Higher Order Multiple Object Tracking for Crowded Scenes

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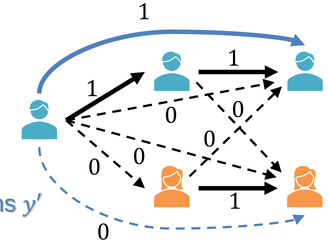
Introduction:

We introduce an approximate solver for lifted disjoint paths (LDP) [1] problems and integrate it into a tracking framework to make LDP based tracking applicable to large and crowded video sequences.

LDP :

- Flow network $G = (V, E)$
- Lifted graph $G' = (V', E')$
  (encoding higher order information)
- Costs c and c' between detections
- Find 0/1 flow y and 0/1 lifted edge activations y'
  with: $\min_{y} \langle c, y \rangle + \langle c', y' \rangle$
- $y'_{vw} = 1$, iff flow from v to w



LDP graph

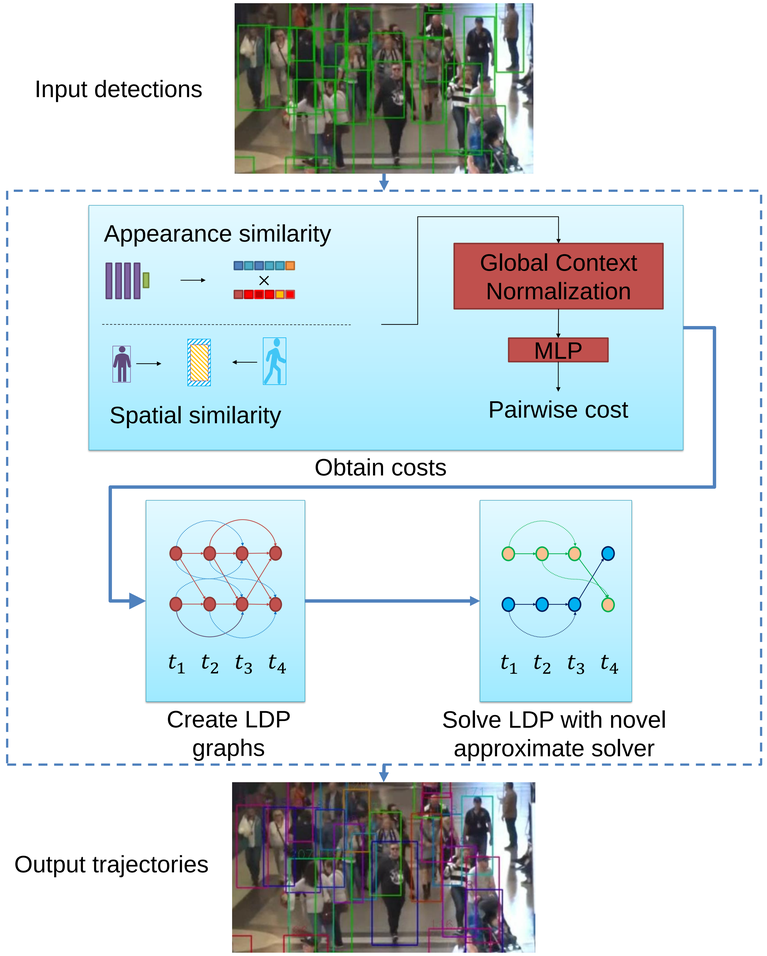
Method:

1. Calculate lightweight pairwise costs between detection pairs
2. Create sparse LDP graphs based on the costs
3. Solve the problem with our novel approximate LDP solver

Approximate LDP solver:

- Polynomial complexity (instead of exponential complexity)
- Lagrangean (dual) decomposition into small tractable subproblems
- Main subproblems:
  - All edges going out from a node (outflow subproblem)
  - All edges going to a node (inflow subproblem)
- Message passing improves dual solution (lower bound)
- Propagating cost from lifted to base edges within each in/outflow subproblem → high quality primal solution by solving minimum cost flow problem

Overall Framework:



Evaluation:

Dataset	Method	MOTA	IDF1
MOT20 [2]	ApLift (ours)	**58.9**	**56.5**
	Lif_T [1]	-	-
MOT17 [3]	ApLift (ours)	**60.5**	**65.6**
	Lif_T [1]	**60.5**	**65.6**
MOT16 [3]	ApLift (ours)	**61.7**	**66.1**
	Lif_T [1]	61.3	64.7

Table 1: Tracking results compared to Lif_T with optimal LDP solver

Summary

- Novel approximate LDP solver
- Extends the applicability of the LDP model to massive sequences
- Better runtime than optimal LDP solver
- Similar tracking results as with an optimal LDP solver
- Comparable to state-of-the-art
- Find videos at:

References

[1] Andrea Hornakova, Roberto Henschel, Bodo Rosenhahn, and Paul Swoboda. Lifted disjoint paths with application in multiple object tracking. In ICML, July 2020.

[2] Patrick Dendorfer, Hamid Rezatofighi, Anton Milan, Javen Shi, Daniel Cremers, Ian Reid, Stephan Roth, Konrad Schindler, and Laura Leal-Taixé. Mot20: A benchmark for multi object tracking in crowded scenes.arXiv:2003.09003[cs], Mar. 2020.

[3] Anton Milan, Laura Leal-Taixé, Ian Reid, Stephan Roth, and Konrad Schindler. MOT16: A benchmark for multi-object tracking.arXiv:1603.00831 [cs], Mar. 2016.