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Study of State-Of-The-Art Cloud Based Big Data Analytics Approaches for Business Decision Support System

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ABSTRACT

A Decision Support System (DSS) is an information system driven by computers, aimed at supporting organizations in decision-making. It aids managers and decision-makers by providing essential information, models, and analytical tools to make well-informed choices. The primary focus lies in exploring the landscape of big data analytics specifically tailored to augment decision support systems. By employing descriptive and predictive analytics methods on extensive datasets, our objective is to extract actionable insights that substantially enhance the efficiency and effectiveness of decision-making within organizations. This study presents an in-depth exploration of a cutting-edge approach merging cloud-based technology with advanced big data analytics for decision support systems (DSS). The research investigates the integration of cloud computing infrastructure with sophisticated big data analytics methodologies to enhance the efficacy of decision support mechanisms within organizations. Emphasizing the utilization of state-of-the-art cloud-based frameworks and analytics tools, this study delves into the implications, benefits, and challenges associated with implementing this novel approach. By examining contemporary advancements and methodologies, the research endeavors to shed light on the transformative potential of this fusion in optimizing decision-making processes and fostering enhanced organizational outcomes.

Keywords: Cloud Computing, Decision Support Systems, Big Data

1. INTRODUCTION

The marketing approach, obtaining procedures, along with layout of web or e-merchants appropriating goods and service industries via the Internet will be affected by data about the customers' social buying nature. Whether or not stores decide to expand their current circulation outlets to provide online product information and shop services to their consumers depends on the characteristics of their products and customers and their propensity to make purchases online. In order to better serve specific classes, audiences, or customers, websites can be altered to reflect their particular shopping habits and preferences. Predicting an individual customer's propensity to make a purchase on a website may also result in a shift in perspective when operating online. In order to reduce the risks associated with making an online purchase, furniture buyers should pay close attention to additional information and demonstrate enthusiasm. Therefore, the model is proposed to increase business output via efficient and automated prediction.

2. BACKGROUND

2.1 Decision Support Systems (DSS)

It represents a pivotal technological framework designed to empower both individuals and organizations in navigating intricate decision-making processes. At its core, DSS amalgamates data, analytical models, and tools within a computer-based system, aiming to facilitate informed decisions across diverse industries. Comprising fundamental components like robust data management systems, sophisticated modeling and analytical tools, user-friendly interfaces, and specialized decision support databases, these systems serve as dynamic repositories for consolidating and interpreting multifaceted data. By harnessing these tools, DSS caters to decision-making needs at various organizational levels—strategic, tactical, and operational—allowing for streamlined, informed choices that align with overarching organizational goals. Its

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impact is far-reaching, enabling enhanced decision quality, swifter decision-making timelines, increased productivity through automation, and the adaptability to address evolving challenges. However, challenges such as ensuring data quality and integration, fostering user adoption, and managing system complexity pose ongoing hurdles, demanding continual refinement and strategic adaptation of DSS within organizational contexts. Nonetheless, Decision Support Systems remain integral and influential tools, providing invaluable assistance to individuals and organizations alike in navigating the complexities of modern decision-making landscapes.

2.2 Cloud computing

Cloud computing has revolutionized the landscape of computing and information technology by offering on-demand access to a shared pool of configurable computing resources over the internet. This paradigm shift from traditional on-premises infrastructure to a virtualized, scalable, and pay-as-you-go model has significantly transformed how businesses, organizations, and individuals store, process, and manage data and applications. At its core, cloud computing provides access to a wide array of services, including computing power, storage, databases, networking, analytics, and software, delivered over the internet. This architecture allows users to scale resources dynamically, reducing the need for physical infrastructure and upfront investment while offering flexibility and agility in resource allocation.

A. Key Components and Models of Cloud Computing:

- *Infrastructure as a Service (IaaS):* Offers virtualized computing resources like virtual machines, storage, and networking, allowing users to build their own IT infrastructure.
- *Platform as a Service (PaaS):* Provides a platform allowing users to develop, run, and manage applications without dealing with the underlying infrastructure.
- *Software as a Service (SaaS):* Delivers software applications over the internet, eliminating the need for installation or maintenance, and allowing users to access applications on a subscription basis.

B. Deployment Models

- *Public Cloud:* Services provided by third-party providers available to the general public over the internet.
- *Private Cloud:* Cloud infrastructure exclusively dedicated to a single organization, offering more control and privacy.
- *Hybrid Cloud:* Integration of both public and private cloud infrastructure, allowing data and applications to be shared between them.

C. Advantages of Cloud Computing

- *Scalability and Flexibility:* Allows users to scale resources up or down based on demand, ensuring optimal resource utilization.
- *Cost Efficiency:* Eliminates the need for upfront investment in hardware and software, with a pay-as-you-go model reducing overall costs.
- *Accessibility and Collaboration:* Enables remote access to data and applications from any location, fostering collaboration among geographically dispersed teams.
- *Reliability and Security:* Offers advanced security measures and high reliability through data redundancy and backup services.

D. Challenges

- *Data Security and Privacy:* Concerns regarding data protection, compliance, and security in the cloud environment.
- *Integration and Interoperability:* Ensuring seamless integration with existing systems and applications.
- *Vendor Lock-in:* Dependency on a single cloud service provider, limiting flexibility and choice.

Cloud computing continues to evolve and play a pivotal role in driving digital transformation, enabling innovation, and reshaping the way businesses and individuals leverage technology to meet their computing needs.

2.3 Big Data Analytics

Big Data Analytics refers to the process of examining, processing, and deriving insights from large volumes of complex and diverse data sets to uncover patterns, correlations, and valuable information that can drive informed decision-making and business strategies. This field has emerged as a crucial component in the era of massive data generation, where traditional data processing methods often fall short in handling the scale, variety, and velocity of data being produced.

A. Characteristics of Big Data:

- *Volume:* Refers to the enormous amount of data generated from various sources such as social media, sensors, transactions, and more.
- Variety: Encompasses the diverse formats and types of data including structured, semi-structured, and unstructured data like text, images, videos, and sensor data.
- *Velocity:* Signifies the speed at which data is generated and needs to be processed in near real-time to extract timely insights.

B. Components *o*f Big Data Analytics:

- *Data Collection and Aggregation:* Involves the gathering and storage of large data sets from multiple sources.
- *Data Processing and Cleaning:* The preparation phase where data is cleaned, transformed, and organized for analysis.
- *Data Analysis and Modeling:* Using various techniques such as statistical analysis, machine learning, data mining, and predictive modeling to uncover patterns and insights.
- *Data Visualization and Interpretation:* Presenting the analyzed data in a visual format to make it easily understandable for decision-makers.

C. Types of Big Data Analytics:

- *Descriptive Analytics:* Focuses on summarizing historical data to provide insights into what has happened.
- *Diagnostic Analytics:* Aims to determine why certain events occurred by analyzing historical data.
- *Predictive Analytics:* Uses statistical models and machine learning algorithms to forecast future trends or outcomes based on historical data.
- *Prescriptive Analytics:* Recommends actions to optimize outcomes based on predictive analysis.

D. Applications and Benefits:

- *Business Intelligence:* Improving decision-making, identifying trends, and understanding customer behavior for strategic business decisions.
- *Healthcare and Medicine:* Enhancing patient care, disease prediction, and drug discovery through analysis of vast medical datasets.
- *Finance and Banking:* Detecting fraud, risk assessment, and improving customer experience through personalized services.

E. Challenges:

- *Data Quality:* Ensuring data accuracy, completeness, and reliability.
- *Privacy and Security:* Safeguarding sensitive information and complying with regulations.
- *Skills and Expertise:* Shortage of skilled professionals proficient in Big Data Analytics tools and techniques.

Big Data Analytics continues to be a transformative force across industries, enabling organizations to extract valuable insights from data to make data-driven decisions, enhance operational efficiency, and gain a competitive edge in today's data-centric world.

3. STATE-OF-THE-ART TECHNIQUES

Numerous methods exist for analysing customer behaviour and credit risk analysis in light of modern consumer needs. The system's proposed solution is geared toward providing a highquality prediction strategy for purchasers' behaviour. The proposed method can benefit from several aspects of repetitive neural networks. Most of the time, they are well-suited for the prototyping process because of the special focus they place on data sequences. Predictions from machine learning models are also in high demand.

G. Rompolas et al. (2022): The study emphasizes the crucial role of efficient information utilization for business progress. It explores the application of time-series analytics in social media to predict shifts in customer attitudes and actions towards a specific brand. The proposed approach adopts a more coarse-grained analysis of overall behavioral dynamics in social networks compared to existing methods. The study introduces a data mining model leveraging users' linguistic and emotional characteristics to anticipate patterns of collective behavior, resulting in an effective and automated tool for companies to forecast connections between products and customers [1].

A. Pal et al. (2022): Email, a widely used channel for digital marketing, requires personalized campaigns to overcome challenges such as low interaction rates and unsubscribing. The study focuses on determining the optimal time to send emails for maximum visibility. Utilizing Reinforcement Learning, the research dynamically adjusts predictions based on feedback, achieving real-time accuracy. The proposed system, known for its simplicity, facilitates accurate forecasts and customization, enhancing the effectiveness of email marketing campaigns [2].

P. Chen et al. (2022): The study investigates negative emotions as reliable indicators of a service provider's disposition, utilizing algorithm optimizations based on the BERT model. Two approaches, involving sentence prompts and virtual adversarial training, enhance emotional polarity classification. The proposed ANFIS model effectively assesses the Industry Leadership Index for Emergencies, showcasing its potential for analyzing preparedness of business leaders in crisis situations [3].

C. S. Cerqueira et al. (2022): Addressing the high-risk nature of the petroleum industry, the study introduces an Adaptive Neuro-Fuzzy System (ANFIS) to assess the Industry Leadership Index for Emergencies. The model considers expertise, behavior, skill, and attitude as inputs, successfully predicting leader profiles and demonstrating adequate performance through RMSE analysis [4].

N. Nguyen et al. (2022): Focusing on the shift from cash to digital payments, the study proposes a model for anticipating fraudulent credit cards using CatBoost and Deep Neural Network. The model incorporates methods for handling imbalanced datasets and feature engineering, showcasing strong performance in experimentation [5].

D. Koksal et al. (2022): Acknowledging the increased value of visitor time on websites, the study employs BERT, ELECTRA, and RoBERTa models for text classification and customer intent analysis in e-commerce. The models prove effective for prioritizing Turkish language e-commerce products and enhancing user experience [6].

A. Zadoo et al. (2022): Recognizing the wealth of information on telecom customers, the study delves into customer segmentation and churn prediction using machine learning algorithms. The research focuses on classifying customers and predicting churn, contributing valuable insights for the telecom industry [7].

S. Panda et al. (2022): Examining the low allocation of GDP to public healthcare in India, the study proposes an ML Health Insurance Prediction System. The model, incorporating

Polynomial Regression, effectively predicts insurance costs, demonstrating its potential for enhancing decision-making in the insurance sector [8].

Y. H. KO et al. (2022): The study explores customer satisfaction using Automatic Speech Recognition, extracting features from Mandarin-speaking customers' voices. LSTM and SVM models achieve high accuracy in predicting customer happiness, showcasing the effectiveness of the proposed approach [9].

Sushmitha et al. (2022): Introducing Belief Mining as a sophisticated form of sentiment analysis, the study employs Bi-LSTM for emotional analysis of Amazon product reviews. The proposed framework outperforms traditional NLP techniques, providing accurate product rankings [10].

S. Bhati et al. (2022): Addressing the widespread adoption of electronic services, the study focuses on evaluating E-Service Quality's impact on online purchases. Structural Equation Modeling validates the correlation between critical E-SQ features and internet-related judgments, contributing to quantitative E-SQ measures for e-commerce sites [11].

D. Gupta et al. (2022): The study proposes a model for extracting relevant information from online customer reviews in the restaurant business. Natural language processing techniques and machine learning classification algorithms prove effective in extrapolating customer sentiment [12].

M. Joudaki et al. (2022): Considering wind energy's role in sustainable development, the study introduces the AM CNN Bi-LSTM model for forecasting wind speed and power. The proposed model outperforms alternatives, demonstrating high accuracy in power forecasting [13].

S. J. Haddadi et al. (2022): Addressing the high cost of customer churn for banks, the study presents a time series Deep Neural Networks (DNNs)-based approach to customer retention. The Bi-LSTM neural network outperforms conventional machine learning methods in predicting customer churn [14].

S. Nguyen et al. (2022): Focusing on utilities, the study explores the use of distributed generation, especially solar, to supplement rural circuits. Proposed models assess the impact of new devices on circuit dependability, aiding utilities in infrastructure planning [15].

A. Sharma et al. (2022): The study explores predicting customers' next date of purchase using various statistical and machine learning models. Neural network models, including Linear Regression and XGBoost, outperform static statistical models, providing a comprehensive review for estimating customer purchase dates [16].

T. Rianthong et al. (2022): This study explores the potential of service robots as companions in office settings to alleviate work-related stress. By employing the OpenPose library for feature extraction, the research categorizes human behavior toward service robots using deep learning algorithms [17].

Y. Liong Lim et al. (2022): Investigating the impact of the COVID-19 pandemic on the auto industry, this research employs machine learning algorithms such as Random Forest, Support Vector Machine, Neural Network, and Multilayer Perceptron to predict post-pandemic car purchases. The Neural Network model demonstrates superior accuracy at 99.97% [18].

F. Daniel Shadrach et al. (2022): Addressing challenges in the fashion industry exacerbated by the COVID-19 pandemic, this study proposes a virtual trial room system that enables customers to customize their online try-on experience. The system analyzes customer height and width to provide an interactive and personalized virtual shopping experience [19].

B. Shivani et al. (2022): Focusing on stock market prediction, the authors utilize LSTM-based models to forecast stock behavior based on various factors such as stock price, average daily return, and trend risks. Major players like Verizon, Netflix, Salesforce, and Amazon are analyzed for stock prediction [20].

A. M. Mohamed et al. (2022): Highlighting the significance of the electrical power sub-system in spacecraft, this study introduces the Nickel Hydrogen Storage Battery (NHSB) for spacecraft. Using MATLAB, the research simulates the NHSB's dynamic behavior under worst-case

scenarios, charging, and discharging, presenting data on state of charge, thermal emission, voltage, and pressure [21].

R. Y. Goh et al. (2022): Examining financial volatility using current account transaction data, this research compares linear regression and XGBoost to predict price fluctuations in financial markets. The study identifies high-risk financial behaviors and explores the potential risks associated with both high and low financial volatility [22].

N. Rangsaritvorakarn et al. (2022): Investigating machine learning's efficacy in predicting high-end butcher purchases, this research utilizes classifier algorithms such as k-nearest neighbors, decision tree, random forest, and xgboost model. The random forest algorithm demonstrates the highest accuracy in predicting Thai consumers' spending behavior on premium beef [23].

L. Das et al. (2022): This paper introduces the concept of feature engineering for predicting client behavior, allowing the development of custom features for machine learning algorithms. The focus is on data warehousing and using features to predict various behaviors across different domains [24].

D. Kilroy et al. (2022): Addressing the identification of customer perspectives in user-generated content, this study proposes a multidocument key phrase extraction algorithm to anticipate future customer needs based on social media posts. The method proves effective in predicting emerging market trends and future product demands [25].

S. D. Raj et al. (2022): Exploring the application of AI in the healthcare domain, this article emphasizes meeting high standards for AI-based applications. The study discusses trends such as smart decision-making, content moderation, language comprehension, speech recognition, emotion identification, and media processing to enhance patient and doctor experiences [26].

W. Kumwilaisak et al. (2022): This research focuses on call centre workforce management using deep neural networks and reinforcement learning. The proposed method employs a deep neural network, including LSTM and DNN, to recognize call centre traffic patterns. The Erlang A model is used to compute service metrics. Reinforcement learning with the Q-learning algorithm is then utilized to optimize shift start times and call agent numbers. Experimental results demonstrate the superiority of the proposed method in terms of service quality and average waiting time [27].

H. Wu et al. (2022): Addressing the challenges of predicting customer purchase behavior in e-commerce, this paper introduces the GBDT-NN algorithm, an enhanced version of the gradient boosting decision tree. GBDT-NN incorporates an artificial neural network to process automated feature and feature combination screening results, allowing adaptive learning of complex and nonlinear features. Experimental results on an actual customer dataset show improved accuracy and AUC compared to the baseline GBDT algorithm [28].

P. Massaferro et al. (2022): This study proposes a deep learning architecture with multiple resolutions to forecast and enhance non-technical losses (NTL) on smart grids. The architecture is designed to handle data from both high-resolution smart meters and low-resolution electromechanical meters. The multi-resolution approach outperforms algorithms optimized for a single class of meters in detecting legitimate and fraudulent activities [29].

F. Zhu et al. (2022): The paper addresses click fraud in internet-based advertising by introducing a tensor-based mechanism. The proposed model utilizes tensor decomposition and transformation to reveal latent information in the data, improving accuracy and prediction-recall rate compared to state-of-the-art machine learning algorithms [30].

A. Perisic et al. (2022): Focusing on game analytics, the study aims to predict player behavior and customer churn in the mobile gaming industry. The proposed framework includes an expanded recency, frequency, and monetary value feature set. Multivariate churn prediction models identify key features related to user lifetime, intensity, and rewards, contributing to the understanding of player behavior in the context of churn prediction [31].

N. Ashill et al. (2022): This research explores the relationship between static and fluid capabilities of a company, corporate reputation, and customer satisfaction and loyalty in project management. Dynamic capabilities, particularly relational capabilities, are identified as strong predictors of customer satisfaction and repurchase intentions. The study emphasizes the importance of both static and fluid capabilities in influencing customer satisfaction [32].

R. Claudia Lois et al. (2021): The authors develop an application usage behavior analytics system to create dynamic bundles for each customer. An H2O Deep Learning model is employed to predict products each customer is likely to reorder. The system, which addresses the cold-start effect and popularity bias, demonstrates accuracy, precision, and recall scores, contributing to customer satisfaction [33].

Z. Guo et al. (2021): Investigating risky behavior in pedestrians in the context of traffic accidents in China, the study employs social norms, self-construal, anticipated regret, and risk perception. The findings highlight the significance of personal and descriptive norms, anticipated regret, and risk perception in predicting pedestrians' intention to jaywalk. Self-construal moderates the relationship between norms and behavior [34].

C. –N. Kuo et al. (2021): The research predicts customer behavior in insurance product purchases using a machine learning decision tree. Customer characteristics are treated as independent variables, and product categories are treated as dependent variables. The decision tree model achieves an accuracy rate of nearly 70%, with actual insurance fee and currency identified as the most influential factors [35].

S. Lu et al. (2021): Addressing the challenge of predicting consumer behavior in dynamic and heterogeneous e-commerce networks, the study proposes the Dynamic Community aware Heterogeneous Network Embedding (DyCHNE) framework. The framework outperforms existing practices by incorporating high-order structural information and dynamic features from network snapshots [36].

A. Chowdhury et al. (2021): The paper focuses on predicting customer churn in telecommunications companies. An advanced oversampling technique and ensemble methods, including Random Forest, Gradient Boost, Extreme Gradient Boost, and AdaBoost, are introduced to address data imbalance. The proposed model outperforms predecessors by significantly improving accuracy and reducing false positive and negative predictions [37].

S. J. E. Taylor et al. (2021): The study explores the concept of "digital twin" in comparison to modeling and simulation (M&S) methods. It investigates whether digital twins represent a "refresh" or "rebranding" of M&S or offer novel synergies. The research examines recent innovations in digital twins and debates their relationship with M&S [38].

Summary of Related Literature

Paper	Focus and Methodology	Key Findings
W. Kumwilaisak et al. (2022)	Call Centre Workforce Management using Deep Neural Networks and Reinforcement Learning	Proposed a method employing a deep neural network (LSTM and DNN) to recognize call centre traffic patterns. Utilized Erlang A model for computing service metrics. Applied reinforcement learning with Q-learning to optimize shift start times and call agent numbers. Outperformed human supervisors and previous workforce management schemes in terms of service quality and average waiting time.
H. Wu et al. (2022)	GBDT-NN Algorithm for Predicting Customer Purchase Behavior in E-commerce	Introduced GBDT-NN algorithm, an enhanced version of gradient boosting decision tree, incorporating artificial neural network for adaptive learning of complex features. Achieved improved accuracy and AUC compared to baseline GBDT algorithm.

P. Massaferro et al. (2022)	Deep Learning Architecture for NTL Forecasting on Smart Grids	Proposed a multi-resolution deep learning architecture for forecasting non-technical losses (NTL) on smart grids. Outperformed algorithms optimized for a single class of meters in detecting legitimate and fraudulent activities.
F. Zhu et al. (2022)	Tensor-Based Mechanism for Combating Click Fraud in Internet-Based Advertising	Introduced a tensor-based mechanism using tensor decomposition and transformation. Outperformed state-of-the-art machine learning algorithms in terms of accuracy and prediction-recall rate for identifying fraudulent clicks.
A. Perisic et al. (2022)	Feature Framework for Predicting Customer Churn in the Mobile Gaming Industry	Proposed an expanded recency, frequency, and monetary value feature framework. Identified long-term frequency as the most important feature. Multivariate churn prediction models highlighted the significance of features related to user lifetime, intensity, and rewards.
N. Ashill et al. (2022)	Relationship Between Company Capabilities, Corporate Reputation, and Customer Satisfaction in Project Management	Explored the impact of static and fluid capabilities of a company on customer satisfaction and loyalty. Found relational capabilities to be three times stronger at predicting customer satisfaction. Dynamic capabilities were identified as influencing repurchase intentions.
R. Claudia Lois et al. (2021)	Application Usage Behavior Analytics System for Dynamic Bundle Recommendation	Developed an analytics system using an H2O Deep Learning model to predict products for dynamic bundles. Achieved high accuracy, precision, and recall scores. Addressed the cold-start effect and popularity bias in bundle recommendation systems.
Z. Guo et al. (2021)	Predicting Pedestrian Jaywalking Behavior in China	Investigated the role of social norms, self-construal, anticipated regret, and risk perception in predicting pedestrian intention to jaywalk. Found personal and descriptive norms, anticipated regret, and risk perception to be significant predictors. Self-construal moderated the relationship between norms and behavior.
C. –N. Kuo et al. (2021)	Predicting Customer Behavior in Insurance Product Purchases	Used machine learning decision tree to predict customer behavior in insurance product purchases. Achieved an accuracy rate of nearly 70%. Identified actual insurance fee and currency as the most influential factors.
S. Lu et al. (2021)	DyCHNE Framework for Predicting Consumer Behavior in E-commerce Networks	Proposed the Dynamic Community aware Heterogeneous Network Embedding (DyCHNE) framework for predicting consumer behavior in dynamic and heterogeneous e-commerce networks. Outperformed existing practices by incorporating high-order structural information and dynamic features from network snapshots.
A. Chowdhury et al. (2021)	Ensemble Methods and Advanced Oversampling for Customer Churn Prediction in Telecommunications	Introduced advanced oversampling technique and ensemble methods (Random Forest, Gradient Boost, etc.) for predicting customer churn. Outperformed

		predecessors, significantly improving accuracy and reducing false positive and negative predictions.
S. J. E. Taylor et al. (2021)	Digital Twin vs. Modeling and Simulation: A Comparative Study	Investigated the concept of "digital twin" in comparison to modeling and simulation (M&S) methods. Explored whether digital twins represent a "refresh" or "rebranding" of M&S or offer novel synergies. Examined recent innovations in digital twins and debated their relationship with M&S.

K. Aditya Sobika et al. (2021): Online food delivery in India has gained traction during the COVID-19 pandemic, driven by government support and consumer preferences. Understanding customer behavior during this health crisis is crucial for online food delivery services. This study employs Machine Learning algorithms to predict customers' willingness to place online food orders post-pandemic. Online surveys yielded 415 responses, with 369 expressing a preference for online food delivery. Affective and instrumental belief, perceived benefits (Health Belief Model variables), and demographic factors such as mobile usage time, COVID ordering frequency, app convenience, family size, age, education, and occupation significantly influence order decisions [39].

Y. Ren et al. (2021): Retailers can enhance sales through targeted coupon distribution. This study introduces an RFM-based RFS model, incorporating customer coupon sensitivity. Segmentation using K-means and analysis with XGBoost, GBDT, and LightGBM predict coupon effectiveness. The proposed model outperforms other algorithms, serving as a benchmark for real-world coupon distribution [40].

B. S. Nascimento et al. (2021): Utility providers face substantial losses (up to 2% of bills) from bad debt. This study employs machine learning to assess payment patterns, focusing on default prediction, spontaneous payment, and reaction to collection actions. Evaluation using AUC, ROC, and FDR demonstrates high accuracy, comparable to the financial sector [41].

M. Kamel et al. (2021): Predictive maintenance in the telecom industry is critical for addressing network outages. The study proposes a concurrency-based Rare Association Rule Mining method for event prediction. This approach enhances AI's ability to foresee and prevent unfavorable outcomes [42].

H. F. Charlie et al. (2021): Support Vector Machines (SVMs) are introduced for water quality evaluation in pipelines, achieving 99.25% accuracy. The SVM-based system monitors water distribution, providing real-time information on drinkability [43].

S. Kanwal et al. (2021): Forecasting customer churn in the telecommunications industry is addressed using Decision Tree, k-NN, Gradient Boosted Tree, and Naive Bayes, combined with PSO for feature selection. The proposed method shows superior performance, achieving 93% accuracy and 87% precision [44].

Y. Jing et al. (2021): A SVM model is used for accurate prediction of new energy vehicle users' preferences. The study employs correlation coefficients and dynamic programming for brand-specific predictions, indicating significant shifts in willingness to purchase with improved product indicators [45].

Y. Zhang et al. (2021): The paper focuses on estimating customers' gender in online shopping recommendation systems. Using the FTP group's data, the proposed method achieves 75% accuracy despite imbalanced data, providing insights into customers' shopping habits [46].

X. Wang et al. (2021): A Complaint Behavior Predicting Model (CBPM) is proposed for power companies using RFC and grid search. The CBPM anticipates customer complaints, reducing their number and increasing satisfaction through effective pre-warning [47].

O. Suprun et al. (2021): The study addresses challenges in online delivery, emphasizing order rejection prediction to mitigate losses. Data mining methods are compared, with proposed

penalty functions for false positives. Real-world tests demonstrate the efficacy of the methods [48].

W. Zhao et al. (2021): RFID data analysis is crucial for understanding in-store customer behavior. The paper proposes a customer movement trajectory prediction model using LSTM neural networks, demonstrating superior accuracy and generalization in trajectory prediction [49].

T. Pc et al. (2021): The recommendation system, vital for data relevance, is explored using the SVD algorithm and Pearson correlation. The study focuses on predicting user preferences and behavior across various sectors [50].

H. Irawan et al. (2021): This study focuses on analyzing customer feedback on review websites to improve service quality, customer loyalty, and revenue. By examining linguistic properties and behavior in specific customer reviews from Traveloka.com in the Bandung Raya area, the research suggests that linguistic properties serve as predictors of customer satisfaction [51].

F. Zhou et al. (2021): The paper introduces a deep reinforcement learning-based combinatorial recommendation system to enhance revenue. By simulating user behavior through a hierarchical recurrent neural network, the system optimally recommends product combinations. The approach proves effective in increasing sales and customer satisfaction [52].

T. M. Shafkhan et al. (2021): The study proposes a cost-effective solution for pricing strategies, employing machine learning components, including LSTM, ARIMA, Facebook Prophet, and clustering. By considering production cost, shipping cost, competitor prices, and customer behavior, the model optimizes pricing for maximizing profit and minimizing cost [53].

B. Ganhewa et al. (2021): Addressing challenges in the women's clothing fashion retail industry, this research utilizes machine learning to maximize sales. A web app incorporating demand analytics, customer segmentation, and sales forecasting is developed, employing Naive Bayes, K-means, and Extra Trees Regressor algorithms [54].

M. Ramirez et al. (2021): The study explores neuromarketing using EEG, fNIRS, GSR, and HRV to understand the impact of color schemes on consumer preferences. K-nearest neighbor (kNN) and support vector machine (SVM) algorithms are employed for sentiment analysis in neuromarketing research [55].

K. Sinha et al. (2021): The research focuses on predicting fatigue failures in electronic components in autonomous vehicles. By constructing a simulation framework, the study efficiently predicts the fatigue life of semiconductor packages, identifying critical parameters for durability [56].

S. H. Lye et al. (2021): Analyzing customer intent, the study proposes a hybrid representation for sentiment classification and customer intent prediction. Word2Vec and Random Forest classifier are used to enhance accuracy, and Power BI influencer module aids in predicting clientele intentions [57].

D. Vidanagama et al. (2021): The paper addresses the issue of fake online reviews by presenting a filter-wrapper hybrid approach. Optimal features for detecting fraudulent testimonials are selected using K-Nearest Neighbor (KNN) classifier, achieving higher model accuracy compared to conventional methods [58].

H. A. M. Priyanwada et al. (2021): The research focuses on using machine learning for on-shelf detection, stock forecasting, and empty shelf detection in supermarkets. Time series analysis and various algorithms predict supermarket sales and demand, optimizing supply and demand forecasting [59].

Y. Wang et al. (2020): Applying machine learning algorithms like Logistic Regression, Decision Tree, and Random Forest to credit scoring, the study evaluates credit risk using data from a financial institution. Results demonstrate the feasibility of using machine learning for financial risk analysis [60].

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H. Tang et al. (2020): The research proposes a Particle Swarm Optimization-based combination model of Support Vector Machines (SVM) for user credit risk assessment. The model is compared to other algorithms, demonstrating its effectiveness in predictive classification [61].

P. Bedi et al. (2020): The article explores the influence of AI-based tools on risk assessment in various domains, including credit risk, market risk, organizational risk, and compliance enforcement. Limitations and future perspectives are discussed, highlighting AI's role in risk management [62].

C. H. Chang et al. (2020) introduced a credit card fraud risk control framework employing an autoencoder for anomaly detection. Fraud events, statistically outliers in the autoencoder's reconstruction error, are identified using anomaly detection. The autoencoder, trained for normal and fraudulent transactions, exhibits robust fitness. Thresholds, established based on the reconstruction error percentiles of normal transactions, allow managing false positives and assessing the risk of false negatives. By setting the threshold at the 95th percentile, an 86% false-positive rate and a 5% normal transaction misclassification rate occur. At the 99th percentile, a well-controlled 1% false-positive rate is expected, with an 83% success rate in detecting fraud activities [63].

VidhiKhanduja et al. (2020) addressed credit risk analysis's significance in preventing massive financial losses due to non-repayment. Utilizing machine learning models, they assessed loan approval predictions. Logistic regression emerged as the most accurate method, outperforming random forest classification and KNN. Employing LDA and PCA for feature extraction, Logistic regression's superior performance suggests confidence in machine learning algorithms for lending decisions [64].

Shivanna et al. (2020) emphasized the need for lending institutions to implement effective credit risk assessment systems for Basel II compliance. Their study, using data mining and machine learning, aimed to identify potential loan defaulters. DSVM was found to be the most effective model among four. The models, validated on a dataset with 25 attributes and 30k instances from UCI, provide a reliable tool for credit risk management systems [65].

P. Maheswari et al. (2020) highlighted the importance of precise forecasting in lending. Acknowledging the significant role of data science, they employed statistical methods for data pre-processing, constructing a reliable model for predicting loan defaults [66].

Dattachaudhuri et al. (2020) proposed Transparent Decision Support System for Credit Risk Evaluation (TDSSCRE), addressing the need for explainability in credit risk evaluation systems. Using neural networks, TDSSCRE extracts clear rules, providing explanations for application decisions. Ten-fold cross-validation on three credit risk datasets validates its accuracy and transparency [67].

R. Z. Xu et al. (2020) introduced a deep belief network-based approach for credit risk assessment in online supply chains. Their model, utilizing RBM and SOFTMAX, demonstrated effective evaluation, providing a scientific index for risk assessment [69].

M. J. Ariza-Garzón et al. (2020) emphasized the need for effective and transparent credit risk models in P2P lending. Evaluating machine learning algorithms, they found superior classification performance and explainability compared to logistic regression. SHAP values showcased the ability to capture heterogeneity and nonlinearity, enhancing trust in machine learning for credit scoring [70].

4. CHALLENGES AND OPPORTUNITIES IN BIG DATA ANALYTICS

The realm of big data analytics presents both challenges and opportunities that shape its landscape and impact various industries. Here's an overview of some of these challenges and opportunities:

A. Challenges:

- *Volume, Velocity, and Variety:* Dealing with the sheer volume, speed, and diverse formats of data generated by various sources can be overwhelming. Managing, processing, and analyzing such massive volumes efficiently pose significant challenges.
- Data Quality and Reliability: Ensuring the quality, accuracy, and reliability of data is crucial. With vast amounts of data, there might be inconsistencies, errors, or biases that can impact analysis outcomes.
- Privacy and Security Concerns: Big data often contains sensitive and personal information. Ensuring data privacy, complying with regulations (like GDPR), and safeguarding against cyber threats is critical but challenging.
- Complexity of Analysis: Analyzing diverse data sources and extracting valuable insights requires advanced analytics techniques, machine learning algorithms, and specialized skills. Dealing with unstructured data further adds complexity.
- Infrastructure and Technology: Maintaining the infrastructure capable of handling large-scale data processing and storage is costly. Keeping up with evolving technologies and tools is also challenging.

B. Opportunities:

Actionable Insights: Analyzing big data offers opportunities to derive meaningful insights, patterns, and trends that can drive informed decision-making in various domains, from healthcare to finance and beyond.

- *Predictive Analytics:* Leveraging big data enables predictive modeling and forecasting, empowering businesses to anticipate trends, customer behavior, and market shifts.
- *Innovation and Efficiency:* Big data analytics fosters innovation by enabling organizations to create new products, services, and business models. It also enhances operational efficiency by optimizing processes.
- *Personalization and Customer Experience:* Understanding large datasets allows businesses to personalize offerings, improve customer experience, and tailor marketing strategies based on individual preferences.
- *Healthcare and Research:* Big data analytics in healthcare facilitates disease prediction, drug discovery, and personalized medicine, transforming the industry.

5. CONCLUSION

Big data analytics presents a vast array of challenges, from handling massive volumes of data to ensuring its quality, security, and analysis complexity. However, it also offers immense opportunities for businesses, governments, and research institutions to gain valuable insights, innovate, and improve decision-making processes across multiple domains. Addressing these challenges while capitalizing on the opportunities can unlock the true potential of big data analytics. In conclusion, this study underscores the profound impact of the state-of-the-art cloud-based big data analytics approach on decision support systems, presenting an avenue for organizations to optimize decision-making processes and gain a competitive edge in today's dynamic business landscape. Embracing this synergy offers a pathway towards harnessing actionable insights, driving innovation, and fostering a data-driven culture poised for continued growth and success.

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