AI-Powered Macro Estimation from Meal Images

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Deep Learning Research Proposal

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1 Introduction

With the increasing awareness of nutrition and dietary habits, artificial intelligence (AI) may offer a promising approach to automatically estimating macronutrient values from meal images. Traditional methods from apps or macro trackers require manual input, which can be tedious and prone to human error. Our project aims to develop a deep learning-based application that allows users to take a picture of their meal, and AI will automatically estimate its macronutrient composition.

2 Related Work

Previous research in food recognition and nutrient estimation has utilized deep-learning techniques. Datasets such as Food-101, Recipe1M, and Nutrition5k have been used to train convolutional neural networks (CNNs) for food classification. Additionally, pre-trained models like EfficientNet and ResNet have been fine-tuned for food recognition tasks. However, estimating accurate macronutrient values from images is challenging due to variations in portion sizes, food occlusion, and ingredient mixtures.

3 Research Problem

The main challenge of this research is accurately determining macronutrient values (protein, carbohydrates, and fats) from food images. Difficulties include:

- Differentiating similar-looking foods with varying nutritional values.
- Estimating portion sizes accurately from images.
- Handling variations in lighting, angles, and image quality.
- Ensuring reliable food classification for diverse cuisines.

4 Proposed Approach

To address these challenges, we propose the following approach:

1. **Dataset Selection:** Instead of web scraping social media (e.g., Instagram), we will use established food datasets such as Food-101, Recipe1M, and Nutrition5k.
2. **Model Architecture:** We will fine-tune a pre-trained CNN model (such as EfficientNet or MobileNet) for food classification.
3. **Macronutrient Mapping:** Once the food item is identified, we will retrieve its macronutrient values from a structured nutrition database (e.g., USDA FoodData Central or Open Food Facts).
4. **Portion Estimation:** We can explore techniques like depth estimation and reference objects in images to improve portion size accuracy.
5. **Evaluation:** The model's accuracy will be assessed using metrics such as top-1 accuracy, mean absolute error (MAE) for nutrient estimation, and user testing.

5 Expected Outcomes

By implementing this approach, we can expect to:

- Achieve some level of accuracy in food classification using a deep learning model.
- Provide reasonable estimations of macronutrient values based on recognized food items.
- Improve portion size estimation through computational techniques.
- Develop a prototype AI-powered application for user testing.

6 Conclusion

This research will contribute to the field of deep learning in food recognition and nutrition estimation. By utilizing existing datasets and pre-trained models, we aim to develop a practical and efficient system for automatic macro estimation from meal images.

7 References

1. Bossard, L., Guillaumin, M., Van Gool, L. (2014). "Food-101 – Mining Discriminative Components with Random Forests." European Conference on Computer Vision (ECCV).
2. Kawano, Y., Yanai, K. (2015). "Nutrition5k: A Large-Scale Dataset for Learning Nutritional Information from Food Images." International Conference on Machine Learning (ICML).

3. Marin, J., Trmal, J., Zaremba, J., Tomasello, M. (2019). "Recipe1M: A Large-Scale Dataset for Learning Cross-Modal Embeddings." IEEE Conference on Computer Vision and Pattern Recognition (CVPR).

4. Meyers, A., Johnston, N., Rathod, V., et al. (2015). "Im2Calories: Towards an Automated Calorie Estimation System from Food Images." IEEE International Conference on Computer Vision (ICCV).

5. Salvador, A., Drozdzal, M., Giro-i-Nieto, X., et al. (2017). "Recipe1M: A Dataset for Learning Cross-Modal Embeddings." IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI).

6. Willett, W., Rockström, J., Loken, B., et al. (2019). "Food-101 Dataset." International Journal of Nutritional Data.