Project Title	**SolarGuard: Intelligent Defect Detection on Solar Panels using DeepLearning**
Skills take away From This Project	**Data Cleaning and Preprocessing, Exploratory Data Analysis (EDA), Data Visualization ,SQL, Streamlit, Deep Learning(CNN & Object Detection).**
Domain	**Renewable Energy and Computer Vision**

Problem Statement:

Solar energy is a crucial renewable resource, but the accumulation of dust, snow, bird droppings, and physical/electrical damage on solar panels reduces their efficiency. While manual monitoring is time-consuming and expensive, automated detection can help improve efficiency and reduce maintenance costs.

This project aims to develop **deep learning models for both classification and object detection** to accurately identify and localize different types of obstructions or damages on solar panels. The objective is to:

1. **Classify** solar panel images into six categories: Clean, Dusty, Bird-Drop, Electrical-Damage, Physical-Damage, and Snow-Covered.
2. **Detect and localize** the presence of dust, bird droppings, or damages on the panel using object detection models.

Business Use Cases:

1. **Automated Solar Panel Inspection:** Develop an AI-based system to automatically classify and detect issues on solar panels, reducing the need for manual inspections.
2. **Optimized Maintenance Scheduling:** Identify which panels require immediate cleaning or repair, optimizing maintenance efforts and reducing operational costs.
3. **Efficiency Monitoring:** Analyze the impact of different obstructions on solar panel efficiency and generate reports for performance improvement.
4. **Smart Solar Farms:** Integrate AI models into smart solar farms to trigger alerts for cleaning/repair, ensuring maximum energy production.

Objective:

1. Classification Task: Identifying Solar Panel Conditions

Aim:
Develop a classification model to categorize solar panel images into one of six conditions:

- Clean
- Dusty
- Bird-Drop
- Electrical-Damage
- Physical-Damage
- Snow-Covered

Use Case:

- Automate the process of identifying the condition of solar panels from images.
- Provide insights into common issues affecting panel efficiency.
- Help solar maintenance teams prioritize cleaning and repair tasks.

Possible Inputs (Features):

- Raw solar panel images

Target:

- A category label indicating the panel condition

2. Object Detection Task: Localizing Issues on Solar Panels (Optional)

Aim:
Develop an object detection model to identify and localize dust, bird droppings, and physical/electrical damage on solar panels.

Use Case:

- Instead of just classifying images, this approach will help pinpoint **where** the issue is located on the panel.
- Helps in targeted cleaning and repair rather than replacing entire panels.
- Can be integrated with robotic cleaning systems to automate maintenance.

Possible Inputs (Features):

- Annotated images with bounding boxes for dust, bird droppings, and damage.

Target:

- Bounding boxes with class labels (Dust, Bird-Drop, Electrical-Damage, Physical-Damage).

Approach:

1. Data Preprocessing & Annotation:

- Perform **image augmentation** to balance the dataset.
- Resize images to a suitable dimension for deep learning models.
- Annotate images with bounding boxes for object detection tasks.
- Normalize pixel values for better model performance.

2. Model Training:

- **Classification:** Train CNN models (ResNet, EfficientNet, MobileNet) for panel condition classification.
- **Object Detection:** Train models like YOLOv8 or Faster R-CNN to detect and localize damages/obstructions.

3. Model Evaluation:

- **Classification Metrics:** Accuracy, Precision, Recall, F1-Score.
- **Object Detection Metrics:** mAP (Mean Average Precision), IoU (Intersection over Union).

4. Deployment:

- Deploy a **Streamlit web app** where users can upload solar panel images to:
    - Get **classification results** for panel conditions.
    - Get **bounding box outputs** for detected obstructions.(optional)

Expected Results:

1. **Predictive Modeling:** Develop models to classify solar panel defects (e.g., dust, snow, bird droppings, physical damage, electrical damage) and detect affected areas using object detection.
2. **Actionable Insights:** Provide recommendations for optimal cleaning schedules, maintenance strategies, and defect mitigation to enhance solar panel efficiency and reduce operational costs.
3. **Streamlit Application:** Build a Streamlit application to display detected defects, predict potential issues, and provide maintenance recommendations based on real-time data input.

Project Evaluation metrics:

🧹 Data Preparation

- Accurate cleaning, labeling, and preprocessing of image data.
- Well-documented augmentation and normalization steps.

📊 EDA

- Class distribution and visual inspection of image samples.
- Insights on defect patterns and occurrence.

📈 Data Visualization

- Effective visuals like sample images, bounding boxes, and confusion matrices.
- Clear representation of model outputs.

🧠 Model Performance

- Metrics: Accuracy, Precision, Recall, F1, mAP, IoU.
- Comparison across models (e.g., CNN, YOLO).

💡 **Business Insights**

- Actionable findings for maintenance and efficiency improvement.
- Identify defect hotspots or common issues.

📽️ **Presentation**

- Clear, concise reporting with a user-friendly Streamlit interface.

Technical Tags:

🧹 **Data Cleaning**

⚙️ **Data Preprocessing**

📊 **Exploratory Data Analysis (EDA)**

🧠 **Deep Learning**

🎯 **Object Detection**

🌐 **Streamlit**

Data Set:

Dataset: 🖿 Solar_Panel_Dataset

Data Set Explanation:

This image dataset is designed for classifying and detecting various types of defects found on the surfaces of solar panels. The dataset is categorized into six distinct classes, each representing a specific surface condition or defect type:

🔆 Clean
Images of solar panels in optimal condition with no visible surface issues.

🌫️ Dusty
Images showing accumulation of dust particles that may reduce solar efficiency.

🐦 Bird-Drop
Images containing bird droppings that obscure the panel surface.

⚡ Electrical-Damage
Images with visible electrical damage such as burn marks, wiring faults, or short circuits.

🧱 Physical-Damage
Images capturing physical issues like cracks, broken glass, or dents.

❄️ Snow-Covered
Images depicting panels covered in snow, which blocks sunlight absorption.

Project Deliverables:

Cleaned Dataset:

- Final preprocessed dataset used for analysis.

Source Code:

- Python or other scripts used for data cleaning, analysis, model building and visualization.

Application:

- Streamlit Application for classification

Documentation:

- A concise report explaining the approach, key findings, and actionable insights.

Project Guidelines:

1) 🧹 **Data Preparation**
   Clean images → Resize & normalize → Detect defects.
2) 🔍 **EDA**
   Inspect sample images → Analyze defect frequency → Understand class balance.
3) 📊 **Visualization**
   Display sample defects → Bounding box previews → Highlight image patterns.
4) 🧠 **Model Building**
   Train deep learning model → Validate → Test.
5) 📈 **Evaluation & Insights**
   Assess model accuracy, mAP → Interpret detection results → Provide actionable insights.

Timeline:

The project must be completed and submitted **within 10 days from the assigned date**.

References:

Project Orientation Recording (English)	video1621739743.mp4
Project Orientation Recording (Tamil)	Project Session Recordings(Tamil) (12/0…
Annotation Tool	LabelImg-https://github.com/HumanSignal/labelImg Roboflow-https://roboflow.com/annotate
Project Live Evaluation	Project Live Evaluation
EDA Guide	Exploratory Data Analysis (EDA) Guide

Streamlit Reference	https://docs.streamlit.io/get-started/fundamentals/main-concepts
Capstone Explanation Guideline	Capstone Explanation Guideline
GitHub Reference	How to Use GitHub.pptx

PROJECT DOUBT CLARIFICATION SESSION (PROJECT AND CLASS DOUBTS)

About Session: The Project Doubt Clarification Session is a helpful resource for resolving questions and concerns about projects and class topics. It provides support in understanding project requirements, addressing code issues, and clarifying class concepts. The session aims to enhance comprehension and provide guidance to overcome challenges effectively.
Note: Book the slot at least before 12:00 Pm on the same day

Timing: Monday to Saturday (4:00PM to 5:00PM)

Booking link :https://forms.gle/XC553oSbMJ2Gcfug9

LIVE EVALUATION SESSION (CAPSTONE AND FINAL PROJECT)

About Session: The Live Evaluation Session for Capstone and Final Projects allows participants to showcase their projects and receive real-time feedback for improvement. It assesses project quality and provides an opportunity for discussion and evaluation.
Note: This form will Open on Saturday and Sunday Only on Every Week

Timing: Monday-Saturday (5:30PM to 6:30PM)

Booking link : https://forms.gle/1m2Gsro41fLtZurRA