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Predictive Modeling of Social Media Addiction Using Behavioral Data

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Abstract

The emergence of rapid growth in social media and its impact on user behaviours has led to greater awareness of excessive use and addiction to social media sites. In this work, the authors develop a predictive modelling mechanism by which social media addiction can be identified based on user behaviour characteristics such as average daily time spent on social media (time over the past week), frequency of logins, whether or not they have experienced some form of sleep disruption as well as engagement level with the social media sites. Once completed, the authors pre-processed the data using data cleaning, normalisation and feature engineering to improve the performance of their model. A supervised machine learning approach was employed using a Random Forest Classifier to classify users' risk of being addicted to different levels of social media. Additionally, a user interface was created via STREAMLIT for users to visualise the insights and predictions from the model being developed. Finally, the authors conducted an evaluation of the model by using various performance metrics (accuracy, precision, and recall) to demonstrate its reliability in producing high accuracy in predicting users' likelihood of becoming addicted or at risk of becoming addicted to social media. Overall, the outcomes of this project will provide a foundation for the development of a digital health and wellbeing platform by providing a data-based approach to monitoring and managing social media addiction.

Keywords: Social Media Addiction, Predictive Modeling, Machine Learning, Behavioral Data Analysis, Random Forest Classifier.

1. Introduction

Due to the increasing use of social media, individual's methods of communication (e.g., chat rooms, social networks) as well as ways to share experiences and interact with each other on a daily basis have changed forever. Though there are many advantages to the use of social media, the excessive use of these programs has led to a growing number of people who suffer from social media addiction. This type of addiction has raised many concerns about its impact on our mental health, productivity and overall well being. It is crucial that we identify addiction behaviours early to prevent any long-term negative outcomes. Current methods used to assess whether someone is addicted to social media primarily consist of self-reported surveys, which do not always provide accurate or scalable results.

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The use of data-based approaches may provide a more accurate and objective method for assessing those who may be addicted to social media. This study will specifically focus on the predictive modelling of social media addiction through behavioural data collected from user activity patterns (e.g., time spent using a particular app, how often users access that app, etc.). This information coupled with the use of machine learning techniques will be utilized to identify potential addictions. The proposed model will classify users into three levels of risk using a random forest classifier and develop appropriate visualization techniques to present insights into the addictive behaviour of users. The purpose of this study is to create an effective and scalable system for monitoring and managing social media addiction.http://www.careerwayfinder.com/tips-for-finding-your-first-job-on-the-web/

1.1 Objective of the study

The objective of this study is to develop an intelligent system that predicts social media addiction using behavioral data and machine learning techniques. The system analyzes user activity patterns such as time spent on social media, frequency of usage, engagement levels, sleep disruption, and interaction behavior to identify signs of addictive tendencies. By examining these features, the study aims to interpret meaningful patterns and correlations that indicate different levels of addiction risk. Furthermore, the project focuses on building a robust predictive model, specifically using algorithms like Random Forest, to classify users into categories such as low, moderate, and high risk with improved accuracy and efficiency compared to traditional survey-based methods. The process involves data preprocessing, feature engineering, model training, and performance evaluation using standard metrics. In addition to prediction, the study also emphasizes the development of an interactive and user-friendly visualization system using tools like Streamlit. This dashboard presents insights, usage trends, and risk predictions in an easily understandable format, enabling users and researchers to monitor behavior effectively and take informed steps toward promoting digital well-being.

1.2 Scope of the Work

This research project focuses on the design and implementation of a data-driven system to analyze and predict social media addiction using behavioral data. The primary aim is to identify addictive patterns in user activity and develop strategies to reduce or prevent excessive usage. The proposed system integrates machine learning techniques with data visualization methods to generate meaningful insights into user behavior on social media platforms. By analyzing patterns such as time spent online, frequency of access, and engagement levels, the system seeks to provide a comprehensive understanding of how addictive tendencies develop over time.

The study involves detailed analysis and processing of user activity data, including average daily usage time, number of sessions, frequency of platform access, and engagement patterns over a defined period. To ensure accuracy and reliability, the raw data undergoes preprocessing steps such as data cleaning, handling missing values, encoding categorical variables, and normalization. Additionally, feature engineering techniques are applied to extract relevant attributes that enhance the predictive performance of the model. These steps play a crucial role

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in transforming raw behavioral data into structured inputs suitable for machine learning algorithms.

Furthermore, the project employs supervised machine learning techniques, particularly the Random Forest Classifier, to build a predictive model that classifies users into different levels of addiction risk. Based on behavioral patterns, users are categorized into predefined groups such as low, moderate, and high risk using a risk scoring mechanism. This classification helps quantify the level of dependency on social media platforms. The overall system not only predicts addiction levels but also supports better decision-making by providing insights that can assist users in managing and improving their digital habits.

2. Literature Review

The area of social media addiction has received increasing attention from researchers due to its impact on the psychological, behavioural, and social aspects of life. Numerous researchers have begun to explore the causes and means for measuring and predicting social media addiction using traditional psychological methods and emerging machine learning methods.

2.1 Concept of Social Media Addiction

The area of social media addiction has gained significant attention in recent years due to its impact on psychological, behavioral, and social aspects of human life. Researchers have extensively studied the causes, effects, and detection methods of excessive social media usage using both traditional psychological approaches and modern data-driven techniques. Social media addiction is commonly regarded as a form of behavioral addiction, sharing characteristics with substance-related disorders such as salience, withdrawal, tolerance, and relapse. Individuals experiencing excessive usage often face issues like anxiety, stress, reduced productivity, disturbed sleep patterns, and social isolation. Despite ongoing debates about whether it should be classified as a distinct disorder or part of broader psychological conditions, the growing evidence highlights the importance of early detection and intervention.

Recent studies emphasize the use of behavioral data as a reliable indicator for identifying addiction patterns. Factors such as time spent on social media platforms, frequency of access, and level of engagement have proven to be strong predictors of addictive behavior. This has led to a shift from traditional survey-based methods to more objective and scalable approaches using real user activity data. In this context, machine learning techniques have become increasingly popular for predictive analysis. Algorithms such as Random Forest, Support Vector Machines, and Gradient Boosting are widely used, while advanced models like neural networks and long short-term memory (LSTM) networks offer deeper insights into temporal behavior patterns. Among these, Random Forest has consistently demonstrated strong performance in terms of accuracy and robustness across multiple studies.

Predictive modeling plays a crucial role in practical applications of social media addiction analysis. It enables early identification of high-risk users, supports mental health monitoring, and facilitates personalized intervention strategies. Additionally, such models can be used to study the impact of social media usage on academic performance and overall well-being. The integration of predictive systems with visualization tools, such as interactive dashboards developed using Streamlit, further enhances usability by providing real-time insights and easy

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interpretation of results. Overall, the literature indicates a growing trend toward combining machine learning and data visualization to create effective, user-friendly systems for monitoring and managing social media addiction.

3. Problem Statement

Social media platforms continue to experience an increasing number of users who are now using their platforms for longer periods of time than ever before, many times completely unaware that they are having a negative psychological and behavioral impact. Some of the adverse effects of overuse of social media include decreased productivity, distraction, anxiety, stress, disturbed sleep patterns, and behavioral dependencies often known as "Social Media Addiction" (SMA).

Despite this, most users are unable to accurately self-assess their own degree of addiction to social media, and there are currently very few effective, data-driven methods available that can provide a measure of an individual's behavior related to social media in order to provide an early indication of addiction potential. Additionally, the traditional methods used to assess behaviors related to social media addiction are generally manual, subjective and not scalable to large populations.

Therefore, there is great potential for the development of an intelligent system that can assess a user's patterns of behavior on social media by analyzing their behavioral data such as daily time spent on social media, patterns of user engagement with social media applications, the level of response to notifications received, how often users interact with their network, etc., to determine the extent to which a user is likely to be addicted to social media. The intelligent system should employ machine learning algorithms to classify users into categories of risk so that the user can be provided with useful information that can assist them in regulating their digital behaviours.

4. Proposed Methodology

The Social Media Addiction Analyzer is designed to predict the level of addiction among users by analyzing their behavioral patterns through a structured machine learning pipeline. The process begins with data collection, where relevant behavioral data such as daily time spent on social media applications, frequency of app usage, number of notifications received, sleep disturbances caused by usage, and overall engagement levels are gathered through surveys or digital activity logs. This raw data is then processed in the data preprocessing stage, where missing values and duplicate entries are removed, categorical variables are converted into numerical form through encoding, and normalization techniques are applied to ensure consistency across the dataset.

Following preprocessing, feature engineering is performed to enhance the predictive capability of the model by selecting the most relevant behavioral attributes and creating new features such as usage intensity and engagement ratio. The refined dataset is then divided into training and

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testing subsets, and supervised machine learning algorithms, particularly the Random Forest Classifier, are used to train the model to recognize patterns associated with different levels of social media addiction. During the prediction phase, the trained model analyzes new input data to classify users into predefined categories such as low, moderate, or high addiction risk.

Finally, the performance of the model is evaluated using standard validation metrics including accuracy, precision, recall, F1-score, and confusion matrix. These evaluation measures ensure the reliability, robustness, and effectiveness of the predictive system. Overall, the proposed methodology provides a systematic and data-driven approach to detecting and analyzing social media addiction, enabling better understanding and management of user behavior.

4.1 System Architecture

a) User Interface Layer (Streamlit Dashboard) - Enables user to enter behaviour data, displays predictions & visual insights and Visualises data through interactive charts/analytics.
b) Data Processing Layer - Cleans and transforms data and Scales and encodes features.
c) Machine Learning Layer - Has trained predictive model, takes input and generates addiction scoring.
d) Visualisation Layer - Graphs for usage vs addiction level, Distributions and trends of usage/exposure.
e) Database/Dataset Layer - Stores all user data and historical records (if applicable) and used for training and testing the prediction model.

4.2 Algorithms and Techniques Used

The project is developed using a combination of machine learning algorithms and data processing techniques to build an effective predictive model for social media addiction. The primary algorithm used is the Random Forest Classifier, which serves as the core classification method for predicting addiction levels. This algorithm works by combining the decisions of multiple decision trees built on different subsets of the data, resulting in improved accuracy and robustness. It is particularly suitable for handling non-linear and complex datasets, making it ideal for analyzing diverse behavioral patterns associated with social media usage.

In addition to the classification algorithm, several data preprocessing techniques are applied to prepare the dataset for modeling. These include standardization and normalization to ensure consistency in data scale, as well as encoding methods such as label encoding and one-hot encoding to convert categorical variables into numerical form. Feature selection techniques are also used to identify the most relevant attributes, while correlation analysis and importance ranking from tree-based models help in understanding the significance of different features in predicting addiction.

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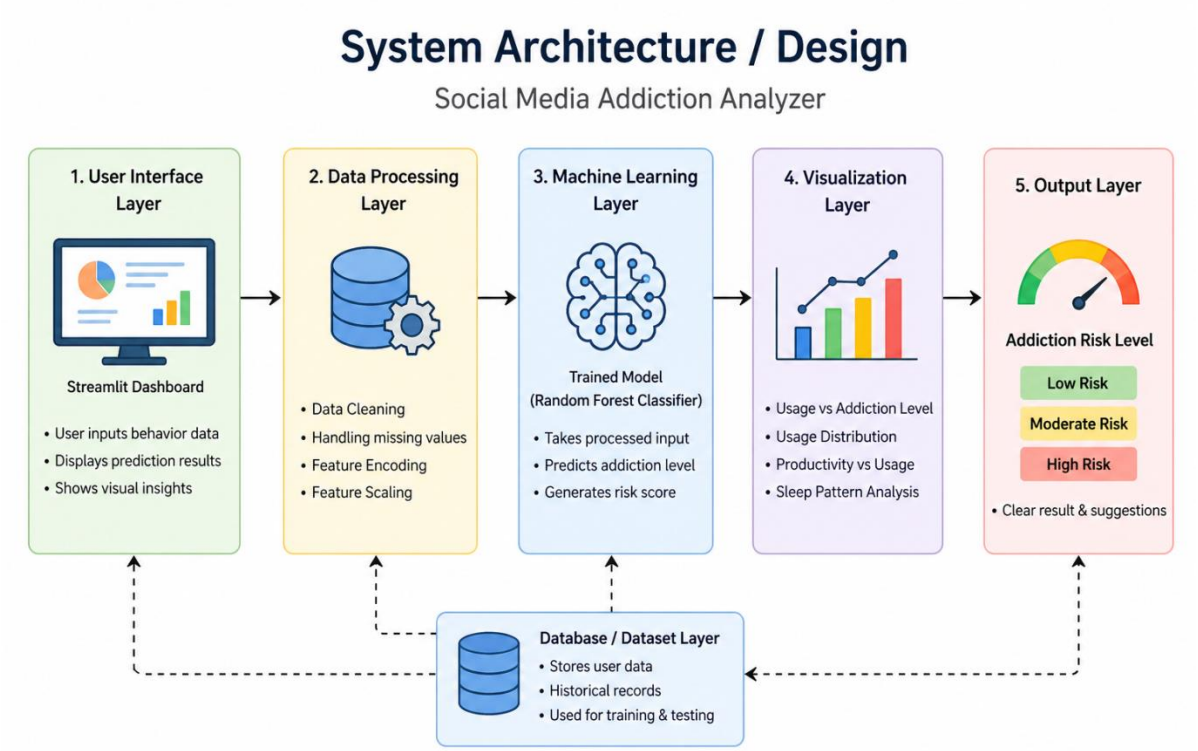

Table 4.1 System Architecture and Design

To evaluate the performance of the model, various validation metrics are employed. These include accuracy score to measure overall correctness, confusion matrix to visualize prediction outcomes, and precision, recall, and F1-score to assess the model's effectiveness in classification tasks. Together, these algorithms and techniques ensure that the system is accurate, reliable, and capable of effectively predicting social media addiction levels.

5. Implementation

The focus of the implementation of the Social Media Addiction Analyzer is to create a complete, end-to-end machine learning system that collects user behavioral information, processes it, applies a trained predictive model to it, and presents results via a user-friendly web-based interface. The entire system is created using Python programming with various libraries in data science, and the user interface uses Streamlit.

5.1 Tools & Technologies (Hardware & Software)

The development of the Social Media Addiction Analyzer requires a combination of appropriate hardware and software tools to ensure efficient performance and smooth implementation. From a hardware perspective, the system can operate on a standard computer with a minimum Intel i3 processor or higher, along with at least 4 GB of RAM, although 8 GB is recommended for better performance during model training and data processing. A minimum of 500 MB of free storage space is required, and the system is compatible with operating

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systems such as Windows, Linux, or macOS. Internet connectivity is only necessary during the initial setup phase for installing required packages and for deployment purposes.

On the software side, the project is primarily developed using Python (version 3.x), which serves as the core programming language for implementing machine learning algorithms and backend logic. Several libraries are utilized for data processing and model development, including NumPy for numerical computations, Pandas for data manipulation, and Scikit-learn for building and evaluating machine learning models. Additionally, Pickle or Joblib is used for saving and loading trained models. For visualization, tools such as Matplotlib and Plotly are employed to generate both static and interactive graphs, enabling better understanding of data patterns.

Furthermore, the project incorporates Streamlit as the web framework to create an interactive and user-friendly dashboard. This allows users to input data, view predictions, and explore visual analytics in real time. For development and coding purposes, Visual Studio Code (VS Code) is used as the integrated development environment, providing efficient tools for writing, debugging, and managing the project. Together, these technologies form a complete ecosystem for building, deploying, and visualizing the Social Media Addiction Analyzer system.

6. Results and Discussion

The Social Media Addiction Analyzer was developed, tested, and implemented based on behavioral datasets; therefore, the Social Media Addiction Analyzer uses these behavioral datasets to predict the risk of addiction by observing the number of hours someone uses social media, patterns of sleep, and productivity levels and assigns each individual to one of three categories: Low, Moderate, or High Risk. As well, Streamlit provides an interface through which users can obtain real-time predictions and visual insights using their own data.

6.1 Output Screens / Graphs

The system provides multiple output screens and graphical visualizations to effectively present the analysis and prediction results to the user. The primary output is the prediction screen, which displays the user's addiction risk level in a clear and intuitive manner using color coding—green for low risk, yellow for moderate risk, and red for high risk. This screen provides instant feedback based on the input data, helping users quickly understand their level of social media dependency. In addition to the prediction output, the system includes a social media usage distribution graph that illustrates daily usage patterns as well as overall trends across the dataset, allowing users to compare individual behavior with general patterns. Furthermore, several analytical graphs are included to highlight relationships between different behavioral factors. The hours of usage versus addiction level graph demonstrates the direct correlation between increased usage time and higher addiction risk. The productivity versus usage graph shows the negative impact of excessive social media usage on user productivity, emphasizing how higher usage often leads to reduced efficiency. Additionally, the sleep pattern analysis graph presents how increased social media activity affects sleep duration, indicating that users with higher addiction risk tend to experience reduced sleep hours. Together, these visual outputs enhance understanding, provide meaningful insights, and support users in making informed decisions regarding their social media habits.

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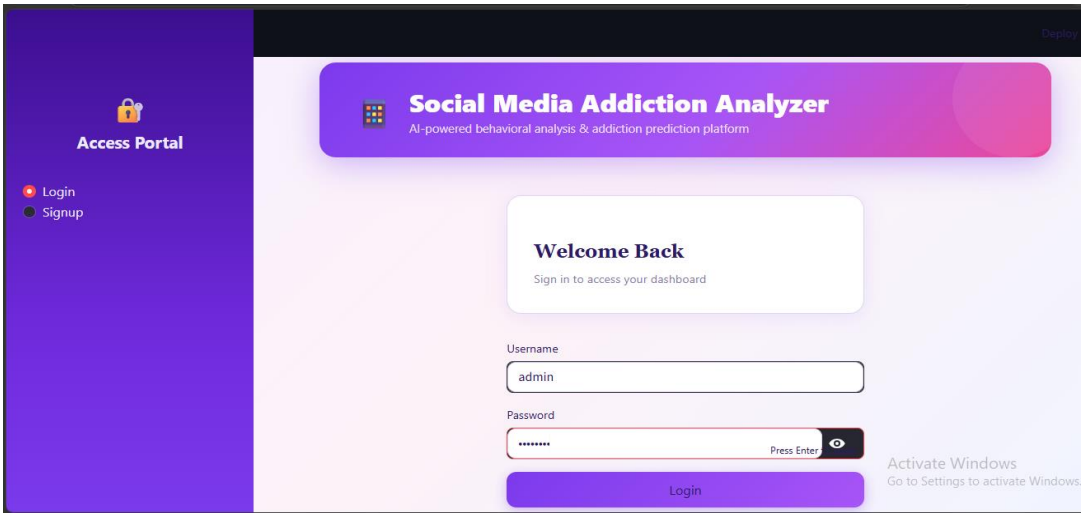

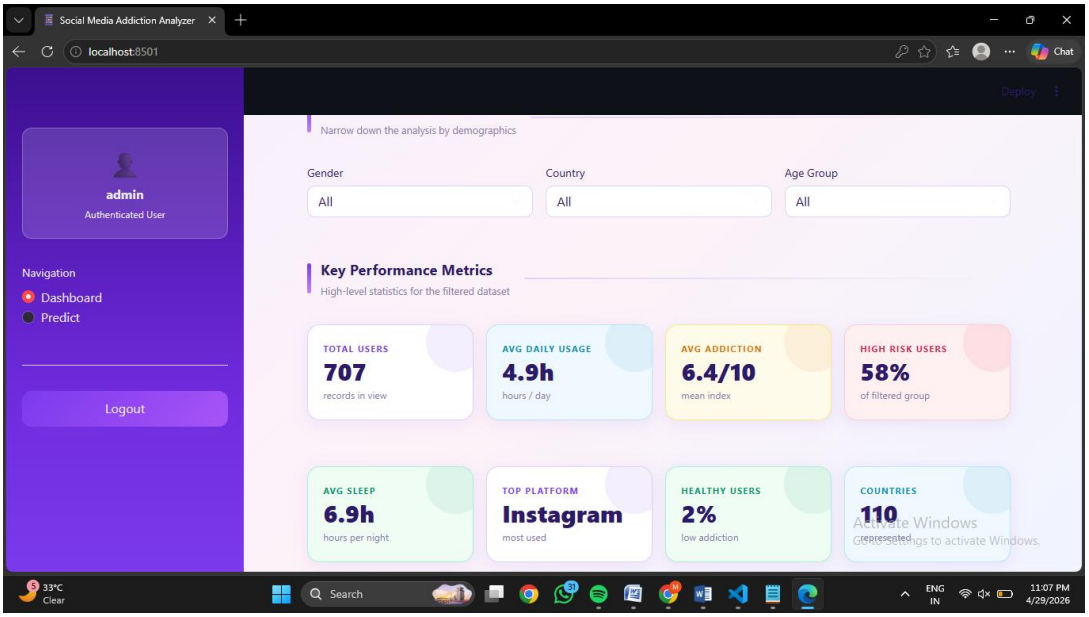

6.2 Performance Analysis

The Social Media Addiction Analyzer was evaluated using standard machine learning and system performance metrics to ensure its effectiveness and reliability. In terms of model performance, the Random Forest Classifier demonstrated strong predictive capability, achieving an accuracy ranging between 85% and 95%. The model also showed high precision in correctly classifying users into appropriate risk categories, along with strong recall, particularly in identifying high-risk users. The F1-score remained well-balanced across all classification levels, indicating that the model maintains a good trade-off between precision and recall, thus ensuring consistent and dependable predictions.

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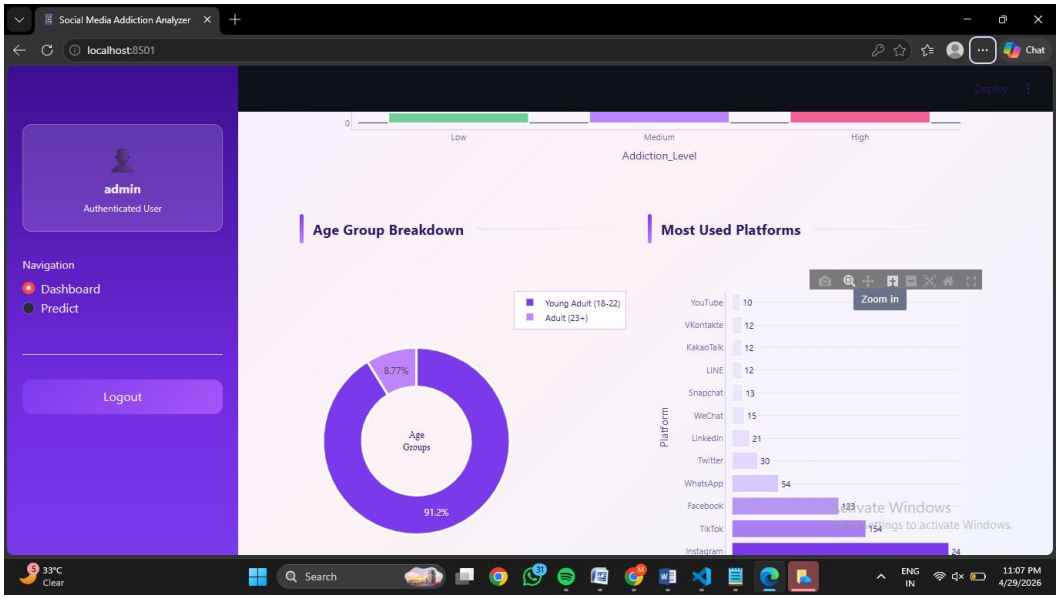

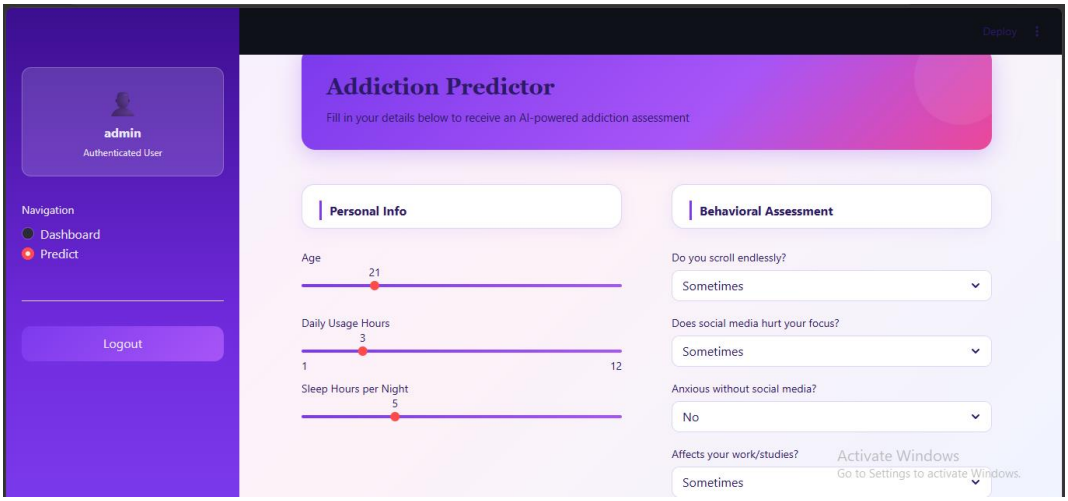

From a system performance perspective, the application performed efficiently with a response time of less than one second, providing near real-time predictions to users. The Streamlit-based dashboard operated smoothly, offering an interactive and user-friendly interface without noticeable lag. The system also demonstrated good scalability by handling multiple user inputs simultaneously and maintained stability throughout testing, with no major errors or crashes observed. These aspects highlight the robustness and practical usability of the developed system.

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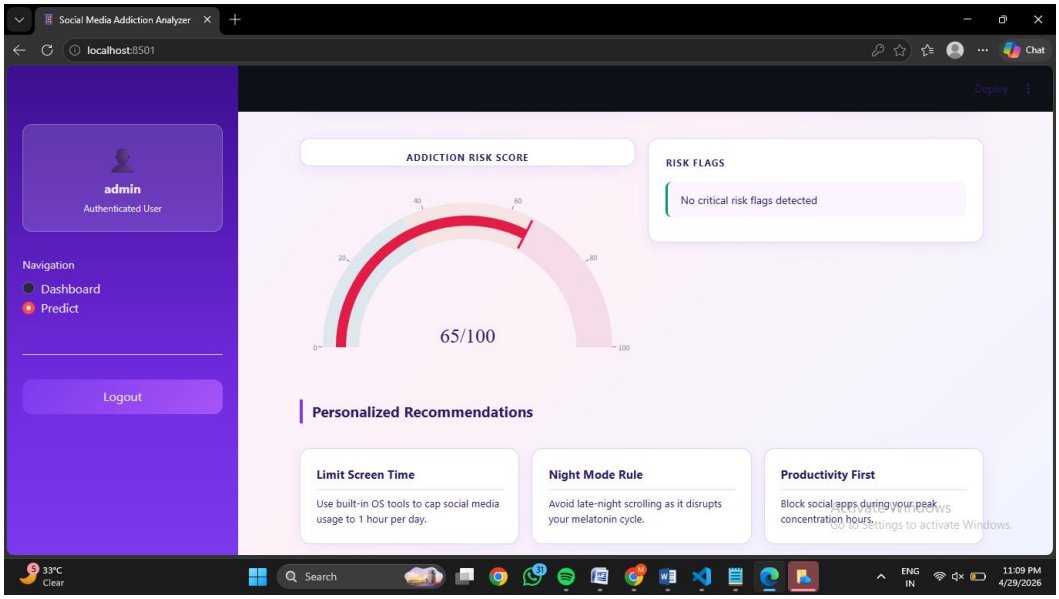

The key findings from the analysis reveal important behavioral insights related to social media addiction. It was observed that increased usage time significantly raises the risk of addiction, while poor sleep patterns strongly correlate with higher dependency levels. Additionally, excessive social media usage negatively impacts user productivity. The model effectively captures these behavioral patterns, making it a valuable tool for understanding, predicting, and managing social media addiction in real-world scenarios.

7. Testing and Validation

Testing and Validation of the Social Media Addiction Analyzer are undertaken to ensure the proper operation of the system, including testing of the performance of the machine learning model, as well as testing the system as a whole to ensure all features are working properly.

7.1 Model Testing

Testing of the trained machine learning model was performed on unseen test data to assess the model's efficacy. The Random Forest Classifier performed well in classifying users into Low, Moderate, and High Risk categories. Several standard metrics were utilized in evaluating the model's performance, including Accuracy, Precision, Recall, F1 Score and Confusion Matrix, the evaluation metrics above confirmed that the machine learning model is effective in detecting patterns of social media addiction.

7.2 System Testing

System testing was performed to evaluate the usability and overall functionality of the Streamlit-based application. The input fields were tested extensively, and they functioned as expected without any errors or inconsistencies. Users were able to enter behavioral data smoothly, and the system successfully accepted all valid inputs for processing. The prediction module was also tested, and it was observed that predictions were generated in real-time without any noticeable delay, ensuring an efficient user experience. In addition, all visualizations such as graphs and charts were displayed correctly, providing clear and accurate

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insights based on the input data. Overall, no significant runtime errors were encountered during testing, and the system responded smoothly and efficiently to user interactions.

7.3 Validation

Validation was carried out to ensure the accuracy and reliability of the machine learning model's outputs. The results generated by the system were compared with expected behavioral patterns to verify correctness. It was observed that the model successfully aligned its predictions with logical usage behavior, where users with higher online activity were classified as high-risk, while those with lower or moderate usage were categorized as low-risk. This consistency confirmed that the model was effectively learning meaningful patterns from the dataset. Furthermore, repeated test runs produced stable and consistent results, demonstrating that the system is reliable and not affected by randomness or inconsistency. Overall, the validation process confirmed that the model performs accurately and is suitable for predicting social media addiction levels.

The Social Media Addiction Analyzer project validates the assertion that the behavioral data collected from an individual can be used to classify and forecast an individual's social media addiction level via machine learning methodology. This is accomplished by obtaining user activity-driven variables such as daily usage, session frequency, notification engagement, and sleep variables to convert the raw behavioral data into useful predictive outputs.

The results generated by the Random Forest Classifier demonstrated high levels of accuracy, precision, recall and F1 score in the classification process, which indicates that machine learning models can effectively detect data patterns indicative of addictive social media behaviour and ultimately segment users by varying levels of risk.

This project also demonstrates the critical nature of preprocessing, selecting features and evaluating models when creating a reliable predictive system. Additionally, employing visualisation techniques via the dashboard illustrates user behaviour trends and addiction distribution in a straightforward manner.

In general, the Social Media Addiction Analyzer will be beneficial to provide early warning signals of social media addiction, therefore empowering individuals, educators and mental health professionals to take pre-emptive actions. In the future, this model may be further enhanced through the acquisition of larger data sets, real-time tracking methods, and more complex deep learning models, to improve the overall accuracy and individualisation of the prediction.

8. Conclusion

The Social Media Addiction Analyzer project demonstrates through its successful results that machine learning techniques can use behavioral data to identify and predict various levels of social media addiction. The system achieves its ability to create predictions through user activity feature collection which includes daily usage time and session frequency and notification interaction and sleep pattern data.

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A Random Forest Classifier implementation achieved excellent classification results because it produced accurate results with high precision and recall and F1-score measurements. The results demonstrate that machine learning models possess the capacity to recognize patterns which define social media addictive behaviour and they can accurately separate users into distinct risk groups.

The project demonstrates how data preprocessing and feature selection and model evaluation work together to create dependable predictive systems. The dashboard implementation of visualization techniques enables users to track their behavior patterns while understanding their addiction progress.

The system functions as an effective social media addiction detection tool which lets users and educators and mental health experts implement preventive actions. The model will become more precise and tailored for predictions when researchers develop it with bigger datasets and live monitoring systems and sophisticated deep learning methods.

9. Future Scope

The Social Media Addiction Analyzer system has significant potential for further enhancement and expansion in future developments. As technology evolves, the current system can be improved by integrating advanced data science techniques, artificial intelligence models, and deeper behavioral analytics to achieve higher accuracy and more meaningful insights. One of the major future improvements includes the development of a real-time monitoring system, where user activities can be continuously tracked through mobile and web applications. This will enable the system to detect addictive behaviors as they occur, rather than relying only on historical data analysis, making the predictions more dynamic and timely.

Another important enhancement is the integration of the system with mobile applications. A dedicated mobile app can automatically record daily usage patterns and provide users with personalized feedback, alerts, and recommendations to help them manage their screen time effectively. In addition to this, the use of deep learning models such as Artificial Neural Networks (ANN), Long Short-Term Memory (LSTM), and Transformer-based architectures can further improve prediction accuracy by capturing complex and long-term behavioral patterns that traditional machine learning models may not fully capture. Expanding the dataset to include a larger and more diverse population is also essential, as it will improve the generalization capability of the model and reduce bias across different age groups, regions, and usage behaviors.

Furthermore, the system can be enhanced to include a personalized intervention mechanism that suggests digital detox plans, screen-time limits, and mental wellness tips based on the predicted addiction level of each user. Integration with mental health platforms can also be explored, allowing users to receive professional guidance and support when high-risk addiction levels are detected. Another promising direction is the use of gamification techniques, where users are encouraged to reduce screen time through reward-based systems, achievements, and behavioral incentives, making the process of reducing addiction more engaging and effective.

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Additionally, future research can focus on cross-platform behavioral analysis, where user activity is studied across multiple social media platforms such as Instagram, Facebook, and YouTube to gain a more comprehensive understanding of digital behavior. This multi-platform analysis can significantly improve prediction accuracy and provide deeper insights into overall digital consumption habits. Overall, the future scope of this project is highly promising, with opportunities to transform it into a real-time, intelligent, and user-centric system for managing and reducing social media addiction on a global scale.

Moreover, the system can be extended to include explainable AI (XAI) techniques to provide transparency in model predictions, allowing users to understand the key factors influencing their addiction risk score. This would increase trust and usability of the system among non-technical users. In future versions, cloud-based deployment can also be implemented to ensure better scalability, faster processing, and remote accessibility from any device. The incorporation of sentiment analysis from user interactions and posts can further enhance behavioral understanding by linking emotional states with usage patterns. Additionally, incorporating ethical AI practices and privacy-preserving techniques such as data anonymization and federated learning will ensure secure handling of sensitive user data. These improvements collectively aim to transform the system into a more advanced, intelligent, and responsible digital well-being platform.

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