INDIA INTERNATIONAL SCIENCE FESTIVAL 2023

SPACE HACKATHON

In Association with

Team Name: Stellarcoders

Name of College/University: Indian Institute of Information Technology, Vadodara

Team Member Details:

- Talpada Foram Jiteshbhai
- Janmay Joshi
- Nitya Patel

Problem Statement:

Aadhaar Centre Placement Challenge
Strategic placement for efficient service delivery.
Leveraging nighttime light, population density, and census data.

Significance:

Critical for Improved Coverage.
Nighttime light indicates economic activity.
Population density helps identify high-demand areas.
Census data tailors services to local population needs.

Topological Approach:

Utilizing Topological Spaces
Topological spaces around existing Aadhaar centres.
Radius calculated based on population density.

Objective: Identify gaps or holes in coverage.

Detailed Proposal and Solution Approach

Spatial Analysis
Nighttime Light Overlay
Overlaying district polygons with nighttime light data.
Identifying economically active areas.

Hole Detection:
Topological Analysis
Gaps or holes in coverage identified.
Prioritizing areas based on nighttime light and population density.

Candidate Selection:
Strategic Placement
Selecting candidate locations in identified holes.
Prioritizing candidates based on higher population density.

Accessibility Analysis:
Transportation Considerations
Considering transportation infrastructure.
Ensuring optimal accessibility for the local population.

Integration of Census Data:
Demographic Tailoring
Integration of census data.
Tailoring Aadhaar services to local demographics.

Optimization:
Fine-Tuning Placement
Use of optimization algorithms.
Goal: Minimizing total distance traveled to reach a centre.

Validation and Iteration:
Real-World Validation
Validating proposed locations against real-world conditions.
Iterative refinement based on community feedback and changes.

Tools and devices used on development

- Primary Language : Python
  Utilized for its versatility and extensive libraries.
- Data Analysis : Pandas,NumPy for data manipulation
- Spatial Analysis : Geopandas, Shapely for geographic and data processing.
- Optimization : Scipy, optimization libraries.
- VIsualization : Matplotlib, Seaborn for creating visualizations.

Technologies involved/used

- Spatial Analysis Technologies: GIS Tools . Geographic Information System tools for overlaying shapefiles.
- Spatial Analysis Techniques : Leveraging spatial analysis techniques for identifying economically active areas.
- Data Processing Technologies: Data Handling. Custom scripts for processing population density, census and nighttime light data.
- Optimization Libraries : Leveraging Scipy for fine-tuning Aadhaar Centre placement.
- Visualization Technologies : Matplotlib and Seaborn for generating maps and charts.

Flowchart of Proposed Approach

References

Carlsson, Johansson - Topological Data Analysis with Applications (2022)
Botnan - Topological Data Analysis Mastermath (2022)

GitHub Link - https://github.com/nityapatel19/aadhar-centers-tda

Initial Results and Analysis

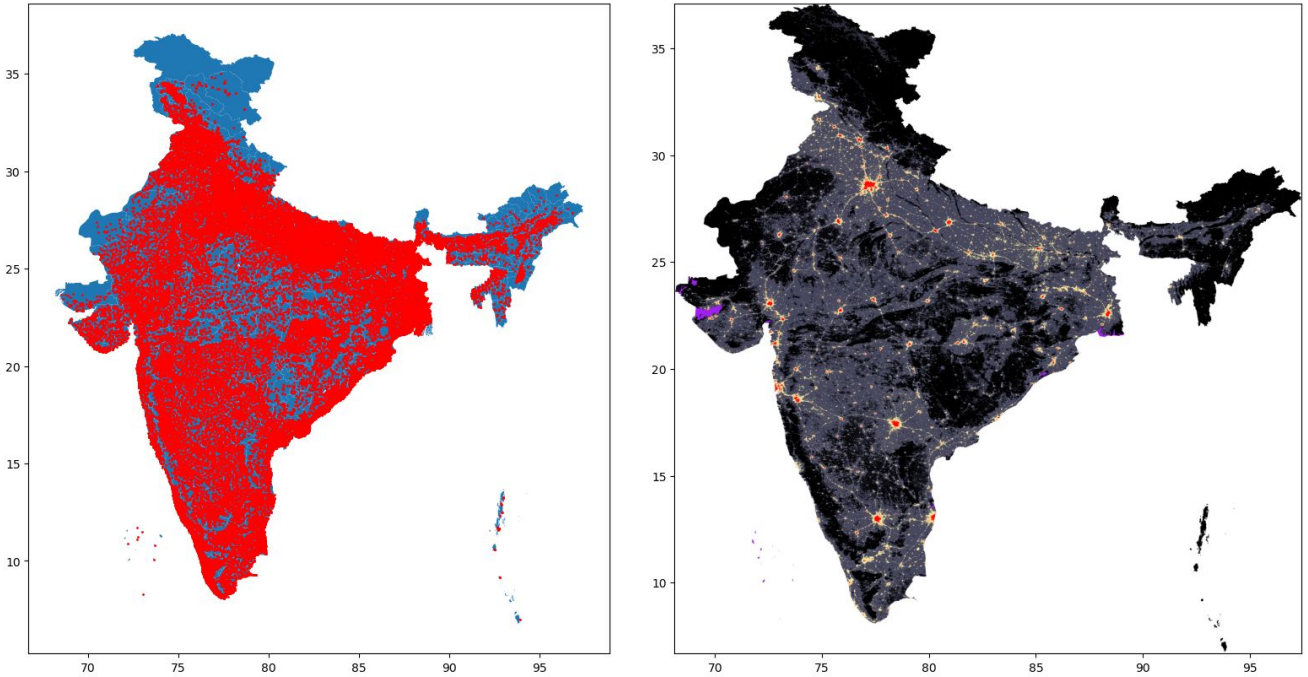

Fig: (a) Existing Adhaar Centers on the Indian Map (b) Night Light data

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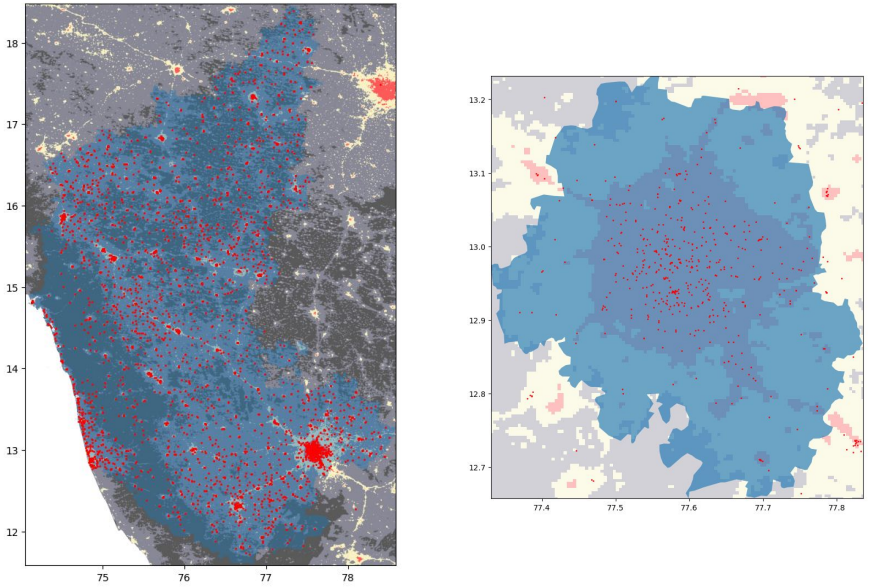

Fig: Data from Karnataka and Bengaluru

Remarks: We can see that some areas on the outskirts have higher population density but don't have enough centers in their vicinity. So using our proposed method of using a Topological space using a radius of centers based on population density will be able to find out and show these areas as holes in our final outcome to find the places which most need a center.

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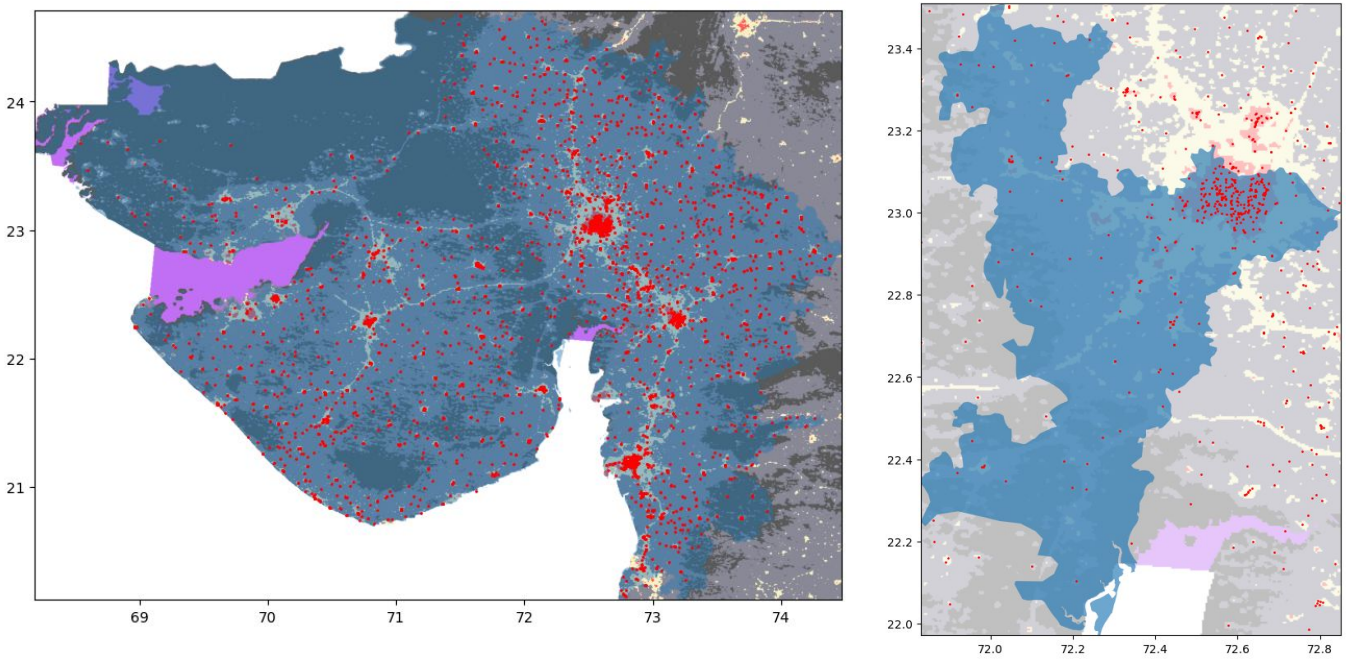

Fig: Data from Gujarat and Ahmedabad

Remarks: In Gujarat and Ahmedabad we can see that most the areas with higher population density have centers. Our proposed approach would be able to accurately approve these centers as well, and tell us that we do not need a set of new centers to be set up in Ahmedabad district.