How E-commerce Websites Track User Behavior: A Review of Q1 Research Articles

Abstract

In today's digital market, it is important for e-commerce websites to understand and analyze customer behavior to be successful. This paper discusses how cutting-edge data tracking and analysis methods are employed to analyze and forecast user behavior. Three Q1 journal articles are reviewed based on their contributions, methods, results, comparisons to state-of-the-art methods, and limitations. The aim is to have a comprehensive overview of the technological and ethical aspects of user behavior tracking in e-commerce.

1.Introduction

Online shopping has transformed how people shop, enabling customers to window shop, compare, and purchase products from any part of the world. Beneath the seamless shopping experience lies a complex web of data collection and behavioral tracking. Websites constantly track user behavior—from mouse movements and clicks to search queries and time spent on a product page.

This behavioral data is analyzed using machine learning, predictive analytics, and other advanced tools to personalize the shopping experience, increase engagement, and boost sales. However, with increased tracking comes serious issues of user privacy, transparency, and data ethics.

To gain a better understanding of the state of the art in this area, this paper reviews three Q1 research papers, each of which takes a distinct perspective on how e-commerce websites monitor and analyze user behavior.

2. Article 1: Deep Learning for Predicting User Intent

Title: Deep Learning Methods for Understanding User Behavior in E-Commerce

Published in: IEEE Transactions on Knowledge and Data Engineering (Q1)

Contribution

This article proposes a real-time user intent prediction model based on deep learning. The authors believe that understanding intent is the key to constructing personal recommendations and conversion rate optimization.

Methodology

The study utilized session-level interaction logs of a leading e-commerce site. A session of each user included time-ordered activities like product views, searches, cart modifications, and clicks. The authors utilized an LSTM-based RNN (Recurrent Neural Network) to capture sequential patterns of user behaviors. The model was trained to predict user behavior into categories: probable buyer, casual browser, or cart abandoner.

Result Analysis

The RNN model achieved an average classification accuracy of 91% with a precision value of 89% for predicting purchase intention. Interestingly, the model was able to detect potential buyers within just the first few clicks, enabling timely intervention through personalization recommendations.

Comparison with Other Works

Compared to SVMs and Random Forest classifiers, the deep learning approach improved accuracy by 10–15% significantly. The ability of RNNs to handle sequential dependencies made them more suitable for time-sensitive prediction tasks.

Limitations and Gap

Despite its high performance, the model's decision-making process was not interpretable. Moreover, the reliance on labeled data and high computational resources makes it less viable for small businesses. The cross-device behavior tracking and session interruption effects were not examined in the study.

3. Article 2: Browser Fingerprinting for Identity Tracking

Title: **Web Tracking with Browser Fingerprinting in E-Commerce Platforms**

Published in: **ACM Transactions on the Web (Q1)**

Contribution

The practice of browser fingerprinting in order to track users without relying on cookies is the focus of this study. It is particularly well-placed in a world where cookies do not exist, privacy legislation and browser policies are eroding the effectiveness of normal tracking.

Methodology

Researchers collected data from over 100,000 user sessions and tracked device-based information like screen resolution, installed fonts, language support, and WebGL information. Personal fingerprint was subsequently established for each user by the implementation of hash-based matching.

Result Analysis

The system achieved a 95% user re-identification rate in multiple sessions, including incognito mode. This indicates that browser fingerprinting can be used as a replacement for cookies to ensure long-term tracking.

Comparison with Other Works

Classic tracking methods (e.g., cookies, session IDs) are compromised when customers delete browser cache or switch hardware. Fingerprinting, in contrast, supports persistent tracking and works even if users are not logged on. But it is less effective than behavioral models at predicting user behavior or intent**.**

Limitations and Gap

Fingerprinting has large ethical issues at its core. It functions without direct user agreement, and because of that, it's the target of privacy laws such as the GDPR. Additionally, fingerprinting cannot say anything about why a user takes a particular action—it just names them, not their motive.

4. Article 3: Predictive Analytics with Clickstream Data

Title: Predictive Analytics for User Engagement in E-Commerce Using Clickstream Data

Published in: Information Systems Research (Q1)

Contribution

The article suggests a hybrid clustering-machine learning approach to segment users and predict future engagement levels. The model enables firms to discover the behavior of different types of users and which user behaviors lead to higher sales.

Methodology

The authors used clickstream data from a fashion retailer. The authors initially applied K-means clustering for segmenting users based on session length, number of clicks, and product categories visited. They trained a Gradient Boosting Machine (GBM) model to forecast behaviors including cart abandonment, buying products, and revisiting.

Result Analysis

The hybrid model performed 18% better than the traditional logistic regression in engagement prediction. The segmentation allowed marketing campaigns to be more personalized, with higher email click-through rates and precision of product recommendations.

Comparison with Other Works

Unlike with deep learning models, this solution was both actionable and interpretable. It enabled the company to target specific clusters (e.g., “window shoppers” or “frequent buyers”) with tailored content. Though more behaviorally revealing than fingerprinting, this method required more computational effort to update regularly.

Limitations and Gap

The model’s accuracy decreased over time, especially during holidays or promotions, when users’ behavior varied from usual. Real-time deployment was also challenging due to system latency. The paper suggests including streaming analytics as a future improvement.

5. Comparative Analysis

Aspect	Article 1 (Deep Learning)	Article 2 (Fingerprinting)	Article 3 (Predictive Analytics)
Contribution	Predicting user intent	Tracking identity without cookies	Segmenting users by engagement
Accuracy	91%	95%	82%(with interpretability
Real-Time Capability	High	High	Moderate
Interpretability	Low	Low	High
Ethical implications	Moderate	High	Low
Limitations	Requires large labeled data	Privacy concerns	Not real-time, data may be outdated

6. Conclusion

User behavior tracking is at the heart of e-commerce success. This review has shown that there is no one-size-fits-all solution. Deep learning provides the best performance in behavior prediction but lacks explainability. Fingerprinting is efficient for identifying users but faces privacy concerns. Predictive analytics offers business-friendly insights but struggles with real-time adaptation.

Future research should aim to combine the strengths of these methods—developing hybrid models that are accurate, interpretable, real-time, and privacy-compliant. At the same time, e-commerce platforms must be transparent about their tracking methods and respect user privacy to maintain trust and comply with global regulations.