MS By Research Thesis Defense Presentation

LSI-STAT: A Visualization and Analytics Platform

Under the guidance of
Dr. K S Rajan, Head, LSI

Outline

- Introduction on Analysis and Visualization
- OLAP to Spatial OLAP
- Research Questions
- Research Objectives
- Examples of existing tools
- Analysis of existing tools
- LSI-STAT: Design and Development
- Demo 1
- Case Study 1: Online Retail Data
- Demo 2
- Case Study 2: Visualizing Health Services in Khammam, Telangana
- Demo 3
- Conclusion

Introduction on Analysis

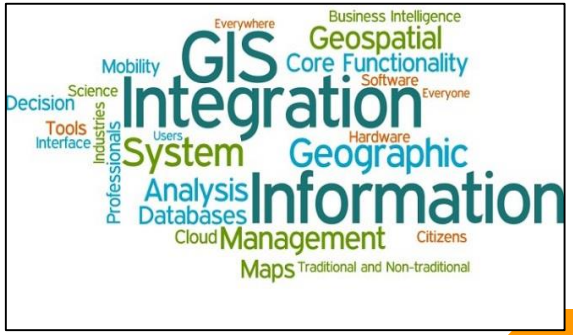
IIIT, HYDERABAD

- Data exploration helps to gain an **overall understanding of data, its context** and the **interesting variables** that are present.
- Based on this, different questions can be generated and verified.
- Several **interesting patterns can be discovered which were not obvious before**.

Introduction on Analysis (2)

- Understanding **locations of objects** along with their attributes and **how they vary over time** helps discover hidden insights and patterns in data.
- A large number of tools are available for single and multiple variable analysis but **analyzing multiple variables over a period of time across different regions** is still a challenge.

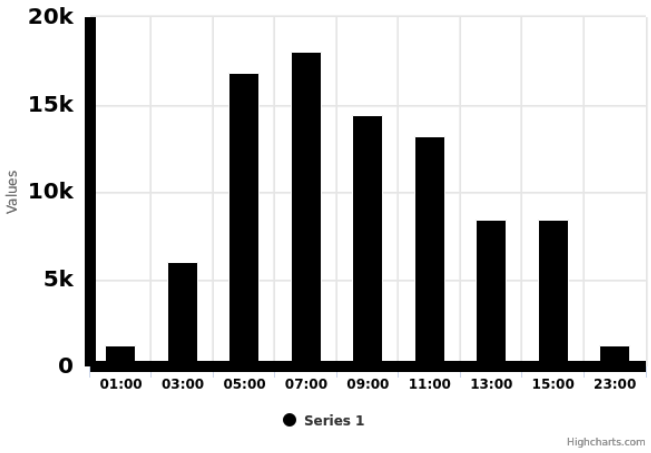
Bubble Chart



Word Cloud

Introduction on Visualization

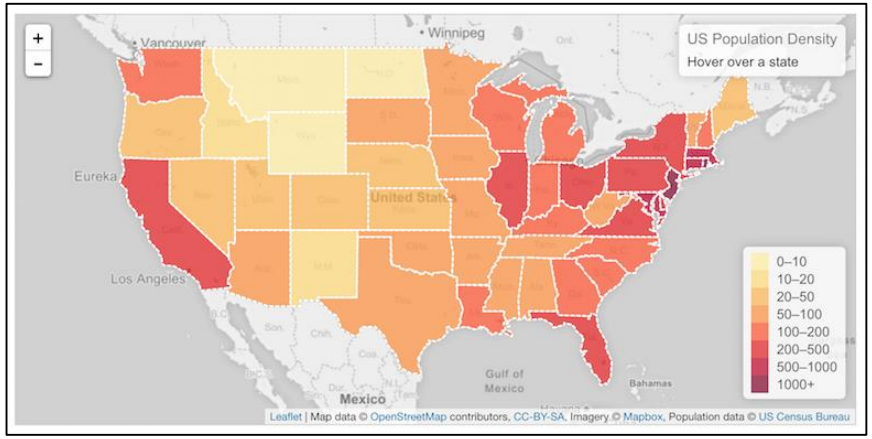
- **Statistical analysis** alone is not always sufficient to make inferences from data.
- **Interaction** in most visualization tools **is limited to panning or zooming to different levels** in the map without any change in values displayed.



Hour	Product Sales
1:00	1200
3:00	6000
5:00	16800
7:00	18000
9:00	14400
11:00	13200
13:00	8400
15:00	8400
23:00	1200

Introduction on Visualization (2)

- **Choropleth mapping techniques** used involve visualizing values over a geographical area in relation to a single variable.
- **Charts** can be used for **visualizing relationships and patterns between two or more variables.**
- Graphs in different spatial regions **may show similar trends at particular level** however **on aggregation/disaggregation to another level, the pattern may be lost.**



Choropleth Map

OLAP to Spatial OLAP

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- **OLAP technology** helps users see multi-dimensional view of data and perform drill-up and drill-down operations but **they don’t consider geospatial characteristics for decision-making**.
- On **combining GIS with OLAP tool features**, OLAP can be extended to spatial systems.
- Spatial OLAP helps us look at interactions between spatial objects as well.
- But it comes with its own set of challenges.

Research Questions

- **Can the maps be made more intuitive to the information they are presenting?**

  - Provide for a platform which allows user to choose from different visualization options

  - Add fields be added to the menu on the fly instead of precomputing them

  - Change the geo-related information change with changing geographic extents

- **How do we incorporate geo-hierarchy in the analysis?**

  - Create a linking between attribute data and geographical data

  - Extend platform to look across time-scales and spatial-hierarchical levels

- **Can such a platform be developed entirely using open source tools and technologies?**

  - Gain new and interesting insights to find patterns in data using visualization

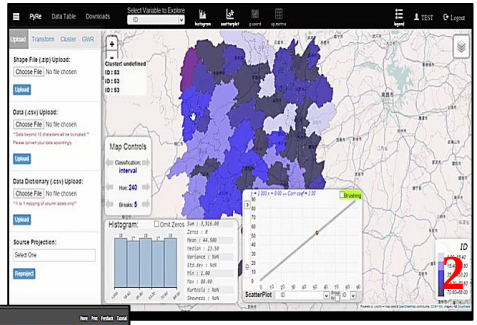
Research Objectives

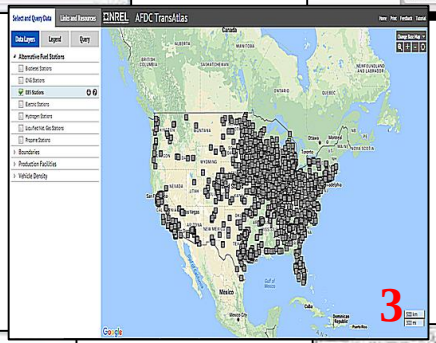
- Develop a **web-based spatio-temporal interactive analytical platform** which generates dynamic data visualizations based on user-given data and captures both spatial and temporal variations in map.
- Find a way to **incorporate user-defined hierarchy** in the platform and **compute aggregation on field names**.
- Provide for a way to handle **field level information and its aggregation options associated with the respective geo-hierarchies** on a user need basis.
- A system to allow **for temporal visualization (charts) over geographical region**
- **Apply the system over real-world use-cases** where it can help provide valuable insights into the data for knowledge extraction.

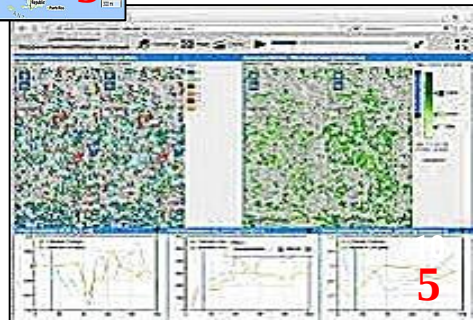
Note: Evaluating the cause of some of these interactions or outcomes is out of the scope of this thesis.

Current Spatio-Temporal Visualization Toolkits

- Large variety of spatio-temporal visualization toolkits with different set of features are present today.
- A few popular and unique spatio-temporal visualization toolkits are shown here
    1. Tableau
    2. EWGAT
    3. TransAtlas
    4. GeoVista CrimeViz
    5. LANDIS-II







Features in Existing Toolkits (1)

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Toolkit	UI Design	Legend	Charts on map for each data point	Timeslider	Zoom
TransAtlas	2D	Y	N	N	Y
LANDIS-II	2D	Y	N	Y	Y
Tableau	2D	Y	Y	Y	Y
EWGAT	2D	Y	N	N	Y
GeoVista CrimeViz	2D	Y	N	Y	Y

Features in Existing Toolkits (2)

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Toolkit	Overlay	Multiple Map Types	Multiple Data Input types
TransAtlas	Y	Y	N
LANDIS-II	N	N	N
Tableau	Y	N	Y
EWGAT	N	N	N
GeoVista CrimeViz	Y	Y	N

Features in Existing Toolkits (3)

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Toolkit	Geocoding (inbuilt)	Connection to DB	Aggregation / Dis-aggregation on zoom
TransAtlas	NA	N	N
LANDIS-II	NA	NA	N
Tableau	Y	Y	Y
EWGAT	Y	N	N
GeoVista CrimeViz	Y	Y	Y

Observations and Summary

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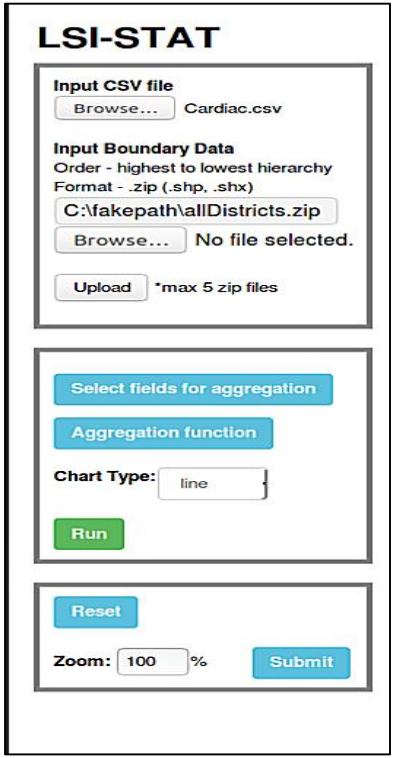
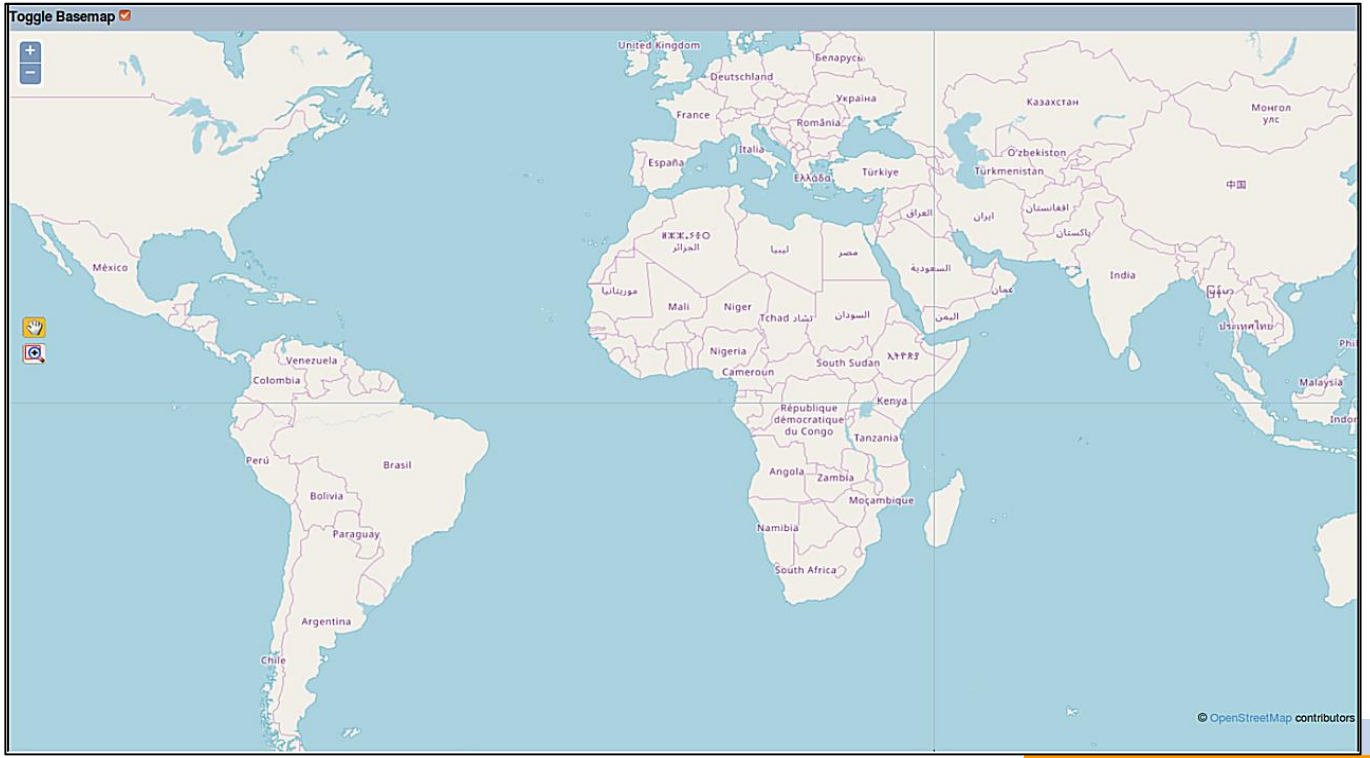
- **Pre-stored Data:** Data is pre-stored in some tools. Eg. LANDIS-II, TransAtlas
- **Map-based or Graph-based:** Some are map-based. Eg. EWGAT, TransAtlas, LANDIS-II and GeoVista CrimeViz. Others are graph-based tools. Eg. Tableau
- **Single or Multiple Geometry**: Some of them represent multiple geometries at a time. Eg. Tableau. Others are not able to do so. Eg. EWGAT, LANDIS-II
- **Open Source or Proprietary:** Some tools are open source. Eg. EWGAT, TransAtlas
- **Spatial interaction:** Neighboring trends and geometries are not captured by all tools. Eg. LANDIS-II
- **Data input:** Some allow only one format. Eg. EWGAT. Others allow multiple formats. Eg. Tableau
- **Feature Implementation:** A simple feature may be implemented differently in different tools. Eg. Time Slider feature.
- **Number of Features:** Not all features are present in most tools today. In any kind of tools that are currently available, we catch a couple of them and we lose some of them.

Design and Development of LSI-STAT





Overall System Design Criteria

- **System usability, user-friendliness** and **performance** were the main criterion used
- It is assumed that user **may or may not have any knowledge of GIS** to use this tool
- The user should not require to **install additional software or undergo any training** to use this tool

System Objectives

- **Handling temporal patterns**
  - Show chart and map simultaneously
  - Overlay charts on map
  - Allow user to configure chart parameters
  - Provide field names in menu options on the fly once user has uploaded input data
  - Pre-generate charts using user-given data and user-configured chart parameters

System Objectives

- **Handling data-aggregation across geo-hierarchies**
  - Display different geographical extents (boundary files) on change in geo-hierarchy level
  - Display of aggregated or disaggregated data based on change in geo-hierarchy level
  - Compute aggregation based on field names based on user-defined geo-hierarchy
- **Integrating locational and temporal patterns using principles of geo-hierarchy**
  - Incorporate spatial area aggregations in the analysis
  - Provide an integration between temporal data visualization along with its positional or locational information

LSI-STAT: Design and Development

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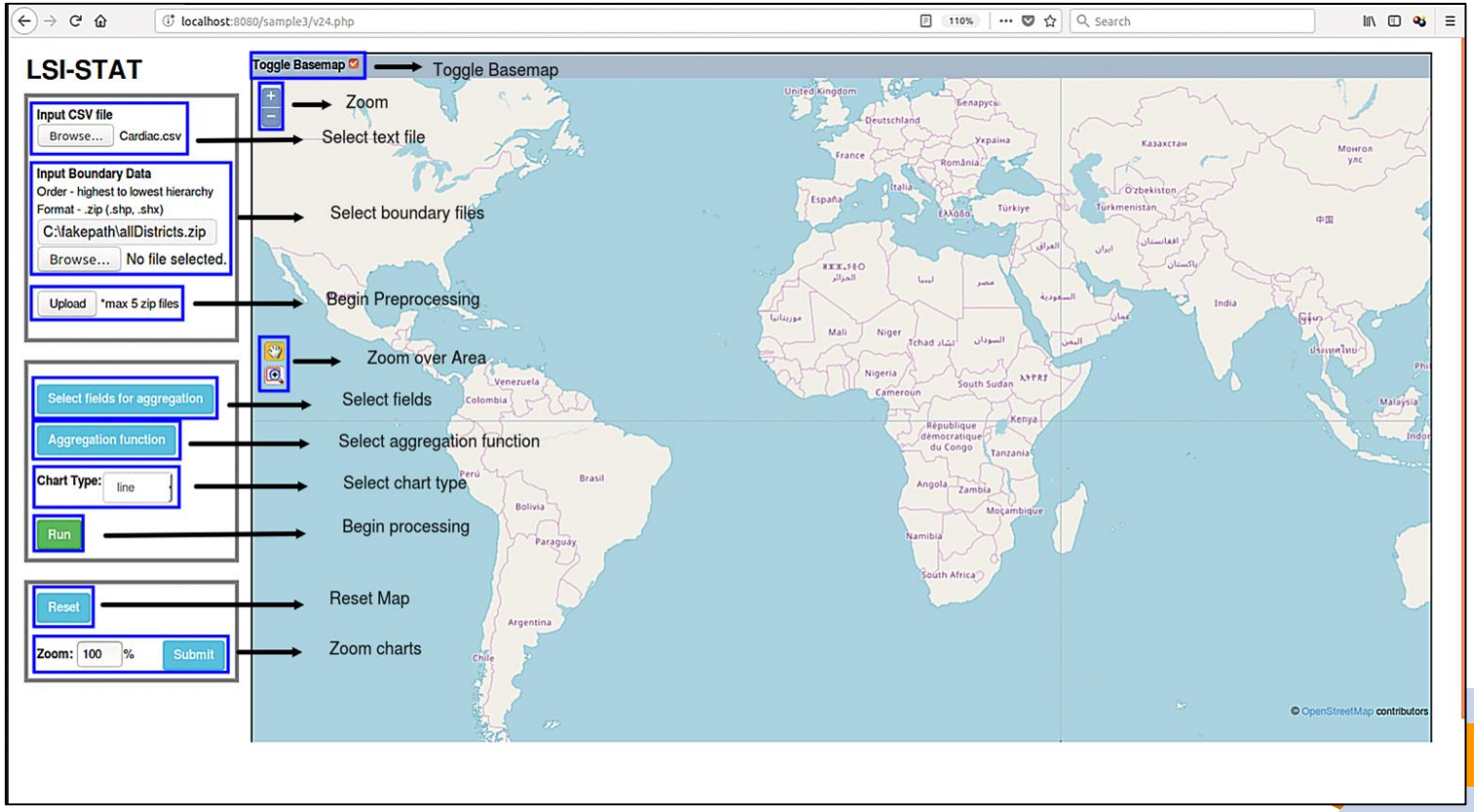
Interactive Controls

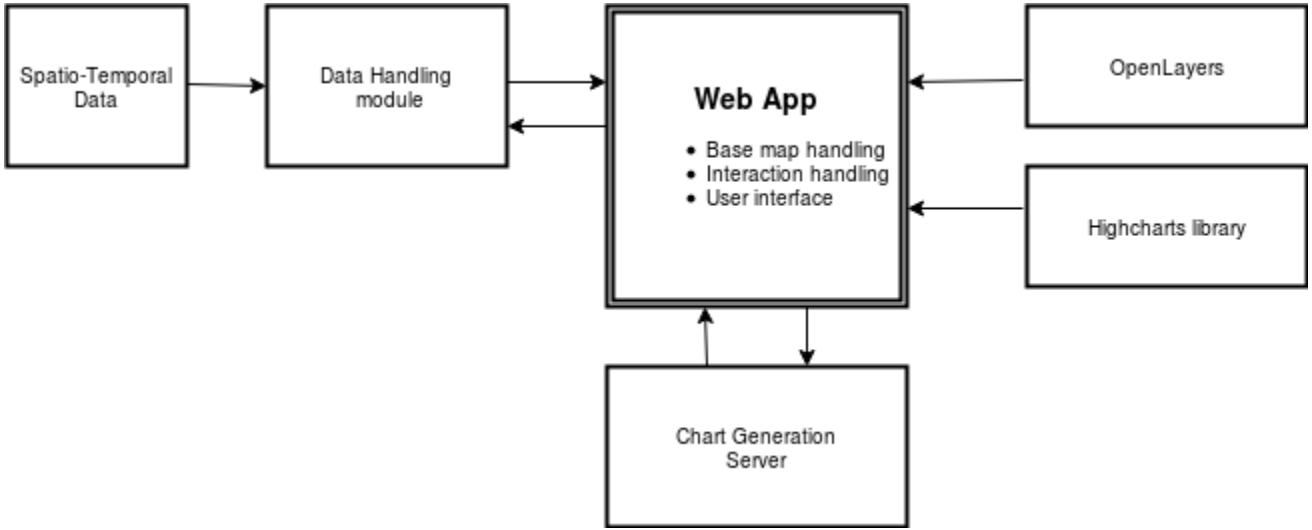


DEMO - 1

DEMO 1

Proposed Architecture

- System is hosted on **Apache Tomcat 8**.
- **OpenLayers library** is used to display map on the web page.
- Charts are configured using the **Highcharts JavaScript charting library**.
- **Phantomjs** exports charts on receiving chart generation requests.



LSI-STAT: Design and Development

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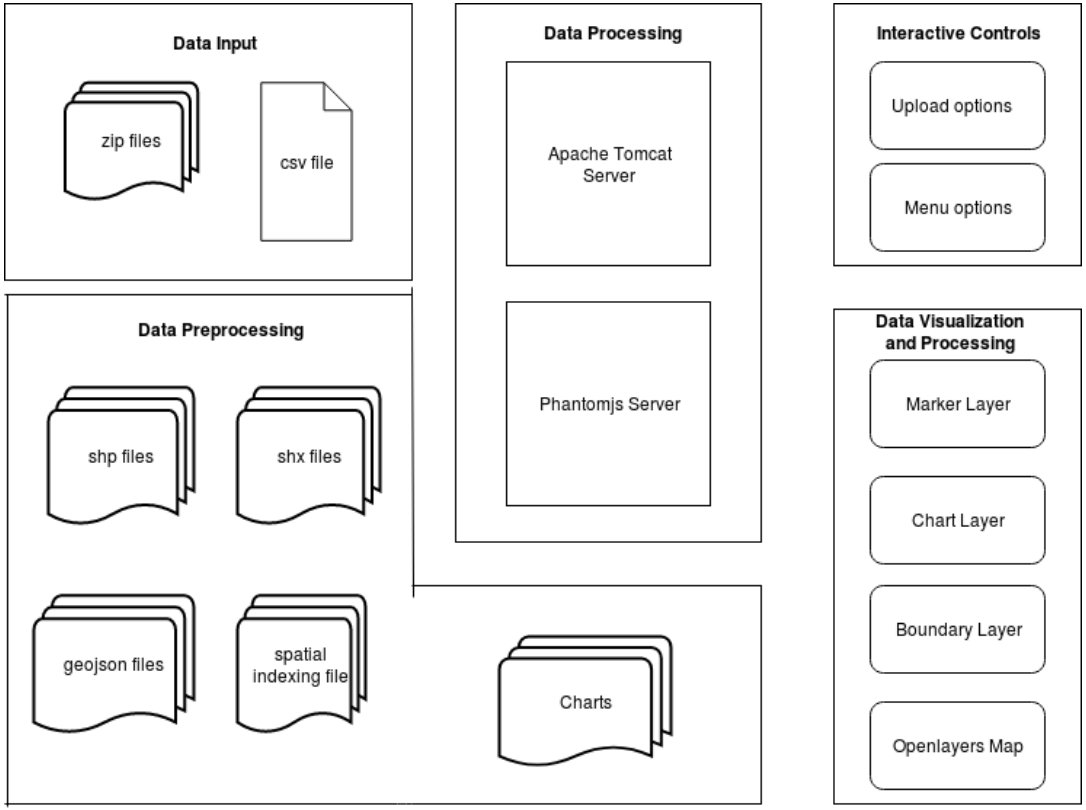
System Components

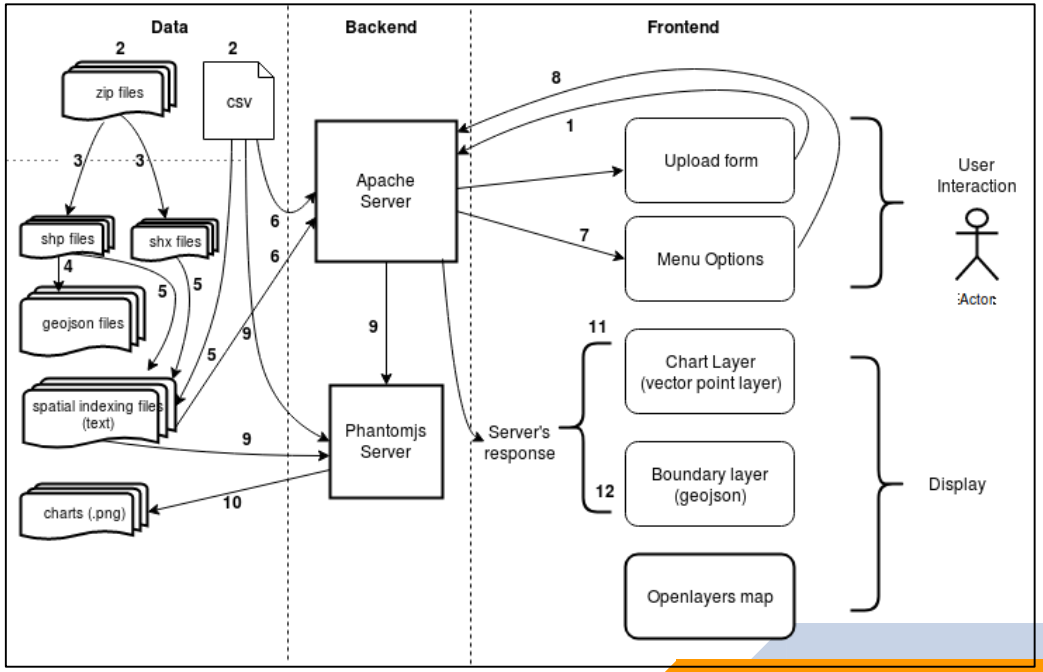


Input Data model

- Data input: csv (for data file) and zip (for boundary shapefiles).
- Levels of spatial boundaries: 5.
- Latitude and Longitude coordinates: To be given by user in csv file.
- Boundary file hierarchy: To be given by user from the highest to lowest level.

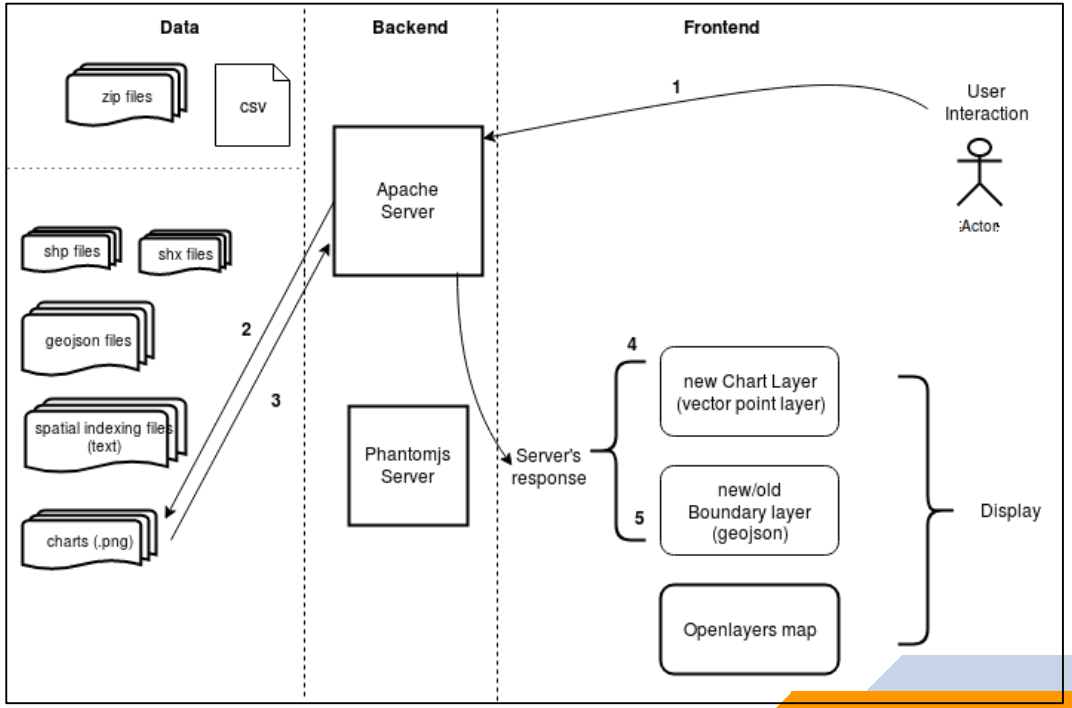
Working flow of the system

- Three sections- System Backend, System Frontend and Data sections.
- System Backend: Apache Tomcat Server and Chart Generation Server (Phantomjs).
- Data section: User input data, pre-generated charts, spatial model etc.
- System Frontend: Interactive controls for the user and layers to be displayed on map.



Change in zoom level

1. New geo-hierarchy level is calculated based on the zoom level.
2. If the new geo-hierarchy level is different from the previous one, new charts are to be displayed.
3. These charts are obtained from chart cache by the tool.
4. A new vector layer composed of another set of charts is created.
5. This layer is then rendered along with the new geojson layer in the map panel of the browser.



GeoBI - Online Retail Case Study

Aim:

- To demonstrate the application of LSI-STAT using a GeoBI case study
- To show the utility of the tool for online retailers in finding:
  - Their popular products
  - Regional preferences
  - Popular payment options etc.

Input Data Used:

- Online Retail data (publicly available dataset):
  - Time-period: 1st to 31st January, 2009 (day-wise sales data)
  - Data: 999 records
  - Type: Spatio-Temporal Dataset
  - Attributes (30): transaction_date, product, price, payment_type, name, city, state, country etc.
  - Temporal-hierarchy (3 levels) – Hour, Day, Month
- Boundary shapefiles of World, Continent, UK and Canada

GeoBI - Online Retail Case Study

IIIT, HYDERABAD

Preparing input files:

- Added latitude and longitude to input data [Source: Google Maps]
- Added additional attributes:
  - Product1Sales, Product2Sales, Product3Sales
  - Hourly Total Sales
  - Payment Type Visa, Payment Type Amex, Payment Type MasterCard, Payment Type Diner

Generating multiple visualizations:

- Used combinations of different attributes, time-periods and geo-location
  - Attributes: Single, Multiple or Aggregated
  - Time-Periods: Single, Multiple or Aggregated
  - Geo-locations: Single or Multiple Points

DEMO - 2

DEMO 2

Case Study Results

- Total sales of retail data all over the world were found to be 1551000.
- Among the three retail products, product1 was sold in maximum quantity (1028400), followed by product2 (489600) and product3 (112500).
- Time-series analysis of retail data showed the peak hour for online sales in United Kingdom (UK) at 7am in the morning (18000). Almost no sales of any product occurred after 4pm
- Top five countries with maximum sales of retail data were found to be - United States of America, United Kingdom, Canada, Switzerland and Israel.
- The payment options in decreasing order of popularity were found to be Visa, MasterCard, Amex and Diners.

Visualizing Health Services access and reach in Khammam district, Telangana case study

Aim:

- To demonstrate the application of LSI-STAT using case study on visualizing health services
- To show the utility of the tool for policy makers in finding:
  - Regions which lack certain healthcare services
  - Regions which have fewer healthcare facilities
  - Identify services to be added to an existing healthcare facility etc.

Visualizing Health Services access and reach in Khammam district, Telangana case study

IIIT, HYDERABAD

Input datasets:

- Patients claims data of Rajiv Aarogyasri Health Insurance Scheme in Khammam district of Telangana
- Census data of Khammam district [source: District Handbook of Andhra Pradesh]
- Travel time estimates (on road) for a patient to reach the nearest hospital [source: google map]
- Administrative level boundary shapefiles of India.

Patient claims data of Rajiv Aarogyasri Health Insurance Scheme:

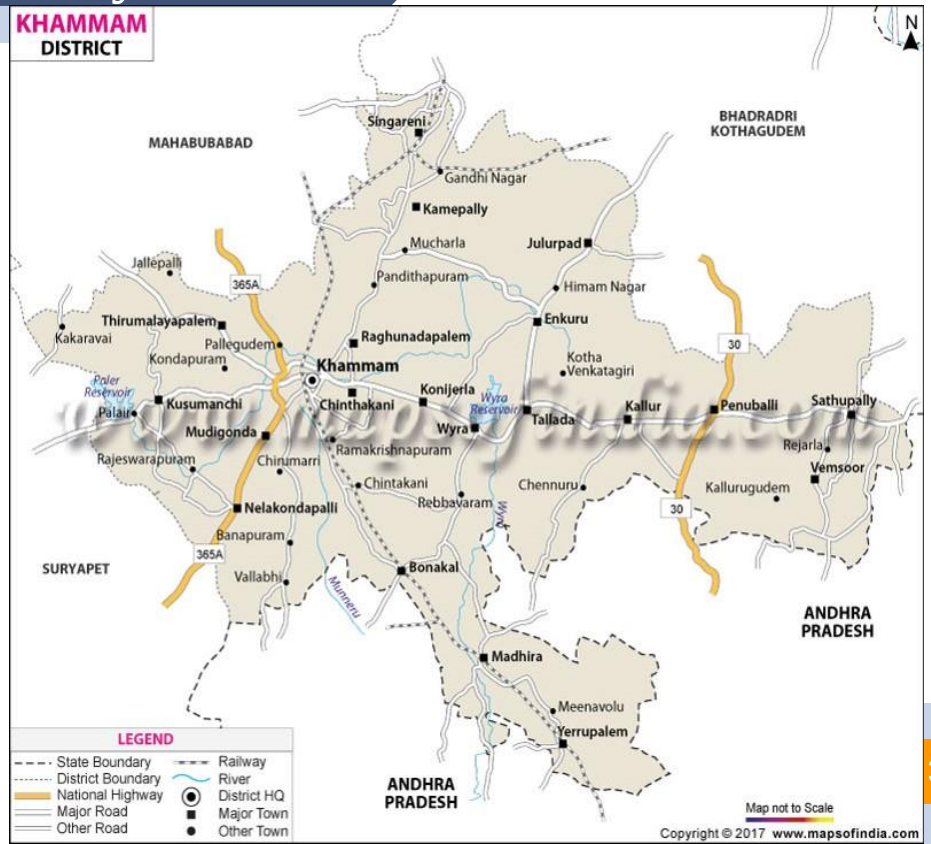
- Data: 6000+ records.
- Type: Spatio-temporal Dataset
- Time-period: July 2013 to July 2015 (Day-wise counts for 24 months).
- Data Attributes (27): card number, village, mandal, district, category, hospital name, type of hospital, pre-auth date and claim amount
- Geographical-hierarchy: 3 levels (Village, Mandal, District)
- Temporal-hierarchy: 3 levels (Day, Month, Year)

Visualizing Health Services access and reach in Khammam district, Telangana case study

IIIT, HYDERABAD

Study Area:

- Khammam is a district located in Telangana state in India
- Total population: 1,401,639 (2011 census)
- Density of 320 per square km.
- District is sub-divided into mandals.
- District Headquarters: Khammam (city)



Visualizing Health Services access and reach in Khammam district, Telangana case study

IIIT, HYDERABAD

Scope of the study:

- Patients from Khammam district travel to hospitals within Khammam district.
- The population of a mandal is uniformly distributed across its area.
- Eleven hospitals included in the insurance scheme since the year 2013 were considered. They are:
  1. Area Hospital - Badrachalam
  2. Area Hospital - Kothagudem
  3. Area Hospital - Penuballi
  4. Area Hospital - Sathupally
  5. Area Hospital - Paloncha
  6. District Hospital-Khammam
  7. Mamatha General And Super Specialty Hospital
  8. Jayabharathi Multispecialty Hospital
  9. SriRaksha Hospitals
  10. Sri Ram Kidney Infertility and Laparoscopic center
  11. Srujan Ortho and Accident Care Hospital

Visualizing Health Services access and reach in Khammam district, Telangana case study

IIIT, HYDERABAD

Preparing input files:

- Added latitude and longitude to input data [Source: Google Maps]
- Added additional attributes:
  - Population, Time taken, Area
  - Population Density, Distance, Pop1hr, Pop1to2hr
  - Pop2hrplus, Areain1hr, Area1to2hr, Area2hrplus

Generating multiple visualizations:

- Used combinations of different attributes, time-periods and geo-location

  Attributes: Single, Multiple or Aggregated
  Time-Period: Singl, Multiple or Aggregated
  Geo-location: Single or Multiple Points

DEMO - 3

DEMO 3

Case Study Results

- Only one out of eleven hospitals provides cardiac services.
- More than 60% of the population in Khammam district was not able to avail cardiac services within travel time of one hour.
- In terms of area, it is more than 70% of the total area of Khammam district.
- For categories-gynecology and obstetrics and pediatrics patients prefer going to the nearest accessible hospital providing treatment.
- The difference between percentages of patients going to private hospitals compared to government hospitals was very high.

Comparison of LSI-STAT with Tableau and LANDIS-II

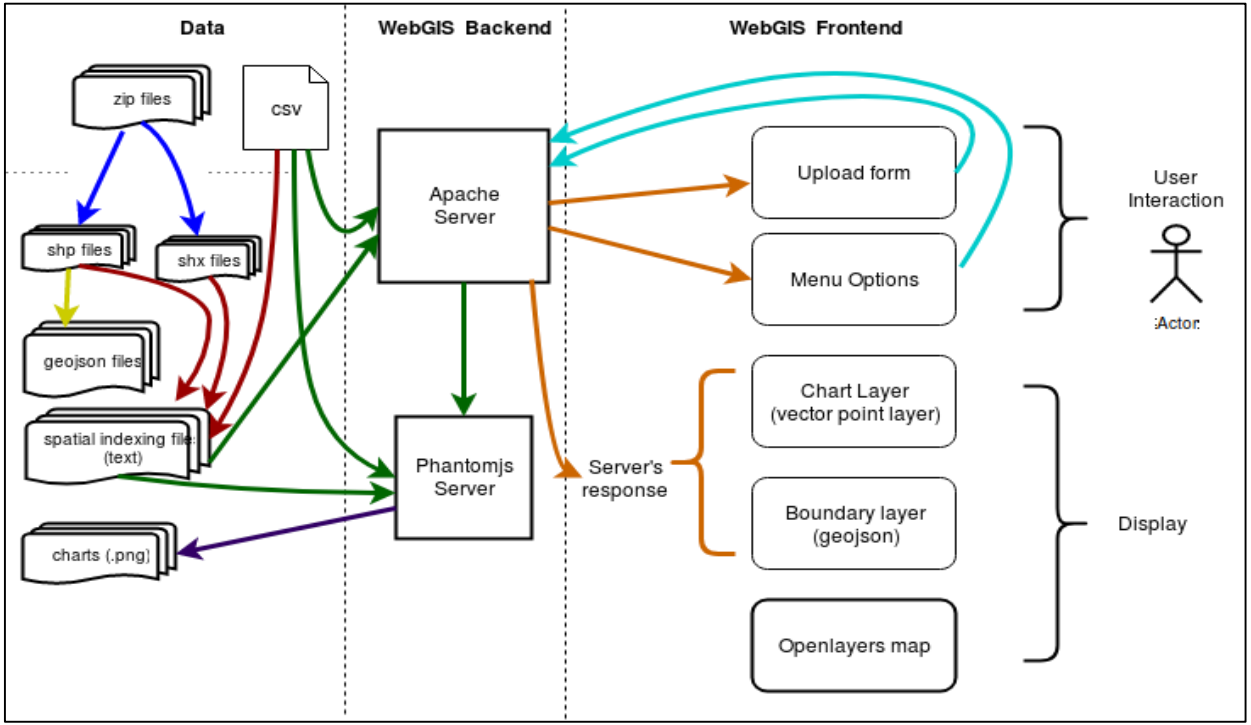
- **Pre-stored Data:** LSI-STAT and Tableau accepts user-given data whereas LANDIS-II doesn't.
- **Charts on map for each data point:** LSI-STAT shows this, Tableau show this only for pie charts recently whereas LANDIS-II doesn't.
- **Data aggregation with drill-down into the charts on map for each data point:** LSI-STAT supports this whereas Tableau and LANDIS-II doesn't.
- **Data aggregation and change in geo-hierarchy with drill-up and drill-down into the charts on map**: LSI-STAT supports this Tableau and LANDIS-II don't.
- **Capturing neighborhood with charts:** LSI-STAT and Tableau supports this whereas LANDIS-II doesn't.
- **Add fields to the menu on the fly instead of precomputing them:** LSI-STAT, Tableau supports this whereas LANDIS-II doesn't.
- **User-defined Geo-hierarchy (from boundary files):** LSI-STAT allows this whereas Tableau and LANDIS-II

Conclusion

- An **interactive, web-based, spatio-temporal, analytical tool** to find hidden patterns using both user-driven and data-driven analysis has been presented.
- The tool produces an **interactive map with online analytical capabilities** and **computes data aggregation** based on **user-defined geo-hierarchy**.
- With this tool, any user can successfully visualize data with the help of a web browser **without requiring any additional software, training or knowledge of GIS.**
- It **overcomes the limitations of the existing tools** such as allowing user to define geo-hierarchy, change in information content on zoom-in/zoom-out, visualizing more than one variable etc.
- **Two case studies** – on online retail data and another on visualizing health services access and reach in Khammam, Telangana has been presented **here to understand the application and utility of this tool.**
- A **working model of this tool** has been developed.

Thank You!!

Technologies Chosen



Color	Technologies
Blue	PHP
Red	Python, GDAL, Shapely
Yellow	ogr2ogr
Green	JavaScript, AJAX
Purple	Python, Highcharts
Orange	HTML, JavaScript, CSS
Cyan	JavaScript, JQuery

Backup Slide

Health framework consists of three important dimensions - accessibility, provision of services (availability) and reach.

- Accessibility here refers to access to health care. Are the healthcare providers available when you need them? Do they give appointments when required?
- Availability refers to the opportunity to access the right type of health care services when needed as well as having the appropriate type of service providers, materials, and equipment.
- Reach refers to the physical distance or travel time between the service delivery point (primary or secondary health facility) and the user. Are the roads well connected between the user and the health facility? What are the alternative modes of transport in the region?

Backup Slide

Future Scope

- Enhance tool features by adding additional features - TimeSlider, Word Cloud, supporting multiple data input formats
- Reduce boundary file rendering time by using tile-based approach instead of geojson

Select Attributes

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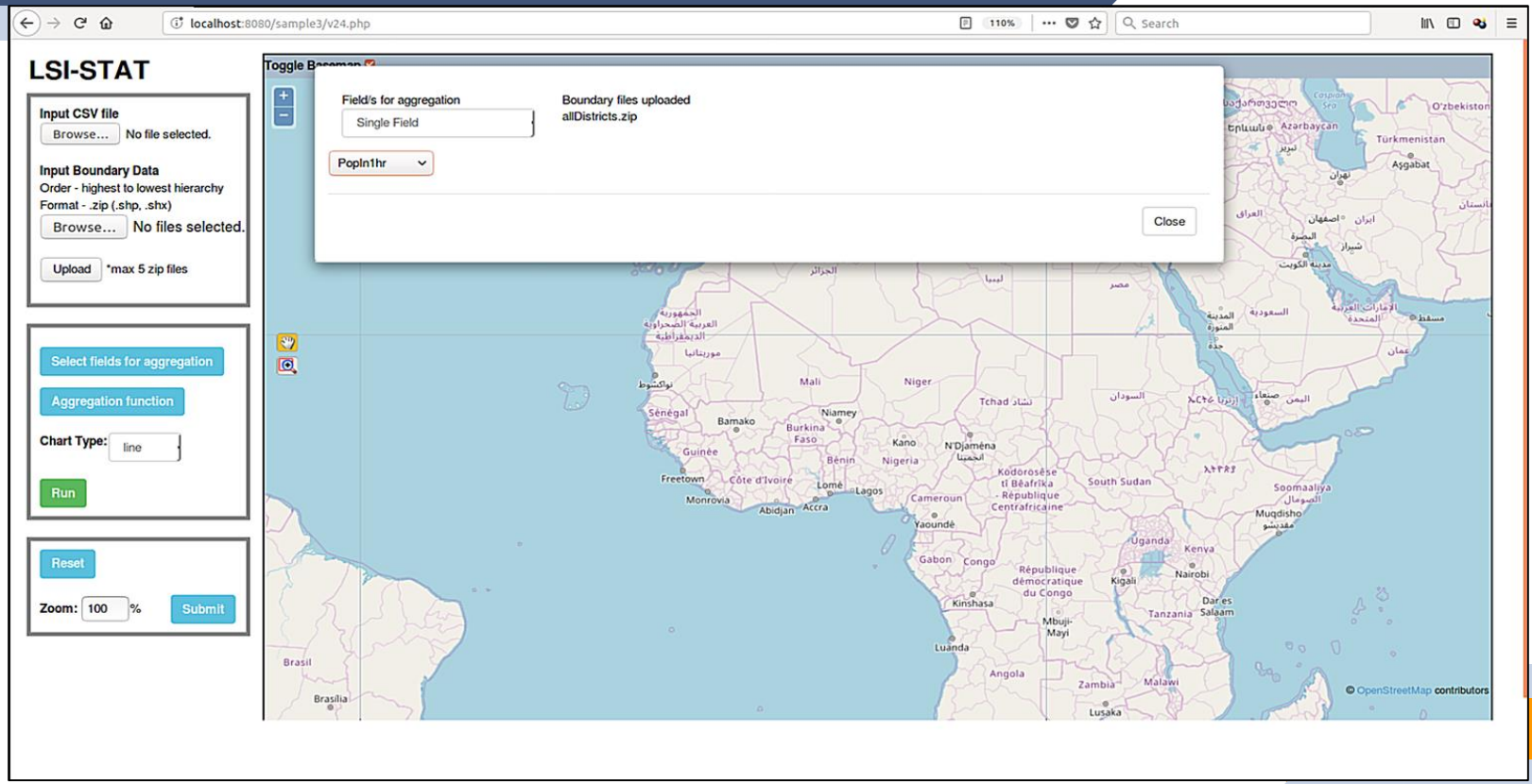


Aggregation Type

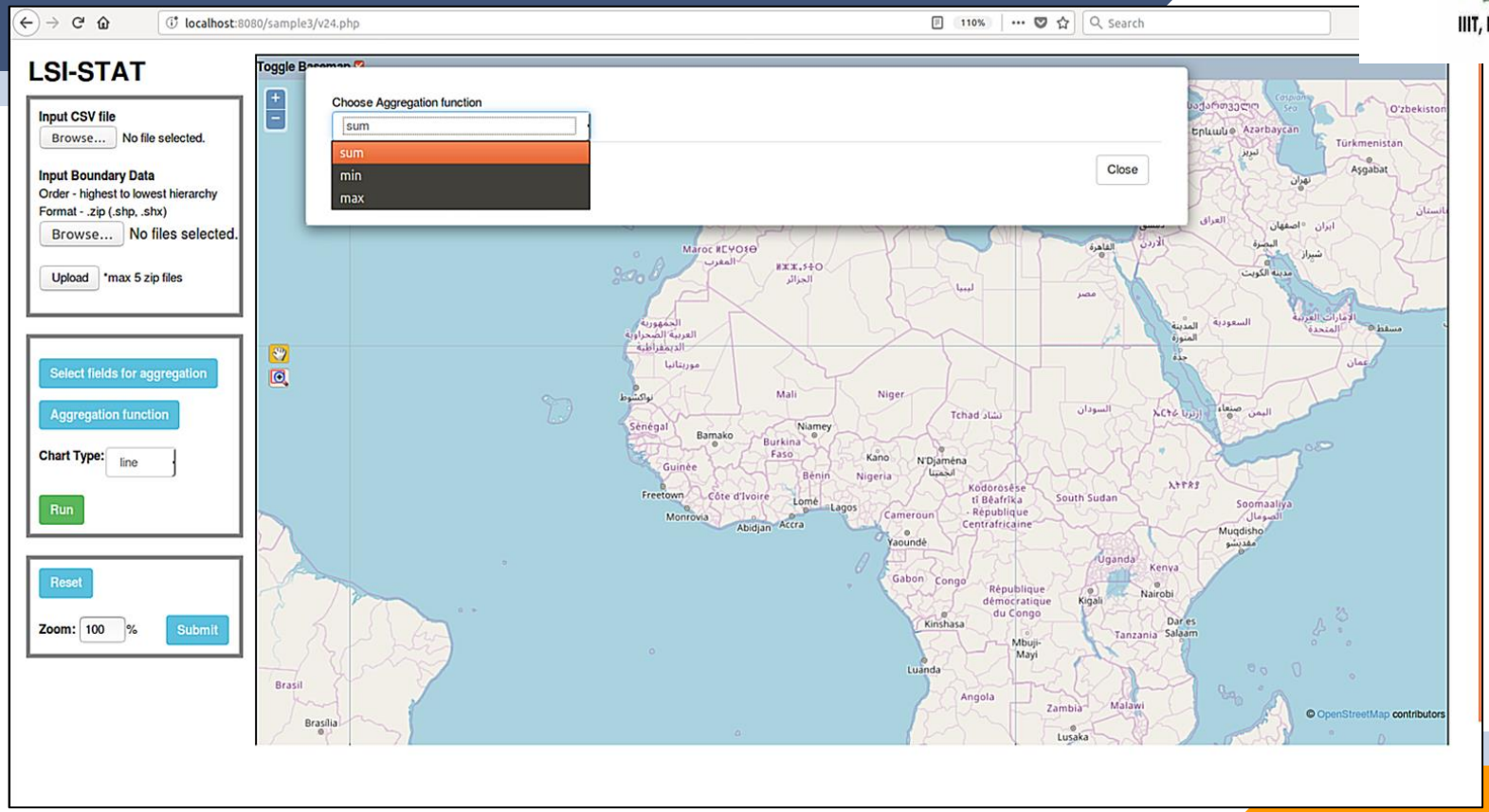
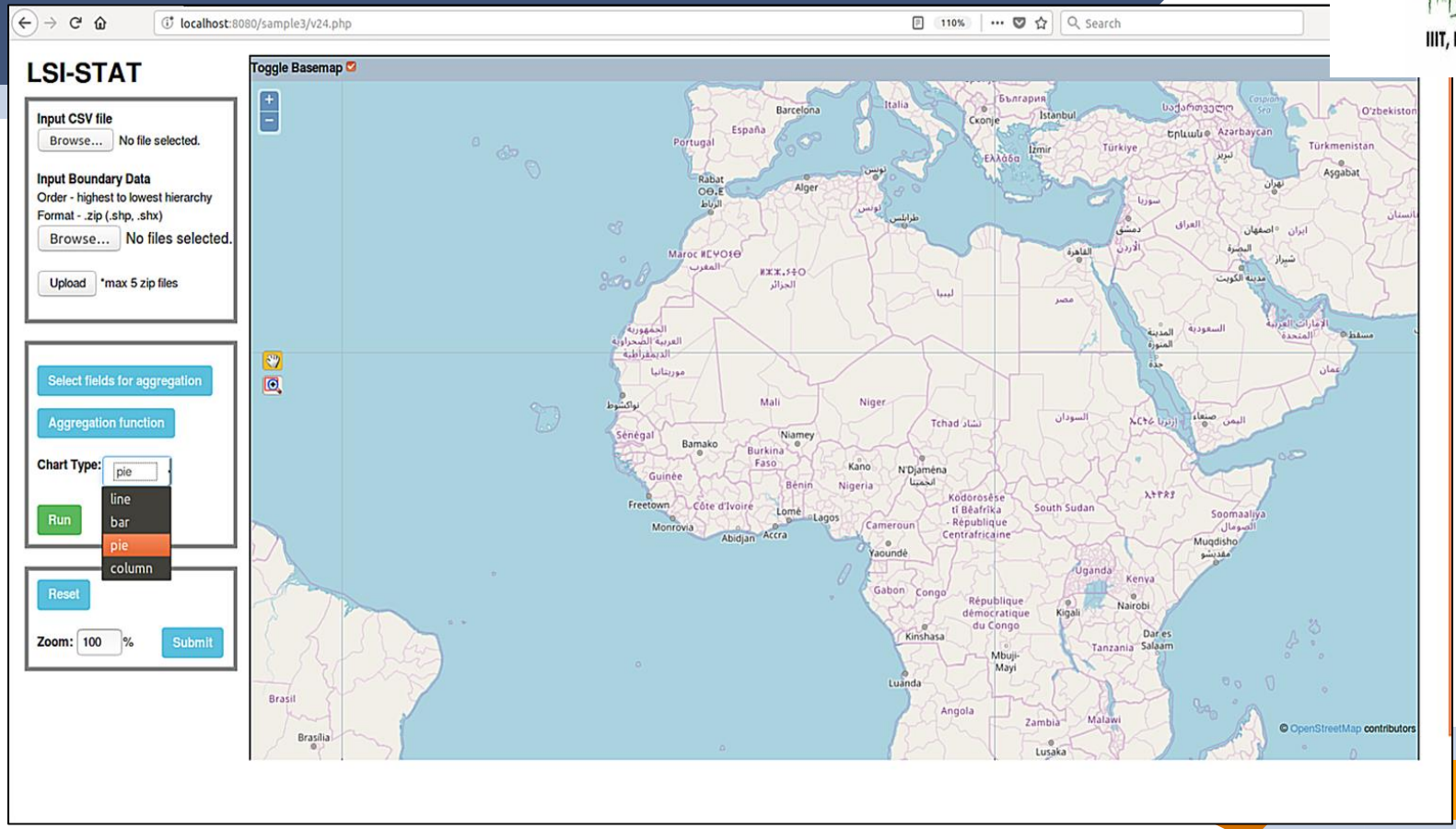


Chart Type


localhost:8080/sample3/v24.php
110%
Search
LSI-STAT
Input CSV file
Browse...
No file selected.
Input Boundary Data
Order - highest to lowest hierarchy
Format - .zip (.shp, .shx)
Browse...
No files selected.
Upload
*max 5 zip files
Select fields for aggregation
Aggregation function
Chart Type:
pie
line
bar
pie
column
Run
Reset
Zoom:
100
%
Submit
Toggle Basemap
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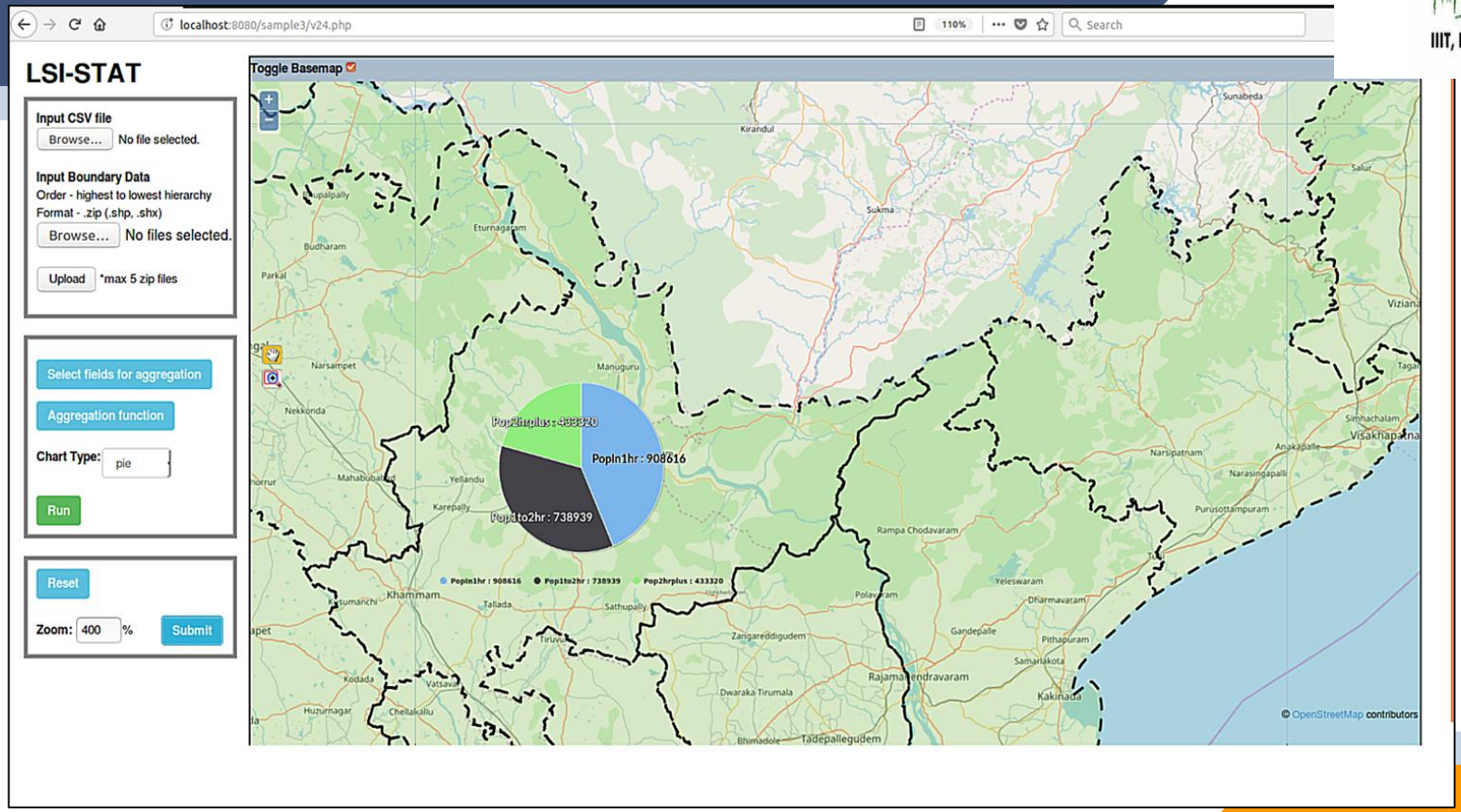
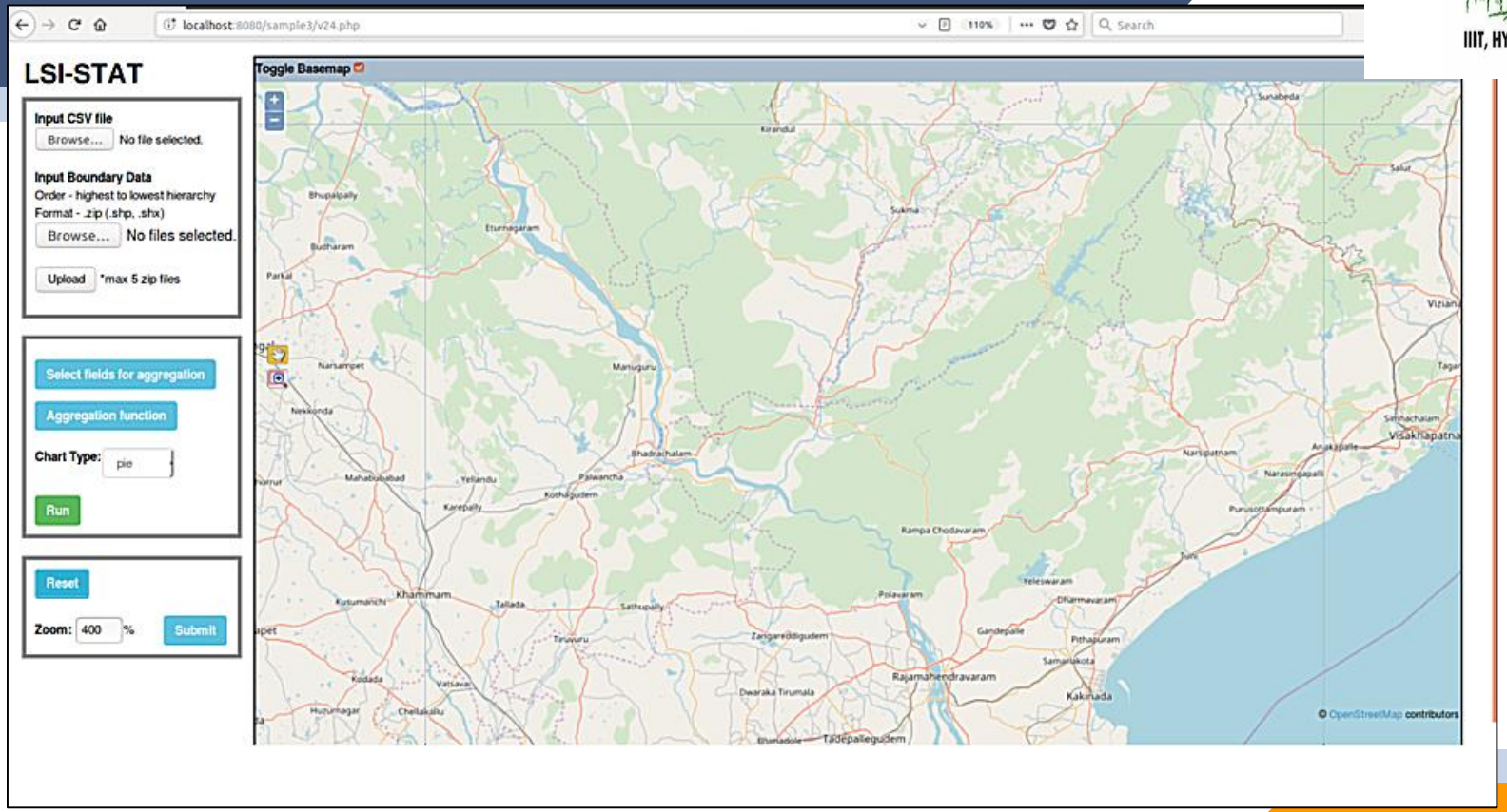
Before Reset



After Reset


localhost:8080/sample3/v24.php
LSI-STAT
Input CSV file
Browse...
No file selected.
Input Boundary Data
Order - highest to lowest hierarchy
Format - zip (.shp, .shx)
Browse...
No files selected.
Upload
*max 5 zip files
Select fields for aggregation
Aggregation function
Chart Type:
pie
Run
Reset
Zoom:
400
%
Submit
Toggle Basemap
Kirandul
Bhupalpally
Eturnagaram
Budharam
Parkal
Sukma
Narsampet
Manuguru
Nekkonda
Bhadrachalam
Mahabubabad
Yellandu
Palwancha
Kothagudem
Kamepally
Rampa Chodavaram
Khammam
Tallada
Sathupally
Kusumanchi
Tiruvuru
Polavaram
Zangareddigudem
Rajamahendravaram
Dwaraka Tirumala
Kakinada
Tadepallegudem
Narsipatnam
Visakhapatnam
Simhachalam
Anakapalle
Narasingapalli
Purusottampuram
Yeleswaram
Dharmavaram
Gandepalle
Pithapuram
Samarlakota
Tuni
Vatsava
Kodada
Huzurnagar
Chillakallu
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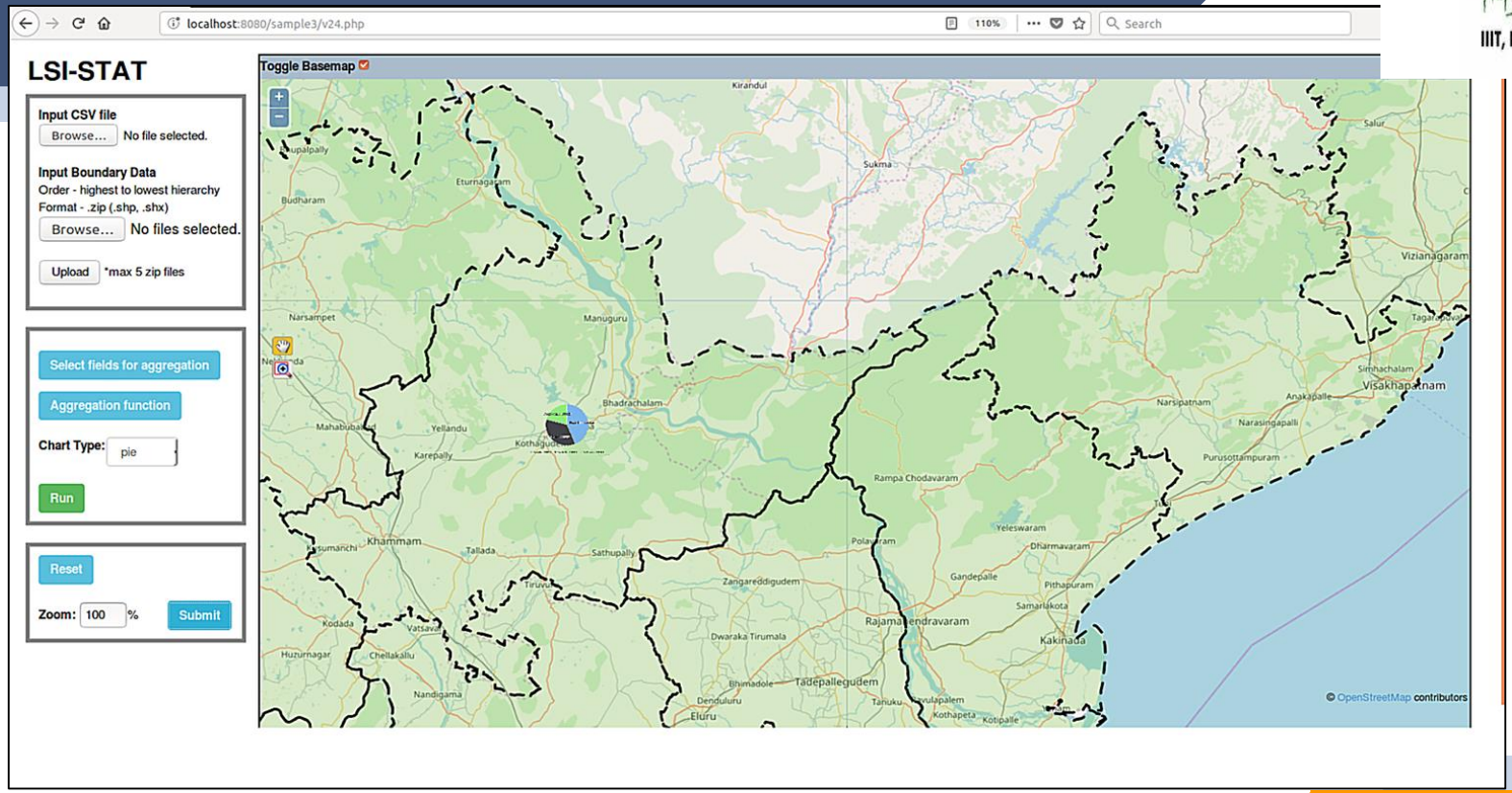
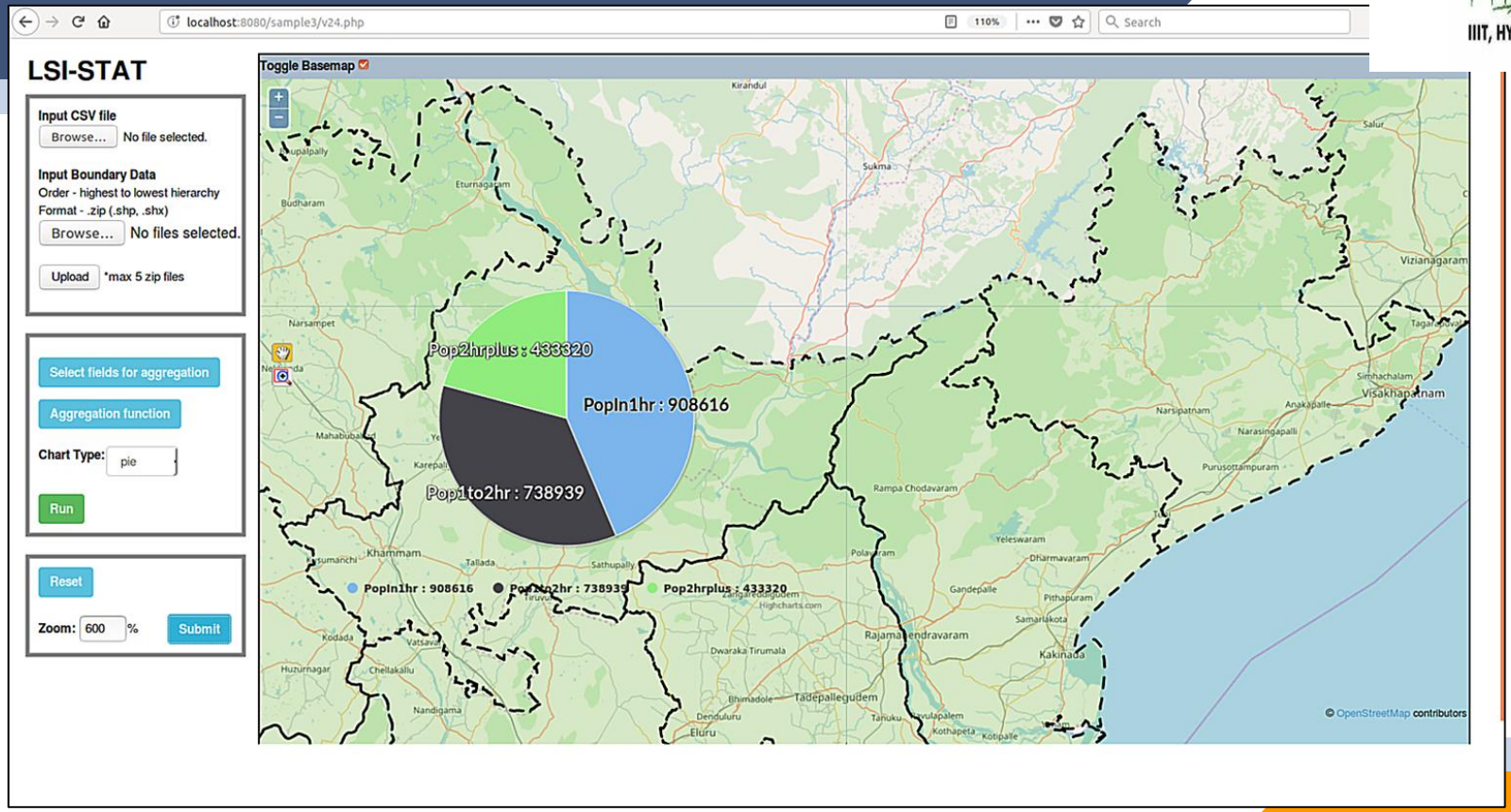
Zoom All Charts

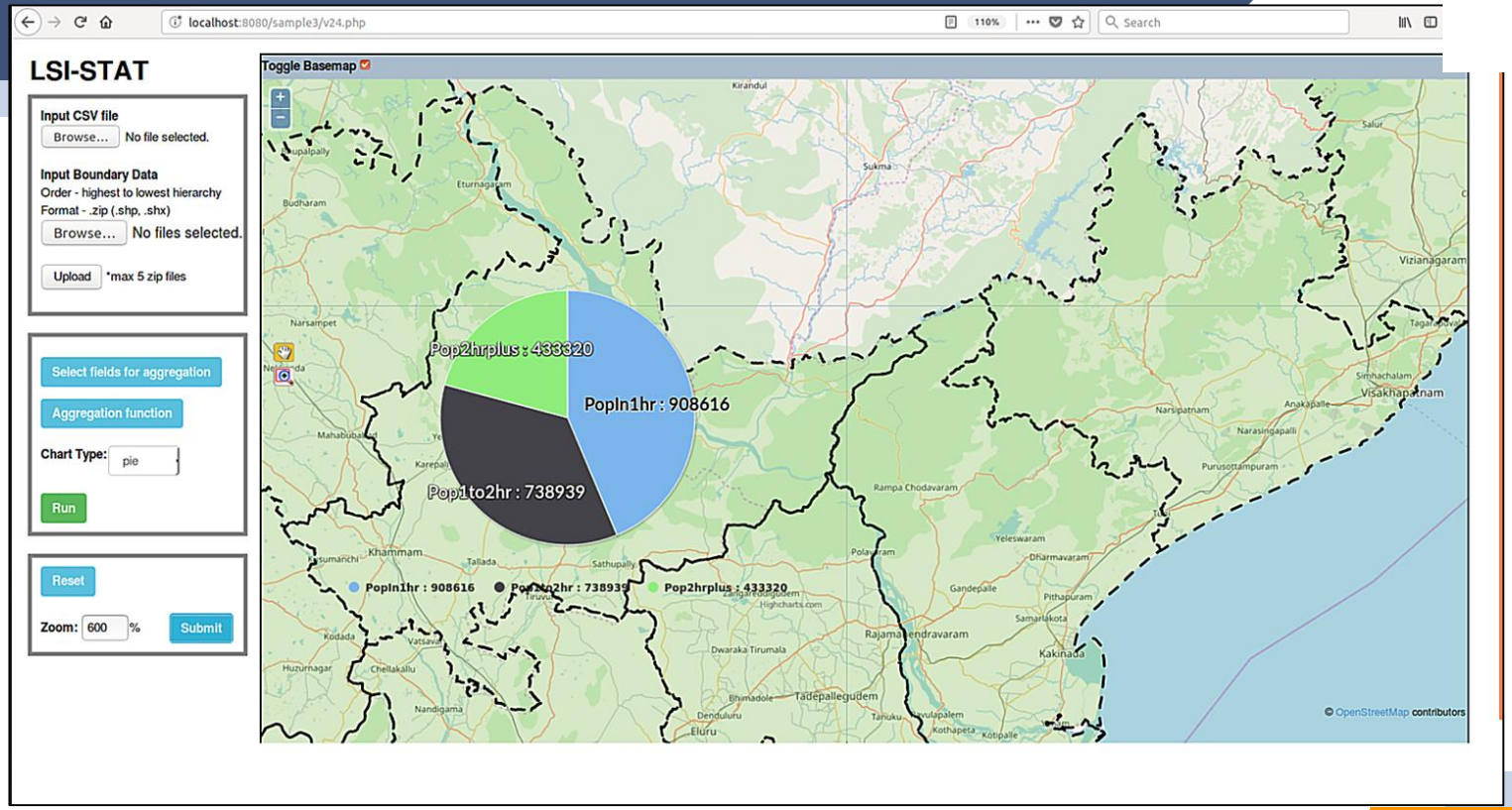


Zoom All Charts (by 600%)



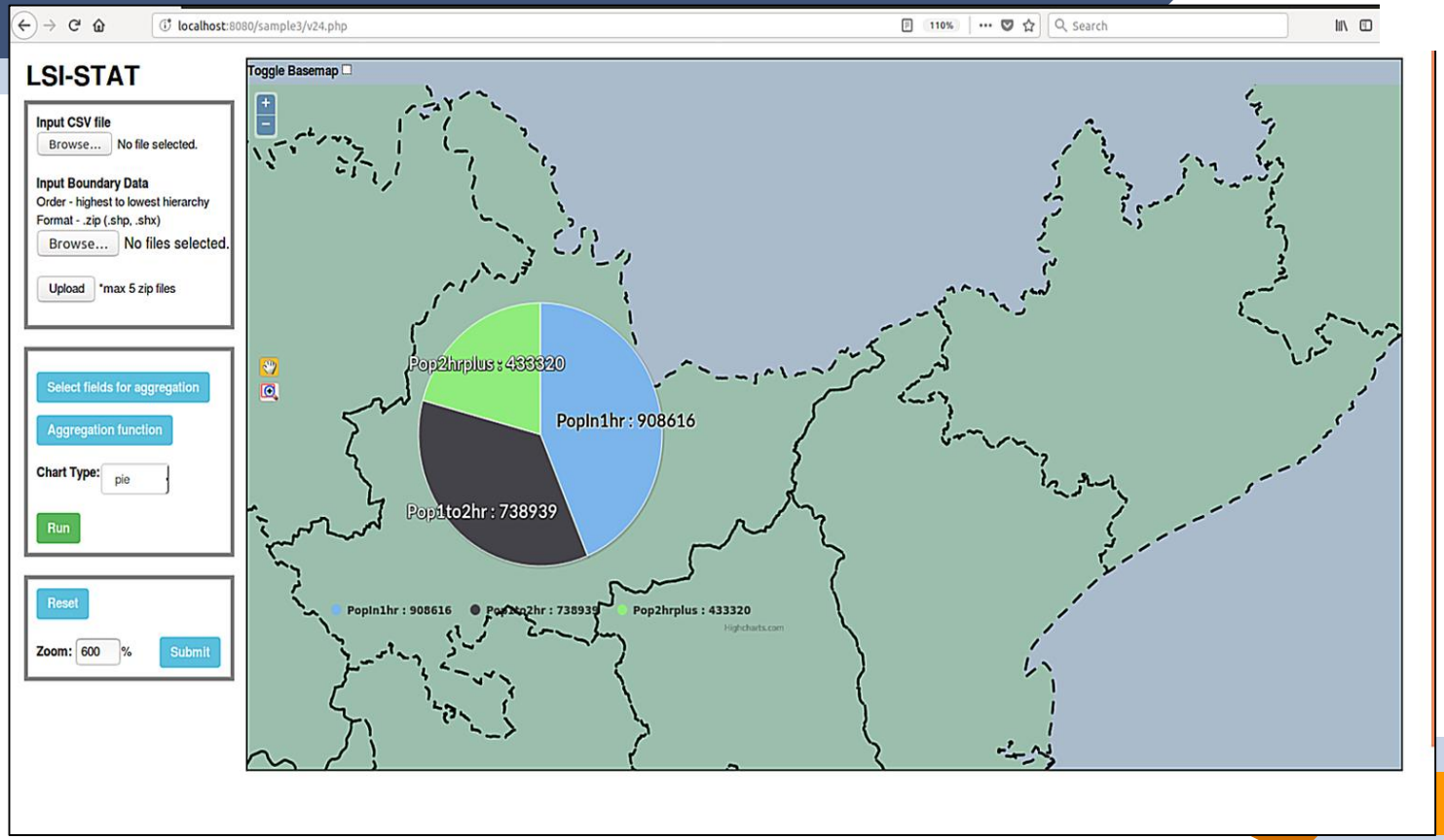
Toggle Basemap (Before)

IIIT, HYDERABAD

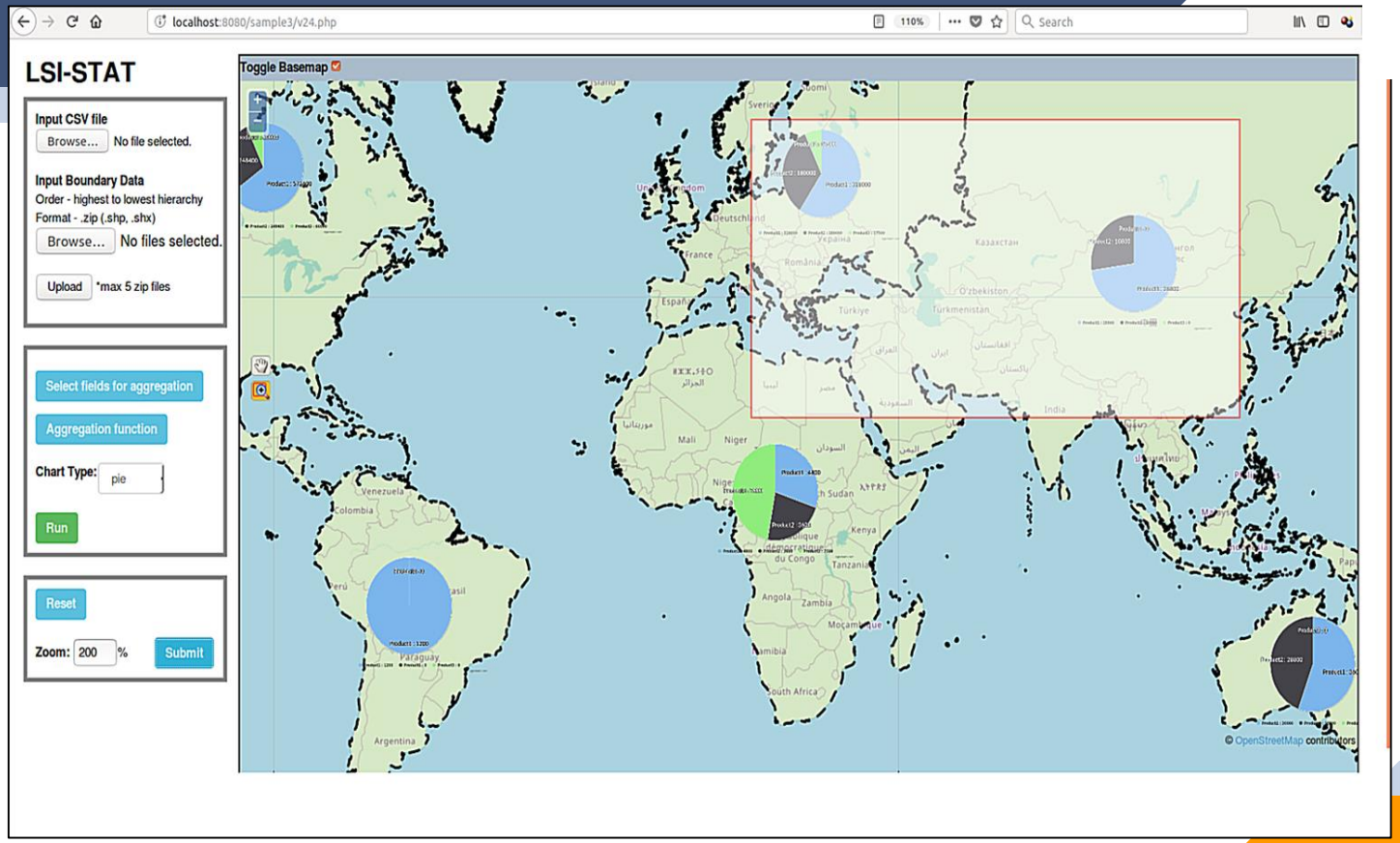


Toggle Basemap (After)

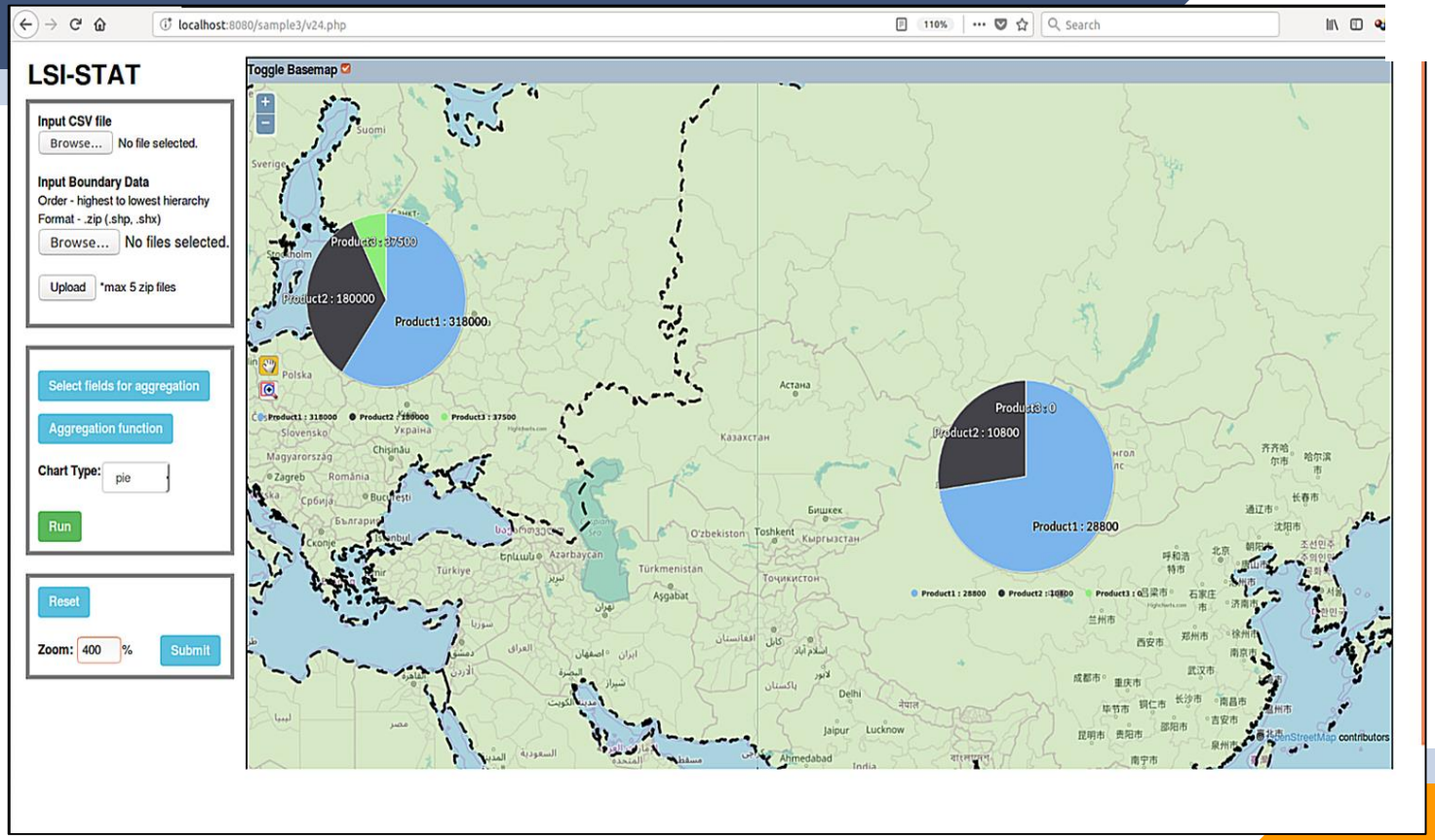
IIIT, HYDERABAD



Zoom by Area (Before)

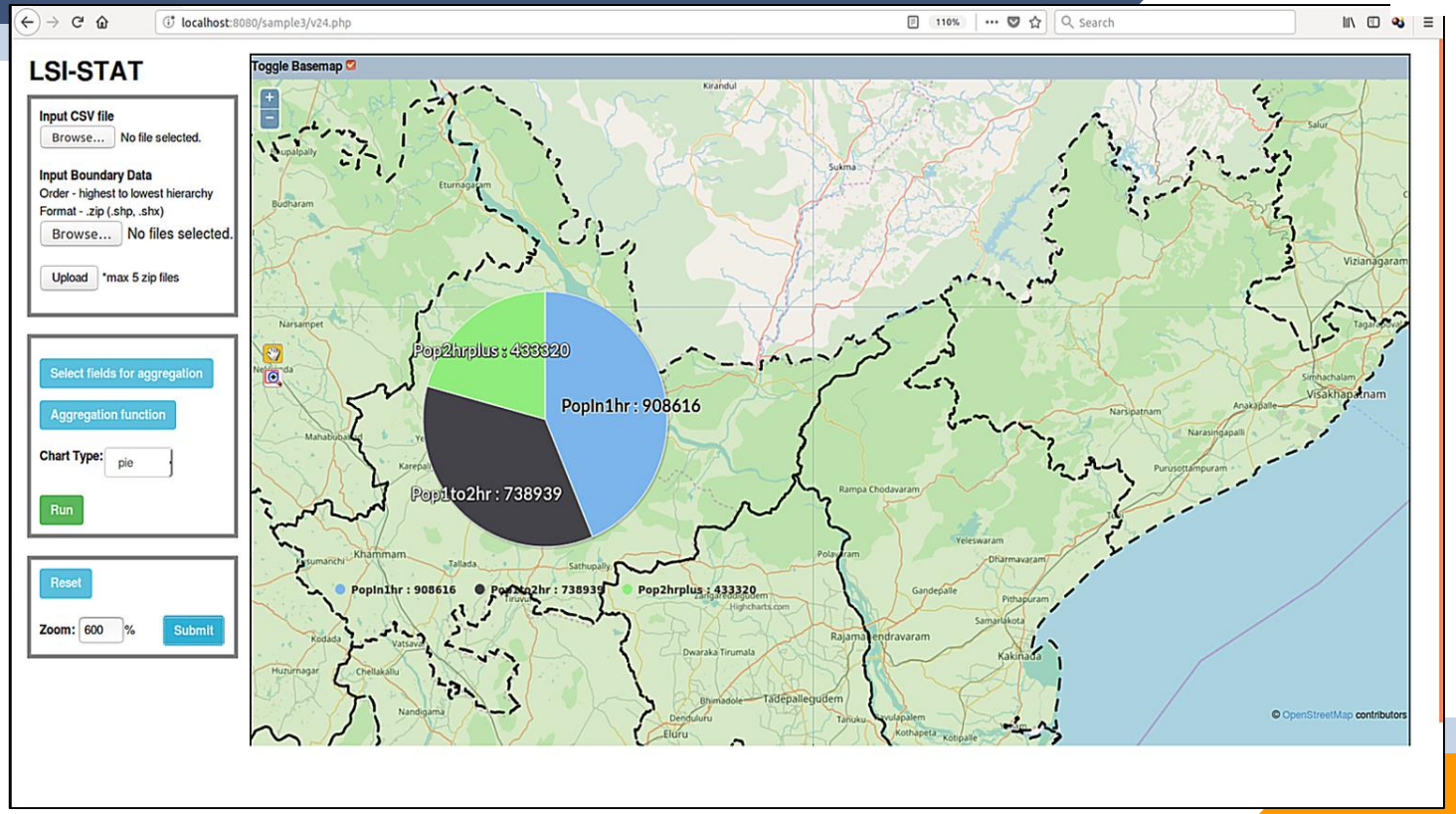


Zoom by Area (After)

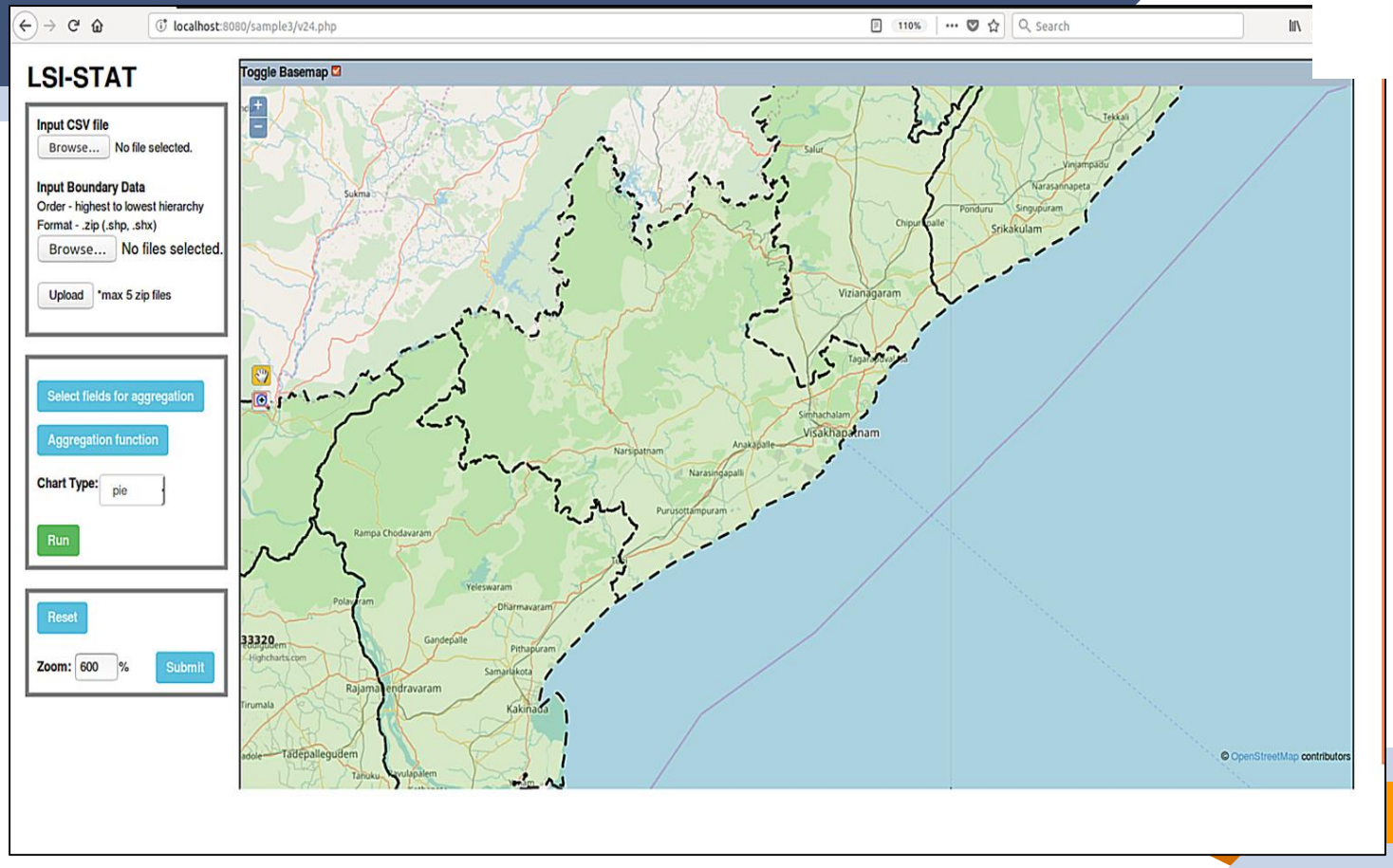


Shift left/right (Before)

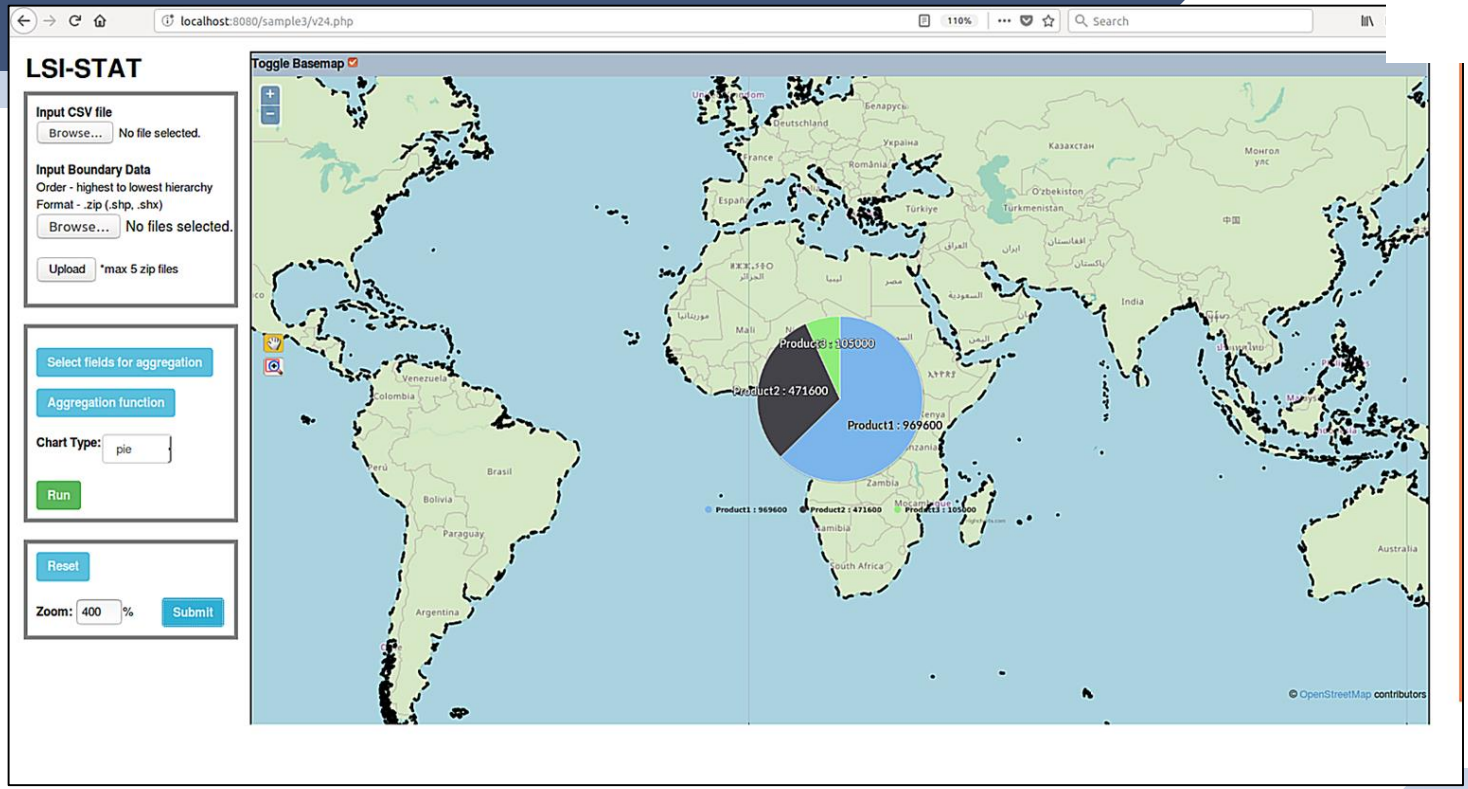
IIIT, HYDERABAD



Shift left/right (After)



Zoom (Before)


localhost:8080/sample3/v24.php
110%
Search
LSI-STAT
Input CSV file
Browse...
No file selected.
Input Boundary Data
Order - highest to lowest hierarchy
Format - .zip (.shp, .shx)
Browse...
No files selected.
Upload
*max 5 zip files
Select fields for aggregation
Aggregation function
Chart Type:
pie
Run
Reset
Zoom:
400
%
Submit
Toggle Basemap
Product3 : 105000
Product2 : 471600
Product1 : 969600
Product1 : 969600
Product2 : 471600
Product3 : 105000
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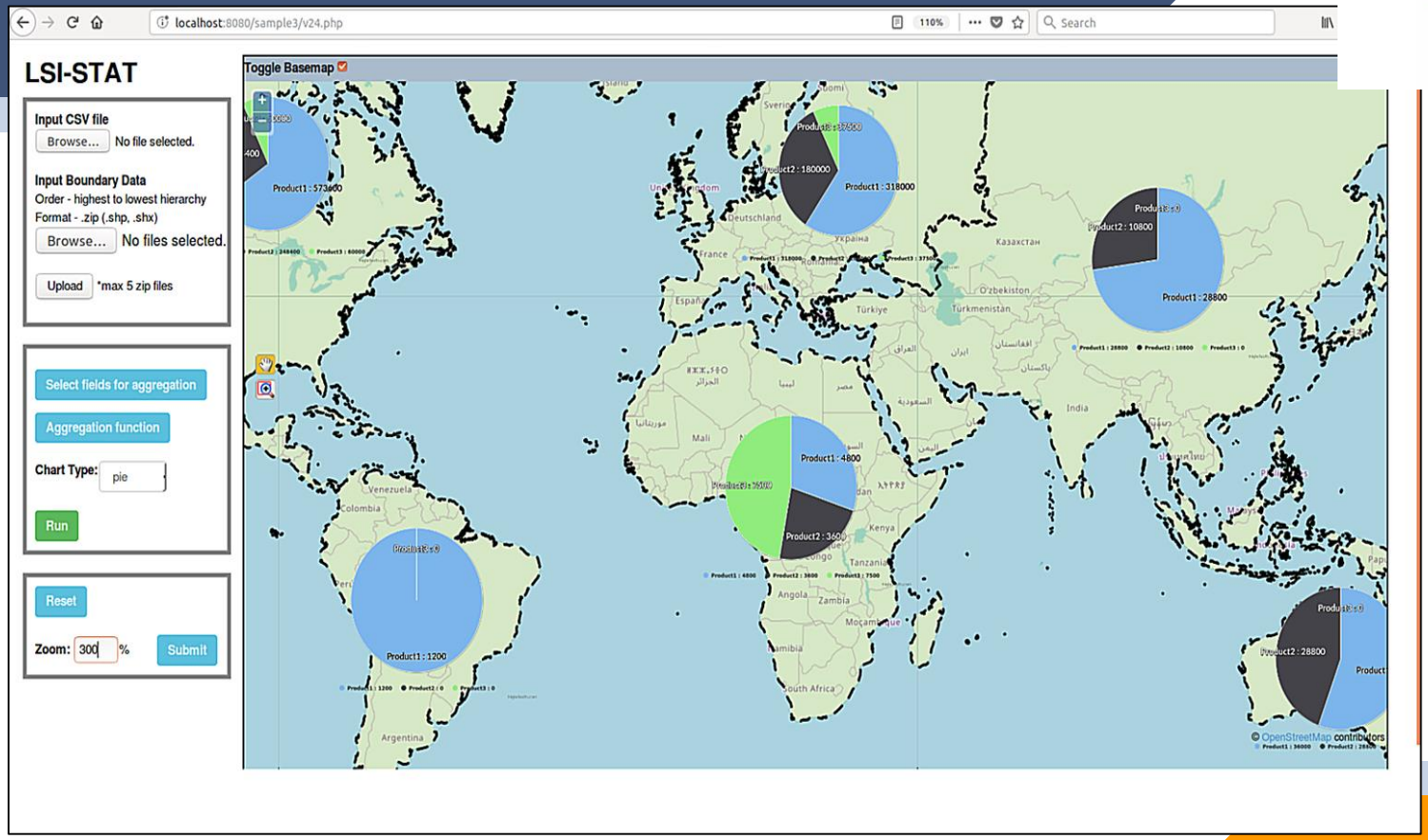
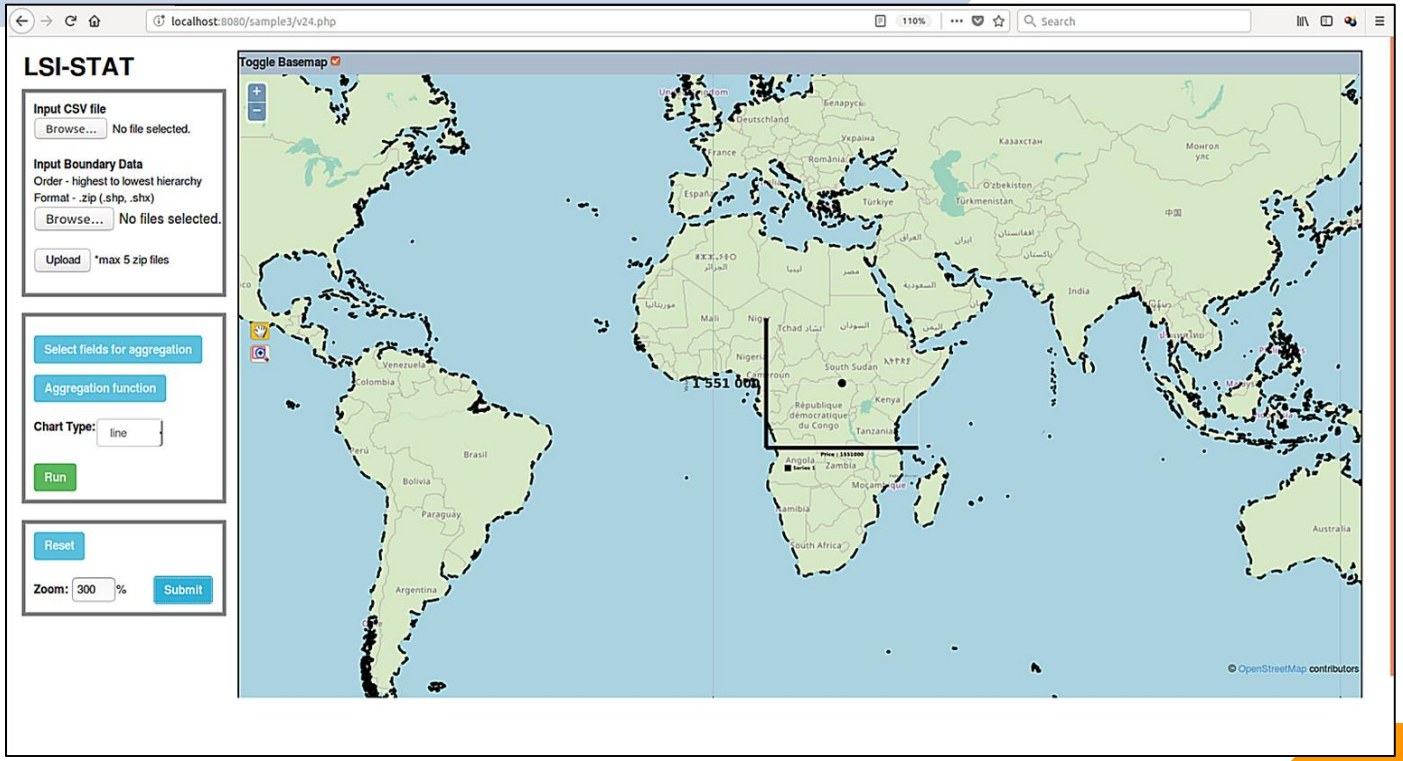
Zoom (After)


localhost:8080/sample3/v24.php
110%
Search
LSI-STAT
Input CSV file
Browse...
No file selected.
Input Boundary Data
Order - highest to lowest hierarchy
Format - .zip (.shp, .shx)
Browse...
No files selected.
Upload
*max 5 zip files
Select fields for aggregation
Aggregation function
Chart Type:
pie
Run
Reset
Zoom:
300
%
Submit
Toggle Basemap
Product1 : 573600
Product2 : 180000
Product1 : 318000
Product2 : 10800
Product1 : 28800
Product1 : 4800
Product2 : 3600
Product1 : 1200
Product2 : 28800
OpenStreetMap contributors

Case Study 1: Online Retail

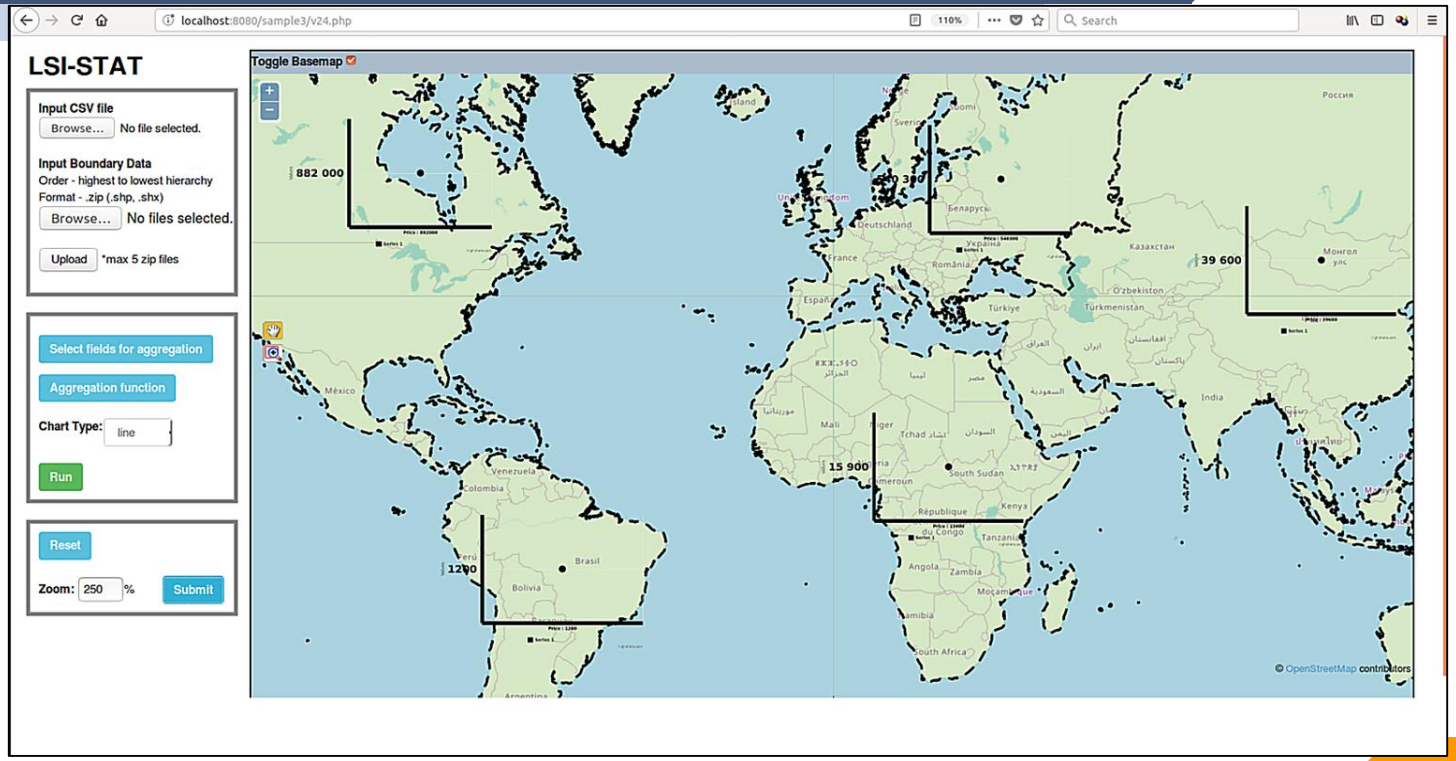
Aggregated Attributes, Aggregated over Time-period, Single Geo-location



GeoBI - Online Retail Case Study

Aggregated Attributes, Aggregated over Time-period, Multiple Geo-locations

IIIT, HYDERABAD



GeoBI - Online Retail Case Study

Aggregated Attributes, Aggregated over Time-period, Multiple Geo-locations

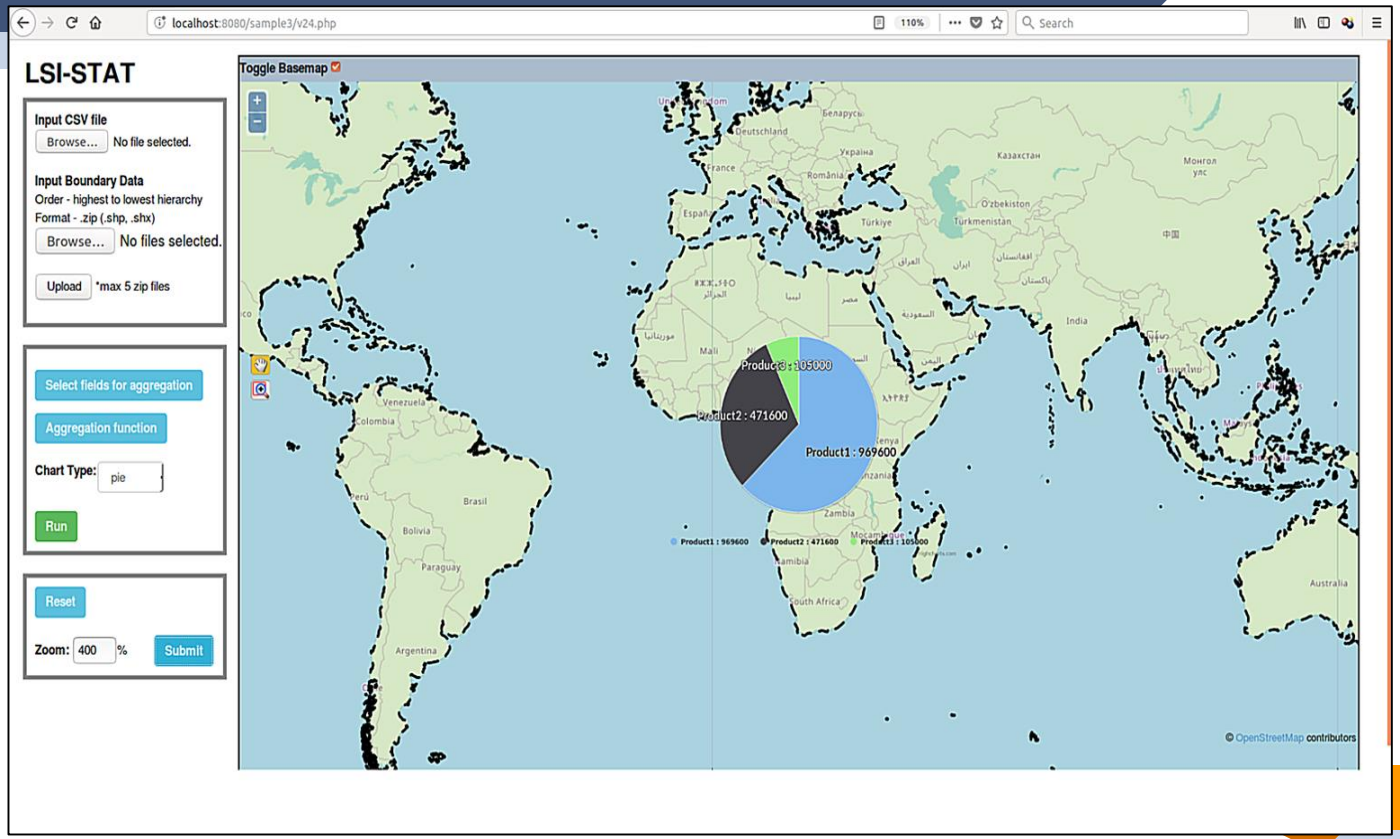
- In which continent were maximum products sold?
  North America (882000)
- In which continent were minimum products sold?
  South America (1200)
- What is the order of continents from maximum products sold to minimum products sold?
  North America (8,82,000) followed by Europe (5,40,300), Oceania (72,000), Asia (39,600), Africa (15,900) and South America (1200).
- Which continents constitute together constitute large market shares?
  North America and Europe together constitute more than 95% of the total market share.

Continent	Total Sales
North America	882000
Oceania	72000
Africa	15900
Europe	540300
Asia	39600
South America	1200
Australia	64800

GeoBI - Online Retail Case Study

Multiple Attributes, Aggregated over Time-period, Single Geo-location

IIIT, HYDERABAD



GeoBI - Online Retail Case Study

Multiple Attributes, Aggregated over Time-period, Single Geo-location

IIIT, HYDERABAD

- What is the order of products from most popular to least popular?

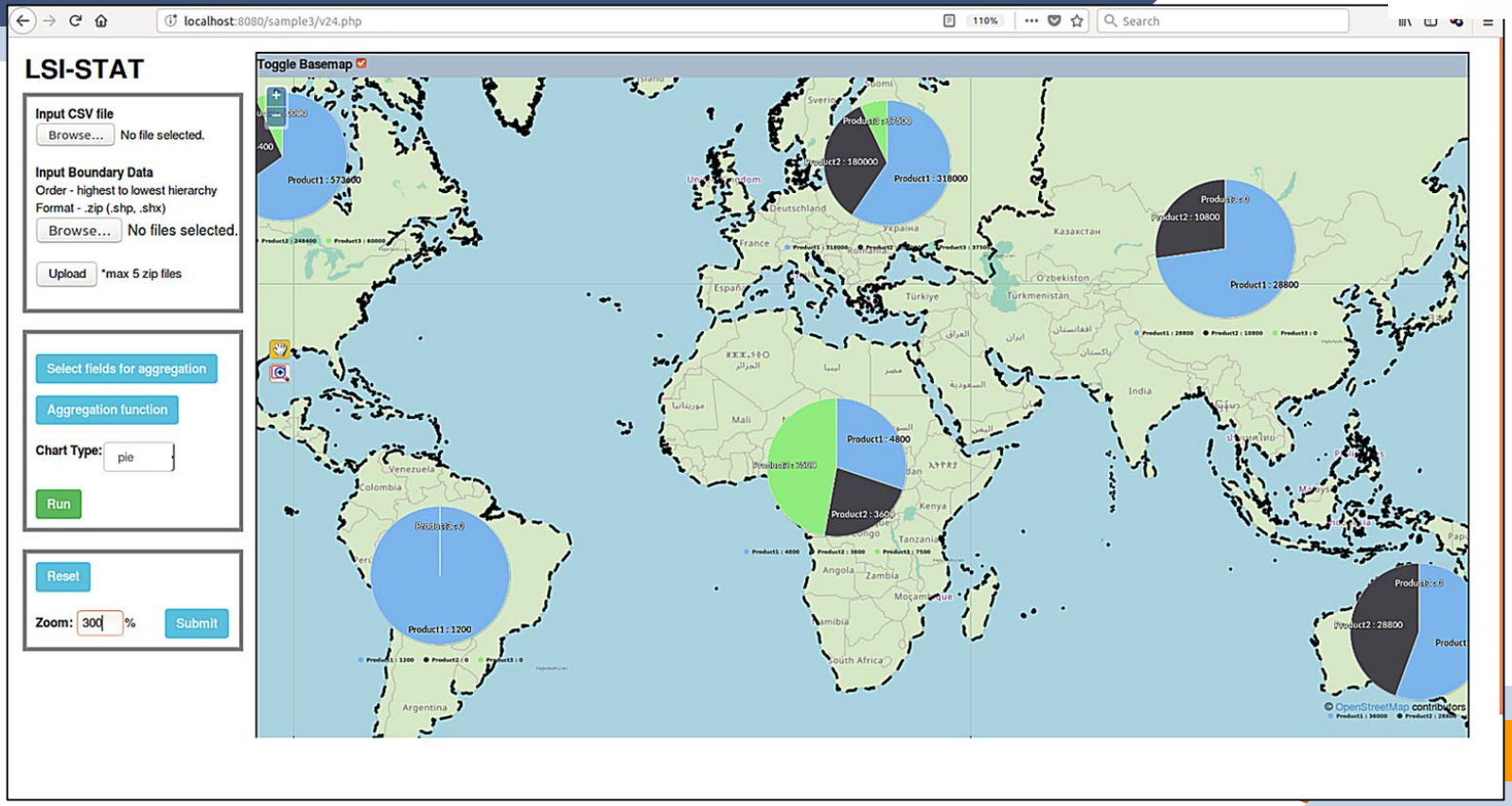
  Product 1 (969600) was found to be the most popular product, followed by Product2 (471600) and Product3 (105000).

Product	Total Sales
Product1	969600
Product2	471600
Product3	105000

GeoBI - Online Retail Case Study

Multiple Attributes, Aggregated over Time-period, Multiple Geo-locations

IIIT, HYDERABAD



GeoBI - Online Retail Case Study

Multiple Attributes, Aggregated over Time-period, Multiple Geo-locations

IIIT, HYDERABAD

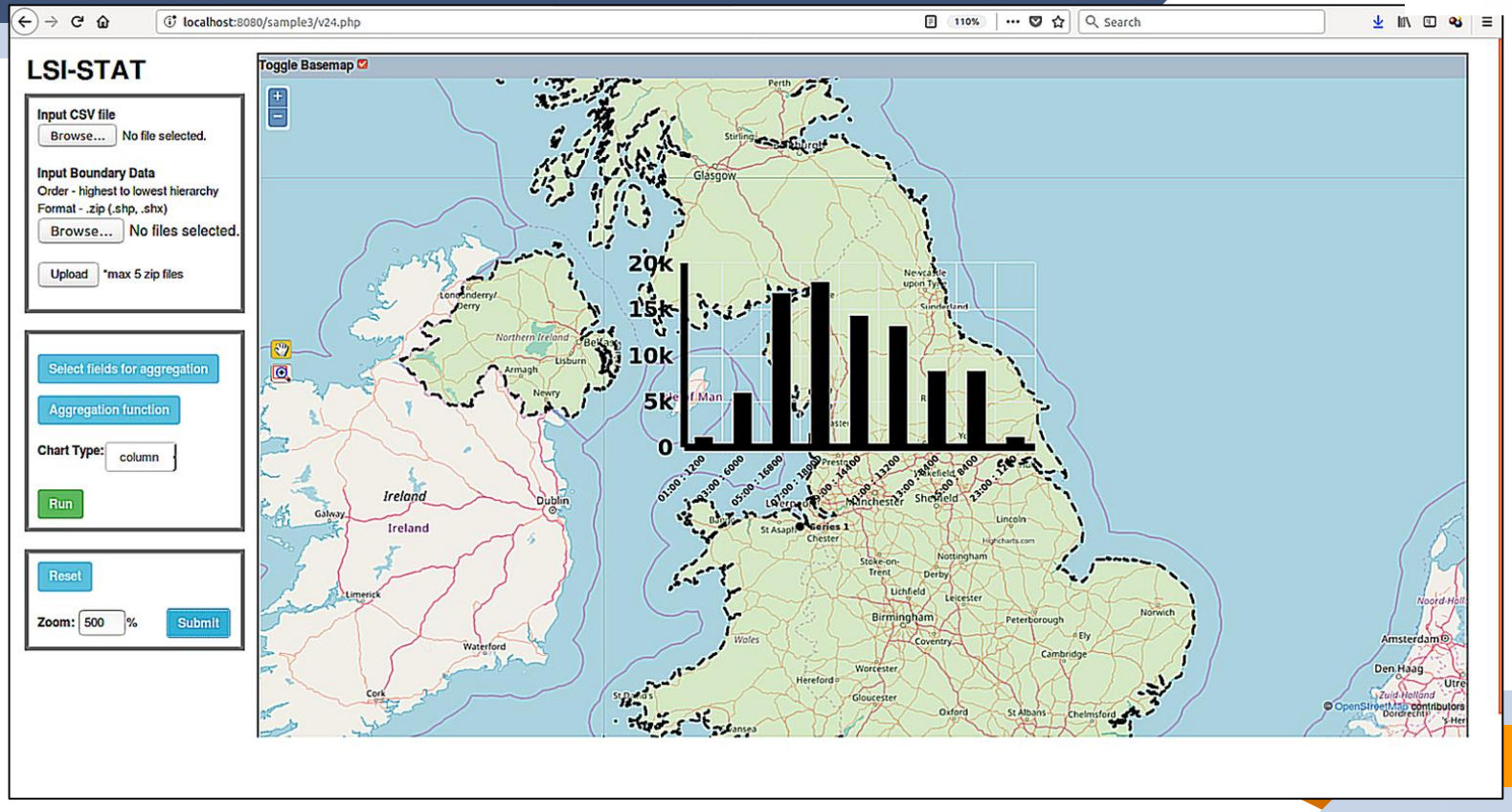
- In which continents, only Product1 was sold?
  South America and Oceania
- In which continents, only Product1 and Product2 were sold?
  Asia and Australia
- In which continents, all the three products were sold?
  Africa, North America and Europe
- What is the order of popularity for the continent North America?
  Product1, Product2 and then Product3
- In which all continents, is the order of popularity - Product1, Product2 and then Product3?
  All continents except Africa
- What is the order of popularity for the continent Africa?
  Product3, Product1 and then Product2

Continent	Product1 Sales	Product2 Sales	Product3 Sales
North America	573600	248400	60000
Oceania	7200	0	0
Africa	4800	3600	7500
Europe	318000	180000	37500
Asia	28800	10800	0
South America	1200	0	0
Australia	36000	28800	0

GeoBI - Online Retail Case Study

IIIT, HYDERABAD

Multiple Attributes, Multiple Time-periods, Single Geo-location



GeoBI - Online Retail Case Study

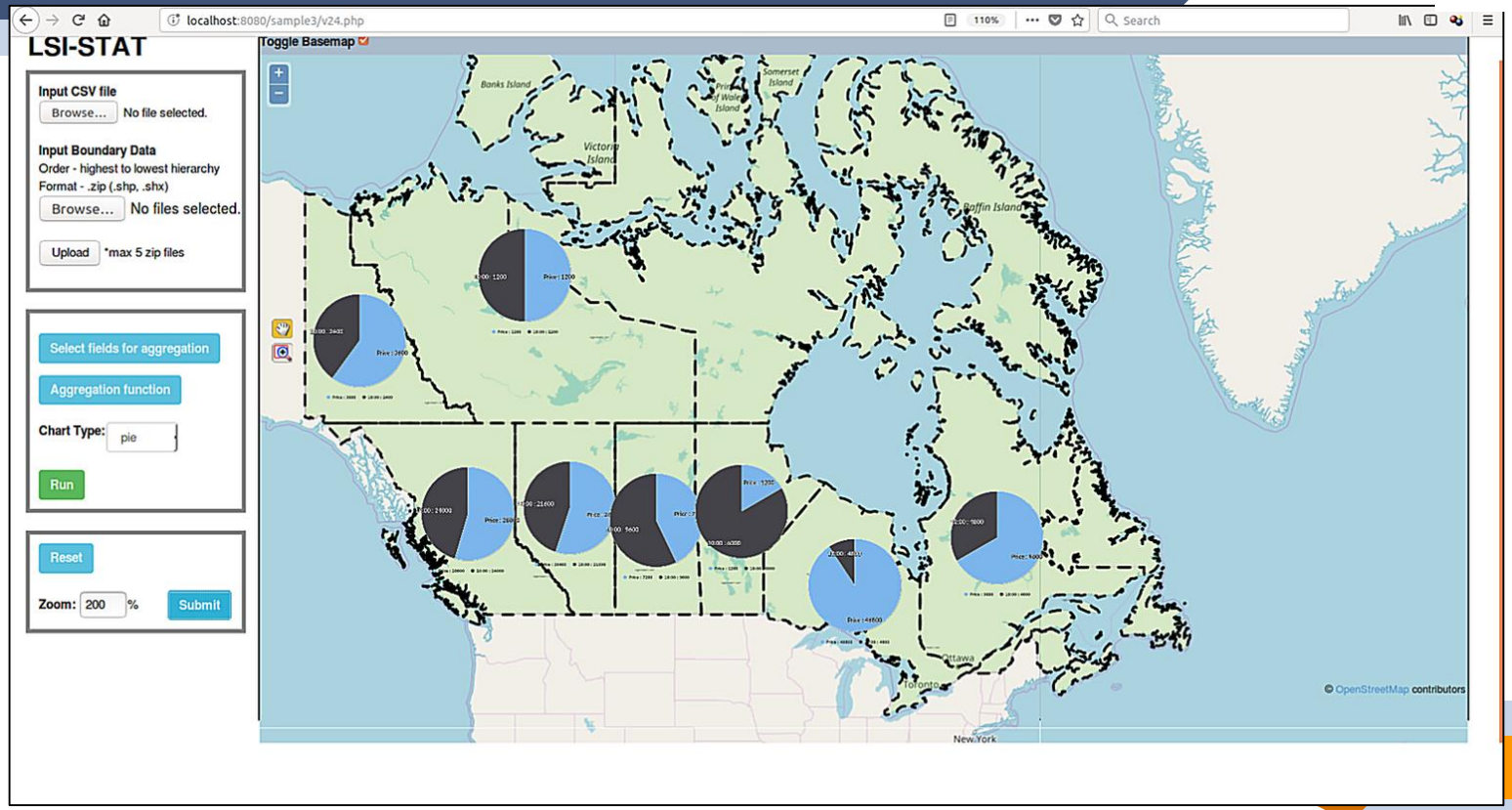
Multiple Attributes, Multiple Time-periods, Single Geo-location

- At what time did maximum sales occur and what was the quantity?
  At 7am, 18000
- During which time-period were a large number of products sold?
  Between 7am to 11am
- What was the trend observed?
  Sales increased gradually from 1am onwards, a peak was observed at around 7am and then it began to decrease till 3pm.
- From which hour did sales decline?
  7am
- Did sales halt during any time-period?
  Sales almost came to a halt around 3pm.

Hour	Product Sales
1:00	1200
3:00	6000
5:00	16800
7:00	18000
9:00	14400
11:00	13200
13:00	8400
15:00	8400
23:00	1200

GeoBI - Online Retail Case Study

Multiple Attributes, Single Time-period, Multiple Geo-locations



IIIT, HYDERABAD

GeoBI - Online Retail Case Study

Multiple Attributes, Single Time-period, Multiple Geo-locations

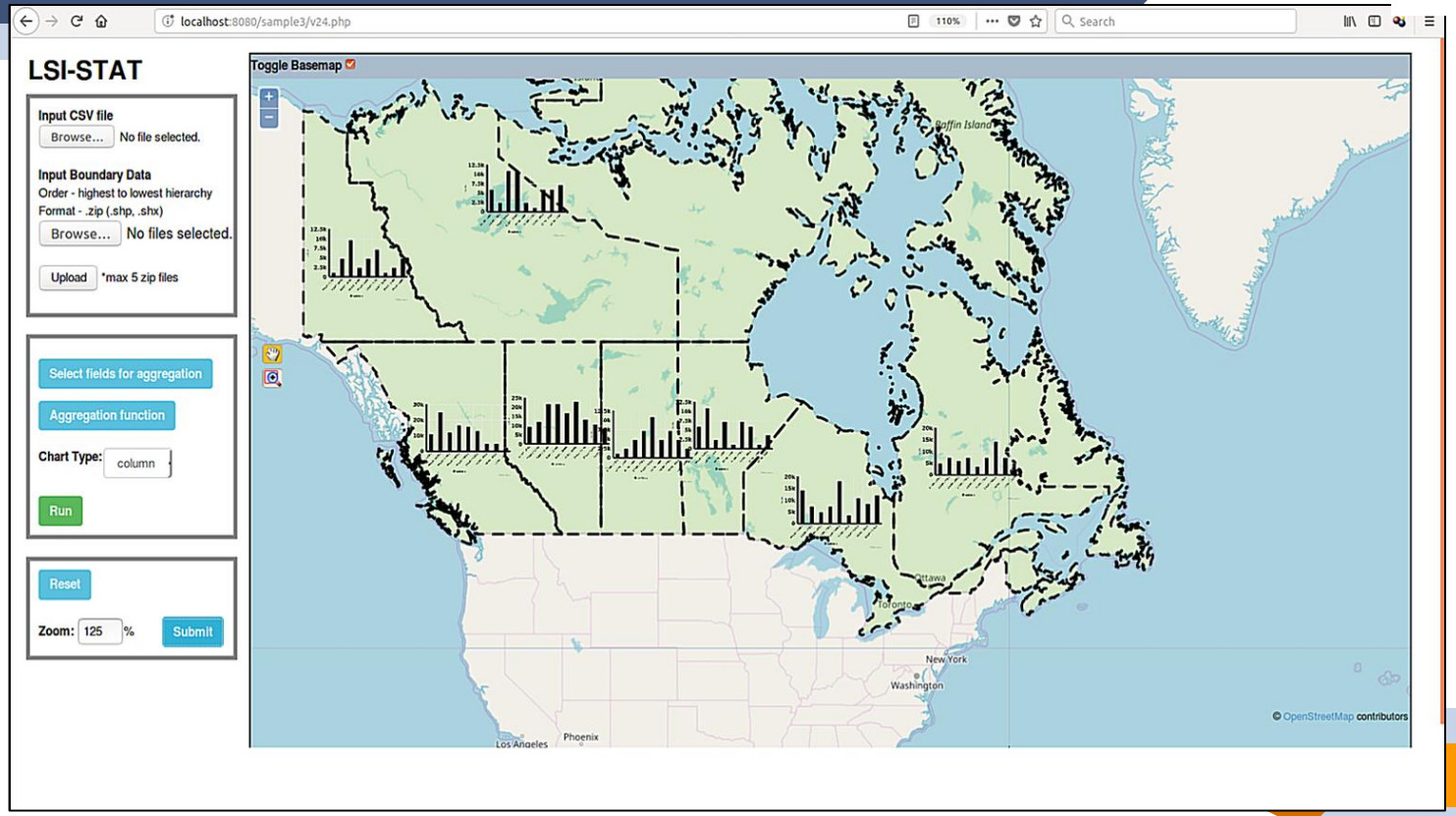
- Was the percentage share of sales at 10am more than 50% or less?
  It was less than 50% in all of them
- In which provinces was the share the least and the most of all the provinces?
  Least was in North Western Territories and Maximum in British Columbia

Province	10:00	Total Sales
Alberta	10800	144000
British Columbia	14400	115200
Manitoba	6000	87600
Northwestern Territories	1200	100800
Ontario	3600	68400
Quebec	4800	111600
Saskatchewan	9600	92400
Yukon Territory	2400	58800

GeoBI - Online Retail Case Study

Multiple Attributes, Multiple Time-periods, Multiple Geo-locations

IIIT, HYDERABAD



Province	01:00	03:00	05:00	07:00	09:00	11:00	13:00	15:00	23:00
Alberta	1200	6000	16800	18000	14400	13200	8400	8400	1200
British Columbia	7200	10800	4800	10800	6000	6000	2400	1200	1200
Manitoba	6000	10800	2400	7200	1200	7200	6000	1200	3600
Northwest Territories	6000	2400	10800	10800	2400	1200	6000	6000	7200
Ontario	3600	6000	2400	3600	10800	1200	7200	1200	2400
Quebec	4800	7200	6000	7200	3600	7200	14400	7200	2400
Saskatchewan	1200	2400	4800	7200	10800	4800	7200	4800	2400
Yukon Territory	1200	4800	9600	2400	4800	7200	1200	2400	4800

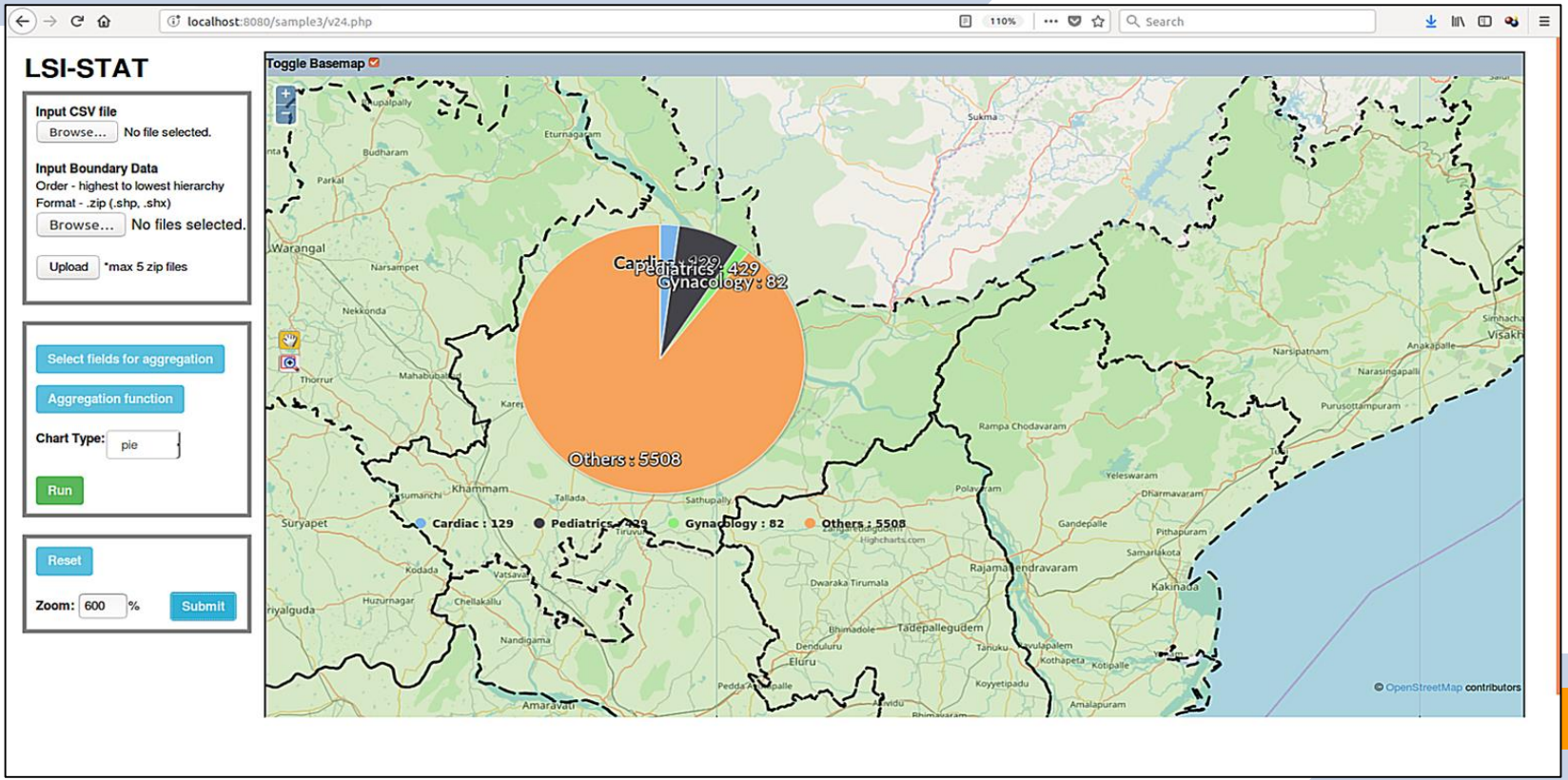
Multiple Attributes, Multiple Time-period, Multiple Geo-locations

- Is there any general trend or pattern followed across all the provinces?
  No
- What is the general trend or pattern followed in Alberta province?
  The number of products sold increases continuously to 18,000 at 7am and then decreases continuously. The number of products sold at 11pm when the day ends is the same as the number of products sold when sales began at 1am.
- Do any of the neighboring provinces have peak sales at 7am as Alberta?
  No
- Which of the provinces has the provinces has the highest sales in the entire day?
  Alberta has highest sales at 7am (18000)
- How many of the provinces have peak sales for continuously for two or more hours of the day?
  Northwest Territories has peak sales continuously from 5am to 7am.

Visualizing Health Services

Aggregated Attributes, Aggregated over Time-period and Single Geo-location

IIIT, HYDERABAD



Visualizing Health Services

Aggregated Attributes, Aggregated over Time-period and Single Geo-location

IIIT, HYDERABAD

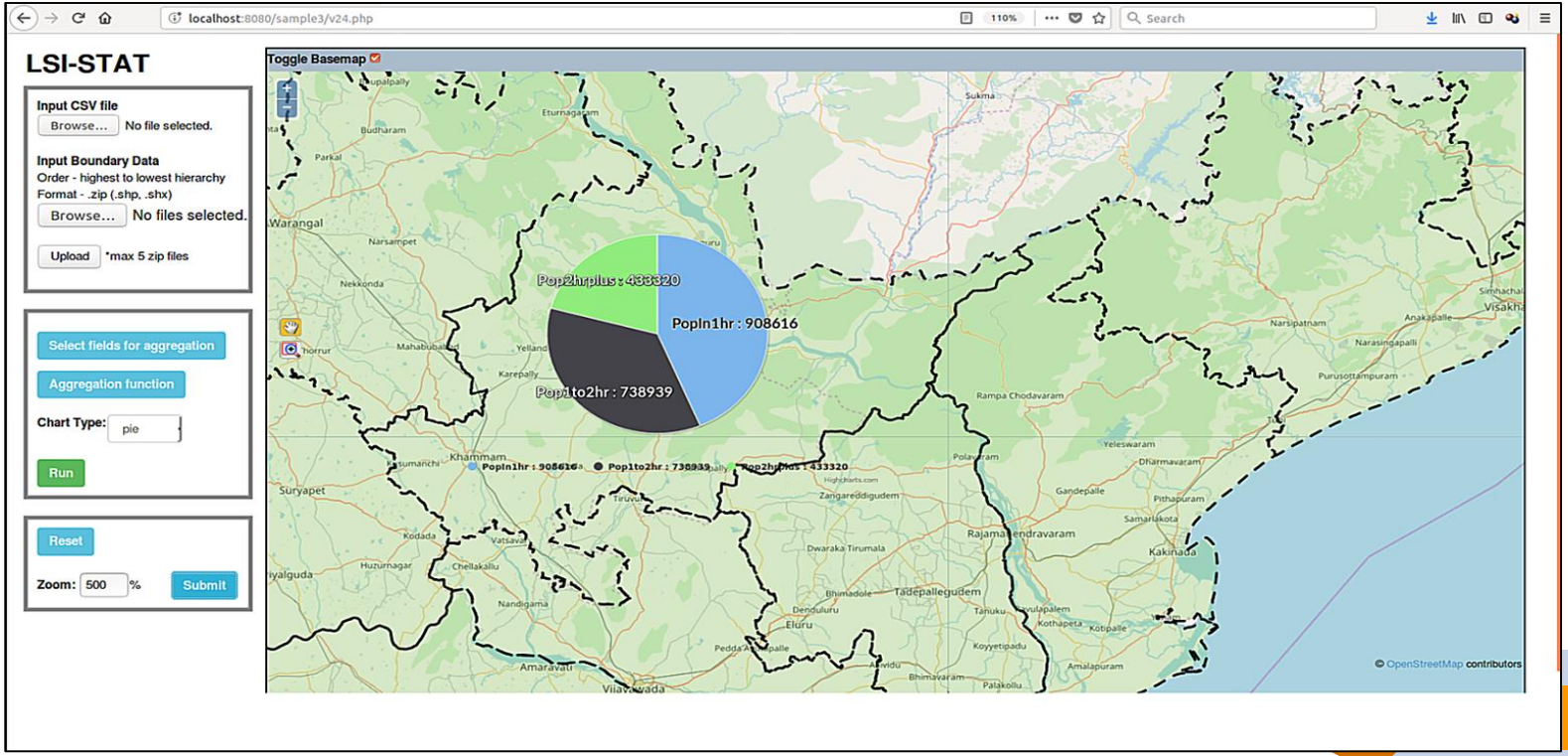
- Among categories- Pediatrics, Cardiac and Gynecology which had the highest number of patients?
  Pediatrics (429)
- What is the order of number of patients from maximum to minimum?
  Pediatrics (429), Cardiac (129) and Gynecology (82)
- What is the percentage share of patients from these three categories together?
  Less than 25%

Category	Patient Counts
Cardiac	129
Pediatrics	429
Gynecology	82
Others	5508

Visualizing Health Services

Multiple Attributes, Aggregated over Time-periods and Single Geo-location

IIIT, HYDERABAD



Visualizing Health Services

Multiple Attributes, Aggregated over Time-periods and Single Geo-location

IIIT, HYDERABAD

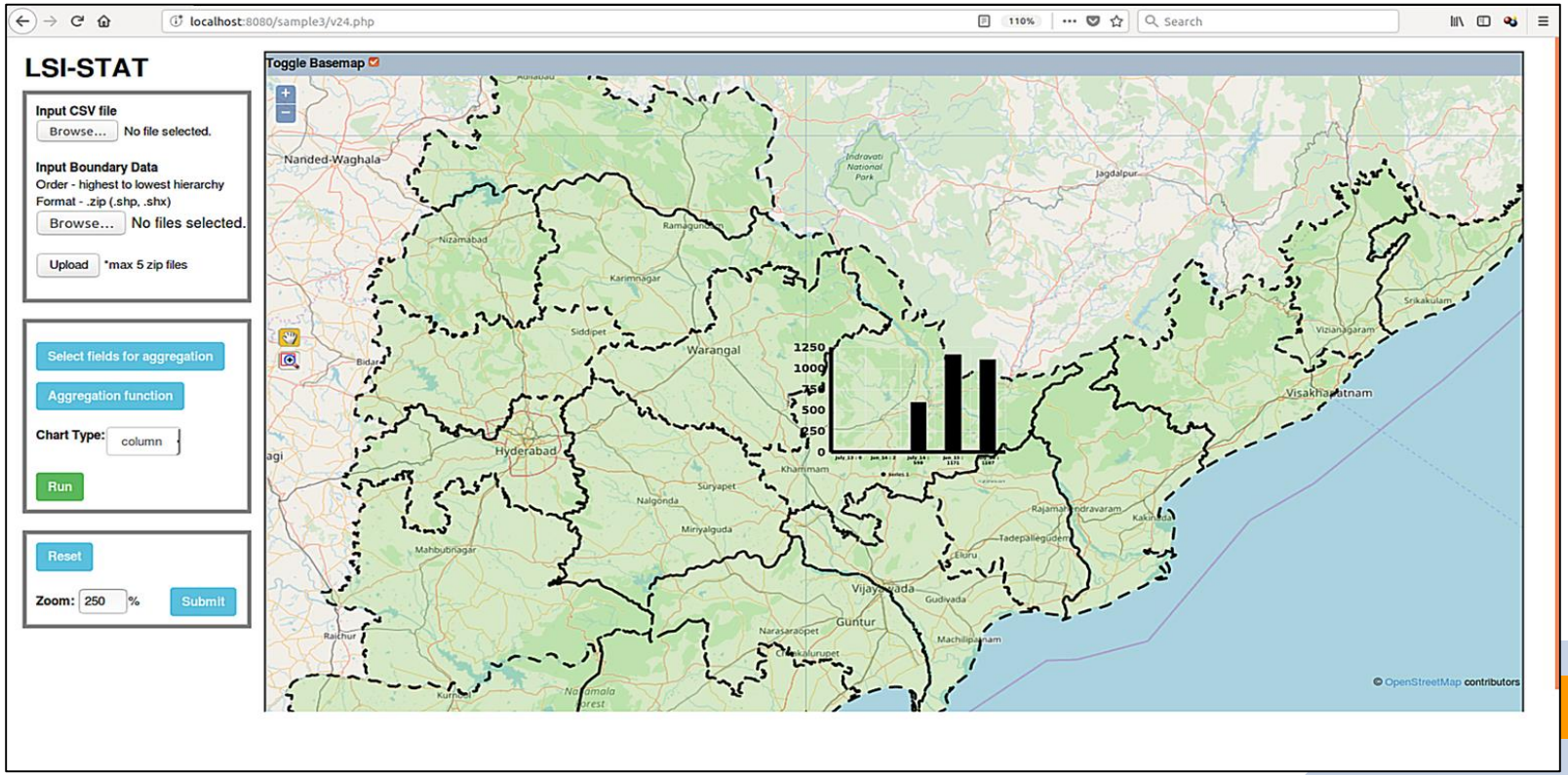
- What is the time taken to travel for cardiac services for most of the population in Khammam district?
  In less than 1 hour
- What is the percentage of the population which can travel in less than 1 hour?
  Between 25% to 50%
- What are the time-periods taken by the population to reach hospital for cardiac services?
  In less than one hour (908616), 1 to 2 hours (738939), more than 2 hours (433320)

Time taken for population to reach	Population Count
Less than 1 hour	908616
In 1 to 2 hours	738939
In more than 2 hours	433320

Visualizing Health Services

Multiple Attributes, Multiple Time-periods and Single Geo-location

IIIT, HYDERABAD



Visualizing Health Services

Multiple Attributes, Multiple Time-periods and Single Geo-location

IIIT, HYDERABAD

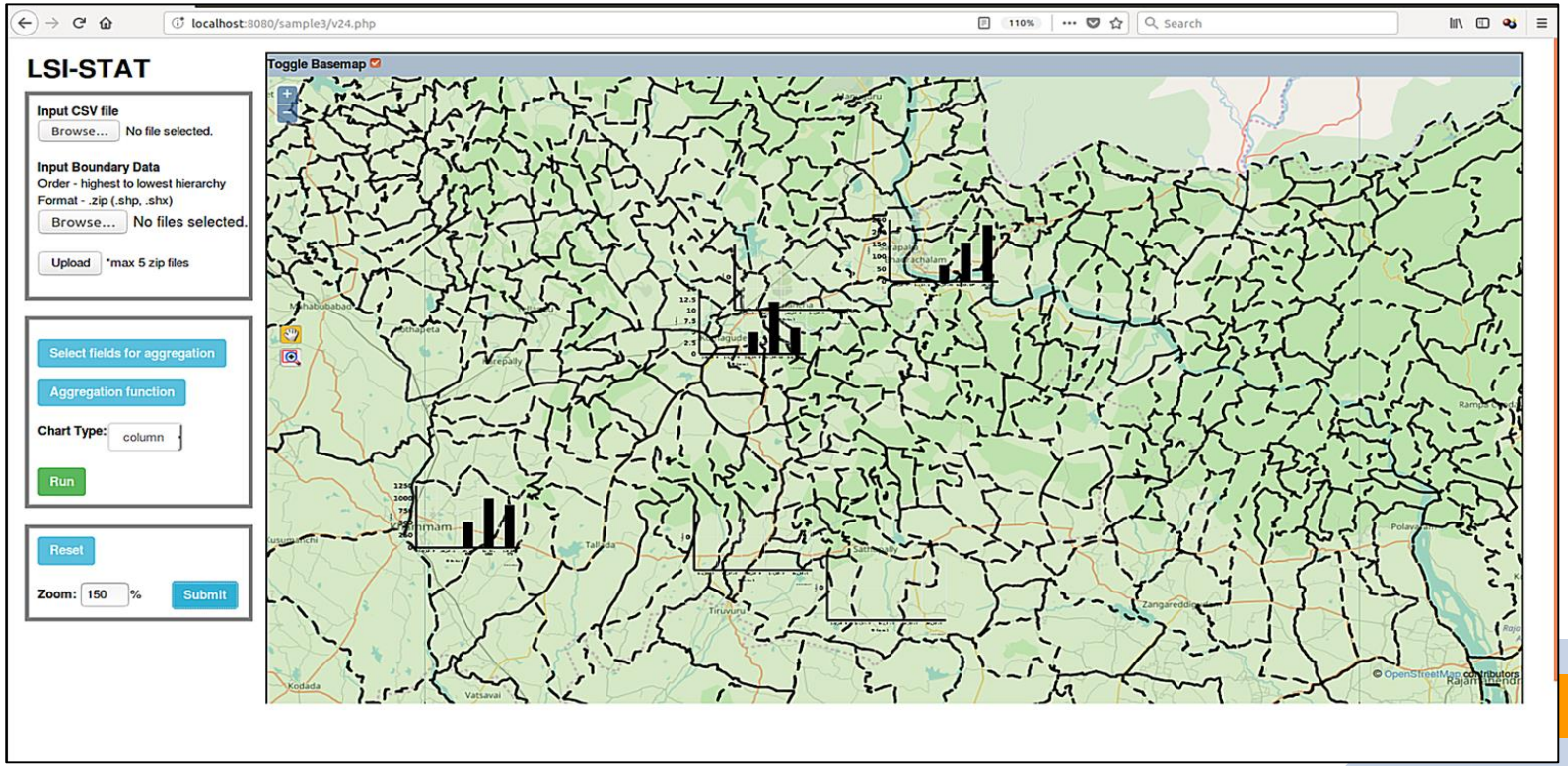
- What is the trend observed?
  The number of people going to hospitals for treatment has increased over the time and then slightly decreased towards the end.
- During which time-period did most people avail treatment?
  July 2015-Jan 2016

Time-period	Population Count
July 2013 - Jan 2014	0
Jan 2014 - July 2014	2
July 2014 - Jan 2015	598
Jan 2015 - July 2015	1171
July 2015 - Jan 2016	1107

Visualizing Health Services

Multiple Attributes, Multiple Time-periods and Multiple Geo-locations

IIIT, HYDERABAD



Visualizing Health Services

Multiple Attributes, Multiple Time-periods and Multiple Geo-locations

IIIT, HYDERABAD

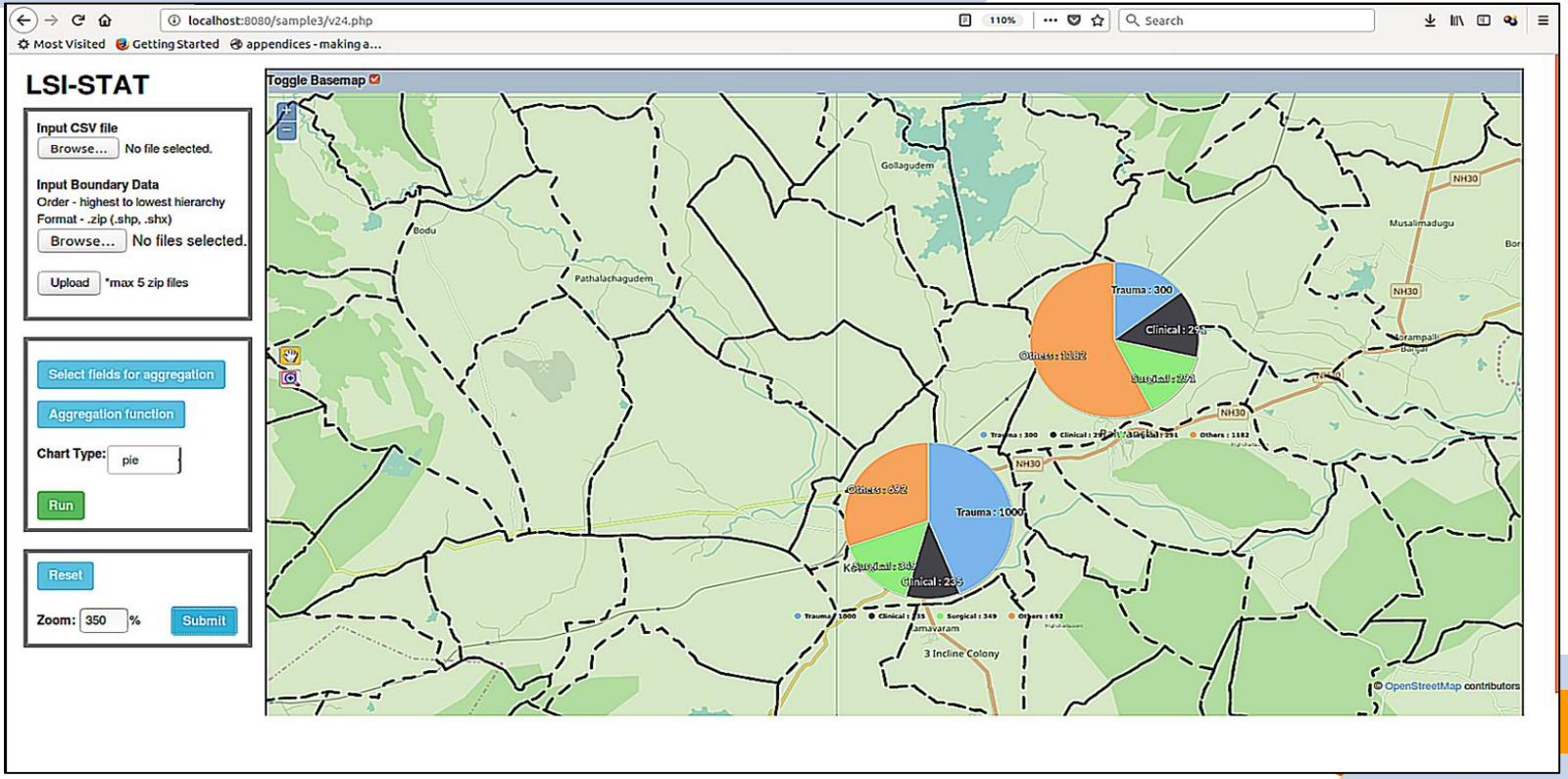
July'13	Jan'14	July'14	Jan'15	July'15
0	0	5	12	6
0	1	527	1002	872
0	1	66	157	229

- Are patients for all mandals availing treatment in these hospitals?
  No
- Is the trend same across all mandals?
  No, not the same
- Is the trend identical similar in some mandals?
  The trend is same for two of the mandals. The number of people going to these hospitals for treatment has increased over the time and then slightly decreased towards the end.
- Are these two mandals neighbors?
  These two mandals are in the same neighborhood but are not neighbors.
- What is the other trend observed?
  The number of people going to these hospitals for treatment has continuously increased over time.

Visualizing Health Services

Aggregated Attribute, Single Time-period and Multiple Geo-locations

IIIT, HYDERABAD



Aggregated Attribute, Single Time-period and Multiple Geo-locations

Hospital	Trauma	Clinical	Surgical	Others
Bhadrachalam	2911	1145	635	319
Kothagudem	1000	235	349	692
Penuballi	9112	450	354	193
Sathupally	530	719	1129	912
Paloncha	300	291	291	1182
District	1111	1145	222	212
Jaya	29	114	935	919
Mamatha	113	114	356	192
Raksha	211	615	935	1675
Sriram	1411	1445	1235	1679
Srujan	911	945	435	419

Aggregated Attribute, Single Time-period and Multiple Geo-locations

- Which type of services are availed by maximum number of patients in hospital in Kothagudem?
  Maximum number of people avail Trauma services in hospital in Kothagudem (1000).
- What is the order of services availed by patients in Kothagudem (from highest to lowest number of patients)?
  The order is Trauma, followed by Others, Surgical and Clinical services
- Is the order similar in neighboring mandal?
  In neighboring mandal - Paloncha, the order is different. The order is Others, Trauma, Clinical and Surgical (from highest to lowest number of patients) services. The number of patients for Clinical and Surgical services are equal.