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ARTIFICIAL INTELLIGENCE AND BIG DATA TECHNOLOGIES IN TOURISM

Abstract. *This article analyzes the theoretical foundations and key development directions of Artificial Intelligence (AI) and Big Data technologies in the tourism industry. The study is conceptual and is based on a systematic review and synthesis of contemporary academic research. Particular attention is given to digital transformation theory, data-driven decision-making, information processing approaches, and service automation concepts as explanatory frameworks for technological integration in tourism.*

The research shows that AI and Big Data are not isolated digital tools but interconnected systems that influence strategic management, service design, forecasting mechanisms, and destination governance. The main directions of development include service personalization, predictive analytics for demand management, smart tourism ecosystems, operational automation, and sustainability monitoring. At the same time, the paper identifies challenges related to data security, ethical regulation, and workforce adaptation.

The findings provide a structured theoretical perspective on how intelligent technologies reshape competitiveness and long-term sustainability in tourism. The study may serve as a foundation for further empirical investigations and practical digital strategies in the tourism sector.

Keywords: *Artificial Intelligence, Big Data, tourism industry, digital transformation, smart tourism, predictive analytics, service automation, sustainable tourism development.*

Introduction

Tourism is widely recognized as one of the most dynamic and rapidly changing sectors of the global economy. Its development depends on a wide range of interconnected factors, including economic stability, technological progress, social trends, environmental conditions, and geopolitical processes. In recent years, the acceleration of digitalization has significantly reshaped the structure and functioning of the tourism industry. Traditional management models that relied heavily on experience and intuition are increasingly being replaced by technology-oriented approaches grounded

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in data analysis and intelligent systems.

The expansion of digital technologies has transformed how tourism services are designed, promoted, distributed, and consumed. Online reservation platforms, travel aggregators, social media networks, mobile applications, and review websites have become integral components of the tourism ecosystem. As a result, enormous volumes of digital information are continuously generated through users' searches, bookings, online interactions, feedback, and geolocation activities. This growing data environment has created favorable conditions for the active implementation of Artificial Intelligence (AI) and Big Data technologies within tourism management and operations.

Artificial Intelligence refers to advanced computational systems capable of learning from data, identifying patterns, and performing analytical or decision-support tasks that previously required human involvement. Big Data, in turn, represents large and complex datasets that cannot be effectively processed using traditional data management tools. In tourism, these two technologies function in close interconnection: Big Data provides the informational basis, while AI offers the analytical mechanisms that transform raw data into meaningful insights.

The increasing availability of real-time digital information has opened new opportunities for tourism enterprises and destination management organizations. Data collected from booking systems, customer relationship management platforms, smart sensors, mobile devices, and social networks makes it possible to better understand tourist behavior, preferences, motivations, and expectations. Through the use of machine learning algorithms, predictive analytics, and natural language processing tools, organizations can identify demand trends, forecast visitor flows, assess customer satisfaction, and optimize pricing strategies.

At the same time, the integration of AI-driven technologies has enhanced the level of service personalization within the tourism sector. Modern travelers expect fast, convenient, and customized services throughout all stages of their journey. Intelligent recommendation systems, chatbots, automated support services, and dynamic pricing mechanisms enable tourism providers to respond quickly to customer needs and offer tailored travel solutions. This shift toward personalized and data-based service models strengthens competitiveness and improves overall customer experience.

Beyond operational improvements, AI and Big Data also contribute to strategic development goals in tourism. Advanced analytics support more accurate planning, resource allocation, and risk management. Destination authorities can use data insights to manage tourist flows, reduce overcrowding, and monitor environmental impacts. In this sense, intelligent technologies play an important role not only in increasing efficiency but also in promoting sustainable tourism development.

Despite the growing practical adoption of AI and Big Data solutions, there is still a need for a deeper theoretical understanding of their role within tourism systems. Many studies focus primarily on technological applications, while less attention is given to conceptual frameworks that explain how these technologies reshape industry structures and management processes. A systematic analysis of theoretical foundations and future development directions is therefore essential to ensure that digital transformation in tourism remains effective, balanced, and strategically aligned with long-term industry objectives.

In this context, the present study seeks to explore the theoretical background underlying the use of Artificial Intelligence and Big Data in the tourism industry and to outline the key directions of their further development. By combining conceptual analysis with industry perspectives, the article aims to contribute to academic discussion and provide practical insights for stakeholders involved in

tourism digitalization.

Theoretical Foundations of AI and Big Data in Tourism

Digital Transformation Theory

The integration of Artificial Intelligence and Big Data technologies into the tourism industry is conceptually grounded in digital transformation theory. Digital transformation is understood as a systemic and strategic process that involves the deep integration of digital technologies into organizational structures, business models, and value creation mechanisms. In tourism, this transformation is not limited to the adoption of new technological tools; rather, it reflects a comprehensive restructuring of operational, managerial, and marketing processes.

The evolution of information technologies in tourism has been extensively documented in academic literature. Buhalis and Law [1] highlight that the development of information systems has fundamentally reshaped tourism management over the past decades, enabling new forms of distribution, communication, and customer interaction. Further conceptualization of smart tourism demonstrates that digital infrastructure, data analytics, and intelligent platforms form the foundation of contemporary tourism ecosystems [3; 4]. According to Xiang, Fesenmaier and Werthner [5], digital transformation in tourism represents a shift from traditional service delivery models toward interconnected, data-driven, and technology-enabled systems.

Within this framework, AI and Big Data function as core drivers of digital transformation. Big Data technologies allow tourism enterprises to collect and manage extensive volumes of information generated through booking systems, mobile applications, online reviews, and social media platforms [10]. Artificial Intelligence, in turn, provides analytical capabilities that convert this information into strategic insights and predictive models [6; 18]. As a result, tourism organizations are able to enhance operational efficiency, improve customer engagement, and strengthen competitiveness in a rapidly evolving digital environment.

Thus, digital transformation theory explains how AI and Big Data reshape tourism enterprises from conventional service providers into intelligent, adaptive, and customer-centered systems.

Data-Driven Decision-Making Theory

Another important theoretical basis for understanding the implementation of AI and Big Data in tourism is data-driven decision-making theory. This approach emphasizes that effective managerial decisions should rely on systematic analysis of empirical data rather than solely on intuition or past experience. In highly volatile industries such as tourism, characterized by seasonal fluctuations and external shocks, data-based decision-making becomes particularly significant.

The increasing availability of digital data has enabled tourism organizations to analyze consumer behavior patterns, market dynamics, and demand trends with greater precision [1; 10]. Davenport and Harris [7] argue that organizations capable of leveraging analytics gain strategic advantages through improved forecasting and performance optimization. In tourism, the application of data mining and predictive analytics techniques has been shown to improve hotel performance forecasting and revenue management [11].

Artificial Intelligence strengthens data-driven management by applying machine learning algorithms, natural language processing, and predictive modeling techniques to large datasets. For example, online review analysis provides valuable insights into customer satisfaction and service quality [8], while social media analytics allows organizations to identify emerging trends and adjust marketing strategies accordingly [14]. According to Li et al. [10], Big Data analytics significantly enhances research and managerial capabilities in tourism by uncovering complex relationships within

large-scale datasets.

Therefore, data-driven decision-making theory provides a conceptual explanation of how AI-supported analytics contributes to strategic planning, pricing strategies, demand forecasting, and overall performance optimization in tourism enterprises.

Information Processing Theory

Information processing theory offers another analytical perspective for examining the role of AI and Big Data in tourism systems. According to this theoretical approach, organizations function as information-processing entities that continuously collect, interpret, and utilize data to reduce uncertainty and enhance performance. The more dynamic and complex the external environment, the greater the need for advanced information-processing capabilities.

The tourism industry operates in a highly dynamic environment influenced by technological innovation, consumer behavior changes, global crises, and sustainability challenges [9; 20]. In such conditions, the ability to process large volumes of structured and unstructured data becomes a strategic resource. Big Data technologies expand the informational capacity of tourism enterprises by enabling the storage and management of extensive datasets derived from digital interactions [10].

Artificial Intelligence enhances this process by transforming raw information into actionable knowledge. AI systems identify patterns in consumer behavior, predict tourist flows, and detect operational inefficiencies [6; 12]. Rust and Huang [18] emphasize that AI-based service systems extend organizational intelligence by augmenting human decision-making with computational capabilities. From this perspective, intelligent technologies serve as cognitive tools that strengthen analytical capacity and reduce informational uncertainty.

Consequently, the combination of Big Data and AI increases organizational adaptability and resilience, enabling tourism enterprises to respond effectively to environmental complexity.

Service Automation and Human–Computer Interaction

The theoretical explanation of AI implementation in tourism is also closely related to service automation theory and human–computer interaction (HCI) theory. Service automation theory examines the replacement or augmentation of human labor through technological systems designed to perform repetitive, standardized, or data-intensive tasks. In tourism, automation includes online booking systems, automated check-in services, robotic assistants, and AI-powered customer support platforms.

Ivanov and Webster [13] analyze the adoption of robots and service automation in tourism and highlight their impact on operational efficiency and cost reduction. Similarly, Wirtz et al. [19] discuss the emergence of service robots in frontline interactions and emphasize their potential to transform customer service models. Tussyadiah [12] further notes that automation in tourism represents a long-term structural shift driven by technological advancement and changing consumer expectations.

However, the effectiveness of AI-based services depends not only on technological performance but also on user perception and interaction quality. Human–computer interaction theory underscores the importance of transparency, usability, and trust in intelligent systems. Technology-enhanced tourism experiences require seamless integration between digital interfaces and human-centered service design [17]. If AI systems lack transparency or fail to align with user expectations, customer satisfaction may decline despite operational efficiency gains.

Thus, service automation and human–computer interaction theories together explain both the functional and experiential dimensions of AI implementation in tourism. Intelligent systems must not only optimize operations but also enhance customer engagement and trust.

Development Directions of AI and Big Data in the Tourism Industry

Personalization of Tourism Services

One of the most significant development directions of Artificial Intelligence and Big Data technologies in tourism is the deepening of service personalization. In the contemporary tourism environment, consumer expectations are increasingly shaped by digital platforms that offer individualized recommendations and tailored content. Travelers expect customized travel packages, dynamic offers, and real-time assistance throughout all stages of their journey.

The theoretical foundations of personalization in tourism are closely related to the development of smart tourism ecosystems [3; 4]. According to Buhalis and Amaranggana [2], smart destinations rely on digital infrastructure and data analytics to enhance tourist experiences through adaptive services. Big Data technologies enable the collection and processing of information regarding tourists' preferences, search histories, booking patterns, and online interactions [10]. This data serves as the informational basis for AI-powered recommendation systems.

Artificial Intelligence algorithms analyze behavioral data and generate personalized suggestions for destinations, accommodation options, transportation routes, and leisure activities. Research on online reviews demonstrates that user-generated content provides valuable insights into customer expectations and satisfaction levels [8]. Additionally, social media analytics contributes to identifying individual interests and lifestyle preferences [14]. As a result, tourism enterprises can design targeted marketing strategies and improve customer loyalty through individualized engagement.

Therefore, personalization supported by AI and Big Data enhances not only customer satisfaction but also competitive positioning in the global tourism market.

Demand Forecasting and Market Analysis

Another key development direction involves the use of Big Data analytics and AI-based predictive models for demand forecasting and market analysis. Tourism demand is highly sensitive to seasonal variations, economic fluctuations, and unexpected external events. Consequently, accurate forecasting becomes essential for effective resource allocation and risk management.

The application of Big Data in tourism research has demonstrated significant potential for identifying demand patterns and predicting tourist flows [10]. Data mining techniques have been successfully applied to hotel performance prediction and revenue optimization [11]. By integrating historical data with real-time indicators such as booking trends, online searches, and social media activity, tourism organizations can anticipate changes in demand and adjust operational strategies accordingly.

Data-driven decision-making approaches further support dynamic pricing, capacity planning, and investment strategies [7]. AI-enhanced forecasting models reduce uncertainty and improve financial stability, especially in volatile environments influenced by global crises [9]. Thus, predictive analytics represents a strategic instrument for strengthening resilience and competitiveness in the tourism industry.

Smart Tourism and Destination Management

The concept of smart tourism constitutes a central development trajectory supported by AI and Big Data technologies. Smart tourism integrates digital infrastructure, information systems, and intelligent analytics into destination management processes. This approach transforms destinations into interconnected ecosystems where stakeholders share data and coordinate services in real time [3; 4].

Smart tourism destinations rely on advanced information technologies to enhance visitor experience and operational efficiency [2]. According to Wang, Li, and Li [16], smart destination initiatives involve digital governance mechanisms that optimize transportation systems, visitor flow management, and public service provision. AI technologies allow real-time monitoring of tourist density, infrastructure usage, and mobility patterns.

Digital transformation processes described by Xiang, Fesenmaier, and Werthner [5] highlight that destination management organizations increasingly depend on integrated data platforms to ensure strategic coordination. Smart tourism systems also contribute to improved safety measures, environmental monitoring, and interactive visitor engagement.

Therefore, the integration of AI and Big Data within smart tourism frameworks strengthens both managerial effectiveness and tourist experience quality.

Operational Efficiency and Automation

Operational automation represents another significant development direction driven by Artificial Intelligence. Tourism enterprises are progressively implementing AI-powered solutions to streamline routine processes and enhance service efficiency.

Research on service automation and robotics in tourism demonstrates that intelligent systems can perform repetitive tasks more consistently and efficiently than manual operations [13; 19]. Automated check-in kiosks, digital concierge services, chatbots, and robotic assistants reduce waiting times and operational costs. Tussyadiah [12] emphasizes that automation is becoming a structural element of tourism service delivery rather than a temporary technological trend.

Artificial Intelligence also supports advanced pricing algorithms and fraud detection systems, which improve financial control and revenue management [11]. Technology-enhanced experiences further integrate digital tools into customer interactions, creating seamless service environments [17].

Consequently, automation not only increases organizational performance but also contributes to service standardization and scalability in tourism enterprises.

Sustainable Tourism Development

Sustainable development has emerged as a strategic priority for the tourism industry in the context of environmental challenges and resource constraints. AI and Big Data technologies provide new opportunities for promoting sustainability through data-driven monitoring and evidence-based policymaking.

Digitalization enables the collection of environmental data related to visitor density, energy consumption, and ecological impacts [20]. Big Data analytics can identify patterns of over-tourism and support regulatory interventions aimed at balancing economic benefits with environmental protection [9]. Smart tourism systems facilitate real-time monitoring of natural and cultural resources, enabling more responsible management practices [3].

By integrating AI-driven analytics into policy frameworks, destination authorities can optimize resource allocation, reduce environmental risks, and align tourism development with long-term sustainability goals. Thus, intelligent technologies contribute not only to economic efficiency but also to ecological responsibility and social balance.

Challenges and Limitations

Despite the significant advantages associated with AI and Big Data implementation, several challenges and limitations remain. One of the primary concerns relates to data privacy and cybersecurity. Tourism enterprises handle large volumes of personal and transactional information, making them vulnerable to data breaches and regulatory non-compliance.

High implementation costs and the need for specialized technical expertise also limit widespread adoption, particularly among small and medium-sized enterprises. Digital transformation requires substantial investment in infrastructure, training, and system integration [5]. Moreover, algorithmic decision-making may introduce issues related to transparency and bias in automated systems [6; 18].

The rapid expansion of service automation raises additional social and ethical considerations, including workforce displacement and the changing nature of human–technology interaction [13; 19]. Therefore, responsible governance, regulatory frameworks, and continuous professional development are necessary to ensure that AI integration supports inclusive and sustainable growth.

Results

The theoretical review of contemporary research on Artificial Intelligence and Big Data in tourism made it possible to identify several interconnected patterns that characterize the current stage of digital transformation in the industry. Since this study is conceptual in nature, the results are based on analytical synthesis, comparison of scientific approaches, and generalization of theoretical frameworks presented in the literature.

The analysis demonstrates that AI and Big Data are no longer auxiliary technological instruments but systemic elements that influence strategic management, service design, operational efficiency, and sustainability governance in tourism. Intelligent technologies increasingly shape decision-making processes, redefine customer interaction models, and enhance the adaptive capacity of tourism enterprises and destinations.

The main results of the study are summarized in Table 1.

Table 1 – Main Results of the Theoretical Analysis of AI and Big Data in Tourism

№	Key Result	Theoretical Basis	Practical Implications	Scientific Justification
1	AI and Big Data act as systemic drivers of digital transformation in tourism	Digital transformation approach [1;5]	Shift toward platform-based and data-oriented management	Research confirms evolution toward smart tourism ecosystems
2	Big Data provides informational capacity, AI ensures analytical processing	Data-driven management theory [7;10]	More accurate forecasting and strategic decisions	Predictive analytics improves managerial effectiveness
3	Personalization is the leading development vector	Smart tourism concept [2;3;4]	Growth of customer satisfaction and loyalty	Behavioral analytics enables adaptive service models
4	Predictive analytics enhances resilience and reduces uncertainty	Information processing logic [10;11]	Improved pricing and capacity planning	Machine learning increases forecast reliability
5	Automation increases efficiency but changes workforce dynamics	Service automation theory [12;13;19]	Cost optimization and service standardization	Studies show AI reshapes operational structures

Continued on the next page

Continuation of Table-1

6	AI contributes to sustainable destination management	Sustainable digital development [3;20]	Monitoring of tourist flows and environmental impact	Real-time data supports balanced development
7	Implementation generates ethical and regulatory challenges	AI governance perspective [6;18]	Need for data protection and algorithmic transparency	Literature highlights privacy and bias concerns

Note – compiled by the authors based on the analytical synthesis of sources [1–20].

Interpretation of the Results

The first identified result confirms the structural character of technological transformation in tourism. The literature indicates that the industry is evolving toward integrated smart ecosystems where digital infrastructure and analytics form the foundation of value creation [1;3;5]. In this context, data becomes a strategic asset, while Artificial Intelligence enhances the analytical and adaptive capabilities of organizations.

The second result highlights the interconnection between Big Data and AI. Data accumulation alone does not generate competitive advantage; value emerges when advanced algorithms transform information into managerial insights [7;10]. This dual model strengthens forecasting accuracy, supports strategic planning, and enhances revenue management practices.

The third result demonstrates that personalization is becoming the dominant development trajectory in tourism. Smart tourism frameworks emphasize the importance of individualized and experience-oriented services [2;3]. AI-driven analytics enables tourism enterprises to adapt offers to specific consumer preferences, increasing customer satisfaction and long-term loyalty.

The fourth result concerns predictive analytics as a stabilizing factor in a volatile industry. The application of data mining and machine learning techniques improves the reliability of demand forecasting and capacity management [10;11]. This strengthens organizational resilience and reduces financial risks.

The fifth finding addresses service automation and operational restructuring. The growing adoption of AI-powered systems and robotics enhances efficiency and service consistency [12;13;19]. However, this process also transforms workforce structures and requires new professional competencies.

The sixth result underlines the contribution of intelligent technologies to sustainable tourism development. Real-time monitoring systems enable more balanced destination management, helping prevent over-tourism and environmental degradation [20]. Thus, digitalization supports both economic and ecological objectives.

Finally, the analysis identifies significant ethical and regulatory considerations. Issues of data privacy, algorithmic transparency, and cybersecurity require careful governance and institutional regulation [6;18]. Sustainable technological integration must therefore combine innovation with responsible management practices.

Overall, the results confirm that Artificial Intelligence and Big Data are reshaping tourism at strategic, operational, and institutional levels. Their impact extends beyond efficiency gains, influencing governance models, sustainability strategies, and the future architecture of the global tourism ecosystem.

Conclusion

The conducted theoretical analysis shows that Artificial Intelligence and Big Data are becoming central elements of transformation in the tourism industry. They influence not only operational processes but also strategic management, service models, and destination governance.

The study confirms that AI and Big Data function as interconnected systems: Big Data provides the informational foundation, while AI ensures analytical processing and predictive modeling. Their integration supports personalization of services, demand forecasting, smart destination management, operational automation, and sustainability control.

At the same time, digital transformation creates new risks related to data security, algorithmic transparency, and workforce restructuring. Therefore, technological modernization must be accompanied by regulatory mechanisms and professional training.

Overall, AI and Big Data should be considered strategic tools that shape the future competitiveness and sustainability of tourism systems.

Based on the conducted theoretical analysis, the authors propose the following recommendations:

1. Form a unified digital ecosystem in tourism organizations, where AI and Big Data are integrated into strategic management, marketing, and operational processes simultaneously.
2. Develop national and regional AI adoption programs in tourism to ensure coordinated digital transformation at the destination level.
3. Introduce mandatory data governance standards in tourism enterprises to ensure transparency, cybersecurity, and ethical use of algorithms.
4. Strengthen interdisciplinary training programs combining tourism management and data analytics in higher education institutions.
5. Promote AI-based sustainability monitoring systems at destination level to prevent over-tourism and support balanced resource use.

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ТУРИЗМДЕГІ ЖАСАНДЫ ИНТЕЛЛЕКТ ПЕН ҮЛКЕН ДЕРЕКТЕР ТЕХНОЛОГИЯЛАРЫ

Аңдатпа. *Мақалада туризм саласында жасанды интеллект пен үлкен деректер технологияларын қолданудың теориялық негіздері және олардың даму бағыттары қарастырылады. Зерттеу тұжырымдамалық сипатта жүргізіліп, заманауи ғылыми еңбектерді талдау мен жүйелеуге негізделген. Цифрлық трансформация теориясы, деректерге негізделген басқару тұжырымдамасы, ақпаратты өңдеу тәсілдері және сервистерді автоматтандыру теориясы туризмге интеллектуалды технологияларды енгізудің әдіснамалық негізі ретінде талданады.*

Зерттеу нәтижелері жасанды интеллект пен үлкен деректердің жекелеген құралдар емес, туризмдегі стратегиялық басқаруға, қызмет көрсету моделіне, сұранысты болжауға және туристік дестинацияларды басқаруға ықпал ететін өзара байланысты жүйелер екенін көрсетеді. Негізгі даму бағыттары ретінде қызметтерді дараландыру, болжамдық аналитиканы қолдану, «ақылды туризм» экожүйелерін қалыптастыру, операциялық процестерді автоматтандыру және тұрақты дамуды қамтамасыз етуге бағытталған цифрлық шешімдер айқындалды. Сонымен қатар деректер қауіпсіздігі, алгоритмдердің ашықтығы және еңбек нарығындағы өзгерістерге байланысты мәселелер атап өтілді.

Зерттеу қорытындылары интеллектуалды технологиялардың туризм саласының бәсекеге қабілеттілігі мен ұзақ мерзімді тұрақтылығын арттырудағы рөлін теориялық тұрғыдан негіздейді және болашақ эмпирикалық зерттеулер мен цифрлық даму стратегияларын әзірлеуге негіз бола алады.

Кілт сөздер: *жасанды интеллект, үлкен деректер, туризм саласы, цифрлық трансформация, ақылды туризм, болжамдық аналитика, қызметті автоматтандыру, туризмнің тұрақты дамуы.*

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ТЕХНОЛОГИИ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА И БОЛЬШИХ ДАННЫХ В ТУРИЗМЕ

Аннотация. *В статье рассматриваются теоретические основы и ключевые направления развития технологий искусственного интеллекта и больших данных в туристской отрасли. Исследование носит концептуальный характер и основано на анализе*

и обобщении современных научных публикаций. Особое внимание уделяется теории цифровой трансформации, концепции управления на основе данных, подходам к обработке информации и теории автоматизации сервисов как методологической базе внедрения интеллектуальных технологий в туризм.

В работе показано, что искусственный интеллект и большие данные представляют собой взаимосвязанные цифровые инструменты, влияющие на стратегическое управление, проектирование туристских услуг, прогнозирование спроса и управление дестинациями. Среди приоритетных направлений развития выделены персонализация услуг, применение предиктивной аналитики, формирование «умных» туристских экосистем, автоматизация процессов и использование цифровых решений для устойчивого развития. Одновременно обозначены вызовы, связанные с защитой данных, этическими аспектами алгоритмических решений и трансформацией рынка труда.

Полученные результаты формируют целостное теоретическое представление о роли интеллектуальных технологий в повышении конкурентоспособности и устойчивости туристской отрасли и могут служить основой для дальнейших прикладных исследований и разработки цифровых стратегий в туризме.

Ключевые слова: *искусственный интеллект, большие данные, туристская отрасль, цифровая трансформация, умный туризм, предиктивная аналитика, автоматизация услуг, устойчивое развитие туризма.*