

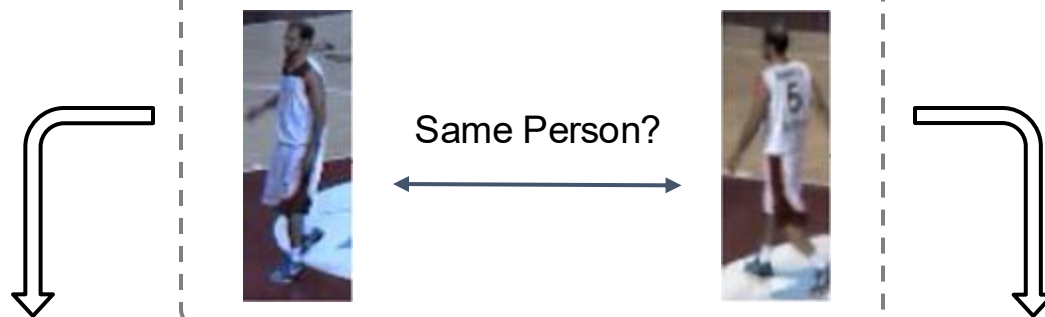
Person Re-Identification and its Application to Multi-Object Tracking

Vladimir Somers, Christophe De Vleeschouwer, Alexandre Alahi.

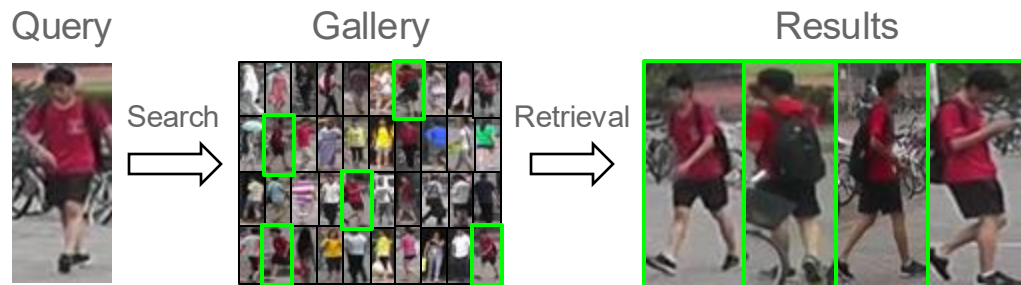
Sportradar - UCL - EPFL

Objective & applications

Person Re-Identification (ReID)



Retrieval

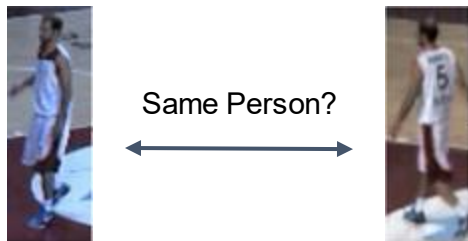


Tracking (MOT)

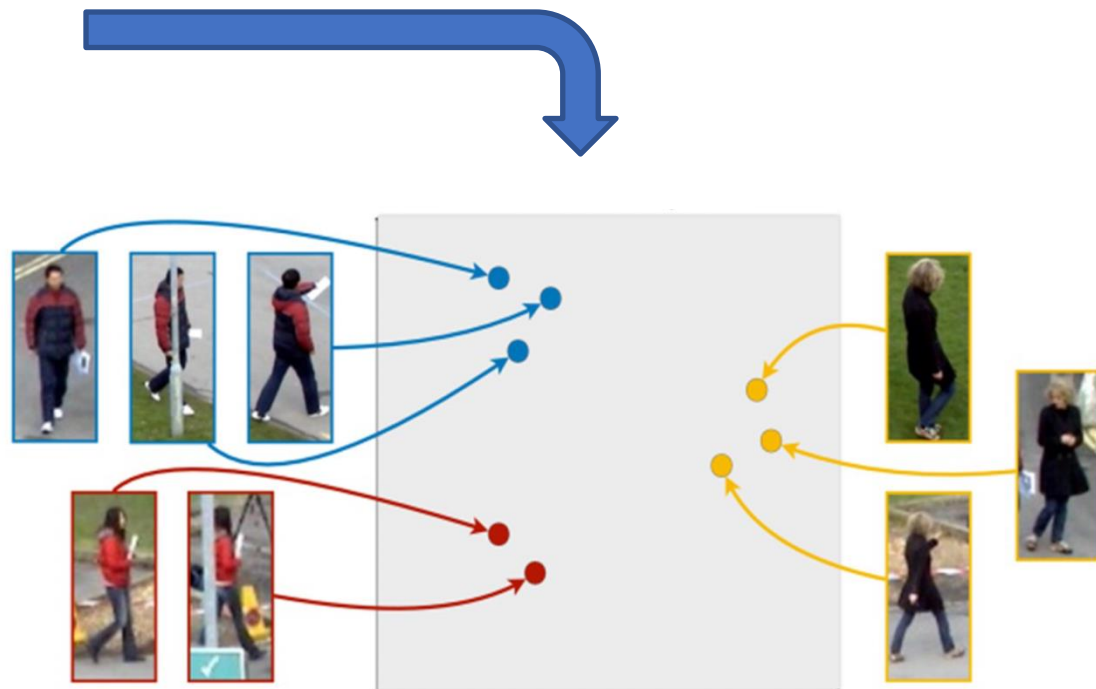


Problem Statement

Person Re-Identification (ReID)



Build a feature/embedding space
in which ReID becomes trivial

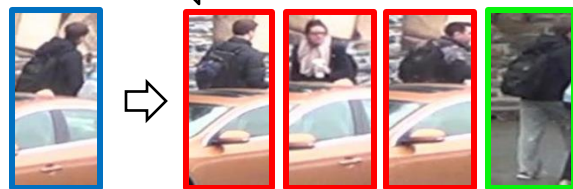


Core contributions : overview

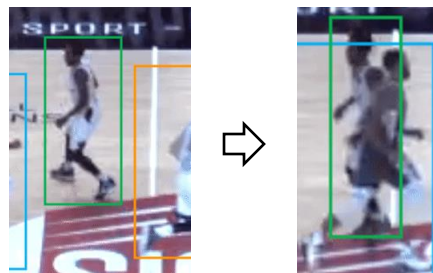
1. Make ReID robust to occlusions

Query

Retrieval Result

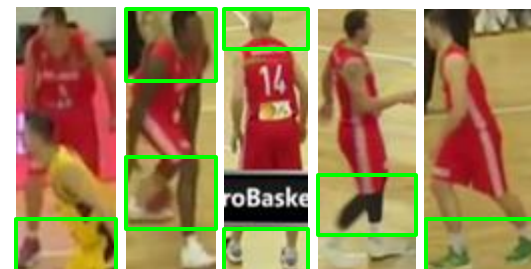


Occlusion vs Retrieval



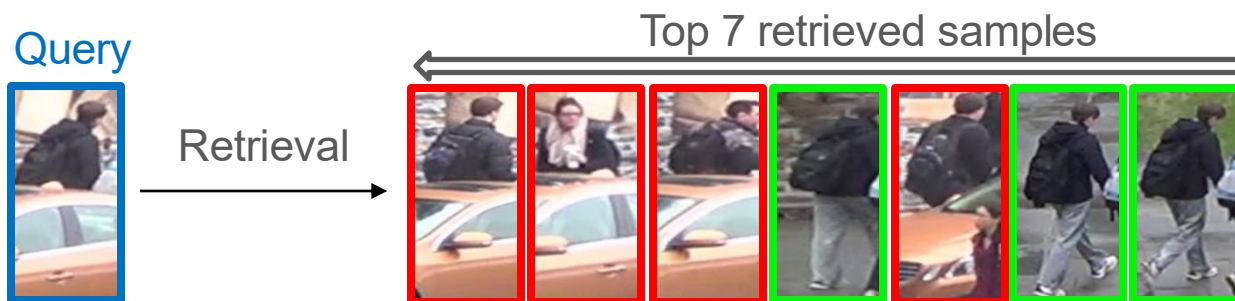
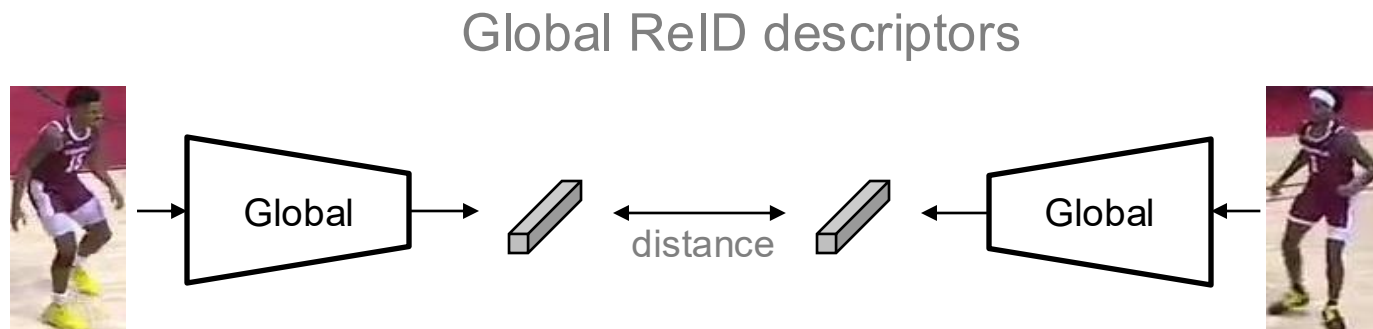
Occlusion vs Tracking

2. ReID ☐ Tracking



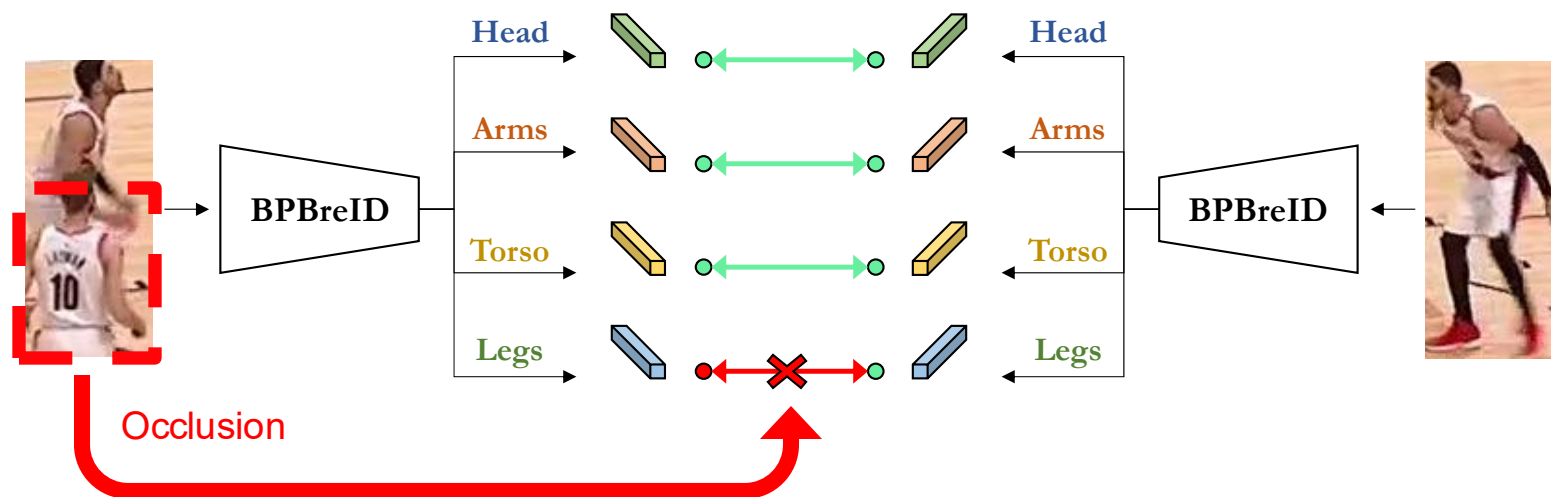
Need Context-Aware Processing

ReID limitation in presence of occlusions



Our solution to occlusions : Body Part-Based ReID

Part-based ReID method



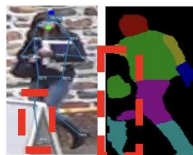
✓ **Part-to-part matching:** Compare only mutually visible parts

BBPReID challenges

Training part-based methods is **challenging**:

Challenge 1

✗ ReID datasets do not provide **human parsing** labels



Information from **external model** is inaccurate

Challenge 2

✗ Parts **can not** simply inherit from ID labels.

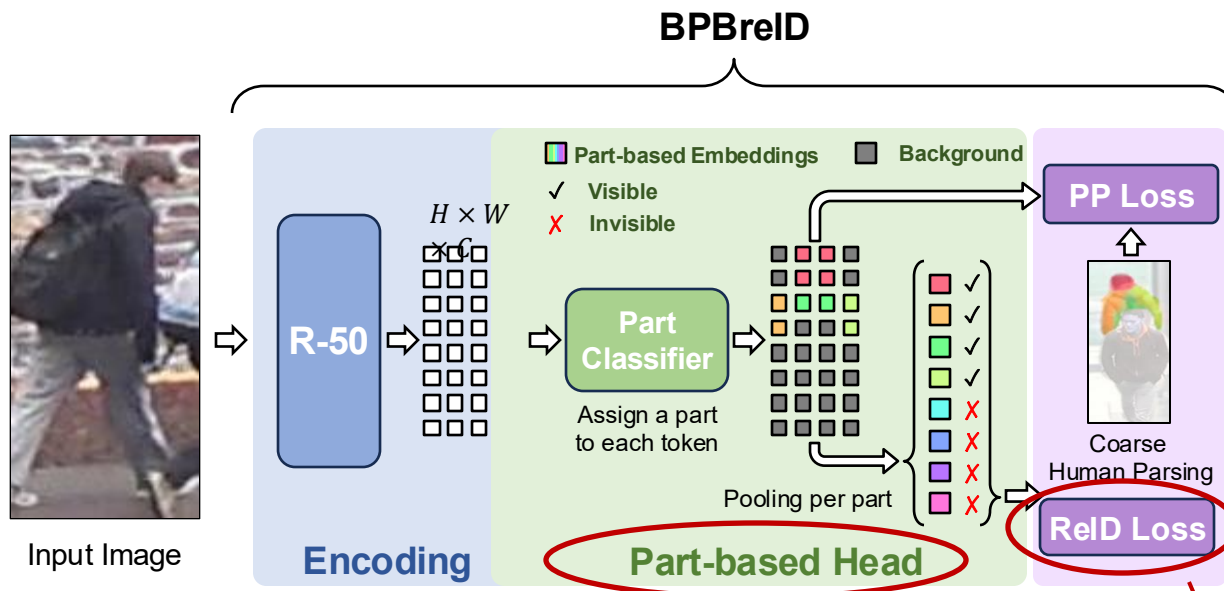


Some parts might
be **occluded**



Some parts are
non-discriminative

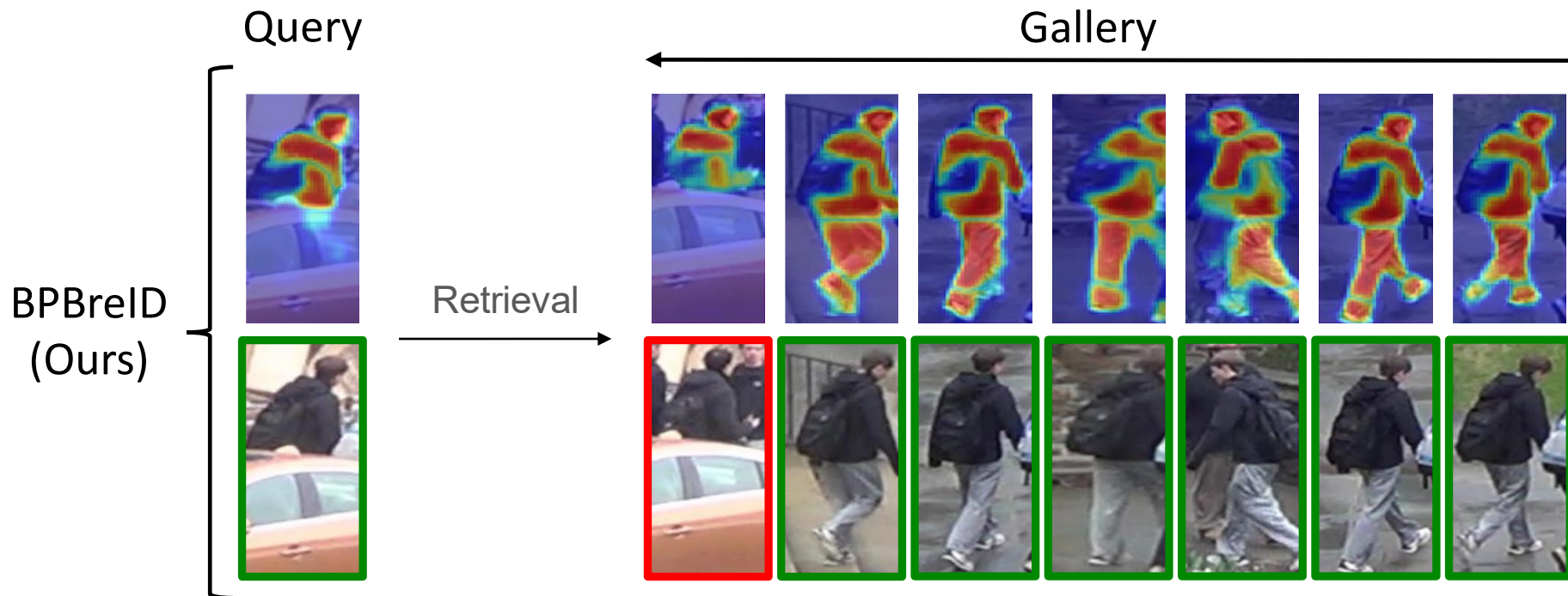
BPBreID Architecture



Contribution 1:
Part-based embeddings and visibility scores
from human parsing labels.

Contribution 2:
Robust to occlusions and
non-discriminative parts.

Results



Remaining Issue



Occlusions from objects

Target



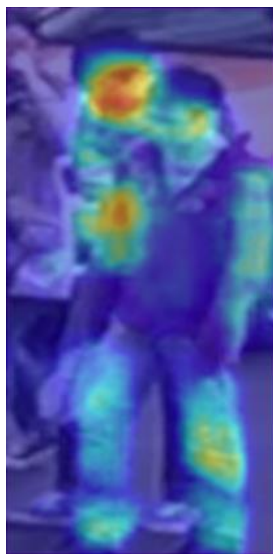
Occluder

✗ Occlusions from other persons

Remaining Issue

Multi-Person Ambiguity (MPA)

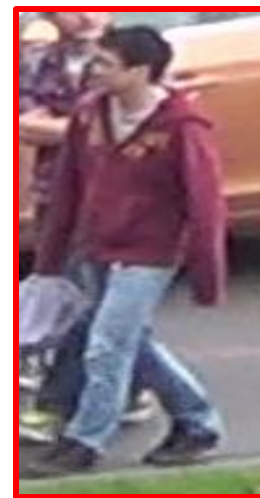
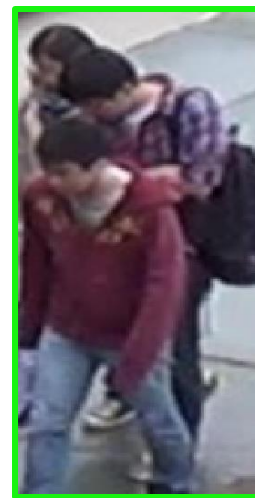
Target



Retrieval



Incorrect ranking



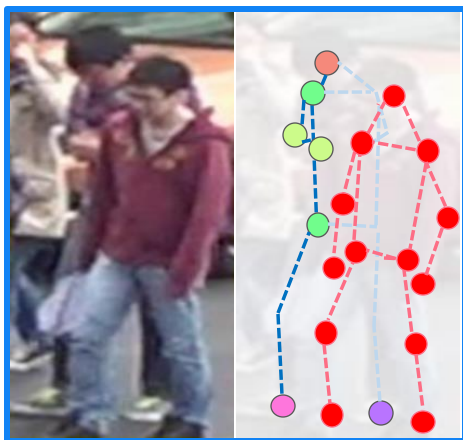
Occluder

Our solution to address Multi-Person Ambiguity

Keypoint Prompts!

Query

Image + Prompt



Attention



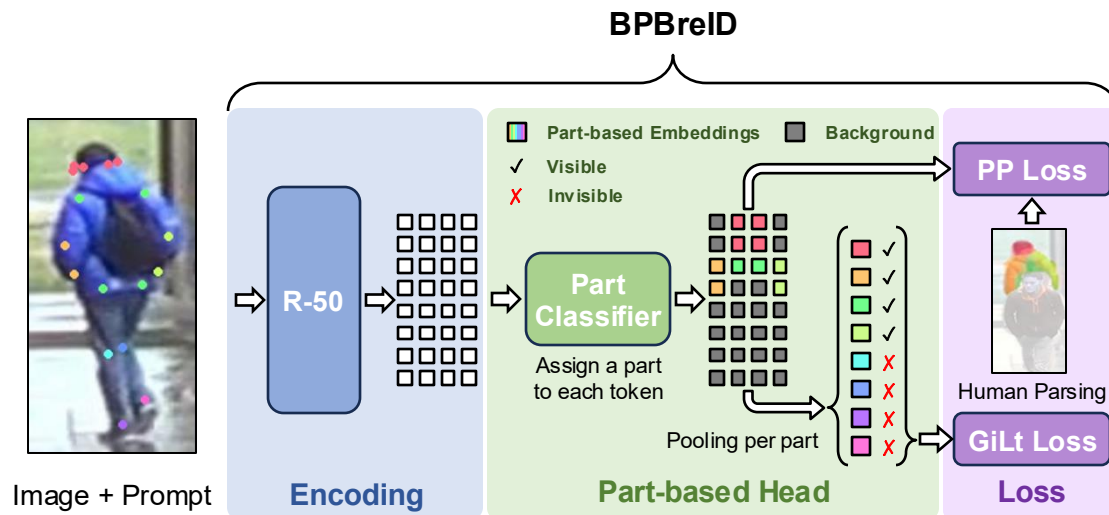
Retrieval



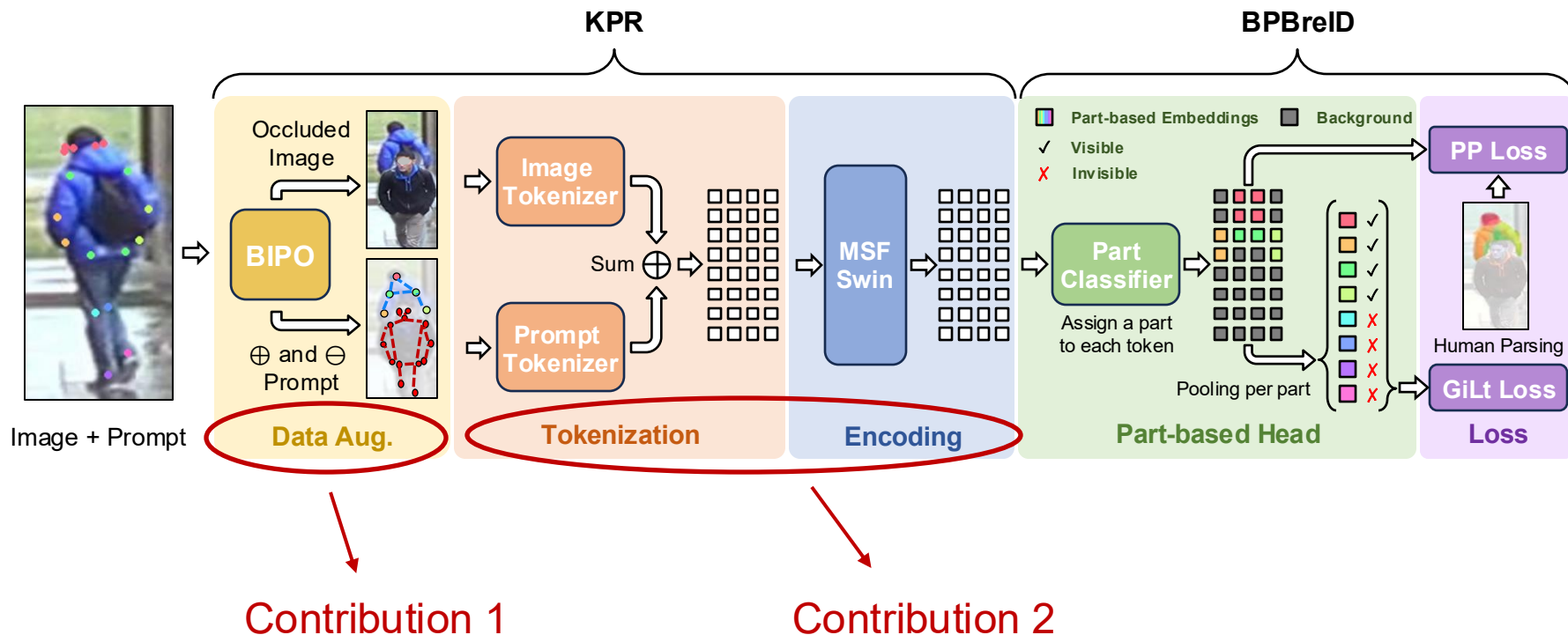
Correct ranking



KPR: Keypoint Promptable Re-Identification

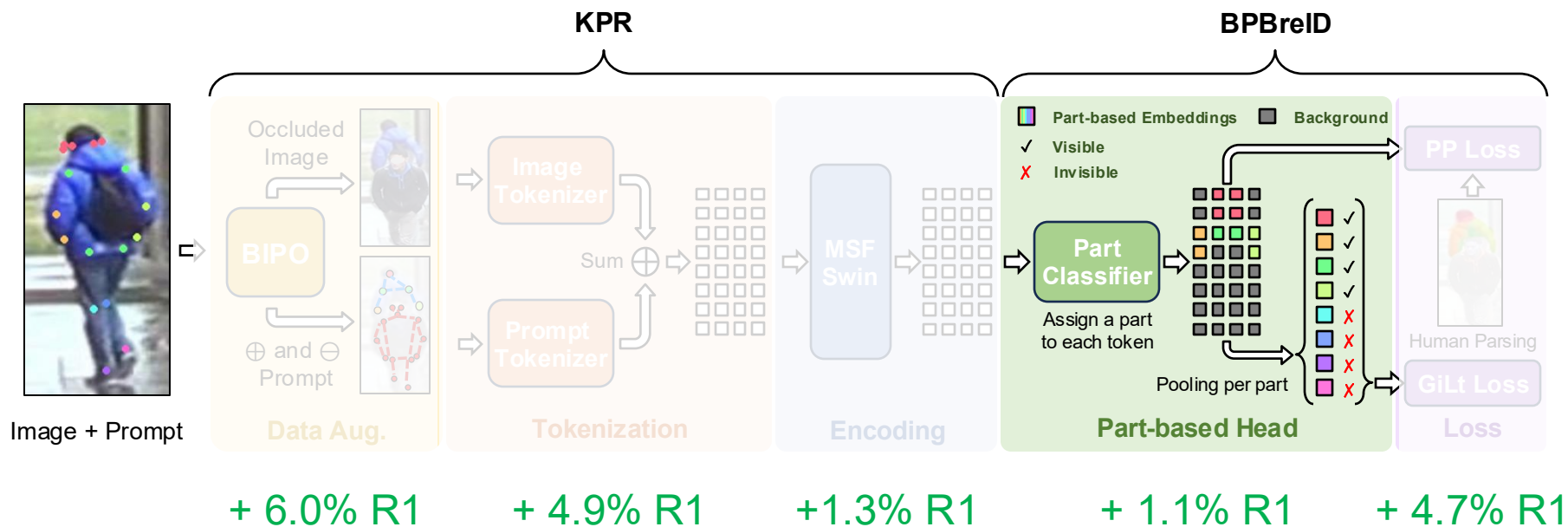


KPR: Keypoint Promptable Re-Identification



Ablation Studies

- Baseline: **61.8% Rank-1**
- KPR + BPBreID: **79.8% Rank-1 (+18%)**

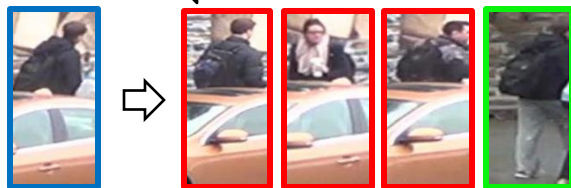


Core contributions : overview

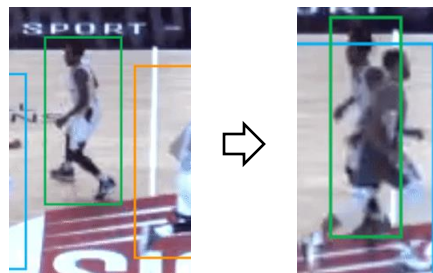
1. Make ReID robust against occlusions

Query

Retrieval Result

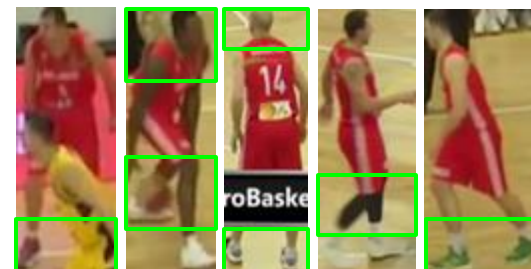


Occlusion vs Retrieval



Occlusion vs Tracking

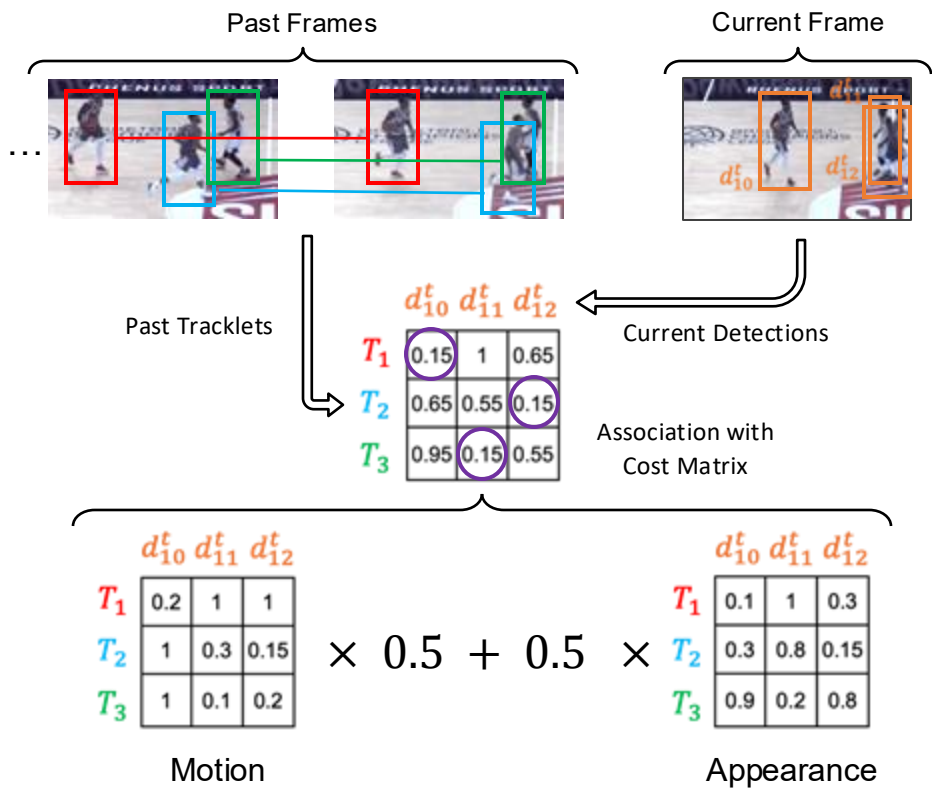
2. ReID Tracking



Need Context-Aware Processing

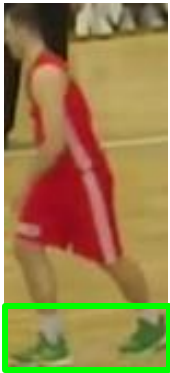
Motivation

Need for Context-Aware Feature Fusion



Need for Group-Aware Re-Identification

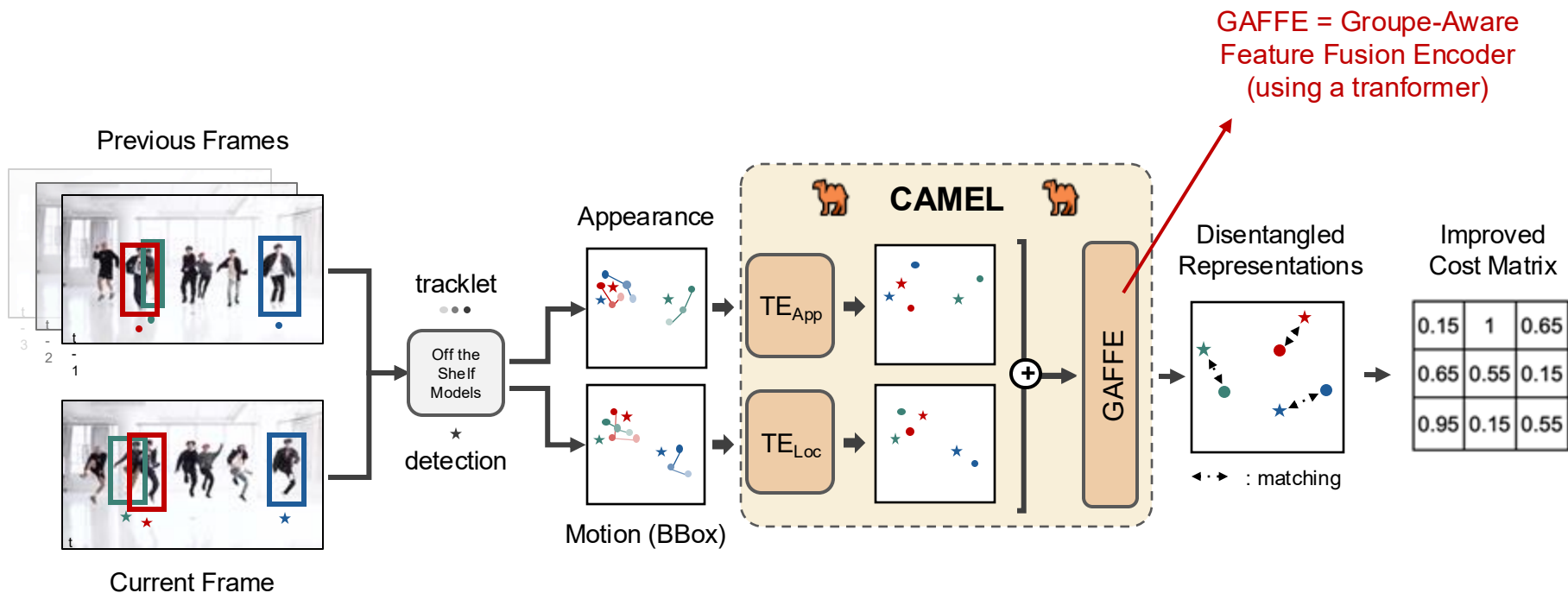
Which features are discriminative?



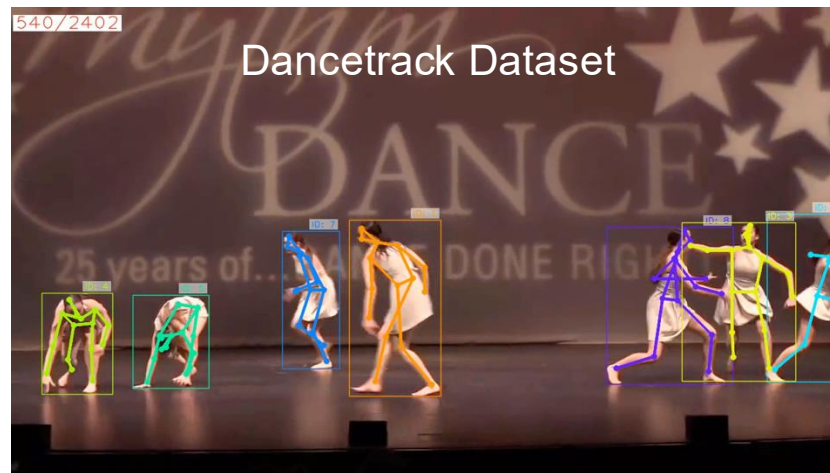
⇒ It depends on the group!



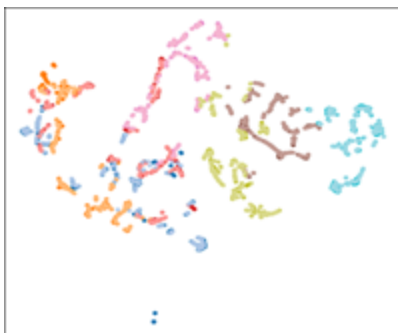
CAMELTrack : Context-Aware Multi-Cue ExpLoitation



Results



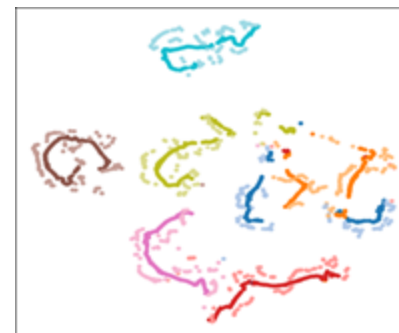
Motion



Appearance



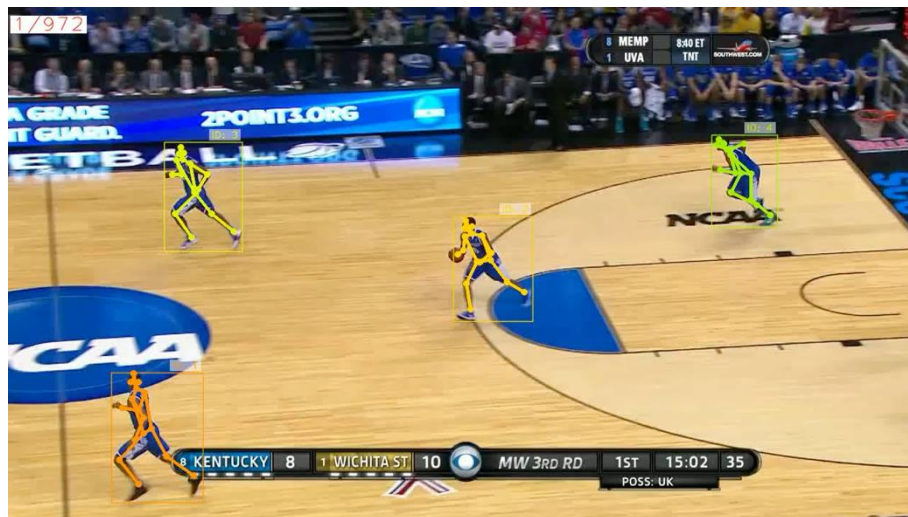
CAMEL



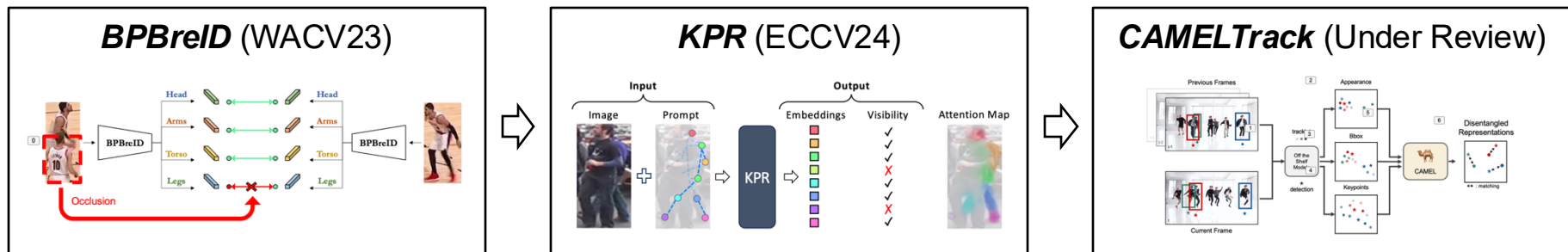
Performance

On SportsMOT:

- +6.1% HOTA vs **baseline**
- +3.2% HOTA vs SotA **SORT-based heuristic** method
- +8.5% HOTA vs SotA **end-to-end (E2E) learned** method



Presentation Overview



arXiv : <https://arxiv.org/abs/2505.01257>

GitHub : <https://github.com/TrackingLaboratory/CAMELTrack>;
<https://github.com/TrackingLaboratory/tracklab>

Full Paper List

[illegible]

Multi-view 3D Human Pose Estimation

Seyed Abolfazl Ghasemzadeh and Christophe De Vleeschouwer

Goal

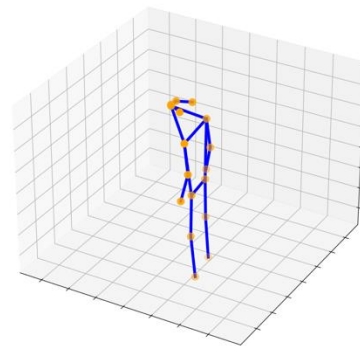
Multi-view Images



Multi-view 3D
Pose Estimator

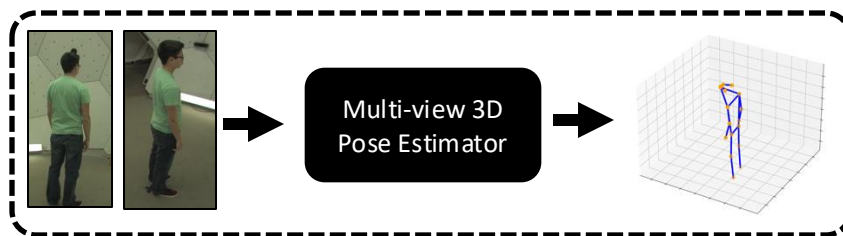


3D Pose
in absolute
world referential



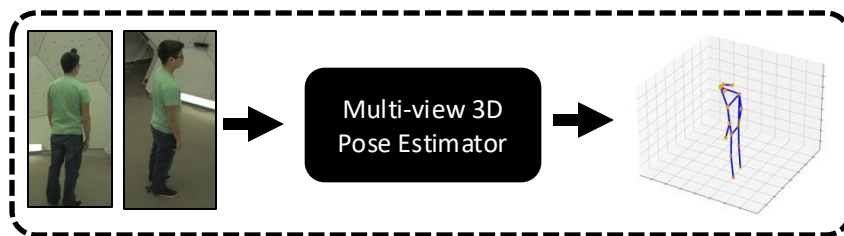
SOTA

SOTA: In-the-lab Images → 3D Pose



Challenges

SOTA: In-the-lab Images → 3D Pose



Requires multi-view images + 3D GT

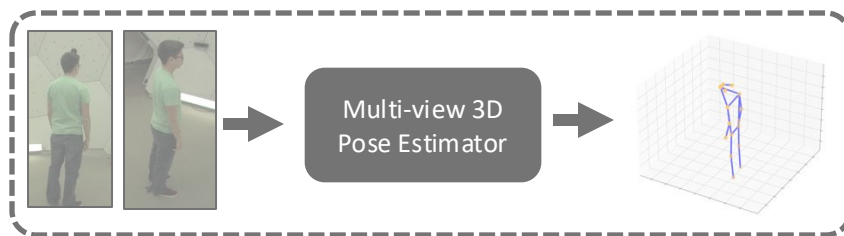
Model is specific to
acquisition set-up
(scene & cameras).



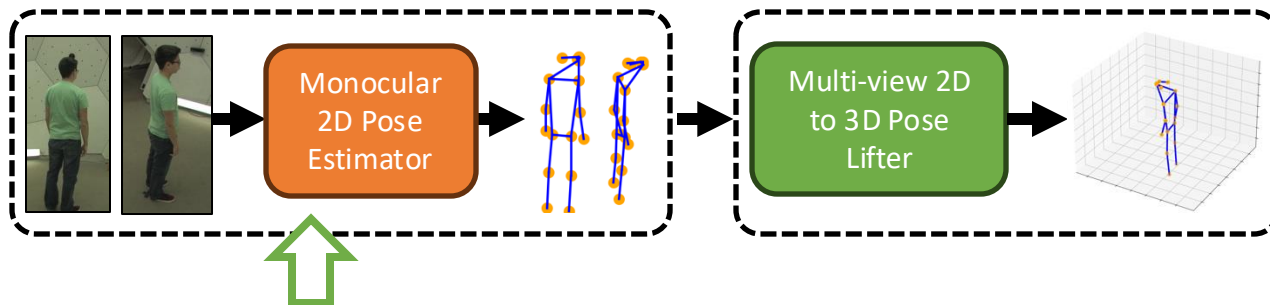
Impractical
deployment.

Our Approach

SOTA: In-the-lab Images $\rightarrow$ 3D Pose

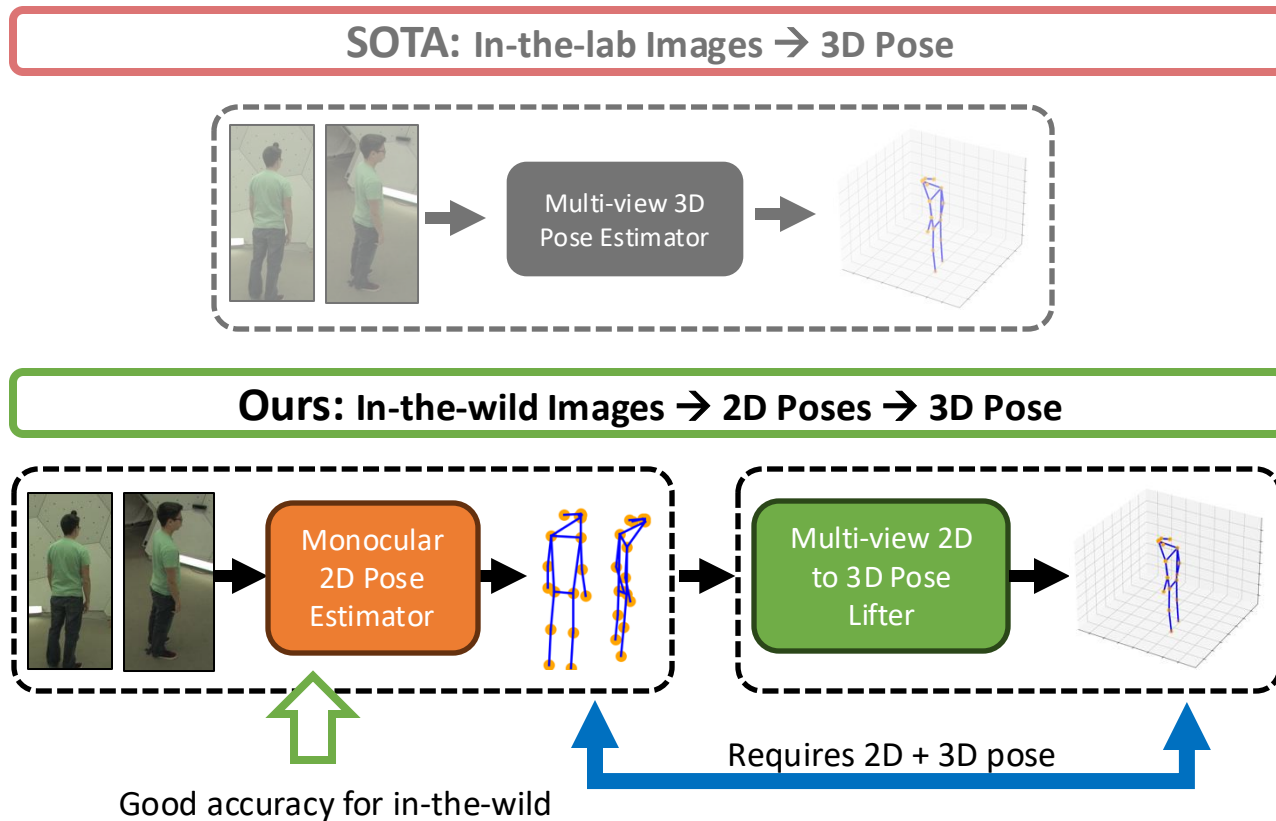


Ours: In-the-wild Images $\rightarrow$ 2D Poses $\rightarrow$ 3D Pose

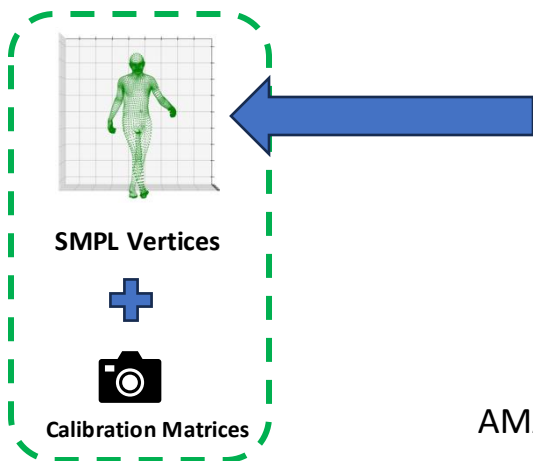


Good accuracy in-the-wild

Our Approach

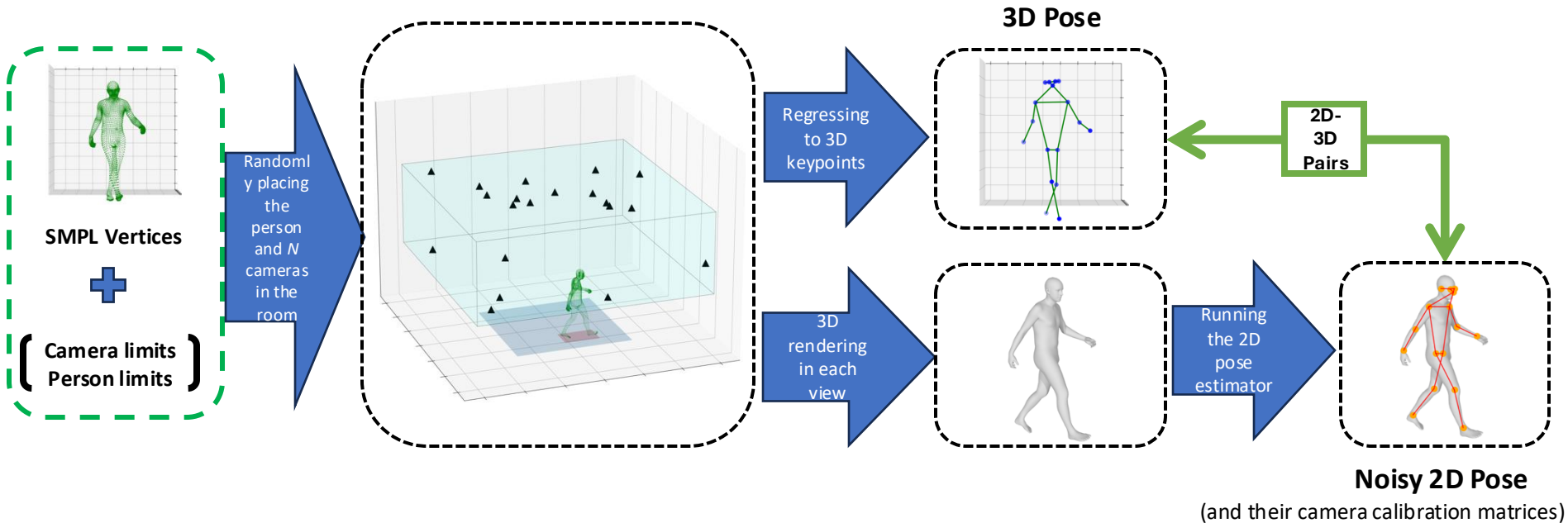


3D Dataset Generator



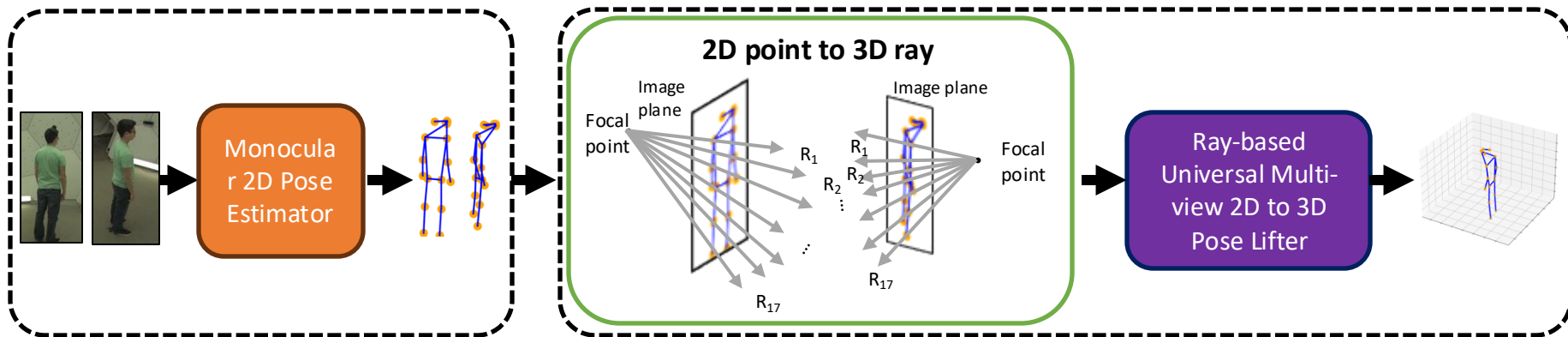
AMASS: Archive of Motion Capture as Surface Shapes, ICCV 2019.

Data generated for arbitrary camera parameters



Model agnostic to camera parameters: 3D rays to represent 2D keypoints.

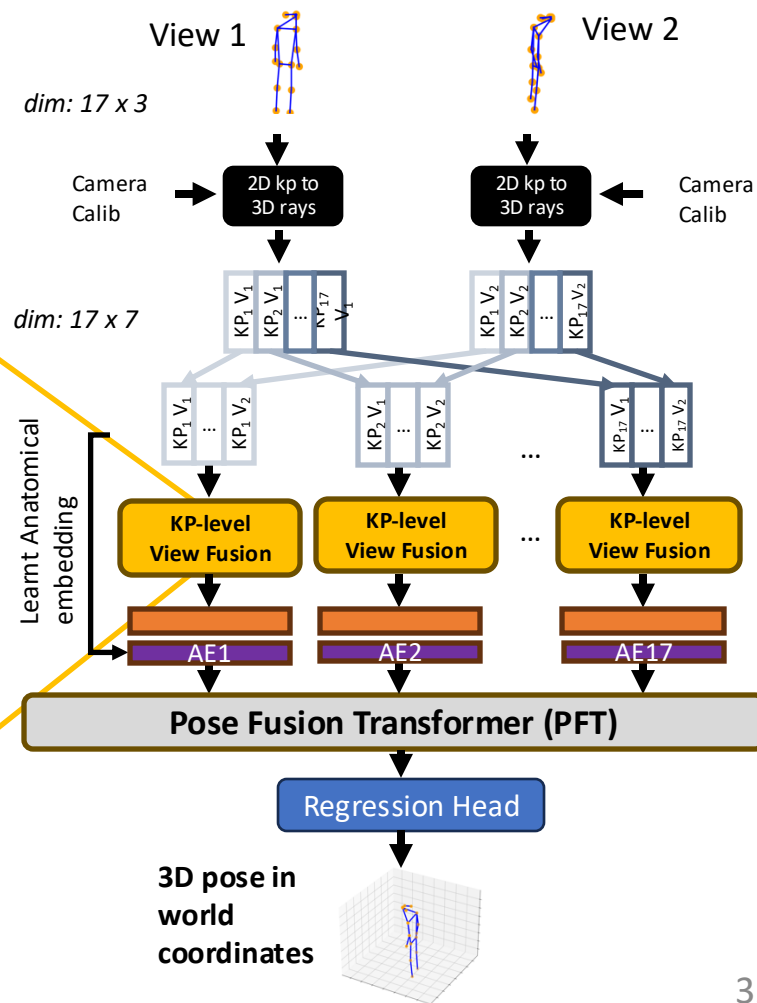
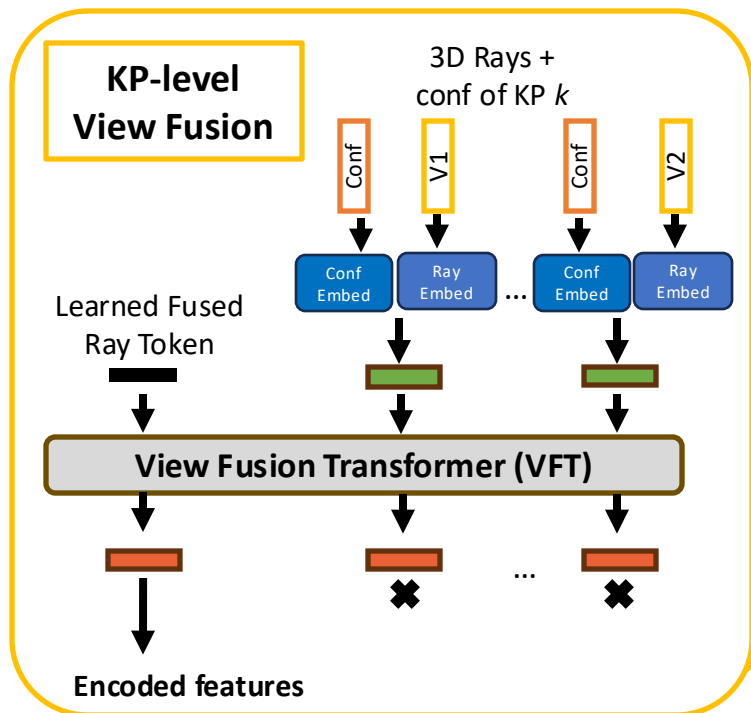
In-the-wild Images $\rightarrow$ 2D Poses $\rightarrow$ **3D Rays** $\rightarrow$ 3D Pose



Stage 1: Off-the-shelf 2D pose estimation on each view

Stage 2: Our Universal Multi-view 2D to 3D pose lifter

Transformer-based architecture



Results

On Human3.6M

Method	# Views	↓ MPJPE (mm)
PPT [1]	4	196.2
Triangulation	2	121.2
MPL (ours) Camera specific	2	53.3
MPL (ours) + RCS	2	437.5
RUMPL (ours) Camera agnostic	2	52.5

(3) Submitted to ICCV 2025
"RUMPL"

On CMU

Method	# Views	↓ MPJPE (mm)
Learnable-triangulation [2]	5	130.9
PPT [1]	5	114.2
Triangulation	2	43.0
MPL (ours) Camera specific	2	29.3
MPL (ours) + RCS	2	274.9
RUMPL (ours) Camera agnostic	2	30.8

[1] Ma et al. "PPT: token-pruned pose transformer for monocular and multi-view human pose Estimation," ECCV 2022.

[2] Skakov et al. "Learnable triangulation of human pose," ICCV 2019.

Publications

- **Directly related:**

1. **S. A. Ghasemzadeh**, A. Alahi, and C. D. Vleeschouwer, “RUMPL: Ray-based Transformers for Universal Multi-view 2D to 3D Human Pose Lifting,” in *IEEE International Conference on Computer Vision (ICCV)*, 2025. (Submitted)
2. **S. A. Ghasemzadeh**, A. Alahi, and C. D. Vleeschouwer, “MPL: Lifting 3D Human Pose from Multi-view 2D Poses,” in *Proceedings of the IEEE/CVF European Conference on Computer Vision (ECCV) Workshops*, 2024.
3. **S. A. Ghasemzadeh**, G. V. Zandycke, *et al.*, “Deepsportlab: A Unified Framework for Ball Detection, Player Instance Segmentation and Pose Estimation in Team Sports Scenes” in *Proceedings of the British Machine Vision Conference (BMVC)*, 2021.

- **Remotely related:**

1. E. Lacroix, *et al.*, “Walking towards the future – Exploring OpenTUG's validity in automatic walking activity analyses and the relationship with cognition in vestibular patients,” in *Behavior Research Methods*, 2025. (Submitted)
2. A. Maiorca, *et al.*, “Impact of 3D Cartesian Positions and Occlusion on Self-Avatar Full-Body Animation in Virtual Reality,” in *IEEE International Conference on Artificial Intelligence and eXtended and Virtual Reality*, 2025.
3. V. Somers, *et al.*, “SoccerNet game state reconstruction: End-to-end athlete tracking and identification on a minimap,” in *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR) Workshops*, 2024.
4. A. Maiorca, *et al.*, “Self-Avatar Animation in Virtual Reality: Impact of Motion Signals Artifacts on the Full-Body Pose Reconstruction,” in arXiv, 2024.

Thanks for your attention!

