A food classification & recommendation system based on artificial intelligence to promote healthy dieting in Mauritius.

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Health Innovation Seminar
Mauritius Innovation and Research Council (MRIC)
16 OCT 2025

NCDs Worldwide in 2021 (WHO)

- NCDs are responsible for **75% of death globally**.

18M

10M

4M

>2 M

- Tobacco use, physical inactivity, the harmful use of alcohol, **unhealthy diets** and air pollution all increase the risk of dying from an NCD.

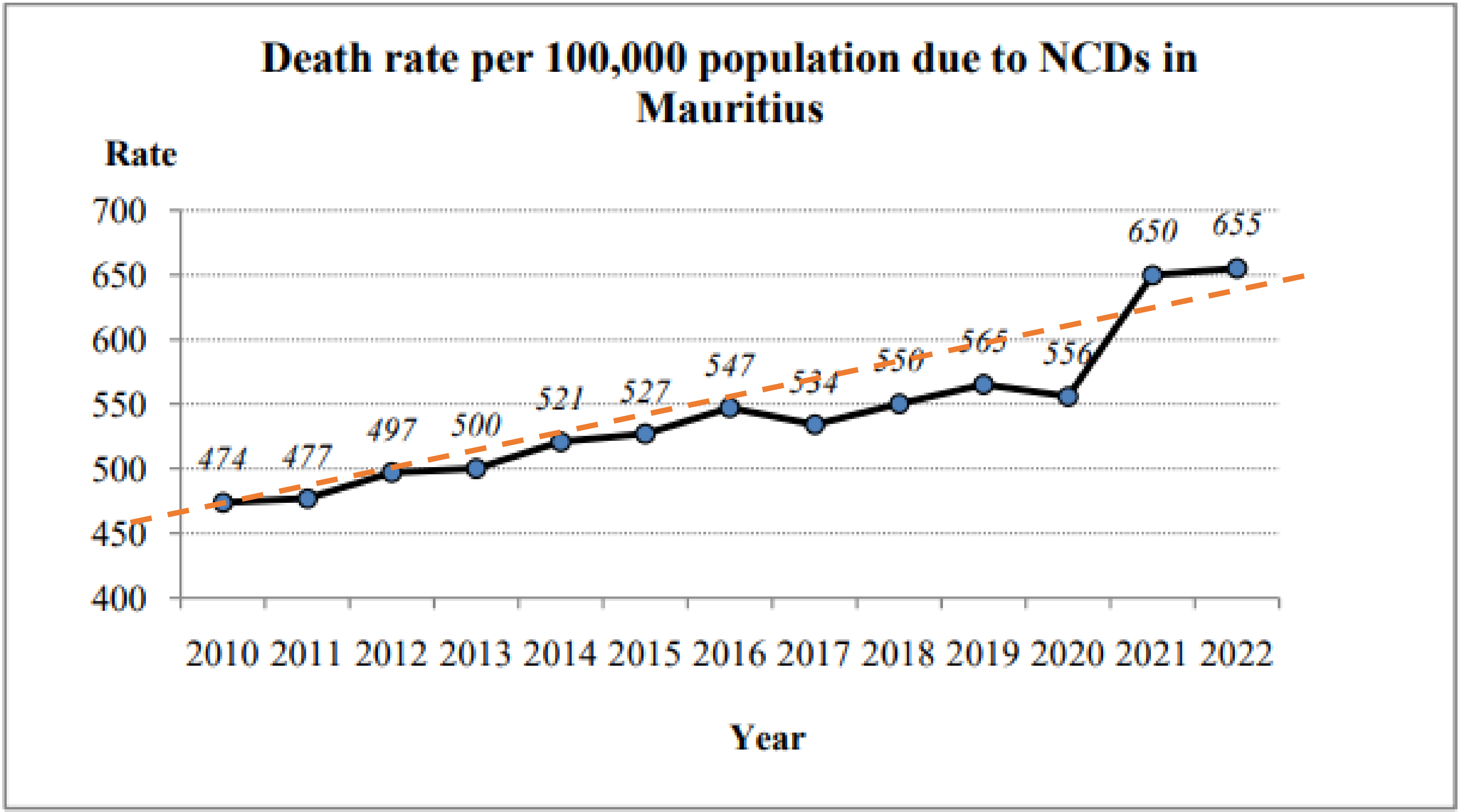
- 73% of deaths occur in low- and **middle-income** countries.

(Upper)middle-class
World Bank 2023

WHO NCD Survey 2021

- Diabetes (Type-2): 19.9%
- Hypertension: 27.2%
- Obesity/Overweight: 36%
- High Cholesterol: 34.8%

Statistic Report: NCDs in Mauritius



Statistic Report: NCDs in Mauritius

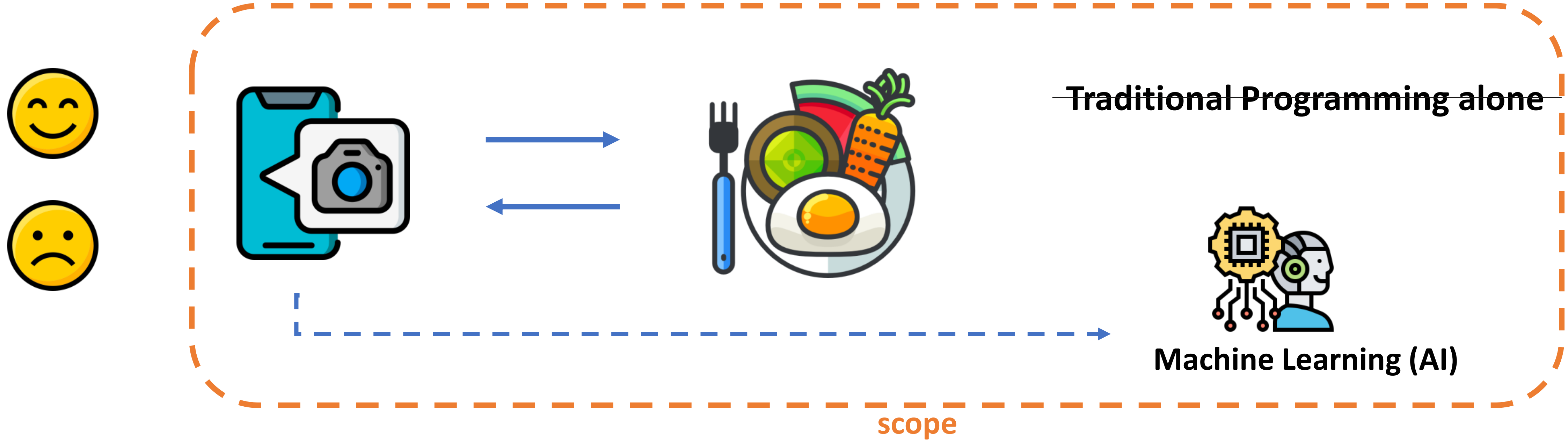
Health Statistic Report 2022 – Ministry of Health and Wellness

SORTED OUT-PATIENT ATTENDANCES AT SPECIALISED CLINICS -2022

Specialty	Number	Specialty	Number
Orthopaedics	117,190	Paediatrics	23,661
Cardiology	129,151	Chest Disease	21,931
General Medicine (including NCD)	99,378	ENT	20,340
General Surgery	89,359	Endocrinology	16,330
Ophthalmology@	80,427	Neurosurgery	13,102
Psychiatry	69,745	Diabetology	13,382
Oncology	54,316	Neurology	13,313
Gynaecology	43,436	Nephrology	8,641
Obstetrics	41,165	Cardiac Surgery	6,346
Physical Medicine	30,883	Plastic Surgery	3,579
Dermatology	29,930	Vascular Surgery	2,690

Proposal: Mobile App to Engage in Healthy Dieting

- As per recommendation of the WHO
- Targeting all groups interested in healthy dieting
  - Specifically groups suffering from NCDs (including overweight)



Initial Approach

Create a Food Database

Identification, collection and pre-processing of images in Mauritian context (Dish-Level)

Assessment of DL Techniques

Assess the relevance of existing Deep Learning techniques for food classification using images

Experimenting

Design experiments to train and evaluate the Deep Learning approaches using the image dataset

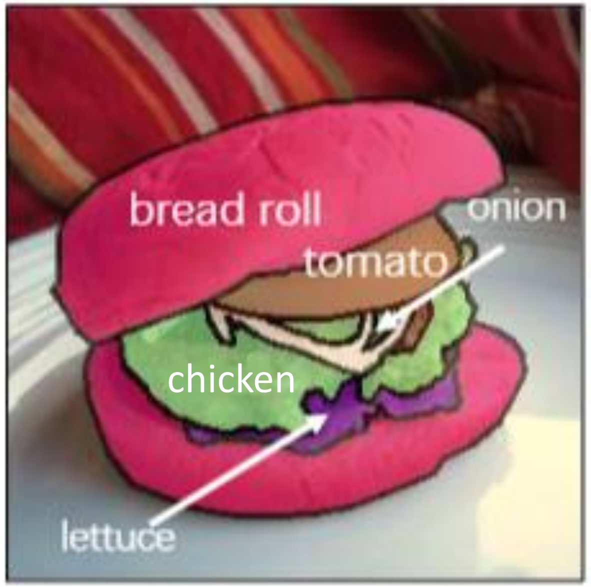
Prototyping

Design and implement a prototype mobile application solution for food recognition and recommendation

The Challenge

Source Image

Dish-level Classification

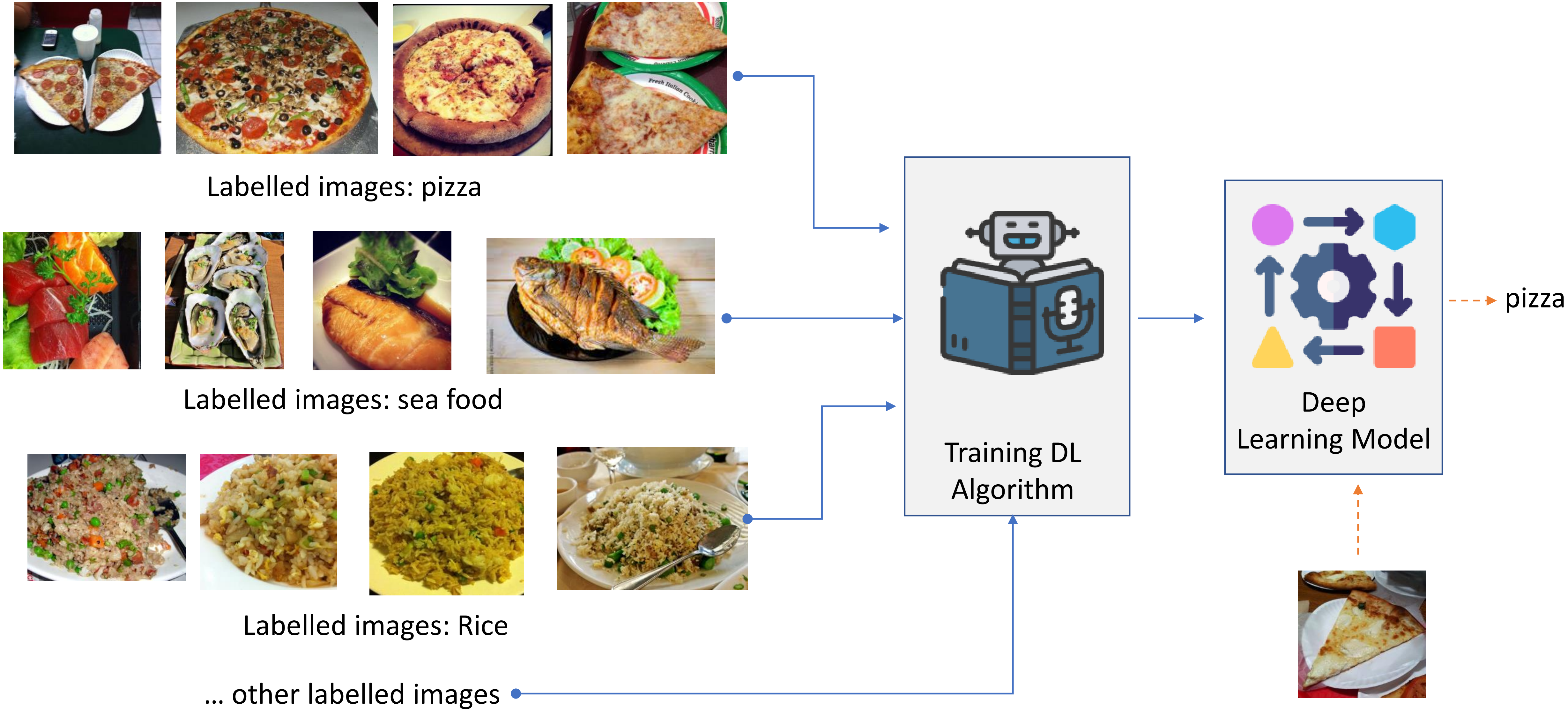


Ingredient-level Classification

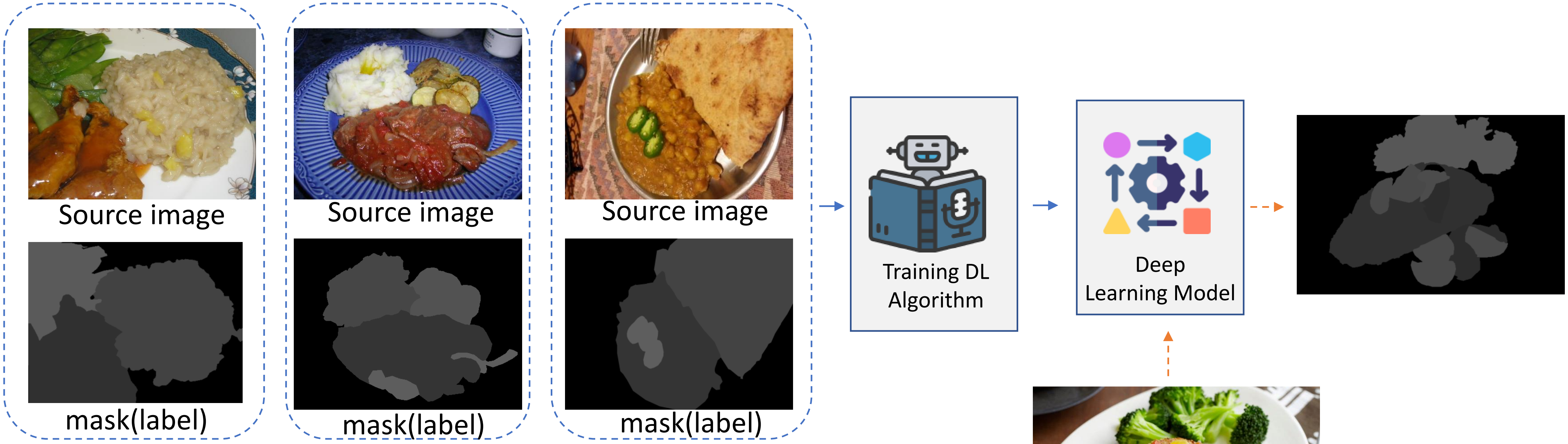
- To classify and identify each individual element in a dish can be achieved by **segmentation.**
- Requires a pixel-wise mask.

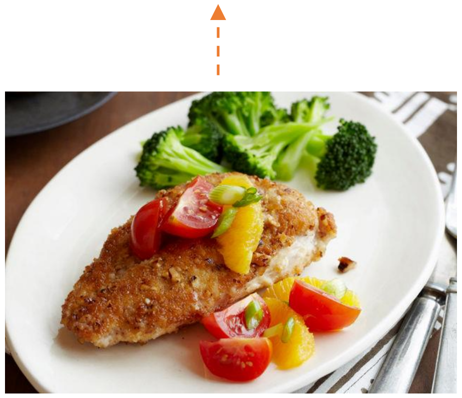
Image reference: Adapted from FoodSeg103, Xu et al. 2021

Classification Approach in Machine Learning (ML)



Segmentation Approach in Machine Learning





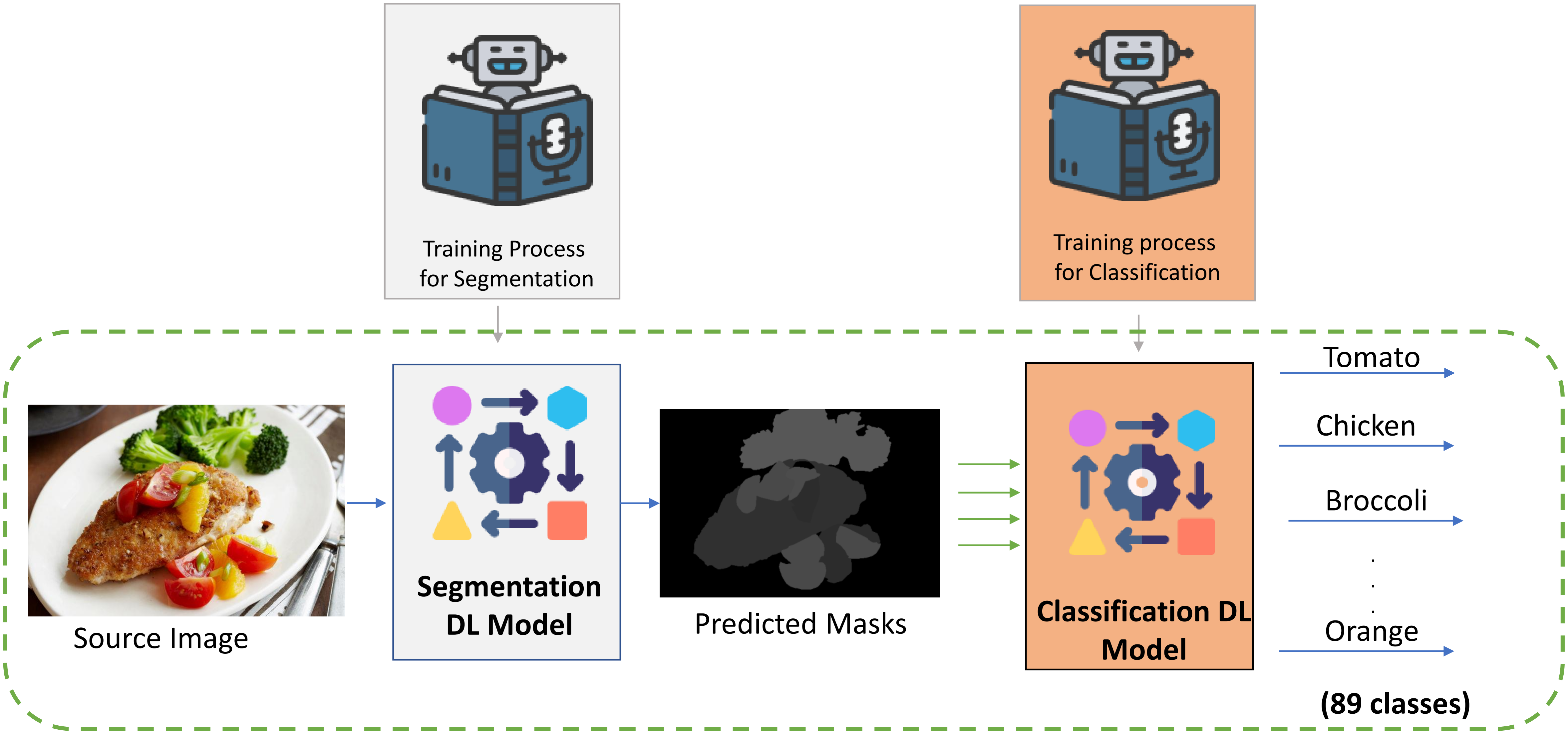
- Initially: 7118 images with ingredient level pixel-wise annotations.
- After Augmentation (Customisation): 112,000 images.
- Duration: over 720 hours for tuning, training & validation.
- Prediction of Segment masks only is not enough.

Datasets

- Food Classification Datasets
    - Food-5K
    - Food-11
    - Food-101
    - Food-101N
    - Food-524DB
    - UEC-Food-100
    - UEC-Food-256
    - **Our local dataset (around 7000 images in different classes: Biryani, Fried Rice, Fried Noodles, Gateau Piment, …) Segmentation is on going.*

- Food Segmentation Datasets
    - Food201 *(29,000 masks)*
    - UECFoodPix *(14,011 masks)*
    - UECFoodComp *(16,060 masks)*
    - Foodseg103 *(42,097 masks)**

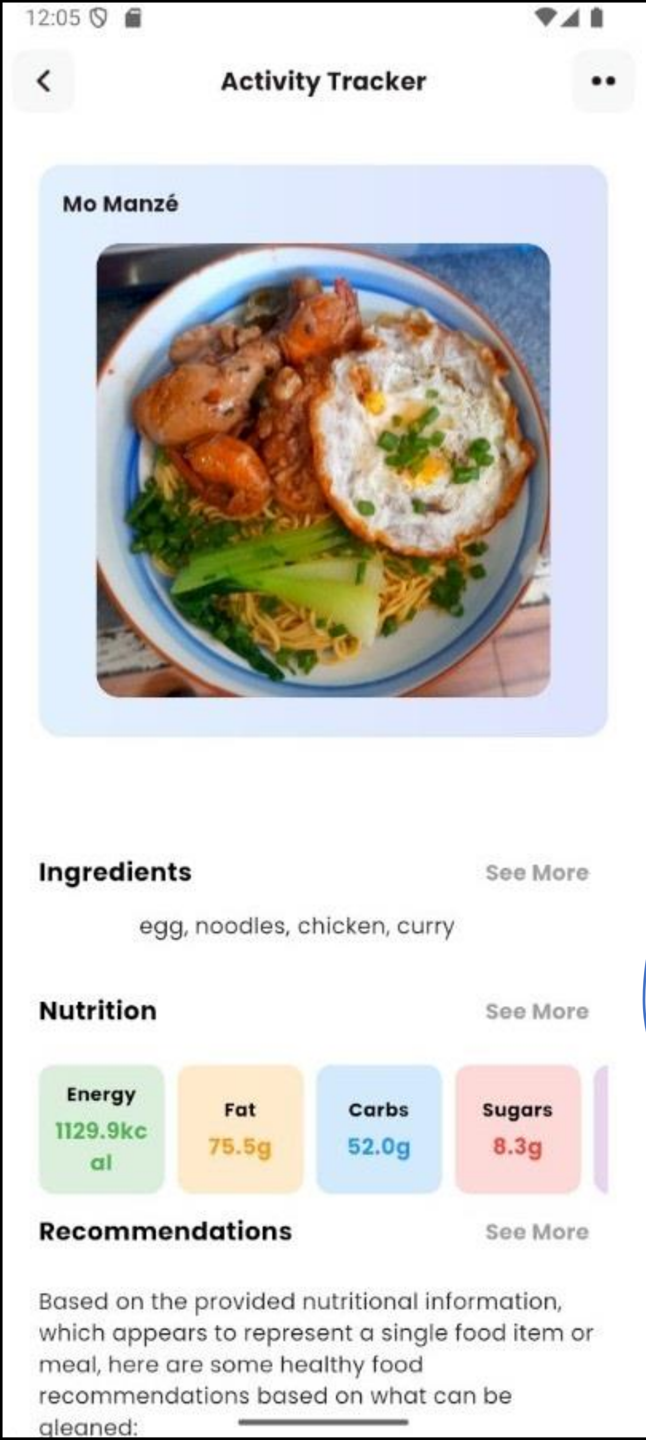
Proposed Solution: Hybrid DL Approach



Segmentation Results (Visual)

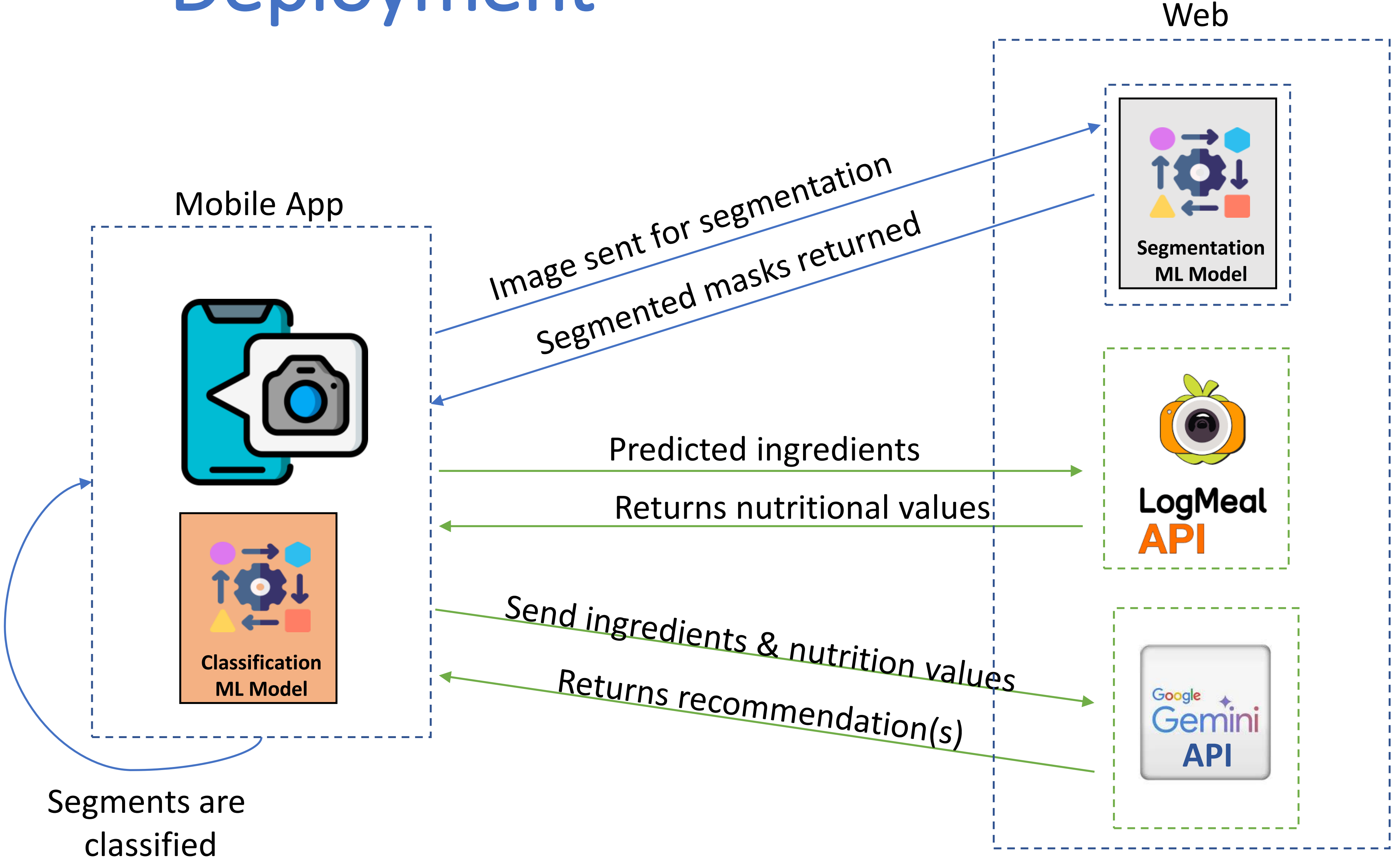
Performance of the Hybrid Approach

- Segmentation Model
  - Based on Encoder-Decoder (DeepLabV3+)
  - ConvNeXtXLarge, Xception, DenseNet, NasNetLArge, EfficientNetV2L
  - ConvNeXtXLarge Model performed better
    - mIoU: 41.9%
    - Best performing from literature: 48.7%
- Classification Model
  - CNN based
  - EfficientNetB0, EfficientNetV2L, ConvNeXtXLarge
  - ConvNeXtXLarge Model results:
    - **Top-1: 96.9%**
    - Top-5: 99.7%
    - Best Performing from literature: 95.66% (local), 94.4% (global)



12:05
Activity Tracker
Mo Manzé
Ingredients
See More
egg, noodles, chicken, curry
Nutrition
See More
Energy 1129.9kcal
Fat 75.5g
Carbs 52.0g
Sugars 8.3g
Recommendations
See More
Based on the provided nutritional information, which appears to represent a single food item or meal, here are some healthy food recommendations based on what can be gleaned:

Deployment



Web
Mobile App
Image sent for segmentation
Segmented masks returned
Segmentation ML Model
Predicted ingredients
Returns nutritional values
LogMeal API
Classification ML Model
Send ingredients & nutrition values
Returns recommendation(s)
Google Gemini API
Segments are classified

Conclusion

- Segmentation Performance
  - The DeepLabV3+ architecture, powered by the ConvNeXt-XLarge backbone, achieved successful image segmentation results.

- High-Accuracy Hybrid Model
  - Our hybrid segmentation and classification approach delivered 96.9% prediction accuracy after comprehensive data preprocessing.

- Real-World Validation
  - The entire deep learning pipeline was successfully validated and deployed within a mobile application (prototype), demonstrating its practical use.

Future Works

- Improve the Segmentation approach using Vision Transformer technology. *(Note: convNeXtXLarge >350M parameters)*

- Extend the local data collection and embark on the creation of image mask.

- Collection nutritional information for specific ingredients (local context)

Thank you

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