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COLLABORATIVE FILTERING RECOMMENDATION ALGORITHMS

In the digital economy, recommendation systems are vital as they help users find personalized solutions among vast amounts of data. Their implementation enables companies to increase user satisfaction, boost sales, and retain customers. One of the primary approaches to generating recommendations is Collaborative Filtering (CF), which provides recommendations based on the experiences of other users and object data.

Collaborative Filtering is a method based on analyzing user interactions with the system. It leverages shared user behaviours to identify which objects might be of interest. There are two main approaches to CF:

1. User-based Collaborative Filtering.

This approach identifies users with similar preferences or tastes. Recommendations are generated based on their ratings. The algorithm is structured as follows:

- similar users are identified using the Pearson correlation coefficient;
- a subset of the most similar users (neighbourhood) is selected;
- recommendations or predictions are generated based on a combination of ratings from this subset [1].

2. Item-based Collaborative Filtering.

Instead of searching for similar users, this method analyzes the similarity between items the user has already rated and those that might be recommended. This method is more efficient in large-scale systems due to reduced computational complexity, focusing on analyzing items rather than users [2].

Collaborative Filtering is widely used in systems like Amazon and Netflix. For example, Amazon utilizes Item-based CF to recommend products based on users' purchase histories, improving the relevance of recommendations [3]. Meanwhile, Netflix applies User-based CF to suggest movies, considering users' viewing and rating histories.

CF can also be applied in areas such as healthcare (for personalized treatment recommendations), education (for adapting training materials) and recruitment (for matching candidates with job opportunities).

Among the advantages of Collaborative Filtering, it is worth noting that this approach does not require prior information about object content, such as product or movie descriptions. In addition, the method facilitates the discovery of new content that may not be immediately obvious to the user, thereby broadening their interests [3].

However, this approach has significant disadvantages:

1. Cold start problem. The system performs poorly for new users or objects due to a lack of prior data for analysis.
2. Sparsity problem. Often, there is insufficient data in large "user-object" matrices, making computations challenging.
3. Scalability problem. As the number of users and objects grows, computation times increase, necessitating additional optimizations [4].

Despite its shortcomings, collaborative Filtering is gaining traction and continues to evolve thanks to the integration of advanced machine-learning techniques. For example, hybrid recommender systems that combine CF with content- or demographic-based filtering aim to overcome the limitations of stand-alone methods. In addition, deep learning has shown potential in solving problems such as cold start and sparsity problems by learning hidden representations of users and elements.

Conclusion: Collaborative Filtering is one of the most effective approaches for building personalized recommendation systems, as it considers other users' preferences and does not rely on object content. However, CF faces several challenges, such as cold start, sparsity, and scalability problems, which require further research and integrating hybrid approaches to improve efficiency. Despite these limitations, CF remains the foundation of many modern systems, such as Amazon and Netflix, demonstrating its effectiveness in real-world applications.

References

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