

**Artificial Intelligence (AL-2002)**  
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**Final Project Report**

**“Optimized Pathfinding: Karachi Market Explorer & A\*  
Maze Escape”**

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## **Introduction**

This project demonstrates the application of Artificial Intelligence (AI) algorithms to solve two distinct but related problems “Urban path finding in complex environments”, and

“Interactive maze solving using informed search”.

Developed using Python and Streamlit, the system provides an interactive interface where users can experience the power of AI-driven decision-making in both real-world (Karachi traffic navigation) and abstract puzzle-based (Escape Room) environments.

## **Objectives**

Apply A\* and CSP algorithms to real-world and simulated search problems

Visualize how AI finds optimal solutions under different types of constraints

Create a clean, intuitive, and responsive user interface using Streamlit

Offer comparative insight into multiple AI techniques in pathfinding

## **The Karachi Market Path**

Karachi, Pakistan’s largest city and economic hub, presents a unique challenge for navigation due to its dense network of roads, markets, and congested alleyways. The **Karachi Market Path Finder** addresses this challenge by implementing AI-based algorithms to determine optimal routes between markets. The system models the city as a **graph**, where:

- **Nodes** represent markets
- **Edges** represent roads
- **Weights** reflect distances, accessibility, and traffic conditions

By leveraging **A\*** and **Constraint Satisfaction Problem (CSP)** algorithms, the system ensures not only shortest-path calculations but also constraint-based decision-making such as avoiding closed or restricted roads.

## **A\* Algorithm vs. CSP (Comparative Analysis):**

Both algorithms contribute distinct strengths depending on the scenario:

### **A\* Algorithm:**

#### Strengths:

1. Combines path cost and heuristic estimate to efficiently find optimal paths.
2. Prioritizes exploration of the most promising routes
3. Well-suited for dynamic environments with changing conditions

### Applications:

1. Ideal for scenarios prioritizing **minimum travel time or distance**
2. Performs well when **real-time traffic** and **road closures** are factored in
3. Used effectively in the Karachi simulation for quick and adaptive routing

### **Constraint Satisfaction Problem (CSP):**

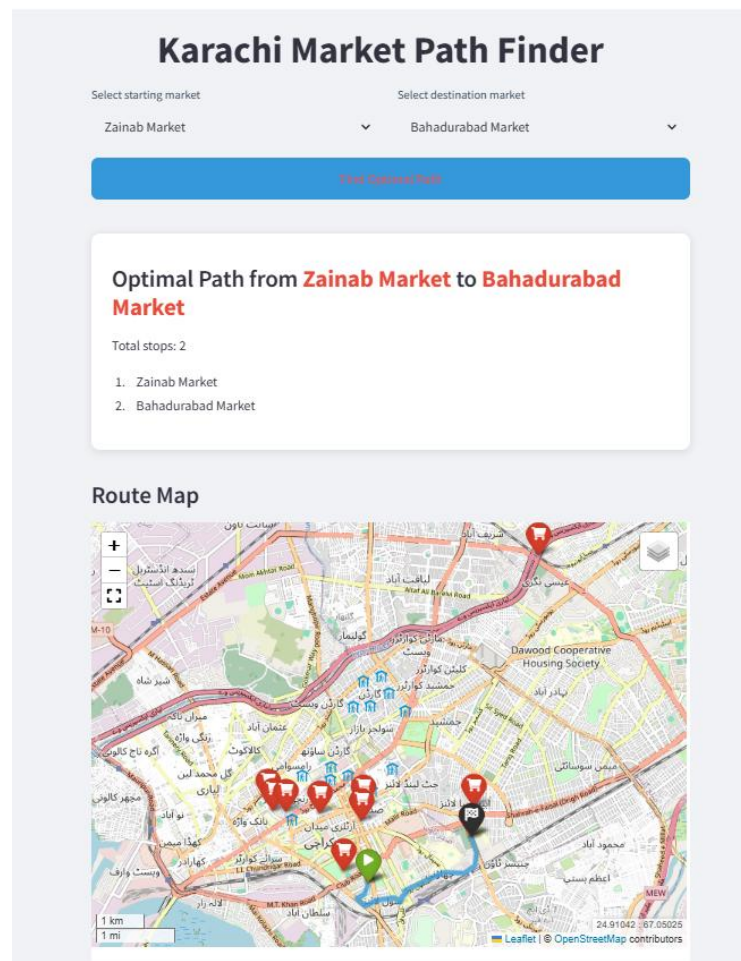
#### Strengths:

1. Combines path cost and heuristic estimate to efficiently find optimal paths.
2. Prioritizes exploration of the most promising routes
3. Well-suited for dynamic environments with changing conditions

#### Applications:

1. Useful where **safety, regulations, or accessibility** matter more than speed
2. Ideal for scenarios involving **construction zones, vehicle-specific restrictions, or local rules**

### **Graphical Interface Demonstration**



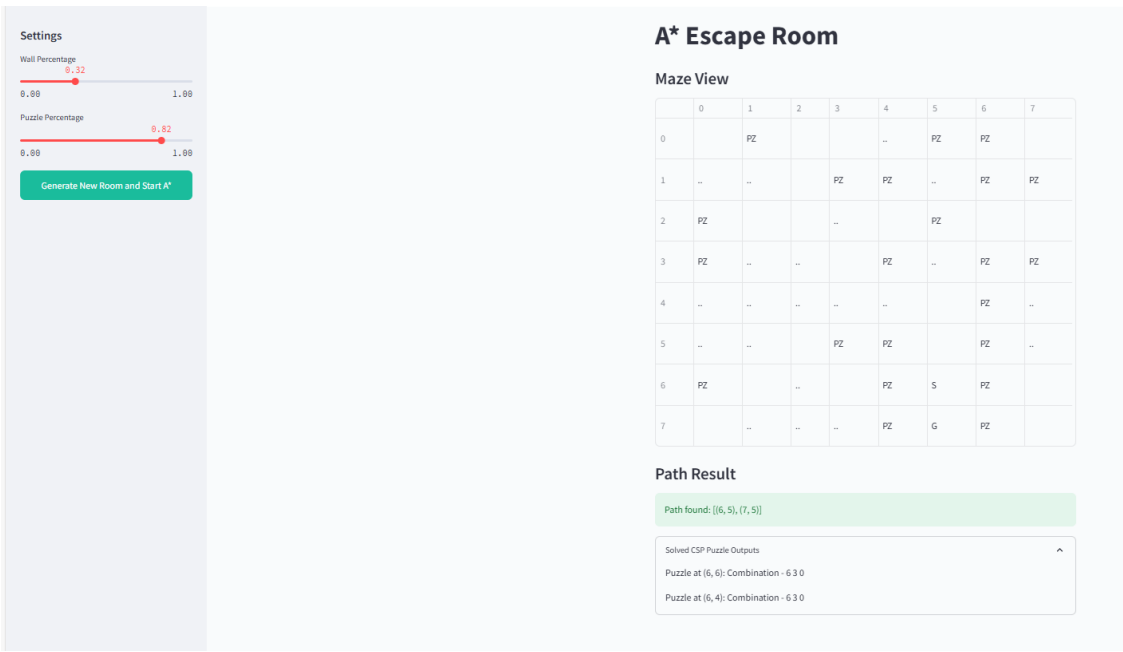
# A\* Escape Room Challenge

The **A\* Escape Room Challenge** is a gamified module that demonstrates the effectiveness of AI in puzzle solving. Players must escape a maze-like environment filled with locked doors and obstacles. The system applies the **A\*** algorithm to dynamically calculate the shortest escape route based on:

- Start and goal positions
- Obstacles or puzzles as barriers
- Movement cost and heuristic distance

This setup simulates a real-world search problem in a controlled environment, allowing users to visualize how A\* makes decisions step-by-step. The algorithm ensures the chosen path is both **optimal** and **efficient**, reinforcing core AI search concepts in an engaging format.

## Graphical Interface Demonstration



## **Conclusion**

The Karachi Market Path Finder and A\* Escape Room Challenge collectively showcase how AI algorithms can be applied to both real-world and virtual problem-solving.

- A\* excels in fast, dynamic navigation, particularly where real-time adaptation is needed. Its application in Karachi's complex road network proves its scalability and effectiveness.
- CSP is better suited for constraint-heavy tasks, ensuring safe and rule-compliant routing. It enhances decision-making in scenarios where avoiding prohibited paths is critical.
- The Escape Room module provides an intuitive understanding of how AI computes solutions in maze-like puzzles.

These implementations highlight the growing importance of AI-driven path optimization in urban mobility, smart systems, and interactive game environments. As urban infrastructure becomes increasingly complex, such intelligent systems will be essential in shaping the future of navigation and decision automation.