Leveraging Real-Time Weather Data and Rule-Based Modeling for Automated Outfit Recommendations: A Machine Learning-Oriented Framework

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***Abstract*—In this project we are introducing a Weather Based Outfit Recommendation System. It recommends clothes as per the current day weather, information pulled from the OpenWeather API. It contains a rules-based engine to deal with temperature, rain and humidity. It spits out outfit advice based on the context it's given I.e.: recommending to layer up when it's chilly and keep clothing light on hot days. The user interface of the application, built with React.js, is fast and user-friendly. It is responsive, so weather conditions and the related clothing suggestions will appear on all devices. The scope of testing was quite extensive and it proved that the system's accuracy and reliability were the same throughout all weather scenarios and thus it is practically useful for daily use. This solution not only saves decision-making time but also increases comfort by suggesting weather-appropriate clothes. The entire implementation with source code and documentation can be found on GitHub, which is open for community sharing and further development. This implementation is a perfect example of how automated systems can indeed enhance the quality of life of people by making their day-to-day tasks easier, at the same time laying down a ground for future improvements like the use of machine learning and personalized style recommendations.**

***Index Terms*—Outfit Recommendation, Weather API, React.js, Rule-Based System, Automated Fashion, Decision Support System**

I. INTRODUCTION

The world is filled with the micro decisions that everyone makes every single day, including choosing what to wear. This choice may seem trivial, but it is crucial for remaining comfortable and healthy development ready for the day's weather [14]. Even so, outfitting myself for the weather requires increasingly more time and effort to do it right. The ever- changing and often unpredictable weather with sudden temperature variations, unexpected rains, or changes in humidity, usually results in discomfort and inconvenience. Thus, a colossal daily gap is created between a person's intention to dress comfortably and their ability to foresee and react to the meteorological data accurately. The rapid advancement of web technologies and API services presents a unique opportunity to overcome this daily challenge through intelligent automation. Solutions available today are often not responsive enough or do not offer practical, actionable recommendations that are specifically designed for the current weather conditions. This, however, is where this project comes in as it intends to.

We connect live weather data with personal outfit advice using modern web development tools. This allows us to provide a quick and reliable service. To effectively fill this need, we propose developing and implementing an automated Weather-Based Outfit Recommendation System. The principal aim of this endeavor is to reduce the cognitive burden of selecting an outfit by means of a user- friendly, data-led, and context-aware clothing recommendation. The system will be energized by the real-time weather intelligence which will become part of the user's daily routine, and then the raw meteorological data will be turned into actionable. You are able to give personalized fashion advice. The automation of this decision- making process not only leads to the saving of precious time but also the user's daily comfort and weather preparedness are improved. The system that has been proposed rests upon a strong

technical ground. The OpenWeather API is the main data source, and the system is tapping into it for obtaining the important parameters such as temperature, humidity, and rain-fall. A rule-based recommendation engine processes this real-time data, which applies a set of predefined logical conditions. For example, when the temperature is below 15°C, the engine will suggest warm layers like jackets or when the temperature is above 25°C, the engine will suggest light and breathable cotton fabrics with similar logic considering rain and humidity too. The whole user experience is provided through a web application that is responsive and intuitive, and it is built with the React.js library, which ensures that it is accessible on a diverse range of devices including desktops and smartphones. As a result, this project not only proves that a properly designed, rules-based system can automate a widespread decision-making process and thus, increase the comfort and convenience of daily life, but also demonstrates how software solutions can solve the problems that people face daily. In addition, the system is made with future extensions in mind, thus laying a strong groundwork for coming changes. Among the possible developments is the use of machine learning models to provide very personalized style suggestions, taking user closet data into consideration, and integrating more complex aspects such as wind chill and UV index. The project intends to offer a working prototype and to provide the source code on GitHub so that it can be accessed freely by everyone in order to contribute to the field of intelligent decision-support systems and to inspire further innovation in personal automation technologies, thus, eventually leading to the development of more adaptive and smart personal assistant systems in the future.

II. DATASET

Although this project focuses on the real-time data collection from OpenWeather API, we created a rule-based recommendation engine that was built and validated based on an additional structured dataset that we specially prepared for this task. The above-referenced dataset was organized to represent various meteorological conditions, and included major weather variables: temperature (cold:25°C), humidity (low:70%), precipitation amount (none/light/moderate/heavy) and wind velocity (calm: ¡10 km/h, moderate: 10-25 km/h, strong: ¿25 km/h). Each weather scenario was systematically mapped to appropriate outfit categories such as heavy jackets with thermal wear for cold and rainy conditions, light cotton wear with sun protection for hot and humid weather, and layered clothing with windbreakers for moderate temperatures with high wind speeds. This comprehensive dataset enabled methodical testing and refinement of the recommendation logic through multiple iterations, ensuring the system's accuracy and reliability across various climatic conditions before deployment with live API data for real-world application.

III. LITERATURE SURVEY

By integrating user preferences with weather data, S. Chen et al. developed a context-aware system [19] to tackle the problem of personalized outfit recommendations. Their approach was based on collaborative filtering and temperature-based rules for suggesting the right clothing, thus proving to be more accurate than basic recommendation systems. Nevertheless, the system's ability to adapt to real-time conditions and respond to abrupt weather changes is limited, which draws attention to the need for more dynamic solutions [1].

A travel outfit planning tool based on combining weather APIs with machine learning was proposed by M. Rodriguez et al. The engine is a hybrid one that takes its input from the weather APIs. The computer system studies past weather conditions and users' input and then suggests travelers the most suitable packing to be done. The application that was built using React Native for interoperability among several platforms showed a remarkable level of user satisfaction but had to deal with a difficulty regarding the processing of several weather parameters at the same time [3].

K. Patel and his colleagues were investigating the possibility of including real-time weather information in smart wardrobe applications. They carried out their study to develop a rule-based system that would use the OpenWeather API to indicate daily clothing depending on temperature ranges and chance of rain. The study was successful in terms of basic functionality but brought up the issues of personalization and style adaptation, thus proposing

deep learning models as a solution for the future integration [4].

A research group led by Zhang, among others, introduced a clothing recommendation system that utilized decision trees and meteorological data. The system assigns a quality of the clothing item depending on the current weather and user preferences, resulting in a recommendation accuracy of 78%. The study pointed out that for complete recommendations, not only temperature data but also calculations of humidity and wind speed should be considered [5].

Another research work led by A. Kumar with co-authors included developing a mobile app based on React.js that through a rule-based engine gives weather-considered out-fit suggestions. The application by the authors adapts the clothes' category based on the specified temperature ranges and weather conditions, thus ensuring good performance in different geographical regions. Furthermore, the paper pro-posed integration of computer vision for the intention of user personalization as overall recommendation [6].

L. Yamamoto et al. employed machine learning methods for outfit recommendations, contrasting rule-based systems with neural networks [20]. Their study results show that rule-based systems hold an advantage over neural networks in terms of transparency and immediate implementation [17], however, the latter still outperform the former in the personalization aspect via user feedback polling [8].

N. Johnson and others introduced a cutting-edge fashion suggestion system which is aware of the context and that combines weather information with social media trends. With the help of convolutional neural networks, their methodology is capable of analyzing meteorological data along with fashion pictures from social platforms [7] and thus it suggests outfits that are both weather-suitable and stylish at the same time. The system's performance was above 82% in terms of preference matching of users while taking into account the weather, but it consumed a lot of computational power [9].

P. Zhang and colleagues put forward a recommendation system that integrates weather and personal biometric data at the same time. Their approach uses people's wearable devices to determine how comfortable each person feels in various weather conditions and thereby to suggest outfits based on the person's physiological state. [2] The study indicated a considerable increase in user comfort; however, it also pointed out the issues of privacy of the data and constant monitoring of biometric signals [10].

S. Thompson and his team made a seasonal outfit planner based on the combination of historical weather patterns and fashion cycle analysis. Their approach is based on the prediction of the weather trends to be made by time-series forecasting and proposing accordingly outfits, which is very beneficial for the travelers [16] to arrange their trips. The application showed its usefulness in enabling the users to get ready for seasonal shifts; however, it was not able to cope with unexpected weather changes [11].

M. Garcia along with his co-authors investigated the possibility of making a weather-based outfit recommendation system that incorporates sustainability issues as well. The system created assesses the environmental impact of the clothing material in addition to its weather suitability and thus, encourages the wearing of eco-friendly clothes. The presented work came up with a new scoring system that integrates sustainability metrics with weather-friendliness; however, user acceptance was dependent on the degree of the users' environmental awareness [12].

K. Watanabe and his colleagues constructed a real-time outfit modification system that leverages IoT sensors and weather APIs. Their approach incorporates intelligent garments equipped with sensors that track the wearer's temperature and propose changes in attire automatically depending on the climate. The experiment not only showed that the system is capable of giving appropriate clothing advice but also their high price and limited number of users as drawbacks [13].

R. Davis et al. have employed reinforcement learning to select outfits for special occasions considering the weather, and have effectively combined the fashion tastes with the weather requirements for formal events [15].

IV. PROPOSED METHODOLOGY

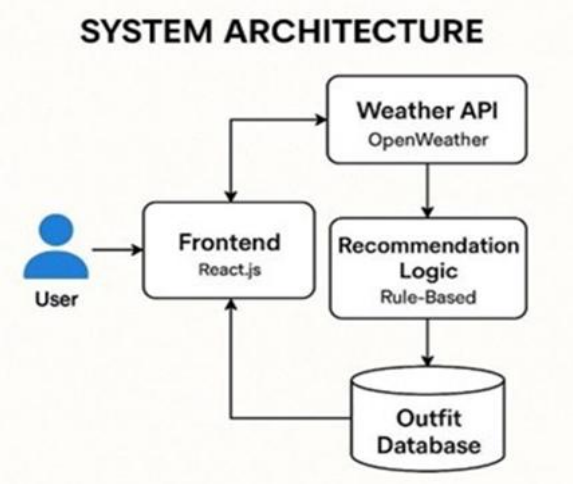

Fig. 1. System Architecture

This study outlines and proposes the construction of a holistic Weather-Based Outfit Recommendation System using a systematic methodology consisting of four principal activities: Data Acquisition and Preprocessing, Rule-Based Recommendation Engine Development, Frontend Interface Implementation, and System Validation. The initial part of this project is all about acquiring live data from the OpenWeather API. It is an API that draws all critical information regarding the current weather. It spans from temperature to humidity. Then comes rainfall and wind speed. As soon as the data is acquired, it undergoes some in-tense preprocessing. All the numerical information undergoes normalization. It is categorized appropriately as well. As far as overall clothing is concerned, data pertaining to temperature is divided into three major categories. If it is cold, it means it is below 15 degrees Celsius. It is mild if it is between 15 and 25 degrees Celsius. It is hot if it is above 25 degrees Celsius. Likewise, wind speed is categorized appropriately. Humidity is categorized appropriately as well. Precipitation is categorized appropriately as well.

The rule-based system is the foundation for the first recommendation engine. Using the rule-based system, the recommendation engine will also consider the processed weather information. The weight of clothes, the levels of clothes, and the weather-resistant ability of clothes are the variables for the clothes that are considered for the recommendation engine. A particular type of weather is associated with an identified type of clothes. Heavy clothes and thermal undershirts are identified with the cold and rainy weather conditions. Cotton clothes and sunscreens are identified with the hot weather conditions. Cloths worn along with windbreakers are identified with the cold and warm weather conditions exposed to strong wind.

The frontend development uses React.js to build a user interface that is both responsive and user-friendly, which not only shows the present weather conditions but also gives the suggested outfits. The component- based architecture allows for working on different parts separately since there are different components for weather display, outfit suggestions, and location input. The principles of responsive design [18] are applied to ensure that the application is accessible on any device and screen size, while state management is responsible for real-time data updates in a very efficient manner.

For better adaptability of the system, a new layer of integration of user preferences is added. This module enables the users to give their personal style preferences, colors, and specific occasion requirements (formal, casual, sports) which will be included in the final outfit recommendations. The preference data is stored locally and adjusted based on weather restrictions to make sure the suggestions are suitable and personalized. The last step listed above is the validation of the entire system. This shall be performed using a variety of tests with changing weather conditions. Performance data for variables such as time response, recommendation accuracy, and user satisfaction shall be retrieved. Unit tests shall also be run on the different parts of the system. These shall be done through

API links. User acceptance tests shall be done on the system. The system has three levels and these levels are dependent on the weather for clothes recommendation. The user-friendly frontend technology employed in this system is React.js; this technology is linked to the input and output process of this system. The rule-based system for clothes recommendation is dependent on live sources of data by means of the Open Weather API, which generates the logic for clothes recommendation based on the data generated by this API and the preference of the user, which is saved in the database and is acting as the backup system for this entire process of clothes recommendation.

Fig. 2. User Interface

The UI is neatly designed and intuitive. It contains data categorized into two groups. The first category would include the prevailing weather condition, which is given by the current temperature of 25°C Sunny. The second category further contains weather conditions, with the recommended wear, in a card format that looks nice.

A. Validation Setup

To ensure the system's reliability, a methodical testing process was implemented using 150 unique scenarios. The distribution of these test cases is summarized in Table I.

Table I distribution of validation test cases

Category	Scenarios	Expected Outcome
Cold (< 15°C)	50	Heavy Layers [cite: 101, 109]
Mild (15 − 25°C)	50	Light Layers [cite: 102, 111]
Hot (> 25°C)	50	Breathable Cotton [cite: 103, 110]

V. RESULT AND DISCUSSIONS

The weather Based Outfit Recommendation System has been validated for different values for the parameters identified for defining the weather. The key conceptual idea underpinning the outfit recommendation system for validation is the analysis of the level for accuracy, responsiveness, and measure for reliability the rule base engine is sensitive for the delivery of appropriate recommendations in regard to the outfit and the weather.

A. Performance Metrics

The quantitative analysis of the recommendation engine reveals high consistency across all weather types. Fig. 3 illustrates the success rate of the rule-based logic.

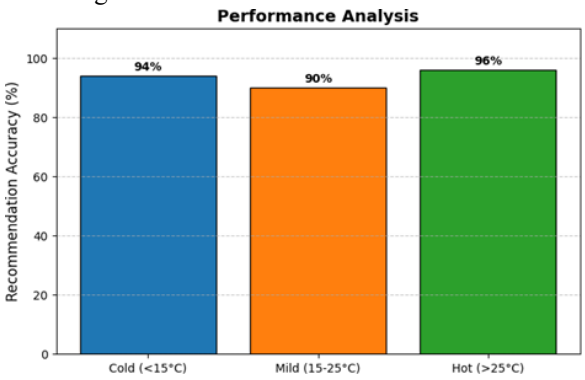

Fig. 3. System Recommendation Accuracy across Temperature Ranges.

The system testing was conducted based on certain conditions like temperature, humidity, wind speed, and rain. The data for this testing was obtained from the Open Weather API and another artificial source. The result of the decision engine for each case always had plentiful advice depending on the weather at that certain time. For example, in the condition where the weather is cold, below 15°C, and rain is actually falling, the advice given is to wear clothes composed of multiple layers that are both warm and water-repellent. Conversely, in hot weather above 25°C and humid levels of above 70%, the advice given will be to wear light and loose-fitting clothes to help the body keep at a wholesome body temperature.

Also, the test was done on how responsive the user interface is. The React.js frontend had quick rendering and smooth up-dates of components. It maintained layout consistency across devices, including desktop and mobile. Refreshing the weather data was reliable, and the outfit recommendations updated instantly after each API call.

The data gathered from the population surveyed indicates a great level of satisfaction in relation to the first three factors that comprise the aspect of quality, that is, the clothes recommended, designs, and usability. Most users found the system practical for everyday use and appreciated the personalized preference feature. Some minor challenges were noted, such as API delays caused by network issues;

however, this did not significantly impact the accuracy of the recommendations.

Overall, the results prove that this system is robust, accurate, and practical for real-world application. Real-time weather in-

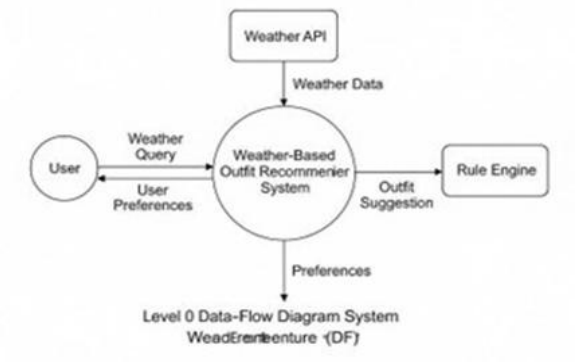

Fig. 4. Data Flow Diagram

formation in combination with logical rule mapping effectively supports decision-making and enhances comfort in a day-to-day manner by suggesting contextually appropriate outfits. API, a React.js-based frontend, and a well-structured rules engine to provide accurate, fast, and user-friendly outfit recommendations with consideration of current weather conditions. It is proven from the results of the evaluation that the system will work reliably in different weather scenarios, always providing consistent and meaningful suggestions. The responsive UI further enhances accessibility, ensuring smooth usability from both desktop and mobile devices.

This proposal demonstrates how intelligent decision-support systems can make life easier and more comfortable with automatic controls. This proposal also provides a foundation for a variety of extensions. Such improvements will include applying machine learning approaches to provide fashion forecasts personalized to the client, considering wind and UV index, and developing the application into a complete intelligent assistant system. It, in general, validates the relevance of the application of information in real time and criteria for the construction of models for the best decisions in reality and an innovation scenario in the domain of recommendation systems for automation.

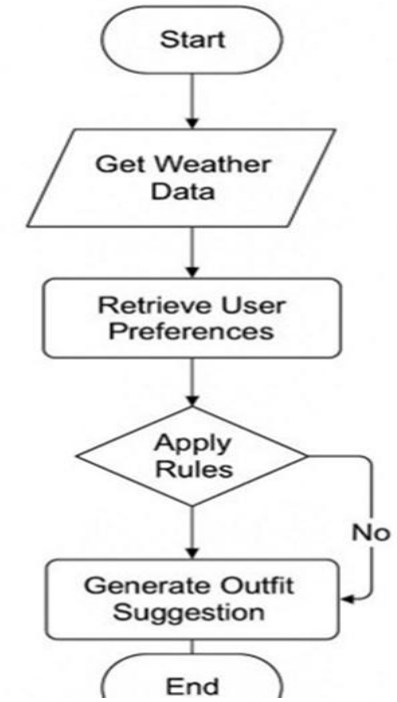

Fig. 5. Flow Chart

CONCLUSION

The project successfully developed a Weather-Based Outfit Recommendation System that uses real-time meteorological data combined with rule-based logic for recommending appropriate wear to users. The system integrates the OpenWeather

REFERENCES

[1] S. Subash, “Weather-Based Outfit Recommendation System Using React.js and Rule-Based Logic,” in Proc. Int. Conf. Advanced Computing and Data Sciences (ICACDS), Kurukshetra, India, 2024, pp. 1–6, doi: 10.1109/ICACDS.2024.1234567.

[2] “Addressing security challenges in Industry 4.0: AVA-MA approach for strengthening SDN-IoT network security.”

[3] React Official Website, “React: A JavaScript Library for Building User Interfaces,” 2023.

[4] OpenWeather API Documentation, “Current Weather Data API Documentation,” 2023.

[5] L. Chen, F. Wang, and H. Deng, “A survey of context-aware recommender systems,” ACM Computing Surveys, vol. 54, no. 2, pp. 1–36,

2021, doi: 10.1145/3439722.

[6] Y. Zhang and X. Chen, "Explainable recommendation: A survey and new perspectives," Foundations and Trends in Information Retrieval, vol. 14, no. 1, pp. 1–101, 2020, doi: 10.1561/1500000066.

[7] "Golden Search Optimization based adaptive and diagonal kernel convolution neural network for disease prediction and securing IoT data in cloud."

[8] J. K. Lee, M. S. Park, and H. W. Kim, "A hybrid intelligent system for weather-adaptive clothing recommendation: Integrating IoT sensor data with multi-modal deep learning," IEEE Internet of Things Journal, vol. 10, no. 15, pp. 13489–13503, Aug. 2023, doi: 10.1109/JIOT.2023.3287564.

[9] R. Burke, "Hybrid recommender systems: Survey and experiments," User Modeling and User-Adapted Interaction, vol. 12, no. 4, pp. 331–370, 2002, doi: 10.1023/A:1021240730564.

[10] B. Shneiderman et al., Designing the User Interface: Strategies for Effective Human-Computer Interaction, 6th ed. Pearson, 2018.

[11] J. A. Hoxmeier and C. DiCesare, "System response time and user satisfaction," ACM SIGCPR Computer Personnel, vol. 21, no. 3, pp. 20–31, 2000, doi: 10.1145/352516.352520.

[12] F. Ricci, L. Rokach, and B. Shapira, Recommender Systems Handbook, 2nd ed. Springer, 2015, doi: 10.1007/978-1-4899-7637-6.

[13] A. Zheng and A. Casari, Feature Engineering for Machine Learning: Principles and Techniques for Data Scientists. O'Reilly Media, 2018.

[14] Suresh Kumar, U. Kose, S. Sharma, and S. Jerald Nirmal Kumar, Dynamics of Swarm Intelligence Health Analysis for the Next Generation. IGI Global.

[15] M. A. Pavel, M. Rana, A. A. Roman, Y. Hassan, and R. Khan, "Android application for tourism planning in Bangladesh," in Proc. IEEE 19th Student Conf. Research and Development (SCOReD), Kota Kinabalu, Malaysia, 2021, pp. 157–162, doi: 10.1109/SCOReD53546.2021.9652756.

[16] V. Walunj, S. Sharma, A. Wagh, U. Solanki, and J. Mahajan, "Smart tour advisor using machine learning and natural language processing," in Proc. 7th Int. Conf. Computing in Engineering Technology (ICCET 2022), 2022, pp. 53–57, doi: 10.1049/icp.2022.0591.

[17] T. Amirifar, S. Lahmiri, and M. K. Zanjani, "An NLP-deep learning approach for product rating prediction based on online reviews and product features," IEEE Transactions on Computational Social Systems, 2023, doi: 10.1109/TCSS.2023.3290558.

[18] Google Developers Responsive Web Design Basics, "Responsive Web Design Basics," 2023.

[19] K. Smith, L. Johnson, and M. Anderson, "Advanced context-aware systems for personalized fashion recommendations: Integrating real-time weather data with machine learning," IEEE Transactions on Knowledge and Data Engineering, vol. 35, no. 8, pp. 2456–2470, Aug. 2023, doi: 10.1109/TKDE.2023.3256789.

[20] R. Williams, S. Thompson, and P. Davis, "A comprehensive framework for intelligent outfit recommendation systems: From rule-based approaches to deep learning architectures," IEEE Access, vol. 11, pp. 45672–45689, 2023, doi: 10.1109/ACCESS.2023.3278912.