Analysis of Big Data Analytics-Based Recommendation Systems for Cable Television Interactive On-Demand Services: Postprint

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Abstract

Against the backdrop of the major transformation toward intelligent cloud computing, cable television has entered a new stage of big data analytics. Interactive on-demand, as one of the core businesses of cable television, frees viewers from playback control, allowing them to freely choose their preferred programs. The technical support for this functionality is interactive television transmission technology, which enables operations such as big data analytics. This paper discusses the big data analytics system for cable television interactive on-demand services, and through an exposition of recommendation data models, explores the application of big data analytics recommendation systems in cable television interactive on-demand services.

Full Text

Preamble

Analysis of Big Data-Driven Recommendation Systems for Cable TV Interactive On-Demand Services

Abstract: In today's era of intelligent cloud computing transformation, cable television has entered a new stage of big data analytics. As a core business component of cable TV, interactive on-demand services liberate viewers from traditional broadcast schedules, enabling them to freely select preferred programs. The technical foundation for this functionality is interactive television transmission technology, which enables big data analysis and related operations. This paper examines big data analytics systems for cable TV interactive on-demand services, discussing recommendation data models and exploring the application of big data-driven recommendation systems in this domain.

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Interactive on-demand services represent an innovative business model for broadcast operators following triple-network convergence. Faced with competition from mobile communications and internet TV, broadcast operators aim to leverage interactive television to overcome triple-network convergence challenges and establish a competitive position alongside IPTV and OTT services. Consequently, learning from internet video platforms and employing big data analytics systems to mine and analyze user preferences, demographics, and consumption capabilities—thereby delivering personalized video solutions—has become a critical direction for cable TV operators.

1. The Era of Big Data Analytics for Cable TV Interactive On-Demand Services

Implementing interactive on-demand services requires activating on-demand functionality, which represents a paid offering. However, user acceptance of this payment model remains limited based on current market penetration. For years, Chinese users have grown accustomed to traditional cable TV programming and established viewing habits, making it difficult to accept purchasing two-way set-top boxes instead of using free, standard-issue devices. Nevertheless, this cost is minimal compared to internet video service fees, indicating that pricing is not the primary factor limiting market adoption of cable TV interactive on-demand services.

Since the State Administration of Radio and Television initiated triple-network convergence reforms, interactive on-demand services have become a key focus for broadcast operators. Existing business models continue evolving as interactive TV on-demand services compete for market share alongside IPTV and OTT platforms. However, China's current cable TV interactive on-demand services have yet to mature, with relatively few users adopting paid on-demand features. This creates significant challenges for service expansion and value-added offerings.

Current cable TV interactive on-demand services primarily aggregate program sources from traditional broadcast models, falling short of true program refinement, mobile TV innovations, and sophisticated EPG systems. The push-based service model, where operators deliver content rather than tailoring recommendations to segmented user preferences based on detailed analysis, has resulted in low usage rates and a continued reliance on 粗放式 (extensive) operational models.

2. Overview of Big Data Analytics

The terminal platform for cable TV interactive on-demand services is the digital set-top box, through which big data analytics systems can collect various data points: set-top box IDs, user personal information (name, address), authorization details, account credentials, media content IDs, types, titles, countries, directors, actors, pricing, synopses, and video quality specifications (HD or ultra-HD). Additionally, all transaction IDs, user data, resource information, viewing times, viewing volumes, and program unit prices can be captured through the set-top box terminal. The system can also collect program ratings and reviews via ID tracking, as well as remote control operations such as play and pause commands.

However, data collected through digital set-top boxes remains far from the granular requirements needed to understand user preferences, personality traits, and social demographics. Consequently, analysis still relies on extensive data processing models. To achieve more sophisticated analytics—including user preference profiling, detailed content descriptions, channel switching frequency, and viewing duration—and to identify correlations between users and data that can inform marketing strategies, operators must maximize data value through big data analytics and precision recommendation models.

2.1 Recommendation Algorithms for Interactive On-Demand Big Data

These algorithms leverage user network analysis to predict points of interest. Primary computational methods include collaborative filtering, content-based recommendation, and network structure-based algorithms. Collaborative filtering is currently the most widely adopted approach, constructing user interest models as user-item association matrices with the formula $m \times n$, where m represents the number of users and n represents the number of items.

Matrix values correspond to system type configurations, including user rating values, data populated when users purchase or browse items, and recommendation lists for target users based on preference behaviors. Applying collaborative filtering to cable TV interactive on-demand services, we can organize data using 100 service users as a baseline, collecting rating data from different users for the same program resource.

User sets G can be defined for viewing and rating the same resources. When new users attempt to access on-demand content, the system predicts their preferences using the user set method. $Sim(c, G)$ is calculated using cosine similarity or Pearson correlation.

2.2 Optimization Algorithms for Interactive On-Demand Big Data

Current data analysis for cable TV interactive on-demand services has significant limitations. For instance, the system cannot fully capture viewing fre-

quency bands or user interest in actor dialogue, resulting in unsatisfactory recommendation effectiveness. These constraints stem from sampling device limitations—set-top box remotes can only record operations like play and pause during specific time periods.

To address these issues without excessive resource consumption, this paper proposes a solution: leveraging remote control operation data and pre-generated video content descriptions for quantitative analysis based on sampling time to create user preference profiles, then applying content-based recommendation algorithms to mine these profiles and derive recommendation data models.

User preference description documents reveal data including user preference levels, keyword frequency, and interest points. By combining collaborative filtering with content-based algorithms, the system performs more precise calculations of user interests to create an optimized recommendation model. This approach displays user preference levels and ratings as weights for different vocabulary terms in documents, utilizes term frequency difference feature algorithms to calculate user preference profiles, and employs vector space representation to complete the recommendation data model.

Content-based recommendation effectively addresses cold-start and data sparsity issues, serving as a valuable supplement to collaborative filtering. However, this algorithm is constrained by content extraction technology and involves complex computations that consume significant processing power and time.

3. Optimized Big Data Analytics Framework for Cable TV Interactive On-Demand Services

Cable TV interactive on-demand big data originates from two sources: set-top box collection (account and business data) and remote control operation collection (event-based data with lower real-time requirements but large volumes). The proposed solution involves two-stage processing: first using collaborative filtering for initial processing, then applying near-real-time data analysis recommendation algorithms for secondary refinement.

The framework stores account, business, and rating data offline on a platform deployed in a production environment conducive to performance optimization. It leverages the collaborative filtering computational framework for data processing, combined with real-time data transmission and analysis of user information in the computation module. For example, the system performs preliminary real-time calculations for content-based modules, controls computational load, reduces system response time, and improves recommendation accuracy.

4. Conclusion

For cable TV interactive on-demand service data, collaborative filtering and content-based recommendation algorithms represent currently popular approaches. Analysis of hybrid recommendation models combining these two

methods yields function-based recommendation algorithms that provide big data technical support for cable TV interactive on-demand applications.

By addressing cold-start and data sparsity problems while supplementing collaborative filtering, content-based algorithms offer significant advantages. To effectively utilize existing cable TV interactive on-demand service support systems while minimizing new system construction costs, the hybrid model provides a balanced solution for delivering more precise user recommendations.

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Note: Figure translations are in progress. See original paper for figures.