International Journal of Scientific Research in Science and Technology
Print ISSN: 2395-6011 | Online ISSN: 2395-602X (www.ijsrst.com)
doi : https://doi.org/10.32628/IJSRST523103117

Enhancing Fashion Recommendations: Deep Neural Networks for Personalized Outfit Suggestions

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ARTICLEINFO

Article History:
Accepted: 05 May 2023
Published: 30 May 2023

Publication Issue
Volume 10, Issue 3
May-June-2023
Page Number
576-581

ABSTRACT

Technology and Artificial Intelligence have a significant impact on all aspects of Fashion, from designing to production and consumption. Fashion has always been a forward-looking phenomenon, willing to adopt new technologies as they emerge. Artificial Intelligence is no exception as it moves as fast as Fashion. The AI has been used in analyzing fashion trends and consumer needs for over a decade. An AI- based stylist model is proposed based on fundamental fashion theory and the early work of AI in fashion. The implementation and performance of Neural Network used in the fashion domain are discussed in detail.

Keywords: Artificial Intelligence, Fashion, Clothing, Styling

I. INTRODUCTION

Artificial Intelligence (AI), often called machine intelligence, is the kind of Intelligence that machines show. The general purpose of Artificial Intelligence, an academic discipline that was founded in computer science in 1956, is to create technology that enables computers and machines to operate intelligently. According to the current state-of-art, AI is considered any device that perceives its environment and takes actions that maximize its chance of successfully achieving its goals. In short, therefore, AI is a machine that can learn and think, and can perform specific tasks independently. The traditional goals of AI research include reasoning, planning, learning, knowledge representation, language processing, perception, and the ability to move and manipulate objects.

Fashion experts are sceptical about if an industry built on creativity can be ever computerized completely. Fashion, as a materialization of human fantasy concerning the human body, shaping of the silhouette of the outfit, and creation of custom beauty, is eternally an art, an activity addressed to designers and artists. If AI, as augmented Intelligence, can help the human thinking process to focus on higher-value decision- making, arises a logical question: Can AI become a fashion designer? The answer is, unfortunately: Yes. The San Francisco based research centre of the giant merchandising Amazon was launched the year 2004. Lab126 has developed an algorithm able to recognize particular fashion styles

tracing on images; later, the tool can generate similar style new items.

The organization of this document is as follows: In Section 2 (Related Work), It will provide a detailed overview of the existing research conducted in this field. Section 3 (Proposed Work) will present the proposed system and analyse its findings. Lastly, in Section 4 (Conclusion), the document will conclude by summarizing the main points and outcomes of the study.

II. RELATED WORK

AI-enabled computer programs can assist customers in deciding how to wear their chosen fashions. They can process a lot of data quickly, pick up on specific users' styles, and retain user input. AI is anticipated to open the door to environmentally friendly solutions that can boost fashion product productivity while consuming less energy. Due to changes in the environment of information and communications technology, customers in the fashion sector are anticipated to have distinct characteristics from current consumers. This study examines strategies to actively include AI into design work in order to concentrate on more creative work, enhance designers' basic tasks, and apply AI in innovative design for complex systems.

Due to the COVID-19 epidemic, technology and big data are now used to support many facets of human existence, including fashion. The apparel industry has been using AI (Artificial Intelligent) technologies to reduce its carbon impact. It is less expensive and uses less energy when AI abstracts the similarities or differences between all apparel and collections from the dataset. Insights on the application of AI for analysis and prediction from a dataset or group of fashion images are provided in this article. Future AI will continue to develop, and designers and manufacturers will be able to prevent over- or under-producing by anticipating the trends of the next customer. To avoid unintended harmful effects in the future, it is vital for engineers and researchers to construct and develop AI ethically.

The use of artificial intelligence (AI) methods to the garment sector is covered in this article. It highlights the paucity of research on AI applications in the garment sector and discusses challenges in implementing AI technologies there. According to the research, neural networks, hybrid intelligence, simulated annealing, multi-agent systems, genetic programming, artificial immune systems, fuzzy logic, and genetic algorithms are the most often employed AI approaches in garment manufacturing applications. Due to severe barriers at various stages, the research challenges examined in prior studies are constrained, and the industrial usage of AI technology in the garment sector is still quite limited. Examining how different AI model parameters affect how solutions are produced may help to develop techniques for setting.

Artificial intelligence (AI) has been used in recent research on creativity support tools (CST) to help creative activity. With the use of a case study of an AI-based CST tool for fashion design, this paper seeks to clarify the function of AI in fostering creativity. Three cognitive activities (extending, restricting, and mixing) connected to divergent and convergent thinking were externalised to create AI models. We proved FashionQ's usefulness in supporting divergent and convergent thinking through interviews and user research with 20 fashion design experts. We also recognised potential and limitations of integrating AI in the ideation process. Based on the knowledge of experts, our findings emphasise the function and application of AI in each cognitive activity and offer potential future applications of AI-based CST development. Future efforts may be improved.

Back in 2000, Genetic Algorithms were used in a fashion design assistant system (Kim & Cho, 2000). Clothing colour styling model was proposed in the Virtual Stylist Project in (Tokumaru, Muranaka, &Imanish, 2003). Decision Trees with Genetic Algorithms were used to model individual's clothing

in (Kokol, Verlic, &Krizmaric, 2006). Researchers implemented Category Learning and Neural Networks in an intelligent clothing shopping assistant system in 2008 (Cheng & Liu, 2008). Computer Vision techniques with Support Vector Machine (SVM) classifiers were used to discover the semantic correlations between attributes in (Chen, Gallagher, &Girod, 2012)

Two earlier studies focused on predicting clothing colour fashion trends. Mello's team developed an expert system that assists the stylist with the proposal of new colour trends. Their system implemented a Bayesian Network model stylist proposing process (Mello, Storari, & Valli, 2008). Yu's team compared different AI models for predicting fashion color trends with an expert system (Yu, Hui, & Choi, 2012). There are many interesting models of fashion trends. One model on simplified general fashion cycles was of specific interest. This model has three major factors: base utility, social influence and user boredom (Sarma, Gollapudi, Panigraphy, & Zhang, 2012).

There is one very successful company called stitch fix that implement how AI and data mining can help to suggest clothes for customers. Using both human intelligence and Artificial intelligence. At Stitch Fix their business model is simple: They send you clothing and accessories they think you'll like; you keep the items you want and send the others back. They will leverage data science to deliver personalization at scale, transcending traditional brick-and-mortar and e-commerce retail experiences. Customers enjoy having an expert stylist do the shopping for them and appreciate the convenience and simplicity of the service.There is one very successful company called stitch fix that implement how AI and data mining can help to suggest clothes for customers. Using both human intelligence and Artificial intelligence. At Stitch Fix their business model is simple: They send you clothing and accessories they think you'll like; you keep the items you want and send the others back. They will leverage data science to deliver personalization at scale, transcending traditional brick-and-mortar and e-commerce retail experiences. Customers enjoy having an expert stylist do the shopping for them and appreciate the convenience and simplicity of the service.

III.PROPOSED WORK

While they are mostly focus on providing best cloths for their customers. We think you just suggest the clothes or recommend which outfit is best for them. Using a massive custom big dataset of body metrics. Having said that process those body metrics with fashion designers. A fashion designer they will have better understanding about what clothes is best for them. Using their input, it creates one dataset.

Popular AI methods used previously include Fuzzy Logic, Genetic Algorithms, Neural Networks, Decision Trees, Bayesian Networks and Knowledge Based Systems and their variations. But we used deep neural network to train the model.

3.1 DATA INPUT

As on initial basis we take 7 parameters as an input.

- Gender (Male/Female)
- Age
- Height
- Weight
- Chest size
- Waist size
- Skin color (black, dark, fair, mid, tan)

First, we are only going with t-shirt and jeans selection. We have total 5 category of t-shirt color. Each category has 5 different colors so that will be 25 t-shirt color. With that we have 3 categories of jeans. So, there are total 75 outfits.

T-shirt categories:

- Light
- Very light
- Mid
- Dark
- Very Dark Jeans categories:

- Very light
- Light
- Dark

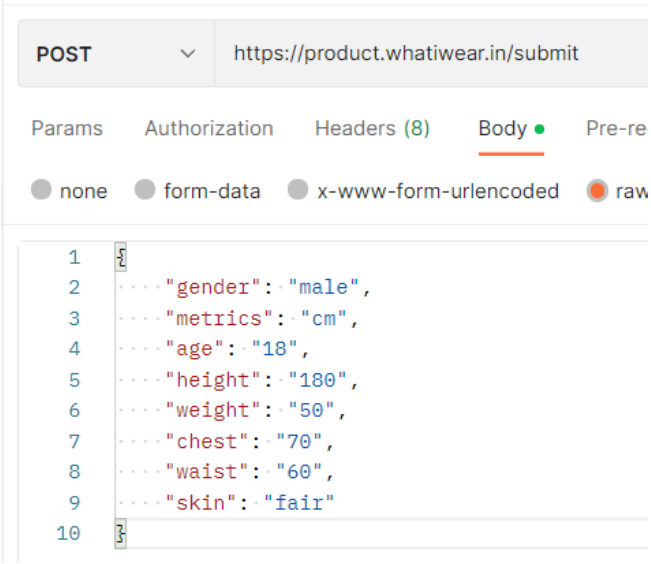

Figure 1. Data Input

Color:

Table 1. ColorCategorization

Light	#33618	#57BE	#96DC	#FFEED	#CD648

	B	D3	CC	E	C
VeryLight	#F1B9AC	#F4D291	#d4d4d4	#BBEDBE	#C0C6ED
Mid	#61BB46	#FDB827	#F5821F	#E03A3E	#963D97
Dark	#9B0E0E	#467A72	#AB7963	#132a9b	#583270
VeryDark	#323949	#423E3B	#011140	#083221	#3E1B34

3.2 DATA PRE-PROCESSING

gender	age	height	weight	Chest	Waist	color
2	18	160.02	60	20.32	35.56	fair
1	18	203.2	72	38.1	86.36	black
1	18	203.2	73	71.12	68.58	mid
2	18	208.28	75	71.12	68.58	mid
2	18	170.18	59	81.28	68.58	tan
1	18	167.64	56	43.18	106.68	fair
1	18	162.56	61	40.64	106.68	tan
2	19	172.72	62	78.74	71.12	mid
2	19	165.1	58	76.2	66.04	black

Figure 2. Data Pre-Processing parameters

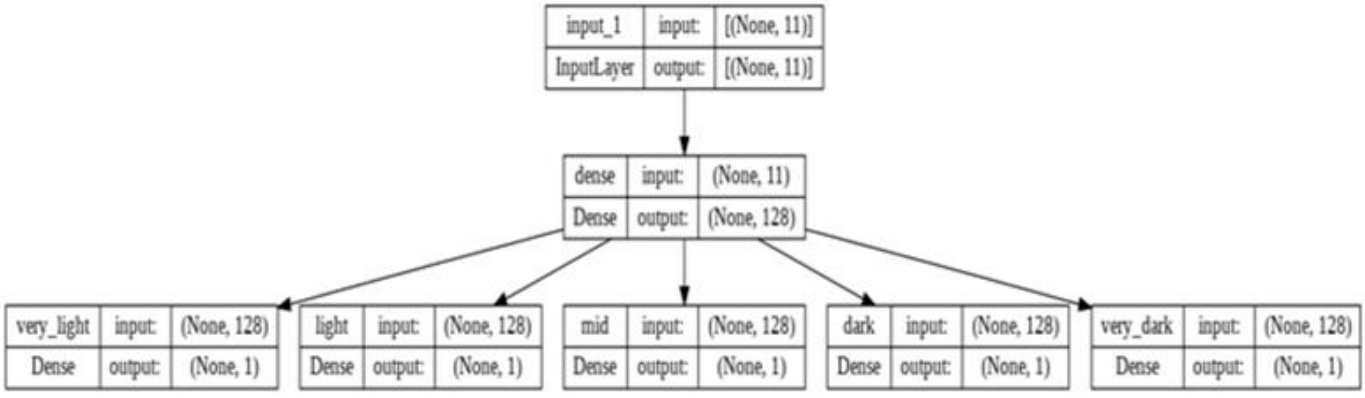

Figure 3. Proposed Model

Here we can see there are 7 different parameters which has different data types. So first we convert the colour column into 0 or 1 by using one hot encoder algorithm. So that will add up extra 5 columns because we have 5 different types of categories in colour section. So, our total input metrics will be n,11. Now we normalize the data and make to numpy array to better performance.

3.3 TENSORFLOW FUNCTIONAL API

The Keras functional API is a way to create models that are more flexible than the tf.keras.Sequential API. The functional API can handle models with non-linear topology, shared layers, and even multiple inputs or outputs. The main idea is that a deep learning model is usually a directed acyclic graph (DAG) of layers. So, the functional API is a way to build graphs of layers.

The sequential API allows you to create models layer-by-layer for most problems. It is limited in that it does not allow you to create models that share layers or have multiple inputs or outputs.

The functional API in Keras is an alternate way of creating models that offers a lot more flexibility, including creating more complex models.

Here we have 11 inputs nodes. We go for 128 node of hidden layer which is densely connected to input layer and 5 output layers. Here we predict for 5 different types outputs. There are very light, light, mid, dark, very dark. These 5 are t-shirt colour prediction. By default, we provide sigmoid activation function and Adam optimizer for better accuracy.

```
input_layer = tf.keras.layers.Input(shape=(11,))
hidden_layer = tf.keras.layers.Dense(128,activation='relu')(input_layer)
very_light_output = tf.keras.layers.Dense(1,activation='sigmoid', name='very_light')(hidden_layer)
light_output = tf.keras.layers.Dense(1, activation='sigmoid', name='light')(hidden_layer)
mid_output = tf.keras.layers.Dense(1, activation='sigmoid', name='mid')(hidden_layer)
dark_output = tf.keras.layers.Dense(1, activation='sigmoid', name='dark')(hidden_layer)
very_dark_output = tf.keras.layers.Dense(1, activation='sigmoid', name='very_dark')(hidden_layer)
output_list = [very_light_output, light_output, mid_output, dark_output, very_dark_output]
model = tf.keras.Model(inputs= input_layer, outputs = output_list)
model.compile(optimizer=tf.keras.optimizers.Adam(learning_rate=0.001),loss=['binary_crossentropy','binary_crossentropy','binary_crossentropy','binary_crossentropy','binary_crossentropy'], metrics=['accuracy'])
```

We trained our model using the 50 data entries we currently have with 150 epochs and a 0.001 learning rate. Our model's accuracy is 98 percent; however, however this can be further tested with larger dataset.

IV.CONCLUSION

Forbes Magazine highlights that AI is fundamentally transforming the fashion industry, from manufacturing to marketing and sales.AI-enabled improvements are already found in the fashion sector, with forward-thinking retailers using social networks to track and respond to fashion trends. Leading companies are powered by smart technologies, enabling higher speed, lower cost, and improved flexibility at every stage of the supply chain. AI capabilities include forecasting, analyzing new trends, choosing sustainable fabric and color combinations, designing desired cuts with zero waste, and organizing production processes in a flexible and sustainable way. Further in future proposed approach can be improved with larger dataset and explore the integration of additional fashion domain knowledge and expertise into the recommendation system to improve the performance and flexibility of the recommendation model.

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Cite this Article

Abhijitsinh Parmar, Ayush Rajgor, "Enhancing Fashion Recommendations: Deep Neural Networks for Personalized Outfit Suggestions", International Journal of Scientific Research in Science and Technology (IJSRST), Online ISSN : 2395-602X, Print ISSN : 2395-6011, Volume 10 Issue 3, pp. 576-581, May-June 2023. Available at doi : https://doi.org/10.32628/IJSRST523103117
Journal URL : https://ijsrst.com/IJSRST523103117