**Object Detection Questions**

1. **How does Region Proposal Network (RPN) work in Faster R-CNN?**
   * The **Region Proposal Network (RPN)** in **Faster R-CNN** generates candidate object regions (region proposals) instead of using a selective search. It works by:
     1. **Sliding a small neural network over the feature map** generated by the backbone (e.g., ResNet, VGG).
     2. **Generating anchor boxes** of different scales and aspect ratios at each sliding window location.
     3. **Classifying anchors** as either "object" or "background."
     4. **Refining anchors** by regressing their coordinates to better fit potential objects.
     5. **Selecting top proposals** using Non-Maximum Suppression (NMS).
2. **What is the difference between IoU (Intersection over Union) and GIoU (Generalized IoU)?**
   * **IoU (Intersection over Union)** measures the overlap between the predicted bounding box and the ground truth.
   * **GIoU (Generalized IoU)** improves IoU by considering the **smallest enclosing box** that contains both the predicted and ground truth boxes.
   * GIoU helps when two boxes have **no overlap** (IoU = 0), providing a better gradient for optimization.
3. **How does the SSD (Single Shot MultiBox Detector) model handle multi-scale detection?**
   * **SSD uses feature maps at multiple scales** to detect objects of different sizes:
     1. **Extracts feature maps** from different layers of the backbone CNN.
     2. **Uses default anchor boxes** at each scale for different aspect ratios.
     3. **Predicts bounding boxes and class scores** for objects at each scale.
     4. **Combines results** across all scales and applies Non-Maximum Suppression (NMS) to remove duplicates.
4. **What are some real-world applications of object detection in different industries?**
   * **Autonomous Vehicles**: Detecting pedestrians, traffic signs, and other vehicles.
   * **Healthcare**: Identifying tumors in medical images (X-rays, MRIs).
   * **Retail**: Inventory management, cashier-less stores (e.g., Amazon Go).
   * **Security & Surveillance**: Intruder detection, facial recognition.
   * **Agriculture**: Plant disease detection, livestock monitoring.
5. **Explain how anchor boxes are matched to ground truth boxes during training.**
   * Each **anchor box** is compared to all ground truth boxes using **IoU**:
     1. **Best IoU assignment**: The ground truth box with the highest IoU is assigned to an anchor.
     2. **Positive anchors**: If IoU > threshold (e.g., 0.5), the anchor is considered positive.
     3. **Negative anchors**: If IoU < threshold (e.g., 0.3), the anchor is treated as background.
     4. **Neutral anchors**: IoU between thresholds (ignored during training).
     5. **Box Regression**: The model learns to refine anchor box coordinates to match the ground truth more closely.