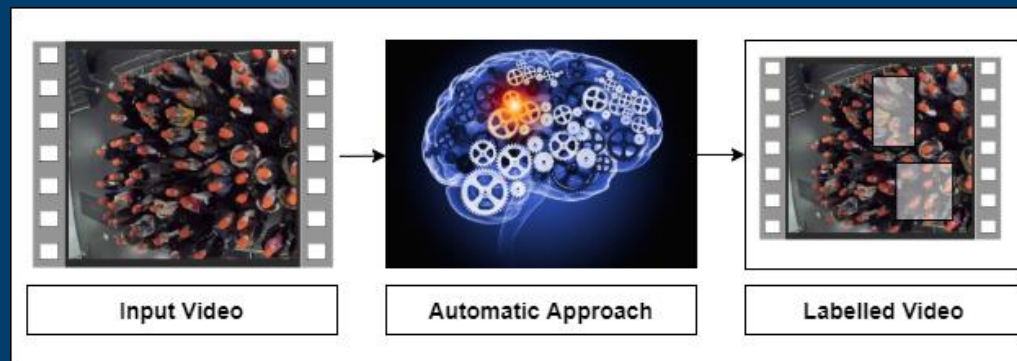


INSTITUTE FOR ADVANCED SIMULATION-7

Pedestrian Dynamics - Modeling

Automatic pushing behavior detection in videos



IAS-7 Ph.D. Workshop
07 Sep. 2021 | AHMED ALIA

Motivation



High Density Crowd



[2]

Unsafe and Uncomfortable

[1] https://ped.fz-juelich.de/da/doku.php?id=start#entrance_2_entry_with_guiding_barriers_corridor_setup

[2] <https://www.newyorker.com/magazine/2011/02/07/crush-point>

Motivation

Pressing Demand→



- ☐ Identifying pushing behavior.
- ☐ Localizing dangerous situations.

Outline

- ❑ The research overall goal.
- ❑ Pushing behavior definition.
- ❑ Main challenges.
- ❑ Overview of our approach.
- ❑ Dataset preparation.
- ❑ Limitation of the solution.
- ❑ Outlook.

In Collaboration with Social Psychology Division



The Overall Goal

- Developing an automatic and accurate approach for

- **Detecting** and
- **Localizing**



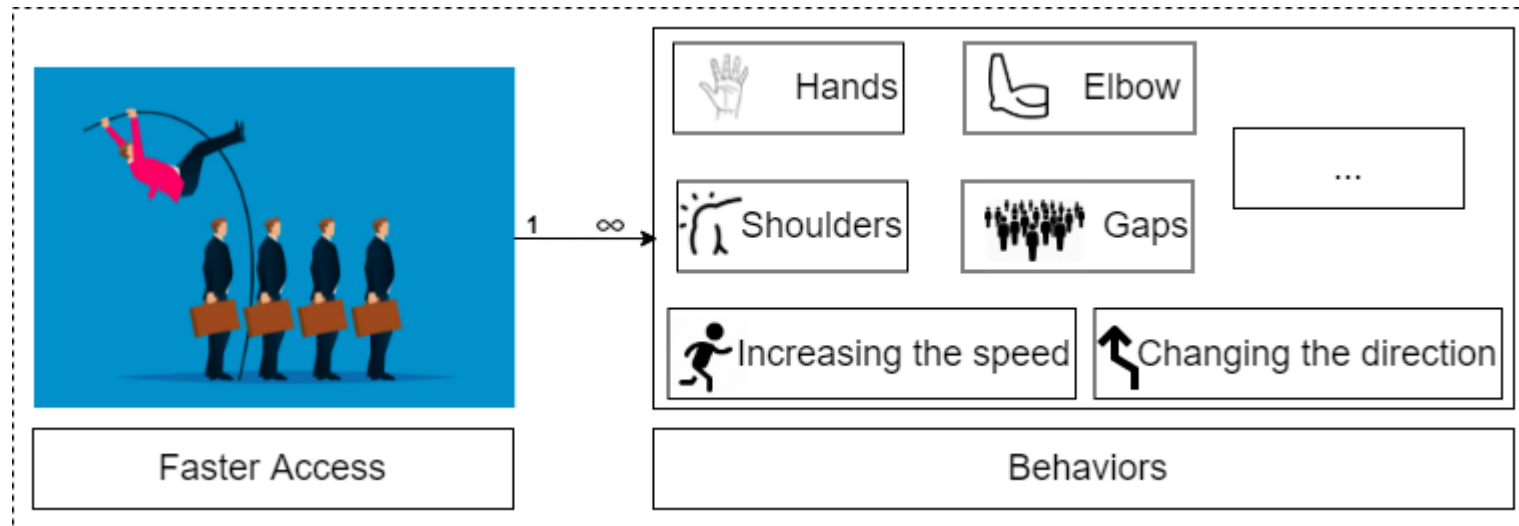
pushing behavior in crowded event entrances from videos.



Detection: When?

What is Pushing Behavior?

- ❑ Pushing behavior could be defined as **a list of unfair strategies for faster access.**



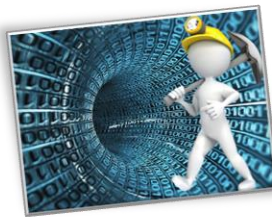
Main Challenges

Automatic approach is a challenging task



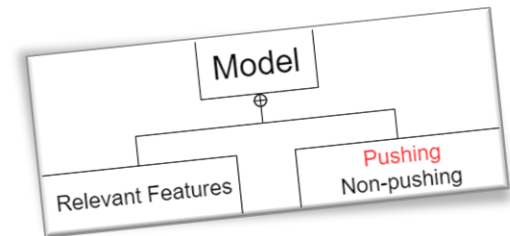
Available labeled videos

- ☐ Rare



Feature Extraction

- ☐ Dense crowd.
- ☐ Complexity of features.



Modeling

- ☐ Several strategies.
- ☐ High similarity between pushing and non-pushing.

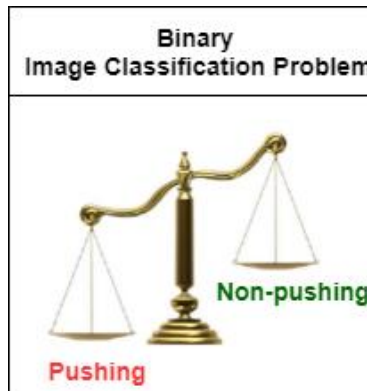
Overview of our Approach

The Main Idea

The automatic pushing
behavior detection and
localization

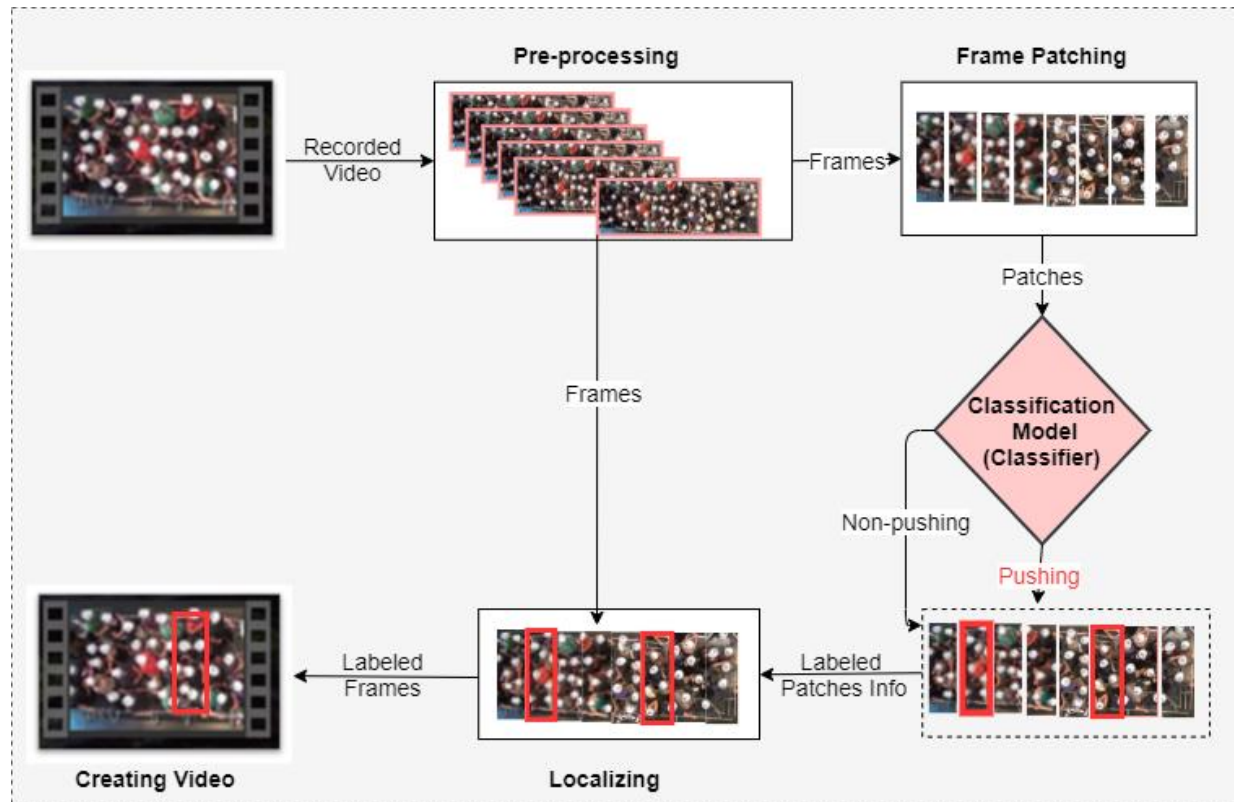


**A binary image
classification problem**



A video is a sequence of
images called frames.

Our Approach Flowchart



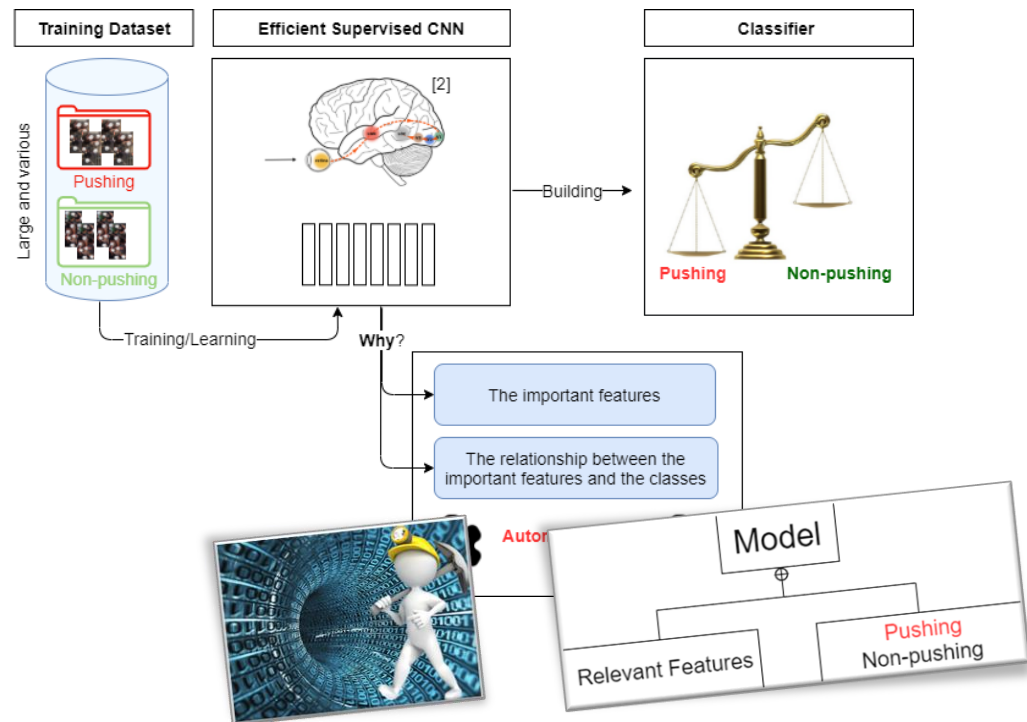
How to build a binary image classification model?

Convolutional Neural Networks (CNNs)

- CNNs are class of artificial neural network, but with convolutional and pooling layers, most commonly applied to analyze visual imagery [1].

?

Can we create a large and various training dataset for our problem?

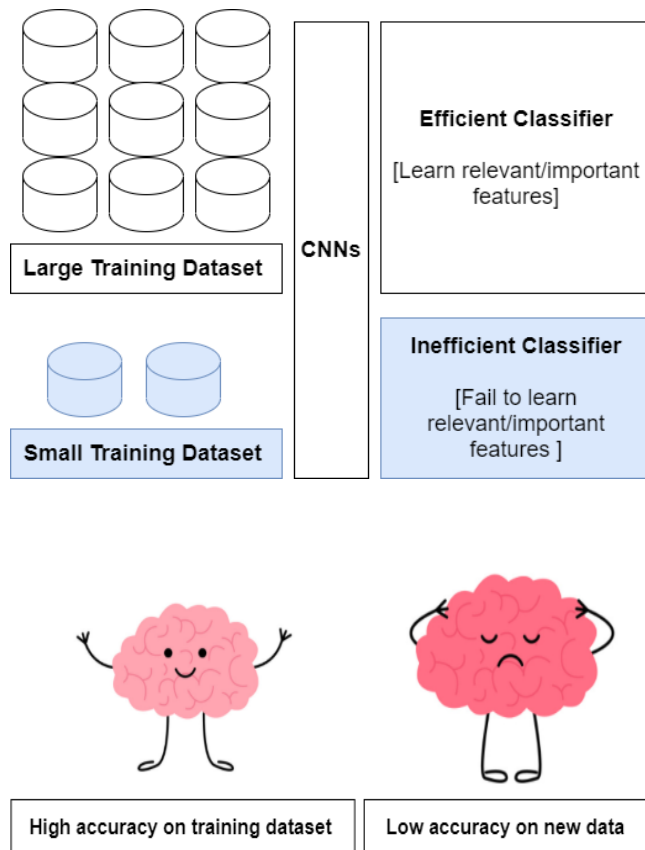


[1] Valueva, Maria V., et al. "Application of the residue number system to reduce hardware costs of the convolutional neural network implementation." Mathematics and Computers in Simulation 177 (2020): 232-243.

[2] figshare.com

CNNs with Small Dataset

❑ Overfitting Problem.

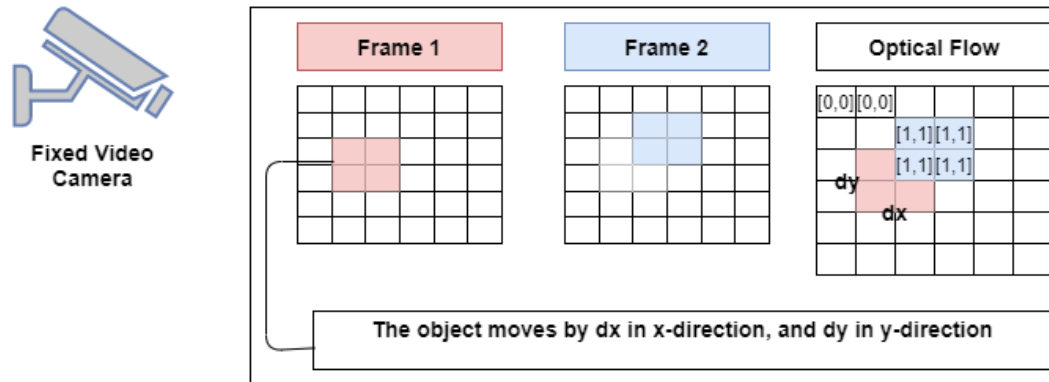


- ❑ To improve the feature extraction:
 - ❑ Guiding supervised CNNs to learn from the overall scene motion.
 - ❑ The overall scene motion mostly involves the important features that represent pushing behavior.



Optical Flow

- ❑ **Dense Optical Flow** is the task of estimating per-pixel motion between video frames.
 - ❑ Caused by the relative movement between the object and camera ^[1].



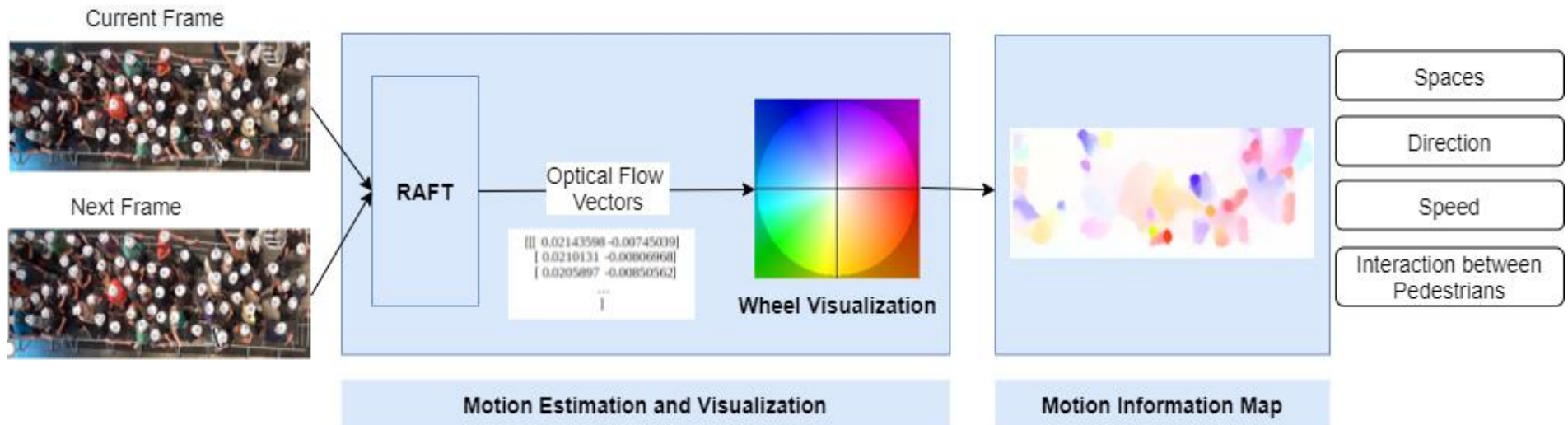
- ❑ Main challenges:
 - ❑ Variation in the lighting and occlusions within the crowd.
- ❑ Optical flow based on deep learning approaches improved the optical flow performance.
- ❑ RAFT: Recurrent All-Pairs Field Transforms ^[2]
 - ❑ One of the best deep learning approaches for optical flow, it was introduced in 2020.

[1] Burton, Andrew; Radford, John (1978). Thinking in Perspective: Critical Essays in the Study of Thought Processes. Routledge

[2] Teed, Zachary, and Jia Deng. "Raft: Recurrent all-pairs field transforms for optical flow." European conference on computer vision. Springer, Cham, 2020.

Motion Estimation and Visualization

- A hybrid approach of RAFT_[1] and Wheel Visualization_[2].



[1] Teed, Zachary, and Jia Deng. "Raft: Recurrent all-pairs field transforms for optical flow." European conference on computer vision. Springer, Cham, 2020.

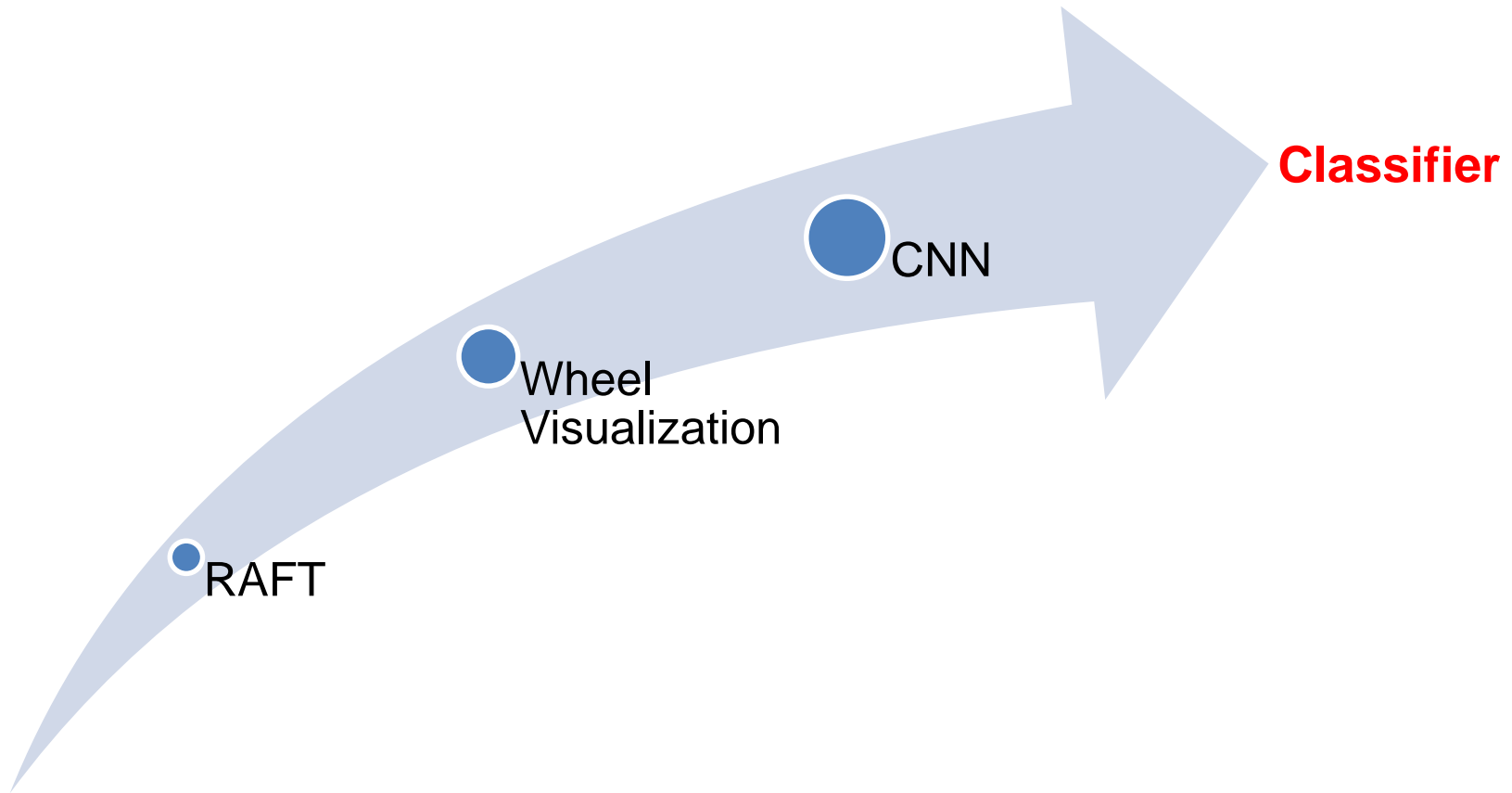
[2] Baker, Simon, et al. "A database and evaluation methodology for optical flow." *International journal of computer vision* 92.1 (2011): 1-31.

Example: RAFT and Wheel Visualization

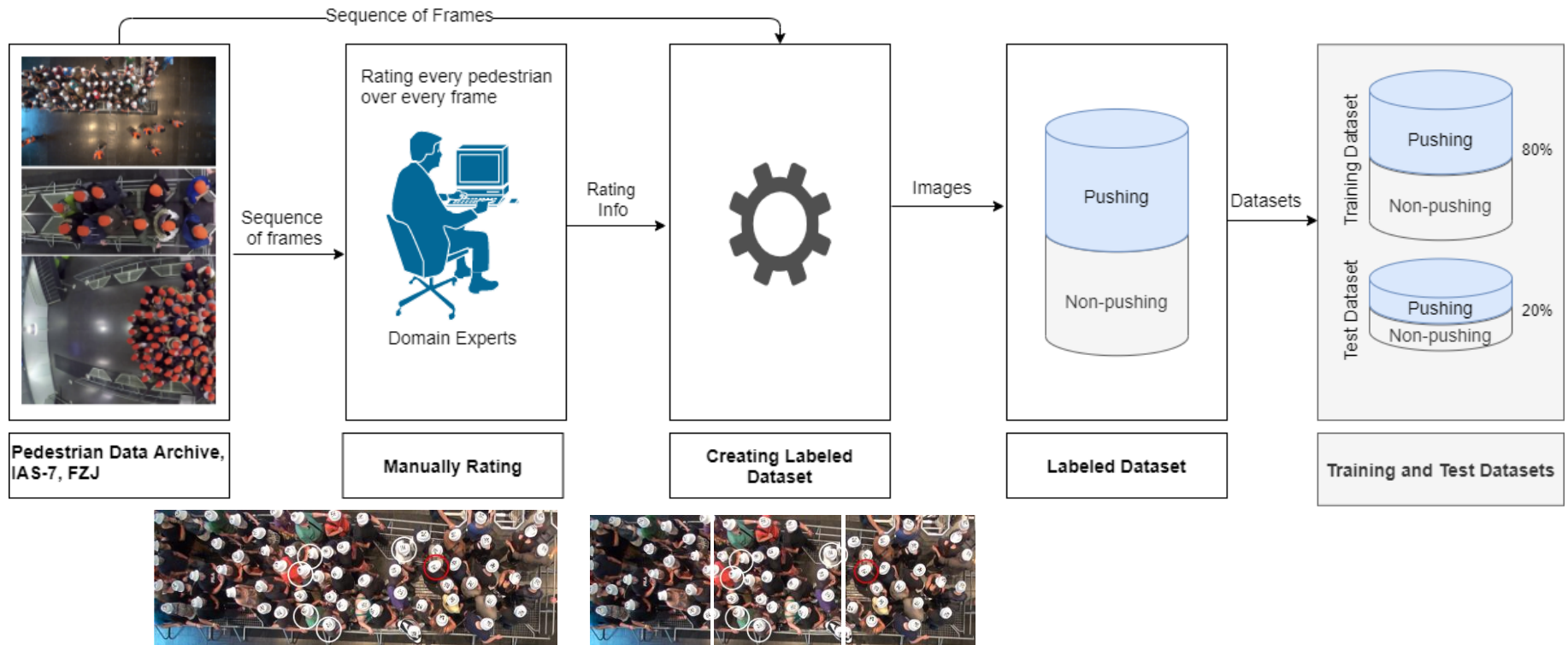
Every five successive frames



Our Approach for Building the Classifier



Dataset Preparation

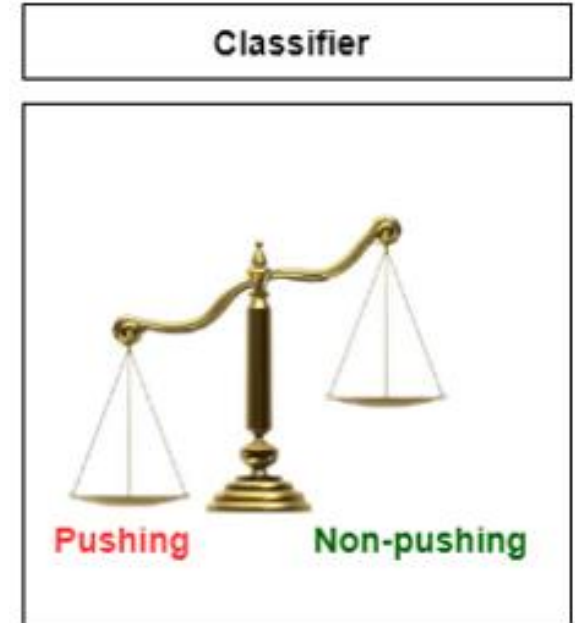
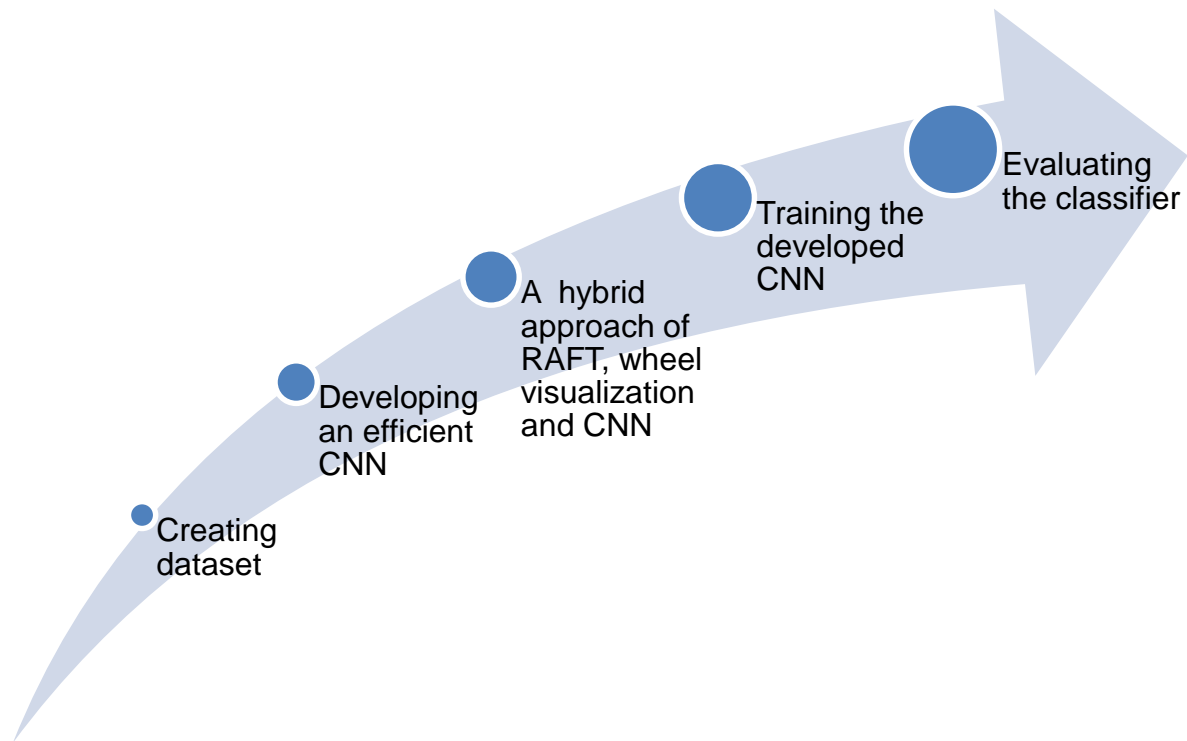


Limitation of the Approach



Outlook

Building the Classifier

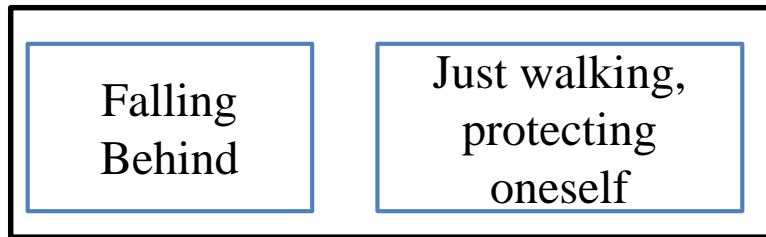


Thank you for your attention

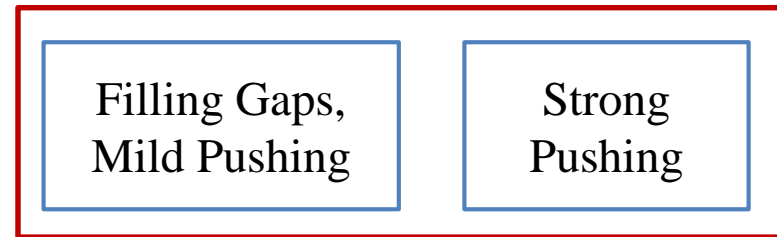
Extra Slides

Psychological Rating System

- ❑ **Psychological Rating System** is being developed by Social Psychology Division.
 - ❑ Understanding the heterogeneity of movements in crowds.
 - ❑ It classifies forward motion of pedestrians into four classes.



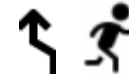
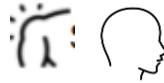
Non-pushing Class



Pushing Class

- ❑ It uses six features to distinguish between the classes.

Psychological Rating System-Features



	Arms + hands	Shoulders + head	Space	Interaction	Speed/ Acceleration	Attention
3. Filling gaps, mild pushing	<ul style="list-style-type: none"> Extending of elbows and arms to have more space around (and prevent others from overtaking) Using of barriers to stabilize themselves and prevent others from overtaking Raised arms applying force on the back of other persons 	<ul style="list-style-type: none"> Strong shoulder movement sideways 'fast penguin' 	<ul style="list-style-type: none"> Much body contacts Rapid change in distance to others Actively close the gap to the next person → closing gaps Bigger distance behind Changing lines to be faster 	<ul style="list-style-type: none"> ----- 	<ul style="list-style-type: none"> Fast movements (generally not just in forward direction) 	<ul style="list-style-type: none"> Attention focused on bottleneck Searching for gaps (in a mild level)
4. Strong pushing	<ul style="list-style-type: none"> Pulling other people backwards Strong usage of elbows Using of barriers to pull themselves forward Using of hands to create gaps (→ Moses-move) Adjusting the body before crash Actively change hand & arm position 	<ul style="list-style-type: none"> Turned sideways to use one shoulder as plough Very strong shoulder movement sideways Bouncing backwards after crash Forward-leaned head 	<ul style="list-style-type: none"> Much body contacts Rapid change in distance to others Perhaps some distance in the back before it gets filled 	<ul style="list-style-type: none"> Short interaction before 'go start' (perhaps a planned behavior?) Communicative pushing Aggressive role playing (e.g. American football game) 	<ul style="list-style-type: none"> Fast High acceleration 	<ul style="list-style-type: none"> Attention focused on bottleneck Actively searching and acting towards gaps