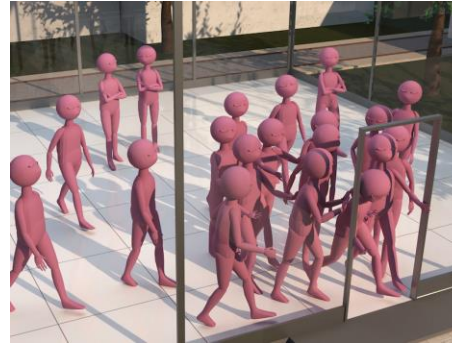INSTITUTE FOR ADVANCED SIMULATION

Civil Safety "IAS-7"

Two Methods for Detecting Pushing Behavior from Videos:
A Psychological Rating System and a Deep Learning-based Approach

29-30 Nov. 2021 I **Ahmed Alia**, Mohammed Maree, David Haensel, Mohcine Chraibi, Helena Lügering, Anna Sieben, **Ezel Üsten**
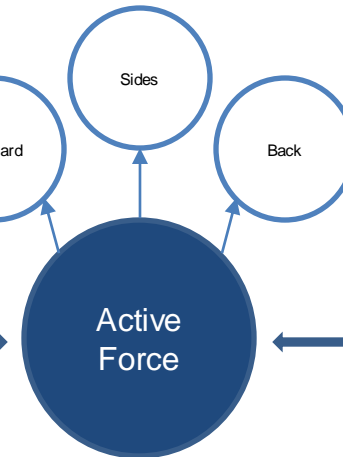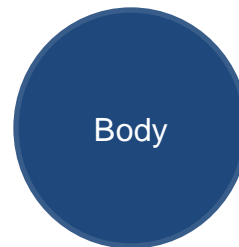
JÜLICH
Forschungszentrum

Crowds, High Density & Pushing

Increased density

Safety issues

Unfairness

Pushing ⟹ Body ⟷ Active Force ⟷ Speed / Acceleration

Forward   Sides   Back

JÜLICH
Forschungszentrum

Detecting Pushing Behavior

Psychological Rating System

Automatic Deep Learning Approach

JÜLICH
Forschungszentrum

Psychology - Method
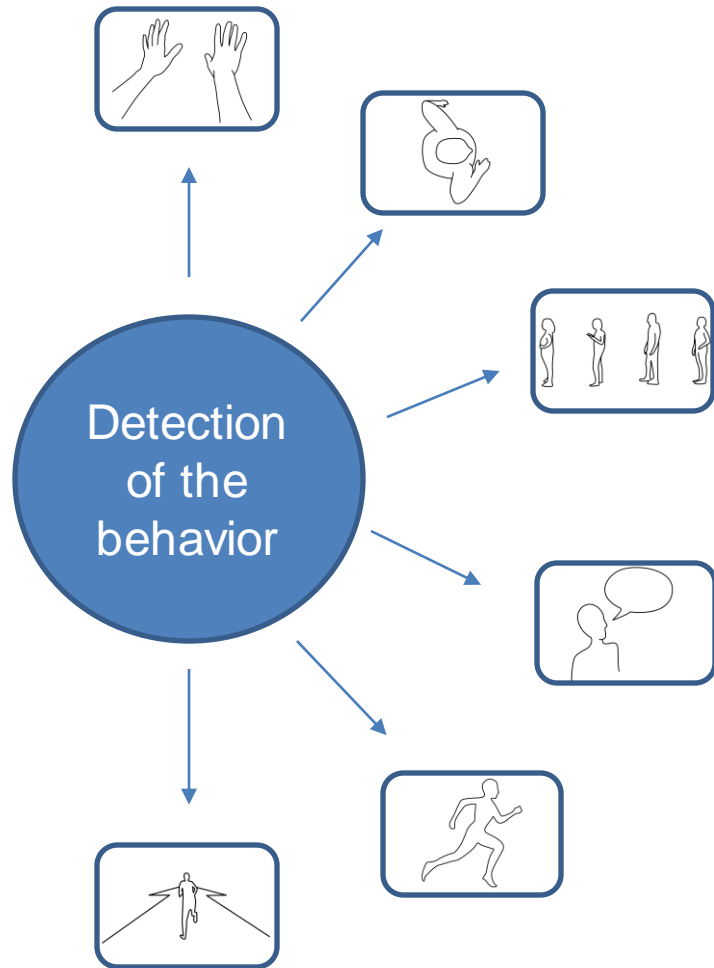
Arms & Hands	- Crossed arms - Dropped arms - Holding barriers - Pulling people - …
Shoulders & Head	- Slow penguin - Fast penguin - Sideway movement - Forward leaning - …
Space	- Having distance - Close body contact - Closing the gaps - Changing lines - …
Interaction	- Chatting with others - Checking the environment - Communicative pushing - Aggressive role playing - …
Speed & Acceleration	- Fast movements - High / low acceleration - Frequent movements - Slow and steady movements - …
Attention	- Focus on reaching the bottleneck - Focus on protection - Checking phone - Searching for gaps - …

Detection of the behavior

JÜLICH
Forschungszentrum

Categories

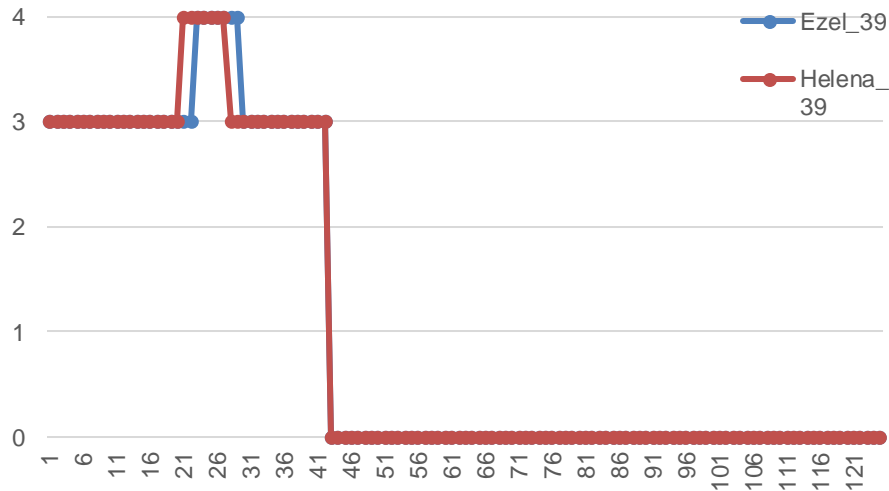**Pushing**

Non-pushing

Results


```
Run MATRIX procedure:

Krippendorff's Alpha Reliability Estimate

            Alpha    LL95%CI    UL95%CI     Units   Observrs      Pairs
Ordinal     .7030      .6736      .7326  2367.0000     2.0000  2367.0000

Probability (q) of failure to achieve an alpha of at least alphamin:
    alphamin          q
     .9000      1.0000
     .8000      1.0000
     .7000       .4056
     .6700       .0138
     .6000       .0000
     .5000       .0000

Number of bootstrap samples:
   10000

Judges used in these computations:
  Ezel      Helena

Examine output for SPSS errors and do not interpret if any are found

------ END MATRIX ------
```
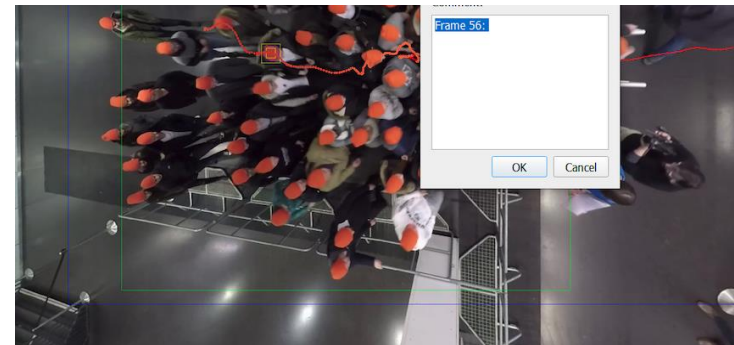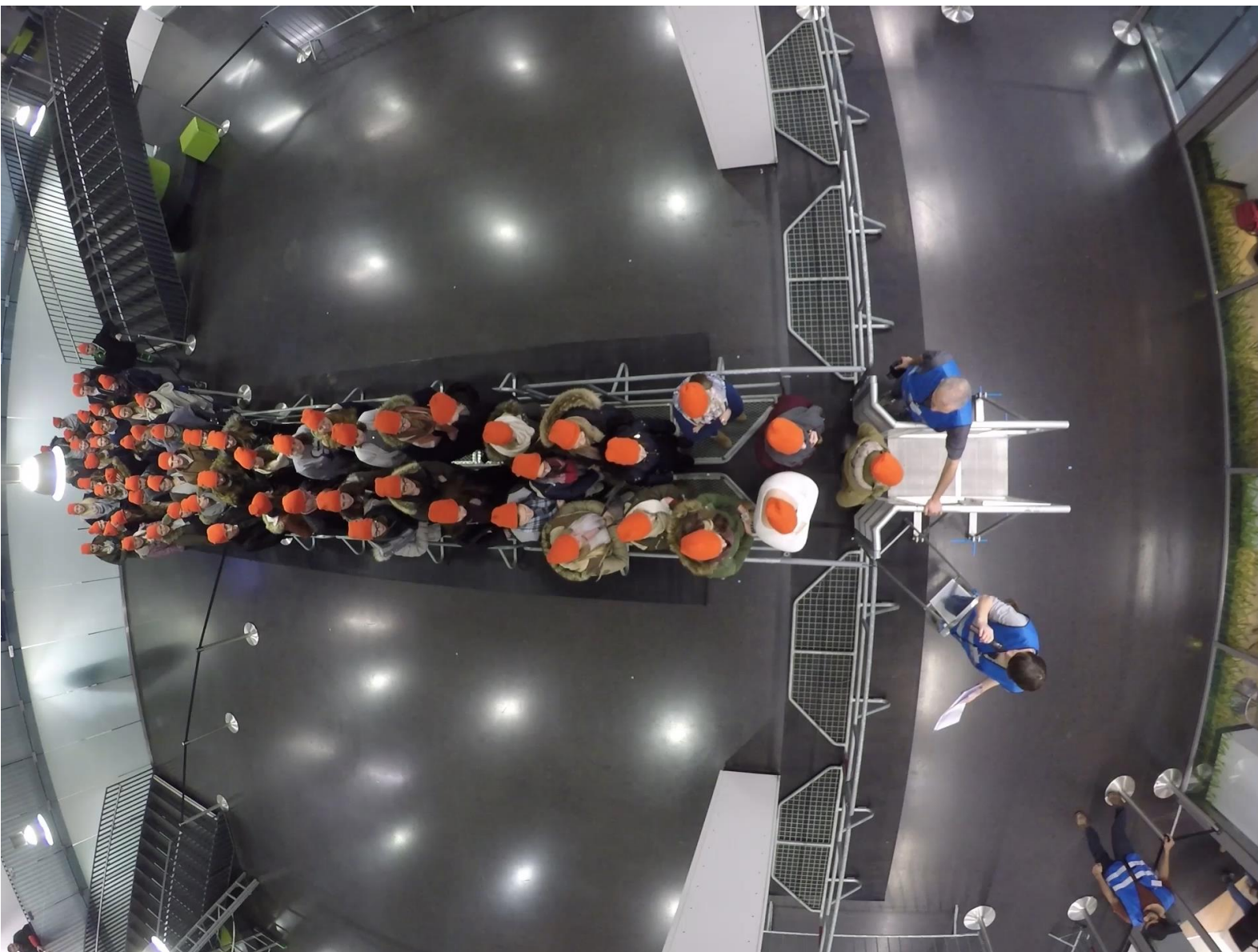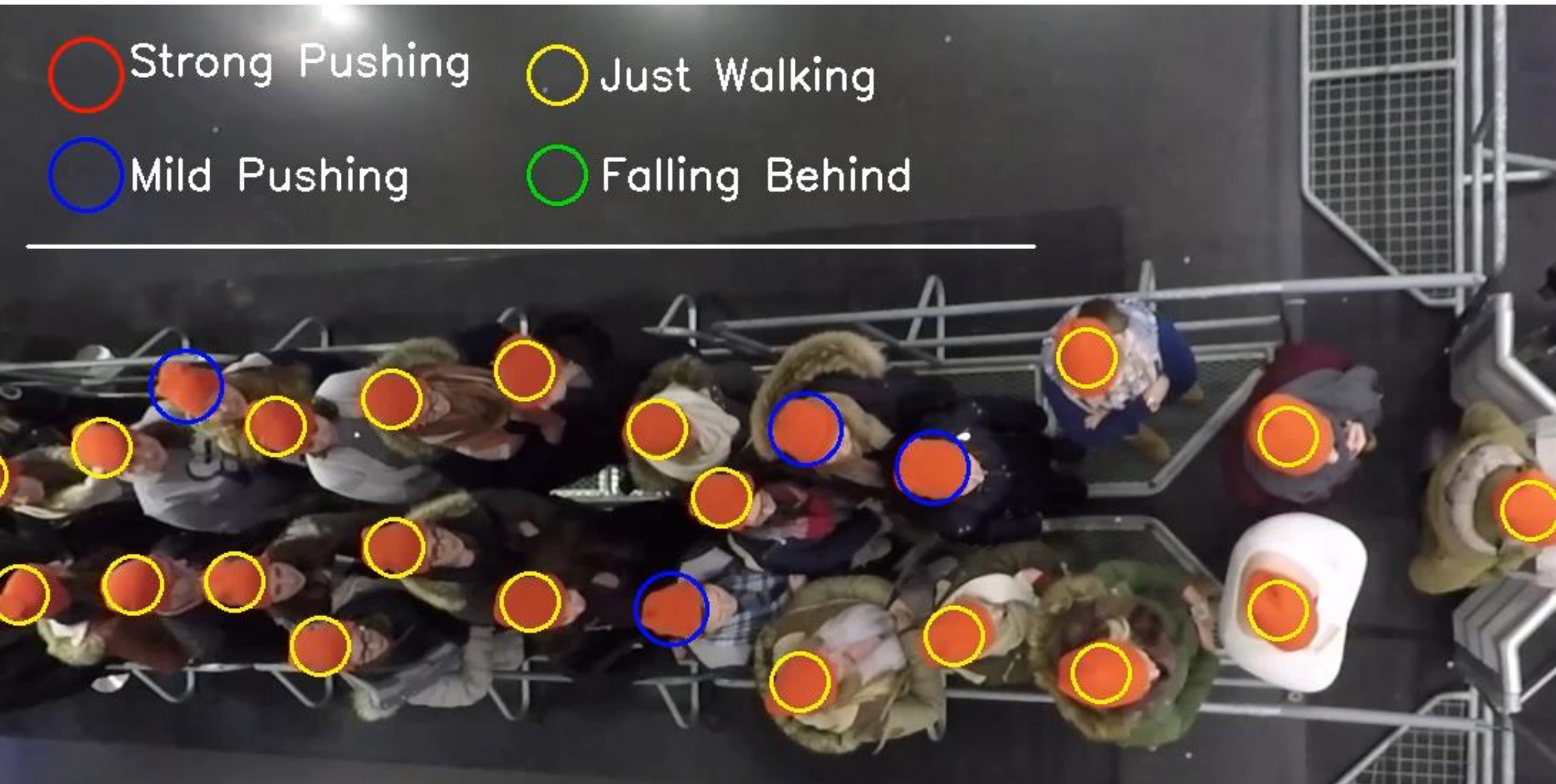
JÜLICH
Forschungszentrum

Automatic Deep Learning Approach for Pushing Behavior Detection in Videos

JÜLICH
Forschungszentrum

Problem

❑ Automatically detecting the video frames that contain pushing behavior in crowded event entrances.

Mild Pushing	Strong Pushing

Pushing behavior

Falling Behind	Just Walking

Non-pushing behavior

JÜLICH
Forschungszentrum

Main Challenges

Automatic approach is a challenging task

High similarity	High variability	Dense crowds

→ They make **feature extraction** and **building a model** difficult.
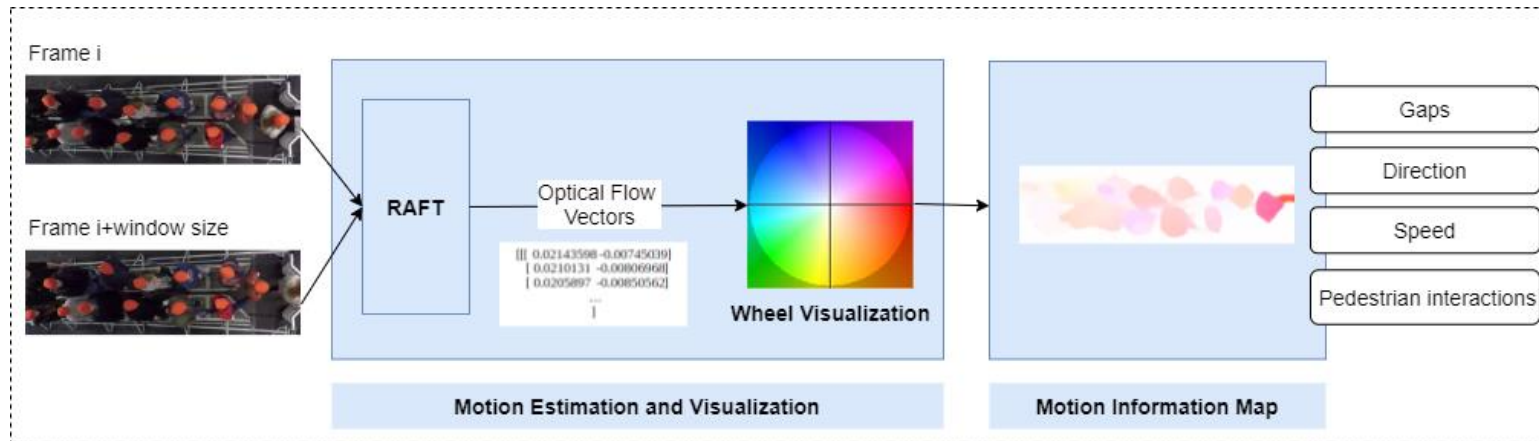
JÜLICH
Forschungszentrum

General Idea of our Approach
Image Classification Problem
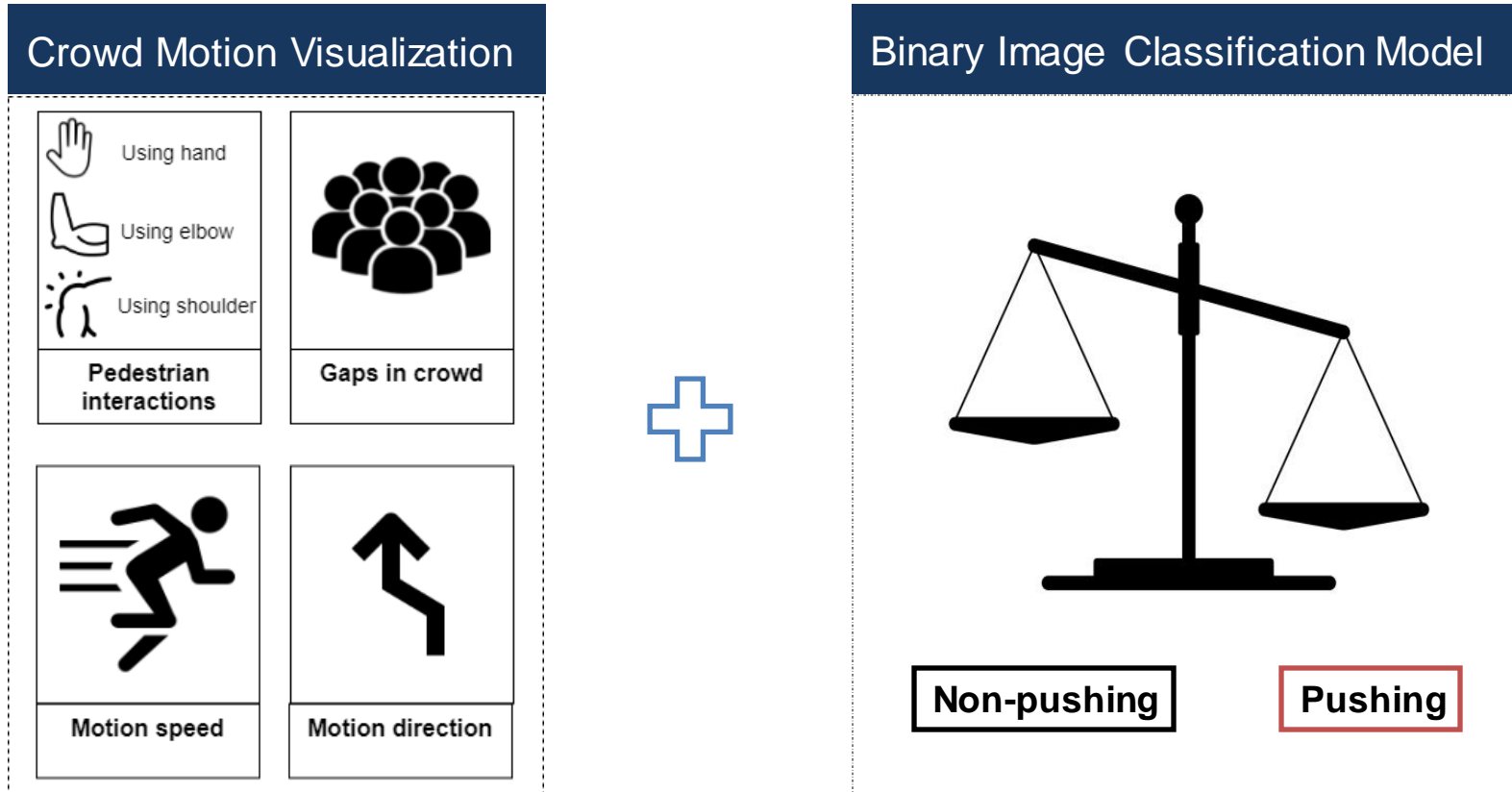
Crowd Motion Estimation and Visualization

❑ **Deep optical flow:** Estimating **per-pixel** motion between video frames.
  ❑ RAFT: Recurrent All-Pairs Field Transforms [1].
  ❑ RAFT is one of the most promising and newest deep optical flow approaches.
❑ Wheel visualization method [2].

[1] Teed, Zachary, and Jia Deng. "Raft: Recurrent all-pairs field transforms for optical flow." European conference on computer vision. Springer, Cham, 2020.
[2] Baker, Simon, et al. "A database and evaluation methodology for optical flow." *International journal of computer vision* 92.1 (2011): 1-31.
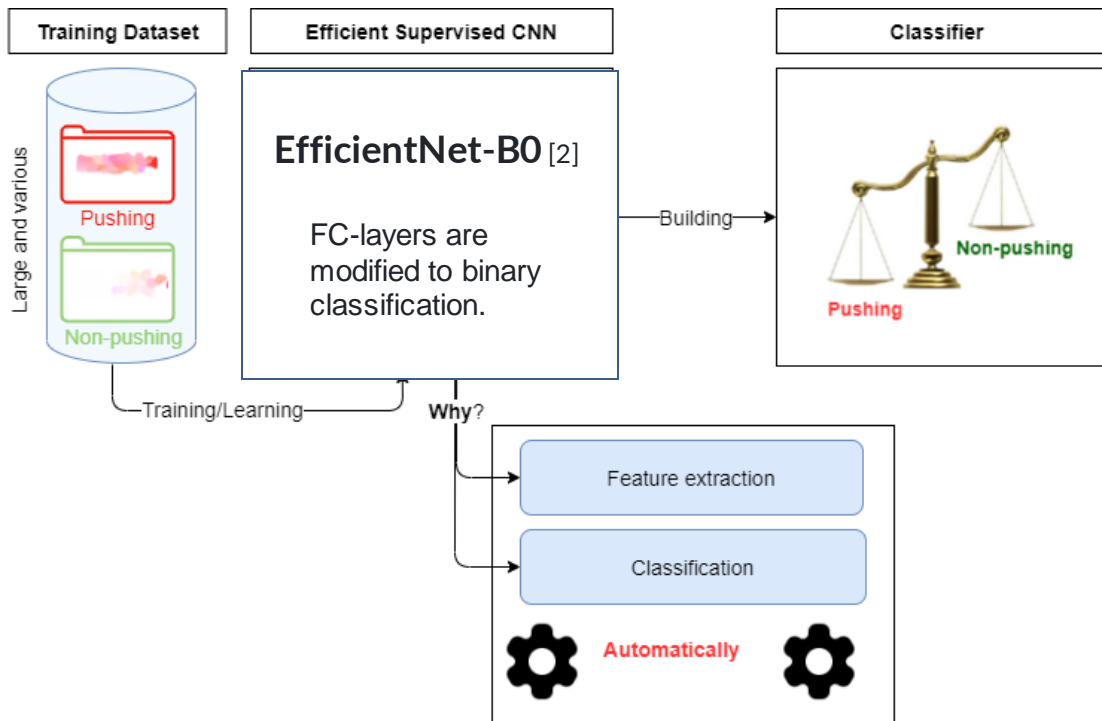
How to build a binary image classification model?
Convolutional Neural Network (CNN)

❑ CNN is a class of artificial neural network, but with convolutional and pooling layers, most commonly applied to analyze visual imagery [1].

Labeled videos are rare.

[1] Valueva, Maria V., et al. "Application of the residue number system to reduce hardware costs of the convolutional neural network implementation." Mathematics and Computers in Simulation 177 (2020): 232-243.
[2] Tan, Mingxing, and Quoc Le. "Efficientnet: Rethinking model scaling for convolutional neural networks." International Conference on Machine Learning. PMLR, 2019.

JÜLICH
Forschungszentrum

Dataset Preparation

1 Data Source [1]

Video name:100_c_12_h-
Duration: 23s
Participants: 24
Frame rate: 25

Video name:110_c_12_h0
Duration: 53s
Participants: 63
Frame rate: 25

2 Manually Rating

○ Strong Pushing   ○ Just Walking
○ Mild Pushing   ○ Falling Behind

3 Motion Information Maps [12 frames]

165 samples

4 Labeled Dataset

Pushing, 117 samples

Non-pushing, 48 samples

5 Training and Test Datasets

85 Pushing
36 Non-pushing
Training Dataset, 70%

32
12
Test Dataset, 30%

Datasets

RAFT   Farneback [2]

[1] Pedestrian Dynamics Data Archive hosted by the FZJ, https://ped.fz-juelich.de/db, DOI: 10.34735/ped.2018.1.

[2] Gunnar Farnebäck. Two-frame motion estimation based on polynomial expansion. In Scandinavian conference on Image analysis, pages 363–370. Springer, 2003
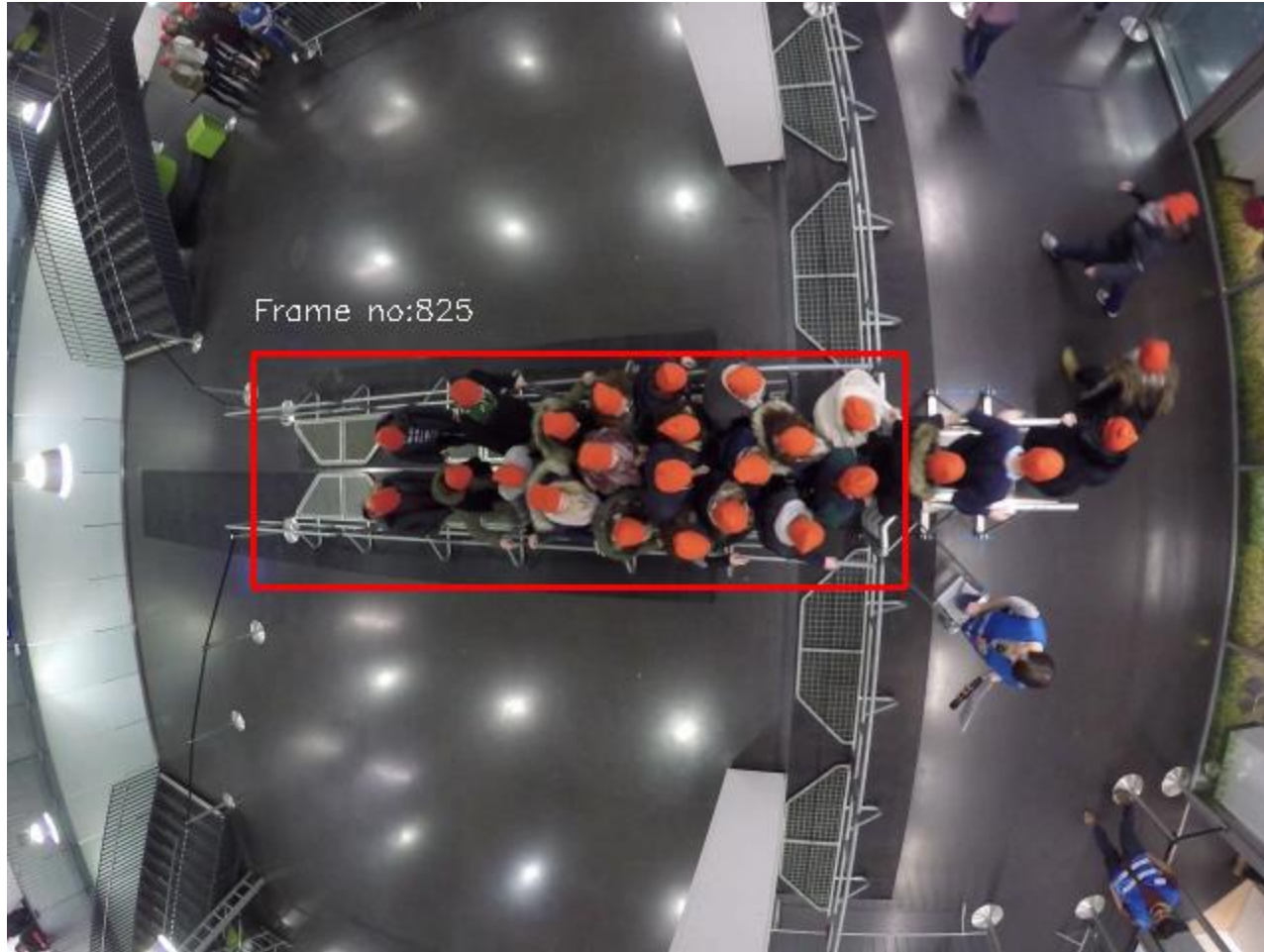
JÜLICH
Forschungszentrum

Results

EfficientNet-B0 with RAFT

1. MobileNet with RAFT
2. ResNet50 with RAFT
3. EfficientNet-B0 with Farneback
4. MobileNet with Farneback
5. ResNet50 with Farneback
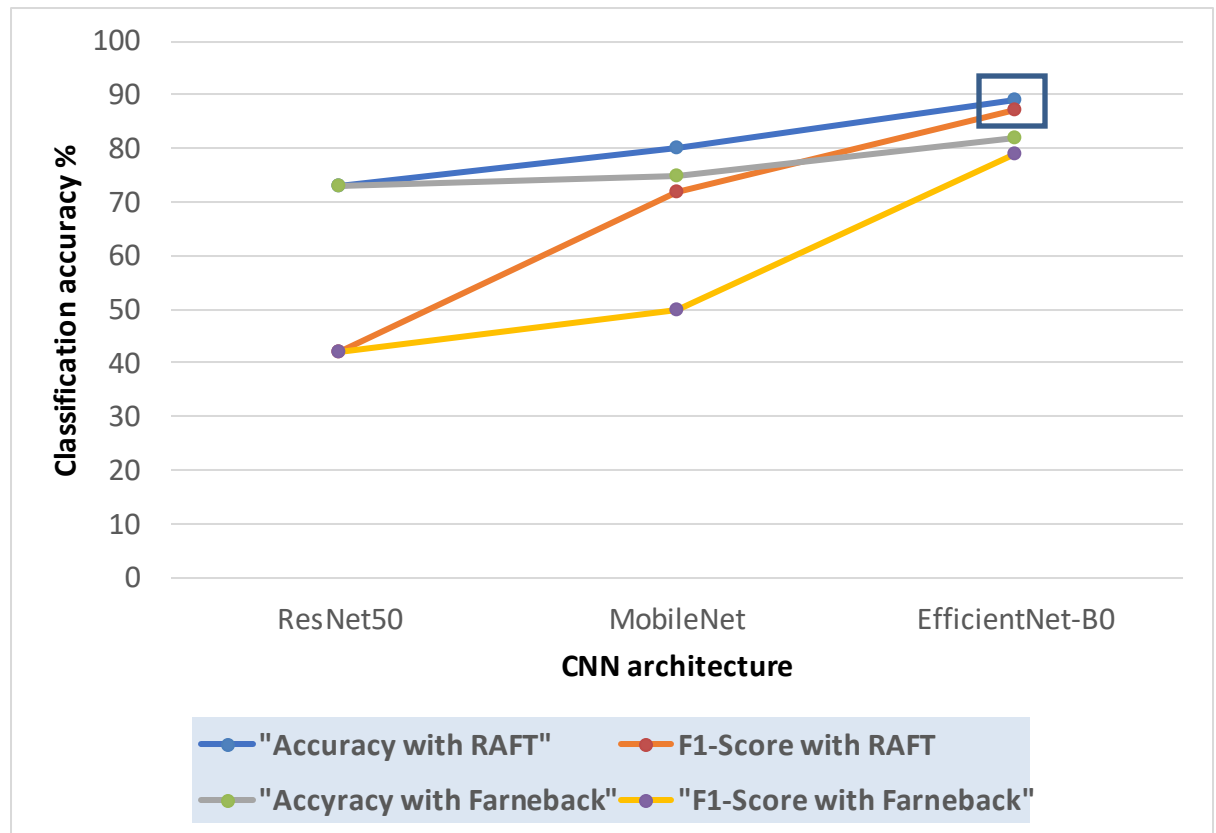
Results

Output

Outlook

Psychological rating system

- ❑ Gaining the perspective of investigating the crowd heterogeneously.
  - ▪ Investigating the behavior clusters.
  - ▪ Investigating behavior/motivation propagation.
  - ▪ Investigating behavior/motivation localizations.
- ❑ Handling real-life data.
- ❑ Understanding why some crowds get a lot denser than others.

Automatic deep learning approach

- ❑ Developing a new methodology to enlarge the labeled dataset using the small number of rated videos.
- ❑ Improving the efficiency of the proposed approach.
  - ▪ Generality.
  - ▪ Accuracy.
  - ▪ Computational time.

JÜLICH
Forschungszentrum

Thank you for your attention

e.uesten@fz-juelich.de
a.alia@fz-juelich.de

JÜLICH
Forschungszentrum