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Editorial

The Software Tools for Personalized Nutrition

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Abstract

The creation of software tools for generating personalized healthy nutrition plans (MMPS -Monthly Menu Planner Software), considering the absolute compliance with the nutrients recommended daily intake (RDI) and using correct and different combinations of foods as nutrient sources (according to the international food chemical composition databases, e.g. USDA/CIQUAL/BEDCA) in the daily menus recipes (considering the food recipe database), is based on an optimization problem solving algorithm (Mixed-Integer Linear Programming, MILP).

The "Simplex" algorithm solves the linear part of the problem. Considering the most important restriction of 30-days non-replication of the same food nutrient source, the binary variables of MILP solver (CBC, GLPK, OR-Tools, Gurobi) are applicable for correct monthly menu plan integrated in a practical application, easy-to-use and understand by the final user.

Keywords: *Monthly Menu Planner Software (MMPS); Mixed-Integer Linear Programming (MILP); Personalized Nutrition*

Introduction

The growing demand for personalized nutrition and healthy eating requires automatic meal planning tools capable of meeting daily nutrient requirements while maintaining variety and food preferences. Current studies often optimize for macronutrients and a limited set of micronutrients, without enforcing restrictions to prevent repetition of key nutrient sources or recipes:

1. **NutriGen: Personalized meal plan generator using large linguistic models (LLM):** This study introduces NutriGen, an LLM-based framework for generating personalized meal plans. The system integrates a personalized nutritional database and prompt engineering techniques to generate structured and practical meal plans that meet users' caloric and nutritional goals. Evaluations show that the Llama 3.1 8B and GPT-3.5 Turbo models have low percentage errors (1.55% and 3.68%, respectively), demonstrating their potential in personalized nutritional planning.
2. **Meal optimization using linear programming:** The study explores the use of linear programming to optimize meal planning for nutritional and cost-effectiveness purposes. The model minimizes meal costs while respecting specific nutritional requirements and considering additional complexities such as fractional weights and nutrient ratio constraints. The study addresses common nutritional challenges and provides personalized diet plans, contributing to effective and sustainable meal planning.

3. **MPG (Meal plan generation):** The published in Springer introduces MPG (Meal Plan Generation), a solution based on adapting the transportation optimization problem to simulate the human process of generating daily meal plans. This approach allows for the generation of plans that meet recommended caloric requirements, taking into account food preferences, variety, food compatibility, and meal compatibility [1-6].

While dietary planning software and tools exist, they often face several limitations:

1. **Incomplete nutrient coverage:** Many tools optimize for calories, protein, fats, and a few key micronutrients but ignore a broader set of essential nutrients.
2. **Limited variety enforcement:** Repeated use of the same foods or recipes can reduce dietary diversity, which is crucial for long-term adherence and overall health.
3. **Manual planning dependency:** Personalized meal planning often relies on dietitians, which is time-consuming and not scalable.

The research in creation of automatic meal planning tools has explored multiple approaches:

1. **Linear and integer programming:**

- Optimizes nutrient intake by adjusting food quantities.
- Examples: Food linear programming models for cost minimization while meeting nutrient requirements.
- Limitations: Typically considers only a subset of nutrients and does not enforce non-repetition constraints.

2. **Genetic algorithms and AI approaches:**

- Evolve meal plans iteratively to meet nutrient targets and preferences.
- Can introduce variety and balance but struggle with strict nutrient constraints across long periods (e.g. 30 days).

3. **Rule-based and heuristic systems:**

- Use predefined rules for food combinations, meal structure, or recipe rotation.
- Limitations: Cannot guarantee full DRV adherence for a large set of nutrients and may not optimize ingredient quantities.

4. **Open available databases:**

- USDA FoodData Central provides comprehensive nutrient composition for thousands of foods, enabling precise nutrient calculations.
- However, few studies leverage these data for large-scale, multi-day meal optimization while enforcing strict non-repetition of nutrient sources and recipes [5,7,8].

Results and Recommendations

The recommendated algorithms for correct solving the multi-restricted and multi-variables problem of correct and personalized MMPS (Monthly Menu Planner Software) are as followings:

- Linear/mixed problem solving (Mathematical Optimization Programming).
- Combinatorial optimization problem solving using Mixed-Integer Linear Programming (MILP).

The application interface need to be easy use-to-use and easy-to-understand for the final user and science-based for regulation and technical acceptability:

- Web or mobile (React Native/Flutter for mobile, React or Angular for web).
- Useful functions:
- Daily/weekly/monthly menu generation
- Menu filtering by allergies/preferences (vegan, low-carb etc.)
- Automatic food shopping list
- Automatic nutrition report.

The storage and back-end recommended algorithms are as followings:

- Database: PostgreSQL/MySQL.
- Back-end: Python (Django/Flask/FastAPI) or Node.js.
- Python is very good for the mathematical optimization part (libraries like PuLP, SciPy, OR-Tools).

Conclusion

The nowdays scientific research demonstrate that it is feasible to generate a stable software tool for fully optimized, nutritionally complete while maintaining non-repetition of nutrient sources and recipes.

Proper nutrition is fundamental for maintaining health, preventing chronic diseases, and supporting optimal physical and cognitive performance. Modern dietary guidelines define Daily Recommended Values (DRV) for a broad spectrum of nutrients, including macronutrients, vitamins, and minerals.

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