MODELING OF MULTI-AGENT SYSTEMS WITH COMPUTER GRAPHICS

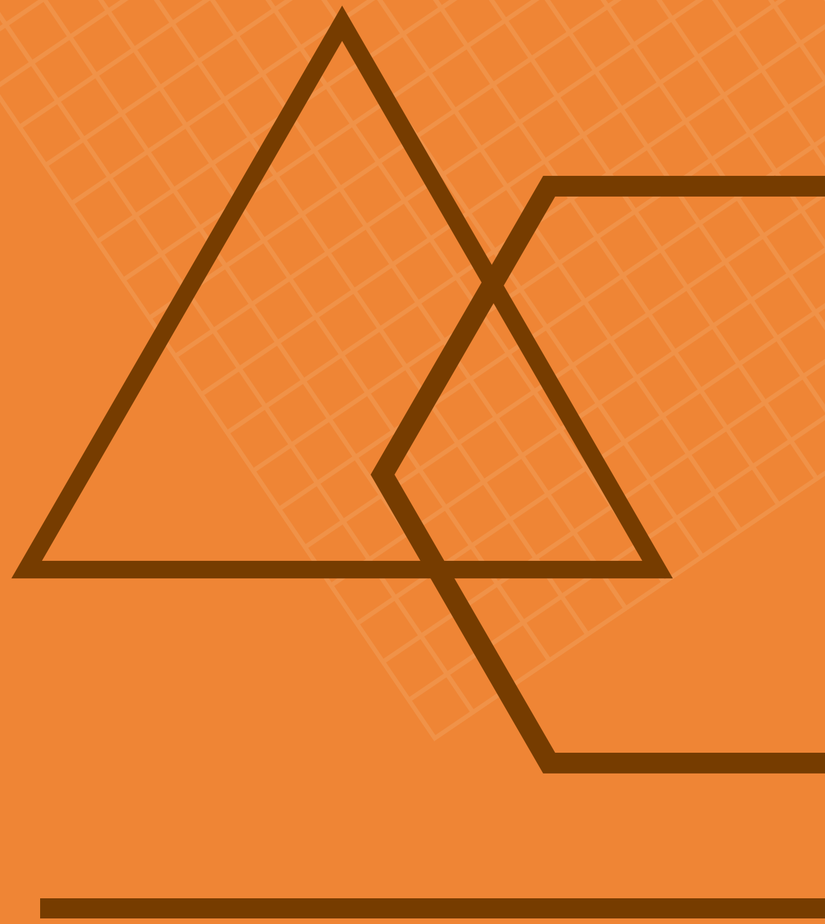
CATCH THE ROBBER

CONTEXT

MATERIALS BANK

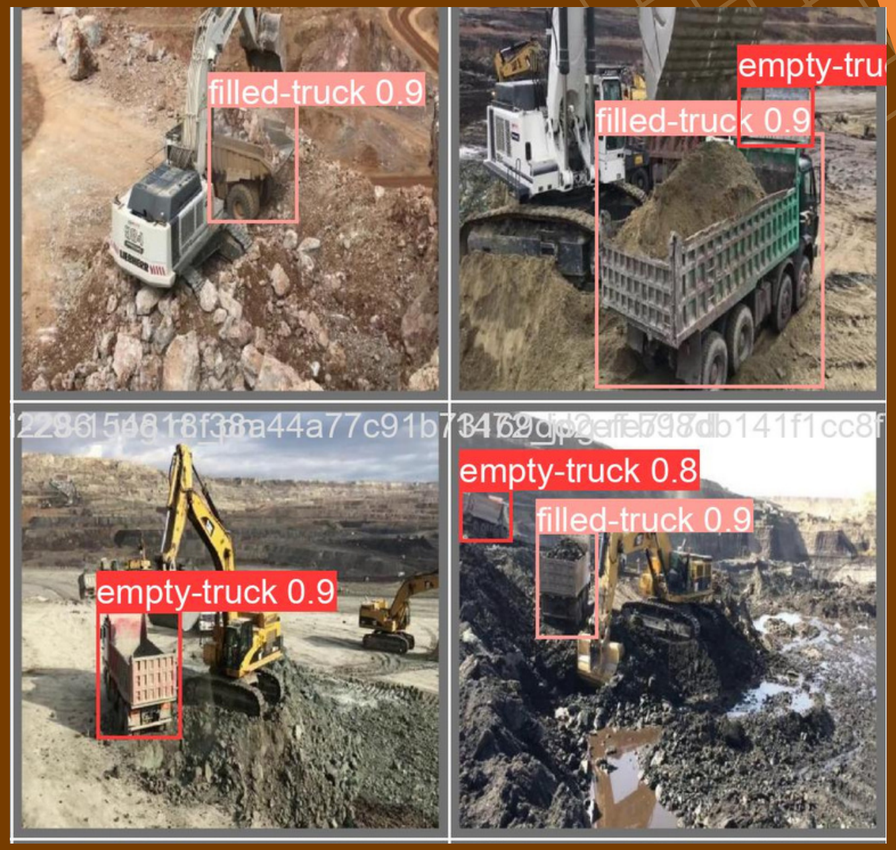
With the rapid development of cities, there is a huge demand for construction materials. In a general sense, materials are obtained from natural areas composed of gravel, clay and stone; this is known as a material bank.

Often found in regions away from civilization, material banks can be difficult to secure, leaving vulnerable the location for robberies.



SOLUTION

- **Track incoming/outgoing** and **empty/full** trucks at the material bank.
- Save **daily reports** to compare paid entrances with **outgoing full trucks** at the material bank.



CAMERA AI SECURITY SYSTEM

A robust, real-time monitoring system that ensures every truck entering and exiting the premises is accurately logged and accounted for. To achieve this, the project will employ intelligent agents capable of sophisticated communication and interaction, leveraging the latest advancements in computer graphics to create a dynamic simulation environment within the Unreal Engine platform.

CAMERAS LOCATION

It was determined to consider two specific entrances to the material bank, the alternative routes prove too irregular for a material-laden truck. By focusing on these accessible entry points, we can maintain a straightforward and cost-effective solution.

COMPONENTS

SOFTWARE

Unreal Engine:
Software to simulate the agents interaction and communication

Python:
Programming language to create the model training for the agents

Roboflow:
Simplified computer vision platform to identify different states of the trucks and movement

COMMUNICATION

BETWEEN AGENTS

BDI

Language ACL : KQML

Structure of Messages

- ***msg***: The message.
- ***performative***: The type of action, such as:
  - ***Request***: Used when an agent seeks information or an action from another agent.
  - ***Inform***: Employed when an agent communicates information to another.
- ***content***: The information or data being communicated.
- ***sender***: The identifier of the message sender.
- ***query***: Identifier for tracking queries or replies.
- ***is_reply***: A flag indicating whether the message is a reply.

UNREAL ENGINE

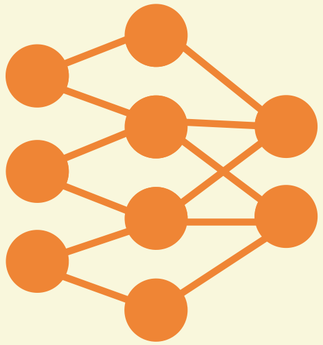
COMPUTER VISION MODEL

Colection of data

To determine if the truck is loaded, we compiled a dataset of over **250** images, capturing trucks in both states.

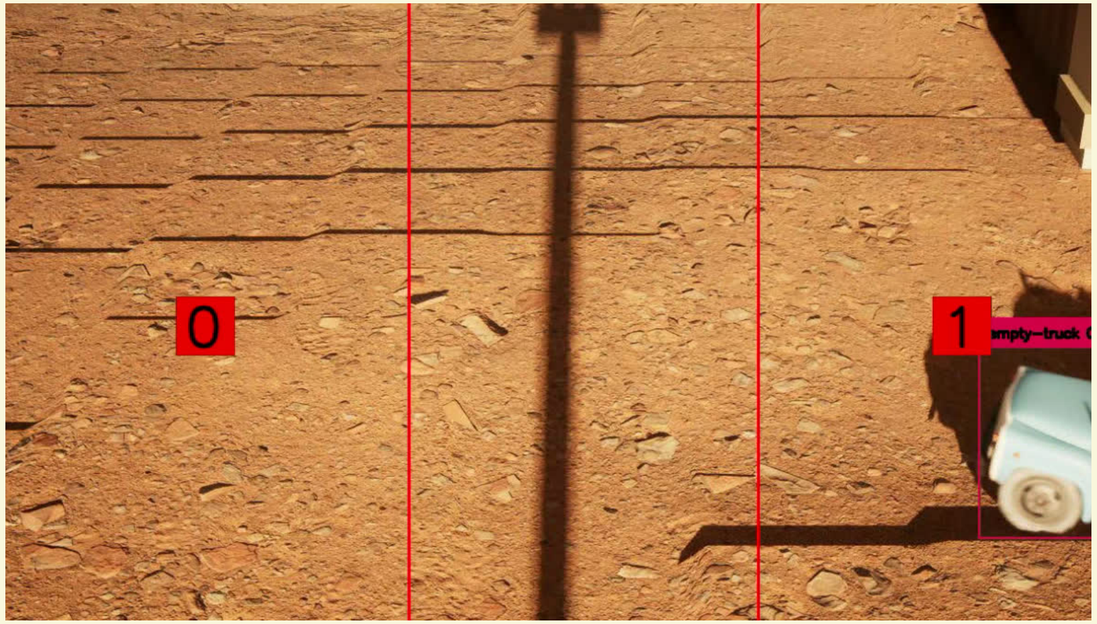
Training

Utilized the **YOLOv8n** pretrained model as a foundation, considering over **3.5 million** parameters.



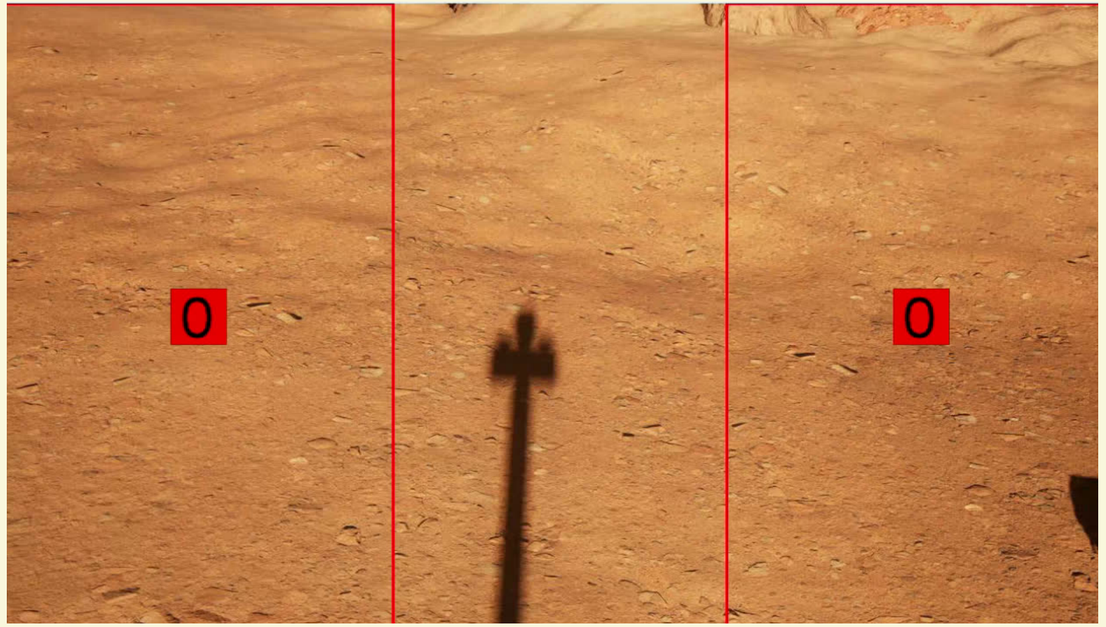
Validation

Our final model **TrucksV12** achieves a validation accuracy of **89.7%** for verifying the truck states.



ENTRANCE

For this case, the most common case it’s to find the trucks in the empty state

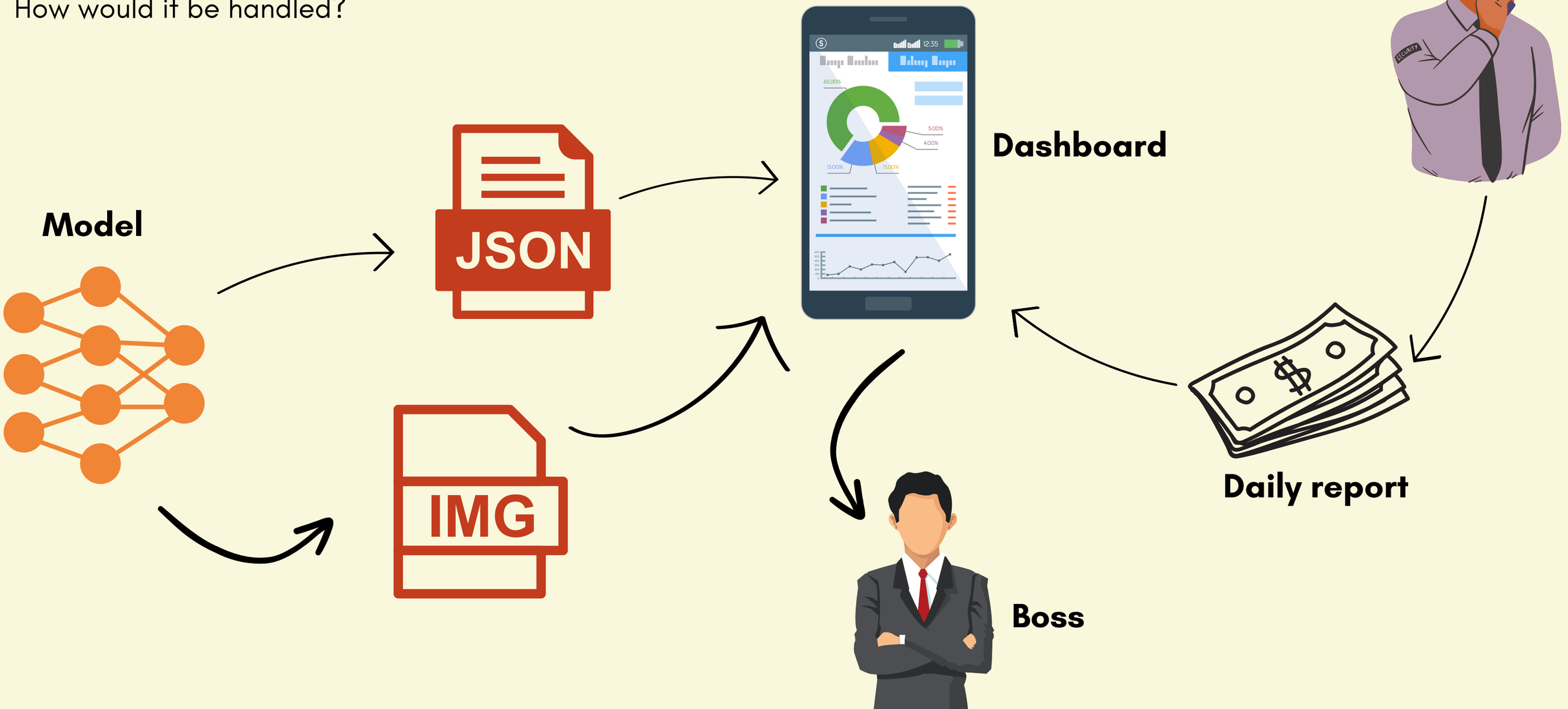


EXIT

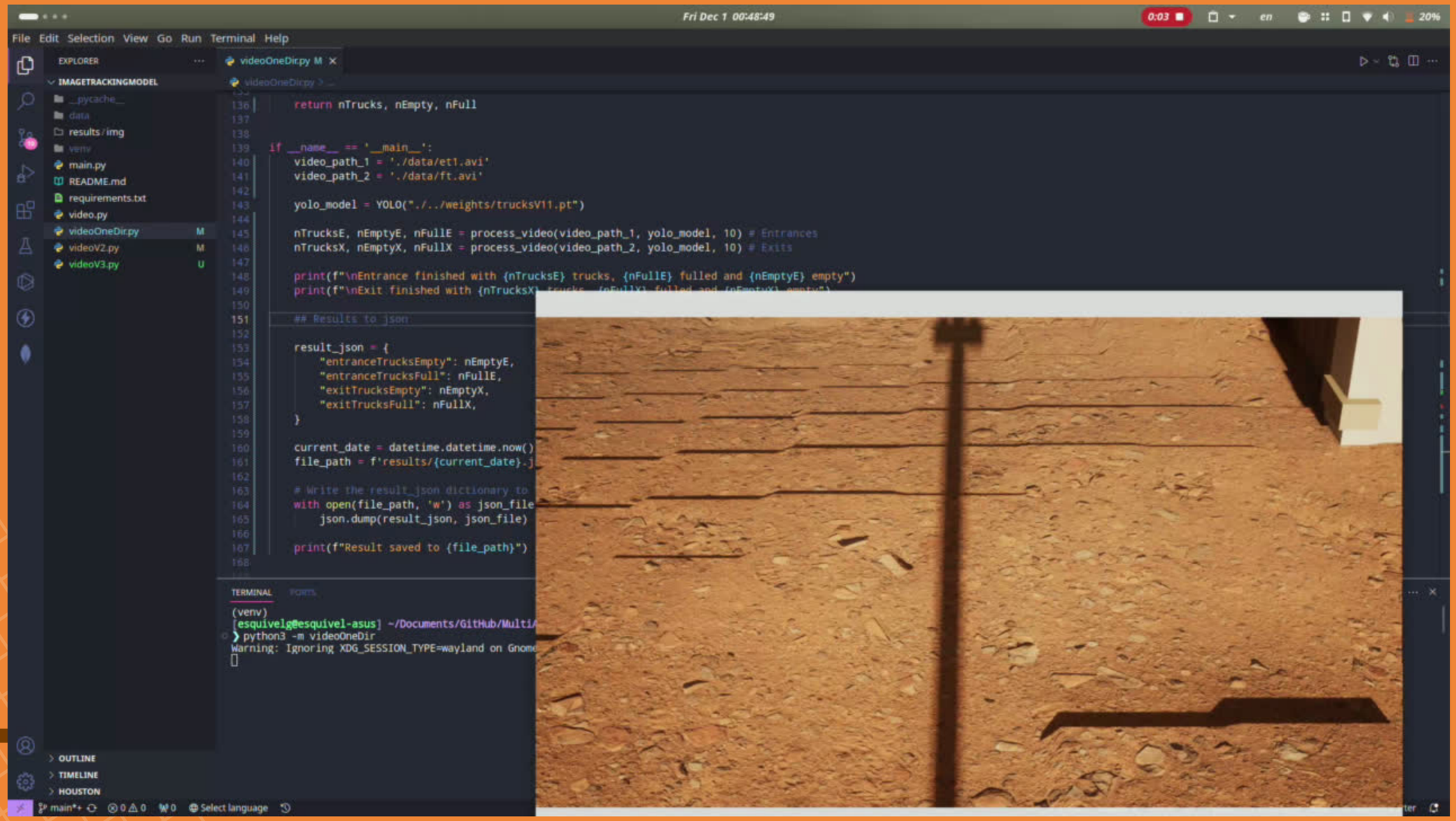
Here, we are looking for all the trucks that are fulled with material, to count all of them, compare them with the entrance and report everything to the system.

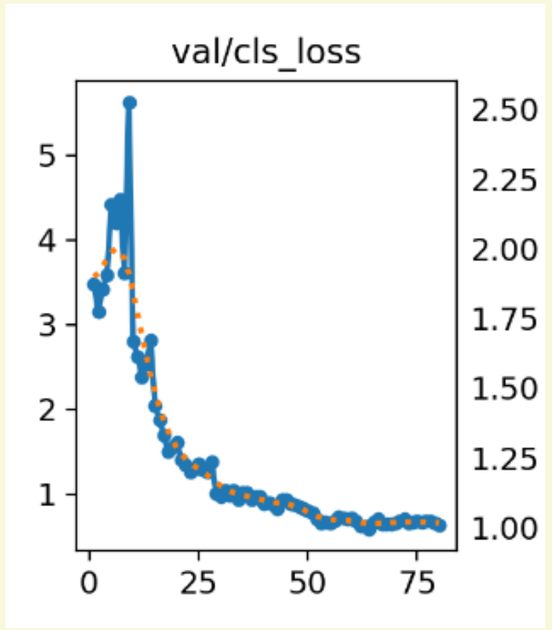
RESULTS

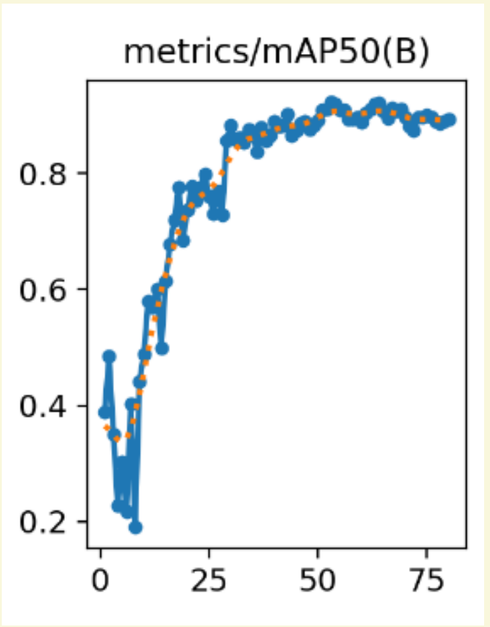
How would it be handled?



DEMO

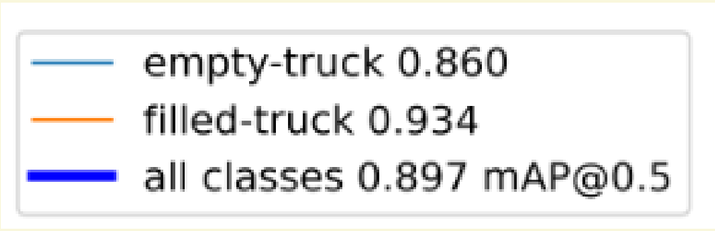

File Edit Selection View Go Run Terminal Help
EXPLORER
IMAGETRACKINGMODEL
videoOneDir.py M
return nTrucks, nEmpty, nFull
if __name__ == '__main__':
video_path_1 = './data/et1.avi'
video_path_2 = './data/ft.avi'
yolo_model = YOLO("./../weights/trucksV11.pt")
nTrucksE, nEmptyE, nFullE = process_video(video_path_1, yolo_model, 10) # Entrances
nTrucksX, nEmptyX, nFullX = process_video(video_path_2, yolo_model, 10) # Exits
print(f"\nEntrance finished with {nTrucksE} trucks, {nFullE} fulled and {nEmptyE} empty")
Results to json
result_json = {
"entranceTrucksEmpty": nEmptyE,
"entranceTrucksFull": nFullE,
"exitTrucksEmpty": nEmptyX,
"exitTrucksFull": nFullX,
}
current_date = datetime.datetime.now()
# Write the result_json dictionary to
with open(file_path, 'w') as json_file
json.dump(result_json, json_file)
print(f"Result saved to {file_path}")
TERMINAL
(venv)
esquivelg@esquivel-asus ~/Documents/GitHub/MultiA
python3 -m videoOneDir
Warning: Ignoring XDG_SESSION_TYPE=wayland on Gnome
OUTLINE
TIMELINE
HOUSTON





MODEL VALIDATION

The examples refer to the error with the bounding boxes and to the mean average precision to detect classes



TESTING EFECTIVITY

- **TOTAL TRUCKS: 10**

- **ENTRANCE**

  10 Empty Trucks

- **EXIT**

  7 Full Trucks

  3 Empty Trucks

- **TRUCKSv12**

  7 Full

  1 Empty

results > {} 2023-12-01-08.json > ...

```
1  {"entranceTrucksEmpty": 10, "entranceTrucksFull": 0, "exitTrucksEmpty": 1, "exitTrucksFull": 7}
```

COMPONENTS

PHYSICAL

Cameras

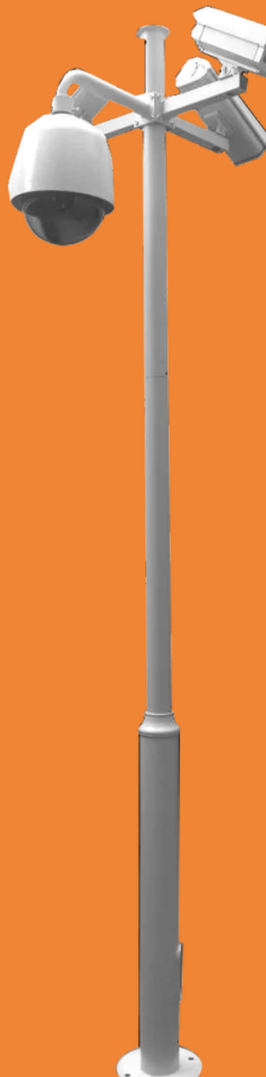
- Resolution: 2688 x 1520 Pixels
- Name: Hikvision Cámara IP Bullet IR Outside IDS-TCM403-BI, Wired
- Unit price: 1124.45 dls each
- Day and Night
- Quantity: 2

Infrastructure

- Construction material
- Specialized 6m pole for CCTV installation, XGAPOLE-6M
- Unit Price: 363.49dls
- Quantity: 2

System Maintenance

- Between 8 and 12% of the total project cost.



$3,200.00

THE IMPLEMENTATION OF AN AI-ENHANCED MONITORING SYSTEM IS NOT MERELY A SECURITY UPGRADE; IT IS A STRATEGIC INVESTMENT.

By ensuring accurate tracking of all trucks, the system directly contributes to preventing material theft and loss. This enhanced oversight leads to better inventory management and reduces unnecessary expenditures.

CONTACT INFORMATION

FOR QUESTIONS AND CONCERNS

Ana Luisa González Del Rosal **A01566927**

Moisés Hiram Pineda Campos **A01625510**

Emilio Berber Maldonado **A01640603**

Liliana Solórzano Pérez **A01641392**

Guillermo Esquivel Ortiz **A01625621**

Samuel García Berenfeld **A01642317**