Q1. mAP is evaluation matric for object detection model. It measures how well a model performs in detecting objects across different categories by considering both precision and recall.

$$\text{Precision} = \frac{TP}{TP + FP}$$

where, TP = True Positive
FP = False Positive

$$\text{Recall} = \frac{TP}{TP + FN}$$

where, FN = False Negative

~~Avg~~ Average Precision (AP):-
Avg Precision is computed from the precision-recall curve. The curve is plotted with recall values on the x-axis & precision values on the y-axis. AP is the area under this curve.

Mean Average Precision (mAP):-
mAP is a mean of AP values for all classes. If there are N classes, it is calculated

$$mAP = \frac{1}{N} \sum_{i=1}^{N} AP_i$$

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~~Q1. Rest Net~~

Q2.

Features	RCNN	Fast RCNN	Faster RCNN
① Region Proposals	Selective Search	Selective search	Region Proposal Network (RPN)
② Feature Extraction	For each Proposal	Sigle Feature map	Single Feature map
③ Classification & Regression	SVM & linear regressor	Integrated into network	Integrated into network
④ Test on particular image	46 sec	2 sec	2 milisecond

Q3. The RPN in Faster RCNN significantly improves the effeciency of the detection process through several key & optimizations.

① In Faster RCNN the RPN shares convolutional layers with the main detection network.

② For each position in the feature map.

RPN generates multiple anchor boxes of different scales & aspect ratios leading to 9 anchors per position.

(3) For each anchor, the RPN simultaneously predicts an objectness score & and refines the anchor's coordinates through bounding box regression.

(4) Optimizing the entire network for both region proposal & detection tasks through unified training.

(5) Reducing the no. of proposals via Non-Maximum Suppression, minimizing computational load in detection stage.

Q8. IOU measures the overlap b/w two bounding boxes: a predicted bounding box and a ground truth bouding box. It is defined as the ratio of the area of the intersection of the two bounding boxes to the area of their union.

$$IOU = \frac{\text{Area of Intersection}}{\text{Area of Union}}$$

Importance of IOU :-

(1) It helps in setting thresholds for evaluating true positive & false positive.

(11) It is used in loss functions during training to improve model performance.
(12) It plays a key role in post-processing steps like Non-Maximum Suppression.

Q9. In object detection, multiple bounding boxes can often be proposed for the same object. These bounding boxes usually usually have different confidence scores indicating the containing an object. NMS helps in selecting the most accurate bounding box for each object.

Significance of NMS:-
(1) Redundacy Reduction
(2) Improved Accuracy
(3) Efficiency.