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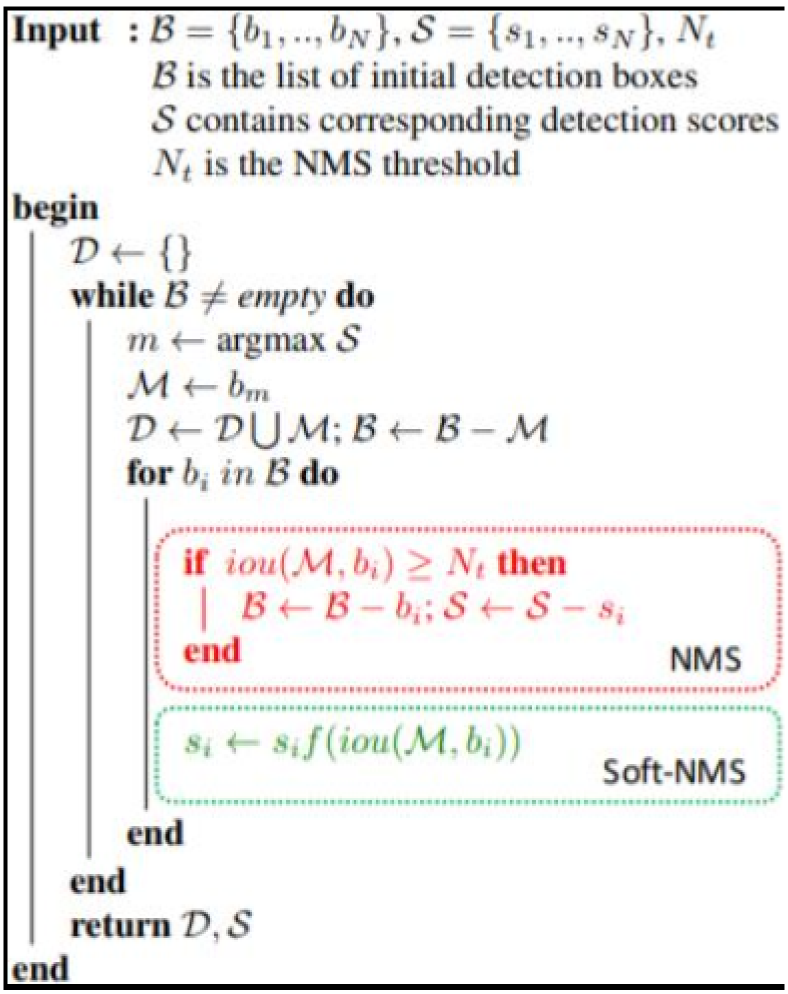
NMS

[details information]

- [soft NMS],
- [Softer NMS]



Input : $\mathcal{B} = \{b_1, .., b_N\}$, $\mathcal{S} = \{s_1, .., s_N\}$, N_t
$\mathcal{B}$ is the list of initial detection boxes
$\mathcal{S}$ contains corresponding detection scores
N_t is the NMS threshold
begin
  $\mathcal{D} \leftarrow \{\}$
  while $\mathcal{B} \neq empty$ **do**
    $m \leftarrow \text{argmax } \mathcal{S}$
    $\mathcal{M} \leftarrow b_m$
    $\mathcal{D} \leftarrow \mathcal{D} \bigcup \mathcal{M}; \mathcal{B} \leftarrow \mathcal{B} - \mathcal{M}$
    for b_i in $\mathcal{B}$ **do**
      if $iou(\mathcal{M}, b_i) \geq N_t$ **then**
        $\mathcal{B} \leftarrow \mathcal{B} - b_i; \mathcal{S} \leftarrow \mathcal{S} - s_i$
      end
      NMS
      $s_i \leftarrow s_i f(iou(\mathcal{M}, b_i))$
      Soft-NMS
    end
  end
  return $\mathcal{D}, \mathcal{S}$
end

Algorithm 1 softer-NMS

$\mathcal{B}$ is $N \times 4$ matrix of initial detection boxes. $\mathcal{S}$ contains corresponding detection scores. $\mathcal{C}$ is $N \times 4$ matrix of corresponding variances. N_t is the softer NMS threshold. The lines in blue and in green are soft-NMS and softer-NMS respectively.

$\mathcal{B} = \{b_1, .., b_N\}, \mathcal{S} = \{s_1, .., s_N\}, \mathcal{C} = \{\sigma_1^2, .., \sigma_N^2\}, N_t$
$\mathcal{D} \leftarrow \{\}$
$\mathcal{T} \leftarrow \mathcal{B}$
while $\mathcal{T} \neq$ empty **do**
    $m \leftarrow$ argmax $\mathcal{S}$
    $\mathcal{M} \leftarrow b_m$
    $\mathcal{T} \leftarrow \mathcal{T} - \mathcal{M}$
    $\mathcal{S} \leftarrow \mathcal{S} f(IoU(\mathcal{M}, T))$ ▷ soft-NMS
    $idx \leftarrow IoU(\mathcal{M}, B) \geq N_t$ ▷ softer-NMS
    $\mathcal{M} \leftarrow \mathcal{B}[idx] / \mathcal{C}[idx] / sum(1/\mathcal{C}[idx])$
    $\mathcal{D} \leftarrow \mathcal{D} \bigcup \mathcal{M}$
end while
return $\mathcal{D}, \mathcal{S}$

[soft nms implement]

- [IoU Guided NMS]

Algorithm 1 IoU-guided NMS. Classification confidence and localization confidence are disentangled in the algorithm. We use the localization confidence (the predicted IoU) to rank all detected bounding boxes, and update the classification confidence based on a clustering-like rule.

Input: $\mathcal{B} = \{b_1, ..., b_n\}$, $\mathcal{S}$, $\mathcal{I}$, Ω_{nms}
    $\mathcal{B}$ is a set of detected bounding boxes.
    $\mathcal{S}$ and $\mathcal{I}$ are functions (neural networks) mapping bounding boxes to their classification confidence and IoU estimation (localization confidence) respectively.
    Ω_{nms} is the NMS threshold.
Output: $\mathcal{D}$, the set of detected bounding boxes with classification scores.

$\mathcal{D} \leftarrow \varnothing$
while $\mathcal{B} \neq \varnothing$ **do**
    $b_m \leftarrow \arg\max \mathcal{I}(b_j)$
    $\mathcal{B} \leftarrow \mathcal{B} \setminus \{b_m\}$
    $s \leftarrow \mathcal{S}(b_m)$
    for $b_j \in \mathcal{B}$ **do**
        if $\mathrm{IoU}(\mathrm{b_m}, \mathrm{b_j}) > \Omega_{\text{nms}}$ **then**
            $s \leftarrow max(s, \mathcal{S}(b_j))$
            $\mathcal{B} \leftarrow \mathcal{B} \setminus \{b_j\}$
        end if
    end for
    $\mathcal{D} \leftarrow \mathcal{D} \cup \{\langle b_m, s \rangle\}$
end while
return $\mathcal{D}$

- [Conv NMS]
- Learning NMS

- Adaptive NMS

Input : $\mathcal{B} = \{b_1, .., b_N\}$, $\mathcal{S} = \{s_1, .., s_N\}$,
$\mathcal{D} = \{d_1, .., d_N\}$, N_t
$\mathcal{B}$ is the list of initial detection boxes
$\mathcal{S}$ contains corresponding detection scores
$\mathcal{D}$ contains corresponding detection densities
N_t is the NMS threshold

begin
  $\mathcal{F} \leftarrow \{\}$
  while $\mathcal{B} \neq empty$ **do**
    $m \leftarrow \text{argmax } \mathcal{S}$
    $\mathcal{M} \leftarrow b_m$
    $N_{\mathcal{M}} \leftarrow \max(N_t, d_m)$
    $\mathcal{F} \leftarrow \mathcal{F} \bigcup \mathcal{M}; \mathcal{B} \leftarrow \mathcal{B} - \mathcal{M}$
    for b_i in $\mathcal{B}$ **do**
      if $iou(\mathcal{M}, b_i) \geq N_t$ **then**
        $\mathcal{B} \leftarrow \mathcal{B} - b_i; \mathcal{S} \leftarrow \mathcal{S} - s_i;$
      end Greedy-NMS
      if $iou(\mathcal{M}, b_i) \geq N_{\mathcal{M}}$ **then**
        $\mathcal{B} \leftarrow \mathcal{B} - b_i; \mathcal{S} \leftarrow \mathcal{S} - s_i;$
      end Adaptive-NMS
    end
  end
  return $\mathcal{F}, \mathcal{S}$
end

- [Pure NMS Network]
- Yes-Net: An effective Detector Based on Global Information