



The Automated Competitive Discount Awareness System

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Abstract: The article analyzes the development of an automated system designed to inform about discounts offered by competitors on the clothing e-commerce platform. The main goal was to replace manual data collection and integration processes with an automated approach that improves the accuracy of company pricing steering strategy and reduces operational overhead. The system model is based on Lagrange equations, which ensures the integration of price information into strategic management.

The implementation methodology includes web scraping through Selenium, scrappy tools, and data processing using machine learning methods. The approach to analyzing text materials allows you to effectively extract meaningful information from advertising content. The architectural solution is based on a microservice model, which increases the adaptability of the system and simplifies scaling. Existing scientific research, studies, and developments, as well as the author's practical experience working on a commercial e-commerce fashion platform, were used as sources, allowing for a comprehensive exploration of the topic.

The results demonstrate cost reduction and improved accuracy of processes related to pricing. The developed system finds applications in e-commerce, marketing, data processing, and software development, where automated solutions for business process management are in demand.

The study presents a method for collecting and analyzing data on competitors' price offers. The developed system uses big data processing algorithms to monitor changes in pricing policy. This allows you to quickly adapt pricing strategies, as well as make adjustments to marketing decisions.

The formulated conclusions confirm the achievement of

the stated goals. The introduction of an automated approach has made it possible to optimize tasks related to monitoring and analyzing competitive offers as well as ensuring pricing steering accuracy, i.e. meeting certain business targets on total sales discount rates.

Keywords: Automation, competitive discounts, pricing steering, web scraping, machine learning, price management, and microservice architecture.

Introduction: E-commerce is evolving within the context of dynamic market changes, necessitating prompt responses to shifts in the external environment. One of the key management strategies involves analyzing competitors' pricing policies, with a particular focus on discounts and special offers. The data obtained through such analysis helps the company to ensure an attractive proposition for its customers relative to the competition, strengthens the company's market position and enables adjustments to pricing strategies.

Traditional methods of collecting discount information, which rely on manual processes, are characterized by low accuracy, high costs, and dependency on human factors. Big data processing technologies eliminate these limitations. Automated price monitoring systems ensure the accuracy, and speed of data processing, and minimize the likelihood of errors.

The design of an automated competitive discounts information system (ACDIS) involves utilizing web scraping methods, machine learning techniques, and optimization algorithms. This system handles tasks related to data collection and processing while integrating into pricing optimization processes. Its microservice architecture provides flexibility, scalability, and adaptability to market environment changes.

This study aims to develop, describe, and evaluate the effectiveness of ACDIS for the discount optimization process. The article also examines the advantages of employing automated solutions in the e-commerce sector.

METHODS

Automated bidding systems and auction mechanisms have been presented in several studies. The work by Zhang H. et al. [1] describes the structure of personalized automated bidding systems that account for individual participant conditions while ensuring fairness. Y. Xing et al. [5] developed truthful auction models that guarantee honest interactions. Shenjun Xue et al. [6] examined time-dependent data and

proposed mechanisms to account for its value under dynamic conditions. Wen C. et al. [3] investigated multi-component models where agent interactions through cooperation and competition create a fluctuating environment for advertising platforms.

The issue of pricing automation is addressed in the study by Brown Z. Y. and MacKay A. [2], which examines algorithms influencing the market. Javed M. A. et al. [4] proposed a system for generating competitive offers, enabling more accurate market data analysis. Karlsson N. and Sang Q. [9] developed algorithms for optimizing shadow bids in first-price auctions, reducing advertiser costs.

Automation in e-commerce is explored by James N. et al. [7], which employs computer vision technologies for automated calculations. A. Singh and S. Kapoor [10] studied order automation and price monitoring using web analytics methods.

Methods applied in recommendation systems and pricing are discussed in the study by Marchand A. and Marx P. [11], which implemented a recommendation system based on user preferences. Ajiteru S. O. et al. [8] described a web application for automated price regulation. The integration of auction modules in electronic procurement is detailed in Bodak B. V. and Doroshenko A. Y. [12], which outlines approaches to improving these processes.

An analysis of the literature demonstrates a wide range of methods for automating bidding and pricing. However, differences in the definitions of fairness and honesty presented in publications complicate comparisons of their effectiveness. The adaptation of systems to the specifics of local markets and changes in consumer behavior remains insufficiently explored. The lack of integration between bidding automation technologies and recommendation approaches limits the potential for their application in comprehensive solutions.

This study employed an analytical methodology based on a systematic approach to collecting, examining, and synthesizing information.

RESULTS AND DISCUSSIONS

The development of an automated system for intelligent data collection and integration into a larger optimization system focuses on creating a streamlined process to take into account competitors' prices while solving a revenue maximization problem given the target growth level. This system structures data, preparing it for strategic decision-making [1]. The functionality of the automated system for competitor discounts integration is detailed in Table 1.

Table 1. Functionality of the Automated System for Competitor Discounts Integration (compiled by the author)

Functionality	Description
Competitor Price Monitoring	Automated data collection on competitor prices for targeted goods from websites, marketplaces, and other sources.
Price Analysis and Comparison	Real-time comparison of prices for similar goods and services from various competitors.
Alerts and Notifications	Notifications about changes in competitor prices or discounts via email, or within the system.
Demand Forecasting	Machine learning algorithms to predict future demand changes based on historical data.
Filter and Search Criteria Setup	Customizable filters for tracking discounts by product category, brand, region, and other parameters.
Discount Effectiveness Analysis	Evaluation of the impact of competitor discounts on the total sales discount rate and projected sales and revenue e
Monitoring Promotions and Offers	Tracking special offers (discounts, sales, bonuses) from competitors, including their validity periods.
Integration with CRM and ERP Systems	Integration with corporate systems for automatic updates of prices, discounts, and offers in real-time.
Real-Time Price Dynamics Monitoring	Continuous updates on price data in real-time for rapid response to market changes.
Multichannel Monitoring Support	Capability to track prices and promotions through multiple channels (online stores, offline retailers, social media).
Dashboards and Data Visualization	Visual dashboards displaying prices, discounts, and other data for quick situation analysis.
Historical Analysis and Trends	Archiving historical data for dynamic price and discount trend analysis, aiding in long-term trend identification.
Pricing Strategy Recommendations	Based on collected and predicted data, the system provides recommendations for pricing adjustments and promotional activities to enhance competitiveness.

The primary tasks of the automated system for in Figure 1. competitive discounts integration are illustrated below

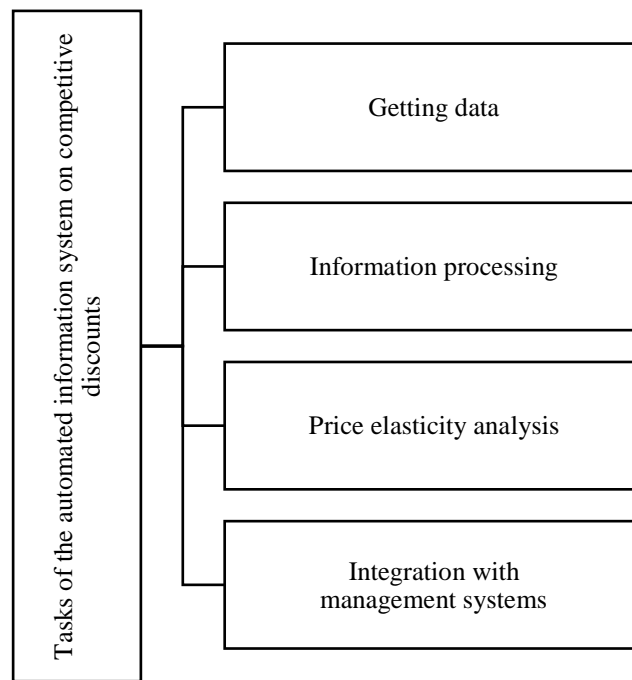


Figure 1. Tasks of the Automated System for Competitive Discounts Integration [1].

The system operates by regularly monitoring competitors' pricing offers, promotions, and discounts. In a competitive environment, even minor price changes by market participants can influence demand for goods or services, especially for popular items that are in high demand. Through systematic analysis of pricing offers, companies can adjust their strategies promptly.

Data collection employs several methods. One such method is web scraping, which involves automated extraction of data from competitor websites. Using parsing, the system retrieves information about prices, discounts, promotions, and product listings. In some cases, data is also obtained through open interfaces provided by marketplaces, aggregators, or other services.

Various technologies are used for processing and storing the collected data. Relational databases like MySQL and PostgreSQL are employed for structured information storage, such as data on discounts and promotions tied to specific products, timeframes, or geographical locations. For handling large volumes of data in JSON, XML, or CSV formats, NoSQL-based solutions like MongoDB are utilized, enabling fast processing of unstructured data [3, 5, 6].

The system also facilitates comparisons between external data and the company's internal offers. Based on the insights gained, recommendations are generated to adjust pricing or launch promotions aimed at improving market positions. This feature is valuable for pricing specialists and marketers responsible for launching special offers in response to

changes in the competitive landscape.

Data analysis utilizes visualization tools such as Power BI and Tableau. These tools present information on prices, discounts, and projected financial data in a clear and accessible format, aiding in the rapid identification of trends, decision-making, and responses to competitive changes. The system also generates reports that enable tracking sales and discounts' changes over time.

The system can send notifications about significant price changes or competitor promotions. Notifications are delivered through various communication channels, such as email or messaging platforms. This feature is particularly relevant for companies operating in environments where pricing policy changes require swift reactions.

Automating data collection and analysis processes accelerates the monitoring of changes and reduces the likelihood of errors that can occur during manual processing. This automation allows employees to focus on strategy development and customer engagement, freeing them from routine tasks [7, 10].

Additionally, such systems can be integrated with other corporate solutions, such as CRM systems and pricing management platforms. This creates opportunities for close collaboration between various company departments, enhancing overall efficiency. Integration with a pricing management system enables automatic adjustment of product prices based on changes in the market environment.

Platforms supporting distributed computing, such as Apache Kafka and Spark, are used for analysis, while data visualization is performed using BI platforms like

Tableau or Power BI. The Automated Competitive Discounts Information System (ACDIS) is built on a microservice architecture, which allows it to be adapted for various tasks [2,4,9]. The main

components of the system are shown in Figure 2.

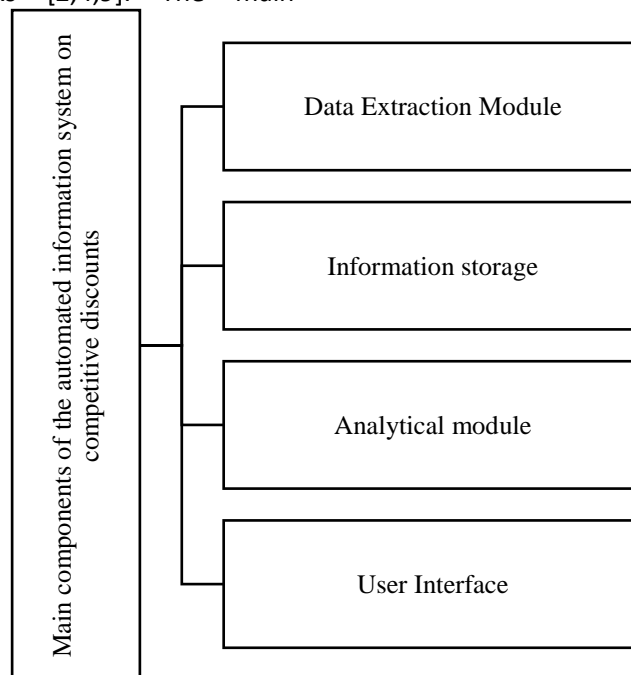


Figure 2. Main components of the automated competitive discounts information system (created by the author)

The implementation process of an automated system for integrating competitive discounts will now be considered based on practical experience. The developed solution automates the collection, processing, and analysis of market price information, enabling real-time price adjustments. The system is based on a mathematical model utilizing Lagrange equations, ensuring accurate approximation of the optimal solution and consideration of multiple business targets restricting the solution.

Before the implementation of this technology, competitive discount data was collected and applied on top of recommended internal discounts manually, creating additional technical overhead, and resulting in pricing steering inaccuracies (as the overall optimization solution did not account for competitive discounts which were applied later) and introducing the risk of human errors. The process, which relied on web scraping tools such as Selenium and Scrapy, was labor-intensive and limited responsiveness to market changes. The new competitive discount aware system can take into account the discounts of market competitors to ensure an attractive proposition for the company's customers relative to the competition when outputting optimal final discounts. Without awareness of these discounts, pricing steering accuracy is negatively affected because the

optimization system cannot account for their contribution to the total sales discount rate.

Automation increased the speed of data updates, ensured high calculation accuracy, integrated analysis results into pricing management, and what's most important - ensured the pricing steering accuracy. The system collects up-to-date information, performs calculations, and incorporates the results into the company's strategy. A user-friendly interface simplified the pricing steering process and reduced time spent on operational tasks.

The iterative solution of the Lagrangian optimization problem enables accurate calculations while accounting for business constraints embedded in pricing policies. This approach eliminates the influence of human error, guarantees decision reliability, and allows the identification of optimal discount parameters. The combination of analytical capabilities with ease of use creates a tool that meets business needs in a constantly changing market environment.

The implementation of the automated system addressed labor-intensive tasks, reduced risks associated with data processing, and ensured high process reliability. Zalando, as a case study, gained the ability to quickly respond to market changes, minimizing the impact of external factors. Pricing became more

manageable, freeing employees to focus on other strategic tasks.

The project resulted in reduced time and financial costs, improved process accuracy, and simplified pricing management. The new solution demonstrated how automation can transform traditional approaches,

enhancing their effectiveness and adaptability to current conditions [11,12]. Table 2 outlines the advantages and disadvantages of using automated competitor discount information systems.

Table 2. Advantages and disadvantages of using automated competitive discounts information systems (compiled by the author)

Advantages	Disadvantages
Time and resource savings: eliminates manual extraction and loading, enabling a focus on strategic tasks.	High implementation costs: initial setup and system acquisition may be expensive.
Data accuracy: minimizes human error in data collection and processing.	Requires integration: integration with existing company IT systems may be complex.
Pricing management accuracy: ensures sales discount rate targets are accurately met	Accuracy limitations: insufficient data coverage or restricted access to competitor pricing.
Real-time updates: enables immediate access to competitor discount changes.	Need for staff training: requires time for employees to learn the system's functionality.
Enhanced competitiveness: facilitates quick responses to price changes and competitive offers.	Dependence on data quality: inaccuracies or errors in competitor data can distort results.
Analytics and forecasting: provides tools for analyzing market trends.	Ethical and legal concerns: potential issues regarding the legality of competitor data use.
Flexibility: can be customized to specific business needs.	
Scalability: easily adapts to both large and small businesses.	
Reduced operational costs: automation reduces labor expenses.	

Automated systems designed for analyzing competitors' pricing strategies are utilized to optimize commercial activities under heightened market competition. Developing such solutions involves leveraging advanced technologies, detailed data processing, and designing architectures that ensure high operational accuracy and reliability.

CONCLUSION

The automated competitive discounts information system (ACDIS) has proven effective in addressing tasks related to optimizing pricing steering accuracy and monitoring pricing strategies. The system's

foundation comprises web scraping methods, text information processing algorithms, and analytical technologies. These components have reduced time costs, simplified processes, enhanced analysis accuracy, and integrated data into strategic pricing management.

ACDIS has demonstrated its practical relevance by processing large datasets from various sources while eliminating errors associated with manual collection. The implementation of a microservice architecture and the integration of modern computational solutions have enabled the system to adapt to changing market conditions and address the specific needs of e-commerce.

The findings of this study highlight the potential of automated approaches in pricing management, providing competitive advantages. The developed system is suitable for use across various e-commerce segments. Its capabilities encompass data analysis and the optimization of business processes. Future development directions include improving predictive models and incorporating recommendation solutions, which will expand the application of automated methods.

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