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MACHINE LEARNING TECHNIQUES TO PREDICT SMARTPHONE ADDICTION

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ABSTRACT

The rapid proliferation of smartphones has transformed daily life, but excessive usage has led to a growing concern of smartphone addiction, impacting mental health, productivity, and social interactions. Traditional methods for assessing smartphone addiction, such as self-reported questionnaires and surveys, are often subjective, time-consuming, and prone to bias. This research explores the application of **machine learning (ML) techniques to predict smartphone addiction** using behavioral, usage, and demographic data collected from smartphone users. By leveraging supervised learning algorithms, such as decision trees, random forests, support vector machines (SVM), and neural networks, the system can identify patterns indicative of addictive behavior and classify users according to their risk levels. Experimental results demonstrate that ML-based prediction models achieve high accuracy in detecting potential smartphone addiction, offering a scalable, objective, and proactive approach. The study highlights the potential of integrating ML into mental health monitoring systems, enabling early interventions, personalized recommendations, and improved awareness of smartphone usage patterns.

Keywords: Machine Learning, Smartphone Addiction, Behavioral Analysis, Prediction Models, Mental Health, Support Vector Machine, Neural Networks, Decision Trees, Random Forest, Data Analytics.

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INTRODUCTION

Smartphones have become an indispensable part of modern life, providing instant access to communication, social media, entertainment, and information. While their widespread use has offered numerous benefits, excessive reliance on smartphones has led to the emergence of smartphone addiction, characterized by compulsive usage, anxiety when not using the device, and impaired social and academic functioning. Studies have linked smartphone addiction to mental health issues such as stress, anxiety, depression, and sleep disturbances, highlighting the need for effective monitoring and intervention strategies.

Traditional methods for assessing smartphone addiction primarily rely on self-reported questionnaires and surveys, which, although useful, are subjective and often influenced by personal bias. These methods also fail to provide real-time or continuous monitoring of usage behavior. To address these limitations, **machine learning (ML) techniques have emerged as a promising approach for predicting smartphone addiction**. ML models can analyze large volumes of data generated by smartphone usage, including screen time, app usage patterns, frequency of notifications, and user interaction behaviors. By identifying patterns and correlations within this data, ML algorithms can classify users based on their risk of addiction and provide early warnings or interventions.

LITERATURE REVIEW

Smartphone addiction has garnered increasing attention in recent years due to its widespread impact on mental health, social interactions, and productivity. Traditional approaches to studying smartphone addiction largely rely on self-reported surveys and psychometric assessments, such as the Smartphone Addiction Scale (SAS) and the Mobile Phone Problem Use Scale (MPPUS). While these tools provide valuable insights, they

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are limited by subjectivity, recall bias, and their inability to continuously monitor user behavior. To overcome these limitations, researchers have explored the application of **machine learning (ML) techniques** for predicting and identifying smartphone addiction based on behavioral data.

Several studies have applied supervised learning algorithms to classify users into different addiction risk categories. Decision trees, random forests, and support vector machines (SVM) have been employed to analyze features such as daily screen time, frequency of app usage, notification interactions, and usage during specific times of day. These models have demonstrated promising accuracy in detecting patterns associated with compulsive smartphone use. Deep learning models, such as neural networks, have also been applied to capture complex, nonlinear relationships between usage behaviors and addiction risk, offering higher predictive performance in some cases.

EXISTING SYSTEM

The existing approaches to identifying smartphone addiction primarily rely on traditional psychometric assessments, questionnaires, and self-reported surveys, such as the Smartphone Addiction Scale (SAS) and the Mobile Phone Problem Use Scale (MPPUS). These methods involve collecting responses from users about their smartphone usage habits, frequency of checking the phone, and the psychological impact of usage. While these tools provide a standardized way to assess addiction, they are largely subjective, prone to biases, and often fail to capture real-time behavioral patterns. Additionally, they are not scalable for continuous monitoring and cannot automatically detect changes in user behavior over time.

Some systems use basic logging of smartphone usage, such as screen time tracking or app usage statistics, to infer potential overuse. However, these approaches typically lack intelligent analysis and cannot accurately distinguish between normal high usage and addictive behavior. Furthermore, traditional methods do not effectively integrate multiple factors, such as social media engagement, notification responses, and time-of-day usage patterns, which are crucial for accurately predicting addiction risk. Consequently, while existing systems provide initial insights into smartphone usage, they are insufficient for proactive, accurate, and real-time detection of smartphone addiction, highlighting the need for advanced solutions like machine learning-based prediction models.

PROPOSED SYSTEM

The proposed system leverages **machine learning (ML) techniques** to predict smartphone addiction by analyzing behavioral, usage, and demographic data collected from smartphone users. Unlike traditional survey-based methods, this system provides an objective, data-driven, and real-time approach to identifying potential addiction. Behavioral features such as daily screen time, frequency of app usage, number of notifications, time spent on social media, and usage during late-night hours are collected alongside demographic information to create a comprehensive dataset. Supervised learning algorithms, including decision trees, random forests, support vector machines (SVM), and neural networks, are trained on labeled data to classify users according to their addiction risk levels.

In addition to supervised methods, unsupervised learning and clustering techniques can be applied to identify groups of users with similar behavioral patterns, helping detect emerging addiction trends. The system also incorporates feature engineering, including time-series analysis and sequence modeling, to capture temporal usage patterns and improve prediction accuracy. A real-time monitoring component enables continuous tracking of smartphone usage, while automated alerts and personalized recommendations provide users with insights and interventions to manage their smartphone habits. Overall, the proposed ML-based system offers a scalable, adaptive, and precise solution for predicting smartphone addiction, supporting early intervention and promoting healthier smartphone usage behaviors.

METHODOLOGY

The methodology of the proposed machine learning-based system for predicting smartphone addiction involves several key steps, designed to

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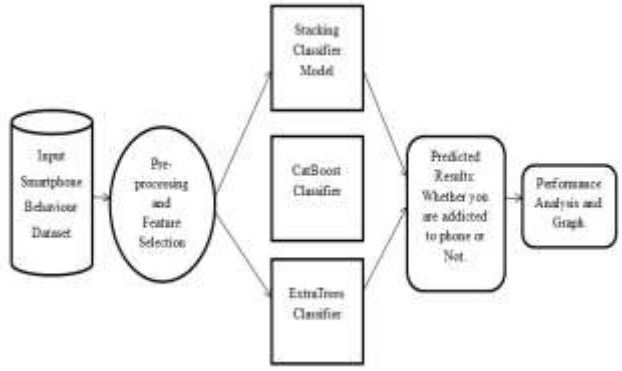
ensure accurate, real-time, and scalable detection. The first step is **data collection**, where behavioral and usage data are gathered from smartphones. This includes features such as daily screen time, frequency and duration of app usage, number of notifications, social media engagement, night-time usage, and demographic data like age and occupation. The collected data is then **preprocessed** to handle missing values, normalize features, and remove noise, ensuring that machine learning models can analyze the dataset effectively.

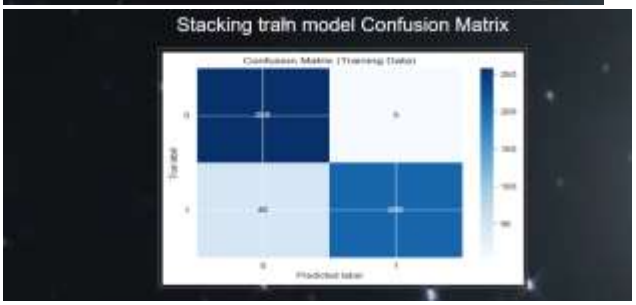
The next step is **feature extraction and selection**, where relevant attributes indicative of addictive behavior are identified. Temporal patterns, such as usage trends over hours or days, and sequence-based features, such as repetitive app-checking behavior, are incorporated to capture behavioral nuances. **Machine learning models** are then trained on this processed dataset using supervised learning algorithms like decision trees, random forests, support vector machines (SVM), and neural networks, which classify users according to their addiction risk levels. Unsupervised learning techniques, such as clustering, are also employed to identify hidden patterns and emerging addiction trends.

System Model

System Architecture



Results and Discussions



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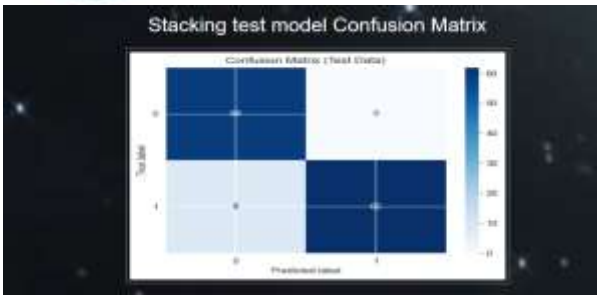
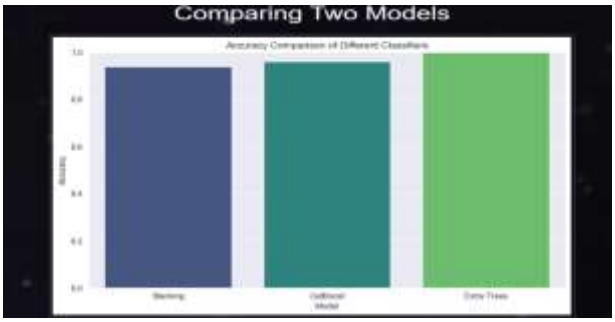
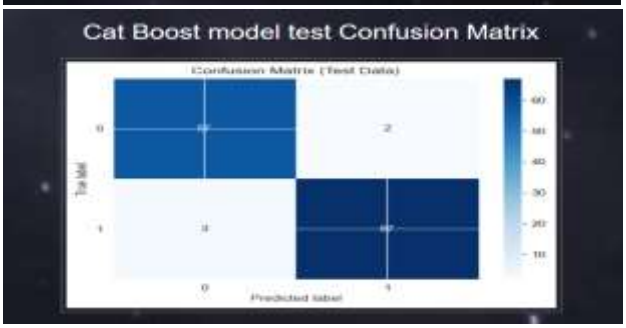




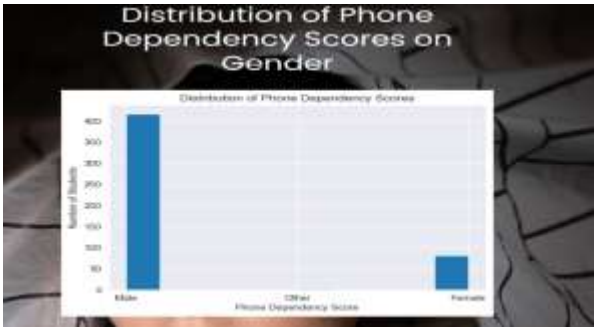
CatBoost Model Test

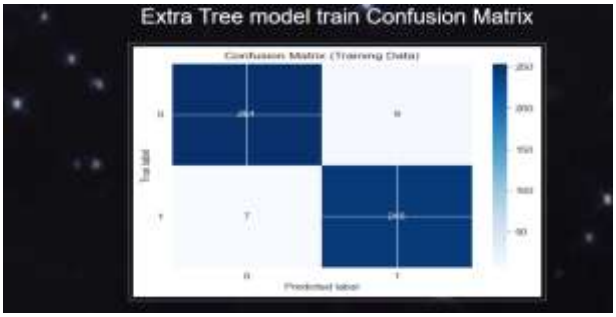
	Precision	Recall	F1-Score
0	0.95	0.97	0.96
1	0.97	0.96	0.96
Accuracy		0.96	
Macro avg	0.96	0.96	0.96
Weighted avg	0.96	0.96	0.96

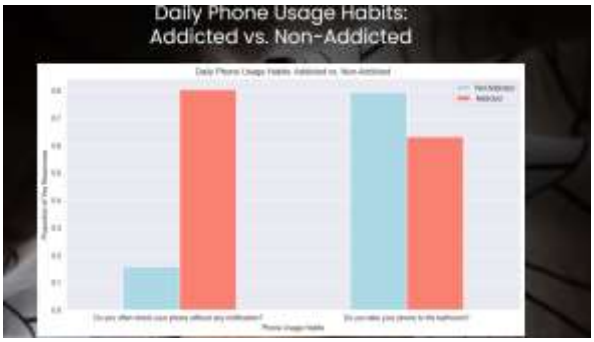


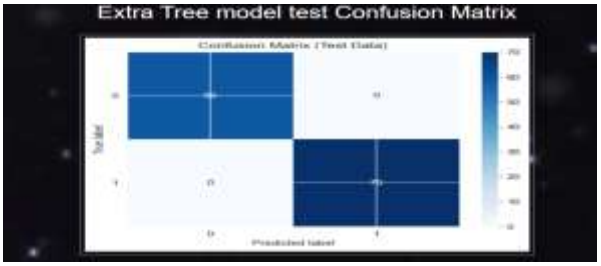
Extra Trees Model Test

	Precision	Recall	F1-Score
0	1.00	1.00	1.00
1	1.00	1.00	1.00
Accuracy		1.00	
Macro avg	1.00	1.00	1.00
Weighted avg	1.00	1.00	1.00









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CONCLUSION

The proposed machine learning-based system provides an effective and data-driven approach to predicting smartphone addiction, addressing the limitations of traditional survey and self-report methods. By analyzing behavioral, usage, and demographic data, the system can accurately identify users at risk of addiction and classify them into different risk levels. Supervised learning algorithms, such as decision trees, random forests, support vector machines (SVM), and neural networks, combined with unsupervised learning and clustering techniques, enable the detection of both known patterns and emerging trends in smartphone usage behavior.

The integration of real-time monitoring and automated alert mechanisms allows for timely interventions, providing users with personalized recommendations to manage their smartphone habits and reduce the risk of addiction. Feature engineering and temporal analysis of usage patterns further enhance prediction accuracy, ensuring the system can adapt to changing behavior over time. Overall, this ML-based approach offers a scalable, objective, and proactive solution for predicting smartphone addiction, contributing to mental health awareness, early intervention strategies, and the promotion of healthier smartphone usage habits.

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  Link to article
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