

Content Based Movie Recommendation System

N. Pradeep *, K. K. Rao Mangalore, B. Rajpal, N. Prasad, R. Shastri

Department of MCA, School of Computer Science and IT, Jain (deemed-to-be) University, Bengaluru, India.
(*Corresponding Author's Email Address: nikithapradeep11@gmail.com)

ABSTRACT

Recommendation based systems can be used for recommending different web page, books, restaurants, tv shows, movies etc. The aim of movie recommendation system is to recommend movies to different users based on their interests. This helps the user to save time browsing the internet looking for movies from the thousand already existing ones. Content-based recommendation system describes the items that may be recommended to the user. Based on a data set, it predicts what movies a user will like considering the attributes present in the previously liked movies. Recommendation systems can recommend movies based on one or a combination of two or more attributes. While designing a movie recommendation system various factors are considered such as the genre of the movie, the director or the actors present in it. In this paper, the recommendation system has been built on cast, keywords, crew, and genres. A single column is created which will be the sum of all the 4 attributes, and it acts as a dominant factor for this movie recommender system.

Keywords: Content based recommendation, PyCharm, Python, Machine learning, Web application.



Article history: Received: 05 July 2020 Reviewed: 10 August 2020 Revised: 08 October 2020 Accepted: 25 November 2020



Pradeep, N., Rao Mangalore, K. K., Rajpal, B., Prasad, N., & Shastri, R. (2020). Content based movie recommendation system. *International journal of research in industrial engineering*, 9(4), 337-348.

1. Introduction

The enhancement of science and technology leads to make the life more comfortable than older days. The emerging technologies like neutrosophic shortest path [1-5], transportation problem [6-8], uncertainty problem [9-14], fuzzy shortest path [15-18], powershell [19], wireless sensor network [20-27], computer language [28, 29], neural network [30], routing [31], image processing [32] making the products more intelligent and self-healing based. The smart city applications like smart water [33, 34], smart grid, smart parking, smart resource management, etc. are based on IoT and IoE [35-38] technologies. In this manuscript, the recommendation system has been built on cast, keywords, crew, & genres. The recommendation system aims to predict or take users' interests and recommend related items that quite likely are interesting for

them. The growth in the amount of information that is available online and the increase in the number of Internet users has created an overload of information which makes it difficult to find the correct information at the right time. The recommender system solves this problem by filtering the required data from a large amount of information that is generated based on the user's interest or preferences.

Recommender systems are used for recommending products, generating playlists, matchmaking, and a lot more. Recommender systems function with characteristic information and user-item interactions. Characteristic information is the information about the user and the items whereas user-item interaction is the information regarding ratings, the number of purchases, likes of the users, and many more. Based on this, the recommendation system can be developed using collaborative filtering, content-based filtering, or hybrid filtering [39-41].

Collaborative Filtering. This system identifies users with similar tastes and uses their opinion to recommend the same to another user with similar interest. It generates recommendations using information about rating profiles for different users or items. It has been implemented in different applications such as YouTube, Netflix, and Spotify. It is a widely used approach and is used as a part of the hybrid system.

Content-Based Filtering. Content-based filtering methods are done based on user characteristics. This method is used in situations where data is known on an item such as name, location, or description and not on the user. It predicts the items based on user's information and completely ignores contributions from other users as with the case of collaborative techniques. It uses the data that is provided by the user either explicitly or implicitly. When the user provides more content-based filtering mechanisms actions on the recommendations such as content-based recommender the engine becomes more and more accurate.

Hybrid Approach. A hybrid approach is a combination of collaborative filtering content-based filtering, or any other approaches. Hybrid approaches can be implemented by making predictions separately on content-based and collaborative-based approach and later combining them. It increases the accuracy and performance of the recommender systems.

2. Problem Definition

In collaborative filtering, the system combines the interest and preferences of many users. This results in various issues such as cold start, scalability, and sparsity [42]. Cold start problem occurs when a new user or an item enters the system and similar items cannot be detected because of the lack of information. It also requires a large amount of existing data on which the user can make correct recommendations [43]. It is also called the new user problem or new item problem [44, 45]. Chances of new users getting good recommendations on new products will be low because of the lack of rating or purchase history by the existing users.

The problem of scalability occurs because of the huge amount of information that is being generated daily. A large amount of computation power is often necessary to calculate recommendations and how quickly a recommender system can generate a recommendation.

Every active user must have rated very few products or items that are available in a huge database. This prevents the rest of the items from going unnoticed by the rest of the users. This leads to data sparsity.

Content-based filtering techniques normally generate their predictions based on the user information and does not rely on the contributions or ratings from other users as done in collaborative techniques [46, 47]. It helps in building their user profile by providing independence that is specific to that particular user. This makes it easier to scale to a large number of users. The models understand the interests of a user specifically, and recommend items that best matches which are the interest of very few other users. Our system provides a web application to the user in which the user can give their inputs and generate outcomes based on their interest. It also displays the top-rated movies and also the most popular movies among them.

3. Literature Review

After the study of recommending items from some fixed database has been done, two main recommending techniques have emerged which are content-based technique and collaborative technique.

In content-based recommendation, items are recommended which are similar to those provided by the user, whereas in collaborative recommendation users whose tastes are similar are identified to those of the given user and recommends items they have liked. Later with the evolution of the recommender system hybrid method has been invented which merges two or more techniques.

Before the invention of the recommending system, people had to read reviews and choose the movie that best suited their interest or had to randomly choose any movie based on some other criteria. This became difficult as the number of movies that are available online started increasing rapidly.

3.1. Different Researcher's Contributions

Some of the major contributions on the existing movie recommendation systems are discussed in *Table 1*.

Table 1. A literature review on existing systems.

Authors	Years	Different approaches on movie recommendation
Fisk [48]	1996	The author proposed a method where the movie recommendation system is based on the principle of social filtering.
Chen and Aickelin [49]	2008	The authors proposed a model in which artificial immune system technology is applied to collaborative filtering technology.
Choi and Han [50]	2010	The authors proposed a different collaborative filtering approach based on the category correlation of contents.
Son and Kim [51]	2017	The authors proposed a method that uses the multi-attribute network to reflect several attributes when calculating correlations.

Table 2 discusses the different contributions in recommendation system.

Table 2. Literature review on recommendation system.

Author	Year	Different approaches on recommendation system
Basu et al. [52]	1998	The authors proposed a model in which the user likes and dislikes are taken to compute the rating threshold for movie prediction.
Debnath et al. [53]	2008	The authors proposed a hybridization of content-based and collaborative techniques for the recommendation of movies.
Deldjoo et al. [59]	2016	The authors proposed new algorithms for youtube video recommendation systems.
Jannach et al. [54]	2010	The authors proposed the basic concepts of recommendation systems and their recent developments.

Table 3 discusses the different contributions in collaborative and content based approach.

Table 3. Literature review on collaborative and content based system.

Author	Year	Different approaches on Collaborative and Content based system
Basilico and Hofmann [55]	2004	The authors proposed a model in which a unified approach integrates all the available training information such as past user-item ratings as well as attributes of items or users to learn a prediction function.
Liu et al. [56]	2010	The authors proposed a model in which personalized news recommendation system is made by developing an effective information filtering mechanism.
Hameed et al. [57]	2012	The authors proposed different measures, methods, algorithms, and functionalities of the collaborative filtering method.
Uluaymur et al. [58]	2012	The authors proposed a method in which content-based movie prediction is done by merging the user-specific weight using a particular feature set.
Deldjoo et al. [59]	2016	The authors proposed a model that values a technique that is used to analyze the contents of a video to extract a set of stylistic features such as lighting, colour, and motion.

Table 4 discusses the different contributions on filtering techniques.

Table 4. Literature review on filtering techniques.

Author	Year	Different approaches on filtering techniques
Goldberg et al. [60]	1992	The authors introduced the collaborative filtering technique.
Good et al. [61]	1999	The authors proposed a model to alleviate information overload by using Information filtering agents and collaborative filtering.
Adomavicius and Kwon [62]	2007	The authors proposed the similarity based approach and the aggregation function-based approach.
Liu et al. [63]	2014	The authors introduced a new method to provide an accurate recommendation.

The previous recommendation systems had certain gaps in them such as:

- Since it is based on the user ratings, it does not recommend any new product or items.
- Products or items which already exist but have not been rated by any user will not be considered for recommendation to a new user.
- A large amount of computation power is used.

Therefore, this motivates us to provide new model for the society:

- The method of cosine similarity is used to determine how similar documents are, irrespective of their size.
- Every item new and old, rated, and non-rated are recommended to the user based on their input.
- It also displays the top voted and the most popular movies.

4. Description of the Research Work

One of the major problems that exist in the collaborative filtering is that it provides recommendation of items based on user ratings and user preferences. If an item is not rated by any user it can affect the accuracy of the recommendation and the product is not recommended to a new user. Only when adequate information about a user is provided or only if the user has given ratings on any items or products the system is able to identify the user and provide the recommendations. A content-based recommender system overcomes these challenges of collaborative filtering. The recommendation accuracy is not affected as the user preferences are not considered and it provides privacy to the user as they need not share any information about themselves. This system also can adjust its recommendations very fast when different users do not share the same item preference. In the method used the user provides the name of a movie based on which outputs are generated. Ten movies that are similar to the input given by the user will be displayed as output.

4.1. Pseudo Code of Proposed System

Table 5. Pseudo code movie recommendation system.

Steps	Overview
Step 1	Import the dataset and perform the data pre-processing steps.
Step 2	Import Pandas and create count matrix using the count vectorizer method.
Step 3	Using Cosine similarity matrix determines the similarity of documents irrespective of their size.
Step 4	Create a directory setup for the website where the main input field is placed inside the form.
Step 5	Connect the page to flask and render it.
Step 6	In the terminal open the python file and provide the link in the browser.
Step 7	The user enters the movie name and if it is available in the dataset the cosine matrix is calculated and top 10 similar movies are sorted and displayed to the user.
Step 8	If the movie does not exist in the dataset then message regarding the reason for the same is displayed.
Step 9	Five top voted and top five popular movies are also displayed in their respective pages.

5. Result and Discussions

The content-based recommendation is best in situations where there is known data to the item rather than the user as it analyses the attributes of items for generating predictions. *Figure 1* shows the homepage of our website. The user can enter a movie name in the given text box and then click the “Submit” button. The home page also provides two other options for the users, to view five movies based on the popularity and the vote count.

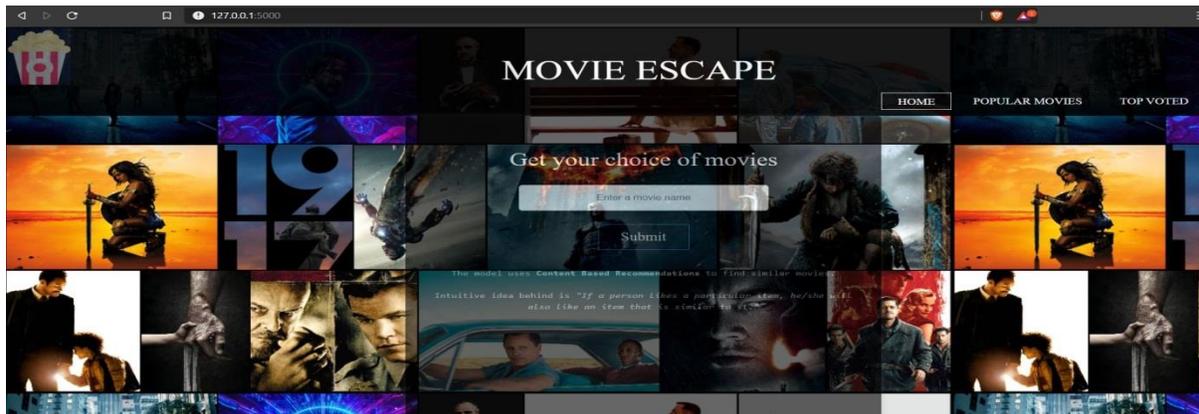


Figure 1. Our proposed movie recommendation system website home page.

In *Figure 2* and *Figure 3*, the recommendations that are given to the users are shown based on the input that they have provided to our proposed system.

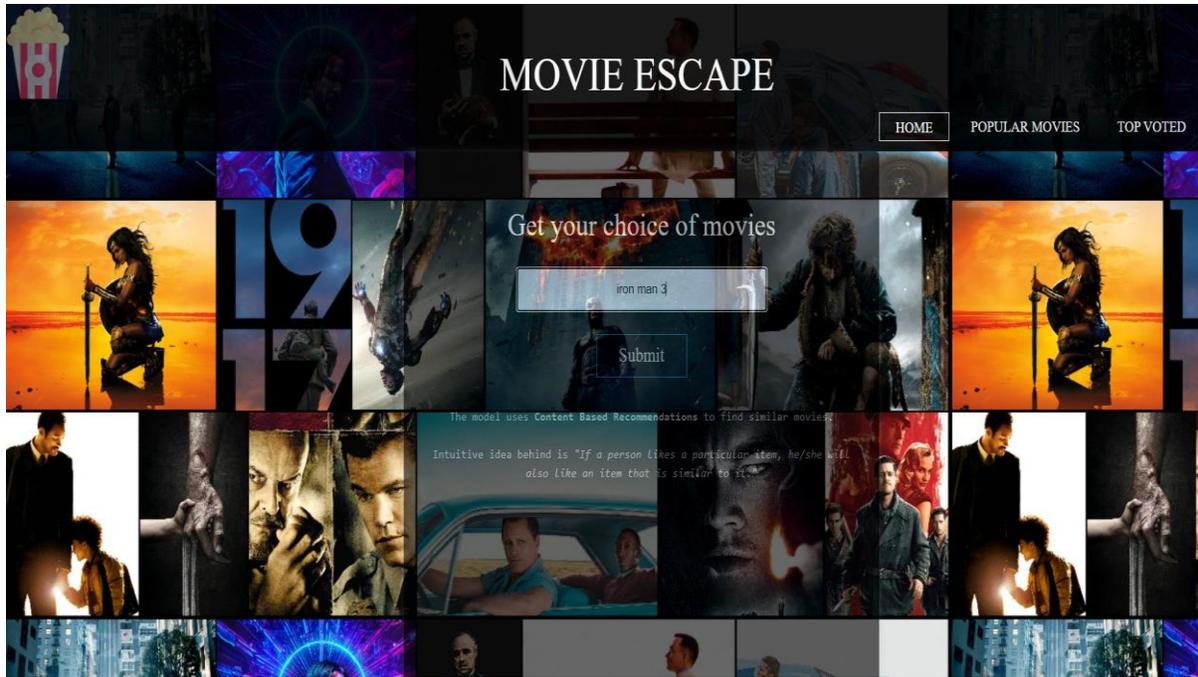


Figure 2. Home page of our proposed movie recommendation system with user input option.

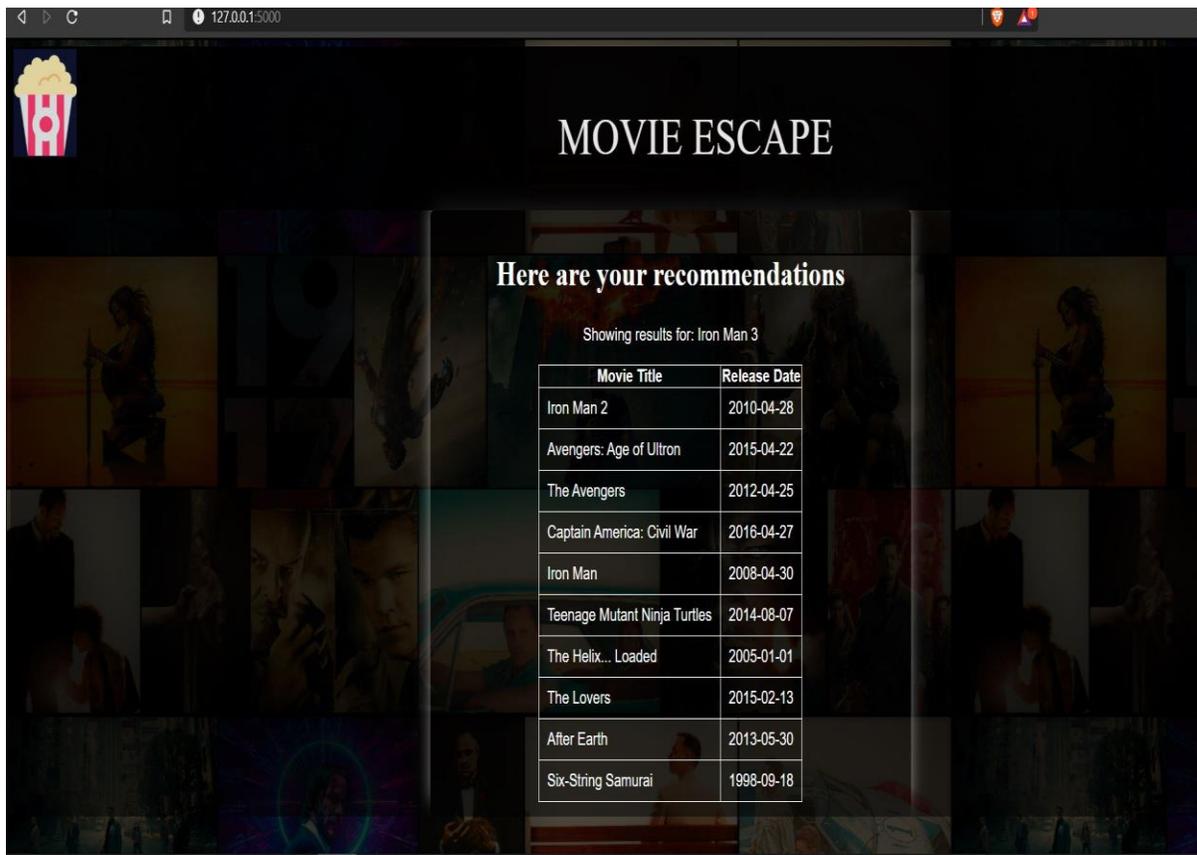


Figure 3. Search result suggestions based on the search input “Iron Man 3”.

Figure 4 and Figure 5 show the popular movies of all time and top voted movies by the users.

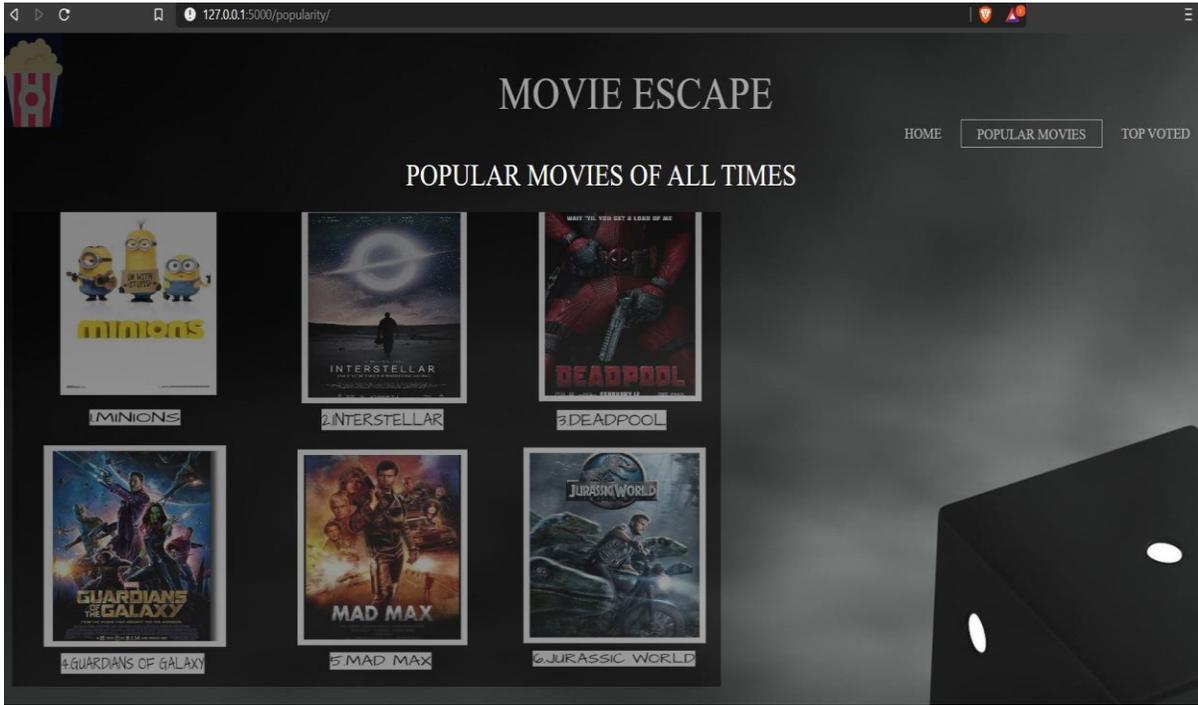


Figure 4. Popular Movies of all time.

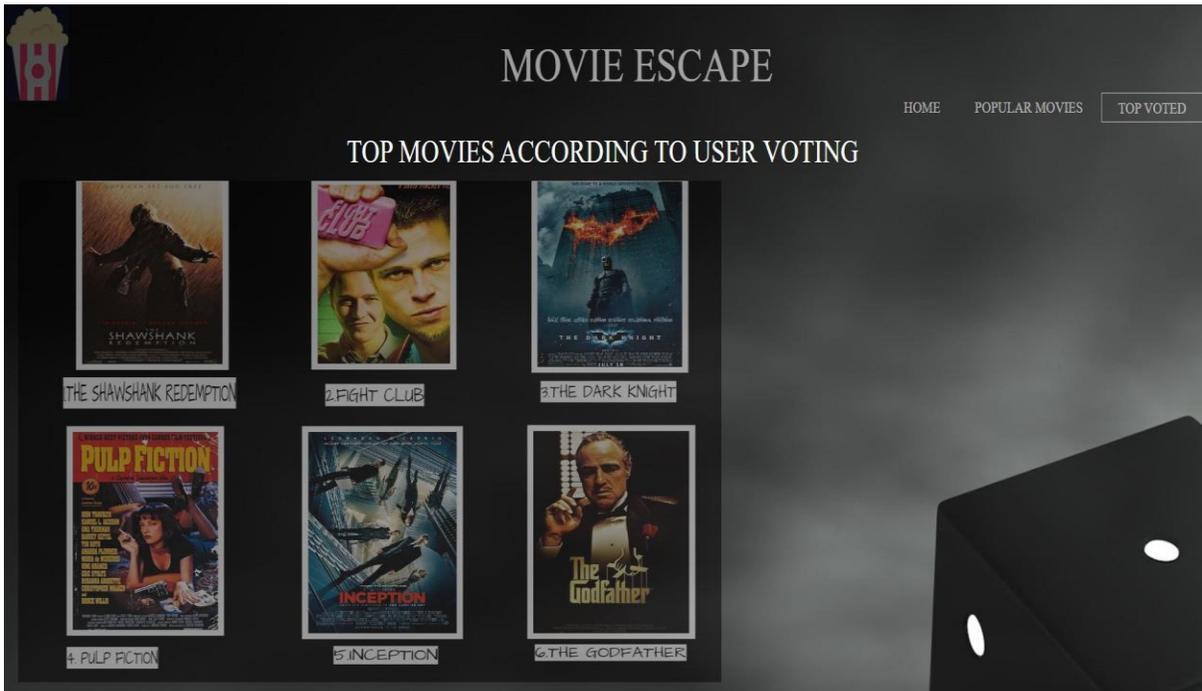


Figure 5. Top voted movies by users.

6. Conclusion

Information retrieval has become very difficult nowadays because of the overloading of data and this issue has restricted the users from accessing the items that best match their preferences. This is where the recommendation system comes into use. It helps to retrieve personalized information for different users. Also, movies have become a popular medium of entertainment but also the concern of what to watch is also rising along. The content-based recommendation approach does not consider other user profiles while making recommendations. This will help the user get personalized suggestions for their input.

7. Acknowledgments

We would like to express our sincere feeling and obligation to Dr MN Nachappa and project coordinators for their effective steering and constant inspirations throughout our analysis work. Their timely direction, complete co-operation, and minute observation have made our work fruitful.

References

- [1] Broumi, S., Dey, A., Talea, M., Bakali, A., Smarandache, F., Nagarajan, D., ... & Kumar, R. (2019). Shortest path problem using Bellman algorithm under neutrosophic environment. *Complex and intelligent systems*, 5(4), 409-416.
- [2] Kumar, R., Dey, A., Broumi, S., & Smarandache, F. (2020). A study of neutrosophic shortest path problem. In *Neutrosophic graph theory and algorithms* (pp. 148-179). IGI Global.
- [3] Kumar, R., Edalatpanah, S. A., Jha, S., Broumi, S., Singh, R., & Dey, A. (2019). A multi objective programming approach to solve integer valued neutrosophic shortest path problems. *Neutrosophic sets and systems*, 24, 139-151. https://digitalrepository.unm.edu/nss_journal/vol24/iss1/13
- [4] Kumar, R., Edalatpanah, S. A., Jha, S., & Singh, R. (2019). A novel approach to solve gaussian valued neutrosophic shortest path problems. *International journal of engineering and advanced technology*, 8(3), 347-353.
- [5] Kumar, R., Edalatpanah, S. A., Jha, S., Broumi, S., & Dey, A. (2018). Neutrosophic shortest path problem. *Neutrosophic sets and systems*, 23, 5-15. https://digitalrepository.unm.edu/nss_journal/vol23/iss1/2
- [6] Pratihari, J., Kumar, R., Dey, A., & Broumi, S. (2020). Transportation problem in neutrosophic environment. In *Neutrosophic graph theory and algorithms* (pp. 180-212). IGI Global.
- [7] Kumar, R., Edalatpanah, S. A., Jha, S., & Singh, R. (2019). A Pythagorean fuzzy approach to the transportation problem. *Complex and intelligent systems*, 5(2), 255-263.
- [8] Pratihari, J., Kumar, R., Edalatpanah, S. A., & Dey, A. (2020). Modified Vogel's approximation method for transportation problem under uncertain environment. *Complex and intelligent systems*, 1-12. <https://doi.org/10.1007/s40747-020-00153-4>
- [9] Gayen, S., Jha, S., Singh, M., & Kumar, R. (2019). On a generalized notion of anti-fuzzy subgroup and some characterizations. *International journal of engineering and advanced technology*, 8, 385-390.
- [10] Gayen, S., Smarandache, F., Jha, S., & Kumar, R. (2020). Interval-valued neutrosophic subgroup based on interval-valued triple t-norm. In *Neutrosophic sets in decision analysis and operations research* (pp. 215-243). IGI Global.

- [11] Gayen, S., Smarandache, F., Jha, S., Singh, M. K., Broumi, S., & Kumar, R. (2020). Introduction to plithogenic subgroup. In *Neutrosophic graph theory and algorithms* (pp. 213-259). IGI Global.
- [12] Gayen, S., Smarandache, F., Jha, S., Singh, M. K., Broumi, S., & Kumar, R. (2020). Soft subring theory under interval-valued neutrosophic environment. *Neutrosophic sets and systems*, 36(1), 16, 193-219.
- [13] Gayen, S., Smarandache, F., Jha, S., & Kumar, R. (2020). Introduction to interval-valued neutrosophic subring. *Neutrosophic sets and systems*, 36(1), 17, 220-245.
- [14] Gayen, S., Smarandache, F., Jha, S., Singh, M. K., Broumi, S., & Kumar, R. (2020). Introduction to plithogenic hypersoft subgroup. *Neutrosophic sets and systems*, 33(1), 208-233. https://digitalrepository.unm.edu/nss_journal/vol33/iss1/14
- [15] Yang, Y., Yan, D., & Zhao, J. (2017). Optimal path selection approach for fuzzy reliable shortest path problem. *Journal of intelligent & fuzzy systems*, 32(1), 197-205.
- [16] Kumar, R., Jha, S., & Singh, R. (2020). A different approach for solving the shortest path problem under mixed fuzzy environment. *International journal of fuzzy system applications (IJFSA)*, 9(2), 132-161.
- [17] Kumar, R., Jha, S., & Singh, R. (2017). Shortest path problem in network with type-2 triangular fuzzy arc length. *Journal of applied research on industrial engineering*, 4(1), 1-7.
- [18] Kumar, R., Edalatpanah, S. A., Jha, S., Gayen, S., & Singh, R. (2019). Shortest path problems using fuzzy weighted arc length. *International journal of innovative technology and exploring engineering*, 8(6), 724- 731.
- [19] Singh, A., Kumar, A., & Appadoo, S. S. (2019). A novel method for solving the fully neutrosophic linear programming problems: Suggested modifications. *Journal of intelligent & fuzzy systems*, 37(1), 885-895.
- [20] Mohapatra, H., Panda, S., Rath, A., Edalatpanah, S., & Kumar, R. (2020). A tutorial on powershell pipeline and its loopholes. *International journal of emerging trends in engineering research*, 8(4), 975- 982.
- [21] Mohapatra, H., Rath, S., Panda, S., & Kumar, R. (2020). Handling of man-in-the-middle attack in WSN through intrusion detection system. *International journal of emerging trends in engineering research*, 8(5), 1503-1510.
- [22] Mohapatra, H., Debnath, S., & Rath, A. K. (2019). Energy management in wireless sensor network through EB-LEACH. *International journal of research and analytical reviews (IJRAR)*, 56-61. <https://easychair.org/publications/preprint/tf5s>
- [23] Mohapatra, H., Rath, A. K., Landge, P. B., & Bhise, D. A. (2020). Comparative analysis of clustering protocols of wireless sensor network. *International journal of mechanical and production engineering research and development (IJMPERD) ISSN (P)*, 10(3) 8371-8385.
- [24] Mohapatra, H., & Rath, A. K. (2020). Survey on fault tolerance-based clustering evolution in WSN. *IET networks*, 9(4), 145-155.
- [25] Mohapatra, H., Debnath, S., Rath, A. K., Landge, P. B., Gayen, S., & Kumar, R. (2020). An efficient energy saving scheme through sorting technique for wireless sensor network. *International journal of emerging trends in engineering research*, 8(8), 4278-4286.
- [26] Mohapatra, H., & Rath, A. K. (2020). Fault tolerance in wsn through uniform load distribution function. *International journal of sensors, wireless communications and control*, 10(1), 1-10. <https://doi.org/10.2174/2210327910999200525164954>
- [27] Mohapatra, H., & Rath, A. K. (2019). Fault tolerance through energy balanced cluster formation (EBCF) in WSN. In *Smart innovations in communication and computational sciences* (pp. 313-321). Springer, Singapore.
- [28] Mohapatra, H., & Rath, A. K. (2019). Fault tolerance in WSN through PE-LEACH protocol. *IET wireless sensor systems*, 9(6), 358-365. DOI: 10.1049/iet-wss.2018.5229
- [29] Mohapatra, H (2018). *C programming: practice*. Amazon.
- [30] Mohapatra, H., & Rath, A. K. (2020). *Fundamentals of software engineering: designed to provide an insight into the software engineering concepts*. BPB Publications.

- [31] Mohapatra, H. I. T. E. S. H. (2009). *HCR using neural network* (Master's Thesis, College of Engineering and Technology, Bhubaneswar).
- [32] Panda, M., Pradhan, P., Mohapatra, H., & Barpanda, N. K. (2019). Fault tolerant routing in heterogeneous environment. *International journal of scientific and technology research*, 8, 1009-1013.
- [33] Nirgude, V. N., Nirgude, V. N., Mahapatra, H., & Shivarkar, S. A (2017). Face recognition system using principal component analysis & linear discriminant analysis method simultaneously with 3d morphable model and neural network BPNN method. *Global journal of advanced engineering technologies and sciences*, 4, 1-6.
- [34] Mohapatra, H., & Rath, A. K. (2020, October). Nub less sensor based smart water tap for preventing water loss at public stand posts. *2020 IEEE microwave theory and techniques in wireless communications (MTTW)* (Vol. 1, pp. 145-150). IEEE.
- [35] Mohapatra, H., & Rath, A. K. (2020). IoT-based smart water. In *IOT technologies in smart-cities: from sensors to big data, security and trust*. DOI: 10.1049/PBCE128E
- [36] Mohapatra, H. (2020). Offline drone instrumentalized ambulance for emergency situations. *International journal of robotics and automation (IJRA)*, 9(4), 251-255.
- [37] Mohapatra, H., & Rath, A. K. (2019). Detection and avoidance of water loss through municipality taps in India by using smart taps and ICT. *IET wireless sensor systems*, 9(6), 447-457.
- [38] Panda, H., Mohapatra, H., & Rath, A. K. (2020). WSN-based water channelization: an approach of smart water. In *Smart cities—opportunities and challenges* (pp. 157-166). Singapore: Springer.
- [39] Chen, L. S., Hsu, F. H., Chen, M. C., & Hsu, Y. C. (2008). Developing recommender systems with the consideration of product profitability for sellers. *Information sciences*, 178(4), 1032-1048.
- [40] Jalali, M., Mustapha, N., Sulaiman, M. N., & Mamat, A. (2010). WebPUM: a web-based recommendation system to predict user future movements. *Expert systems with applications*, 37(9), 6201-6212.
- [41] Acilar, A. M., & Arslan, A. (2009). A collaborative filtering method based on artificial immune network. *Expert systems with applications*, 36(4), 8324-8332.
- [42] Su, X., & Khoshgoftaar, T. M. (2009). A survey of collaborative filtering techniques. *Advances in artificial intelligence*. doi:10.1155/2009/421425
- [43] Kim, H. N., El-Saddik, A., & Jo, G. S. (2011). Collaborative error-reflected models for cold-start recommender systems. *Decision support systems*, 51(3), 519-531.
- [44] Adomavicius, G., & Tuzhilin, A. (2005). Toward the next generation of recommender systems: A survey of the state-of-the-art and possible extensions. *IEEE transactions on knowledge and data engineering*, 17(6), 734-749.
- [45] Yu, K., Schwaighofer, A., Tresp, V., Xu, X., & Kriegel, H. P. (2004). Probabilistic memory-based collaborative filtering. *IEEE transactions on knowledge and data engineering*, 16(1), 56-69.
- [46] Min, S. H., & Han, I. (2005). Detection of the customer time-variant pattern for improving recommender systems. *Expert systems with applications*, 28(2), 189-199.
- [47] Celma, Ò., & Serra, X. (2008). FOAFing the music: Bridging the semantic gap in music recommendation. *Journal of web semantics*, 6(4), 250-256.
- [48] Fisk, D. (1997). An application of social filtering to movie recommendation. In *Software agents and soft computing towards enhancing machine intelligence* (pp. 116-131). Berlin, Heidelberg: Springer.
- [49] Chen, Q., & Aickelin, U. (2008). Movie recommendation systems using an artificial immune system. *6th international conference in adaptive computing in design and manufacture (ACDM 2004)*. arXiv preprint arXiv:0801.4287
- [50] Choi, S. M., & Han, Y. S. (2010, September). A content recommendation system based on category correlations. *2010 Fifth international multi-conference on computing in the global information technology* (pp. 66-70). IEEE.
- [51] Son, J., & Kim, S. B. (2017). Content-based filtering for recommendation systems using multiattribute networks. *Expert systems with applications*, 89, 404-412.

- [52] Basu, C., Hirsh, H., & Cohen, W. (1998, July). Recommendation as classification: Using social and content-based information in recommendation. *Aaai/iaai* (pp. 714-720). <https://aaai.org/Papers/AAAI/1998/AAAI98-101.pdf>
- [53] Debnath, S., Ganguly, N., & Mitra, P. (2008, April). Feature weighting in content based recommendation system using social network analysis. *Proceedings of the 17th international conference on world wide web* (pp. 1041-1042). <https://doi.org/10.1145/1367497.1367646>
- [54] Jannach, D., Zanker, M., Felfernig, A., & Friedrich, G. (2010). *Recommender systems: an introduction*. Cambridge University Press.
- [55] Basilico, J., & Hofmann, T. (2004, July). Unifying collaborative and content-based filtering. *Proceedings of the twenty-first international conference on machine learning* (p. 9). <https://doi.org/10.1145/1015330.1015394>
- [56] Liu, J., Dolan, P., & Pedersen, E. R. (2010, February). Personalized news recommendation based on click behavior. *Proceedings of the 15th international conference on intelligent user interfaces* (pp. 31-40). <https://doi.org/10.1145/1719970.1719976>
- [57] Hameed, M. A., Al Jadaan, O., & Ramachandram, S. (2012). Collaborative filtering based recommendation system: A survey. *International journal on computer science and engineering*, 4(5), 859.
- [58] Uluyagmur, M., Cataltepe, Z., & Tayfur, E. (2012, October). Content-based movie recommendation using different feature sets. *Proceedings of the world congress on engineering and computer science* (Vol. 1, pp. 17-24). http://www.iaeng.org/publication/WCECS2012/WCECS2012_pp517-521.pdf
- [59] Deldjoo, Y., Elahi, M., Cremonesi, P., Garzotto, F., Piazzolla, P., & Quadrana, M. (2016). Content-based video recommendation system based on stylistic visual features. *Journal on data semantics*, 5(2), 99-113.
- [60] Goldberg, D., Nichols, D., Oki, B. M., & Terry, D. (1992). Using collaborative filtering to weave an information tapestry. *Communications of the ACM*, 35(12), 61-70.
- [61] Good, N., Schafer, J. B., Konstan, J. A., Borchers, A., Sarwar, B., Herlocker, J., & Riedl, J. (1999). Combining collaborative filtering with personal agents for better recommendations. *AAAI/IAAI*, 439. <https://www.aaai.org/Papers/AAAI/1999/AAAI99-063.pdf>
- [62] Adomavicius, G., & Kwon, Y. (2007). New recommendation techniques for multicriteria rating systems. *IEEE intelligent systems*, 22(3), 48-55.
- [63] Liu, H., Hu, Z., Mian, A., Tian, H., & Zhu, X. (2014). A new user similarity model to improve the accuracy of collaborative filtering. *Knowledge-based systems*, 56, 156-166.
- [64] Pan, C., & Li, W. (2010, June). Research paper recommendation with topic analysis. *International conference on computer design and applications* (Vol. 4, pp. V4-264). IEEE.
- [65] Konstan, J. A., & Riedl, J. (2012). Recommender systems: from algorithms to user experience. *User modeling and user-adapted interaction*, 22(1-2), 101-123.



©2020 by the authors. Licensee International Journal of Research in Industrial Engineering. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).