Institución Universitaria
Reacreditada en Alta Calidad

Object Detection

Aprendizaje Automático Embebido

Somos Innovación Tecnológica con Sentido Humano

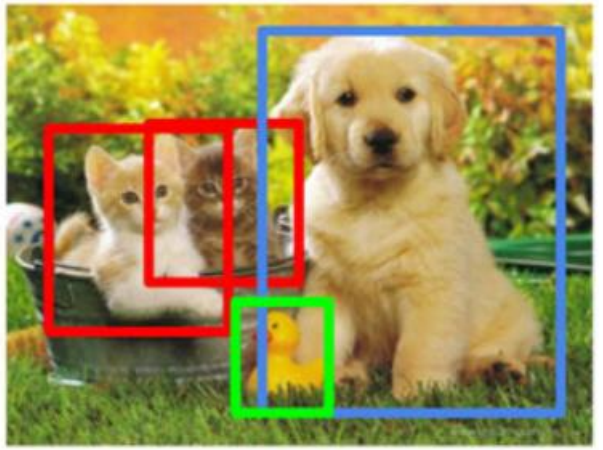
Alcaldía de Medellín

Image Classification vs Object Detection

Classification

CAT

Object Detection



CAT, DOG, DUCK

Object Detection

Object detection is a challenging task due to the complexity of natural scenes, which are often cluttered and contain significant variations in object appearance, size, and orientation. Recent advancements in deep learning algorithms, particularly convolutional neural networks (CNNs), have made object detection a more accurate and efficient technique with a wide range of applications across various industries.

https://deeplobe.ai/exploring-object-detection-applications-and-benefits/

Object Detection: Benefits

1. Automation: can automate many manual tasks, saving time and reducing errors. Businesses can quickly and accurately identify objects within images or videos, and trigger automated responses based on those detections.
2. Accuracy: can provide highly accurate results, enabling businesses to make better decisions. Businesses can gain a deeper understanding of the data they're working with.
3. Safety: can improve safety in a variety of settings, from monitoring traffic flow to detecting potential hazards in industrial environments. By detecting and tracking objects in real-time, businesses can prevent accidents before they happen.

https://deeplobe.ai/exploring-object-detection-applications-and-benefits/

Object Detection: Benefits

1. Insights: can provide valuable insights into business operations, helping businesses make data-driven decisions. By analyzing visual data at scale, businesses can gain a deeper understanding of their operations and customers.
2. Scalability: can scale to handle large amounts of data, allowing businesses to process and analyze visual data at scale.

https://deeplobe.ai/exploring-object-detection-applications-and-benefits/

Annotation

The process of labeling the images is known as annotation and can be done in various ways.

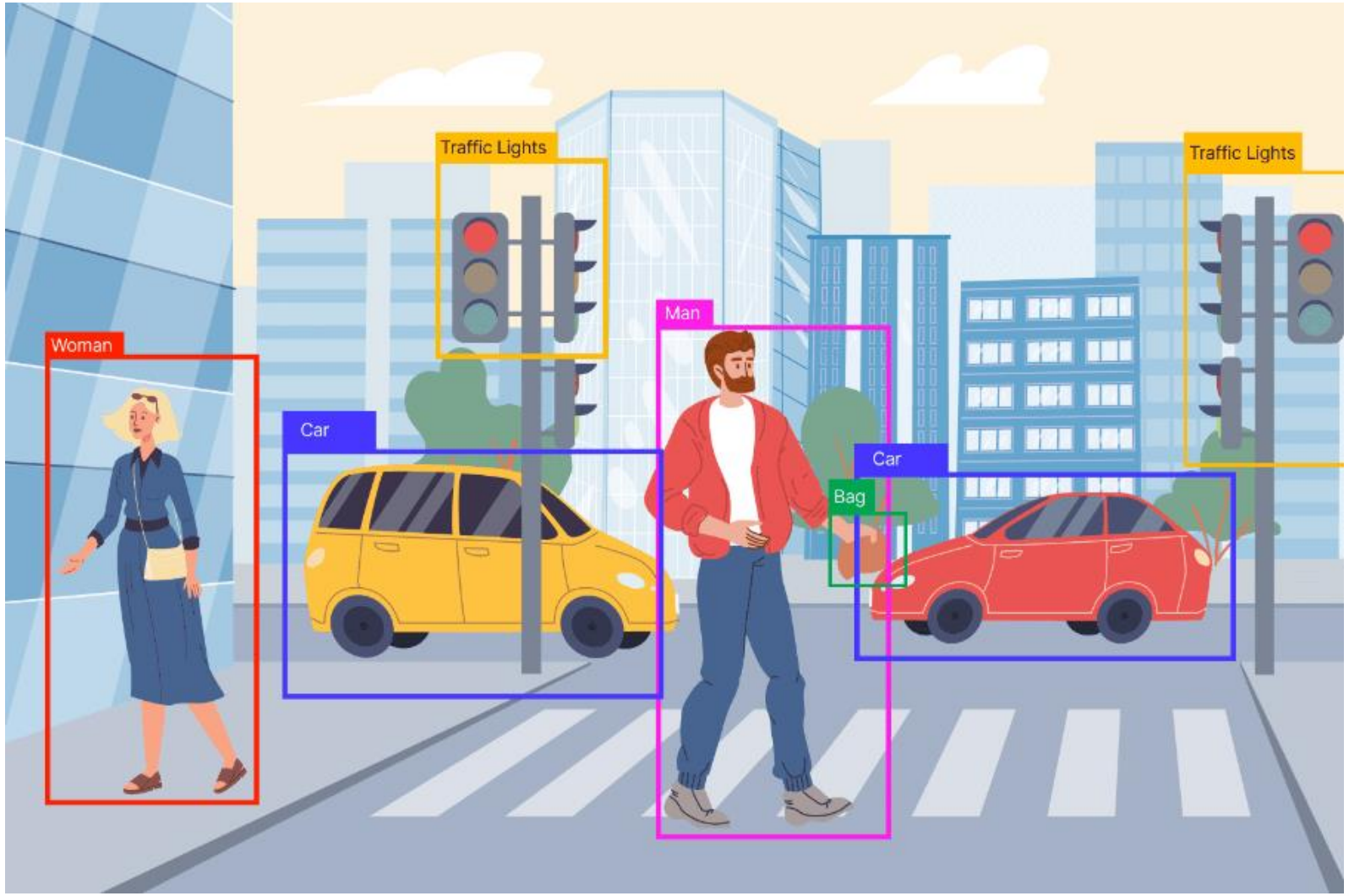
Bounding boxes: Bounding boxes are a commonly used annotation type for object detection. They are used to mark the rectangular area of an object within an image.

Polygons: Polygons are a more precise annotation type than bounding boxes. They can be used to mark the exact shape of an object in an image.

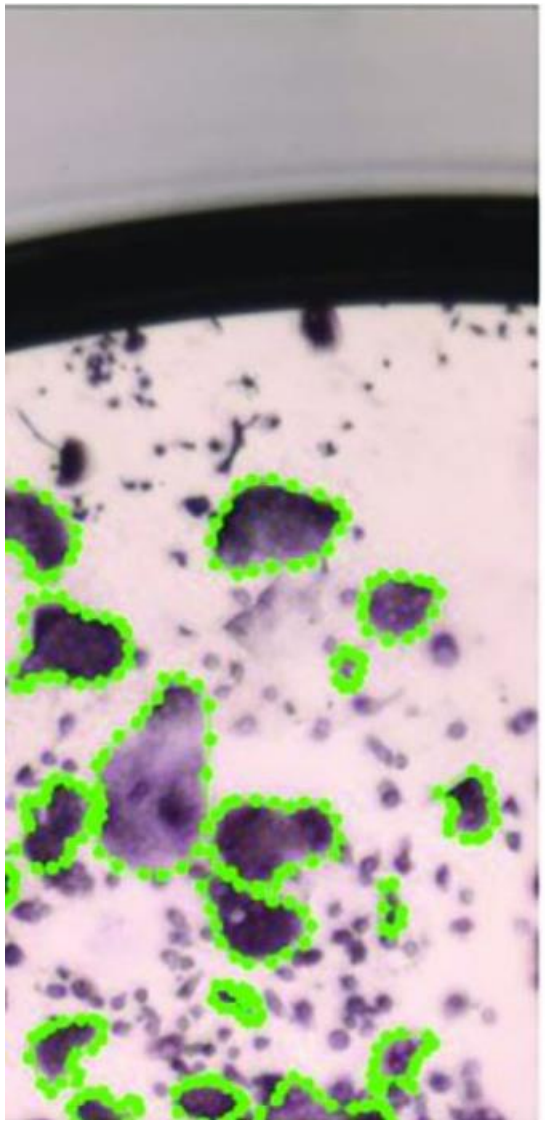
Points: Points can be used to mark a specific location within an image. This annotation type is often used for facial recognition or keypoint detection.

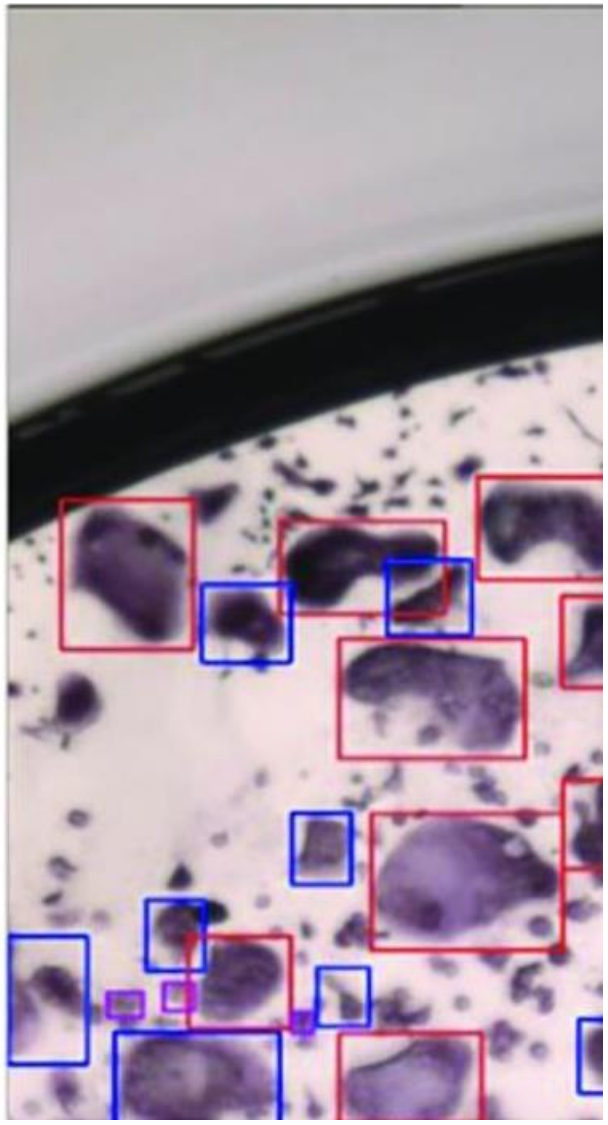
Lines: Lines are used for annotating objects with linear features such as roads, lanes, or boundaries.

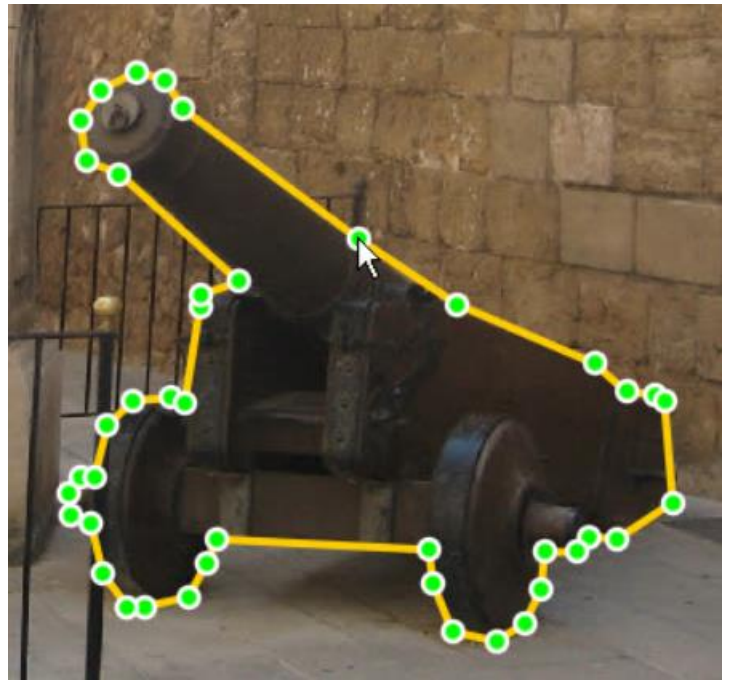
Bounding Boxes



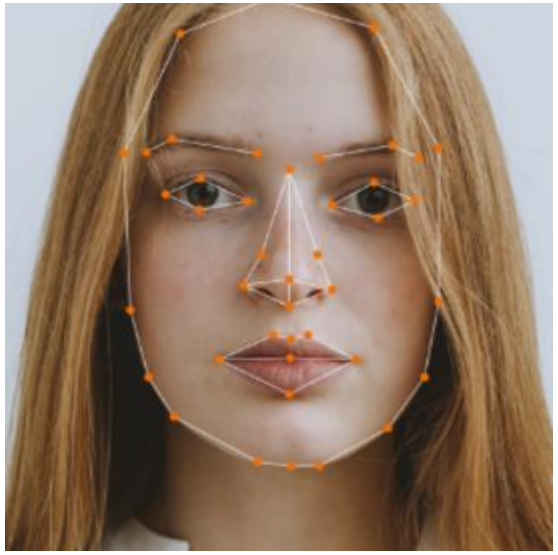
Polygons

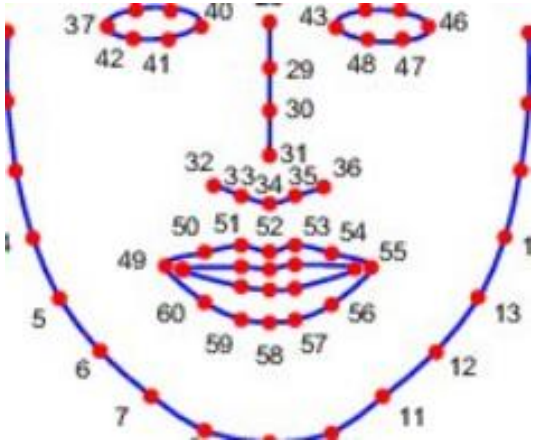






Points





Techniques for OD

Traditional computer vision techniques: Traditional computer vision techniques involve hand-engineered features and algorithms to detect objects within an image. Examples of traditional techniques include edge detection, template matching, and HOG (Histogram of Oriented Gradients).

Deep Learning Techniques: Deep learning techniques involve training neural networks to detect objects within an image. Some popular deep learning frameworks for object detection include YOLO (You Only Look Once), Faster R-CNN (Region-based Convolutional Neural Network), and SSD (Single Shot Detector).

Applications: Retail

The retail industry faces various challenges, such as managing inventory, ensuring customer satisfaction, preventing fraud, and maintaining perfect shelf conditions. Object detection technology can help retailers overcome these challenges by providing real-time insights on

- Inventory management
- Customer tracking and analytics
- Fraud detection
- Shelf monitoring

https://deeplobe.ai/exploring-object-detection-applications-and-benefits/

Applications: Manufacturing

The manufacturing industry demands precision and efficiency to ensure quality products are produced in a timely manner. Object detection technology can assist in

- Quality control
- Equipment monitoring and maintenance
- Defect detection
- Supply chain management

Applications: Healthcare

The healthcare industry is constantly striving to improve patient care and treatment outcomes. Object detection technology can assist in

- Medical imaging analysis
- Surgical assistance
- Patient monitoring
- Disease diagnosis and prevention

Applications: Transportation

The transportation industry involves moving people and goods across various modes of transportation. Object detection technology can assist in

- Autonomous vehicles
- Traffic management
- Pedestrian detection and safety
- Cargo monitoring and security

Application: Security

Security and surveillance are critical in maintaining public safety and protecting assets. Object detection technology can assist in

- Intruder detection
- Crowd monitoring and management
- Facial recognition
- Perimeter security

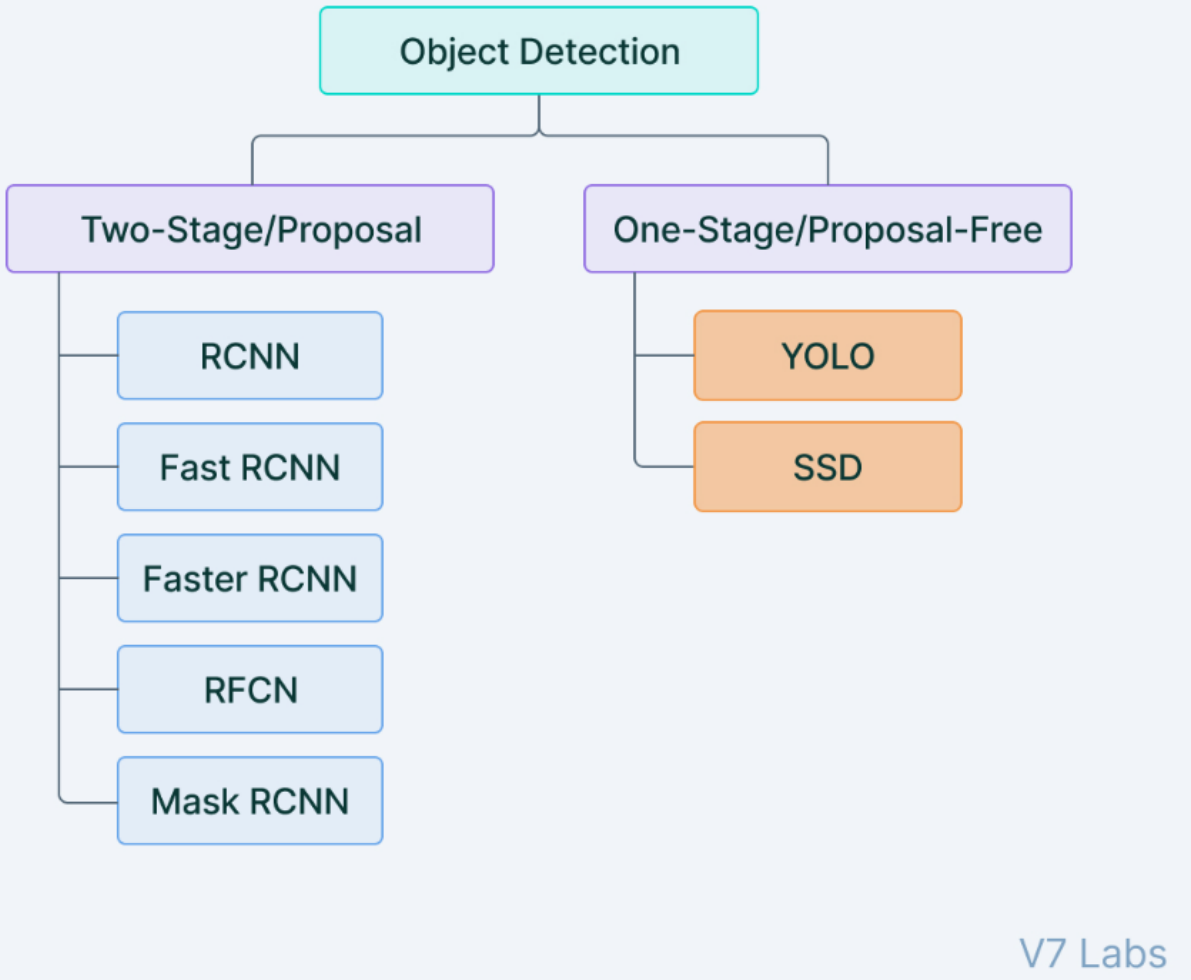
Types of OD Systems

Before deep learning took off in 2013. almost all object detection was done through classical machine learning techniques. Common ones included viola-jones object detection technique. scale-invariant feature transforms (SIFT), and histogram of oriented gradients.

These would detect a number of common features across the image. and classify their clusters using logistic regression. color histograms. or random forests. Today's deep learning-based techniques vastly outperform these.

Deep learning-based approaches use neural network architectures like RetinaNet. YOLO (You Only Look Once). CenterNet. SSD (Single Shot Multibox detector). Region proposals (R-CNN. Fast-RCNN. Faster RCNN. Cascade R-CNN) for feature detection of the object, and then identification into labels.

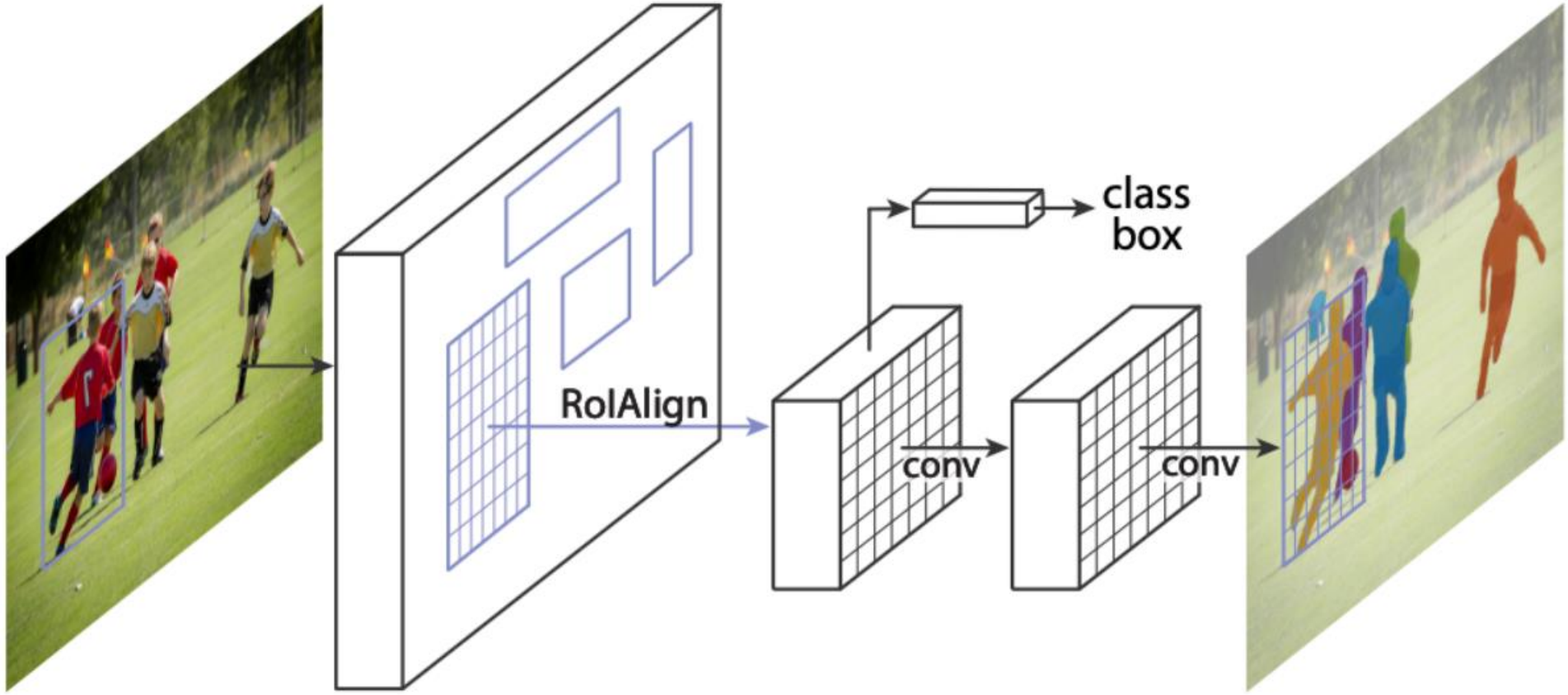
Types of OD Systems



A single-stage detector removes the RoI (Region of interest), extraction process and directly classifies and regresses the candidate anchor boxes.

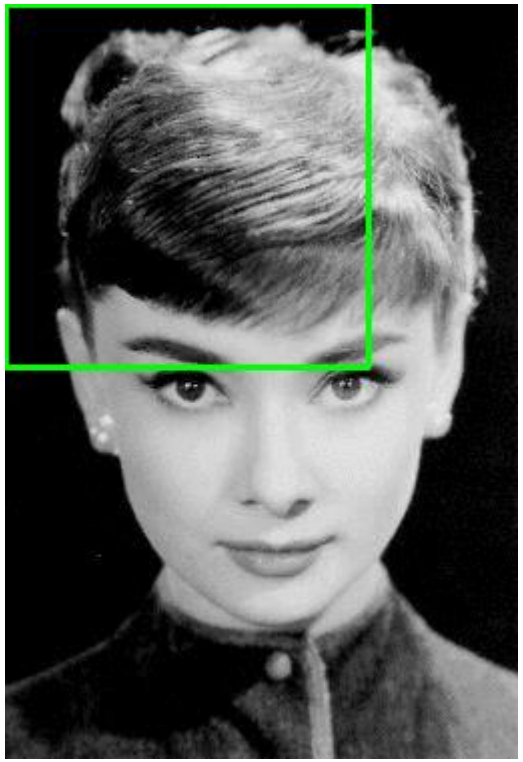
Two-stage detectors divide the object detection task into two stages: extract RoIs then classify and regress the RoIs.

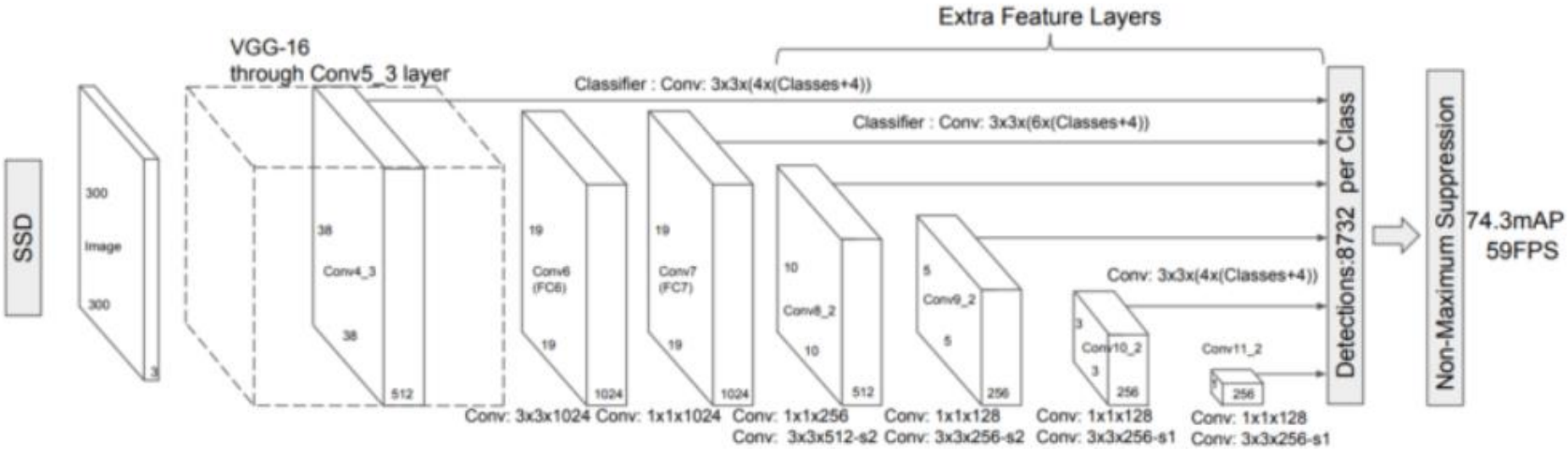
Mask R-CNN



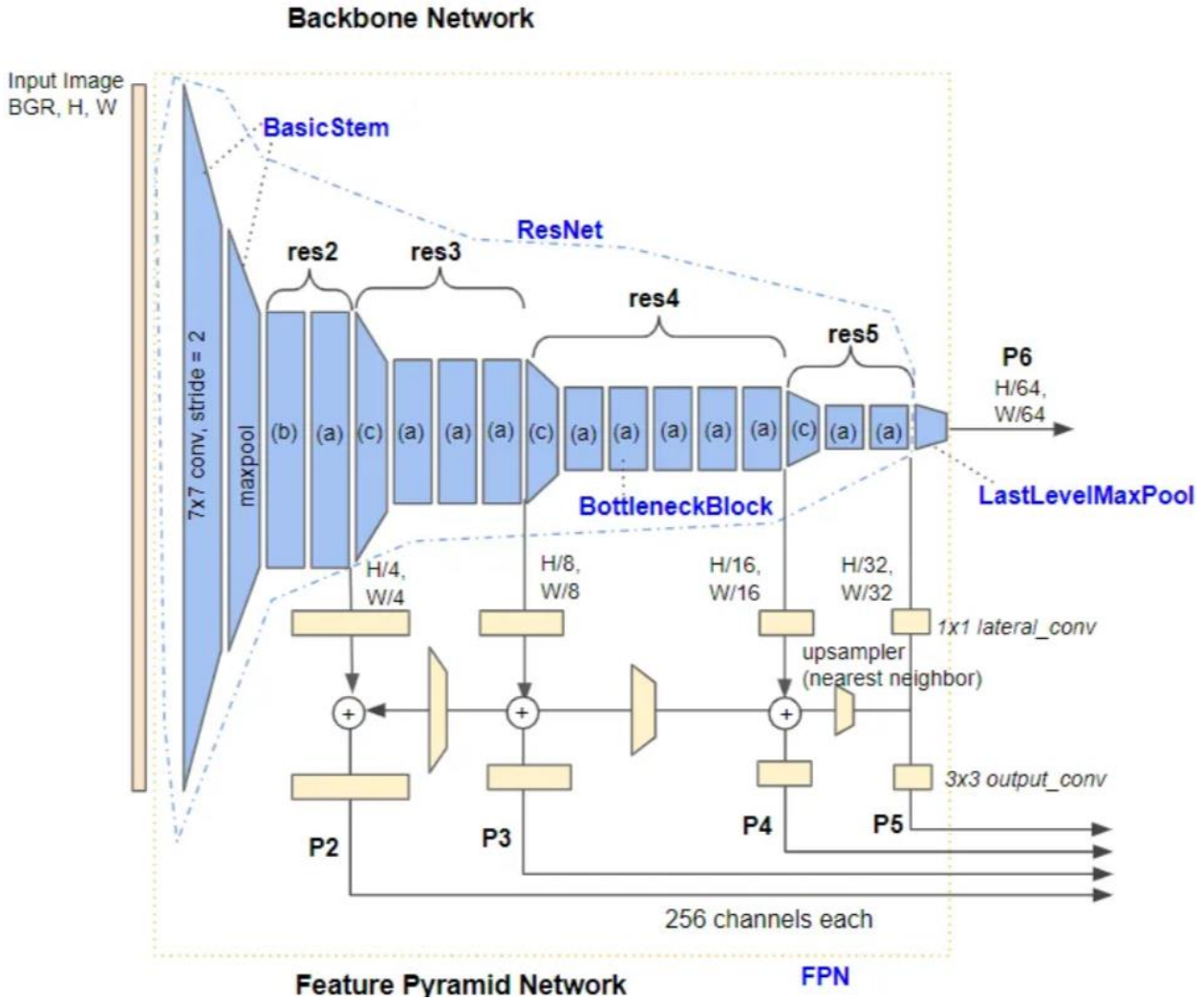
Mask R-CNN is a typical Object Instance Segmentation technique for object detection

Single Shot Detection (SSD)



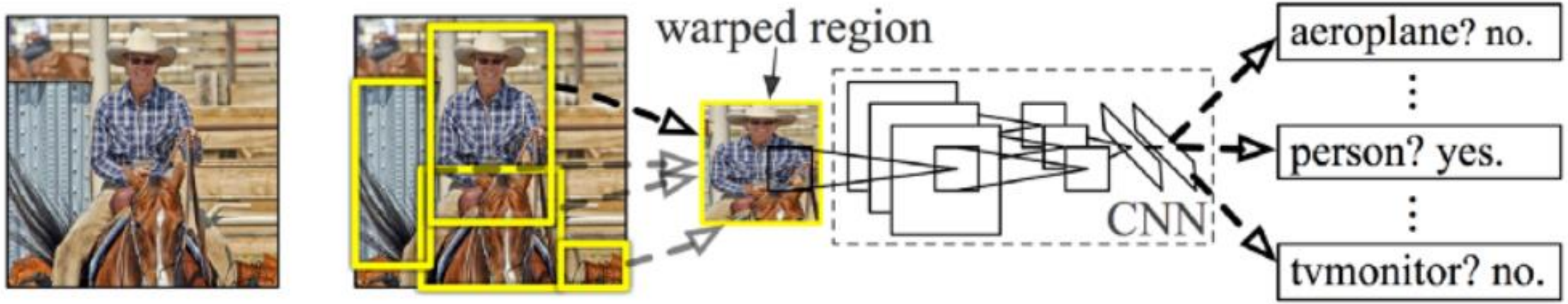


Feature Pyramid Network (FPN)



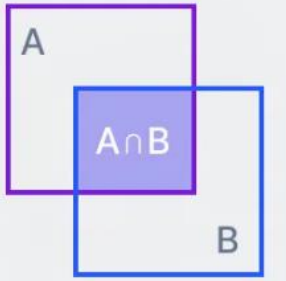
https://medium.com/@hirotoschwert/digging-into-detectron-2-part-2-dd6e8b0526e

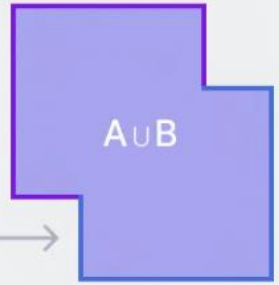
R-CNN



Intersection over Union

$$IoU = \frac{\text{Area of Overlap}}{\text{Area of Union}}$$





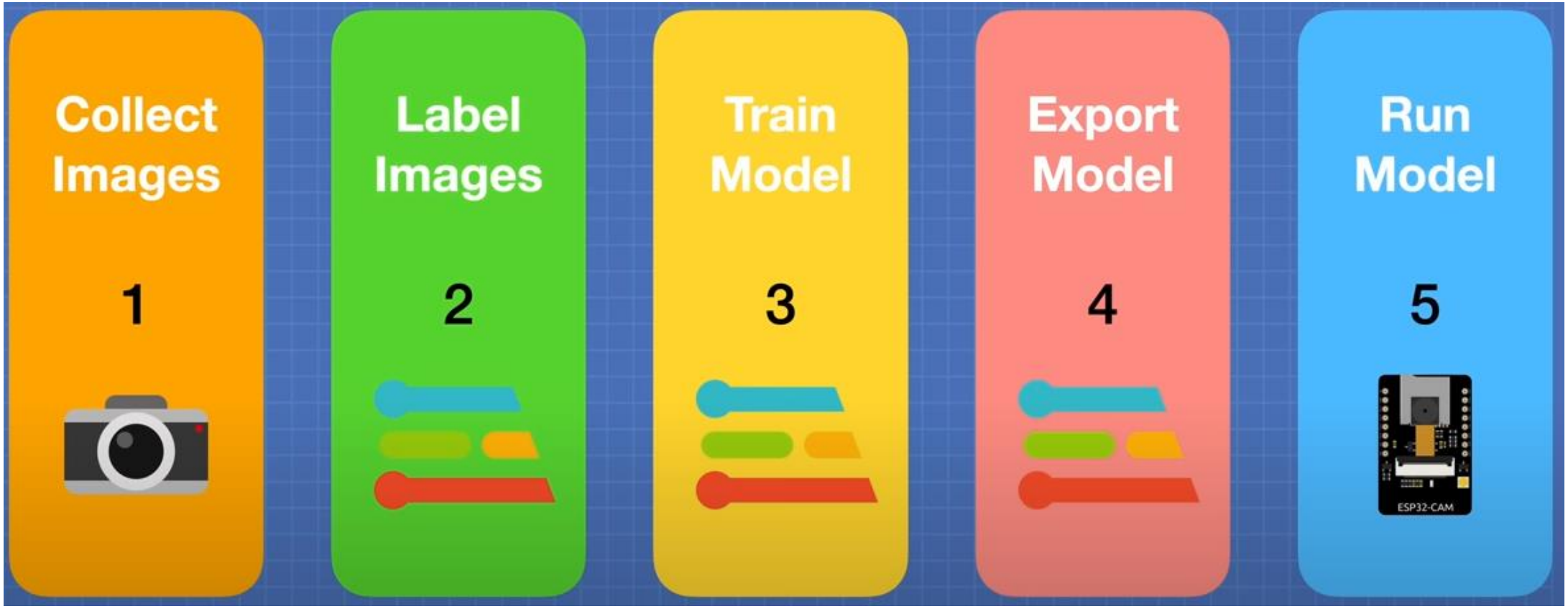
https://www.v7labs.com/blog/intersection-over-union-guide

Evaluation Metric: IoU

$$\text{Score} = \frac{\text{Area of overlap}}{\text{Area of union}}$$

Evaluation Metric: IoU

Edge Impulse Implementation



Edge Impulse OD Implementation

Edge Impulse provides two different methods to perform object detection:

- Using MobileNetV2 SSD FPN
- Using FOMO
- Using NVIDIA TAO

Edge Impulse OD Implementation

Specifications	MobileNetV2 SSD FPN	FOMO
Labelling method	Bounding boxes	Bounding Boxes
Input size	320×320	Square (any size)
Image format	RGB	Greyscale & RGB
Output	Bounding boxes	Centroids
MCU	❌	✅
CPU/GPU	✅	✅
Limitations	- Works best with big objects - Models use high compute resources (in the edge computing world) - Image size is fixed	- Works best when objects have similar sizes & shapes - The size of the objects are not available - Objects should not be too close to each other

https://edge-impulse.gitbook.io/docs/edge-impulse-studio/learning-blocks/object-detection

References

General

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Edge Impulse

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¡Gracias!

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