Solar Panel Detection Model Card

1. Overview
This model is created to automatically detect whether a solar panel is present within a rooftop area and check if the available space matches two key installation ranges: 1200 sq.ft and 2400 sq.ft. It also evaluates roof type and recommends whether solar panels can be installed effectively.

Purpose: To support households and industries in deciding if their rooftop is suitable for solar installation using automated analysis.

Model Category: Hybrid ML + rule-based decision model.

2. Data Used
The dataset includes: Total rooftop area (in sq.ft) Presence or absence of solar panels Roof type (flat / sloped) Optional: sunlight exposure, location, shading Data preprocessing includes cleaning incorrect area values, encoding roof types, and normalizing numerical features for optional ML models.

3. Assumptions
Input rooftop area is measured correctly. Solar panels, if present, belong to either 1200 or 2400 sq.ft installation ranges. Roof structure is stable and usable for installation. No major shaded regions are considered in the prediction.

4. Logic of the Model
The system follows a step-by-step flow: Read total rooftop area. Check if solar panel is present in the 1200 sq.ft range. If not, check for 2400 sq.ft range. If absent in both, check overall roof suitability. Evaluate roof type (flat/sloped) and recommend ideal solar installation options. Machine learning can be used to classify roof suitability or predict optimal solar output.

5. Known Limitations & Bias
Model may misinterpret mid-range areas (e.g., 1500 sq.ft). Roof type recommendations may not reflect real structural limitations. Performance depends on training data; biased regions lead to biased predictions. No consideration of sunlight hours or weather, reducing accuracy in real environments.

6. Failure Modes
Incorrect solar panel detection for irregular roof shapes. Wrong area input may lead to invalid recommendations. Sloped roof detection errors may reduce installation accuracy. Model may fail when roof has multiple uneven sections.

7. Retraining Guidance
Retrain the model every 6–12 months with new rooftop images and area data. Include more roof types (asymmetrical, multi-level, curved). Add shading and sunlight exposure datasets for better accuracy. Use drone imagery or satellite data to enhance detection capability.

8. Performance Metrics
Evaluation metrics used for the model: **Accuracy:** Correct detection of panel presence. **Precision & Recall:** Useful for imbalance in presence/absence data. **F1 Score:** Balanced performance measure. **RMSE (if regression is used):** Measures prediction error for area suitability. These metrics ensure transparency and reliability before deploying the system.