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Fashion Design Classification Based on Machine Learning and Deep Learning Algorithms: A Review

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Abstract

Integration of machine learning algorithms in fashion design classification brought transformational change by allowing the automated analysis, categorization, and prediction of fashion items based on different attributes of the item. This paper reviews the state-of-the-art in fashion design classification through machine learning techniques. Review of literature, methodology, and challenges in this area indicate that an array of algorithms and methods, stretching from traditional machine learning algorithms to convolutional neural networks and further to transfer learning approaches, is being tried and tested. In this paper, I will discuss performance comparison among several machine learning algorithms, pinning their strengths, limitations, and possible applications in the fashion industry. We further elaborate on crucial challenges, such as touching on the issue of data variability, interpretability, and others on ethical consideration issues, all pointing to the need for fairness and sustainability with respect to the representation of reality in algorithmic decision-making. This paper aims to inform researchers, practitioners, and stakeholders of the opportunities and challenges brought about by the use of machine learning in a fast-paced world like fashion, hence demystifying current directions in landscape classification of fashion design.

A. Introduction

Fashion is a dynamic, developing interconnected environment that marries creativity with technology for the production of inventing countless designs, styles, and new trends [1]. Since the advent of digitalization and a plethora of online platforms, the fashion world has taken a complete somersault, which has finally led to the generation of huge data, emanating from sources like social media, e-commerce websites, fashion shows, etc [2]. World over, maybe loaded with data; the necessity of effective tools to analyze, classify, and predict fashion designs has always remained the most important need in today's world, for designers and retailers and to some extent even for consumers [3]. See figure 1.

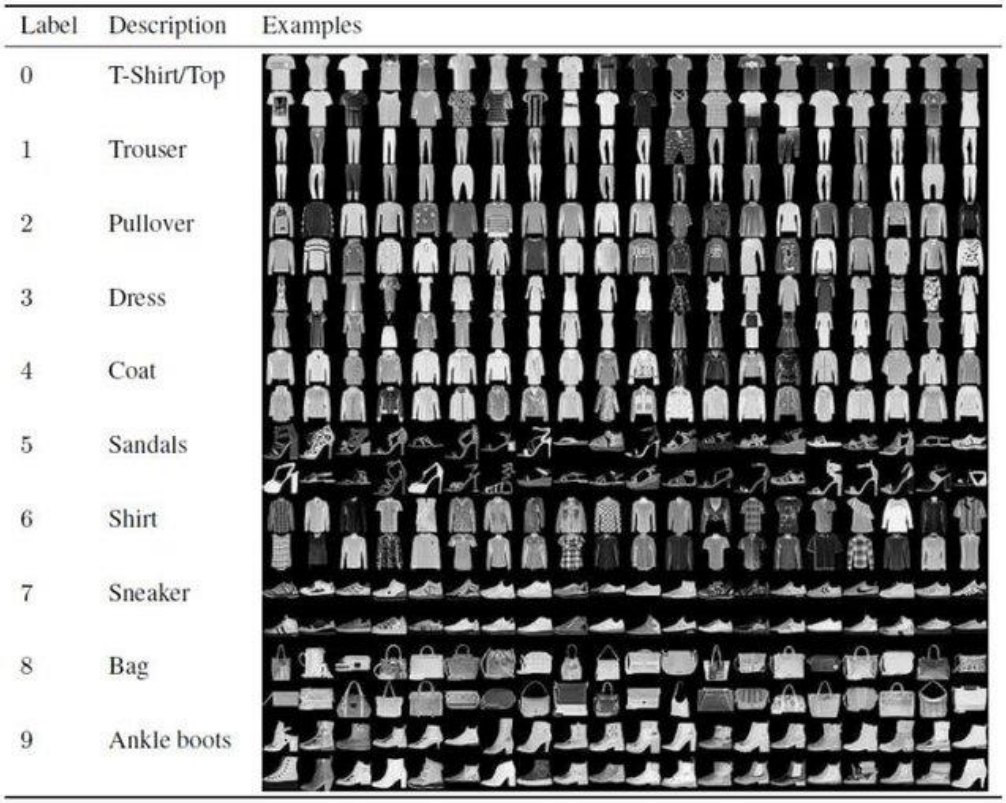

Figure 1. Fashion Classification Images [4]

Fashion design classification is a very important process in a few of the applications that belong to the fashion industry, where a need arises for categorization of fashion items depending on its characteristic like color, pattern, texture, and style [5]. From trend prediction and inventory management to providing individual recommendations and, moreover, visual search, the exact classification of fashion designs is important for many procedures that have effects on decision-making [6]. That being said, these large volumes of fashion data are very hard and slow for manual classification, filled with subjectivity, which brings out the pressing needs for automated solutions that can handle the scale and complexity presented by modern fashion datasets [7].

With the recent advent of machine learning algorithms, the line of design class in fashion has taken a turn for the revolution that brings very powerful tools towards the analysis and interpretation of complicated patterns [8][9]. Machine

learning is a field of artificial intelligence that provides computational systems with the ability to learn from data and make predictions or take actions based on acquired knowledge; it finds applications in various areas, including computer vision, natural language processing, pattern recognition, etc [10][11]. In the context of such a classification of fashion design, the label information allows machine learning algorithms to make sophisticated pattern distinctions so that a new fashion item can be classified very accurately [12][13].

Against this background, the present research paper is conducted to give a comprehensive review of the current panorama of fashion design classification based on machine learning algorithms. Our aim is to present an exploratory view with the existing literature, methodologies, challenges, and future directions in which machine learning research has to offer for the field of fashion design classification and its implications on industry.

The rest of this paper is organized with an exhaustive review of existing literature on machine learning algorithms for fashion design classification. Following sections of the following paper shall highlight different algorithms, methods, and approaches applied in previous studies. Major findings and key results were then discussed in a critical way by the group. It included the comparison in performances of different machine learning algorithms, challenges, and limitations faced during this application period, and what ethical considerations have been made during the application of machine learning in fashion. Concluding with some conclusions drawn that sum up the main arguments of the review and outline some potential future research in this relatively new area of inquiry.

B. Machine Learning Algorithms For Fashion Design Classification

Machine learning algorithms have become essential tools in the fashion industry, particularly for classifying and categorizing fashion designs. These algorithms can analyze large datasets of fashion items, learning to recognize complex patterns and styles from various eras and designers. Techniques like Random Forest and Logistic Regression are commonly used for image-based classification, enabling the identification of garment types, fabrics, and design elements automatically. This technology not only helps in sorting and recommending fashion products but also aids designers by providing insights into current trends and consumer preferences. By leveraging machine learning, the fashion industry can achieve greater accuracy and efficiency in design classification, leading to more personalized and innovative fashion experiences.

Ziegler at al. [14] The paper introduces novel methods for automated clothing category classification and fashion landmark detection, demonstrating superior performance compared to existing models on new datasets, and contributes a new algorithm and data augmentation techniques for robotic clothing manipulation tasks. Dong at al. [15] introduces an interactive, knowledge-based design recommender system for personalized fashion product design schemes, involving iterative interaction between virtual product demonstration and designer's knowledge, validated through successful real design cases.

Jain and Kumar [16] focuses on using data mining and machine learning techniques to create a classification model for predicting garment categories and

sub-categories based on product attributes in the apparel industry. The random forest classifier showed better performance with accuracies ranging from 73% to 90% for different garment categories and sub-categories. Liu at al. [17] introduces two image recognition approaches, GA-RF and VGG-IE, to improve classification accuracy and computation time, with VGG-IE showing the highest classification accuracy and VGG having the shortest computational time. The methodology involves the introduction of two image recognition approaches (GA-RF and VGG-IE), optimization using genetic algorithms, utilization of batch normalization and data augmentation in VGG-IE, and proposal of six Deep Neural Network architectures.

Zhao at al. [18] discusses the impact of customer demand for virtual fitting and personalized fashion on fashion design, the development of fashion design models based on big data and digitization, the use of virtual fitting technologies, consumer design-support platforms, and fashion recommendation systems, while also highlighting the current limitations in fashion design systems. LEITHARDT [19] discusses the importance of algorithms in the online fashion market to identify garments, improve user experience, and target specific niches for sales, with a focus on providing better comparisons between classification methods for future research. It also emphasizes the significance of Machine Learning in generalizing beyond existing examples in the training set.

Yethindra at al. [20] proposes a framework for recommending men's clothing based on user preferences and historical data, achieving high accuracy and precision. The methodology involves preprocessing user data, feature extraction, classification, semantic similarity computation, and providing recommendations based on the results. Samia at al. [21] focuses on using machine learning methods to correctly identify and categorize clothing images, evaluating their performance using accuracy and confusion matrix metrics, with the best results obtained for ML models using ANN and for DL models using the GoogleNet architecture. The study also emphasizes the impact of the number of epochs and network depth on achieving optimal results.

Yang [22] introduces a solution using deep learning and decision tree algorithms to improve clothing recommendation methods, emphasizing the importance of recognizing clothing styles for intelligent recommendations and evaluating performance using precision, recall rate, and F1 value. It also discusses the influence of science and technology on fashion design and the significance of personalized consumer needs. Satinet at al. [23] explores the use of machine learning tools to assess the environmental sustainability of clothing products, aiming to provide rapid environmental feedback to online retailers and interested consumers, potentially leading to the development of an all-inclusive environmental label. The methodology involves using supervised machine learning tools, particularly the random forest algorithm, to assess the environmental sustainability of clothing products based on life cycle assessment studies.

Wang at al. [24] had earlier approached the customization of clothing for sustainability fashion using 3D digital simulation along with machine learning. That approach emphasized an improved garment design parameter for an improved fit of the personalized fashion. Ling at al. [25] apply machine learning and data mining techniques to embed conflict rule processing with the

development of a knowledge base. It focuses on individualized fashion recommendations through the classification and analysis of fashion style and preference data. Xia and Zhang [26] proposed a new method for clothing classification using transfer learning in combination with the Squeeze-and-Excitation block for enhancing better feature extraction and classification performance. This would illustrate another possibility for the development of fashion classification through deep learning.

In conclusion, all the reviewed research has been compared based on the main findings, key results, and limitations. as shown in Table 1.

Table 1. Comparison Amongst Machine Learning Algorithms for Fashion Design Classification

Authors & Ref	**Year**	**Datasets**	**Models**	**Key Results**	**Advantages**	**Limitations**
Ziegler at al. [14]	2020	DeepFashion CTU Color and Depth Image In-Lab	elastic warping rotation invariant	Achieved high results compared to other algorithms	The paper introduces data augmentation and model adjustments to improve clothing category classification and fashion landmark detection generalization.	Elastic warping may have a negative effect on the results due to the limited size of the dataset.
Dong at al. [15]	2020	Private	IKDRS	Knowledge updating twice 98.75%	The paper introduces an interactive, knowledge-based design recommender system for personalized fashion product design schemes	N/M
Jain and Kumar [16]	2020	DeepFashion	Decision Trees, Naïve Bayes, Random Forest, and Bayesian Forest	The random forest classifier showed better performance with accuracies ranging from 73% to 90%	A data mining classification model was created to predict garment categories and subcategories.	Manual labeling of data collected through the internet is expensive and labor-intensive.
Liu at al. [17]	2020	Fashion-MNIST	GA-RF VGG-IE	The most accurate classification method is VGG-IE.	VGG-IE outperformed state-of-the-art algorithms in 10 image recognition categories in classification accuracy and computational time.	Image recognition systems' robustness to noise and scalability are not studied
Zhao at al. [18]	2021	Fashion-MNIST	FDM	Improved consumer satisfaction with	Virtual fitting tools and recommendatio	Functional fashion design and comfort are

				fashion design	n systems improve customer satisfaction.	not part of current fashion design systems, which ignore textile material performance.
LEITHARD T [19]	2021	Fashion-MNIST	ML	A new CNN model called cnn-dropout-3 improved accuracy from 89.7% to 99.1%.	The paper compares fashion product classification methods using CNN models, which outperform traditional machine learning algorithms and improve accuracy.	Due to clothes' many properties, categorization is difficult, limiting the study.
Yethindra at al. [20]	2021	Fashion-MNIST	Logistic Regression and Ontologies	Accuracy of the Onto infused recommendation system (97.14%)	The paper suggests semantically similar men's clothing items and brands.	The proposed system is limited to only men's clothing recommendation.
Samia at al. [21]	2022	Fashion-MNIST	DNN ML TL	Models perform best with ANN 88.71%	The study used deep learning and machine learning to identify and categorise clothing images, with ANN and GoogleNet performing best. The number of epochs and network depth affected model performance.	Accuracy-only metric is used and lack of exploration of lighting conditions and image quality
Yang [22]	2022	Private	Decision Tree	The accuracy 86.25% achieved.	A clothing style recognition and a decision tree algorithm-based clothing recommendation system are presented in the study.	The experimental results are affected by imperfect samples that don't meet subjects' needs.
Satinet at al. [23]	2022	Private	Random forest	The random forest algorithm achieved an average accuracy of 91%	The model allows rapid environmental feedback on clothing products with limited data, helping online retailers provide sustainability information and possibly create a comprehensive	Study did not extend model to other product categories or datasets

					environmental label.	
Wang at al. [24]	2023	Fashion-MNIST	RBF-ANN GA PNN SVR	The results show that it can powerfully support the designers' quality personalized design solutions for consumers more accurately	Improve the customization process of garments, leading to better sustainability practices in fashion by allowing for accurate control over garment design parameters.	The complexity of accurately simulating fabric behavior and garment fit in 3D digital environments
Ling at al. [25]	2023	Fashion-MNIST	Fuzzy-Logic	Results show that the proposed mechanism is feasible and able to enhance the success of the recommendatio n	Integrating a conflict rule processing mechanism with machine learning and data mining into a fashion design knowledge base significantly enhances the accuracy	Limited in handling diverse and nuanced fashion preferences.
Xia and Zhang [26]	2023	Fashion-MNIST	TL	Classification accuracy of 97.205%	Incorporating transfer learning with squeeze and excitation blocks into clothing classification models improves the models' ability to extract and utilize relevant features	The approach might be limited by the transferability of features across different datasets

C. Deep Learning Algorithms For Fashion Design Classification

Deep learning algorithms have revolutionized the way fashion designs are classified and analyzed, offering a powerful tool for trend prediction and style segmentation. By employing deep neural networks, specifically convolutional neural networks (CNNs), these algorithms can process and learn from vast amounts of image data, recognizing intricate design features and patterns that distinguish different fashion genres and trends. This capability allows for the automatic categorization of apparel into various classes such as casual, formal, sportswear, and more, based on visual characteristics alone. Additionally, deep learning facilitates the extraction of fashion elements like textures, colors, and shapes, enabling designers and retailers to quickly adapt to changing fashion trends and better understand consumer preferences. The use of these advanced algorithms not only streamlines the design and production process but also enhances the shopping experience by providing more tailored recommendations to consumers.

Hussain at al. [27] proposes a deep learning model for automated classification and recognition of woven fabrics, achieving state-of-the-art accuracy, robustness to fabric property changes, and outperforming traditional approaches, without relying on handcrafted features. The model utilizes data augmentation and transfer learning for computational efficiency and handling variations in fabric properties. Jo at al. [28] presents the development of intelligent fashion techniques for Sketch-Product and personalized coordination, aiming to improve customer satisfaction and increase sales revenue by overcoming the limitations of text-based search methods in the fashion industry.

Shubathra at al. [29] discusses challenges in clothing image recognition, the use of image recognition technologies for online shopping, classification of the MNIST fashion dataset using deep learning techniques, and highlights the effectiveness of deep neural networks in image recognition and cloth prediction evaluation, with impressive results in the Fashion-MNIST dataset. Kayed at al. [30] discusses the application of CNN in fashion businesses for tasks like clothes recognition, search, and recommendation, with a focus on image classification using the LeNet-5 architecture on the Fashion MNIST dataset, achieving over 98% accuracy and outperforming other models.

Zhang at al. [31] explores the use of landmarks and texture features in clothes category classification and attribute recognition tasks, proposing a model called TS-FashionNet that enhances shape and texture extraction, leading to improved accuracy compared to existing models. Li at al. [32] proposes a multi-deep feature fusion algorithm for clothing image style recognition, which eliminates interference factors, focuses on clothing itself, and improves accuracy compared to traditional methods. The main contributions include the proposal of a multicategory feature extraction model (MFEM), an improved ResNet model, and a multi-feature fusion method.

Jeon at al. [33] introduces the FANCY framework, a deep learning-based system for fashion style analysis that redefines fashion attributes, develops new fashion styles, and presents quantitative standards and trends in fashion analysis. The methodology involved developing the FANCY framework integrating deep learning with fashion professionals' insights, working closely with professionals, and using a large dataset of attribute-annotated fashion images to create new styles. Zhou at al. [34] proposes a clothing classification method using a parallel convolutional neural network (PCNN) and an optimized random vector functional link (RVFL) to improve accuracy in clothing image recognition, achieving 92.93% accuracy on the Fashion-Mnist dataset and outperforming other algorithms. The PCNN is employed for feature extraction, addressing limitations of traditional convolutional neural networks.

Zhou at al. [35] they introduce a new method for clothing image classification that outperforms existing algorithms and significantly improves classification performance. The methodology involves using Alexnet with ImageNet transfer learning, optimized and regularized extreme learning, feature selection based on mutual information, regularization to prevent overfitting, and the Runge Kutta optimization algorithm to enhance the classifier's performance. Vijayaraj at al. [36] discusses the application of CNN in classifying fashion images using the Fashion-MNIST dataset and aims to enhance the dataset's performance for fashion

classification, providing a summary of various CNN models used for this purpose. The methodology involves training CNN models with different fashion styles using the Fashion-MNIST dataset, experimenting with various parameters, utilizing batch normalization and skip connections, and comparing different activation functions.

Nocentini at al. [37] presents the development and testing of multiple convolutional neural network models for fashion image classification, with the MCNN15 model achieving the highest accuracy of 94.04% on the Fashion-MNIST dataset compared to other models and literature architectures. The study also introduces new datasets for evaluation. Shin at al. [38] introduces a deep learning-based classification method focusing on Convolutional Neural Networks (CNN) and an innovative dynamic learning rate update algorithm, aiming to enhance the accuracy of fashion clothing image classification.

Amin at al. [39] developed a deeper architecture in order to have a better classification of the categorization of fashion items and thus predict their attributes more accurately, employing many deep learning architectures to increase the accuracy of recognizing the fashion category. Tasnim at al. [40] focus on the environmental side and suggest using deep learning for the classification of textile visual pollutants. They even discuss deep learning and building a dataset for training these models and further move onto how robust deep learning models can be in finding various types of textile waste.

Wang [41] has spoken of clothing image classification in a deep learning framework with a focus on multi-angle learning together with feature enhancement, which lays the emphasis on efficient and precise garment image identification. Priya at al. [42] Recently, a novel deep learning framework, called STD-net, is proposed for detection of saree texture from Indian sarees. It shows a brilliant potential for increasing cloth categorization accuracy, especially for e-commerce applications.

In conclusion, all the reviewed research has been compared based on the main findings, key results, and limitations. as shown in Table 2.

Table 2. Comparison Amongst Deep Learning Algorithms for Fashion Design Classification

Authors & Ref	**Year**	**Datasets**	**Models**	**Key Results**	**Advantages**	**Limitations**
Hussain at al. [27]	2020	Private	ResNet	The proposed deep learning model achieved 99.30%	The model demonstrated robustness in handling variations in fabric color, yarn thickness, diameter, orientation, and lighting effects.	The limitations of the study include heavy reliance on handcrafted features engineering
Jo at al. [28]	2020	Private	CNN	The image-based retrieval model showed high accuracy with a Precision at 5 of 0.774.	Fashion requires efficient product searching and recommendation. Vector-based user-preferred fashion recommendation	Limitations of text-based search method due to the importance of design in the fashion industry

					worked well.	
Shubathra at al. [29]	2020	Fashion-MNIST	DNN	Proposed model succeeds with a good precision result of 97.5%	Deep neural networks were effective for image recognition and cloth prediction evaluation, and the Fashion-MNIST dataset yielded impressive results.	The algorithm could be tested on different image classification tasks to determine its generalizability.
Kayed at al. [30]	2020	Fashion-MNIST	CNN LeNet-5	The LeNet-5 model achieved accuracy over 98%	LeNet-5 outperformed CNN and other state-of-the-art models in the literature.	The many properties of clothes and the similarity of features between classes make clothes categorization difficult, limiting the study.
Zhang at al. [31]	2020	DeepFashion-C	TS-FashionNet	Improve the top-3 classification accuracy by 0.83% and improve the top-3 attribute recognition recall rate by 1.39%	Landmarks assist in extracting shape features and improve classification and recognition accuracy.	It suggests further research for a more in-depth exploration of the impact of landmarks on clothing attribute recognition.
Li at al. [32]	2021	DeepFashion FashionMNIST	Multideep feature fusion algorithm	The final model is 0.95% more than the traditional residual network precision	By focusing on clothing and eliminating interference factors, the multi-deep feature fusion algorithm improves clothing style recognition accuracy.	Reduced recognition rate if the clothing image is severely occluded
Jeon at al. [33]	2021	Private	FANCY	Yielded very high performance (91.2% F1 score)	From attribute-annotated runway fashion images, the study presents 25 new fashion styles and the FANCY framework for fashion style analysis.	The study relies heavily on subjective experiences of fashion professionals for style classification criteria.
Zhou at al. [34]	2021	Fashion-MNIST	PCNN	Accuracy of the algorithm is 92.93%	PCNN and RVFL improve clothing image recognition accuracy, outperforming other algorithms. Key techniques like batch normalization and	Few algorithm comparisons and Lack of computational efficiency insights

					activation functions improved feature extraction.	
Zhou at al. [35]	2022	Fashion-MNIST	CNN	The precision, recall, F1-score, and accuracy of the proposed algorithm are 93.06%, 93.17%, 92.82%, and 93.14%, respectively	The proposed algorithm outperformed other algorithms in precision, recall, F1-score, and accuracy. The results show that the new algorithm greatly improves clothing image classification.	The algorithm could be tested on different image classification tasks to determine its generalizability.
Vijayaraj at al. [36]	2022	Fashion-MNIST	CNN	The accuracy 94.52% achieved.	CNN classified fashion images accurately on the Fashion-MNIST dataset, and the trained model predicted images well on the test dataset.	The CNN architecture is not tested on high-resolution or real-life apparel images.
Nocentini at al. [37]	2022	Fashion-MNIST	CNN	MCNN15 model achieving the highest accuracy of 94.04%	On Fashion-MNIST, MCNN15 outperformed state-of-the-art models in accuracy.	Difficulty in training for new designs of fashion accessories.
Shin at al. [38]	2023	Fashion-MNIST	CNN	The classification accuracy of the suggested method was 93%	The CNN-based image classification technique, enhanced by the dynamic learning rate update algorithm, accurately classifies fashion clothing images	Potential limitations could include reliance on specific dataset characteristics
Amin at al. [39]	2023	Fashion-MNIST	FSCAP	The experimental results clearly show that the proposed model outperforms the recent baseline methods	deep learning architectures can improve the classification of fashion items and prediction of their attributes, enhancing the accuracy and efficiency of fashion categorization.	The effectiveness of attribute prediction could be constrained by the granularity and variability of fashion sub-categories.
Tasnim at al. [40]	2023	Private	EfficientDet	Achieved the best performance with 97% and 93% training and test accuracies	Deep learning networks are highly effective in classifying textile visual pollutants	The model's performance dependency on the quality and variability of the dataset used for training

Wang [41]	2023	Fashion-MNIST	R-FCN	Accuracy rate reaches 96.69%.	Emphasizes multi-angle learning and new feature extraction techniques, greatly improves the accuracy and effectiveness of garment image classification	Limitations may include potential overfitting to specific garment image characteristics within the training dataset
Priya at al. [42]	2024	Fashion-MNIST	STD-Net	Accuracy of 99.1%	Substantially enhances fabric classification accuracy for e-commerce applications, highlighting its potential for specific textile categories.	Include the model's specificity to saree textures, which may not generalize well to other fabric types or clothing items without further training

D. Discussion

Fashion design classification using machine learning algorithms is a field that belongs to many methodologies, potential applications for the fashion industry, and challenges [43]. This section of the paper focuses on different elements within this interdisciplinary field: comparison of algorithm performances, transfer learning techniques, domain adaptation, and ethical considerations for future research.

Various kinds of machine learning algorithms have been considered for comparative studies of classifiers, and these algorithms are applied to the task of fashion design classification. Due to simplicity, efficiency, and interpretability, traditional algorithms have been taken into account rather than others. While these algorithms work on handcrafted features from fashion images—features like color histograms, texture descriptors, and shape features—ANN are very competitive in the area of fashion classification.

State of the art in deep learning models, such as Convolutional Neural Networks (CNNs), are presented by the most recent technology in the domain of fashion classification [44]. CNNs are usually stacked with convolutions and poolings, which allows learning a hierarchical representation of the fashion image data, hence effectively capturing fine-grained patterns or features with very little human intervention [45]. The method of transfer learning, with pre-trained CNN, has shown promising results with significant improvements in classification accuracy, in particular, when the available labeled training data is small [46]. In view of the above, the pre-trained CNN model is fine-tuned for the fashion dataset [47]. However, deep learning models are mostly implemented through a lot of annotated data and, at the same time, demand a huge number of computational resources for the sake of being trained, thus being not very pragmatic in an environment scarce in resources [48].

The algorithm ultimately used, therefore, will depend on the size and quality of the data set, availability of computational resources, and the exact requirements of the application [49]. On the other hand, deep learning models tend to score higher than basically all measures of accuracy, but in some cases are easier to interpret or

scale than traditional algorithms[50]. It should be in this context that the target of future research has to be achieved through hybrid methodologies and techniques that combine the potential of conventional machine learning approaches with the representational capability of deep learning models for optimally accomplishing the design classification task[51].

It has demonstrated promising results in the application of techniques of transfer learning to problems such as data scarcity and the domain shift in fashion design [52]. This makes use of the pre-trained models of CNN on a large-scale of image datasets, such as ImageNet, whereby initialization with the learned feature weights is done, and fine-tuning is carried out on smaller fashion datasets by adjusting them according to domain specific characteristics [53]. This allows better generalization of the models to the unseen categories and variations of fashion, thereby yielding improved performance in the respective classification, even with limited labeled data [54][55].

The domain adaptation method, translated knowledge from the source domain that has much labeled data to the target domain with different distributions, has been applied in the domain of fashion design classification [56]. Techniques that were proposed to align the feature distributions of the source and target domains include adversarial training, domain-specific regularization, and instance weighting, and this way, the generalization abilities of the classification models were said to improve [57]. However, domain adaptation is one of the most challenging problems in machine learning, particularly when there exist great domain discrepancies or labeled data are very scarce in the target domain [58].

Last but not least, it may be rather appropriate to further point out that one issue for discussion in the research to come is that of pushing ahead with ethical considerations that would ensure promoting integrity, accountability, and sustainability in applying these technologies within the bounds of the fashion industry. It is only through such collaboration among researchers, industry practitioners, policymakers, and advocacy groups that the development of these ethical guidelines, standards, and best practice policies may be realized in order to guarantee that fashion design classification through machine learning technologies is done equitably and with responsibility.

E. Conclusion

This definite big step of the classification of fashion designs for the fashion industry shows new doors of analysis, prediction, and personalization powered by machine learning algorithms. In this review, we have gone through the presented methodologies for fashion design classification from traditional machine learning algorithms to the most modern deep learning models. Although each may have its strength or weakness, the overall advance in the field is pushing for automation and efficiency in fashion classification tasks, making it easy for designers, retailers, and consumers to surf more easily and accurately across the field of fashion.

It is presented in the literature, and as explained herein, machine learning algorithms applied in fashion design classification will have the capability to bring out several accomplishments. These will include improvements in accuracy, ensuring there are increased scalabilities, and diversity in terms of the different fashion domains. On the other hand, domain adaptation methods help in

compensating for the difficulties caused by domain shift and further support model generalization improvement, while transfer learning techniques prove promising due to their capability to exploit pre-trained models and cope with scarce data.

In the future, this could guide research if a bit more emphasis is given to the interpretability of the model, ethical practices, and sustainability initiatives. The effort requires, in fact, to be such collaborative efforts from academia and industry inclusive of civil society for shaping the future of how the classification of design is drafted in a manner befitting inclusivity, transparency, and environmental consciousness. In the process of doing so, it is imagined that harnessing the game-changing powers of machine learning will make it possible to enter an era in which the implementation of fashion innovation not only embodies advanced technologies but has a base in ethics.

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