Approaches to Object Detection: Edge-Based vs. AI-Based

Evolution from Traditional Techniques
to Machine Learning-Powered Detection

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Introduction & Purpose

- **Objective:** The transition from traditional edge-based detection to modern machine learning-driven object detection

- **Importance in Open Technologies:** In Free Software and Open Technologies, object detection tools are invaluable for precise, rapid object identification

- **Audience Takeaway:** The advancements and flexibility brought by Machine Learning-based detection in open-source environments

Background on Object Detection in Open Source

- **Free Software Impact:** Open-source detection tools embody free software principles, promoting customization, transparency, and collaboration

- **Technological Context:** Powerful tools for real-time detection in images and videos, customizable and integrable across diverse applications

- **Innovation Drive:** Community-driven advancements supporting specialized and scalable solutions

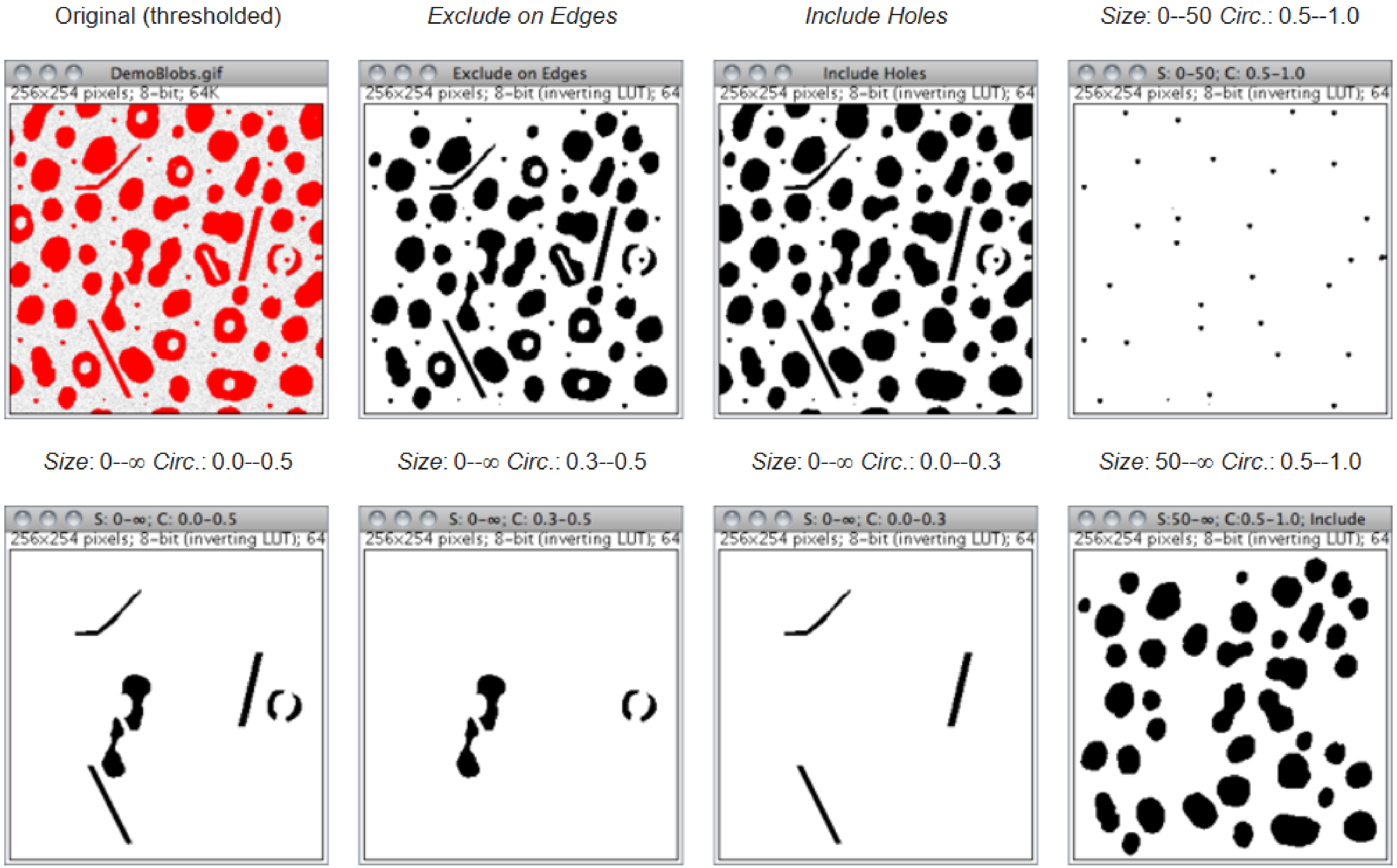
OPEN SOURCE

Edge-Based Detection Approach

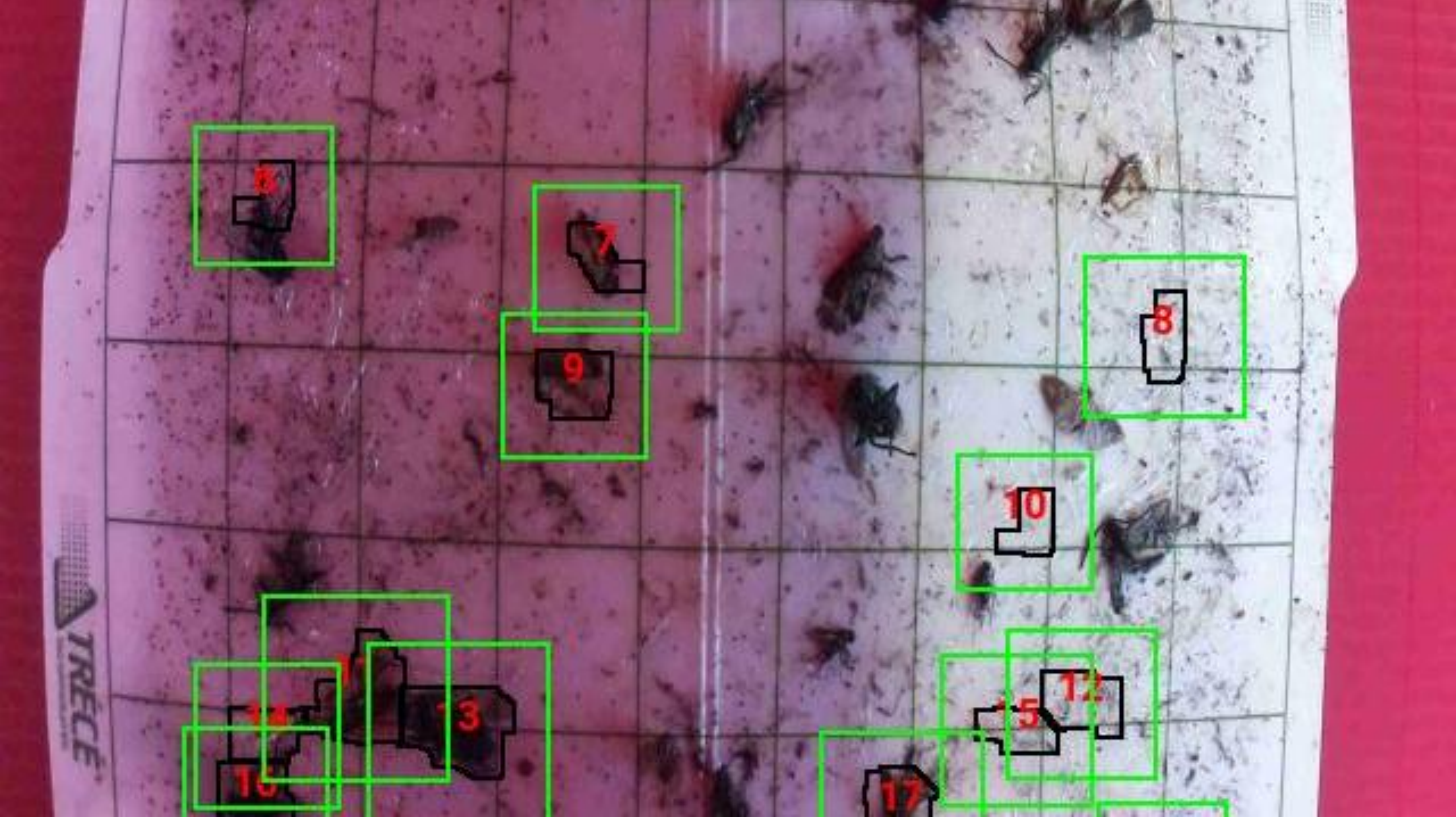
- **Overview of Traditional Edge-Based Detection:**
  - **Expert System Approach:** Relies on traditional image analysis techniques
  - **Attributes Analysed:** Object shape, size, colour based on expert knowledge and testing

- **Case Study - Edge-Based Detection for Preliminary Analysis:**
  - Integration
  - MorphoLibJ Plugin
  - Particles Extraction

- **Strengths & Limitations:**
  - **Advantages:** Quick setup for consistent, structured settings
  - **Challenges:** Limited adaptability to varying backgrounds and complex scenes



Features of thresholded images extracted by specifying suitable *Size* and *Circularity* ranges



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Transition to Machine Learning-Based Detection

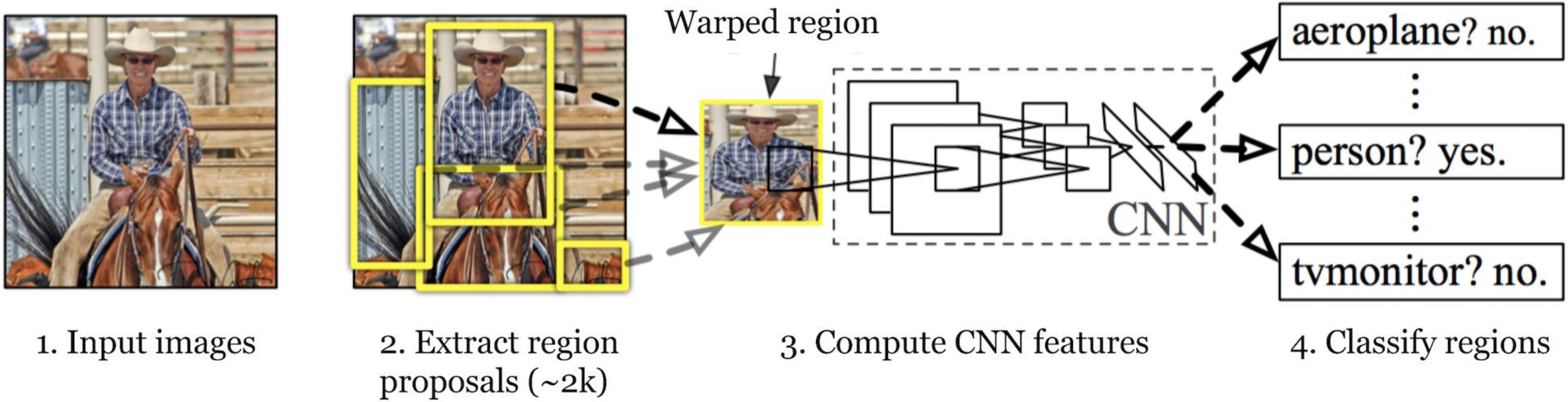
- **Limitations of Edge-Based Methods:**
  - Restricted to controlled conditions; prone to reduced accuracy in dynamic scenes

- **Why Move to Machine learning-Based Detection?**
  - **Machine learning** leverages data-driven algorithms, enabling adaptability across diverse real-world conditions and objects
  - Enhanced detection accuracy and real-time processing capability

Machine learning-Based Detection Approach

Overview of Machine learning-Based Detection:

- **Machine Learning Models:** Machine learning detection (e.g., Faster R-CNN, RetinaNet, MobileNet, YOLO) learns features from vast datasets, allowing it to generalize and recognize various object types
- **Training and Flexibility:** Trained on diverse datasets, adaptable to complex and dynamic environments


Warped region
aeroplane? no.
person? yes.
tvmonitor? no.
CNN
1. Input images
2. Extract region proposals (~2k)
3. Compute CNN features
4. Classify regions

Comparative Analysis

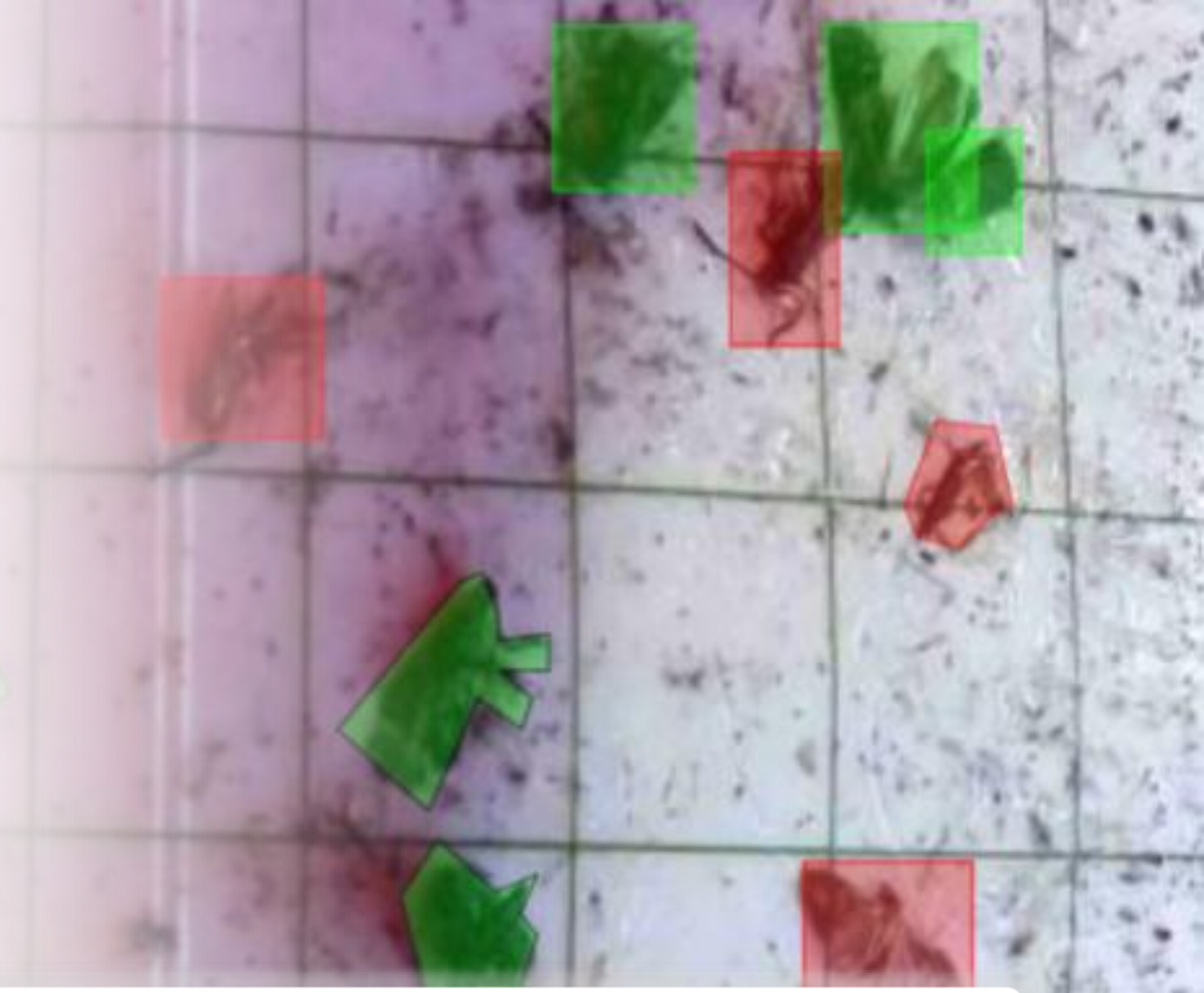
Edge-based vs Machine learning-based

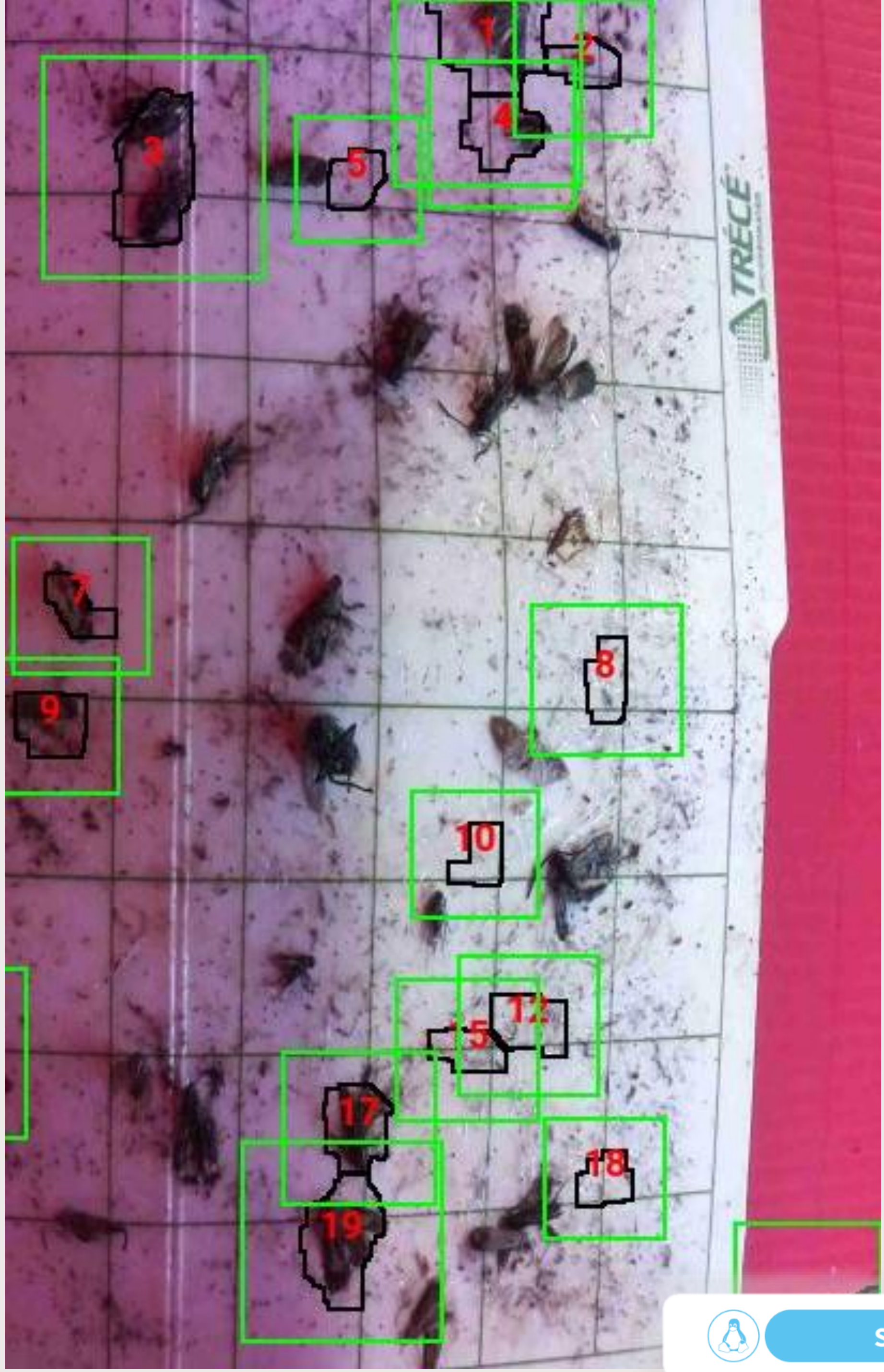
1. Performance in Different Conditions
2. Accuracy and Efficiency
3. Adaptability in Free Software Context

Evaluation Datasets and Metrics

- **Dataset Diversity:**
  - **Edge-Based Analysis:** Specify characteristics (fixed lighting, known backgrounds)
  - **Machine learning Training Sets:** Broad datasets capturing multiple object types, different scenes, and challenging lighting
- **Evaluation Metrics:**
  - **Accuracy:** Rate of correct detections under varied conditions
  - **Efficiency:** Real-time processing speed and system responsiveness

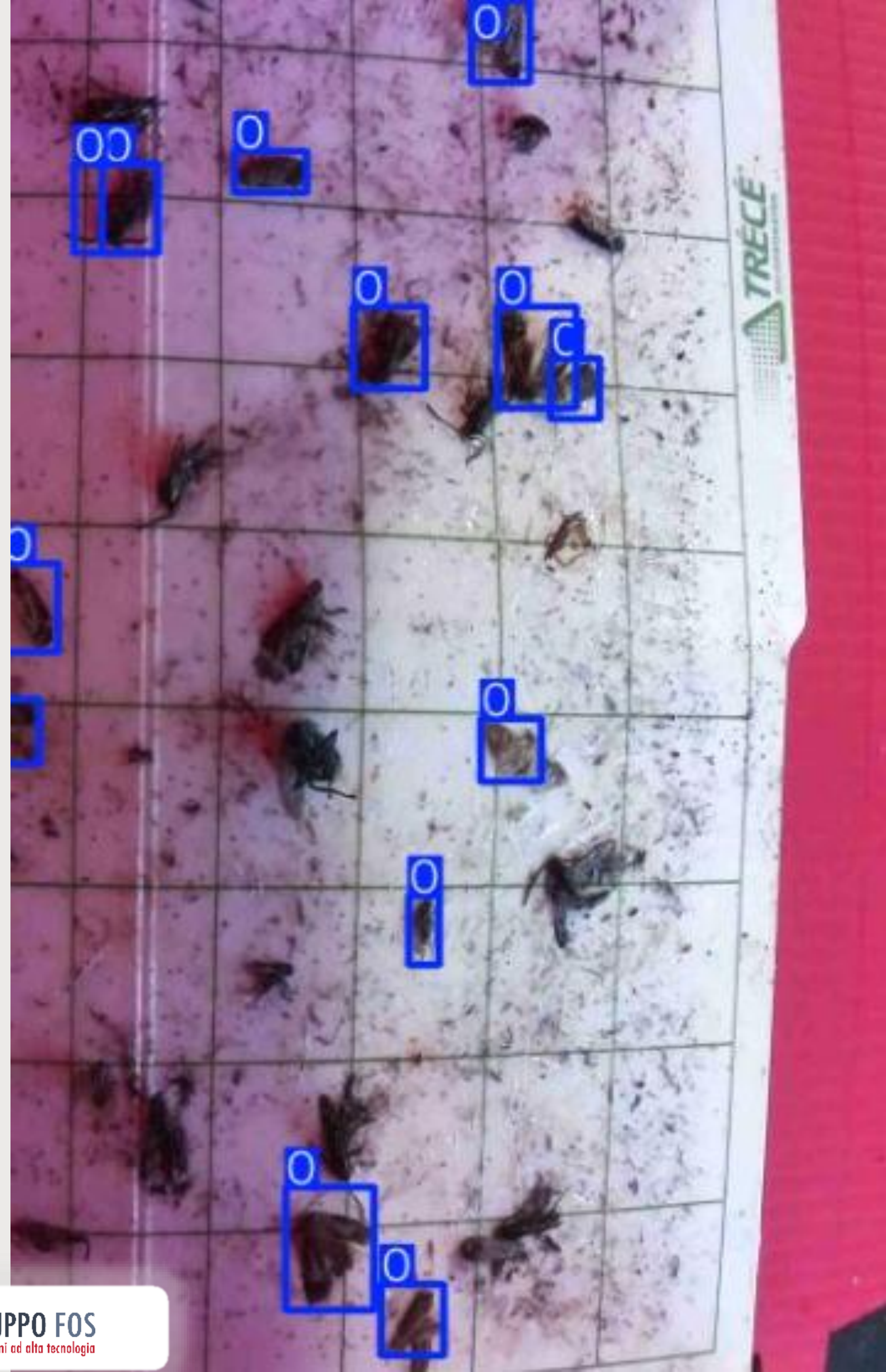
- **Adaptability:** Consistency across new and unpredictable environments





Practical Applications and Use Cases

- **Edge-Based Detection Applications:**
  - Effective in structured, predictable settings (e.g., quality control in manufacturing)
- **Machine Learning-Based Detection Applications:**
  - Suitable for real-time object recognition in traffic analysis, autonomous vehicles, and dynamic monitoring environments
- **Case Example:**
  - Real-time pest identification for crop management



Conclusion: Advancements and Open-Source Benefits

•**Community and Collaboration:** Free Software tools in object detection encourage ongoing improvement, innovation, and user-driven enhancements

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Thank you!

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