

# Intelligent Fashion Recommender System: Redefining Style with Deep Learning

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## ABSTRACT

Industrialization and manufacturing are growing tremendously over the past few years. In fact, customers don't really prefer going outside for their service. Due to rapid online commercialization, customers don't have to visit stores, try products in the dressing area. There is an immense number of various products available on the online websites and platforms. In this article, authors review the quality of the fashion recommendation system and their corresponding techniques. Moreover, this paper focuses on various models that could be created and developed to support the fashion recommender system. For the better understanding of the students and researchers and scholars we have decided to take on this study. It also briefly explains machine learning algorithms and computer vision techniques which signifies the fashion recommender system. A recommendation program or technique, basically is an algorithm that aims to identify and filter out the relevant information from a hefty amount of dataset so as to give customers the right recommendations. It consists of engines that enquire and resolve patterns associated with this algorithm. Some examples of software/companies that use recommender systems are Amazon, Myntra, AJIO, TATA CLiQ, etc.

**Keywords:** Fashion, Recommender systems, Deep Learning, Neural Network, Feature Extraction

## 1 Introduction

There have been some major advancements in technology, especially the domain of online services which has given us the ability to do hefty tasks in a faster manner. However, these advancements resulted in a huge data overloading problem for us. It makes it difficult to find the relevant information for the internet [1]. These advancements have helped users to find relevant information in a faster manner by using a specialized machine learning system of recommendations. Recommender systems are used to find the meaningful and related patterns according to the needs of the user. It helps them to personalize the content of their own choice and customize in whatever way they prefer. It reduces their time of surfing through the whole internet and preserves their effort for relevant and desired information. The aim of the project is to build or use a special machine learning model for the fashion recommendations system which will work just by looking at its image. The model accepts an input image and then gives the most similar image relating to a fashion product. The main objective of this work is to develop a fashion recommendation system that answers queries related to fashion services, identifying the features of the input images, if the input image is right, then the similar recommendations will get displayed on the interface. After that implement the project to different software [2].

## 2 Literature Survey

Recommender systems are widely used by many domains such as fashion. There exist multiple researches related to enhancing recommendation techniques and metrics to boost the precision rate as



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well as the satisfaction level of users. For example, [1] surveyed different general recommender systems to see their roles in higher education . It can be used in other fields like fashion. CNN algorithms have been widely adopted for the image classification technique to classify the input images with labels using supervised learning techniques . Deep learning has explored great potential in style detection and feature extraction. A research in [2] introduced a deep learning-based recommendation system for fashion, designing a clothing style categorization and classification algorithm to improve the effectiveness of feature extraction. Another major contribution discussed AI-driven approaches in recommendation systems in fashion and highlighted how the development in deep learning contributed to the accuracy and personalization of recommendations [3]. Hybrid approach recommendation systems combining both collaborative and content-based methods has also been widely reviewed [4]. These techniques ensure that user preferences are captured accurately for personalized suggestions. This study presented a review about scientific paper recommender systems and possible methodologies to be adapted to the fashion domain [6].Advanced neural networks, such as ResNet-50 have been used for demanding feature extraction tasks, as shown in [7]. These models allow for accurate detection and categorization, which are crucial for fashion-related tasks. Also, for balancing the datasets, undersampling methods based on kNN are used, ensuring high robustness in similar tasks [9].This includes cross-domain applications such as recommending for building damage assessment [10]. Overall the multi-applicability of AI-driven models further increases the versatility of recommender systems. This is in line with another study which surveyed other models and techniques for fashion recommendation

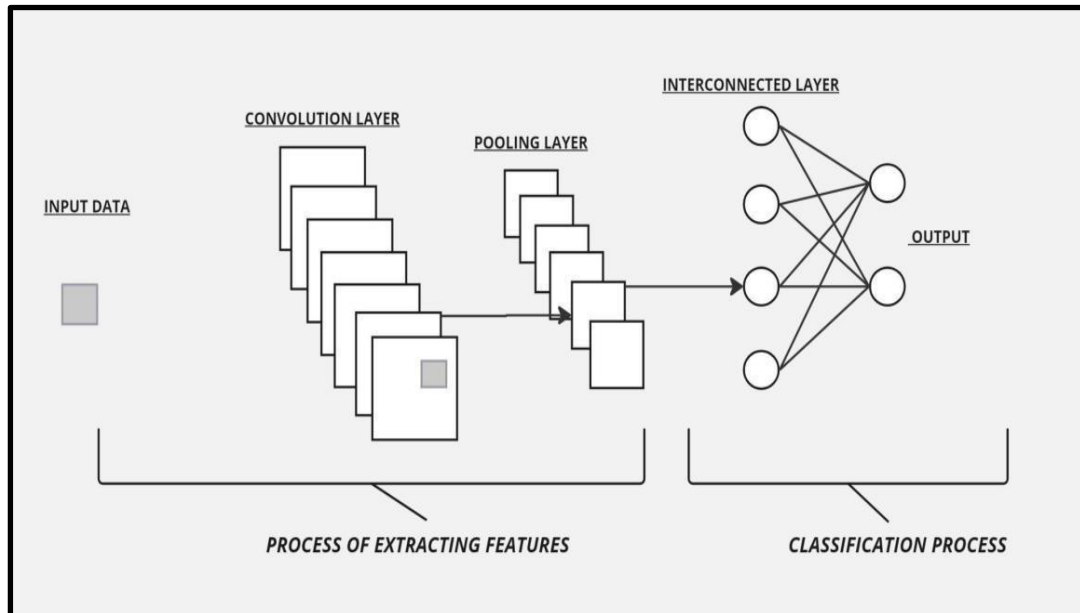
### **3 Comprehensive Framework for a Fashion Recommendation System**

The project is built on a system architecture that involves several key steps, such as image preprocessing, model selection, and the development of a recommendation engine. Image preprocessing ensures that input images are refined for accurate analysis, while the chosen machine learning model identifies key features to recommend similar fashion items. The recommendation engine dynamically provides relevant product suggestions based on the input image. A dynamic web application is developed to allow users to interact easily with the system, supported by a user friendly interface that ensures seamless navigation and smooth user experience. Additionally, the architecture is designed to handle large datasets, ensuring scalability and reliability for real world applications. By integrating transfer learning, the system leverages pre-trained models, reducing training time while improving accuracy. Each module is optimized to enhance performance, ensuring that recommendations are both relevant and personalized. The user interface is designed with simplicity in mind, making it accessible even for non-technical users. This cohesive system architecture bridges the gap between advanced machine learning techniques and user-centric design, creating an engaging and efficient platform.

#### **3.1 Model Selection and Preprocessing**

Here we are using a pre trained model ResNet50 designed by advanced engineers and developers for computer vision. It uses deep learning for extracting features and processing input images for computer vision and recommender systems. It helps to extract features ranging from high level (shapes and patterns) and low level (edges, textures). ResNet50 uses transfer learning where the knowledge of this model can be reused to any system project [4] . Input image gets processed and prepared for further process by using deep learning technique in Resnet50 model. Here we will use CNN (Convolution Neural Networks). CNN is basically a deep learning algorithm which is used for image classification and feature extraction of multidimensional dataset by using specialized layers known as convolutional

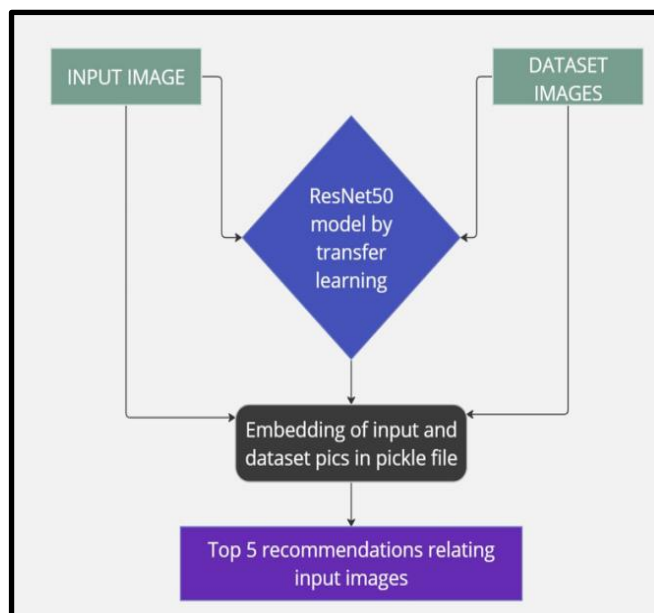
layers. These layers are used to label and extract features from input datasets. A filter is passed through these layers to produce feature maps that will highlight important aspects. Reduction of noise and securing relevant and required data is done by reducing size of the final layer by process of pooling. These pooling layers are flattened into 1D vectors for interconnection with neurons and further output classification [5]. Figure 1 depicts the whole process for making a Convolutional neural network by using various layers and then performing interconnection between neurons to get output.



**Figure 1:** Diagram for depicting the basic process of Convolutional Neural Network

### 3.2 Recommendation engine

The recommendation engine provides the model to recommend the top 5 most similar images to the input image. By using the relevant classification that is KNN algorithm in this project we can find the nearest euclidean system of the input data features with the dataset embedded features. That is how the process of classification works in this project. Let us explain the process of recommendation. First of all gathering and preprocessing of data is held where all the noise and errors are removed and data is cleaned and prepared for filtering. The missing values of the dataset are either removed or filled with a null value. Afterwards, we analyze the data for predictions and filtering of the relevant feature by checking the implicitness of the dataset [6]. The filtered dataset is ready to undergo the process of model building and producing accurate predictions. The recommended images are ranked and displayed for the user, ensuring that the most relevant results are presented. This approach leverages the power of transfer learning with ResNet50 to extract robust image features that aid in accurate similarity comparison. Figure 2 depicts flowchart of the working of the ResNet50 model by using transfer learning which takes input image and embed it in a pickle file and generates the closest five recommendations based on the features of the given input image by using the k nearest neighbors algorithm.



**Figure 2:** Flowchart depicting the deployment of model

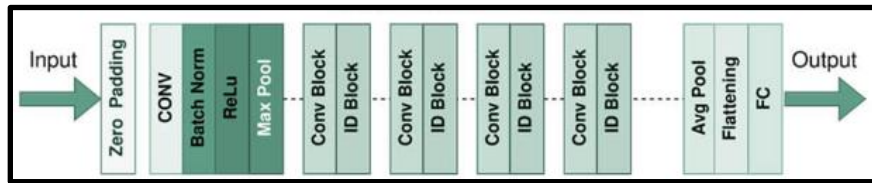
### 3.3 Dynamic web application

The usage of Python library Streamlit will be to create a dynamic web application that runs on our default browser. The app will feature a user-friendly interface allowing users to browse and upload an image from a sample folder. After processing, the system will display the top 5 most similar image recommendations, providing relevant fashion suggestions based on the input image. The recommendations will be generated in real time, ensuring quick and efficient results. Streamlit's flexibility allows for smooth updates, making the application responsive and easy to use across various devices [7]. Streamlit application is used to display the user interface and the upload browsing button to input images in the system. It creates a web application that connects our python code from backend to frontend display on our preferred web browser. This application contains a Browse button that fetches the file which we want to input. Then it saves the image and sends the uploaded image to the recommender engine which again performs the relevant algorithms such as KNN on our provided dataset of 44k images [11].

## 4 Implementation

After applying transfer learning, the ResNet50 model is integrated into our system using the Keras and TensorFlow libraries in Python. Transfer learning allows us to leverage a pre-trained model, enhancing the performance of our system by fine-tuning it with relevant data. ResNet50, known for its deep architecture and residual learning capabilities, is particularly effective in identifying and classifying features from images, making it well-suited for our fashion recommendation system. To provide a clearer understanding of the ResNet50 architecture, we have included a flowchart that outlines its key components and the step-by-step process involved in feature extraction and classification. Figure 3 depicts the basic architecture of the ResNet50 in an easy format with every abstract component, which includes various steps of layer building like max pooling, padding, convolutional blocks, average pooling, and flattening. The use of bottleneck blocks further optimizes computational efficiency while preserving the accuracy of feature extraction. This architecture allows the model to extract both low-level and high-level features effectively, ensuring a comprehensive understanding of input images. By

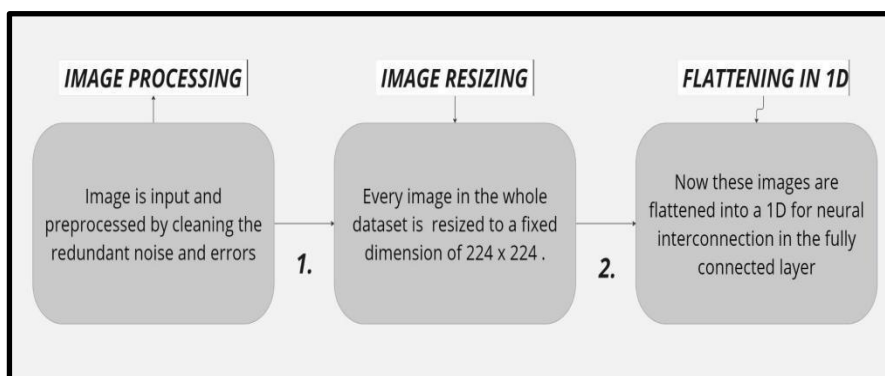
employing ReLU activation functions, ResNet50 introduces non-linearity, which is crucial for capturing complex patterns and textures in fashion images. The integration of global average pooling also reduces the number of parameters, making the model lightweight and faster to process. Ultimately, this enables real-time recommendations in our fashion system with enhanced precision.



**Figure 3:** ResNet50 Model Architecture with important components

#### 4.1 Image Preprocess

Numpy stands for numerical python which is a library used to perform numerical functions and create dynamic arrays and to perform high level mathematical operations on these arrays. Open CV is a popular computer vision library used for text and image recognition and their preprocessing. It is mainly used for converting text to images and vice versa. Tensorflow is an open source library used in deep neural network algorithms. It allows rapid prototyping of the neural networks. Pickle is used for serializing and deserializing and input and saving of features of the images. Scikit Learn is a python library used to perform various algorithms like classification, regression on machine learning models. Pandas is an open source library for data manipulation and engineering by using dataframes packages. Streamlit: python library to create dynamic and user interactive web applications which connect our program from the backend. Pillow: it is a python library that helps us to process images and extend the support of various file formats of an image like .jpg, .png, .jpeg, etc. Figure 4 depicts the whole process of image processing and resizing and flattening in flowchart form, where images are flattened in 1D layer for neural network process.

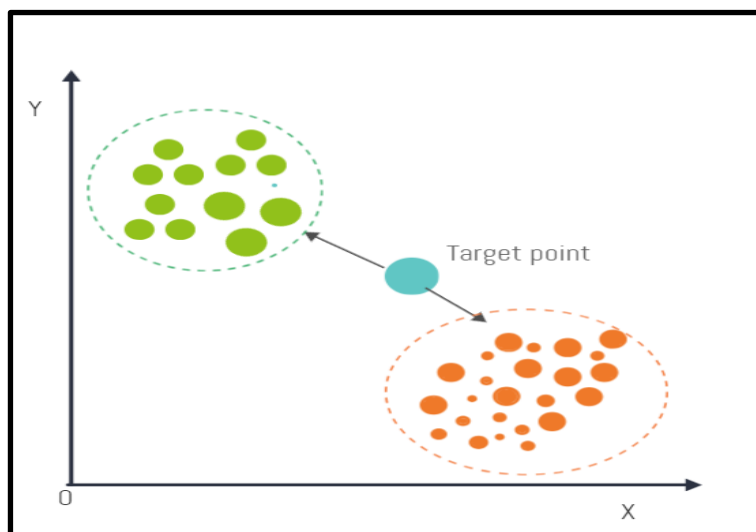


**Figure 4:** Flowchart representing process of image processing

#### 4.2 Recommendation Engine and K Nearest Neighbour

Initially it takes up the input by the browsing feature present at the application. Afterwards, that input image is stored in a separate folder named as upload folder. Then that image is sent to the recommendation engine where the main classification process will go on further. After classification and calculating the metrics, the similarity between input and dataset image is established. Due to which we further get our generated recommendation on our web applications [8]. Let's discuss the major

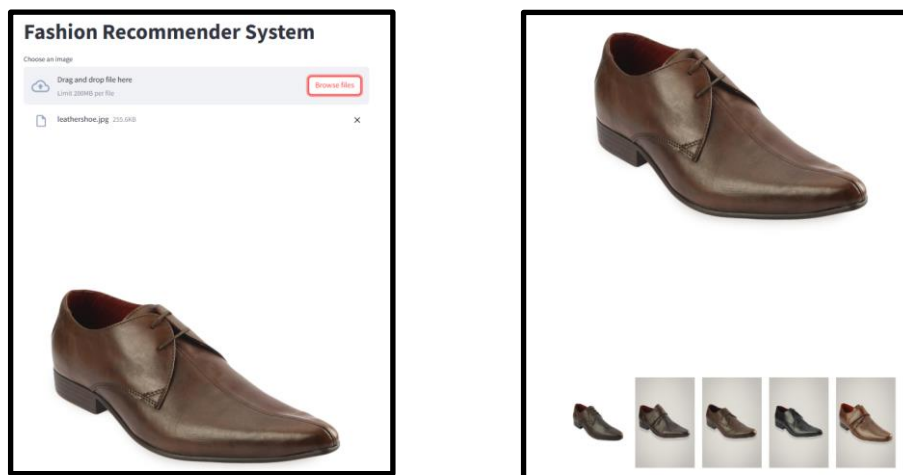
algorithm which is used in our project. K Nearest Neighbour is a supervised learning algorithm which has been used here to predict the closest images to our input data point by calculating the distance metric which is Euclidean Distance. The 5 images having the minimum distance are selected and recommended [9]. This algorithm is widely used in regression and classification models where the dataset is in large amounts. K is the total number of neighbors which is 5 in our case [10]. Figure 5 depicts the basic diagram for KNN algorithm used for classification of data points to subsequent classes.



**Figure 5:** Graph depicting the KNN classification algorithm

## 5 Result

The web application makes it easy to find the nearest five products to the one for which one is searching based on fashion. One can upload any type of image the user wants, and the web application will give the best five products that are most alike to what the user wants. It's catering to an audience that's in search of visually similar clothing and accessories, therefore personalizing their shopping experience. Once the user uploads an image, the system will process it to extract salient features and fetch relevant data from the database based on similarity metrics of Euclidean distance. This would ensure, in addition to visual alignment, contextual relevance to user inputs. Immense utility can be established for e-commerce platforms. In this way, the model learns products quickly and facilitates the purchasing process because users can identify their likes from the provided list. As an illustration, if a user uploads an image of a shoe, the model assesses the features of the shoe and returns five recommendations to the user according to style, color, and design. As demonstrated in Figure 6, the user interface is intuitive and aesthetically pleasing to see, so the users can easily find and choose their favorite product. This application that combines advanced image recognition with user friendly functionality makes shopping more efficient and pleasant, but it is also a robust instrument for businesses when contacting customers and stimulating sales.



**Figure 6** : Screenshots of user interface of the corresponding streamlit application

## 6 Conclusion

Today, recommendation systems are integral parts of any e-commerce in the fashion industries, keeping personalization and user experience in mind. For instance, a product developed from the proposed project is the fashion recommender system, which gives one superb integration of machine learning techniques and state-of-the-art algorithms to come up with recommendations based on user inputs. Thus, through these technologies, a model determines the important features from the uploaded images by the user and retrieves the visually similar product with high precision, thus enhancing the shopping experience. Therefore, using such methodology as feature extraction and Euclidean distance-based similarity measurement to develop this system ensures that the given recommendations are both relevant and visually appealing according to user preferences. It thus makes the discovery of products less complicated, thus eliminating choice fatigue on the side of customers, making online shopping intuitive and enjoyable. This project shows that this system is capable of providing accurate, highly personalized recommendations that do greatly improve customer engagement and satisfaction. These systems have a deep implication on e-commerce platforms, as they can fulfill varied customer needs, create opportunities for product discoverability, cross-selling and upselling, and scalability in the handling of large datasets in applications. This is in line with the practices of the top e-commerce websites like Amazon, Myntra, and AJIO, since they are employing similar technologies that enhance the UI and consequently result in better customer interaction. The system performs its intended function and enables it to recommend relevant products; thus, the capabilities of machine learning are highlighted in revolutionizing the world of fashion. This project proves all the claims made to it in terms of its name and really worth something for both the customers and businesses using it by building customer engagement, streamlining the shopping process, and offering a personalized experience. Therefore, with real world use-cases like e-commerce websites having solid application, its importance is effectively stated and further development potential demonstrated.

## Declarations

### Competing Interests

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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