

ENHANCING SAFETY WITH YOLOV8 IMAGE CLASSIFICATION FOR DROWSINESS DETECTION

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NANAY, E.,
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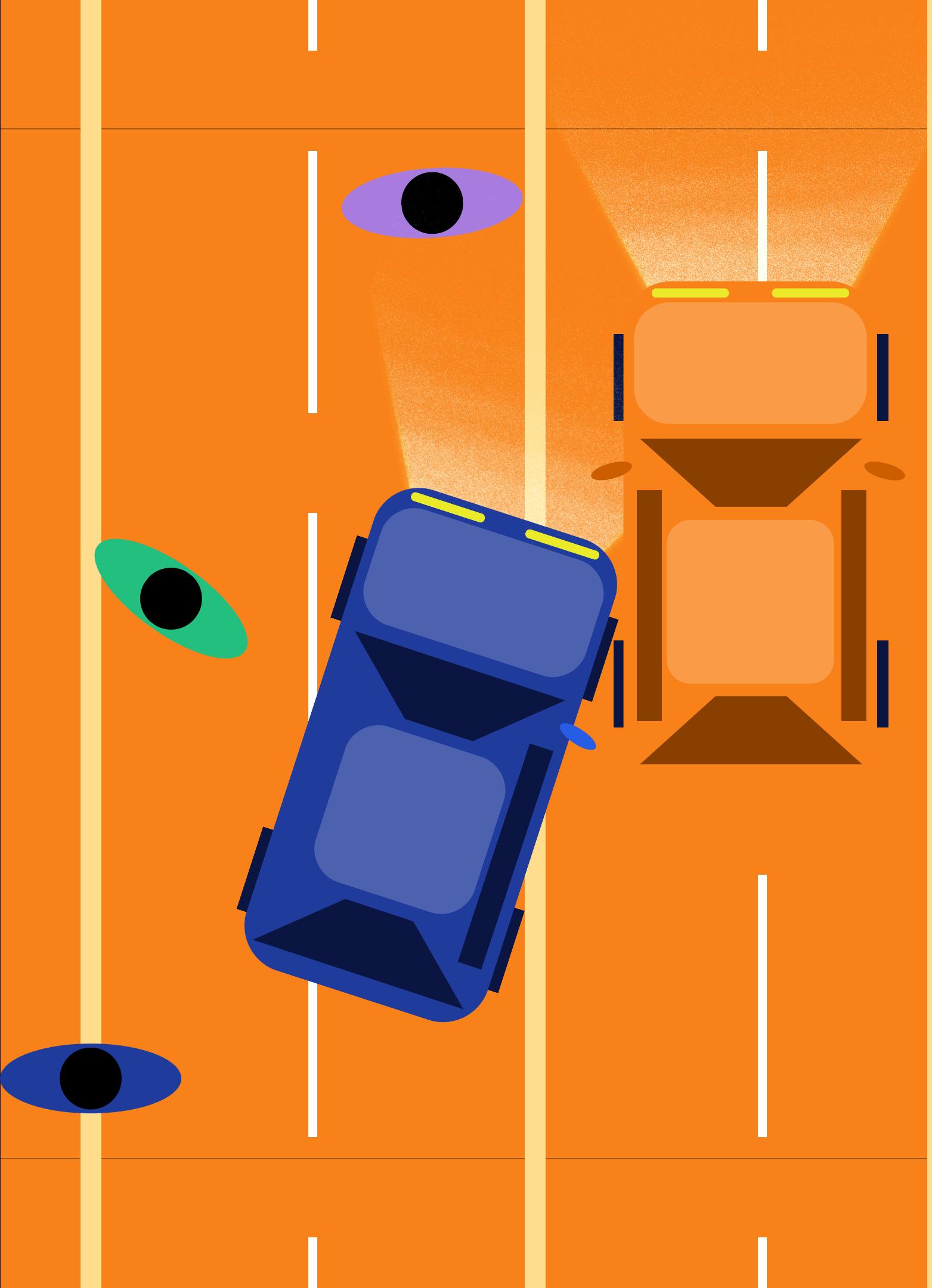
DANGERS OF DROWSY DRIVING

Most drivers understand the dangers of drinking, driving, texting and driving, but many people underestimate the dangers of drowsy driving.

Each year, drowsy driving accounts for about 100,000 crashes, 71,000 injuries and 1,550 fatalities. (National Safety Council)

Drowsy driving accidents are caused by several factors such as:

- inability to focus
- delayed reaction time
- poor judgment
- falling asleep

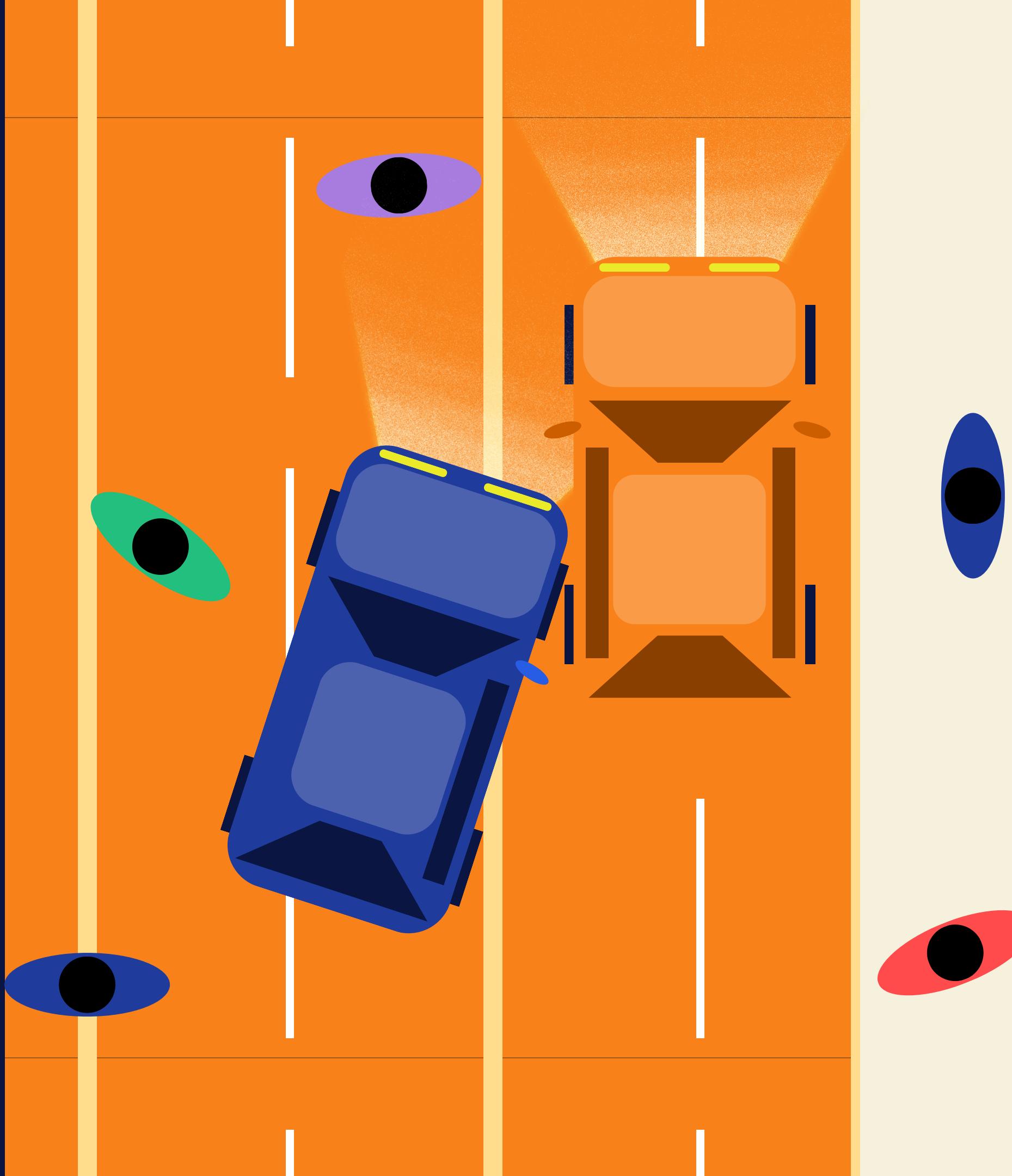


DID YOU KNOW?

Did you know that *when an individual is awake for more than 18 hours*, the effects on its body are the same as if you had a Blood Alcohol Concentration (BAC) of 0.05 percent. According to the CDC, after being awake for 24 hours, it's similar to having a BAC of 0.10 percent, which far exceeds the legal limit in all states. Considering the legal blood alcohol content (BAC) limit is 0.08 percent, **drowsy driving is similar to drunk driving.**

Table 1. Drivers involved in crashes who were drowsy in the U.S

Years	Drivers involved in fatal crashes who were drowsy	Fatalities involving drowsy driving
2018	1,221	785
2017	1,319	697
2016	1,332	803

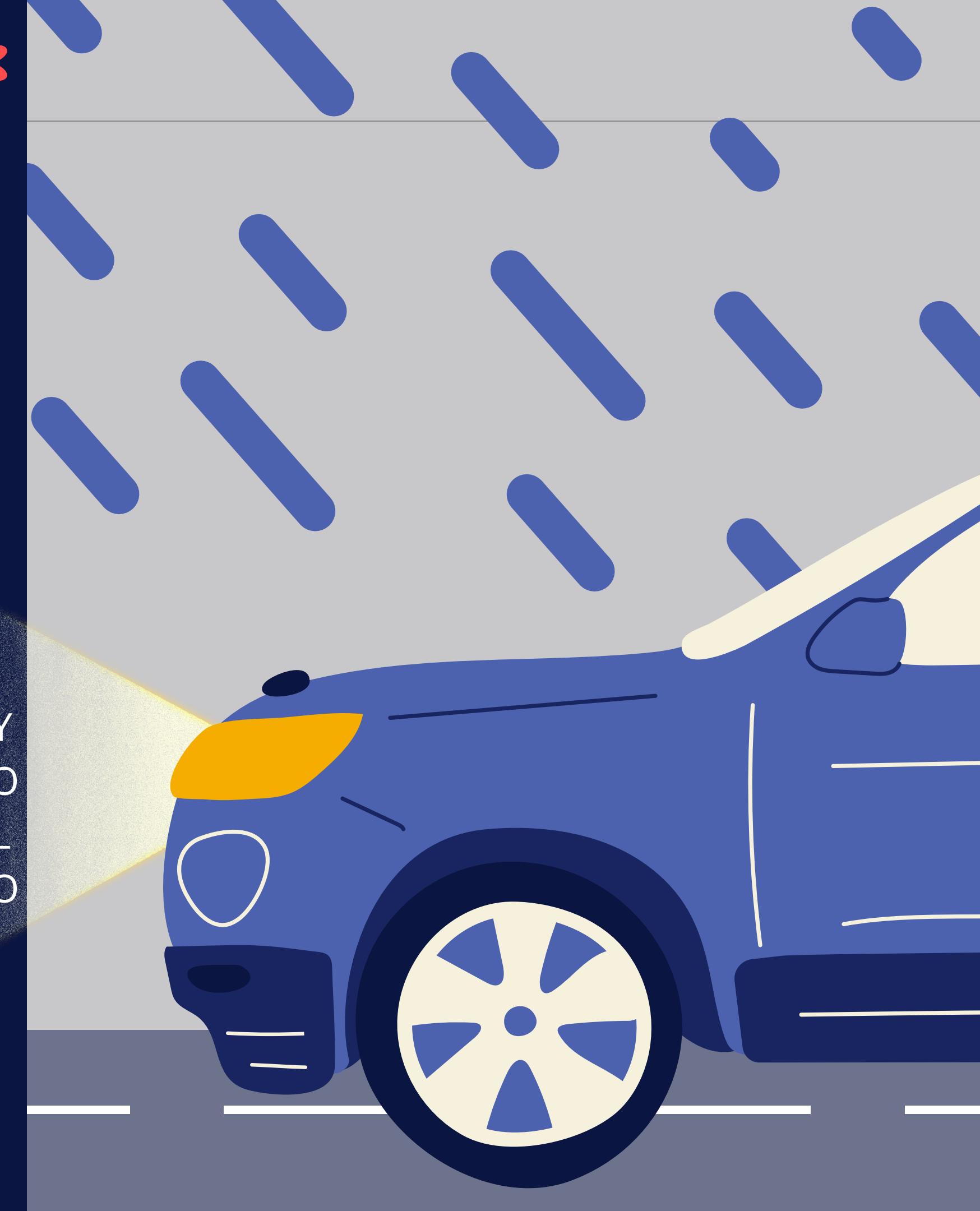


WHAT CAN WE DO?

The researchers built a model using YOLOv8, which is the latest iteration in the YOLO series of real-time object detectors, offering cutting-edge performance in terms of accuracy and speed.

IS THE SKY THE LIMIT?

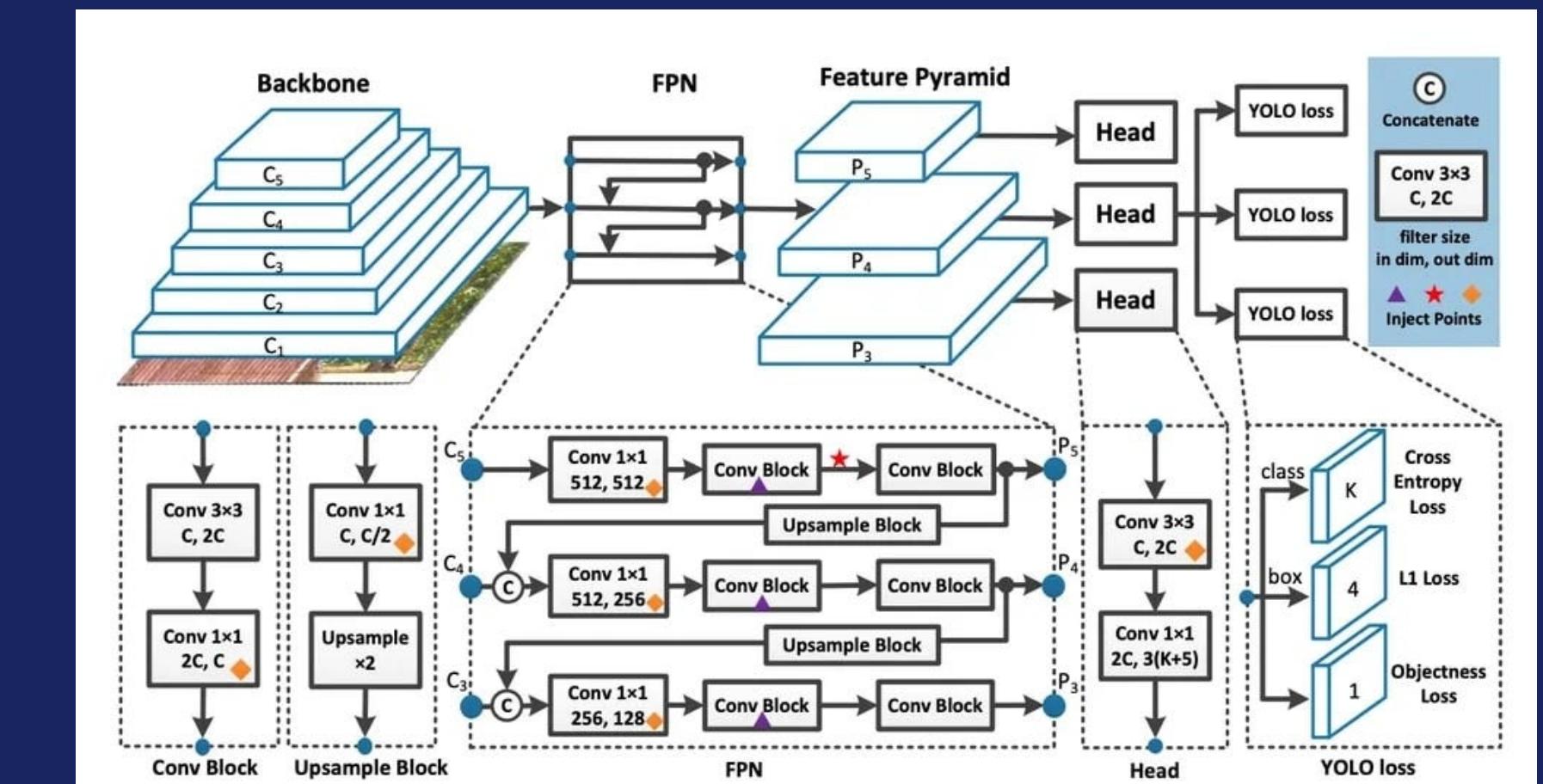
No, while study will focus on a selection of deep learning models for classification under YOLOv8 such as YOLOv8l, and YOLOv8x, other models or algorithms that could potentially yield different results. Lastly, despite that this study is focused on drivers, the model can still be used on other entities or any individual who is not driving.



THE YOLOV8

The researchers leveraged YOLOv8's cutting-edge architecture, because of its availability of pre-trained models and implementation libraries like Ultralytics. The researchers chose specifically the YOLOv8x and YOLOv8l, and unlike most other algorithms, it can process both still photos and moving video in real time.

THE ARCHITECTURE



SPLIT RATIO

The dataset was divided into three sets: **85%** for training, **5%** for testing, and **10%** for validation.

LOSS FUNCTIONS

Box Loss: measures the difference between the predicted bounding boxes and the actual bounding boxes of the objects in the training data. *A lower box loss means that the model's predicted bounding boxes more closely align with the actual bounding boxes.*

Class Loss: measures the difference between the predicted class probabilities and the actual class labels of the objects in the training data.

DFL Loss (Dynamic Feature Learning): measures the difference between the predicted feature maps and the actual feature maps of the objects in the training data. *A lower DFL loss means that the model's predicted feature maps more closely align with the actual feature maps.*



OPTIMIZER

AdamW was used and is an optimization algorithm that extends the Adam optimizer by decoupling weight decay from the learning rate. This separation helps prevent excessive weight decay, addressing a common issue in Adam when applied to deep learning models.

METRICS

Mean Average Precision (mAP) was used and is a popular evaluation metric in object detection, including the YOLO model. mAP takes into account both the number of correctly identified objects and the quality of the detections. In YOLO, mAP is particularly important because it measures the accuracy of the model in detecting objects of interest.



DISCUSSION



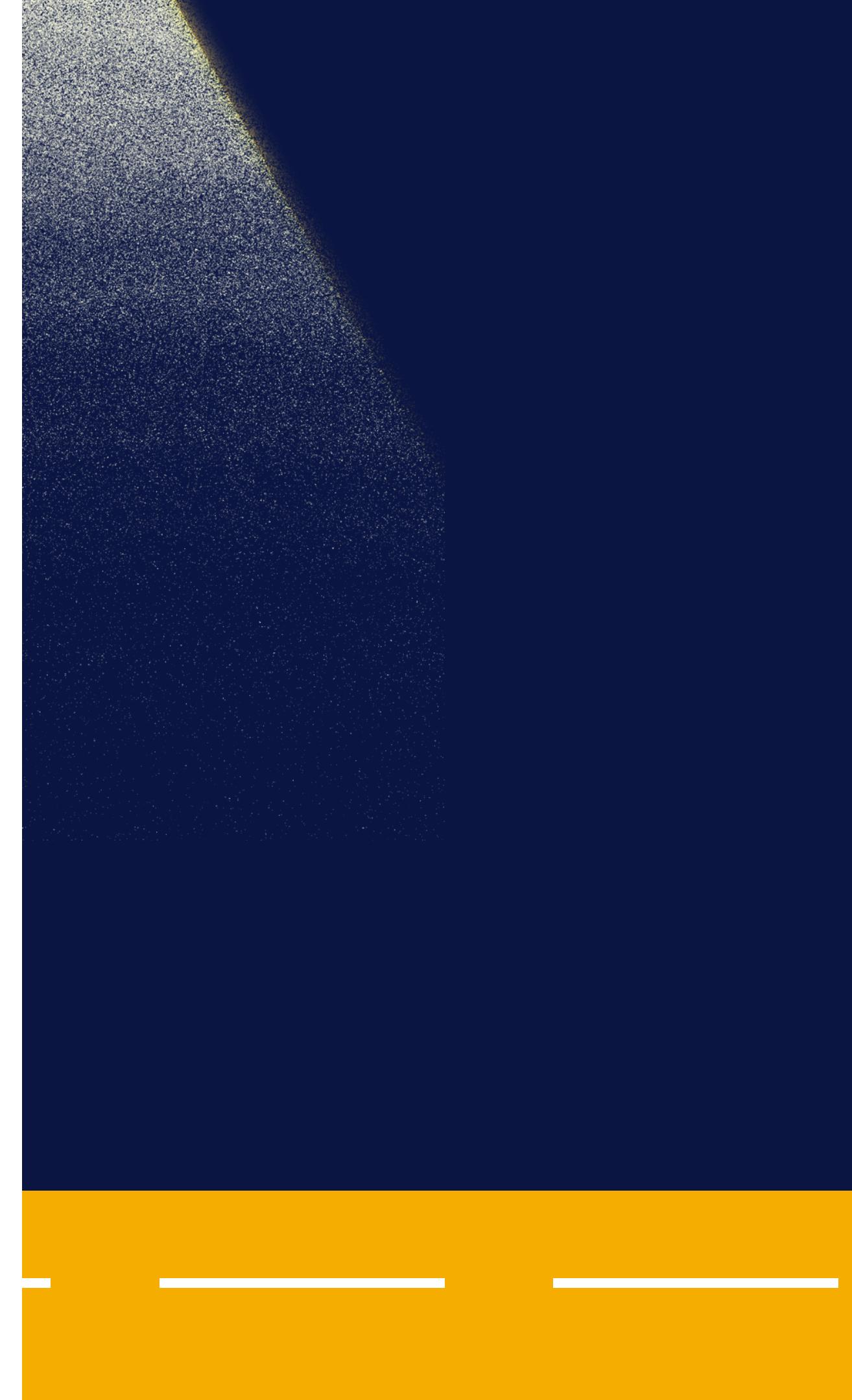
DISCUSSION

ON BEST MODEL



DISCUSSION

ON BEST MODEL



DISCUSSION

ON BEST MODEL

Model	Performance on Test	
	mAP50	mAP50-95
YOLOv8x	0.903	0.825
YOLOV8l	0.933	0.842

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YOLOV8L

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ON BEST MODEL

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YOLOV8L
PERFORMS

DISCUSSION

ON BEST MODEL

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**YOLOV8L
PERFORMS
BETTER**

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YOLOV8L
PERFORMS
BETTER
THAN YOLOV8X

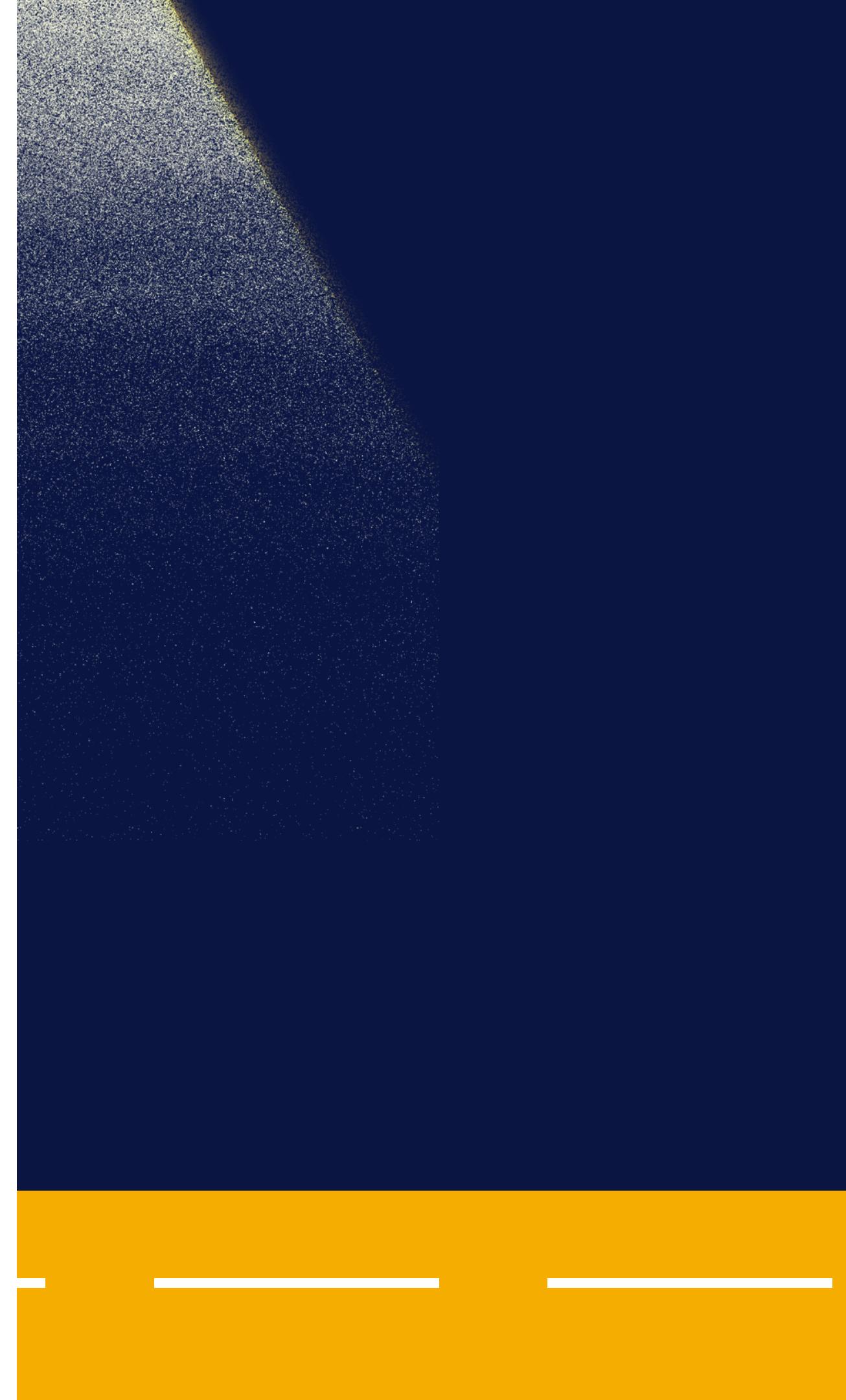
DISCUSSION

OF LOSSES

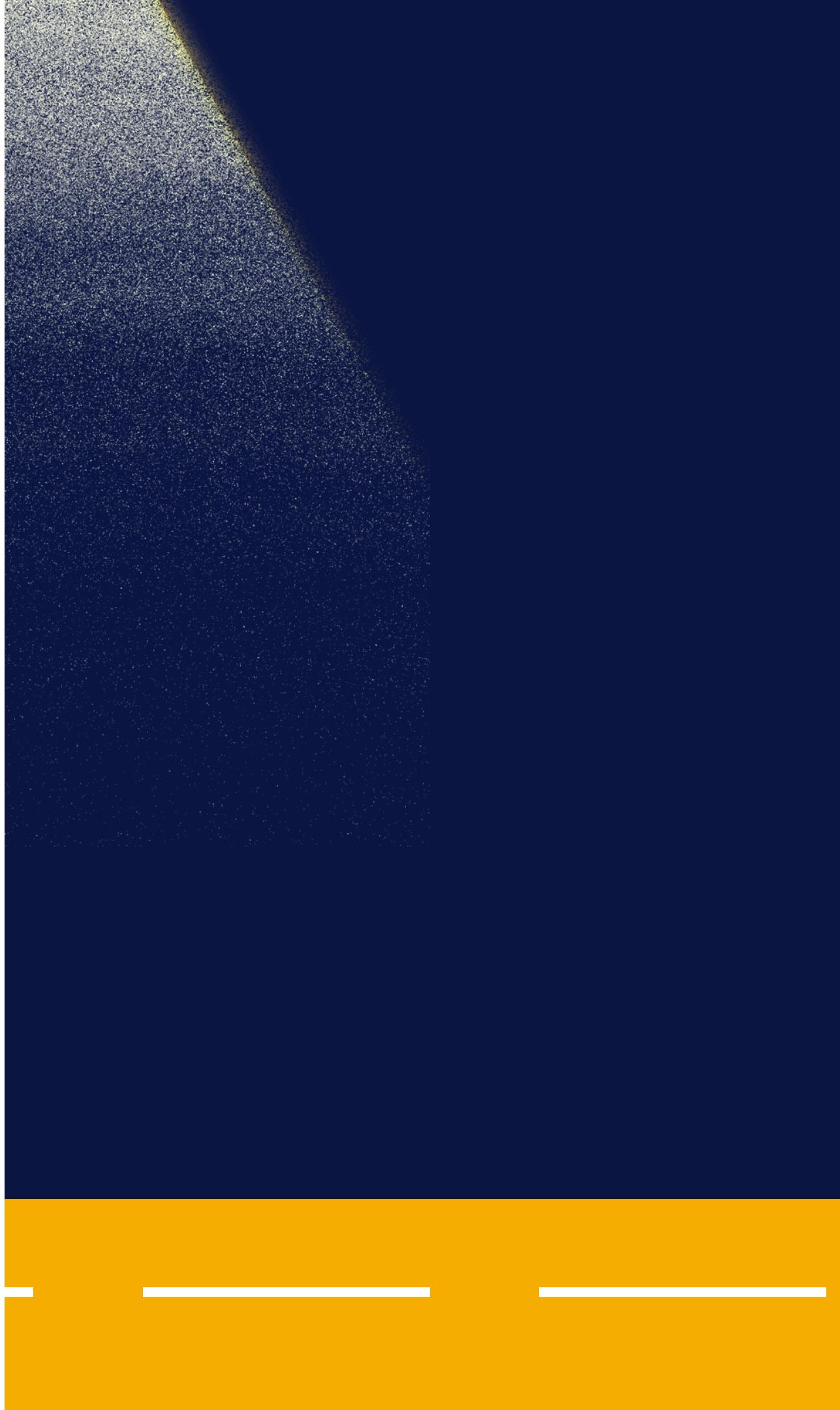
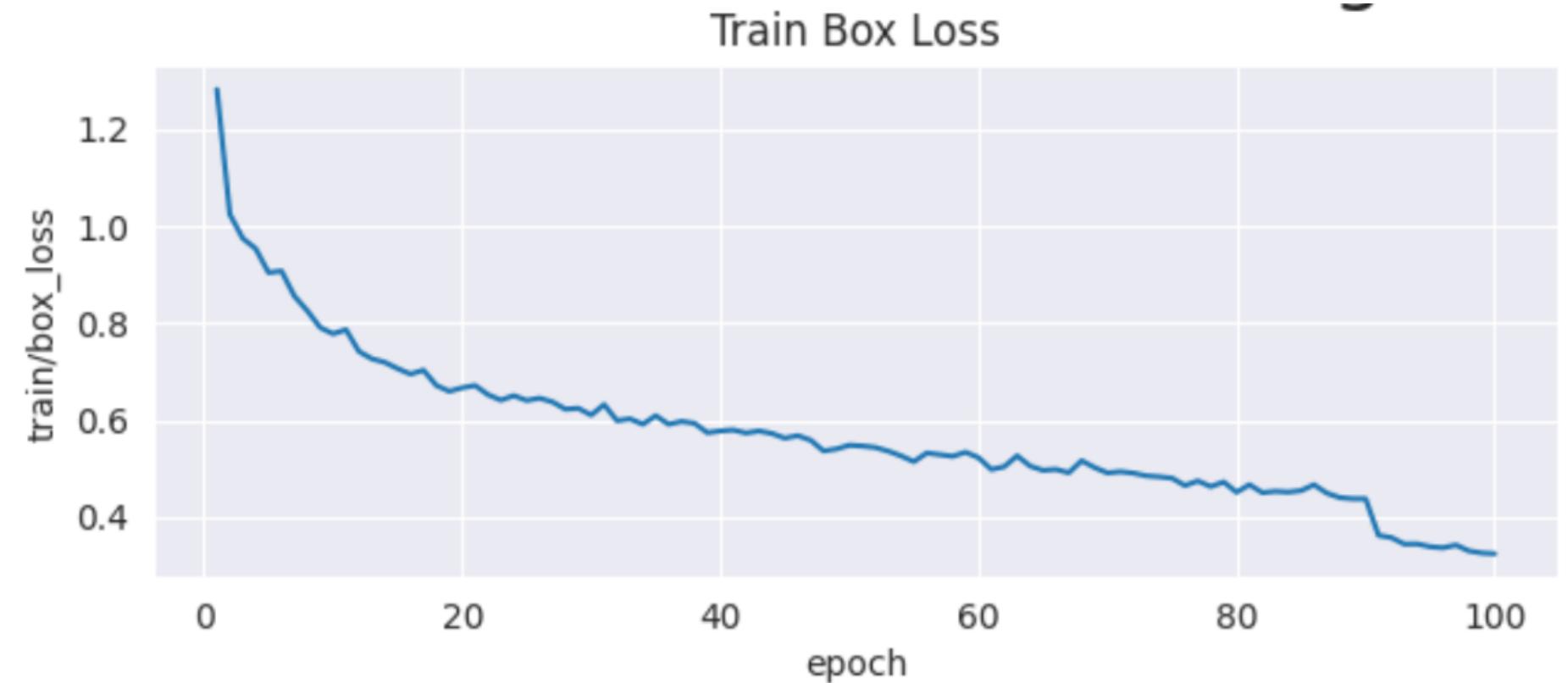


DISCUSSION

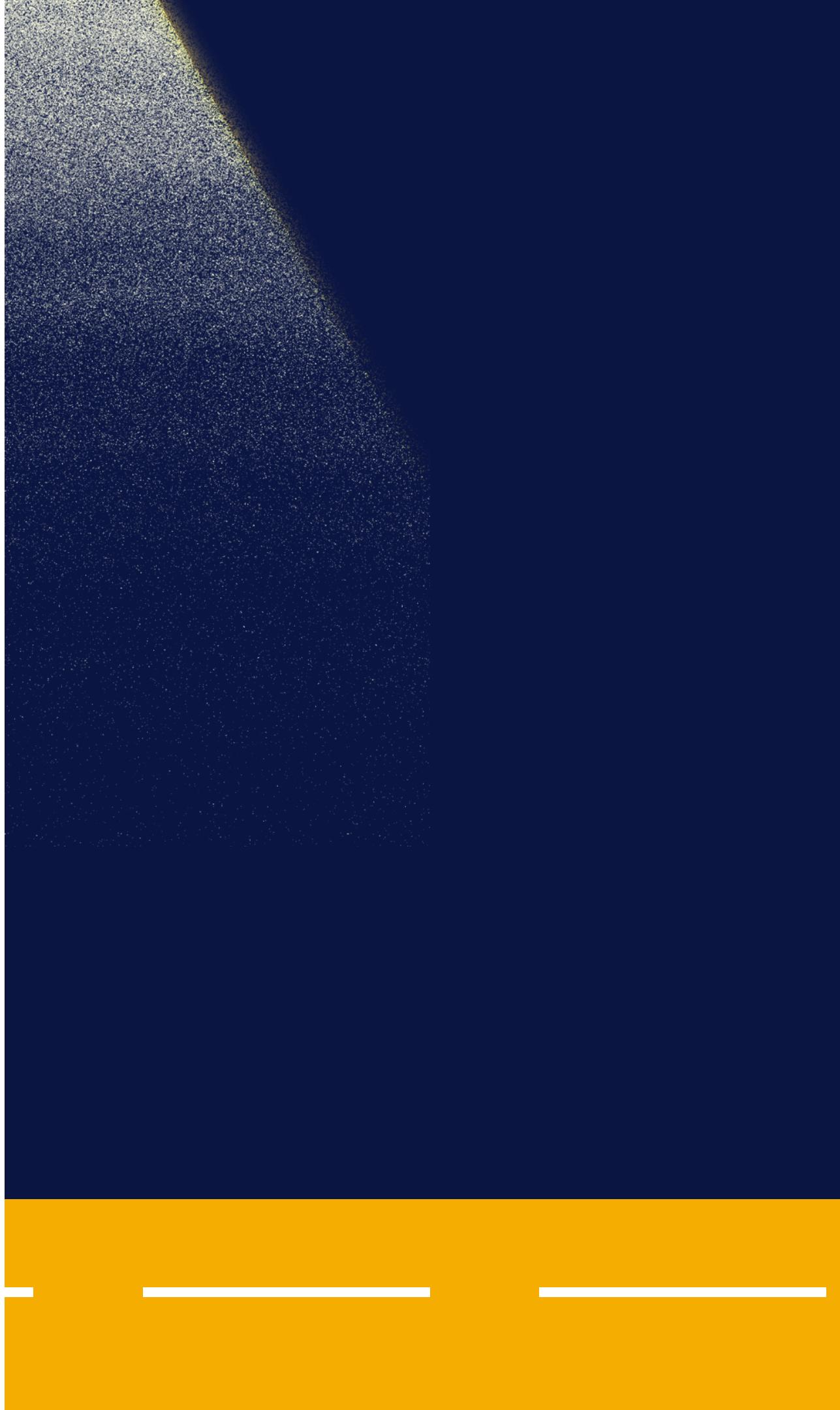
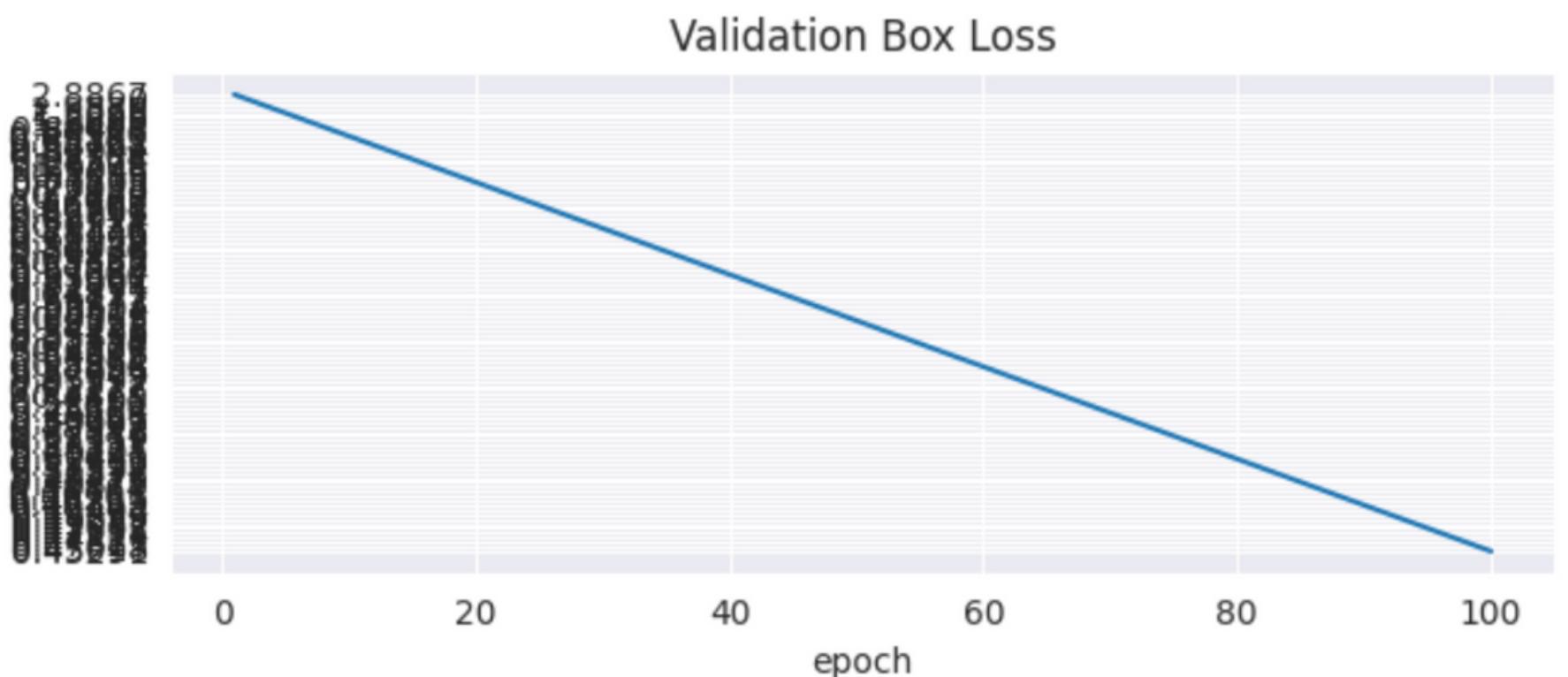
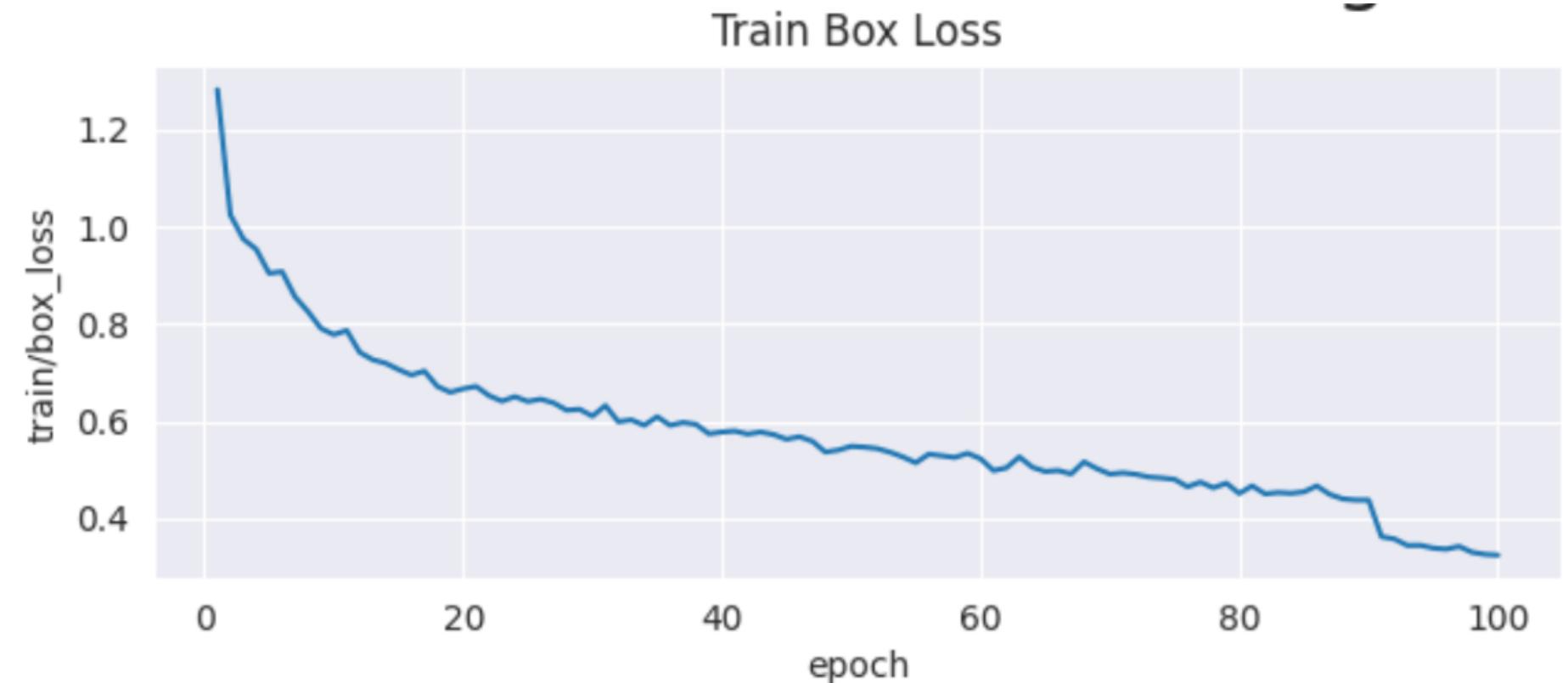
OF LOSSES



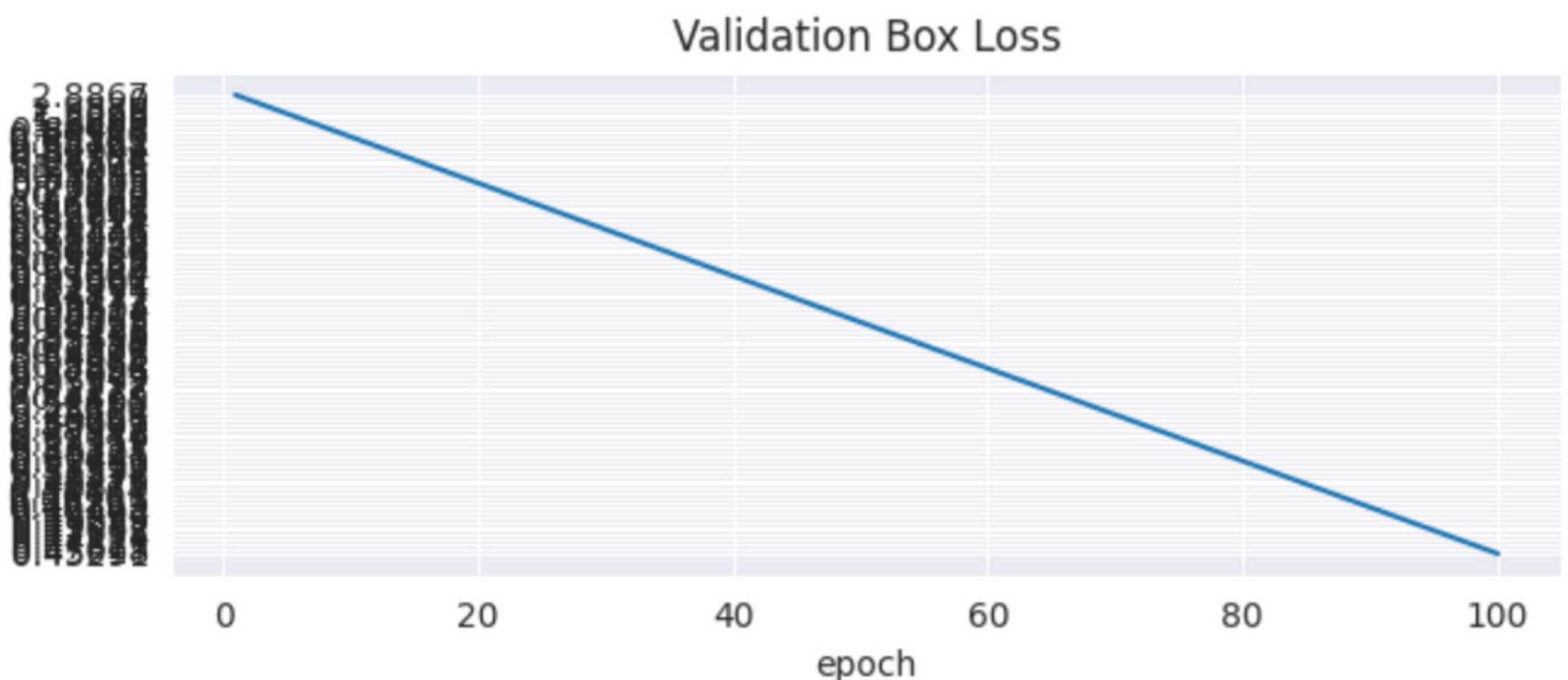
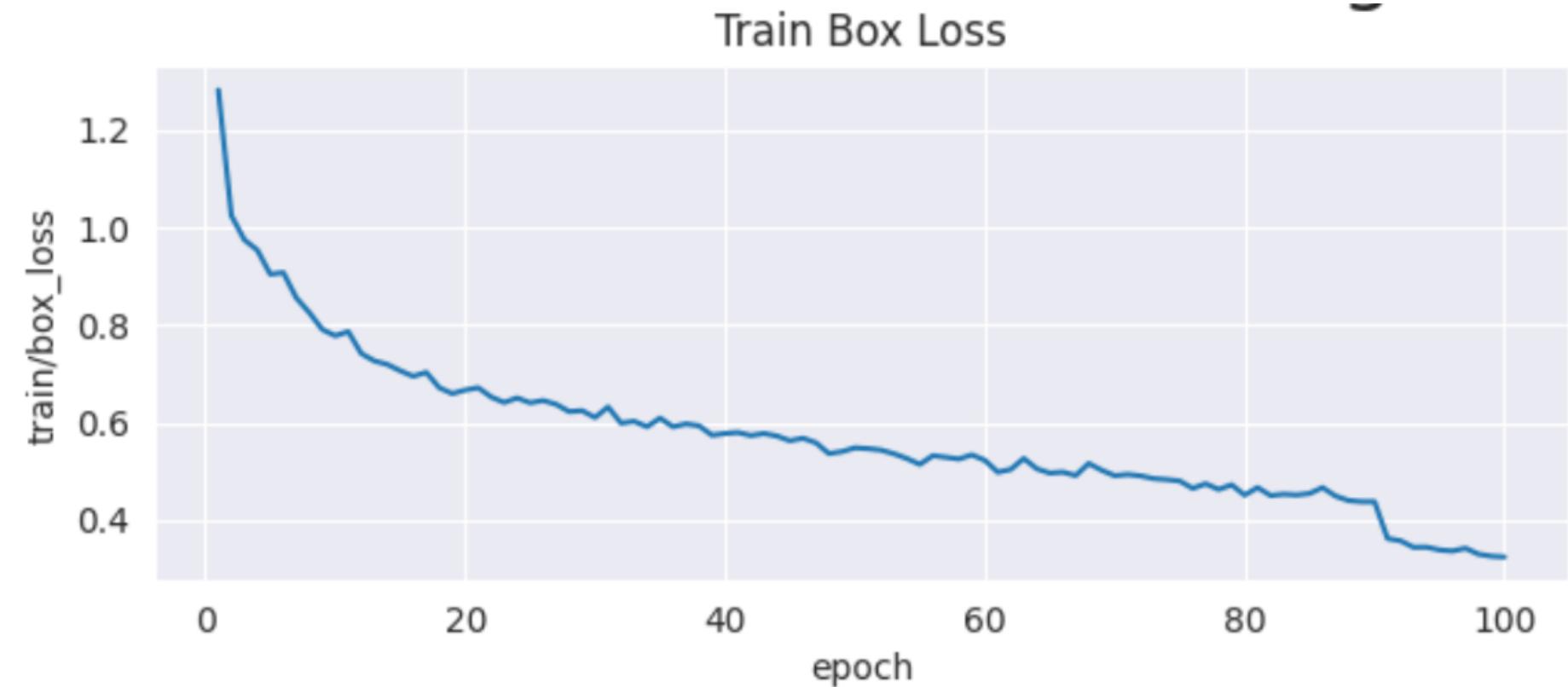
DISCUSSION OF LOSSES



DISCUSSION OF LOSSES

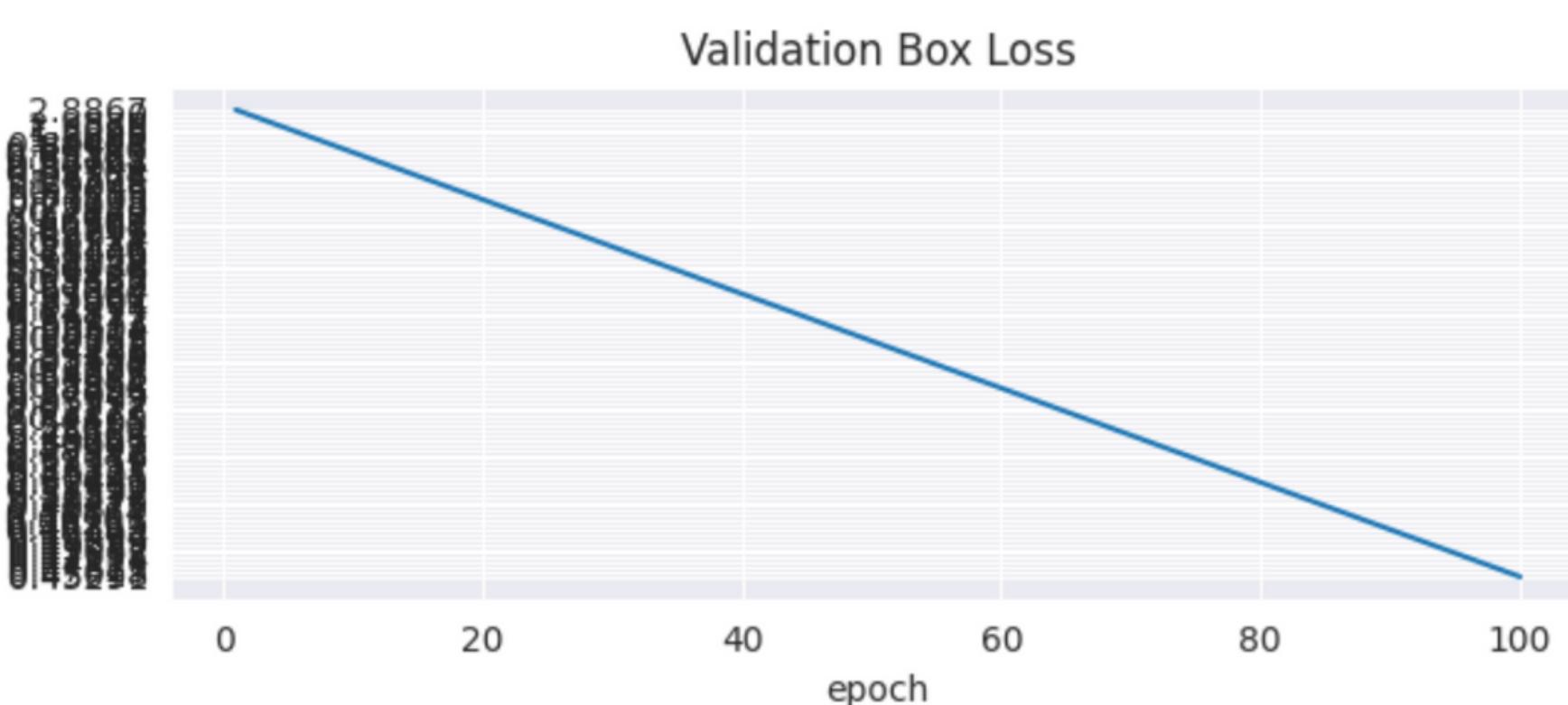
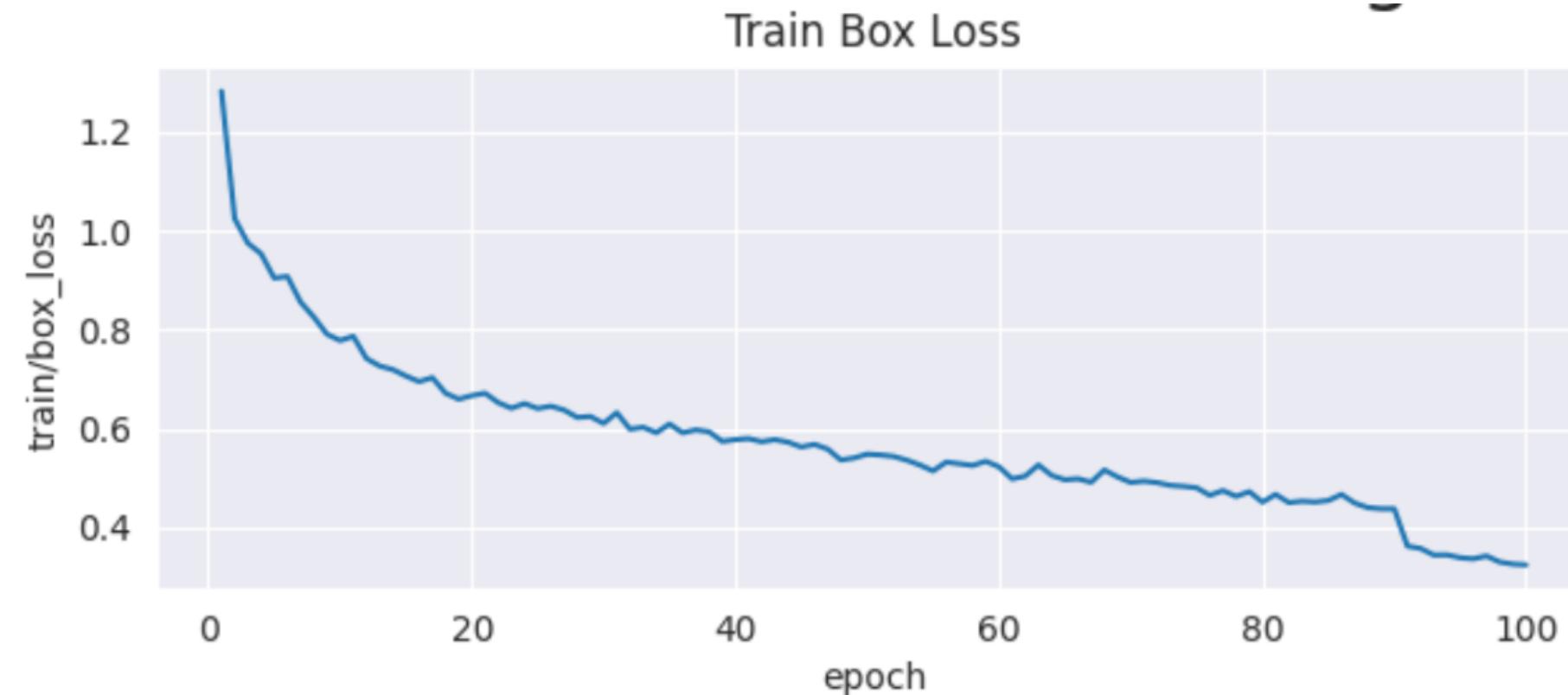


DISCUSSION OF LOSSES



TRAIN BOX LOSS
OF
0.32474

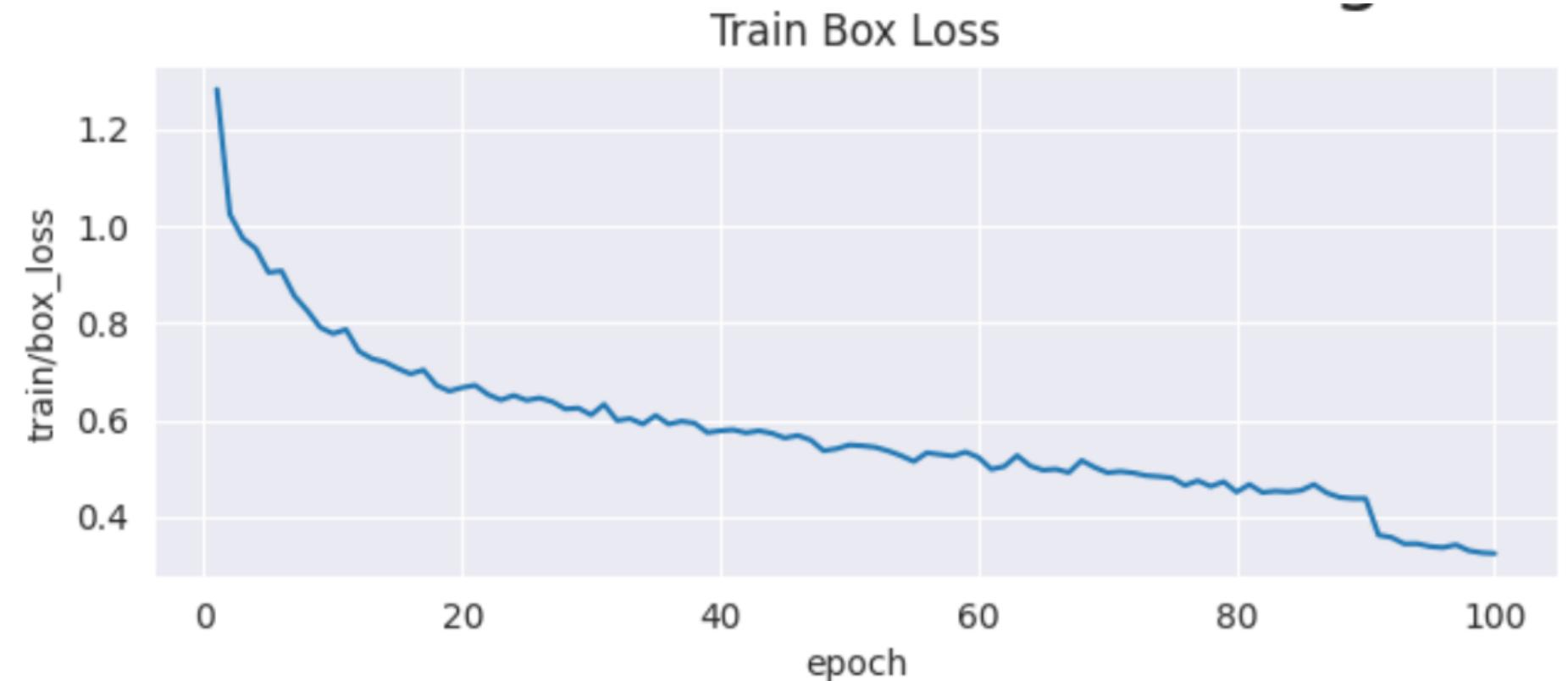
DISCUSSION OF LOSSES



TRAIN BOX LOSS
OF
0.32474

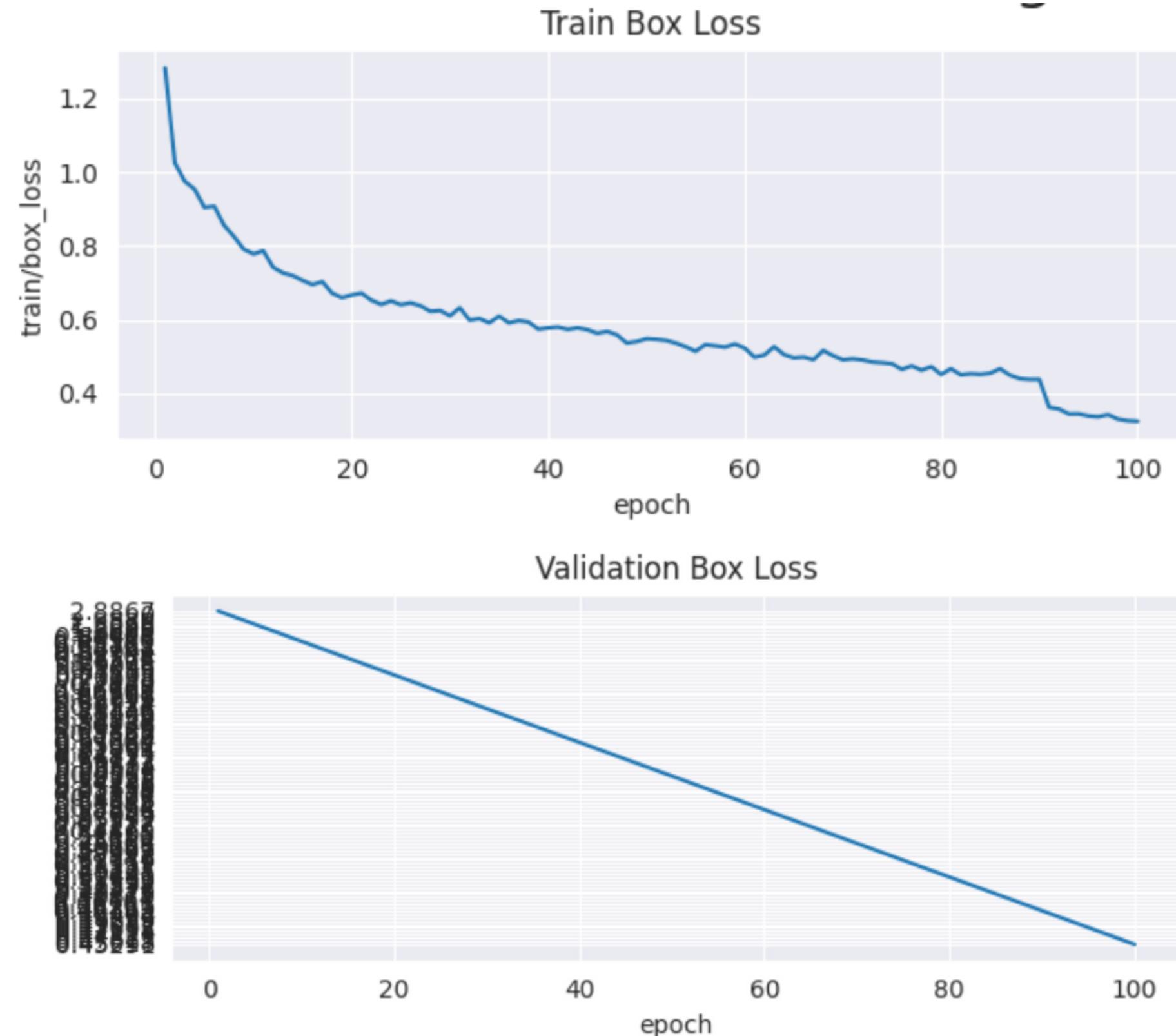
VALIDATION
BOX LOSS OF
0.45291

DISCUSSION OF LOSSES



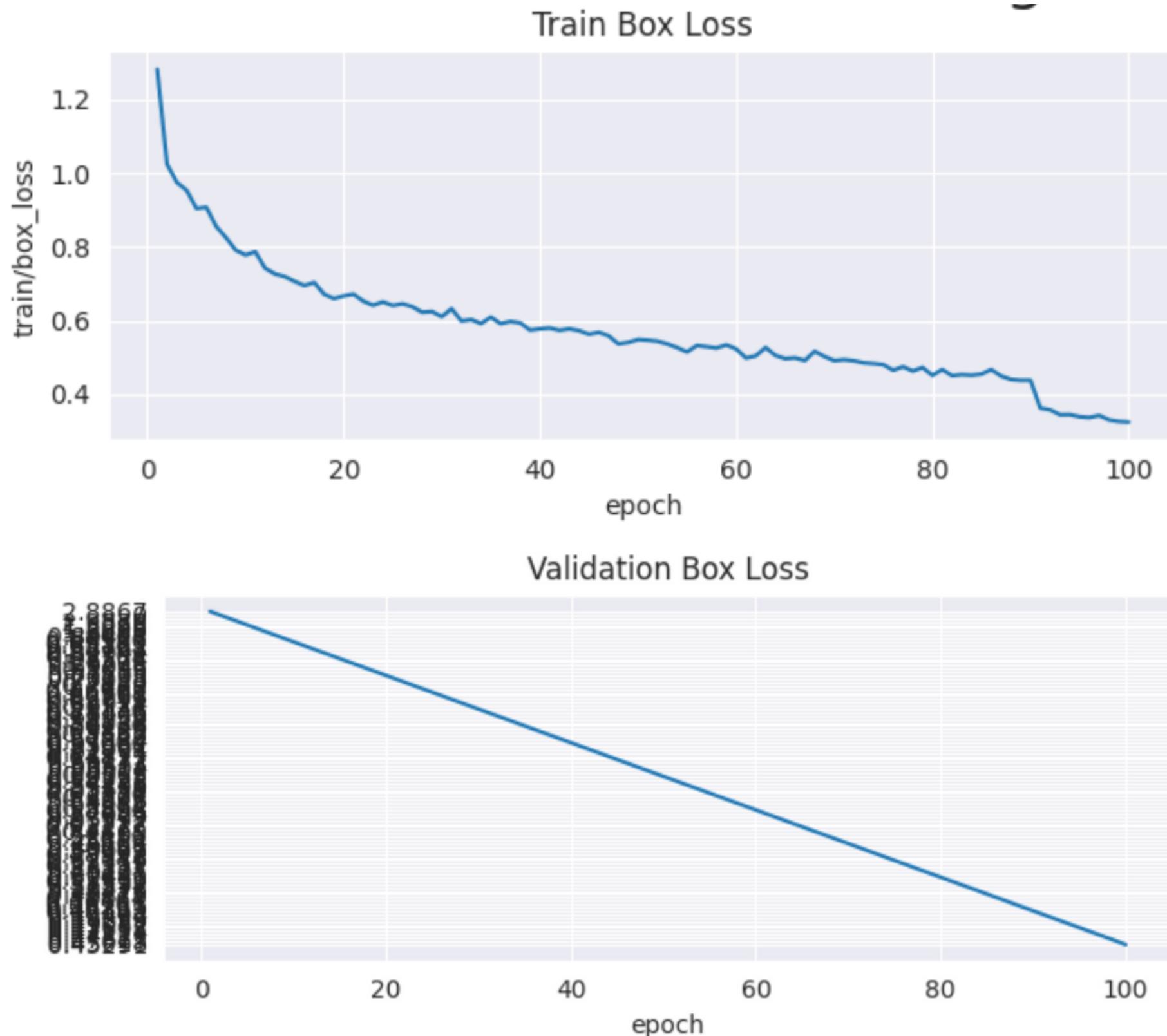
MODEL'S ABILITY
TO IDENTIFY
DRIVER'S FACE
BOUNDING
BOXES

DISCUSSION OF LOSSES



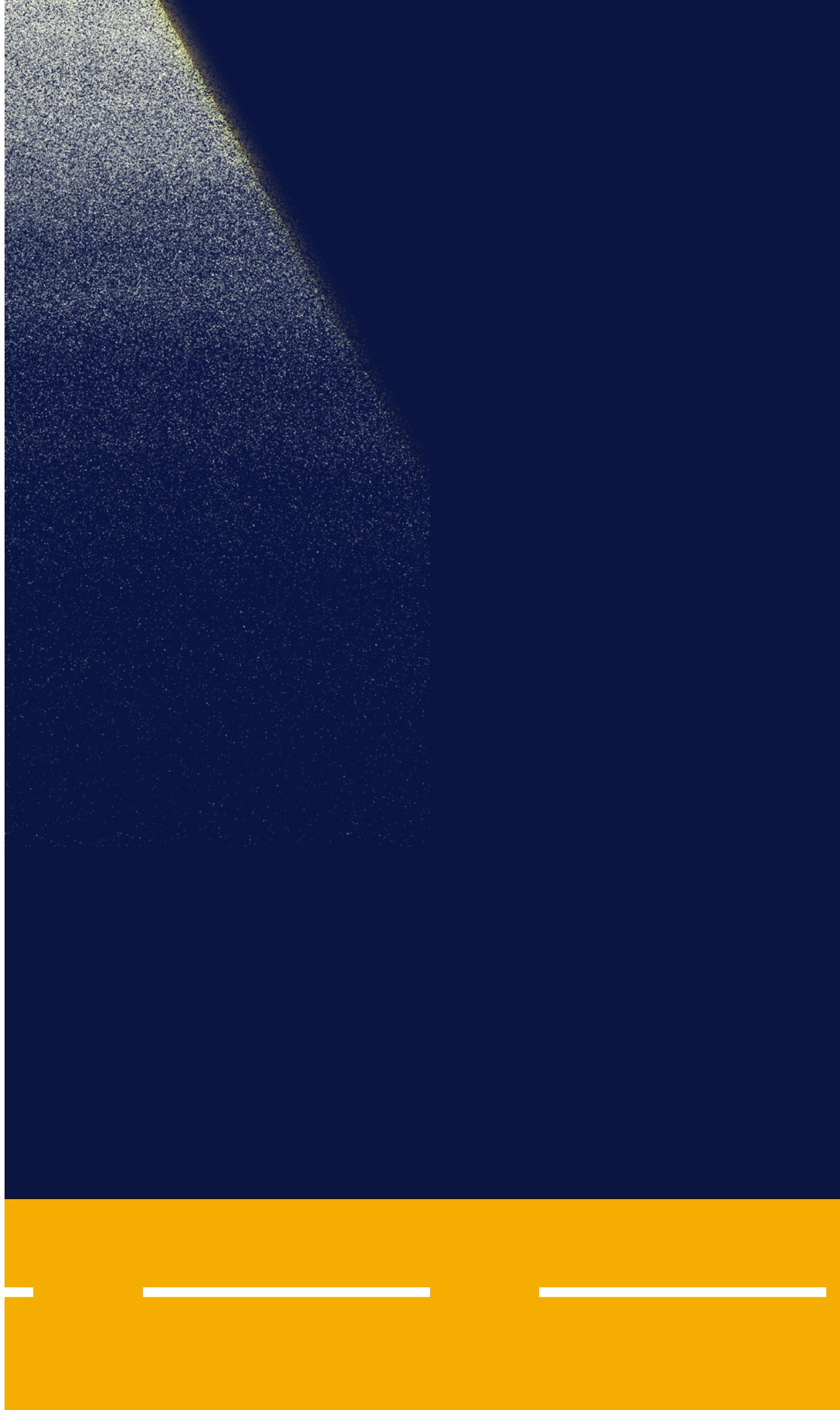
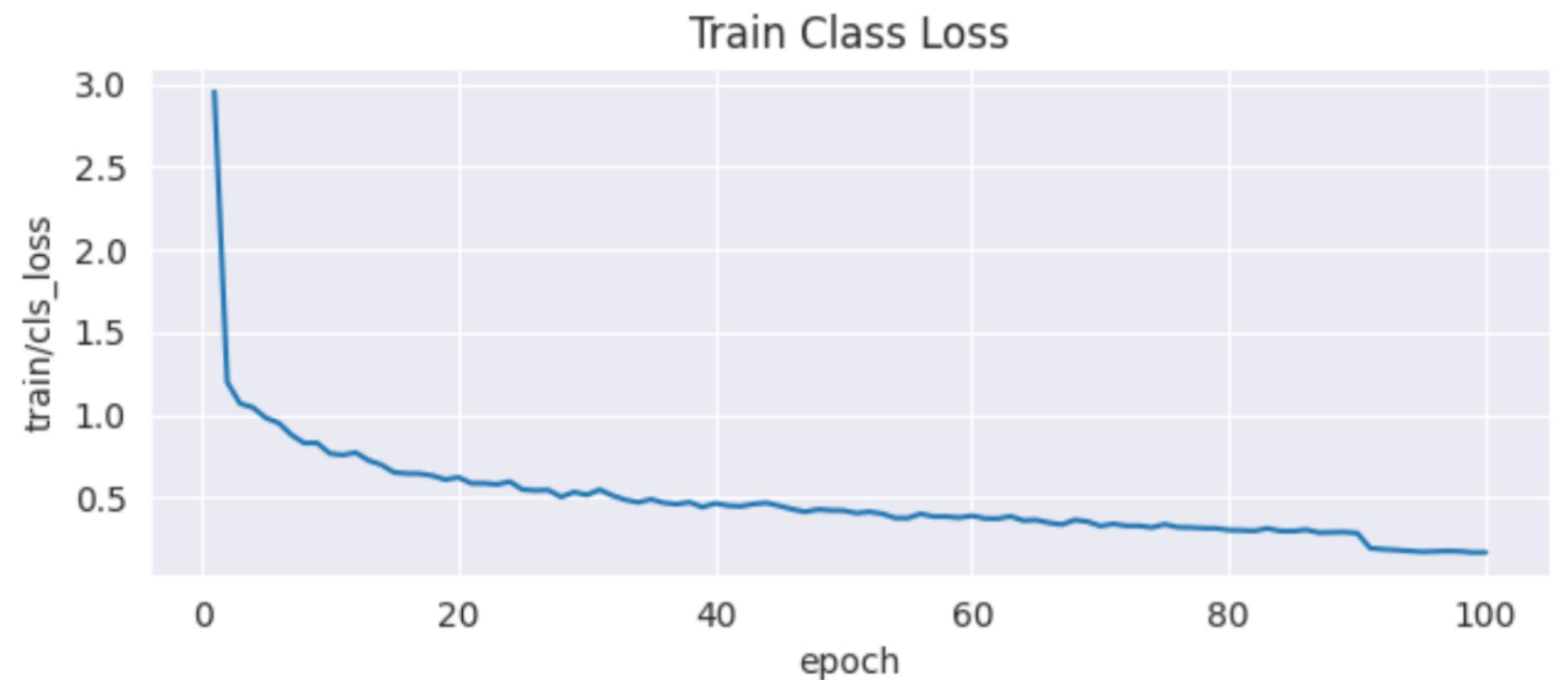
MODEL'S ABILITY
TO IDENTIFY
DRIVER'S FACE
BOUNDING
BOXES
**PROGRESSIVELY
IMPROVED**

DISCUSSION OF LOSSES

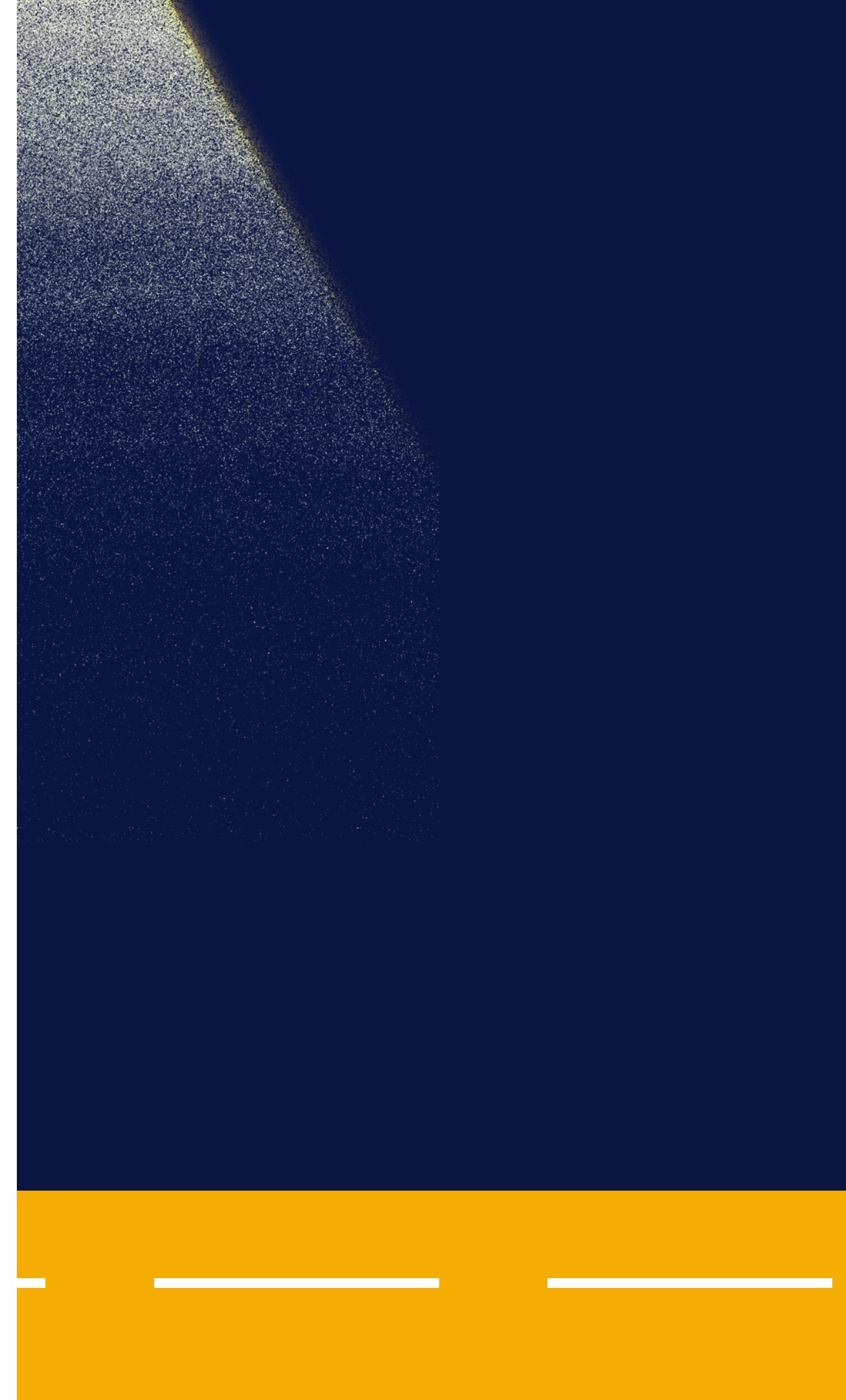
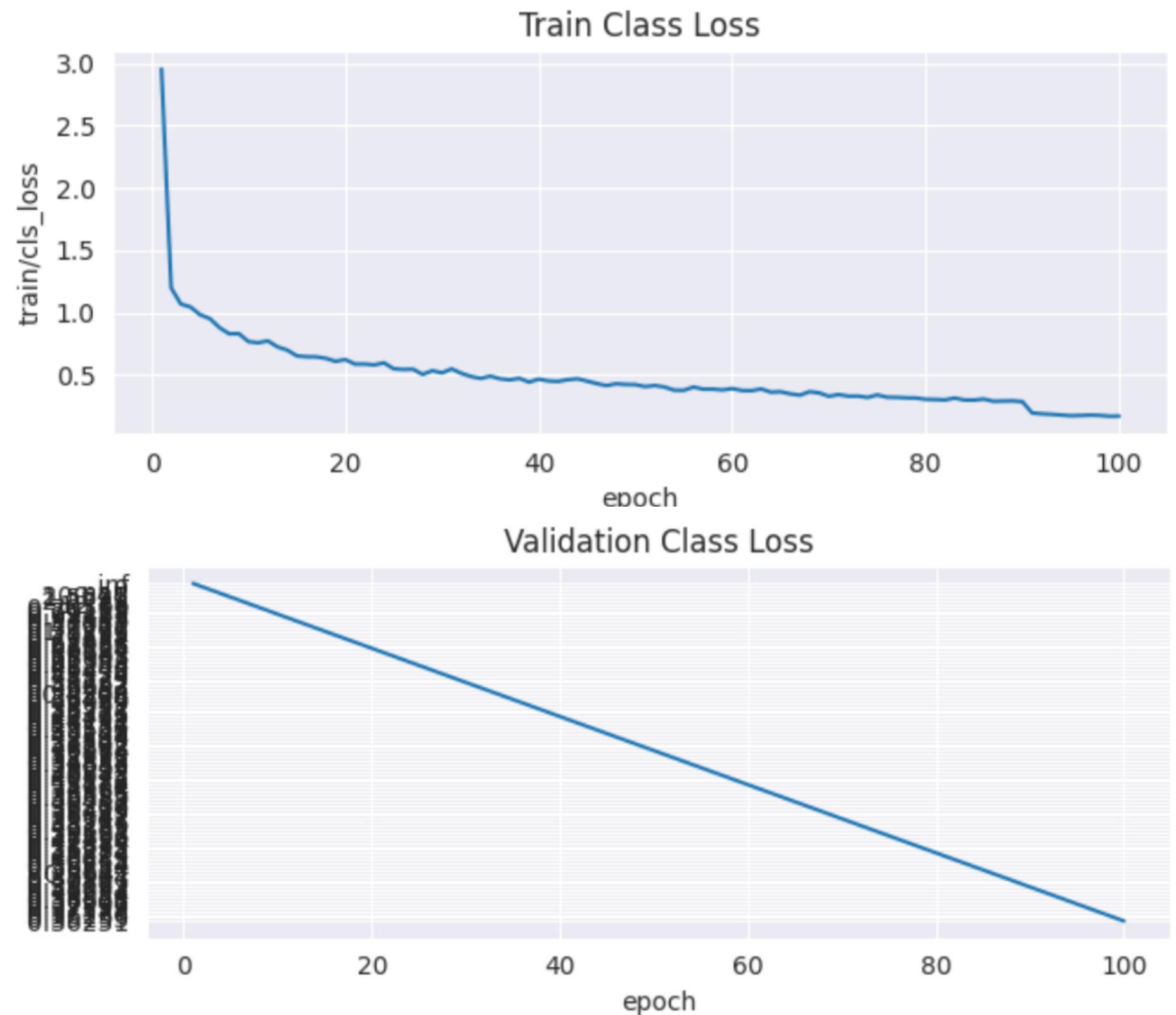


MODEL'S ABILITY
TO IDENTIFY
DRIVER'S FACE
BOUNDING
BOXES
**PROGRESSIVELY
IMPROVED
DURING
TRAINING.**

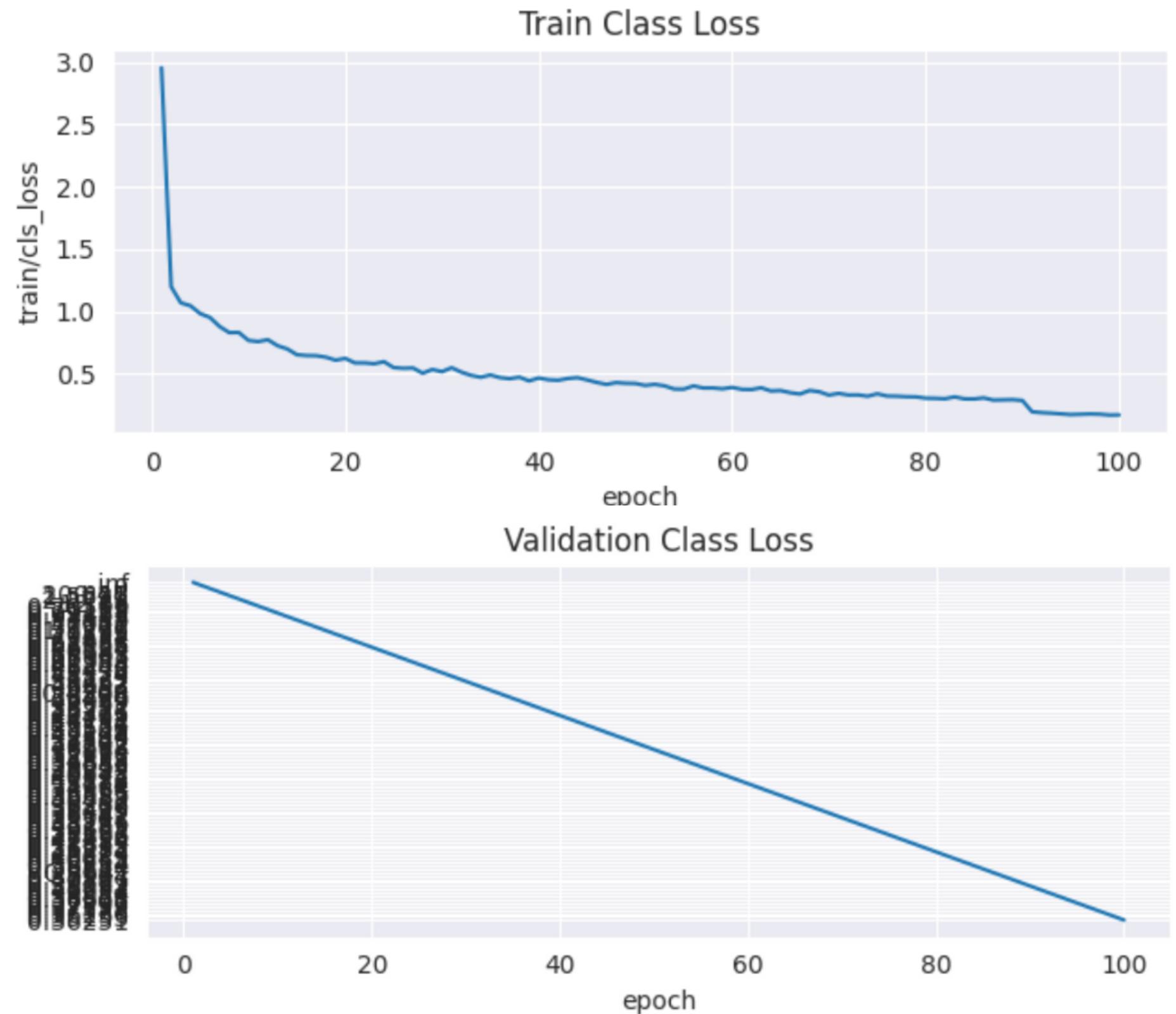
DISCUSSION OF LOSSES



DISCUSSION OF LOSSES

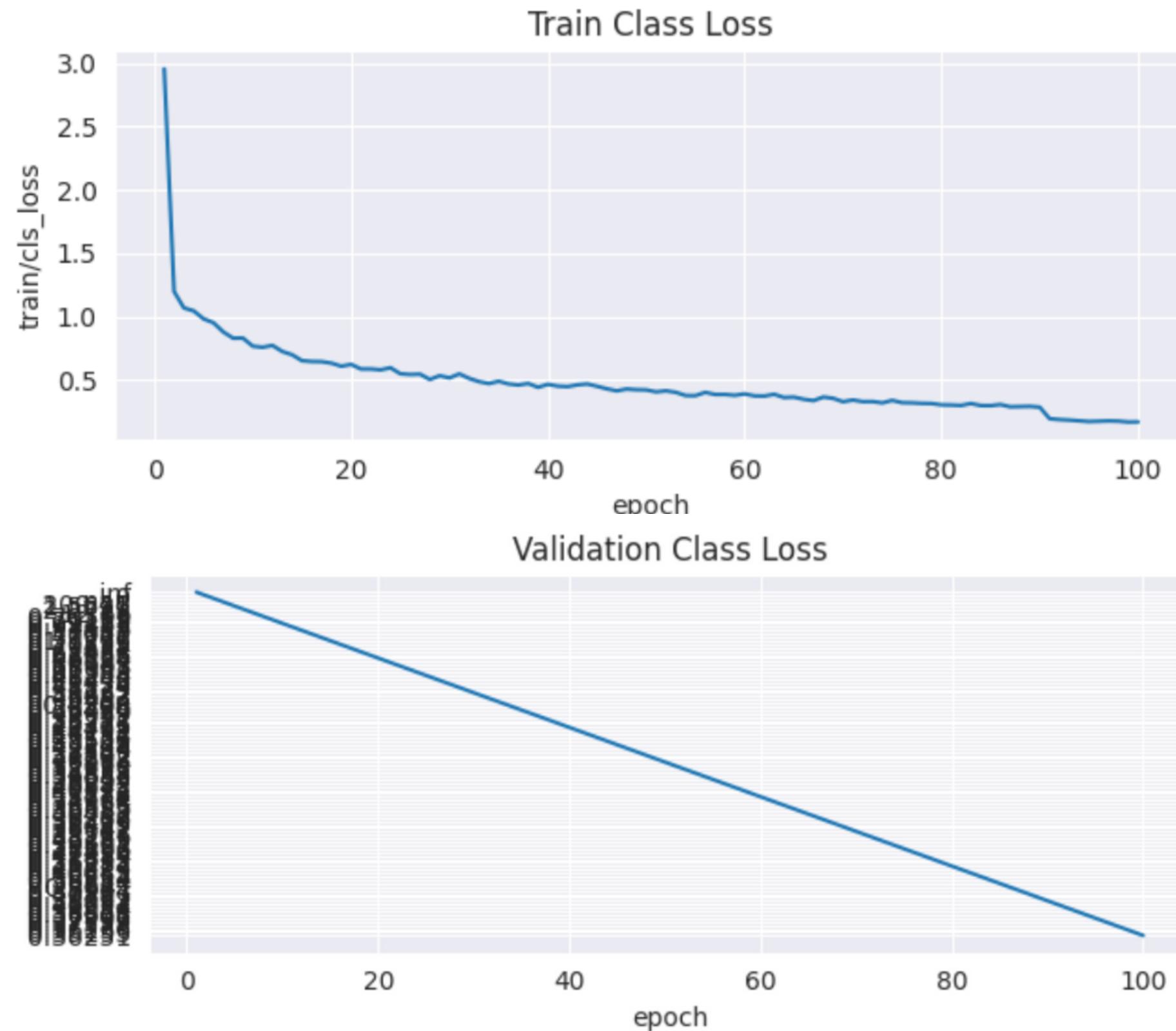


DISCUSSION OF LOSSES



TRAIN CLASS
LOSS OF
0.17063

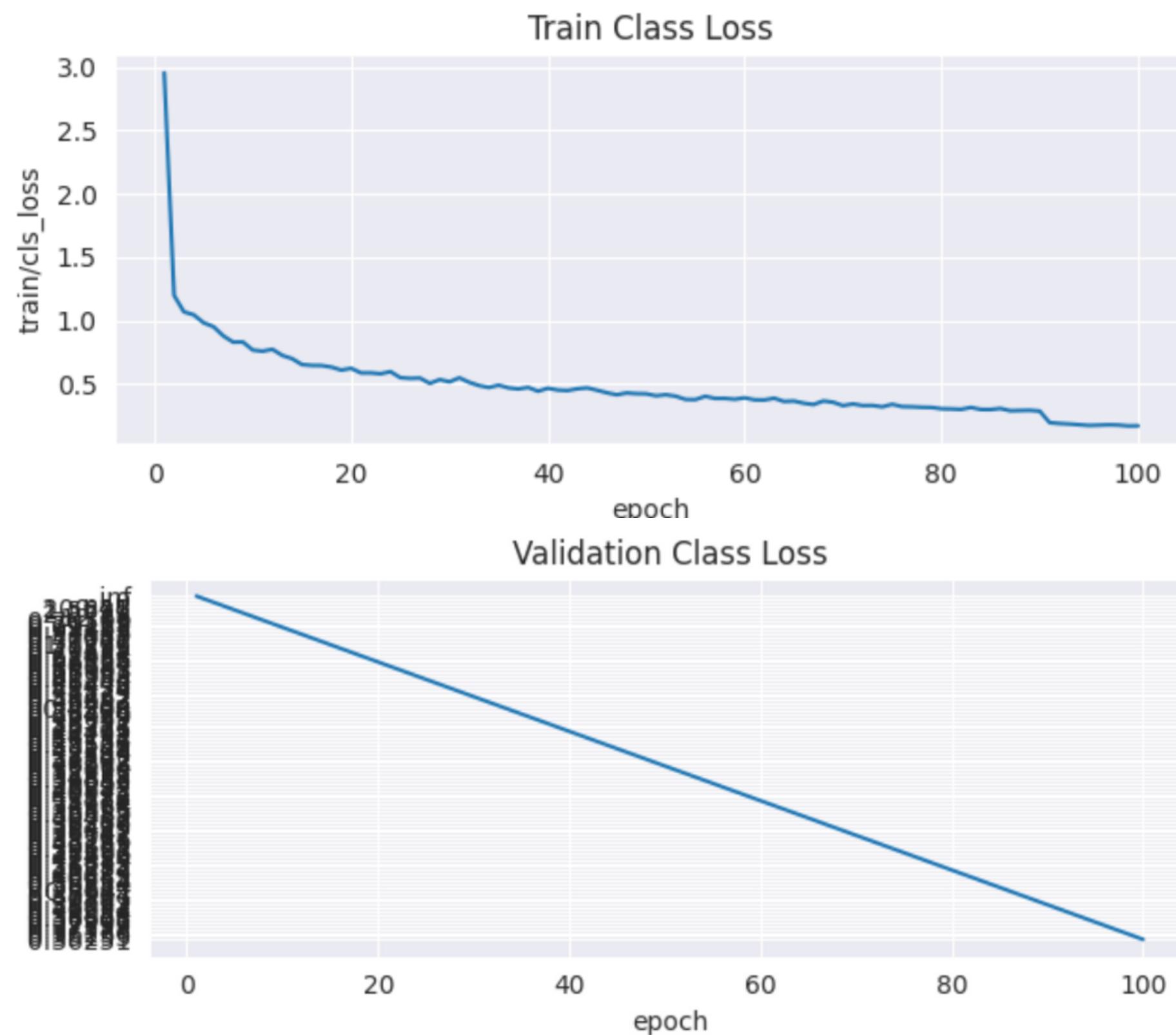
DISCUSSION OF LOSSES



TRAIN CLASS
LOSS OF
0.17063

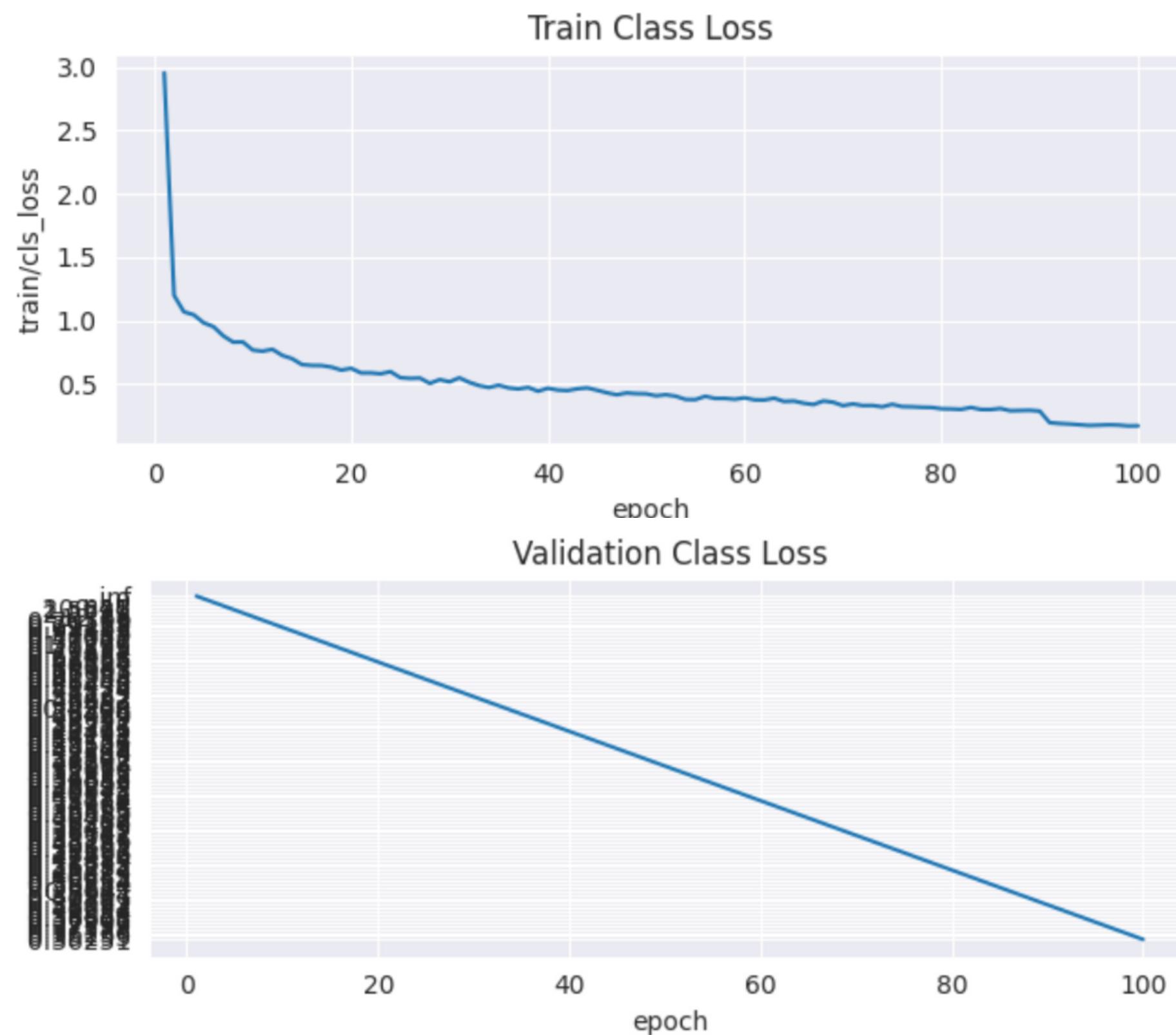
VALIDATION
CLASS LOSS OF
0.36251

DISCUSSION OF LOSSES



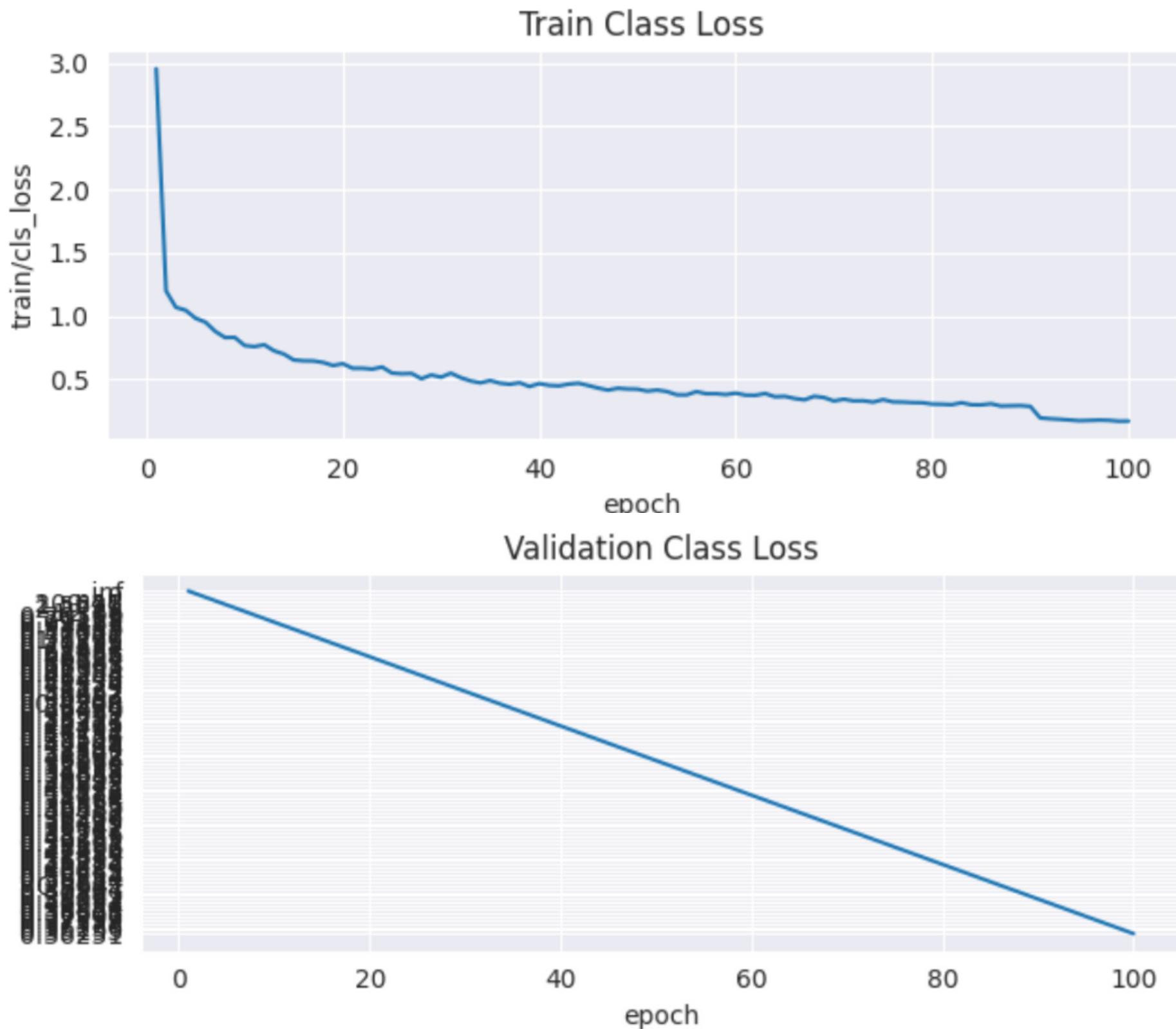
MODEL'S ABILITY
TO
DIFFERENTIATE
BETWEEN
DROWSY AND
NON-DROWSY
DRIVERS BECAME

DISCUSSION OF LOSSES



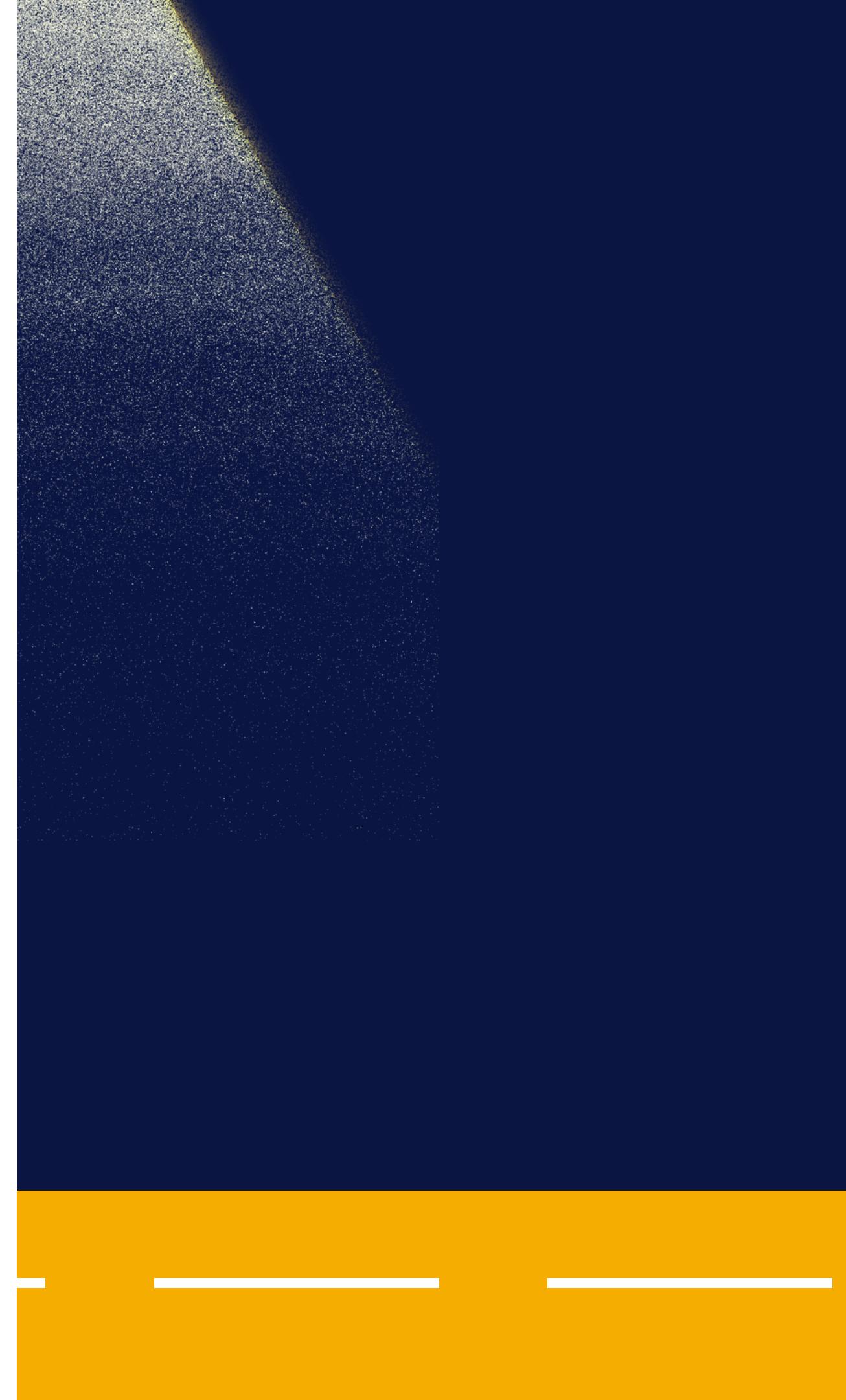
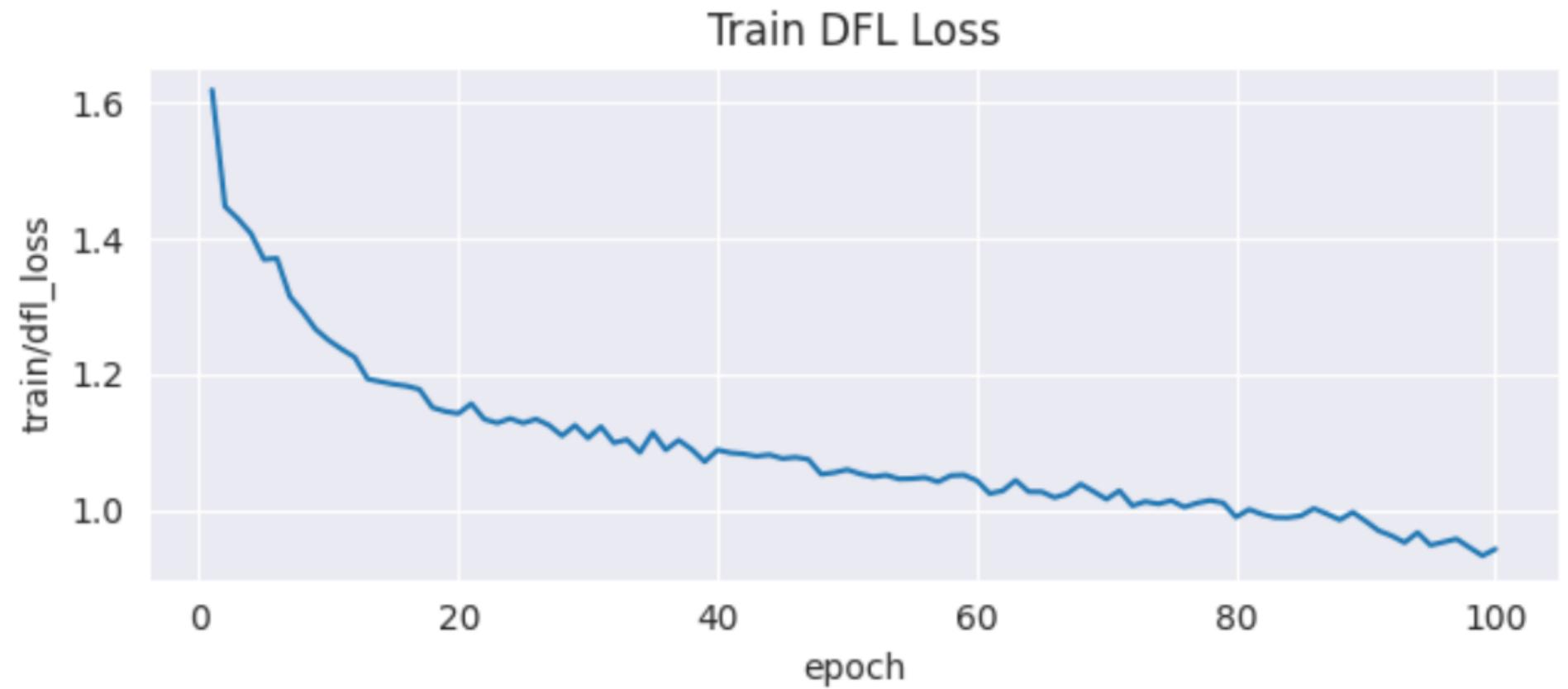
MODEL'S ABILITY
TO
DIFFERENTIATE
BETWEEN
DROWSY AND
NON-DROWSY
DRIVERS BECAME
MORE REFINED

DISCUSSION OF LOSSES

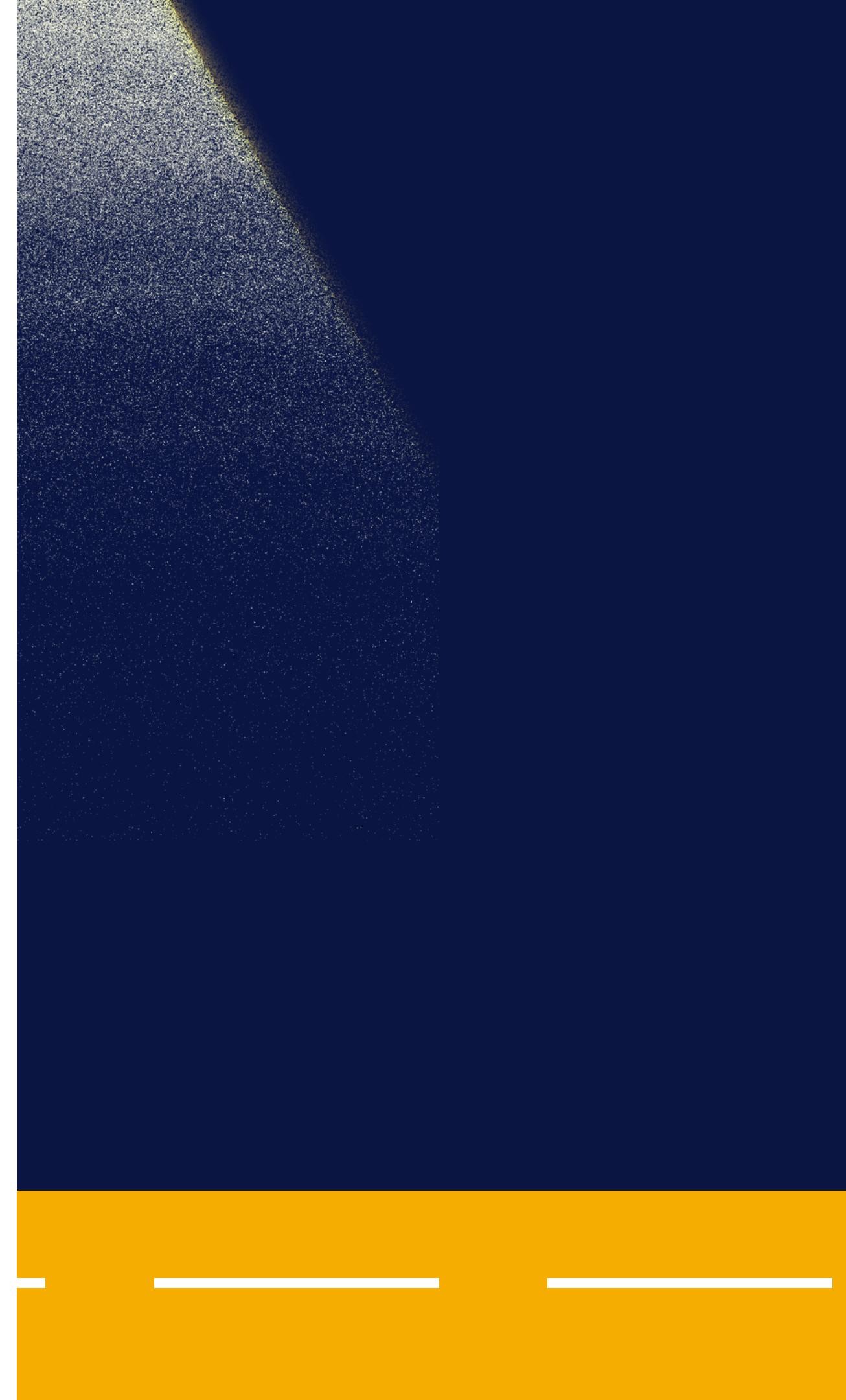
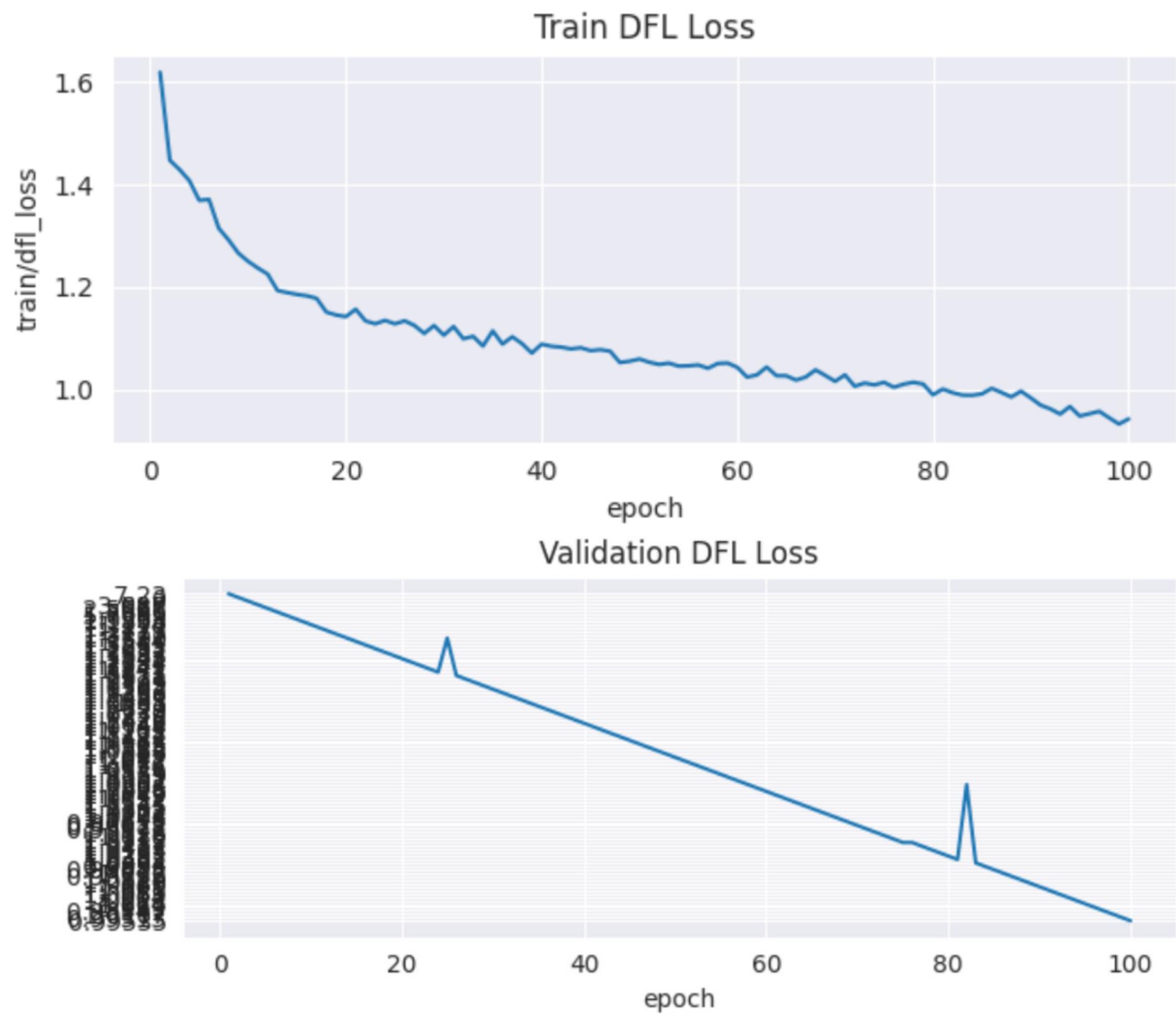


MODEL'S ABILITY
TO
DIFFERENTIATE
BETWEEN
DROWSY AND
NON-DROWSY
DRIVERS BECAME
MORE REFINED
AS TRAINING
PROGRESSED.

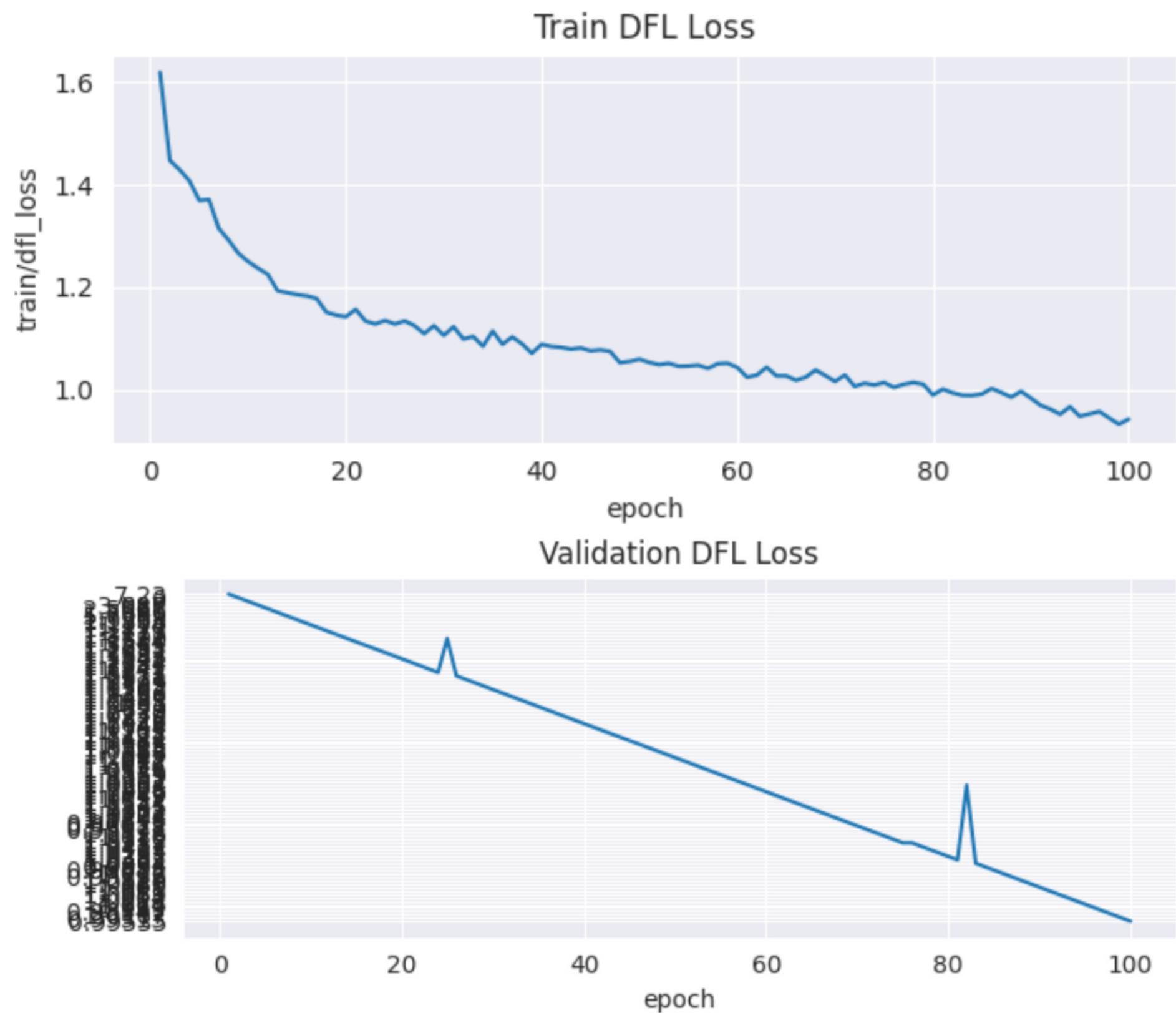
DISCUSSION OF LOSSES



DISCUSSION OF LOSSES

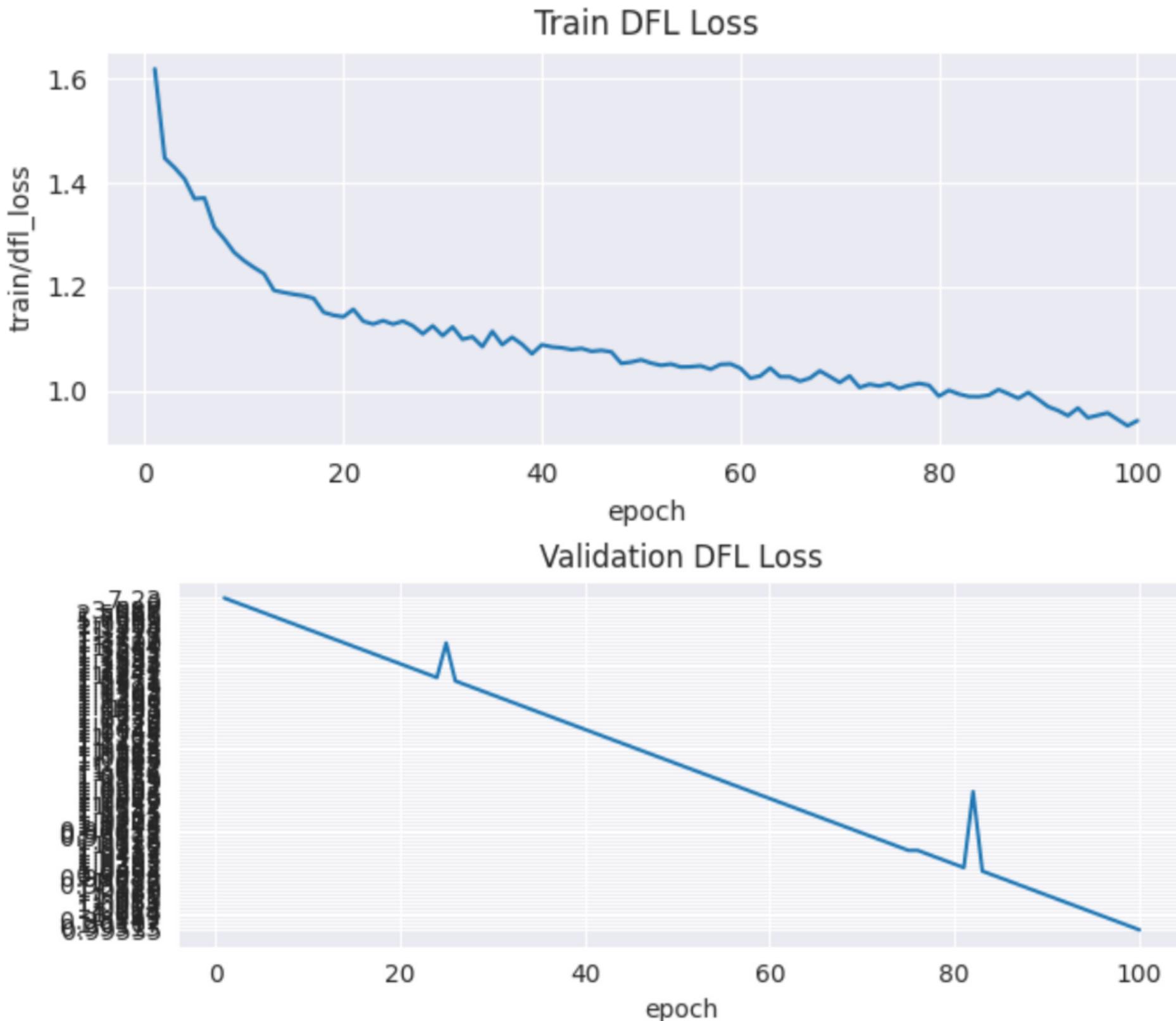


DISCUSSION OF LOSSES



TRAIN DFL LOSS
OF
0.94239

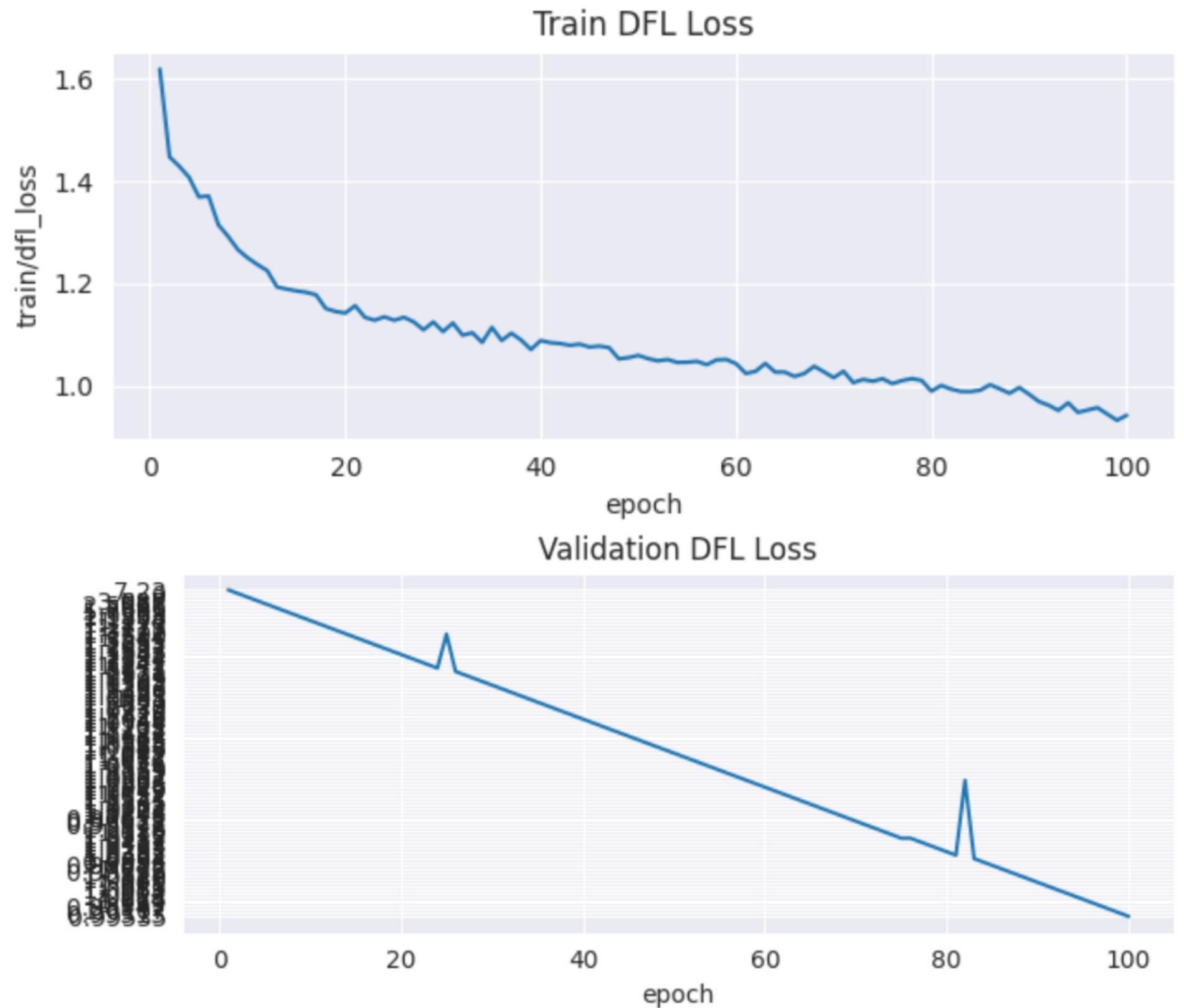
DISCUSSION OF LOSSES



TRAIN DFL LOSS
OF
0.94239

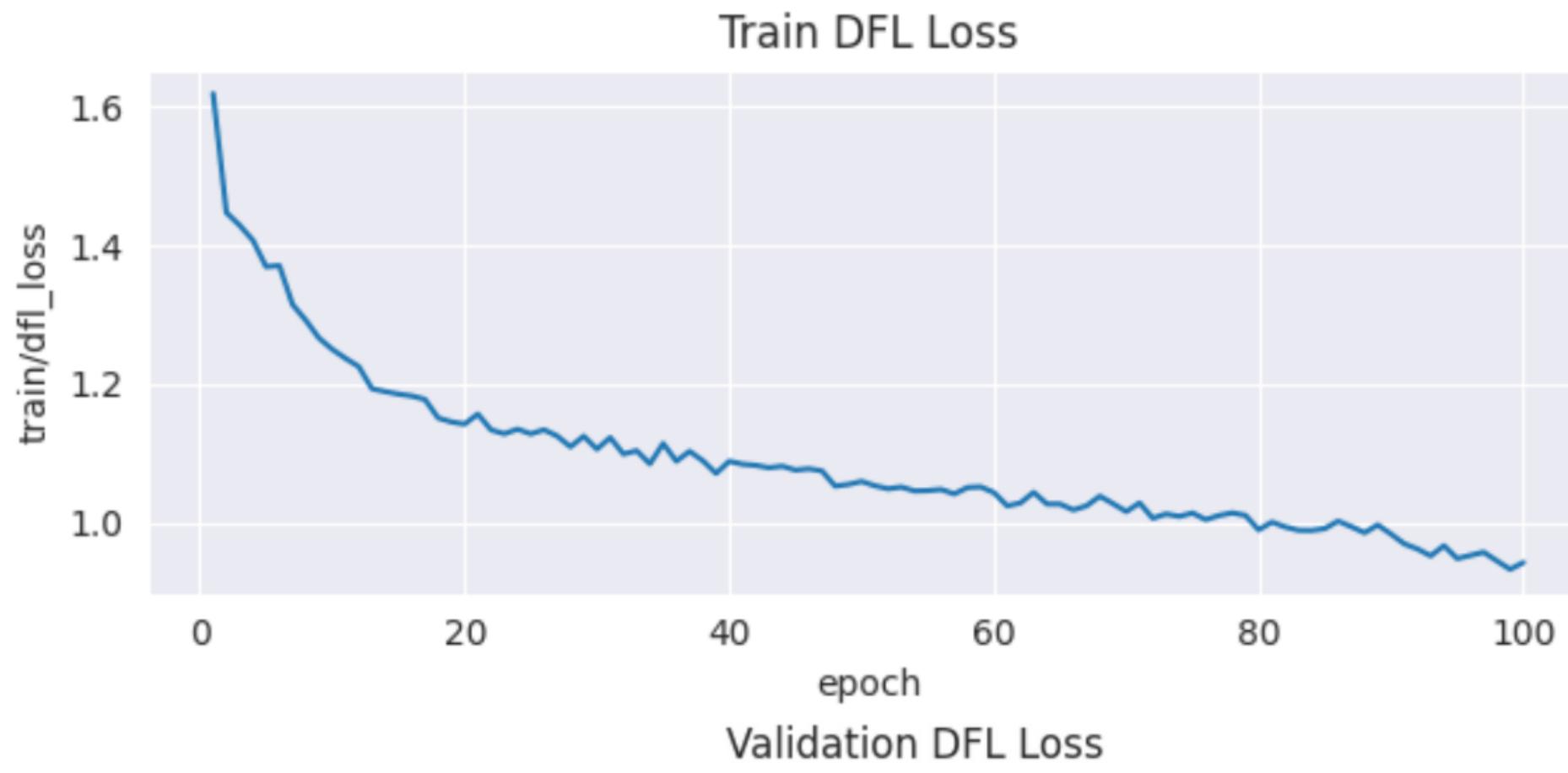
VALIDATION
DFL LOSS OF
0.99535

DISCUSSION OF LOSSES



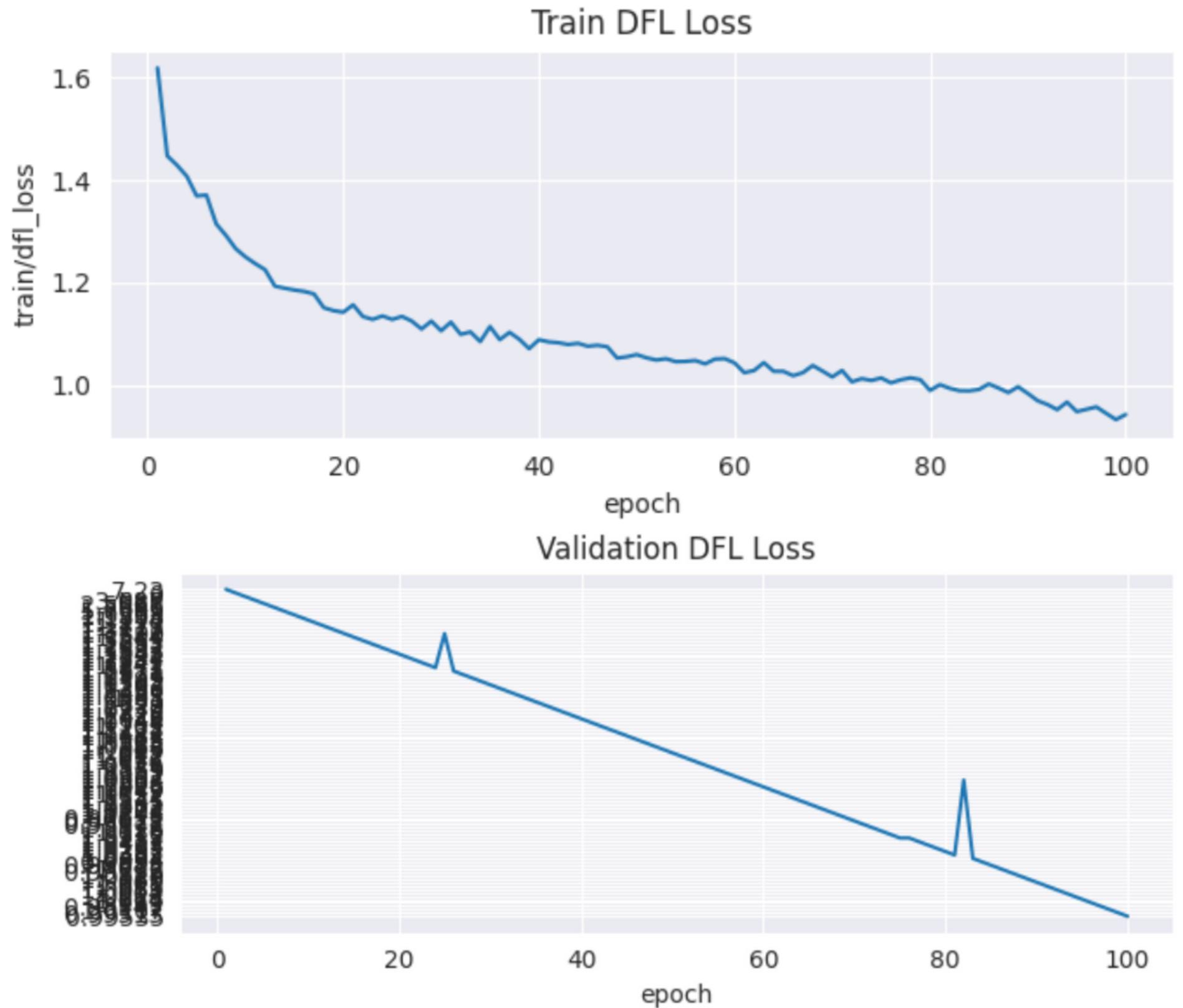
MODEL
SUCCESSFULLY

DISCUSSION OF LOSSES



MODEL
SUCCESSFULLY
**LEARNED
EFFECTIVE
FEATURES**

DISCUSSION OF LOSSES



MODEL
SUCCESSFULLY
LEARNED
EFFECTIVE
FEATURES
FOR
DROWSINESS
DETECTION
DURING
TRAINING.

DISCUSSION

ON COMPARISON



DISCUSSION

ON COMPARISON



DISCUSSION

ON COMPARISON

Run	Performance Metric Values	
	mAP50	mAP50-95
Training	0.98189	0.89259
Testing	0.933	0.842

DISCUSSION

ON COMPARISON

TESTING
(UNSEEN) DATA

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DISCUSSION ON COMPARISON

TESTING
(UNSEEN) DATA
**IS MORE
CHALLENGING**

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DISCUSSION ON COMPARISON

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HOWEVER, THE
SCORE IS STILL

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DISCUSSION

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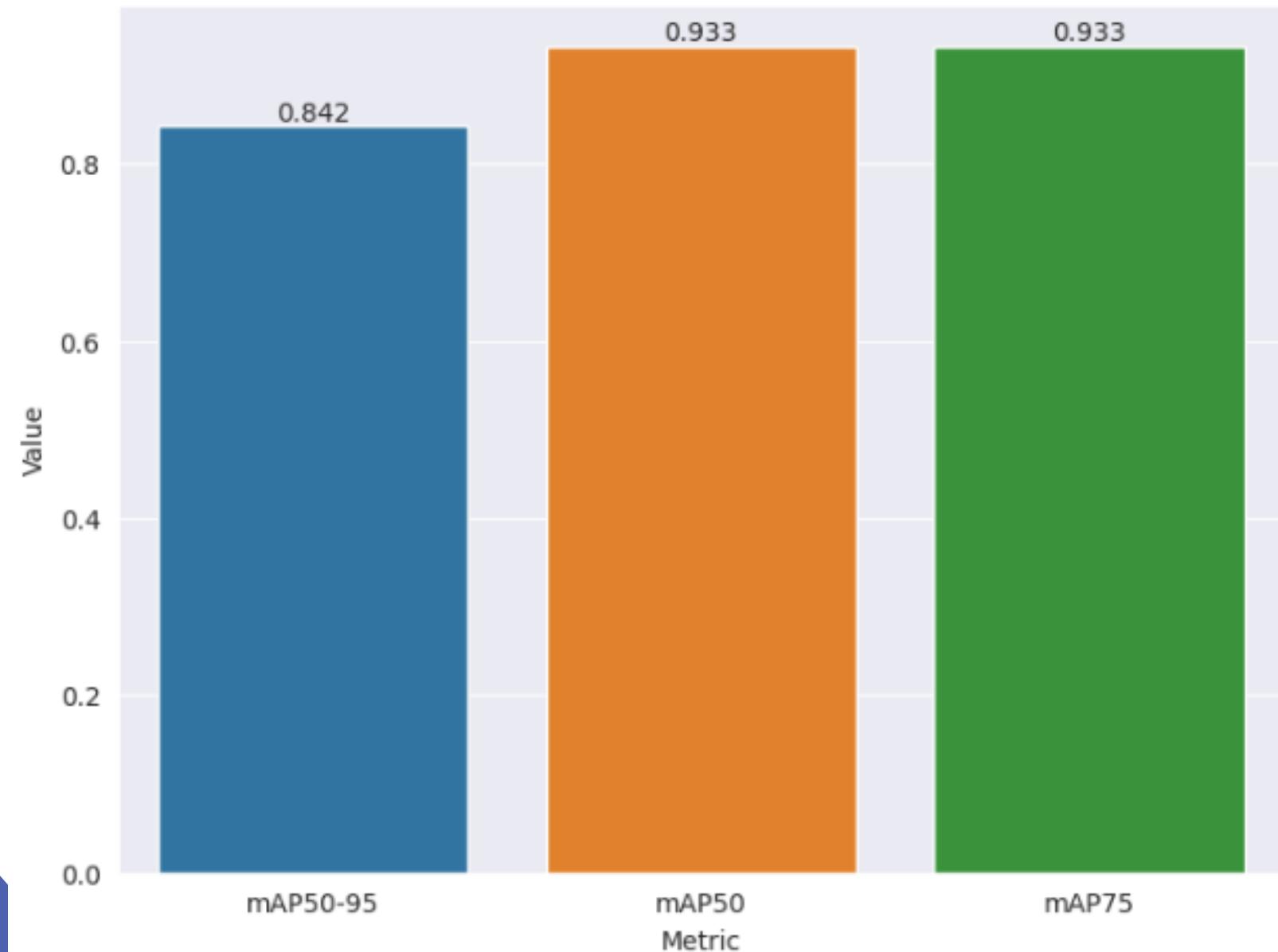
HOWEVER, THE
SCORE IS STILL
VERY GOOD

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DISCUSSION

ON COMPARISON

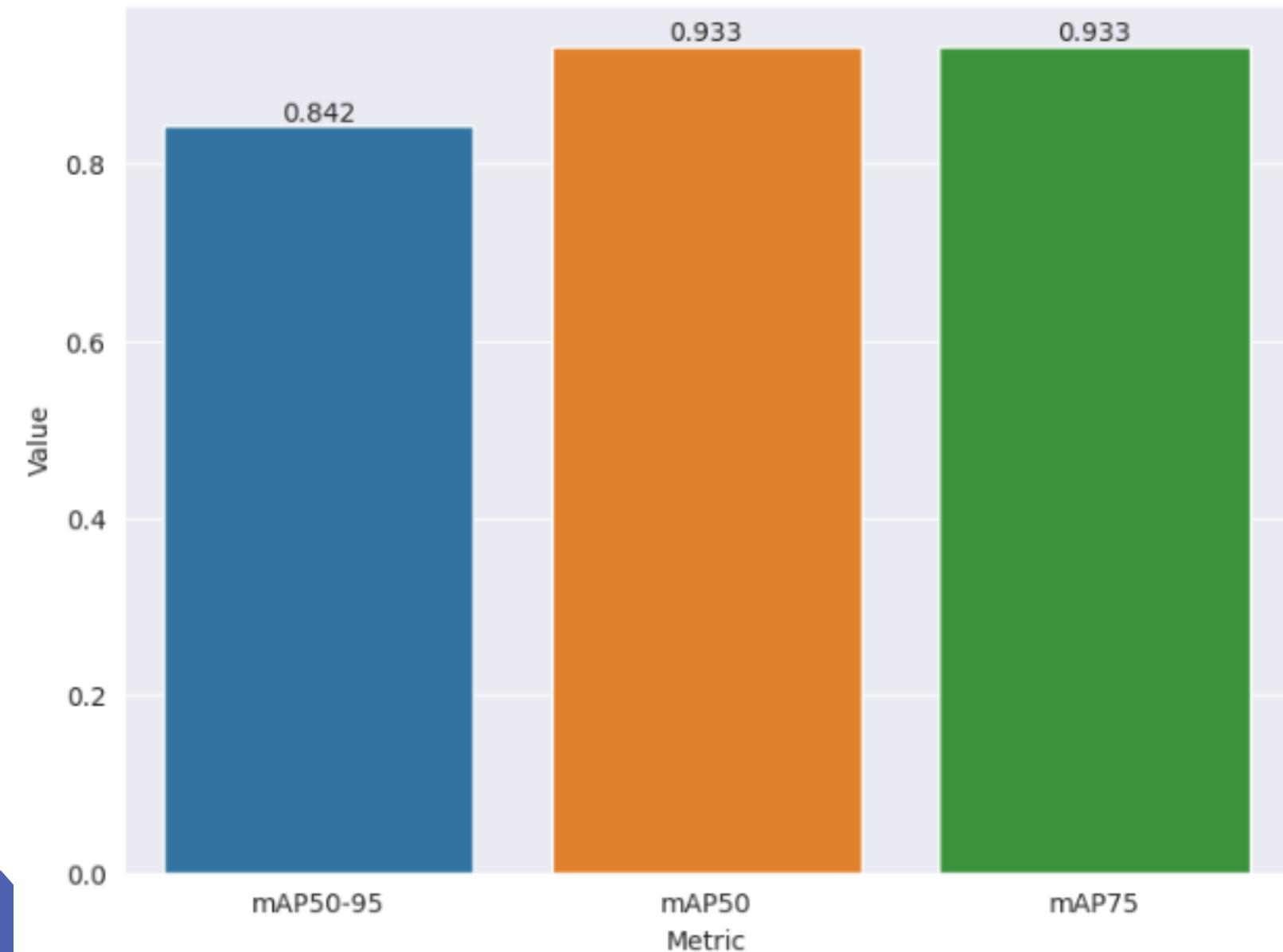
YOLO Evaluation Metrics



DISCUSSION ON COMPARISON

MODEL MAY BE
MORE LENIENT
IN ACCEPTING
DETECTIONS

YOLO Evaluation Metrics

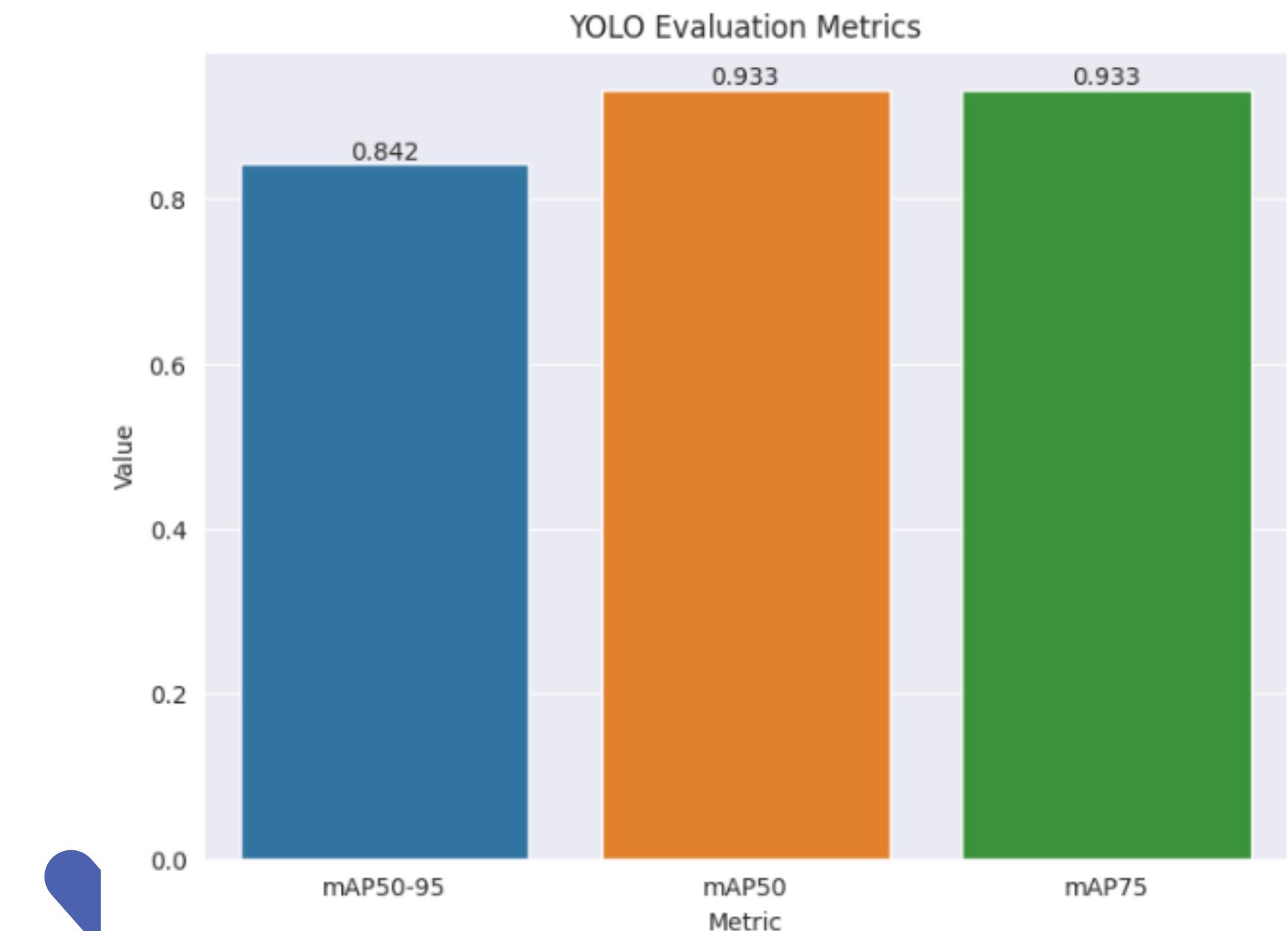


DISCUSSION

ON COMPARISON

MODEL MAY BE
MORE LENIENT
IN ACCEPTING
DETECTIONS

**WITH LOWER
OVERLAP**



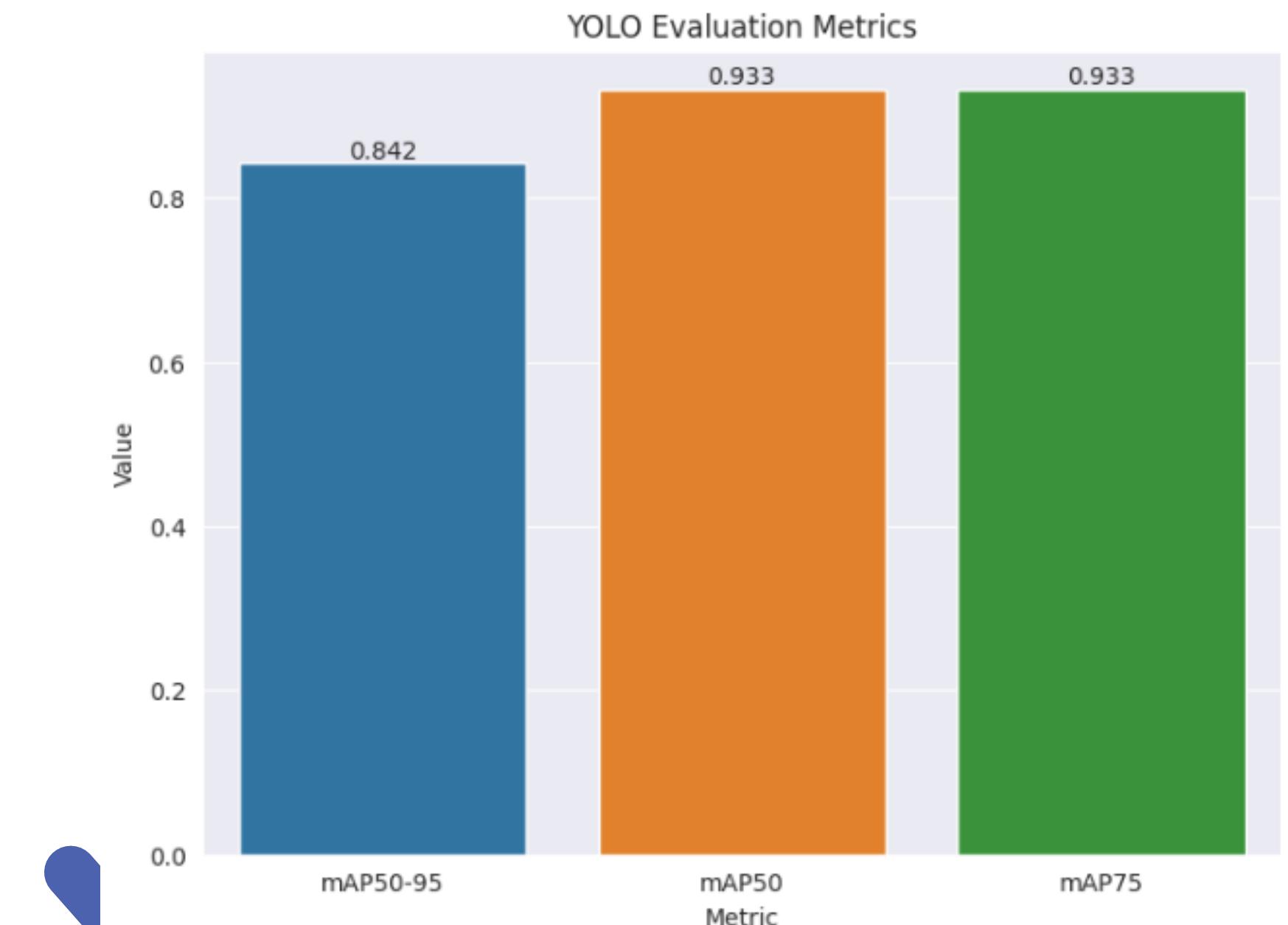
DISCUSSION

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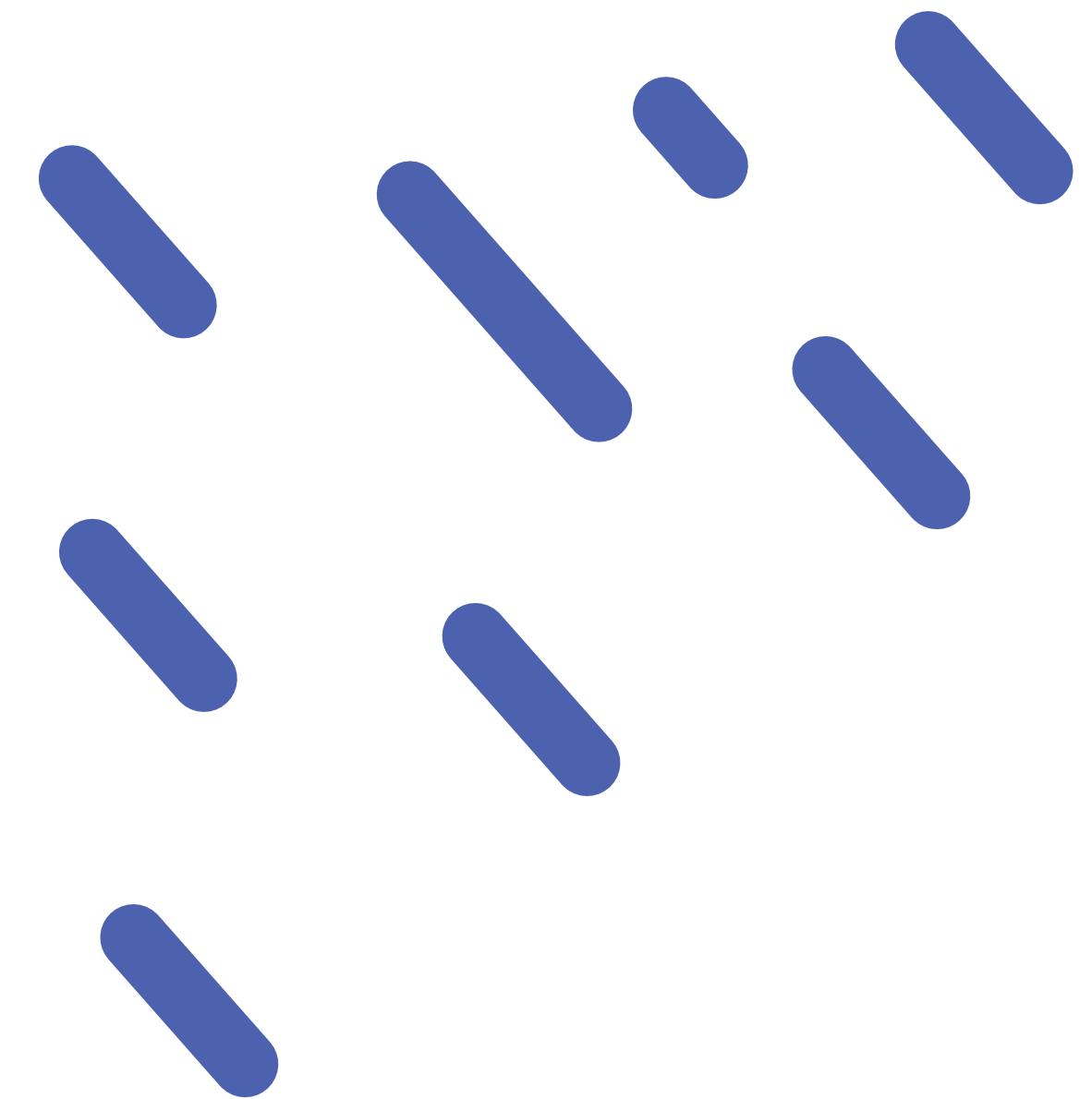
**WITH LOWER
OVERLAP**

WITH THE
ACTUAL OBJECTS

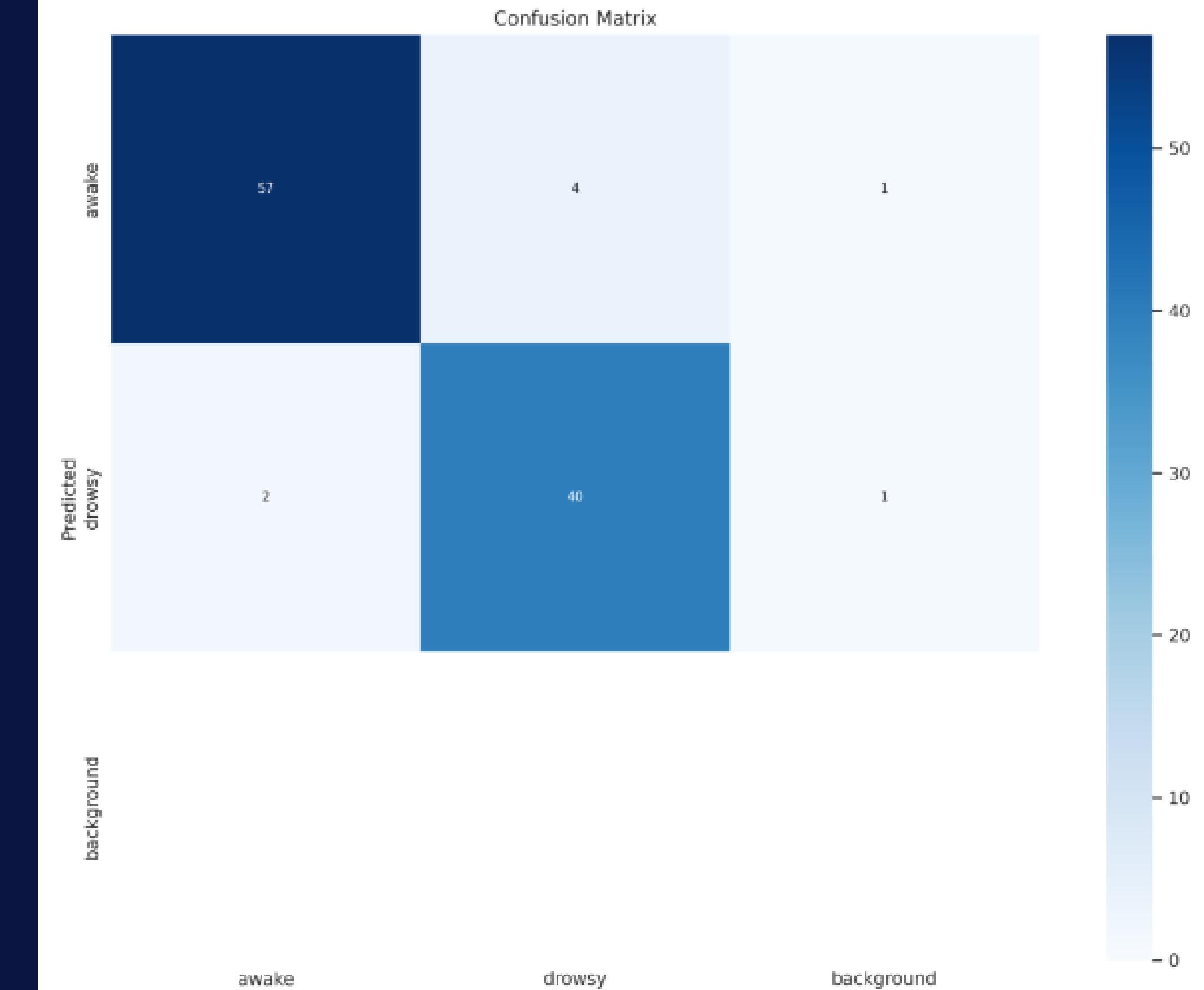


DISCUSSION

ON CONFUSION MATRIX

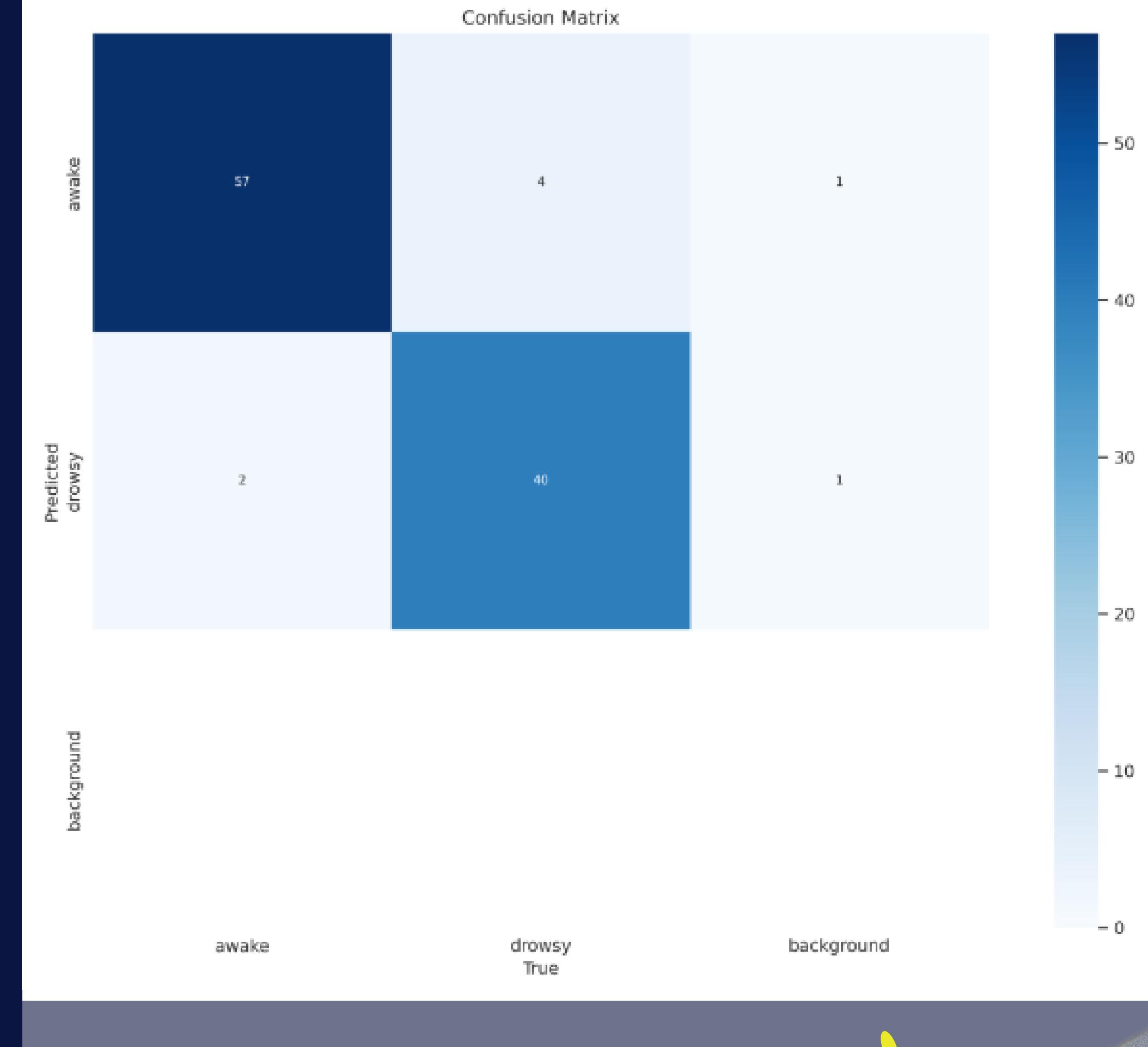


DISCUSSION ON CONFUSION MATRIX



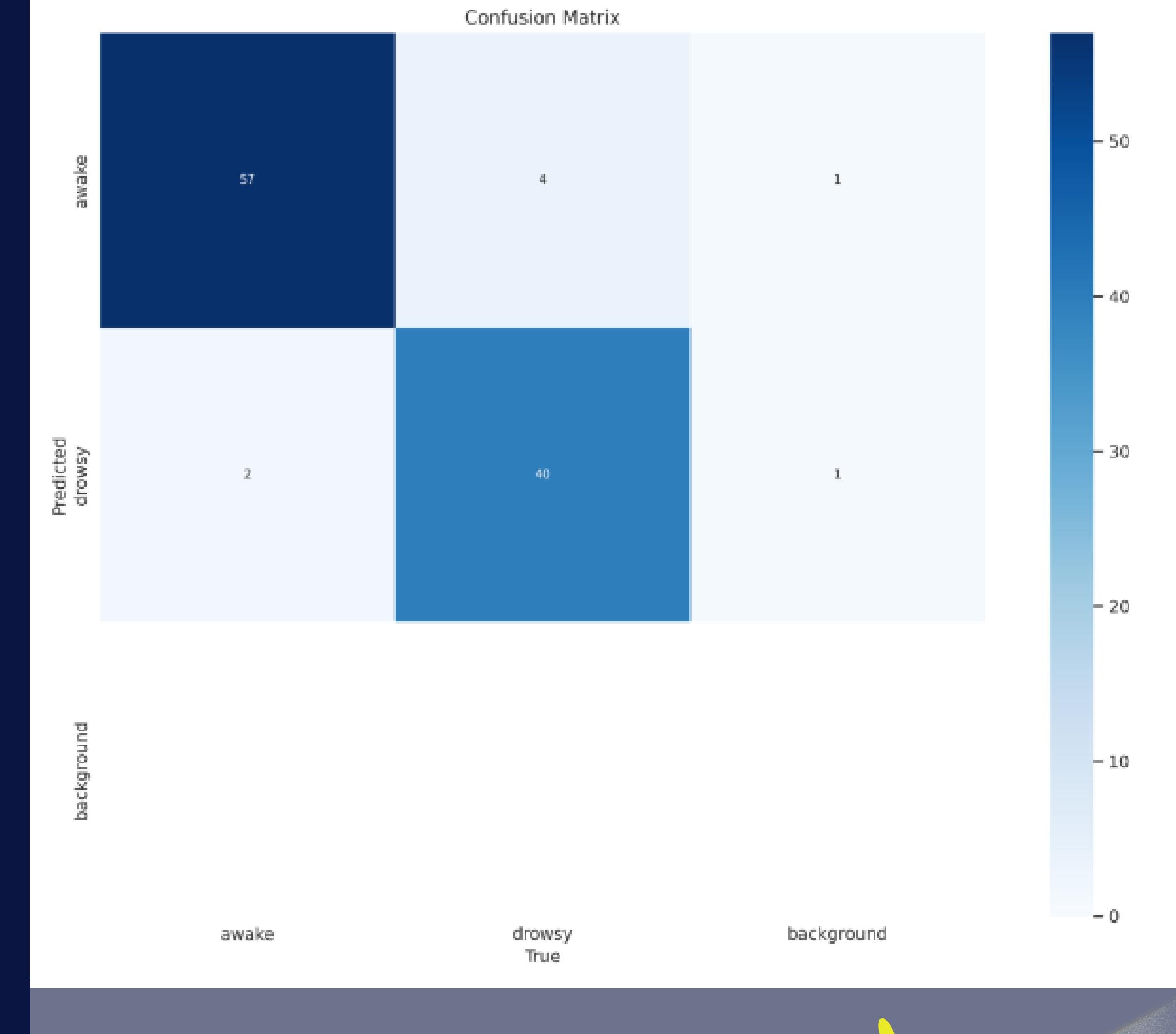
DISCUSSION ON CONFUSION MATRIX

HIGH PROPORTION OF CORRECT



DISCUSSION ON CONFUSION MATRIX

HIGH PROPORTION
OF CORRECT
CLASSIFICATIONS

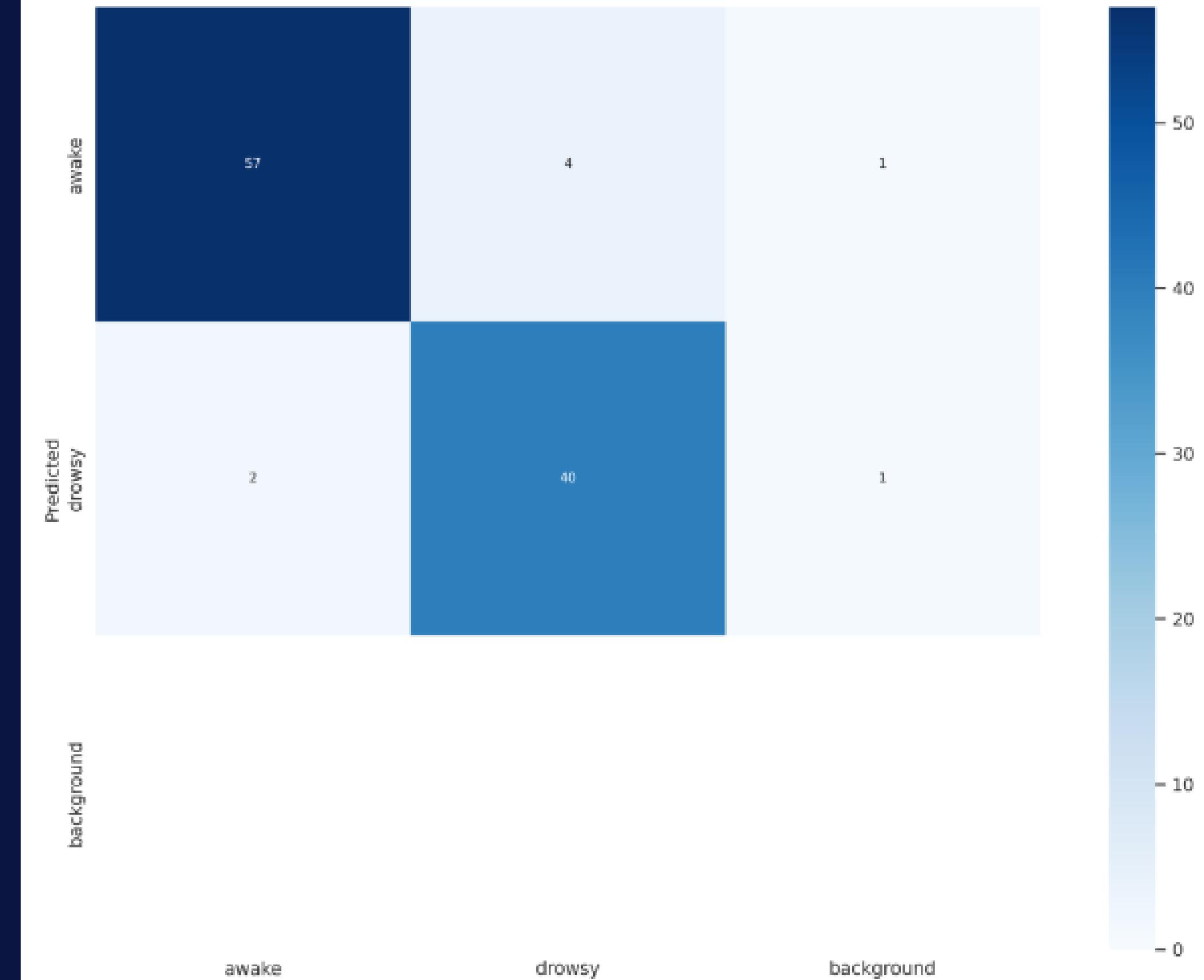


DISCUSSION ON CONFUSION MATRIX

HIGH PROPORTION
OF CORRECT
CLASSIFICATIONS

LOW NUMBER OF
MISCLASSIFICATIONS

Confusion Matrix

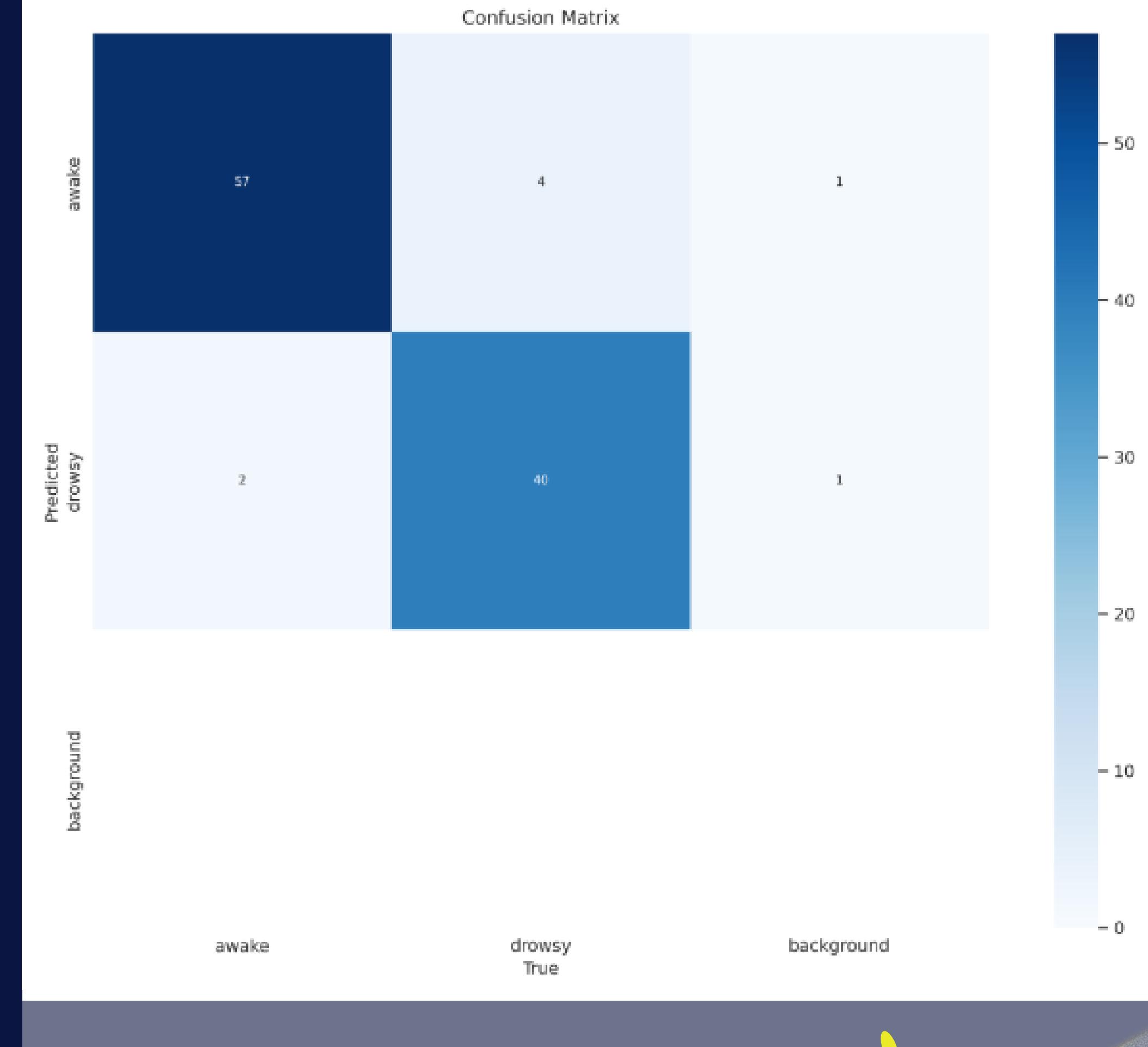


DISCUSSION ON CONFUSION MATRIX

HIGH PROPORTION
OF CORRECT
CLASSIFICATIONS

LOW NUMBER OF
MISCLASSIFICATIONS

SIGNIFIES A SMALLER
MARGIN OF ERROR



RECOMMENDATIONS FOR FUTURE WORKS

DRIVER DETECTION

Given the scope of this study on drowsiness detection, future fine-tuning efforts should emphasize training the model exclusively for detecting drowsiness in the driver.

This ensures that the model's scope is to the driver alone, excluding other entities, such as unrelated individuals captured by the camera or any object. This mitigates unnecessary detections and greatly improves overall model performance.

ALARM SYSTEM INTEGRATION

The researchers recommend to include an alarm system triggered by the models' consecutive detections of drowsiness in the driver.

This system can be integrated into an Android application or a camera interface. Such an alarm system serves to promptly alert the driver, thereby mitigating the risk of drowsiness-related vehicle accidents and promoting road safety.

