SciWaveBulletin
Vol. 1, No. 4, 32-37, 2023
https://sciwavebulletin.com/
DOI: 10.61925/SWB.2023.1405

Machine Learning and Cloud Computing Case Study for Online App Usage Tracking

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Abstract

Scalability, data processing, and real-time insights are not present in traditional online app usage tracking. ML can overcome these restrictions and open new possibilities with cloud data, in accordance with this study. In our case study, cloud data and ML boosted how a fitness software tracked user activity hours. Cloud systems store and manage massive amounts of user activity logs, device data, and network traffic of program usage. ML systems can learn trends, predict user behavior, and gain insights from this data. Fitness app data accuracy, user experience, and scalability improved with these technologies. On other web app domains, this method can improve user engagement tracking and personalization.

Keywords: Tracking, Machine Learning, Cloud Computing, Scalability.

I. INTRODUCTION

Due to the abundance of online apps, user interaction must be better controlled. Conventional monitoring systems struggle to capture app usage's constant change through manual analysis or static data points. Cloud computing and ML enable smart insights, real-time processing, and scalable data storage. Cloud computing provides online app usage tracking more effective. It offers scalability, affordability, and many data analysis tools and services for user behavior understanding. Developers can enhance app functionality, user experience, and business goals with cloud technologies [1].

New app usage tracking methods are needed because apps are so common online. Previous tracking methods that use static data points or human analysis fail due to app fluidity. Cloud computing and ML enable real-time processing, scalable data storage, and intelligent insights. Cloud computing offers a reliable platform for tracking online application efficiency. It is cheap, has many data analysis and user behavior understanding features, and can be scaled up or down. Cloud solutions help developers optimize app functionality, user experience, and business goals [2].

II. CLOUD COMPUTING

The term "cloud computing" describes the practice of utilizing the internet to access and make use of various computer resources like as servers, storage, databases, networking, software, analytics, and intelligence on an as-needed basis. Technology services may be accessed as required, like flipping on a light switch, rather than buying, owning, and maintaining real data centers and servers. The many services offered by cloud computing platforms are together known as cloud services [3]. There are essentially three distinct kinds of these services:

IaaS: Provides virtual computers, storage, and networking resources, the fundamental building blocks of computing, through Infrastructure as a Service (IaaS). Imagine it as renting a real-life computer or server on the cloud. Google Cloud Compute Engine, Microsoft Azure Virtual Machines, and Amazon Web Services (AWS) Elastic Compute Cloud are just a few examples of well-known cloud services.

PaaS: You can build, deploy, and manage apps on top of a platform as a service (PaaS) without than having to worry about the underlying infrastructure. You may avoid worrying about configuring the server or software by working in a pre-built environment. Some examples of PaaS are Google Cloud App Engine, Azure App Service, and Amazon Elastic Beanstalk.

Saas: Provides pre-built software applications over the web; this model is known as software as a service (SaaS). Imagine being able to use popular apps like Gmail or Office 365 without actually downloading them on your PC. Take, for instance, SaaS applications like Sales force, Office 365 from Microsoft, and Workspace from Google.

2.1. Advantages of employing cloud-based software and services

Without having to buy new gear up front, scalability allows you to simply increase or decrease resources to match fluctuating demands.: Minimize out-of-pocket costs and maximize operating expenses by paying only for the resources you really utilize. Remote work and collaboration are made possible by the ability to access data and apps from any location with an internet connection. Pick the best services according to your own requirements and tastes. Data availability and dependable infrastructure are provided by cloud providers. Benefit from the stringent safety protocols that cloud service providers have set up. To keep you one step ahead of the competition, cloud providers are always innovating and releasing new services and features [4].

III. MACHINE LEARNING (ML)

Computers can learn and get better at what they do without human intervention, thanks to a fast developing area of AI called machine learning (ML). Algorithms are able to do this because they can sift through mountains of data, find trends, and then act on those trends. The term "ML services" describes a wide range of resources that may be used to create and implement machine learning models. There are several main types of these services [5,6]:

3.1. 1st Party Services for Model Training and Development

Cloud-hosted machine learning platforms: These facilitate ML the creation of models, release, and management. For instance, Amazon Sage Maker, Tensor Flow, Azure Machine Learning, and Google Cloud AI Platform. Open-source machine learning training and model construction software libraries deserve to be distributed. Examples include Scikit-learn, OpenCV, TensorFlow, and PyTorch.

3.2. Next is, Services for Model Deployment and Inference

Programmers can easily add ML features to apps using machine learning APIs. The likes of Watson, Amazon Recognition, Google Cloud Vision AI, and Azure Cognitive Services. Machine-learning containers: encapsulate your learned models for deployment and mobility. Examples include Docker and Kubernetes.

3.3. One more is, Professional Services for Model Management and Monitoring

ML observability tools: Show model performance in production. Prometheus, Amazon CloudWatch, Azure Monitor, and Google Cloud Monitoring are examples. ML governance tools aid version control, security, and compliance in ML model lifecycle management. A few instances include MLflow and Kubeflow.

3.4. Benefits of ML services

Simplified development and deployment of ML models; shorter time to market. Although an expensive software and hardware infrastructure is unneeded, costs are reduced. Get more done in less time by utilizing expert methods and pre-trained models. Simplicity: Gain access to user-friendly tools and interfaces that even those without technical training can navigate with ease. One important feature is the ability to scale up or down determined by changes in demand or data volume.

3.5. Challenges of ML service utilization

The safekeeping and moral use of data must be guaranteed. Prejudice and equity in simulation: Stop biased training data and algorithms from producing unfair results. Make sure the models can be explained and understood by stakeholders by ensuring that they can be both interpreted and grasped. The model's performance declines as a result of drift. Be on the lookout for changes in data patterns that could affect the performance of the model, and address them as soon as you identify them. In the future, ML services will most certainly see more developments and enhancements. Emerging trends such as explainable AI, edge computing, and automated machine learning (AutoML) will make ML services more accessible, efficient, and reliable for a wider range of applications in the future.

IV. CASE STUDY OF FITNESS APP USING ML WITH CLOUDS

App usage data, such as user activity logs, device information, and network traffic, may be stored and managed efficiently on cloud systems. Next, machine learning algorithms may be taught to analyze this data to spot trends, foretell how users will act, and provide insightful analysis. Because of restrictions on data collecting and processing, a fitness app struggled to reliably record the amount of time users spent exercising. Due to its reliance on user self-reporting, the software was susceptible to discrepancies and mistakes. In this case study, we take a look at how one fitness app improved their activity monitoring by utilizing cloud data and ML.

***Issue*:** Self-reported statistics and other conventional ways of monitoring user activity hours were unreliable and did not provide insights in real-time. A rising user base made it difficult to scale data collecting and processing.

4.1. Implementation: Acquiring Information

Wearable devices, such as fitness trackers, recorded the users' activities and other activities. We collected data on app usage, including the total number of workouts and the types of activities done. We obtained data about users' gender, age, and fitness objectives from their profiles as well.

4.2. Processing and Storage of Data

To facilitate efficient access and evaluation, information was stored in the cloud. The expansion of the cloud's storage and processing power was an immense help to the burgeoning user base.

4.3. Developing a Machine Learning Model

Using past participation data, we trained a model using machine learning to spot similarities and generate predictions for users' active time. The model utilized user profiles, app usage, and data from wearable devices as some of its parameters.

4.4. Tracking Activities in Real Time

The ML model constantly assessed data on user activities in real time, suggesting the number of activity hours. It would then be possible to observe the user's progression and provide timely remarks.

4.5. End result

In contrast to self-reported data, ML-based activity hour tracking was much more efficient. Being capable of to get immediate assistance improved the whole user experience as well as inspired folks to work out more and reach their goals for wellness. With the cloud-based system, data management and scalability became more efficient.

4.6. Positive aspects

More Reliable Activity Tracking and Customized Feedback Led to Greater User Engagement and Appreciation. The data-driven insights provided by ML models are invaluable for app marketers and developers looking to better understand user behavior and activity patterns. Improved App Performance: By analyzing data in real-time, any issues with the app's performance can be remedied swiftly and easily.

Table 1: ***Tabulated data of users with their Tracking ratio***

Date	User ID	Wearable Steps	App Recorded Steps	Tracking Ratio
26-10-2023	12345	10,000	9500	0.95
27-10-2023	12345	7500	7300	0.96
28-10-2023	12345	15,000	14,800	0.987
29-10-2023	12345	8000	8100	1.0125
30-10-2023	12345	12,000	11,500	0.9583
26-10-2023	54321	5000	4800	0.96
27-10-2023	54321	3,500	3,300	0.9428
28-10-2023	54321	8000	7900	0.9875
29-10-2023	54321	6,000	5,800	0.9666

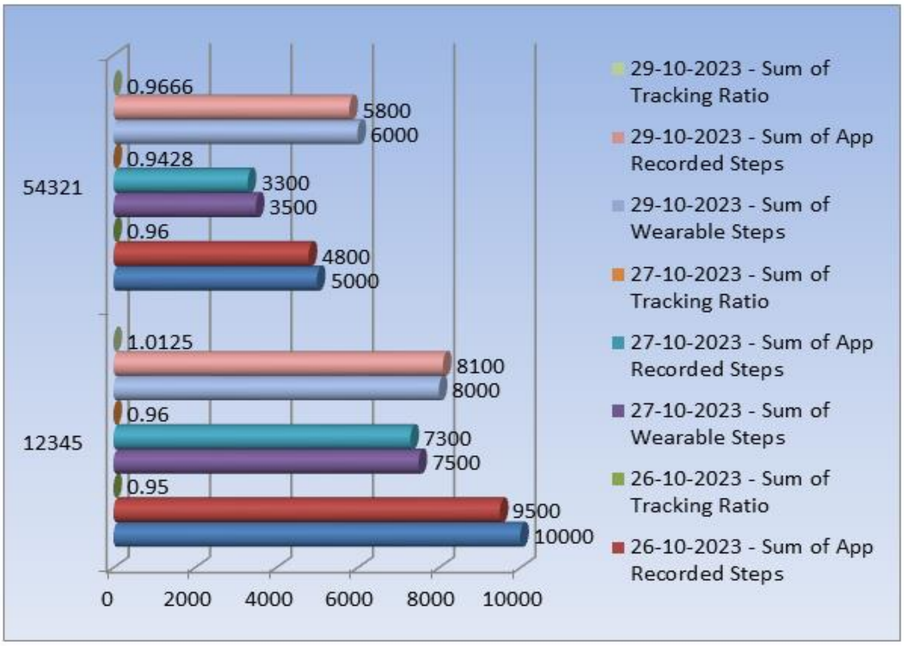

Figure 1: ***Table and Graph: Fitness App Tracking Details.***

From the table dataset, the tracking ratio can reveal these insights:

Overall trends: For every user and every date, the average tracking ratio is close to 0.97. The app records 97% of the steps utilized by the user, according to data from wearable devices. a number of factors, including the user and the date, tracking ratios might shift. Walking patterns, the accuracy of wearable devices, and outside influences could all play a role in this.

User-specific insights: On average, user 12345 has a better tracking ratio than user 54321, meaning 0.9735 compared to 0.9669. In light of this, the app may be able to accurately record the steps taken by user 12345. The tracking ratios of both users are considerably higher or lower than 1.0 on specific days. It is potential that the app's step counting algorithms or the accuracy of wearable devices are to blame. On October 29, the tracking ratio was 1.0125, implying the app increased user 12345's step count. We haven't collected enough information about user activities in the dataset. Metrics like this could be used to determine biases or inefficiencies in tracking ratios across a number of assignments.

Possible Issues: The app's step count may occasionally be overinflated, due to the data. A handful of potential causes for this include app sensitivity or excessive phone use. A few instances of environmental constraints that could impact tracking ratio include uneven terrain and slippery surfaces. To get the app's step counting more accurate, it would be excellent to have more data about the users' habitats and the activities they do. App developers are definitely exploring ways to tailor step counting algorithms to suit different users and various kinds of activities. Notifications regarding tracking ratio and issues impacting data accuracy should be sent to users. The accuracy of the step counting algorithms in the fitness app is shown by the tracking ratio. By analyzing this data, developers could enhance and provide users with the most accurate activity statistics. The sample size is too small to draw firm conclusions about the user population as a whole. For one to reach any firm conclusions, further research and analysis must be conducted [7,8].

Additional metrics for tracking ratios include: Share of users on average, Daily average ratio Breakdown by type of activity, Ratios of tracking for different gadgets that are wearable.

Tacking Ratio Analysis: Detecting issues with data precision or device calibration, In order to test how well the app's step counting algorithms work, Seeing patterns along with discovering how people use activity trackers, Providing recommendations for bettering and enhancing the performance of the app. This case study demonstrates how a fitness app made use of cloud data and ML in order to improve its activity hour monitoring. The use of these technologies led to improvements in accuracy, usability, and scalability. The rise in the number of online apps will open up new possibilities for app creation and user experience improvement with the utilization of cloud data and ML.

Extra Things to Think About: Important ethical concerns that need addressed include data privacy and security. If ML models want to stay realistic and sensitive to user input, they need to be modified and examined frequently. Based on the requirements of the app and our available resources, we shall select technologies and solutions suitably. To better recognize and enhance the online app user experience, this instance study illustrates how to link cloud data with ML. The widening of these technologies into new categories might give app makers greater freedom to create interactive, tailored interactions for those who download them.

V. MACHINE LEARNING FOR FITNESS ONLINE TRACKING

When it involves tracking and assessing user conduct on the internet and app usage, machine learning (ML) presents an extensive number of alternatives. The ones that follow constitute a few probable applications of ML:

5.1. Segmenting Users Clustering

Arrange clients into segments depending to their demographics, app use motifs, and other information that might come in beneficial. Insights generated from this process may influence the building of app features and advertising campaigns by catering to the habits and requirements of targeted user segments. Three dimensions that are inadequate: Principal component analysis (PCA) and similar methods may illuminate latent patterns and trends in user behavior by analyzing and presenting high-dimensional user data.

5.2. Activity Tracking and Session Prediction

Combining historic data and sequence modeling, you are able to predict how users will be interacting with your app in the future. This data can be employed to fine-tune applications, content recommendations, and consumer experiences. Spotting suspicious or out-of-the-ordinary user actions that might hint at fraud, bugs, or other issues is what anomaly detection is all about. This makes optimizing security, repairing issues, and avoiding harm straightforward.

5.3. We will analyze engagement and predict retention

Implement a survival study to evaluate the app's endurance over time. This can help to pinpoint the root cause of user churn and developing methods to keep them as customers. Identify which clientele you should focus on in accordance with their activity level and spending habits with RFM (recent, frequency, and monetary value) research. This makes things simpler to set priorities for user engagement activities and create customized marketing campaigns.

5.4. Analyzing Sentiment and Processing Feedback

Analyse comments applying natural language processing (NLP) to figure out user sentiment and find potential enhancements. The makers of the application can fix feedback from consumers and render the program excellent for consumers.

5.5. Modelling topics

Using the themes and topics that were extracted, evaluate any patterns or reoccurring problems in the user feedback. Building solutions as well as developing plans of action both benefited hugely from these insights.

Here are a few particular instances of how ML is utilized to keep tabs on online applications:

Netflix uses machine learning to suggest movies and TV shows to users based on their preferences and viewership history.

Using ML to analyze a customer's purchase and browsing history, Amazon can provide more relevant suggested goods and search results.

Facebook tailors users' news feeds and displays material that is highly relevant to their interests using machine learning, a powerful tool.

Spotify can create custom playlists and offer more relevant music suggestions by analyzing a user's listening habits [9].

5.6. App Tracking Tools and Resources Based on Machine Learning

Engineering occupation with softwaring having accessable to a variety of machine learning (ML) servicing on the Google Cloud AI Platforms, such as TensorFlow and Vertex AI, that they can utilizing creating custom app tracking models. On the Amazon SageMaker platform, you can train and deploy machine learning models within a controlled environment. There are also already prepared tools that can be used to monitor user behavior. Azure Databricks, an extension of Microsoft Azure Machine Learning, can handle processing big datasets. The balance of resources for constructing and carrying out

ML models are comprehensive. Popular open-source ML libraries such as Scikit-learn, TensorFlow, and PyTorch allow you to construct your own models for app tracking [10].

5.7. Aspects and Challenges

Both honest distresses and legal commitments associated with data privacy must be extremely taking into accounting when collecting and analyzing multiple user datum. The relatingly simplify within which the modeling can be described. The eliminating of bias and a sense of justice depending on the concepting of how ML models creating judgments. Building and trainings ML models can being a computing challengings and time-consuming endeavors.

VI. CONCLUSION AND FUTURE DIRECTIONS

This case study showing how working around the limitations associating with conventional application usages trackables using plenty of cloud datum and ML. The fitness app-submission might propagate better, give more truthful data, and improve the user experience attributable to these advancements. To better track and optimize users engagement, this method can be applied athwart numerous web app domains. Keeping tabs on and evaluating the performance of web applications is now feasible with the using multiple cloud datum and Machine Learning. This article offerings a case study that shows how these technologies can recover user bustle tracking when coming to accurateness and efficacy. As the number of web claims keeps on mounting, plenty of cloud datum and ML will open up new avenues for improving client experiences as well as examining user behavior.

Future Areas of Study: The contemporary study recommends sustaining tabs on how habitually people use apps online from side to side combining cloud data with ML. Going ahead, we hope to investigate into: Making neural network algorithms that work only with convinced applications usages casing and user engagements. Exploring strategies to use cloud data and ML to foresee user patterns and customizing application experiences. Executing guidelines to govern data security and ethical observes in cloud-based application usage systemin trackables.

Funding

This research received no specific grant from any funding agency, commercial or not-for-profit sectors.

Conflicts of Interest

The authors declare no conflict of interest.

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