

# Facial Mask Wearing Identification System Based on Deep Learning

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01

## Introduction & Background

# Introduction and Background



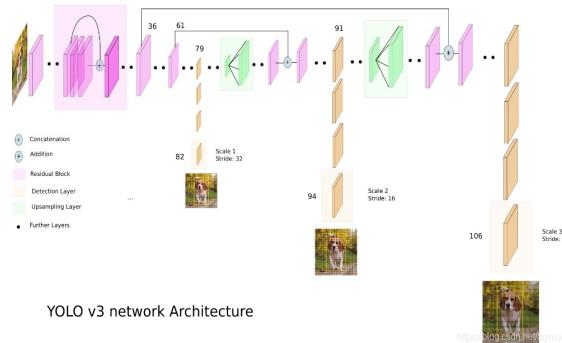
## Manual Check:

- High labor cost
- Risk of cross-infection
- Low efficiency

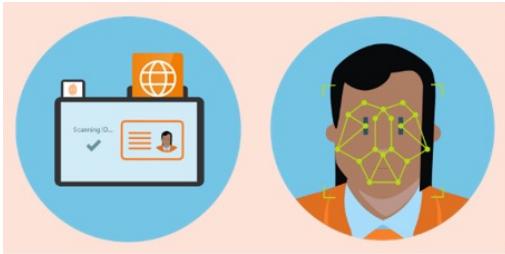
# Introduction and Background



DEEP LEARNING



YOLO v3

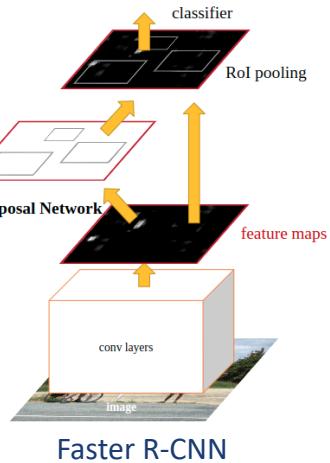


## Human face detection :

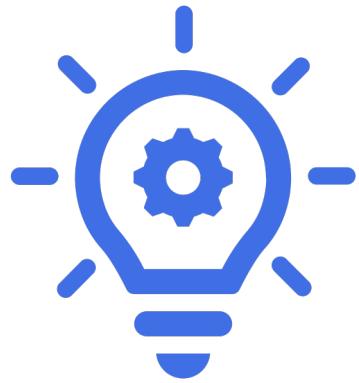
Face recognition payment  
Identity verification

Emotion detect

.....



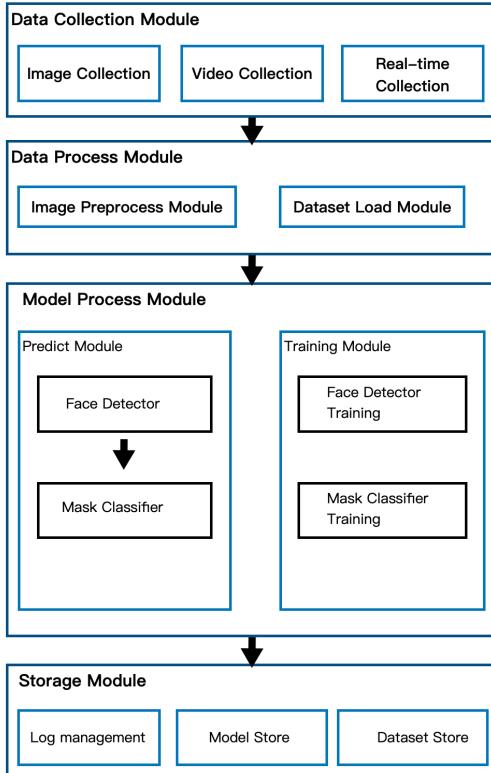
# Introduction and Background



02

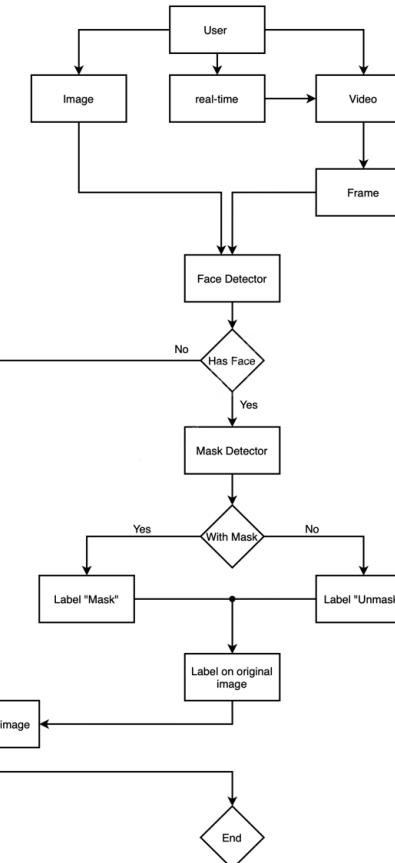
## System Design & Implement

# System Design & Implement

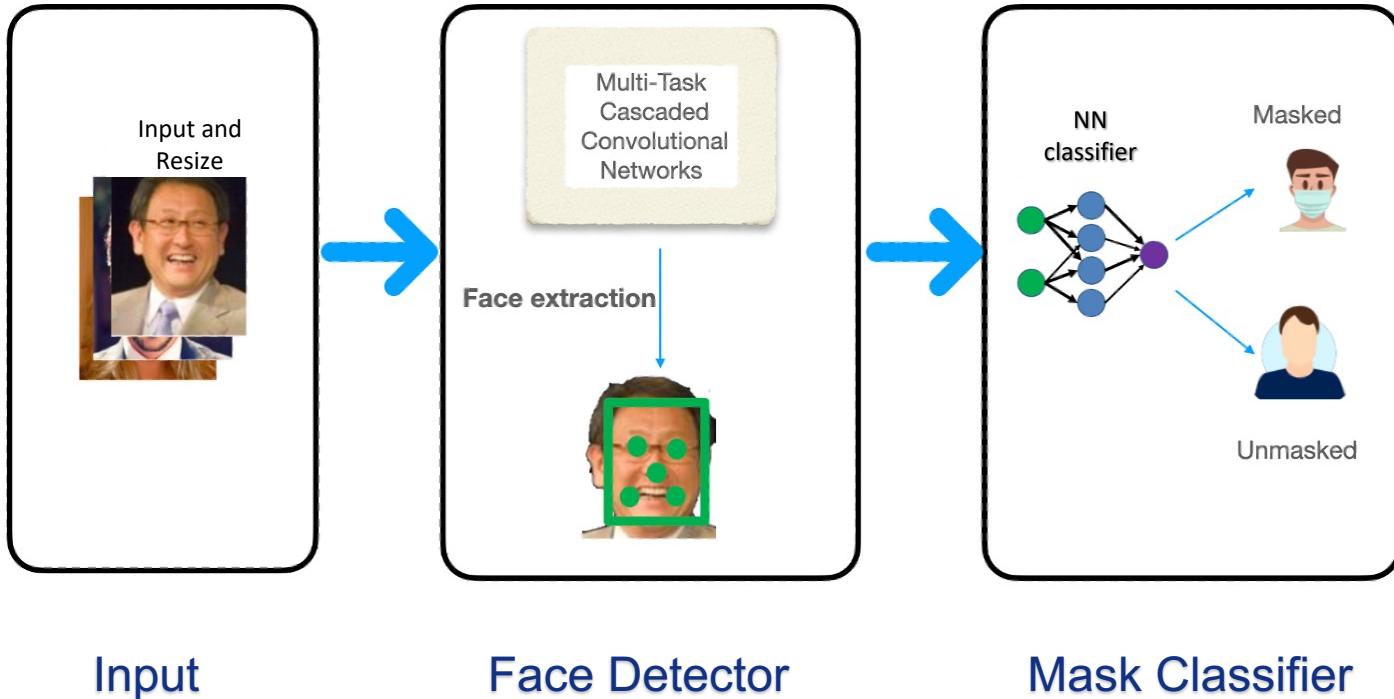


Module Design

Flow chat



# System Design & Implement



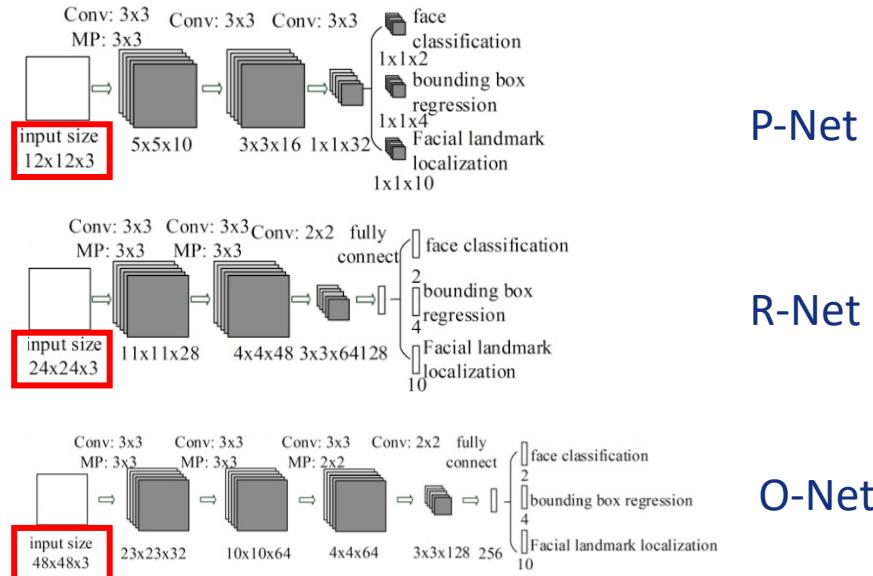
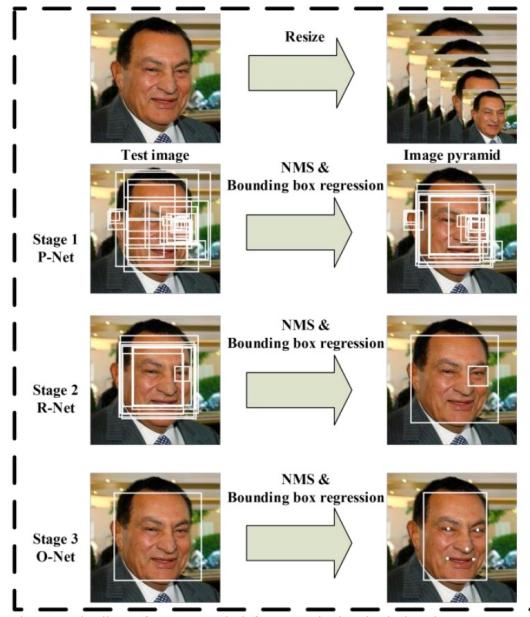
# System Design & Implement

## Face Detector

---- Based on MTCNN

# System Design & Implement

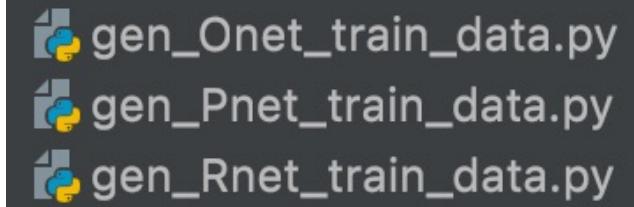
## Multi-Task cascaded Convolutional Neural Network



# System Design & Implement

## Data Preparation

- Cut and resize the images
- Calculate the IoU and classify the images



$$IoU = \frac{\text{Area of Intersection of two boxes}}{\text{Area of Union of two Boxes}}$$

Type	Definition	Task
Positive	$IoU \geq 0.65$	Face classification task, bounding box regression
Negative	$IoU < 0.3$	Face classification task
Part faces	$0.45 \leq IoU \leq 0.65$	bounding box regression
Landmark faces	$IoU \geq 0.65$	facial landmark localization

# System Design & Implement

## Training

### Dataset

Name	Content	Numbers
WIDER FACE	Human Faces	32,203
Celeb A	Human Faces	202,599



### Loss function

Face classification:  $L_i^{det} = -(y_i^{det} \log(p_i) + (1 - y_i^{det})(1 - \log(p_i)))$

Bounding box regression:  $L_i^{box} = \|\hat{y}_i^{box} - y_i^{box}\|_2^2$

Landmark localization:  $L_i^{landmark} = \|\hat{y}_i^{landmark} - y_i^{landmark}\|_2^2$

	PNet	RNet	ONet
End_Epoch	10	10	10
Learning rate	0.01	0.05	0.005
Batch Size	64	640	640
Lr_decay	9	8	8

# System Design & Implement

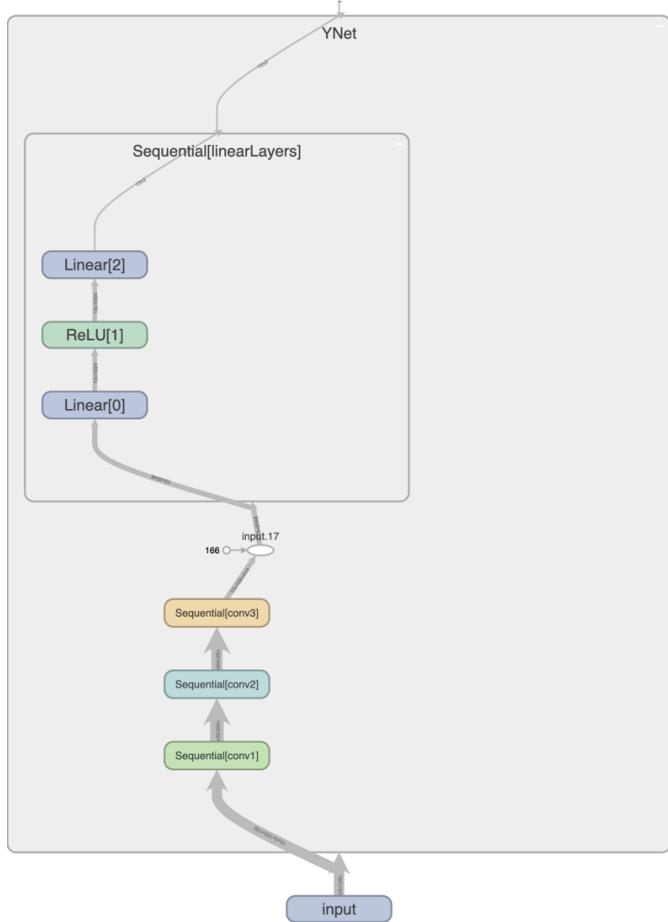
## Face Mask Classifier

---- Based on YNet

# System Design & Implement

Type	Input channels	Output channels	kernel	padding
Conv 1	3	32	3x3	1x1
MaxPool			2x2	
Conv 2	64	128	3x3	1x1
MaxPool	-	-	2x2	-
Conv 3	64	128	3x3	1x1
MaxPool	-	-	2x2	-
Linear	2048	1024	-	-
Linear	1024	2	-	-

Structure and parameters of YNet



# System Design & Implement

## Dataset

Name	Content	Numbers
RMFD	Masked & unmasked face	5,000 masked 90,000 unmasked
Masked LFW	Masked faces	10,000
MAFA	Masked faces	1000



Samples of RWMF



Images by MaskTheFace

# System Design & Implement

15,000 masked vs 90,000 no masked

→ Weight allocation !

Cross Entropy Loss

$$Loss = -(y \log P + (1 - y) \log(1 - p))$$



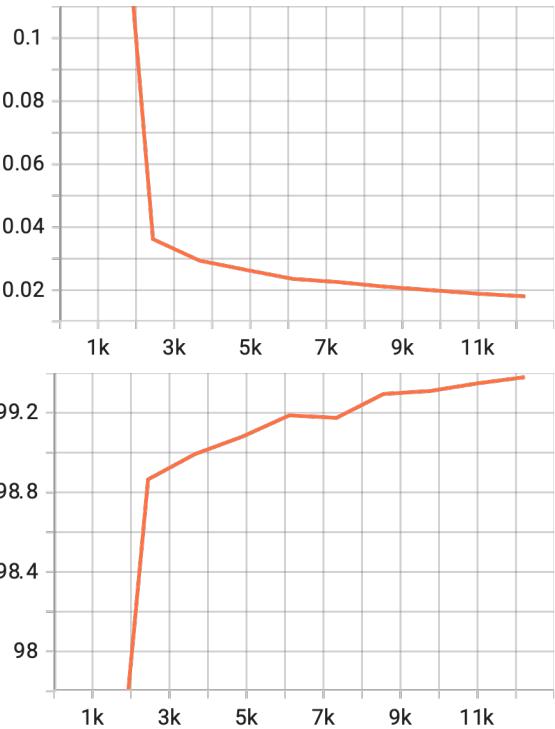
$$class\_weight = 1 - \frac{Class\_Cardinality}{\sum All\_Classes\_Cardinalities}$$



$$Loss = -class\_weight (y \log P + (1 - y) \log(1 - p))$$

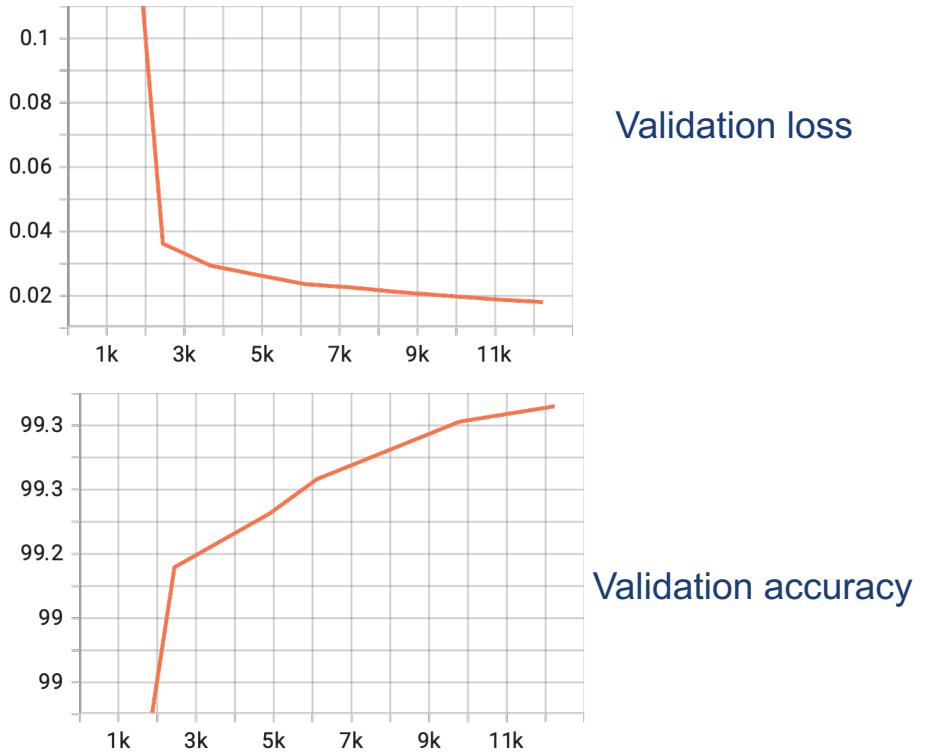
	Parameters
Epoch	10
Learning rate	0.0001
Batch Size	32
Optimizer	Adam

# System Design & Implement



Train loss

Train accuracy



Validation loss

Validation accuracy

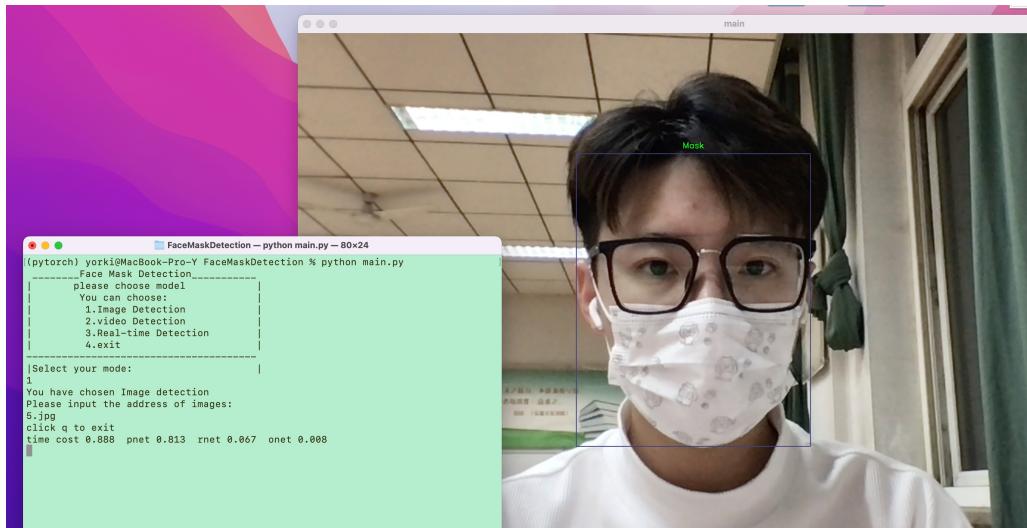
03 |

## Results and Discussion

# Results and Discussion

## Demo of system

```
(pytorch) yorki@MacBook-Pro-Y FaceMaskDetection
-----
Face Mask Detection
-----
|   please choose model
|   You can choose:
|   1.Image Detection
|   2.video Detection
|   3.Real-time Detection
|   4.exit
|
|Select your mode:
```



# Results and Discussion

## Face detector

Style	F1
Easy	71.4%
Medium	70.4%
Hard	43.2%



Many faces inside



Images with mask



Side face

# Results and Discussion

## Face mask classifier

	Mask	0.95	0.05
	No Mask	0.08	0.92
Mask			
No Mask			

	Mine	Vinh's model
Accuracy	93.10 %	90.1%
Precision	91.93 %	83%
Recall	94.60 %	90.1%

Vinh's model: one-stage YOLO v3 based detector

Confusion matrix

# Results and Discussion



04

## Conclusion & Further Work

# Conclusion and further work

- 1 A face mask dataset of 100,000 images
- 2 A human face detection model
- 3 A lightweight face mask classifier model
- 4 A software to detect face mask



Further work ...

Not good on poor image quality  
More robust  
More types

# Thank you



Queen Mary  
University of London



北京郵電大學

Beijing University of Posts and Telecommunications