

COMP9727 Project Design Report

Project: Smart Home Furnishing Recommendation System

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1. Scope

Why a Smart Home Furnishing Recommendation System?

In today's rapidly evolving digital era, the furniture industry faces unprecedented opportunities for transformation. Traditional furniture purchasing methods suffer from numerous pain points: consumers often feel overwhelmed when confronted with a dazzling array of furniture products, unsure which items best suit their home environment and personal preferences; physical stores have limited display space, unable to showcase all possible product combinations; and the professional expertise of sales personnel varies significantly, making it difficult to provide personalized, professional advice.

Modern consumers commonly face the issue of "choice overload" when buying furniture. As durable consumer goods, furniture items are not only relatively expensive but also have long usage cycles. Choosing incorrectly can incur significant replacement costs. Traditional methods for custom buying furniture are very difficult, because only customs know a lot in furniture design and products knowledge can they make a good decision.

To address this, I have decided to create an intelligent home furnishing recommendation system, utilizing artificial intelligence to provide users with precise, personalized recommendations.

Our Goals and Positioning:

Our target market focuses on the mid-to-high-end furniture e-commerce segment, dedicated to solving the core pain point of "scenario-based home furnishing coordination." Our core users are newly middle-class families aged 25-45. They aspire to create tasteful living spaces but are often constrained by limited professional knowledge and time. This demographic possesses relatively high purchasing power and desire. Our recommendation system not only suggests furniture pieces but also delivers complete coordination schemes based on the user's actual space, helping them achieve their ideal home scenario with a "what you see is what you get" approach, eliminating coordination anxiety.

System Design:

Our UI design adheres to the principle of "simplicity without being simplistic," employing a card-based layout and immersive experience design. The main interface features warm, home-like tones, creating a comfortable browsing atmosphere. Product displays utilize high-definition 3D renderings and AR preview functionality. Users can select entire recommended coordination sets, view their overall effect within their own space with a single click, and see a displayed "Overall Coordination Score," facilitating system learning and the generation of new schemes.

Interaction experience is the soul of this system. On mobile, we designed three very useful functions:

First is AR Space Scan. Users just need to scan their room by phone camera. Then the system can know the room size, light and furniture inside. It will make a 3D room model with a score called "Dimensional Fit Score".

Second is 10-Second Style Gene Test. Users can do some simple quiz to show their style preference. Then the system will make a personal "Style DNA Profile". It will also keep tracking user behaviors like likes, favorites, how long they look at products and what they buy, so the system can keep updating their style profile.

Third is Dynamic Inspiration Wall. It is like a community for furniture lovers. There are many pictures of real home decoration from other users. If you like something, you can click it and get similar product recommendations.

Also, we have Conversational Recommendation. Users can just type their needs in daily English, and the system will understand and give good suggestions. This makes the shopping process more fun and interesting.

Our recommendation algorithm uses a mixed method. It includes three main ways:

- Collaborative Filtering: It finds similar users and recommends what they like.
- Content-Based Filtering: It looks at the product features to match user needs.
- Deep Learning: It learns more complex relations between users and products.

Also, we use Reinforcement Learning to let system learn from user feedback and improve itself automatically.

Besides, we also consider time, seasons and fashion trends, so the recommendations can always keep up-to-date and accurate.

Based on study of user behavior and psychology, we think best recommendation list is 5 to 7 products each time. Because too few choices (like 1 to 3) make users feel limited, and too many (over 10) make users feel confused and hard to choose. So 5 to 7 is a good number for users to easily choose.

We also make a real-time data update system. The system connects to big furniture brands and online shopping platforms by API, to get latest products, price changes and stock updates. Also, we follow social media, magazines, websites, to find new home trends and put them into our system. The system will also change recommendation based on holidays, seasons and user feedback, to make sure users always get useful suggestions.

Lastly, we build a strong feedback system. Users can give feedback by likes/dislikes, reviews, buying history, time spent on browsing, etc. The system will analyze the feedback, find out what works and what not, then use the result to improve recommendation.

The system automatically analyzes this feedback data, identifies patterns of success and failure in recommendations, and feeds these insights back into algorithm optimization. We also designed a "Recommendation Reason Evaluation" feature, allowing users to rate the accuracy of the reasoning behind suggestions, helping the system better understand their true needs. Additionally, we conduct regular user satisfaction surveys to gather deeper experiential feedback, guiding product iteration direction.

For new users, we developed the "Quick Portrait Generation" feature. Through an engaging 30-second interactive test (including image selection, scenario simulation, budget range choice, etc.), we quickly gather basic information, lifestyle, aesthetic preferences, and functional needs in a relaxed atmosphere. Simultaneously, we offer a "Reference Cases" function, showcasing real renovation examples from different family types. New users can express their preferences by selecting liked cases. For new products, we have built a similarity calculation model based on product attributes, enabling rapid categorization into suitable recommendation pools, with effectiveness validated through A/B testing.

2. Dataset(s)

Feasibility Assurance:

Our selection of the Kaggle Furniture Sales Data dataset as the system's foundational data source, serving also as the basis for cold-start and prototype validation, is the result of thorough analysis and consideration. This dataset contains rich furniture product information, covering 15 dimensions: price, cost, sales volume, profit margin, inventory, discount, delivery time, category, material, color, region, season, store type, and brand. It provides a comprehensive feature foundation for our recommendation algorithm. The dataset's 2,500+ records cover major furniture categories (beds, chairs, tables, sofas, desks), various materials (wood, metal, glass, plastic, fabric), a wide range of colors, and diverse regional and seasonal distributions. This diversity ensures we can provide personalized recommendations for all user types.

While the Furniture Sales Data dataset provides a solid foundation, we are acutely aware of its limitations:

The dataset is relatively small, potentially unable to cover all furniture types and user demand scenarios.

It lacks user behavior data and review information, limiting the effectiveness of collaborative filtering.

Certain features within the dataset may contain biases, e.g., uneven regional distribution.

To address these limitations, we have formulated a data augmentation strategy: expanding dataset scale via data generation techniques, supplementing user behavior information by integrating external data sources, and establishing a data quality monitoring mechanism to ensure accuracy and representativeness. Crucially, we will continuously collect real user data during system operation, progressively replacing and optimizing the initial dataset.

To validate the system's effectiveness, we designed a comprehensive user simulation process. Simulated users cover diverse age groups, income levels, family structures, and lifestyles, including typical profiles like young professionals, newlyweds, nuclear families, and empty nesters. Each simulated user has detailed background settings: living environment, budget range, aesthetic preferences, functional requirements, etc. By having these simulated users undergo realistic purchase decision-making processes within the system, we can collect vast amounts of behavioral data, analyze recommendation effectiveness, identify potential issues, and continuously refine the algorithm. This simulation not only helps uncover and resolve problems before launch but also provides invaluable data support for the system's ongoing improvement.

3. Method(s)

Our recommendation algorithm employs a hybrid strategy, leveraging the strengths of three mainstream algorithms: collaborative filtering, content-based filtering, and deep learning.

After we did some deep study about user behaviors and psychology, we decided to recommend 5 to 7 items each time. This number is from a psychology rule called “Magic Number 7 ± 2 ”, which means people can remember around 7 things at same time. If we show too few items, like only 1 to 3, users may feel they don't have enough choices and miss better options. But if we show too many items, like more than 10, users will feel confused and tired to choose. So we think 5 to 7 is a good number, not too much, not too little.

We also built a very complete real-time data update system. This system makes sure users can always see the newest and hottest furniture products. It connects with famous furniture brands and shopping websites by API, to get latest product information like new arrivals, price changes, and stock updates. Also, we check social media, magazines, and design websites to find newest furniture trends, and add them into the recommendation system. The system will also change the recommendation based on holidays, seasons, user feedback and other reasons, so the recommendations are always useful and up-to-date.

We also have a strong feedback system. Users can give feedback in many ways, such as like or dislike, writing reviews, their purchase history, and how long they browse the products. Our system will collect these data, analyze them, and find which recommendations are good and which are not. Then the system will improve the recommendation based on these results. We also made a feature called "Recommendation Reason Evaluation", which lets users rate whether they agree with the reason behind the recommendation. This can help the system understand user needs better. Besides, we also do user satisfaction surveys regularly to collect more deep feedback, so we can improve the product in future updates.

For new users, we developed the "Quick Portrait Generation" feature. Through an engaging 30-second interactive test (including image selection, scenario simulation, budget range choice, etc.), we quickly gather basic information, lifestyle, aesthetic preferences, and functional needs in a relaxed atmosphere. Simultaneously, we offer a "Reference Cases" function, showcasing real renovation examples from different family types. New users can express their preferences by selecting liked cases. For new products, we have built a similarity calculation model based on product attributes, enabling rapid categorization into suitable recommendation pools, with effectiveness validated through A/B testing.

4. Revenue Model

Our business model adopts a diversified monetization strategy to ensure sustainable development. Primary revenue streams include:

Commission Sharing: Partnering with furniture brands and e-commerce platforms to earn commissions from finalized orders.

Advertising Revenue: Offering precise ad placement services for premium brands.

We also have **Membership Services**. For high-end users, we provide some special services, like talking to professional designers and getting priority recommendations.

We also provide **Data Services**. We can give furniture companies useful reports, such as market trend analysis and user needs data.

We also have a paid service called "Virtual Renovation". Users can use VR to see the full effect of their room after buying furniture. This helps them make better decisions before they buy.

This kind of diversified revenue model is very helpful. It can reduce the risk of only having one way to make money. At the same time, it also creates value for many partners.

In fact, this furniture recommendation system is not just a technology product. It is more like a new way of shopping for home furniture. It combines the strong power of artificial intelligence with a user-friendly experience. Every user can enjoy a special shopping journey. We believe, with our carefully designed algorithms, strong technology, and continuous updates, this system will become a very important part of digital transformation

in the furniture industry. It can bring good profits to investors and make users enjoy a better home life.