

Customer Relationship Management for Personalized Nutrition Service

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Abstract. Sufficient food and nutrition supplement is very important for the health of our body. However, most of us do not know which food or nutrition is needed for our bodies, because we do not know our bodies' detail nutrition requirement. Each person's nutrition demand is different because of the differences of each person's genes, age, and life style. With the fast development of genomics, genetics, nutrigenomics, nutrigenetics, and nutrition science, we can now provide personalized nutrition service for customers. The service can provide personalized food supplement solutions based on the DNA genetic testing and the lifestyle evaluation. For the nutrients that can not be supplemented sufficiently from food, the service can provide dietary supplement solutions for customers. Since the dietary supplement products on the market are general products for all the people that can not meet the need of each person's unique nutrition requirement, therefore, our solution collaborates with nutrition product production factory to produce customized nutrition products for the customers. Personalized nutrition service needs to connect customers, genetic testing laboratories, and nutrition product production factory, therefore a customer relationship management (CRM) system is necessary to let customer read genetic report, order personalized nutrition products, place an order to nutrition factory to produce personalized nutrition products. In the paper, we give the technical design and deployment of a CRM system for supporting the personalized nutrition service. The CRM system has been delivered online and provides very successful service for customers, business partners, and intelligent nutrition factory.

Keywords: Nutrition · Genetic testing · Personalized service · Customer relationship management

1 Introduction

Sufficient proteins, carbohydrates, fats, vitamins, and minerals are very important to each person's body to maintain heath and strengthen immune ability. Proteins, carbohydrates, fats are easy to be obtained from our daily food and are required in large amounts for the development of body. Proteins could be obtained from fish, eggs, milk, and meats; carbohydrates could obtained from

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bread and rice; fats could also obtained from meats. Vitamins including vitamin A, vitamin B2, vitamin B3, vitamin B6, folic acid, vitamin B12, vitamin C, vitamin D, vitamin E, and vitamin K are very important for disease prevention and immune strengthening. Minerals including calcium, zinc, iron, magnesium, selenium, phosphorus are also vital for the wellness of body. Vitamins, minerals and the other micronutrients can not be produced in body and must be absorbed from diet. Therefore, reasonable diet and nutrition supplement are very important to make our bodies work in good condition and far from diseases.

Each person's physical condition is different from others, due to the variations of genes and lifestyle, therefore, the nutrition supplement solutions should be personalized for each person.

The fast development of nutrigenomics [1], nutrigenetics [2,3] and nutrition science, makes personalized nutrition solution possible. Based on the analysis of DNA genetic testing and lifestyle evaluation data, we can provide food supplement solutions, and for the nutrients that can not be absorbed sufficiently from food, we give the diet supplement solution. Further, since the diet supplement products on market are general products for all the people, we therefore collaborate with nutrition products production factory to produce tailored diet supplement products to meet the nutrition requirement of each person.

We published a personalized nutrition service which requires the customer to have genetic testing first, and based on the electronic genetic interpretation report the customer can order personalized nutrition products online, then the nutrition factory will receive the customer's order and begin to produce the customized nutrition products for the customer. Therefore, a customer relationship management system is necessary to connect customers, genetic testing laboratory, and nutrition product production factory to let different parities to finish their tasks respectively and orderly. Without a CRM the personalized nutrition service can not be completed efficiently, especially when the factory needs to produce hundreds or thousands of personalized nutrition products in one day.

2 Related Works

CRM systems have been existed for many years, and there are very popular CRMs such as Salesforce [14], Oracle CRM [15] and etc. However, since the personalized nutrition service is very new, its business process is not supported by the existing CRMs, and the extension development of the existing commercial CRMs is very expensive. Therefore, in this paper we first describe the personalized nutrition business process, then we give the technical design and implementation of the CRM system for supporting the personalized nutrition service.

3 Personalized Nutrition Service

Figure 1 describes the business process of personalized nutrition service. The service platform is composed by multiple systems: E-commerce System, Customer Relation Management (CRM) System, Laboratory Information Management

System (LIMS), Bioinformatics Analysis System, Genetic Interpretation System, Business Partner's Systems, and Factory's Order System.

E-commerce system, supports the business to customer service, which has the similar shopping functions like Amazon.com, Alibaba Tmall.com and the other online shopping systems, however the system only sells genetic testing products and personalized nutrition products. Additionally, the e-commerce system has the functions of registering sample, viewing genetic testing report, viewing personalized nutrition supplement solutions, registering personalized nutrition product card.

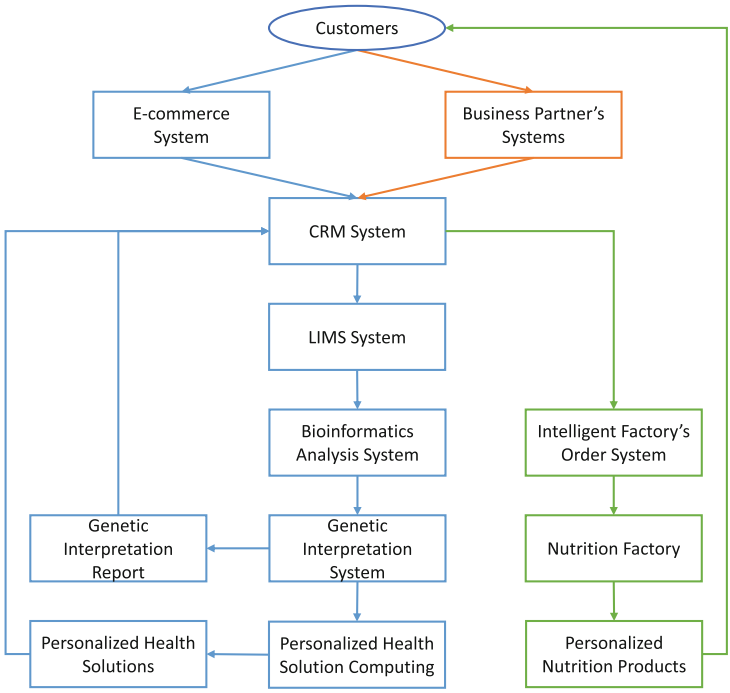

Fig. 1. The business process of personalized nutrition service.

Our customer relation management system, provides both the services of business to customer (B to C) and business to business (B to B).

– To support the business to customer service, the CRM system will communicate with the E-commerce system to receive product order information from customers. Then, the CRM system will notify warehouse operator to send the DNA (saliva) collection kit to customer. When the DNA collection kit has been posted back to the laboratory, the CRM system will synchronize the laboratory operation processes from LIMS and let the customer know the sample status. The CRM system also has an interface to transfer the genetic report from the genetic interpretation system to the e-commerce system.

– To support the business to business service, the CRM can provide services for multiple business partners through APIs or directly. For each business partner, the CRM system provides a customized service to support partner's business.

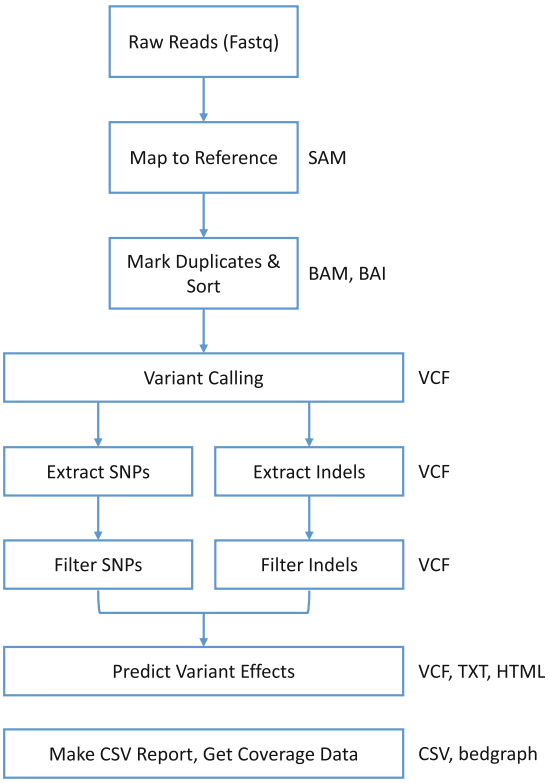

Fig. 2. The next generation sequencing data SNP calling pipeline workflow.

Laboratory Information Management System (LIMS), manages all the gene sequencing laboratory jobs, which include DNA extraction, quality control, DNA sequencing, and etc. DNA sequencing has multiple methods [10], the DNA sequencing-by-synthesis (SBS) technology has four basic steps: library preparation, cluster generation, sequencing, and data analysis. LIMS standardizes the experimental process, schedules experiment tasks, and monitors experiment progress in the laboratory. After laboratory experimental process, the DNA samples will get their sequencing data generated by DNA sequencing equipment such as HiSeq X Ten [11], NovaSeq [12], or iScan System[13], the DNA sequencing data (generally in FASTQ [16] format) will be stored in persistent data storage disks or the network attached storage (NAS) [17] system.

Bioinformatics Analysis System, supports the parallel running of multiple genetic data analysis pipelines to analyze the DNA sequencing data, such as the SNP (Single Nucleotide Polymorphisms) [8] calling analysis pipeline [4] and the DNA insertions and deletions (indels) [5] identifying pipeline can analyze thousands of DNA samples in parallel. The next generation sequencing data SNP calling pipeline workflow is described in Fig. 2 [9]. The SNP calling pipeline applies the Genome Analysis Toolkit 4 (GATK4) [6,7] to perform variant calling, which includes the steps of map to reference, mark duplicates & sort, variant calling, and etc.

Genetic Interpretation System, interprets the SNPs and Indels based on the SNP calling and Indels identifying result. Genetic interpretation should follow standards and guidelines for the interpretation [18], using the interpretation database such as the Locus-Specific Mutation Databases for Neurodegenerative Brain Diseases [25], the Online Mendelian Inheritance in Man, an Online Catalog of Human Genes and Genetic Disorders (OMIM) [21,22], the AutDB [23], and the highly recognized published scientific papers such as Crider KS, Yang TP et al. [24]. The genetic interpretation should also employ polygenic algorithm model [19,20] to evaluate the impact of different genes on phenotypes, because many phenotypes are associated with multiple genes. Since the bioinformatics analysis can analyze thousands of DNA samples in parallel, therefore, the genetic interpretation system is required to have the ability to interpret thousands of DNA samples in parallel, and generate reports automatically in html or pdf format. At the same time, the genetic interpretation is required to interpret and generate multiple different types of genetic reports such as disease risks, nutrition, safe medication, monogenic hereditary disease, and so on to support different business requirements.

Factory's Order System, accepts the orders for producing customized nutritional products. The product orders are based on the analysis result of different people's genetic interpretation data, diet data, and sports data. The product order describes clearly which kind of product to be produced including the nutritional ingredients to be contained in the product, the nutrient contents of the product and so on. The packing of each product is also customized that, the name of the corresponding customer will be printed on the box of the product. The produced customized nutritional products will be posted to customers respectively from the factory, and the customers will be notified the production and posting status information through the e-commerce system.

4 Customer Relationship Management System Implementation

The CRM system supports both the:

- business to customer service, and
- business to business service.

The CRM connects with the E-commerce system to provide business to customer service, and connects with the business partner's business management systems to provide business to business service.

Additionally, not all the business partners (especially the small business partners such as a private mom and baby store) have their own business management system, therefore, the CRM system opens online accounts for different small business partners. Suppose Kidswant is one of the small business partners, then the CRM will open an online account for Kidswant; through the online CRM account, Kidswant can apply for DNA and nutrition products for sale, monitor Kidswant's customers' DNA testing status and customized nutrition product producing status.

The CRM system also supports sales management with the functions of:

- sales' channels management;
- business partner management;
- salesperson management;
- contract management;
- sales task management;
- sales accounting management;
- product inventory management;
- customer management.

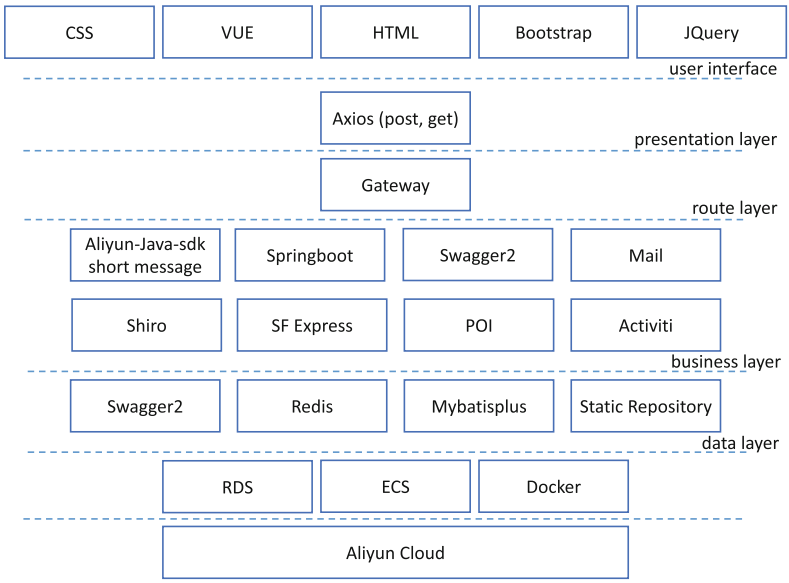

Fig. 3. The technical architecture of CRM system.

Figure 3 demonstrates the technical architecture of the CRM system. The CRM is implemented in Alibaba cloud [26] environment, using elastic compute service (ECS) [28] as system server and relational database service (RDS) [27] as database. Above the computing and storage layer:

- MyBatis-Plus [33] is a persistence database framework used to support for SQL, procedures and mappings, MyBatis-Plus provides enhanced and efficient operations for MyBatis;
- Redis [31] is used to cache the user login session and shopping cart;
- Swagger2 [32] is used to design and document the APIs, so that different layers of the system can communicate through standardized APIs;
- Activiti [39] is a lightweight workflow business management engine providing business process approval service;
- Shiro [38] is a security framework used to provide authentication, authorization, session management, and the other security services;
- SF express service is the API that provided by the express company SF, through which the customer can order express service from home or office online;
- Aliyun Java sdk short message is the API that provided by Aliyun, through which a company can call the API and send short messages to customers;
- Spring cloud [29] is used to host distributed microservices [37], and each microservice is implemented by Springboot [30];
- Spring cloud gateway [34] provides simple and effective way to route to the APIs provided by the business layer such as Activiti, Mail and etc, all of which provide external services through swagger standardized APIs;
- Axios [35] is used to provide Promise based HTTP client for the browser and Vue [36] javascript framework.

The user interface of the CRM is developed with Vue, BootStrap, JQuery, HTML and CSS, and the user interface can adjust to different equipment (mobile phones, pads, and computers).

Figure 4 describes the system architecture of the CRM system, which provides primarily the business service and the report service respectively:

- The business service focuses more on the CRM business part, such as the sales management, customized nutritional product orders. The CRM B to C business service primarily provides services, such as customized nutritional product order process to customers, sales management, customer management, business partner management to sales and product managers. The CRM B to B business service opens APIs to connect with business partner's business system to provide services, such as accept the customized nutritional product order from business partner, place order to the factory to produce the customized product, tell the posting status of the customized product.
- The report service focuses more on the genetic testing report and the corresponding nutritional solution report part. The CRM B to C report service transfers the genetic testing reports and the corresponding nutritional solution reports to E-commerce system and then to customers. The B to B

report service provides genetic testing reports and the corresponding nutritional solution reports to business partner's business systems.

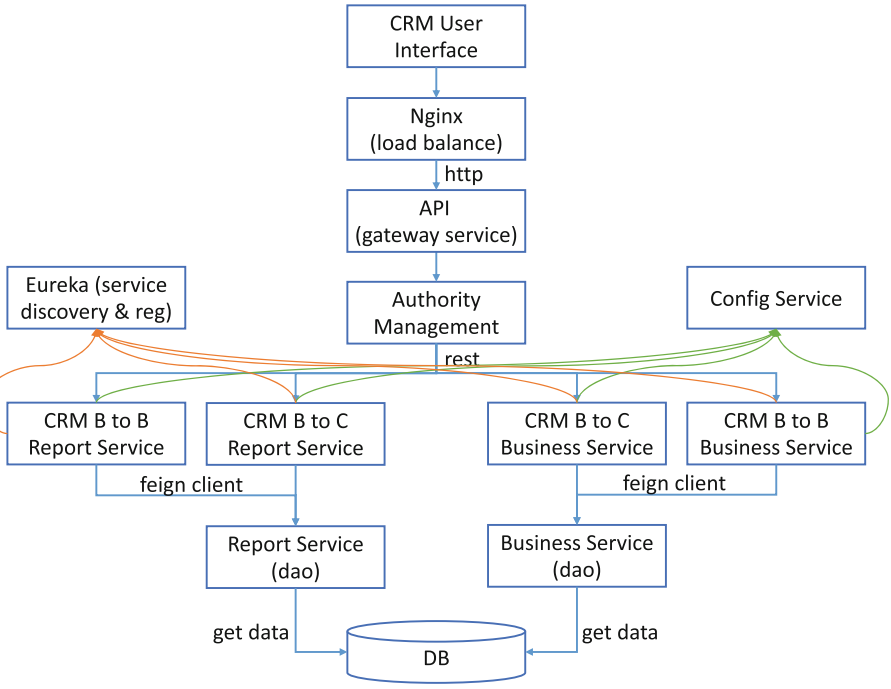

Fig. 4. The system architecture of CRM system.

All the services (such as CRM B to C business service) mentioned above are deployed as microservices which should be registered in Eureka (service discovery & register) so that to be discovered and used through port and IP address. Config service provides a properties configuration place for microservices-side and client-side across the whole system environments. Feign is used to write java http clients to exchange data. Nginx is in charge of the load balance service. The API (gateway service) distributes the business requests to different microservices. The Authority Management module makes sure the data access is authorized and secured.

The CRM system has been implemented and delivered online providing personalized nutrition services efficiently and successfully. For instance, to now the maximum one-day order number is 1008, under the management of the CRM, the nutrition factory has produced the 1008 personalized nutrition products and posted the products to customers in different areas in one day successfully.

5 Conclusions

People's nutrition demands differs from individual to individual due to the differences of DNA and lifestyle, therefore, in this paper, we first introduce the concept of personalized nutrition, then we describe the personalized nutrition service business process based on nutrigenomics, nutrigenetics and nutrition science. Finally, we give the technical solution and deployment of a customer relationship management system to support the personalized nutrition service.

The CRM system can provide both business to customer and business to business services, connecting with the customers, genetic testing laboratory, and nutrition factory to produce personalized nutrition products efficiently. The CRM system has been working online successfully and has provided services for tens hundreds of thousands of customers.

Concerning future work, the CRM will further provide more functions including monthly sales data statistics, personalized nutrition products consumption status forecast, customer data mining and etc.

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