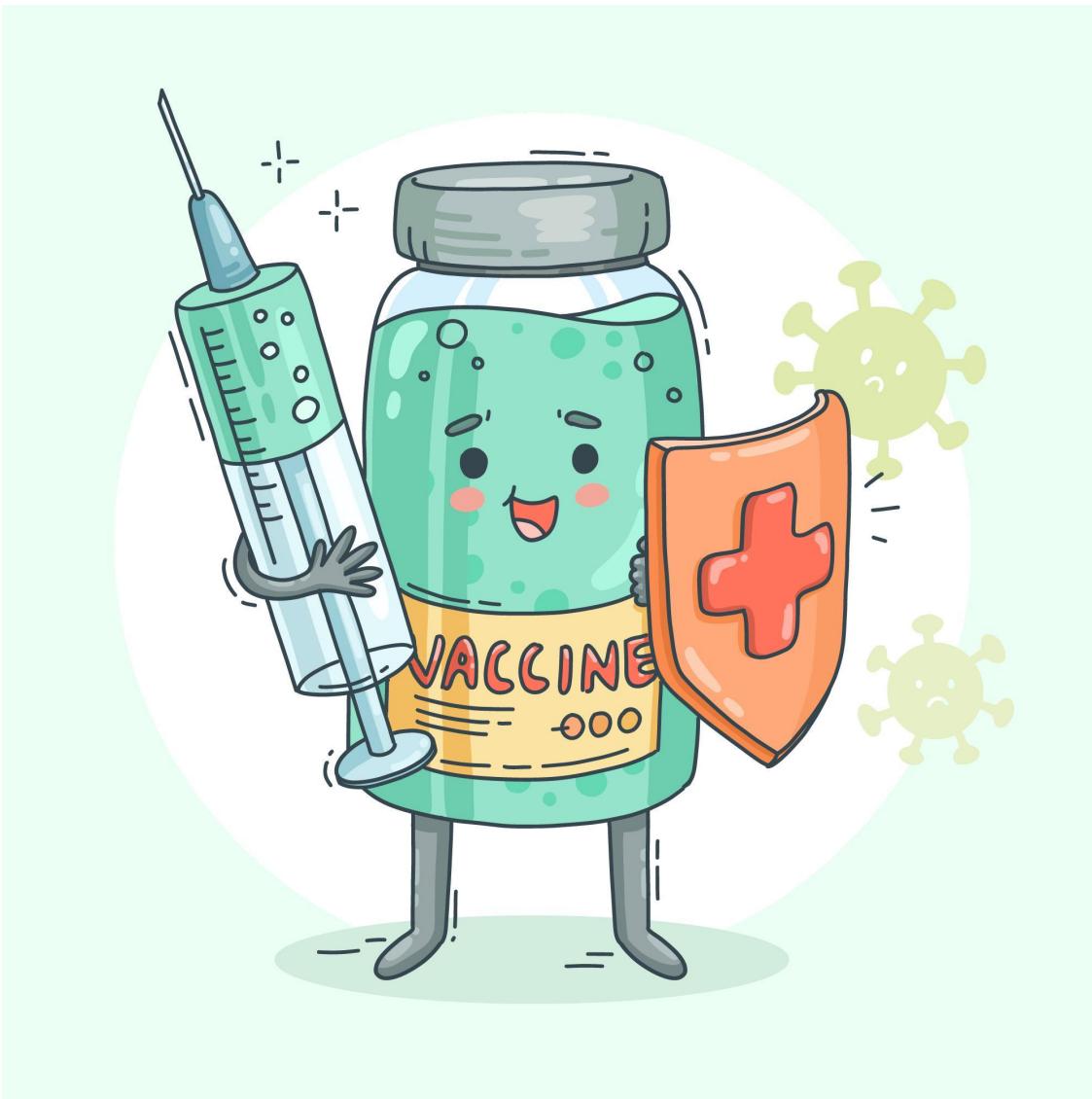


Covid-19 Vaccination Center Locator



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Covid-19 Vaccination Center Locator

Spatial and Graph Databases

Sem - V course for B.Tech, IT

CE & IT Department,

VJTI, Matunga

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Certificate

This is to certify that the project entitled “Covid-19 Vaccination Center Locator” submitted by

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in the partial fulfillment of the requirements for the subject Spatial and Graph Databases of the third year of a four year course for Bachelor of Technology degree in Information Technology at Veermata Jijabai Technological Institute, Mumbai is an authentic work carried out by them under my supervision and guidance.

To the best of my knowledge, the matter embodied in the project has not been submitted to any other University/Institute for the award of any Degree or Diploma course.

Prof. Sowmiya Raksha
Department of CE & IT
Veermata Jijabai Technological Institute,
Mumbai

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We take this opportunity to thank the Department of Computer Engg & IT, VJTI, for giving us a chance to pursue this project work.

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Finally, we are grateful to Prof. Sowmiya Raksha for her constant mentorship and guidance.

Abstract

Coronavirus disease (COVID-19) is an infectious disease caused by the SARS-CoV-2 virus.

Most people infected with the virus become seriously ill and require medical attention. Older people and those with underlying medical conditions like cardiovascular disease, diabetes, chronic respiratory disease, or cancer are more likely to develop serious illnesses. Anyone can get sick with COVID-19 and become seriously ill or die at any age.

Covid-19 vaccines have been tested by multiple drug administration authorities in the world. They are proven to be effective in reducing your probability of contracting COVID-19. Vaccinations are known to boost your immune system by teaching your body how to fight threats. Therefore many consider vaccinations as a way to build up your immune system and the manner in which your body reacts to foreign bodies.

Equitable access to safe and effective vaccines is critical to ending the COVID-19 pandemic. But it's not vaccines that will stop the pandemic, it's vaccination.

In order to speed up the process of vaccination and increase the rate of vaccination, many vaccination centers have been developed in India providing free as well as paid Covid-19 vaccines.

COVID-19 vaccination drive has been initiated, by the Government of India, to cover healthcare and frontline workers and is to be scaled up to cover citizens above 18 years of age suffering from comorbidities.

The goal of this project is to locate and provide information about covid-19 vaccination centers in India.

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1. Introduction

Problem Statement

Locate and display the information about vaccination centers developed in India.

Motivation

Covid-19 is considered as the biggest pandemic ever.

In order to reduce the spread of Covid-19 and increase immunity against the virus, vaccination is a must.

In order to speed up the vaccination process, Vaccination Centers are developed across the country.

The idea of this project is to locate these vaccination centers and provide information about the centers so that users can quickly and easily find a vaccination center in the nearby region.

2. Dataset

2.1. Co-WIN Public APIs

For collecting the information of vaccination centers in India we have used Co-WIN public APIs, which are provided by the government of India.

Co-WIN Public APIs allow any third-party application to access certain un-restricted information that can be shared with its users.

Using these APIs, we can get the data about vaccination centers available in a particular state, in a specific district.

We can also get data about vaccination centers using area pin-codes.

Along with this, these APIs also provide information about vaccination sessions.

According to the documentation provided by public Co-WIN APIs, the appointment availability data is cached and may be up to 5 minutes old. Further, these APIs are subject to a rate limit of 100 API calls per 5 minutes per IP.

2.2. Queries and JSON Responses from the Co-WIN APIs

States

The request URL to get all the states in India is:

<https://cdn-api.co-vin.in/api/v2/admin/location/states>

The response obtained contains a JSON object. The object obtained has a property with key ‘states’ and its value is an array of JSON objects as described in the table below:

Property	Type	Description
state_id	Integer	The unique property that acts as a key to identify each state uniquely.

state_name	String	Name of the state.
------------	--------	--------------------

Districts

The information of the districts within a particular state can be obtained by providing the ‘state_id’ as mentioned previously using the request URL:

https://cdn-api.co-vin.in/api/v2/admin/location/districts/{state_id}

The response obtained contains a JSON object. The object obtained has a property with key ‘districts’ and its value is an array of JSON objects as described in the table below:

Property	Type	Description
district_id	Integer	The unique property that acts as a key to identify each district uniquely.
district_name	String	Name of the district.

Vaccination Centers

The location of a vaccination center is obtained using the following request URL:

<https://cdn-api.co-vin.in/api/v2/appointment/centers/public/findByLatLong?lat={latitude}&long={longitude}>

In the above URL, the latitude and longitude parameters need to be provided such that they are within the political boundary of India.

The response obtained contains a JSON object. The object obtained has a property with key ‘centers’ and its value is an array of JSON objects as described in the table below:

Property	Type	Description
center_id	Integer	The unique property that acts as a key to identify each center uniquely.
name	String	Name of the place where the vaccination center is located.
district_name	String	Name of the district.
state_name	String	Name of the state.
location	String	The address of the vaccination center.
pincode	Integer	The pincode of the area of the vaccination center.
block_name	String	Name of the block where the vaccination center is located.
lat	Float	The latitude through which the vaccination center passes.
long	Float	The longitude through which the vaccination center passes.

Vaccination Sessions

The sessions to get a vaccine in a particular vaccination center can be obtained for a particular pincode for a particular date (dd-mm-yyyy format) using the request URL:

<https://cdn-api.co-vin.in/api/v2/appointment/sessions/public/findByPin?pincode={pin}&date={dd-mm-yyyy}>

The response obtained contains a JSON object. The object obtained has a property with key ‘sessions’ and its value is an array of JSON objects as described in the table below:

Property	Type	Description
center_id	Integer	The unique property that acts as a key to identify each center uniquely.
name	String	Name of the place where the vaccination center is located.
location	String	The address of the vaccination center.
state_name	String	Name of the state.
district_name	String	Name of the district.
block_name	String	Name of the block where the vaccination center is located.
pincode	Integer	The pincode of the area of the vaccination center.
from	String	The start time of the vaccination session.
to	String	The end time of the vaccination session.
lat	Float	The latitude through which the vaccination center passes.
long	Float	The longitude through which the vaccination center passes.
fee_type	String	The type of fee, i.e. paid or free.
fee	Number	The amount of the fee in Rupees.
session_id	String	The unique id for the session.
date	String	The date of the vaccination session.
available_capacity	Number	The number of doses for the particular session for the particular date for the

		particular type of vaccine.
available_capa city_dose1	Number	The number of doses for the particular session for the particular date for the particular type of vaccine.
available_capa city_dose2	Number	The number of doses for the particular session for the particular date for the particular type of vaccine.
min_age_limit	Number	The minimum age limit for vaccination.
allow_all_age	Boolean	Whether people of all ages are allowed.
vaccine	String	The name of the vaccine.
slots	Array of Strings	The slots of timings between which the doses will be administered.

3. Visualization of Data

3.1. Gathering Data

As mentioned earlier, we are collecting the data from API Setu's Co-WIN Public API.

API Setu: <https://apisetu.gov.in/>

Co-WIN Public API: <https://apisetu.gov.in/api/cowin>

First, we have collected latitude and longitude of various cities in India and stored that data in a CSV file.

The data of latitude and longitude of various city centers in India were collected from the following site:

<https://simplemaps.com/data/in-cities>

Then using this data and Co-WIN Public API, we collected the information of vaccination centers.

The Co-WIN API site used for this purpose:

<https://cdn-api.co-vin.in/api/v2/appointment/centers/public/findByLatLong?lat={latitude}&long={longitude}>

In the above URL, the latitude and longitude parameters need to be provided.

Using this API, we managed to collect data from about 24208 vaccination centers located across the country.

3.2. Storing the data in PostGIS

After getting all the data in CSV format, we imported that CSV file in PostGIS using pgAdmin4.

The corresponding table obtained after importing the CSV file in pgAdmin4 is as shown below:

	center_id	center_name	district	state	location	pincode	block_name	lat	long	geom
1	702684	S.S Jain KP Chandani C...	Central Delhi	Delhi	Gali Sanhian, Chandan...	110006	Not Applicable	28.65646	77.22798	0101000020E610000018096D39974E5340D52137C30DA83C40
2	743049	GGSSS BARPH VALI CH...	Central Delhi	Delhi	GGSSS GALIBARPH V...	110006	Not Applicable	28.6552	77.232021	0101000020E61000000EBF9B6ED94E5340D565EC2FBBA73C40
3	743051	L.N GIRDHARI LAL K.U.F...	Central Delhi	Delhi	L.N GIRDHARI LAL K.U...	110006	Not Applicable	28.65872	77.22362	0101000020E61000000D1AE42CA4F4E5340938B90FA1A83C40
4	743406	SBV Kadirpur	Central Delhi	Delhi	Kadipur	110084	Not Applicable	28.65872	77.22362	0101000020E61000000D1AE42CA4F4E5340938B90FA1A83C40
5	8117	Northern Railway Hospit...	Central Delhi	Delhi	Near Fire Station, Shya...	110006	Not Applicable	28.661212	77.222595	0101000020E6100000335019FF3E4E53406E99B3045A93C40
6	632961	Rouse Avenue Court	Central Delhi	Delhi	Rouse Avenue Court C...	110001	Not Applicable	28.66262	77.23717	0101000020E6100000E96514CB2D4F5340EFACDD76A1A93C40
7	4818	DGD Gall Gulyan PHC	Central Delhi	Delhi	Gali Gullan, Jama Mas...	110006	Not Applicable	28.6528156	77.234947	0101000020E6100000C652245F094F5340915154ECE1EA73C40
8	693446	Sarvodhya V Mori G NO...	Central Delhi	Delhi	Mori Gate No.1	110006	Not Applicable	28.66571	77.22259	0101000020E6100000AA9A20EA3E4E5340C39E76F86BAA3C40
9	693750	Sarvodhya V Mori G NO...	Central Delhi	Delhi	Mori Gate No.1	110006	Not Applicable	28.66571	77.22259	0101000020E6100000AA9A20EA3E4E5340C39E76F86BAA3C40
10	693752	Sarvodhya V Mori G NO...	Central Delhi	Delhi	Mori Gate No.1	110006	Not Applicable	28.66571	77.22259	0101000020E6100000AA9A20EA3E4E5340C39E76F86BAA3C40
11	693754	Sarvodhya V Mori G NO...	Central Delhi	Delhi	Mori Gate No.1	110006	Not Applicable	28.66571	77.22259	0101000020E6100000AA9A20EA3E4E5340C39E76F86BAA3C40
12	693756	Sarvodhya V Mori G NO...	Central Delhi	Delhi	Mori Gate No.1	110006	Not Applicable	28.66571	77.22259	0101000020E6100000AA9A20EA3E4E5340C39E76F86BAA3C40
13	693450	SBV JAMA MASJID UR...	Central Delhi	Delhi	Jama Masjid (Urdu Me...	110006	Not Applicable	28.65221	77.2347	0101000020E6100000C2172653054F5340C91F0C3CF7A63C40
14	693763	SBV JAMA MASJID UR...	Central Delhi	Delhi	Jama Masjid (Urdu Me...	110006	Not Applicable	28.65221	77.2347	0101000020E6100000C2172653054F5340C91F0C3CF7A63C40
15	693768	SBV JAMA MASJID UR...	Central Delhi	Delhi	Jama Masjid (Urdu Me...	110006	Not Applicable	28.65221	77.2347	0101000020E6100000C2172653054F5340C91F0C3CF7A63C40

Fig.: The final table

The above image shows the tabular format of the data contained in the CSV file of the vaccination centers. The first 15 tuples along with their attribute values are shown above.

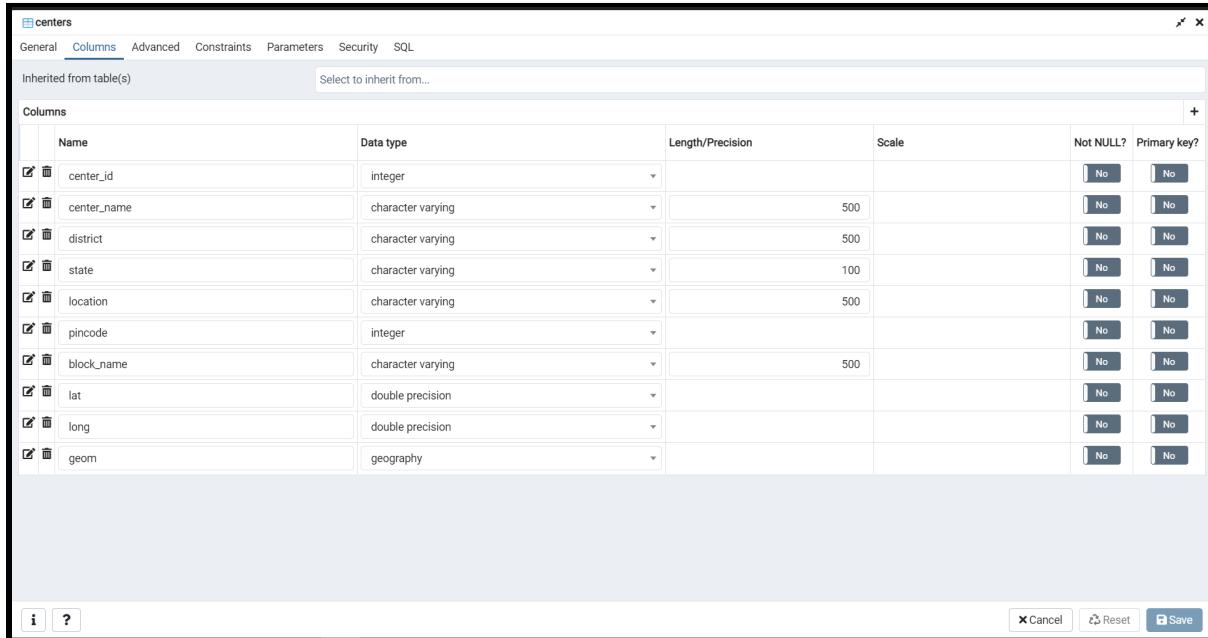


Fig.: Attributes of the 'centers' schema

The attributes of the 'centers' schema are mentioned in the figure above.

3.3. Visualization of data in QGIS

For visualization of data, we have used QGIS.

QGIS is a free and open-source cross-platform desktop geographic information system application that supports viewing, editing, and analysis of geospatial data.

We have connected QGIS with the PostGIS database created in the previous step. QGIS renders the vaccination center positions based on that data.

Layer Architecture

In this project, we have used two layers: a basemap layer, and centers layer.

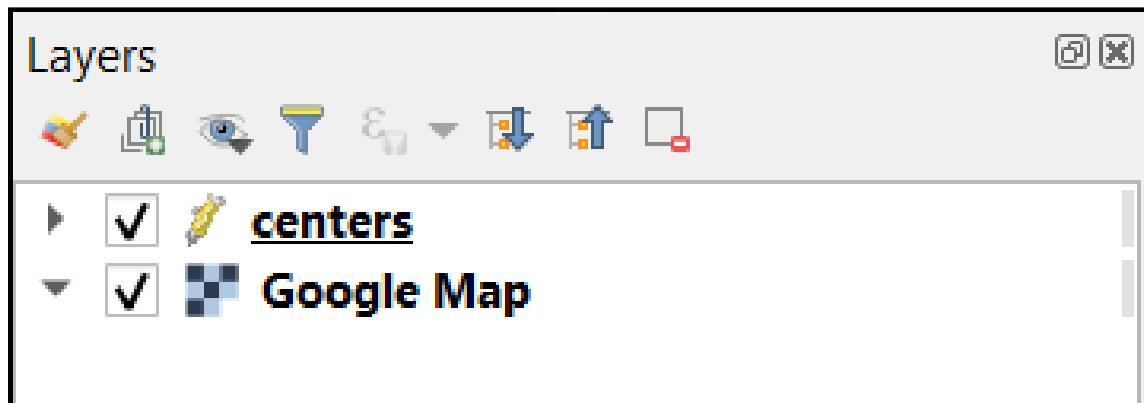


Fig.: Layers in QGIS

Basemap Layer

The term basemap is seen often in GIS and refers to a collection of GIS data and/or orthorectified imagery that form the background setting for a map. The function of the basemap is to provide the background detail necessary to orient the location of the map. Basemaps also add to the aesthetic appeal of a map.

In our project, to add the basemap we have used the **Tile+ plugin** which provides some popular basemaps.

Here we have used the Google Map basemap.



Fig.: Google Map Layer in QGIS

Visualize Data in QGIS

To visualize the vaccination centers in QGIS, a PostGIS layer is added to the QGIS project by connecting to the database present in PostGIS.

After the connection is made, the appropriate database was chosen and the layer was added.

To represent the vaccination centers state-wise, a colour-scheme was used as shown in the figure below.

Thus, vaccination centers are grouped by the property state.

Symbol	Value	Legend
✓ ●	Andaman and Nicobar Islands	Andaman and Nicobar Islands
✓ ●	Andhra Pradesh	Andhra Pradesh
✓ ●	Arunachal Pradesh	Arunachal Pradesh
✓ ●	Assam	Assam
✓ ●	Bihar	Bihar
✓ ●	Chandigarh	Chandigarh
✓ ●	Chhattisgarh	Chhattisgarh
✓ ●	Dadra and Nagar Haveli	Dadra and Nagar Haveli
✓ ●	Daman and Diu	Daman and Diu
✓ ●	Delhi	Delhi
✓ ●	Goa	Goa
✓ ●	Gujarat	Gujarat
✓ ●	Haryana	Haryana
✓ ●	Himachal Pradesh	Himachal Pradesh
✓ ●	Jammu and Kashmir	Jammu and Kashmir
✓ ●	Jharkhand	Jharkhand
✓ ●	Karnataka	Karnataka
✓ ●	Kerala	Kerala
✓ ●	Ladakh	Ladakh
✓ ●	Lakshadweep	Lakshadweep
✓ ●	Madhya Pradesh	Madhya Pradesh
✓ ●	Maharashtra	Maharashtra
✓ ●	Manipur	Manipur
✓ ●	Meghalaya	Meghalaya
✓ ●	Mizoram	Mizoram
✓ ●	Nagaland	Nagaland
✓ ●	Odisha	Odisha
✓ ●	Puducherry	Puducherry
✓ ●	Punjab	Punjab
✓ ●	Rajasthan	Rajasthan
✓ ●	Sikkim	Sikkim
✓ ●	Tamil Nadu	Tamil Nadu
✓ ●	Telangana	Telangana
✓ ●	Tripura	Tripura
✓ ●	Uttar Pradesh	Uttar Pradesh
✓ ●	Uttarakhand	Uttarakhand
✓ ●	West Bengal	West Bengal
✓ ●	all other values	

Fig.: Colour-scheme for different states and UTs

Final Visualization In QGIS

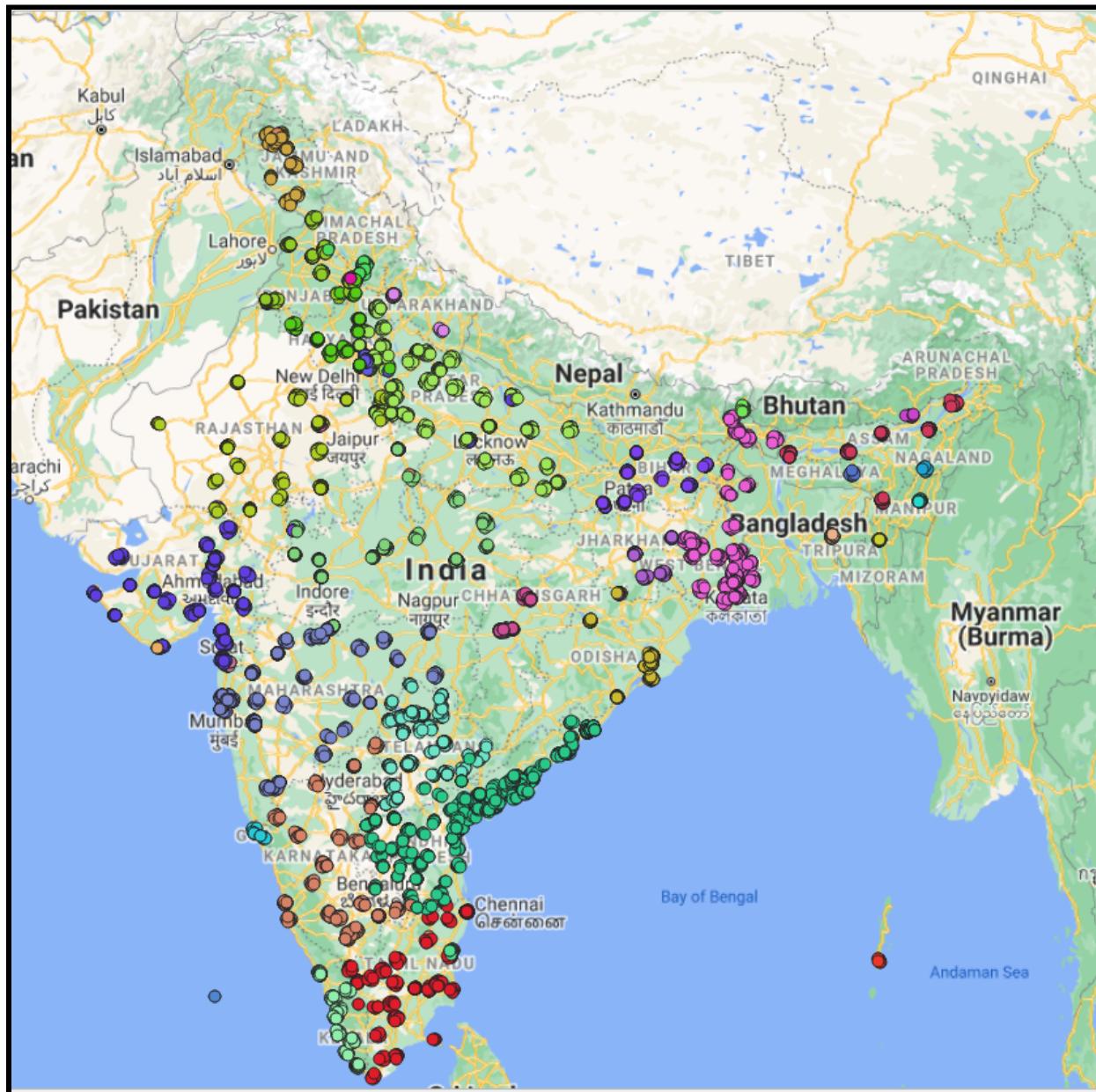


Fig.: Vaccination centers visualized in QGIS

4. Graph Database Implementation

Graph Database

The data obtained from the Co-WIN API is stored in the Neo4j AuraDB database.

Neo4j AuraDB is a fully managed cloud graph database service.

AuraDB is reliable, secure, and fully automated, enabling you to focus on building graph applications without worrying about database administration.

AuraDB contains various nodes which are linked to each other through relationships that are represented using edges connecting various nodes.

The relationships can be unidirectional or bidirectional.

Nodes and relationships can also have a number of various properties.

The following image gives an overview of the database used in this project:

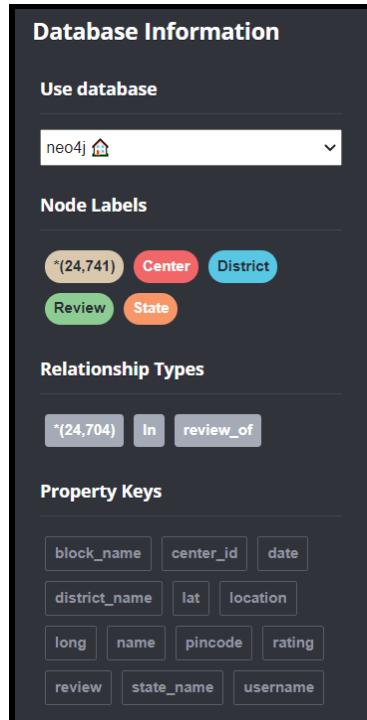


Fig.: AuraDB graph database information

As shown in the above image, there are 4 types of nodes available in the database:

- Center
 - State
 - District
 - Review

We have defined 2 types of relationships:

- In
 - review_of

Nodes

1. Center

These nodes are basically used for representing the vaccination centers.

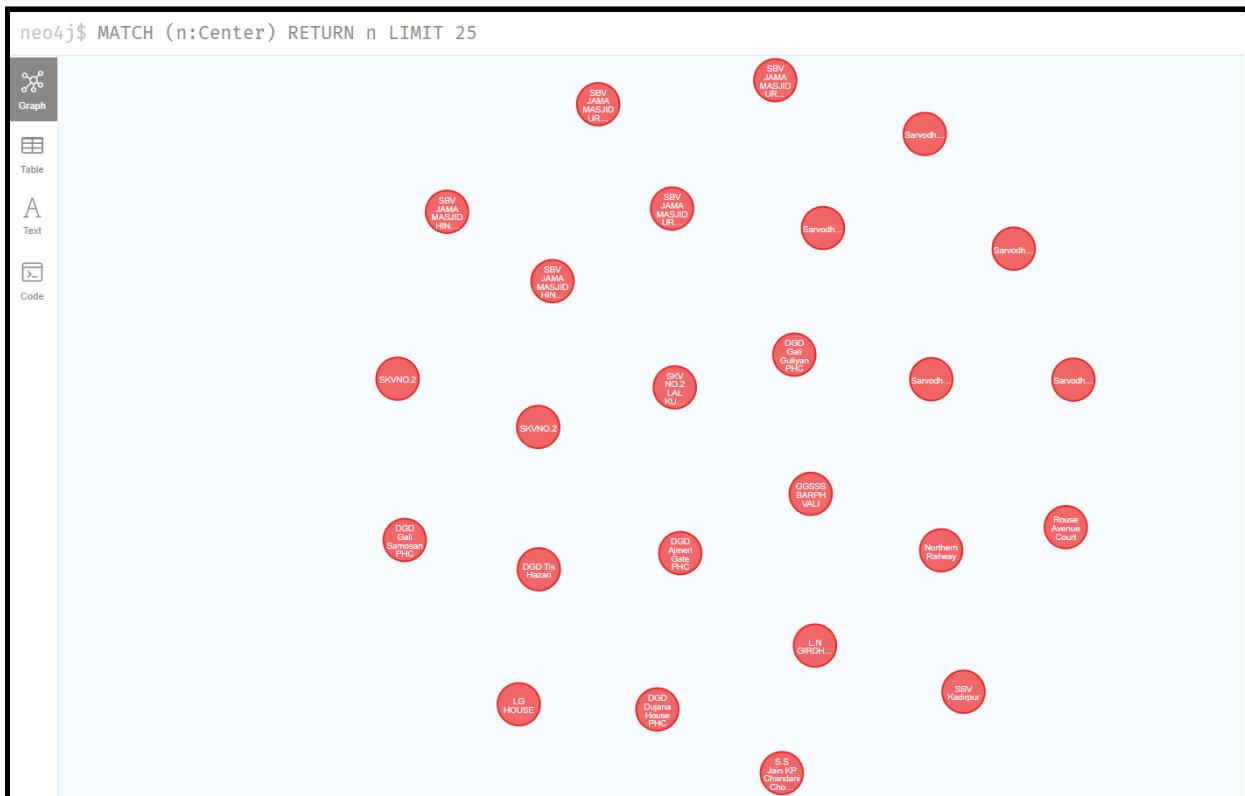


Fig.: Nodes representing vaccination centers

The above image shows the result of query

```
MATCH (n:Center) RETURN n LIMIT 25
```

The result of this query returns **25** Center nodes from the database.

In the database, we have data of **24207** centers.

The properties of Center Nodes are:

- id
- block_name
- center_id
- district_name
- state_name
- location
- pincode
- lat
- long
- name

For example, the following image represents the properties of a center node:

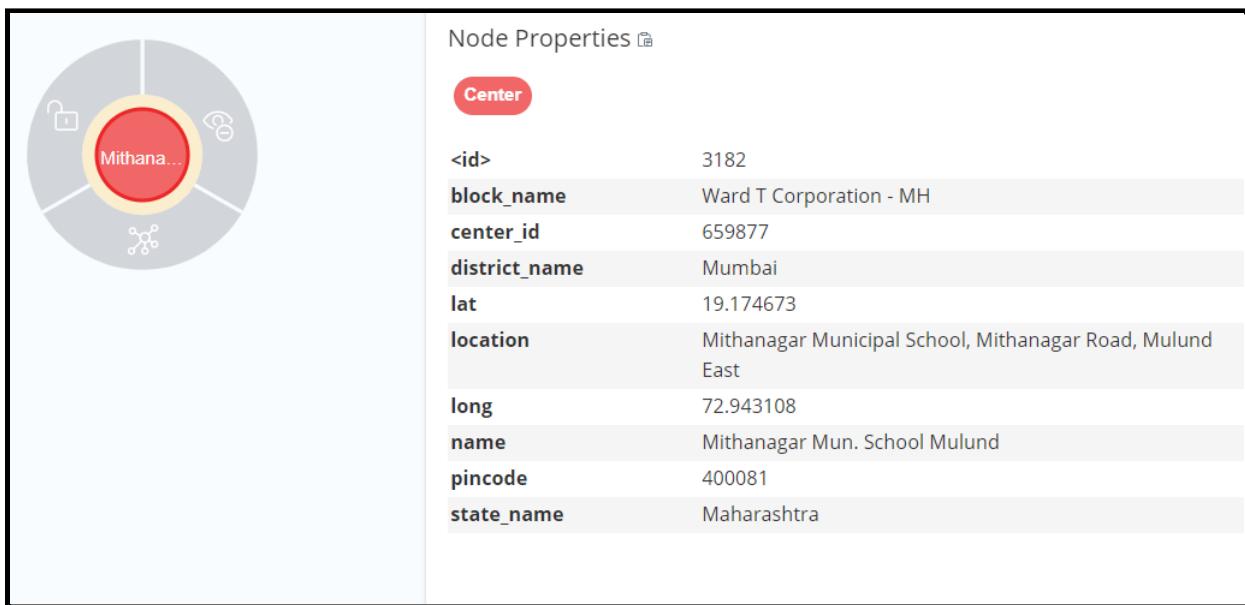


Fig.: Example of a 'Center' node

2. State

State nodes represent the various districts from the database.

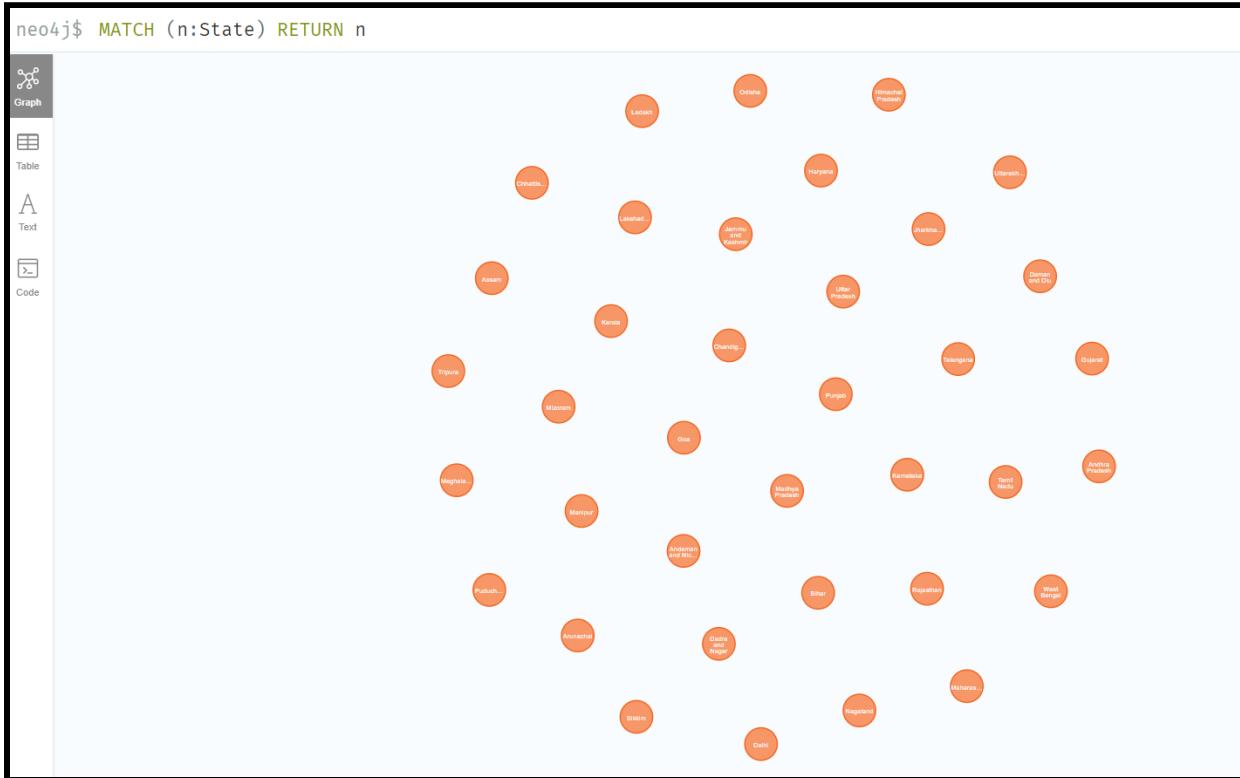


Fig.: Nodes representing states and UTs in India

The above image shows the result of query

```
MATCH (n:State) RETURN n LIMIT 25
```

The result of this query returns 25 State nodes from the database.

In the database, we have data of 24207 centers.

The properties of State Nodes are:

- id
 - state name

For example, the following image represents the properties of a state node:

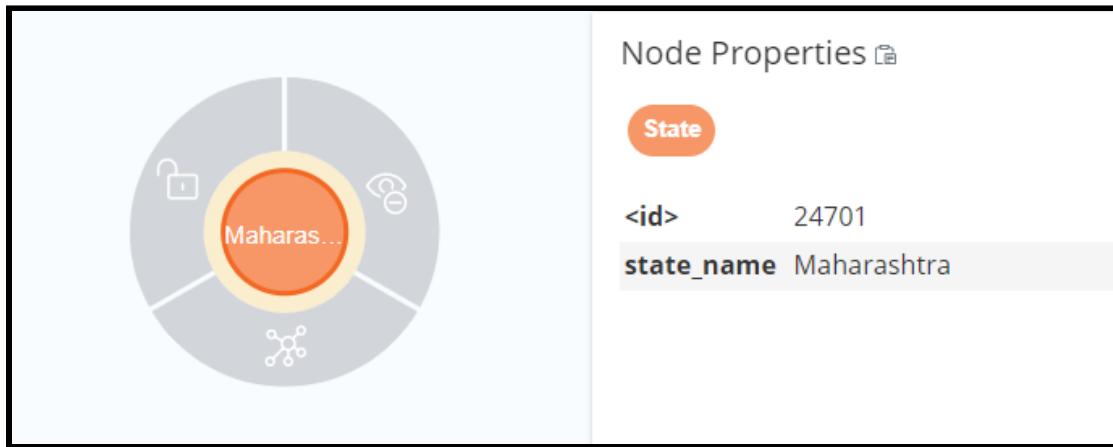


Fig.: Example node of a 'State'

3. District

District nodes represent the various districts from the database.

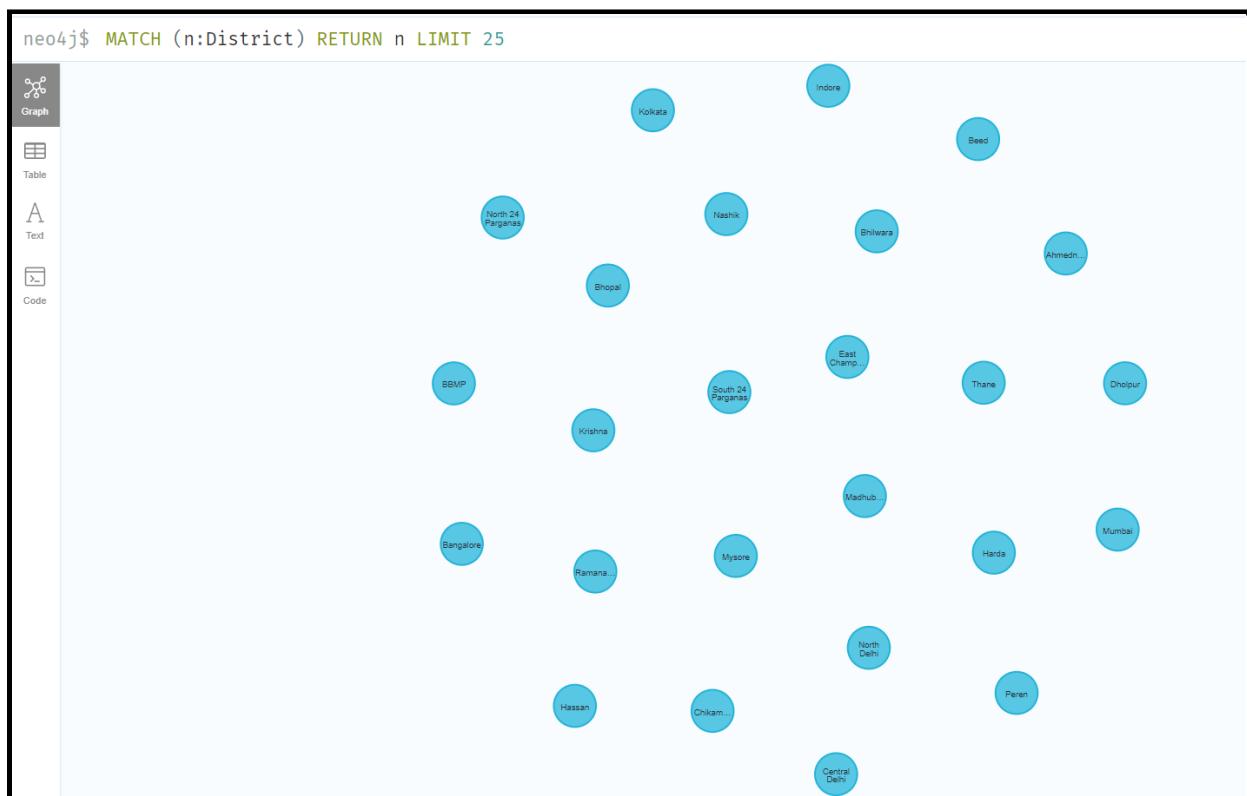


Fig.: Nodes representing districts in India

The above image shows the result of query

```
MATCH (n:District) RETURN n LIMIT 25
```

The result of this query returns 25 District nodes from the database.

In the database, we have data of 37 districts.

The properties of District Nodes are:

- id
- district_name
- state_name

For example, the following image represents the properties of a district node:

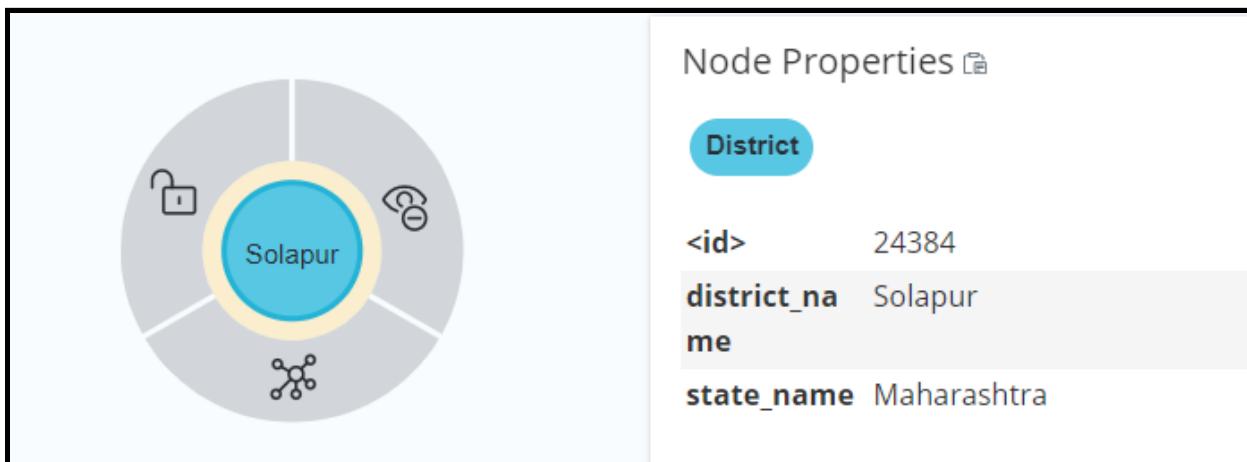


Fig.: Example node of a 'District'

4. Review

Review nodes represent the reviews of vaccination centers as provided by the users.

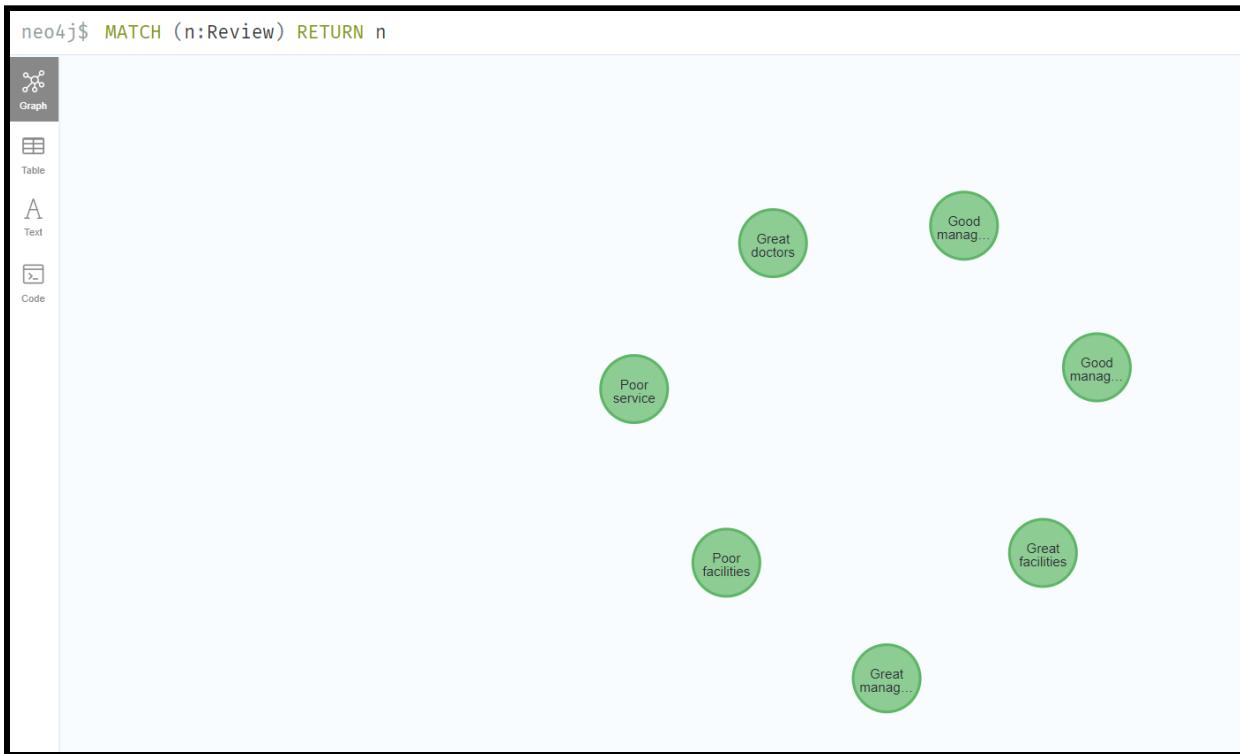


Fig.: Reviews for various vaccination centers

The above image shows the result of query

```
MATCH (n:Review) RETURN n
```

The result of this query returns Review nodes from the database.

As the user writes a review of a particular center, a new review node is created in the database.

The properties of District Nodes are:

- id
- center_id
- date
- rating
- review
- username

For example, the following image represents the properties of a review node:

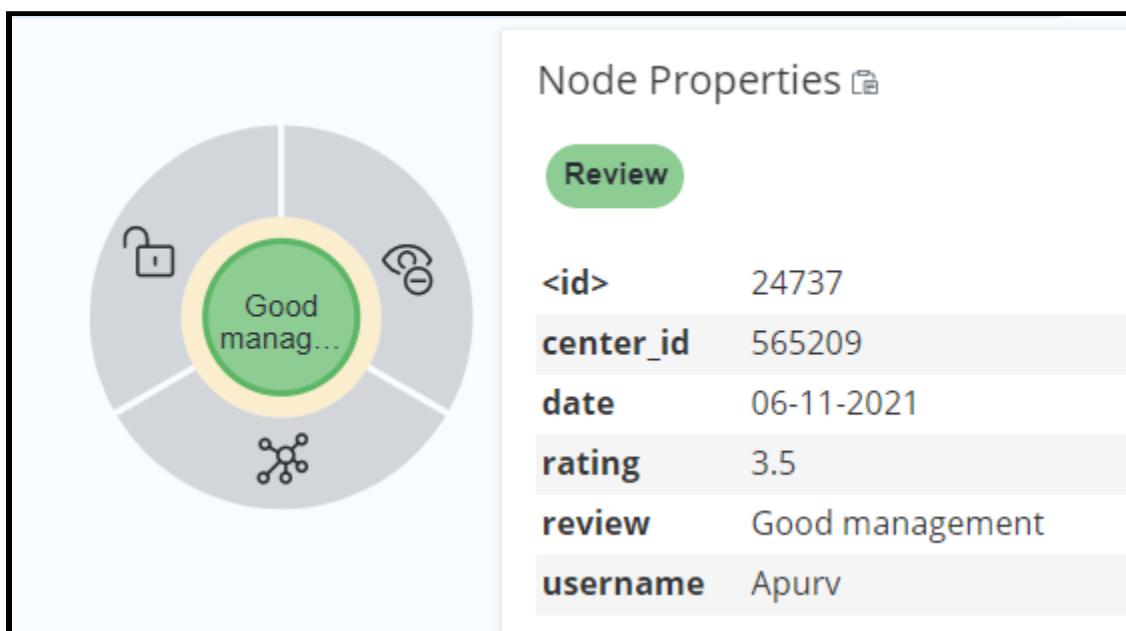


Fig.: Example of a 'Review' node

Relationships

1. In

This relationship is defined between

- District node and State node
- Center node and District node

Example representing In relationship between a state node and districts nodes:

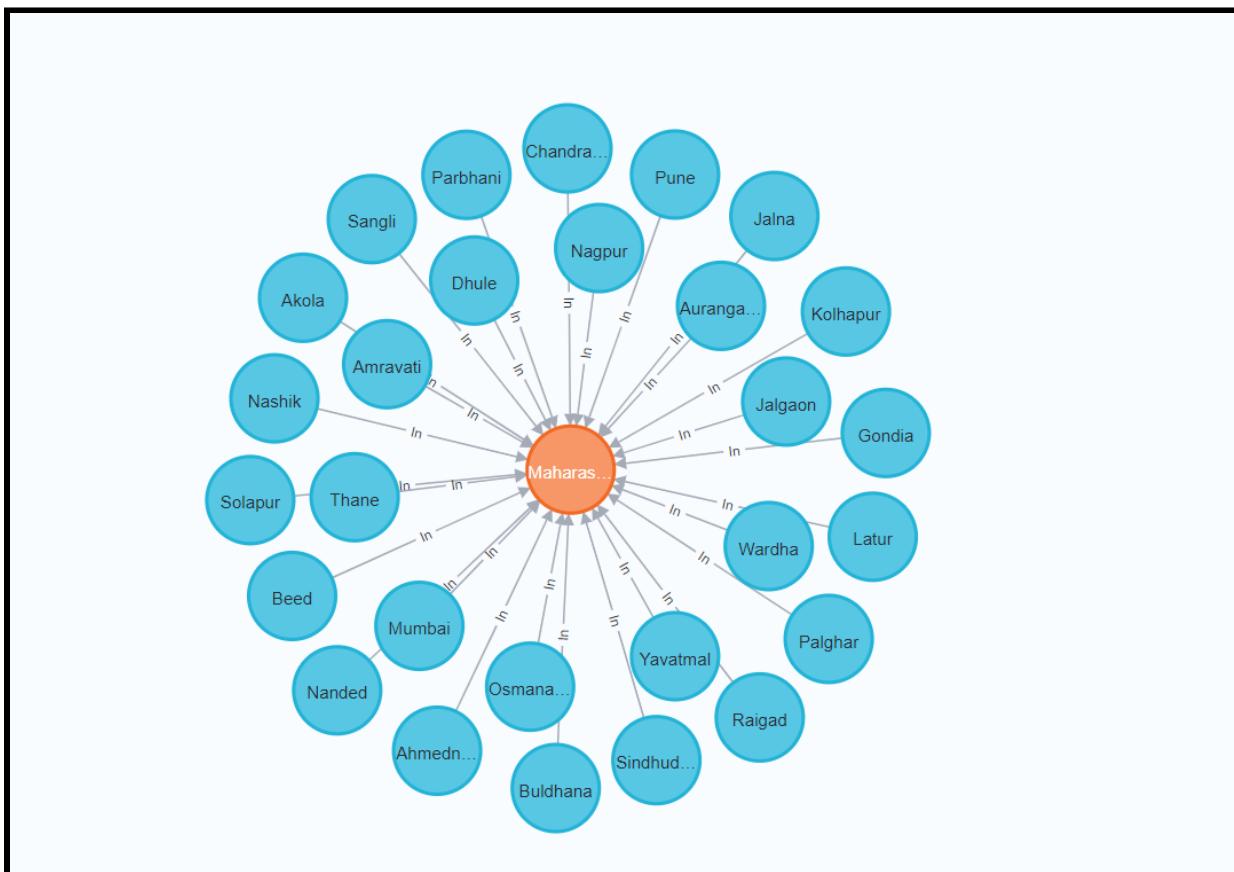


Fig.: Diagram depicting the relationship between a state and the districts in that state

The above image shows a State node with state_name 'Maharashtra' and districts nodes which are having In relationship.

This 'In' relationship is directed from district node to state node.

Example representing In relationship between a district node and center nodes:

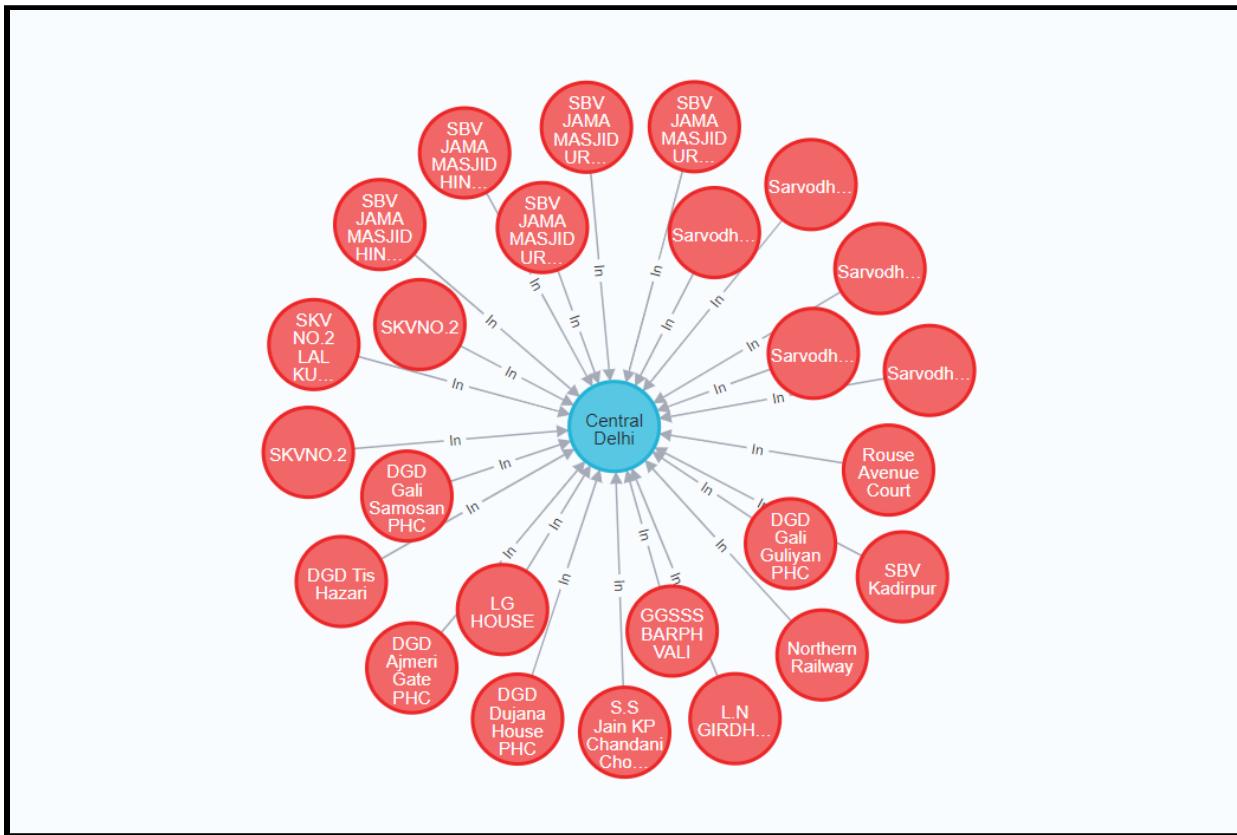


Fig.: Diagram depicting the relationship between a district and the vaccination centers in that state

The above image shows a district node with district_name ‘Central Delhi’ and center nodes which are having ‘In relationship’.

This In relationship is directed from center node to district node.

2. review_of

This relationship is defined between the Center node and Review node

Example representing review_of relationship between a center node and review nodes:

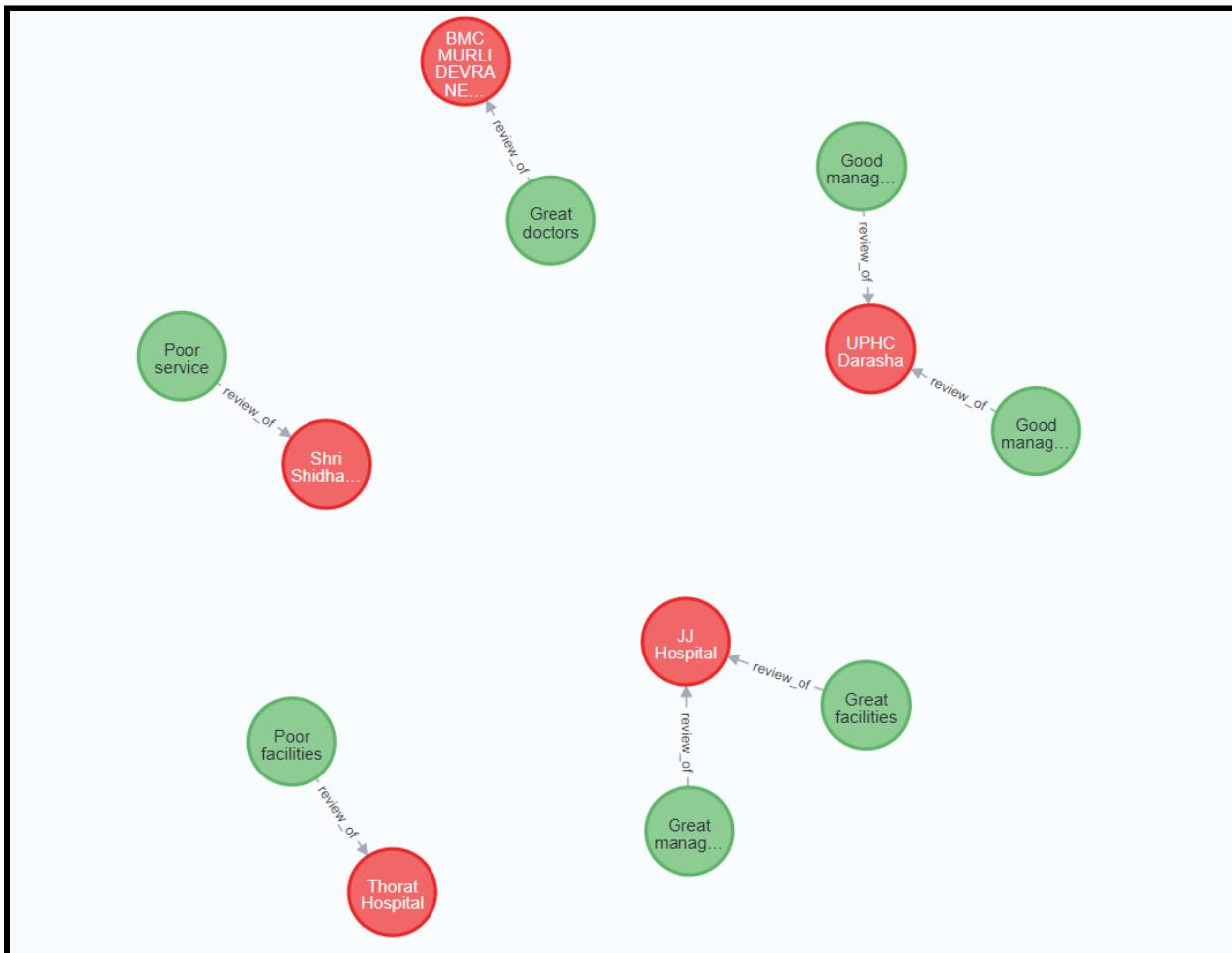


Fig.: Diagram depicting the relationship between the Review node and the Center node

The above image shows center nodes with and review nodes that are having review_of relationship.

This review_of relationship is directed from the review node to the center node.

5. Tools and Technologies

5.1. Implementation technology

5.1.1. QGIS Desktop 3.10

A Free and Open Source Geographic Information System.

It is a GIS data viewer used for daily GIS data-viewing needs, for data capture, for advanced GIS analysis, and for presentations in the form of sophisticated maps, atlases, and reports.

We have used it to create, edit, visualize and publish geospatial information which we have obtained from the Co-WIN Public API.

5.1.2. Python 3

We have written a program in Python 3, to run the query using the Co-WIN Public API.

Secondly, it was used to convert the JSON response, obtained from the API, into CSV format data.

And at last, we created and stored data in CSV format containing the response of the API.

5.1.3. NodeJS, ExpressJS

NodeJS, and ExpressJS are used for providing backend services.

Using NodeJS and ExpressJS, we have created a RESTful API that provides an appropriate response to the requests made by users.

It fetches the data from the database according to the request made by the user and returns the response in JSON format.

5.1.4. Neo4j AuraDB

Neo4j AuraDB is a fully managed cloud graph database service.

AuraDB is reliable, secure, and fully automated, enabling you to focus on building graph applications without worrying about database administration.

This database is used for storing information about the vaccination centers.

It also stores the reviews of vaccination centers as provided by the users.

5.1.5. Flutter

Flutter is an open-source UI software development kit created by Google.

It is used for developing mobile applications.

Using flutter, we have made our own app: Covid-19 Vaccination Center Finder.

5.1.6. Android Studio

It is used to develop the mobile application and run it.

5.1.7. Mapbox

Mapbox is the location data platform for mobile and web applications. It is a provider of custom online maps for websites and applications.

The Mapbox web services APIs allow you to programmatically access Mapbox tools and services.

The Mapbox Maps Service includes several APIs for creating and requesting maps.

This is used to develop a map in a mobile application where vaccination center locations can be rendered.

5.1.8. Heroku

Heroku is a container-based cloud Platform as a Service (PaaS). Developers use Heroku to deploy, manage, and scale modern apps.

It enables developers to build, run, and operate applications entirely in the cloud.

In this project, we have used Heroku for hosting the server that provides essential backend services.

6. Mobile Application

In this project, we have used Flutter for developing a mobile application.

The name of the application is **Vaccination Centers**.



This application basically displays the location of various vaccination centers in India and also provides information about the vaccination centers.

- **Key Features of the Application**
 - Users can browse vaccination centers in a particular state.
 - Users can browse vaccination centers in a particular district.
 - Users can browse vaccination centers by providing pincode.
 - Users can browse the nearest 30 vaccination centers from their current location.
 - The application provides information about vaccination centers,

which includes:

- Center ID
 - Address of Vaccination Center
 - Pincode, State, and District of Vaccination Center.
- Users can also check the location of the vaccination center on the map.
 - Users can submit the review for a particular vaccination center and can also provide ratings for the services provided at the center.
 - The mobile application also renders information about vaccination sessions planned at a particular vaccination center.

This session information is dynamic data and it changes with time.

The data about vaccination sessions planned at a particular vaccination center is fetched from the Co-WIN Public API.

Co-WIN Public APIs include Appointment Availability APIs which provide the data about vaccination sessions planned at a particular vaccination center.

This data includes:

- Vaccination Center ID
- Vaccination Center Name
- Vaccination Center Pincode
- Fee Type (whether vaccination at this center is free or paid)
- Date and time slot for vaccination
- Vaccine Name
- Age Limit
- Availability of vaccines for Dose 1 and Dose 1

Screenshots of Mobile Application:

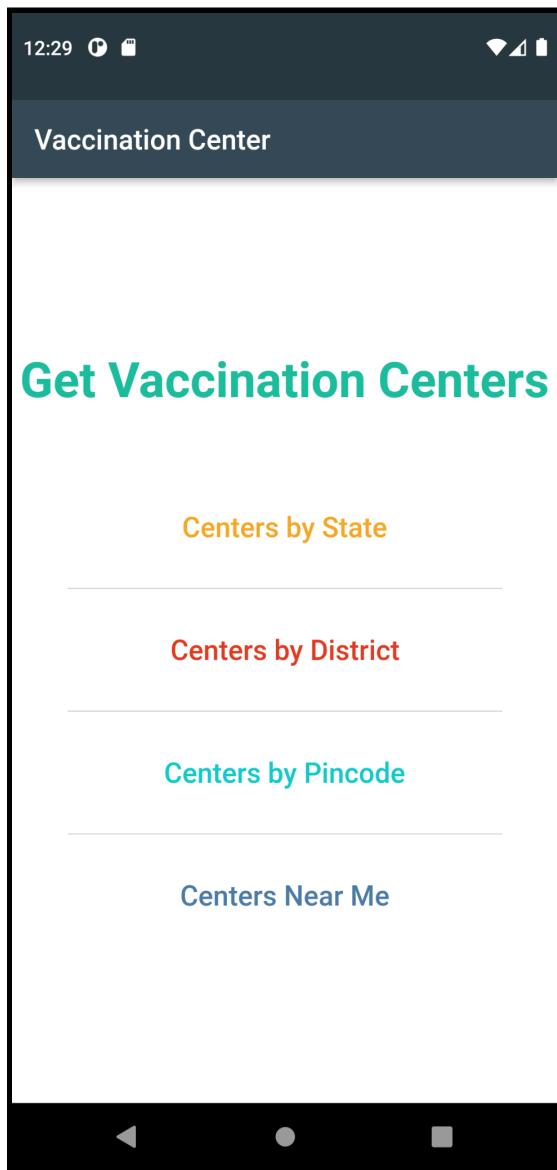


Fig.: Home screen

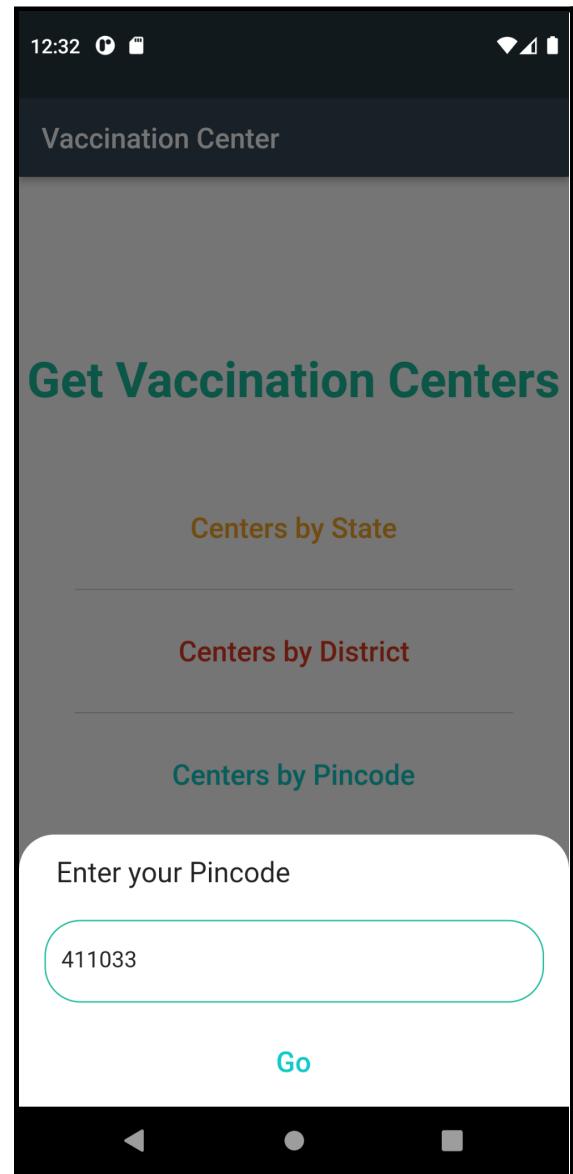


Fig.: Get vaccination centers by pincode

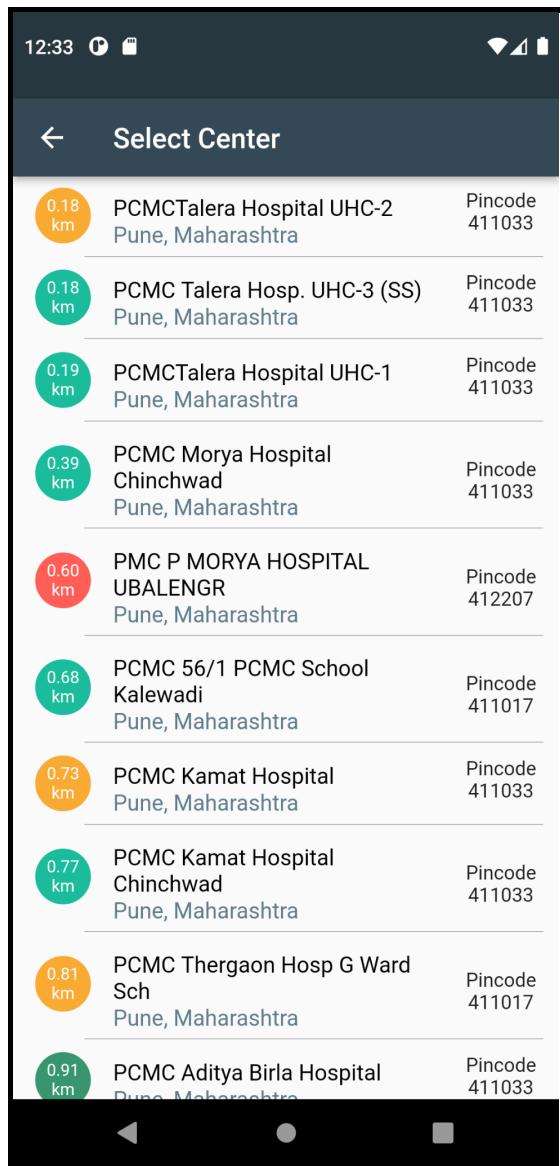


Fig.: List of all vaccination centers

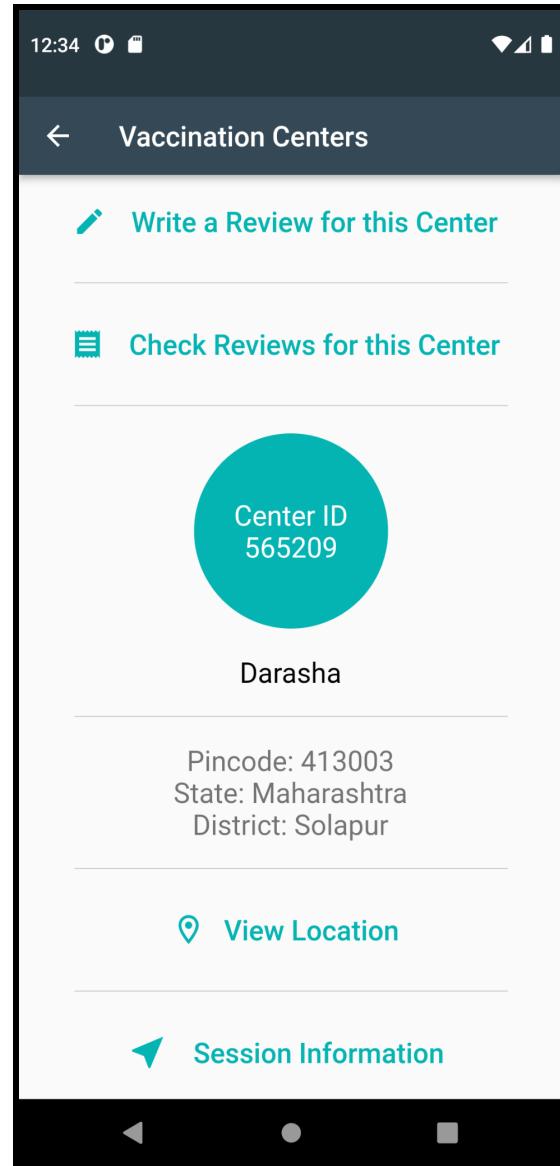


Fig.: Information of vaccination center

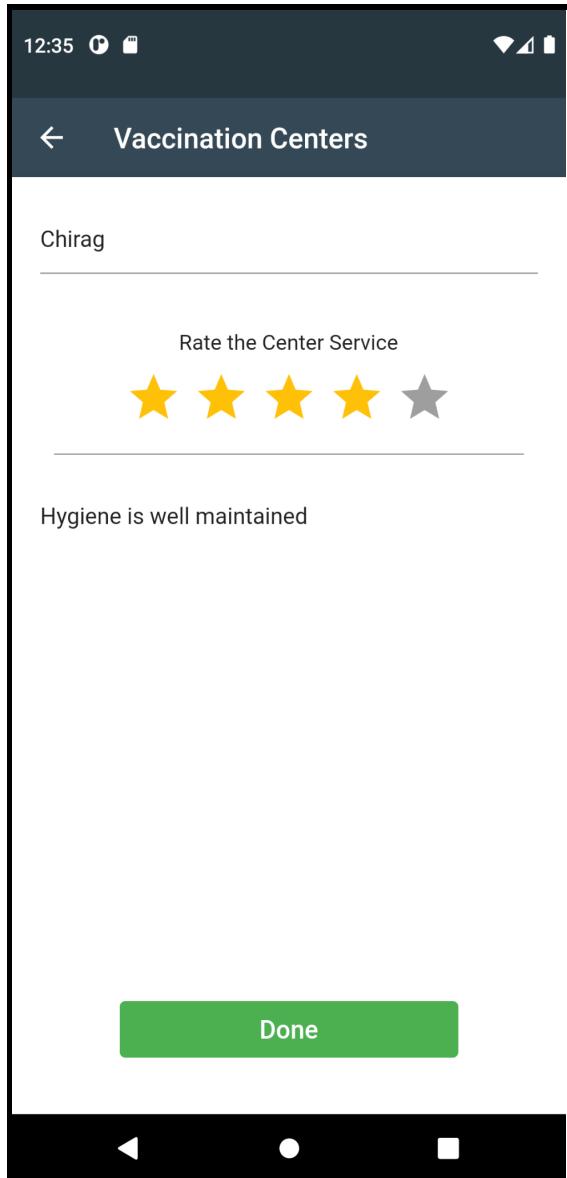


Fig.: Writing a review

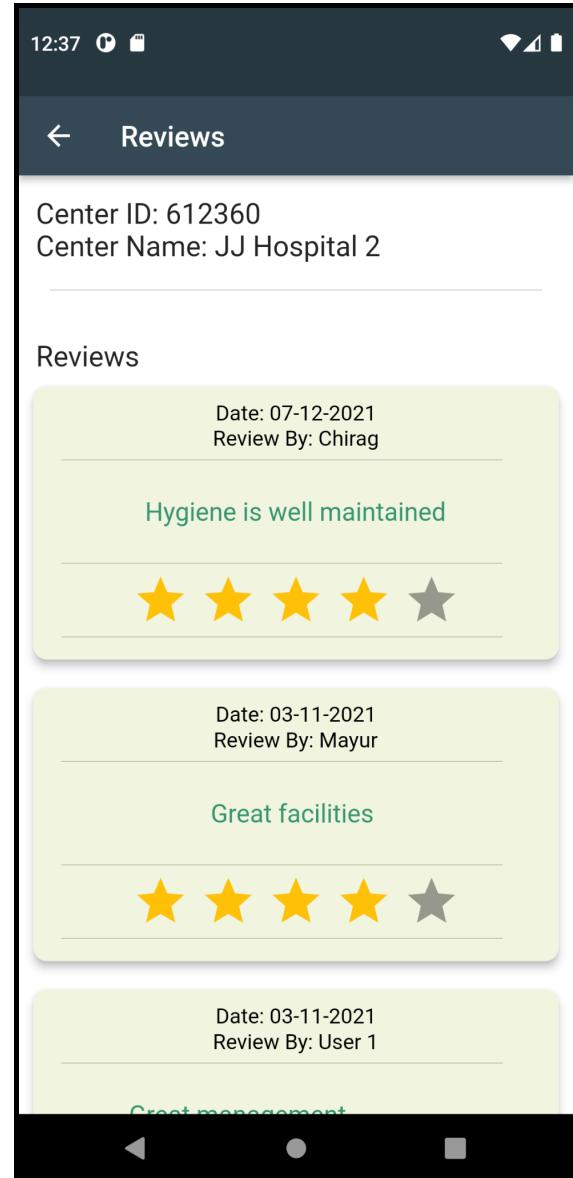


Fig.: Seeing reviews for a center

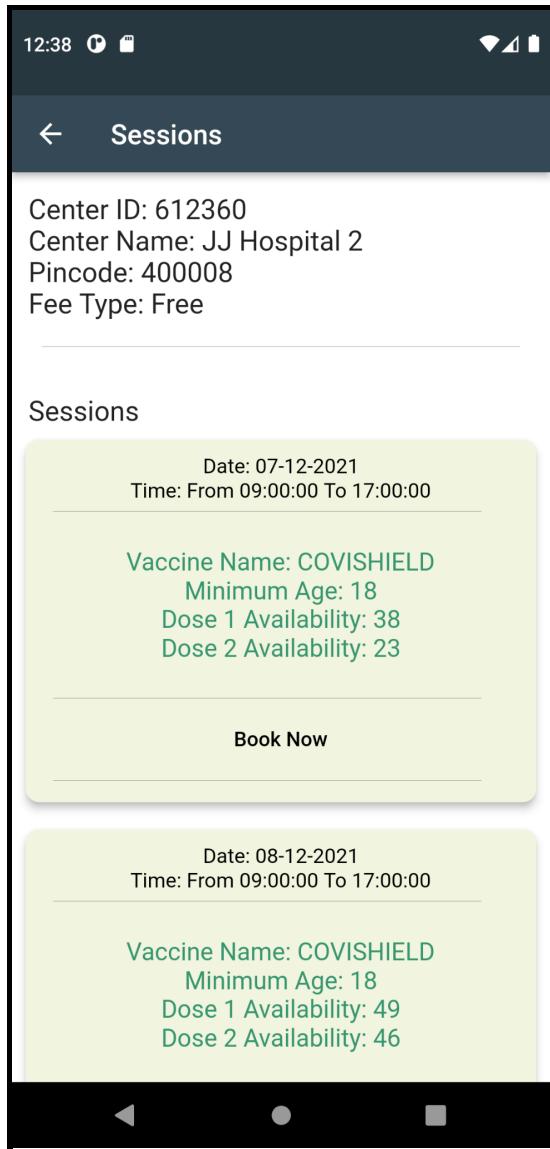


Fig.: Vaccination sessions at a center

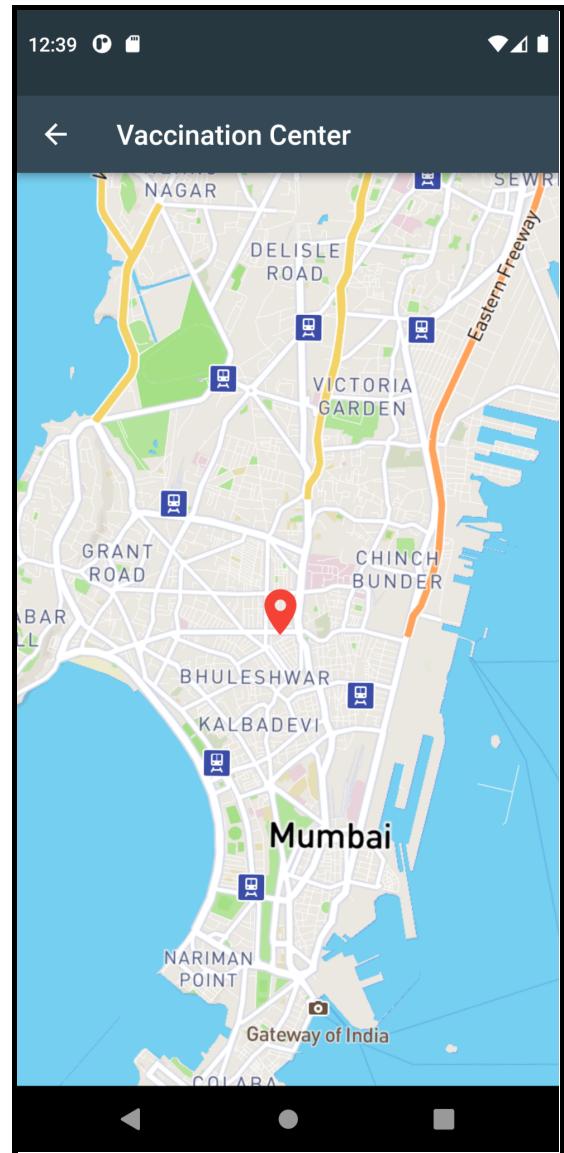


Fig.: Location of a center on the map

7. References

1. API Setu Documentation

<https://apisetu.gov.in/>

2. Co-WIN Public APIs Documentation

<https://apisetu.gov.in/api/cowin/cowin-public-v2>

3. Latitude and Longitude of Indian Cities

<https://simplemaps.com/data/in-cities>

4. MapBox API documentation for Maps

<https://docs.mapbox.com/api/maps/>

5. Neo4j AuraDB

<https://neo4j.com/cloud/aura/>

6. Spatial Analysis

<https://mgimond.github.io/Spatial/introGIS.html>

7. QGIS Tutorials

<https://www.qgistutorials.com/en/>