Team Project: Tharsus

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Durham University

THARSUS

Outline

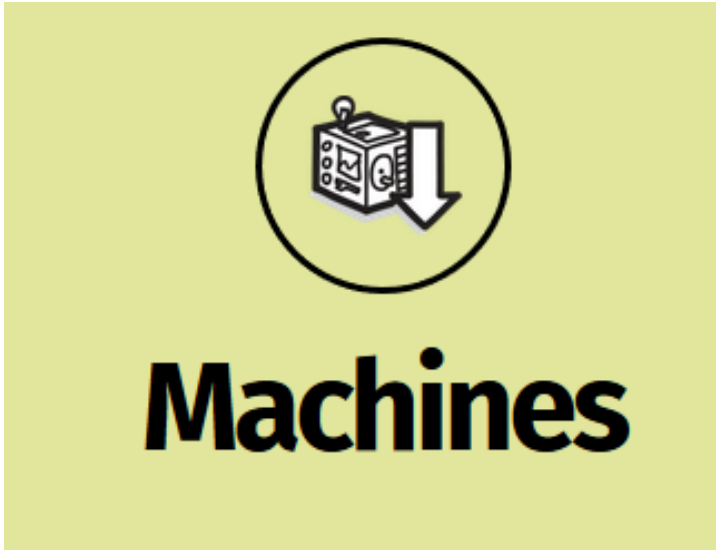
1. **Presentation of the project**
   a) Tharsus
   b) The Problem
   c) Data and tools

2. **Methodology**
   a) Background subtraction
   b) Object detection algorithm (YOLO)
   c) Path tracking

3. **Conclusions**

The Project

THARSUS is a robotics company



Designing and Manufacturing

https://www.tharsus.co.uk/

THARSUS is a robotics company

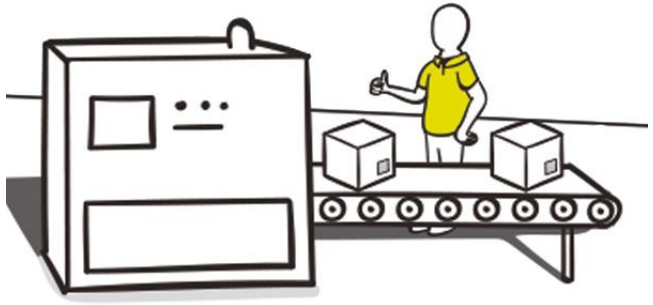
The Gazette · The Journal
North East business awards 2017
With North East England Chamber of Commerce
WINNER
Manufacturing Award

BFA 2015 WINNER
MANUFACTURING EXCELLENCE AWARDS
Institution of Mechanical Engineers
2014 Finalists
Best SME Category

THE Manufacturer
OF THE YEAR AWARDS 2012
SME Manufacturer of the Year
(Over 125 employees)
WINNER

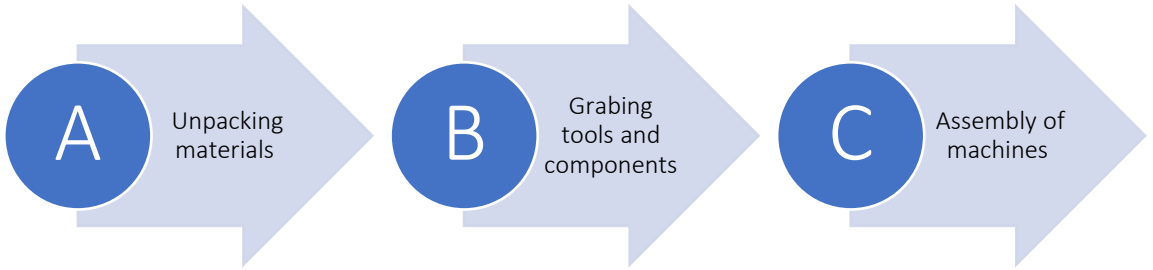
BT · ocado · BAE SYSTEMS · Rolls-Royce
3M · Clear Channel · DHL · JAGUAR · LAND ROVER
NISSAN · weedingtech · ITM POWER Energy Storage | Clean Fuel · safetykleen
AKER WADE · ekko GLASS CRUSH & COLLECT · Cummins · propeller
orrb · RENOVAGEN · V-Tex · OPENWORKS
QinetiQ · Automata · E"Xray · Dogtooth

Looking for a manufacturing partner?

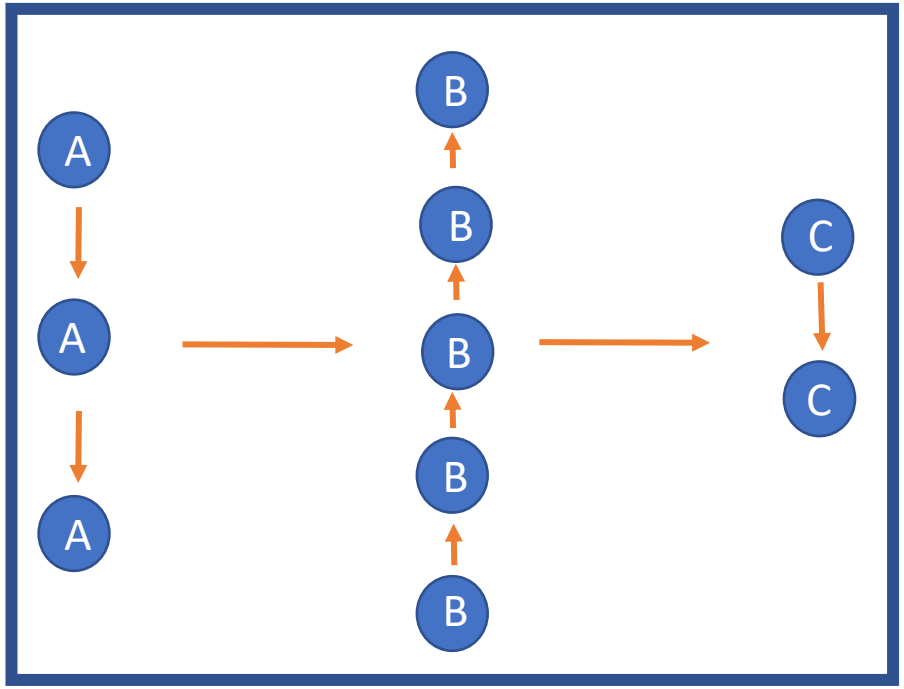


https://www.tharsus.co.uk/

Production line: The life in the workshop



Ideal Case:



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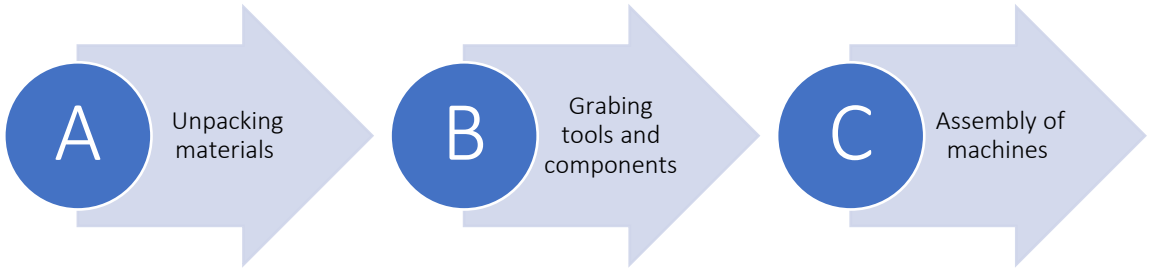
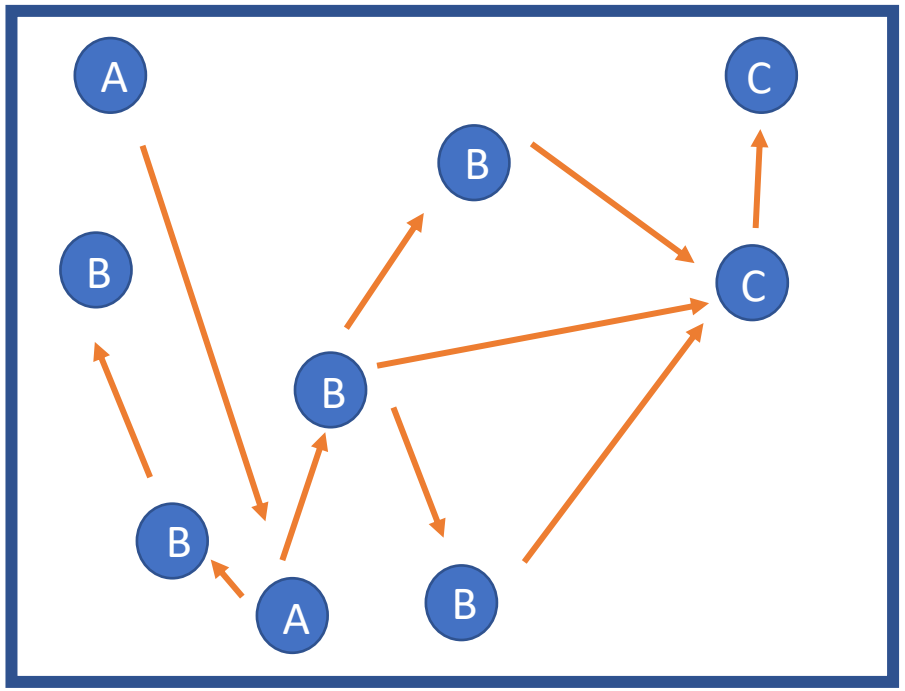
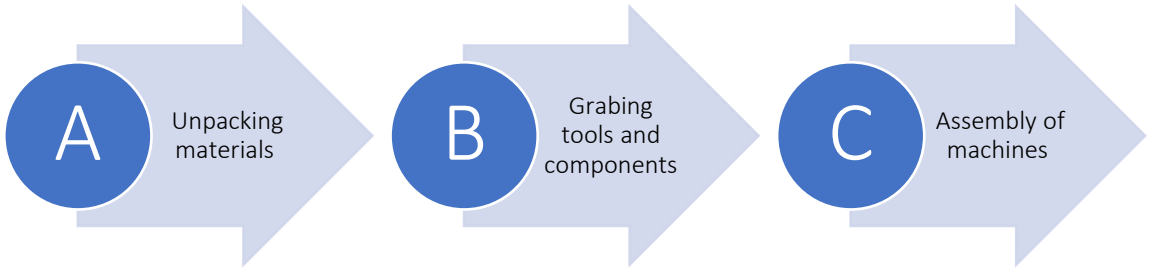


Real Case:

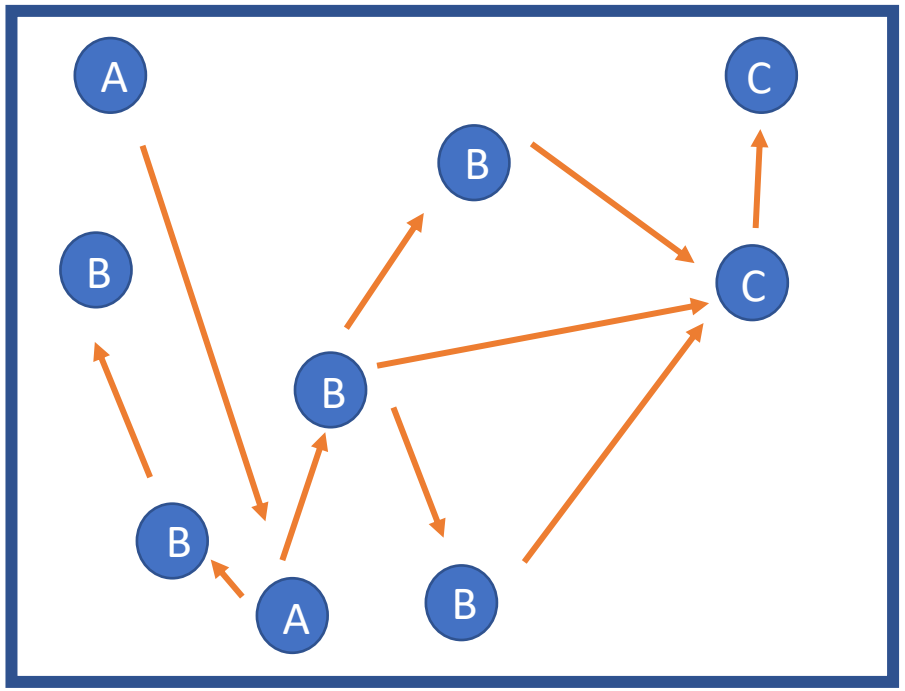


Production line: The life in the workshop



Real Case:

Is it possible to register how well distributed is the workshop?



How to approach to the problem?

Track the movement of people in a large area:

- Recording the **activities of a person in the production line**
- **Identify the person**
- Repeat during several minutes and for different people

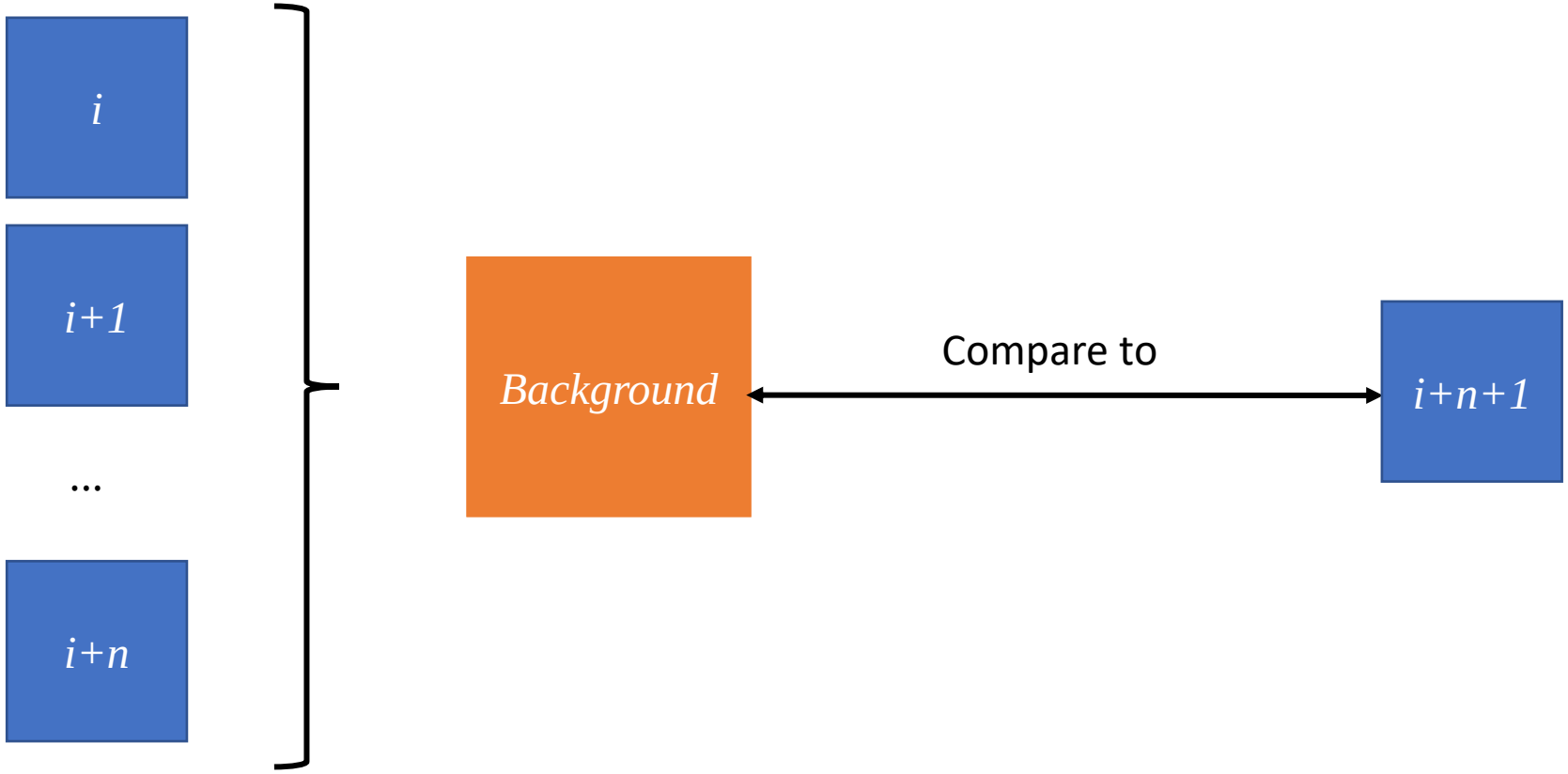
Examine the data to find ineffectively located spots:

- A **RaspberryPi camera** is used to register the data
- **Python, OpenCV** and some object detection algorithms can be used to do the analysis

https://opencv.org/

Methodology

Use background subtraction in order to detect movement



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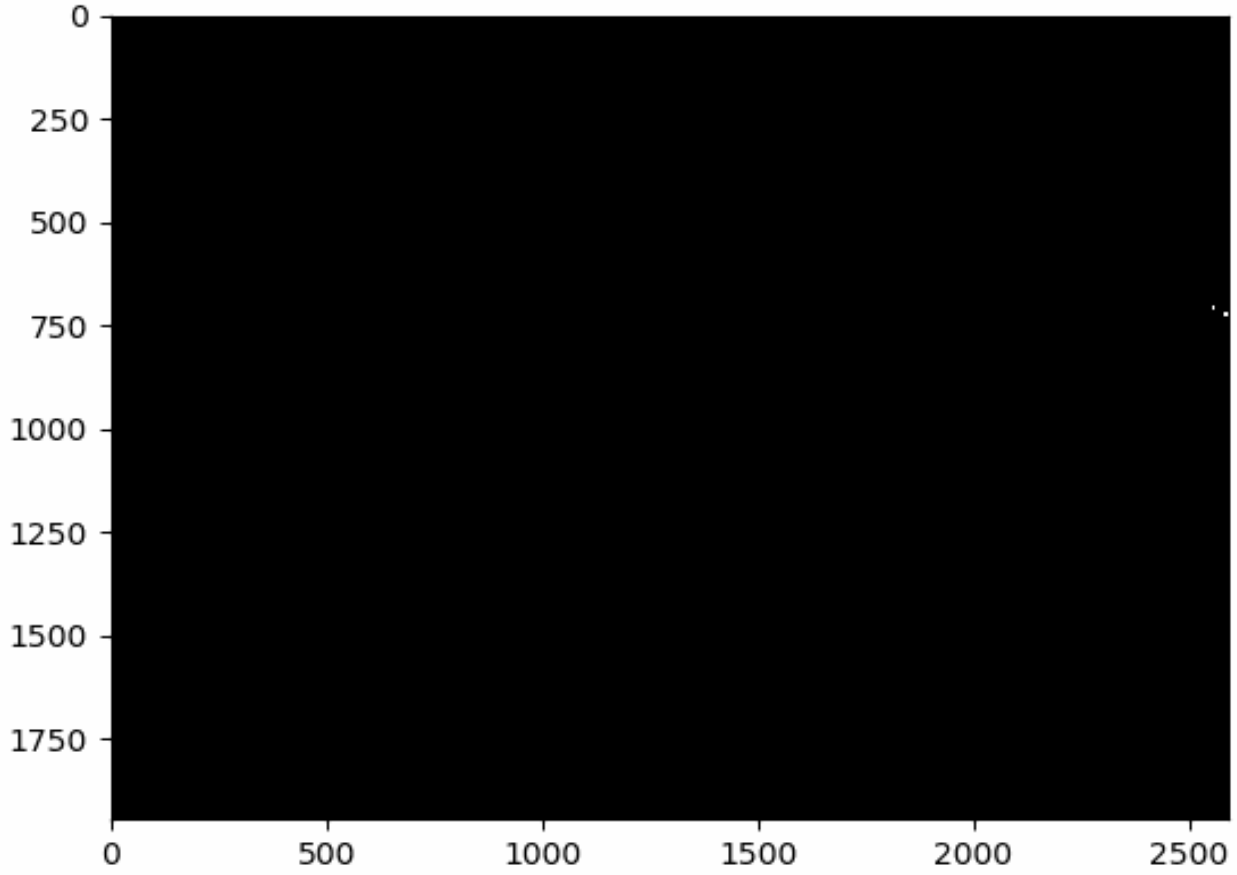
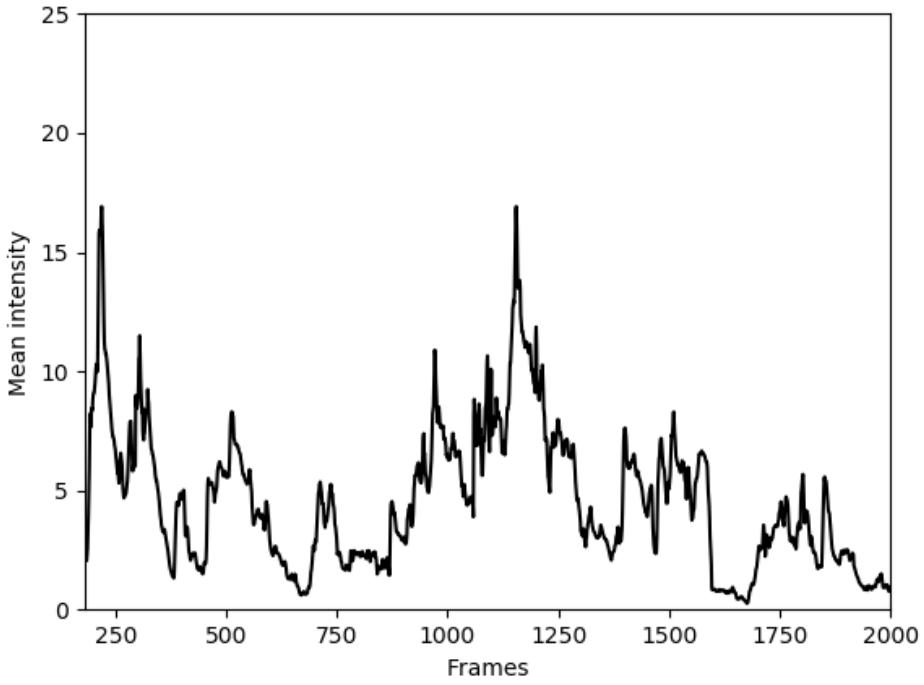


Plot Intensity vs time to detect high activity segments



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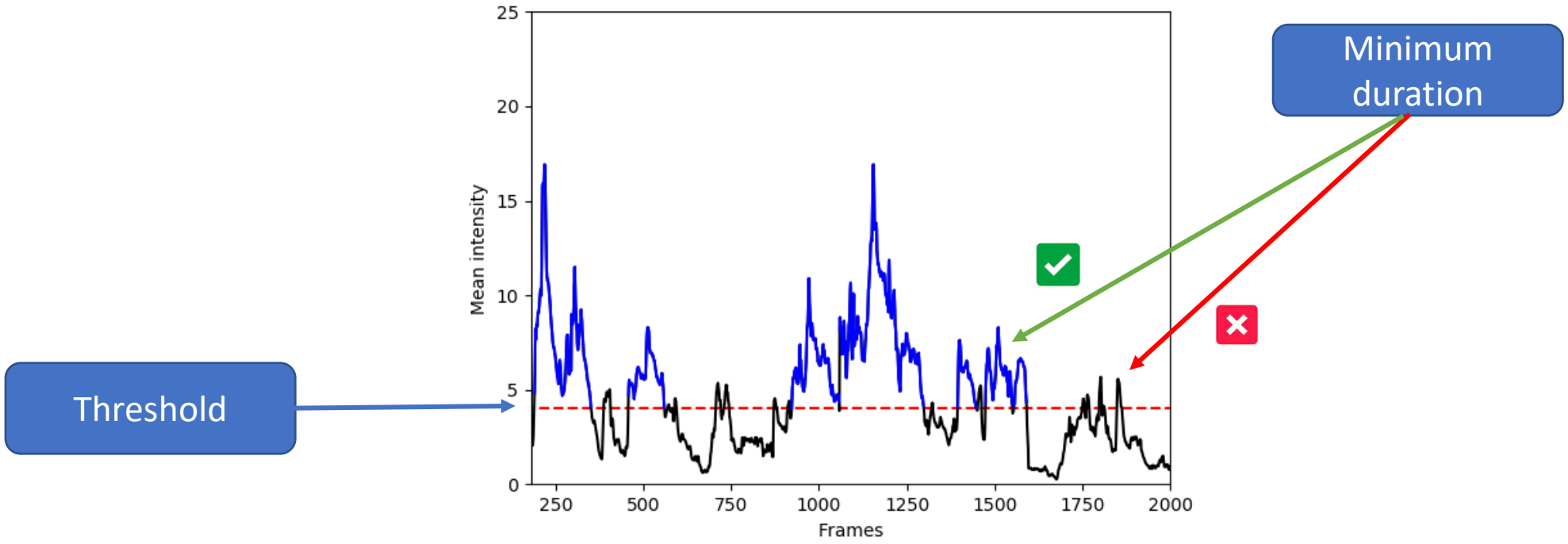
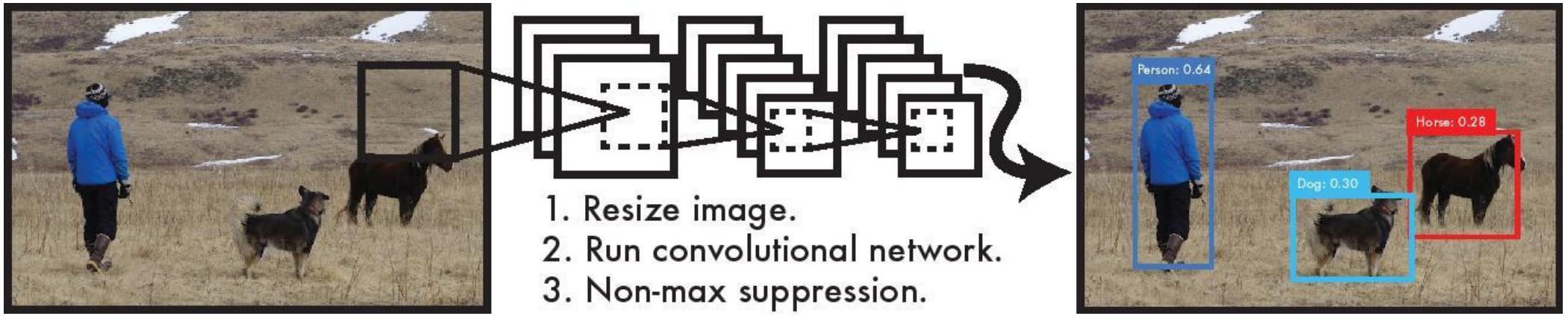


YOLO (You Only Look Once):

Unified, Real-Time Object Detection

arXiv:1506.02640



Redmon et al. (2015)

YOLO (You Only Look Once):

Unified, Real-Time Object Detection

arXiv:1506.02640

100x faster than competitors

https://pjreddie.com/darknet/yolo/

YOLO (You Only Look Once):

Unified, Real-Time Object Detection

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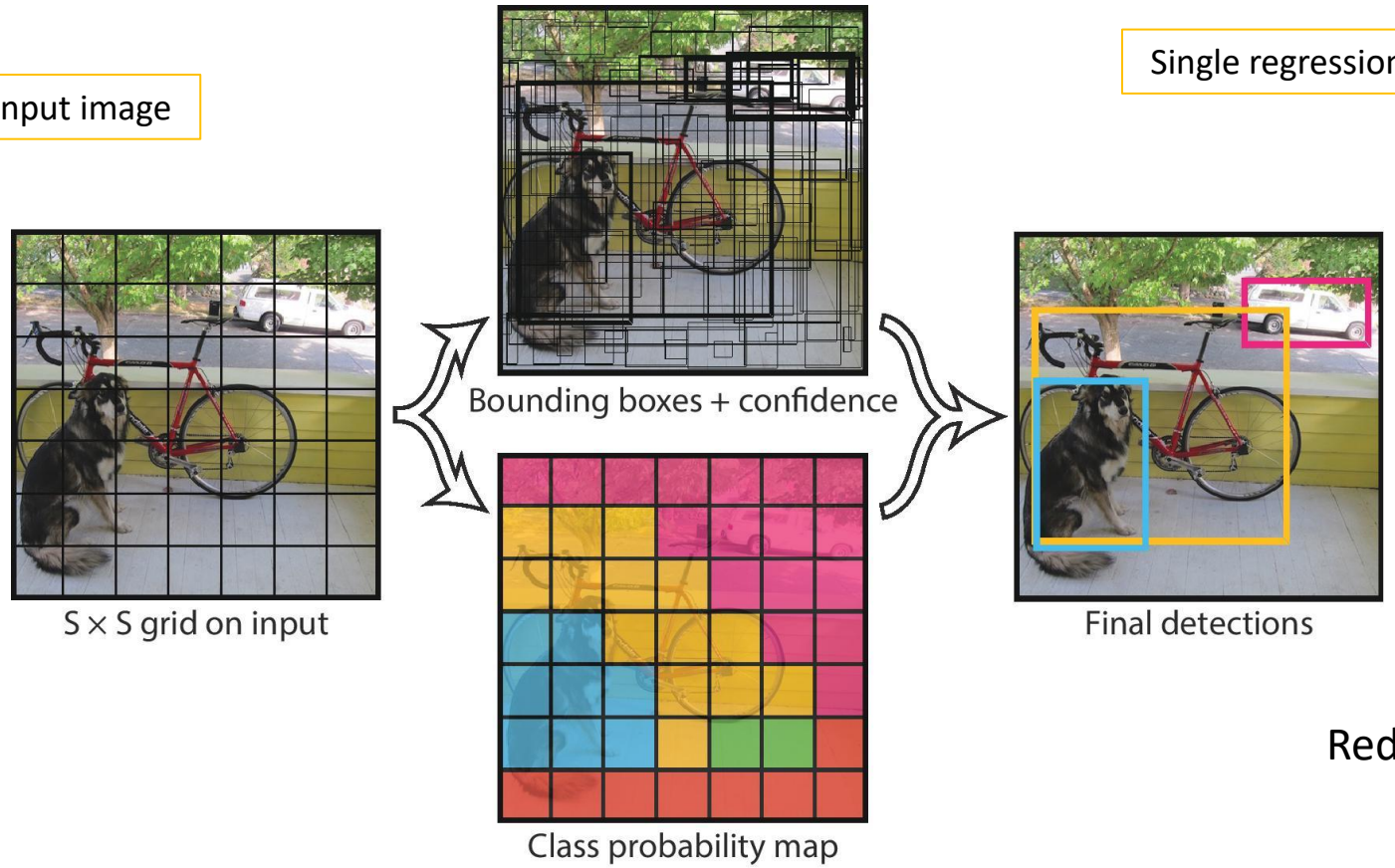
Resize of the input image

Single regression analysis



Redmon et al. (2015)

Prediction of bounding boxes

YOLO (You Only Look Once):

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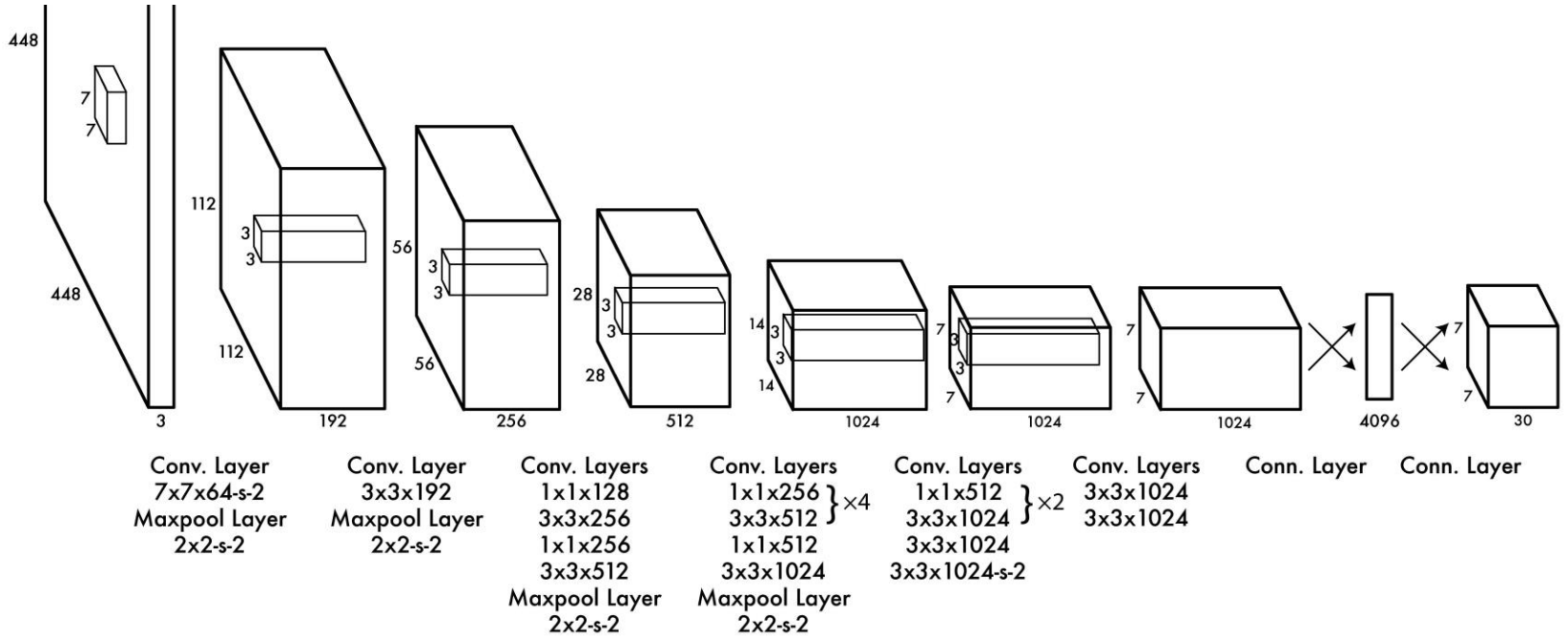

Redmon et al. (2015)

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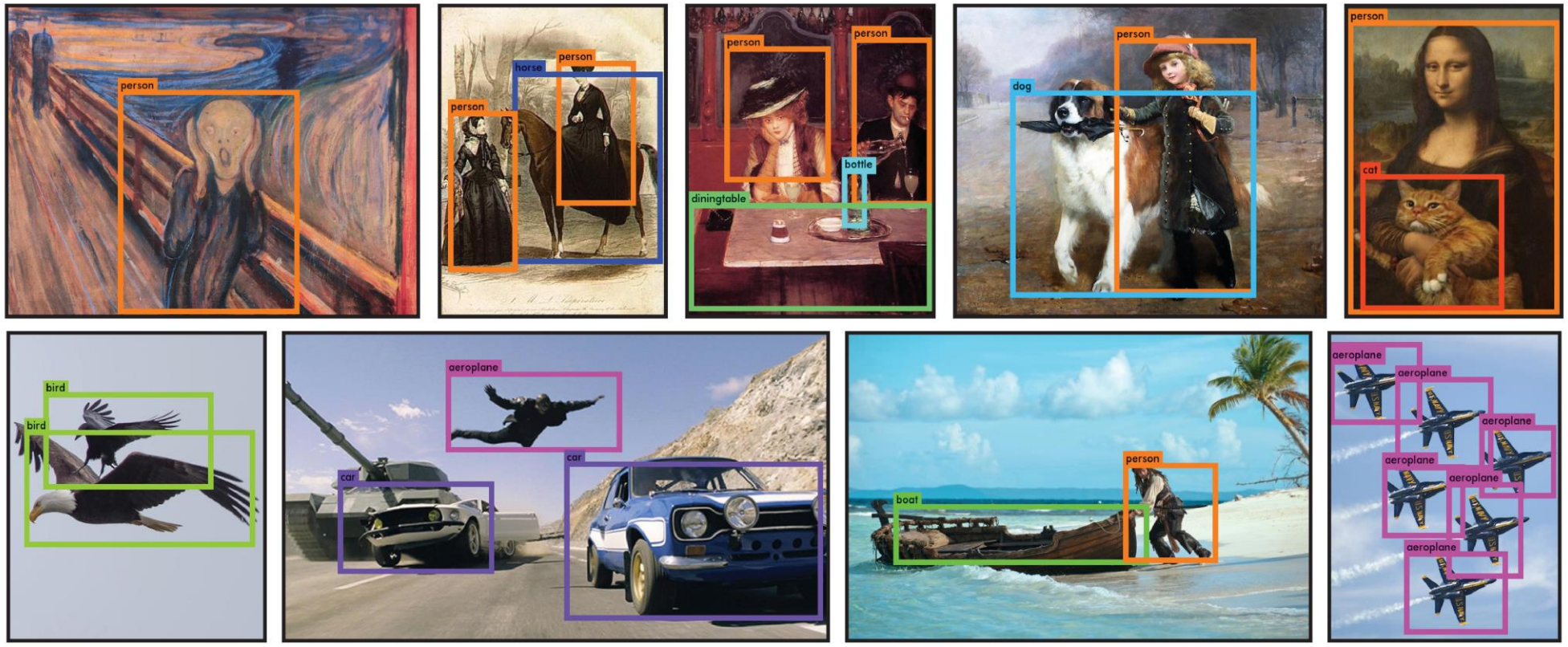
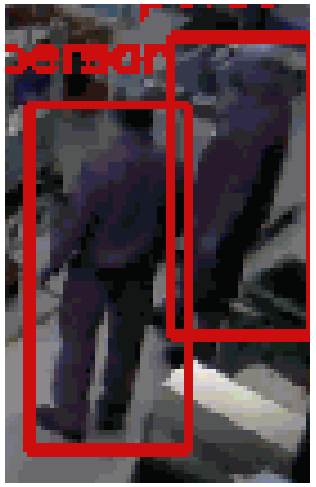


Redmon et al. (2015)

Can we apply YOLO to this problem?

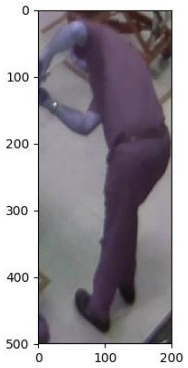


- Short answer: Yes. Nevertheless, limitations are present in the process (open problem).
- We apply YOLO to identify the individuals on every frame.
- Workers path at the workshop can be tracked on real time.

YOLO outputs

- Once a 'Person' is detected, useful information is saved.
- Pixel position (x,y), width and height of YOLO output boxes, and confidence of the YOLO class.
- Can we find all the tracks of one individual person?

Path tracking: the simplest approach?



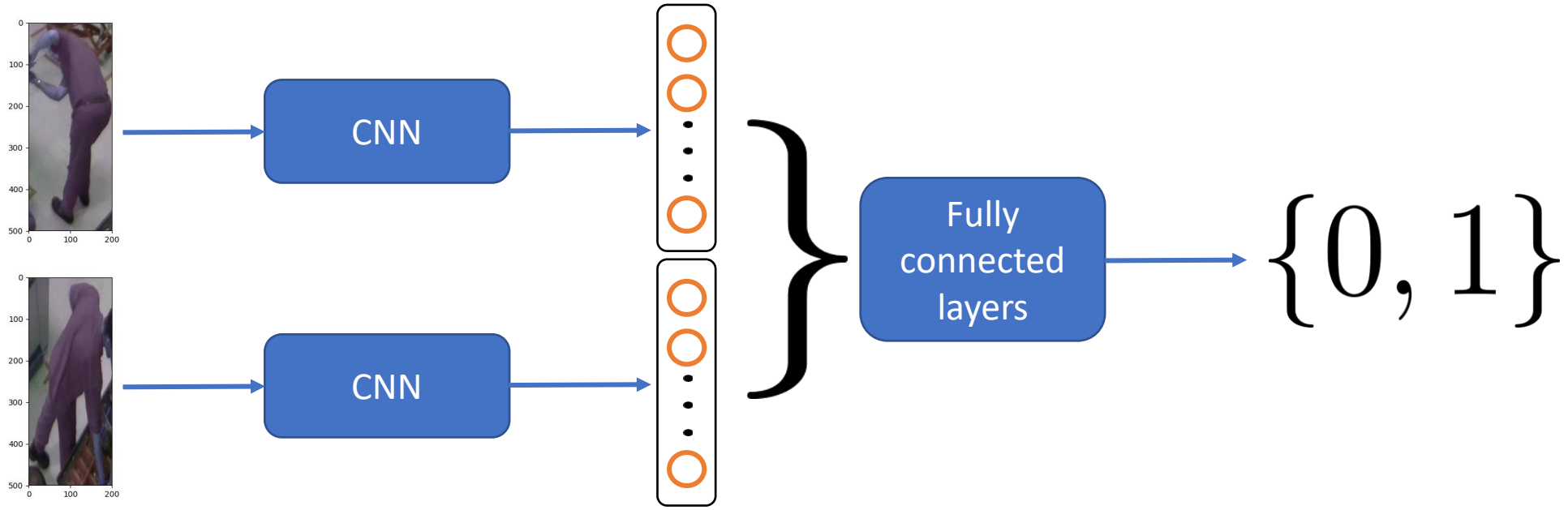
CNN

$\{1\}$

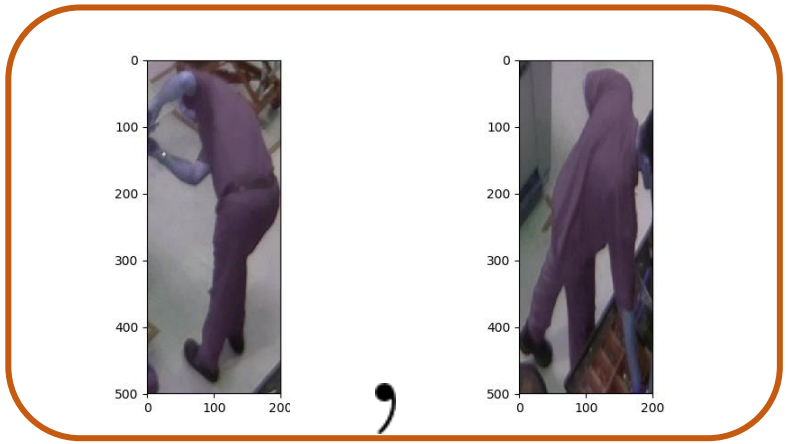
CNN

$\{2\}$

Path tracking: siamese network approach

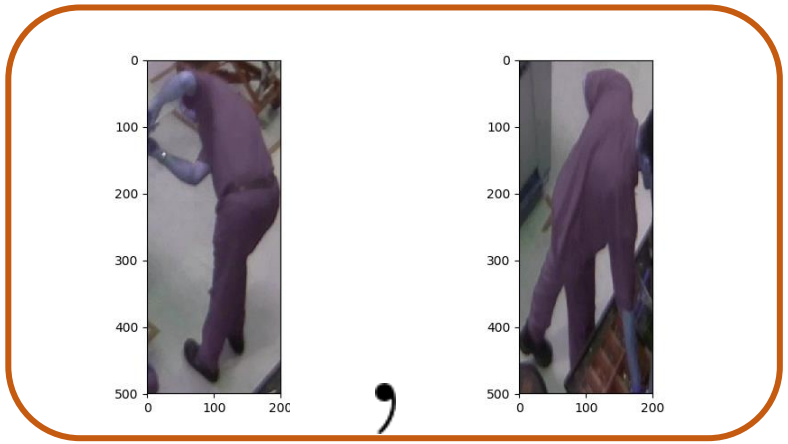


Path tracking: siamese network approach



$\{0\}$

Path tracking: siamese network approach



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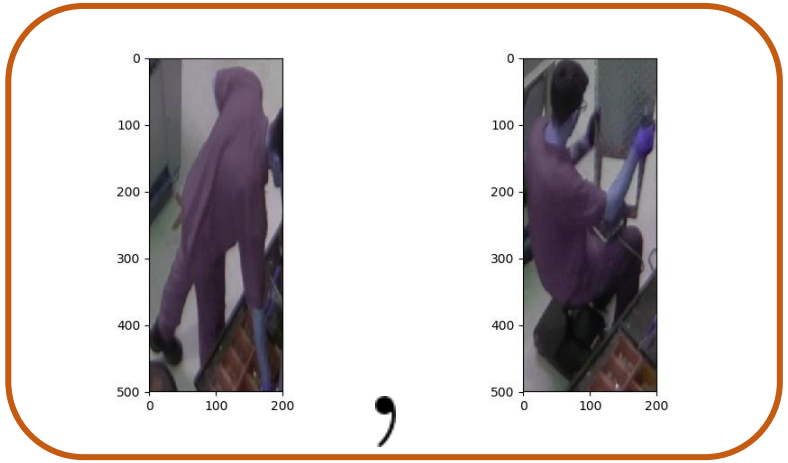
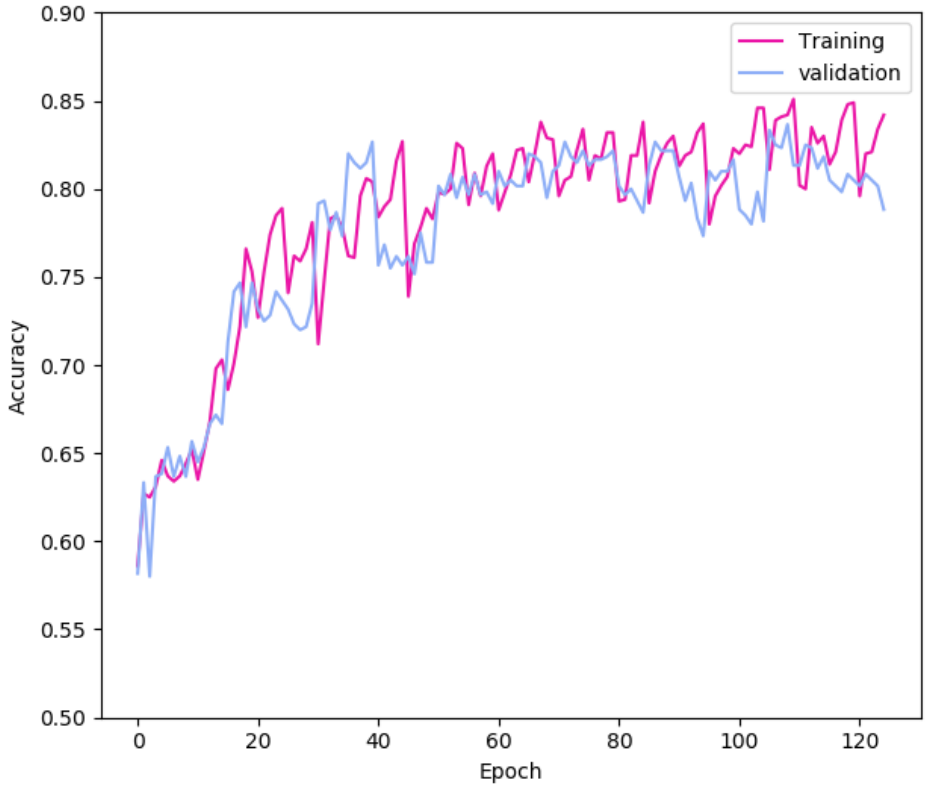
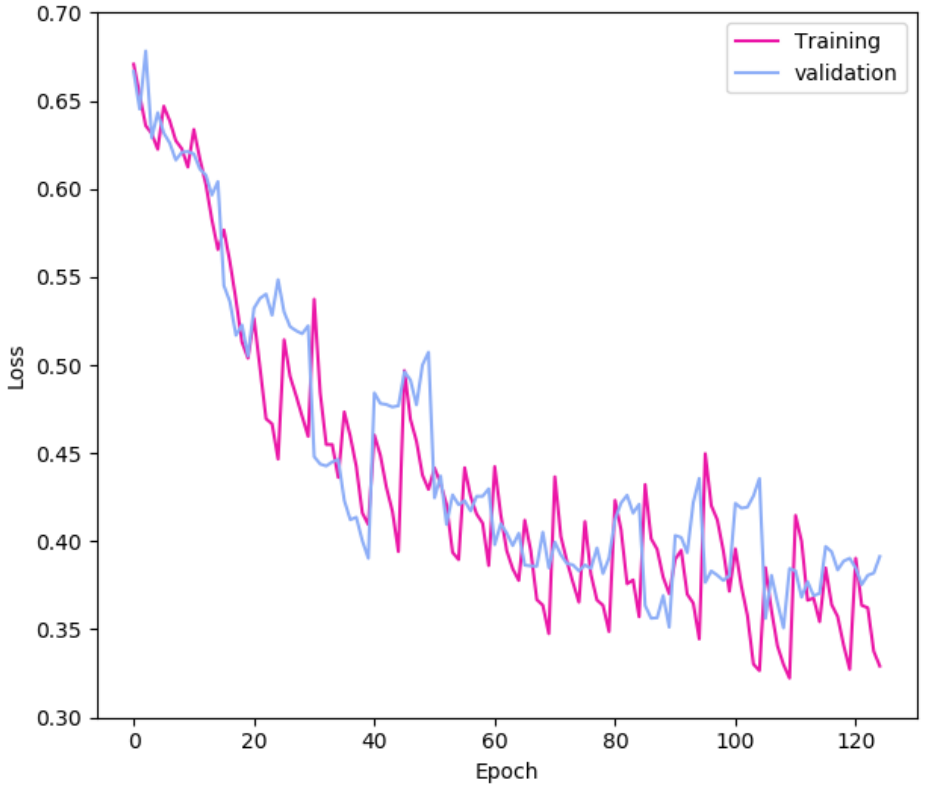


$\{1\}$

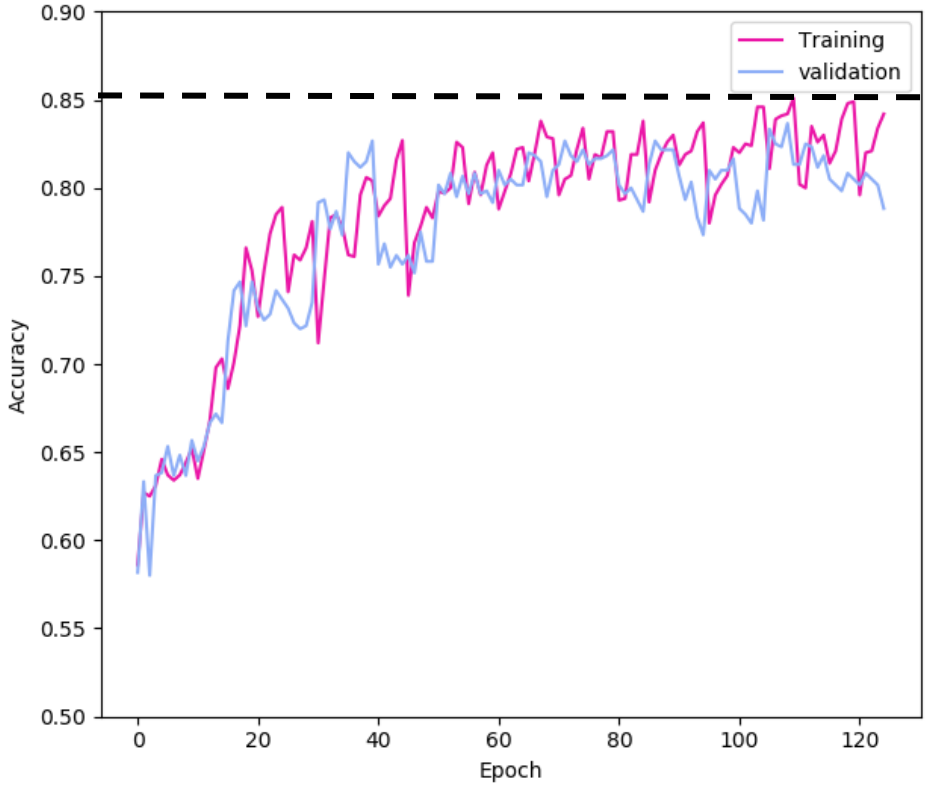
Training and validation loss for the siamese network approach





$$L_i = -y_i \log(\hat{y}_i) - (1 - y_i) \log(1 - \hat{y}_i)$$

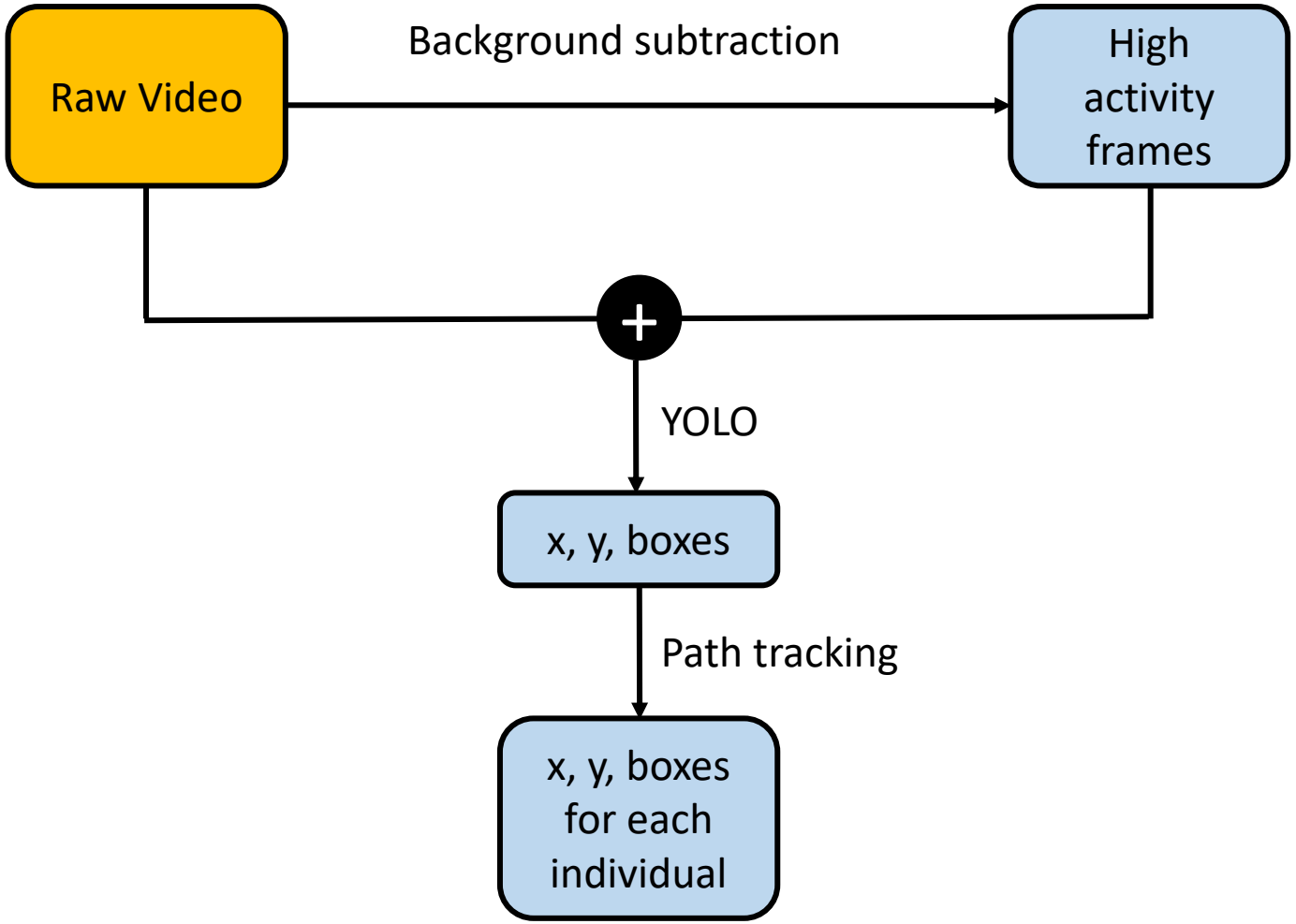
Training and validation loss for the siamese network approach



- The training and validation highly depends on how the data sets are selected.
- 13,000 pictures labeled.
- The accuracy could be improved by labeling more data and training on more epochs.

Conclusions

Pipeline


Raw Video
Background subtraction
High activity frames
YOLO
x, y, boxes
Path tracking
x, y, boxes for each individual

Summary and conclusions

- **Workers activities can be tracked** by using a combination of background subtraction and an object detection algorithm. However, **we require an additional tool to identify all the individuals** in the workshop.

- In comparison to different approaches, as CNN and unsupervised learning, **the siamese network approach works better**.

- Although the siamese network approach gives a good accuracy in both the training and the validation, **more data is need to** produce results with a higher fidelity and **solve the problem**.