DEVELOPMENT OF RECOMMENDATION FUNCTIONS FOR FOOD SUPERMARKET E-COMMERCE SYSTEMS

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Introduction. Currently, recommendation systems have become widely used to increase sales volumes, providing customers with the convenience of choosing products or services based on their personal preferences. The task of implementing recommendation functions in e-commerce systems is to determine methods for obtaining and analyzing customer preference data. With the help of these methods, the system automatically generates various types of recommendations for customers, suggesting product purchases.

The analysis of the studies presented in the monographs [1, 2] and articles [3–5], with a description of recommendation methods, leads to the conclusion that most of them focus on specific, limited domains. These are primarily related to services such as movie [3], music playlist creation [4], and book recommendations [5]. In this regard, it is of practical interest to explore the implementation of recommendation functions for food supermarket e-commerce systems.

The object of the research is the process of selling food products, which is carried out through the e-commerce system of the supermarket. This system manages the registration of users (customers), who can be conditionally divided into two types:

– customers who order food products and receive them at pickup points or through a delivery service;

– customers who purchase food products using individual loyalty cards, which are issued in the supermarket upon their registration in the system.

The system tracks all purchases of registered customers and the availability of food products on the supermarket shelves.

The purpose of the study is to explore the practical implementation possibilities of recommendation methods in e-commerce systems for food supermarkets

Classification of Recommendation Methods. To explore the options for implementing recommendation functions, in accordance with [1–5], we will examine the classification of recommendation methods to determine their suitability for use in e-commerce systems for food supermarkets (fig. 1).
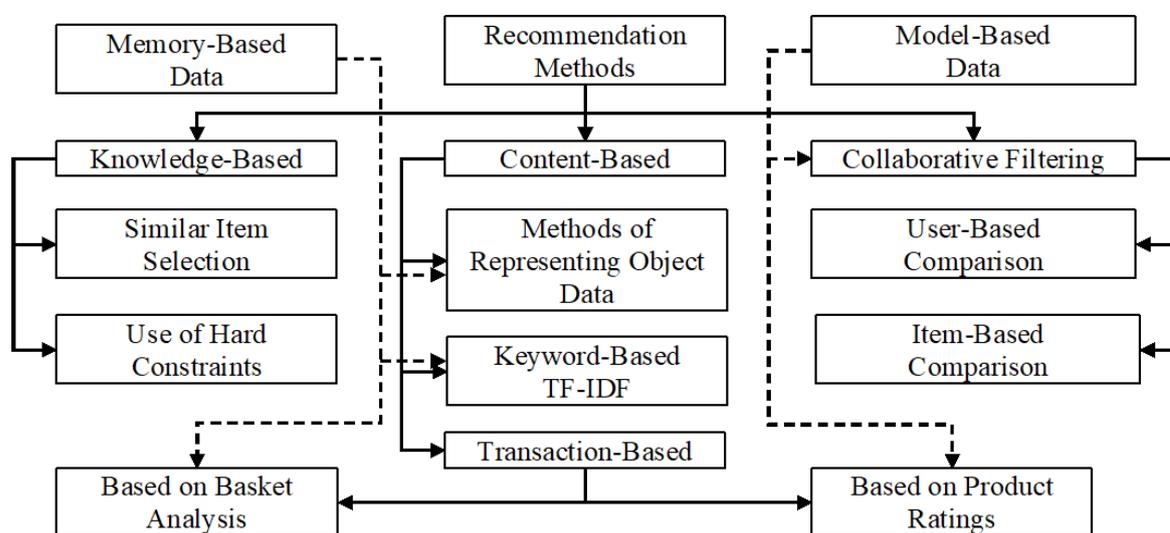

Fig. 1. **Classification of recommendation methods**

Based on the presented classification approach, three recommendation methods can be identified:

– knowledge-based methods, which use expert knowledge or strictly defined rules to generate recommendations;

– content-based methods, which analyse product properties and generate recommendations based on characteristics that interest the customers;

– collaborative filtering methods, which are based on analysing customer preferences and are determined according to the model of ratings of purchased products.

For another classification approach (fig. 1), the type of information source used to prepare recommendations is applied:

– memory-based methods, where information stored in the e-commerce system's database is used to generate recommendations;

– model-based methods, where the system's interface model is used, which records specific actions of users;

– a hybrid approach, where the methods mentioned above are used together.

Results of the analysis. The analysis of recommendation methods (fig. 1) allowed us to determine their applicability to practical implementation in e-commerce systems for grocery supermarkets (Table 1).

Table 1

Analysis of the possibility of implementing recommendatory methods

Method Type	Knowledge-Based		Content-Based			Collaborative Filtering	
Method	Similar Item Selection Method	Hard Cons-traints Method	Methods of Representing Product Data	Transaction-Based Methods	TF-IDF Rating Methods	User Comparison Method	Item Comparison Method
Data Type	Memory-Based	Memory-Based	Memory-Based	Memory-Based	Memory-Based	Model-Based	Model-Based
Information Used for Recommendations	Product Attribute Descrip-tion	Product Attribute Descrip-tion	Product Attribute Description	Purchase History	Annota-tion Key-words	User Rating Comparison	Rating Comparison of Movies (Books)
Use in Cold Start	Yes	Yes	Yes	No	Yes	No	No
Advantages	Represen-tation of Products by Similar Attributes	Relevant Product Selection	Representation of All Product Attributes	Use of Purchase History	Used for Books and Movies	Recommendations for Similar Users	Recommendations for Similar Products
Disadvan-tages	Requires Detailed Product Informa-tion	Product Set Selection	Depends on the Complete-ness of Product Descriptions	Not Suitable for New Users Without History	Requires Creation of a Keyword Database	Not Suitable for New Users of the System	Not Suitable for New Users of the System
Decision on Use	YES	YES	YES	YES	NO	NO	NO

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Based on the results of the analysis, it was concluded that collaborative filtering methods are not suitable for implementation. This decision is based on the fact that food products are in everyday demand. Shopping carts contain a large number of items, and customers do not have the time to assess each of them, unlike evaluating movies, music tracks, or books.

When making decisions about the use of methods, "the cold start" problem was taken into account. This issue arises when there is no data available to

determine the preferences of new customers, making it difficult to prepare recommendations for the.

Features of the implementation of recommendation methods. A database (DB) of the e-commerce system for the food supermarket has been developed for the study of implementation options for recommendation methods (fig. 2).

For implementing various types of accounting in the DB, the following tables are used: for tracking registered users (clients) of the system, the table "Customer" is used; for tracking food products on the supermarket shelves and their purchases, the following tables are used in the DB: "Customer", "Order", "Shopping_cart" and "Product ".
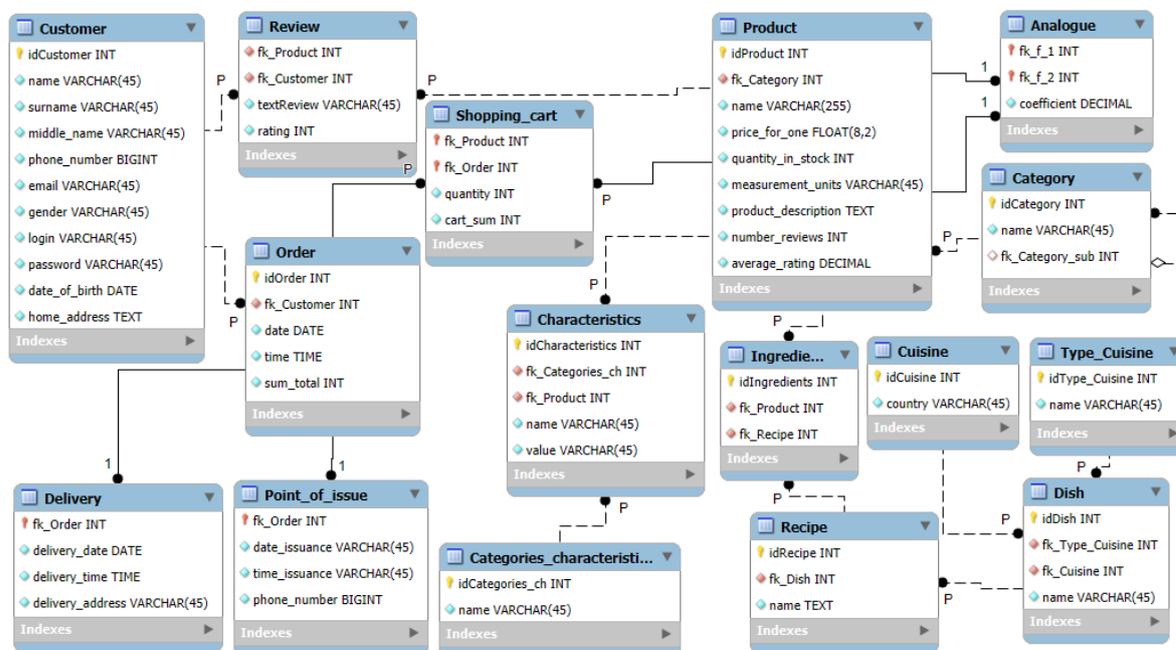

Fig. 2. **E-Commerce System Database**

Implementation of content-based object description methods. For implementing the recommendation functions of the system, two methods have been chosen: the method of representing object data and the method based on transaction analysis.

Object Data Representation Method. Implementation of the object data representation method requires storing the characteristics of each food category in the system DB. For different food categories, the relevant characteristics that customers pay attention to should be defined. An example of defining the category

"canned food" and its characteristics is presented in Table 2. Database tables "Categories_characteristics" and "Characteristics" are used to store these characteristics.

Table 2

Example of defining characteristics for the category «canned food»

Category	Canned food
Characteristics	Manufacturer name, brand, product name, ingredients, weight/volume, country of origin, expiry date, allergens, calories, cooking instructions, shelf life after opening
Types	Meat, vegetable, fish, fruit, baby food, organic, premium
Usage	For main dishes, for snacks
Packaging	Tin can, plastic packaging, Tetra Pak
Additional characteristics:	Allergens: gluten, milk; caloric content per 100g; cooking instructions: heat before consumption; shelf life
Classification	By ingredient type (meat, vegetable), by country of origin (Italian, Ukrainian), by dietary properties (vegan, gluten-free)
Processing method	Sterilization, pasteurization
Dietary characteristics	Vegan, low-carb, sugar-free
Aromatic and Taste Characteristics	Spicy, sweet, umami, savory
Usage recommendations	Pairs well with pasta, use in soups, add to salads
Product history	Production history, quality certifications, partnerships with environmental organizations
Reviews and Ratings	Average rating: 4.5, number of reviews: 100

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The object data representation method is implemented to display food characteristics by categories and also to provide its search. Using the interface, the user selects the characteristics of food products (Table 2), which are used as parameters to form a query for selection from DB. The results of the query are displayed to the client as a search result.

To realise the calculation of food products rating (Table 2) DB table "Review" is used. Using the system interface the client can make a review and rate the product within the realised scale (range). The number of reviews and the calculated average rating value are stored in the DB table "Product", fields "average_rating", "number_reviews" (fig. 2).

Methods based on transaction analysis. In the e-commerce system, the transaction analysis method is implemented as two recommendation functions.

The first function provides non-personalised recommendations, which are determined using Data Mining methods when analysing customers' shopping cart transactions. Based on the analysis, associated food products that are most frequently purchased together are identified. Methods such as Apriori-TID, Apriori-Hybrid and others [6] are used for this purpose.

The second function is realised with the help of a view. This DB object combines table data and contains information about the history of customer orders (fig. 3).
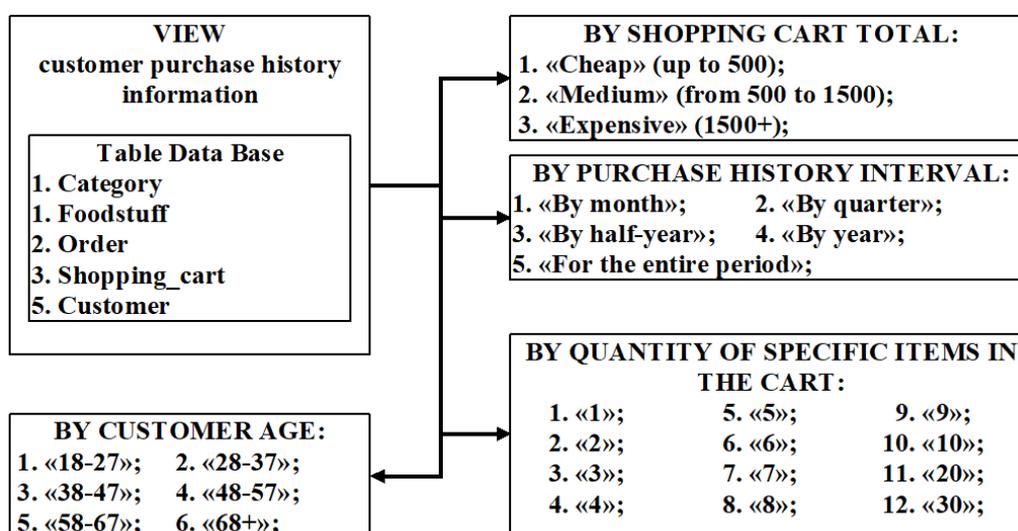

Fig. 3. **View that allows creating customer profiles**

The view combines data from five related DB tables (fig. 3). Queries for data retrieval, including those with grouping, to the created view allow for the creation of a profile for a selected customer or the classification of customers (creating profiles for customer groups) based on specific attributes, such as age, average transaction amount, and the number of items in the shopping cart over a given period or specific categories of food products. Using the created profile, product sets are recommended to customers. Using the created profile, sets of food products that customers have purchased a certain number of times over a specified period are recommended to them.

Implementation of Knowledge-Based Methods. Two methods were chosen to implement the system's recommendation functions: the method of using hard constraints and the method of selecting similar objects.

The method of using hard constraints allows providing the customer with information about sets of products that correspond to recipe ingredients. In the e-commerce system, this function is implemented through a parameter selection interface that displays the ontology of dish preparation according to recipes (fig. 4). The customer sequentially selects the required parameters, ending with the selection of the price, and upon request, receives a recommendation for purchasing a set of products. This function is implemented using the following DB tables (fig. 2): "Cuisine", "Ingredients", "Type_cuisine", "Dish" and "Recipe".
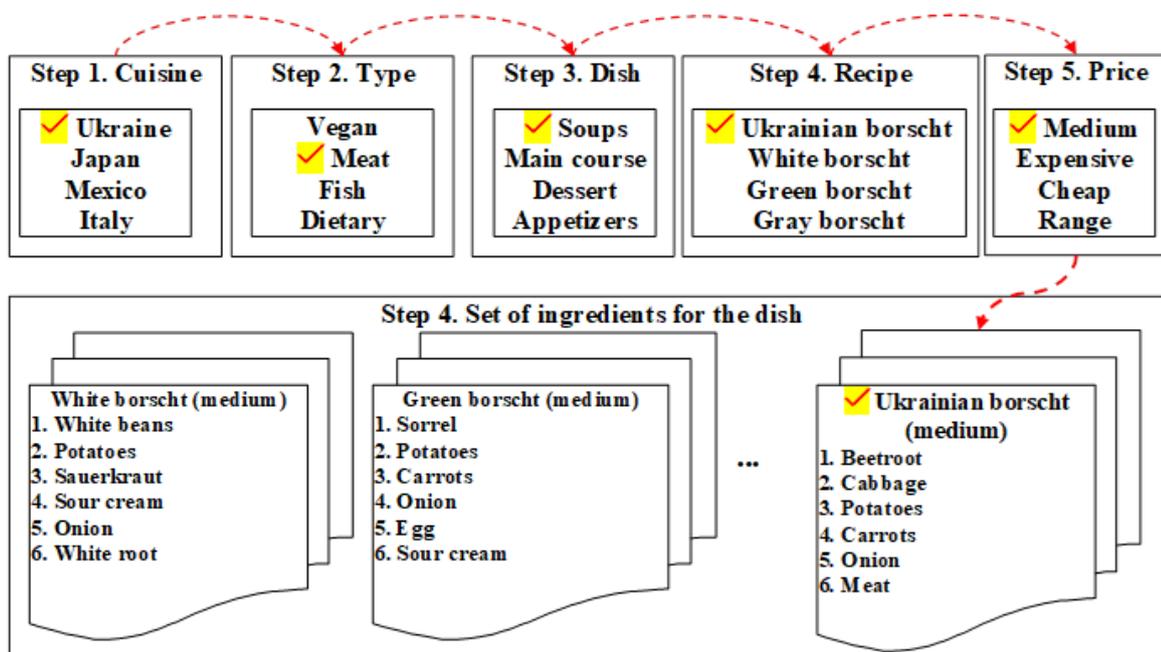

Fig. 4**. Example of building a food ontology in the form of search parameters**

The method of selecting similar objects is implemented as a recommendation function called "Similar Food Products". This function, through a query to the database, allows the selection of food products based on their degree of similarity. To implement this method, the "Analogue" table in the database (fig. 2) is used, where the "k-analogy" coefficient is defined for each pair of food products.

Conclusions. According to the presented classification of recommendation methods, the features of their implementation for the e-commerce system of a food supermarket have been identified. The proposed approach could serve as the basis for developing recommendation functions for e-commerce systems focused on the sale of food products.

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