HydeGraph - Cultural Network Recommenders for Hyderabad

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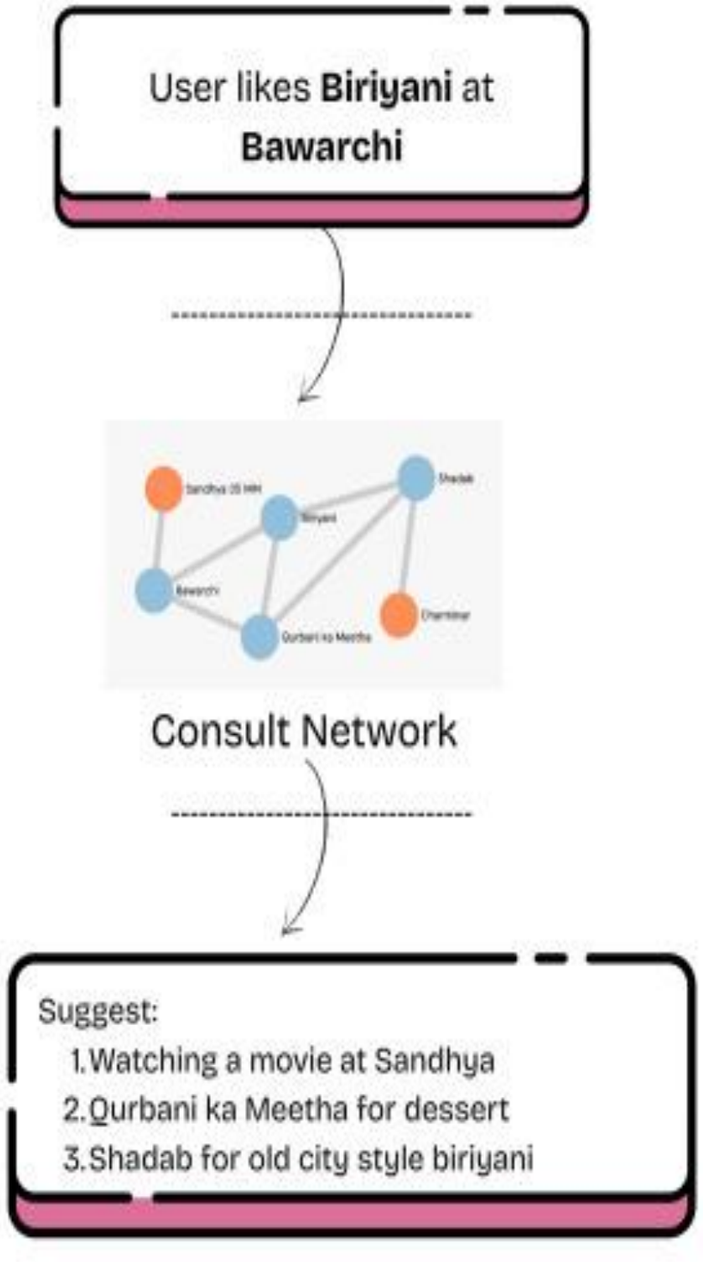


Motivation & Objectives

The Goal

The goal of this project is to develop a **graph-based recommender system** that captures and highlights the rich cultural landscape of Hyderabad, including its monuments, heritage sites, and iconic food traditions. The system aims to provide meaningful, culturally grounded connections between these entities through a structured network representation.

Our Solution

We built a system with three key components:

Word-Occurrence Network: Scraped web text to build a co-occurrence graph linking cultural entities.

Entity Mapping: Converted free-form user text into recognized cultural entities.

Recommendation Engine: Used graph relationships to provide direct, exploratory, and guided recommendations.

System Overview

Our end-to-end pipeline transforms user queries into rich, visual recommendations through five integrated steps.

1

Free-Text Input

User enters natural language query

2

Named Entity Recognition

spaCy with fallback matching

3

Entity Matching

Map to NetworkX graph nodes

4

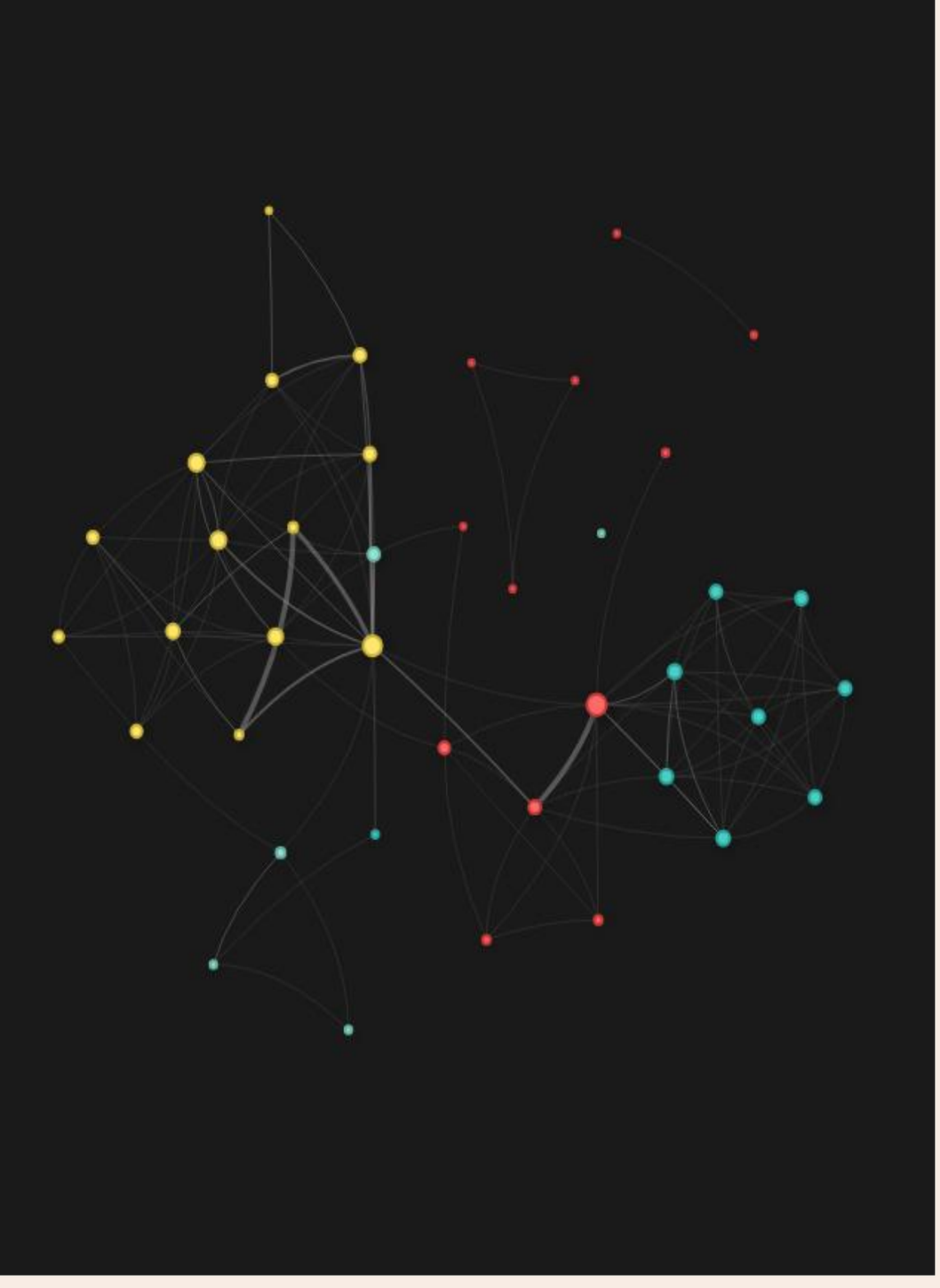
Run Network based Recommenders

Apply algorithm suite

5

Visual Dashboard

Display results and paths



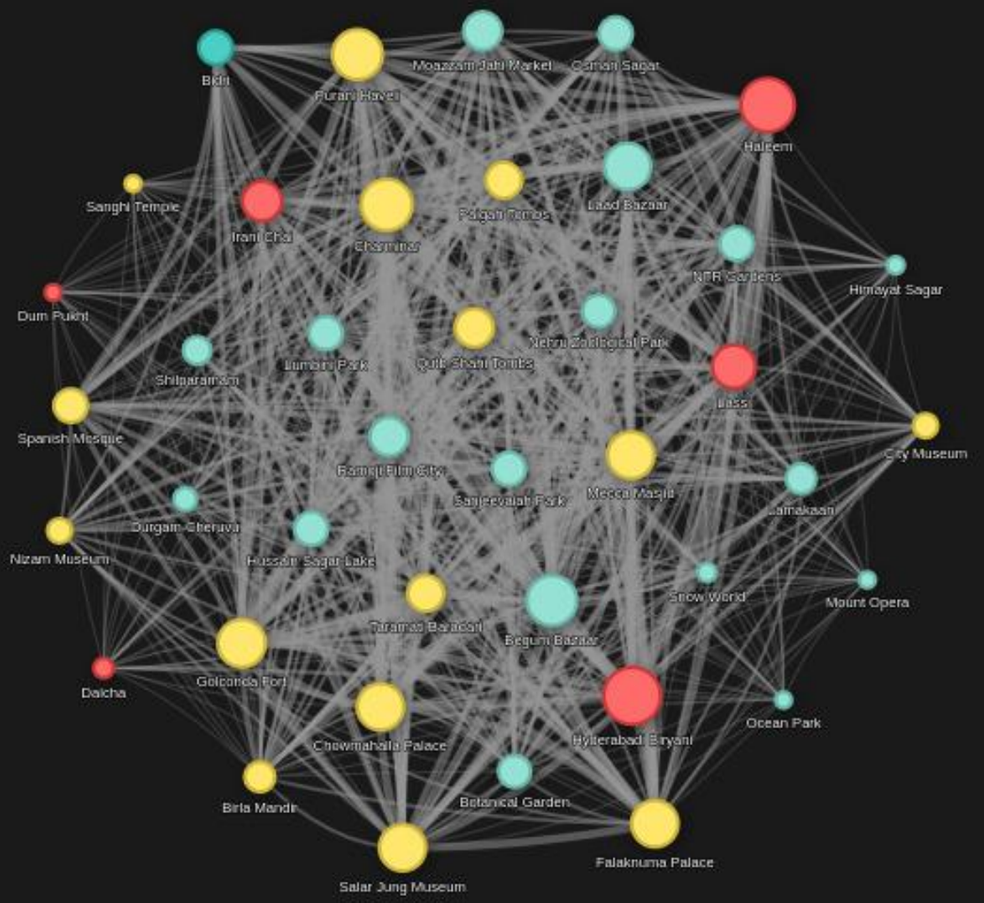
Data & Graph Construction

Corpus Details

Our knowledge base consists of scraped sentence/paragraph/Page -level content capturing Hyderabad's cultural entities.

Nodes: Places, food items, people, and organizations identified through NER and corpus matching.

Edges: Co-occurrence relationships within sentences, weighted by frequency count.



Named Entity Recognition & Matching

Converting user query into graph corresponding entities requires robust NER with intelligent fallback mechanisms.

01

spaCy NER Processing

Tokenizes input and labels entities: places, people, organizations, and food items. Serves as the primary entity extraction tool.

02

Entity Matching

Maps recognized entities to graph nodes using exact string matching against the knowledge base.

03

Fallback Strategies

Handles NER misses through exact-text and substring matching, improving recall for single-word inputs and case variations like "Charminar".

04

Recommenders Overview

We developed **seven** distinct recommender algorithms, each optimized for different user needs and exploration styles.

Local/Deterministic

Simple Co Occurence Recommender

Fast, explainable direct associations

Centrality-Based

PageRank Recommender

Global context and importance-aware

Discriminative

Inverse Frequency Recommender

Favors distinctive, specific entities

Exploratory/Stochastic

Random Walk & Exploratory Walk

Serendipitous discovery with relevance

Goal-Directed

Guided Walk & Guided Exploratory

Thematic journeys with destinations

Algorithm Details: Part A

1

Simple Co-Occurrence Recommender

Returns top neighbors ranked by co-occurrence weight. Fastest option providing direct, explainable associations. Ideal for users seeking immediate cultural connections.

Example: "Charminar" → Laad Bazaar, Mecca Masjid

2

PageRank Recommender

Applies personalized PageRank biased toward seed entities, capturing indirect connections and central nodes. Leverages global graph structure to identify culturally important entities.

Example: Surfaces influential landmarks beyond immediate neighbors

3

Inverse Frequency Recommender

Weights neighbors by edge weight multiplied by IDF score, favoring distinctive over generic entities. Reduces common, less informative results.

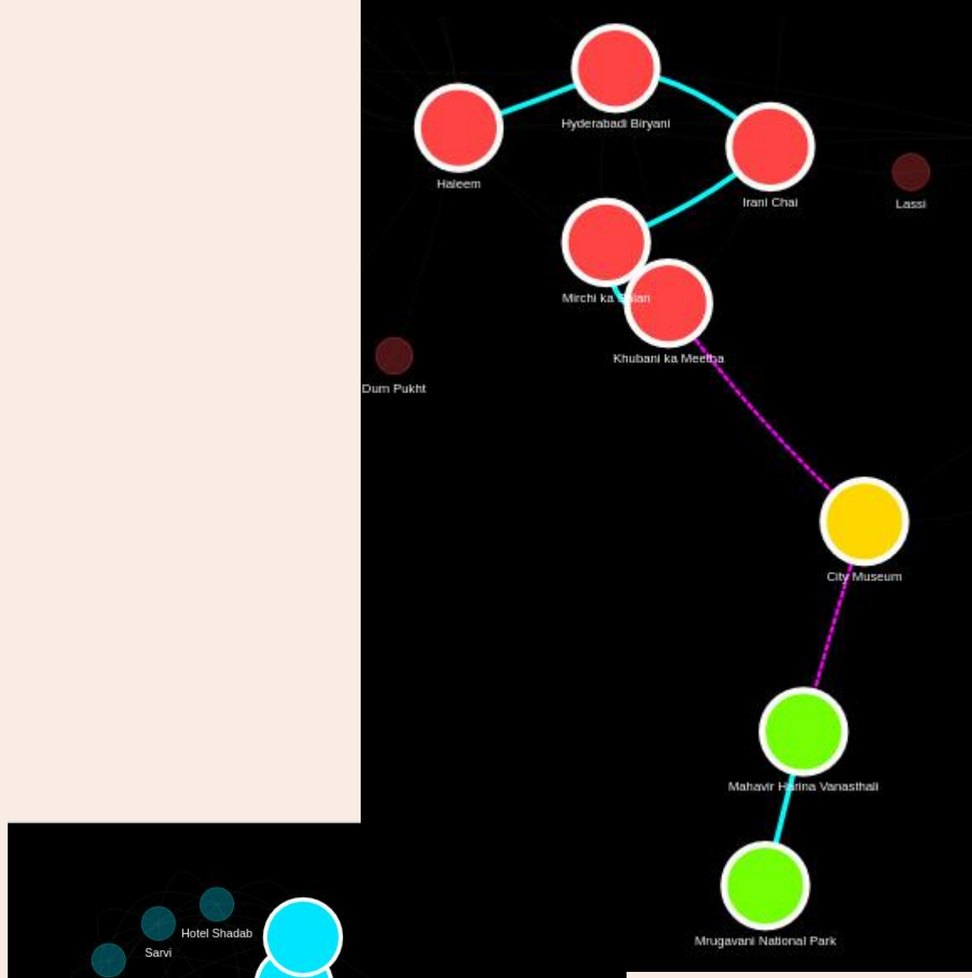
Example: Prioritizes unique cultural items over ubiquitous mentions

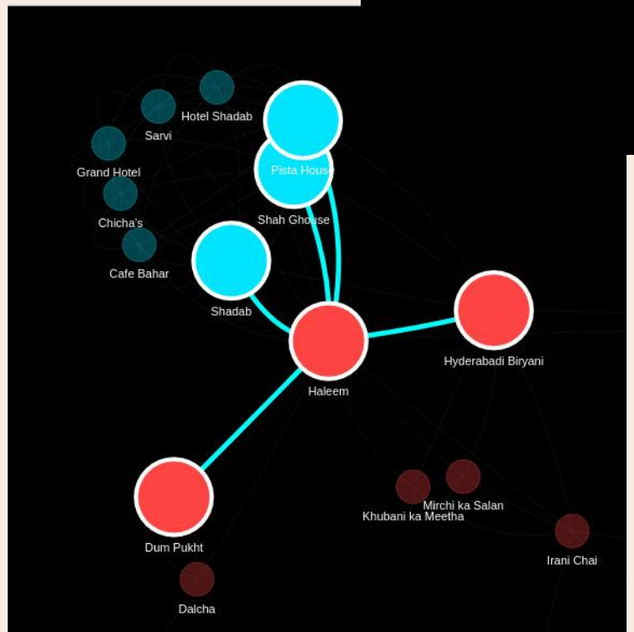
4

Random Walk Recommender

Executes multiple stochastic walks, collecting visit frequencies. Yields serendipitous yet relevant discoveries through probabilistic exploration.

Example: Uncovers unexpected cultural connections





Algorithm Details: Part B

Goal-directed and hybrid approaches enable thematic journeys through Hyderabad's cultural landscape.

1 Guided Walk Recommender

Uses Dijkstra-based pathfinding to maximize cumulative cultural connection between start and end points. Returns ordered itinerary optimizing for meaningful transitions.

Best for: Start → end recommendations with clear destinations

2 Exploratory Walk Recommender

Random walk with small teleportation probability, balancing local context with global serendipity. Prevents getting trapped in dense local clusters.

Best for: Open-ended exploration with occasional surprises

3 Guided Exploratory Walk

Bias-random-walk toward destination using proximity scoring. Produces engaging, thematic journeys that feel both purposeful and surprising.

Best for: Balanced exploration with directional guidance

Dashboard & User Interaction.

Key Interface Elements

Search box: Free-text input for natural queries

Network view: Highlighted graph with weighted edges

Recommendation pane: Ranked results with explanations

Path overlay: Visual itinerary on network

Explanation badges: "Why recommended" justifications

Example Flow

Query: "Charminar"

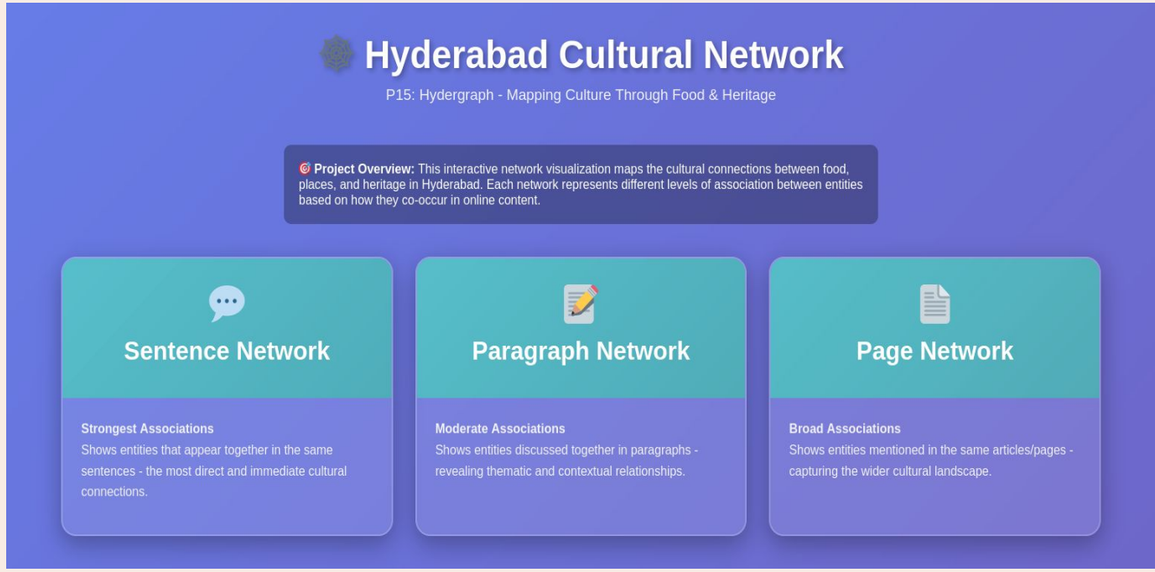
Simple Recommender:

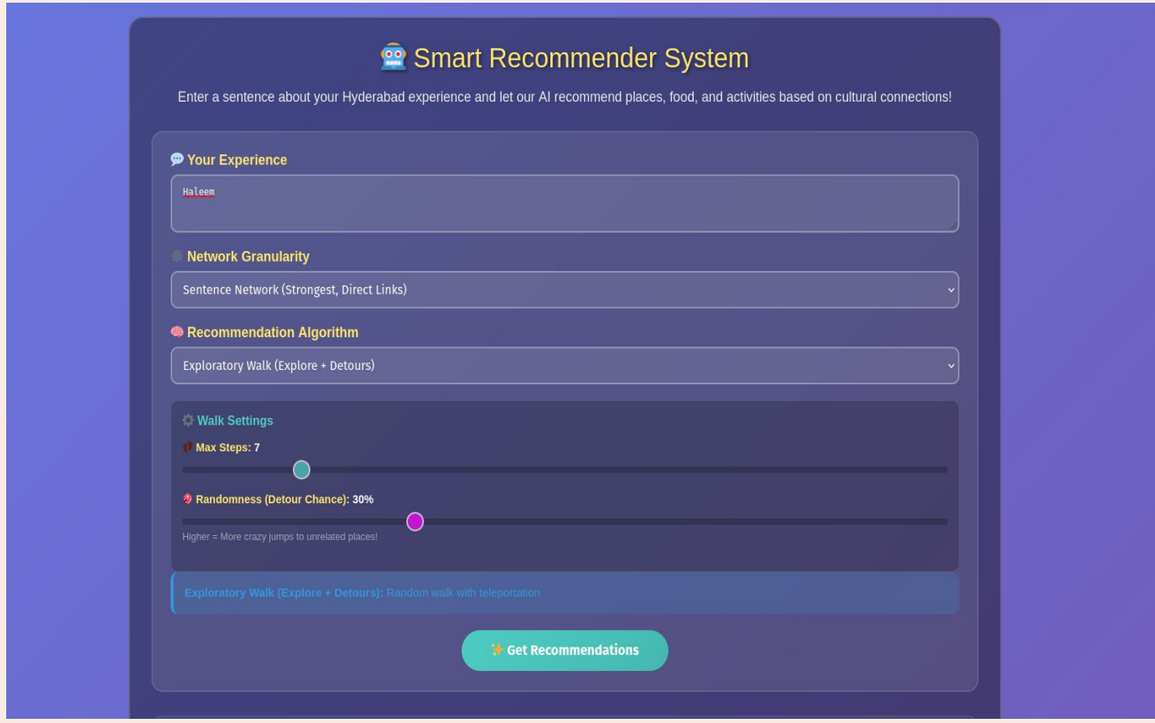
- Laad Bazaar (weight: 45)
- Irani Chai (weight: 38)
- Osmania Biscuits (weight: 32)

Guided Path:

Charminar → Mecca Masjid → Laad Bazaar → Lumbini Park

Each step includes edge weight and cultural connection explanation, building user trust through transparency.





HydeGraph Dashboard

Sentence Network - Hyderabad Cultural Connections

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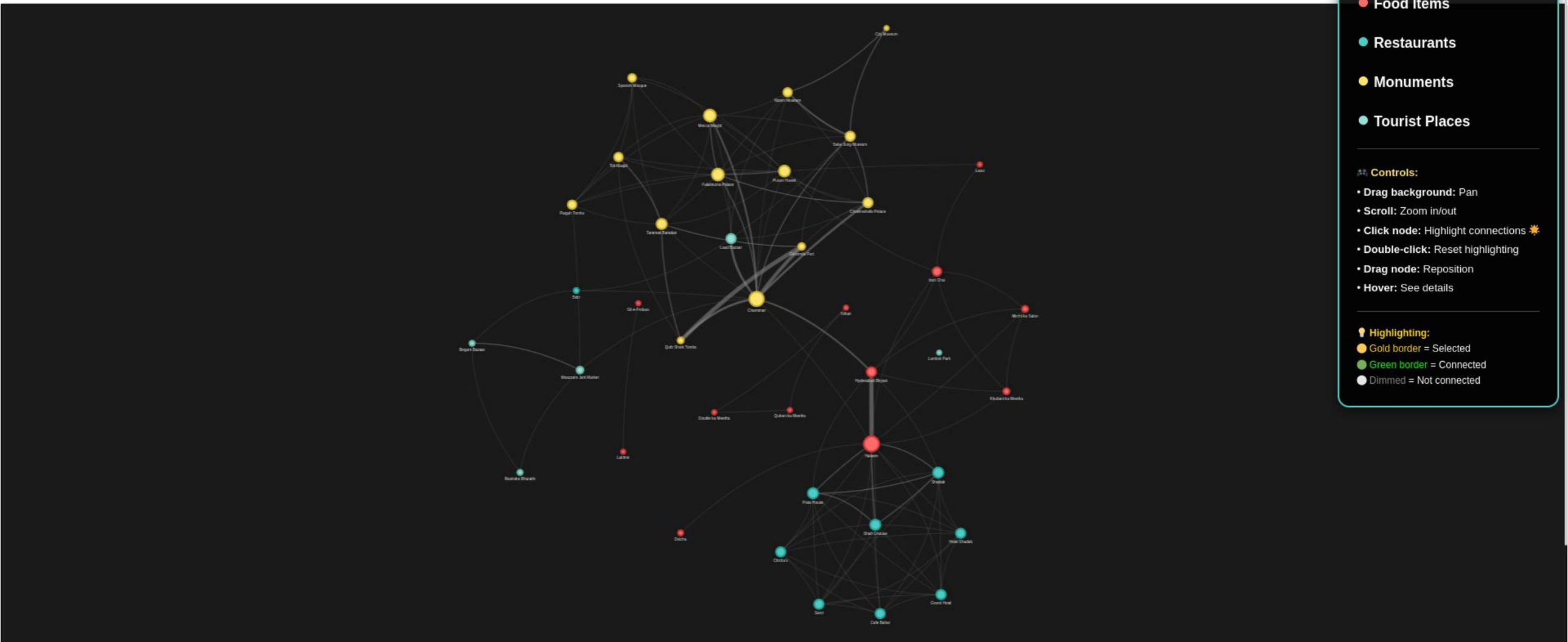

HydeGraph Dashboard

Paragraph Network - Hyderabad Cultural Connections

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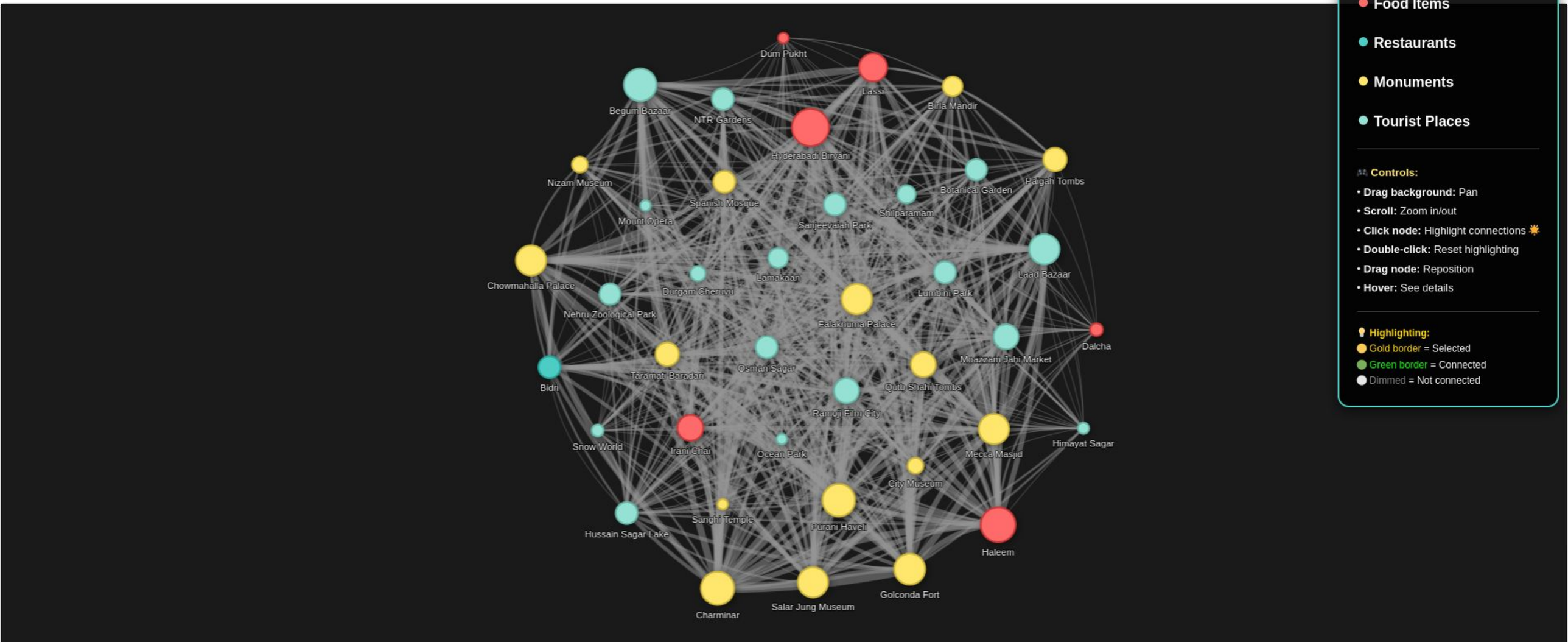


Legend

- Food Items
- Restaurants
- Monuments
- Tourist Places

Controls:

- **Drag background:** Pan
- **Scroll:** Zoom in/out
- **Click node:** Highlight connections
- **Double-click:** Reset highlighting
- **Drag node:** Reposition
- **Hover:** See details

Highlighting:

- Gold border = Selected
- Green border = Connected
- Dimmed = Not connected

HydeGraph Dashboard

🤖 Smart Recommender System

Enter a sentence about your Hyderabad experience and let our AI recommend places, food, and activities based on cultural connections!

💬 Your Experience

I am eating Haleem.

⚙️ Network Granularity

Sentence Network (Strongest, Direct Links)

🧠 Recommendation Algorithm

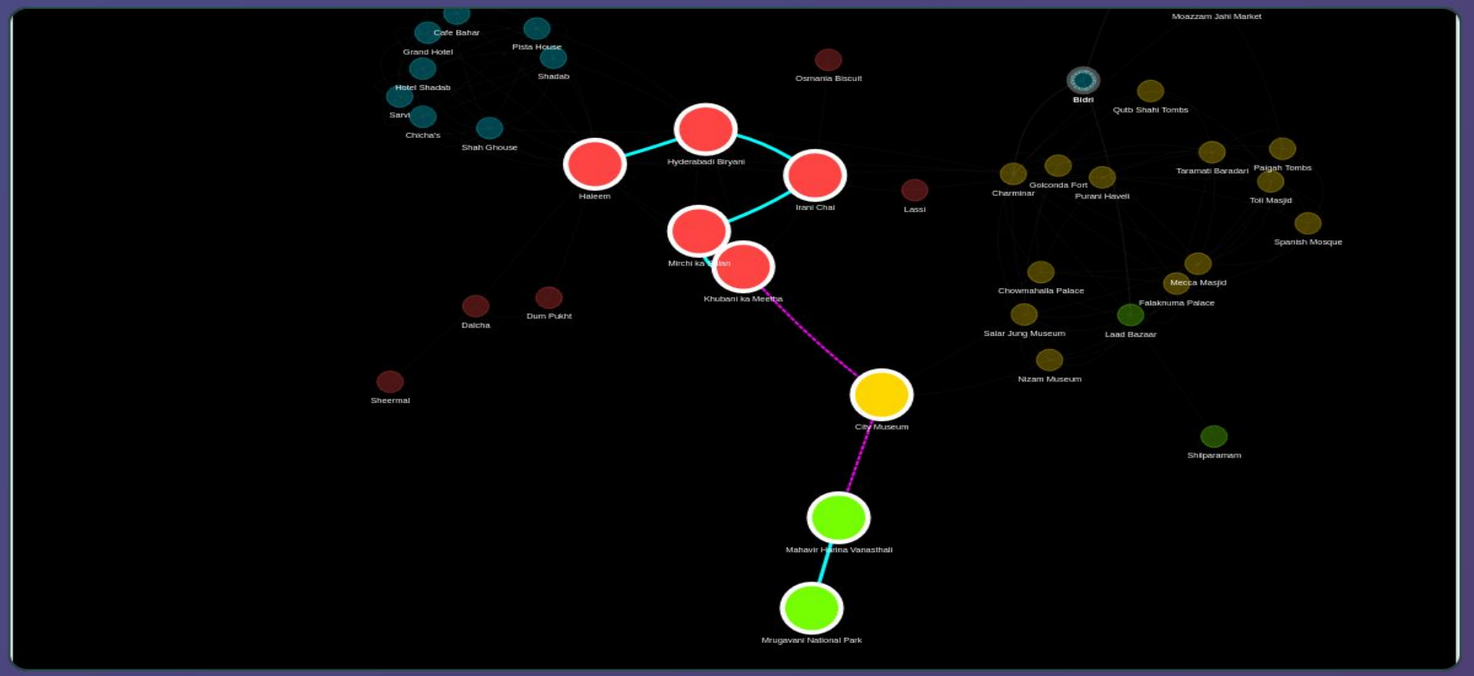
Inverse Frequency

Inverse Frequency: Balances popularity with rarity

✨ Get Recommendations

🎯 Recommendations

(Interactive Graph: Zoom, Pan, and Drag nodes!)



🤖 AI Recommendation

"It's wonderful you enjoyed the Haleem! You absolutely must also try the Hyderabadi Biryani, followed by a steaming Irani Chai, and don't forget to sample the Mirchi ka Salan and the sweet Khubani ka Meetha. For a deeper dive into history and nature, consider detouring to the City Museum, Mahavir Harina Vanasthali, or Mrugavani National Park."

🏷️ Entities Found:

Haleem

🎯 Haleem

Haleem → Hyderabadi Biryani → Irani Chai → Mirchi ka Salan → Khubani ka Meetha → ⚡ City Museum (Detour!) ⚡ Mahavir Harina Vanasthali (Detour!) Mrugavani National Park

📊 Generated using: **Exploratory Walk (Explore + Detours)** on **Sentence Network**

Now, let's dive into the ACTUAL DEMO !