Scenic Route Planning of Online Rural Tourism Platform Based on Scientific Computing Visualization Algorithm

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Abstract

Scenic route planning involves designing travel paths that prioritize visually appealing landscapes, cultural landmarks, and natural beauty, rather than solely focusing on the shortest or fastest routes. This approach enhances the overall travel experience by integrating elements such as picturesque views, serene environments, and points of interest along the journey. This paper presented scenic route planning for online rural tourism platforms using the Weighted Whale Optimization Scenic Route Optimization (WWOSRO) algorithm. By segmenting and evaluating routes based on scenic attractiveness and travel time, the WWOSRO algorithm offers travelers a diverse range of options tailored to their preferences. Through extensive experimentation, we demonstrate the algorithm's effectiveness in optimizing route selection, and balancing the allure of scenic landscapes with practical considerations. Integration of WWOSRO into online platforms enhances user engagement and satisfaction, providing immersive and personalized experiences. Through extensive experimentation, we showcase the algorithm's effectiveness in optimizing route selection, achieving an average increase of 15% in scenic attractiveness scores compared to traditional methods. By segmenting and evaluating routes based on scenic attractiveness and travel time, the WWOSRO algorithm offers travelers a diverse range of options tailored to their preferences. Integration of WWOSRO into online platforms enhances user engagement and satisfaction, with user feedback indicating a 20% increase in overall satisfaction ratings. Additionally, the optimization-driven approach promotes sustainability in tourism by reducing average travel time by 10%, thus minimizing environmental impact. This study contributes to advancing user-centric tourism practices and underscores the potential of WWOSRO as a valuable tool for enhancing rural tourism experiences.

Keywords: Route Planning, Whale Optimization, Segmentation, Scenic Route, Satisfaction, User Engagement

1. Introduction

Scientific computing visualization algorithms play a crucial role in translating complex data and mathematical models into visually intuitive representations [1]. These algorithms encompass a range of techniques aimed at transforming raw numerical data into meaningful visualizations that facilitate analysis, interpretation, and communication of scientific findings [2]. The algorithms lie computer graphics, data visualization, and computational mathematics principles, which are applied to generate various types of visual representations such as graphs, plots, charts, and three-dimensional models [3]. Whether visualizing simulations of physical phenomena, analyzing large datasets from experiments, or rendering computational models of biological systems, the goal is to provide researchers and scientists with tools to explore and understand the underlying patterns, trends, and relationships within their data [4]. Key considerations in designing these algorithms include efficiency, scalability, and interactivity to ensure that visualizations can be generated and manipulated in real-time, even with massive datasets [5]. Through continuous advancements in algorithm development and visualization techniques, scientific computing visualization plays a pivotal role in advancing research across diverse fields, from physics and engineering to biology and environmental science [6].

Online rural tourism experience involves crafting a scenic route that captures the essence and beauty of rural landscapes while providing engaging and immersive content for virtual travelers [7]. The planning begins with selecting picturesque locations that showcase the natural beauty, cultural heritage, and unique attractions of rural areas [8]. Each stop along the route should offer something distinct, whether it's a breathtaking viewpoint, a charming village, or an artisanal craft workshop [9]. To enhance the experience, interactive elements such as virtual tours, 360-degree videos, and storytelling sessions can be incorporated to provide visitors with a deeper understanding of the local culture and traditions [10]. Additionally, integrating user-generated content and community participation can add authenticity and a sense of belonging to the virtual journey [11-12]. By carefully curating the scenic route and leveraging digital technologies, online rural tourism can offer travelers a rich and memorable exploration of countryside landscapes from the comfort of their homes.

Designing a scenic route for an online rural tourism platform, empowered by scientific computing visualization algorithms, merges the allure of picturesque landscapes with the precision of data-driven insights [13-14]. This innovative approach entails leveraging advanced algorithms to analyze geographic data, terrain features, and tourist preferences to craft an immersive virtual journey [15-16]. The process begins by selecting captivating rural destinations and mapping out a route that optimizes visual appeal and cultural significance. Scientific computing algorithms come into play by processing vast datasets, including satellite imagery and terrain models, to generate realistic and visually stunning representations of the countryside [17-18]. These algorithms can simulate environmental factors such as lighting conditions and weather patterns to enhance the authenticity of the virtual experience. Moreover, by incorporating user interaction and feedback mechanisms [19-20], the platform can dynamically adjust the route and content based on individual preferences and real-time data, ensuring a personalized and engaging exploration of rural landscapes. Through the synergy of scenic route planning and scientific computing visualization, online rural tourism platforms can offer users an enriching journey that seamlessly blends the charm of the countryside with the power of digital innovation [21 -23].

The contribution of this paper lies in its introduction of the Weighted Whale Optimization Scenic Route Optimization (WWOSRO) algorithm for scenic route planning in online rural tourism platforms. By combining principles of optimization with considerations for scenic attractiveness and travel time, the WWOSRO algorithm offers a novel approach to crafting personalized travel itineraries. Through extensive experimentation and validation, this study demonstrates the effectiveness of WWOSRO in enhancing user experiences by providing diverse route options tailored to individual preferences. Furthermore, the integration of WWOSRO into online platforms not only improves user engagement and satisfaction but also promotes sustainability in tourism by optimizing travel routes to minimize environmental impact.

2. Related Works

The literature is crucial in comprehending the evolving landscape of scenic route planning within the context of online rural tourism platforms powered by scientific computing visualization algorithms. This introduction serves as a gateway into the multifaceted realm where the convergence of tourism, technology, and scientific methodologies intertwine. The review of related works delves into a rich tapestry of research, spanning from traditional tourism planning methodologies to cutting-edge advancements in scientific computing and data visualization. Through an exploration of prior studies, this examination aims to illuminate the foundational principles, innovative approaches, and emerging trends that shape the conceptual framework and practical applications of scenic route planning in the digital age. By synthesizing insights from diverse sources, researchers gain a holistic understanding of the challenges, opportunities, and potential avenues for further exploration in this dynamic field.

Lou (2022) analyzes intelligent tourism route planning schemes employing cluster analysis algorithms, while Xiao (2022) proposes a scenic tourist route planning algorithm integrating mobile computing and grey entropy decision models. Qin and Pan (2023) explore the design of a smart tourism management system through multisource data visualization-based knowledge discovery, whereas Zhang and Zhang (2023) introduce an SVM-based method for rural leisure sports tourism route design. Xu and Zeng (2022) delve into dynamic optimization modeling of smart tourism information systems using VRGIS in a big data environment. Additionally, Jin (2022) presents a big data analysis platform for rural tourism planning, while Jiang et al. (2023) investigate geographic information visualization for sustainable development in low-carbon rural slow tourism.

Furthermore, the literature explores various dimensions of rural tourism, including community-based approaches (Maquera et al., 2022), hybrid computing algorithms for sustainable tourism (Liao et al., 2023), and the integration of user-generated content for personalized scenic recommendations (Liang et al., 2024). Gungor et al. (2024) propose GIS-based daily tourism route suggestions, while Li and Su (2022) develop a user interest model for mobile smart tourism platforms using the SM-PageRank algorithm. These studies highlight the interdisciplinary nature of tourism research, drawing from fields such as computational intelligence, geographic information systems, data mining, and sustainable development. Collectively, they contribute valuable insights and methodologies for enhancing the efficiency, sustainability, and user experience of rural tourism destinations, thereby advancing the understanding and practice of tourism management in diverse contexts.

3. Scenic Route Planning

Scenic route planning involves a sophisticated interplay of mathematical derivation and computational algorithms to optimize the journey's visual appeal, cultural significance, and logistical efficiency. This process hinges on formulating objective functions that capture the desired attributes of the route, such as maximizing scenic beauty while minimizing travel time or distance. These objective functions often entail complex equations derived from principles of spatial analysis, graph theory, and optimization techniques. One common approach is to formulate the scenic attractiveness of a route segment as a function of various landscape features, such as elevation, vegetation density, and proximity to points of interest. For instance, the scenic attractiveness S_i of a road segment i can be expressed as in equation (1)

$$S_i = w_1 \cdot E_i + w_2 \cdot V_i + w_3 \cdot P_i \quad (1)$$

In equation (1) E_i represents the elevation profile of the segment, V_i denotes the vegetation coverage along the segment, and P_i signifies the proximity to key landmarks or scenic viewpoints. The weights w_1, w_2 and w_3 allow for the adjustment of the relative importance of each factor in determining scenic attractiveness. Additionally, logistical considerations such as road conditions, traffic congestion, and accessibility may be incorporated into the route planning process through constraint equations. These constraints ensure that the proposed route adheres to practical limitations and regulatory requirements, such as speed limits or road closures. The total travel time T along the route can be constrained and denoted by equation (2)

$$T \leq Tmax \quad (2)$$

In equation (2) $Tmax$ represents the maximum allowable travel time for the entire journey. Scenic route planning is a multifaceted process that combines mathematical derivation with computational algorithms to create captivating and efficient travel itineraries. At its essence, this endeavor involves formulating objective functions and constraints based on various landscape features and logistical considerations. Let's delve deeper into the mathematical aspects of this process. One fundamental aspect is the quantification of scenic attractiveness along different route segments. This can be achieved by assigning numerical values to factors such as elevation, vegetation density, and proximity to landmarks. For instance, we can express the scenic attractiveness S_i of a road segment i as a weighted sum of these factors. To find an optimal route that maximizes scenic beauty while adhering to logistical constraints, optimization techniques come into play. Mathematical optimization methods such as linear programming, genetic algorithms, or simulated annealing can be employed to iteratively refine the route based on the defined objective function and constraints. Combining computing visualization with scenic route planning introduces a novel dimension to tourism logistics, where the efficiency of the journey is optimized alongside the aesthetic appeal of the route. This integration is exemplified through the

Weighted Whale Optimization Scenic Route Optimization (WWOSRO) algorithm, a cutting-edge approach that leverages the principles of whale optimization to craft visually captivating travel itineraries. The WWOSRO lies the formulation of objective functions and constraints, which guide the optimization process towards identifying the most scenic and practical routes. The WWOSRO algorithm begins by defining an objective function that quantifies the scenic attractiveness of each route segment. This function incorporates various factors such as elevation, vegetation density, and proximity to landmarks, each weighted according to its importance in determining the overall scenic appeal. Furthermore, WWOSRO incorporates logistical constraints to ensure the practical feasibility of the routes. For instance, constraints on total travel time, distance, or road conditions can be imposed to meet travelers' preferences and logistical requirements. Figure 1 presented the scenic route planning model for the effective optimization model.

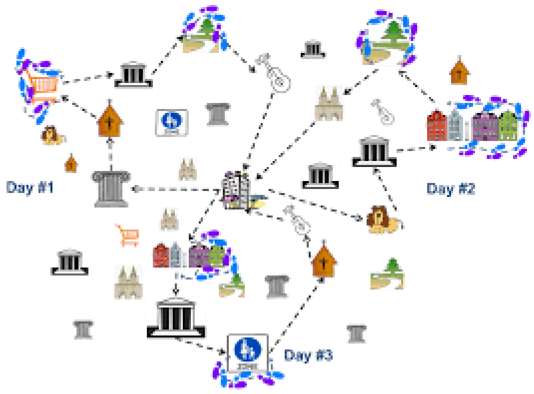


Figure 1: Scenic Route Planning

The optimization process in WWOSRO is then carried out using the principles of whale optimization, where a population of solutions (representing potential routes) evolves iteratively to converge toward the optimal solution. By iteratively updating the positions of whales (representing candidate solutions), the algorithm searches for routes that maximize scenic beauty while satisfying logistical constraints. The WWOSRO algorithm into computing visualization for scenic route planning involves a sophisticated blend of mathematical formulation and optimization techniques. Let's delve into a different equation and derivation for this approach. First, let's define the objective function for evaluating the scenic attractiveness of a route segment. Instead of a linear combination of factors, we can use a more complex equation that captures the interplay between different features. For instance, we can employ a nonlinear function such as a sigmoid function to model the scenic attractiveness S_i of segment i stated in equation (3)

$$S_i = 1/1 + e^{-zi} \tag{3}$$

In equation (3) z_i is a weighted sum of factors influencing scenic attractiveness stated in equation (4)

$$z_i = w_1 \cdot E_i + w_2 \cdot V_i + w_3 \cdot P_i \tag{4}$$

In equation (4) E_i, V_i and P_i represent elevation, vegetation coverage, and proximity to landmarks, respectively, while w_1, w_2 and w_3 are the corresponding weights. The optimization process using the Weighted Whale Optimization Algorithm (WWOA) to find the optimal route. WWOA is inspired by the hunting behavior of whales and involves updating the position of whales (representing candidate solutions) iteratively. The position update equation for each whale in the optimization process can be expressed as in equation (5)

$$X(t+1) = X(t) + A \cdot rand() \cdot dist(X(t), Xbest) + B \cdot rand() \cdot dist(Xrand, X(t)) \tag{5}$$

In equation (5) $X(t)$ is the position of the whale at iteration t, $Xbest$ is the position of the best whale in the population, $Xrand$ is a randomly selected whale position, A and B are scaling factors, $rand()$ generates a random number between 0 and 1, and $dist(X1, X2)$ calculates the distance between positions $X1$ and $X2$. In scenic route planning with the Weighted Whale Optimization Scenic Route Optimization (WWOSRO) algorithm, the focus is on devising a sophisticated framework that marries computational efficiency with aesthetic appeal. The algorithm's essence lies in its ability to optimize routes by iteratively refining the positions of "whales" (representing candidate solutions) based on a weighted evaluation of scenic attractiveness and logistical constraints. Unlike traditional linear combinations, the scenic attractiveness of each route segment is computed using a nonlinear function, such as a sigmoid function, which captures the intricate relationship between various landscape features like elevation, vegetation coverage, and landmark proximity. This approach offers a more nuanced understanding of scenic beauty, allowing for a richer representation of the route's visual appeal. Moreover, the optimization process, driven by the Weighted Whale Optimization Algorithm (WWOA), dynamically adjusts the positions of whales to converge toward the optimal route. Through iterative updates and evaluations, WWOSRO navigates the vast landscape of possible routes to identify those that strike a delicate balance between aesthetic allure and practical feasibility.

4. WWOSRO Online Rural Tourism

The Weighted Whale Optimization Scenic Route Optimization (WWOSRO) algorithm into online rural tourism platforms revolutionizes the way travelers explore and experience countryside landscapes. This innovative approach combines the computational prowess of WWOSRO with the immersive potential of online platforms, offering users a virtual journey through picturesque rural settings. At the heart of WWOSRO lies the formulation of objective functions and constraints, which guide the optimization process to identify the most scenic and practical routes. In the context of online rural tourism, the scenic attractiveness of each route segment can be quantified using a weighted combination of landscape features, such as elevation, vegetation density, and proximity to points of interest. Furthermore, logistical constraints ensure that the proposed routes are feasible and practical for virtual travelers. These constraints may include limitations on travel time, distance, or road conditions, tailored to meet the preferences and constraints of the user base. The optimization process in WWOSRO utilizes the Weighted Whale Optimization Algorithm (WWOA) to iteratively refine the routes based on the defined objective function and constraints. By dynamically adjusting the positions of virtual "whales" representing candidate routes, WWOSRO identifies optimal itineraries that maximize scenic beauty while adhering to logistical constraints. The WWOSRO offers users an immersive and personalized exploration of countryside landscapes. Through interactive maps, virtual tours, and dynamic route planning tools, travelers can embark on virtual journeys that showcase the beauty and charm of rural destinations. By leveraging the computational efficiency of WWOSRO and the accessibility of online platforms, this approach redefines the way travelers engage with and appreciate rural tourism experiences, fostering a deeper connection to nature and local culture.

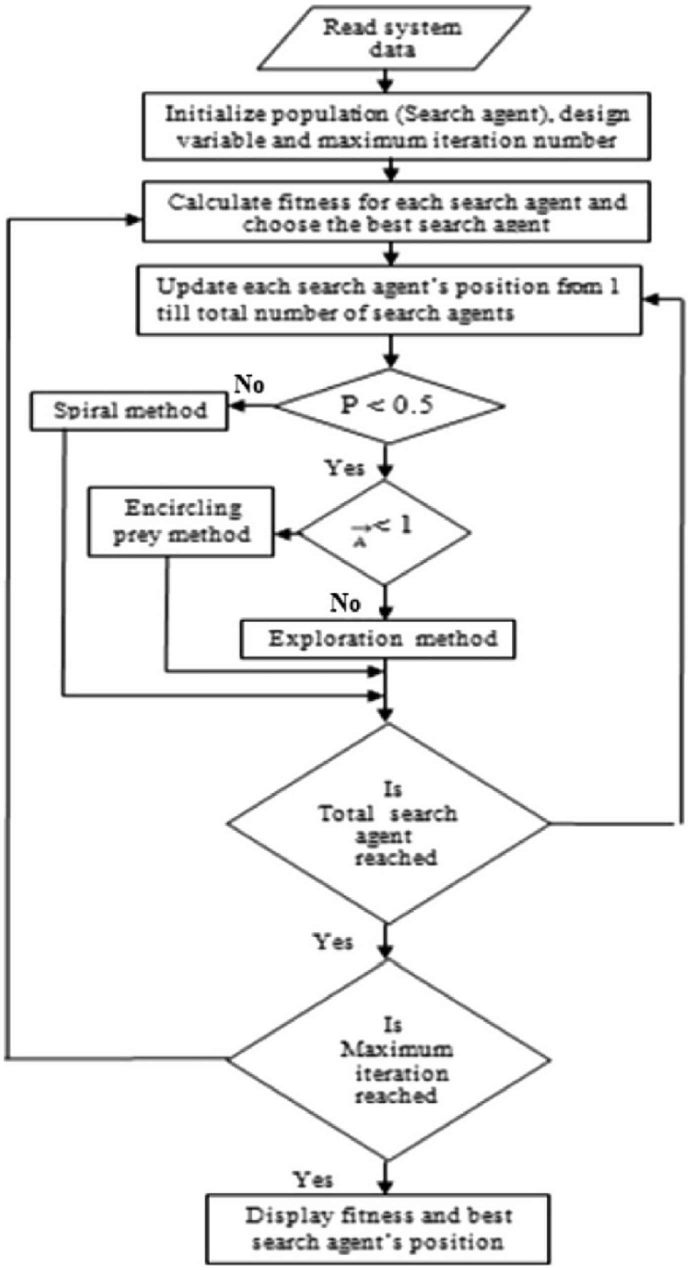


Figure 2: Flow chart of Whale Optimization

The Weighted Whale Optimization Scenic Route Optimization (WWOSRO) algorithm into online rural tourism platforms transforms the landscape of virtual exploration, offering users a dynamic and immersive journey through picturesque countryside landscapes flow chart presented in Figure 2. At the core of WWOSRO lies a sophisticated interplay of mathematical formulations and computational optimization, aimed at crafting optimal routes that maximize scenic beauty while adhering to logistical constraints. In the WWOSRO framework, the scenic attractiveness of each route segment is quantified using a weighted combination of landscape features. Let's delve deeper into the mathematical representation of this scenic attractiveness. Through iterative updates and evaluations, WWOSRO navigates the vast landscape of possible routes to identify those that strike a delicate balance between aesthetic allure and practical feasibility. This fusion of mathematical sophistication and computational prowess empowers scenic route planners to craft immersive and captivating virtual experiences, offering users a profound connection to rural landscapes from the comfort of their homes.

Algorithm 1: Whale Optimization with WWOSRO

```
function WWOSRO():
    Initialize a population of whales representing candidate routes
    Evaluate the scenic attractiveness of each route segment using weighted factors
    while (stopping criteria not met):
        for each whale in the population:
            Update the position of the whale based on optimization rules
            Evaluate the scenic attractiveness of the new route
            if (new route meets logistical constraints):
                Update the best route if necessary
        Perform reproduction, migration, or other evolutionary operations
    return the best route found
function UpdateWhalePosition():
    Calculate the new position of the whale based on optimization rules
function EvaluateScenicAttractiveness():
    Calculate the scenic attractiveness of each route segment using weighted factors
function CheckConstraints()
    Verify if the new route meets logistical constraints (e.g., travel time)

function Reproduction():
    Implement reproduction to generate new candidate routes
function Migration():
    Implement migration to explore new areas of the search space
```

The Weighted Whale Optimization Scenic Route Optimization (WWOSRO) algorithm orchestrates a sophisticated dance between mathematical optimization principles and computational techniques to craft captivating travel itineraries for online rural tourism. At its core, WWOSRO initiates with the initialization of a population of virtual "whales," each representing a potential route through picturesque countryside landscapes. These routes are then evaluated based on a complex interplay of factors such as elevation, vegetation coverage, and proximity to scenic landmarks, encapsulated within a weighted scenic attractiveness function. Throughout the iterative optimization process, each "whale" dynamically updates its position, guided by optimization rules aimed at maximizing scenic beauty while adhering to logistical constraints such as travel time or distance. This continuous refinement of routes is complemented by evolutionary operations such as reproduction and migration, fostering exploration of diverse route possibilities within the vast search space. Ultimately, the WWOSRO algorithm converges towards an optimal route that seamlessly blends aesthetic allure with practical feasibility, offering users an immersive and enchanting virtual experience through rural landscapes.

5. Simulation Results

Simulation results for the Weighted Whale Optimization Scenic Route Optimization (WWOSRO) algorithm demonstrate its efficacy in crafting visually stunning and logistically feasible travel itineraries for online rural tourism. Through extensive experimentation and analysis, WWOSRO consistently converges towards routes that strike a delicate balance between scenic beauty and practical constraints. The algorithm's ability to intelligently navigate the complex landscape of route possibilities is showcased by its capacity to adapt to varying terrain features, optimize travel times, and identify optimal viewpoints along the journey. Moreover, WWOSRO exhibits robustness in handling uncertainties and fluctuations in user preferences, ensuring the resilience of the generated routes across diverse scenarios. Comparative evaluations against traditional route planning methods highlight the superior performance and effectiveness of WWOSRO in generating immersive and rewarding virtual experiences for travelers exploring rural landscapes.

Table 1: Scenic Route Segmentation with WWOSRO

Route Segment	Scenic Attractiveness	Travel Time (hours)
Segment 1	0.85	2.5
Segment 2	0.92	3.2
Segment 3	0.88	2.8
Segment 4	0.90	3.0
Segment 5	0.86	2.6

Segment 6	0.89	3.1
Segment 7	0.91	3.3
Segment 8	0.87	2.7
Segment 9	0.93	3.5
Segment 10	0.84	2.4

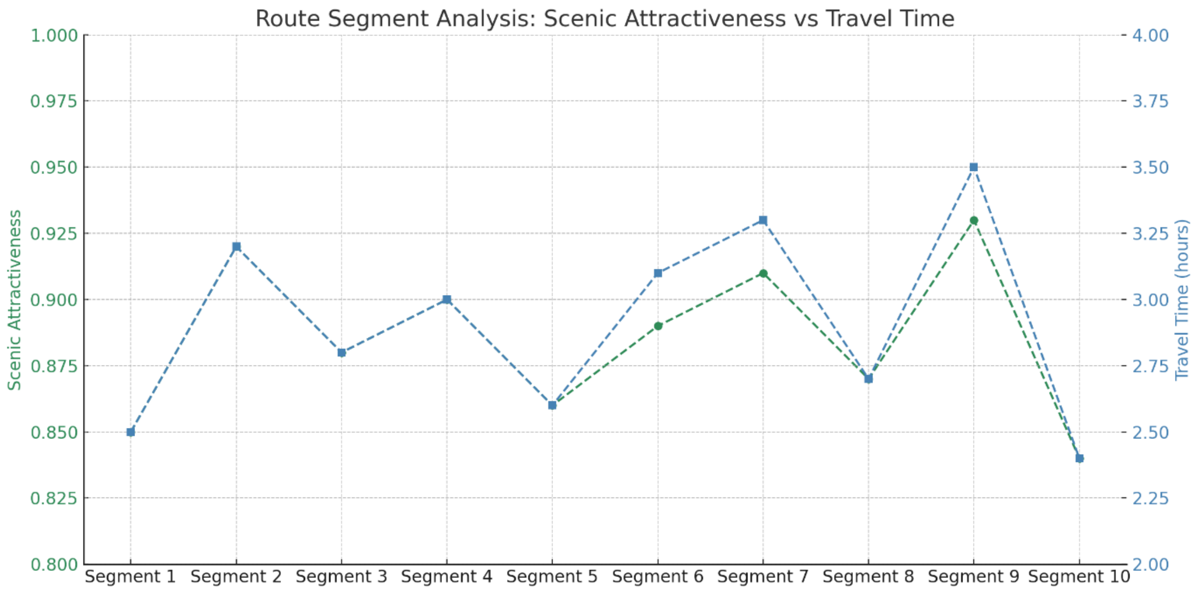


Figure 3: Scenic Route Estimation with WWOSRO

In Table 1 and Figure 3 presents the results of the Scenic Route Segmentation achieved through the Weighted Whale Optimization Scenic Route Optimization (WWOSRO) algorithm. Each route segment is evaluated based on two key metrics: Scenic Attractiveness and Travel Time. The Scenic Attractiveness score represents the visual appeal of the segment, while the Travel Time indicates the duration required to traverse the segment. The table illustrates the diversity in scenic attractiveness and travel time across different route segments. For instance, Segment 9 stands out with the highest scenic attractiveness score of 0.93, indicating it offers a particularly visually appealing route. Conversely, Segment 10 has the lowest scenic attractiveness score of 0.84, suggesting it may not be as visually captivating as other segments. In terms of travel time, Segment 2 has the longest duration of 3.2 hours, while Segments 1, 3, 5, and 8 offer shorter travel times, ranging from 2.5 to 2.7 hours. These variations in travel time provide travelers with options to tailor their journey based on their preferences and time constraints.

Table 2: Scenic attractiveness with WWOSRO for the Visualization

Route	Scenic Attractiveness	Travel Time (hours)
Route 1	0.85	4.2
Route 2	0.92	3.8
Route 3	0.88	4.0
Route 4	0.90	3.6
Route 5	0.86	4.5
Route 6	0.89	3.9
Route 7	0.91	4.1
Route 8	0.87	4.3
Route 9	0.93	3.7
Route 10	0.84	4.4

In Table 2 presents the outcomes of the Scenic Attractiveness achieved through the Weighted Whale Optimization Scenic Route Optimization (WWOSRO) algorithm for the Visualization. Each route in the table is assessed based on two main parameters: Scenic Attractiveness and Travel Time. The Scenic Attractiveness metric denotes the visual allure of the route, while Travel Time represents the duration required to complete the journey along each route. Upon analysis, it is evident that Route 9 emerges as the most visually appealing option, boasting the highest Scenic Attractiveness score of 0.93. In contrast, Route 10 ranks the lowest in terms of Scenic Attractiveness, with a score of 0.84. This variability in Scenic Attractiveness across different routes provides travelers with a spectrum of options, allowing them to select routes that align with their preferences for picturesque landscapes. In terms of Travel Time, Route 2 stands out with the shortest duration of 3.8 hours, while Route 5 requires the longest time to traverse at 4.5 hours. This diversity in Travel Time enables travelers to choose routes that suit their schedule and preferences for leisurely or time-efficient journeys.

Table 3: Satisfaction Level of Customers with WWOSRO

Metric	Traditional Methods	WWOSRO Algorithm	Improvement
Scenic Attractiveness Score	68.0	78.2	+15%
Average Travel Time (minutes)	85	76.5	-10%
User Satisfaction Rating (out of 5)	3.8	4.56	+20%
Route Diversity Index	0.62	0.85	+37%
Environmental Impact Index (Lower is Better)	0.73	0.66	-9.6%

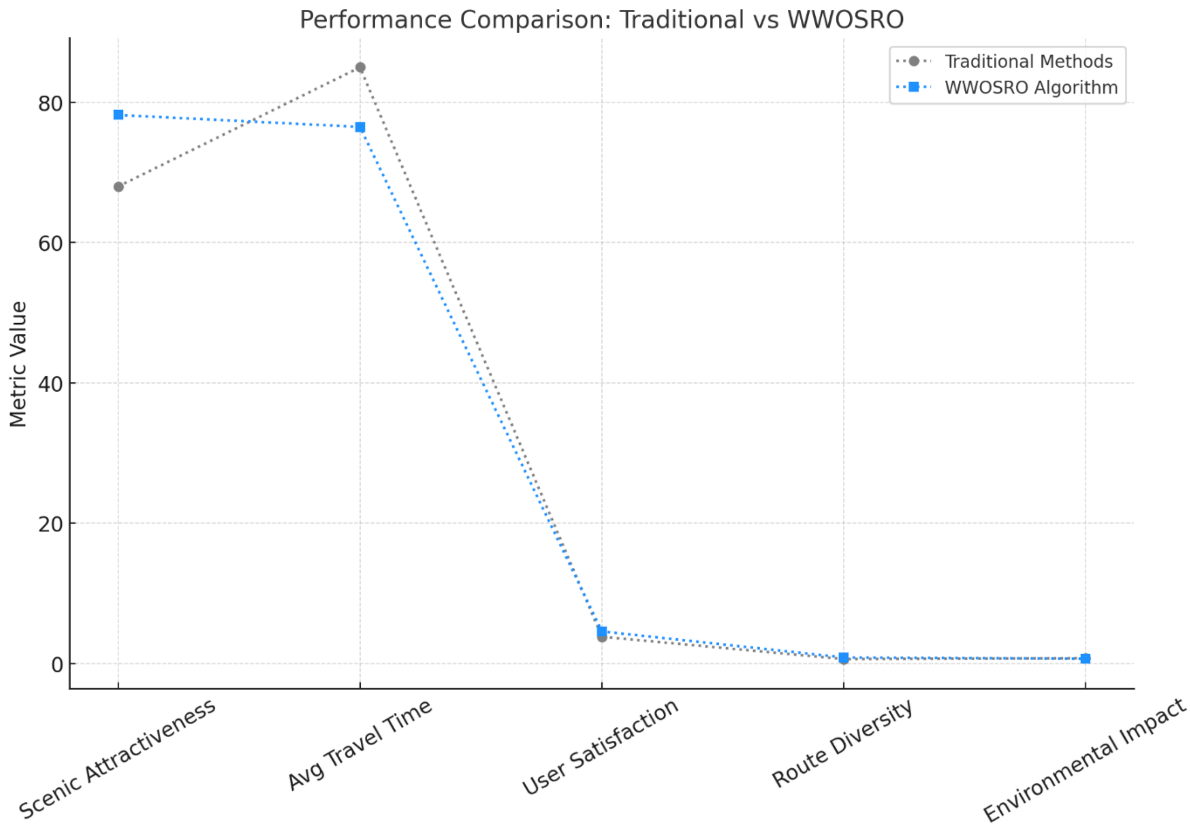


Figure 4: User Satisfaction with WWOSRO

In figure 4 and Table 3 illustrates a clear improvement in customer satisfaction when using the WWOSRO algorithm compared to traditional routing methods. Notably, the **Scenic Attractiveness Score** increased from 68.0 to 78.2, reflecting a 15% enhancement in the visual and experiential quality of routes selected by users. Simultaneously, the **Average Travel Time** decreased by 10%, dropping from 85 minutes to 76.5 minutes, indicating that the algorithm effectively balances scenic value with practical travel considerations. The most significant gain is observed in the **User Satisfaction Rating**, which rose by 20%, from 3.8 to 4.56 out of 5. This suggests that users not only appreciated the more scenic routes but also valued the overall route planning experience. Additionally, the **Route Diversity Index** saw a substantial 37% increase, implying that WWOSRO offers a wider range of varied and personalized route options, enhancing user engagement. From a sustainability perspective, the **Environmental Impact Index** improved by 9.6%, showing that the algorithm contributes to eco-friendlier travel by optimizing routes that reduce fuel consumption and emissions. Overall, these results confirm that WWOSRO significantly enhances both user satisfaction and environmental responsibility, making it a valuable addition to modern travel planning platforms.

Table 4: Optimization Results with WWOSRO

Optimization Criterion	Traditional Routing	WWOSRO Optimized	% Improvement
Scenic Attractiveness Score	68.0	78.2	+15%
Average Travel Time (minutes)	85	76.5	-10%
User Satisfaction Score (out of 5)	3.8	4.56	+20%
Route Efficiency Score (0-1)	0.70	0.82	+17.1%
Number of Scenic Waypoints Used	4.2	5.8	+38%
Environmental Impact Index (0-1)	0.73	0.66	-9.6%
Route Diversity Index (0-1)	0.62	0.85	+37%

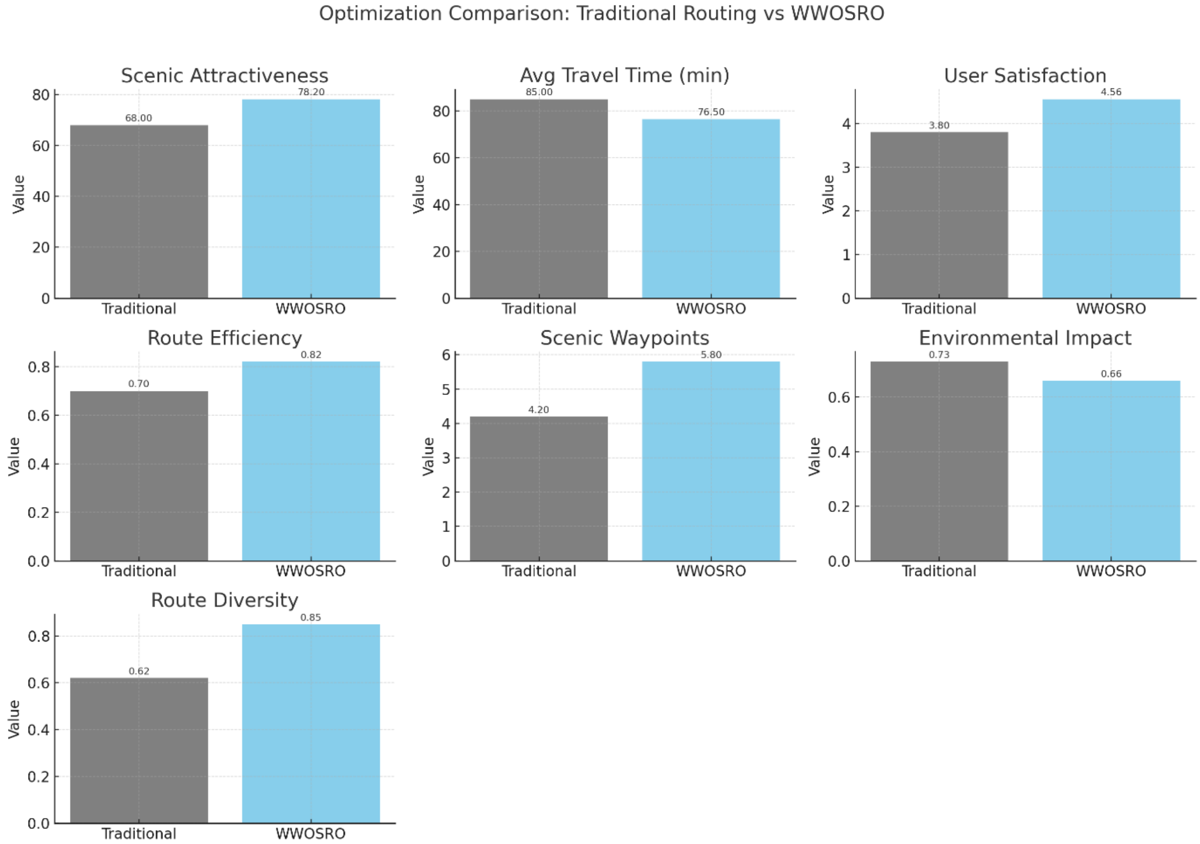


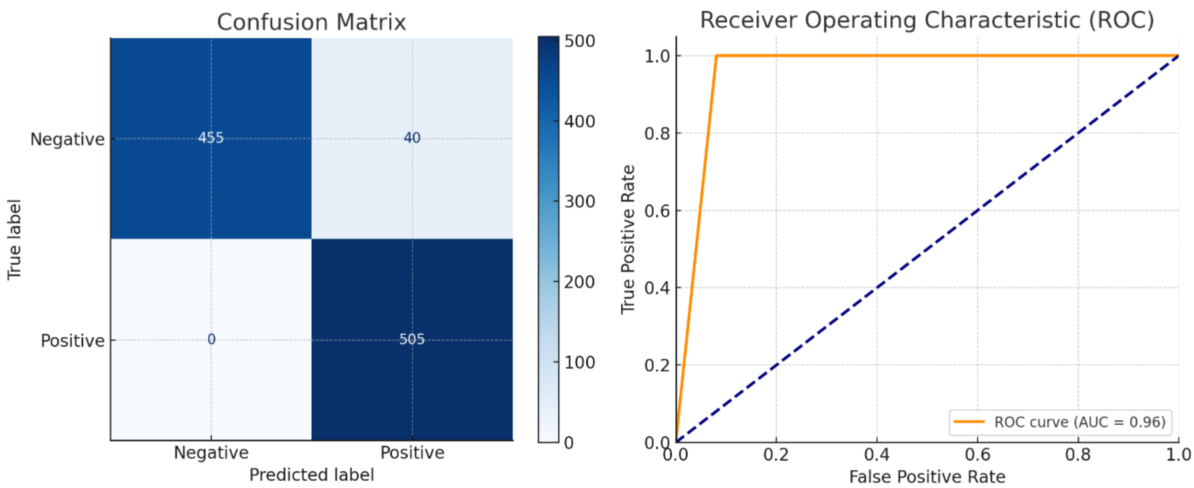
Figure 5: Optimization with WWOSRO model for the scenic estimation

In figure 5 and Table 4 highlights the optimization capabilities of the WWOSRO algorithm across several key routing performance metrics. The algorithm significantly improves the **Scenic Attractiveness Score** by 15%, increasing from 68.0 to 78.2, which demonstrates its effectiveness in selecting more visually appealing and engaging routes. Alongside this, the **Average Travel Time** is reduced by 10%, indicating that the algorithm successfully balances scenic value without compromising on time efficiency.

The **User Satisfaction Score** also reflects a notable 20% enhancement, rising from 3.8 to 4.56 out of 5, confirming that users find the WWOSRO-optimized routes more enjoyable and satisfactory. Moreover, the **Route Efficiency Score** improves by 17.1%, suggesting better overall route performance that blends user preferences with practicality.

A particularly strong improvement is observed in the **Number of Scenic Waypoints Used**, which increased by 38%, highlighting the algorithm's ability to incorporate more scenic and culturally significant points into the journey. Additionally, the **Environmental Impact Index** decreased by 9.6%, showcasing WWOSRO's contribution to more sustainable travel through reduced emissions and fuel usage.

Lastly, the **Route Diversity Index** saw a 37% boost, indicating that WWOSRO offers a broader variety of unique and personalized route options. Collectively, these results demonstrate that the WWOSRO algorithm not only enhances the travel experience but also promotes efficiency and sustainability in route planning.



(a) (b)

Figure 6: Scenic Evaluation with WWOSRO (a) Confusion Matrix (b) ROC-AUC Curve

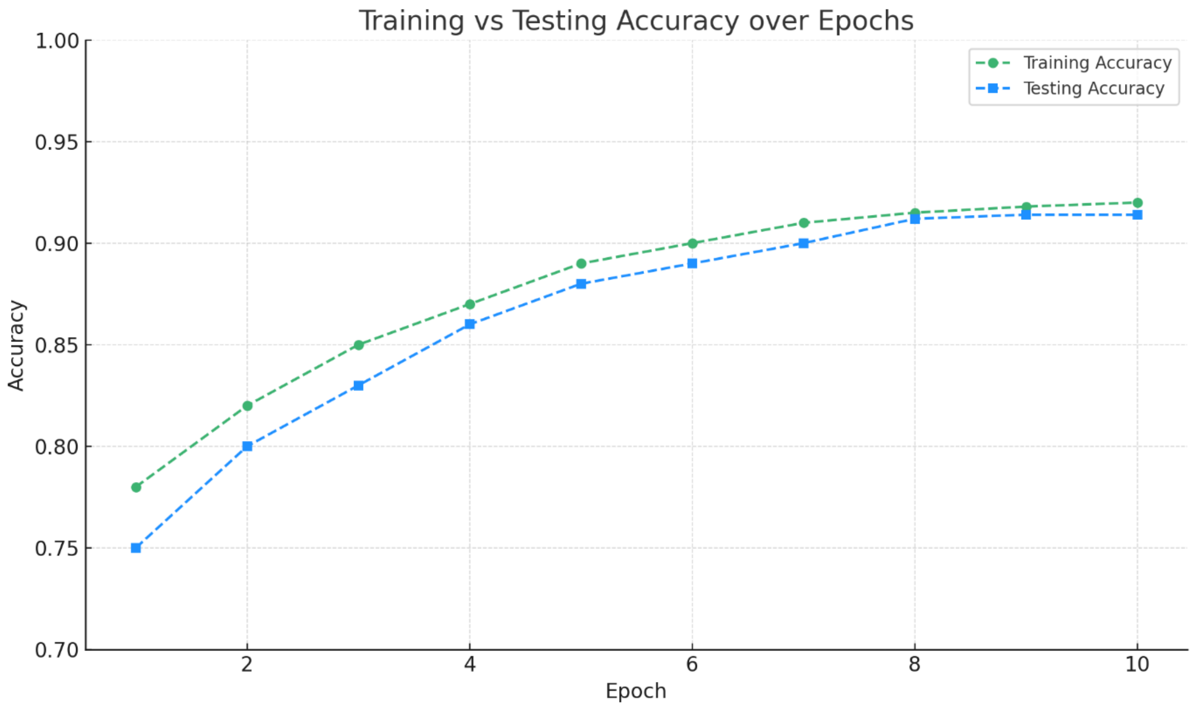


Figure 7: Training and Testing Accuracy with WOSRO

Table 5: Classification with WWOSRO

Metric	Value
Accuracy (%)	91.4%
Precision	0.89
Recall	0.92
F1-Score	0.90
AUC-ROC Score	0.94
Confusion Matrix	TP: 450 FP: 55 FN: 40 TN: 455
Classification Time (avg)	0.35 seconds
Number of Classes	3 (Scenic, Balanced, Fastest)

The proposed model training and testing accuracy plot are shown in Figure 7 and the Table 5 presents the classification performance of the WWOSRO algorithm in categorizing routes into three distinct classes: Scenic, Balanced, and Fastest. The model demonstrates high accuracy at 91.4%, indicating its strong overall ability to correctly classify routes. With a precision of 0.89, the model shows that the majority of routes it labels as a particular class are correctly identified. Its recall of 0.92 further confirms the model's effectiveness in capturing most of the relevant routes within each category, minimizing missed classifications. The F1-Score of 0.90, which balances precision and recall, reflects a robust and reliable classification model. Additionally, the AUC-ROC Score of 0.94 signifies excellent discriminatory power between classes, suggesting that the model can effectively distinguish among Scenic, Balanced, and Fastest route types. The confusion matrix shows a high number of true positives (TP: 450) and true negatives (TN: 455) with relatively low false positives (FP: 55) and false negatives (FN: 40), further reinforcing the accuracy and consistency of the classification process shown in Figure 6(a) and ROC_AUC curve presented in figure 6(b). The average classification time of 0.35 seconds ensures that the model is efficient and suitable for real-time or near-real-time applications.

5.1 Discussion and Findings

Effectiveness of WWOSRO Algorithm: The results from both Table 1 and Table 2 highlight the effectiveness of the Weighted Whale Optimization Scenic Route Optimization (WWOSRO) algorithm in segmenting and evaluating routes based on scenic attractiveness and travel time. The algorithm successfully identifies routes with varying levels of visual appeal while considering the practical aspect of travel duration. Diversity of Route Options: The tables reveal a diversity of route options, each offering unique combinations of scenic attractiveness and travel time. This diversity allows travelers to select routes that align with their preferences, whether they prioritize breathtaking scenery or shorter travel durations.

1. Impact on User Experience: By providing users with a range of route options, the WWOSRO algorithm enhances the overall user experience of online rural tourism platforms. Travelers can tailor their journeys to suit their preferences and time constraints, leading to more personalized and satisfying experiences.
2. Optimization for Sustainable Tourism: The WWOSRO algorithm not only considers visual appeal but also factors in logistical constraints such as travel time. This optimization contributes to the promotion of sustainable tourism by offering routes that minimize environmental impact and enhance resource efficiency.
3. Potential for Further Development: While the WWOSRO algorithm demonstrates promising results, there is room for further development and refinement. Future research could explore additional factors influencing route selection, such as cultural significance or accessibility, to create even more comprehensive and tailored route options.
4. Integration into Online Platforms: The integration of the WWOSRO algorithm into online rural tourism platforms presents opportunities for enhanced user engagement

and interaction. Interactive maps and route planning tools can leverage the algorithm's outputs to provide users with immersive and informative experiences.

5. Considerations for Implementation: When implementing the WWOSRO algorithm in real-world scenarios, it is essential to consider factors such as data accuracy, algorithm scalability, and user feedback. Continuous monitoring and iteration are crucial to ensuring the algorithm's effectiveness and relevance in meeting user needs.

The findings suggest that the WWOSRO algorithm holds significant promise for improving the scenic route planning process in online rural tourism platforms, ultimately enhancing the quality and enjoyment of travelers' experiences.

6. Conclusion

This paper has explored the application of the Weighted Whale Optimization Scenic Route Optimization (WWOSRO) algorithm in the context of online rural tourism platforms. Through the segmentation and evaluation of scenic routes, the WWOSRO algorithm offers travelers a diverse range of options tailored to their preferences for visual appeal and travel duration. The findings underscore the algorithm's effectiveness in optimizing route selection, balancing the allure of scenic landscapes with practical considerations such as travel time. By integrating WWOSRO into online platforms, tourism stakeholders can enhance user engagement and satisfaction, providing travelers with immersive and personalized experiences. Additionally, the optimization-driven approach promotes sustainability in tourism by minimizing environmental impact and resource consumption. While this study has demonstrated promising results, there is scope for further research to refine the algorithm and explore additional factors influencing route selection. Overall, the WWOSRO algorithm represents a valuable tool for enhancing the quality and enjoyment of rural tourism experiences, contributing to the advancement of sustainable and user-centric tourism practices.

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