

# AI-Enhanced Nutritional Label Extraction and Diabetic Health Assessment

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# Presentation Outline

- Motivation
- Objectives
- Scope of Project
- Project Applications
- Methodology
- Results
- Results Analysis
- Remaining Tasks
- References

# Motivation



- Empower individuals with diabetes to make informed dietary decisions
- Improve blood glucose management through personalized food recommendations
- Leverage advanced technology for accurate glycemic index predictions
- Enhance user quality of life with healthier choices

# Objectives

- To develop a mobile app for users to input recent blood sugar levels and medications
- To create a nutritional label scanner to analyze and recommend food suitability based on user profiles

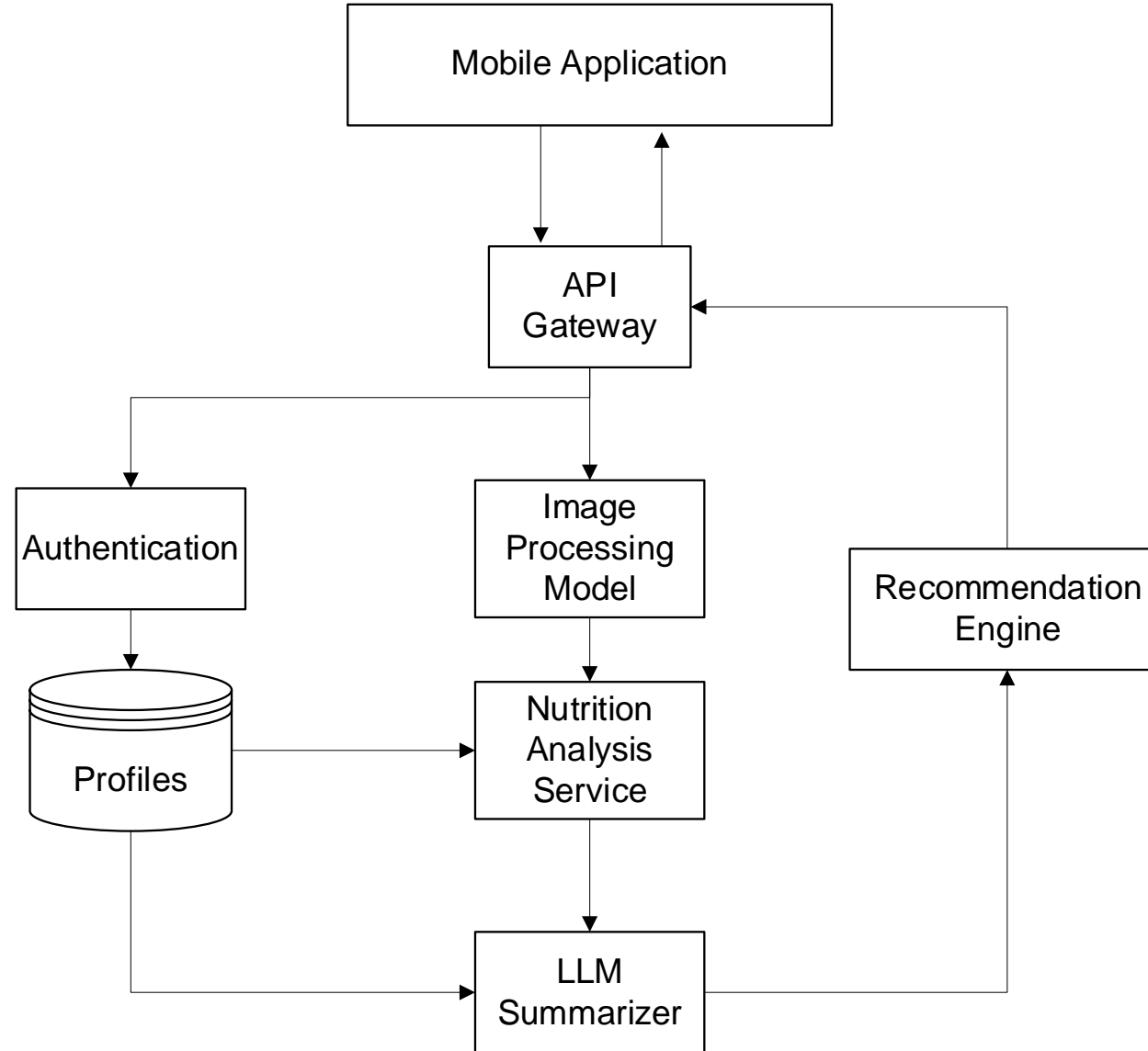
# Scope of Project

- Project Capabilities
  - Provides personalized nutritional advice for diabetes management.
  - Simplifies understanding of food labels and nutrition details.
  - Offers a user-friendly platform for health management.
- Project Limitations
  - May not cover all health conditions or restrictions.
  - Dietary advice can vary between regions and cultures.

# Project Application

- Personalized Health Profiles
  - Create profiles with blood sugar, medications, recommendations
- Nutritional Label Scanner
  - Uses YOLO & OCR to extract nutritional information from labels
- Machine Learning-Driven Recommendation
  - Analyzes data to generate personalized dietary recommendations
- User Empowerment
  - Provides insights and tools for informed health decisions

# Methodology - [1] (System Architecture)

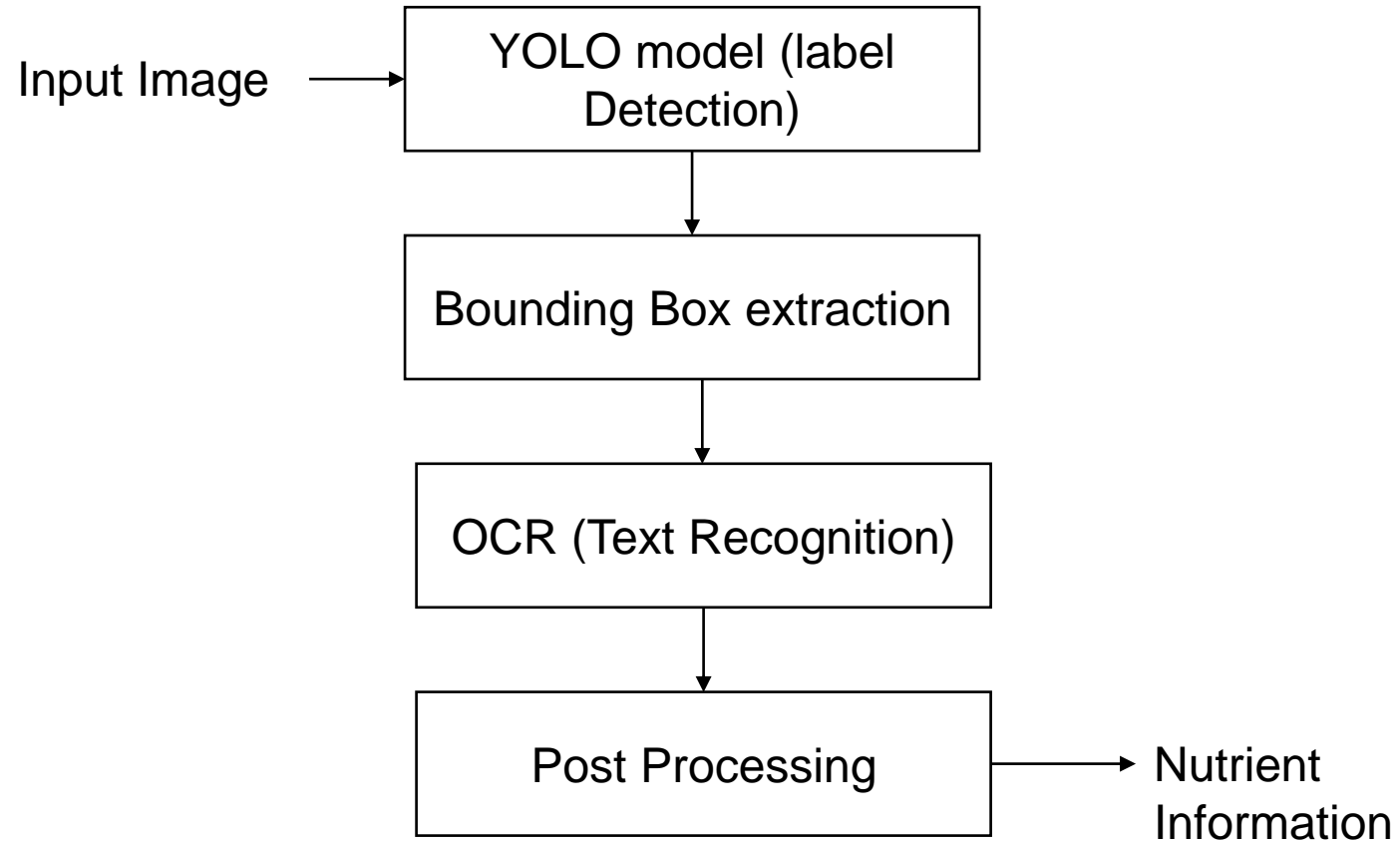


# Methodology - [2] (Mobile Application)

- Purpose
  - User-friendly interface for personalized diabetic profiles
  - Input health data and scan food items easily
  - Receive personalized dietary recommendations in real-time
- Development method
  - Using cross-platform frameworks for compatibility, like Flutter or React Native
  - Integrate user authentication for secure login, data storage
  - Communicate with backend APIs for nutritional analysis display

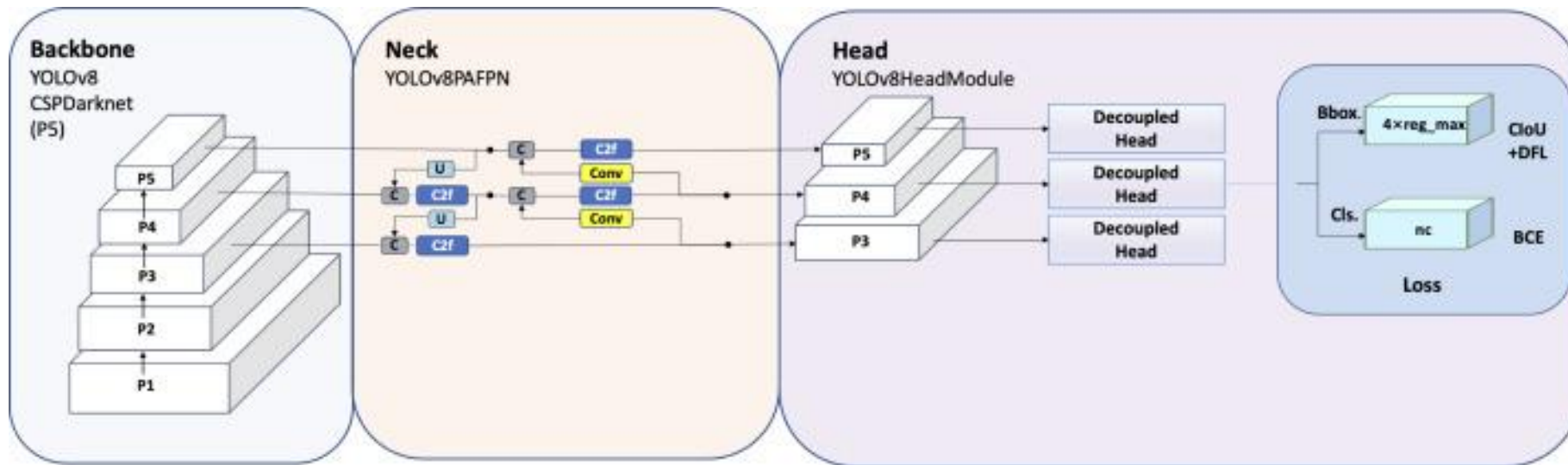


# Methodology - [3] (Image Processing Model)



# Methodology - [4]

## (YOLOv8 for Nutritional Label Detection)

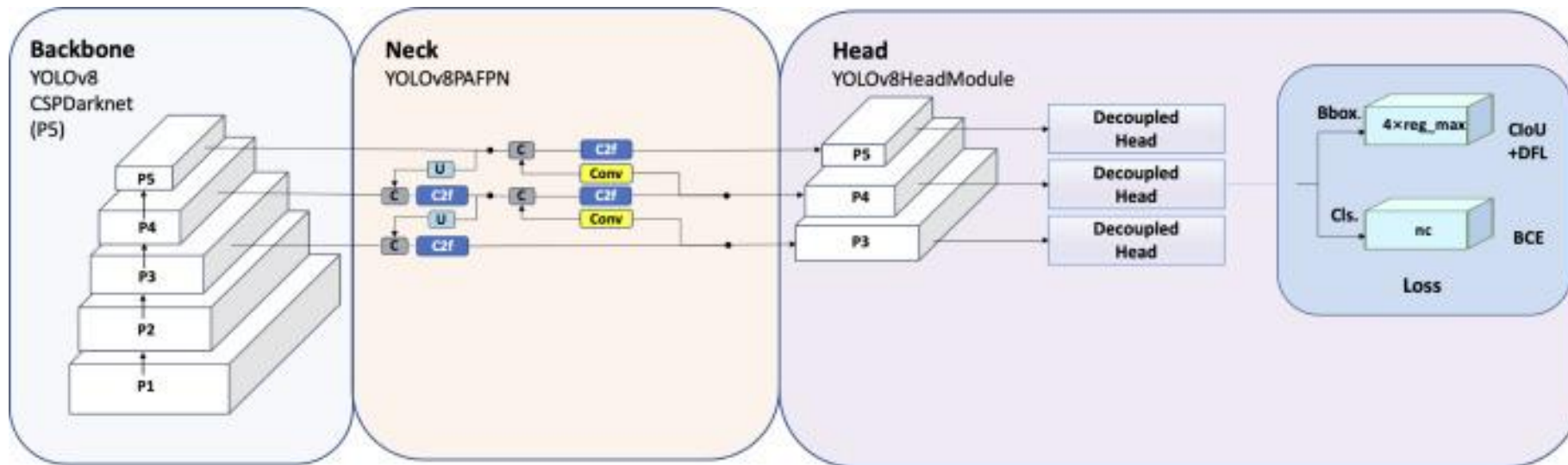


### Backbone: YOLOv8 CSPDarknet

- Convolutional layers extract rich features from image.
- CSP connections enhance efficiency and gradient flow.
- Feature maps progress through stages P1-P5.
- Detecting nutritional label region on food packaging.

# Methodology - [5]

## (YOLOv8 for Nutritional Label Detection)

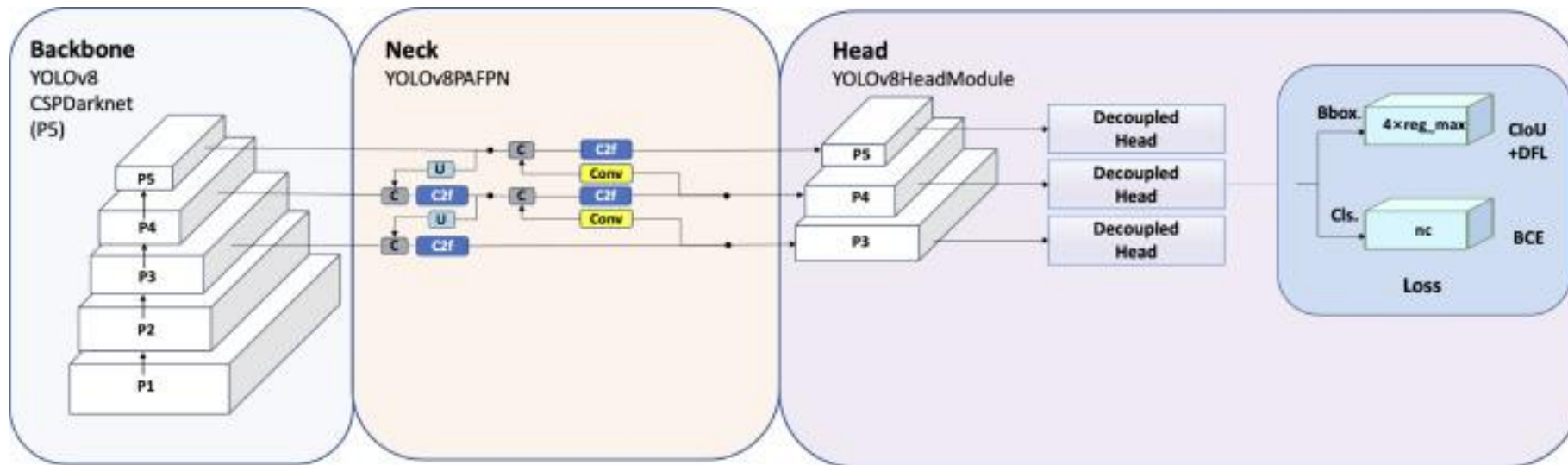


### Neck: YOLOv8 PAFPN

- PAFNet fuses multi-scale features effectively.
- Combine features from P1 (32x32) to P5 (1024x1024).
- Upsample and downsample for accurate feature combination.
- Enhancing localization of entire nutritional label area.

# Methodology - [6]

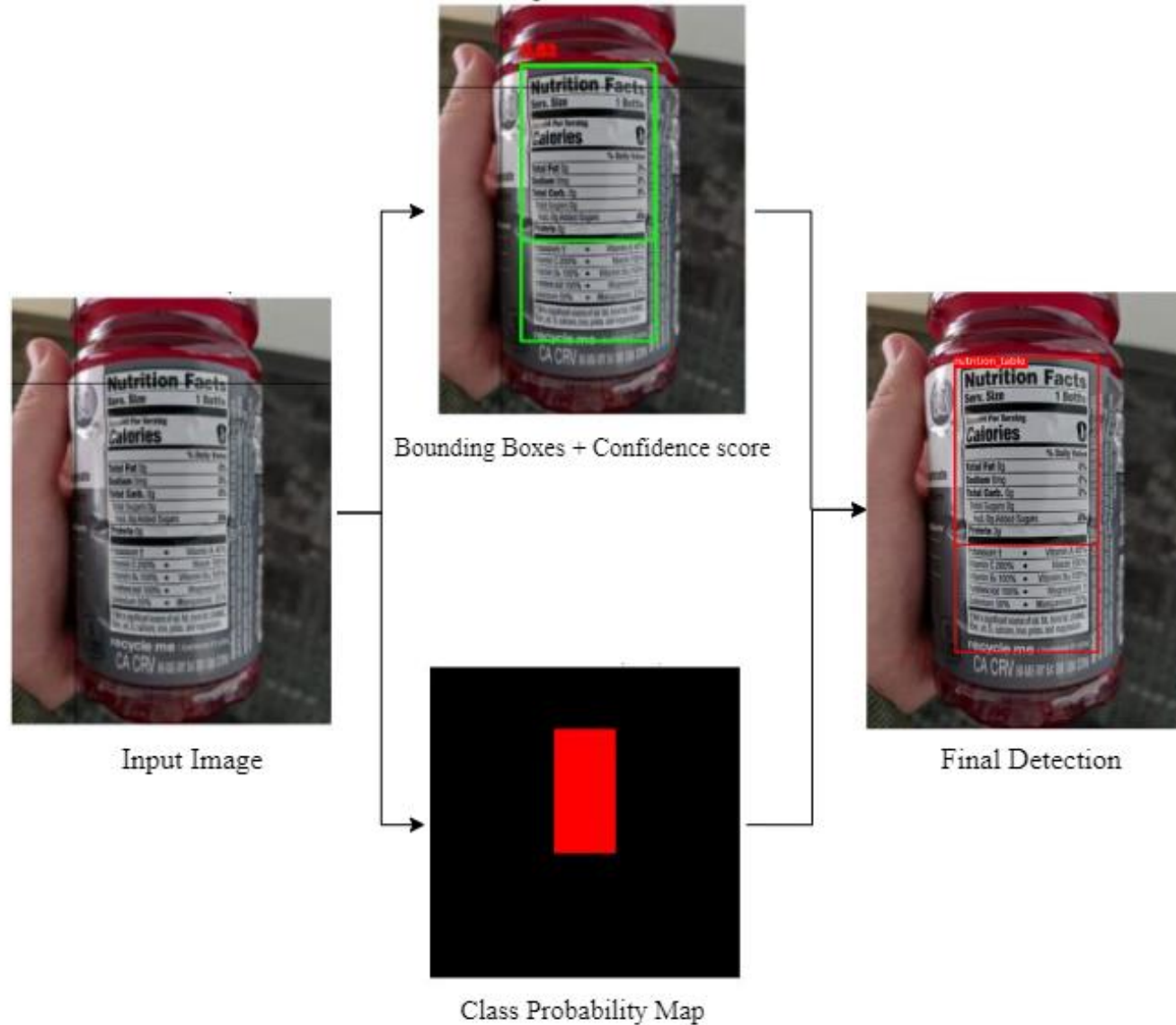
## (YOLOv8 for Nutritional Label Detection)



### Head: YOLOv8 HeadModule

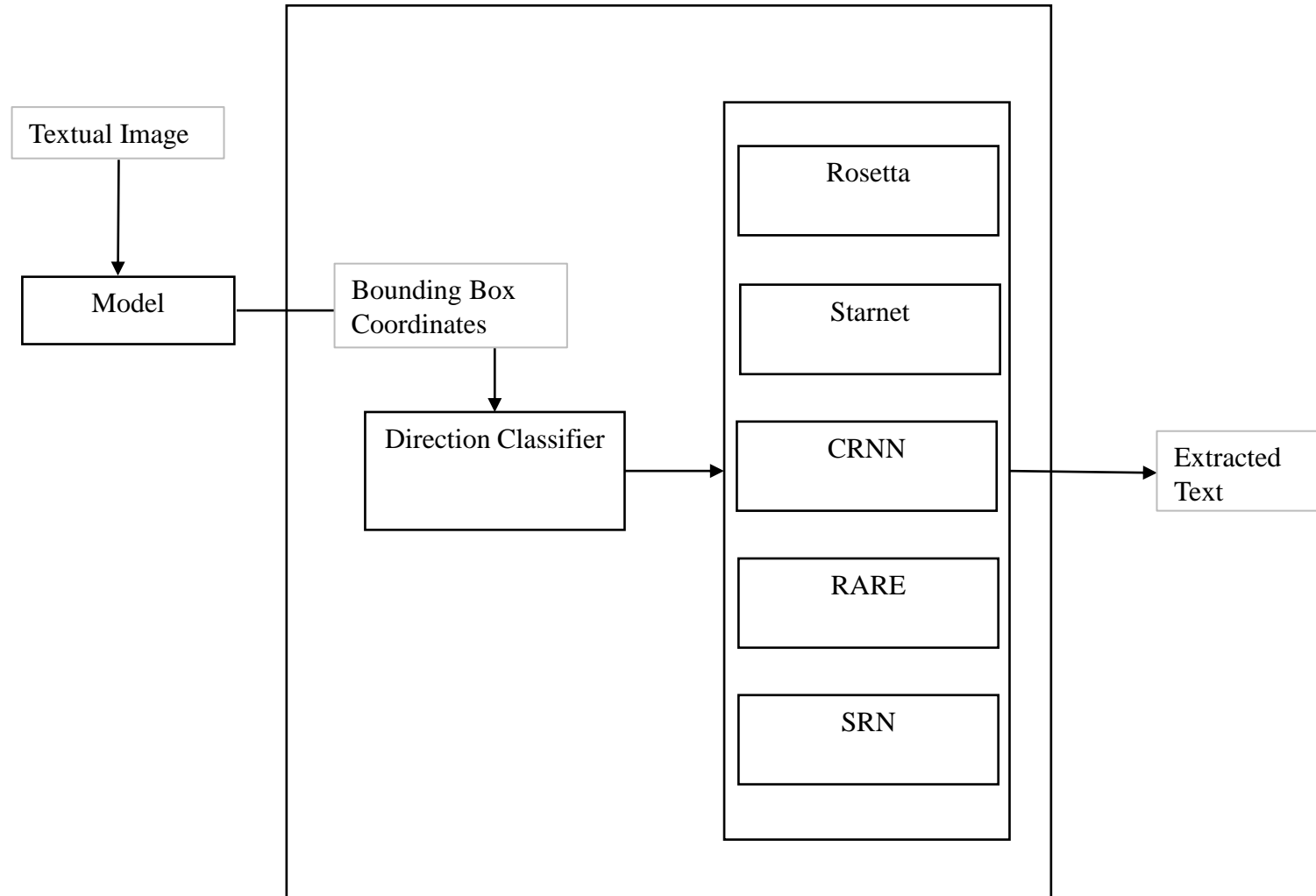
- Separate heads for regression and classification tasks.
- P3 (128x128) to P5 for detailed detection.
- Final bounding boxes for label area identified.
- Determining ROI (Bounding box) of nutritional label on packaging.

# Methodology – [7] (Workflow of Detection Model)



# Methodology - [8]

## (Text Recognition using OCR)



# Methodology - [9]

## (Architecture of PaddleOCR)

### Direction Classifier

- Ensures misaligned text is properly oriented.
- Rotates text to be horizontal and readable.

### Rosetta

- Captures text naturally from packaging images.
- Reads labels like "Calories" and numerical values.
- Interprets text appearance directly from packaging.

### StarNet

- Corrects distortions from curved packaging surfaces.
- Ensures accurate recognition despite surface irregularities.
- Handles warping for clear text identification.

# Methodology - [10]

## (Architecture of PaddleOCR)

### **CRNN (Convolutional Recurrent Neural Network)**

- Combines convolutional and recurrent layers for sequences.
- Captures spatial and temporal text features.
- Assists in recognizing sequential text accurately.

### **RARE (Robust Arbitrary Rectification Network)**

- Corrects arbitrary distortions in text regions.
- Adjusts perspective for better text clarity.
- Ensures accurate reading despite text distortions.

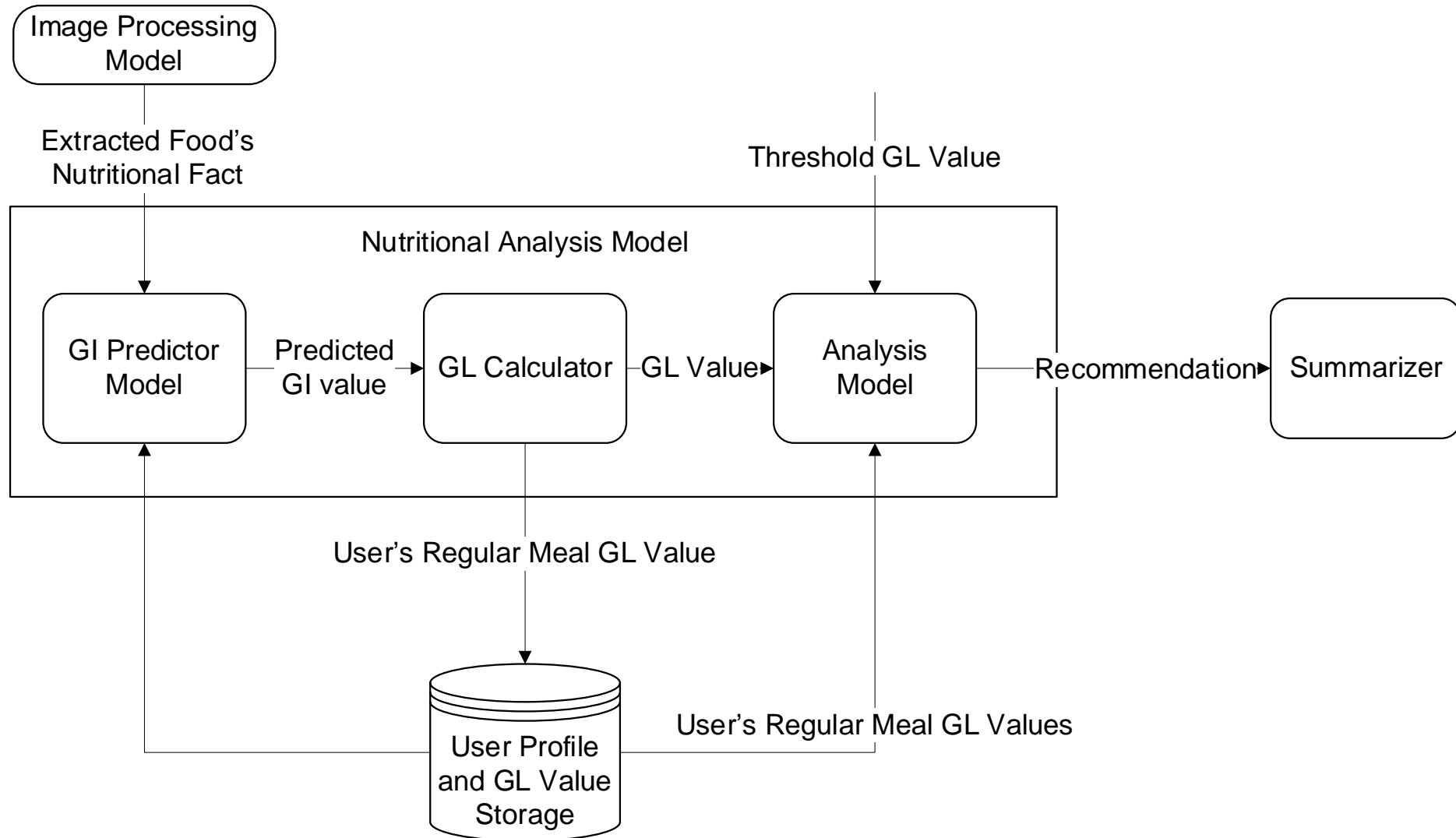
### **SRN (Sequence Recognition Network)**

- Maintains correct order of text sequences.
- Ensures context of nutritional information.
- Accurately reads and predicts text sequences.



# Methodology - [11]

## (Nutritional Analysis Model)



# Methodology - [12]

## (Nutritional Analysis Model)

- GI Predictor Model
  - Scanned food's nutritional information which is extracted by image processing model is passed as input to this model.
  - Trained on dataset with features as nutritional facts and target variable as Glycemic Index(GI) value.
  - It predicts GI value for scanned food.
  - Glycemic Index (GI) of a food is a numerical value (0-100) which represents how quickly the food raises blood glucose levels after consumption.

# Methodology - [13]

## (Nutritional Analysis Model)

- GL Calculator

- Glycemic load (GL) is a measure that assesses the impact of carbohydrate consumption on blood sugar levels.
- It combines both the Glycemic Index and quantity of carbohydrates in a food.
- This calculator calculates the GL value from the predicted GI value by the below given formula:

$$\text{Glycemic Load} = \frac{\text{Glycemic Index} * \text{amount of carbohydrate in gram}}{100}$$

# Methodology - [14]

## (Nutritional Analysis Model)

- Interpretation of GL Values
  - **Low GL (10 or less):** Foods with a low glycemic load have a minimal impact on blood sugar levels.
  - **Medium GL (11-19):** Foods with a medium glycemic load have a moderate impact on blood sugar levels. These can be included in a balanced diet but should be consumed in moderation, especially by those sensitive to changes in blood sugar.
  - **High GL (20 or more):** Foods with a high glycemic load can cause significant spikes in blood sugar levels. These should be limited, particularly for individuals with diabetes.

# Methodology - [15]

## (Nutritional Analysis Model)

- Analysis model
  - Receives Glycemic Load(GL) value stored in the database and threshold GL value as input.
  - Compares total sum of GL value of previous foods and scanned food from the database with threshold value.
  - If the total GL value of the user is less than or equal to the threshold value, then the food is recommended to consume otherwise not.
  - This information is passed as an output to the summarizer model for further processing.

# Methodology - [16]

## (Summarizer)

- Summarizer
  - Uses Large Language Models (LLMs) like Llama or Mistral to generate summaries.
  - Processes detailed nutritional information, GL calculations, and comparison results.
  - Produces clear summaries indicating whether a food item is suitable for consumption.
  - Includes detailed explanations to ensure users understand the reasoning behind the recommendations.

# Methodology - [17] (Dataset Annotation)

\*THIS IS EQUIVALENT TO 10.0 % FRUIT JUICE CONTENT.

NUTRITIONAL INFORMATION (APPROXIMATE VALUES)		
Serve Size: 150 ml   Servings per pack: 0.9		
	Per 100 ml	Per serve % contribution to RDA
Energy	37 kcal	2.8%
Protein	0 g	
Carbohydrate	9.2 g	
Total Sugars*	9.2 g	
Added Sugars	8 g	24%
Total Fat	0 g	0%
Sodium	117 mg	8.8%
Potassium	78.5 mg	3.4%*
Chloride	147 mg	12.3%*
Vitamin C	3.5 mg	6.6%*

% RDA calculated on the basis of average requirements of adult per day  
\*RDA values calculated basis ICMR 2020 for Men - Moderate work

NUTRITIONAL INFORMATION^		
SERVE SIZE 20 g	1.2 SERVES IN THIS PACK	
Nutrients	Per 100 g	%RDA Per Serve
Energy	537 kcal	5%
Protein	6.7 g	
Carbohydrate	53.0 g	
Total Sugars	3.4 g	
Added Sugars	2.0 g	1%
Total Fat	33.1 g	10%
Saturated Fat	12.5 g	11%
Trans Fat	0.1 g	1%
Sodium	643 mg	6%

^Approximate

Lay's is the Registered Trade Mark of PepsiCo, Inc.

INGREDIENTS: ...

# Results – [1]

Nutritional Facts	
Serving per container	
Serving Size	(330mL)
Amount per 100mL	
Calories	12
%RDA* per serve	
Energy 12 (kcal)	0.30%
Protein 0.08 g	0.16%
Carbohydrate 25 g	0.90%
Dietary Fiber 0 g	0%
Total Sugars 25 g	
Added Sugars 25 g	5%
Total Fat 0.2 g	0.26%
Saturated Fat 0 g	0%
Trans Fat 0 g	0%
Sodium 0.63 mg	0.03%

Detecting tabular nutritional label

Nutritional Information.	
1 serving per container. Serving size 150 mL. Amount per portion * (% RDA):	
Energy 142 kcal (7%), Total Fat 4.0 g (6%), Saturated Fat 2.4 g (11%),	
Trans Fat 0.0 g (0%), Cholesterol 12 mg, Carbohydrate 22.5 g, Total Sugars 2.5 g,	
Added Sugars 18.0 g (36%), Protein 3.9 g, Sodium 52 mg (3%), Calcium 14.2 mg	
* RDA stands for Recommended Dietary Allowance per serving	
* Average values	

Single consumption Pack	
Per consumption-17 g	
Nutrients (Approx. per 100 g): Energy-369 kcal,	
Protein-7.5 g, Carbohydrate-80 g, Total Sugars-35 g of	
which Added Sugar-9.5 g, Dietary fibre-2.0 g, Total	
Fat-2.5 g, Saturated Fat-<2.2 g, Trans Fat-<0.1 g,	
Cholesterol-<5 mg, Sodium-<450 mg.	
% RDA^ per consumption pack (17 g): Energy-3%,	
Added Sugar-3%, Total Fat-1%, Saturated Fat-<2%,	
Trans Fat-<1%, Sodium-<4%.	
^Sucrose. ^% of an average Adult's Recommended	
Dietary Allowance (2000 kcal)	
*MDD: Rs. 5/- (Incl. of all taxes)	

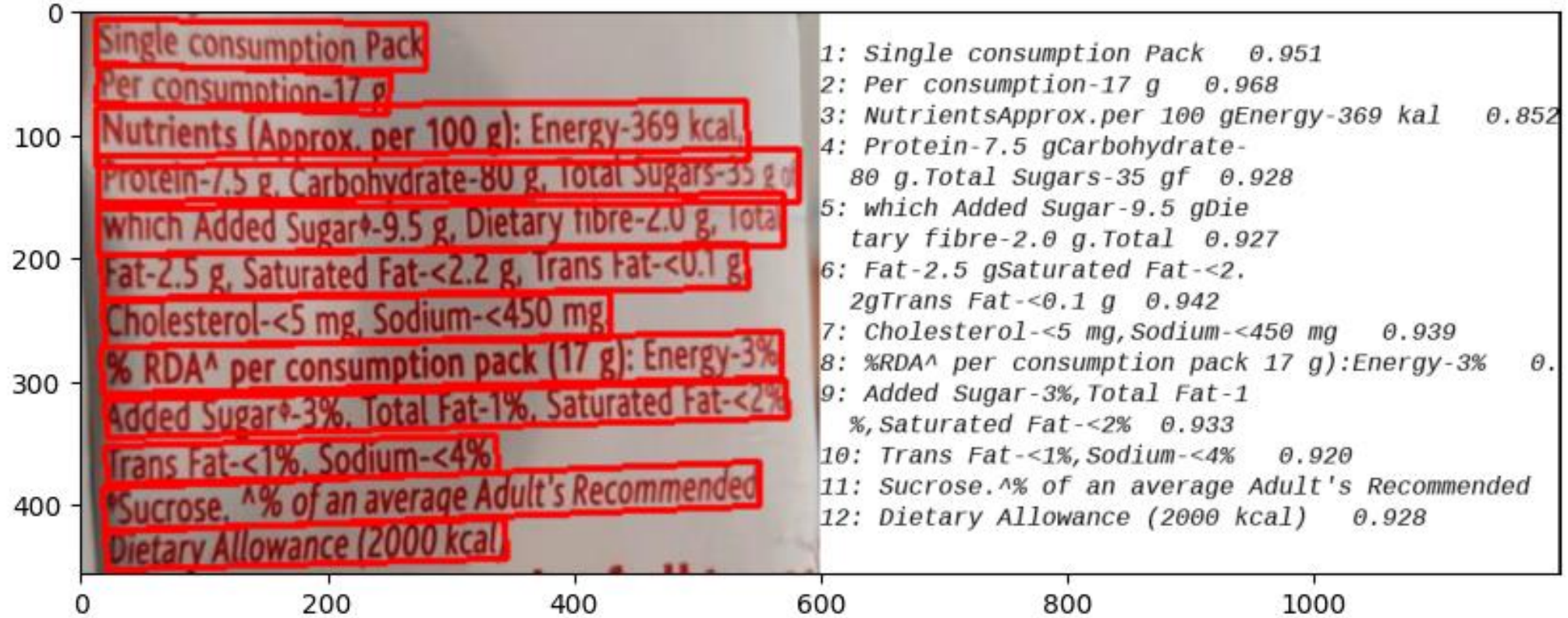
Detecting nutritional label in paragraph format



# Results – [2] (Output of OCR)

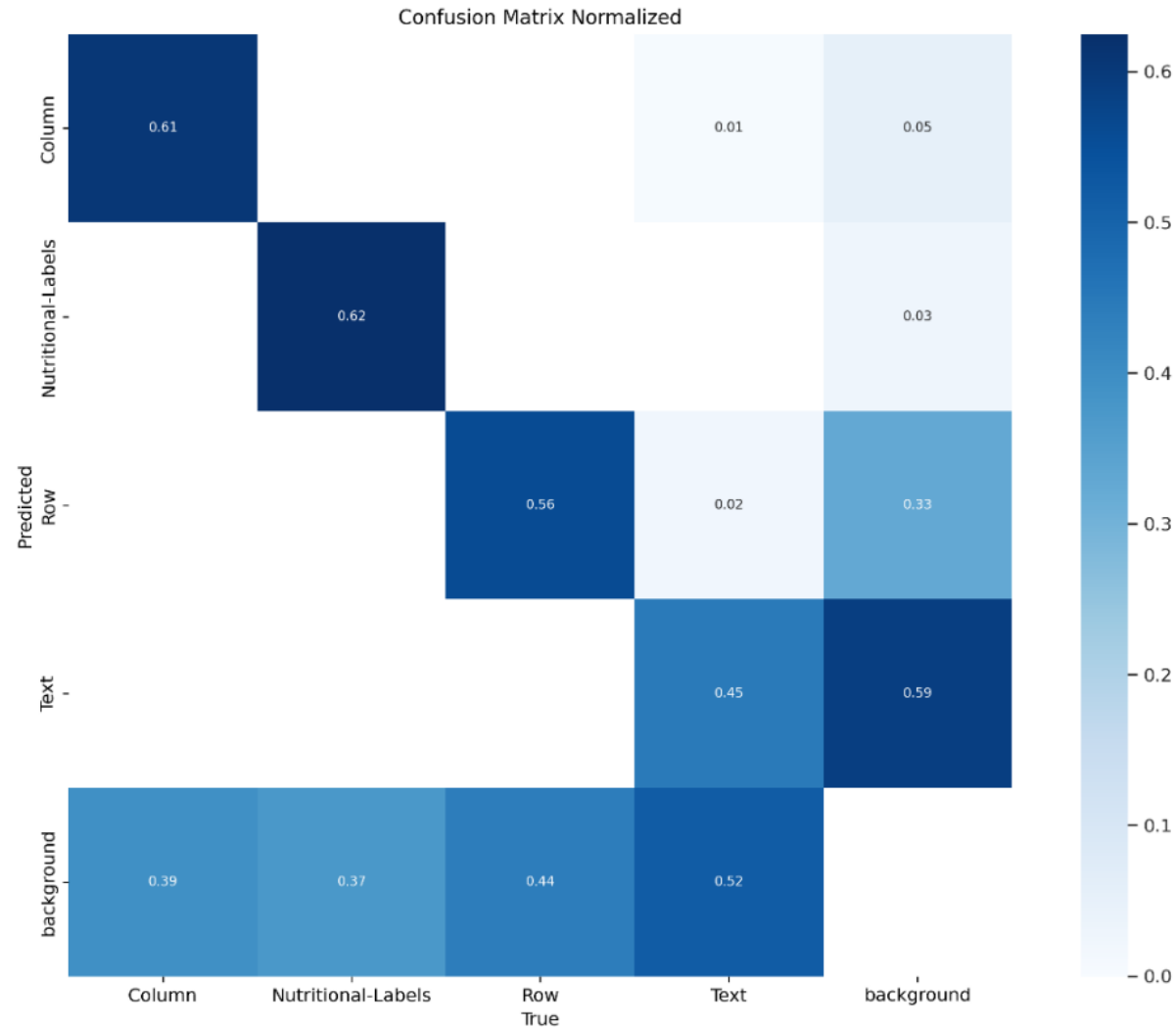
Nutritional Information*			1: Nutritional Information# 0.970		22: Saturated fat (g) 0.949	
Serving Size : 10 g, Number of Servings* : 8			2: Serving Size:10 g, Number of Servings:8 0.934		23: 1.6 0.992	
Nutrients	Per 100 g	Per Serve % Contribution to RDA*	3: Per Serve % 0.909		24: 0.7 0.996	
Energy (kcal)	371.5	1.9	4: Nutrients 0.997		25: Trans fat (g) 0.935	
Protein (g)	2	-	5: Per 100 g 0.900		26: 0.01 0.996	
Carbohydrate (g)	84.6	-	6: Contribution to RDA 0.978		27: 0.04 0.996	
Total Sugars (g)	61.8	-	7: Energy (kcal) 0.965		28: Cholesterol (mg) 0.977	
Added Sugars (g)	61.8	12.4	8: 371.5 0.998		29: Sodium (mg) 0.985	
Total Fat (g)	1.8	0.3	9: 1.9 0.996		30: 216 0.999	
Saturated fat (g)	1.6	0.7	10: Protein (g) 0.977		31: 1.1 0.884	
Trans fat (g)	0.01	0.04	11: 2 0.996			
Cholesterol (mg)	0	-	12: Carbohydrate (g) 0.973			
Sodium (mg)	216	1.1	13: 84.6 0.997			
TOTAL IN COOL AND DRY CONDITIONS			14: Total Sugars (g) 0.953			
			15: 61.8 0.997			
			16: Added Sugars (g) 0.930			
			17: 61.8 0.997			
			18: 12.4 0.996			
			19: Total Fat (g) 0.954			
			20: 1.8 0.997			
			21: 0.3 0.845			

# Results – [3] (Output of OCR)



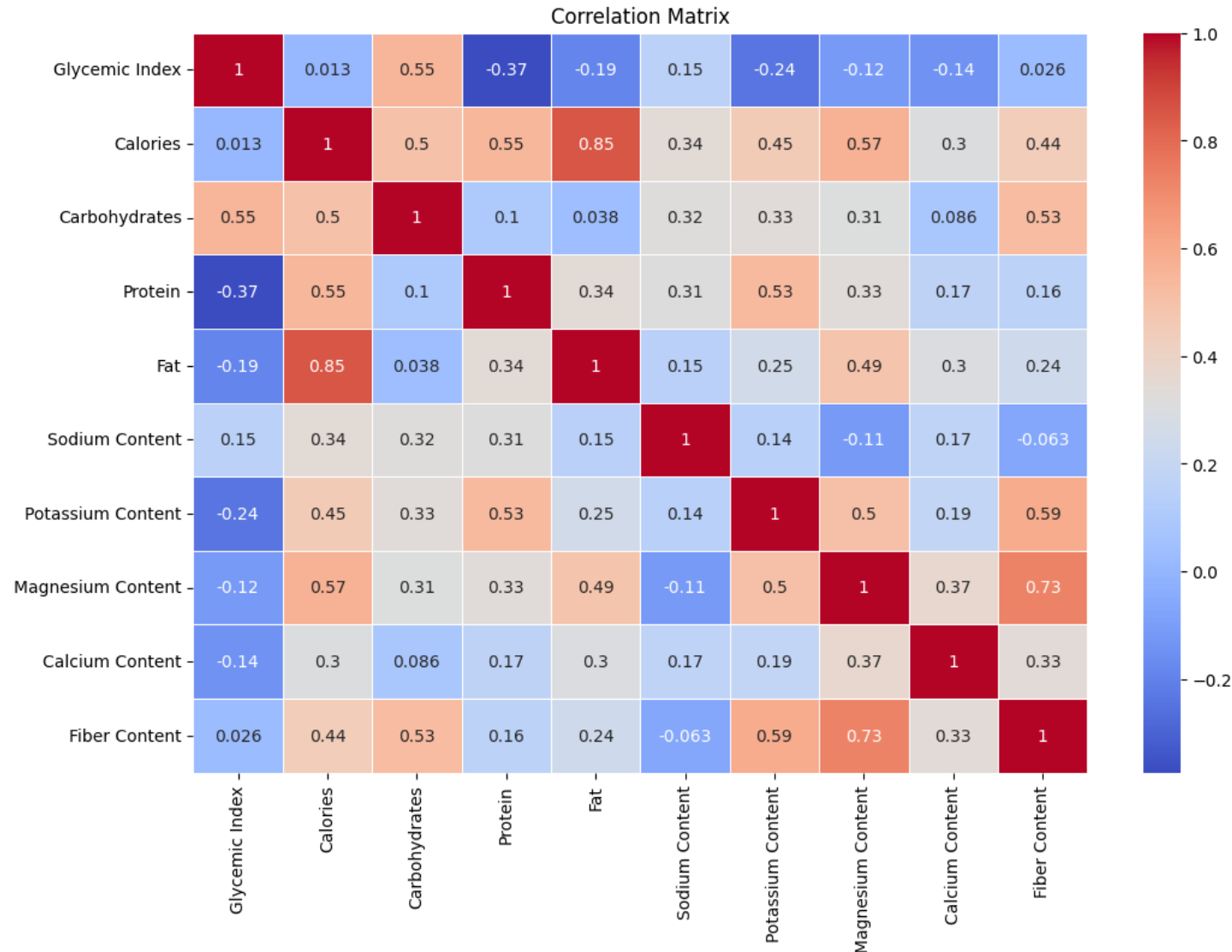
# Results – [4]

## (Confusion Matrix of YOLO model)

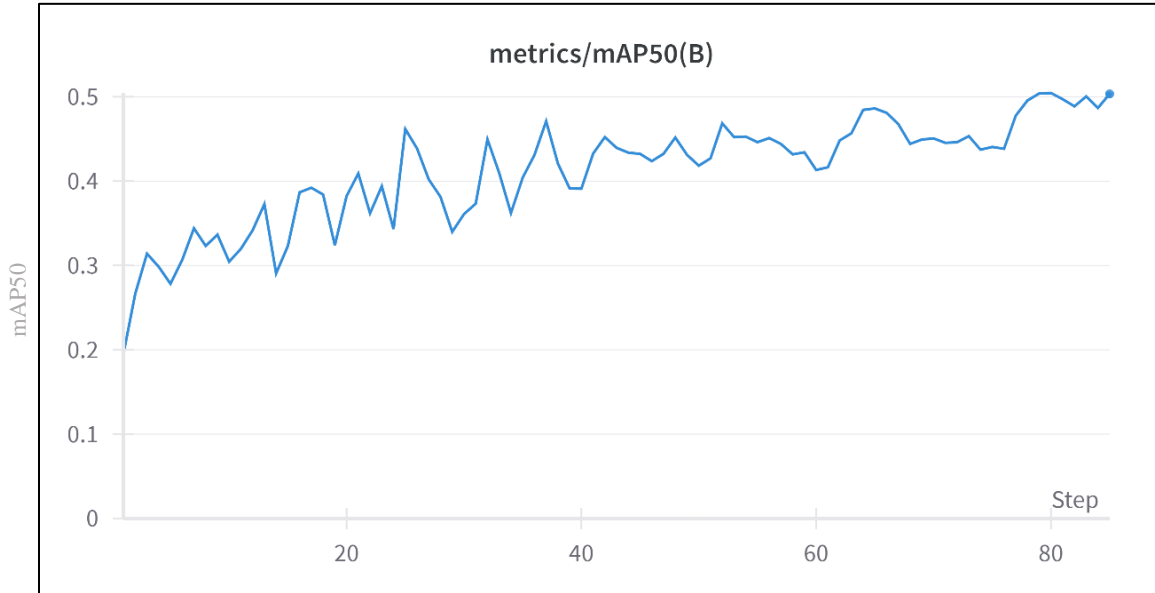


# Results – [5]

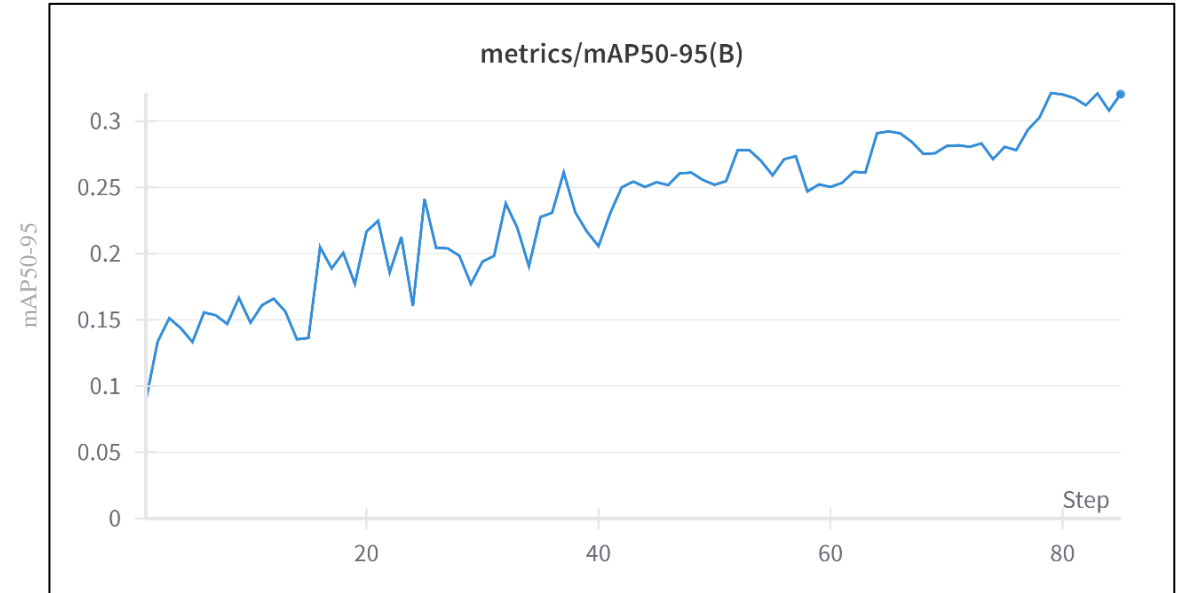
## (Relationship between GI and other Nutritional Contents)



# Results – [6] (Mean Average Precision)

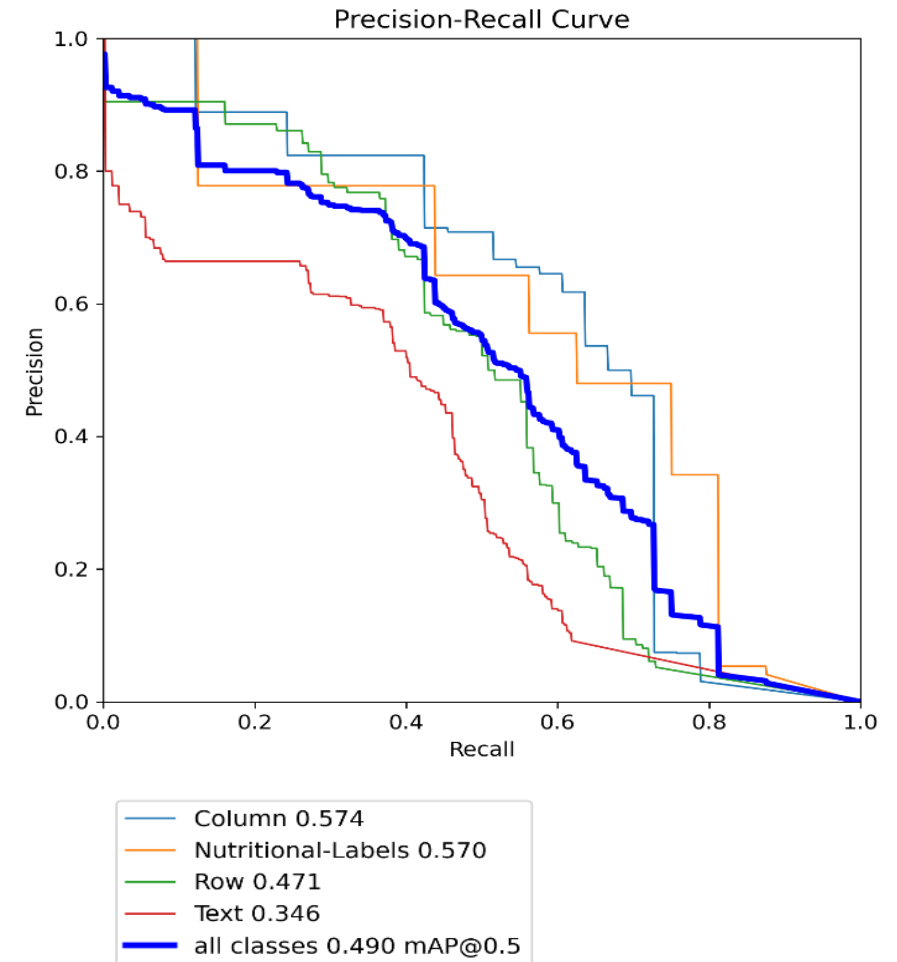
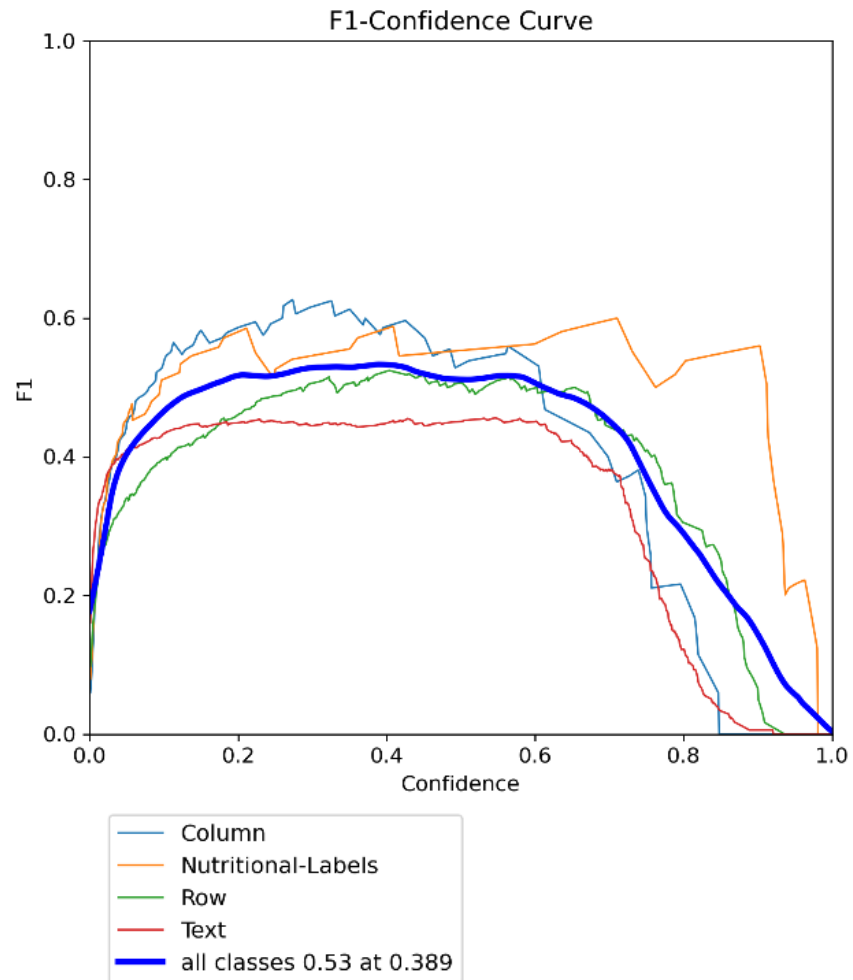


- Mean Average Precision at IoU 0.50
- mAP50 metric starts at 0.2, peaks, and valleys
- Overall mAP50 trend increases, reaching 0.5

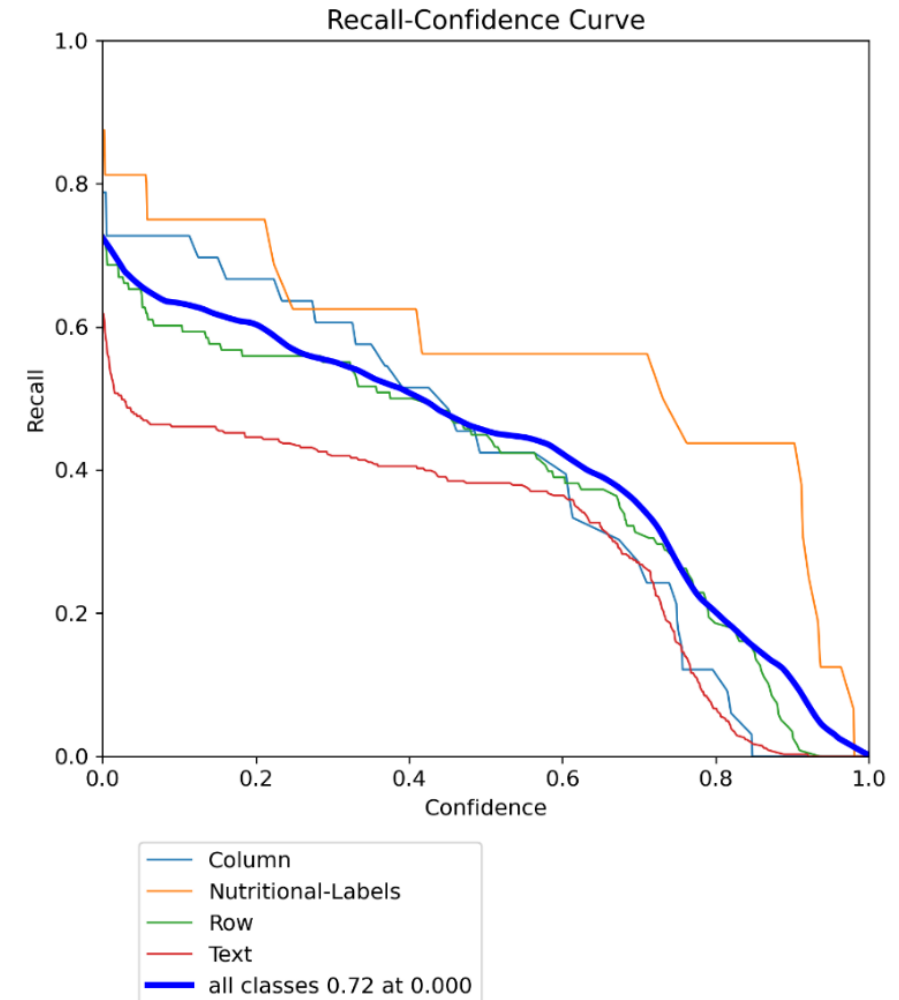
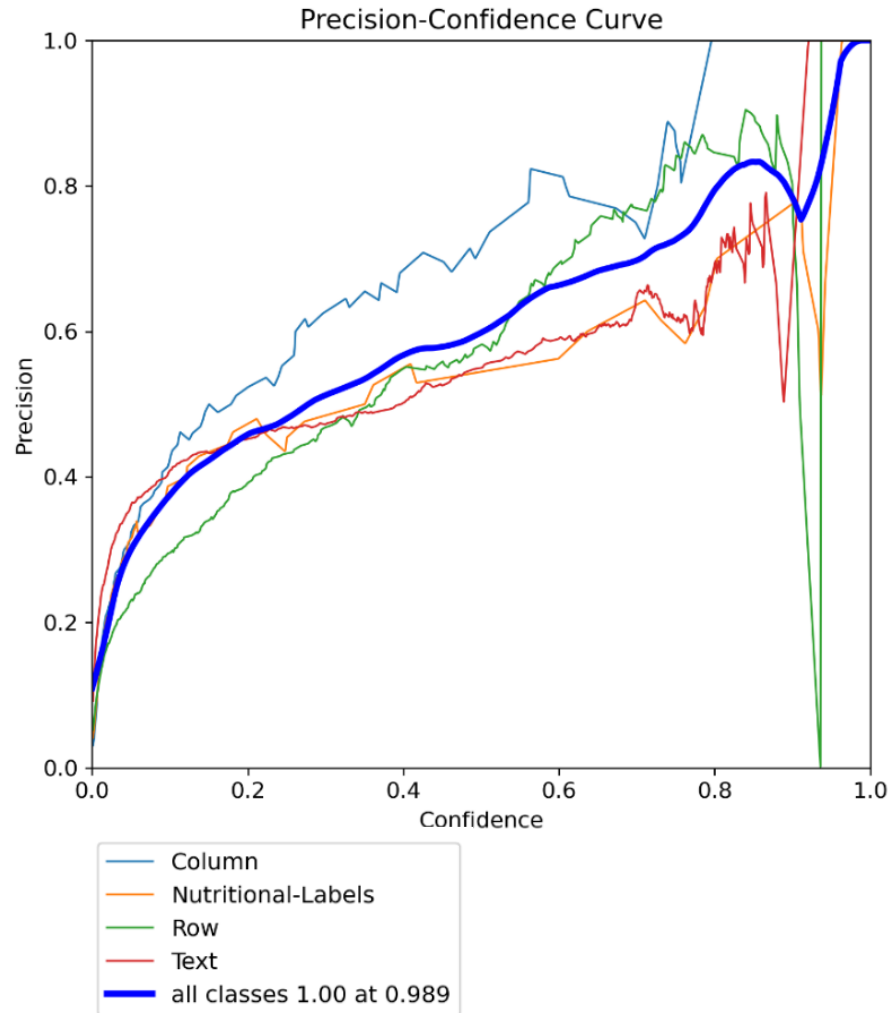


- Mean Average Precision for IoU 0.50-0.95
- mAP50-95 metric starts at 0.1, fluctuates, peaks
- Overall mAP50-95 trend increases, reaching 0.3

# Result Analysis – [1] (Various Curves)



# Result Analysis – [2] (Various Curves)



# Remaining Tasks

- Nutritional Label Post-Processing
- Dataset exploration for GI Calculation
- GI value prediction model training
- Summarizer model exploration
- Mobile Application development
- Integration of all the models



# References-[1]

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**THANK YOU**