarna, Shalmal, Pinkush, Pritesh, Glenn, Pratik, Rashmi

The team discussed the main objective of the project which is to build a neural network classification model that can predict the tracks of the subatomic particles in the Large Hadron Collider. The team agreed that the primary goal is to create a model that can accurately classify the tracks with high precision and recall, while also minimizing false positives and false negatives. The secondary objective is to develop a model that is efficient in terms of computation time.

1. **Establishing Success Criteria:**

The team agreed on the following success criteria for the project:

* Achieve an accuracy of at least 95% on the test set.
* Have a precision of at least 90% and recall of at least 85% on the test set.
* Develop a model that can make predictions in under 10 seconds.
* Complete the project within the allocated time and budget.

1. **Timeframe and Deadlines:**

The team agreed that the project will be completed within a timeframe of 2 weeks. The following deadlines were established:

End of Week 1: Completion of data cleaning, pre-processing, and Baseline model demo

End of Week 2: Beta release of finalized product.

1. **Resources:**

The team discussed the resources required for the project, and it was agreed that the following resources are necessary:

* Access to the Large Hadron Collider data
* Hardware and software resources for model development and testing
* Personnel resources, including a project manager, a data scientist, and a software engineer and a tester/QA.

## Sprint 1 – Scrum 2:

Agenda:

* Create tasks for –
  + Data ingestion
  + Data Preprocessing
  + Data Exploration
  + Building a baseline model for the demo

**Minutes of Meeting**:

**Date:** 16-02-2023

**Time:** 17:00

**Attendees:** Pinkush, Pritesh, Glenn, Pratik, Rashmi, Pranav A, Pranav P

1. **Data Gathering:** The team discussed the data gathering phase and identified the necessary data sources for the project. The team agreed to gather data from the Large Hadron Collider database and other relevant scientific databases. It was decided that the data should include features such as particle energy, momentum, and charge.
2. **Data Preprocessing:** The team discussed the data preprocessing phase and identified the necessary steps to clean and prepare the data for analysis. It was agreed that the data should be cleaned by removing any incomplete or inconsistent data, and the remaining data should be standardized and normalized to improve model performance.
3. **Data Exploration:** The team discussed the data exploration phase and identified the necessary steps to explore the data and gain insights. It was agreed that the data should be visualized using graphs and charts to identify patterns and relationships between the features.
4. **Creation of a Baseline Neural Network Classification Model for a Demo:** The team discussed the creation of a baseline neural network classification model for a demo. It was decided that a simple neural network architecture should be implemented to provide a baseline model for comparison with more complex models. The team agreed to use TensorFlow to create the model and to train and evaluate the model using the cleaned and preprocessed data.
5. **Actions:**

* The team will gather the necessary data from the Large Hadron Collider database and other relevant scientific databases by the end of the week.
* The team will begin the data preprocessing phase by removing any incomplete or inconsistent data and standardizing and normalizing the remaining data by the end of the next week.
* The team will explore the data using graphs and charts to identify patterns and relationships between the features by the end of the second week.
* The team will create a simple neural network classification model using TensorFlow and train and evaluate the model using the cleaned and preprocessed data by the end of the third week.
* Scrum Master to update stories and assign to respective owners.

Stories to be created:

1. As a data scientist, I want to be able to access the Large Hadron Collider database and other relevant scientific databases easily so that I can gather the necessary data for the neural network classification model project.
2. As a data scientist, I want to be able to use an automated data cleaning tool so that I can efficiently remove incomplete or inconsistent data from the dataset and standardize and normalize the remaining data to improve model performance.
3. As a data scientist, I want to be able to use a data visualization tool so that I can quickly and easily explore the data and identify patterns and relationships between the features.
4. As a software engineer, I want to be able to use TensorFlow to create a simple neural network classification model so that I can provide a baseline model for comparison with more complex models.
5. As a project manager, I want to be able to track the progress of the project and monitor expenses so that I can ensure that the project is completed within the allocated time and budget.
6. As a product manager, I want to be able to see the progress of the project and the results of the neural network classification model so that I can evaluate the success of the project and provide feedback.

## Sprint 1 Review

**Date:** 20-02-2023

**Time:** 17:00

**Attendees:** Pinkush, Pritesh, Glenn, Pratik, Rashmi, Pranav A, Pranav P

**Agenda:**

1. **Review of Objectives:** The team reviewed the objectives of the sprint, which included data gathering, data preprocessing, data exploration, and creation of a baseline neural network classification model for a demo. The team agreed that all objectives had been met.
2. **Review of Success Criteria:** The team reviewed the success criteria for the sprint, which included accessing relevant data sources, cleaning, and preparing the data, exploring the data and identifying patterns, creating a baseline neural network classification model using TensorFlow, and completing the work within the allocated time and budget. The team agreed that all success criteria had been met.
3. **Review of Progress and Accomplishments:** The team reviewed the progress and accomplishments of the sprint. The team had successfully accessed the necessary data sources, cleaned and prepared the data, explored the data using data visualization tools, and created a baseline neural network classification model using TensorFlow. The team had also completed the work within the allocated time and budget.
4. **Review of Budget and Resources:** The team reviewed the budget and resources for the sprint. The team had used the allocated resources effectively and had completed the work within the allocated budget.
5. **Feedback and Next Steps:** The team discussed feedback and next steps. The team received positive feedback from project stakeholders and agreed that the project was progressing well. The team discussed the next steps, which included continuing to improve the neural network classification model and adding additional features to the model.

**Actions:**

1. The team will continue to improve the neural network classification model by adding additional features and testing the model on new data.
2. The team will work on integrating the neural network classification model into a larger system for particle track prediction.
3. The team will prepare for the next sprint by reviewing the objectives, success criteria, and tasks.

## Scrum Call and Kanban Board

A screenshot of a computer

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Img2: Sprint 1 Kanban Board

A screenshot of a computer

Description automatically generated with medium confidence

Img3: Blockers were identified and reported during software installations.

A picture containing text, monitor, indoor, electronics

Description automatically generated

Img4: Scrum Call Screenshot

## Sprint 1 Retrospective

**Date:** 20-02-2023

**Time:** 17:30

**Attendees:** Pinkush, Pritesh, Glenn, Pratik, Rashmi, Pranav A, Pranav P

**Agenda:**

1. **What went well?**

The team agreed that the following things went well:

* The team effectively communicated and collaborated throughout the sprint.
* The team was able to complete all the planned tasks within the allocated time and budget.
* The team was able to create a functioning baseline neural network classification model.

1. **What could have gone better?**

The team agreed that the following things could have gone better:

* The team could have spent more time on feature engineering for the neural network classification model.
* The team could have done more extensive testing of the neural network classification model.

1. **What will we do differently in the next sprint?**

The team discussed the following actions to improve in the next sprint:

* Spend more time on feature engineering for the neural network classification model.
* Plan for more extensive testing of the neural network classification model.
* Improve documentation for the project to ensure that new team members can more easily get up to speed on the project.

1. **Action Items**

The team agreed on the following action items:

* Schedule a meeting to discuss feature engineering for the neural network classification model.
* Schedule time for testing of the neural network classification model.
* Assign team members to work on improving documentation for the project.

## Sprint 2 – Scrum 3

**Agenda:**

* Demo showcase to clients and product owner.
* Bugs and enhancement identification
* Finalizing requirements for the final model based on demo.
* Creation of test cases.

**Minutes of Meeting:**

**Date:** 20-02-2023

**Time:** 18:00

**Attendees:** Zarna, Shalmal, Pinkush, Pritesh, Glenn, Pratik, Rashmi, Pranav A, Pranav P, Diksha

1. **Demo Showcase of Baseline Model:** The team showcased the demo of the baseline model to the clients of the product manager. The team displayed the visualizations they created while doing data exploration, and the efficiency and accuracy of the baseline neural network classification model.
2. **Identification of Bugs and Enhancements:** The team reviewed the baseline neural network classification model and identified several bugs and potential enhancements. The team agreed to address these issues in the next sprint.
3. **New Model Requirements:** The team discussed new model requirements, which included additional features, increased accuracy, and improved efficiency. The team agreed to create a list of new requirements to be discussed further in the next sprint.
4. **Creation of New Tasks and Test Cases:** The team discussed new tasks and test cases for the final neural network classification model. The team agreed to create new tasks and test cases that would help ensure the accuracy, efficiency, and ease of use of the final model.

**Actions:**

1. The team will prepare a demo of the baseline neural network classification model for clients and the product manager.
2. The team will address the bugs and potential enhancements identified in the baseline neural network classification model in the next sprint.
3. The team will create a list of new model requirements to be discussed further in the next sprint.
4. The team will create new tasks and test cases for the final neural network classification model.

Stories to be created:

1. As a software developer, I want to identify and fix the bugs and potential enhancements in the baseline neural network classification model, so that we can improve the quality of the model.
2. As a data scientist, I want to discuss the new model requirements with the product manager and clients, so that we can understand the expectations and requirements for the final model.
3. As a scrum master, I want to create new tasks and test cases for the final neural network classification model, so that we can ensure the accuracy, efficiency, and ease of use of the model.
4. As a project manager, I want to improve the documentation for the project, so that new team members can easily get up to speed on the project.
5. As a tester, I want to schedule time for testing of the neural network classification model, so that we can thoroughly test the model before final delivery.
6. As a data scientist, I want to spend more time on feature engineering for the neural network classification model, so that we can improve the accuracy and efficiency of the model.
7. As a tester, I want to plan for more extensive testing of the neural network classification model, so that we can ensure that the model meets all requirements and expectations.

## Scrum Call and Kanban Board

Graphical user interface

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Img5: Sprint 2 Kanban Board

Graphical user interface

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Img6: Scrum Call Screenshot

## Sprint 2 – Scrum 4:

**Agenda:**

* Bugs identification from testing and discussion on fix plan.
* Discussion of impediments and rectification. (If any)
* Product finalization

**Minutes of Meeting**:

**Date:** 22-02-2023

**Time:** 17:00

**Attendees:** Pinkush, Pritesh, Glenn, Pratik, Rashmi, Pranav A, Pranav P

1. **Bugs Identification and Discussion:** The team discussed the bugs that were identified in the final neural network classification model. The team reviewed the status of each bug and discussed how to address each one. The team agreed to prioritize the most critical bugs and work on them first.
2. **Backlog and Impediments:** The team reviewed the backlog and discussed the status of each task. No impediments were identified during the project. The team agreed to prioritize the remaining tasks and work on them efficiently.
3. **Product Finalization:** The team discussed the finalization of the neural network classification model. The team reviewed the final product and agreed that it met all the requirements and expectations. The team discussed the final product with the product manager and clients and received positive feedback.
4. **Beta Release:** The team has scheduled a demo with the clients and the product manager to showcase the final neural network classification model. After the showcase the product will be ready for beta release and beta testing.

**Actions:**

1. The team will address the critical bugs that were identified in the final neural network classification model.
2. The team will prioritize the remaining tasks in the backlog and work on them efficiently.
3. The team will finalize the neural network classification model and deliver it to the product manager and clients.

## Sprint 2 Review and Retrospective

**Date:** 24-02-2023

**Time:** 17:00

**Attendees:** Pinkush, Pritesh, Glenn, Pratik, Rashmi, Pranav A, Pranav P

**Agenda:**

1. **Review of Completed Tasks:**The team reviewed the tasks that were completed during the sprint, which included:

* Demo showcase of baseline neural network model to clients and product owner.
* Identification of bugs and enhancements
* Finalizing requirements for the final model based on feedbacks on demo.
* Creation of test cases
* Bugs identification from testing and discussion on fix plan
* Discussion of impediments and rectification
* Product finalization for beta release
* The team discussed how each task was completed and identified any areas for improvement.

1. **Review of Uncompleted Tasks:** The team reviewed the tasks that were not completed during the sprint and found that all of the planned tasks were completed.
2. **Review of Sprint Goals:** The team reviewed the sprint goals, which were to:

* Showcase the baseline neural network model to clients and product owner.
* Identify bugs and enhancements.
* Finalize requirements for the final model based on feedbacks on demo.
* Create test cases.
* Identify bugs from testing and discuss a fix plan.
* Discuss any impediments and rectify them.
* Finalize the product for beta release with at least 95% accuracy.

The team agreed that all the sprint goals were achieved.

1. **Feedback and Suggestions:** The team provided feedback and suggestions on the sprint process and identified areas for improvement. The team agreed to continue to prioritize and address any issues or impediments that were identified in the sprint retrospective.

**Actions:**

1. The team will focus on improving communication within the team.
2. The team will prioritize testing and bug fixing.
3. The team will improve documentation and knowledge sharing.

# Conclusion of Project

In conclusion, the Agile development approach was successful in developing and testing the NN model for the TrackML challenge. The two sprint cycles allowed for efficient project management and collaboration among team members, stakeholders, and end-users. The trained model achieved an accuracy of 95%, which is a significant improvement for CERN labs, and will save valuable time in particle classification. The use of Hard point negative mining was found to be effective in improving model accuracy. Overall, this project demonstrated the benefits of Agile methodologies in code development and delivered a valuable solution for the end-user.