THE GEORGE WASHINGTON UNIVERSITY

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Data Science Program

Capstone Project Proposal - Spring 2026

Energy-Based Trip Planner
Adaptive Itinerary Optimization with Mid-Trip Replanning

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1. Introduction

The growing use of intelligent digital systems for travel itinerary generation has reshaped how travelers plan and experience destinations, with most systems optimizing attraction coverage, routing, and scheduling through data-driven personalization. However, these planners typically assume constant traveler energy, overlooking physiological and cognitive fluctuations caused by factors such as walking distance, weather, sleep quality, jet lag, and individual pacing preferences. Tourism research shows that such energy variations strongly influence itinerary adherence and overall satisfaction, often rendering computationally optimal plans unrealistic in practice. While prior work has explored route optimization, context-aware guidance, and personalized recommendation systems, explicit modeling of human energy dynamics remains largely unaddressed, with existing energy-constrained approaches focusing primarily on environmental sustainability. This gap motivates the need for an energy-aware travel planning framework that models traveler fatigue, supports adaptive replanning, and learns individual energy patterns to enable more realistic and user-centric itineraries.

2. Problem Statement

Today travelers increasingly rely on digital tools to generate day-by-day itineraries for new cities and destinations. Most existing travel itinerary planners optimize for coverage (the number of places visited) and logistical efficiency (time windows, distances, clustering), but they treat the traveler as if their energy were constant throughout the day. In reality, human energy fluctuates due to walking load, weather, jet lag, sleep quality, and personal preferences about when to be active or relaxed. As a result, many itineraries that look optimal on paper become unrealistic in practice: travelers get tired mid-day, slow down, skip planned stops, or abandon the schedule entirely. There is a clear need for itinerary planning systems that explicitly model and adapt to human energy constraints to produce plans that are realistic, sustainable, and responsive to travelers' physical and cognitive states.

3. Literature Survey

Existing research in travel behavior and tourism emphasizes that fatigue, jet lag, and energy management significantly influence how travelers adhere to itineraries and enjoy their trips. While systems such as the Automatic Travel Itinerary Planning System (ATIPS) and related studies effectively optimize routes based on time, distance, and preferences, they seldom consider dynamic human energy as a core parameter. Context-aware and electronic tourist guide systems demonstrate real-time adaptability using location and time data but primarily emphasize efficiency rather than fatigue or pacing. Some energy-constrained optimization models address sustainable travel, yet their focus lies on environmental rather than human

energy. Recent AI-driven itinerary planners illustrate the potential for personalization and adaptive scheduling but retain the assumption of constant traveler effort. Overall, the literature reveals a distinct gap for systems that integrate human energy fluctuations, support fatigue-driven replanning, and learn individual pacing patterns to enhance travel realism and comfort

4. Objective

Design and develop an energy-aware travel planning system that generates realistic, adaptable itineraries by explicitly modeling traveler fatigue, incorporating user-defined pacing preferences, and enabling real-time replanning based on energy depletion signals.

5. Key Features (MVP)

1. Energy-constrained scheduling - Limits walking distance and activity density per time block; automatically inserts rest stops based on configurable energy budgets and user-selected pacing templates (slow mornings, active afternoons, relaxed evenings)
2. Adaptive replanning - One-tap "I'm tired" signal triggers intelligent itinerary adjustment: drops low-priority distant attractions, inserts nearby low-effort alternatives, and re-optimizes remaining schedule
3. Pattern learning - Tracks fatigue signals and activity metrics to learn individual thresholds (e.g., typical exhaustion point after 6,000 steps or 3 hours) and proactively adjusts default energy budgets

5. Target Users

- Tourists with limited time who want comfort-first travel
- Aging travelers including Senior citizens
- People with mobility constraints or low walking tolerance
- Travelers who want flexible itineraries rather than rigid plans

6. Data Requirements

6.1 Type of Data

For this AI-powered travel itinerary app, we'll need three types of data:

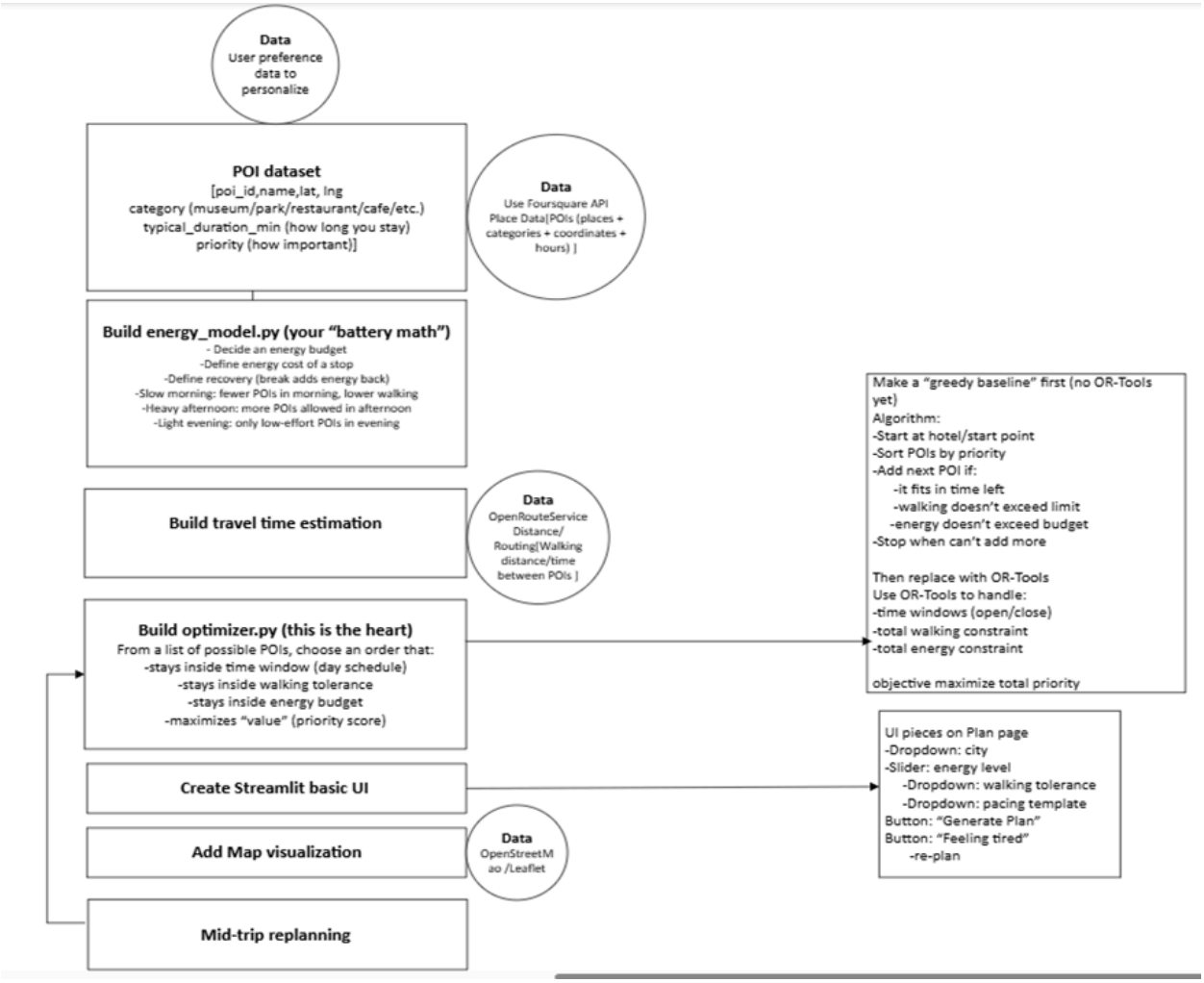
1.User preference data to personalize recommendations and learn from user behavior during trips.
2. Points of Interest (POI) data including attractions, restaurants, parks, and museums with their locations, categories, ratings, and opening hours.

3.Distance and routing data to calculate travel times between locations and optimize itinerary flow.

6.2 Source of Data

1. User preference data will be collected directly through your app's quiz interface or will generate synthetic data.
2. Foursquare Places API provides comprehensive venue data with ratings, categories, and tips - this will be our primary source for places to visit.
3. OpenRouteService API will be used for distance calculations and routing to compute travel times between locations.
4. OpenStreetMap via Overpass API offers completely free geographic data and POIs as a backup/supplement.

7. System Workflow Diagram



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