# Analyzing Fashion Trends across Popular Culture Media Sources and the Subsequent Trend Classification of Secondhand Clothing Articles

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**Abstract**

The world of secondhand clothing resale suffers from much greater ambiguity and variety in their product than their fast fashion competitors, which creates a disconnect between the consumers and the product. Without standardized information about the product for sale, automated marketing techniques like user recommendations become more difficult. As many secondhand clothing retailers rely on individual sellers utilizing their platforms, acquiring standardization information across product listings is nearly impossible. Certain machine learning techniques might provide the ability to process these product listings in a fashion conducive to better marketing. By creating a recommendation system for products, consumer behavior and demand can be better processed and understood to ease user experience. More specifically, this research proposal suggests the use of reinforcement learning to better grasp user preferences, and then subsequently cluster similar users to provide recommendations based on the reactions of the group. Future research into these methods could aim to derive meaning from the recommendations given to various users, such as identifying trends in fashion.

## 1. Introduction

With the emergence of marketing techniques employing social media, fast fashion is positioned to excel in the current marketplace. Top clothing brands often sponsor or provide content creators with merchandise that ends up being viewed by hundreds of thousands of people, which leads to an influx of sales. Predicting the next fashion trend and promoting personalized clothing options will always be lucrative endeavors. However, in order to curb the socially and environmentally reprehensible trend towards fast fashion, similar tools and techniques must be developed for secondhand clothing distributors.

While secondhand clothing retailers are unable to exercise a similar marketing strategy of driving up demand by supplying the content creators with the merchandise, they can more effectively market their existing merchandise by recognizing trends among user groups. Herein lies a potential solution: utilizing similar social media algorithms to gauge and group user preferences, content can be better marketed to users. This proposal suggests the development of a social media app for secondhand clothing that gathers user interaction data from individual articles, perhaps through a swiping interface. Subsequently, the app would cluster users into groups based on the interaction, and update the clothing displayed to be in line with user group preferences.

## 2. Related Works

A great deal of research into recommender systems already exists, including a crucial survey paper from Afsar, et al. (2022), which provides an extensive background and framework for understanding reinforcement learning-based recommenders. One limiting factor is the lack of exploration into bandit-based solutions. Bandit problems are a type of sequential decision-making problem in which to maximize reward, one must go between exploitation, choosing the best paying outcome, and exploration, trying out different actions to learn more (NLP Student, 2021). This limitation is covered by Wu, et al. (2017). They propose a bandit-based solution for improving long-term user engagement for content recommendation. The Afsar and Wu papers provide a strong foundation for exploring the potential applications of reinforcement learning for this proposal.

Another crucial aspect of this proposal lies in the utilization of user clustering. Pandya, et al. (2016) address the potential value of clustering users for a recommendation system. They demonstrate that identifying and grouping similar users, also known as neighbors, is a valid method in the pursuit of a recommender system. By combining successes from both reinforcement learning and user clustering in recommendation systems, it is possible to create a compelling recommendation system for the secondhand clothing retailer's problem.

## 3. Proposed Design

In order to ensure the proposed technology can meet the intended goals, the crucial technology must be individually addressed. Key elements to be considered include app construction and data collection, reinforcement learning-based recommender system implementation, and user clustering. These design aspects are the crucial building blocks that, in tandem, will address the expansive ambiguity in secondhand clothing retail.

### 3.1. App Construction & Data Collection

In order to maximize user engagement, a well-constructed app is crucial. In some sense, the success of this project is linked to crowd sourcing methods, as user engagement is the primary tool for understanding the clothing data. As such, user interface (UI) will be modeled after familiar social media apps that use a swiping feature. David and Cambre (2016) explore swipe logic, attributing the UI feature's success to the novel control over viewing pace. Users will be able to swipe through product listings and engage as they fit. This user engagement data will then be collected for use in the recommender systems.

Metrics for or aspects of user engagement that might be collected include but are not limited to: time spent on the listing, number of photos of the listing viewed, comments on the listing, whether the listing was saved and/or liked by the user, whether the seller's page viewed, etc. This data will then both be attributed to the user and to the listing for subsequent use in the recommender systems.

### 3.2. Reinforcement-Based Recommender System

After a user has swiped through a certain number of product listings, the recommender system will be able to better understand user preferences. This problem will be initially handled as a bandit problem. In essence, there will be an exploration phase to start, which will vary depending on the user and the stage of knowledge and data on the product listings. As the user progresses in using the app, the recommender system will periodically shift to an exploitative stage, in which clothing

will be recommended primarily to maximize user engagement, as determined by earlier described metrics.

### 3.3. User Clustering

The final stage of improving the recommender system will rely on grouping similar users. By generating user data on similar product listings, users can be compared against one another based on their preferences. This could happen via several clustering algorithms; however, the density-based spatial clustering (DBSCAN) algorithm is recommended for its ability to handle noisy data and compatibility with other methods to determine the best number of clusters. Once users are clustered or grouped, clothing that some users engaged strongly with might be recommended to another user in the group. This will allow for a greater number of product listings to be evaluated by users without necessitating that a user evaluate or engage with every single article.

## 4. Anticipated Results

The eventual goal of any marketing tool is to increase sales. Therefore, a primary method of gauging the results of the recommender system might include evaluating the impact on sales. By comparing a control group, who uses the current recommendation systems in place, to test groups who utilize the new recommender system, we can gauge the impact on sales. However, it is important to note that a failure to produce sales is not indicative of a failure of the recommender system. While we might expect an appreciation of the product to yield higher engagement and subsequently higher sales, we could equally expect higher engagement to stem from distain or curiosity, neither of which would produce the desired sales. Therefore, it is equally important to also gauge the success of the recommender system off the amount of engagement with the product. By comparing the average engagement of the control group with that of the test group, once the test group has had sufficient interaction to a primarily exploitative stage of the recommender system, will provide crucial data in understanding the success of the recommender system.

## 5. Conclusion

The expansive applicability of this research could serve many business endeavors moving forward. As the online marketplace continues to dominate the business landscape, it is imperative that companies who emphasize ethics in their practice are supplied with the tools to remain competitive. It is for that reason that whenever possible, research should be invested to combat the unique problems posed to companies who operate under stricter ethical business practices. In developing the recommender system posited by this proposal, the unique secondhand clothing marketing problem which is centered about a highly diverse and difficult to categorize product base might be averted.

## 6. Future Work

In attempting to bridge the gap between secondhand clothing retailers and fast fashion giants, there exists a plethora of future work to be done. Machine learning techniques are often described as black boxes, such that despite the valid and useful output, it is incredibly hard to describe the process in a meaningful fashion. Research into interpretable machine learning models and image classification models might allow for secondhand clothing articles to be categorized similar to how the fast fashion industry does, leveling the playing field. Upon completion of this research, there might be more immediate directions to take

future work with the methodology used above.

## 7. UVA Evaluation

The preparedness I have gained from UVA's computer science program stems primarily from the balance the department is able to strike between teaching theoretical concepts and encouraging the production of tangible computer science products. The problem-solving skills derived from a hands on computer science project cannot be understated; however, the further I have gone in the program, the more I appreciate the theoretical aspects. In refining my programming abilities, the knowledge of pertinent theoretical concepts has allowed me to view problems in a different manner. Nothing made this more evident to me than being a teaching assistant (TA) for the introductory computer science course. As I progressed in the program, I consistently changed the way I view this class's projects. I can think back to my first year, where I wrote out 64 nested if statements to avoid using a for loop. Thankfully, now I am instead thinking about how different logic structures might affect the time complexity while helping students with the same problem. It might be advantageous to encourage more students to TA, possibly even as part of the curriculum.

## 8. Acknowledgements

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## References

Afsar, M. M., Crump, T., & Far, B. (2022). Reinforcement Learning based Recommender Systems: A Survey. *ACM Computing Surveys*, *55*(7). Retrieved on April 11, 2023, from https://doi.org/10.1145/3543846

David, G., & Cambre, C. (2016). Screened Intimacies: Tinder and the Swipe Logic. *Social Media + Society*, *2*(2), 205630511664197. Retrieved on April 11, 2023, from https://doi.org/10.1177/2056305116641976

NLP Student. (2021, October 23). *The Multi-Armed Bandit Problem*. The NLP Student. Retrieved on April 11, 2023, from https://thenlpstudent.github.io/the-multi-armed-bandit-problem.html

Pandya, S., Shah, J., Joshi, N., Ghayvat, H., Mukhopadhyay, S. C., & Yap, M. H. (2016, November 1). *A novel hybrid based recommendation system based on clustering and association mining*. IEEE Xplore. Retrieved on April 11, 2023, from https://doi.org/10.1109/ICSensT.2016.7796287

Wu, Q., Wang, H., Hong, L., & Shi, Y. (2017). *Returning is Believing: Optimizing Long-term User Engagement in Recommender Systems*. Retrieved on April 11, 2023, from https://doi.org/10.1145/3132847.3133025