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Implementation of AI in Cosmetic Industry

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***Abstract* -The beauty industry is experiencing a relentless and dynamic evolution, primarily catalyzed by the driving force of innovation. This inevitability has been further propelled by the advent of Artificial Intelligence (AI), which has ignited an unprecedented wave of transformation permeating every facet of this vibrant sector. Al's advancements have left an indelible mark on various fronts, including but not limited to, the introduction and continual refinement of cosmetics, the delivery of highly personalized skincare recommendations tailored to individual needs, the enhancement of quality control procedures ensuring product safety and efficacy, and the refinement of consumer relationship techniques through advanced analytics and predictive modeling. This paper seeks to comprehensively explore and elucidate the profound influence wielded by Al in the cosmetic industry. It delves into the vast and multifaceted capabilities of Al in these domains, identifies existing obstacles and challenges, and envisions a myriad of possibilities for the future development and growth of the industry. The research underscores how Al, through its innovative applications and algorithms, has the potential to not only meet but exceed consumer expectations, elevating consumer experiences to unprecedented levels of satisfaction and engagement. By showcasing Al's ability to surpass consumer expectations and elevate experiences to unprecedented levels of satisfaction, this research underscores the transformative potential of Al in shaping the future landscape of the beauty industry.**

***Keywords*— Artificial Intelligence (AI), beauty industry, personalized skincare, virtual try-ons, innovation, quality control, consumer engagement, predictive modeling.**

I. INTRODUCTION

This growing and widespread industry is all about helping people improve their personal appearance, image and beauty. It encompasses every category of products such as skin care, cosmetics, hair care or perfumery. The tech trends has improved considerably over the last few years, and there have been salient developments in this sector. In the field of cosmetics, there was a remarkable approach on one horizon. It used cumbersome algorithms to carefully determine every person's skin type and worries as well as what they like best most in the world Consequently, they provide tailor-made product proposals and individual skin treatments. This paper examines the revolutionary trend of popularizing cosmetics, looking at its accomplishments and outlook.

1.1 A Historic Outlook on the Cosmetic Industry

For a full appreciation of how the cosmetics industry has developed over time, it is crucial to examine its historical origins. Cosmetics: a fascinating tale that traverses centuries capturing numerous cultural, social and industrial uproar in its course.

Ancient Ancestries: Cosmetics is one of antique inventions whose origins can be traced back to the ancient world, mainly through contributions of civilizations like the Egyptians, Greeks, and Romans. Such societies utilized natural ingredients like plants extracts and mineral for skin care, cosmetics, and perfumeries purposes varying from other societies. Notably. these early cosmetic practices encompassed a strong cultural and ritual dimension that reflects the pervasive presence of this art or science in these societies or cultures.

Medieval and Renaissance Periods: Cosmetics had narrow scope for use in Europe within the Middle Ages because of cyclical alterations of social norms and religious tenets. But this age saw an interest rise for personal grooming which is called the resurrection. Cosmetics were used by noble men and women not only for beauty but medical reasons as well.

18th and 19th Centuries: Cosmetic Production & Packaging Made Strides During the Industrial Revolution. Exotic ingredients and make-up technologies provided a commercial prospect for skincare and beauty. This era witnessed contribution of prominent personalities such as Helena Rubinstein and Elizabeth Arden in the cosmetic industry.

20th Century: Cosmetics as they are known, realized unparalleled growth that spanned the entirety of the twentieth century. As the outlines of mass production and branding increased the availability of cosmetic products to more consumers. Some memorable brands of this period include L'Oréal, Estée Lauder, and Revlon.

Contemporary Era: Innovation in the Cosmetic Industry of Two Decades. As a result, Al and ML have been revolutionizing the very nature of innovative product development, market sensitive advertising initiatives, and promotional schemes. For instance, simulated try-on tools and data-driven skincare solutions have

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completely redefined the consumer experience. Current, the beauty industry's historical background is rooted in different periods with multiple impacts in various cultures and diversity technological advancement for buyers who have evolved through time. Nevertheless, it has been advancing at all times. Innovative leader in advanced technologies.

1.2 The Role of AI and ML in the Cosmetic Industry

Using Al and machine learning in the beauty industry, has prompted radical transformation in it. This is very important as it helps craft personalized product recommendation. Through scrutiny of the special properties of one's skin, including its special features, needs, likes and dislikes, an AI/ML algorithm could offer personalized recommendations. Thus, it enhances customer satisfaction leading to stronger sales numbers. Furthermore, Al has contributed immensely in the realm of cosmetic concoction and refinement; it is renowned for being able to sense trends in the cosmetics world, and optimally blending of ingredients. The first thing it does is make the procedure of coming up with new products fast and ensure there is exceptional cosmetic product.

Similarly, the use of artificial intelligence in manufacturing of cosmetics has significantly improved the level of quality control within this area. This innovation leverages the capacities of computer vision and data analysis for detecting flaw and disparity in cosmetics goods. This keen observation ensures that there is maintenance of safety and quality standards, hence no low-standard products get to the consumers. In addition, chatbots and virtual assistant that are operated through Al are important in interacting with customer, give an insight on skincare products, how skincare can be done.

Al's authority reaches out even in market analysis and future prediction of industry fashions. It is relentless in pursuing the minutiae of market dynamics, tracking the shifts of customer taste, and delving into rival's tactics. The empowerment that results is geared towards giving beauty companies the know-how of making sound decisions on the new trends emerging and crafting products portfolio accordingly Besides that, AI plays an instrumental task in optimizing the supply chain within the cosmetics. It opens up a new worldview characterized by cost effectiveness, minimized waste and improved operationality through forecasting demands and adequately managing stock levels.

At present when sustainability consciousness is at its peak, Al transforms into a powerful tool, speeding up packaging process, reducing ecological footprints and designing environmentally friendly beauty products! This fits well into increasing consumer demand for eco-friendly options in the cosmetics market. Lastly, AI is instrumental in customization, which is an area through which AI can be described as leading. Thus, it inspires to the customization of tailor-made beauty formulas ranging from perfectly matching foundation shades to custom made fragrances that strike a chord an echo innermost perception to scents.

Additionally, Al goes beyond surface-level data about consumers to uncover valuable insights on attitudes & beliefs, customer population with unprecedented accuracy. As a watchful protector in the field of regulatory compliance, Al assumes an important role when it comes to monitoring the specifics such as ingredients, label correctness and safety requirements. With such careful supervision, any possible threat of lawsuits and products' withdrawal is reduced, thereby increasing customer confidence in the cosmetic industry.

In fact, that is not the end; Al extends its tentacles and assesses how suitable certain skin care alternatives would be in different situations. Leveraging on this understanding, it offers tailored skincare regimen and anti- ageing remedy, thereby enhances the effectiveness of such interventions. Finally, Al acts like a catalyst for innovations in the field of beauty sciences and painstakingly researches numerous scientific books. By performing this role, it remains a faithful friend to researchers enabling them discover new combinations and inventive techniques. To sum up, Al and ML become essential for the cosmetic industry as they drive innovation, enhance customer experience, and secure the sustainable development of the market considering changing consumer expectations.

Key points: -

1) Cosmetics History: Cosmetics can trace its historical background since ancient periods such as in ancient Egypt and Greece. During the middle ages, it witnessed occasional usage but it has grown significantly in this century.

2) Tech Transformation: Indeed, during the 21st century, the cosmetic industry has been transformed by technologies such as Al and ML. Skincare analysis, bespoke recommendations, and eco-friendly upgrades are a few of these services.

3) Al and ML Uses: They help track trends, strengthen customer ties and support "best" practices. These business firms ensure that businesses are able to invent and adjust to shifting markets dynamics.

4) Business Benefits: This allows companies to customize their products and services in a way that caters to the needs of technology enthusiasms.

5) Future Outlook: Customisation is another advantage of the cosmetic industry and AI will undoubtedly be involved in that future.

II. PROBLEM STATEMENT

Considering the growing attention paid to and application of AI technologies in the sphere of cosmetics, it seems highly reasonable to take a close look at potential obstacles and restrictions that may hamper their effective implementation.

This research paper will firstly highlight and tackle head-on the problems blocking development.

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III. METHODOLOGY

3.1 Prologue

Many recommendation models are used during the development of recommendation systems. The models consist of Collaborative Filtering, Content-Based Filtering, Hybrid Recommendation Systems, and Knowledge-Based Recommendation Systems.

1. Collaborative filtering is a well-known and used recommendation system's technique. Such an approach is based on the notion of user-to-user or item-to-item similarity, which assumes that users/items that have shown similar interactions or preferences in the past will do so in the future. Collaborative filtering is the most effective type of filtering when there is substantial user interaction information in the system, such as user ratings, purchase history or user behaviour logs.

2. Unlike collaborative filtering, which relies on the interactions of all users to make recommendations, content-based recommendation is a recommendation system paradigm whereby item suggestions are given based on the attributes or content of those items, as well as the user's profile or preferences. It is done through detailed item attributes evaluation to suggest items analogous to the ones that have attracted the user in the past. Content-based recommendation systems have applications across many areas, such as e-commerce, music, cinema, news and others.

3. The hybrid recommendation systems are a juxtaposition of two or more different recommendation algorithms. They seek to offer recommendations that are not only more accurate but also varied and personalized. The main purpose of hybrid recommender systems is to utilize the strength of each recommendation algorithm to compensate for the weakness of 20 other. This method can thus be considered as a general tool in order to improve the overall quality of recommendations that adequately resolve the problems arising from different recommendation scenarios.

4. Knowledge-based recommenders Or rule-based recommenders, knowledge-based recommendation systems are another branch of recommendation systems. The system variant adds personalized recommendations for users by using knowledge about items and user preferences that were declared explicitly. Unlike the reliance on historical user interactions or item features as in collaborative filtering or content-based recommendation systems. the knowledge-based recommendation system is built on domain-specific knowledge or predefined rules that drive the recommendations.

Steps for Implementation

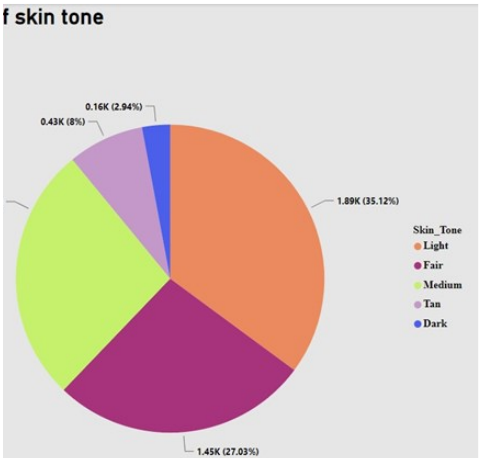
3.2 Steps for Implementation

A. Data Collection:

In order to construct a dataset of make up or skincare products with a large coverage, we need a number of techniques. One option is taking into account e-commerce sites focused on beauty and skincare goods. Such platforms usually provide structured data on product listings such as ingredient lists and user-generated reviews. Through web scraping, the data could be retrieved either systematically or via extraction, ensuring that extracting relevant information such as products' names, ingredients, users' ratings, and reviews is carried

Moreover, beauty forums and online communities created for skincare and makeup lovers are helpful tools. On these Web sites, discussions take place on topics where users exchange about their experiences, preferences and the ratings given to different products. Scraping data from these forums gives insights into sentiments of users, common preferences and the emerging trends in the beauty industry. Thus, we have chosen a csv file of skin care routines which con enter all the requirements indicated above.

Types Of Skin Tones: -



B. Data preprocessing:

Data preprocessing is an extremely important phase in preparing a dataset to be used in machine learning applications especially in the area of makeup and skincare products. The first step entails identification and removal of duplicate records for preservation of dataset consistency and to avoid bias in subsequent analyses. Solving for missing values, endemic in fields such as ingredients or user reviews, is crucial. It is possible by techniques, for example, imputation or removal of incomplete instances. Text cleaning, a core aspect, involves tasks such as transforming text to lowercase, deleting special characters, and dealing with abbreviations. Tokenization, the breaking down of text into sub-units like words or phrases, assists in feature extraction. Feature vectors that are significant in the machine learning perspective for the task in hand could also entail ingredient frequencies, sentiment scores from user reviews, or other relevant features. Using methods like TF-IDF it is possible to process text data into numerical representations, which in turn is a way of making machine learning algorithms compatible with text data. In the end, transforming the dataset so as to accommodate numerical representations of the categorical variables and the standardization/normalization of the numerical features, ensure the uniformity and optimal performance of the machine learning models. Precision-oriented data preprocessing paves the way for accurate, reliable, and efficient machine learning analysis in the cosmetics industry.

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C. Feature Engineering:

Numerous feature extraction methods can be employed to obtain important features which in turn leads to benefit of the dataset for machine learning apps. For textual data such as product descriptions and user reviews the TFIDF (Term Frequency-Inverse Document Frequency) method can be adopted. Unlike other techniques that count the frequency of words in a document, TF-IDF incorporates also rare words, whose ability to inform the similarity of two documents is equally important as the frequency of common ones.

Instead, word embeddings, like Word2Vec or GloVe, can be employed to represent words as dense vectors in a continuous vector space. This method recognizes semantic relations between words which gives a richer depiction of textual meaning.

Regarding product images, image embeddings offer a powerful way out. Methods such as convolutional neural networks (CNNs) can be applied to extract features from images, thus human visual features are represented in a machine learning friendly form.

The combined application of these techniques gives rise to a multi-modal feature set including both textual and visual information. This enriched feature space provides a more complex representation of makeup and skincare products, leading to the development of more sophisticated machine learning models that can benefit from the variety of data aspects for applications such as recommender systems, sentiment analysis, or trend prediction in the cosmetic industry.

D. Model Selection:

Making the right choice of machine learning algorithm is very important in the domain of recommendation systems of makeup and skincare products. Several standard approaches are available, each of which brings specific benefits. In collaborative filtering, user-item interactions play a major role in making recommendations as it analyses user behaviour to determine the preference patterns which are compared to similar sets from other users. Differently, the content-based filtering recommends items based on their attributes and, thus, is good for suggesting comparable products, which the customer has liked in the past. Matrix factorization techniques decompose the user-item interaction matrix to extract latent factors that constitute preference drivers, providing a powerful way to represent complex dependencies in the data. Besides, the deep learning models, for example, neural collaborative filtering, provide the neural networks to explore the complex patterns and connections, thus enabling them to perform well on big and complex datasets. The right choice of algorithm is based on the specific features of the dataset and the aimed result, and thereby considerable thought should be given to aligning the selected model with the objectives of the recommendation system in the cosmetic industry.

E. Training the Model:

Product recommendations systems makeup and skincare are the context for the training of selected models. The training of this models is the most important part. The dataset is carefully curated and an appropriate machine learning algorithm is chosen from many options including collaborative filtering, content based filtering, matrix factorization or neural collaborative filtering. After that the model is applied to the prepared dataset. Training is the iterative tuning of the model's parameters to detect correlations and articulate between the data.

To ensure the robustness and efficiency of the model, established techniques, such as cross validation, are used. The model is trained and tested on different datasets making possible the evaluation of behaviour under the unknown circumstances and picking up regions where it could be improved.

Hyperparameter optimization is vital in taking model adjustment to the next higher level. These parameters are not coming from the data but, in fact, are the key for good performance. The iterations are carried out after cross-validation. This stringent calibration enhances the model's precision and stability while making recommendations.

The training process, marked by its fluid and cyclical nature, demands continued tracking and updating in order to hit the targeted degree of accuracy and generalization. Once the model is well trained and validated, it is ready for deployment and is geared up to present customized recommendations to the customers of the beauty industry using the makeup and skincare product dataset.

F. Recommendation Engine:

The last step of the makeup and skincare products recommendation system is the creation of an interactive recommendation engine. It is created to obtain the user input and provides personalized product suggestions using the knowledge gained from the already trained model. The recommendation system can accept user preferences including product categories that they like, skin issues or ingredients they want.

The engine uses the trained model to make predictions based on the input and the historical data provided. It covers the algorithm’s capability of detecting patterns, similarities, and correlations within the data set and subsequently provide pertinent recommendations based on the specified user's criteria.

The design of the user interface of the recommendation engine can be user-centred, allowing users to input their preferences and get customized recommendations without any stress. Regardless of the medium being a web application, mobile app or another interface, the idea is to make the recommendation process to be smooth and interesting for the users.

Through the deployment of this recommendation engine, users have a chance to enjoy custom recommendations of makeup and skincare products based on their individual

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needs and tastes. This not only improves the usability but also enhances the performance of the advocate system in the cosmetic industry which helps in narrowing the gap between consumer choices and the diverse range of alternatives available.

G. Build User Profiles:

For the purpose of improvement in personalization of product recommendations, the creation of user profiles becomes crucial. The profiles are created utilizing different factors of the different users such as select preferences, skin type, concerns about skin, and preferences in makeup. This purposeful information can be obtained by using user-centred surveys and input mechanisms. These tools give users opportunity to express their custom preferences which are integrated into technologies advanced by the platform.

Such surveys or input mechanisms allow users to disclose the details of their favourite makeup looks, particular skincare requirements as well as other skin-related issues. This information constitutes the basis for developing all-encompassing user profiles that capture the essence of personal choices within the realm of makeup and skincare.

The formation of these user profiles allows the recommendation engine to customize its output to match the unique requirements of each person. Identification of distinctive features and tastes of customers enables recommendation system to offer more precise and appropriate products to users, which all enhance the user experience in beauty field.

H. User Interface:

To make the interaction simpler between the user and the recommendation system, a user-friendly interface is designed, accessible through the web application or mobile app. This interface acts as the user entry point for entering the preference information, and finally, the user receives the personalized product suggestions.

The interface is designed with a mindset of simplicity and ease of use. The efficient and attractive design elements of the platform help users to easily maneuver the platform to submit preferences. The interface (GUI) uses interactive forms allowing users to input product preferences such as makeup styles, skin type, skincare concerns among others.

Upon provision of user preferences, the interface smoothly interfaces with the recommendation engine using the acquired data to produce individualized product recommendations. The recommendations are hence presented to the user in a manner that is both informative and visually pleasing, thereby improving user experience.

Regardless of the access method, whether it is through a browser or a handheld device, a user experience interface is created in such a way that individuals looking for customized makeup and skincare product recommendations have an easy time. This solution also ensures user engagement and at the same time endorses the functionality of the recommender system in meeting the diverse requirements of people in cosmetic sector

I. Feedback Loop:

As a continuous method to improve the efficiency of the recommendation system, an important part is the adoption of a feedback mechanism. This mechanism provides users with an opportunity to provide feedback upon recommended products which in turn fuels an ongoing and continuously improving process.

The feedback loop is set to be user appropriate, allowing users to voice off their personal experiences and opinions. Users might provide comments containing the relevance, satisfaction or other secondary preferences not included in the initial recommendation. This vital input constitutes the cornerstone data which can be introduced into the recommendation system for enhancing and adjusting its algorithms.

The captured user feedback is systemically analysed to surface the detectable patterns, trends, and improvement areas. The iterative process enables the recommendation system to respond to user preferences evolution, emergence of cosmetic trends, and fluctuations in product availability. Through the years the feedback loop incrementally makes the system more responsive and accurate. Thus, it meets the diversified and changing needs of the user base.

Through active engagement of users in the refinement process, the feedback loop not only continuously improves the recommendation system, but also fosters the cooperative user-oriented approach in the makeup and skincare product recommendations.

3.2 Algorithms

```
import pandas as pd
import numpy as np
import re
import matplotlib.pyplot as plt
import numpy as np
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import accuracy_score
from sklearn.metrics import f1_score
from nltk.tokenize import RegexpTokenizer
from nltk.stem import WordNetLemmatizer


df = pd.read_csv('skindataall.csv', index_col=[0])
df.head()
```

EDA AND DATA VISUALIZATIONS

```
skintone_stats = df.groupby('Skin_Tone')['Username'].count()
skintone_stats.plot.bar(color = 'brown', rot=45)
```

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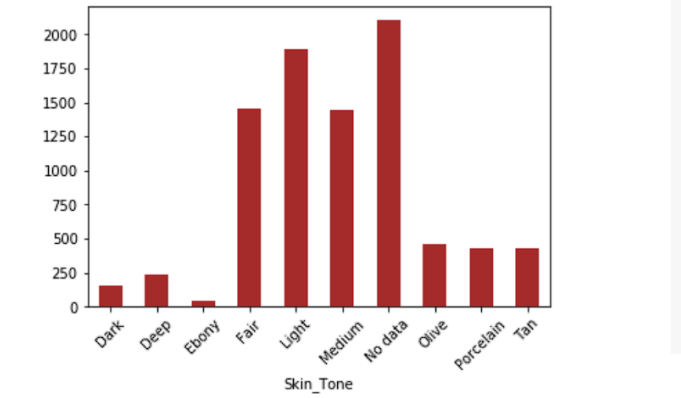
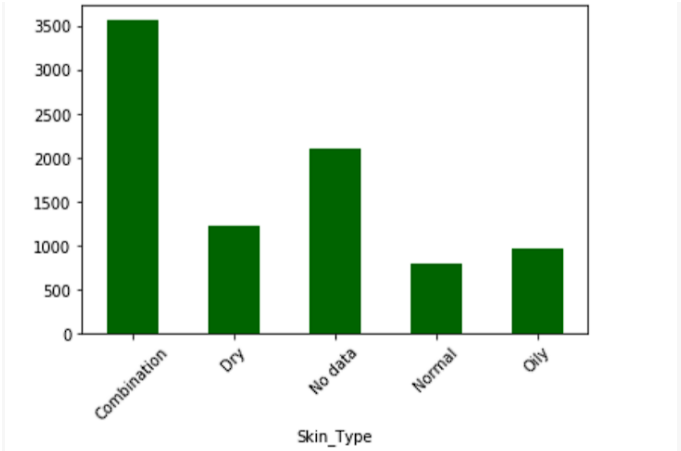
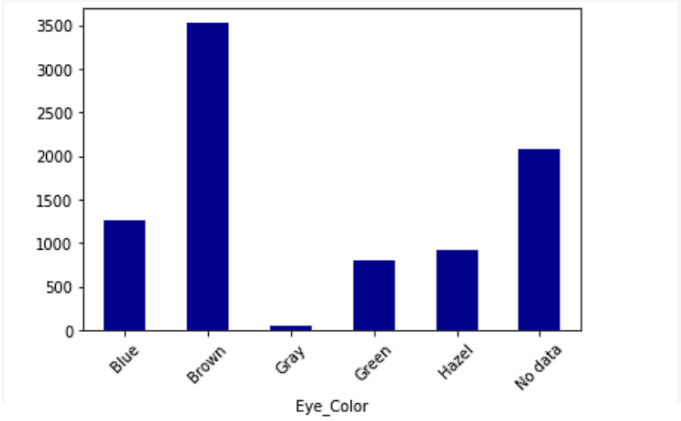


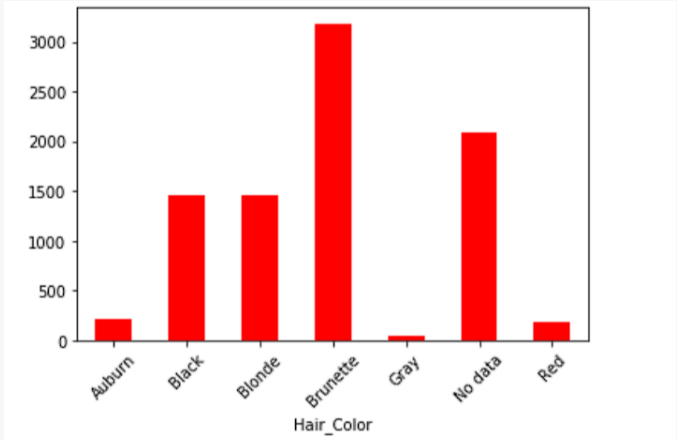

```
skintype_stats = df.groupby('Skin_Type')['Username'].count()
skintype_stats.plot.bar(color = 'darkgreen', rot=45)
```



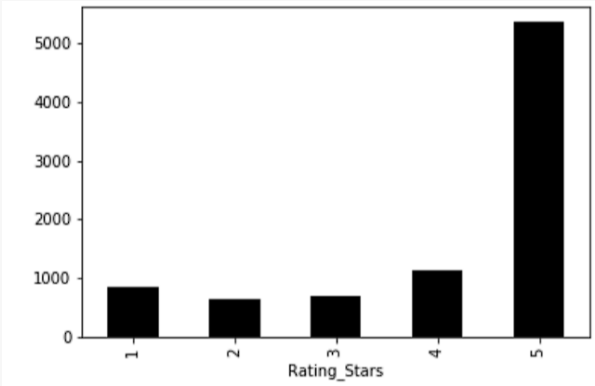

```
eyecolor_stats = df.groupby('Eye_Color')['Username'].count()
eyecolor_stats.plot.bar(color = 'darkblue', rot=45)
```




```
haircolor_stats = df.groupby('Hair_Color')['Username'].count()
haircolor_stats.plot.bar(color = 'red', rot=45)
```




```
rating_stats = df.groupby('Rating_Stars')['Username'].count()
rating_stats.plot.bar(color = 'black')
```



NLP: WORDCLOUDS AND CLASSIFICATION

```
from os import path
from PIL import Image
from wordcloud import WordCloud, STOPWORDS, ImageColorGenerator
generate_wordcloud(negative)
```


```
generate_wordcloud(positive)
```

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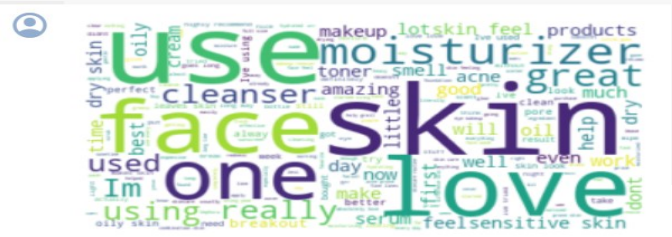

Quality and effectiveness check

What makes a user give a five star rating to a product? Probably visible results of using it. If a woman buys a cream that erases her wrinkles after a week of using it, it is expected that she will go to the website and write a positive review. But what makes a high quality product? Define not the package -- it's ingredients that work! Can we predict whether or not the product will get a 5 star rating just using its ingredient list?

```
accuracy 0.6093388811835414
              precision    recall  f1-score   support

           1       0.58      0.04      0.08       856
           0       0.61      0.98      0.75      1307

   micro avg       0.61      0.61      0.61      2163
   macro avg       0.60      0.51      0.42      2163
weighted avg       0.60      0.61      0.49      2163
```

MODELING RECOMMENDERS

```
from surprise import Dataset, Reader
from surprise import SVD
from surprise import accuracy
from surprise.model_selection import cross_validate
from surprise.model_selection import train_test_split as tts
from surprise.model_selection import RandomizedSearchCV
```

```
RMSE: 0.1155
MAE:  0.0664
0.06636878490542372
```

1. Recommender that uses the customer features only to recommend the products

Based on your features, these are the top products for you:

	Rating_Stars	Product_Url	Product
349	5	https://www.sephora.com/product/bi-facil-doubl...	Bi-Facil Double-Action Eye Makeup Remover
1977	5	https://www.sephora.com/product/ultimate-mirac...	Ultimate Miracle Worker Multi-Rejuvenating Cre...
2800	5	https://www.sephora.com/product/aqua-bomb-slee...	Aqua Bomb Sleeping Mask
2918	5	https://www.sephora.com/product/vitamin-c-anti...	Vitamin Nectar Antioxidant Face Mist
2944	5	https://www.sephora.com/product/peat-miracle-r...	Peat Miracle Revital Cream
2998	5	https://www.sephora.com/product/gold-camellia-...	Gold Camellia Beauty Oil
350	5	https://www.sephora.com/product/bi-facil-doubl...	Bi-Facil Double-Action Eye Makeup Remover
3525	5	https://www.sephora.com/product/the-cleansing-...	The Cleansing Foam
3999	5	https://www.sephora.com/product/clean-bee-ultr...	Clean Bee Ultra Gentle Facial Cleanser
4069	5	https://www.sephora.com/product/time-release-a...	Time Release Acne Cleanser

2.Collaborative filtering with Lightfm

```
from scipy import sparse
from lightfm import LightFM
from sklearn.metrics.pairwise import cosine_similarity
from lightfm.evaluation import auc_score
from lightfm.evaluation import precision_at_k,recall_at_k
```

Product_id	0	1	2	3	4	5	6	7	8	9	...	305	306	307	308	309	310	311	312	313	314
User_id																					
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

5 rows × 315 columns

```
Collaborative filtering AUC: 0.9999994
Train precision: 0.0729
```

3.Content-based recommendations using Ingredients of the product

```
from sklearn.metrics.pairwise import linear_kernel,
cosine_similarity
```

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	Product	Ing_Tfidf	Rating
38	The Essence Plumping Skin Softener	saccharomyces, camellia, sinensis, leaf, clado...	4.4
90	Gold Camellia Beauty Oil	caprylic, capric, triglyceride, ethylhexyl, pa...	4.6
108	Purifying Cleansing Gel	hydrogenated, starch, hydrolysate, diglycerin,...	4.5
165	Clear Complexion Cleanser	hydrogenated, starch, hydrolysate, disodium, c...	4.4
43	Luminous Dewy Skin Mist	glycerin, squalane, olive, origin, cyclopentas...	4.0
115	EradiKate® Daily Cleanser Acne Treatment	sodium, cocoyl, isethionate, coco, glucoside, ...	4.3
135	Detoxifying Black Charcoal Cleanser	glycereth, glycerin, sodium, cocoyl, glutamate...	4.3
307	Breakout Fighters	sodium, cocoyl, isethionate, coco, glucoside, ...	4.0
217	United State™ Balancing Tonic	lavandula, angustifolia, lavender, flower, ext...	4.3
276	GenOptics Aura Essence Serum	galactomyces, ferment, filtrate, pitera, niaci...	4.1

```
import dash
import dash_core_components as dcc
import dash_html_components as html
from dash.dependencies import Input, Output
import base64

import pandas as pd
import numpy as np

import sklearn
from joblib import dump, load
import matplotlib.pyplot as plt

import ast
from scipy import stats
from ast import literal_eval
from sklearn.feature_extraction.text import TfidfVectorizer, CountVectorizer
from sklearn.metrics.pairwise import linear_kernel, cosine_similarity

from nltk.stem.snowball import SnowballStemmer
from nltk.stem.wordnet import WordNetLemmatizer
from nltk.corpus import wordnet

from surprise import Reader, Dataset, SVD
from scipy import sparse

from lightfm import LightFM
from lightfm.evaluation import auc_score
from lightfm.evaluation import precision_at_k, recall_at_k

import pickle
```

```
df = pd.read_csv('/content/skindataall1.csv', encoding='ISO-8859-1', index_col=[0])
with open('/content/mf_model.pkl', 'rb') as f:
 mf_model = pickle.load(f)
```

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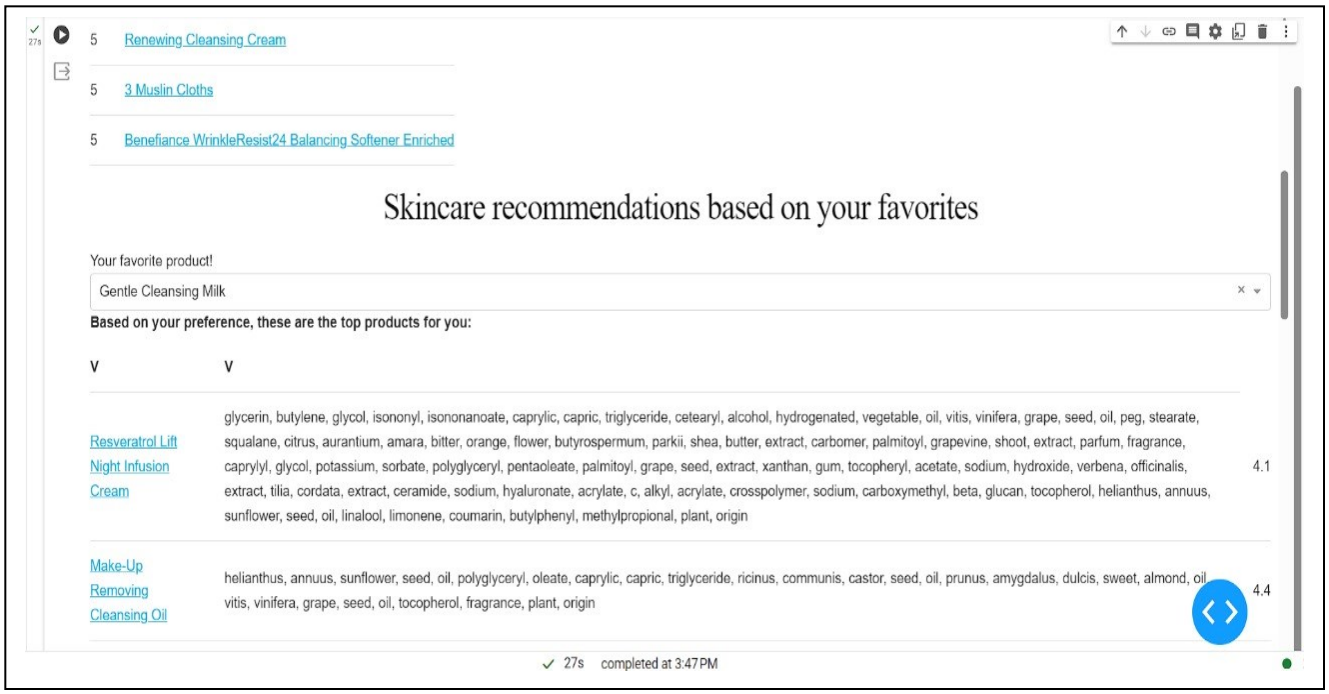

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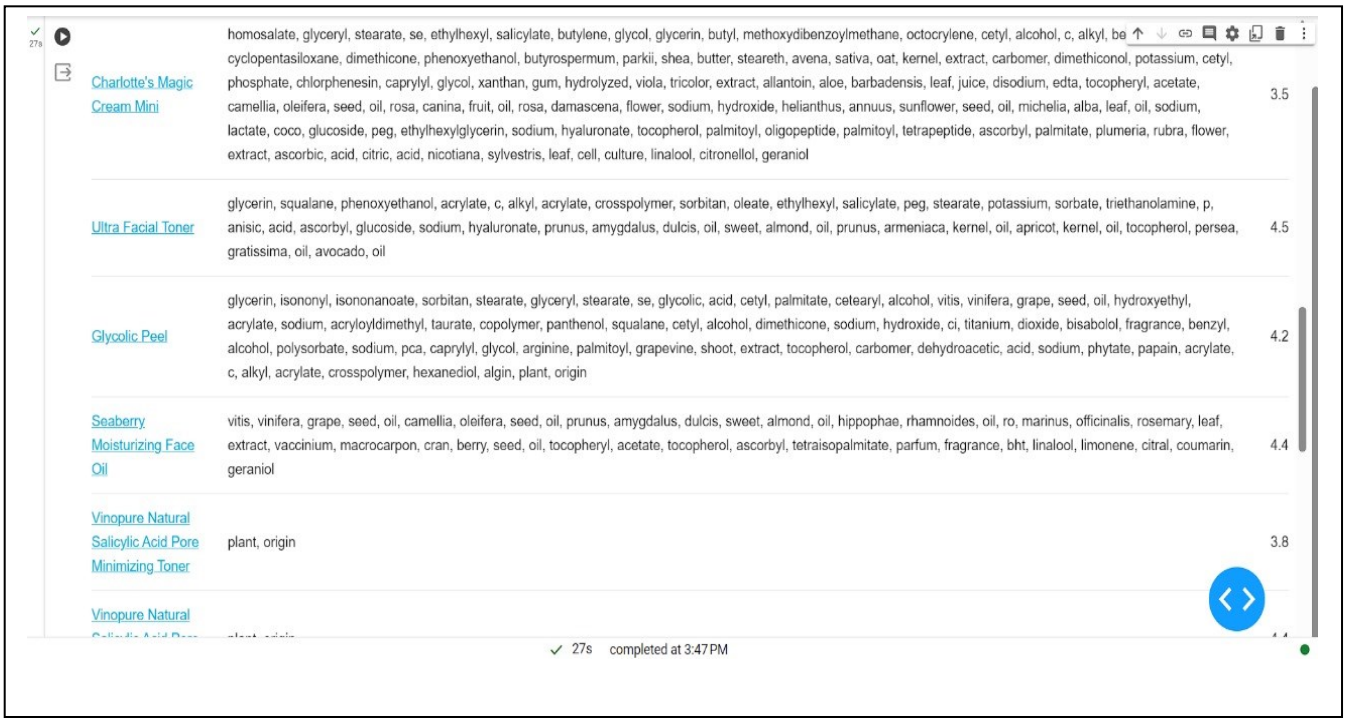

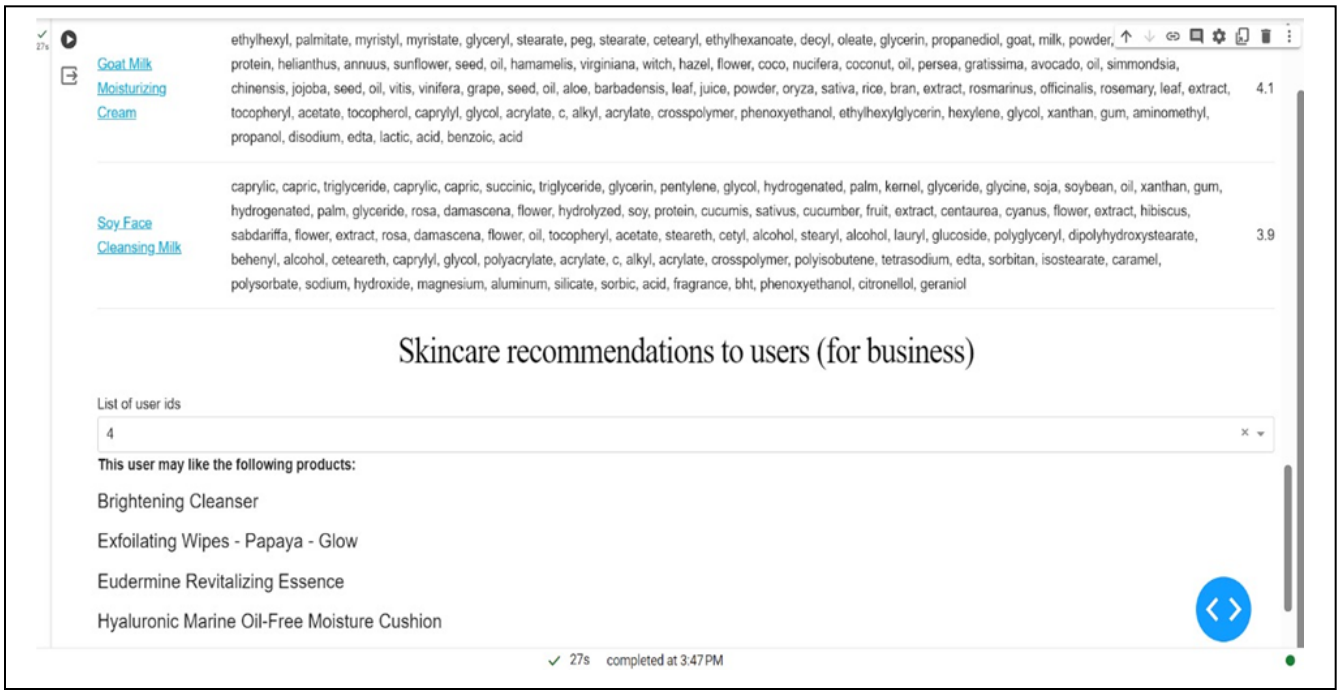

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Table 1: -

Input from user	**Input displayed on display**	**Output from system**
Skin tone	**Select your skin tone**	**Based on your features these are the top products for you** (the list of products that match the features will be displayed from the csv file)
Skin type	**Select your skin type**	**Based on your features these are the top products for you** (the list of products that match the features will be displayed from the csv file)
Eye colour	**Select your eye colour**	**Based on your features these are the top products for you** (the list of products that match the features will be displayed from the csv file)
Hair colour	**Select your hair type**	**Based on your features these are the top products for you** (the list of products that match the features will be displayed from the csv file)

Table 2: -

Input from user	**Input displayed on display**	**Output from system**
Your favourite product	**User input** (name of the product given by user)	**Based on the preference these are the top products for you** (The recommendation model will recommend based on the user's favourite product)

Table 3: -

Input from user	**Input displayed on display**	**Output from system**
List of user id's	**User input** (number of id's given by user)	**This user may like the following products** (The recommendation model will recommend based on the user's data)

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IV. CONCLUSION

In the end, our work has investigated the concept and tooling of the personized recommender system of skincare products based upon users' profiles and interactions. By collecting data, preprocessing and model training, we have shown the efficiency of collaborative filtering and content-based filtering techniques in creating personalized recommendations for skincare enthusiasts.

With the use of user features such as skin tone, skin type, eye colour, and hair colour our recommendation system provides customized product suggestions that match the preferences and needs of individuals. Integration of collaborative filtering models like SVD (Singular Value Decomposition) and Logistic Regression to the system facilitates the system to learn latent features of products and users hence improving accuracy and relevance of recommendations. Also, our research emphasizes user feedback, customization options, and allergy awareness in providing a satisfactory user-experience. We have suggested backup plans, like fallback to general recommendations, user feedback mechanisms and symptom recognition features, to tackle possible weaknesses of the recommendation system including recognizing allergies not initially present in the system.

Overall, our work expands the field of personalized recommendation system for skincare products by discussing algorithmic approaches, user centric design considerations and backup strategies for varying user needs. Turning to future studies, progress in this direction will improve efficacy and usability of skincare recommendation systems so that users are able to make right decisions for better skin health.

FUTURE SCOPE

In the world of skincare recommendation systems there is loads of possibilities for new discoveries and advancements to be made. Here's a look at some areas where we could make big strides:That divides the test into two cases.

1. Using Fancy AI and Machine Learning: We could delve into the recent AI and machine learning techniques, such as deep learning and reinforcement learning, to implement skincare recommendations that are more precise and customized. These advanced techniques notice even the smallest particulars that define everyone's skin.

2. Combining Different Kinds of Data: We will learn how we can merge various types of data, such as reviews, pictures and what people post online to have more information of what people look for and the products. It's all about returning better more comprehensive suggestions.

3. Making Recommendations Fit the Situation: Our recommendation systems could get still smarter if we apply the factor like season of the year or the environment one is into. Like this, you'll be offered ideas that fit your situation perfectly.

4. Personalized Skincare Plans: Why not aid people in developing their own custom skin routine instead of just recommending products? We could provide specific instructions on what to use and when as also the 'when' is a function of mobility and this varies from person to person.

5. Bringing in Expert Knowledge: Powered by the collaboration of dermatologists and skincare specialists, we could advance our recommendations by combining their expertise with the knowledge of what substances are effective. It's all about providing people scientifically proven advice.

6. Using Phones and Wearable Gadgets: By synching our app and gadgets with devices you can wear we will be able to monitor your skin health in real time. It means this answer would vary depending on your complexion during that time.

a.

7.Global Expansion and Localization: Take skincare recommendation systems to wider global markets by adding the regional-specific tastes, cultural aspects and the current product availability. Localization attempts make sure that the suggestions will appeal to users coming from different demographic and geographical backgrounds.

b.

8. Ethical Considerations and Privacy Protection: Deal with the ethical issues and privacy concerns that occur at the time of collection, storage and usage of user data. Establish sound privacy guardrails and open data policies to foster user trust in the recommendation system.

Through these avenues of future scope, skincare recommendation systems will continue to grow and develop becoming an essential element to provide users with tools to make educated choices and achieve the optimal skincare results in a personalized and technology based industry.

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