If You Must Mask

Face Mask Detection with Deep Learning and Computer Vision

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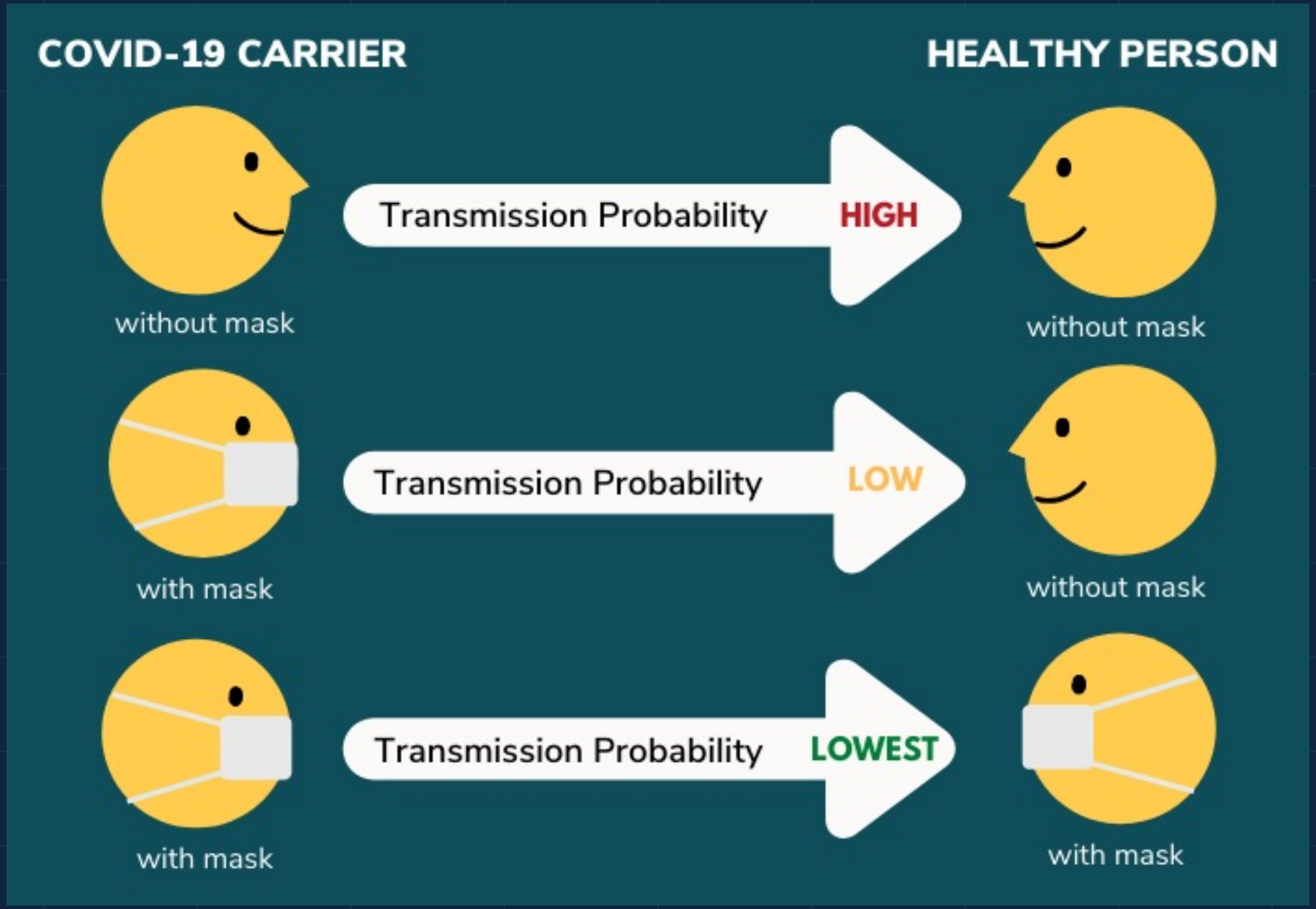
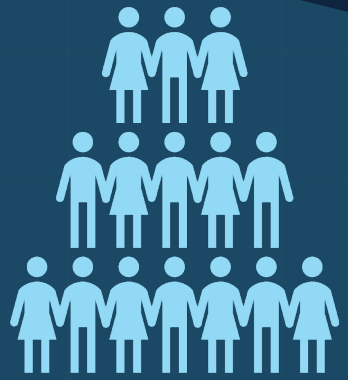
Metis Bootcamp Project VI

INTRODUCTION



10cm

Problem



Increased crowd volume as life returns to normal

Mandated mask at **indoor public** places (i.e. airports, hospital, etc.)

Difficult and **inefficient** to inspect the large crowd with **labor screening**

10cm

GOAL

Build a **face mask detection system** using deep learning algorithm and computer vision

10cm

Tools

Cloud Computing

Google Colab
Python
Numpy
Matplotlib
Seaborn

DL Model

Keras/Tensorflow

Face detection

OpenCV
Haar Cascade

Production

Streamlit
Heroku

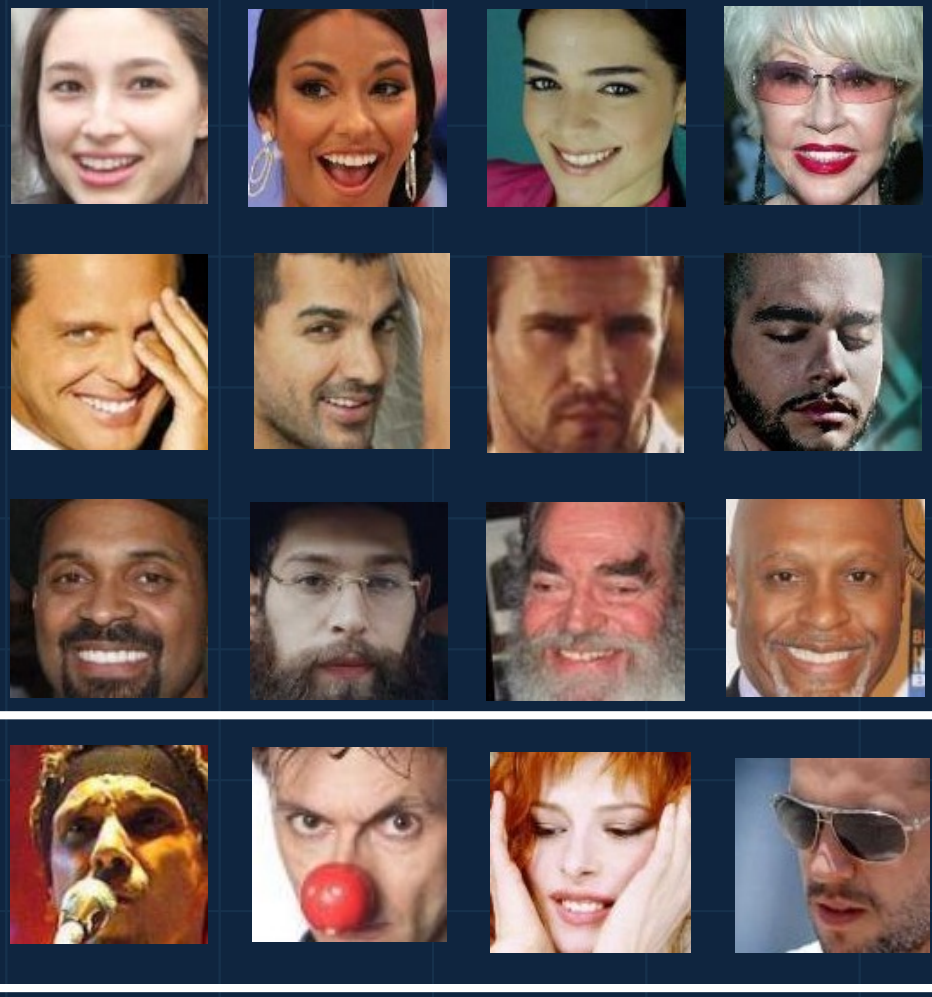
DATA

Face Mask Detection dataset from Kaggle
11,800 Images

DATA

Face Mask Detection dataset from Kaggle
11,800 Images

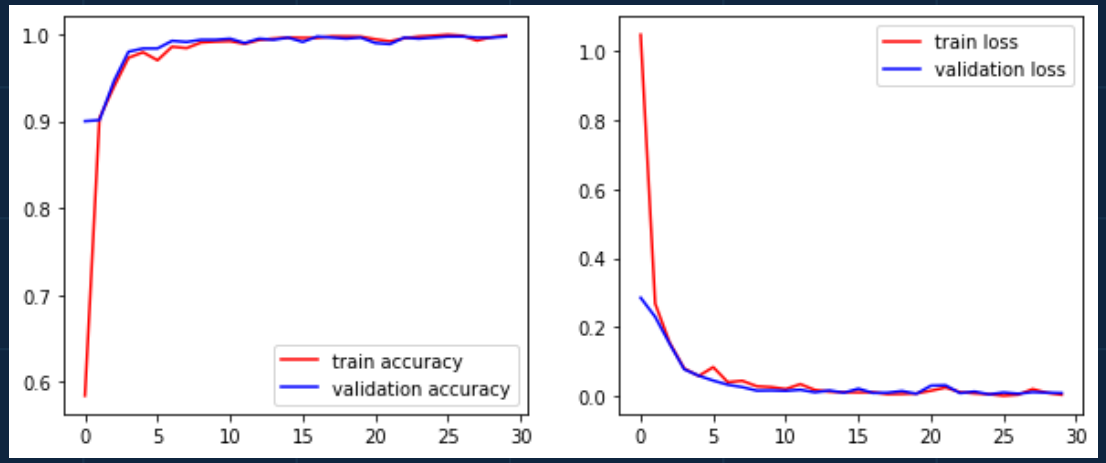
Without Mask

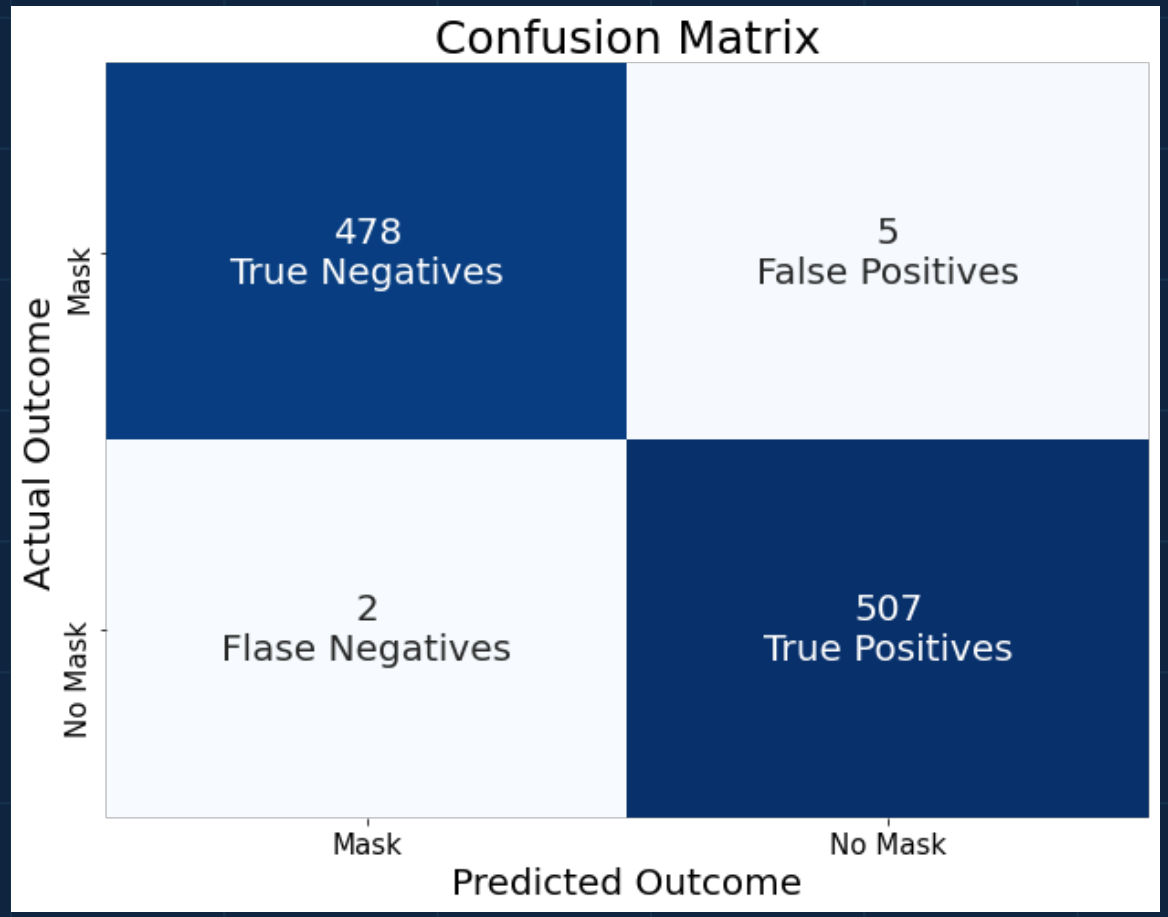


With Mask

Binary Model Performance

Scores	Binary CNN
Accuracy	0.99
Precision	0.99
Recall	0.99
F1	0.99

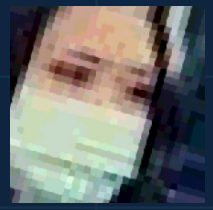


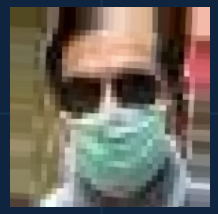
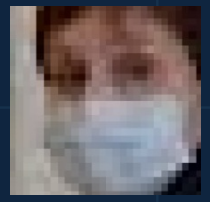


Binary Model Examples

“Good Citizens”

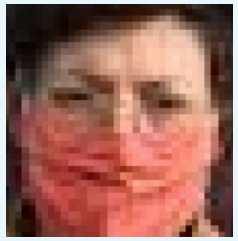
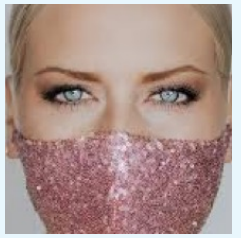
True Negatives

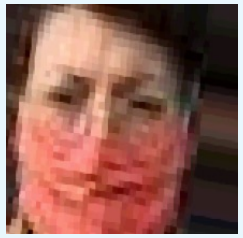
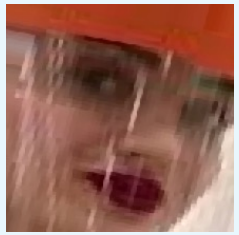


“False Alarm”

False Positives


“Free Pass”

False Negatives


“Gotcha!”

True Positive

Binary Model

1. With Mask
2. Without Mask

3-class Model

1. With Mask
2. Without Mask
3. **Incorrect Mask**

DATA For 3-Class Model

Previous Data:
11,800 Images

+

MaskedFace-Net dataset

CelebFaces dataset

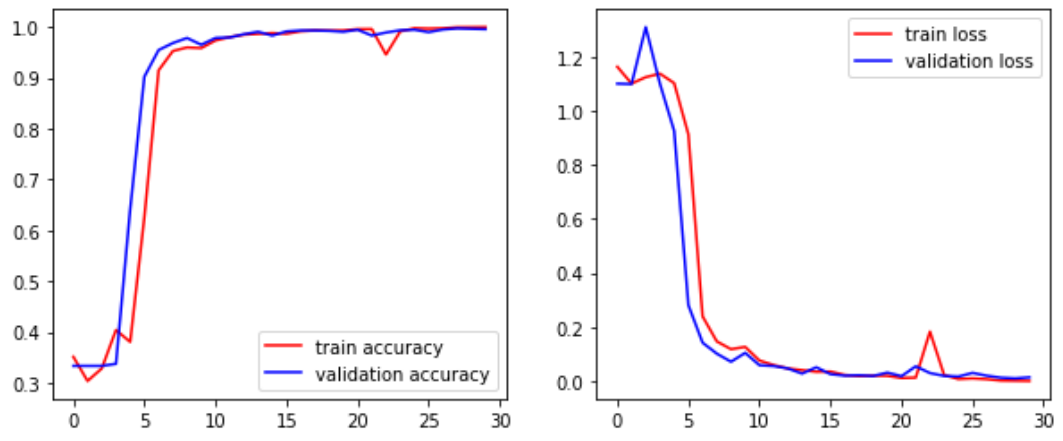
→

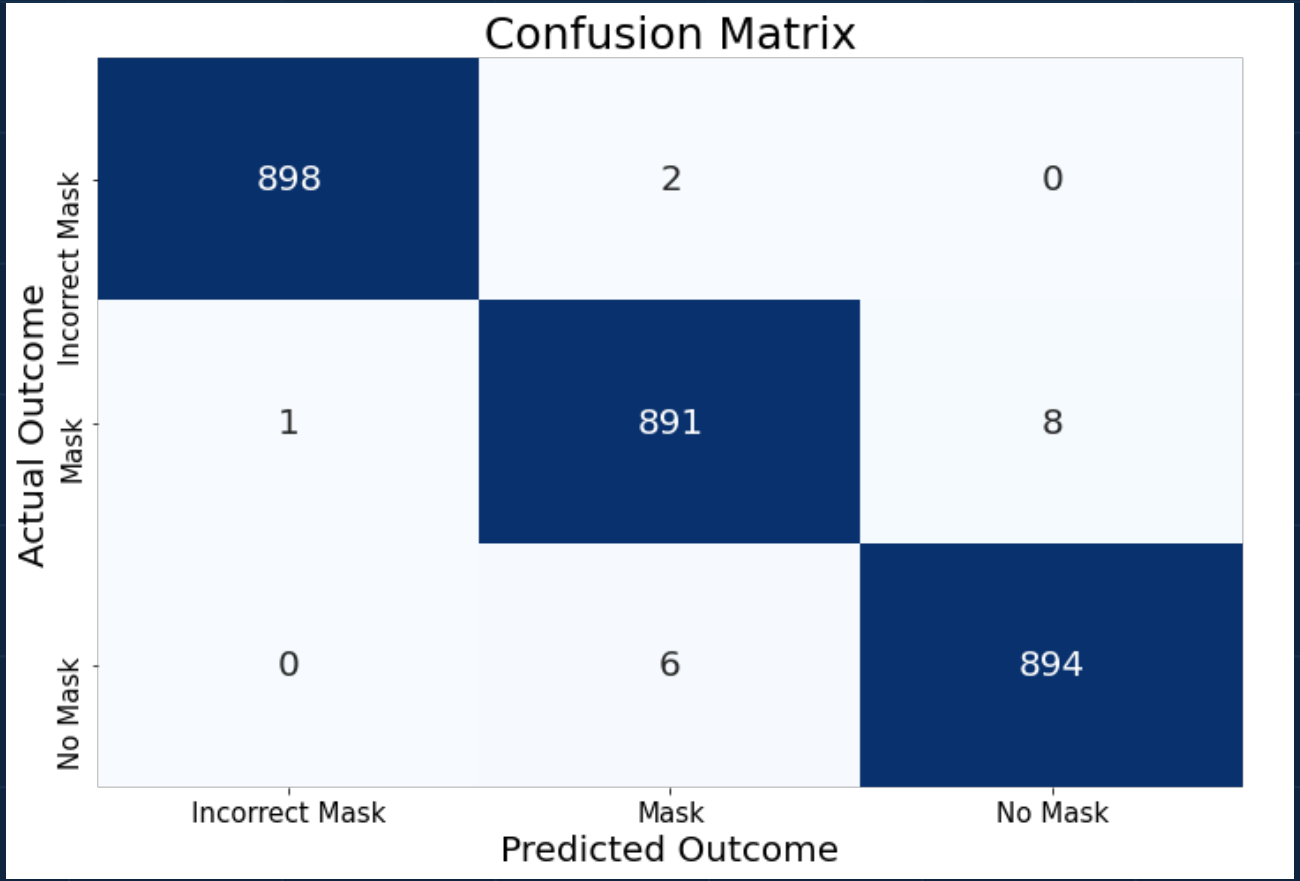
Modified Data:
24,000 Images
(Evenly distribution among classes)

10cm

3-class Model Performance

Scores	Binary CNN	3-Class CNN
Accuracy	0.99	0.99
Precision	0.99	0.99
Recall	0.99	0.99
F1	0.99	0.99





3-class Model Examples

Test set images

New images

With Mask

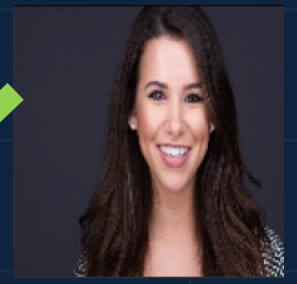
"With Mask"

"With Mask"

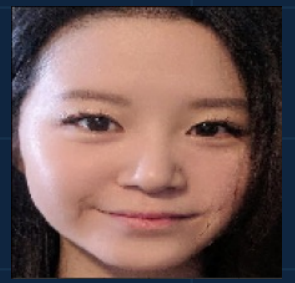
"With Mask"

No Mask

"No Mask"



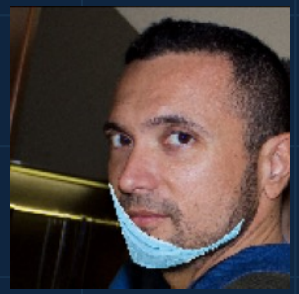
"No Mask"



"No Mask"

Incorrect Mask

"Incorrect Mask"



"Incorrect Mask"

"With Mask"

"With Mask"

Insights

- **Binary Model** – Great performance on both **dataset** and **new real-life images**
- **3-Class Model** – Great performance within the dataset, but **not very good on new real-life images** for “incorrect mask”
- Binary Model is more suitable for **real-life application**

10cm

Application in Real-Life

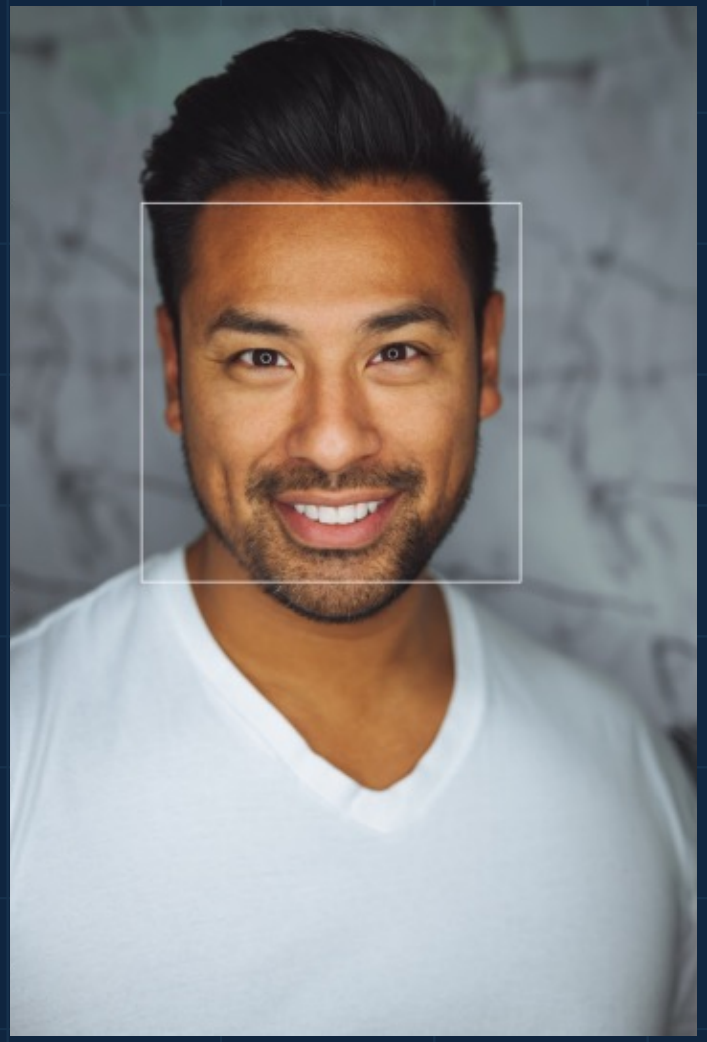
Dataset Image

Real-life Image

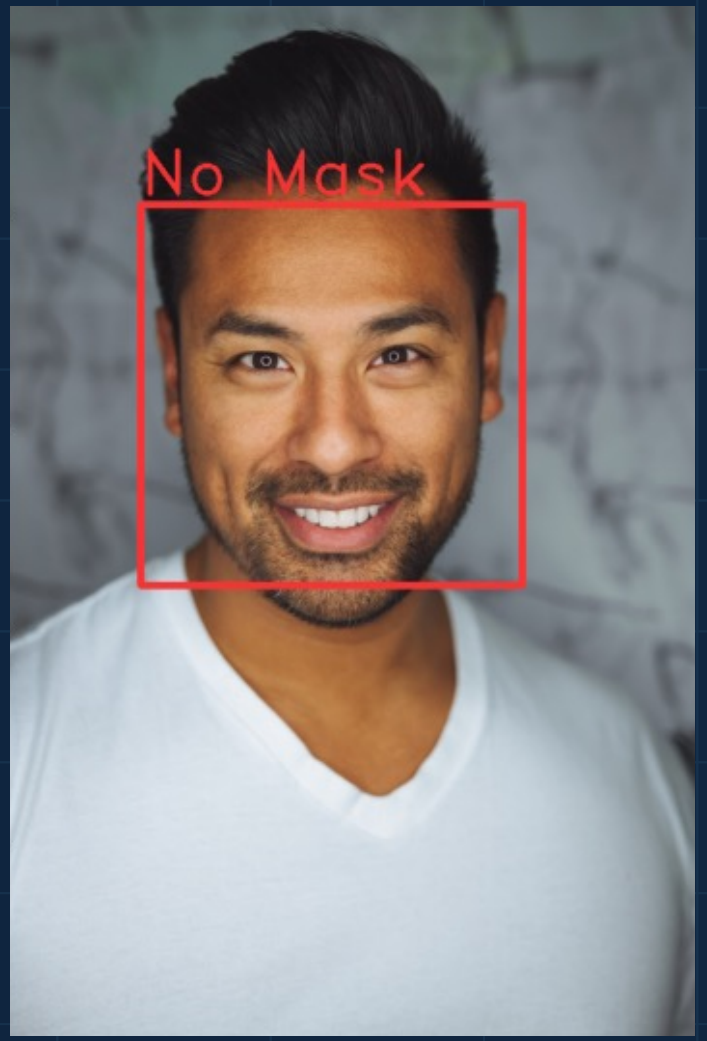
10cm

WORKFLOW for Face mask detection

1 Detect Face



2 Apply Mask Detector



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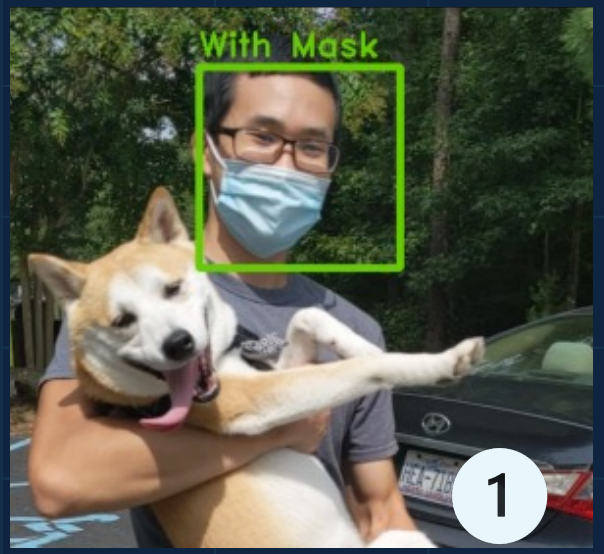
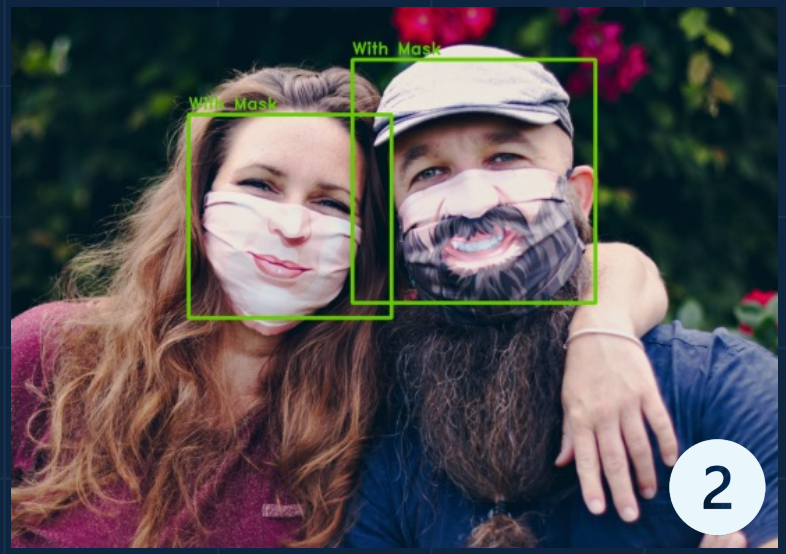
RESULTS
With Mask

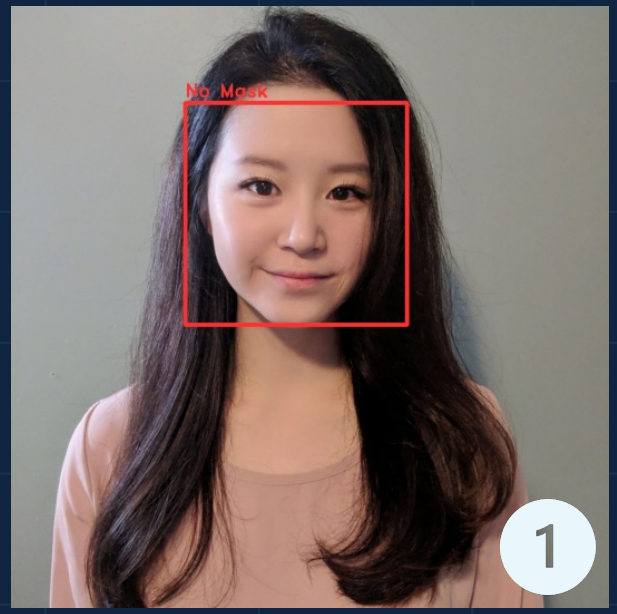


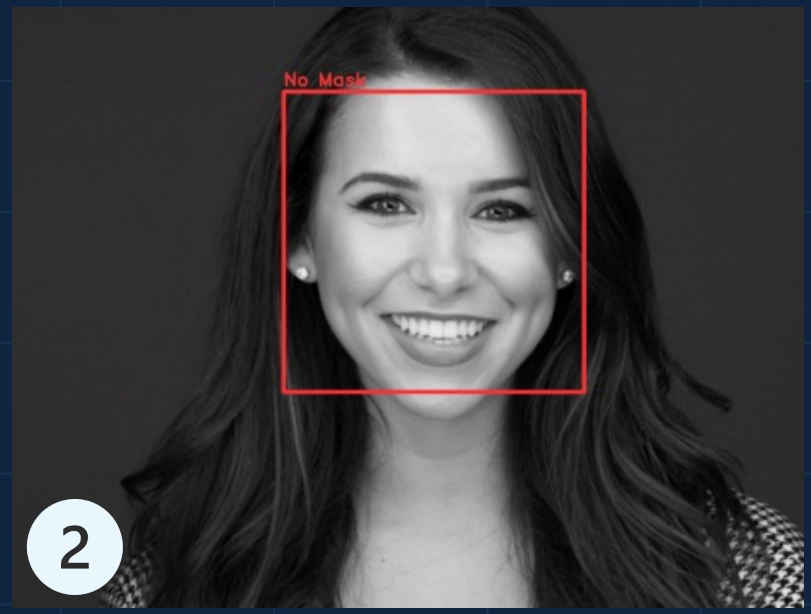


10cm

RESULTS

No Mask





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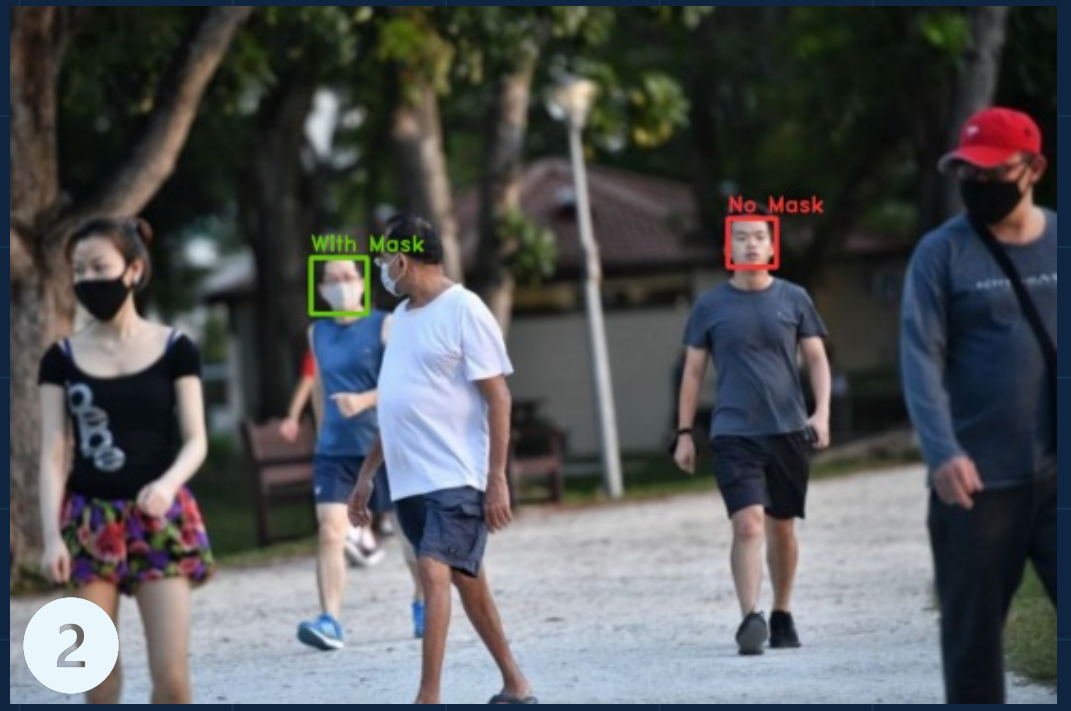
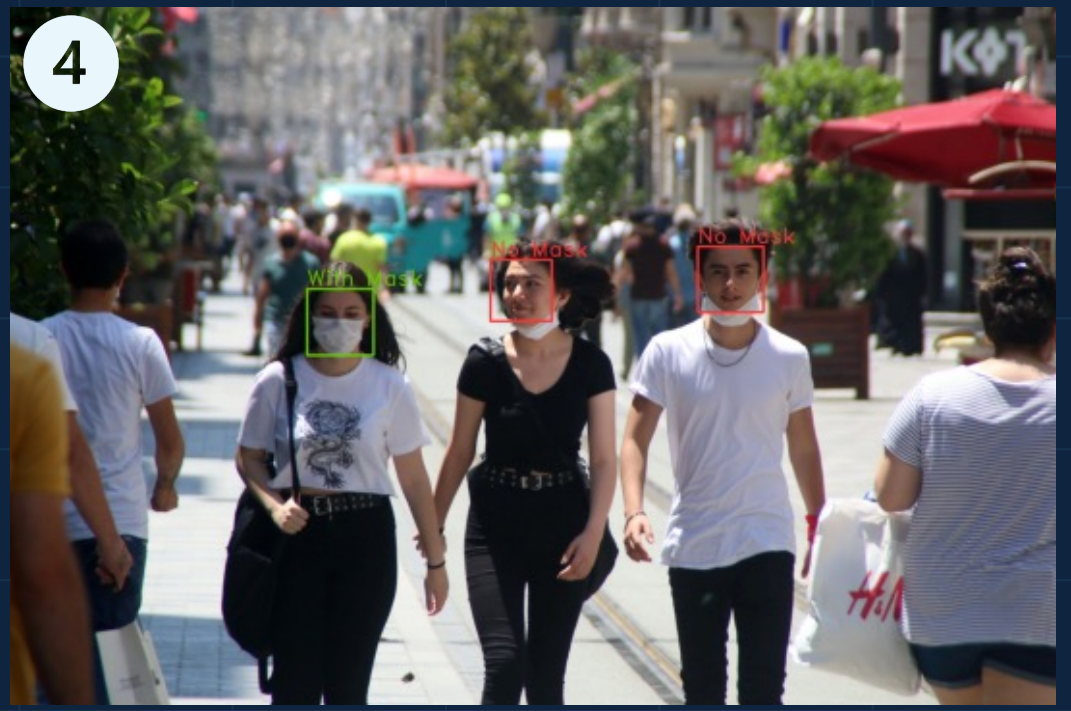
RESULTS
Mixed





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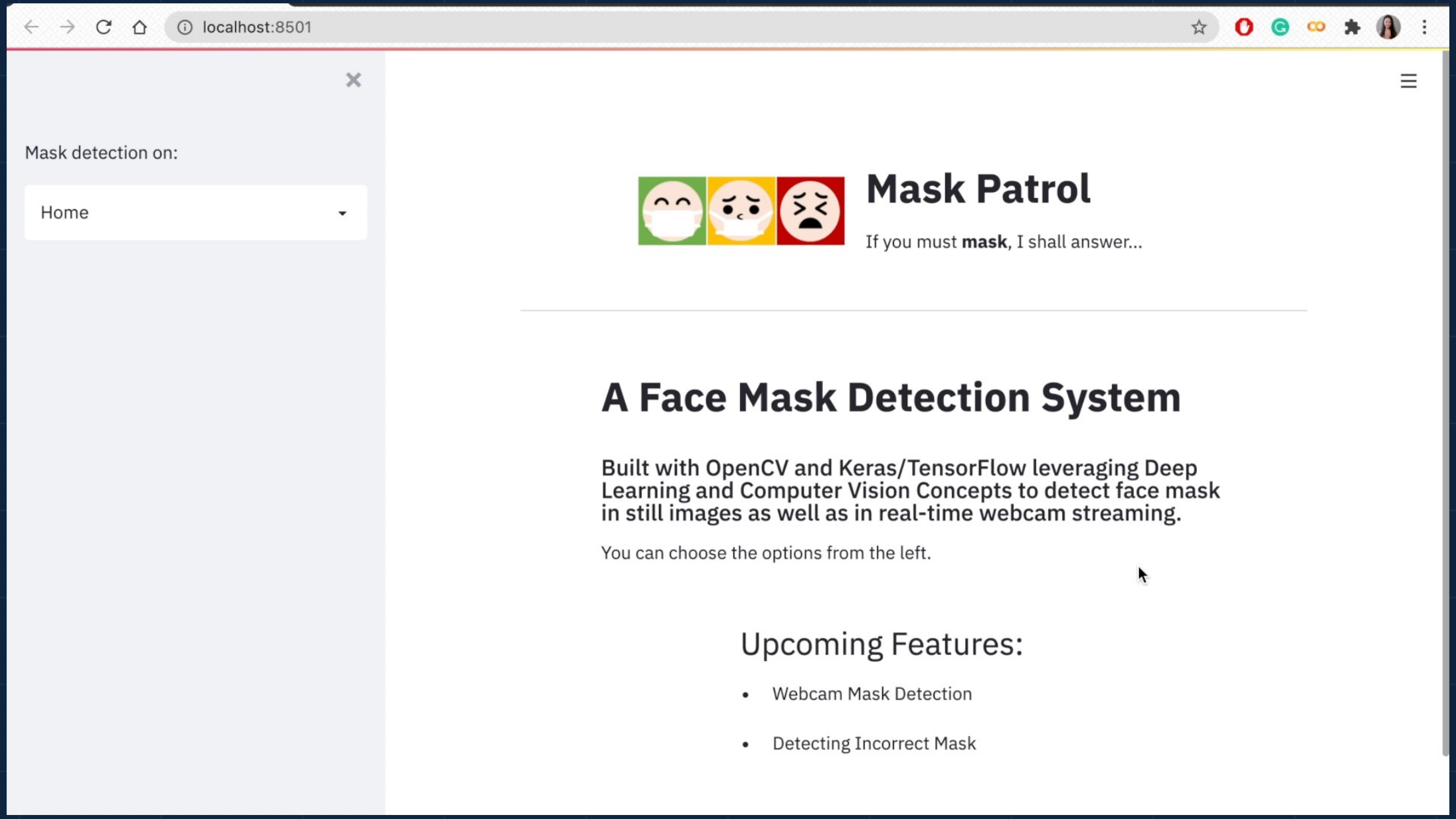
APPLICATION



FUTURE WORK

1. Process 3-Class model images
   Crop to face area with Haar Cascade Classifier

2. Build a robust 3-Class model
   That can be used outside of the dataset

3. Feature Extraction, Data Augmentation
   Generalize images

THANK YOU

Questions?
Mask away!

CrystalHuang-ds

crystal-ctrl

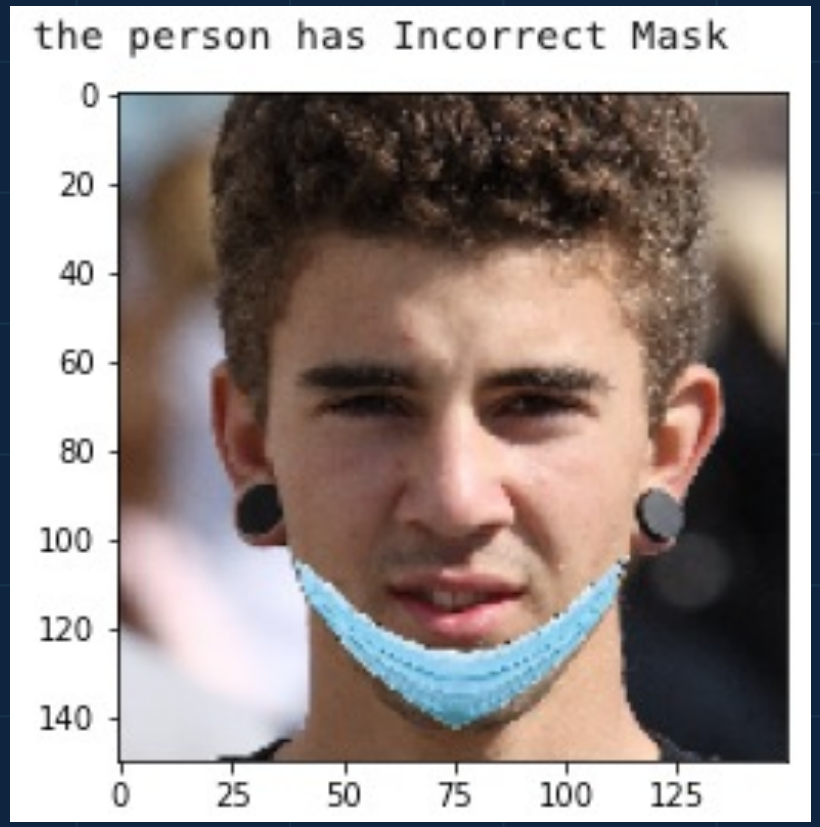
https://mask-patrol.herokuapp.com/

References

1. Mittal, A. 2020. “Haar Cascades, Explained.” *Analytics Vidhya*. *Medium*. https://medium.com/analytics-vidhya/haar-cascades-explained-38210e57970d
2. Menon, A. 2019. “Face Detection in 2 Minutes using OpenCV & Python.” *Towards Data Science*. *Medium*. https://towardsdatascience.com/face-detection-in-2-minutes-using-opencv-python-90f89d7c0f81
3. Rosebrock, A. 2018. “OpenCV Face Recognition”. *Pyimagesearch*. https://www.pyimagesearch.com/2018/09/24/opencv-face-recognition/

10cm

Appendix 1



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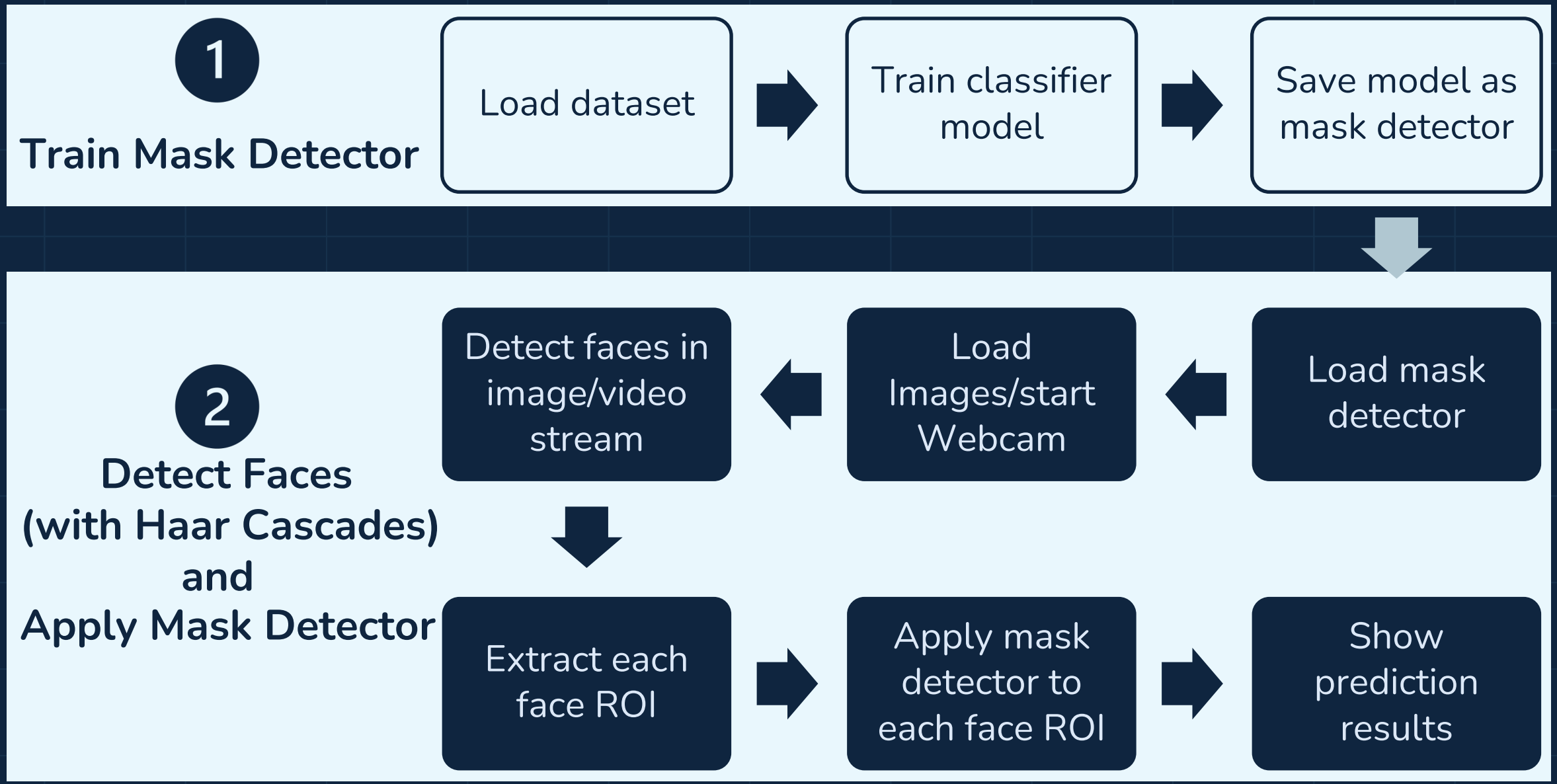
Appendix 2 - WORKFLOW



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Appendix 3-1

Load the model

```
model = load_model('binary_model.h5')
```

```
# load the test set for prediction
test_dir = 'Face Mask Dataset/Test'
image_gen = ImageDataGenerator(rescale=1./255)
test_generator = image_gen.flow_from_directory(test_dir,
                                               target_size=(150,150),
                                               batch_size=80,
                                               seed=42,
                                               shuffle=False,
                                               class_mode='binary')
prediction = model.predict_classes(test_generator)
y_true = test_generator.labels
```

```
Found 992 images belonging to 2 classes.
```

10cm

Appendix 3-2

Map Files to Prediction Results ¶

[17]:
```
filenames = [x for x in test_generator.filenames]
label = [x for x in y_true]
predict = [x[0] for x in prediction]

import pandas as pd
df = pd.DataFrame(list(zip(filenames, label, predict)), columns=['Filenames', 'Label', 'Predict'])
df.head()
```

[17]:

	Filenames	Label	Predict
0	WithMask/1163.png	0	1
1	WithMask/1174.png	0	0
2	WithMask/1175.png	0	0
3	WithMask/1203.png	0	0
4	WithMask/1361.png	0	0

10cm

Appendix 3-3

[18]:
```
# function to add "Outcome" column
def predict_outcome(row):
    if (row['Label'] == 0) & (row['Predict'] == 0):
        return "TN"
    elif (row['Label'] == 0) & (row['Predict'] == 1):
        return "FP"
    elif (row['Label'] == 1) & (row['Predict'] == 1):
        return "TP"
    elif (row['Label'] == 1) & (row['Predict'] == 0):
        return "FN"

# applying function
df['Outcome'] = df.apply (lambda row: predict_outcome(row), axis=1)
```

[56]:
```
# Sanity check
df.sample(5)
```

[56]:

	Filenames	Label	Predict	Outcome
73	WithMask/86.png	0	0	TN
748	WithoutMask/3945.png	1	1	TP
460	WithMask/Augmented_854_5503218.png	0	0	TN
826	WithoutMask/4597.png	1	1	TP
675	WithoutMask/3012.png	1	1	TP

[58]:
```
df.Outcome.value_counts()
```

[58]:
```
TP    507
TN    478
FP      5
FN      2
Name: Outcome, dtype: int64
```

10cm

Appendix 3-4

False Positive

Predict = No Mask

Actual = With Mask

```
[20]: df[df["Outcome"]=="FP"]
```

[20]:

	Filenames	Label	Predict	Outcome
0	WithMask/1163.png	0	1	FP
48	WithMask/45.png	0	1	FP
379	WithMask/Augmented_689_9677847.png	0	1	FP
448	WithMask/Augmented_824_6606851.png	0	1	FP
482	WithMask/Augmented_99_5504654.png	0	1	FP

10cm

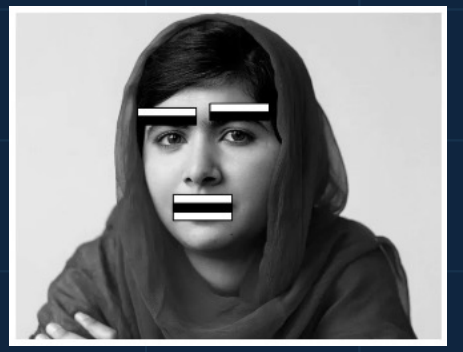
Appendix 4

- Haar Cascades –
  - Key component of the Viola-Jones object detection framework
  - Edge features
  - line features
  - 4-rectangle features

10cm

Appendix 4

- Face Detection –
  - Edge feature indicating **eyes and cheeks**
  - Line feature indicating bridge of the nose



10cm