DiabEats:

Smart Food Analysis for Diabetes Management

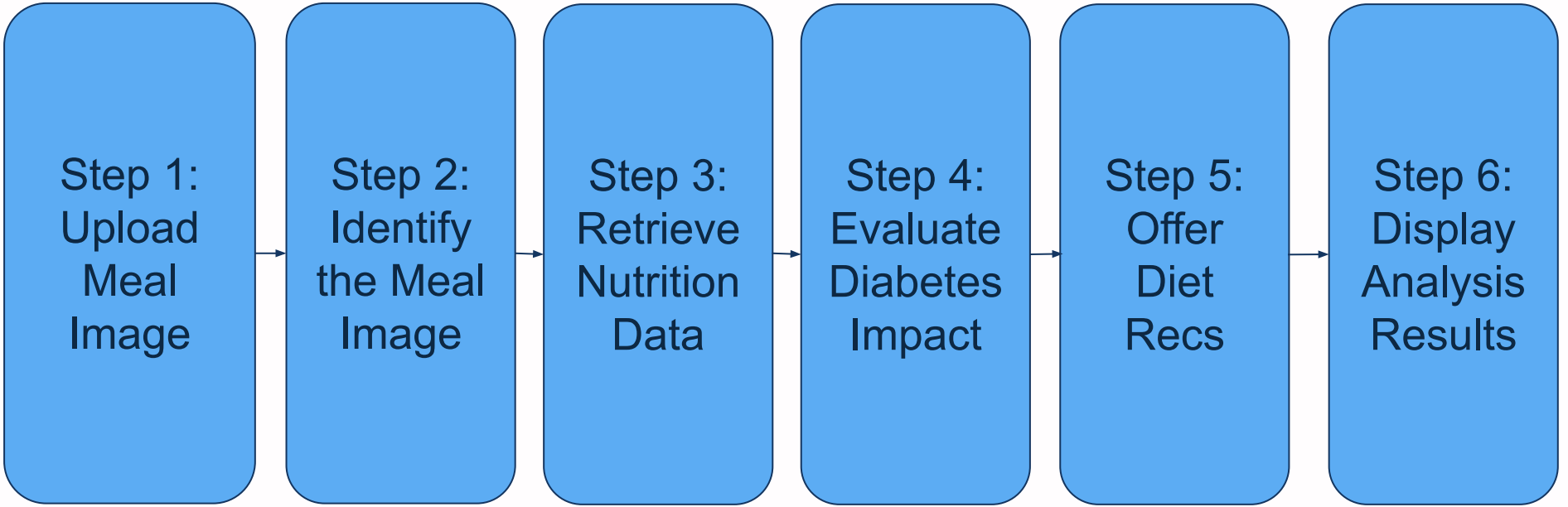
Ted

Background

US diabetes cases to triple from 15.3M (2000) to 43M (2050)

Can we provide diabetes-friendly dietary recommendations for U.S. diabetic and prediabetic users using just a photo of their meal?

Proposed Flow of DiabEats

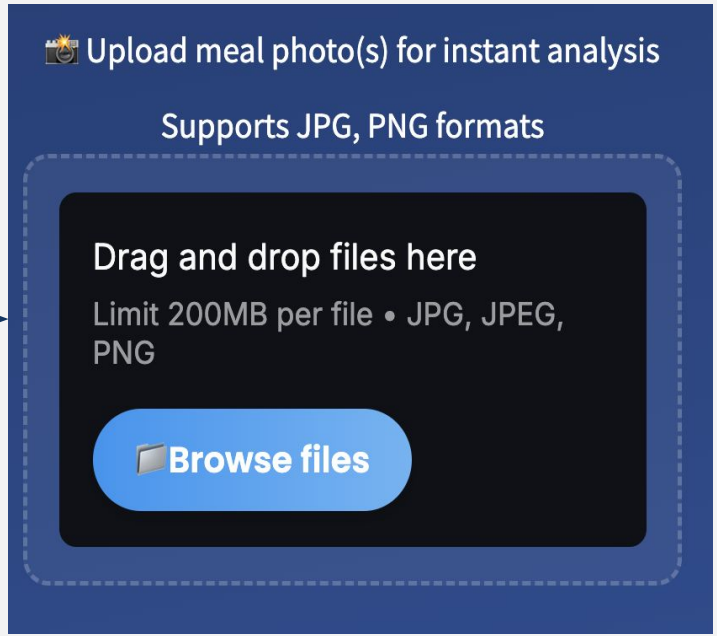


Success Metric

Food Recognition

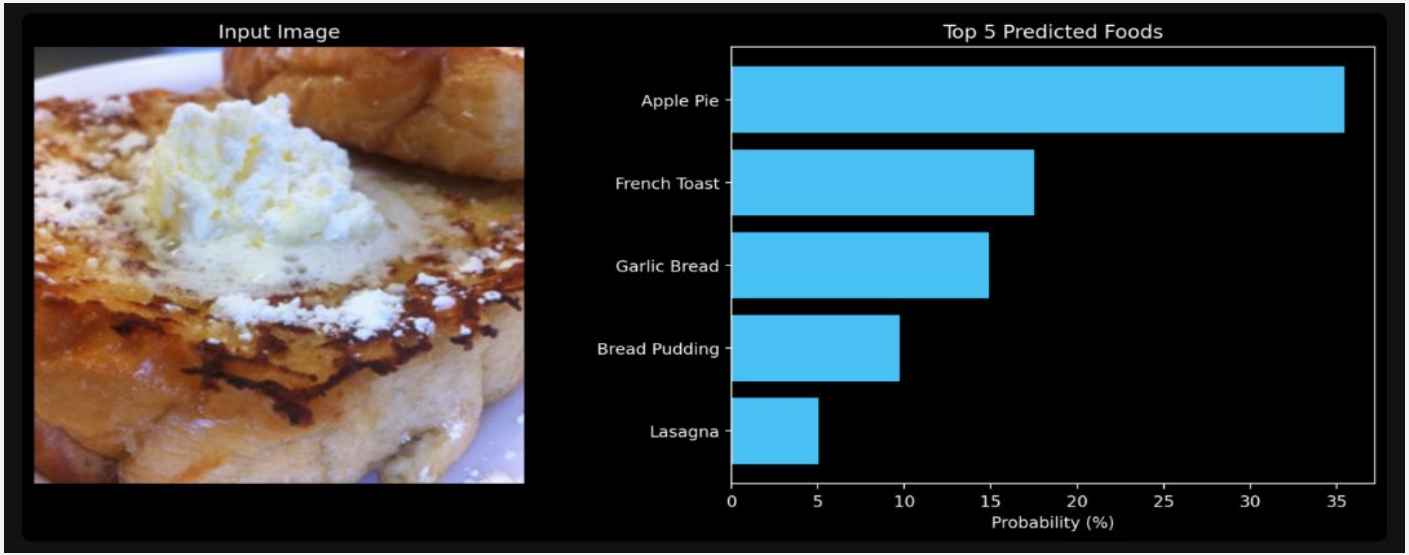
80%+ top-1 food recognition **Accuracy** and 90%+ top-5 **Accuracy**

Upload Meal Image



Identify the Meal Image

- **Objective**: Identify foods from photos to support diabetes-friendly meal choices
- Recognizes foods from a set of 101 different foods
- Lists top 5 likely foods with confidence scores
- Sets foundation for nutritional analysis



1: Upload Image | **2: Identify Image** | 3: Retrieve Nutrition | 4: Evaluate Diab Impact | 5: Offer Diet Recs | 6: Display Analysis

Augumentation for DiabEats

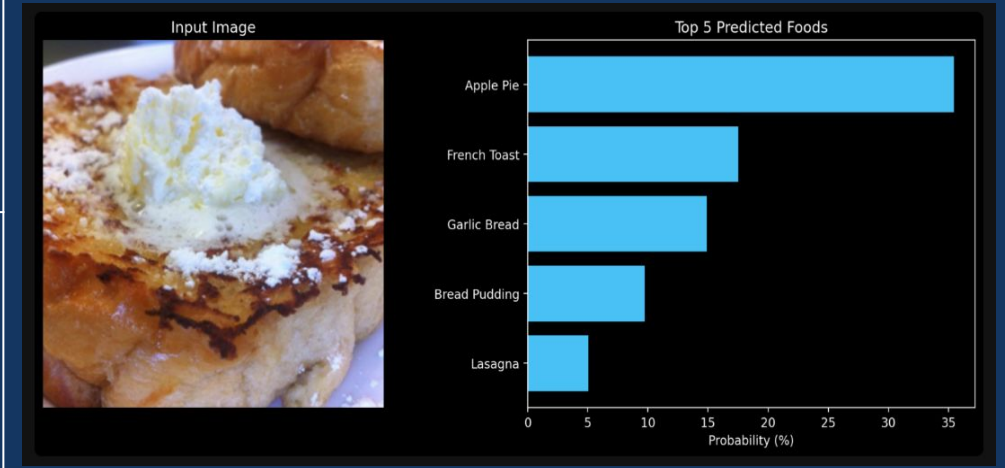
- **Objective**: Ensure accurate food recognition for all kinds of photos
- Tweaks photos with flips, rotations, and color changes
- Handles varied photos (e.g., dim light, odd angles) for reliable results
- Makes food identification trustworthy for diabetes management

Dim light Example

Before Augmentation

After Augmentation

Meal Image Recognition Model Performance

Model	Accuracy (%)	Example of Top-5 Food Prediction
Food Recognition	Top-1: 80.5	
	Top-5: 94.6	

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Nutritional Data Retrieval

- Retrieves nutritional profile from Food101 dataset
- Scales nutritional values based on user-specified portion sizes
- Shows food details in easy-to-read tables

Nutrient	Amount
Calories	300.00 kcal
Protein	3.03 g
Carbohydrates	45.07 g
Fats	12.03 g
Fiber	2.20 g
Sugars	20.00 g
Sodium	150.00 mg

Diabetes Impact Assessment

Food Recognition Model → Apple Pie

Retrieve Nutrition

Nutrient	Amount
Calories	300.00 kcal
Protein	3.03 g
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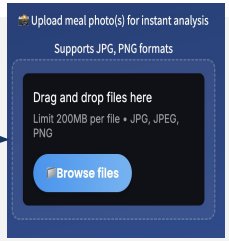
Evaluate Diabetic Impact

Impact Score = 1 (Protein <10) + 2 (carbs > 40) + 2 (sugar > 10) = 5

Factor	Threshold per 100g	Score	Evidence Source
Calories	>400kcal	+1	ADA weight management guidelines
Protein	<10g	+1	ADA balanced macronutrient guidelines
Carbs	>40g 20-40g <20	+2 +1 -1	ADA carbohydrate monitoring recommendations
Fats	>30g	+1	ADA nutrition therapy position statement
Fiber	⩾5g 3-5g	-2 -1	Reynolds et al., Lancet 2019 meta-analysis
Sugars	>10g 5-10g	+2 +1	WHO & ADA sugar intake guidelines
Sodium	>1200mg >800mg	+2 +1	ADA & AHA cardiovascular guidelines

Diabetes Impact Assessment …

Upload Image



Food Recognition Model

Apple Pie

Retrieve Nutrition

Nutrient	Amount
Calories	300.00 kcal
Protein	3.03 g
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Fiber	2.20 g
Sugars	20.00 g
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Evaluate Diabetic Impact

Classifies foods into:

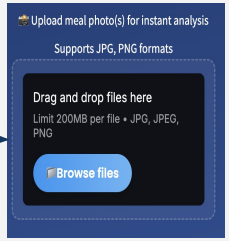
- **Low** (impact score <= 0)
- **Moderate** (1 <= impact score <= 2), or
- **High (**mpact score > 2**)** Diabetes impact categories

Metric	Value
Score	5.00
Impact Level	High
Top Impact Factors	1. Low Protein (3.03g) 2. Refined Carbs (45.07g) 3. Added Sugar (20.00g)

1: Upload Image | 2: Identify Image | 3: Retrieve Nutrition | **4: Evaluate Diab Impact** | 5: Offer Diet Recs | 6: Display Analysis

Offer Dietary Recommendations (Single)

Upload Image



Food Recognition Model

Apple Pie

Retrieve Nutrition

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Fiber	2.20 g
Sugars	20.00 g
Sodium	150.00 mg

Evaluate Diabetic Impact

Metric	Value
Score	5.00
Impact Level	High
Top Impact Factors	1. Low Protein (3.03g) 2. Refined Carbs (45.07g) 3. Added Sugar (20.00g)

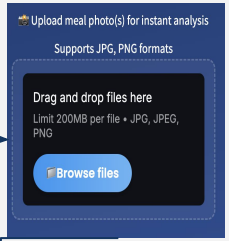
Offer Dietary Recs

No.	Recommendation
1	Apple Pie may significantly impact blood sugar due to high carbohydrates or sugars. Limit to very small portions (<50g) or avoid, and consult a dietitian if needed.

1: Upload Image | 2: Identify Image | 3: Retrieve Nutrition | 4: Evaluate Diab Impact | **5: Offer Diet Recs** | 6: Display Analysis

Offer Dietary Recommendations (Multiple) ...

Upload Image



Food Recognition Model

Apple Pie

Retrieve Nutrition

Nutrient	Amount
Calories	300.00 kcal
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Fiber	2.20 g
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Sodium	150.00 mg

Upload Image

Evaluate Diabetic Impact

Metric	Value
Score	5.00
Impact Level	High
Top Impact Factors	1. Low Protein (3.03g) 2. Refined Carbs (45.07g) 3. Added Sugar (20.00g)

Offer Dietary Recs

Category	Description
Combined Analysis	Analysis for 2 foods. Total nutrients (per 100g equivalent): Calories: 350.00 kcal, Carbohydrates: 53.07 g, Sugars: 22.00 g, Fiber: 5.31 g, Protein: 5.03 g, Fats: 13.45 g, Sodium: 450.00 mg
High-Impact Foods	Apple Pie. These foods may significantly raise blood sugar due to high sugars or carbohydrates. Consider reducing portions or replacing with lower-impact alternatives.
Low-Impact Foods	Seaweed Salad. These are diabetes-friendly choices and can be consumed in standard portions.
Overall Impact Level	High (Score: 3.00). To manage blood sugar, balance carbohydrate intake with fiber and protein, and limit high-sugar or high-sodium foods.
Action	Reduce portion sizes of high-impact foods, avoid combining multiple high-carb items, and include vegetables or whole grains in your meal.

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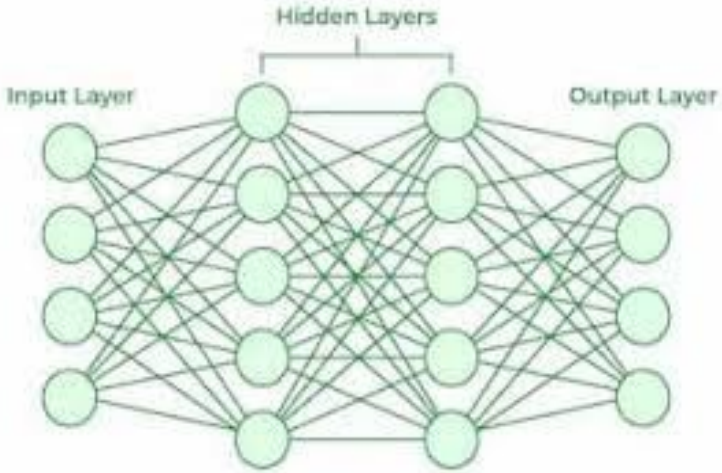
Analysis Dashboard

- Upload single or multiple food images (JPG/JPEG/PNG)
- Set custom portion sizes for each food
- View top 5 predictions with confidence levels
- Get detailed nutritional analysis and impact assessment
- Receive combined analysis for multiple foods

https://diabeats.streamlit.app/



Conclusions

- The system successfully meets its objectives, with the food recognition model achieving 80.5% Top-1 accuracy and the rule-based assessment delivering consistent, evidence-based classifications for Low, Moderate, and High diabetes impact categories.
- The rule-based diabetes impact assessment effectively identifies carbohydrates and sugars as key factors influencing blood glucose levels,
- The Streamlit-based user interface provides an intuitive and interactive experience, enabling users to easily upload meal photos, view nutritional breakdowns, and access personalized recommendations.
- The integration of portion size adjustments in the diabetes impact assessment enhances personalization, allowing the system to reflect real-world eating habits accurately.

Next Steps

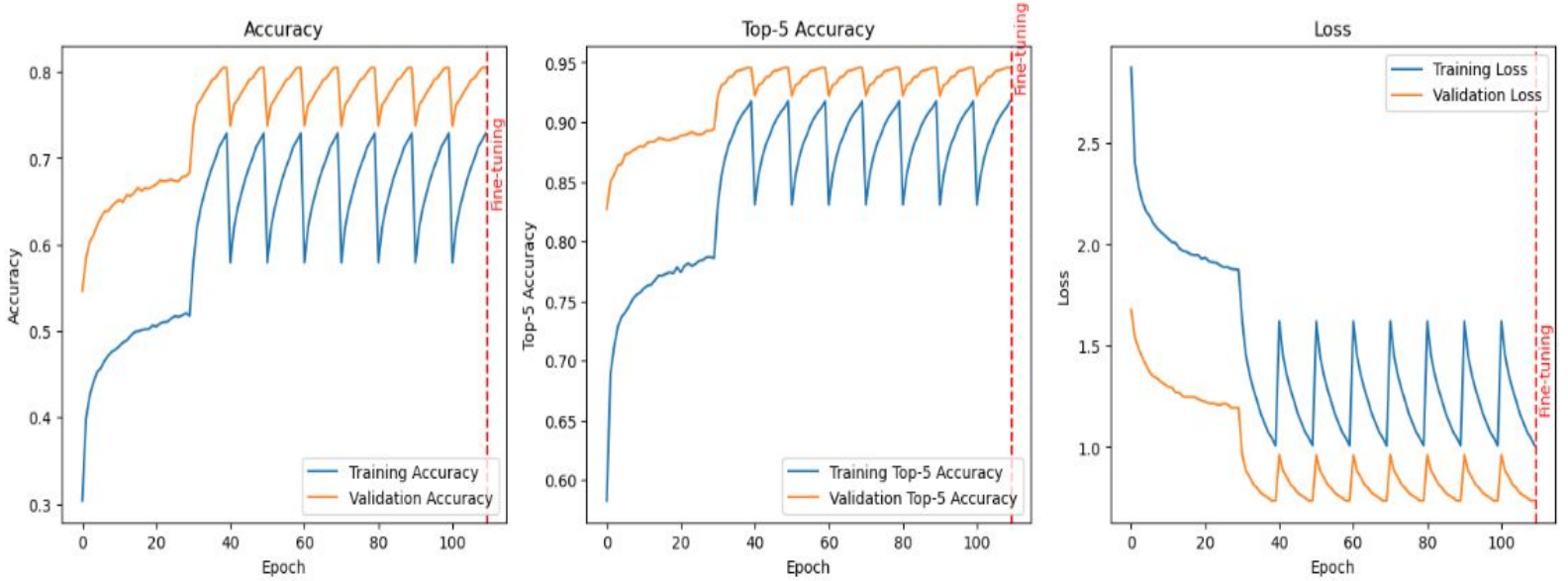
- Expand the nutritional database beyond the current 101 food categories to include a broader range of regional and ethnic food varieties, enhancing the system's applicability to diverse diets.
- Refine the rule-based diabetes impact assessment by incorporating additional nutritional factors (e.g., glycemic index)
- Optimize the EfficientNetV2B3 model to increase Top-1 accuracy beyond 80.5%, potentially through advanced data augmentation techniques or further fine-tuning.
- Implement a user feedback mechanism to allow users to correct misclassifications, improving the system's accuracy and personalization over time.

References

- Senior woman with medical problems
- Smiley covid recovery center female doctor checking elder patient's blood pressure
- Doctor using tensiometer high angle
- International Diabetes Federation
- Mermaid
- The Food-101 Data Set
- FoodData Central
- Edamam Food Database
- Global Diabetes Trends and Burden (PMC10591058)
- AI-Based Diabetes Risk Classification System (IRJMETS)
- Machine Learning for Diabetes Risk Assessment (Frontiers in Applied Mathematics and Statistics)
- Self-Reported Dietary Assessment Limitations (JAMA Internal Medicine)
- Automated Food Image Analysis for Health (PLOS Digital Health)
- Food Image Recognition Using Deep Learning (Nature Scientific Reports)
- AI in Diabetes Risk Prediction (npj Digital Medicine)
- Rule-Based Recommendation Systems for Diabetes (SAGE Open Medicine)

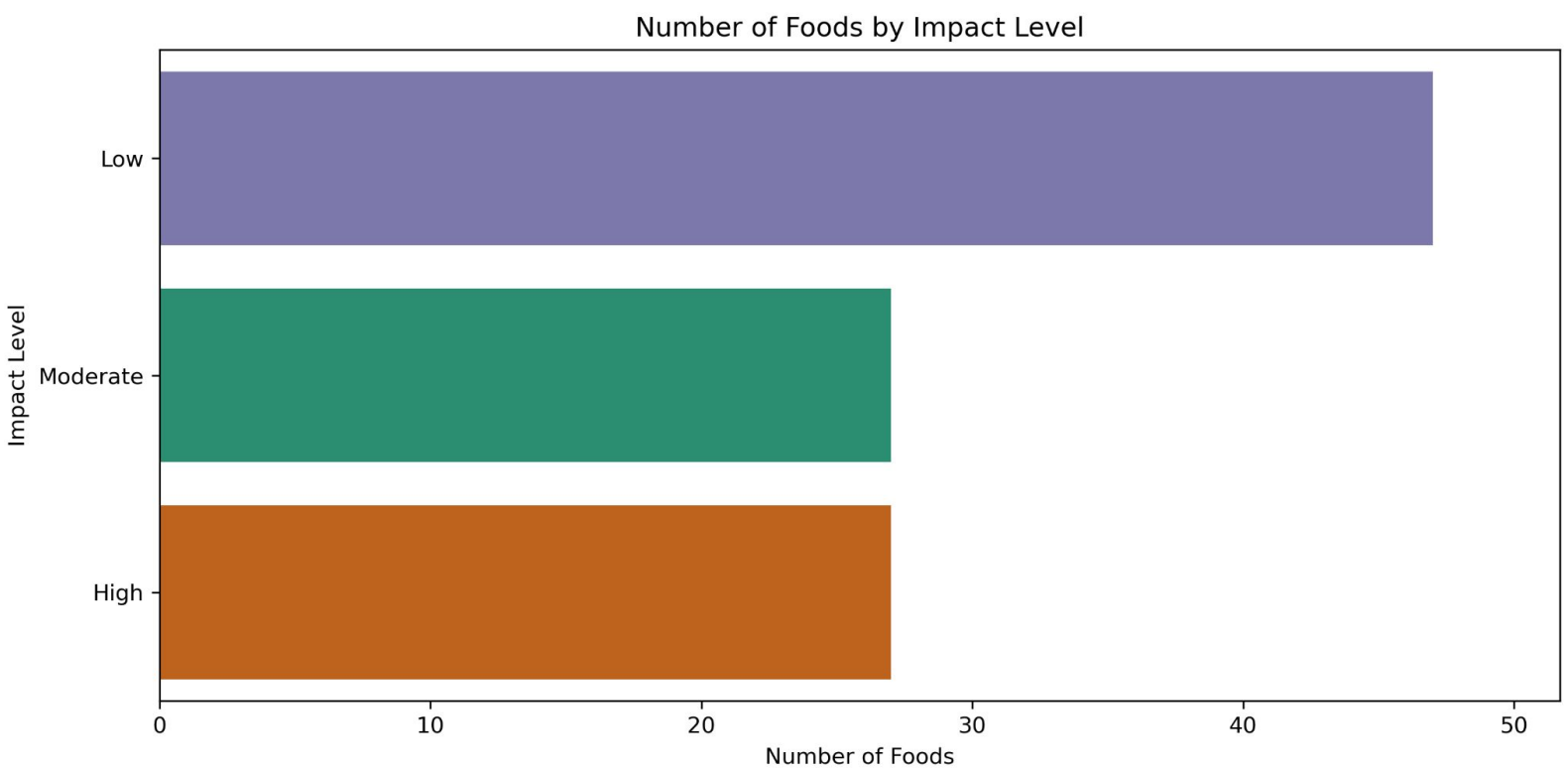
Appendix

Model Loss and Accuracy



Appendix …

Distribution of Diabetes Impact Levels



Appendix …

Aggregation by Impact Levels

Impact Level	Food Class Count	Food Class Labels	Average Impact Score
High	27	Cupcakes, apple_pie, baklava, beignets, bread_pudding, cannoli, carrot_cake, cheesecake, chocolate_cake, chocolate_mousse, churros, creme_brulee, donuts, french_toast, frozen_yogurt, ice_cream, macarons, onion_rings, pad_thai, pancakes, panna_cotta, red_velvet_cake, strawberry_shortcake, sushi, takoyaki, tiramisu, waffles	4.11
Moderate	27	bibimbap, breakfast_burrito, bruschetta, dumplings, fish_and_chips, french_fries, fried_calamari, fried_rice, garlic_bread, gnocchi, grilled_cheese_sandwich, gyoza, hamburger, lasagna, macaroni_and_cheese, nachos, paella, pizza, poutine, pulled_pork_sandwich, ramen, ravioli, risotto, samosa, spaghetti_bolognese, spaghetti_carbonara, spring_rolls	1.63
Low	47	Lobster Roll, baby_back_ribs, beef_carpaccio, beef_tartare, beet_salad, caesar_salad, caprese_salad, ceviche, cheese_plate, chicken_curry, chicken_quesadilla, chicken_wings, clam_chowder, club_sandwich, crab_cakes, croque_madame, deviled_eggs, edamame, eggs_benedict, escargots, falafel, filet_mignon, foie_gras, french_onion_soup, greek_salad, grilled_salmon, guacamole, hot_and_sour_soup, hot_dog, huevos_rancheros, hummus, lobster_bisque, miso_soup, mussels, omelette, oysters, peking_duck, pho, pork_chop, prime_rib, sashimi, scallops, seaweed_salad, shrimp_and_grits, steak, tacos, tuna_tartare	-0.79