Geospatial Analytics for Adventure Tourism in Colorado

Introduction

This project leverages data science and geospatial analytics to identify, analyze, and visualize key recreational locations across Colorado. Our objective was to support strategic planning for adventure-based tourism by evaluating suitable destinations for a variety of outdoor activities.

Project Plan and Methodology

We began by defining a set of eight representative locations across Colorado. These were selected based on several key criteria:
- Activity Suitability: Each location was matched with one or more outdoor sports such as hiking, white-water rafting, rock climbing, mountain biking, skiing, or kayaking.
- Geographic Distribution: Locations were spread across different regions of Colorado to ensure spatial diversity and statewide coverage.
- Elevation and Terrain: Elevation data was included to reflect terrain difficulty and activity relevance.
- Accessibility and Connectivity: Relative distances between sites were considered to evaluate route efficiency and optimize travel paths.

Data Parameters Collected

For each site, we recorded:
- City Name / Region
- Latitude and Longitude
- Elevation (ft)
- Estimated Travel Distance Between Locations
- Activity Type(s) associated with each location

Visualization and Analysis

We used Python libraries such as Folium to generate interactive geographic maps and Plotly for advanced visualizations including elevation profiles, activity distribution charts, and density heatmaps. These tools enabled us to:
- Map spatial patterns of activities
- Analyze terrain variation
- Simulate travel routes between adventure spots
- Highlight high-density recreation areas

Base Route Model

The base model calculates the total distance of a predefined hiking route that connects seven popular trails in Colorado. Unlike the optimized model, which dynamically determines the most efficient path, this approach follows a fixed sequence of locations. The Haversine formula is used to compute the great-circle distance between each pair of consecutive hiking locations. All segment distances are summed to calculate the total route length, ending at the starting point. This model serves as a benchmark for evaluating the effectiveness of the optimized route.

Optimized Route Model

The optimized model uses a greedy nearest-neighbor algorithm to minimize the total travel distance while visiting each location exactly once and returning to the starting point. Coordinates were converted to numeric format and radians for accurate Haversine distance calculations. The model iteratively selects the nearest unvisited location, accumulating distance and marking locations as visited. This approach balances simplicity and performance, providing a practical solution for small to medium-sized datasets.

Results

The optimized route showed significant improvements over the base route. For example, it traveled directly from Boulder to Rocky Mountain and from Grand Junction to the San Juan National Forest, avoiding unnecessary detours. These optimizations reduced the total travel distance and improved route efficiency for adventure planning.

Conclusion

This project demonstrates how data science and geospatial analytics can enhance strategic planning for adventure tourism. By integrating environmental, geographic, and activity-based data, we developed a framework for evaluating and optimizing travel routes across Colorado. Visualizations and algorithmic models provided actionable insights into terrain suitability, route efficiency, and spatial distribution of recreational sites.

Recommendations for Future Research

- Incorporate real-time data such as weather and trail conditions.
- Expand activity types and include seasonal variations.
- Explore advanced optimization algorithms like genetic algorithms or ant colony optimization.
- Include environmental impact metrics to support sustainable tourism.
- Develop user-centric models based on preferences and accessibility.
- Analyze economic and social impacts of optimized tourism routes.
- Integrate the model into a mobile application for real-time planning.