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Supplementary Algorithm 2: Pseudo-codes for calculating 2D mAP and recall.

Algorithm 2*: Calculating per-frame mAP and recall*

Inputs: H estimated bounding boxes $Dboxs_{est} = \{(x_i^e, y_i^e, w_i^e, l_i^e) | i = 1,2, ..., H\}$, G ground truth bounding boxes $Dboxs_{gt} = \left\{\left(x_j^{gt}, y_j^{gt}, w_j^{gt}, l_j^{gt}\right) | j = 1,2, ..., G\right\}$, where $\forall c_i^{pre}$ $(c_j^{gt}) \in \{0,1, ..., n\}$ represents the class label (0 for car in this study. n is determined by classification)

Outputs: *mAP* and *recall*.

1: Set *mAP* = 0, *recall* = 0 and the threshold of intersection over union (IOU) iou_{th} =0.5.

2: **For** c in $\{0, ..., n+1\}$

3: Obtain estimated and ground truth bounding boxes with the class labels equal to c, i.e., $D_{est} = \{(x_i^e, y_i^e, w_i^e, l_i^e) | c_i^e = c, i = 1,2, ..., H\}$ and $D_{gt} = \left\{\left(x_j^{gt}, y_j^{gt}, w_j^{gt}, l_j^{gt}\right) | c_j^{gt} = c, j = 1,2, ..., G\right\}$.

4: Sort D_{est} in a descending order according to s_i^e, i.e., $s_1^e \geq s_2^e \geq \cdots \geq s_{|D_{est}|}^e$, set the total number of true positives $count = 0$.

5: Initialization five sets, i.e., $TP = \left[tp_1, tp_2, ...tp_{|D_{est}|}\right]$, $FP = [fp_1, fp_2, ...fp_{|D_{est}|}]$, $Pr = [pr_1, pr_2, ...pr_{|D_{est}|}]$, $Re = [re_1, re_2, ...re_{|D_{est}|}]$ and $Flag = \left[f_1, f_2, ...f_{|D_{gt}|}\right]$. Initialize all elements in these five sets as 0.

6: **For** k =1 to $|D_{est}|$ do

7: Parameter recover: $iou_{max} = -1$, $j_{max} = 0$.

8: **For** l=1 to $|D_{gt}|$ do

9: Calculate the IOU between the k-th bounding box in D_{est} and l-th bounding box in D_{gt}.

10: **If** IOU > iou_{max} **then**

11: iou_{max} = IOU, $j_{max} = l$.

12: **End If**

13: **End For**

14: **If** $iou_{max} > iou_{th}$ **then**

15: **If** $f_{j_{max}} = 0$ **then**

16: $tp_k = 1$, $f_{j_{max}} = 1$.

17: **Else**

18: $fp_k = 1$.

19: **End If**

20: **End If**

21: **End For**

22: **For** k =1 to $|D_{est}|$ do

23: $count = count + tp_k$.

24: $pr_k = count/k$, $re_k = count/|D_{gt}|$.

25: **End For**

26: $AP = pr_1 * re_1 + \sum_{k=2}^{|D_{est}|} pr_k * (re_k - re_{k-1})$, $recall' = re_{|D_{est}|}$.

27: $mAP = mAP + AP/n + 1$, $recall = recall + recall'$.

28: **End For**

29: **Return** mAP, $recall$