VIETNAM DATATHON 2023

Team 5: Datadark

Dataset #5 - Shelf behaviors CCTV

Hoang Hung
Tran Bao Nguyen
Dang Quoc Minh
Nguyen Dinh Quan
Hoang Thanh Tu

1. Introduction and Problem Statement

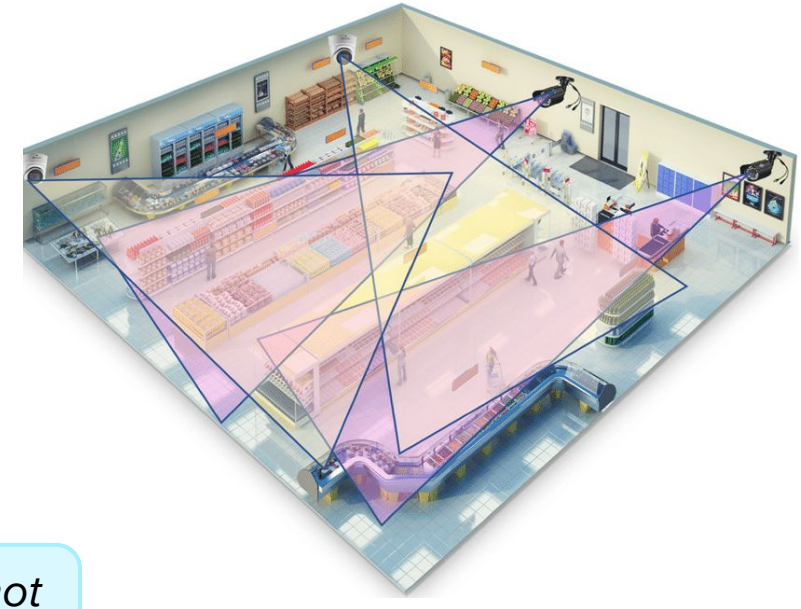
Abstraction

CCTV appears in millions stores.

CCTV provides enormous data

Only some malls analyze those data

Most groceries are not able to leverage them



⚠ **Huge data wasted**

What problems can be treated with data of CCTV?

Problem 1: Unsuitable Items arrangement

VIETNAM DATATHON 2023

The need to bend down to reach products on lower shelves poses challenges for a significant portion of the population. For example, it causes many annoying results

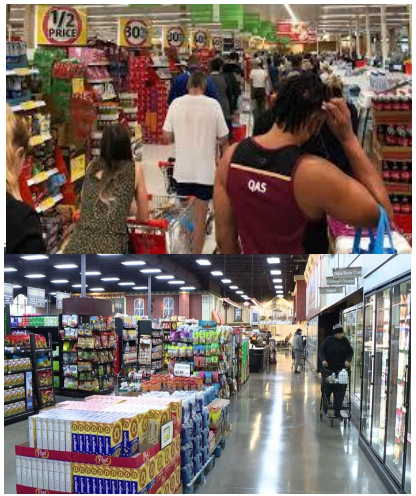
Accessibility Barriers: The current shelf layout makes it difficult for individuals with mobility challenges to retrieve products. This lack of accessibility may deter potential customers and diminish the overall shopping experience.

Customer Safety: The act of bending down increases the risk of accidents, such as trips or falls, particularly among older customers.

Problem 2: Unequal distribution

VIETNAM DATATHON 2023

The imbalance manifests as crowded shelves in certain areas and empty or underutilized shelves in others, contributing to a suboptimal shopping experience for customers.



Operational Inefficiency: Unequal distribution complicates inventory management processes, as some empty places require a lot of money to rent while not generating profit

Customer Frustration: Unequal distribution of products results in crowded shelves, making it challenging for customers to navigate and find desired items.

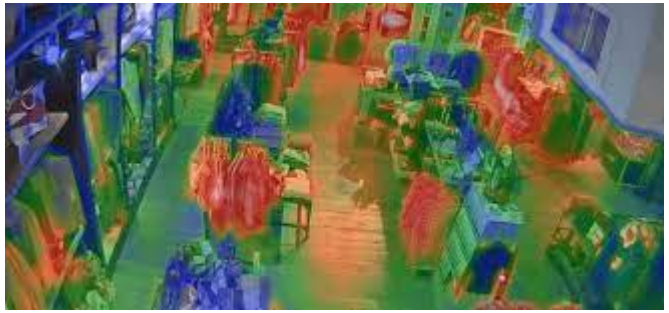
Those two problems are common in many supermarkets and stores but not many people recognize it. Therefore, our MVP will pioneer to provide solutions for the 2 above problems

Insight: Heatmap and analytical data

VIETNAM DATATHON 2023

Providing a heatmap and statistical data can be an effective solution to address the two problems mentioned

Heatmap: a heatmap depicts the product distribution across shelves can quickly convey information. The heatmap visualizes crowded places where mostly people bend down with bright color, while others is presented with dark colors.

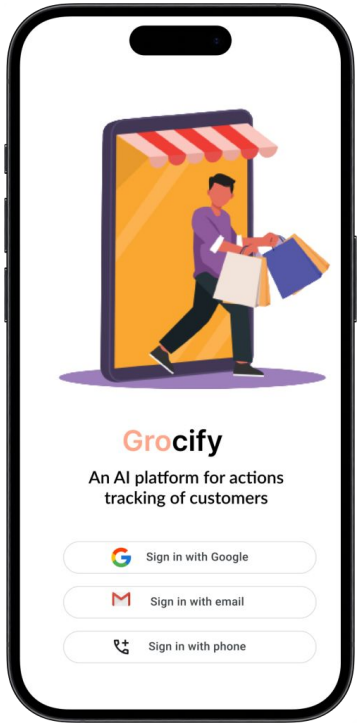


Statistical data: Alongside the heatmap, customer bend-down rates, product turnover rates, sales data, and popularity metrics for each product category can offer a comprehensive understanding of demand patterns.

2. Solution Overview

Solution Overview

Shop owners mainly focus on where their customer shopping. However, we believe that:
"How customer shopping is absolutely much that important".



Accordingly, we propose an app "Grocify" with slogan

Grocify = Grocery + Identify

Grocify is proposed to enhance the visibility of customer behavior in groceries and supermarkets.

We believe the solution plays a crucial role helping the owners in improving shop quality.

Unique features

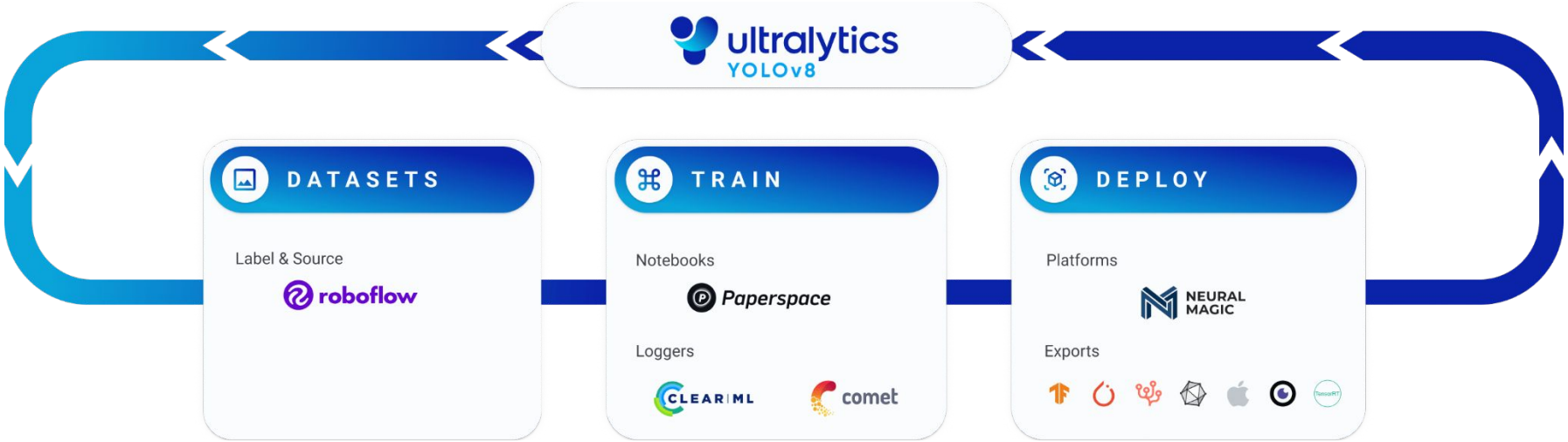
	Features	Features
Detection	Human Tracking	Keypoint Estimator
Visualizaiton	Distribution Heatmap	Pose Heatmap
Statistic	Customer Counter	Pose Comparison

3. MVP Introduction

MVP Introduction

GROCIFY is a responsive web application:

Utilize AI model on the architecture of YOLOV8 providing map and figure of customer movement with data from video.



Product concept

VIETNAM DATATHON 2023

Target users

Supermarket managers and grocery owners, who want to know the distribution of customers for better goods arrangement.

Functional benefits

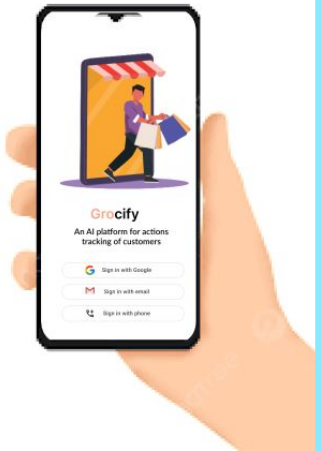
Statisticizing '*arranged inappropriate item*' at which people bend down to inspect items ⇒ ***improve customer satisfaction.***

Analyzing '*distribution of buyers*' in specific time range by plotting heatmaps ⇒ ***optimize the market space.***

Connect to the camera's storage and generate reports at the scheduled time ⇒ ***reduce operational time.***

Platform

Web (suitable for office users) and **App** (suitable for owners away from the store)



Overview

1 | Data import: →

Data source

Proccesable format

MP4 VIDEO

JPG

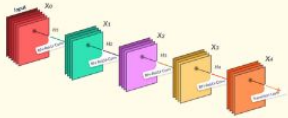
Data preprocessing

2 | Model Processing →

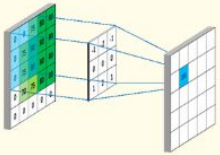
OpenCV

YOLOv8

Pretrained model



Output matrix

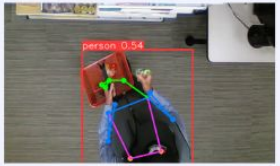


3 | Visualize →

Heatmap

Pose detect

Realtime



4 | Deployment ✓

Save illustration

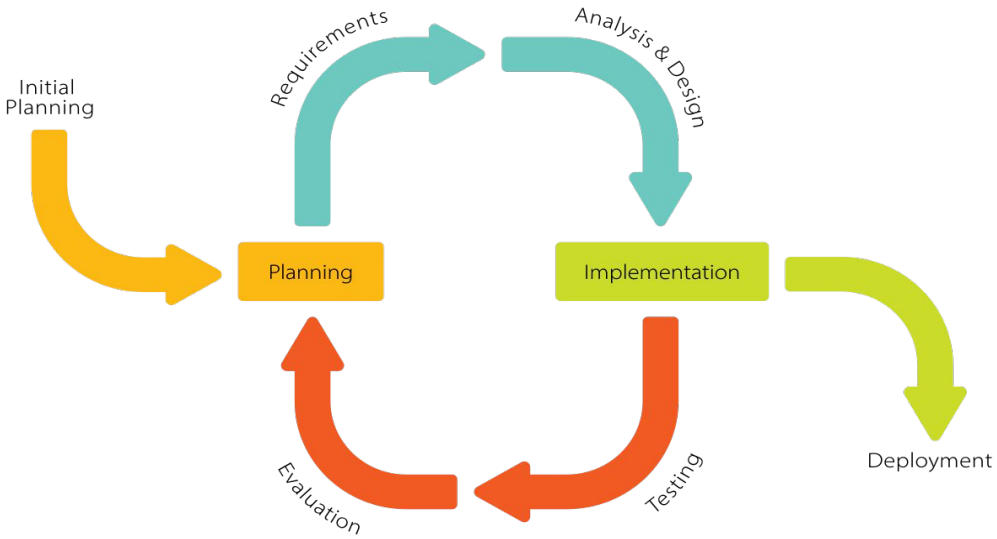
Statistic

Recommendation

4. Methodologies, architecture design and tech stack

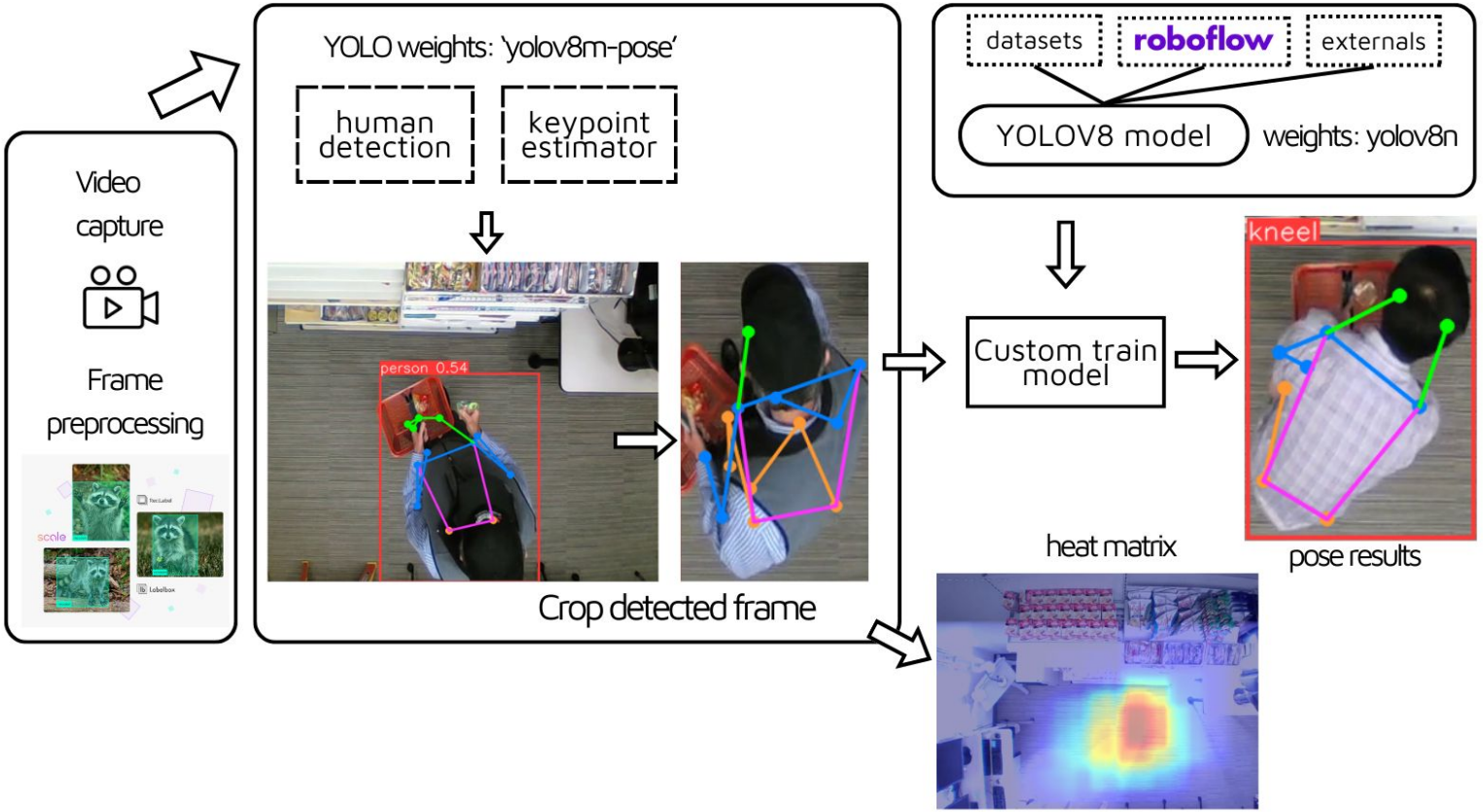
Methodology

Grocify is built on the architecture of incremental development:



- Project is not within budget
- Reduce the cost of accommodating changing user requirements
- Easier to get customer feedback on the development work that has been done.
- Easier to get customer feedback on the development work that has been done.

AI architecture



Tech Stack Overview

VIETNAM DATATHON 2023

Purpose	MVP development	Real-time object detection	Data storage & processing	Deployment
Technology	MERN stack ChartJS	OpenCV YOLOv8	MongoDB Apache Airflow Cloudinary	Docker Render

5. Core functionality and performance metrics

Core Functionality

VIETNAM DATATHON 2023

1. ***Distributed Heatmap Visualization:***
   Frequency that customers appear in the CCTV/Camera.

2. ***Stand/Kneel Pose Heatmap Visualization:***
   Frequency customers stand/bend down at each shelf in CCTV.

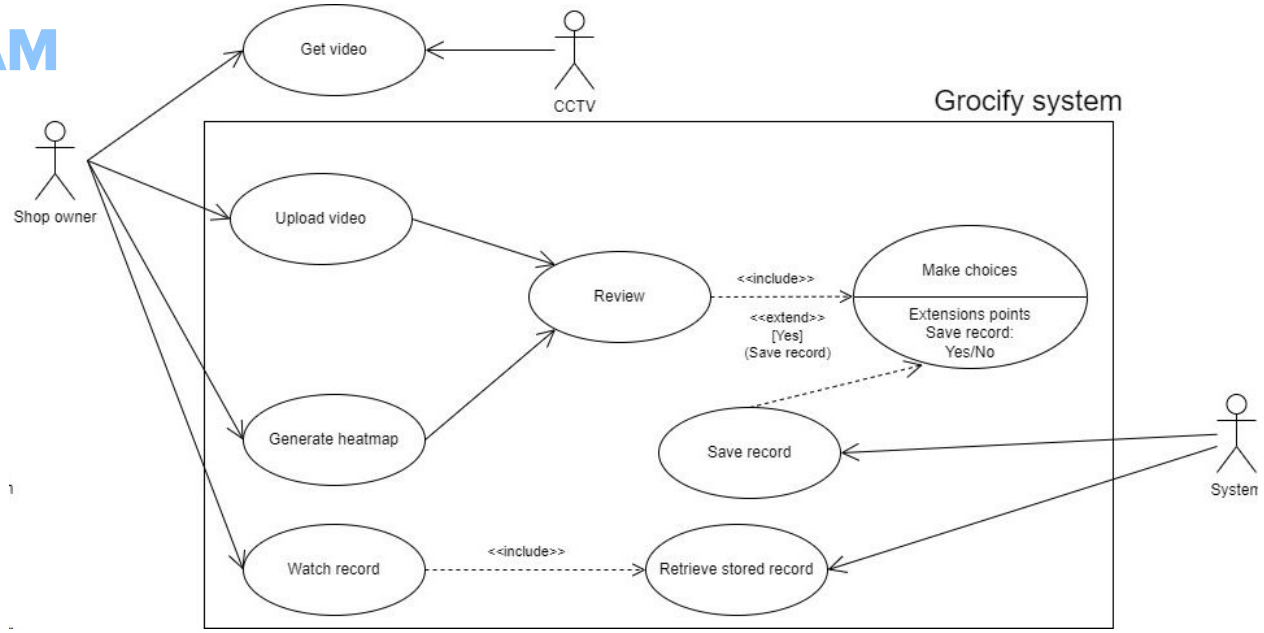
3. ***Customer & Pose realtime detection:***
   Realtime inference of AI model through CCTV data.

4. ***Mixed Heatmap:***
   Combination of distributed and pose heatmap.

5. ***Retrieve statistic:***
   Figures (people counter, kneel proportion, return product rate)

6. ***Replacement recommendation:***
   Suggest which shelf row should be moved and where to move.

USE-CASE DIAGRAM



Due to the use-case diagram, our main flow includes:

1. Shop owner can use video recorded from CCTV or upload new ones.
2. The system returns heatmap and analytical data of videos.
3. After receiving the heatmap and data, users review and then choose to delete/save record.
4. Users can retrieve and watch stored record at anytime, or they can delete helpless records.

UI explanation

The header bar provides services, camera adding

The center of app provide video in database recorded by camera, you can also upload new video if you do not have ones

A heat map is displayed to represent the locations that do not have suitable goods arrangement

Some information extracted from the video is represented as charts and text

The navbar helps us to navigate the main page, the history, and setting manager

Performance Metrics

VIETNAM DATATHON 2023

Application

To maintain the convenience and ease of use for **Grocify**, we consider application's response time, with the focusing on working with large size file (as CCTV source video always long, despite its low quality) as well as output image size.

Model

Of course, the accuracy and speed of AI model can not be neglected. As our model is in field of object detection and classification, we will use mAP (mean Average Precision). It is used to evaluate the accuracy of models in identifying and localizing objects within an image.

Performance Metrics

VIETNAM DATATHON 2023

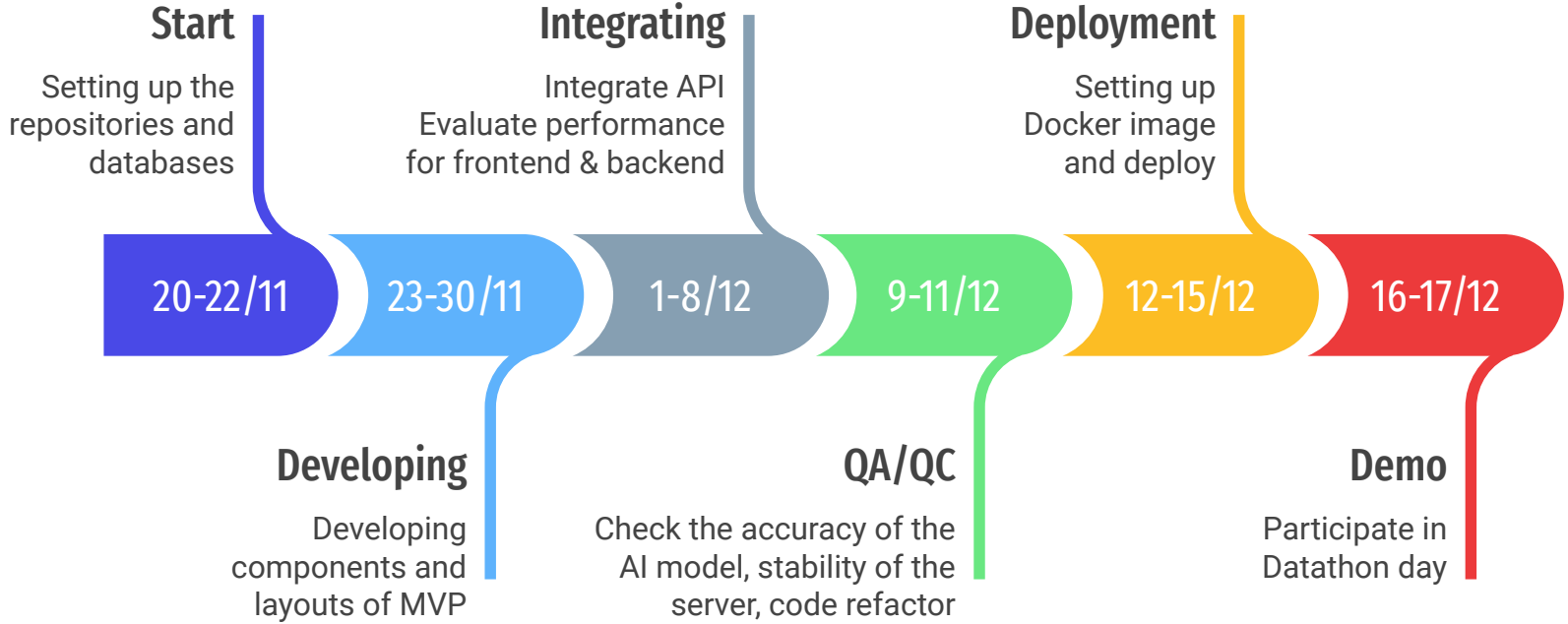
Application evaluation		
Processing time/ Video length	Video Length	Time
	Short (<15 mins)	immediate
	Medium (1 hour)	< 1 min
	Long (n hour)	< log2(n) min
Realtime delay	CCTV/Camera	<1500ms
Output storage	Distribution heatmap	< 500KB
	Pose heatmap	< 500KB

Model Evaluation (mAP)		
Person Detection Model	Precision	> 0.95
	Recall	> 0.95
Pose Estimator Model	Precision	> 0.9
	Recall	> 0.9
Whole Model	Runtime	> 45 frames/ second

6. Timeline

Timeline and Roadmap

VIETNAM DATATHON 2023



7. Current limitations and future development

Potential future development

Initiating new features: Integrating other recognition platform such as shoplifting detection, people shopping habit by analyzing the type of items customer buy

Integrate in public places: Our system can be installed in other public locations.

For example, in library, the shelves are high and the amount of books in each shelf is extremely significant, hence an AI model notify shelves need to be rearranged is important to save time for lectures and students.

Limitations

Direct connection with CCTV is limited: In order to analyze the outcome of retail, our web-app requires access to the storage of past videos on CCTV instead of connecting directly like other service-IoT apps.

CCTV is too expensive: For some middle and small groceries, especially in rural areas. Setting up the whole system may cost a considerable amount of money to operate.

Conclusion

Apart from given information, we can conclude about our app as:

Key-point: customers have to bend down for items and some places in shop do not have equal popularity

Value proposition: solution to two critical challenges: unequal product distribution and lost sales opportunities.

Benefits of AI model: improving the image processing stage, helping plotting heating with providing analytics data for retail sellers.

Potential impact: can adding more detection features such as shoplifting, shopping habits, etc in the app.