



ASIAN INSTITUTE OF MANAGEMENT

LEAD. INSPIRE. TRANSFORM.



ALWAYS REMEMBER!

**Smoking is
Dangerous!**



QUESTION?

Why is secondhand smoking toxic?

“Secondhand smoke is **already contaminated**. It’s **already contaminated by the person who is smoking**. So, that’s even worse, because **you’re being doubly contaminated, more than smoking it**.

Adults exposed in the office setting (workplace)

12.9%

Adults exposed in restaurant establishments

12.2%

Adults exposed on public transportation

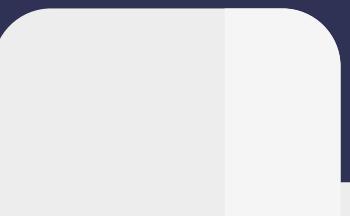
9.5%

Secondhand Smoking Exposure

IN THE PHILIPPINES (ADULTS AGES 15+)

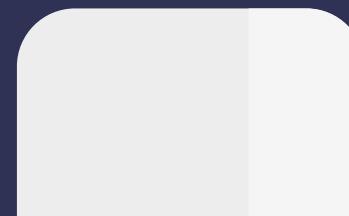
Secondhand Smoking Exposure

IN THE PHILIPPINES (YOUTH AGES 13-15)



Youth exposed in
enclosed public spaces

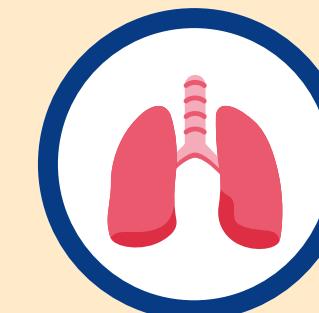
41.7%



Youth exposed at
their own homes

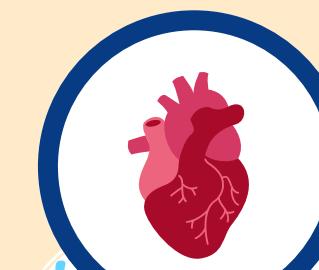
29.3%

DANGERS OF SECONDHAND SMOKING!



RESPIRATORY

COPD, LUNG CANCER, ASTHMA



CARDIOVASCULAR

HEART ATTACK, STROKE, ETC.



REPRODUCTIVE

LOWER BIRTH WEIGHT, ETC.



NERVOUS SYSTEM

BRAIN TUMORS

44.6B
PESOS

Economic **cost of smoking-attributable diseases** in the Philippines (2016)



CHALLENGES IN SMOKING REGULATIONS



ENFORCEMENT

Difficulty in enforcing smoking bans in public spaces.

RESOURCES

Limited resources for manual surveillance.



SCALABILITY

Countries with strict smoking laws like Singapore

PROJECT OBJECTIVE

DETECT SMOKERS

How might we use deep learning image classification to detect smoking in non-designated areas and alert authorities, improving enforcement without constant human surveillance?





HULI KA, BALBON!

AUTOMATED ALARM FOR
SMOKING IN NON-DESIGNATED
AREAS USING DEEP LEARNING



**YOU MIGHT ASK?
WHY NOT RELY
ON SMOKE
DETECTORS?**



SMOKE DETECTOR

WEATHER

Not water-resistant,
available only for
forest fire detection



DEEP LEARNING

COMPETING

Presence of **different**
sources of smoke in
the public setting

CONVENIENCE

Model can be
applied to existing
CCTVs

BUSINESS VALUE



Market size of the
surveillance industry
in 2022



Forecasted market
size of surveillance
industry in 2028

NEW VENTURE?
Business opportunity
for those who want to
enter the **surveillance**
industry

REAL-WORLD APPLICATION



Public Health Applications

- Collect data on smoking behavior for research



Smart City Initiatives

- Integrate the system for auto surveillance

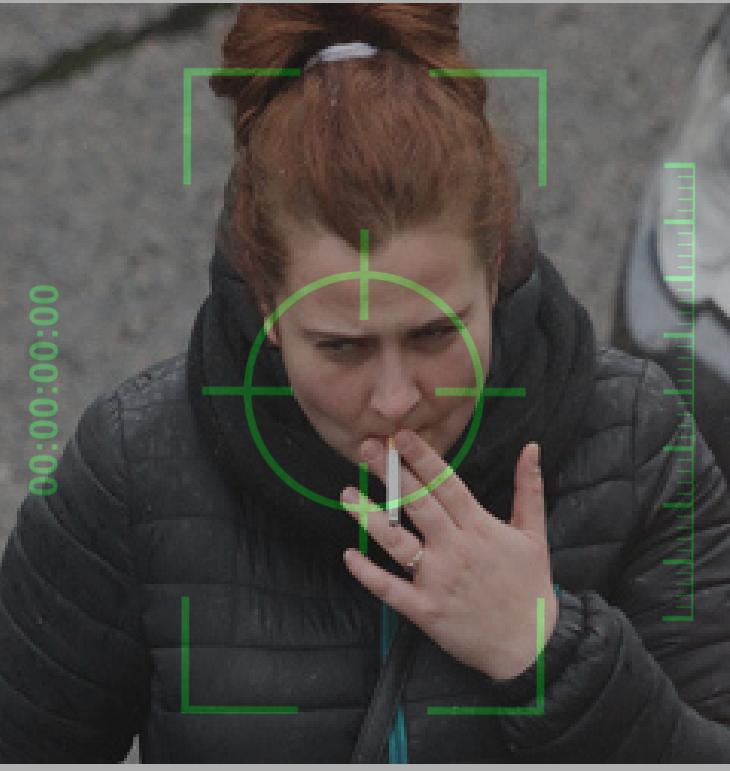


Commercial/ Government

- Can help enforce smoking bans and policies



00:00:00:00



REC

DATA SET

CANDID IMAGES OF PEOPLE

716

NUMBER OF TRAIN
DATA IMAGES

180

NUMBER OF
VALIDATION DATA

224

NUMBER OF TEST
DATA IMAGES

The images taken from Kaggle were labeled as:

✗ NON-SMOKING

✓ SMOKING



IMAGE CLASSIFIER **METHODOLOGY**

METHODOLOGY



01

SELECT BEST MODEL

Compare models (CNN, VGG16, Xception) and choose best



02

IMPLEMENT MODEL

Classify candid images of people and test with multiple cases



03

EVALUATE RESULTS

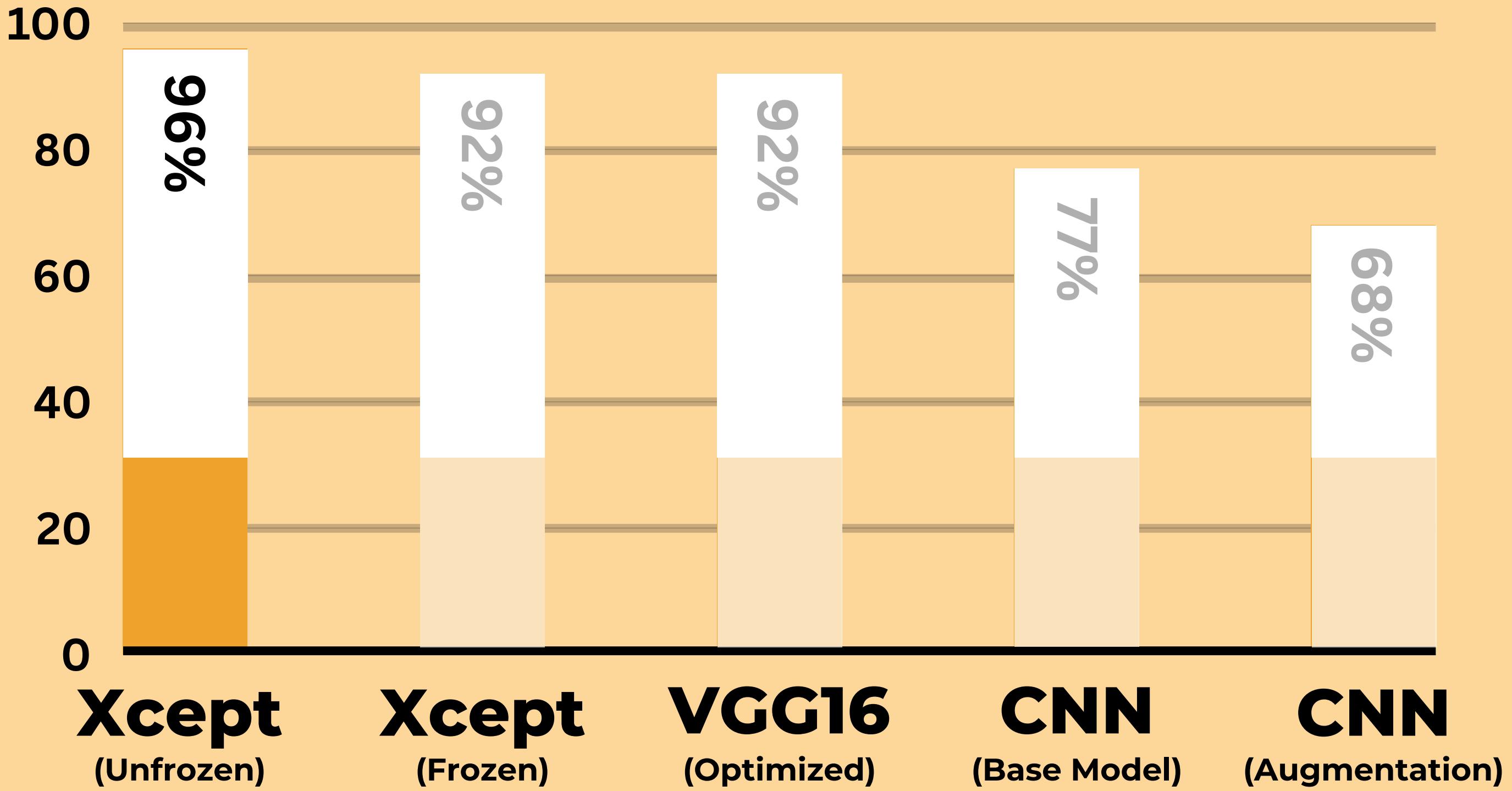
Check test metrics and scores to determine usability of model



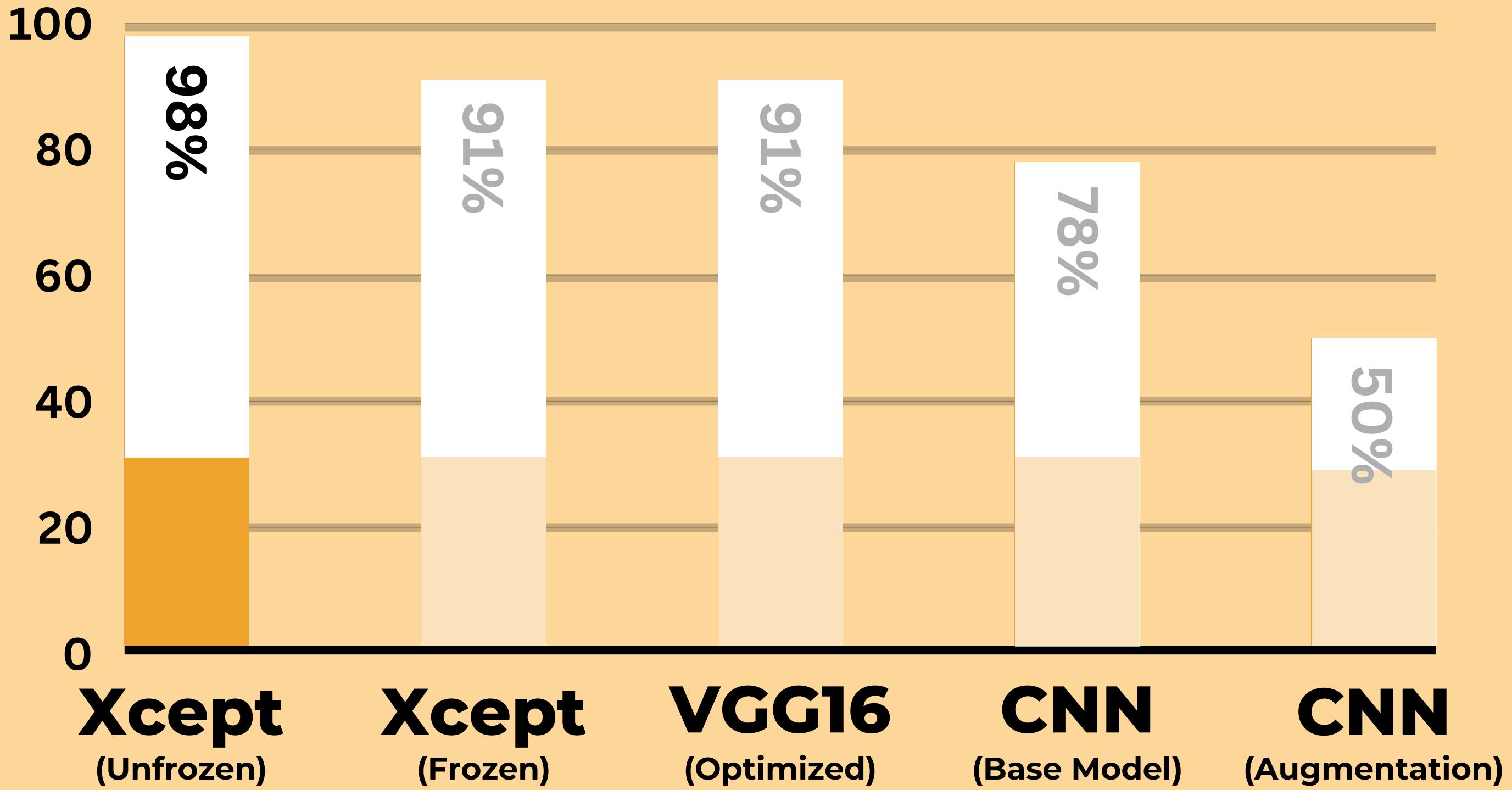
04

EXPLAINABILITY

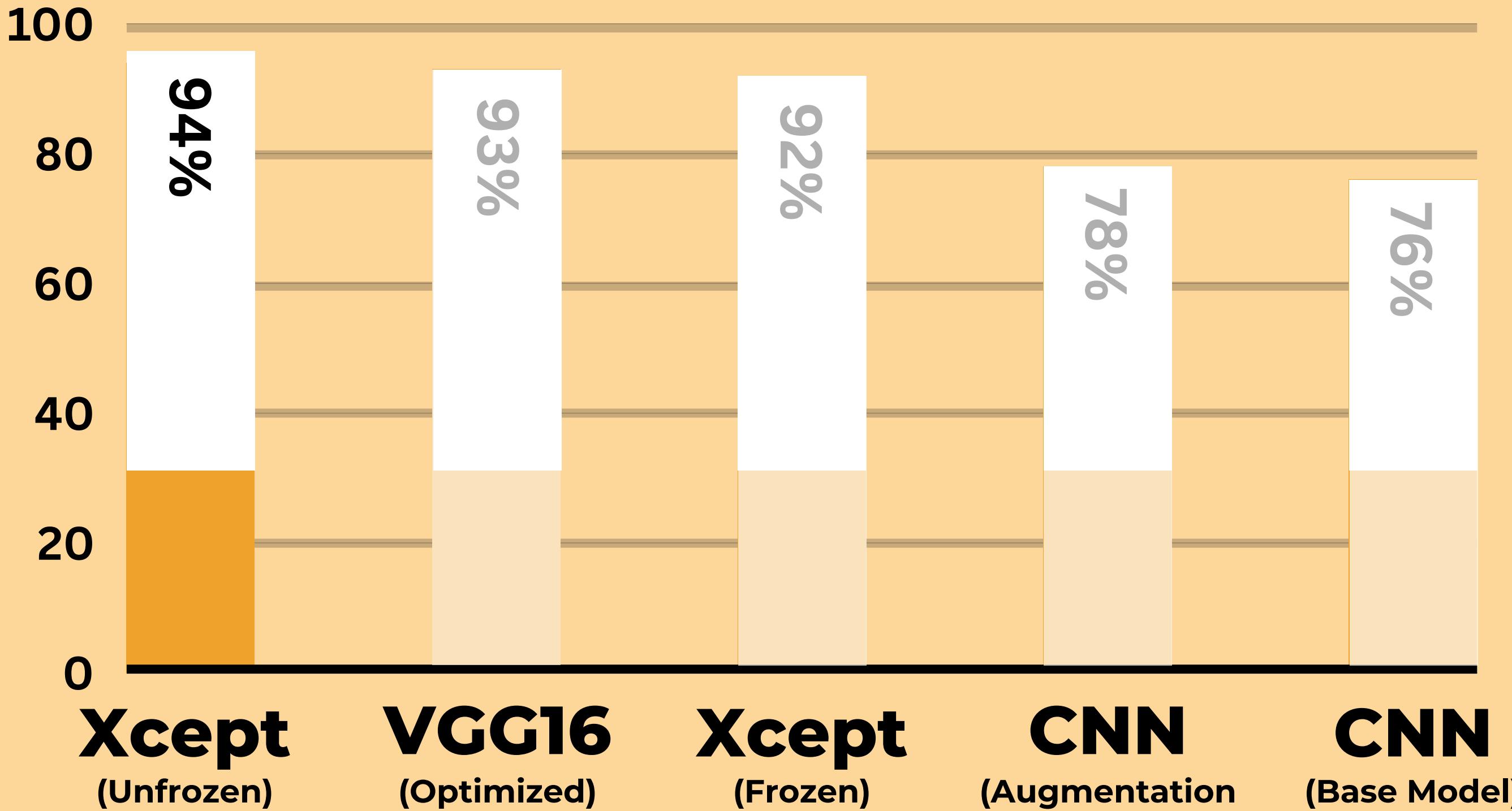
Visualize model decision process and test on different cases



In terms of **validation accuracy**, **Xception (Unfrozen)** performed the best at **96%**



In terms of **validation recall**, **Xception (Unfrozen)** performed the best at 98%.



In terms of validation precision, **Xception (Unfrozen)** performed the best at 94%.

WITH UNFROZEN LAYERS

Xception

- Test Accuracy: **0.96**
- Test Recall: **0.98**
- Test Precision: **0.93**

Results are based on the ER
index (threshold) of 0.11.



WITH UNFROZEN LAYERS

Xception

beats the **62.5% baseline**
(PCC * 1.25) accuracy



WITH UNFROZEN LAYERS

Xception

beats the **average accuracy**
on Kaggle notebooks at 91.8%



RESULTS

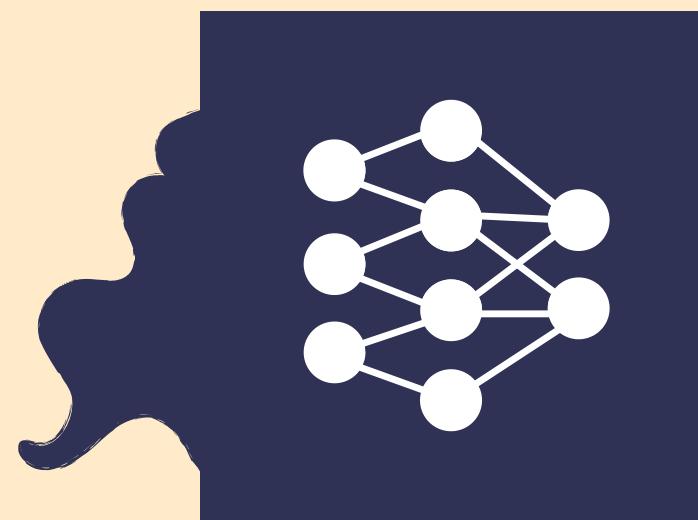
CONFUSION MATRIX



TRUE NEGATIVE	FALSE POSITIVE
118	9
FALSE NEGATIVE	TRUE POSITIVE
2	128

The confusion matrix is **based**
on the test dataset.

MORE DETAILS ABOUT OUR Xception Model



RESIDUALS

Makes use of residual connections to allow deeper learning



POOLING

Makes use of Global Average Pooling to help prevent overfitting



UNFROZEN

Trains its last convolutional layers on the data

LET US TRY SOME TEST IMAGES
TEST OUR
MODEL ON OUR
“MODELS”



JEDDERS IS A CERTIFIED
YOSI BOIIII



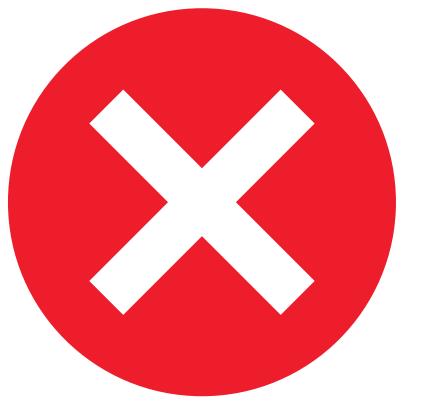
REC



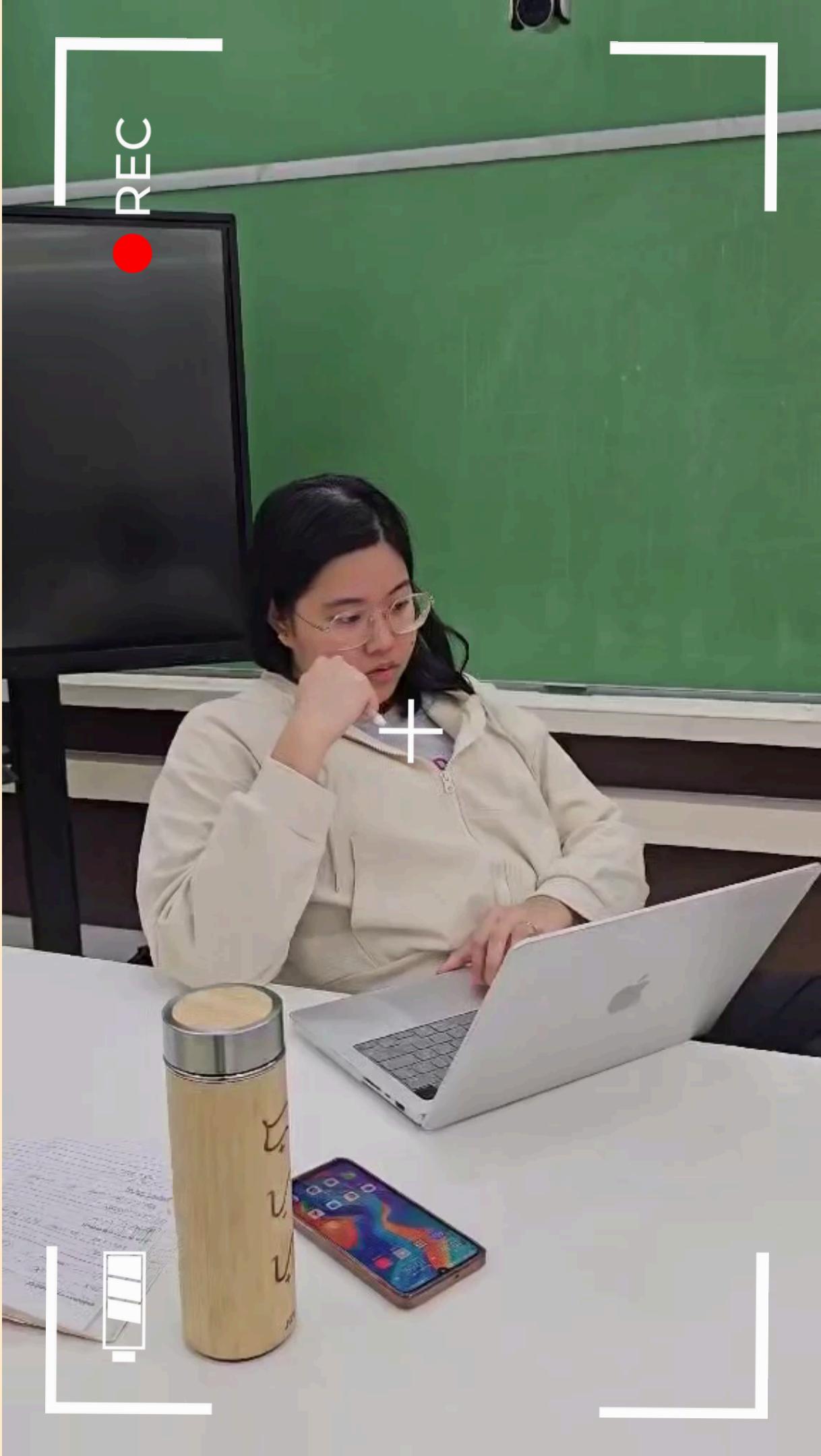
Identified with 100% certainty

IMPORTANT QUESTION

IS PAU GURL A SMOKER?



PAU GURL IS NOT A
SMOKER





DECISION MAKING
**WHERE DOES
THE MODEL
LOOK?**

Class Activation

Identifies activation areas which are used for predicting classes



Class Specific

Interprets differently based on the class it is tested on



Heat Map

Provides a heat map visualization for easier interpretation



THIS IS HOW THE EXPLAINABILITY MODEL WORKS

Gradient-weighted Class Activation Mapping

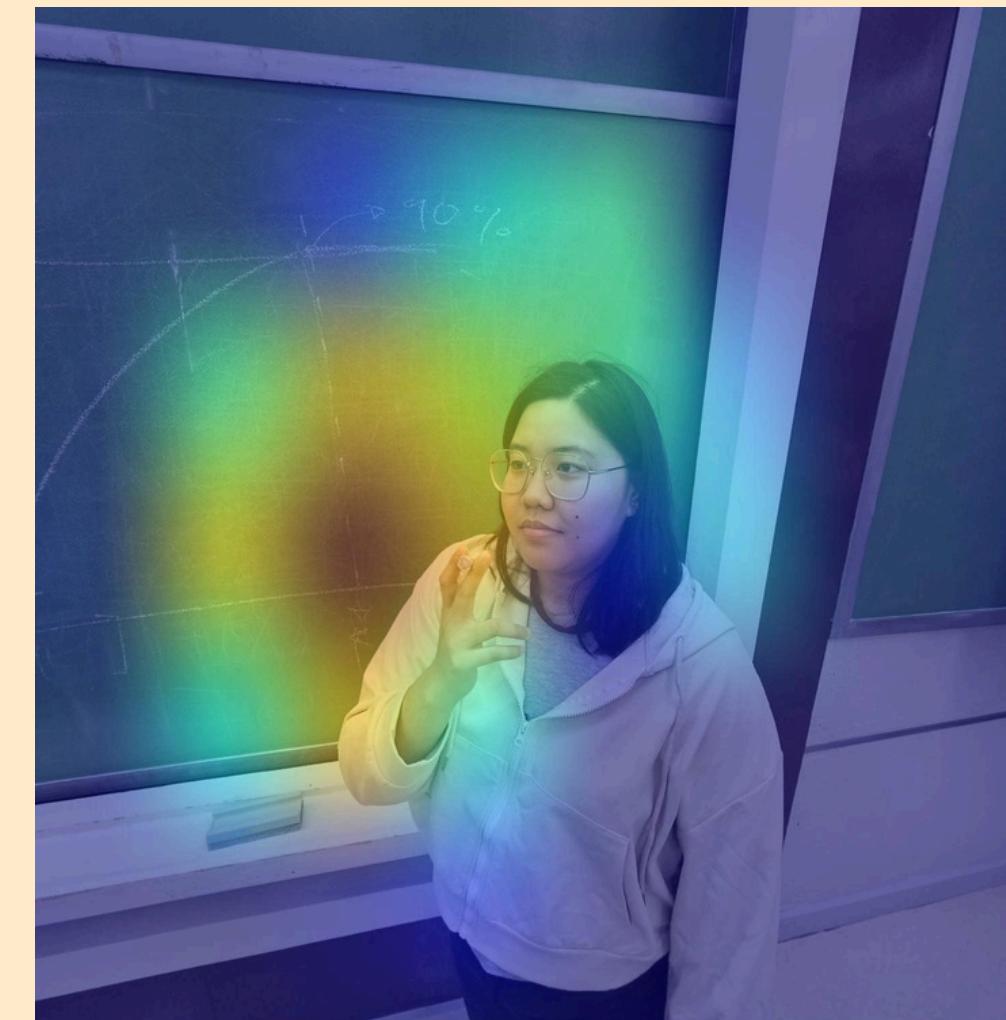
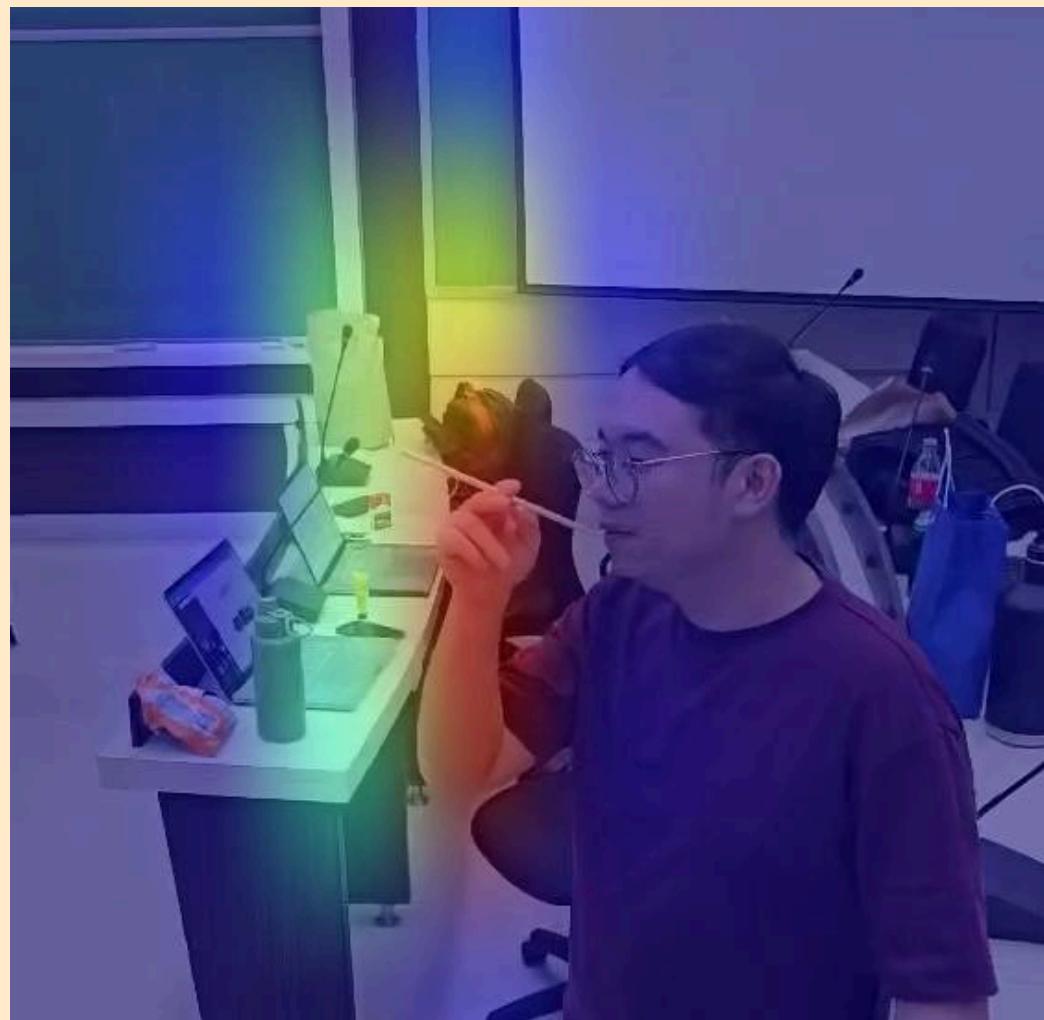
THE MODEL LOOKS AT THE
**STICKS &
HAND AREA**

A photograph of a man sitting on a tiled floor, smoking a cigarette. He is wearing a dark t-shirt and light-colored pants. A vibrant, multi-colored glow (rainbow) surrounds his upper body and head, creating a focal point. The background shows a dark wall and a tiled floor.

TO DETERMINE IF
SMOKING

OTHER SAMPLE IMAGES

MODEL EXPLAINABILITY



The model always looks at both the hand and the cigarette stick.

LIMITATIONS

OF THE SMOKER CLASSIFIER MODEL



THIS IS THE OBJECT THAT JJ WAS SMOKING

HAND CREAM



JEONNE IS A CERTIFIED
SMOKER



IMPORTANT

**HUMAN INTERVENTION
TO HANDLE MODEL LIMITATIONS**

FPS: 5

06-07-2024 Fri 11:15:09



Smokeception Cam

Smoking (100.00%)

CCTV FOOTAGE

Consider **the use of CCTV footage** when **training and testing** the model

LIGHTING

Consider testing on **photos with different lighting (day time and night time)**

MOVEMENT

Look into using the model to **classify videos, with actual moving objects**

NOISE

Train the model on **different environments and backgrounds**



RECOMMENDATIONS FOR FUTURE STUDIES!

IT'S TIME TO OPERATIONALIZE

With the promising results we can start making the world a smoke-free place through CCTV integrations



FINAL REMARKS!



NO

**CIGARETTE SMOKING IS
DANGEROUS FOR YOUR HEALTH!**



HULI KA, BALBON!

AUTOMATED ALARM FOR
SMOKING IN NON-DESIGNATED
AREAS USING DEEP LEARNING

FPS: 10

06-07-2024 Fri 11:12:38

Solution Prototype Appendix

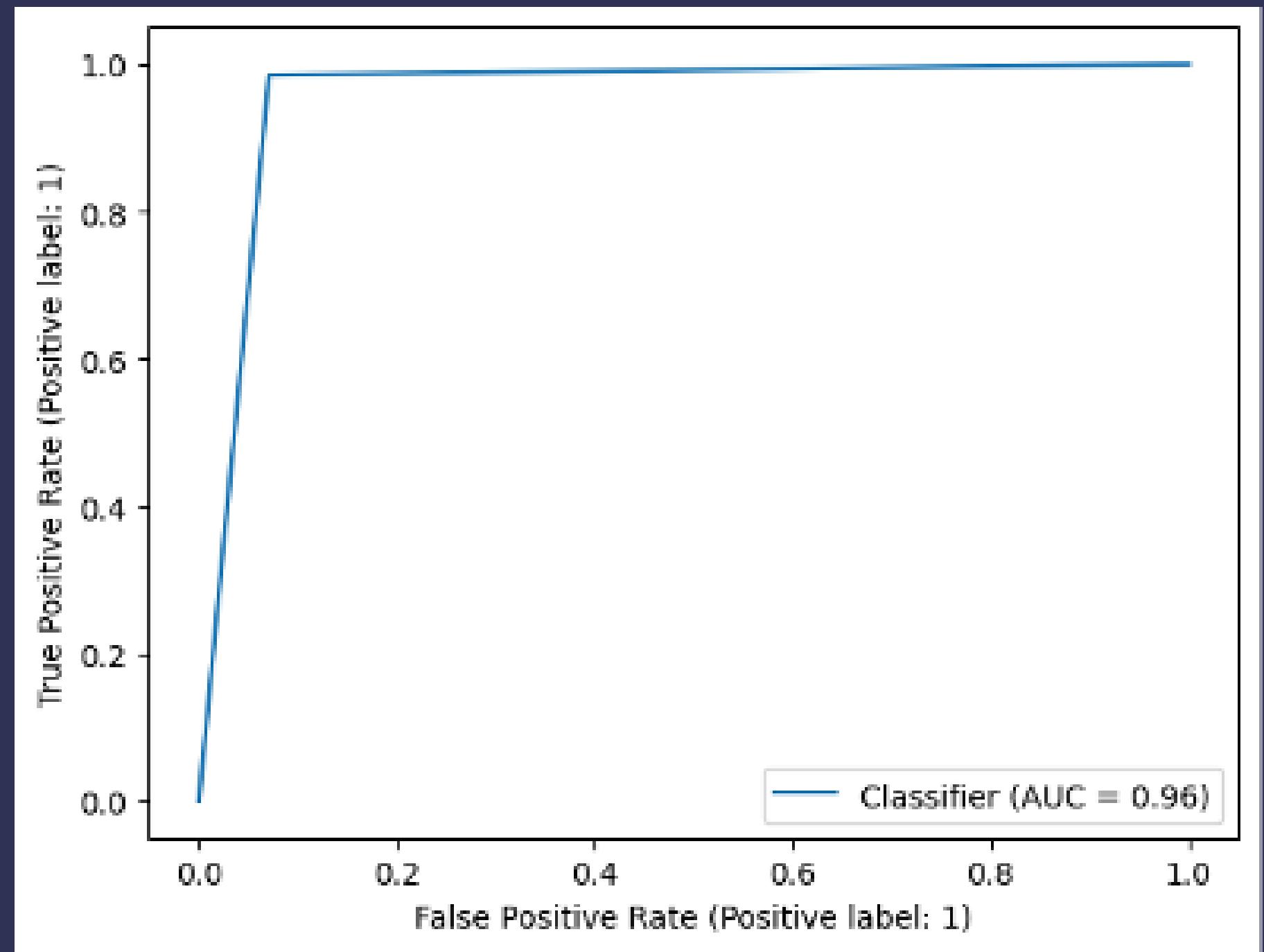


Smokeception Cam

No Smoking (0.00%)

Appendix

ER Index (0.11)

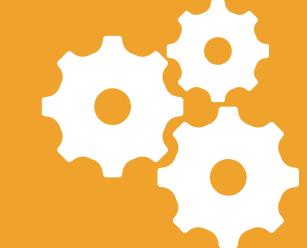


Appendix

Baseline Threshold (0.5)

Thresholds

01



Test Accuracy
0.95

02



Test Precision
0.93

03



Test Recall
0.98

RESULTS

CONFUSION MATRIX

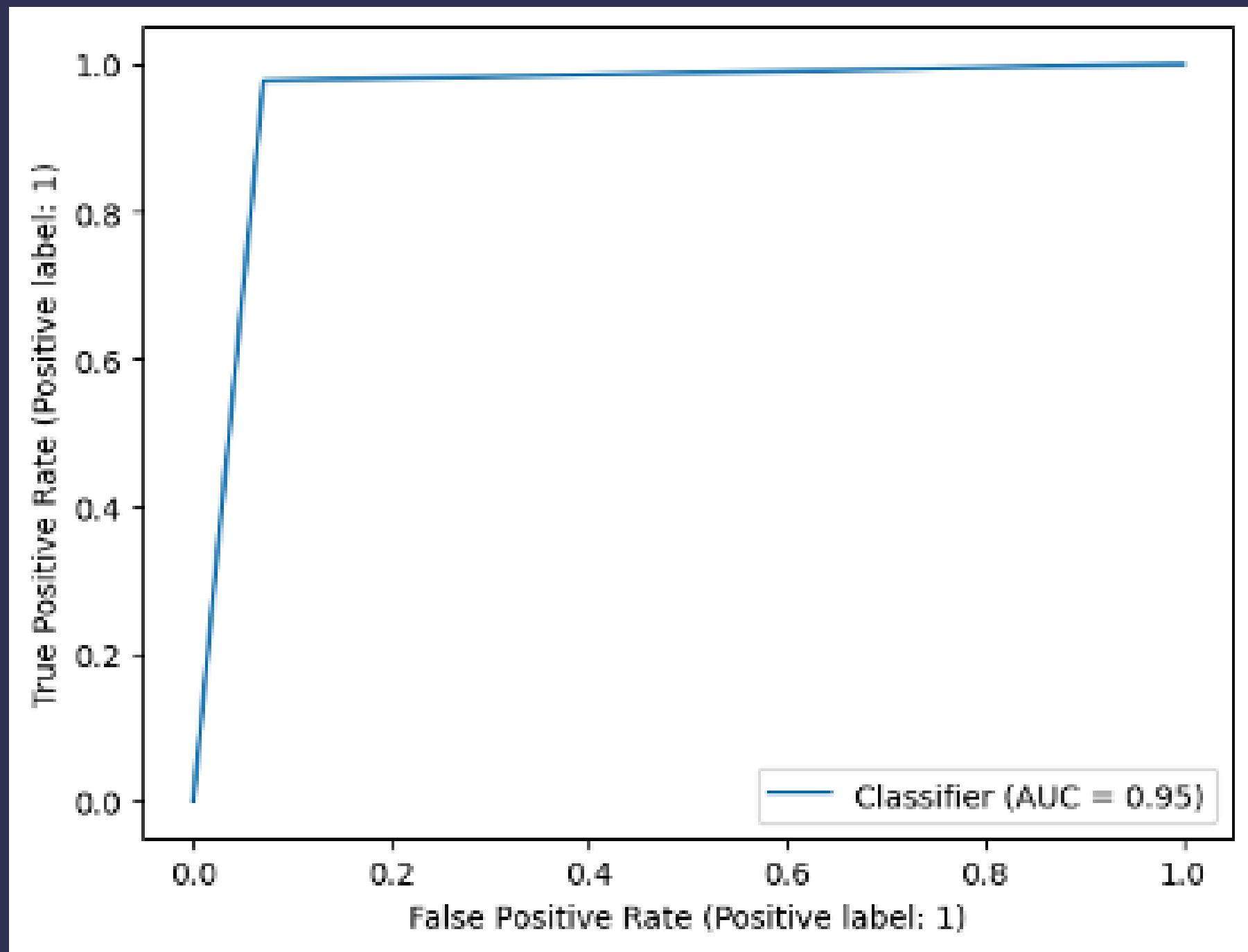


TRUE NEGATIVE	FALSE POSITIVE
118	9
FALSE NEGATIVE	TRUE POSITIVE
3	127

The confusion matrix is **based**
on the test dataset.

Appendix

Baseline Threshold (0.5)



Appendix

Youden's Index (1.0)

Thresholds

01



Test Accuracy
0.93

02



Test Precision
0.96

03



Test Recall
0.89

RESULTS

CONFUSION MATRIX

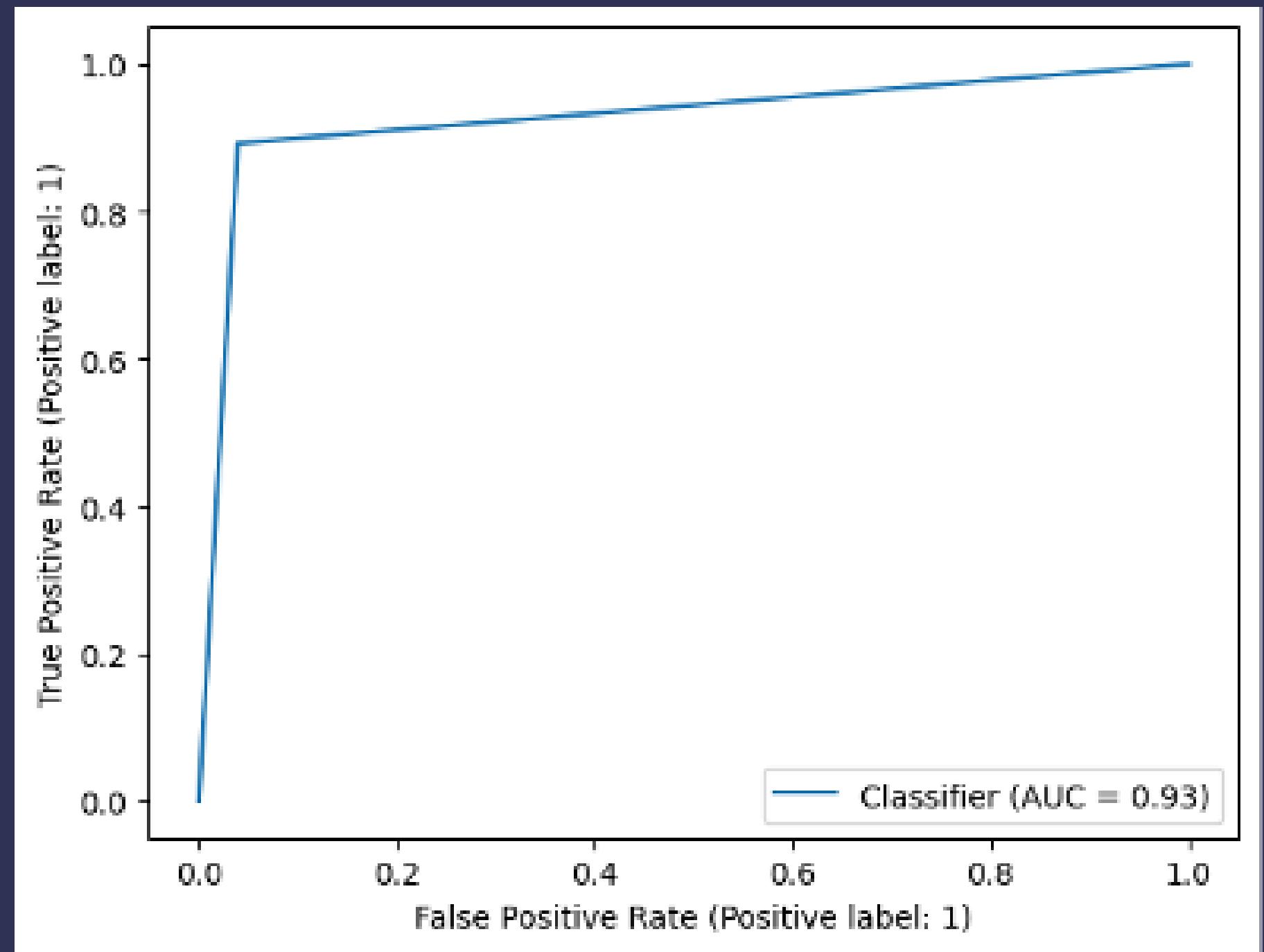


TRUE NEGATIVE	FALSE POSITIVE
122	5
FALSE NEGATIVE	TRUE POSITIVE
14	116

The confusion matrix is **based**
on the test dataset.

Appendix

Youden's Index (1.0)

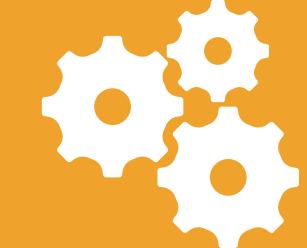


Appendix

F-1 Score (1.0)

Thresholds

01



Test Accuracy
0.93

02



Test Precision
0.96

03



Test Recall
0.89

RESULTS

CONFUSION MATRIX



TRUE NEGATIVE	FALSE POSITIVE
122	5
FALSE NEGATIVE	TRUE POSITIVE
14	116

The confusion matrix is **based**
on the test dataset.

Appendix

F-1 Score (1.0)

