Pseudocode Part

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UCB-D pseudocode

Algorithm 1 UCB-Cluster (General case)

for $t = 1, 2, 3$ **do**
    Pull three arms exactly once and calculate the estimated probabilities
end for
for $t = 4, \cdots, N$ **do**
    Choose the best cluster
    Choose the best arm inside the above chosen cluster
    Update the 'count' and 'probability' of both the arm and the corresponding cluster
end for

Algorithm 2 UCB-Cluster (Given precise basic settings)

for $t = 1, 2, 3$ **do**
  Pull three arms exactly once and calculate the estimated probabilities
end for
for $t = 4, \cdots, N$ **do**
  $G(t) \leftarrow \arg\max_{g \in \{1,2\}}(\hat{\phi_g} + c_1 \cdot \sqrt{\frac{2 \log t}{groupCount(g)}})$ ▷ Choose the best cluster

  if $G(t) = 1$ **then**
    $I(t) \leftarrow 1$ ▷ This cluster has only one arm, simply choose it
    $armCount(1) \leftarrow armCount(1) + 1$ ▷ Update armCount and groupCount
    $groupCount(1) \leftarrow groupCount(1) + 1$
    $\hat{\theta}(1) \leftarrow \hat{\theta}(1) + \frac{1}{armCount(1)} \left[r_{I(1)} - \hat{\theta}(1) \right]$ ▷ Update probability of this arm
    $\hat{\phi}(1) \leftarrow \hat{\phi}(1) + \frac{1}{groupCount(1)} \left[r_{I(1)} - \hat{\phi}(1) \right]$ ▷ Update probability of this cluster
  else if $G(t) = 2$ **then**
    $I(t) \leftarrow \arg\max_{j \in \{2,3\}}(\hat{\theta_j} + c_2 \cdot \sqrt{\frac{2 \log t}{armCount(j)}})$ ▷ Best arm inside this cluster
    $armCount(I(t)) \leftarrow armcount(I(t)) + 1$ ▷ Update armCount and groupCount
    $groupCount(2) \leftarrow groupCount(2) + 1$
    $\hat{\theta}(I(t)) \leftarrow \hat{\theta}(I(t)) + \frac{1}{armCount(I(t))} \left[r_{I(t)} - \hat{\theta}(I(t)) \right]$ ▷ Update probability of arm
    $\hat{\phi}(2) \leftarrow \hat{\phi}(2) + \frac{1}{groupCount(2)} \left[r_2 - \hat{\phi}(2) \right]$ ▷ Update probability of this cluster
  end if
end for

Algorithm 3 UCB-With-Cost

for $t = 1, 2, 3$ **do**
  $I(t) \leftarrow t$
  $count(I(t)) \leftarrow 1$
  $\hat{\theta}(I(t)) \leftarrow r_{I(t)}$
end for
for $t = 4, \cdots, N$ **do**
  $I(t) \leftarrow \arg\max_{j \in \{1,2,3\}} \left(\frac{\hat{\theta_j}}{c_j} + c \cdot \sqrt{\frac{2 \log t}{\text{count}(j)}} \right)$
  $count(I(t)) \leftarrow count(I(t)) + 1$
  $\hat{\theta}(I(t)) \leftarrow \hat{\theta}(I(t)) + \frac{1}{Count(I(t))} \left[r_{I(t)} - \hat{\theta}(I(t)) \right]$
end for