Intripid: Road Trip Optimizer

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1 INTRODUCTION

Intripid is a system that provides the user with the optimal road trip route, combining user interaction and data visualization to optimize time, cost, and enjoyment.

(1) Provide a web service that optimizes personalized road trips for users, recommending points of interest, keeping within time limits, and minimizing gas cost.
(2) Individual research has been done on the topics of route optimization and tourist site recommendation. The limit of these approaches is that they lack scalability and personalized user interaction.
(3) Intripid utilizes the Google Maps API, Google Places API, and extensive vehicle mpg data for route optimization and tourist site recommendations, compiling all into one simplistic user interface.
(4) Intripid is useful for anyone planning a road trip.
(5) Intripid reduces time spent trip planning, reduces gas costs, and provides the user with enjoyment. User studies have measured the success of Intripid. People familiar with the area gave feedback on the efficiency and accuracy of routes.
(6) No risks are present. Payoffs include an easily monetizable product and technical skills gained.
(7) No costs exist.
(8) Intripid was completed in seven weeks.
(9) The midterm check for success is accurately planning a route that integrates API metadata. The final checks for success are customizing route highlights and creating a comprehensive user interface.

2 SURVEY

2.1 Trip Optimization

Bao et al. proposes a shortest path algorithm where optimal route minimizes total distance and maximizes the popularity score of attractions [3]. This article is useful since it highlights the effectiveness of the greedy strategy for selecting popular attractions. We will improve upon this approach by weighting attractions based on Yelp ratings and reviews.

2.2 Gas Mileage

Allstate Insurance has patented a server for vehicles that optimizes gas mileage by suggesting specific refuel locations along a given route while taking into account user preferences [7]. This server will be helpful to Intripid by highlighting crucial variables used. It can be improved upon by relying less on data and more on forecasting gas prices.

Eveland expands on Allstate's patent by generalizing the intermediate stops such as gas stations, restaurants, and hotels, while forecasting gas prices [4]. Intripid will implement a similar forecasting procedure, improving upon the generic intermediate stops by accommodating user-inputs.

Halbey focus on the use of electric vehicles for long distance trips and the absence of a recharging schedule optimizer [5]. The article shows that the network for long-distance electric vehicle travel is too limited to have a reliable model. Intripid has the opportunity to develop a recharging schedule but will be cautious as most of the limitations are due to non-available resources.

2.3 Low-Cost Vacationing

Francken and van Raaij discuss the decision of vacation location and activities on overall satisfaction, finding that 68% of travel preferences align with Intripid's goals [9]. Furthermore, they found that people still want to travel in tough economic times, meaning there is a market for Intripid. A shortcoming is that this paper was published 30 years ago. Although the data may be dated, we will use its core ideas to improve Intripid.

Pan researched how people find information related to a vacation online [8]. This information is useful designing Intripid to determine what information should be made available for travelers. A shortcoming is that their research focuses solely on activities in a predetermined destination, whereas Intripid expands this to the entire US.

2.4 Site Recommendations

Cyberguide is a mobile tour guide that utilizes several emerging technologies [1]. This article is helpful providing potential useful features such as visual and verbal interfaces. The shortcomings are in its limited availability, basic UI, and inability to effectively store data.

Intrigue is a web application that recommends tourist sites based on their travel preferences [2]. The most helpful aspect of this article is its support of a numeric calculation for rating a tourist attraction. This service gives recommendations based upon one location, where we will give recommendations based upon all locations on a planned route.

Huan presents a way to calculate best attractions for a potential tourist based upon a user's travel history [6]. This article will make the attraction recommendation more robust by recording where travelers go on their trips. However, the user interface is outdated, which we will improve upon with a modern UI.

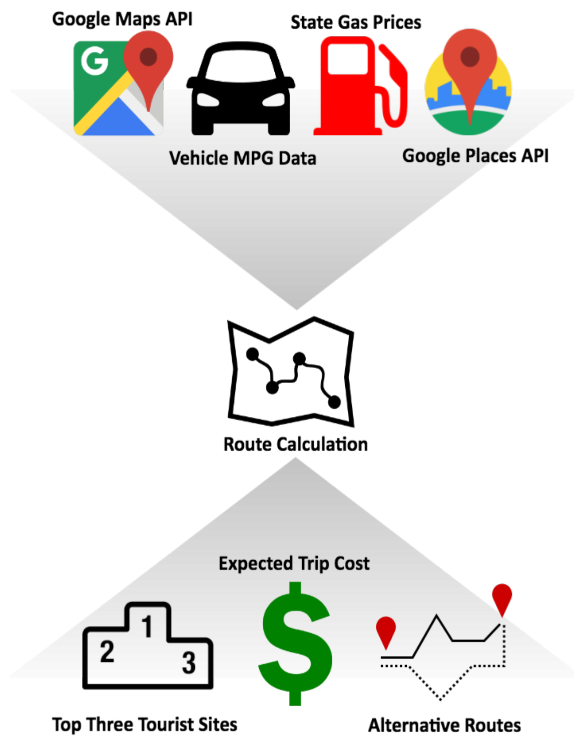

Figure 1: Intripid Framework Overview. Intripid combines resources from Google's APIs and vehicle and gas information to calculate the optimal route, outputting the top three sites, expected trip cost, and alternative route suggestions.

3 METHOD

Intripid is better than the state of the art since it recommends routes based on time, cost, and predicted enjoyment. No other routing software explicitly combines these categories into a single user interface for the entire US.

The Google Maps API calculates the shortest path between the starting point, a variable number of waypoints, and the ending destination by optimizing a minimum cost network flow problem. Additionally, Intripid provides the option to specify mandatory and optional waypoints, so the user can receive tailored routes that are within a given cost and time restriction.

Intripid recommends sites by drawing boxes along the route with a pre-defined radius specified by the user, a default value of 8 miles. For each box, we query the Google Places API to find sites that have at least 3/5 stars, at least one review, at least one photo, and that correspond to the user's preferred site types. Due to Google Places API only returning a maximum of five reviews and ten photos, we had to tune the recommendation algorithm to account for this limitation. These sites are then plotted on the map. The expected enjoyment score is calculated by summing 70% times the rating, 15% times the number of reviews, and 15% times the number of photos. This is based on the notion that more popular places will have more photos and reviews, but the majority of the score should be based on rating. It also gave a smaller weight to photos and reviews since most popular places will have the maximum number of photos and reviews. The score is then standardized based on a theoretical maximum each site recorded be a "perfect" site, having a five star rating, all five reviews, and ten photos. The enjoyment score calculation was tailored with extensive user studies and allows for a quantitative comparison between routes that goes beyond the distance and time of a route.

An important aspect of Intripid is that it allows users to see an estimate of the cost of gasoline for their desired road trip. Users are able to input the make, model, and year of their car and intripid will query a dataset gathered from the EPA to return the estimated highway MPG of the user's car. Alternatively, a user can input their own estimate for MPG if our data does not contain their specific vehicle. An additional dataset hosted within intripid contains the average price of gas within each of the 50 states. The car gas mileage, distance of the trip, and the state gas price dataset are then utilized to calculate and estimated cost for the trip as follows. Each of the "boxes" produced by the route mapping algorithm is reverse geocoded to return the state the box is located in. The amount of "boxes" within each state is then used as the weight to calculate an expected gas cost for the trip. Initially, the gas price algorithm hoped to consider Other gas price algorithms were investigated, but were not plausible due to hardware limits and/or a lack of data.

Intripid's minimalist UI provides users with an intuitive way to get quick results. A user begins by visiting the website and immediately sees everything they need for the rest of their time using Intripid. The UI has a primary map of the US on the left along with user-input data on the right. After the user inputs their preferences, Intripid calculates an ideal trip and display the route, along with stops, on the primary map on the left. This allows the user to visualize their trip and get the most relevant facts about it. Intripid also provides a mini-map located on the bottom of the screen that displays other similar trips that the user may be interested in taking. Clicking a map expands it to the larger map, providing users with a simple way to start planning a road trip.

Intripid's main innovations are outlined below:

(1) No other trip optimizer combines the visualization of a trip with gas expenditure as a constraint.
(2) Intripid makes it incredibly easy to see alternate routes and information about a user's roadtrip.
(3) Rather than just providing suggestions for activities at each location, Intripid provides the user with relevant stops along the drive to each location.
(4) Unlike other routing algorithms, Intripid is efficient and scalable to the entire US.
(5) Intripid breaks the route up into small boxes for site querying, effectively bypassing the Google Places API 20 site per query limit.

4 EXPERIMENTS AND EVALUATION

We implemented two experiments to assess algorithm validity and user interface utility. In the first experiment, users familiar with popular road trip areas rated the accuracy of the algorithm output. These areas were California, the southeast, Texas, and New England. For each region, we selected a pre-defined route, and users answered the following questions:

(1) Rate the potential enjoyment of this route, where 10 is extremely enjoyable.
(2) Is this route an efficient use of your time? Or would you rather see more/less sites?
(3) Are any notable tourist sites missing?
(4) Is cost a significant factor in planning a road trip? Would you rather take a shorter, but cheaper route?

These tests occurred over the week of April 9th with 22 participants. Using results from this experiment, we calculated the theoretical maximum value of one site every ten miles. Although this value varied, it performed best with longer road trips. Due to the overwhelming amount of supported location types with the Google Places API, we limited the available list to choose from to keep in line with a minimalistic UI. Missing tourist sites were addressed through the use of numerous queries along the route, bypassing the 20 site per query limit. Since many participants noted that cost was a significant factor, we implemented a feature that removes optional destinations to keep within a user-defined cost limit.

In the second experiment, over 15 users tested the UI and answered the following questions:

(1) Please enter details of your trip.
(2) Which enter button do you want to click on first?
(3) Tell me about the route. Can you easily determine stops and sites?
(4) Drag and zoom in on the map to navigate the surrounding area.
(5) What is the cost of the trip? Is it clear what the cost refers to?
(6) Learn more about the sites by launching external websites. Which launch button is more intuitive? Are these websites useful?
(7) Is the secondary route suggestion helpful?

Using feedback from this experiment, we selected the optimal button and trip detail box layout. We changed the marker icon to keep the UI simple, created a clearer cost icon, and provided a simple information box about the top three sites. Many users preferred having the secondary suggestion route. In conjunction with the numerous users who reported cost being an important factor, we implemented alternative routes that removed select optional waypoints but significantly lowered the cost of the trip.

5 CONCLUSION

Our approach makes large improvements on common routing algorithms and tourist recommendation systems. Due to the large number of people around the US that take road trips, there is a vast need for a simplified route recommendation system. In this paper, we provide the framework and evaluation of Intripid. This software improves upon the limited, complex routing software currently available. It is fast, scalable to the entire US, and provides access to the petabytes of data available with Google APIs.

Intripid makes use of the Google Maps API for route calculation and the Google Places API for querying sites along the route. An expected enjoyment score is determined using a combination of site ratings, number of photos posted at a site, and a experiment-defined maximum number of sites per mile for a typical route. Additionally, using miles per gallon information for over 30,000 types of vehicles and average state gas prices, the anticipated route cost is efficiently calculated.

In developing Intripid, all team members have contributed similar amount of effort. For future work, the use of paid resources could provide a more comprehensive routing software could be created. With Google's Premium Plan APIs, more map loads and more location search queries would be available per day. Future work should incorporate scenic routing using the free Flickr API. Additionally, travel based APIs could be used to provide a wider range of travel resources such as flight and hotel data. While the Yelp API does not support client-side calls, the 7GB Yelp dataset could support extensive research into efficient tourist site recommendations for specific cities in the US.

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