Visual Person Understanding through Multi-Task and Multi-Dataset Learning

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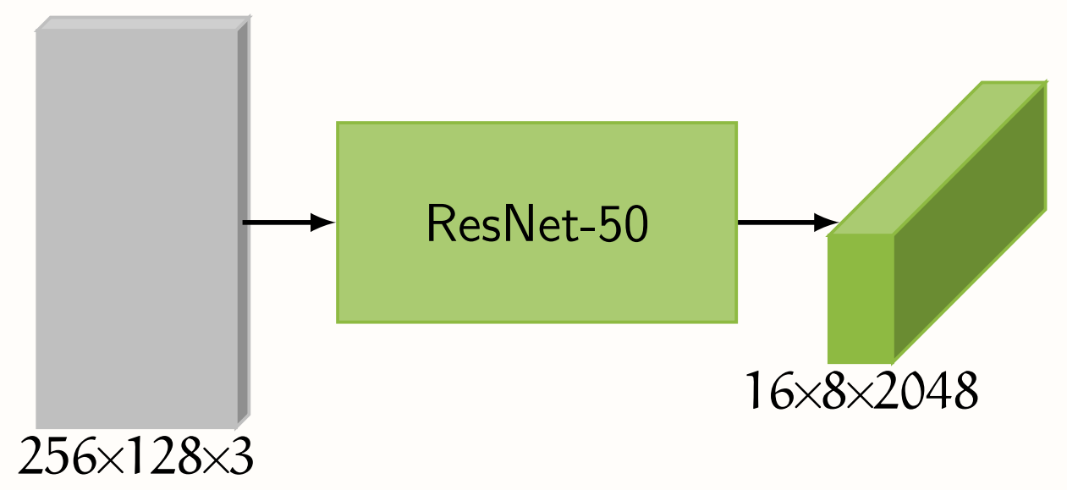
Summary

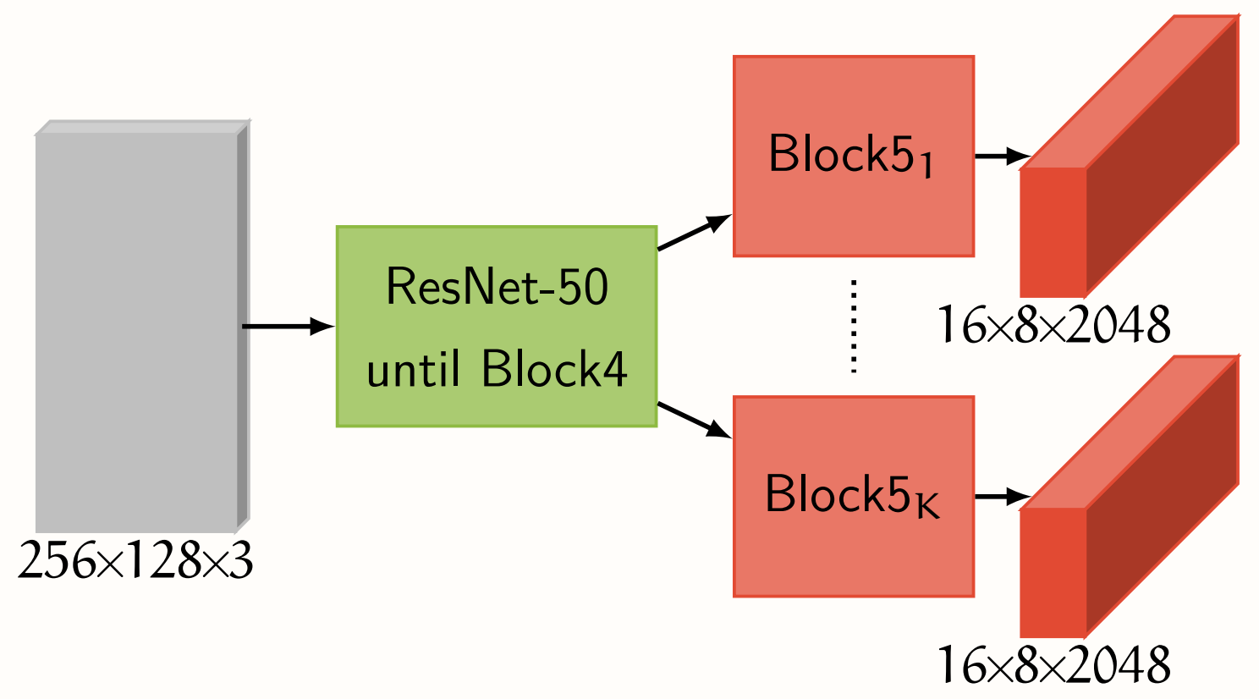
- Mobile vision applications need to perform many person-related tasks. We focus on:
  - Person re-identification (Market-1501)
  - Body part segmentation (LIP)
  - Human pose estimation (MPII, LIP)
  - Attribute classification: gender, clothing etc. (Market-1501)
- These tasks are interdependent and mobile platforms are resource-constrained:
  ⟶ Joint multi-task learning is needed.
- There exists no single dataset that provides annotations for all tasks:
  ⟶ Option 1: Generate pseudo-labels for a single dataset.
  ⟶ Option 2: Combine multiple datasets during training.
- We investigate architectural design choices and their effects on joint training, compared to single-task baselines and the state-of-the-art.

Architecture

How much to share among tasks?

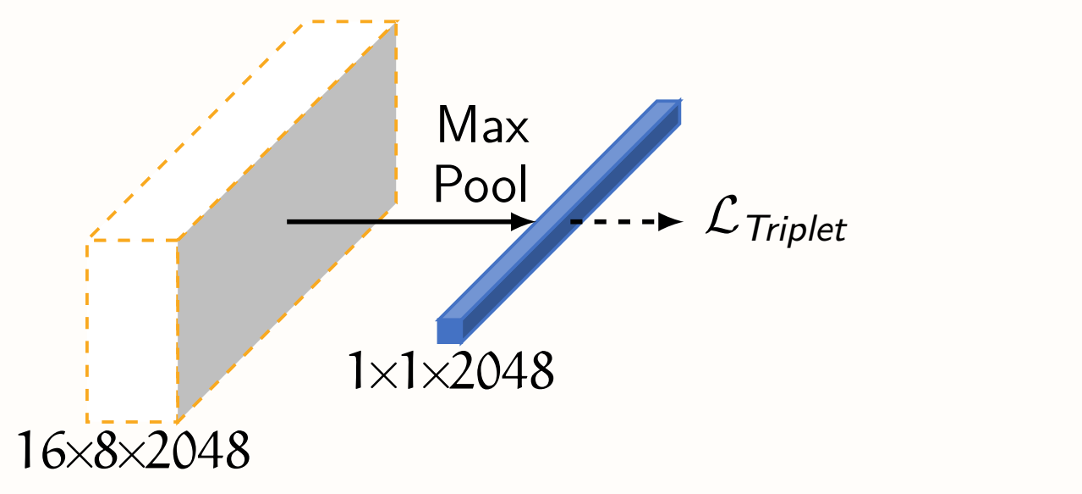


Single-branch backbone $\mathcal{M}^{SB}$

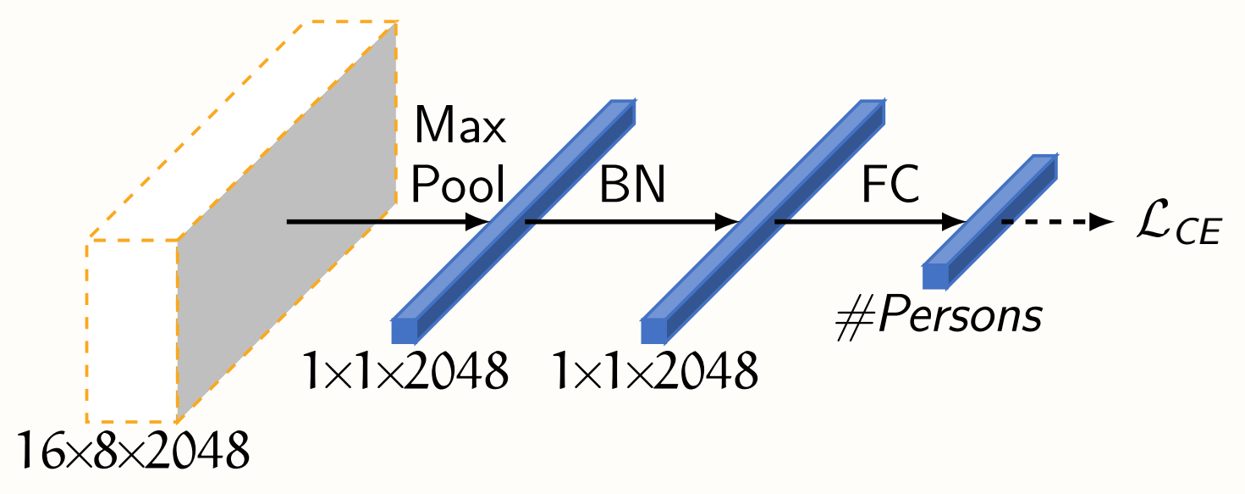


Multi-branch backbone $\mathcal{M}^{MB}$

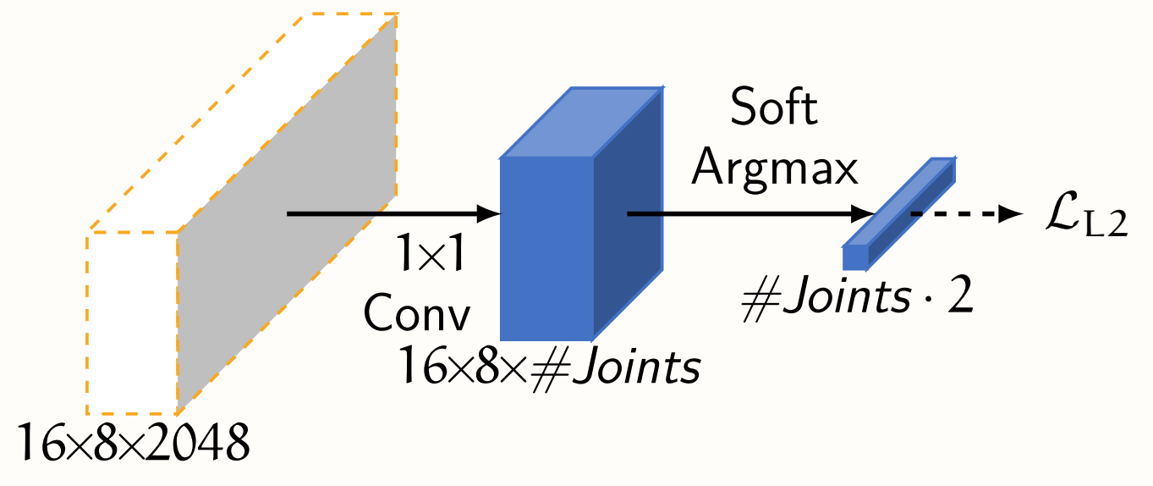
Individual Task Heads



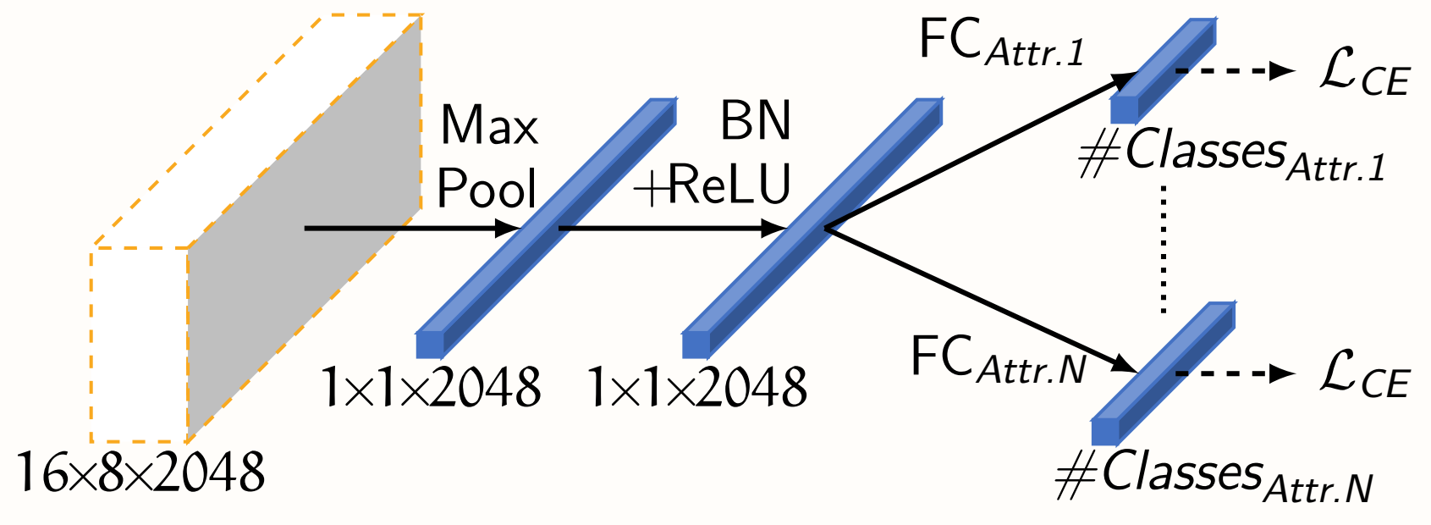
Triplet ReID embedding head



Person classification head

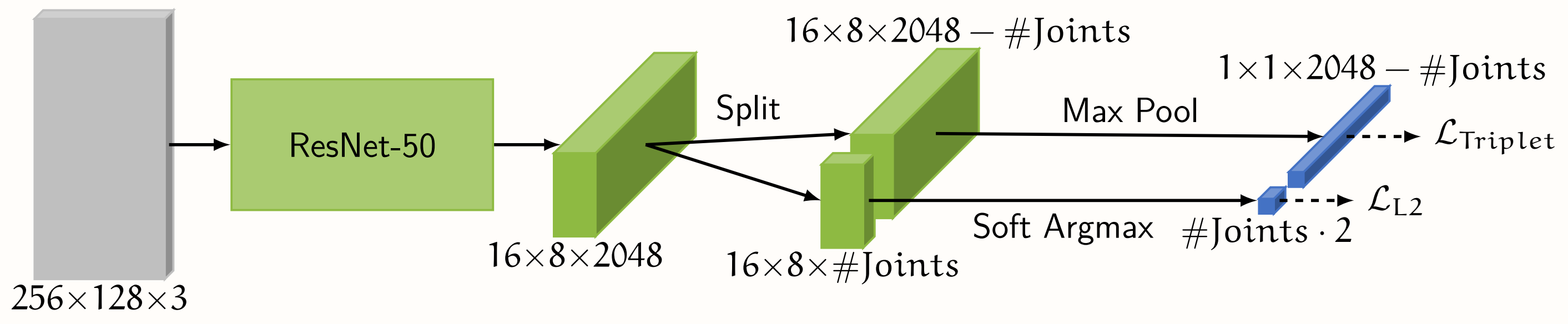


Pose estimation head



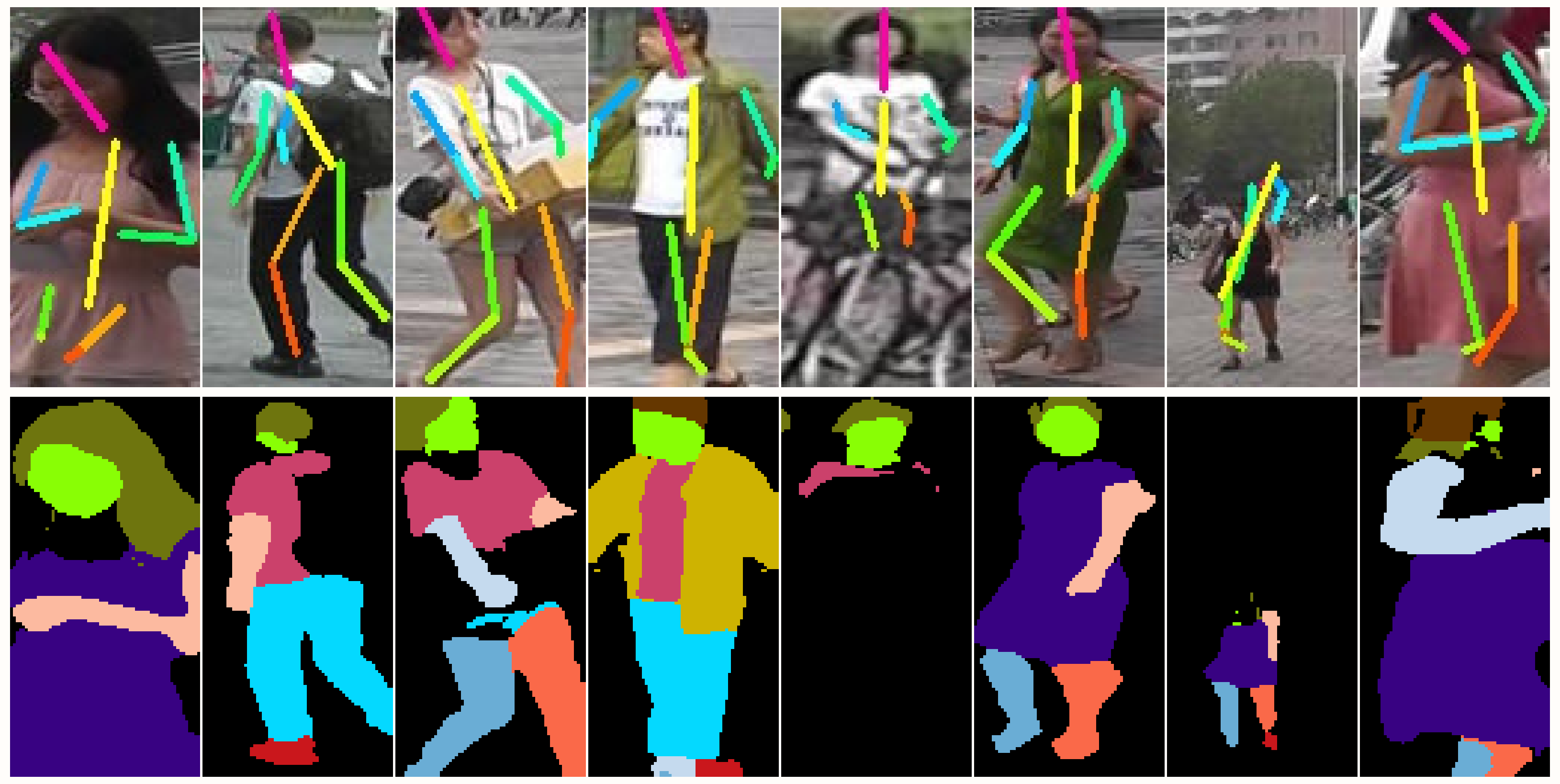
Attribute classification head

ReID task ↯ ↯ Pose task



Split ReID and pose head to avoid interference.

Automatic Annotations



Automatic annotations on the Market-1501 dataset for pose estimation (top) and part segmentation (bottom).

Results

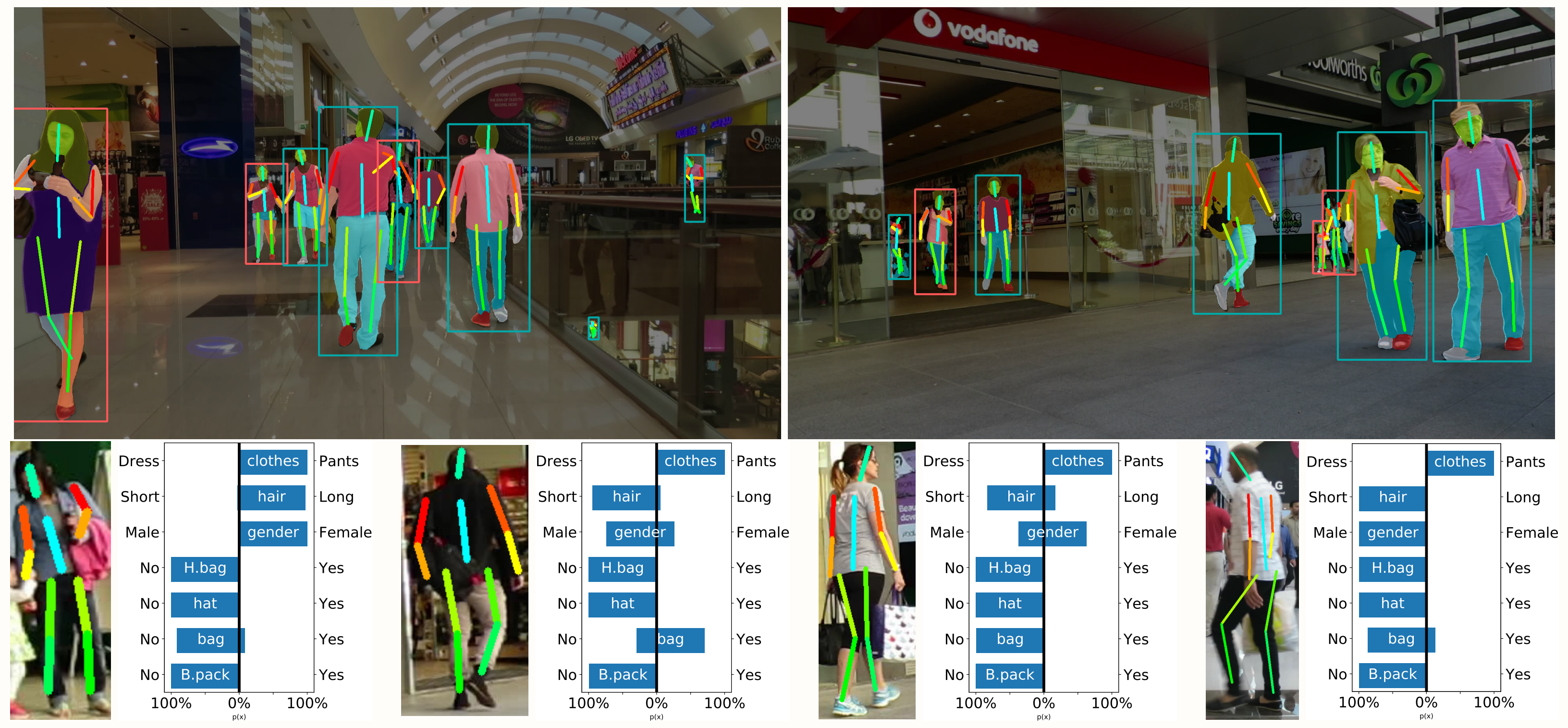
Automatic Annotations

	Market					Evaluation					
	Manual			Auto		Market		MPII	LIP		
	Tripl.	Clas.	Attr.	Pose	Seg.	ReID mAP	Attr. acc	Pose PCKh	Pose PCKh	Segmentation mIoU	Segmentation mIoU$_5$
$\mathcal{M}^{SB}$	✓			✓	✓	78.6	–	30.8	22.4	–	49.6
	✓	✓	✓	✓	✓	79.2	88.0	28.8	21.3	–	47.9
$\mathcal{M}^{MB}$	✓			✓	✓	77.7	–	40.4	28.4	–	47.9
	✓	✓	✓	✓	✓	78.2	87.9	39.7	28.1	–	46.7
Baseline						77.4	88.2	46.9	29.9	–	48.7

Multi-Dataset Learning

	Training						Evaluation					
	Market			MPII	LIP		Market		MPII	LIP		
	Tripl.	Clas.	Attr.	Pose	Pose	Seg.	ReID mAP	Attr. acc	Pose PCKh	Pose PCKh	Segmentation mIoU	Segmentation mIoU$_5$
$\mathcal{M}^{SB}$	✓			✓	✓	✓	78.0	–	86.8	74.3	49.9	71.8
	✓	✓	✓	✓	✓	✓	78.3	87.1	86.7	73.8	49.6	71.6
$\mathcal{M}^{MB}$	✓			✓	✓	✓	77.9	–	86.9	75.0	48.5	71.6
	✓	✓	✓	✓	✓	✓	—— out of GPU memory ——					
$\mathcal{M}^{SB/Split}$	✓	✓	✓	✓	✓	✓	79.1	86.7	86.5	74.4	49.6	71.6
Baselines							77.4	88.2	86.6	73.9	47.8	71.0
SOTA							86.9[5]	89.7[3]	88.5[4]	82.5[2]	54.4[1]	-

Qualitative Results



Given person detections, we can perform all tasks simultaneously with 50 detections/s.

Findings and Conclusions

- GroupNorm > BatchNorm for multi-dataset training.
- Using more training data is beneficial.
- Synergy effects between tasks:
  - ReID & Part Segmentation
  - ReID & Attribute
  - Pose & Part Segmentation

Acknowledgements

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