VAFA: a Visually-Aware Food Analysis System for Socially-Engaged Diet Management

Paper ID 394

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Abstract. In this demo, we demonstrate a visually-aware food analysis (VAFA) system for socially-engaged diet management. VAFA is capable of receiving multimedia inputs, such as the images of food with/without a description to record a user's daily diet. A set of AI algorithms for food classification, ingredient identification, and nutritional analysis are provided with this information to produce a nutrition report for the user. Furthermore, by profiling users' eating habits, VAFA can recommend individualized recipes and detect social communities that share similar dietary appetites for them. With the support of state-of-the-art AI algorithms and a large-scale Chinese food dataset that includes 300K users, 400K recipes, and over 10M user-recipe interactions, VAFA has won several awards in China's national artificial intelligence competitions.

Keywords: Diet Management · Classification · Recommendation · Community Discovery.

1 System Overview

With the development of the Internet and AI technology, and the increasing concerns about more balanced nutritional health, systems for healthy diet management [6, 11, 12] are emerging all over the world. Nevertheless, the existing research and databases, such as food logs [2], are generally based on the western diet data, which leads to insufficient large-scale datasets and analysis results for Chinese users and recipes. Therefore, this paper proposes a visually-aware food analysis (VAFA) system for socially-engaged diet management.

As shown in Fig. 1, VAFA enables users to record their dietary intake through multimedia inputs and produce a nutrition report using a set of artificial intelligence algorithms that are trained by a self-collected large-scale dataset containing over 300K users, 400K recipes, and 10M user-recipe interactions. As a result, VAFA achieves a cutting-edge performance of 87.3% in food classification. More importantly, VAFA can analyze users' eating behaviors for personalized recommendations, and it empowers users with community discovery via the calculation of diet similarity and builds a social-based relationship network named the social cloud. Such functions may enhance the system adherence of the users.

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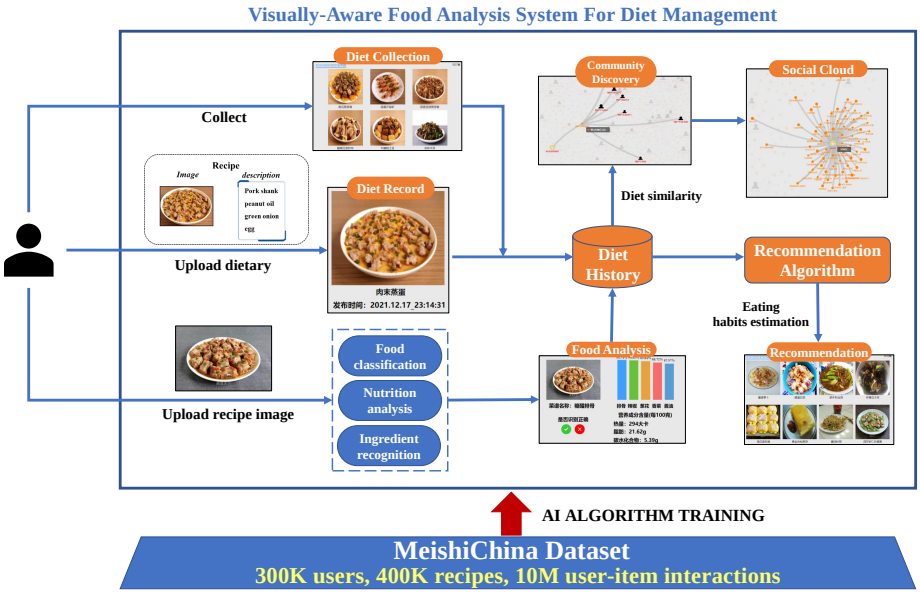

Fig. 1. Framework of VAFA system for diet management.

2 Demo Setups

The VAFA system for Chinese diet management is implemented on Windows10 OS with six 2.8Ghz CPUs.

(1) **Front end**: The Vue framework [1] which focuses only on the view layer and uses a bottom-up incremental development design is applied to build the system's user interfaces and interact with the back-end using Axios. It will check the user's input to ensure the correctness of the input data sent to the back-end, and then send operation requests to access the back-end services based on the user's operation, and upon receiving the returned result processed by the back-end, it will render the data and present it to the user immediately.

(2) **Back end**: The Flask framework [4] and PyTorch are used to build the backend and implement state-of-the-art AI algorithms. It provides APIs to the front-end for various system services and is responsible for receiving user requests sent by the front-end. It will call the corresponding functions to process the requests according to the type of requests, and finally, return the processing results to the front-end. Moreover, the PostgreSQL is installed in this part to access and manage the system's data more efficiently.

(3) **Social cloud**: Users with similar eating habits are detected by GHF-ART [10] as social communities, and then the community relationships are visualized in the form of a social cloud network using ECharts [7], a JavaScript-based data visualization chart library, so that users can easily dig out the recipes they may be interested in and other users similar to them based on this network. The purpose of this module is aimed to solve the problems of lack of social elements

Fig. 2. Demonstration of the functional modules of VAFA.

and low user activity in the existing diet management system, improve user adhesion to the system, and guide users to form scientific dietary habits.

(4) **Food analysis module**: The cross-modal feature alignment algorithm ATNet [8] is used in our system's recognition module for predicting food classes and ingredients, which is trained on the self-collected MeishiChina dataset. Based on the semantic consistency of multimodal data, ATNet simultaneously learns and classify features of data and its semantic modal content through the neural network. Compared with traditional classification algorithms, ATNet enables image features to guide the feature space division of different classes of data with the help of textual features, reducing the influence of image noise information and improving image classification performance. The algorithm has achieved 87.3% Accuracy, outperforming the baseline by 9.6%. Furthermore, the nutrition report is informed by nutrition knowledge which follows Chinese DRIs standards.

(5) **Food recommendation module**: Recent studies [5, 13] have revealed that different users have different visual feature preferences for the same recipe, and the existing recommendation algorithms only use pre-extracted image features, which cannot be modeled for personalized visual preferences. To address this problem, we used PiNet [9], a dual-gated heterogeneous multitask learning algorithm, to recommend recipes that may be of interest to our users. It is trained by more than 10 million user-item interactions, which has achieved the Top-10 precision of 8.11%, outperforming the existing methods by 6.29%. Furthermore, according to users' feedback, our recommendation technology is able to achieve better performance than traditional methods in practical application scenarios, recommending recipes more accurately for users.

3 System Modules and Demo Procedures

VAFA contains five primary modules: diet record module, diet collection module, diet recognition module, diet recommendation module and social cloud module. The diet record module enables users to upload daily diets; the diet collection module allows users to collect recipes they are interested in; the diet recognition module analyzes food images uploaded by users and generates nutrition reports; the diet recommendation module extracts users' individual preferences for the personalized recommendation; the social cloud module enhances recipe sharing through the visualization of users' dietary relationships. As shown in Figure 2, the demo procedures of VAFA will be demonstrated as follows:

i) **Illustration of the homepage of system website**: The homepage includes various information such as healthy diets, nutrition knowledge and the top recommended recipes of the week. In addition, this page serves as the initial page of VAFA, where users can access other modules.

ii) **Interpretation of the user's profile page**: The user's profile page includes the user's diet history, such as diet record, diet collection, and the recommended recipes. The diet record displays information about recipes that users uploaded. As for the diet collection, it shows the recipes that users collected, which are sorted in reverse chronological order allowing users to access their favorite recipes at any time. In addition, the diet recommendation is able to precisely recommend recipes based on users' collaborative information [3] and visual feature.

iii) **Account of the detailed recipe description**: The recipe page describes the specific information of the recipe. Users are able to view the recipe's detail page including the name, the preparation, the directions, and other relevant information about the recipe when they click on any recipe image on any page of the system. From this page, users can learn how this recipe is cooked and discover recipes they may be interested in.

iv) **Formulation of the nutrition report**: The nutrition report is automatically generated by an intelligent food analysis algorithm from the uploaded image, which contains the recipe's name, the top five ingredients with the highest probability, and the nutrition facts. In particular, the nutritional knowledge is obtained from Web APIs provided on the internet, which follows the Chinese dietary reference intakes standards.

v) **Explanation of the social cloud**: The social cloud page presents a social network in the form of points and lines based on users' dietary relationships. With a click on a user's avatar or a recipe in the social network, VAFA will redirect to the user's personal page or the recipe's detailed description. If users have similar preferences, such as having favorited the same recipe, these user nodes will be connected with this recipe.

4 Conclusion

In this demo paper, we demonstrate a novel food analysis system based on leading-edge AI algorithms for socially-engaged diet management. The existing research are generally based on the western food datasets, which are not adapted to the demands of Chinese users and are poor in intelligence. To address these issues, VAFA deploys frontier AI algorithms such as food classification, ingredient identification, diet recommendation, and nutrition analysis, with the support of self-collected large-scale Chinese food datasets to analyze the food images uploaded by users and provide them with nutrition reports. By estimating users' diet habits, it can more precisely recommend personalized recipes. More significantly, it enables users with community discovery via calculating diet similarity. Note that the VAFA system's demo video is shared at: https://b23.tv/Vy5uIB8.

Acknowledgments

This work is supported in part by the Excellent Youth Scholars Program of Shandong Province (Grant no. 2022HWYQ-048) and the Oversea Innovation Team Project of the "20 Regulations for New Universities" funding program of Jinan (Grant no. 2021GXRC073)

References

1. Vue. https://vuejs.org/, Accessed October 8, 2021
2. Aizawa, K., Ogawa, M.: Foodlog: Multimedia tool for healthcare applications. IEEE MultiMedia **22**(2), 4–8 (2015)
3. Chen, C.M., Wang, C.J., Tsai, M.F., Yang, Y.H.: Collaborative similarity embedding for recommender systems. In: The World Wide Web Conference. pp. 2637–2643 (2019)
4. Copperwaite, M., Leifer: Learning Flask Framework. Packt Publishing Ltd (2015)
5. Elsweiler, D., Trattner, C., Harvey, M.: Exploiting food choice biases for healthier recipe recommendation. In: Proceedings of the 40th international acm sigir conference on research and development in information retrieval. pp. 575–584 (2017)
6. Kerr, D.A., Harray, A.J., Pollard, C.M., Dhaliwal, S.S., Delp, E.J., Howat, P.A., Pickering, M.R., Ahmad, Z., Meng, X., Pratt, I.S., et al.: The connecting health and technology study: a 6-month randomized controlled trial to improve nutrition behaviours using a mobile food record and text messaging support in young adults. International Journal of Behavioral Nutrition and Physical Activity **13**(1), 1–14 (2016)
7. Li, D., Mei, H., Shen, Y., Su, S., Zhang, W., Wang, J., Zu, M., Chen, W.: Echarts: A declarative framework for rapid construction of web-based visualization. Visual Informatics pp. 136–146 (2018)
8. Meng, L., Chen, L., Yang, X., Tao, D., Zhang, H., Miao, C., Chua, T.: Learning using privileged information for food recognition. In: MM. pp. 557–565 (2019)
9. Meng, L., Feng, F., He, X., Gao, X., Chua, T.: Heterogeneous fusion of semantic and collaborative information for visually-aware food recommendation. In: MM. pp. 3460–3468 (2020)
10. Meng, L., Tan, A.H.: Community discovery in social networks via heterogeneous link association and fusion. In: Proceedings of the International Conference on Data Mining. pp. 803–811. SIAM (2014)
11. Merler, M., Wu, H., Uceda-Sosa, R., Nguyen, Q.B., Smith, J.R.: Snap, eat, repeat: a food recognition engine for dietary logging. In: Proceedings of the 2nd international workshop on multimedia assisted dietary management. pp. 31–40 (2016)
12. Ming, Z.Y., Chen, J., Cao, Y., Forde, C., Ngo, C.W., Chua, T.S.: Food photo recognition for dietary tracking: System and experiment. In: International Conference on Multimedia Modeling. pp. 129–141. Springer (2018)
13. Yang, L., Cui, Y., Zhang, F., Pollak, J.P., Belongie, S.J., Estrin, D.: Plateclick: Bootstrapping food preferences through an adaptive visual interface. In: Proceedings of the 24th ACM International Conference on Information and Knowledge Management, CIKM 2015. pp. 183–192. ACM (2015)