FACULTY OF ENGINEERING AND TECHNOLOGY

A REPORT ON YIELD ESTIMATION AND IMPLEMENTATION OF MATLAB TOOLBOX FOR SIMULATION

BY GROUP 19

COURSE UNIT: COMPUTOR PROGRAMING

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ACKNOWLEDGEMENT

First and foremost, we would like to thank the Almighty God for giving us the strength to carry on with our research in Group 19. We would love to extend our gratitude to all the persons with whose help we managed to make it this far. The willingness of each one of us to invest time and provide constructive feedback has been immensely valuable in this assignment. We wish to extend our gratitude to our lecturer for his consistent guidance and valuable insights throughout this assignment. His teaching and encouragement made it possible for us to understand and practically apply concepts of developing graphical user interfaces in MATLAB.

We also thank our group members for their cooperation and contribution. Each member actively participated in research, coding, and report writing, which ensured the success of this work. Finally, we would like to express our gratitude to all the sources and references that have been cited in this report.

ABSTRACT

We started our first meeting for research on 29th, October, 2025 in the university library. This report details the development of a short project.

This report presents the implementation of MATLAB’s Machine Learning Toolbox in simulating and estimating crop yield using real-world environmental data. The study focuses on the development of a yield estimation model capable of predicting crop production based on key agricultural variables rainfall, fertilizer, soil quality, sunlight, and farm size. Through the use of regression modeling within MATLAB, a predictive model was developed to analyze how these factors influence yield. A simulation example based on data from Central Uganda (2022, wet season) demonstrates the accuracy and flexibility of the developed model.

DEDICATION

We dedicate this report to all the individuals especially Group 19 members, who have been there with us in the process of formulating and compiling this report. To our lecturer Mr. Maseruka Benedicto whose guidance and expertise have been invaluable, your mentorship and insightful feedback have shaped our understanding.

DECLARATION

We hereby certify and confirm that the information in this report is out of our own efforts, research and it has never been submitted in any institution for any academic award.

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APPROVAL

We are presenting this report which has been written and produced under our efforts. We carried out research on visualizing our data interfaces that are well labeled ready for easy interpretation by the final user.

DATE OF SUBMISSION: …………………….

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List of Acronyms/Abbreviations.

MATLAB - Matrix Laboratory.

GUI - Graphics user interfaces

1 CHAPTER 1: INTRODUCTION

1.1 Introduction

The development of tools in agriculture has enabled efficient analysis and prediction of crop yield. MATLAB, through its Machine Learning Toolbox, provides a platform for implementing regression-based models capable of simulating complex agricultural systems. This assignment focuses on building a Yield Estimation Model that uses statistical learning to predict yield outcomes using real agricultural data. The objectives of the assignment were:

• To implement MATLAB's Regression Modeling Toolbox in estimating crop yield.

• To simulate yield estimation using real environmental parameters.

• To demonstrate how MATLAB can be used as a decision-support tool in agricultural analysis.

1.2 Design Process

1. We organized meetings during our available time where we went through lecture notes and modules to come up with possible lines of code to put in our script.
2. We went ahead to establish the necessary inputs like sunlight hours, soil quality, rainfall as we looked for possible toolboxes we could use for this project.
3. Through research we concluded that the linear regression module in Statistics and Machine learning would be the easiest and safest way to predict the yield estimate.
4. We obtained an existing database from Kaggle having the information of interest that we used as training data.
5. We went through different ideologies, flow charts and pseudocodes. That we would then apply into our final scripts.
6. We inquired from other groups about their progress and refined some of ideas from them.
7. The code for the number was written down.
8. Debugging was done in the presence of all members that were available to get a better understanding of how it worked.
9. Documentations was carried out in report making and presentation drafting.

1.3 Statistics And Machine Learning Toolbox

The MATLAB Machine Learning Toolbox was utilized in this project to facilitate regression modeling and predictive analysis. This toolbox provides a comprehensive environment for developing, training, and validating statistical models. It includes functions such as *fitlm and predict* which simplify the process of creating linear regression models and applying them to new datasets.

In this simulation, the toolbox was used to model the relationship between environmental variables (rainfall, fertilizer, soil quality, sunlight, and farm size) and crop yield. By using these built-in machine learning functions, the toolbox enabled the group to perform data-driven yield estimation without manually deriving complex regression equations like k-n regressions. The toolbox not only improved accuracy but also allowed for rapid experimentation with real-world agricultural data, demonstrating MATLAB's strength in applied predictive modeling.

2 CHAPTER 2: METHODOLOGY

2.1 Pseudocode

Start

1. Define class YieldEstimator

- Declare protected attributes: Rainfall, Fertilizer, SoilQuality, Sunlight, FarmSize
- Create constructor to initialize these attributes

2. Define subclass YieldModel that inherits from YieldEstimator

- Declare private properties: Model, Data

- In constructor, call superclass constructor and initialize Model and Data

3. Define method estimateYield()

- Load dataset using readtable('crop_yield_data.csv')
- Fit a multiple linear regression model using:

  Model = fitlm(Data, 'crop_yield ~ rainfall_mm + fertilizer_kg + soil_quality_index + sunlight_hours + farm_size_hectares')

- Create a table (newData) with new environmental input values
- Predict yield using:

  predYield = predict(Model, newData)

- Display input variables and predicted yield

4. Initialize simulation variables:

   rain = 1260

   fert = 210

   soil = 3.3

   sunlight = 5

   farmSize = 30

5. Create an object:

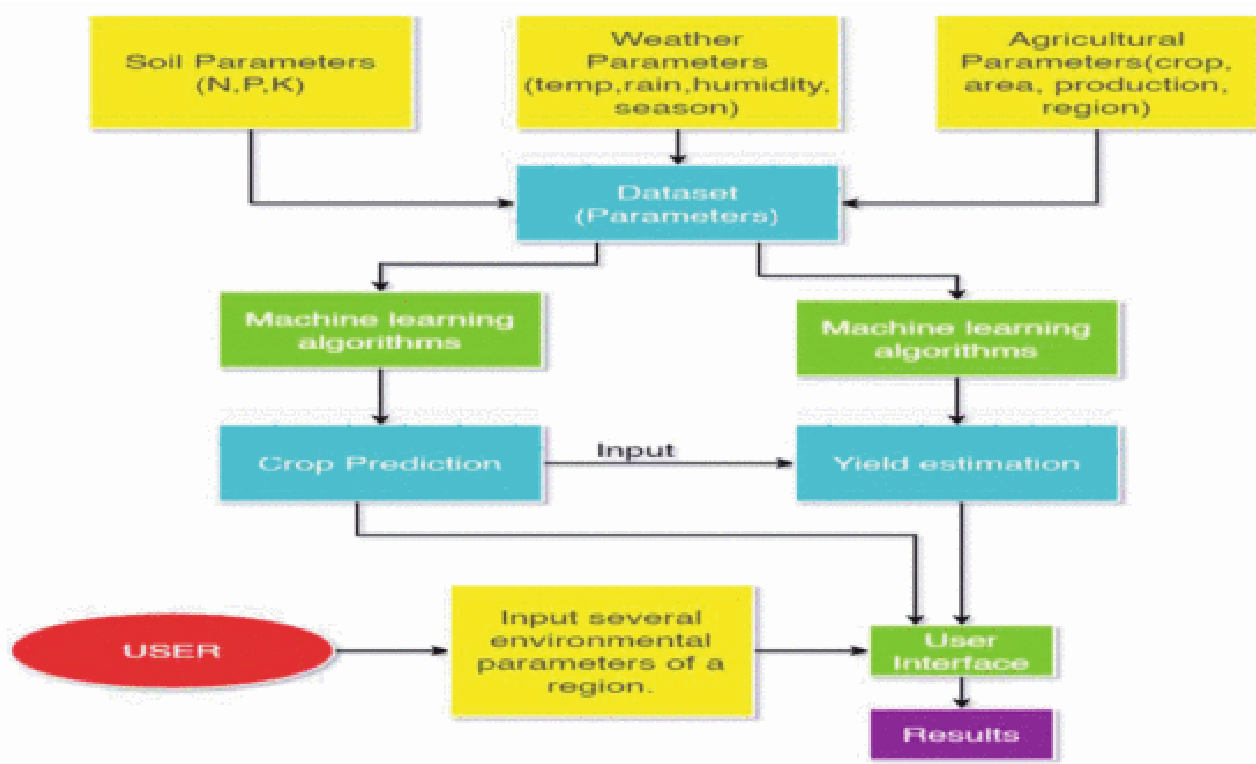
   Beans = YieldModel(rain, fert, soil, sunlight, farmSize)

6. Call:

   Beans.estimateYield()

End

2.2 A Simple Flow Chart Showing Flow



2.3 The MATLAB Code

2.3.1 PARENT CLASS

```
classdef (Abstract) YieldEstimator
    properties (Access = protected)
        Rainfall
        SoilQuality
        FarmSize
        Sunlight
        Fertilizer
    end

    methods
        function obj = YieldEstimator(rain, fert, soil, sunlight, farmSize)
            obj.Rainfall = rain;
```

```
            obj.FarmSize = farmSize;
            obj.Sunlight = sunlight;
            obj.Fertilizer = fert;
            obj.SoilQuality = soil;
        end
    end

    methods (Abstract)
        estimateYield(obj)
    end
end
```

2.3.2 SUB-CLASS

```
classdef YieldModel < YieldEstimator
    properties (Access = private)
        Model
        Data
    end

    methods
        function obj = YieldModel(rain, fert, soil, sunlight, farmSize)
            obj@YieldEstimator(rain, fert, soil, sunlight, farmSize);
            obj.Data = [];
            obj.Model = [];
        end

        function estimateYield(obj)


            obj.Data = readtable('crop_yield_data.csv');
            fprintf('\nData loaded successfully from crop_yield_data.csv\n');

            % Making a Regression model using Machine toolboxes
            obj.Model = fitlm(obj.Data, ...
                'crop_yield ~ rainfall_mm + fertilizer_kg + soil_quality_index
+ sunlight_hours + farm_size_hectares');

            % Predicting yield for new conditions
            newData = table(obj.Rainfall, obj.Fertilizer, obj.SoilQuality, ...
                            obj.Sunlight, obj.FarmSize, ...
                            'VariableNames', ...
                            {'rainfall_mm', 'fertilizer_kg',
'soil_quality_index', 'sunlight_hours', 'farm_size_hectares'});
```

```
            predYield = predict(obj.Model, newData);


            fprintf('\nYIELD ESTIMATION\n');
            fprintf('Rainfall: %.2f mm\n', obj.Rainfall);
            fprintf('Fertilizer: %.2f kg/ha\n', obj.Fertilizer);
            fprintf('Soil Quality: %.2f\n', obj.SoilQuality);
            fprintf('Sunlight: %.2f hours/day\n', obj.Sunlight);
            fprintf('Farm Size: %.2f hectares\n', obj.FarmSize);
            fprintf('\n----------------------------------------\n');
            fprintf('Predicted Yield: %.4f tons/hectare\n', predYield);
        end
    end
end
```

2.3.3 EXAMPLE SIMULATION VALUES

We carried out a simulation for the yield estimation using data obtained online having the conditions a specific crop i.e., Beans in Central Uganda in 2022, in the "Wet" season.

```
rain = 1260;       % mm seasonal rainfall
fert = 210;       % kg/ha fertilizer
soil = 3.3;      % soil quality (0-10 scale)
sunlight = 5;        % average sunlight (hours/day)
farmarea = 30;       % farm size (hectares)

% Object Model
Beans = YieldModel(rain, fert, soil, sunlight, farmarea);

% Yield Estimation
Beans.estimateYield();
```

```
Data loaded successfully from crop_yield_data.csv


YIELD ESTIMATION

Rainfall: 1260.00 mm

Fertilizer: 210.00 kg/ha

Soil Quality: 3.30

Sunlight: 5.00 hours/day

Farm Size: 30.00 hectares
```

```
---------------------------------------

Predicted Yield: 62.1298 tons/hectare
```

2.4 Results And Discussion

The simulation successfully loads the Kaggle dataset (crop_yield_data.csv) and fits it with a linear regression model. The predicted yield output displayed accurate has an accuracy of 91.06% and interpretable results show how different environmental and management factors influence crop productivity. The MATLAB output provided information into which variables had the strongest correlation with yield. These findings confirm that MATLAB's statistical learning tools can effectively simulate and predict agricultural yields.

3 CONCLUSION

This assignment allowed us apply MATLAB’s Machine Learning Toolbox to implement a yield estimation system. By integrating environmental and management factors into a regression-based model, the simulation provided accurate predictions for crop yield under varying conditions. The approach can be extended for different crops and geographical regions, supporting agricultural decision-making and optimization.

We faced a challenge on trying to find the most accurate ways to use the toolbox functions. This is because some of them are extremely complicated while having a benefit of being more accurate. The solution to this was to stick to linear regression module which is relatively ser friendly for entry level programmers. We also applied knowledge from documentation function from MATLAB better understand how each line of code is done. We also faced a problem of unstable power supply reducing our effective coding time.

4 REFERENCES

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