

### Supplementary Algorithm 1: Pseudo-codes for calculating 3D mAP and recall.

**Algorithm 1:** Calculating per-frame mAP and recall

**Inputs:**  $H$  estimated bounding boxes  $D_{boxes}_{est} = \{(x_i^e, y_i^e, z_i^e, w_i^e, l_i^e, h_i^e, \theta_i^e, c_i^e, s_i^e) | i = 1, 2, \dots, H\}$ ,  $G$  ground truth bounding boxes  $D_{boxes}_{gt} = \{(x_j^{gt}, y_j^{gt}, z_j^{gt}, w_j^{gt}, l_j^{gt}, h_j^{gt}, \theta_j^{gt}, c_j^{gt}) | j = 1, 2, \dots, G\}$ , where  $\forall c_i^{pre} (c_j^{gt}) \in \{0, 1, \dots, n\}$  represents the class label (0 for car in this study.  $n$  is determined by classification).

**Outputs:** mAP and recall.

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1: Set  $mAP = 0$ ,  $recall = 0$  and the threshold of intersection over union (IOU)  $iou_{th} = 0.5$ .
2: For  $c$  in  $\{0, \dots, n + 1\}$ 
3:   Obtain estimated and ground truth bounding boxes with the class labels equal to  $c$ , i.e.,  $D_{est} = \{(x_i^e, y_i^e, z_i^e, w_i^e, l_i^e, h_i^e, \theta_i^e, c_i^e, s_i^e) | c_i^e = c, i = 1, 2, \dots, H\}$  and  $D_{gt} = \{(x_j^{gt}, y_j^{gt}, z_j^{gt}, w_j^{gt}, l_j^{gt}, h_j^{gt}, \theta_j^{gt}, c_j^{gt}) | c_j^{gt} = c, j = 1, 2, \dots, G\}$ .
4:   Sort  $D_{est}$  in a descending order according to  $s_i^e$ , i.e.,  $s_1^e \geq s_2^e \geq \dots \geq s_{|D_{est}|}^e$ , set the total number of true positives  $count = 0$ .
5:   Define five sets, i.e.,  $TP = [tp_1, tp_2, \dots, tp_{|D_{est}|}]$ ,  $FP = [fp_1, fp_2, \dots, fp_{|D_{est}|}]$ ,  $Pr = [pr_1, pr_2, \dots, pr_{|D_{est}|}]$ ,  $Re = [re_1, re_2, \dots, re_{|D_{est}|}]$  and  $Flag = [f_1, f_2, \dots, f_{|D_{est}|}]$ . 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  $mAP$ ,  $recall$ 

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