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**Algorithm 4** Optimized SAM Refinement
 

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**Input:**  $\mathcal{I} \in \mathbb{R}^{H \times W \times 3}, \mathcal{S} \in \mathbb{Z}^{H \times W}, \mathcal{L} \in \mathbb{R}^{C \times H \times W}, C \in \mathbb{Z}^+, \mathcal{P}$

**Output:**  $\mathcal{S}' \in \mathbb{Z}^{H \times W}, \mathcal{Q} \in \mathbb{R}^N, \mathcal{L}' \in \mathbb{R}^{C \times H \times W}, \mathcal{B}' \in \mathbb{R}^{N \times 4}$

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0:  $d \leftarrow \mathcal{S}.\text{device}, r \leftarrow 2, (h_d, w_d) \leftarrow (\lfloor H/r \rfloor, \lfloor W/r \rfloor)$ 
0: with no_grad() and mixed_precision(d):
0:  $\mathcal{S}_d \leftarrow \mathcal{F}_{\text{down}}(\mathcal{S}, h_d, w_d), \mathcal{L}_d \leftarrow \mathcal{F}_{\text{down}}(\mathcal{L}, h_d, w_d)$ 
0: if  $\tau_c > 0$  then
0:    $\mathcal{S}_d[\max_c(\mathcal{L}_d) < \tau_c] \leftarrow C, \mathcal{M} \leftarrow \Phi(\mathcal{S}_d, C + 1) \{\text{One-hot encoding}\}$ 
0: else
0:    $\mathcal{M} \leftarrow \Phi(\mathcal{S}_d, C)$ 
0: end if
0:  $\mathcal{M}_{\text{cpu}} \leftarrow \Pi_{\text{mem}}(\mathcal{M}, d), (\mathcal{R}, \mathcal{B}, \mathcal{Q}_b, \mathcal{P}) \leftarrow \text{SplitRegions}(\mathcal{M}_{\text{cpu}}, \mathcal{L}_d, \tau_c)$ 

0: if  $\forall i \in [0, C) : |\mathcal{B}_i| = 0$  then return  $(\mathcal{S}, \emptyset, \mathcal{L}, \emptyset)$ 
0: end if
0:  $b_{\text{size}} \leftarrow \min(32, \max(1, \lfloor M_{\text{free}} / (3 \cdot 10^9) \rfloor)), \mathcal{P}.\text{PrecomputeTransforms}(h_d, w_d, H, W)$ 
0:  $\mathbb{I} \leftarrow \emptyset, \mathcal{B}_c, \mathcal{M}_v, \mathcal{Q}_v, \mathcal{L}_v, \mathcal{R}_f \leftarrow \emptyset, \emptyset, \emptyset, \emptyset, \emptyset \{\text{Collections init}\}$ 
0: for  $i \in [0, C)$  do
0:   if  $|\mathcal{R}_i| > 0$  then
0:      $(h_n, w_n) \leftarrow \mathcal{P}.\text{GetPreprocessShape}(H, W, 256), \mathcal{L}_r^i \leftarrow \mathcal{F}_{\text{resize}}(\mathcal{L}_d[i], h_n, w_n)$ 
0:      $\mathcal{L}_r^i \leftarrow \mathcal{F}_{\text{pad}}(\mathcal{L}_r^i, 256 - w_n, 256 - h_n) \cdot \tau_m \cdot \mathbb{I}_{\{\mathcal{L}_r^i > \tau_c\}}$ 
0:      $\mathcal{B}_t^i \leftarrow \mathcal{P}.\text{TransformBoxes}(\mathcal{B}_i, h_d, w_d), \mathcal{P}_t^i \leftarrow \mathcal{P}.\text{TransformPoints}(\mathcal{P}_i, h_d, w_d)$ 
0:      $\mathbb{I} \leftarrow \mathbb{I} \cup \{(i, \mathcal{B}_t^i, \mathcal{P}_t^i, \mathcal{L}_r^i, \mathcal{R}_i, \mathcal{B}_i, \mathcal{P}_i)\}$ 
0:   end if
0: end for

0: for  $j \leftarrow 0$  to  $|\mathbb{I}|$  step  $b_{\text{size}}$  do
0:    $\mathbb{I}_j \leftarrow \mathbb{I}[j : j + b_{\text{size}}]$ 
0:   for each  $(i, \mathcal{B}_t^i, \mathcal{P}_t^i, \mathcal{L}_r^i, \mathcal{R}_i, \mathcal{B}_i, \mathcal{P}_i) \in \mathbb{I}_j$  do
0:      $(\mathcal{M}_i, \mathcal{Q}_i, \mathcal{L}_i) \leftarrow \mathcal{P}.\text{Predict}(\mathcal{P}_t^i, \mathbf{1}, \mathcal{B}_t^i, \mathcal{L}_r^i), \mathcal{V}_i \leftarrow \{\mathcal{Q}_i > \tau_{\text{iou}}\}$ 
0:     if  $|\mathcal{V}_i| < |\mathcal{R}_i|$  then  $\mathcal{R}_f \leftarrow \mathcal{R}_f \cup \{\mathcal{R}_i[\neg \mathcal{V}_i]\}$ 
0:     end if
0:     if  $|\mathcal{V}_i| > 0$  then  $\mathcal{M}_v \leftarrow \mathcal{M}_v \cup \{\mathcal{M}_i[\mathcal{V}_i]\}, \mathcal{Q}_v \leftarrow \mathcal{Q}_v \cup \{\mathcal{Q}_i[\mathcal{V}_i]\}, \mathcal{L}_v \leftarrow \mathcal{L}_v \cup \{\mathcal{L}_i[\mathcal{V}_i]\}, \mathcal{B}_c \leftarrow \mathcal{B}_c \cup \{\mathcal{B}_i[\mathcal{V}_i]\}$ 
0:     end if
0:   end for
0: end for

0: if  $|\mathcal{B}_c| > 0$  then
0:   with mixed_precision(d):
0:      $\mathcal{M}_{\text{all}} \leftarrow \text{Concat}(\mathcal{M}_v), \mathcal{Q}_{\text{all}} \leftarrow \text{Concat}(\mathcal{Q}_v), \mathcal{L}_{\text{all}} \leftarrow \mathcal{P}.\text{PostprocessMasks}(\text{Concat}(\mathcal{L}_v), H, W)$ 
0:      $\mathcal{B}_{\text{all}} \leftarrow \text{Concat}(\mathcal{B}_c) \cdot r, (\mathcal{S}', \mathcal{L}') \leftarrow \text{MapRefinement}(\mathcal{M}_{\text{all}}, \sigma(\mathcal{L}_{\text{all}}), \mathcal{B}, \mathcal{L})$ 
0:      $\mathcal{S}' \leftarrow \mathcal{S}' \cdot \mathbb{I}_{\{\sum_c \mathcal{L}_c' > 0\}} + \mathcal{S} \cdot \mathbb{I}_{\{\sum_c \mathcal{L}_c' = 0\}}$ 
0:     if  $|\mathcal{R}_f| > 0$  then  $\mathcal{R}_f \leftarrow \text{Resize}(\text{Concat}(\mathcal{R}_f), H, W), (\mathcal{S}', \mathcal{L}') \leftarrow \text{MapFailedRegions}(\mathcal{S}', \mathcal{L}', \mathcal{R}_f, \mathcal{L}, \mathcal{S})$ 
0:     end if
0:     return  $(\mathcal{S}', \mathcal{Q}_{\text{all}}, \mathcal{L}', \mathcal{B}_{\text{all}})$ 
0:   else
0:     return  $(\mathcal{S}, \emptyset, \mathcal{L}, \emptyset)$ 
0:   end if

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