**Final Year Project**

**Q1 Project title**

The title should be concise but also should adequately describe the subject of your project. General advice is to avoid phrases such as "An investigation of...", " A study of..." etc.

**AI-Based Fruit Classification and Detection System for Enhanced Quality Control**

**Q2 Project aim**

2 Points

A short paragraph describing the computer science problem that your project is investigating. This does not need to describe how you solve the problem or with what tools, unless that is fundamental to the work.

**This project seeks to tackle a critical challenge in the agricultural and retail sectors: the efficient, accurate, and real-time classification and detection of fruits, which is a nuanced computer vision problem. Despite advancements in artificial intelligence (AI), current systems struggle with accurately identifying and classifying a wide variety of fruits in real-time, a capability crucial for enhancing the efficiency of sorting processes, optimizing inventory management, and ensuring stringent quality control measures. This difficulty stems from the diverse appearance of fruits, variations in size, shape, color, and the presence of defects, which traditional methods fail to consistently recognize under varying conditions.**

**By leveraging state-of-the-art computer vision and deep learning technologies, this project aims to develop an innovative AI-based solution that significantly improves upon existing systems. The goal is to create a robust, scalable, and accurate system capable of performing real-time fruit classification and detection. This system will not only support fruit processing facilities in reducing waste and enhancing productivity but also aid retailers and consumers in maintaining the highest standards of fruit quality. The project's success will provide a model for applying advanced AI techniques to solve practical, real-world problems in the agricultural and retail industries, highlighting the potential for AI to revolutionize traditional practices through improved accuracy, efficiency, and quality control.**

**Q3 Project objectives**

10 Points

Grading comment:

A list of up to 5 objectives that you will achieve as part of your project. You do not need 5, 3-5 is usually appropriate. These objectives will collectively meet the overall aim of your work. Normal parts of the project such as literature review, background research and report writing are not objectives.

### Q3.1 Objective 1

2 Points

**Collect Diverse Dataset: Gather a comprehensive dataset of fruit images, encompassing various types, sizes, and conditions for effective model training.**

### Q3.2 Objective 2

**Enhance Model Readiness through Data Preparation: Systematically preprocess and augment the collected fruit dataset to achieve high-quality, uniformly sized, and accurately labeled images. This process will include techniques such as noise reduction, normalization, and data augmentation strategies like rotation, scaling, and flipping to simulate varied conditions. The objective ensures the dataset is optimized for training a deep learning model, thereby significantly improving the model’s ability to accurately classify and detect fruits under diverse real-world conditions.**

### Q3.3 Objective 3

2 Points

**Select, Train, and Validate the AI Model: Choose a Convolutional Neural Network (CNN) architecture tailored for efficient fruit classification and detection. This objective goes beyond merely training the model on the enhanced dataset; it explicitly includes a comprehensive validation step to rigorously evaluate the model's performance. By employing a split of the data into training and validation sets, we will assess the model against key performance metrics such as accuracy, precision, and recall. This approach ensures the model’s robustness and reliability for real-world application, directly aligning with our project's aim to elevate quality control standards in the fruit industry through AI."**

### Q3.4 Objective 4

2 Points

**"Comprehensively Evaluate Model Performance for Classification and Detection: Implement a dual-focused evaluation of the AI model to validate its effectiveness in both fruit classification and detection tasks. For classification, accuracy, precision, recall, and F1 score will be utilized to measure the model's ability to correctly identify fruit types. For detection, we will employ mean Average Precision (mAP) and Intersection over Union (IoU) to assess the model's accuracy in localizing and identifying fruits within images. This strategic choice of metrics ensures a thorough evaluation aligned with industry standards for computer vision tasks, providing a clear demonstration of the model's capability to meet the project's aim of improving fruit sorting and quality control processes through advanced AI.**

Objective 5

**"Optimize and Prepare Model for Deployment: Enhance the AI model's performance through targeted optimization post-validation, focusing on improving accuracy and efficiency in fruit detection and classification. This step includes fine-tuning parameters and applying insights from evaluation metrics to address areas of improvement. Concurrently, develop concise yet comprehensive documentation for system deployment and user guidance, ensuring ease of use and integration into existing quality control workflows. This dual approach ensures the model is not only technically advanced but also readily adoptable by industry stakeholders, aligning with our aim to deliver a practical, AI-driven solution for the fruit industry**.

**Q4 Project deliverables**

10 Points

Grading comment:

A list of up to 5 deliverables from your project. Two of these should be your report itself and your software repository. Deliverables are concrete items produced during your project. They are the evidence that you require to meet your objectives, and ultimately your aim. You should link them to your Objectives in the text below such that it will be clear which Deliverable relates to which Objective.

### Q4.1 Deliverable 1

2 Points

Grading comment:

**1. Preprocessed Dataset: Cleaned, resized, and augmented dataset, prepared for model training.**

### Q4.2 Deliverable 2

2 Points

**Trained CNN Model: A fully developed and optimized Convolutional Neural Network model for accurate fruit classification and detection, linked to Objective 3. This deliverable includes the trained model ready for deployment, showcasing the application of deep learning in enhancing quality control within the fruit industry."**

### Q4.3 Deliverable 3

2 Points

**Model Performance and Validation Report: A comprehensive analysis and documentation of the AI model’s performance, focusing on the evaluation metrics specified in Objective 4 (Comprehensively Evaluate Model Performance for Classification and Detection). This report will detail the outcomes of accuracy, precision, recall, F1 score, mean Average Precision (mAP), and Intersection over Union (IoU) assessments, providing evidence of the model's effectiveness in fruit classification and detection tasks. The report will serve as a key piece of evidence for the model's readiness for practical deployment in the fruit industry."**

### Q4.4 Deliverable 4

2 Points

Grading comment:

4. **Comprehensive Documentation: User-friendly documentation for system deployment and maintenance.**

### Q4.5 Deliverable 5

2 Points

**Deliverable 5: "Model Development Package: Includes the model's code, training and validation scripts, and a quick-start guide for adaptation. Aimed at enhancing Objective 3, this package enables users to customize and further develop the AI model to meet changing requirements, ensuring the project's contributions are adaptable and extendable."**

**Q5 Project plan**

2 Points

Grading comment:

A schedule for your project from now until the final submission of the report (week 10 of semester 2). Weekly is probably an appropriate level of planning for most people. This is best presented as an itemised list of Weeks and planned, headline achievements.

**Semester 1:**

* **Week 8-11: Collect a diverse dataset. Detailed activities include identifying sources, acquiring images, and initial dataset organization.**

**Semester Break:**

* **Preparation: Review dataset and plan for preprocessing steps.**

**Semester 2:**

* **Week 1: Preprocess and augment data. Tasks include cleaning data, resizing images, and applying augmentation techniques to enrich the dataset.**
* **Week 2-3: Select and implement the AI model architecture. Begin with model architecture selection, followed by initial model setup and baseline training.**
* **Week 4: Continue training the AI model and start preliminary testing on a validation set to assess baseline performance.**
* **Week 5: Evaluate model performance in depth using a validation set. Document initial findings and identify areas for improvement.**
* **Week 6: Based on evaluation, fine-tune the model to address specific issues identified (e.g., overfitting, underfitting). If necessary, integrate additional data or perform further augmentation to improve model robustness.**
* **Week 7: Implement further optimizations based on fine-tuning results and conduct final performance evaluation. Begin drafting the Performance Evaluation Report.**
* **Week 8: Finalize the AI model's training and commence comprehensive documentation, focusing on deployment, system integration, and user instructions. Start drafting the final project report, incorporating sections on dataset collection, model development, and initial findings.**
* **Week 9: Continue writing the final project report. Include detailed sections on model evaluation, fine-tuning strategies, and final model performance. Complete the Deployment and Integration Guide and the Model Development Package documentation.**
* **Week 10: Review and finalize all project components. Conduct a thorough project audit to ensure completeness and accuracy of all deliverables. Perform last-minute adjustments based on the comprehensive review. Finalize and proofread the project report for submission.**

**Q6 Risk mitigation**

2 Points

Grading comment:

A brief discussion of how to mitigate risk in your project and ensure sufficient work will be completed for final submission. This could include prioritisation of objectives and deliverables or development of prototypes as early-stage deliverables.

1. **Data Quality:**
   * **Mitigation Strategy: Establish early partnerships with data providers to ensure a steady supply of high-quality data. Regularly validate the dataset for diversity and accuracy. Set up a backup plan to source data from alternate providers or use data augmentation techniques to enrich the dataset if initial sources are insufficient.**
2. **Model Complexity:**
   * **Mitigation Strategy: Implement an incremental development approach, starting with a basic model and gradually increasing complexity. Use pre-trained models where feasible to reduce training difficulties. Schedule regular review sessions with a supervisor or mentor to evaluate the model's development and make necessary adjustments.**
3. **Technical Challenges:**
   * **Mitigation Strategy: Develop early-stage prototypes for critical system components to identify potential technical issues. Allocate time for regular testing and debugging sessions. Establish a support network, including peers, faculty, and online communities, for troubleshooting and advice.**
4. **Time Management:**
   * **Mitigation Strategy: Develop a detailed project timeline with built-in buffers for unforeseen delays. Prioritize tasks based on their impact on the project's overall success, using critical path analysis to identify which tasks are essential to maintain progress. Regularly review and adjust the timeline as needed to accommodate any changes or delays.**

**Q7 Ethics**

2 Points

Grading comment:

Describe the ethical issues associated with your project and how you will address them. For example, proper handling of data sets, user testing, etc. If you believe there are no ethical issues associated with your project you should state that here.

1. **Data Privacy:**
   * **Action Plan: Implement strict protocols for data handling, including securing datasets and ensuring they are only accessible to authorized personnel. For any dataset involving human subjects, I will obtain necessary permissions and anonymize personal identifiers. Compliance with GDPR or relevant data protection laws will be strictly followed.**
2. **Bias and Fairness:**
   * **Action Plan: Regularly audit the dataset for representational fairness, ensuring a balanced representation of different fruit types, conditions, and variations. Implement algorithmic fairness checks during model training and make adjustments to the training process if biases are detected. This includes diversifying data sources and using techniques to counteract identified biases.**
3. **User Consent:**
   * **Action Plan: For any phase involving user interaction or data collection, explicit consent will be obtained. Consent forms will clearly state the purpose of data collection, how the data will be used, and the user's rights. An opt-out option will be provided, and user data will be handled with confidentiality.**
4. **Accountability:**
   * **Action Plan: Develop a comprehensive log of the AI model's decision-making process. In case of errors or unintended outcomes, this log will be reviewed to understand the cause and rectify it. Regular updates and reviews of the model's decision-making logic will be conducted to maintain transparency and accountability.**