

Search-Map-Search: A Frame Selection Paradigm for Action Recognition

A. Appendix

A.1. Guided Local Search

Guided Local Search (GLS) [1] is a meta-heuristic method proposed to solve combinational optimization problems. It applies an efficient penalty-based approach to escape from local optima, which improves the efficiency and robustness of the underlying local search algorithms. The problem of frame selection, which selects the best frame combination according to a cost function from all frames in a video, is typically a combinational optimization problem and can be well solved with GLS.

The adapted Guided Local Search on frame selection is described in Algorithm 1, which takes an initial combination \tilde{X}_0 , the search space S , and a cost function L as input. Specifically, for a video X , we first initialize the problem-specific penalty p_i for each frame x_i in the video, to penalize the repetitive selection of the same frames. The augmented cost function is defined by combining the original cost function L and the penalty term with a coefficient μ .

Multiple iterations of search is conducted. In each iteration, a simple local search with the augmented cost function h is conducted to find a local optima \tilde{X}_t , where the local search iterates through the search space to find the best candidate successively for each position in the combination. Then, we update the penalty p_k by incrementing the penalty of the most utilized frame x_k in \tilde{X}_t , to escape from the local optima and find different solutions. Finally, we collect the solutions of each iteration, and return the one with the lowest original cost \tilde{X}^* .

References

- [1] Christos Voudouris, Edward PK Tsang, and Abdullah Alsheddy. Guided local search. In *Handbook of metaheuristics*, pages 321–361. Springer, 2010. 1

Algorithm 1: Guided Local Search

Input: Video X , label y , Pre-trained Model M ,
Number of frame per combination n

1 Function GuidedLocalSearch(\tilde{X}_0, S, L):

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2   /* Initialize penalties */
3   for  $i = 1, \dots, |X|$  do
4      $p_i \leftarrow 0$ 
5   Define augmented cost function
6    $h \leftarrow L + \mu * \sum p_i * I_i$ 
7   for  $t = 1, \dots, T$  do
8      $\tilde{X}_t \leftarrow \text{LocalSearch}(\tilde{X}_{t-1}, S, h)$ 
9     for  $i = 1, \dots, n$  do
10       $util_i \leftarrow I_i(\tilde{X}_t)/(1 + p_i)$ 
11       $p_k += 1$  where  $k = \arg \max_i(util_i)$ 
12  $\tilde{X}^* = \arg \min_{\tilde{X}_t} \{L(\tilde{X}_t) | t = 1, \dots, T\}$ 
13 return  $\tilde{X}^*$ 

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12 Function LocalSearch(\tilde{X}, S, h):

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13  $\tilde{X}^* \leftarrow \tilde{X}, C^* \leftarrow \infty$ 
14 for  $i = 1, \dots, n$  do
15   for  $x \in S_i$  do
16     Derive new combination  $\tilde{X}'$  by
17     replacing the  $i$ -th item with  $x$ 
18     if  $h(\tilde{X}') < C^*$  then
19        $\tilde{X}^* \leftarrow \tilde{X}', C^* \leftarrow h(\tilde{X}')$ 
20 return  $\tilde{X}^*$ 

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