Hamza Hassan w2044381 - Applied AI 2025_6COSC020W_CW

AI Drone Route Planning Nepal

Project Overview and Data Definition

This project focuses on the application of classical artificial intelligence search techniques to the problem of autonomous drone route planning in the mountainous terrain of Nepal. The primary objective set out is to explore how different search algorithms behave when applied to a geographically constrained navigation problem, and to evaluate their suitability for real-world drone deployment scenarios.

Rather than relying on a large external dataset, I've chosen a system that uses a predefined, manually constructed data model. This design choice was deliberate. The aim of the project is to analyse algorithmic behaviour, decision-making, and route optimisation, rather than to perform data-driven prediction or statistical learning.

The data in my project therefore consists of three core components:

1. A weighted graph representing key locations in the Nepal Himalayan region. Each node corresponds to a geographical waypoint, and each edge represents a feasible drone flight path weighted by estimated distance in kilometres.
2. A heuristic distance dictionary is defined to support informed search; however, in the final prototype the heuristic is set to zero to guarantee optimal shortest-path behaviour (Uniform Cost Search).
3. A coordinate mapping used solely for visualisation, allowing computed routes to be plotted on a simplified two-dimensional representation of the region.

All data structures are embedded directly within the Jupyter notebook. No external files or third-party datasets are required to run or reproduce the system. This approach ensures full transparency, reproducibility, and control over the experimental environment.

Because the data is manually defined and validated, no automated preprocessing or cleaning is required. Basic consistency checks ensure that all nodes have valid neighbour mappings and that heuristic values are available for all explored states. This lightweight data handling is appropriate given the scale of the prototype and the focus on algorithmic evaluation rather than data ingestion.

This design mirrors many real-world navigation systems, where planners operate over internally maintained maps and cost models rather than raw datasets. It also allows direct comparison of Breadth-First Search (BFS), Depth-First Search (DFS), and A* under identical conditions, making observed differences in behaviour attributable to the algorithms themselves rather than variations in data quality.

This controlled setup ensures that observed differences in performance arise from the algorithms themselves rather than variability in data quality or scale.

Generative AI tools were used in a limited and supportive capacity during this coursework, primarily to assist with idea clarification, structural planning, and proofreading. All technical decisions, code implementation, analysis, and written content were independently produced.

(Please find the screenshots of these core components & System Diagram below)

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Weighted Graph Dictionary

C3. Graph Structure

The following dictionary models the Himalayan region as a weighted graph. Edges represent estimated drone flight distances in kilometres.

```python
# Weighted graph used for BFS, DFS and A* of the Nepal regions: each key is a location and its neighbours are reachable points
# with estimated drone flight distances (in km). This acts as the search space for BFS, DFS, and A*.
HimalayanNepalRegion = {
    'Lukla': {'Namche Bazaar': 13, 'Muktinath': 34},
    'Namche Bazaar': {'Dolpa': 120, 'Manang': 78, 'Gokyo Valley': 11},
    'Jomsom': {'Lukla': 21, 'Langtang Valley': 33, 'Muktinath': 13, 'Dolpa': 11},
    'Gokyo Valley': {'Muktinath': 41, 'Namche Bazaar': 11, 'Manang': 10, 'Langtang Valley': 29},
    'Manang': {'Gokyo Valley': 10, 'Dolpa': 56, 'Namche Bazaar': 78, 'Thorong La Pass' : 15},
    'Muktinath': {'Lukla': 34, 'Jomsom': 13, 'Gokyo Valley': 41},
    'Langtang Valley': {'Gokyo Valley': 29, 'Jomsom': 33},
    'Dolpa': {'Jomsom': 11, 'Manang': 56, 'Namche Bazaar': 120},
    'Thorong La Pass': {'Manang': 15, 'Muktinath': 19, 'Dolpa': 12}

}
```

Heuristic Distance Dictionary (km)

C4. Heuristic Function (A*)

A zero-valued heuristic was used to ensure admissibility, causing A* to behave as Uniform Cost Search while preserving the same algorithmic structure.

```python
# Heuristic values set to 0 for all nodes.
# This is trivially admissible and makes A* behave like Uniform Cost Search,
# guaranteeing the shortest path by total distance on the weighted graph.
estdronedistanceKM = {
    'Lukla': 0, 'Namche Bazaar': 0, 'Jomsom': 0, 'Gokyo Valley': 0,
    'Manang': 0, 'Muktinath': 0, 'Langtang Valley': 0, 'Dolpa': 0, 'Thorong La Pass': 0
}
```

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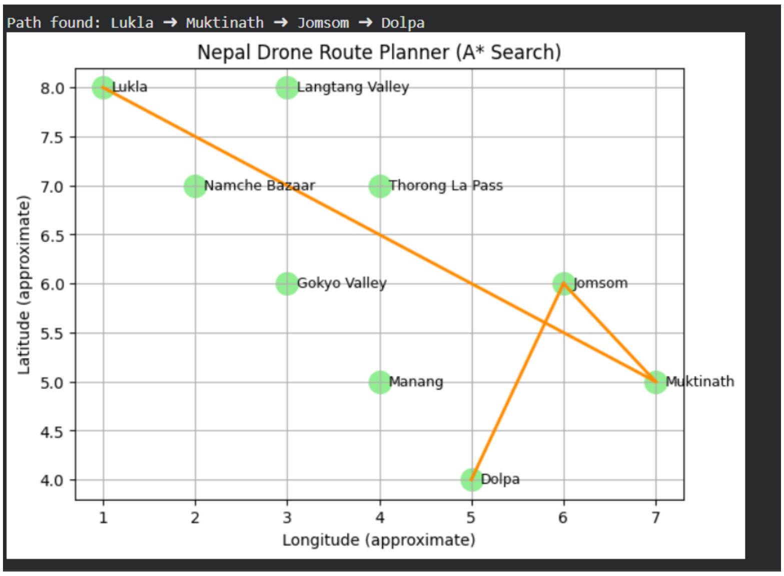
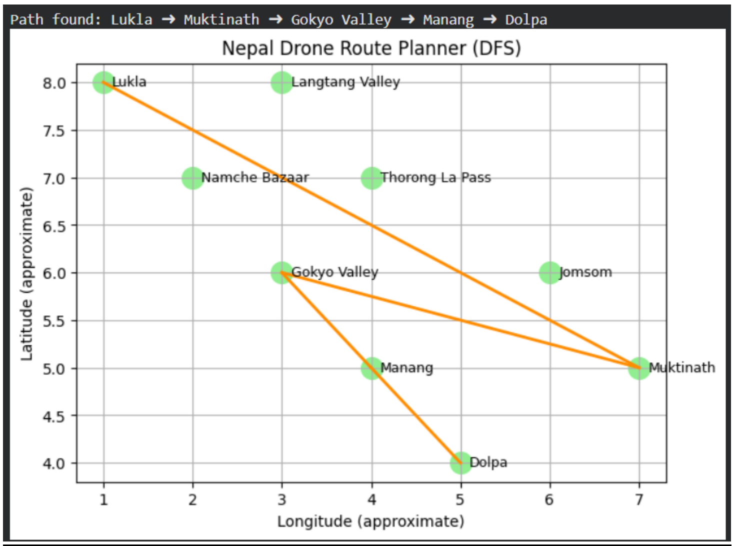
Visualisation Route Mapping





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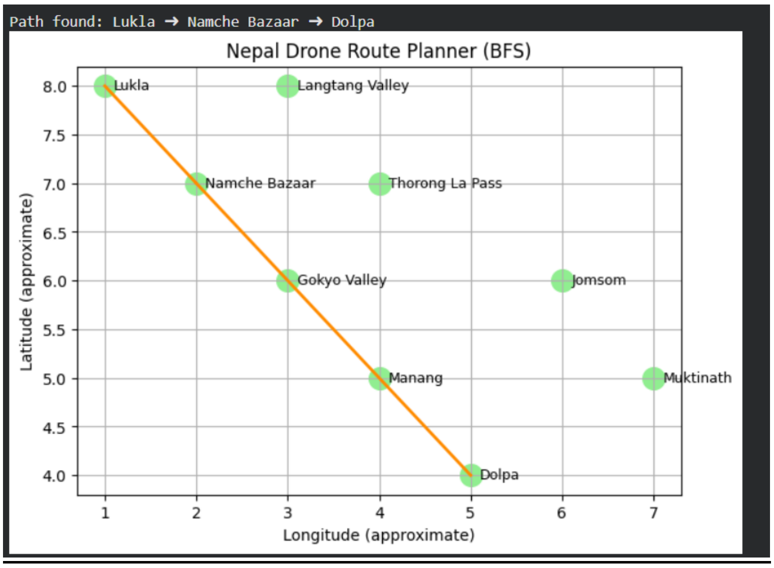

System Architecture Diagram

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