An Entropy Model for Loiterer Retrieval across Multiple Surveillance Cameras

Maguell L.T.L. Sandifort[†, ‡], Jianquan Liu[‡], Shoji Nishimura[‡], Wolfgang Hürst[†]
[†]Utrecht University, the Netherlands
[‡]Biometrics Research Laboratories, NEC Corporation, Japan

ICMR 2018
\Orchestrating a brighter world
NEC

We introduce an entropy model for loiterer retrieval. The resulting entropy serves as a measure for the amount of movement patterns. This entropy is then combined with reappearance and duration to compute a loitering score.

➢ Motivation

- Discover loitering behavior in a large area
  - Loitering behavior can be spread across multiple cameras
- Ease the task of the human operator
  - Keeping track of multiple cameras is difficult
- Reduce false alarms
  - Duration is not enough
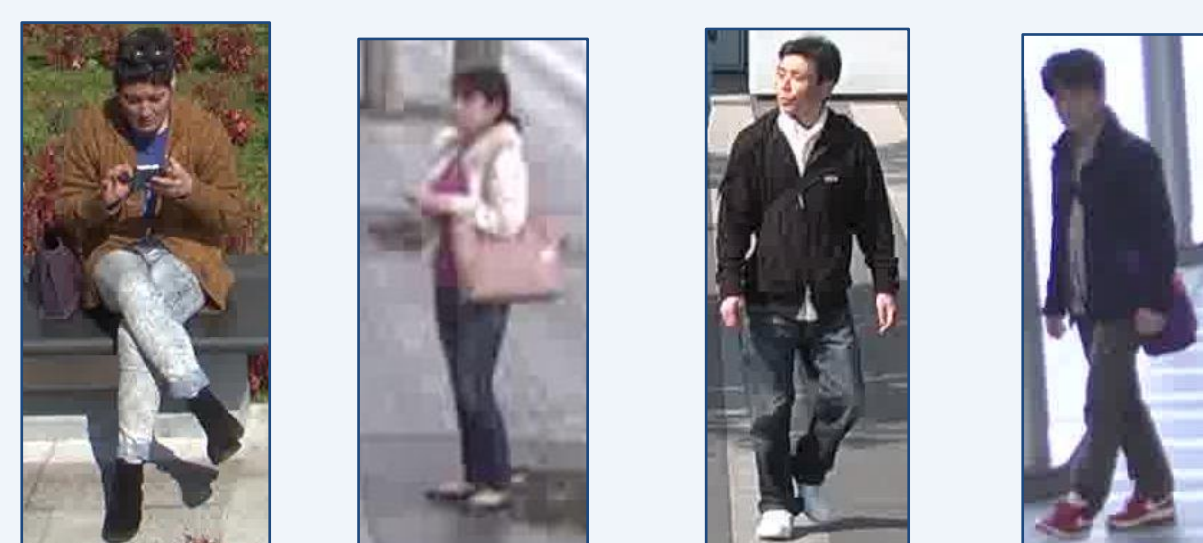
Who is loitering? Who is just waiting?

➢ Approach

- Use three measures to capture different parts of loitering behavior

  Entropy Model
  - ☐ Abstraction of movement across multiple cameras
  - ☐ Discover loitering behavior across multiple cameras
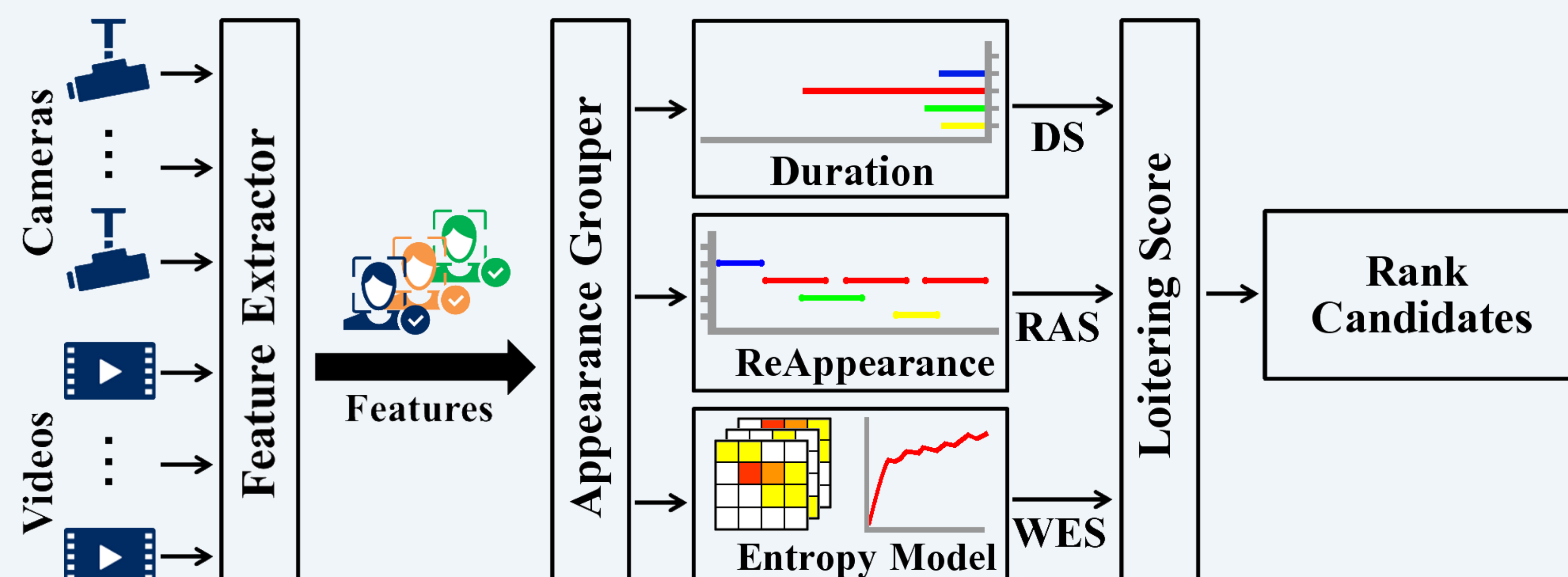
  ReAppearance
  - ☐ Leave and re-enter the same area
  - ☐ Discover loitering behavior in a large area

  Duration
  - ☐ Discover abnormal duration of stay in the area

- Provide an ordered list of candidates
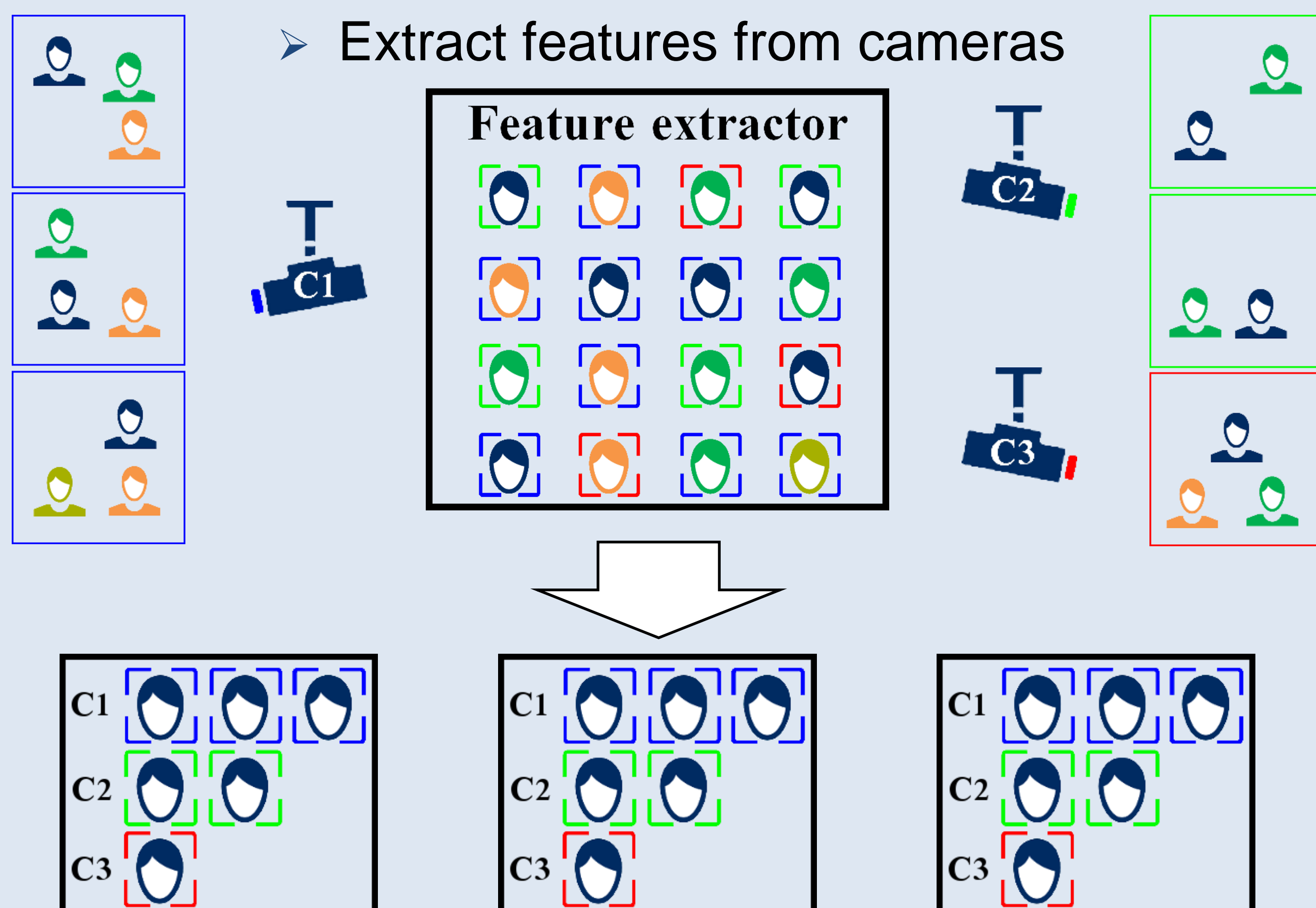 - Let human operator make the final call

➢ Overview

Rank Candidates

➢ Weight scores and add them up

Rank	Face	Scores $\alpha*RAS + \beta*WES + \gamma*DS$
1		$1.81 + 1.93 + 4.12 = 7.86$
2		$0.50 + 2.19 + 3.30 = 5.99$
3		$0.50 + 2.22 + 2.99 = 5.71$

Group Features
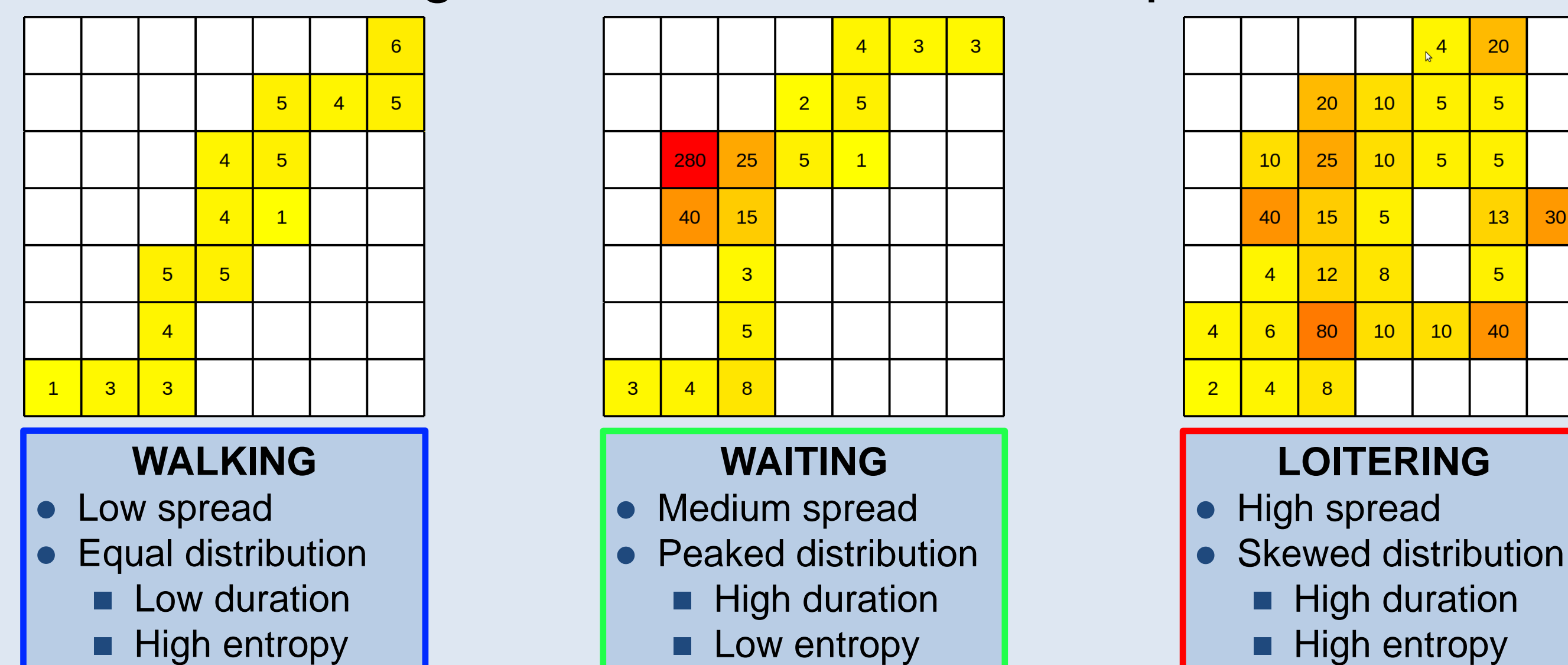
➢ Extract features from cameras

Feature extractor

➢ Group by person and camera

Entropy

➢ Map position of features to the heatmap

get position → map to heatmap → compute entropy
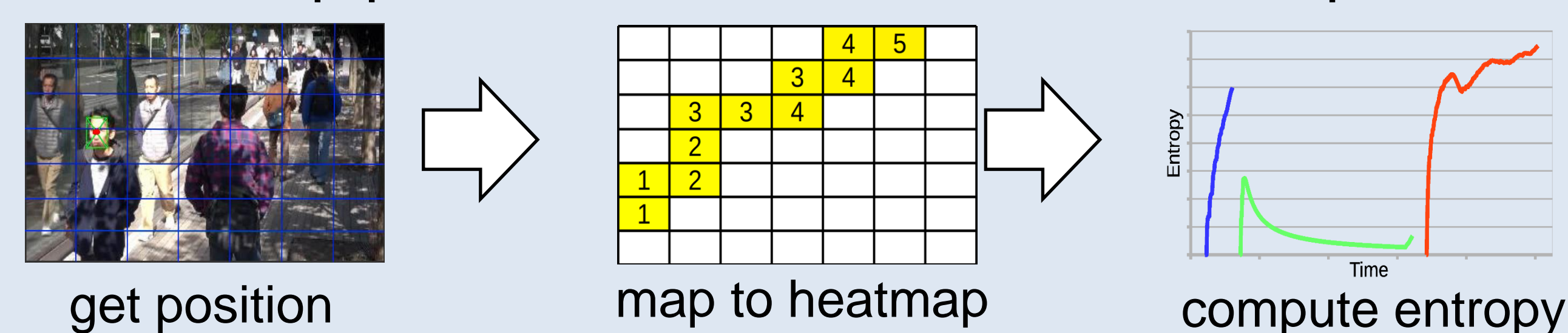
➢ Distinguish different movement patterns

WALKING
- Low spread
- Equal distribution
  - Low duration
  - High entropy

WAITING
- Medium spread
- Peaked distribution
  - High duration
  - Low entropy

LOITERING
- High spread
- Skewed distribution
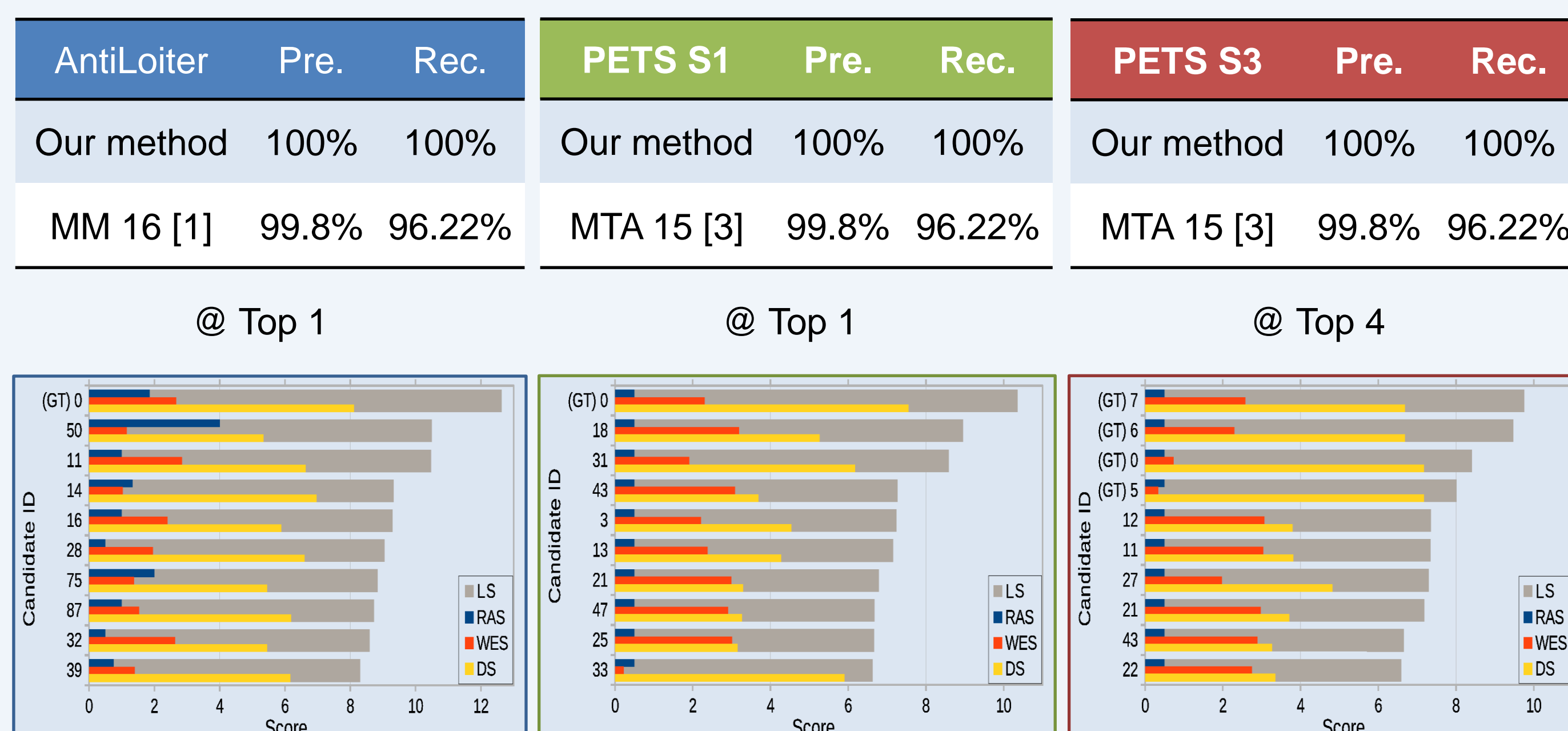 - High duration
  - High entropy

➢ Evaluation

Datasets
- AntiLoiter [1]
  - 1 ground truth
- PETS 2007 [2]
  - S1: 1 ground truth
  - S3: 4 ground truths

Compared to
- MM 16 [1]
- MTA 15 [3]

AntiLoiter	Pre.	Rec.
Our method	100%	100%
MM 16 [1]	99.8%	96.22%

@ Top 1

PETS S1	Pre.	Rec.
Our method	100%	100%
MTA 15 [3]	99.8%	96.22%

@ Top 1

PETS S3	Pre.	Rec.
Our method	100%	100%
MTA 15 [3]	99.8%	96.22%

@ Top 4

➢ References

[1] Jianquan Liu, Shoji Nishimura, and Takuya Araki. AntiLoiter: A Loitering Discovery System for Longtime Videos across Multiple Surveillance Cameras. In ACM MM 2016.
[2] PETS2007 Dataset: http://www.cvg.reading.ac.uk/PETS2007/data.html.
[3] Yunyoung Nam. Loitering detection using an associating pedestrian tracker in crowded scenes. Multimedia Tools and Appl. 74(9): 2939-2961, 2015.
[4] Maguell L.T.L. Sandifort, Jianquan Liu, Shoji Nishimura, Wolfgang Hürst. VisLoiter+: An Entropy Model-Based Loiterer Retrieval System with User-Friendly Interfaces. In ICMR 2018.