COVID 19 - Detection of Social Distancing In Industrial Environment

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Agenda

- Introduction
- Business Understanding
- Problem Statement
- Data Understanding
- Data Preparation
- Data Modelling
- Evaluation

Introduction

- Coronavirus (COVID-19) was a recently discovered coronaviral infectious condition. Many patients with COVID-19 suffer from mild to severe symptoms.
- Current research indicates that COVID-19 is passed through individuals through the means of direct or indirect interaction with infected persons (through infected items or surfaces).
- As a way to avoid the spread of COVID-19, the WHO recommends social isolation.

Business Understanding

- Roughly 80 % of companies believe that the pandemic would negatively harm their business.
- Most (53 percent) manufacturers expect COVID-19 to have its effect on their market.
- Some large industries have shut down facilities and have increased layoffs to curb financial impact
- According to the PWC study 2020, COVID will impact about 13 million American workers
- According to US Bureau of Labor Statistics, the manufacturing industry saw a decline of 720000 jobs since February 2020.

Problem Statement

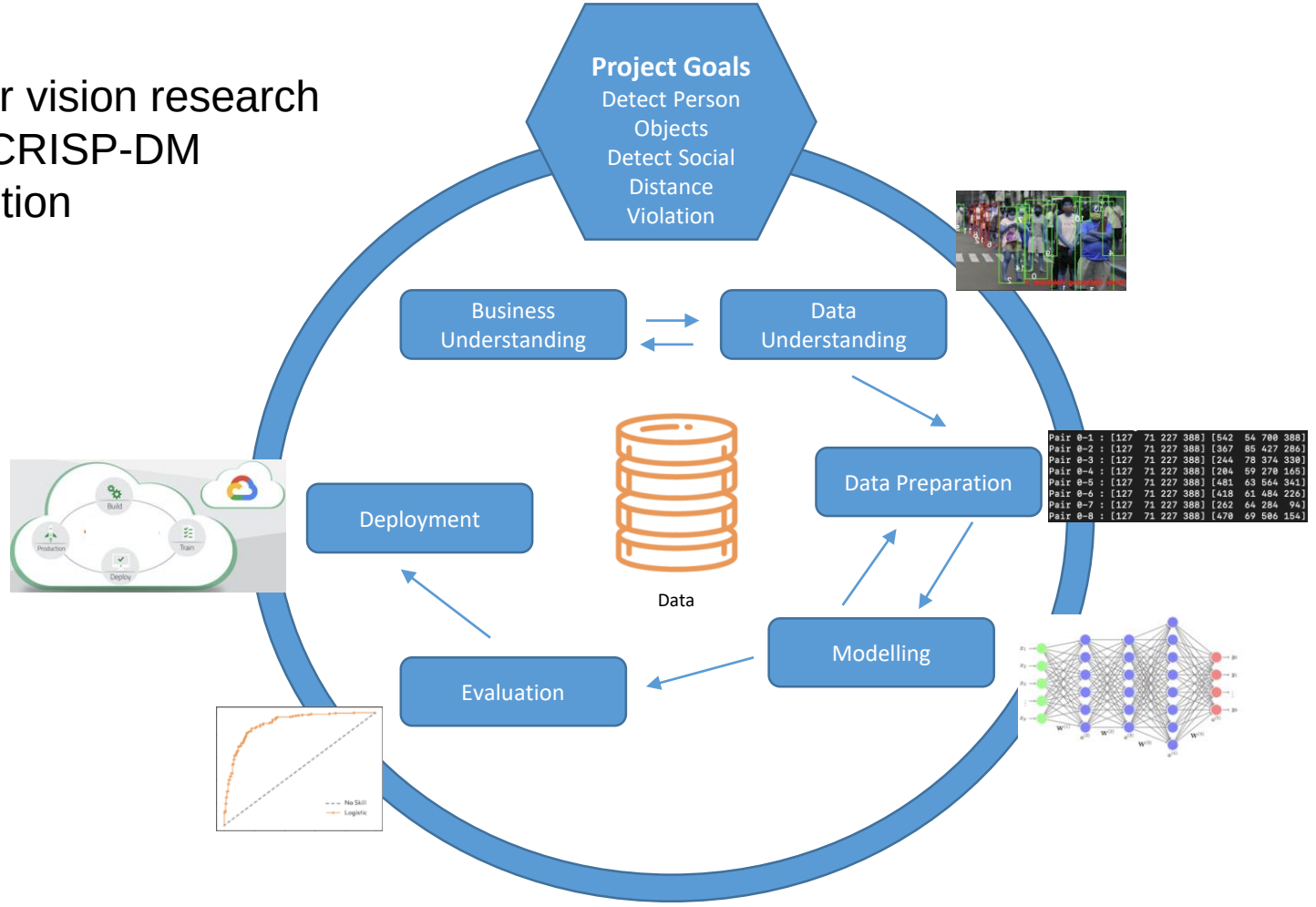
- With COVID 19 requirements eased in numerous countries and factories preparing to reopen, ensuring employee safety in workplaces or factory shops is of priority for the organization.
- The aspect of social distancing at workplace is utmost importance for ensuring safe work environment for the employees and workers.
- **The problem we are trying to address as part of this project is “How do we monitor and measure social distancing on the factory floor?”**

Objectives of the study

- Monitor the movement and placement of workers on the factory shop floor using video streams from cameras
- Measure if the employees are keeping safe distance between each other while being on the floor
- Identify if any of the employees are violating the defined guidelines for social distancing
- Display the violations on a common screen on the floor
- Provide an alert indicating the violation
- Ensure employee health and safety measures are being maintained on the factory shop floor

Project Methodology

This computer vision research project uses CRISP-DM Project execution Methodology.



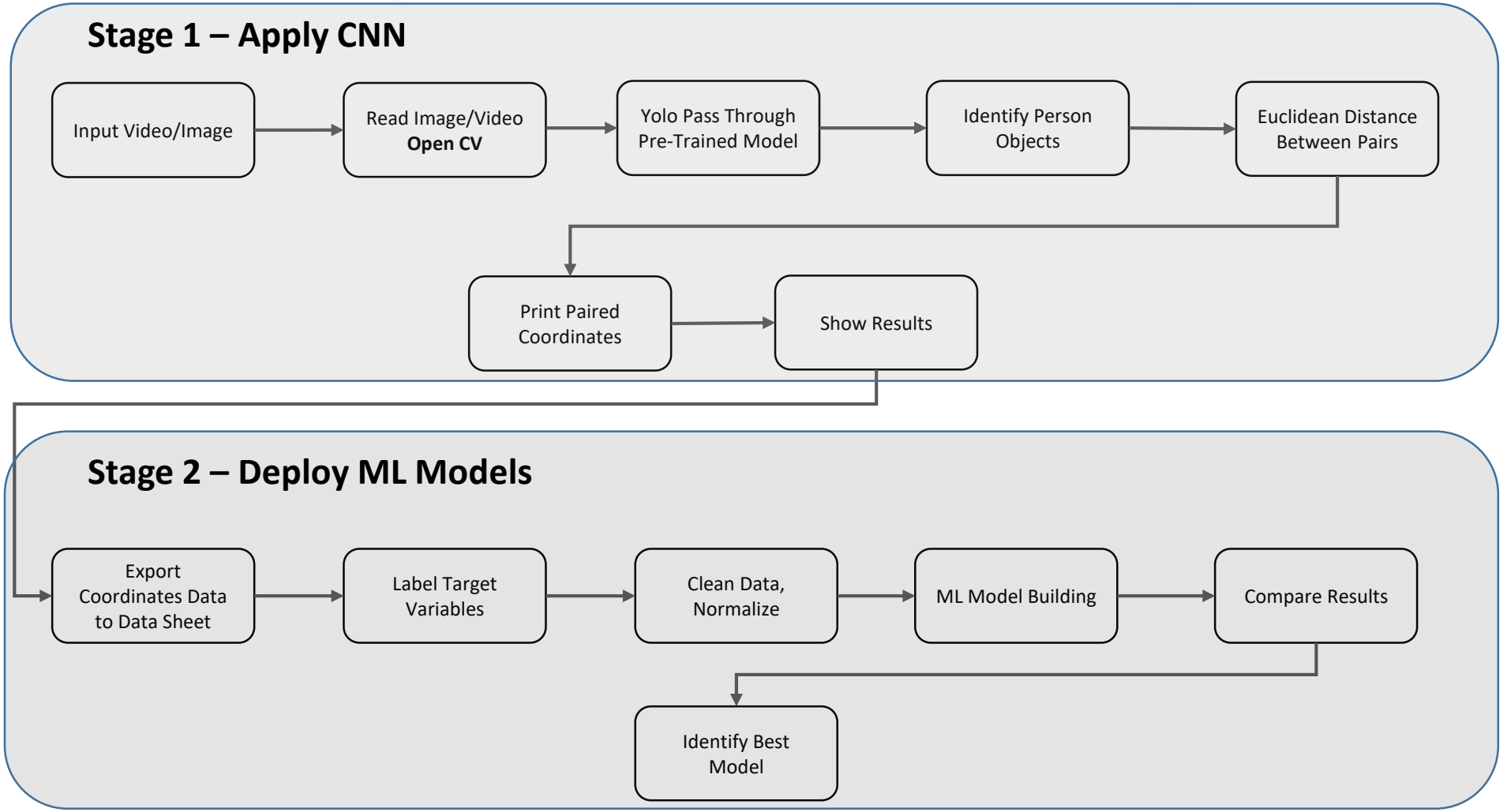
Data Understanding

- Challenge
  - Many factories are yet to have CCTV cameras installed on their shop floors. It becomes very difficult at this moment to get live data from factory shop floors.
- Workaround used to build model
  - We have used publicly available images which comprises of group of people within one image
  - We have also used publicly available video files of “Oxford town center”.

Image Data

Video Data

Data Preparation & Modeling



Data Preparation & Modeling

- Images are passed through an object detection model
- The model uses Darknet along with OpenCV and Yolo pretrained models for “Person” object detection
- 4 coordinates are identified for each object – x,y, Width & Height
  - x = int(centerX - (width / 2))
  - y = int(centerY - (height / 2))
- Function is written to capture coordinates for paired objects, producing 8 data points in a row
- Each row is manually labelled for social distance violation
  - 0 – No violation
  - 1 – Violation present

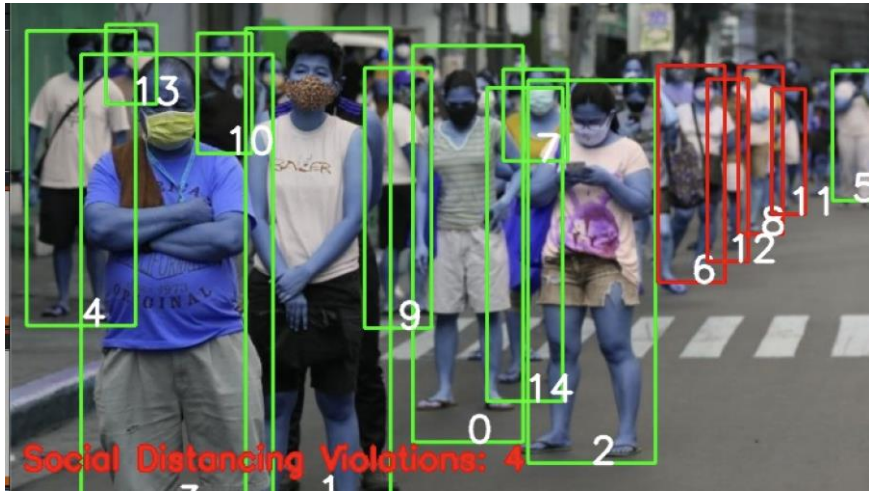
Data Preparation & Modeling

- Data model deployment steps:
- Install dependencies
  - Scipy
  - OpenCV Python
  - Numpy
  - Imutils
- Import all the required libraries
- Download the pre-trained Yolo models – Yolov3 weights and config file
- Read an image and pass it to the model for prediction
- Identify the “Person” objects in the images and the bounding boxes around each object
- Print 4 coordinates for each bounding box – X, Y, Height and Width

- Compute the distance between two people in an image using bounding boxes
- Define a function to compute the Euclidean distance between every two “Person” objects in an image
- Define a function that returns the closest people
- Define a function to change the color of the closest people to red, if the distance between them are less than 50 pixels
- Print how many social distance violations per image
- Extract the coordinates of each paired objects in the image and label for social distance violation
- Run at least 10 machines learning models on the extracted data

Data Preparation & Modeling

Image Processing




```
[INFO] loading YOLO from disk...
[INFO] accessing image...
Pair 0-1 : [325  99 414 419] [190  85 307 468]
Pair 0-2 : [325  99 414 419] [418 127 521 436]
Pair 0-3 : [325  99 414 419] [ 57 106 212 476]
Pair 0-4 : [325  99 414 419] [ 13  87 101 325]
Pair 0-5 : [325  99 414 419] [664 119 697 224]
Pair 0-6 : [325  99 414 419] [523 115 577 290]
Pair 0-7 : [325  99 414 419] [398 118 450 192]
Pair 0-8 : [325  99 414 419] [588 116 624 251]
Pair 0-9 : [325  99 414 419] [286 117 340 327]
Pair 0-10 : [325  99 414 419] [151  89 195 186]
Pair 0-11 : [325  99 414 419] [615 134 642 235]
Pair 0-12 : [325  99 414 419] [563 126 596 273]
Pair 0-13 : [325  99 414 419] [ 77  82 118 146]
Pair 0-14 : [325  99 414 419] [385 133 446 386]
Pair 1-2 : [190  85 307 468] [418 127 521 436]
Pair 1-3 : [190  85 307 468] [ 57 106 212 476]
Pair 1-4 : [190  85 307 468] [ 13  87 101 325]
Pair 1-5 : [190  85 307 468] [664 119 697 224]
Pair 1-6 : [190  85 307 468] [523 115 577 290]
Pair 1-7 : [190  85 307 468] [398 118 450 192]
Pair 1-8 : [190  85 307 468] [588 116 624 251]
```

Image	Pair	Per 1 X	Per 1 Y	Per 1 Width	Per 1 Height	Per 2 X	Per 2 Y	Per 2 Width	Per 2 Height	Violation
4	0-1 :	336	219	442	448	136	209	224	383	0
4	0-2 :	336	219	442	448	419	229	529	459	1
4	0-3 :	336	219	442	448	388	193	440	280	1
4	0-4 :	336	219	442	448	259	239	344	455	1
4	0-5 :	336	219	442	448	188	261	310	468	0
4	0-6 :	336	219	442	448	309	192	354	298	0
4	0-7 :	336	219	442	448	227	184	300	290	0
4	0-8 :	336	219	442	448	288	179	316	224	0
4	0-9 :	336	219	442	448	585	172	622	243	0
4	0-10:	336	219	442	448	588	213	626	277	0
4	0-11:	336	219	442	448	501	179	585	275	0
4	0-12:	336	219	442	448	348	186	386	262	1
4	1-2 :	136	209	224	383	419	229	529	459	0
4	1-3 :	136	209	224	383	388	193	440	280	0
4	1-4 :	136	209	224	383	259	239	344	455	0
4	1-5 :	136	209	224	383	188	261	310	468	1
4	1-6 :	136	209	224	383	309	192	354	298	0
4	1-7 :	136	209	224	383	227	184	300	290	1
4	1-8 :	136	209	224	383	288	179	316	224	0
4	1-9 :	136	209	224	383	585	172	622	243	0
4	1-10:	136	209	224	383	588	213	626	277	0
4	1-11:	136	209	224	383	501	179	585	275	0
4	1-12:	136	209	224	383	348	186	386	262	0
4	2-3 :	419	229	529	459	388	193	440	280	0

Video Processing

Model evaluation

- Implementation classifier review was carried out to assess the different classification methods
- Labelled data was split in to 80%-20% for training and test data
- Data was passed through10 classification machine learning models and KPI results were compared to find the best model
- KPI comparison shows XGBoost is the best model with

  highest Accuracy and F1 Score of 90.5%

Algorithm	Accuracy	Precision	Recall	F1 Score
XGBoost	0.905109	0.686041	0.845920	0.905109
RandomForestClassifier	0.897810	0.752568	0.779442	0.897810
GradientBoostingClassifier	0.890511	0.701214	0.767370	0.890511
LinearDiscriminantAnalysis	0.875912	0.527778	0.937500	0.875912
LogisticRegression	0.868613	0.500000	0.434307	0.868613
LinearSVM	0.868613	0.500000	0.434307	0.868613
rbfSVM	0.868613	0.500000	0.434307	0.868613
QuadraticDiscriminantAnalysis	0.861314	0.542951	0.639394	0.861314
KNearestNeighbors	0.839416	0.601074	0.625726	0.839416
DecisionTree	0.795620	0.670168	0.619430	0.795620
GaussianNB	0.766423	0.464753	0.461002	0.766423

Deployment & Next Steps

- This solution can now to be deployed to the systems connecting to CCTV cameras on the factory shop floors.
- The detector could highlight people using red bounding boxes, if the distance between two or more people is below the minimum acceptable value.
- The system can also be configured to issue an alert to remind people to keep a safe distance or alert a supervisor to take action if the protocol is violated.

Thank You

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Q &A?