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Everyday, millions of people log in to Netflix with no idea what they're actually going to watch. If they just finished an old series or just don't know what they're going to watch, the first course of action is to scroll through the shows and movies that Netflix recommends, based on a percentage match. Some may wonder where this match comes from, or how it is calculated. Essentially, this is a recommender system technique called Collaborative Filtering. Collaborative Filtering is very prevalent in today's world in order to make automatic recommendations about a person or their interests based on the preferences of similar people or the past behavior of that person. In order to truly understand Collaborative Filtering, it is important to understand how Collaborative Filtering works, how it is applied in today's world, and some of the challenges facing Collaborative Filtering.

The first aspect of understanding the applications and challenges of Collaborative Filtering is to understand how it works to begin with. Collaborative Filtering (CF) uses past actions by users with similar interests as the current user in order to predict and recommend items for the current user (Su and Khoshgoftaar, *A survey of collaborative filtering techniques*). The rationale behind this approach is that if the current user has similar tastes or preferences to other users, then recommendations for these users may be relevant or of interest to the current user as well. By finding patterns in what similar users prefer, it is possible to create recommendations for each user based on the common interests (He et al. *Neural collaborative filtering: Proceedings of the 26th International Conference on World Wide Web*). For example, if a user prefers to watch comedy movies on Netflix, and other users that also watch a lot of comedy movies watch a particular movie that the current user hasn't watched, then it would seem likely that the current user would be interested in watching that particular movie.

Collaborative Filtering can also use a user's past preferences or interests to make predictions about what to recommend to the user in the future. The process can be done using a matrix that keeps track of user-item ratings for many users and using that matrix to make predictions on what users should be recommended and what items (Ricci et al. *Chapter 1 Introduction to Recommender Systems Handbook*). With a general understanding of how Collaborative Filtering works, let's look at some applications of Collaborative Filtering and how it can be useful.

In addition to the example mentioned above, let's consider some other applications of Collaborative Filtering. Since this approach can also use a user's past actions to make a future recommendation, this is another example to consider. By keeping a memory of past actions or purchases by a user, memory-based Collaborative Filtering approaches can make recommendations to the user. If a user buys one book in a series, then it would make sense for the Collaborative Filtering algorithm to recommend the next book in the series to that user based on their past actions (Su and Khoshgoftaar, *A survey of collaborative filtering techniques*). As well as this application and the other mentioned previously, this can also be useful for social media sites. An example of this is Reddit, where users subscribe to subreddits based on common interests. A user may join a subreddit for news about the economy, or a subreddit for news about football. If many users in one subreddit are also subscribed to another subreddit, then Collaborative Filtering may recommend that other subreddit to members of the original subreddit that aren't already subscribed to the second. By using the preferences and interests of similar users by looking at users of similar subreddits, it is possible for Reddit to recommend subreddits of interests to users. A similar approach can be employed with Youtube, by looking at past video history and what other users with similar video histories watch, it is possible to use Collaborative Filtering to create a recommendation system to promote videos to a user. Despite all of these

useful applications of Collaborative Filtering, there are also some drawbacks to the approach that must be addressed.

While there are many benefits to using Collaborative Filtering, there are also some challenges to consider. One common challenge is that the user-item matrix will be very sparse, since there are many users and most users only rate a small fraction of the items. This data sparsity can reduce the performance of the recommendations produced or it can make the process more computationally intense than it needs to be. A possible solution would be to reduce the dimensionality of the data through techniques such as Singular Value Decomposition, although this may reduce the accuracy of the system overall in exchange for lower computational costs (Su and Khoshgoftaar, *A survey of collaborative filtering techniques*). Another possible challenge is when a new user enters the system and doesn't have any prior actions. This is a quintessential "cold start" problem where the system has no information on the user or their past actions or preferences, so it is hard for the system to create a recommendation for that user. Once this user starts interacting with the system, then it is possible to determine user preferences for recommendations, but it remains difficult to create recommendations without any prior knowledge about the user (Terveen and Hill, *Beyond Recommender Systems: Helping People Help Each Other*). While most users can be grouped by preferences or actions, some users' opinions don't consistently agree or disagree with any particular group at all, making it difficult to create a recommendation for those users. The lack of consistency in opinion or preference for these users is a problem that is difficult to solve for Collaborative Filtering (Yu et al. *Probabilistic Memory-Based Collaborative Filtering*). Another possible challenge is ensuring that recommended items are acceptable and appropriate to recommend to people. For example, if a user is under 21 and has similar purchases to people who are above 21 and buy alcohol, then it

is important that the system does not recommend an alcoholic purchase to the user under 21, as this may create legal issues for the website or system that is using Collaborative Filtering. As such, unsupervised Collaborative Filtering may present challenges in making sure that users only see items that are appropriate for them to see.

Despite some of the challenges with Collaborative Filtering, its applications are extremely easy to see in today's world, and almost everyone has interacted with a Collaborative Filtering system in their daily lives. As data on preferences and opinions becomes more widely available, it seems clear that Collaborative Filtering is an approach that will only become more common in the future. For many different kinds of companies, from commerce companies like Amazon to social media companies such as Reddit and Youtube, Collaborative Filtering is an important system to help users find the best items or content to fit their needs. As time goes on, more solutions to the challenges of Collaborative Filtering will be discovered, leading to more efficient and accurate recommendations in the future.

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Works Cited

He, Xiangnan, et al. “Neural Collaborative Filtering: Proceedings of the 26th International Conference on World Wide Web.” *ACM*, ACM, 1 Apr. 2017, https://dl.acm.org/doi/10.1145/3038912.3052569.

Ricci, Francesco, et al. *Chapter 1 Introduction to Recommender Systems Handbook - Unibz*. https://www.inf.unibz.it/~ricci//papers/intro-rec-sys-handbook.pdf.

Su, Xiaoyuan, and Taghi M. Khoshgoftaar. “A Survey of Collaborative Filtering Techniques.” *Advances in Artificial Intelligence*, Hindawi, 27 Oct. 2009, https://www.hindawi.com/journals/aai/2009/421425/.

Terveen, Loren, and Will Hill. *Beyond Recommender Systems: Helping People Help Each Other - Grouplens*. http://files.grouplens.org/papers/rec-sys-overview.pdf.

Yu, Kai, et al. “Probabilistic Memory-Based Collaborative Filtering.” *Reserachgate.net*, IEEE, https://www.researchgate.net/profile/Volker-Tresp/publication/3297245_Probabilistic_Memory-Based_Collaborative_Filtering/links/0046351eb81f03630f000000/Probabilistic-Memory-Based-Collaborative-Filtering.pdf?origin=publication_detail.