



# Interactive Urban Navigation System for Icherisheher

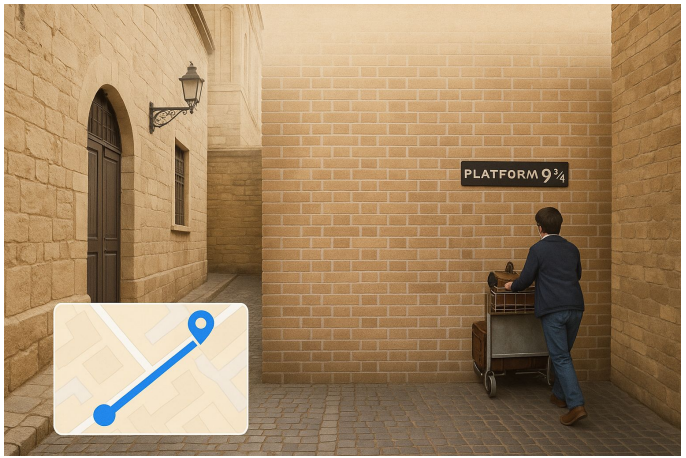
Advisor: Stephen Kaisler

Students: Huru Algayeva,Abbas Aliyev

April 2025

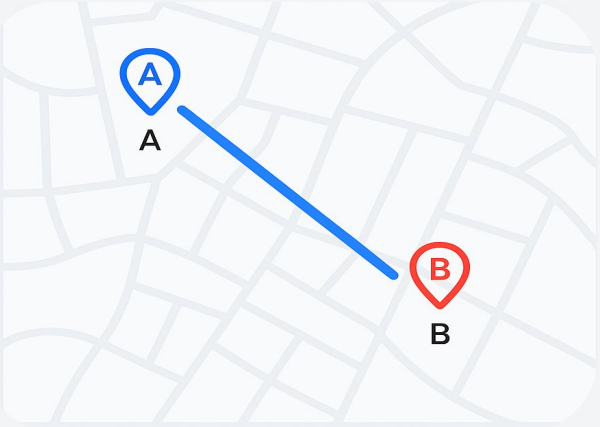
# What If Google Maps Led You ***Straight Into a Wall***?

| | | |
|---|---|---|
| 01 | **Irregular geometry** | • Streets don’t follow modern grid. |
| 02 | **Incomplete labeling** | • Many paths aren’t even recognized by mapping tools. |
| 03 | **Conflicting digital data** | • APIs provide partial or mismatched coverage. |
| 04 | **Physical constraints** | • Narrow alleys, staircases, and stone barriers disrupt routing logic. |



# Beyond Simple Navigation: The Challenge of Historical Districts

## Conventional Navigation



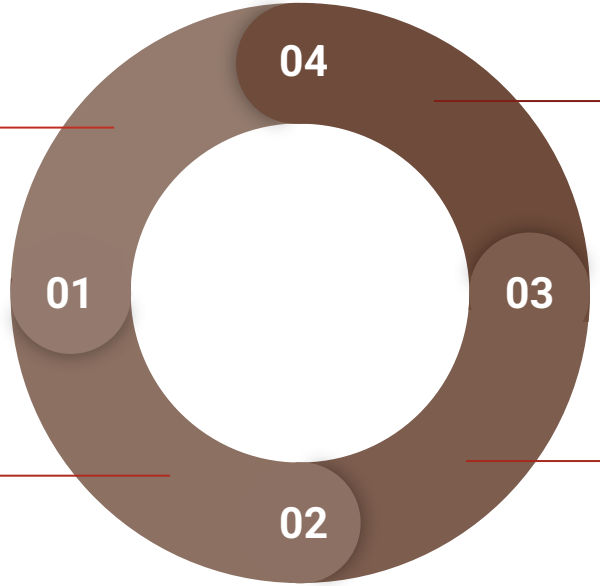

- ✕ Ignores cultural significance
- ✕ Treats all paths equally
- ✕ Lacks historical context

## Icherisheher Reality

- ✓ Narrow, winding lanes
- ✓ Rich historical landmarks
- ✓ Cultural significance varies by path

# Research Questions

How can we design a **navigation system** that accurately interprets historica urban layouts like Icherisheher?


How can **routing algorithms** be designed and integrated to account for **not only distance and time, but also historical and cultural** context?


What are the **limitations of existing maps** in handling culturally and spatially complex environments?

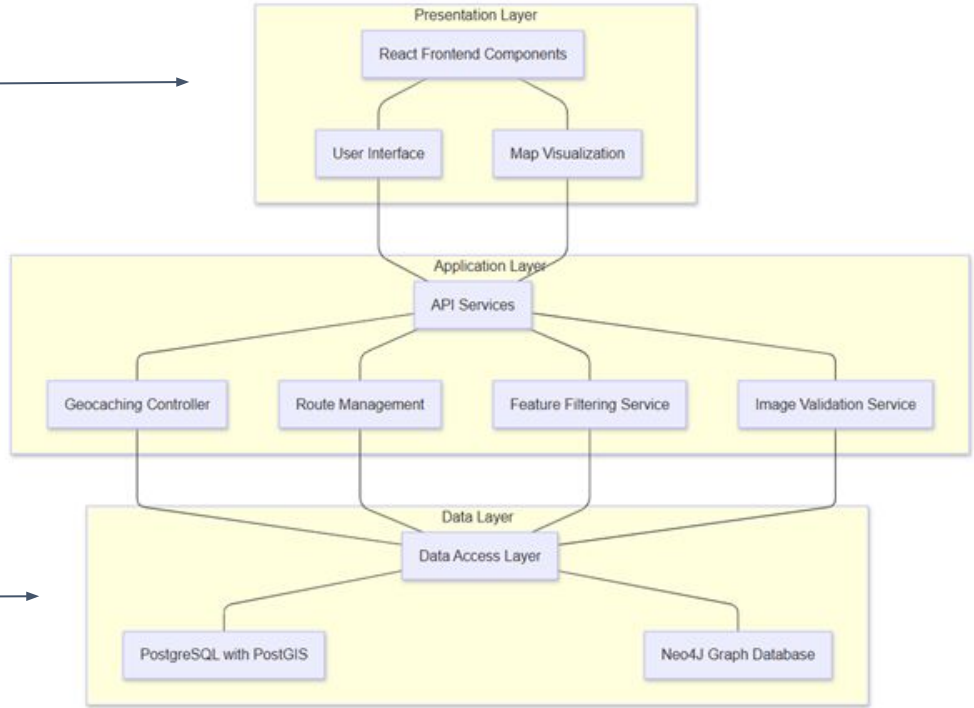
Can computer vision be used effectively to **validate user geocaches** through image?

# High Level Architecture

**Web-based interface** for user interaction and map display.

Modular services for **routing, filtering, image validation, and geocaching**.

Dual-database logic — relational (PostgreSQL + PostGIS) for **geocaching and filtering** and graph-based (Neo4j) for **route relationships.**



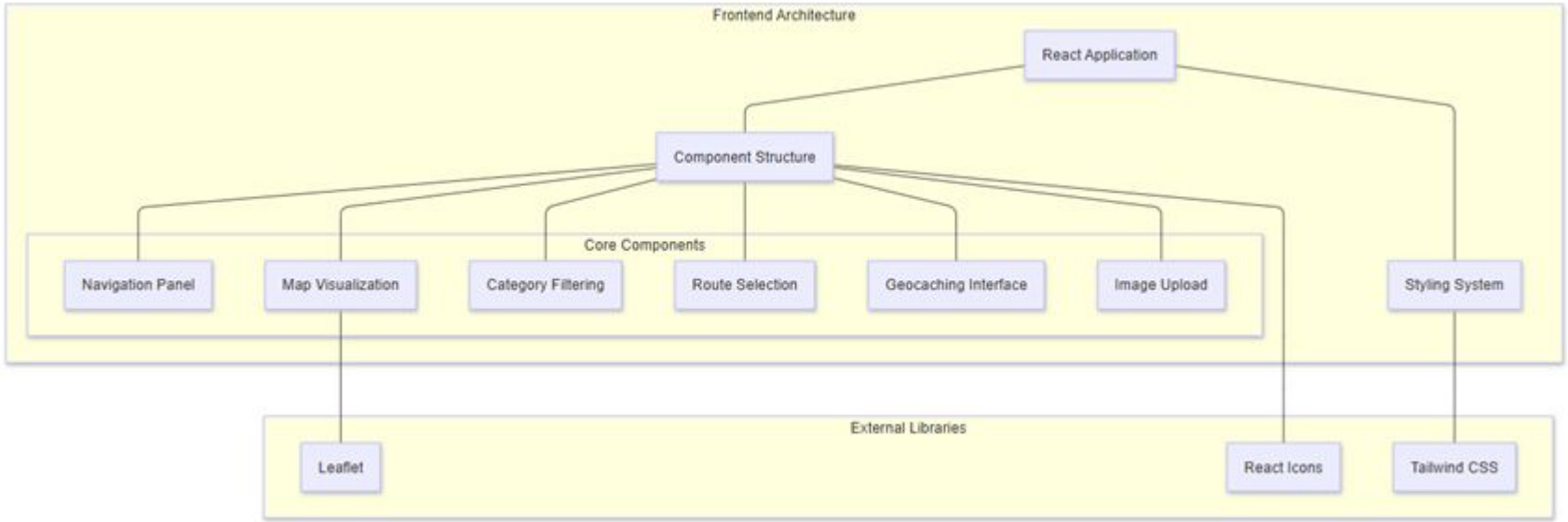
# Frontend Architecture

🧱 **React-based frontend** with reusable components

🗺️ **Leaflet** used for map rendering and route overlays

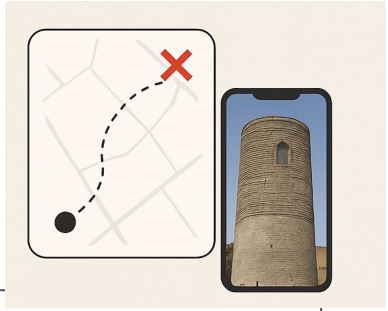
📸 Interfaces for **route selection, feature filtering,geocaching, and image upload**

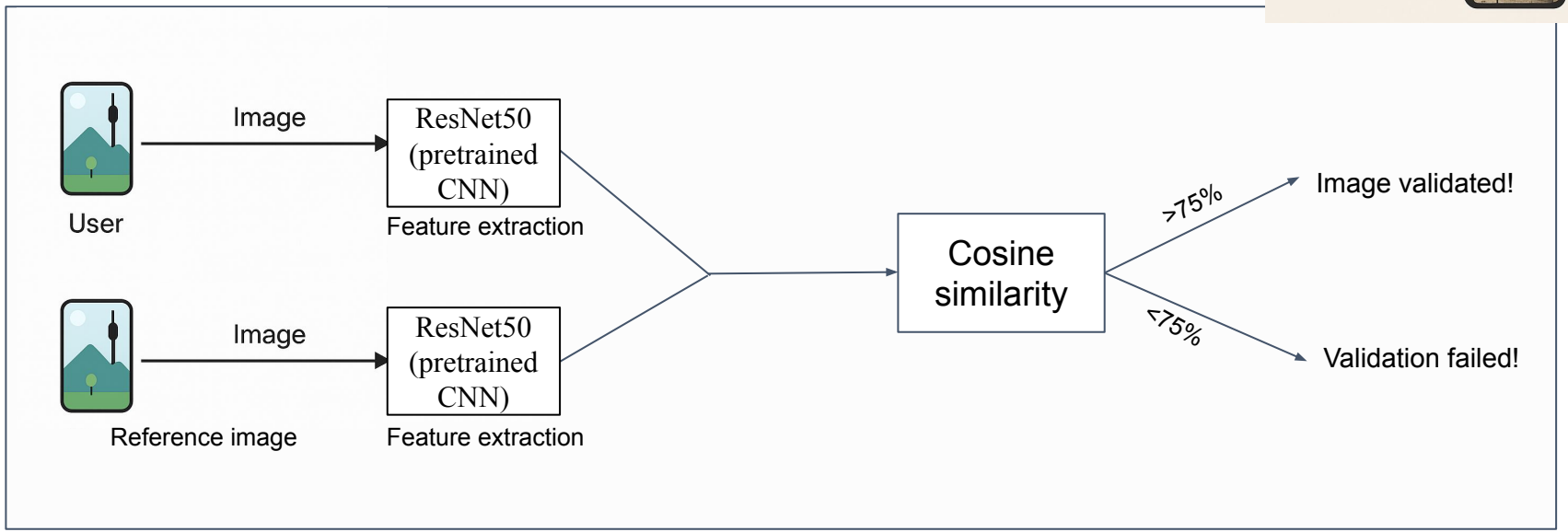
🎨 **Tailwind CSS and React Icons** provide fast styling and visual clarity



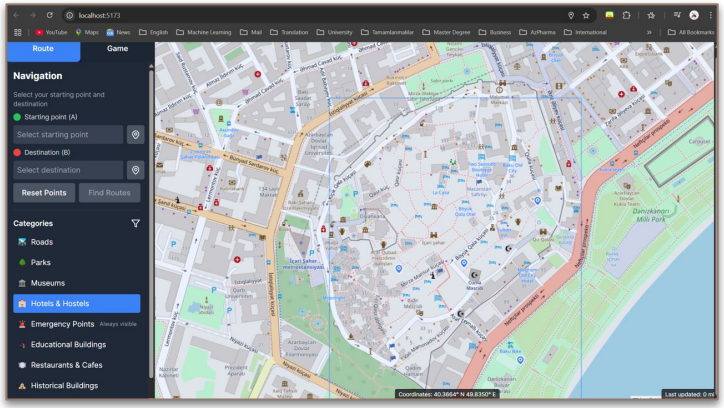
# Geocaching Architecture & Image Validation Flow

**Geocaching** is like a GPS-based *treasure hunt*.
You find hidden spots using clues and maps.
In our system, users take a photo to prove they found it.

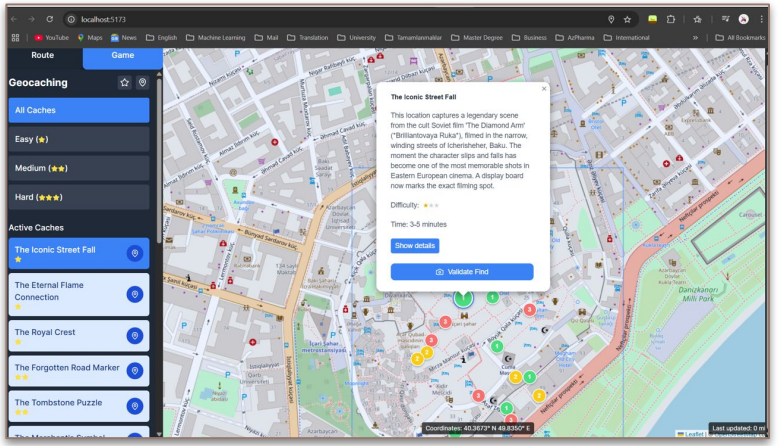




# User Interface Overview: *Where It All Begins*

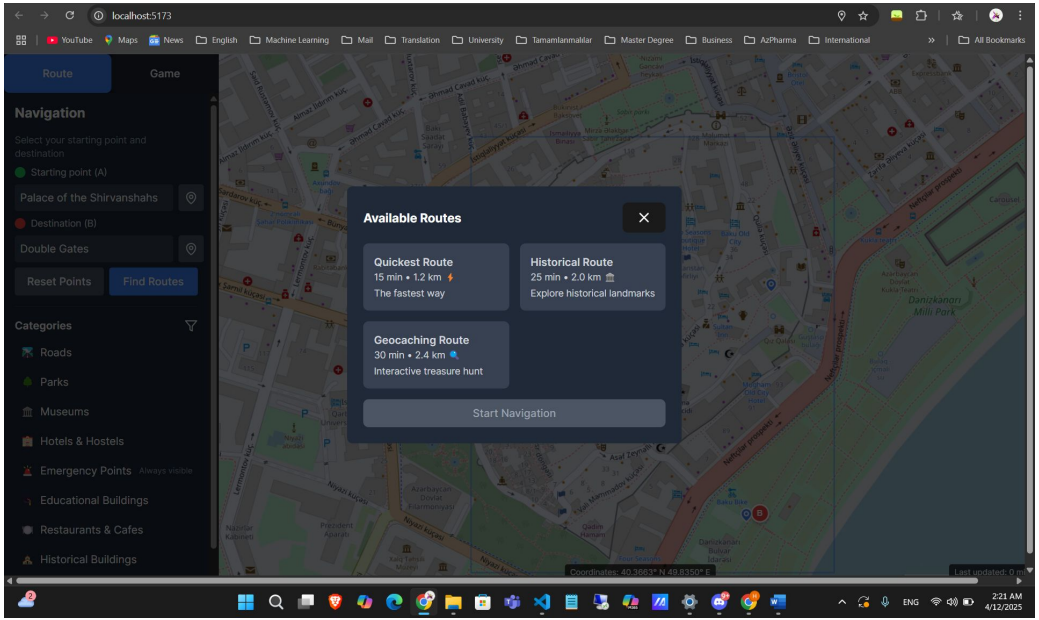



- Choose **start and end points**
- Filter by **location** type (e.g. hotels, parks)
- View optimized **routes**
- Built with **React + Leaflet**, powered by Neo4j and PostgreSQL




- Select **caches by difficulty** (⭐ to ⭐⭐⭐)
- View **cultural info + time to complete**
- **“Validate Find”** with image upload
- Makes urban exploration **fun and interactive**

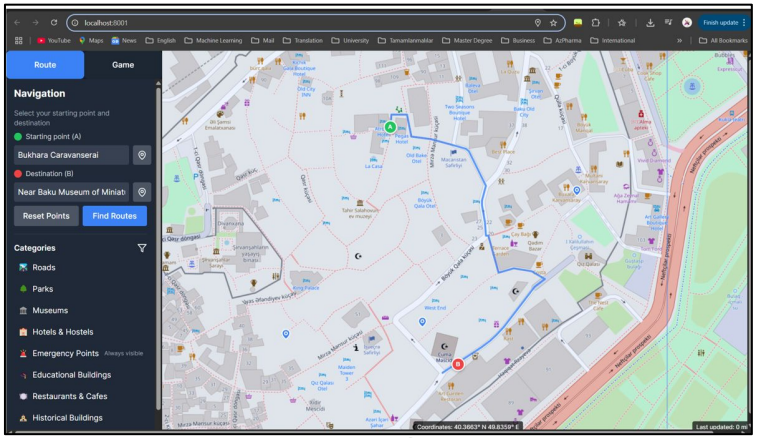
# Route Selection & Pathfinding Results



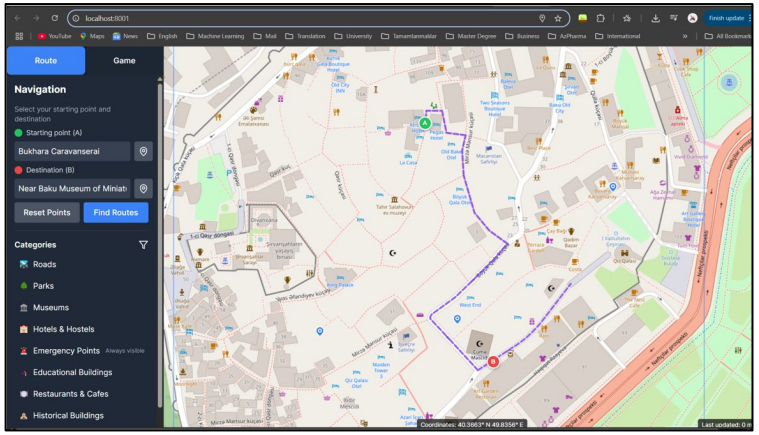

User selects from three modes:

- ➔ **Quickest 🚶 — Fastest route**
- ➔ **Historical 🏛️ — Prioritizes cultural landmarks**
- ➔ **Geocaching 🧭 — Includes hidden cache locations**

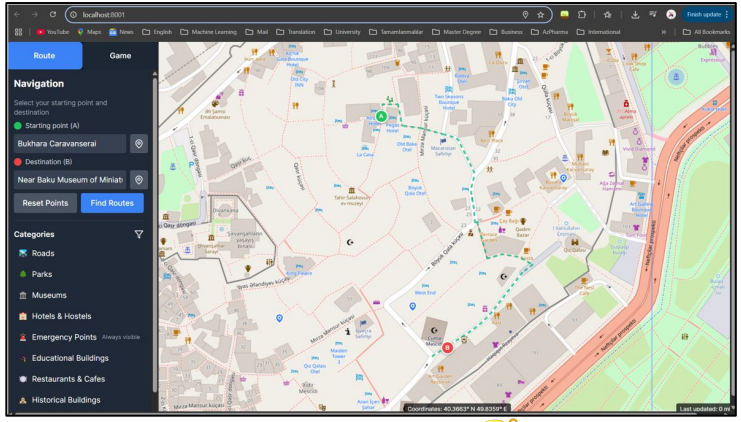
# Pathfinding Results




Quickest 🏃

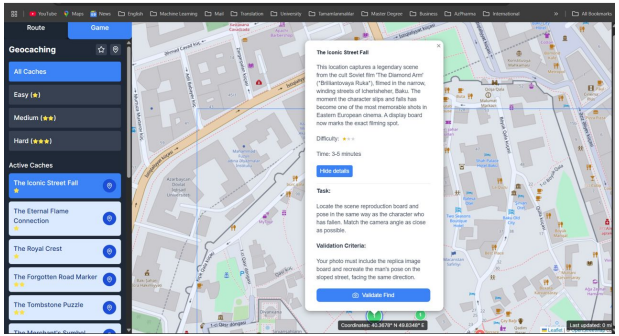



Historical 🏛️

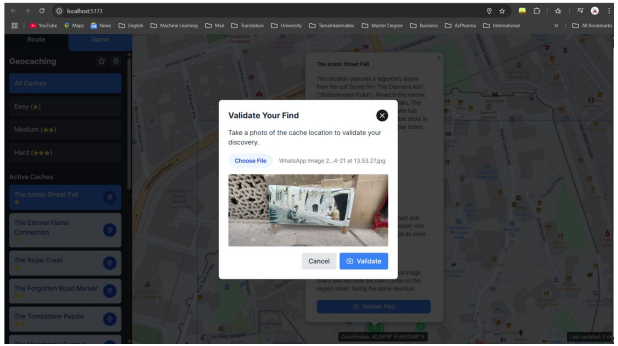



Geocaching 🧭

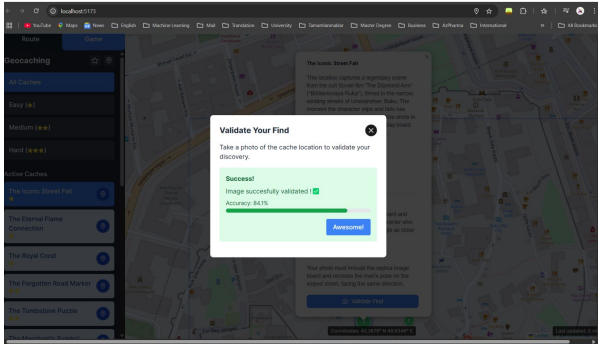
# Image Validation in Action




**Step 1: Read the Challenge**
User receives geocache details including story, difficulty, task, and validation rules.




**Step 2: Upload a Photo**
User uploads an image replicating the scene described in the challenge.




**Step 3: Get Validated**
✔️ Image validated successfully with **84.1% accuracy**.

*Note: All reference photos were collected and validated by us on-site.*

# Conclusion

*From Confusion to Connection in Icherisheher*

- ➔ **A complete navigation system** made for complex historic cities
- ➔ Integrated **route planning, cultural geocaching, and image validation**
- ➔ Built using **React**, **Leaflet**, **Neo4j**, **PostgreSQL**, and **ResNet50**

## ◆ What We Made

- ➔ Makes heritage exploration **interactive**, not passive
- ➔ Helps both tourists and locals engage meaningfully with the city
- ➔ Encourages cultural learning through **gamified discovery**

## ◆ Why It Matters

- ➔ Dual-database setup: **PostgreSQL + Neo4j**
- ➔ Real-world **geocache validation using computer vision**
- ➔ Modular and scalable — adaptable to any cultural city

## ◆ Why It’s Better and Different

# Future Work & Next Steps

## Expansion

- **Offline mode** for low-connectivity areas
- **Augmented Reality** overlays
- Global deployment to **other heritage cities**

## User-Centered

- Larger, **diverse user** testing
- **Adaptive difficulty** in geocaching

## Image Validation

- Exploring different deep learning architectures
- Testing alternative feature extractors

# Thank you for navigating Icherisheher with us!