

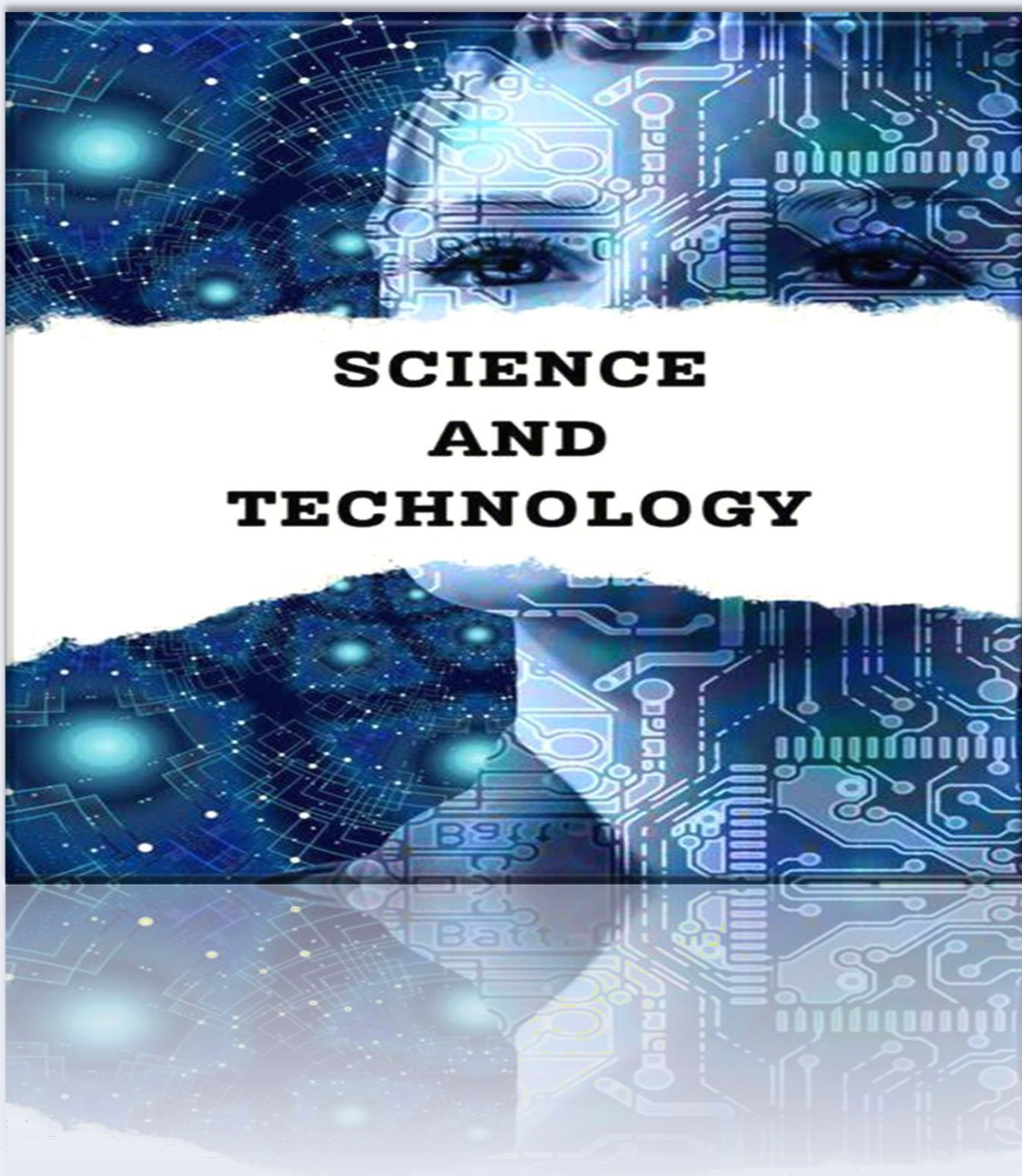
# JTS

## JOURNAL OF TECHNOLOGICAL SCIENCES

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ISSN 2955-2478

Vol. 1 (1/2024)





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**ISSN 2955-2478 Technical Editing/Layout:** Korab Ballanca

**Editorial Office:** Mother Teresa University

Frequency: Published two times per year

**ISSN 2955-2478**

**Mother Teresa University in Skopje,**

**Tax No.** 4080016561272 **Republic of North Macedonia**

Mirce Acev 4, VII floor, Skopje, North  
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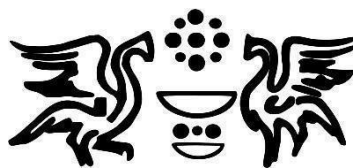
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The publication of the Journal is supported by:



Ministry of Culture of Republic of North Macedonia

# Editorial Foreword

## Editor-in-Chief

### ACKNOWLEDGEMENT

Welcome to the new Issue of the Journal Of Technological Sciences- JTS, Volume 1, Issue1, 2024. The topics covered by this Issue are related to the current trends of research, original research that uncovers sustainable development.

JTS Journal is an international journal that effectively provides a forum for academics, professionals, graduate and undergraduate students, fellows and associates to share the latest developments and advances in knowledge and practice of Technology application; Food and Biotechnology Information Technology and Engineering, Technics and Technology, etc. Our interest in promoting high-quality research is clearly reflected in having an established peer reviewing process and a high-profile expert group of Associate Editors and Editorial Board Members.

Hopefully you find this Issue valuable and we definitely look forward to receiving your high-quality studies for the next issue of the Journal.

Prof. Dr. Bekim Fetaji  
Editor-in-Chief

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## Examining and sketching the graph of Rational Functions using Geogebra

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### ABSTRACT

Rational function in mathematics is the function that can be defined by a rational fraction, which is an algebraic fraction such that both the numerator and the denominator are polynomials.

In this project we will delve into the mathematical solutions and visualization of rational functions. We begin by providing a clear definition of rational functions and proceed to outline the key properties inherent to these mathematical entities. Leveraging the power of Geogebra, we employ visualization tools to elucidate the defined domain and range of the function, identify intersection points with the coordinate axes, pinpoint extremities and transition points, and ultimately create a dynamic graph of the function using sliders. This approach combines analytical explanation with interactive visualization, providing valuable insights for understanding and teaching rational functions.

### KEYWORDS

Rational functions, mathematics, algebraic fraction, visualization, Geogebra.

#### 1. Introduction

Rational functions stand as a cornerstone in the realm of mathematics, offering a rich field for exploration and understanding. These functions, defined by the quotient of two polynomials, encapsulate diverse mathematical phenomena, from asymptotic behavior to critical points. In this project, we embark on a journey to unravel the intricacies of rational functions, employing the powerful visualization tools of Geogebra to enhance our comprehension and teaching methodologies.

Our endeavor begins with a meticulous definition of rational functions as algebraic fractions, with both the numerator and denominator being polynomials. By delving into the mathematical solutions, we aim to shed light on the essential properties inherent in these functions. The exploration encompasses not only theoretical aspects but also practical insights into the behavior of rational functions in various scenarios.

The utilization of Geogebra, a dynamic mathematical software, adds a layer of interactivity to our study. Through this platform, we can visually dissect the defined domain and range of the rational function, identifying crucial points such as intersections with coordinate axes, extremities, and transition points. Geogebra's sliders allow us to create a dynamic graph that responds to parameter variations, providing a hands-on approach to comprehending the impact of changes in the function's parameters on its graphical representation.

The synergy of analytical explanation and interactive visualization serves as a potent tool in elucidating the nuances of rational functions. By combining theoretical concepts with real-time, dynamic representations, our project aims to provide not only a deeper understanding for enthusiasts but also an effective teaching resource for educators navigating the complexities of rational functions in their classrooms.

To delve deeper into the realm of rational functions, our exploration will systematically unfold, examining various aspects that define and characterize these mathematical entities. We will begin by dissecting the anatomy of a typical rational function, exploring how the degree of the numerator and denominator polynomials influences the function's behavior. The interplay between these degrees often dictates the presence of asymptotes, critical points, and the overall shape of the graph.

As we traverse the landscape of rational functions, special attention will be given to asymptotic behavior, where the function approaches certain values as the input approaches infinity or negative infinity. Understanding the asymptotic behavior provides valuable insights into the long-term trends and limits of the function, revealing essential features that may not be immediately apparent from the algebraic expression alone.

Moreover, our exploration will extend to the identification and analysis of critical points, where the function undergoes changes in concavity or experiences points of inflection. These critical points play a crucial role in understanding the overall shape and characteristics of the graph, adding depth to our comprehension of rational functions.

One of the strengths of utilizing Geogebra lies in its capacity to dynamically showcase the impact of changing parameters on the graph. We will employ this feature to explore how variations in coefficients or constants affect the position and nature of asymptotes, the location of critical points, and the overall behavior of the rational function.

Throughout this journey, the goal is not only to unravel the intricacies of rational functions but also to equip educators and learners alike with a versatile toolkit for teaching and understanding these concepts. The interactivity and visualization provided by Geogebra serve as a powerful medium for grasping abstract mathematical ideas, fostering a deeper appreciation for the beauty and utility of rational functions.

In the subsequent sections of our project, we will engage in hands-on activities using Geogebra, guiding you through the process of creating dynamic visualizations, adjusting parameters, and interpreting the resulting graphs. Together, we will navigate the complexities of rational functions, offering both a theoretical foundation and practical insights that will enhance your mathematical understanding and teaching capabilities.

## 2. Rational Functions

A rational function is a mathematical expression that represents the ratio of two polynomials, where the numerator and denominator are both polynomials in one or more variables. In other words, it is a fraction in which both the numerator and the denominator are polynomials. The general form of a rational function is:

$$R(x) = \frac{P(x)}{Q(x)} \quad (1)$$

Here,  $P(x)$  and  $Q(x)$ , are polynomials, and  $Q(x)$  is not the zero polynomial. The domain of a rational function is all real numbers except those values of  $x$  for which  $Q(x) = 0$ .

Rational functions have various applications in mathematics, physics, engineering, and other scientific fields. They are used to model a wide range of phenomena, including physical systems, economic relationships, and statistical patterns.

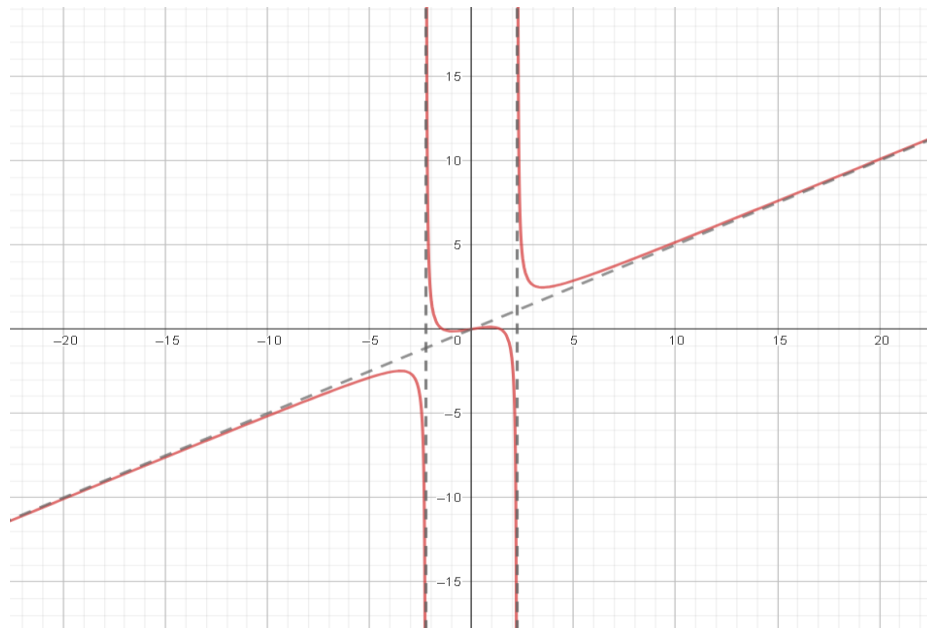


Figure 1: Rational Function.

### Domain of Rational Functions

The domain of a rational function is the set of all real numbers  $x$  for which the denominator  $Q(x)$  is not equal to zero. In symbolic terms:

$$\text{Domain} = \{x | Q(x) \neq 0\}$$

Understanding the domain is essential because division by zero is undefined in mathematics. Therefore, to ensure the rational function is well-defined and meaningful, the values of  $x$  that make the denominator zero must be excluded.

This exclusion creates a set of permissible inputs, forming the domain, within which the rational function exists and is valid. The exploration of this domain allows mathematicians to analyze and utilize the properties of the rational function, providing insights into its behavior and characteristics.

## 3 Domain of Rational Functions

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## 4 Range of Rational Functions

The range of a rational function is the set of all real numbers  $y$  that can be obtained by evaluating the function for all valid inputs within its domain. Symbolically, the range can be expressed as:

$$\text{Range} = \{y | y = f(x), x \in \text{Domain of } f\}$$

Understanding the range is an exploration into the potential outputs of the function. It is influenced not only by the structure of the polynomials  $P(x)$  and  $Q(x)$  but also by the constraints imposed by the excluded values in the domain, where the denominator

$Q(x)$  is zero.

The exclusion of certain values in the domain due to division by zero creates gaps or asymptotic behavior in the range. These nuances contribute to the range being a dynamic space, often revealing patterns of growth, decay, and oscillation.

In essence, the range of a rational function provides a comprehensive view of the possible output values, guiding mathematicians through the landscape of achievable results.

In summary the domain of a function  $f(x)$  is the set of all values for which the function is defined, and the range of the function is the set of all values that  $f$  takes.

## 5 Asymptotes of Rational Functions

An asymptote is a straight line that approaches a curve, but the curve never actually crosses or touches it. Within the mathematical tapestry of rational functions, asymptotes emerge as subtle yet powerful guides, influencing the behavior of the function as it extends toward infinity or approaches singular points.

### 5.1 Vertical Asymptotes:

Vertical asymptotes occur where the denominator  $Q(x)$  is not zero. Symbolically, a vertical asymptote at  $x = a$  is represented as  $Q(a) = 0$  and  $P(a) \neq 0$ . These asymptotes indicate values of  $x$  that the function approaches as it gets arbitrarily close, but never reaches.

## 5.2 Horizontal Asymptotes:

Horizontal asymptotes reveal the behavior of the function as  $x$  approaches positive or negative infinity. They are determined by comparing the degrees of the leading terms of  $P(x)$  and  $Q(x)$ . If the degree of  $Q(x)$  is greater than the degree of  $P(x)$ , the horizontal asymptote is at  $y = 0$ . If the degrees are equal, the horizontal asymptote is the ratio of the leading coefficients. When the degree of  $P(x)$  is greater, there is no horizontal asymptote.

In summary, the asymptotes of a rational function, both vertical and horizontal, guide our understanding of its behavior, revealing points of singularity and providing a glimpse into the function's tendencies at the extremes of the real number line.

## 6 Extremes of Rational Functions

An extremum (or extreme value) of a function is a point at which a maximum or minimum value of the function is obtained in some interval. A local extremum (or relative extremum) of a function designates a point where the function reaches its maximum or minimum value within an open interval encapsulating the point.

Extreme points, often referred to as extrema, mark positions where a function assumes values that stand out as either notably small or exceptionally large when contrasted with neighboring values of the function. These extrema visually resemble the peaks of hills and the troughs of valleys, adding a topographical analogy to the description of their distinctive characteristics.

To identify and characterize these extreme points, one commonly employs calculus techniques. The critical points of a function, where its derivative is either zero or undefined, provide initial insights. Further, the second derivative test helps distinguish between maxima and minima.

**For a function  $f(x)$ :**

1. Find critical points by setting  $f'(x) = 0$  or  $f'(x)$  undefined.
2. Evaluate the second derivative,  $f''(x)$ .
3. If  $f'(c) = 0$  and  $f''(c) > 0$ , then  $f(c)$  is a local minimum.
4. If  $f'(c) = 0$  and  $f''(c) < 0$ , then  $f(c)$  is a local maximum.

## 7 Using Geogebra for Examining and sketching the graph of the Rational

$$\text{Function } f(x) = \frac{x^3}{(x-1)^2} - 2$$

GeoGebra is a powerful and versatile dynamic mathematics software that allows users to explore mathematical concepts through interactive visualizations. It combines geometry, algebra, spreadsheets, and more, making it an ideal tool for studying and graphing mathematical functions.

We leveraged Geogebra to analyze the function  $f(x) = \frac{x^3}{(x-1)^2} - 2$ . Geogebra facilitated a comprehensive examination of the function's behavior, allowing for the identification of critical points, determination of asymptotic behavior, and exploration of key characteristics such as intersections with axes. The following breakdown outlines the steps taken and results obtained through the Geogebra analysis, providing a detailed understanding of the function's properties.

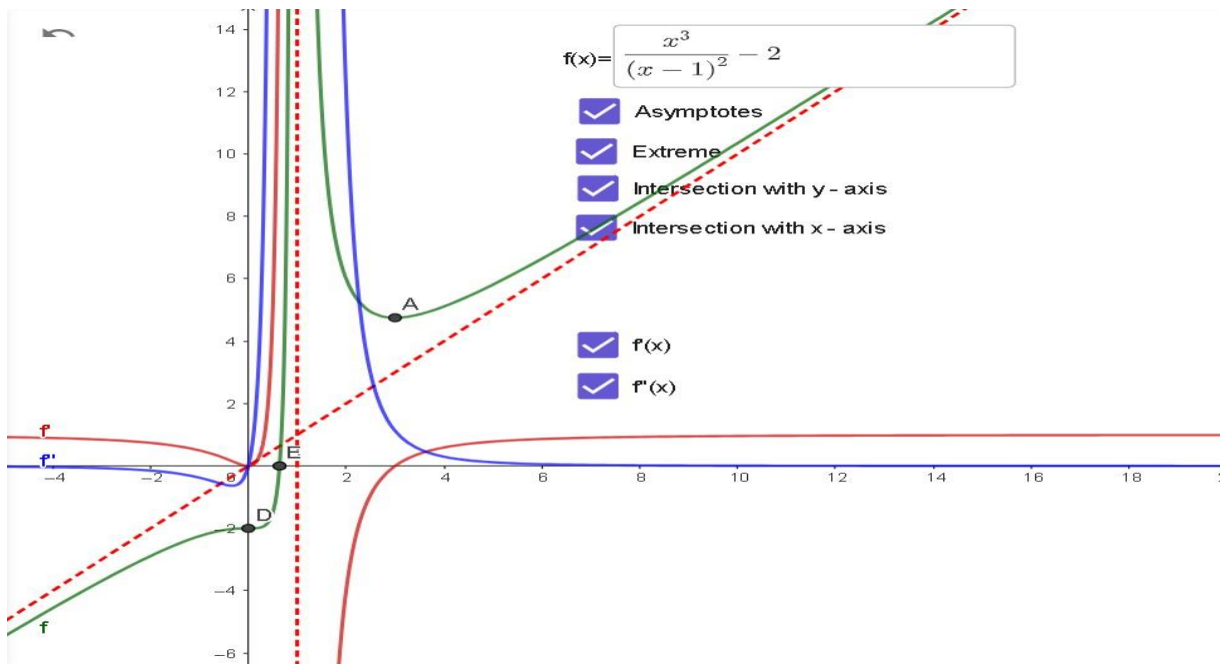


Figure 2: Examining and Sketching the Graph of a Rational Function

1. Asymptote:
  - Identified a vertical asymptote at  $x = 1$ .
  - Reasoned that as  $x$  approaches 1 from the left,  $f(x)$  approaches  $-\infty$ , and as  $x$  approaches 1 from the right,  $f(x)$  approaches  $\infty$ .
2. Extreme Points (Critical Points):
  - Calculated the first derivative  $f'(x)$  to find critical points.
  - Found critical points by setting  $f'(x) = 0$ .
  - Utilized the second derivative test to determine the nature of each critical point (minima, maxima, or neither).
3. Intersection with X-Axis:
  - Solved for  $f(x) = 0$ , to find x-coordinates of points where the graph intersects the x-axis.
4. Intersection with Y-Axis:
  - Substituted  $(x) = 0$  into  $f(x)$  to find the y-coordinate of the intersection with the y-axis.
5. Derivative ( $f'(x)$ ):
  - Computed the first derivative  $f'(x)$  to analyze the rate of change of  $f(x)$ .
6. Second Derivative ( $f''(x)$ ):
  - Computed the second derivative  $f''(x)$  to investigate concavity and identify points of inflection.

In summary, Geogebra emerged as an invaluable tool in unraveling the intricacies of the function  $f(x) = \frac{x^3}{(x-1)^2} - 2$ . This dynamic mathematical visualization platform provided a nuanced perspective, allowing for the identification of critical points, exploration of asymptotic behavior, and precise determination of intersections with axes.

## 8 Applications Rational Function

- **Engineering and Physics:**

Control Systems: Rational functions are used in control theory to model and analyze dynamic systems. The transfer function of a system, which relates the input to the output, is often represented as a rational function.

Electrical Circuits: In electrical engineering, rational functions describe the impedance and transfer characteristics of circuits. This is crucial for designing and analyzing electronic systems.

- **Economics and Finance:**  
Supply and Demand Models: Rational functions are employed in economic models to represent supply and demand curves. These curves help economists and policymakers understand market behavior and make predictions.  
Finance Models: In finance, rational functions can be used to model investment portfolios, risk assessments, and pricing of financial derivatives.
- **Biology and Medicine:**  
Population Growth: Rational functions can model population growth and decay in biology. They are used to describe how populations change over time, considering factors like birth rates, death rates, and migration.  
Pharmacokinetics: Rational functions are used in pharmacokinetics to model the concentration of drugs in the body over time, helping to optimize dosages and treatment plans.
- **Computer Science:**  
Algorithms and Complexity: Rational functions can be involved in the analysis of algorithms and the study of computational complexity. They may arise in the context of analyzing the time or space complexity of algorithms.  
Signal Processing: Rational functions play a role in signal processing applications, such as digital filter design and analysis.
- **Statistics and Data Analysis:**  
Regression Analysis: Rational functions can be used in regression models to fit curves to data points. This is valuable in statistics for understanding relationships between variables.  
Interpolation and Extrapolation: Rational functions can be employed in data interpolation and extrapolation, helping to estimate values between or beyond observed data points.
- **Geometry and Computer-Aided Design (CAD):**  
Curve Fitting: Rational functions are used to represent curves in CAD systems and graphics software. They help create smooth curves that can be manipulated and analyzed.  
Robotics: In the field of robotics, rational functions can be used to model the motion and control of robot arms and other mechanical systems.
- **Environmental Science:**  
Pollution Modeling: Rational functions can be applied to model the dispersion of pollutants in air, water, or soil. This is important in environmental science for assessing the impact of human activities on the environment.

## 9 Conclusion

The utilization of Geogebra for the examination and visualization of rational functions has underscored its instrumental role in mathematical analysis. Geogebra's dynamic visual representation capabilities offer a lucid perspective on the intricate behaviors exhibited by rational functions. From revealing asymptotic trends to identifying critical points and illustrating concavity, the platform has played a pivotal role in simplifying the complexities of rational functions.

The ability to dynamically sketch and manipulate these functions using Geogebra has streamlined the analysis process, fostering a deeper understanding of the intricate relationships between numerators and denominators. Through this exploration, valuable insights into the behavior of rational functions have been gained, insights that extend beyond specific equations to encompass the broader landscape of mathematical structures.

The role of Geogebra as a powerful ally in the study of rational functions is evident, providing a visual and interactive dimension to mathematical analysis. Its application extends beyond the boundaries of our specific investigation, offering a versatile means to approach and comprehend the nuances of various mathematical functions. This project stands as a testament to the synergy between technology and mathematical inquiry, opening avenues for continued exploration and discovery.

## REFERENCES

- [1] James Stewart, Lothar Redlin, and Saleem Watson (2015). "Precalculus: Mathematics for Calculus".
- [2] James Stewart (2015). "Calculus: Early Transcendentals".
- [3] Patrick M. Fitzpatrick (2006). "Advanced Calculus".
- [4] Michael Sullivan (2017). "Algebra and Trigonometry".
- [5] Geogebra: <https://www.geogebra.org/calculator>
- [6] Extrema (Local and Absolute) <https://brilliant.org/wiki/extrema/>
- [7] Paul's Online Math Notes - Rational Functions: <https://tutorial.math.lamar.edu/classes/alg/graphrationalfncs.aspx>
- [8] Rational Functions: <https://www.wolframalpha.com/examples/mathematics/algebra/rational-functions>
- [9] [https://en.wikipedia.org/wiki/Rational\\_function](https://en.wikipedia.org/wiki/Rational_function)
- [10] <https://www.khanacademy.org/math/prec calculus/x9e81a4f98389efdf:rational-functions>
- [11] <https://www.cuemath.com/calculus/rational-function/>
- [12] [https://math.libretexts.org/Courses/Monroe\\_Community\\_College/MTH\\_165\\_College\\_Algebra\\_MTH\\_175\\_Precalculus/03%3A\\_Polynomial\\_and\\_Rational\\_Functions/3.9%3A\\_Rational\\_Functions](https://math.libretexts.org/Courses/Monroe_Community_College/MTH_165_College_Algebra_MTH_175_Precalculus/03%3A_Polynomial_and_Rational_Functions/3.9%3A_Rational_Functions)

- [13] <https://courses.lumenlearning.com/prec calculus/chapter/rational-functions/>
  - [14] <https://www.itl.nist.gov/div898/handbook/pmd/section8/pmd812.htm>
  - [15] <https://www.mathsisfun.com/definitions/rational-function.html>
  - [16] <https://www.geeksforgeeks.org/rational-function/>
  - [17] <https://people.richland.edu/james/lecture/m116/polynomials/rational.html>
  - [18] <https://courses.lumenlearning.com/cuny-hunter-collegealgebra/chapter/applications-of-rational-equations/>
  - [19] [https://www.sfu.ca/math-coursenotes/Math%20157%20Course%20Notes/sec\\_Extrema.html](https://www.sfu.ca/math-coursenotes/Math%20157%20Course%20Notes/sec_Extrema.html)
- Wolfram MathWorld - Rational Function: <https://mathworld.wolfram.com/RationalFunction.html>

## 3D Printing: Innovation And Promising

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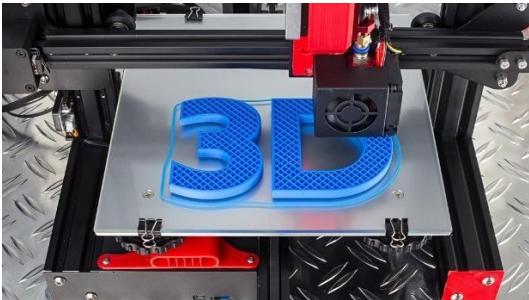
**Abstract:** 3D printing is a newly developing method which reaches a wide application in many areas. Known for its compatibility and adoptability, 3D printing helps in establishing different researching methods and methodologies related to the explanation of several natural phenomena and testing different properties especially of the materials used for the process. Being the main part of additive manufacturing technology, its first idea is creating 3D objects in different shapes and sizes basically with the help of proper materials, especially polymeric filaments in everyday occurrence. Utilization of 3D printers as printing machines provides an easy, flowing process of producing 3D printed parts and objects for numerous purposes.

3D printing is significant in the sustainable development because of its eco-friendly features. No time waste, no natural resources waste and cost efficiency make this activity too familiar for people in general.

**Keywords**—3D printing, 3D printer, additive manufacturing technology, innovation, sustainability

### Introduction

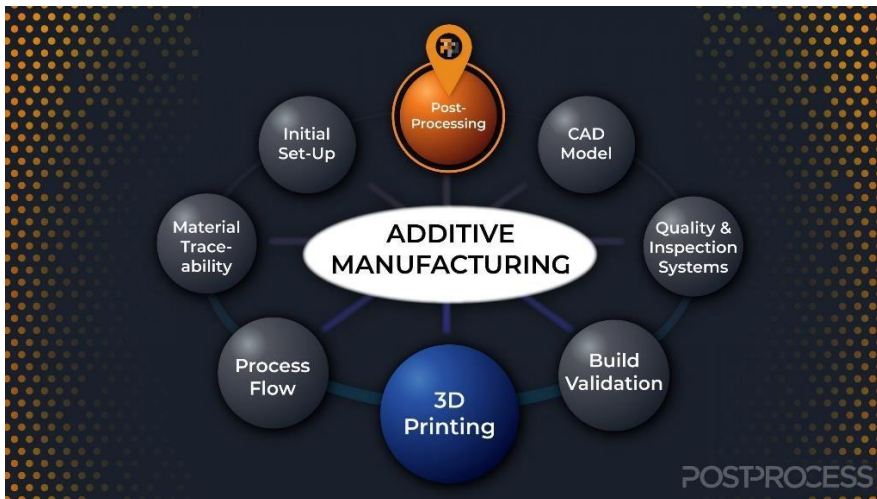
3D printing is one of the most applied methods in the process of manufacturing technology. It helps in creating different objects and parts further used for several researching ideas. Mainly using polymers as promising materials, 3D printers can print useful parts with properties like the initial printing material or different from the material, depending on the printing parameters or environmental circumstances. Because 3D printing is relatively new activity around sustainable development, it is of interest to engage and seek for the revolutionary innovations that this technology holds on its hands.



**Fig.1. 3D printing**

The main and most important purpose is to use 3D printing in easing the life of society and to replace useless items that often can be cancerogenic with practical and healthy items, printed with biomaterials or natural-based polymers. [1] According to sustainable development, 3D printing is very promising because it's characterized with too little waste of useful natural resources as well as electricity and time. This makes the process very easy-going, practical, and approachable even for DIY activities.

3D belongs to additive manufacturing and is a process linked directly to CAD (computer-aided design system) because one must create objects digitally, at first and afterwards print them with 3D printer. It is crucial to inspect the process in order to avoid defects and irregularities that may happen during 3D printing. Generally, 3D printing is an easy-flowing activity and therefore one propagates quick towards great results for a short interval of time.



**Fig.2. Additive manufacturing and 3D printing**

### Research methods

3D objects and parts get 3D printed using polymeric filaments especially PLA (polylactic acid). PLA is the most famous polymer used in 3D printing. It is synthesized from natural sources (cornstarch) and its biocompatibility and bioavailability make it a very promising material for getting recyclable products (3D printed parts) and thus avoiding damages to environment. [2]

3D printed parts and the filament itself can undergo different examinations depending on the purpose of application. They can be analyzed qualitatively or quantitatively. When applied in the electronics, they go through impedance analysis, a process supported by impedance analyzer. Impedance analysis is a qualitative method that gives clear results about their electric properties and one can conclude if these parts behave like conductors, isolators, dielectrics etc. SEM (scanning electron microscopy) is also a well-known qualitative method which analyzes the microstructure and what kind of changes occur when filaments undergo compression tests. SEM analysis gives information about grains containing the material, defects and their types and other physical characteristics of the surface of the material. [3] TGA (thermogravimetric analysis) is quantitative and qualitative method at the same time. It is used to describe how the material (for example PLA-polylactic acid) changes its phases when exposed to high temperatures, until the material melts. Afterwards, follows the cooling process through which the material overcomes to get back to its initial condition. This technique also helps understanding the quality of an unknown material when the components are not evident. Quantitatively, it helps to understand the percentage of elements and substances present in. [4]

### Findings and results

Working with 3D printing gives useful findings and results related to sustainable development in the society. Being familiar with 3D printing enables to provide effective parts, objects that fit perfectly in a puzzle of modern and innovative achievements.

These interesting items apply in medicine, aerospace industry, automotive industry, decoration, electronics, etc.

3D printing and sustainability go along with each other because of some reasons. [5]

3D printing has reduced waste, because the process gives results that don't need enormous correction and reshaping. During the process there is reduced water and energy usage.

It could be a localized production, which avoids the transportation of products from one side of the world to another with huge ships, and therefore reducing the amount of CO<sub>2</sub> released because of shipping.

3D prints can be reproduced and reused for several time and repurposed afterwards for many applications. This reduces the waste of raw, initial polymer.

Choosing the right material also contributes to less waste because one does not waste other materials by testing if they are compatible with the process or not.

### Conclusions and Recommendations

3D printing is a modern activity, easy and flowing, easy maintaining. It has generally low-cost because of utilization of non-expensive materials. It is practical, because one can carry a 3D printer anywhere where it has electricity. The process of 3D printing occurs quickly without dealing with long periods of wait. It is not harmful to the public health because it does not contribute to the release of harmful substances. People enjoy 3D printing, and it is beneficial for the mental health of the society because of its simplicity and joyful nature. It is very promising in sustainable development because of all above-mentioned reasons but also because it implies utilization of biocompatible and biodegradable materials that contribute to the general health of the society.

## References

- [1] me3d.com.au
- [2] [https://www.welover.com/article/how-to-make-a-3d-model-for-printing\\_](https://www.welover.com/article/how-to-make-a-3d-model-for-printing_)
- [3] ThermoFisher Scientific/Scanning Electron Microscopes/
- [4] [https://www.researchgate.net/publication/358993045\\_Thermogravimetric\\_Analysis\\_TGA\\_and\\_Differential\\_Scanning\\_Calorimetry\\_DSC\\_of\\_PLA\\_Cellulose\\_Composites](https://www.researchgate.net/publication/358993045_Thermogravimetric_Analysis_TGA_and_Differential_Scanning_Calorimetry_DSC_of_PLA_Cellulose_Composites)
- [5] [www.sustainableplastics.com/](http://www.sustainableplastics.com/) How sustainable is 3D printing/ Sustainable Plastics

## AI: FROM BIG DATA TO NEW USER EXPERIENCE

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**Abstract:** Artificial Intelligence (AI) has emerged as a transformative technology in various industries, and the tourism sector is no exception. This paper explores the application of AI in tourism, highlighting its potential to enhance customer experiences, optimize operations, and revolutionize destination management. AI-driven chatbots and virtual assistants have become increasingly prevalent, providing personalized recommendations, answering queries, and facilitating seamless interactions. Machine learning algorithms enable sophisticated data analysis, enabling businesses to gain valuable insights into customer preferences, trends, and market dynamics. Furthermore, AI-powered systems aid in streamlining operations by automating tasks such as booking management, resource allocation, and itinerary planning. By leveraging AI, the tourism industry can unlock novel opportunities, improve efficiency, and deliver exceptional services, ultimately shaping the future of travel.

**Keywords**— *Big Data, Machine Learning, Artificial Intelligence, Tourism*

### Introduction

The advent of Artificial Intelligence (AI) has brought about a significant transformation in various industries, and the tourism sector is no exception. AI technologies have revolutionized the way travelers plan, experience, and engage with destinations, offering a plethora of opportunities for innovation and enhanced customer experiences. From personalized recommendations and intelligent chatbots to data analytics and automation, AI has the potential to reshape the landscape of tourism. By harnessing AI's capabilities, tourism businesses can offer tailored experiences, streamline operations, optimize pricing and revenue management, and gain valuable insights into customer preferences and behaviors. At the same time, travelers can enjoy more seamless and personalized experiences, with AI-driven technologies catering to their unique needs and preferences. However, as AI becomes increasingly integrated into the tourism landscape, it is essential to address ethical considerations, data privacy, and the balance between automation and human touch. In this ever-evolving era of AI, it is clear that the tourism industry stands at the forefront of leveraging AI's potential to create immersive, efficient, and unforgettable travel experiences.

### IT foundations for AI

In the realm of tourism, the foundation of AI lies in robust IT infrastructure that supports the seamless integration and utilization of advanced technologies. At the core of this foundation is a reliable and scalable network infrastructure that enables efficient data transmission and communication between various systems. High-speed internet connectivity ensures real-time access to information, enabling AI-powered applications to deliver timely and accurate responses to user queries. Additionally, a secure and resilient data storage system is crucial for storing and managing the vast amounts of data generated in the tourism industry.

Furthermore, AI in tourism heavily relies on the collection and analysis of diverse data sets. Therefore, a comprehensive data management system is essential to aggregate, clean, and organize data from multiple sources, such as customer profiles, booking history, social media interactions, and market trends. Implementing data governance policies and

procedures ensures data quality, privacy, and compliance with regulations, enabling organizations to derive meaningful insights and make data-driven decisions.

In conjunction with data management, robust computational capabilities are indispensable for AI applications in tourism. High-performance computing systems, including cloud infrastructure and powerful processors, enable complex algorithms to process and analyze vast amounts of data efficiently. This computational power facilitates tasks such as natural language processing, sentiment analysis, and image recognition, allowing AI systems to understand and respond intelligently to user requests. [1]

Moreover, the integration of AI technologies requires a flexible and modular software architecture. Application programming interfaces (APIs) and software frameworks provide the necessary building blocks for developing AI-enabled solutions in tourism. These tools allow developers to access pre-trained AI models, leverage machine learning algorithms, and build custom applications tailored to the unique requirements of the tourism industry.

Lastly, ensuring data security and privacy is crucial in the AI-powered tourism landscape. Robust cybersecurity measures, including encryption, authentication protocols, and intrusion detection systems, safeguard sensitive customer information and prevent data breaches. Implementing ethical practices and adhering to regulations surrounding data privacy, such as GDPR (General Data Protection Regulation), builds trust with customers and enhances the overall reputation of the tourism industry.

Establishing a strong IT foundation is paramount for leveraging the full potential of AI in the tourism sector. By investing in reliable network infrastructure, comprehensive data management systems, powerful computational capabilities, modular software architecture, and stringent security measures, tourism organizations can unlock the transformative benefits of AI. From personalized recommendations to streamlined operations, AI-powered solutions have the potential to revolutionize the way tourism businesses operate, enhancing customer experiences and shaping the future of travel. [2]

### **Fundamental elements of tourism industry**

The tourism industry encompasses various elements that collectively contribute to its vibrant and multifaceted nature. One fundamental element is transportation, which connects travelers to destinations worldwide. Whether by air, sea, rail, or road, efficient and reliable transportation infrastructure is essential for facilitating travel and tourism. Accommodation is another critical element, ranging from hotels and resorts to vacation rentals and hostels, offering a diverse range of options to suit different preferences and budgets. Attractions and landmarks form an integral part of the industry, encompassing natural wonders, historical sites, cultural landmarks, theme parks, and entertainment venues that entice tourists to explore and experience new destinations. Additionally, the hospitality sector, including restaurants, cafes, and bars, plays a vital role in providing dining and social experiences that complement travelers' journeys. The travel services segment, which encompasses travel agencies, tour operators, and online travel platforms, acts as intermediaries, facilitating the booking and coordination of various travel components. Lastly, the tourism industry relies heavily on the support of ancillary services, such as travel insurance, currency exchange, tourism boards, and destination management organizations, which contribute to the overall infrastructure and promotion of tourism. Together, these elements form a complex ecosystem that fuels the global tourism industry, providing opportunities for economic growth, cultural exchange, and memorable experiences for travelers worldwide. [3] [4]

### **AI systems used in tourism**

Artificial Intelligence (AI) systems have found numerous applications in the tourism industry, revolutionizing various aspects of the traveler's journey. Here are some key AI systems that are widely used in tourism:

- **AI-Powered Chatbots:** Chatbots are intelligent virtual assistants that leverage natural language processing and machine learning algorithms to interact with customers in real-time. They can provide personalized recommendations, answer

queries, assist with bookings, and offer destination information. Chatbots enhance customer service by providing instant assistance 24/7, improving response times, and reducing the workload on human agents.

- **Recommendation Systems:** AI-driven recommendation systems analyze user preferences, historical data, and behavioral patterns to provide personalized travel recommendations. These systems suggest accommodations, attractions, activities, and dining options tailored to individual preferences, enhancing the overall travel experience and helping travelers discover new destinations and experiences.
- **Sentiment Analysis:** Sentiment analysis utilizes AI algorithms to analyze social media posts, online reviews, and customer feedback to gauge the sentiment and opinions of travelers. This helps tourism businesses monitor their reputation, identify areas for improvement, and respond promptly to customer concerns, ultimately enhancing customer satisfaction and loyalty.
- **Virtual Reality (VR) and Augmented Reality (AR):** VR and AR technologies offer immersive experiences that allow tourists to explore destinations virtually or overlay digital information onto the physical environment. AI algorithms are used to create realistic virtual environments, enhance visualizations, and provide interactive guides, enriching the pre-travel research phase and on-site experiences for travelers.
- **Predictive Analytics:** Predictive analytics leverages AI and machine learning algorithms to analyze historical data and identify patterns and trends. In tourism, it can be used for demand forecasting, pricing optimization, and resource allocation. By predicting future demand, businesses can optimize their offerings, manage inventory, and make informed decisions to maximize revenue and operational efficiency.
- **Image and Speech Recognition:** AI-powered image and speech recognition technologies enable tourism businesses to automatically process and analyze visual and audio data. For instance, image recognition can help identify landmarks, objects, or even specific cuisines, while speech recognition can facilitate language translation or voice-enabled search, making it easier for travelers to navigate unfamiliar destinations and communicate effectively.
- **Robotics and Automation:** Robotics and automation technologies are being increasingly deployed in the tourism industry. For example, AI-powered robots can provide concierge services, deliver room service, or assist with check-in and check-out processes. Automation also streamlines back-office operations, such as reservation management, invoicing, and data entry, improving efficiency and reducing costs.

These AI systems, among others, are transforming the tourism industry by enhancing customer experiences, streamlining operations, and enabling businesses to make data-driven decisions. By leveraging the power of AI, tourism organizations can provide personalized and efficient services, stay competitive, and adapt to the evolving needs and expectations of modern travelers. [5] [6] [7]

### **Devices and integrated systems used in tourism**

The tourism industry utilizes a wide array of devices and integrated systems to enhance efficiency, improve customer experiences, and streamline operations. Here are some notable devices and integrated systems commonly employed in tourism:

- **Mobile Devices:** Mobile devices such as smartphones and tablets have become indispensable tools for both travelers and

tourism businesses. Travelers rely on their mobile devices to research and plan trips, book accommodations and activities, navigate destinations, and share their experiences on social media. Tourism businesses leverage mobile applications to offer mobile check-in/out, push notifications, personalized offers, and location-based services.

- **Point of Sale (POS) Systems:** POS systems are used in various tourism-related establishments, including hotels, restaurants, and souvenir shops. These systems facilitate smooth payment transactions, inventory management, and sales tracking. POS systems can be integrated with other systems such as reservation systems and customer relationship management (CRM) platforms, enabling seamless operations and data synchronization.
- **Reservation and Booking Systems:** Reservation and booking systems are integral to the tourism industry, enabling customers to book accommodations, flights, car rentals, tours, and activities online. These systems automate the reservation process, manage availability, and provide real-time pricing information. Integration with other systems, such as property management systems (PMS) for hotels, ensures smooth operations and seamless data flow.
- **Geographic Information Systems (GIS):** GIS technology combines geographic data with advanced mapping capabilities to provide valuable insights for the tourism industry. It helps in mapping and visualizing destinations, attractions, transportation routes, and infrastructure. GIS systems aid in destination management, resource planning, and analyzing visitor patterns, enabling better decision-making and sustainable tourism development.
- **Internet of Things (IoT) Devices:** IoT devices are increasingly used in tourism to enhance guest experiences and improve operational efficiency. Smart hotel rooms equipped with IoT devices allow guests to control room amenities, adjust lighting and temperature, and request services through voice commands. IoT sensors in tourist destinations can monitor footfall, manage traffic flow, and optimize resource usage.
- **Customer Relationship Management (CRM) Systems:** CRM systems help tourism businesses manage and analyze customer data, enabling personalized marketing campaigns, targeted promotions, and customer loyalty programs. These systems integrate customer information from various touchpoints, including reservations, bookings, feedback, and social media interactions, providing a comprehensive view of customer preferences and behaviors.
- **Digital Signage and Wayfinding Systems:** Digital signage and wayfinding systems are utilized in tourism to provide real-time information, directions, and promotional content. These systems are commonly found in airports, train stations, visitor centers, and large tourist attractions, guiding travelers and delivering relevant messages and advertisements.
- **Wearable Devices:** Wearable devices like smartwatches and fitness trackers are gaining popularity in the tourism industry. They offer features such as GPS tracking, activity monitoring, and personalized recommendations. Wearables provide convenient access to information and services, enhancing the overall travel experience and enabling seamless integration with other systems.

By leveraging these devices and integrated systems, the tourism industry can optimize operations, personalize services, and provide memorable experiences for travelers. The integration and synchronization of these systems enable efficient data management, seamless customer interactions, and data-driven decision-making, ultimately driving innovation and growth within the tourism sector. [8] [9] [10]

## Literature Review

The authors of paper [11] examines the transformative effects of AI and robotics on the tourism industry. It highlights the benefits of AI-powered chatbots, personalized recommendations, and data analytics in enhancing customer experiences and operational efficiency. However, the paper also addresses concerns such as job displacement, loss of human touch, and ethical considerations associated with privacy and bias. Overall, it provides valuable insights into the potential and challenges of integrating AI and robotics in tourism.

The paper [12] investigates the impact of artificial intelligence (AI) and big data analytics in the context of smart tourism. Employing a resource-based view approach, the study explores how AI and big data analytics can be leveraged as strategic resources to enhance the competitiveness and sustainability of tourism destinations. The paper highlights the potential of AI technologies, such as machine learning and natural language processing, in processing vast amounts of data and extracting valuable insights. Additionally, it emphasizes the role of big data analytics in understanding tourist behavior, improving personalized experiences, optimizing resource allocation, and enabling smart decision-making for destination management. By providing a resource-based perspective, the paper contributes to the understanding of how AI and big data analytics can shape the future of smart tourism, facilitating the development of innovative strategies and initiatives in the industry.

The paper [13] explores the effects of artificial intelligence (AI) on the travel, tourism, and hospitality industry. With a focus on the impact of AI technologies, the study examines how AI is transforming various aspects of the industry, including customer experiences, operations, and marketing. The paper discusses the use of AI-powered chatbots and virtual assistants to enhance customer service, personalization, and engagement. It also highlights the role of AI in data analysis, forecasting, and decision-making processes, allowing tourism businesses to optimize their operations and offer tailored services. Furthermore, the paper addresses the challenges and considerations associated with the adoption of AI in the industry, such as ethical concerns and the need for human-AI collaboration. Overall, the research provides valuable insights into the profound impact of AI in reshaping the travel, tourism, and hospitality sector, offering implications for future developments and strategic considerations in the field.

The paper [14] provides a comprehensive literature review on the use of big data in the context of tourism marketing. The study explores the existing research in this field, examining how big data has been employed to gain insights, improve marketing strategies, and enhance customer experiences. The paper highlights the diverse sources of big data in tourism, including social media platforms, online travel reviews, mobile applications, and geolocation data. It discusses how big data analytics techniques, such as data mining, sentiment analysis, and predictive modeling, have been utilized to extract valuable information and trends from these vast datasets. Additionally, the paper explores the potential of big data in understanding tourist behavior, targeting specific customer segments, and creating personalized marketing campaigns. By analyzing past research, the paper identifies gaps and proposes future research directions, suggesting opportunities for leveraging big data to further advance tourism marketing practices. Overall, the paper provides a comprehensive overview of the existing knowledge base on big data in tourism marketing, highlighting its importance, challenges, and future prospects in the field.

The paper titled [15] delves into the intersection of big data and artificial intelligence (AI) and their implications for the tourism industry. The study provides a literature review on how these technologies are transforming various aspects of the tourism sector. It explores the collection and analysis of large-scale data sets, commonly referred to as big data, and how AI techniques, such as machine learning and natural language processing, can be applied to extract meaningful insights from these data sets. The paper discusses how big data and AI are influencing different areas of the tourism industry, including customer experience management, personalization of services, revenue management, destination marketing, and sustainability. It also explores the challenges and ethical considerations associated with the use of big data and AI in tourism. Overall, the paper offers valuable insights into the current state of research on big data and AI in the tourism industry, highlighting their implications, benefits, and potential limitations.

### **Future impacts of AI in tourism**

The future impacts of AI on tourism are expected to be transformative and far-reaching, revolutionizing the way travelers plan, experience, and engage with destinations. With advances in natural language processing, computer vision, and machine learning, AI will further enhance personalized experiences for travelers. AI-powered virtual assistants will become more intelligent and capable, offering tailored recommendations and 24/7 customer support. Additionally, AI algorithms will analyze vast amounts of data, including customer preferences, behaviors, and trends, to

predict and customize travel options, creating more personalized itineraries. This will enable travel businesses to offer highly targeted marketing campaigns, optimize pricing strategies, and improve operational efficiency. Furthermore, AI-driven technologies like robotics and automation will streamline processes such as check-in, baggage handling, and customer service, leading to faster and more seamless travel experiences. However, as AI becomes more prevalent in tourism, it will be important to address concerns around data privacy, security, and the ethical implications of relying heavily on automated systems. The integration of AI in tourism will undoubtedly shape the industry's future, enhancing customer satisfaction, driving efficiency, and creating new opportunities for innovation.

Artificial Intelligence has ushered in a new era for the tourism industry, offering unprecedented opportunities for innovation and improvement. The adoption of AI-driven solutions, such as chatbots, virtual assistants, and machine learning algorithms, has the potential to revolutionize how travelers plan and experience their journeys. These technologies enhance customer experiences by providing personalized recommendations and seamless interactions, leading to higher levels of satisfaction and loyalty. AI's ability to analyze vast amounts of data enables businesses in the tourism sector to gain valuable insights into customer preferences, market trends, and operational efficiencies. This data-driven approach empowers decision-makers to make informed choices and adapt to changing market dynamics effectively. Furthermore, the automation of various tasks through AI-powered systems streamlines operations, reducing manual workload and human errors. Functions like booking management, resource allocation, and itinerary planning become more efficient, allowing tourism businesses to allocate resources more effectively and deliver better services.

## Conclusion

AI has opened up a world of possibilities for the tourism industry, offering the potential to unlock novel opportunities, improve operational efficiency, and deliver exceptional services. As AI technologies continue to advance, we can expect the tourism sector to further shape the future of travel by offering even more personalized, efficient, and delightful experiences for travelers worldwide. It is clear that embracing AI is not just a trend but a strategic imperative for the future of the tourism industry. In conclusion, the integration of AI technologies in the tourism industry brings about numerous benefits and transformative effects. AI works hand in hand with tourism by leveraging its capabilities in data analysis, machine learning, and automation. By processing vast amounts of data, AI algorithms can provide personalized recommendations, enhance customer experiences, and optimize operations. The benefits of AI in tourism include improved customer satisfaction through personalized services, streamlined processes such as automated check-ins and concierge services, and optimized pricing and revenue management. AI also enables tourism businesses to gain valuable insights into customer preferences and behaviors, leading to more targeted marketing campaigns and tailored offerings. Additionally, AI-powered chatbots and virtual assistants provide 24/7 customer support, enhancing engagement and responsiveness. While AI offers tremendous potential, it is crucial to address ethical considerations and ensure that human touch and privacy are not compromised. Overall, the integration of AI in tourism presents a promising future, offering enhanced experiences, operational efficiencies, and opportunities for innovation in the industry.

## REFERENCES

- [1] J. Bulchand-Gidumal, "Impact of Artificial Intelligence in Travel, Tourism, and Hospitality," *Xiang, Z., Fuchs, M., Gretzel, U., Höpken, W. (eds) Handbook of e-Tourism. Springer*, pp. [https://doi.org/10.1007/978-3-030-05324-6\\_110-1](https://doi.org/10.1007/978-3-030-05324-6_110-1), 2020.
- [2] S. Iliadi, "Adoption of Artificial Intelligence in Tourism Industry: A Systematic Literature Review," UNIVERSITY CENTER OF INTERNATIONAL PROGRAMMES OF STUDIES SCHOOL OF HUMANITIES, SOCIAL SCIENCES AND ECONOMICS, Thessaloniki – Greece, 01/2023.
- [3] "EGYANKOSH - TOURISM SYSTEM: COMPONENTS, ELEMENTS AND MODELS," [Online]. Available: <https://egyankosh.ac.in/bitstream/123456789/67180/3/Unit-6.pdf>.
- [4] "Unlocking the future," 21 November 2018. [Online]. Available: <https://unlocking-the-future.com/3-important-elements-of-tourism/>.
- [5] "Mize," [Online]. Available: <https://www.hotelmize.com/blog/6-examples-of-how-ai-is-used-in-the-travel-industry/>.
- [6] "Revfine," [Online]. Available: <https://www.revfine.com/artificial-intelligence-travel-industry/>.
- [7] P. Sukhostavets, "Chisw," 23 November 2022. [Online]. Available: <https://chisw.com/blog/ai-in-travel-and-hospitality/>.
- [8] S. Chen, "Scholarly Community Encyclopedia," 28 September 2020. [Online]. Available: <https://encyclopedia.pub/entry/2239>.
- [9] S. Amsler, "TechTarget," 19 April 2022. [Online]. Available: <https://www.techtarget.com/whatis/feature/6-technology-trends-in-the-travel-industry>.
- [10] O. Z. S. S. Svitlana Labunsk, "THE USE OF INFORMATION SYSTEMS AS A WAY TO ENSURE INTERACTION BETWEEN SMALL AND BIG TOURISM ENTERPRISES," *ACCESS Journal: Access to Science, Business, Innovation in Digital Economy*, no. 2683-1007, pp. 16-28, 2022.

- [11] B. S. K. R. S. B. a. R. V. R. Nagaraj Samala, "Impact of AI and robotics in the tourism sector: a critical insight," *Journal of toruismfutures*, Vols. 8, No.1, pp. 73-87, 2022.
- [12] "ROLE OF ARTIFICIAL INTELLIGENCE AND BIG DATA ANALYTICS IN SMART TOURISM: A RESOURCE-BASED VIEW APPROACH," *ASTERIOS STROUMPOULIS, EVANGELIA KOPANAKI, SOTIRIOS VARELAS*, vol. 256, no. 1743-3541, 2022.
- [13] J. Bulchand-Gidumal, "Impact of Artificial Intelligence in Travel, Tourism, and Hospitality," Las Palmas de Gran Canaria, Spain, 2020.
- [14] A. M. G.-F. P. m. Sofia Blanco Moreno, "Big data in tourism marketing: past research and future opportunities," *Spanish Journal of Marketing - ESIC*, Vols. DOI:10.1108/SJME-06-2022-0134, January 2023.
- [15] E. Çeltek, "Big-Data-Artificial-Intelligence-and-Their-Implications-in-the-Tourism-Industry," *Handbook of Research on Smart Technology Applications in the Tourism Industry*, Vols. DOI:10.4018/978-1-7998-1989-9.ch006, January 2020.

Journal Of Technological  
Sciences- JTS

**ISSN 2955-2478**

Volume 1, Issue1, 2024