Supplementary Material
for
Exploiting Transitivity for Learning Person Re-identification Models on a Budget

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1. Proof of NP-Hardness

Optimization Problem: Given a complete k-partite graph $G_k = (V, E)$ with non-negative edge weights and an integer B, choose a maximum-weight set S of edges from E such that $G' = (V, S)$ is triangle free and $|S| \leq B$. We consider the following decision version of this optimization problem: Given a complete k-partite graph $G_k = (V, E)$ with only $0/1$ edge weights and an input integer B, Does G have a triangle free subgraph with total edge-weight $\geq B$.

Lemma 1. *The above decision problem is NP-hard at least for complete k-partite graphs with $k \geq 4$.*

Proof. We will reduce from vertex cover problem to ours using the construction procedure described in [1]. Given $G_0 = (V_0, E_0)$ as an input the vertex cover problem, we will replace every edge (u, w) in E_0 by a path of length 3 with two new vertices: (u, a_1, a_2, w).We call this new graph G_1. The minimum vertex-cover size increases by an additive $|E0|$ when we go from G_0 to G_1. Also note that G_1 does not have any cycle of length < 9. Now, in [1] it is shown that,there is a vertex cover of a size s_0 in G_0 iff there is a vertex cover of size $s_1 = s_0 + |E_0|$ in $G1$. Now, we add a vertex c and connect every vertex in G_1 with c. We call this new graph $G_2 = (V_2, E_2)$.[1] further shows:there is a vertex cover of size s_1 in G_1 iff there is a set of s_1 edges in G_2 covering all triangles in G_2 iff G_2 has a triangle-free subgraph with $B = |E_2| - s_1$ edges. Now observe that G_2 is a 4-partite graph , with parts $\{c\}, V_0, P_1, P_2$. We create P_1 and P_2 as follows: we take a_1 and a_2 from every path (u, a_1, a_2, w) in G_2. Then for each path we put a_1 in P_1 and a_2 in P_2 respectively. Now, we trasnform G_2 in to a complete 4-partite graph $G'_2 = (V'_2, E'_2)$ by adding zero weight edges between two vertices from two different partitions if only the edge does not exist already. Furthermore, we give unit-weight to each edge in $E_2 = E_2 \cap E'_2$. As G_2 is a subgraph of the complete 4-partite graph G'_2, using the reduction shown above we can conclude:
There is a vertex cover of size s_1 in G_1 iff G'_2 has a triangle-free subgraph with total edge-weight $\geq B$. And this reduction shows our decision problem is NP-hard for k-partite graphs with $k \geq 4$.

□

2. Camera Pairwise Results

In the main paper we provided results using the 'top-B edge selection. Here we present recognition results using 'random-B edge selection' baseline which just selects B number of edges using uniformly random sampling

Method	Pair 1-2	Pair 1-3	Pair 2-3
Full set	0.7429	0.5800	0.8629
Exact Algorithm	0.7314	0.5743	0.8714
1/2-approximation	0.7457	0.5743	0.8714
Greedy	0.7314	0.5657	0.8886
Baseline	0.2103	0.2314	0.3994

Table 1: Rank-1 accuracy table(camera pairwise) for WARD-1 and 15% labeling.

Method	Pair 1-2	Pair 1-3	Pair 2-3
Full set	0.7429	0.5800	0.8629
Exact Algorithm	0.6343	0.4686	0.8286
1/2-approximation	0.6343	0.4686	0.8343
Greedy	0.6343	0.4686	0.8057
Baseline	0.1960	0.1120	0.3469

Table 2: Rank-1 accuracy table(camera pairwise) for WARD-1 and 5% labeling.

Method	Pair 1-2	Pair 1-3	Pair 2-3
Full set	0.2709	0.2143	0.8486
Exact Algorithm	0.2771	0.2343	0.8520
1/2-approximation	0.2771	0.2246	0.8463
Greedy	0.2771	0.2343	0.8657
Baseline	0.1023	0.1097	0.2640

Table 3: Rank-1 accuracy table(camera pairwise) for WARD-2 and 15% labeling.

Method	Pair 1-2	Pair 1-3	Pair 2-3
Full set	0.2709	0.2143	0.8486
Exact Algorithm	0.2566	0.2046	0.8137
1/2-approximation	0.2686	0.2206	0.8166
Greedy	0.2566	0.1989	0.8171
Baseline	0.0954	0.0800	0.1840

Table 4: Rank-1 accuracy table(camera pairwise) for WARD-2 with 5% labeling.

Method	Pair 1-2	Pair 1-3	Pair 1-4	Pair 2-3	Pair 2-4	Pair 3-4
Full set	0.6094	0.2656	0.5938	0.3906	0.5156	0.6563
Exact Algorithm	0.6094	0.2656	0.5938	0.3906	0.5156	0.6563
1/2-approximation	0.6094	0.1719	0.5625	0.3594	0.5156	0.6563
Greedy	0.6094	0.2656	0.5938	0.3906	0.5156	0.6563
Baseline	0.3688	0.1594	0.2125	0.1219	0.1844	0.3250

Table 5: Rank-1 accuracy table(camera pairwise) for RAiD-1 with 15.7% labeling.

Method	Pair 1-2	Pair 1-3	Pair 1-4	Pair 2-3	Pair 2-4	Pair 3-4
Full set	0.6094	0.2656	0.5938	0.3906	0.5156	0.6563
Exact Algorithm	0.5000	0.1250	0.5938	0.1563	0.2031	0.3594
1/2-approximation	0.5000	0.1094	0.5938	0.0781	0.0625	0.4063
Greedy	0.5000	0.1250	0.5938	0.1563	0.2031	0.4219
Baseline	0.2375	0.0813	0.2781	0.0813	0.1781	0.2156

Table 6: Rank-1 accuracy table(camera pairwise) for RAiD-1 with 5% labeling.

Method	Pair 1-2	Pair 1-3	Pair 1-4	Pair 2-3	Pair 2-4	Pair 3-4
Full set	0.3250	0.0531	0.3000	0.3438	0.3438	0.6250
Exact Algorithm	0.3250	0.0531	0.3000	0.3312	0.4000	0.6344
1/2-approximation	0.3125	0.0563	0.3000	0.3281	0.4156	0.6250
Greedy	0.3250	0.0531	0.3000	0.3312	0.4000	0.6344
Baseline	0.1875	0.0875	0.1719	0.1719	0.1656	0.2656

Table 7: Rank-1 accuracy table(camera pairwise) for RAiD-2 with 16% labeling.

Method	Pair 1-2	Pair 1-3	Pair 1-4	Pair 2-3	Pair 2-4	Pair 3-4
Full set	0.3250	0.0531	0.3000	0.3438	0.3438	0.6250
Exact Algorithm	0.2406	0.0656	0.2250	0.1437	0.1344	0.0938
1/2-approximation	0.1563	0.0875	0.2156	0.1000	0.1750	0.3250
Greedy	0.2406	0.0781	0.2156	0.1437	0.1313	0.3000
Baseline	0.1375	0.0125	0.2719	0.0625	0.2344	0.2875

Table 8: Rank-1 accuracy table(camera pairwise) for RAiD-2 with 5% labeling.

Method	Pair 1-2	Pair 1-3	Pair 1-4	Pair 1-5	Pair 1-6	Pair 2-3	Pair 2-4	Pair 2-5
Full set	0.3161	0.4567	0.2267	0.3725	0.2860	0.5487	0.1346	0.3047
1/2-approximation	0.3198	0.4558	0.2248	0.3669	0.2789	0.5447	0.1306	0.3104
Greedy	0.3170	0.4563	0.2258	0.3683	0.2813	0.5430	0.1323	0.3116
Baseline	0.1853	0.3255	0.1580	0.2140	0.1468	0.3351	0.0601	0.1306

Table 9: Rank-1 accuracy table(camera pairwise) for Market 1501 with 8% labeling.

Method	Pair 2-6	Pair 3-4	Pair 3-5	Pair 3-6	Pair 4-5	Pair 4-6	Pair 5-6
Full set	0.2955	0.1583	0.5896	0.3604	0.4944	0.2063	0.2507
1/2-approximation	0.2995	0.1573	0.5913	0.3508	0.4955	0.1996	0.2365
Greedy	0.2995	0.1590	0.5938	0.3533	0.4922	0.2119	0.2457
Baseline	0.1489	0.1061	0.4862	0.2109	0.3128	0.0785	0.1206

Table 10: Rank-1 accuracy table(camera pairwise) for Market 1501 with 8% labeling.

Method	Pair 1-2	Pair 1-3	Pair 1-4	Pair 1-5	Pair 1-6	Pair 2-3	Pair 2-4	Pair 2-5
Full set	0.3161	0.4567	0.2267	0.3725	0.2860	0.5487	0.1346	0.3047
1/2-approximation	0.3128	0.4468	0.2239	0.3565	0.2220	0.5321	0.1334	0.2898
Greedy	0.3123	0.4473	0.2239	0.3457	0.2267	0.5286	0.1334	0.2869
Baseline	0.0475	0.1881	0.0786	0.0263	0.0771	0.0367	0.0407	0.0281

Table 11: Rank-1 accuracy table(camera pairwise) for Market 1501 with 3% labeling.

Method	Pair 2-6	Pair 3-4	Pair 3-5	Pair 3-6	Pair 4-5	Pair 4-6	Pair 5-6
Full set	0.2955	0.1583	0.5896	0.3604	0.4944	0.2063	0.2507
1/2-approximation	0.2595	0.1537	0.5874	0.3092	0.4865	0.1928	0.2147
Greedy	0.2560	0.1530	0.5874	0.3064	0.4877	0.1928	0.2189
Baseline	0.0613	0.0286	0.4288	0.1030	0.0101	0.0258	0.0147

Table 12: Rank-1 accuracy table(camera pairwise) for Market 1501 with 3% labeling.

References

[1] M. Yannakakis. Edge-deletion problems. *SIAM Journal on Computing*, 10(2):297–309, 1981. 2