

Cost Distances & Centering Analysis



ISTANBUL **TECHNICAL** UNIVERSITY
Sp. Anly. and Alg. in GIS
Week 6

Res. Assist. Ömer AKIN

Aim of the Study



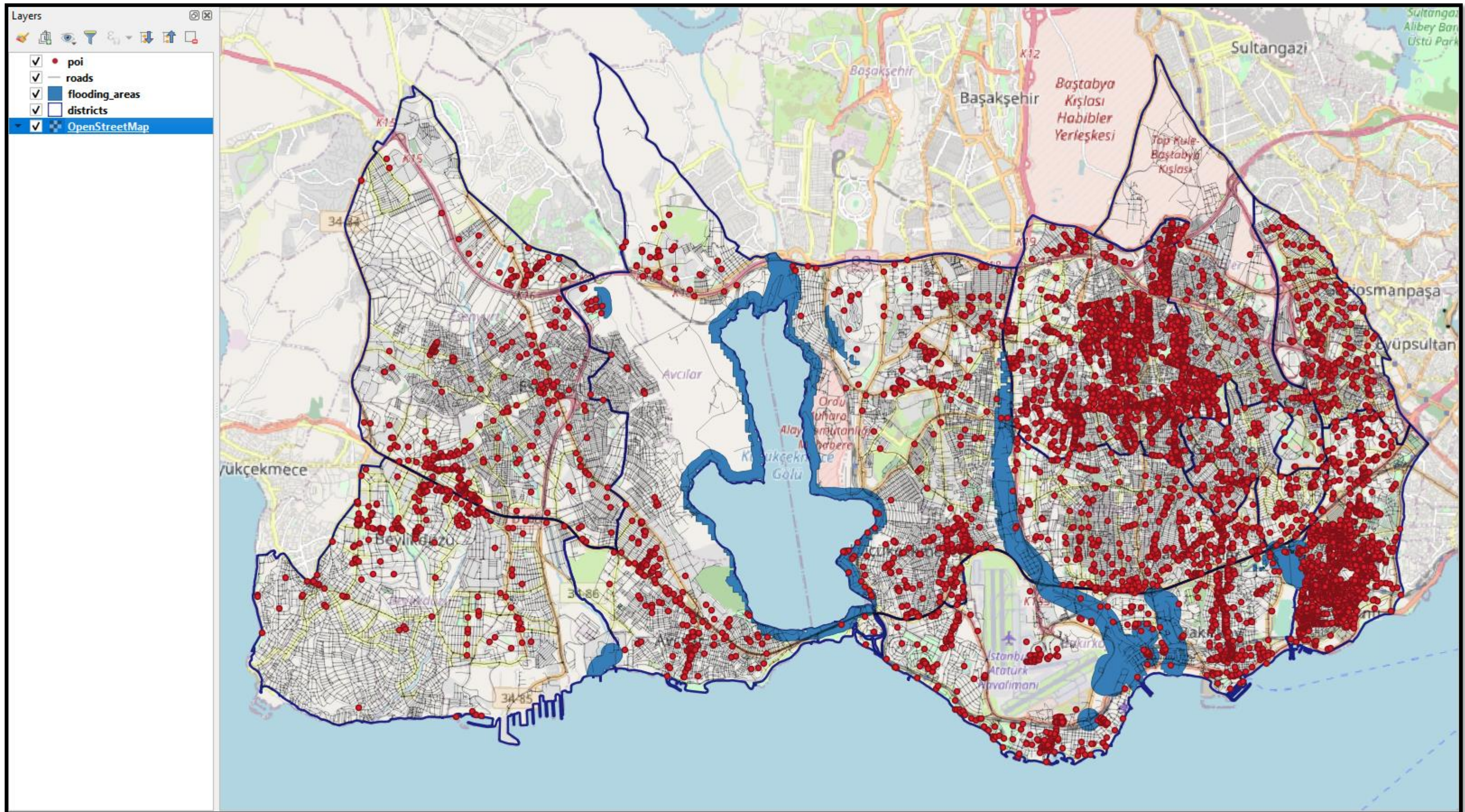
Aim of the Study:

- *Analyze the different type of distance calculation methods and their affects on centering algorithms*
- *Observe the hospitals distribution over districts and find the center of hospitals to analyze the distances between the centers and flooding areas*

Input Data:

- *Data (Geopackage)*
 - *POI (Vector-Point)*
 - *Roads (Vector-Polyline)*
 - *Districts (Vector-Polygon)*
 - *Flooding Areas (Vector-Polygon)*

Exploring Data

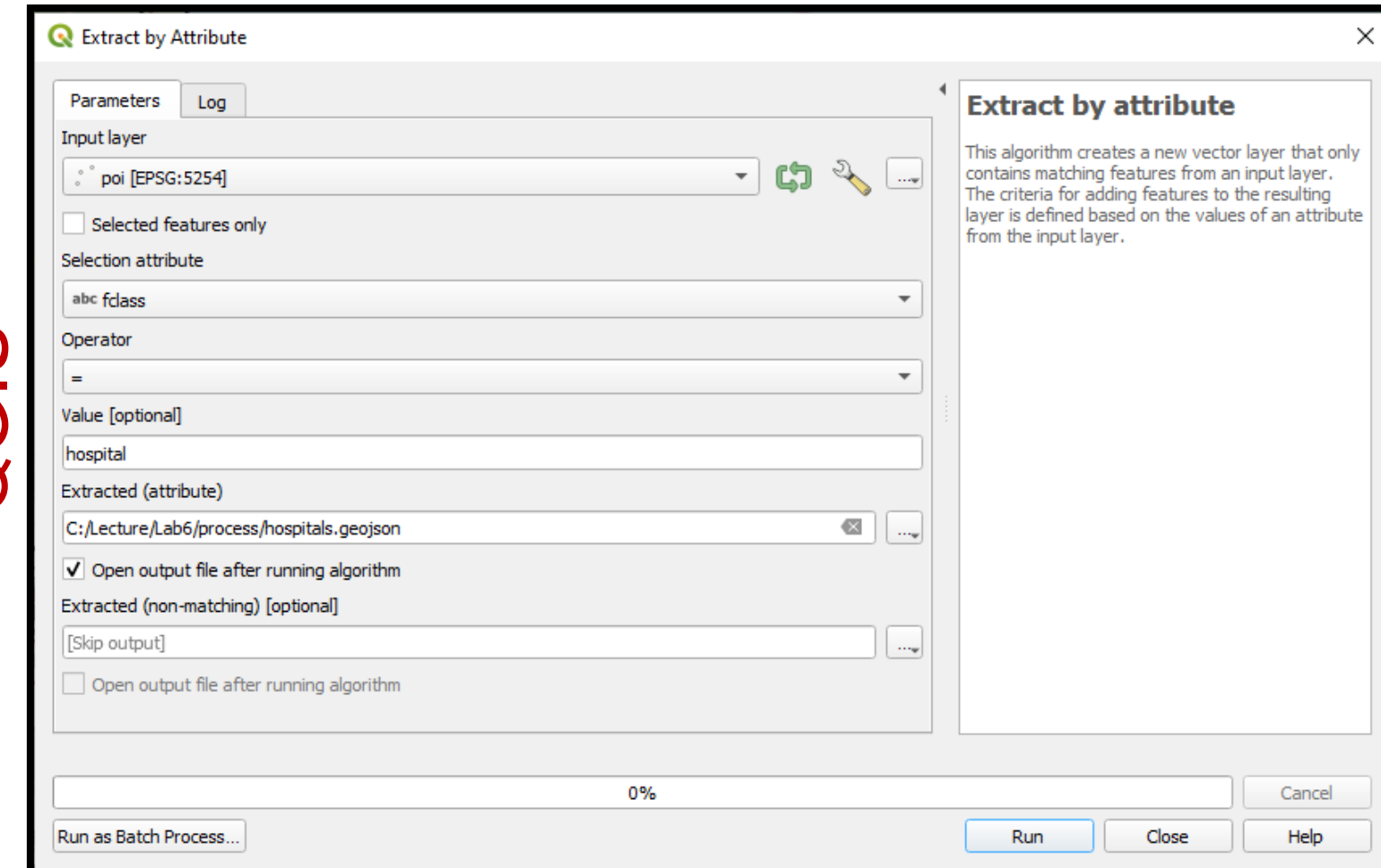


Preparing Analysis Data

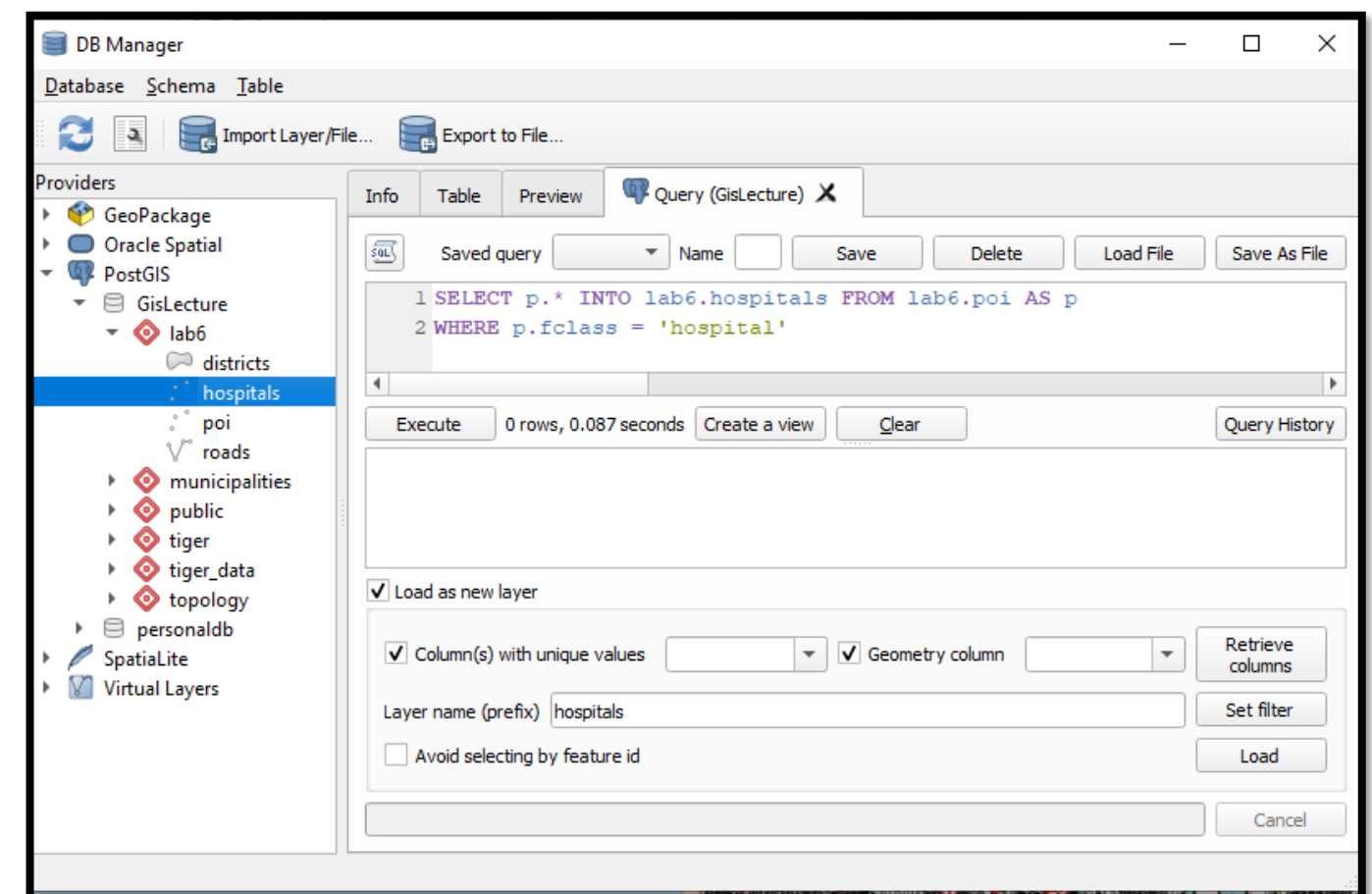
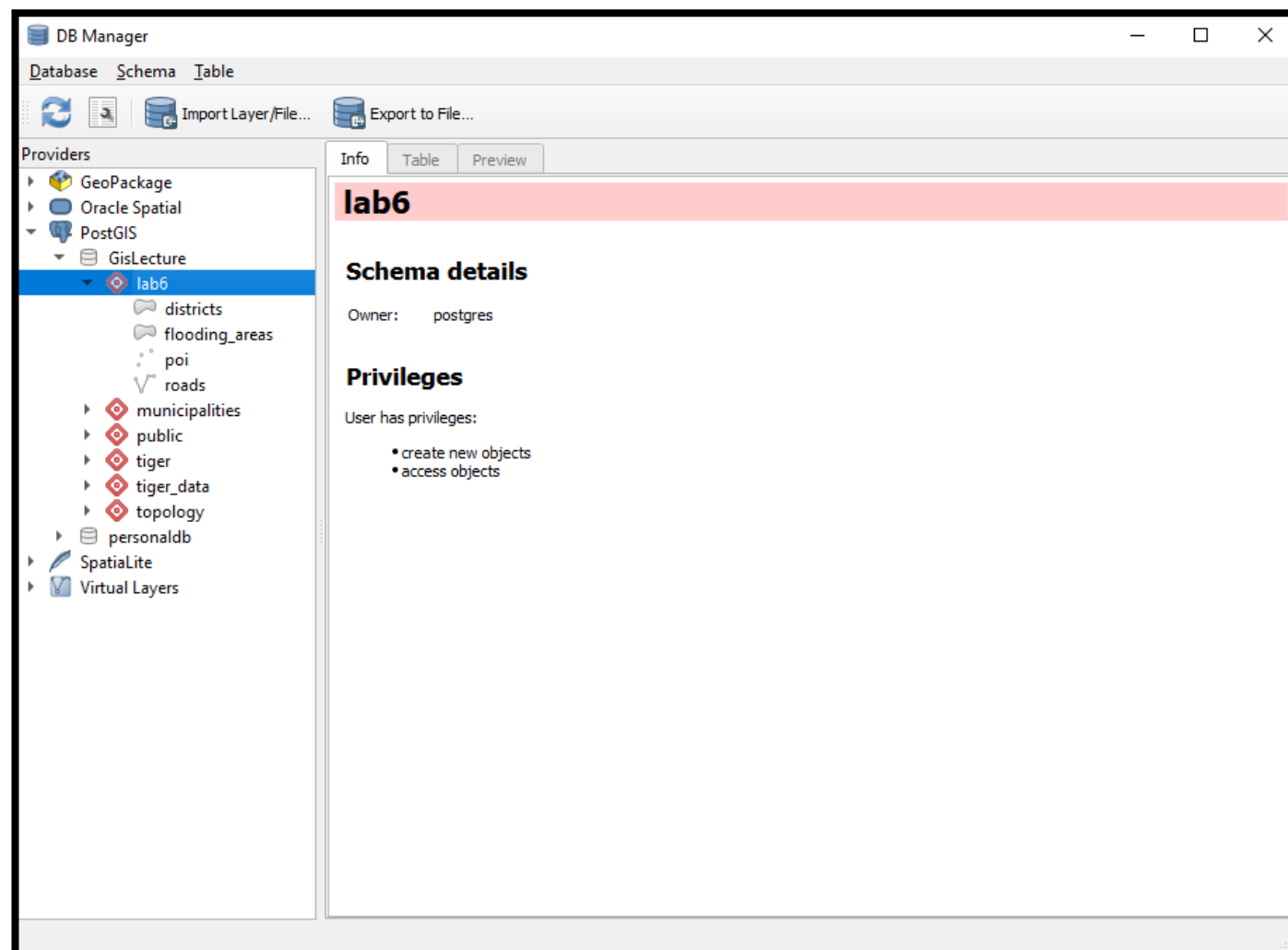
Create a PostGIS database schema named “lab” and import input data into it. Don’t forget the specify **“fid” as primary key** and **create spatial index** when importing data into PostGIS

Select hospitals from poi data for further analyzes

QGIS

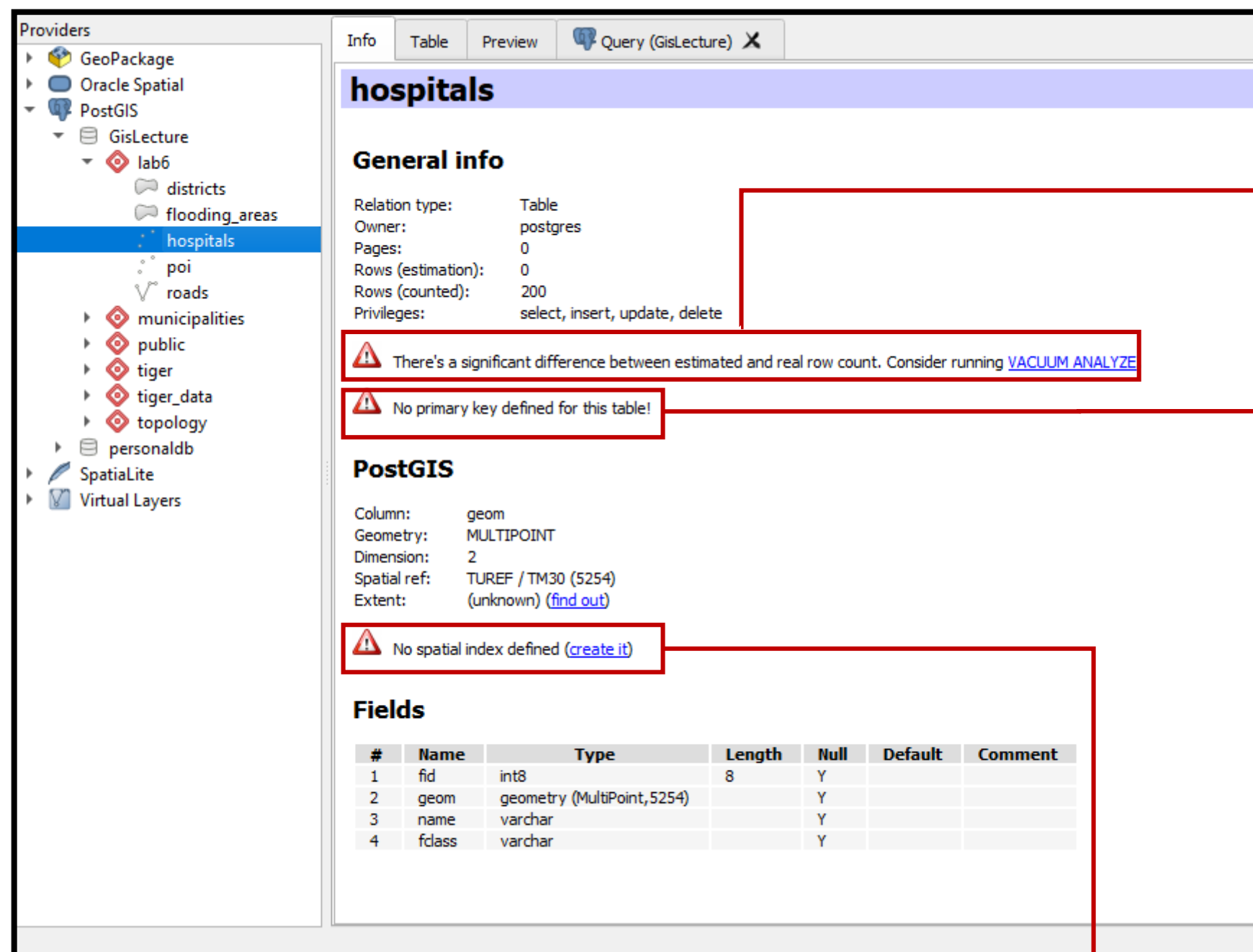


PostGIS



Adding Required Functionalities to PostGIS Table

Inspect the created hospitals table.



hospitals

General info

Relation type: Table
 Owner: postgres
 Pages: 0
 Rows (estimation): 0
 Rows (counted): 200
 Privileges: select, insert, update, delete

⚠ There's a significant difference between estimated and real row count. Consider running [VACUUM ANALYZE](#)

⚠ No primary key defined for this table!

PostGIS

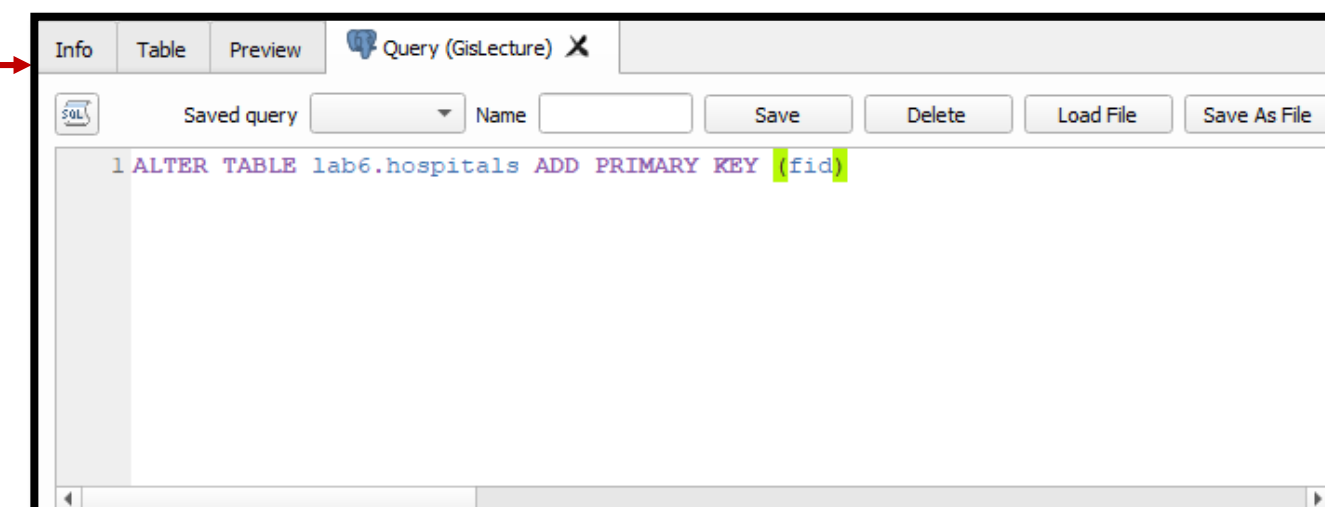
Column: geom
 Geometry: MULTIPOINT
 Dimension: 2
 Spatial ref: TUREF / TM30 (5254)
 Extent: (unknown) ([find out](#))

⚠ No spatial index defined ([create it](#))

Fields

#	Name	Type	Length	Null	Default	Comment
1	fid	int8	8	Y		
2	geom	geometry (MultiPoint, 5254)		Y		
3	name	varchar		Y		
4	fclass	varchar		Y		

Click **VACUUM ANALYZE** to reclaim storage occupied by dead tuples (optimization)



SQL

1 ALTER TABLE lab6.hospitals ADD PRIMARY KEY (fid)

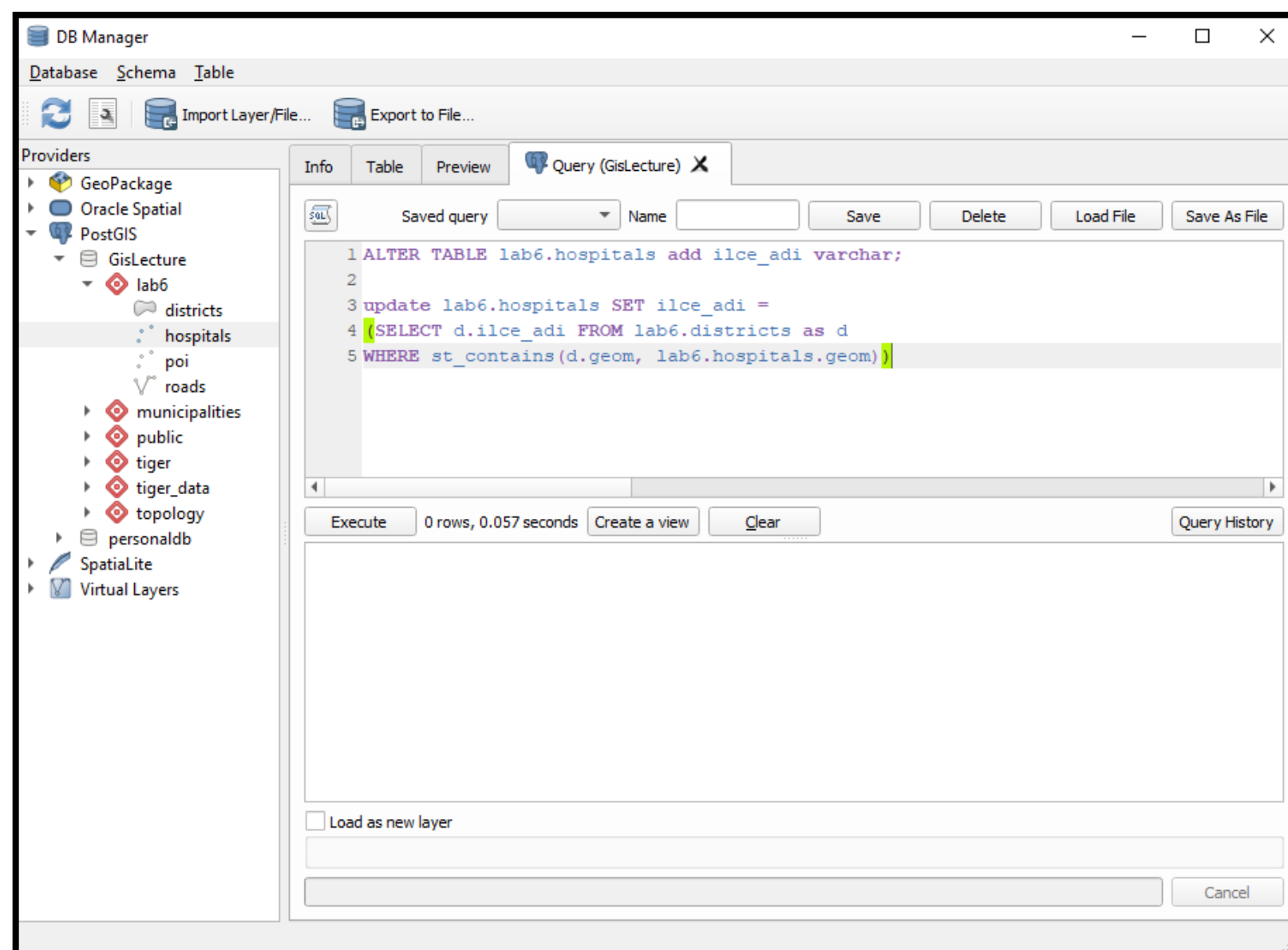
Setting **PRIMARY KEY** as “fid” column of data

Click “create it” to enable **spatial indexing**

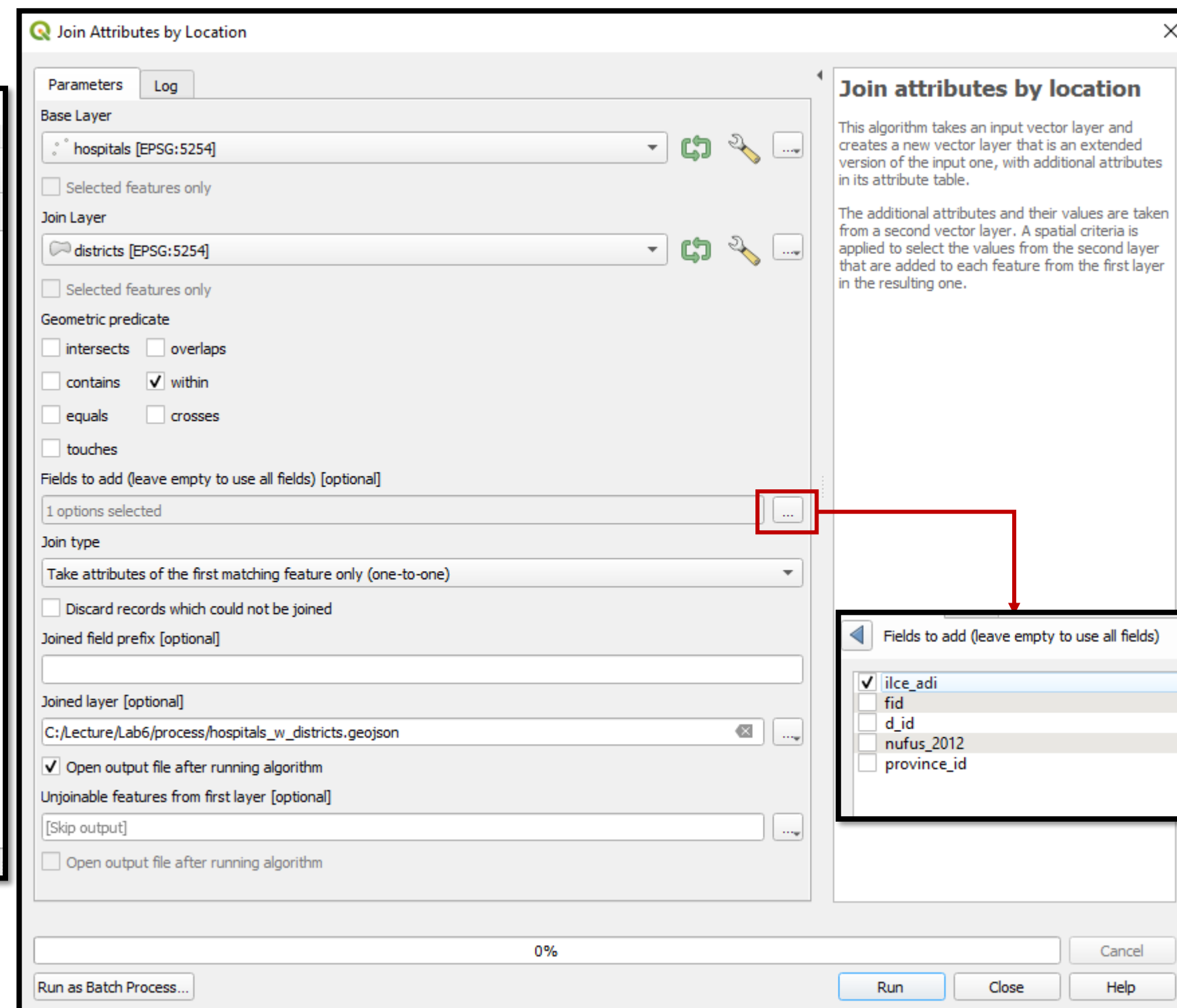
Preparing Analysis Data

Join hospitals with districts to represent district names

Spatial Join
using PostGIS **ST_Contains**

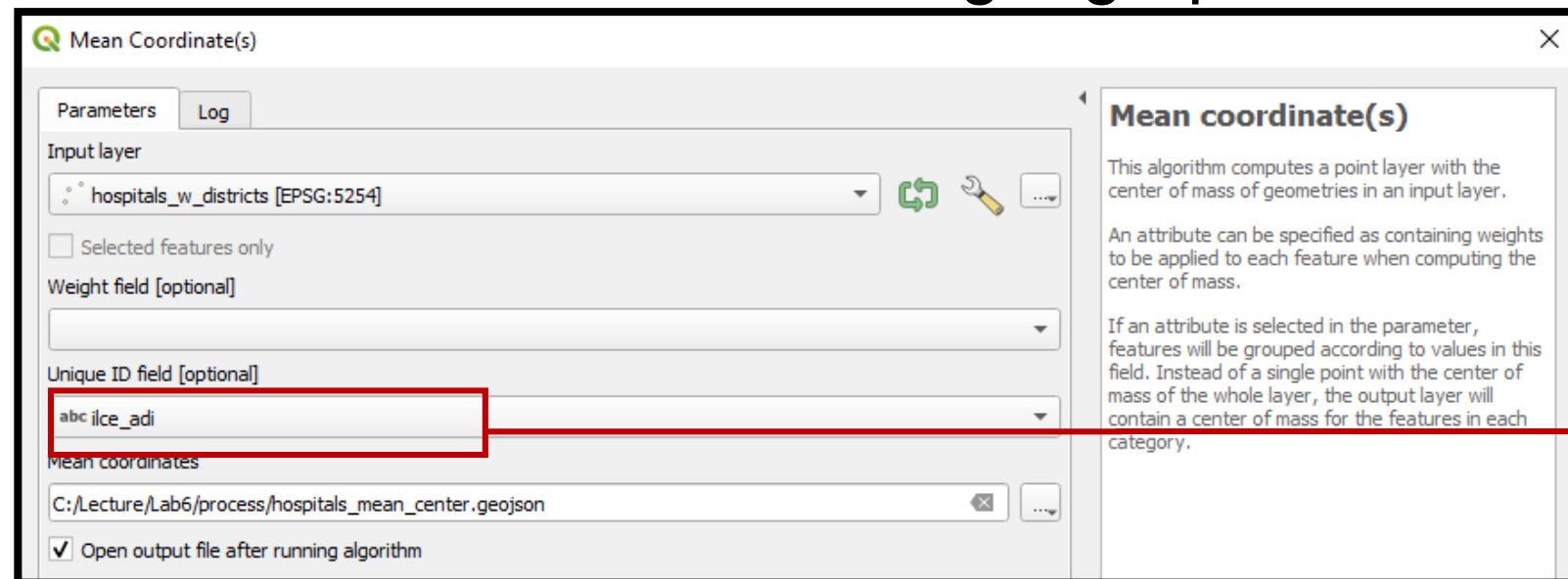


Spatial Join using QGIS

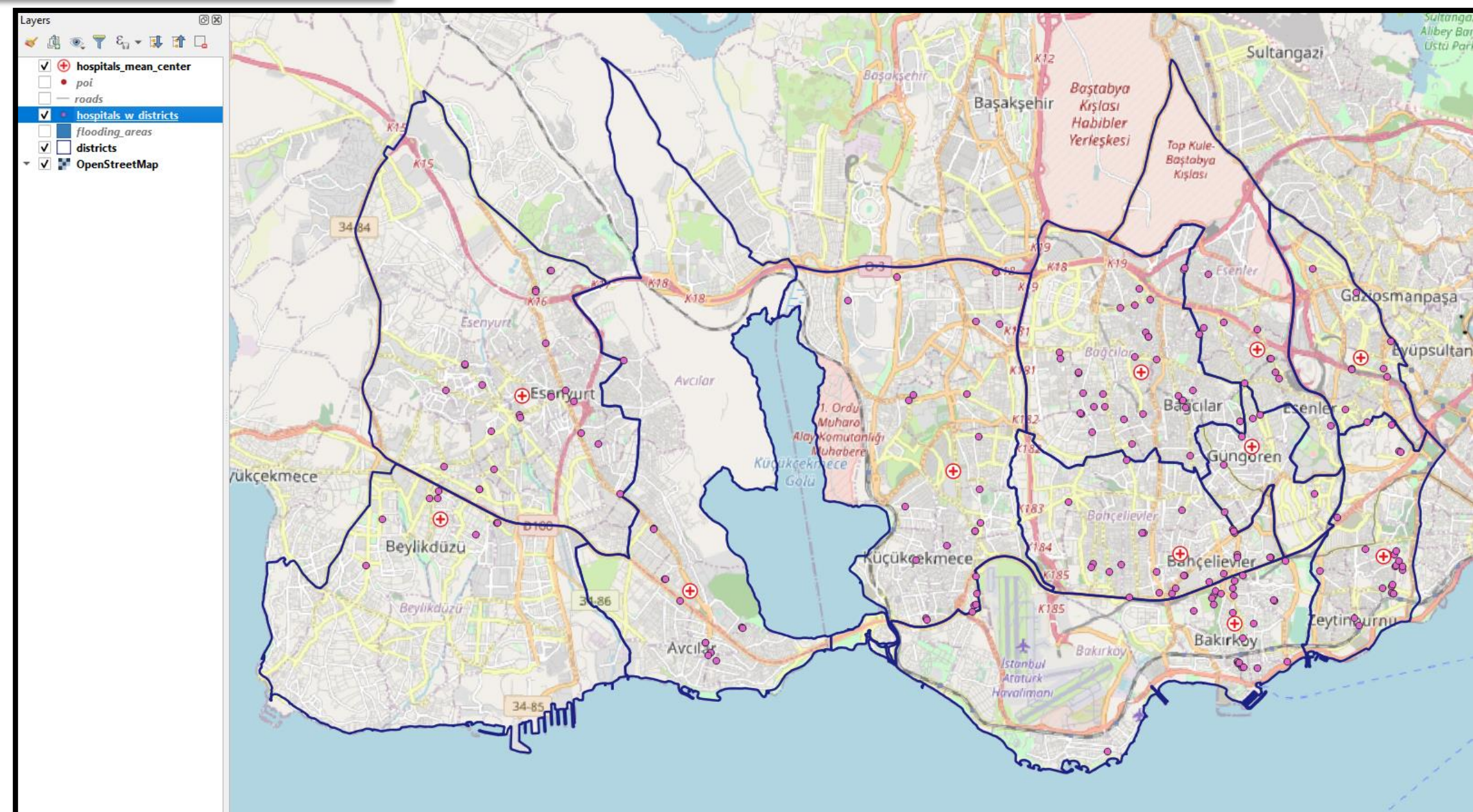


Mean Center

Mean Center: Identifies the geographic center for a set of features



Specify Unique ID field to get mean center for each attribute type (for each district in that case)



Weighted Mean Center Euclidean Distance



Weighted Mean Center: The geographic center of a set of points as adjusted for the influence of a value (distance, time, cost, attribute etc.) associated with each point

Euclidean Distance

To find the weighted mean of each district in QGIS, below work schema is need to be followed.

Filter Hospital data by using **ilce_adi** column to calculate each district's weighted mean center separately



Create distance matrix for the hospitals in each district to find average distance between them



Merge hospitals with calculated mean distances



Use mean distances as **weight field** in Mean Coordinate tool

Weighted Mean Center Euclidean Distance



Implementing the schema for only Gungoren district

Extract by Attribute

This algorithm creates a new vector layer that only contains matching features from an input layer. The criteria for adding features to the resulting layer is defined based on the values of an attribute from the input layer.

Parameters

Input layer: hospitals_w_districts [EPSG:5254]

☐ Selected features only

Selection attribute: abc ilce_adi

Operator: =

Value [optional]: Güngören

Extracted (attribute): C:/Lecture/Lab6/process/hospitals_Gungoren.geojson

☒ Open output file after running algorithm

Extracted (non-matching) [optional]: [Skip output]

☐ Open output file after running algorithm

0%

Run as Batch Process... Run Close Help

Distance Matrix

This algorithm creates a table containing a distance matrix, with distances between all the points in a points layer.

Parameters

Input point layer: hospitals_Gungoren [EPSG:5254]

☐ Selected features only

Input unique ID field: 123 fid

Target point layer: hospitals_Gungoren [EPSG:5254]

☐ Selected features only

Target unique ID field: 123 fid

Output matrix type: Summary distance matrix (mean, std. dev., min, max)

Use only the nearest (k) target points: 0

Distance matrix: C:/Lecture/Lab6/process/dist_matrix_Gungoren.geojson

☒ Open output file after running algorithm

0%

Run as Batch Process... Run Close Help

Note: If the following warning is encountered

Input point layer is a MultiPoint layer - first convert to single points before using this algorithm.
Execution failed after 0.07 seconds

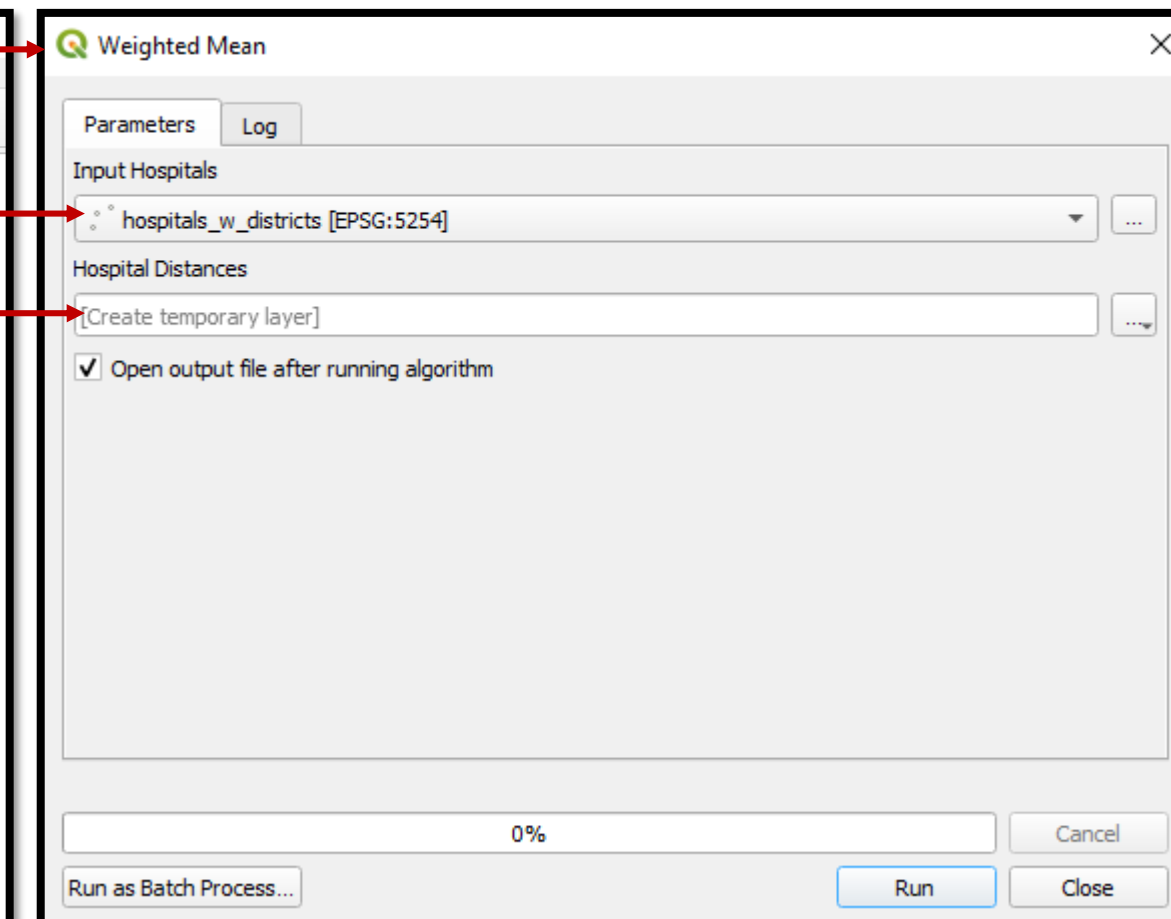
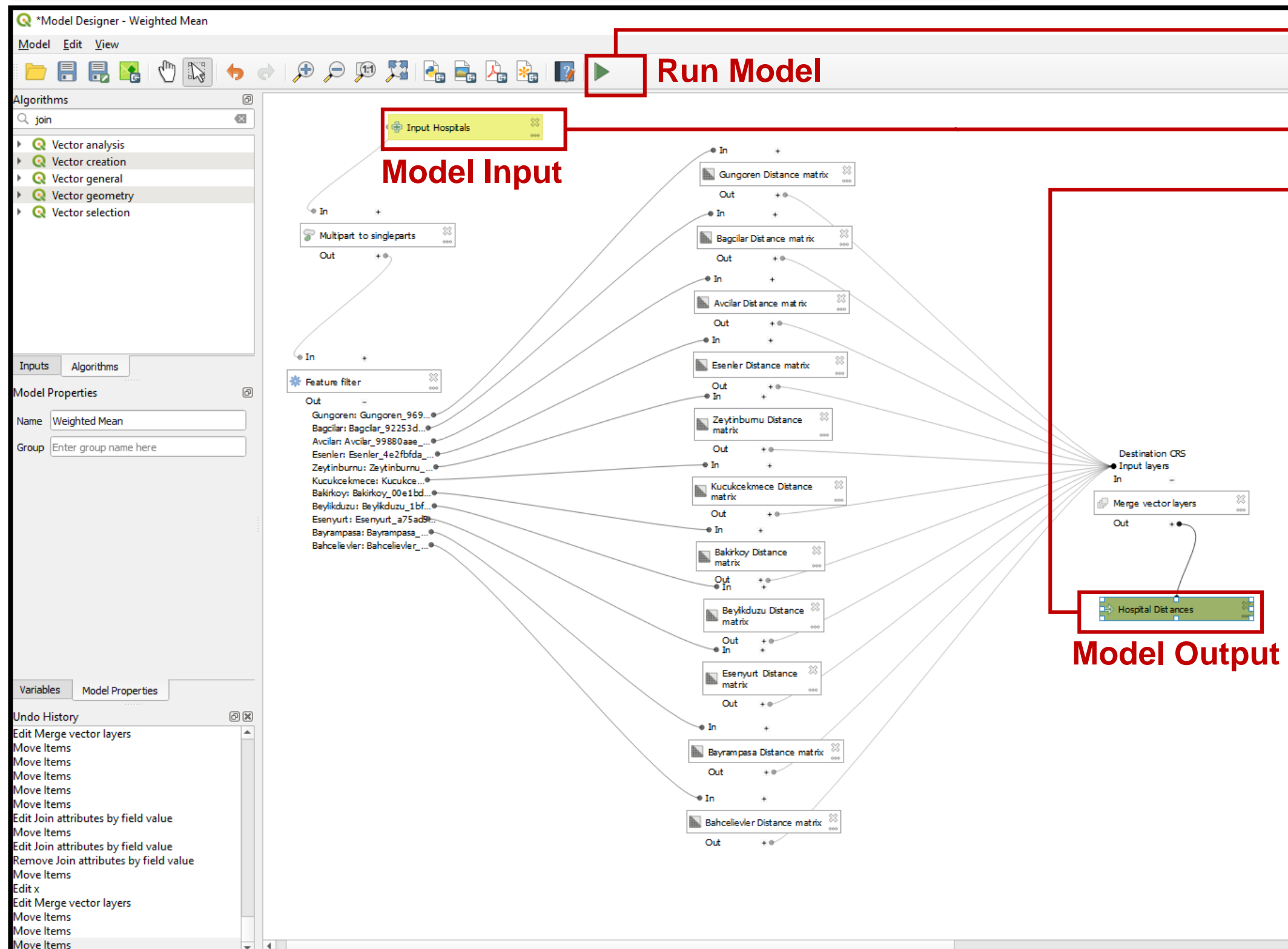
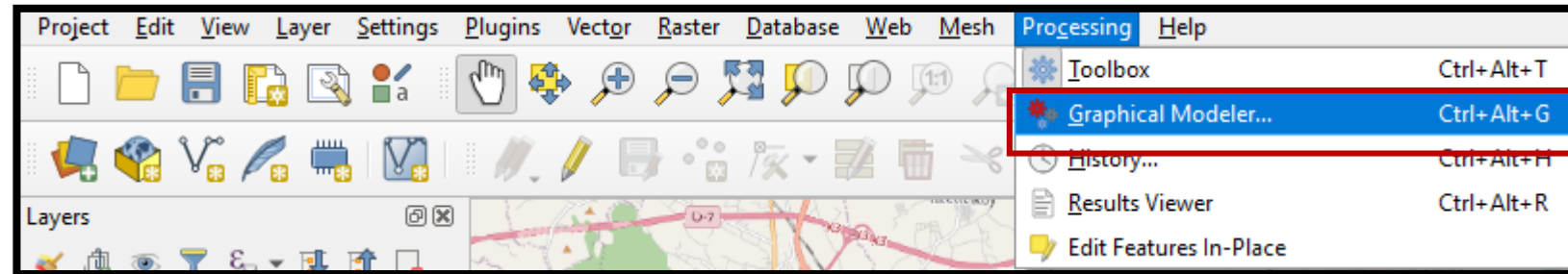
Use **Multipart to Singlepart** tool to fix the problem

dist_matrix_Gungoren — Features Total: 7, Filtered: 7, Selected: 0

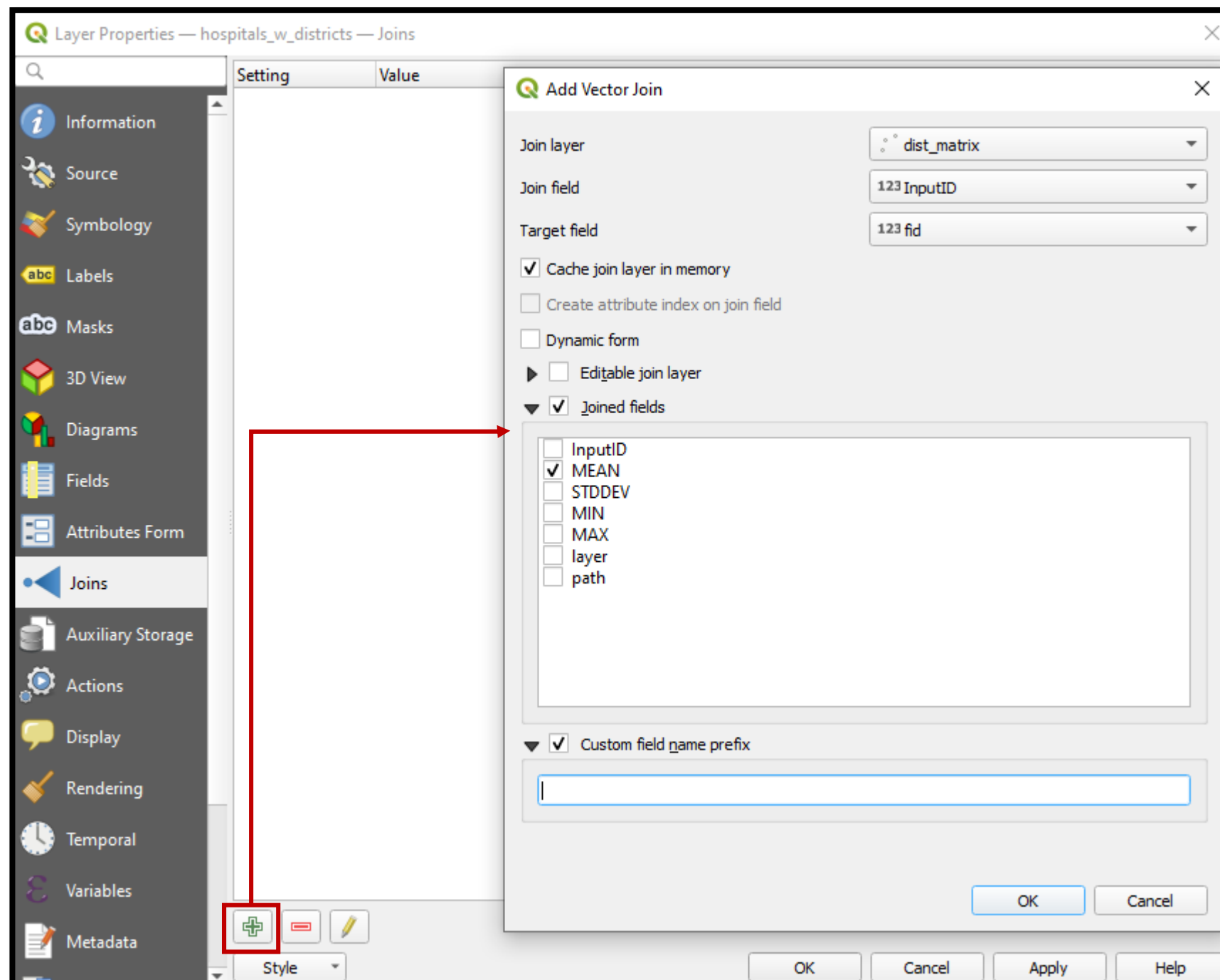
	InputID	MEAN	STDDEV	MIN	MAX
1	10	1214.920778661...	620.889122890662	510.3825726862...	2194.462185912...
2	8	1858.062536208...	960.5996364725...	830.8050660669...	3108.576442866...
3	9	2176.179342841...	599.3311003452...	1136.877457621...	3098.823231508...
4	6	2392.306846266...	324.1735489414...	2176.794895560...	3108.576442866...
5	7	1493.307772910...	501.7317241195...	790.139076103039	2270.947861369...
6	3	1252.042196644...	829.9317771017...	198.0694847708...	2332.691830815...
7	4	1323.159740373...	834.4121878200...	198.0694847709...	2470.945116876...

Using QGIS Graphical Modeler

To implement the model for each district, QGIS Graphical Modeler can be used.



Join Result



hospitals_w_districts — Features Total: 200, Filtered: 200, Selected: 1

	fid	name	fclass	ilce_adi	MEAN
1	7632	Özel Avcılar Ho...	hospital	Avcılar	1890.866063799...
2	7654	Özel Anadolu H...	hospital	Avcılar	2543.764524909...
3	7560	Özel Medicana ...	hospital	Avcılar	1722.414217743...
4	7599	Avcılar Murat K...	hospital	Avcılar	2012.855939405...
5	155	Özel Dermo Cli...	hospital	Avcılar	2022.170661521...
6	156	Özel Asya Göz ...	hospital	Avcılar	1740.328146008...
7	153	Özel Doğan T...	hospital	Avcılar	1842.934216105...
8	154	Özel Vera Top ...	hospital	Avcılar	1867.815033309...
9	151	Özel Medicana ...	hospital	Avcılar	1721.183148890...
10	152	Özel Avcılar ...	hospital	Avcılar	1893.296859043...
11	149	Avcılar Murat ...	hospital	Avcılar	2004.763466930...
12	150	Özel Avcılar A...	hospital	Avcılar	2549.3952297206
13	127	Özel Tosuno I...	hospital	Avcılar	6193.869432043...
14	22	Özel Akademi ...	hospital	Bağcılar	1761.564692561...
15	23	Özel Yunus Em...	hospital	Bağcılar	1791.288677239...
16	20	Özel Zeynep ...	hospital	Bağcılar	2930.461328402...

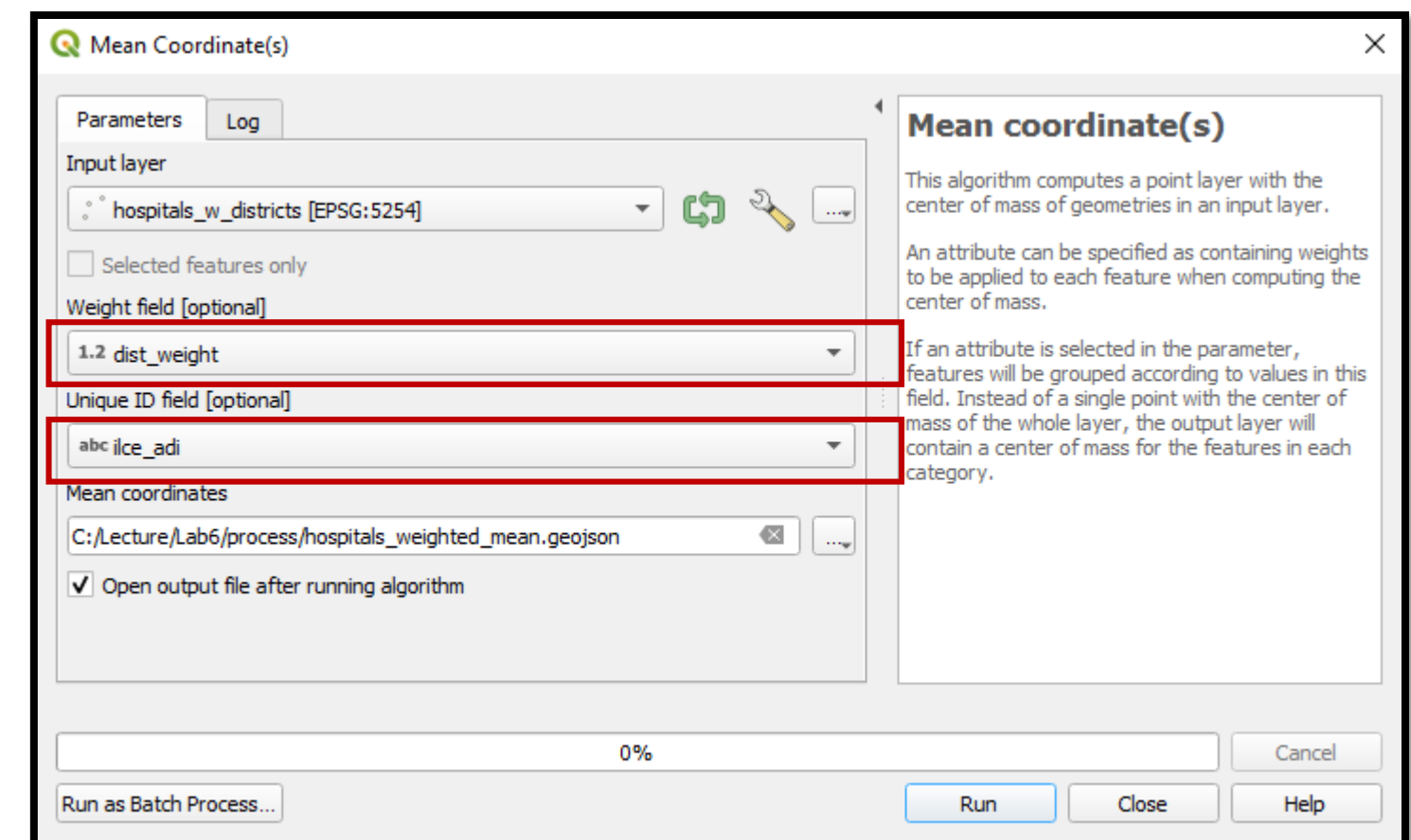
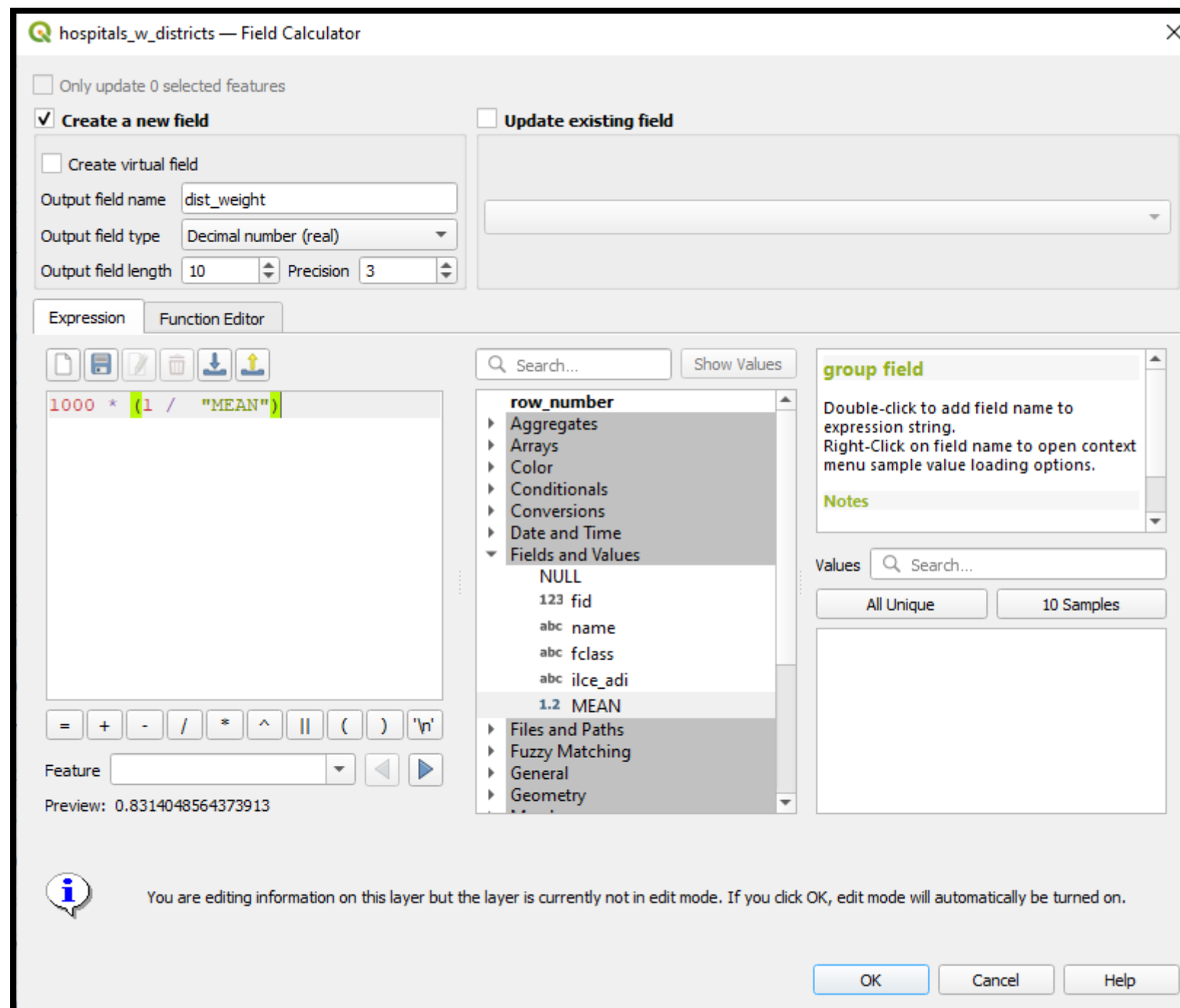
Show All Features

Distances between hospitals for each districts are calculated separately

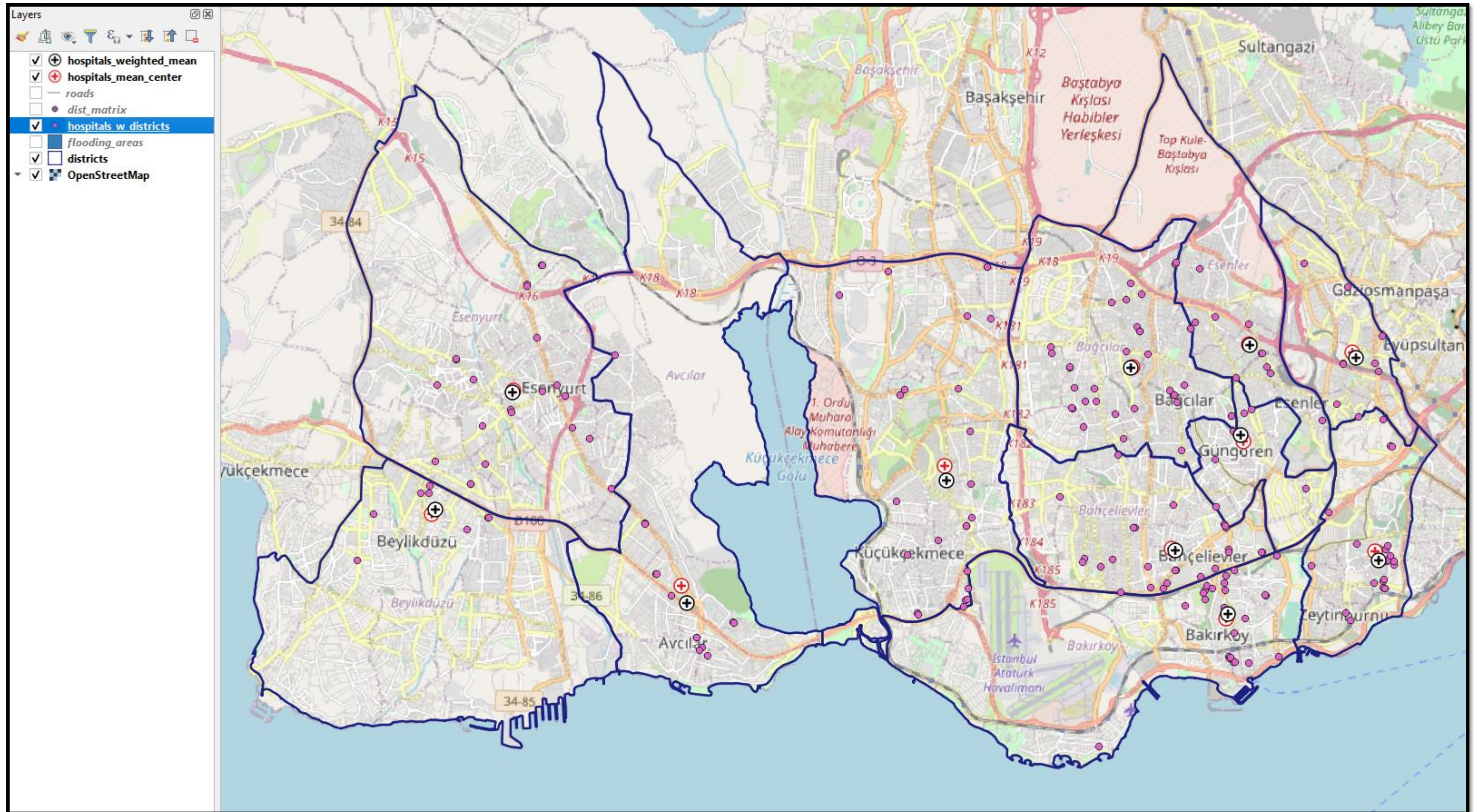
Weighted Mean Center Euclidean Distance



Creating the inverse distance weight attribute by using $1000 * (1 / \text{MEAN})$ formula (1000 multiplier is for discarding the decimal numbers)



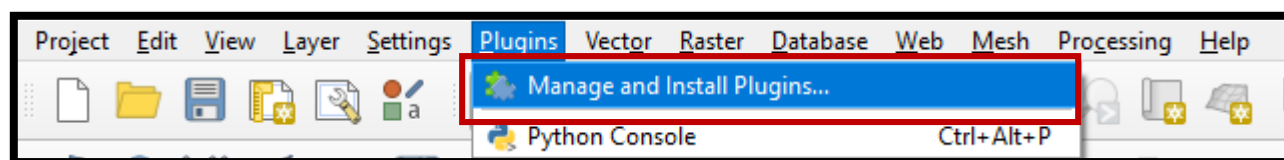
Weighted Mean Center Euclidean Distance



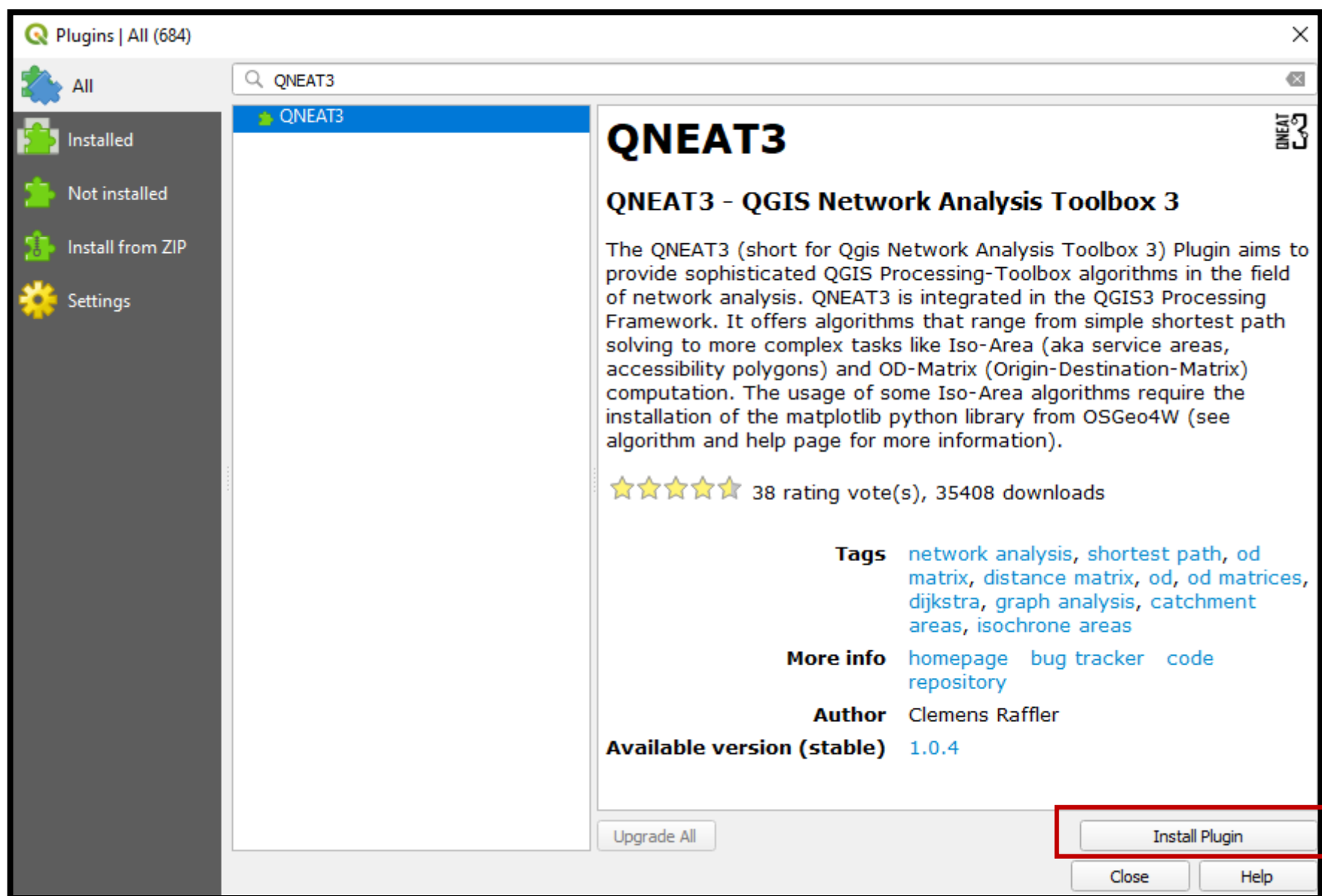
Weighted Mean Center Network Distance

Weighted Mean Center: The geographic center of a set of points as adjusted for the influence of a value (distance, time, cost, attribute etc.) associated with each point

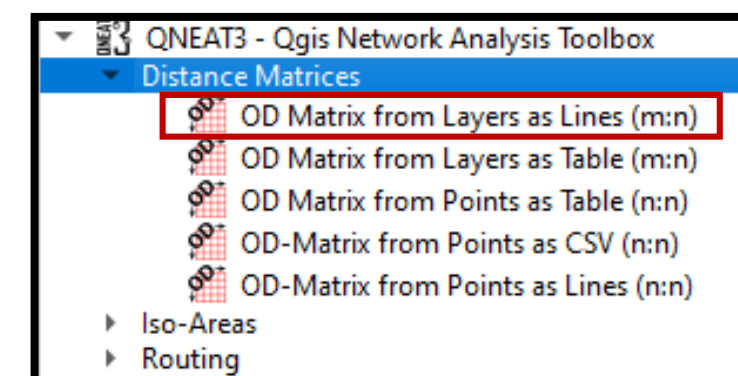
Network Distance



To calculate network distances, **QNEAT3** plugin is needed.



For this concept, network distance between hospitals will be calculated to add them as weight fields



Weighted Mean Center Network Distance



QGIS OD Matrix From Layers as Lines (M:N)

Parameters Log

Input Network

Network Layer
roads [EPSG:5254]

Origins

From-Point Layer
hospitals_w_districts [EPSG:5254]

Unique Point ID Field
123 fid

Destinations

To-Point Layer
hospitals_w_districts [EPSG:5254]

Unique Point ID Field
123 fid

Shortest/Fastest

Optimization Criterion
Shortest Path (distance optimization)

Advanced Parameters

Output OD Matrix
C:/Lecture/Lab6/process/od_matrix.geojson

☒ Open output file after running algorithm

0%

Run as Batch Process... Run Cancel Close

OD Matrix from Layers as Lines (m:n)

General:
This algorithm implements OD-Matrix analysis to return the **matrix of origin-destination pairs as lines yielding network based costs** on a given **network dataset between two layer of points (m:n)**. It accounts for **points outside of the network** (eg. *non-network-elements*). Distances are measured accounting for **ellipsoids**, entry-, exit-, network- and total costs are listed in the result attribute-table.

Parameters (required):
Following Parameters must be set to run the algorithm:

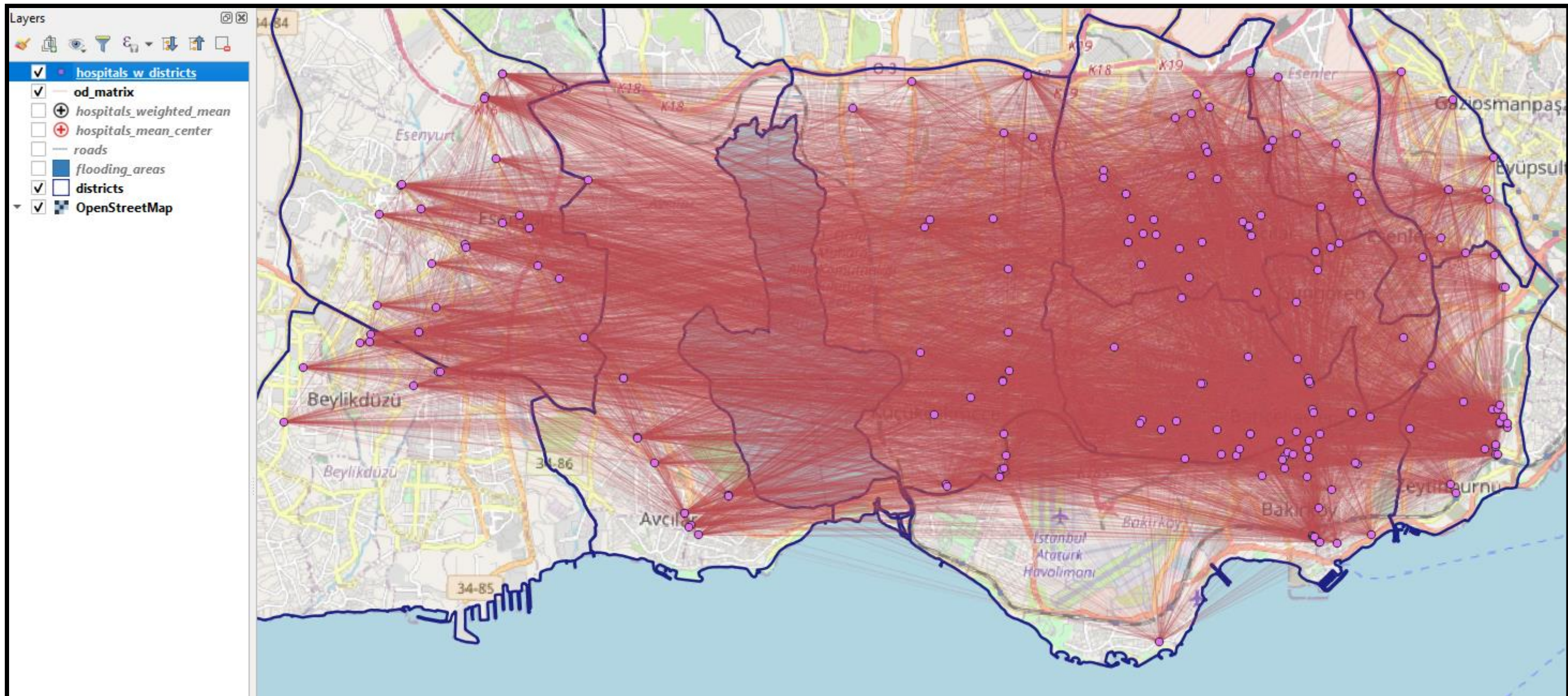
- Network Layer
- From-Point Layer
- Unique From-Point ID Field (numerical)
- To-Point Layer
- Unique To-Point ID Field (numerical)
- Cost Strategy

Parameters (optional):
There are also a number of *optional parameters* to implement **direction dependent** shortest paths and provide information on **speeds** on the networks edges.

- Direction Field
- Value for forward direction
- Value for backward direction
- Value for both directions
- Default direction

To implement the time based network analysis, speed information for roads should be specified as km/h in the data's attributes

Weighted Mean Center Network Distance



- Result of the analysis is shown as straight lines in QGIS. However the distance values in the attributes is calculated as network distances.
- Distances are calculated from each point to every point (For 200 hospitals, 200x200-40000 distance values are calculated)

Weighted Mean Center Network Distance



- For further analysis, we need to summarize the results to show and represent each point's mean distance to other points.
- To do that the result layer need to be imported into PostGIS and SQL queries need to be used.

od_matrix — Features Total: 40000, Filtered: 40000, Selected: 0

	origin_id	destination_id	entry_cost	network_cost	exit_cost	total_cost	od_dist_weight
1	3	3	NULL	NULL	NULL	NULL	NULL
2	3	4	33.0490725	318.3830214	12.3222732	363.7543672	2.749
3	3	6	33.0490725	2816.5507788	8.9807673	2858.5806187	0.35
4	3	7	33.0490725	1436.8120587	16.9347851	1486.7959164	0.673
5	3	8	33.0490725	1004.819855	9.1113386	1046.9802661	0.955
6	3	9	33.0490725	2843.1389409	7.5146746	2883.7026881	0.347
7	3	10	33.0490725	535.130288	16.3564384	584.535799	1.711
8	3	11	33.0490725	2322.0319138	8.1430755	2363.2240619	0.423
9	3	18	33.0490725	2822.0402772	10.2911806	2865.3805304	0.349
10	3	29	33.0490725	2692.1094617	28.977866	2754.1364003	0.363
11	3	32	33.0490725	1775.0087868	7.2285856	1815.2864449	0.551
12	3	33	33.0490725	1687.7779346	12.9996272	1733.8266343	0.577
13	3	35	33.0490725	2514.129174	11.5639442	2558.7421907	0.391
14	3	38	33.0490725	4003.2950695	7.7365767	4044.0807188	0.247
15	3	39	33.0490725	1404.9177432	9.6380955	1447.6049113	0.691

Show All Features

- First, create the inverse distance weight attribute by using $1000 * (1 / \text{total_cost})$ formula (1000 multiplier is for discarding the decimal numbers)
- Import od_matrix into PostGIS lab6 schema and run the following SQL query

Providers

- GeoPackage
- Oracle Spatial
- PostGIS
 - GisLecture
 - lab6
 - municipalities
 - public
 - tiger
 - tiger_data
 - topology
 - personaldb
- Spatialite
- Virtual Layers

Info Table Preview Query (GisLecture) X

SQL Saved query Name Save Delete Load File Save As File

```
1 SELECT o.origin_id, AVG(o.od_dist_weight) AS od_dist_weight FROM lab6.od_matrix as o
2 GROUP BY o.origin_id
```

Execute 200 rows, 0.213 seconds Create a view Clear Query History

	origin_id	od_dist_weight
1	116	0.129545000000...
2	87	0.243974999999...
3	71	0.093409999999...
4	68	0.193444999999...
5	51	0.18492

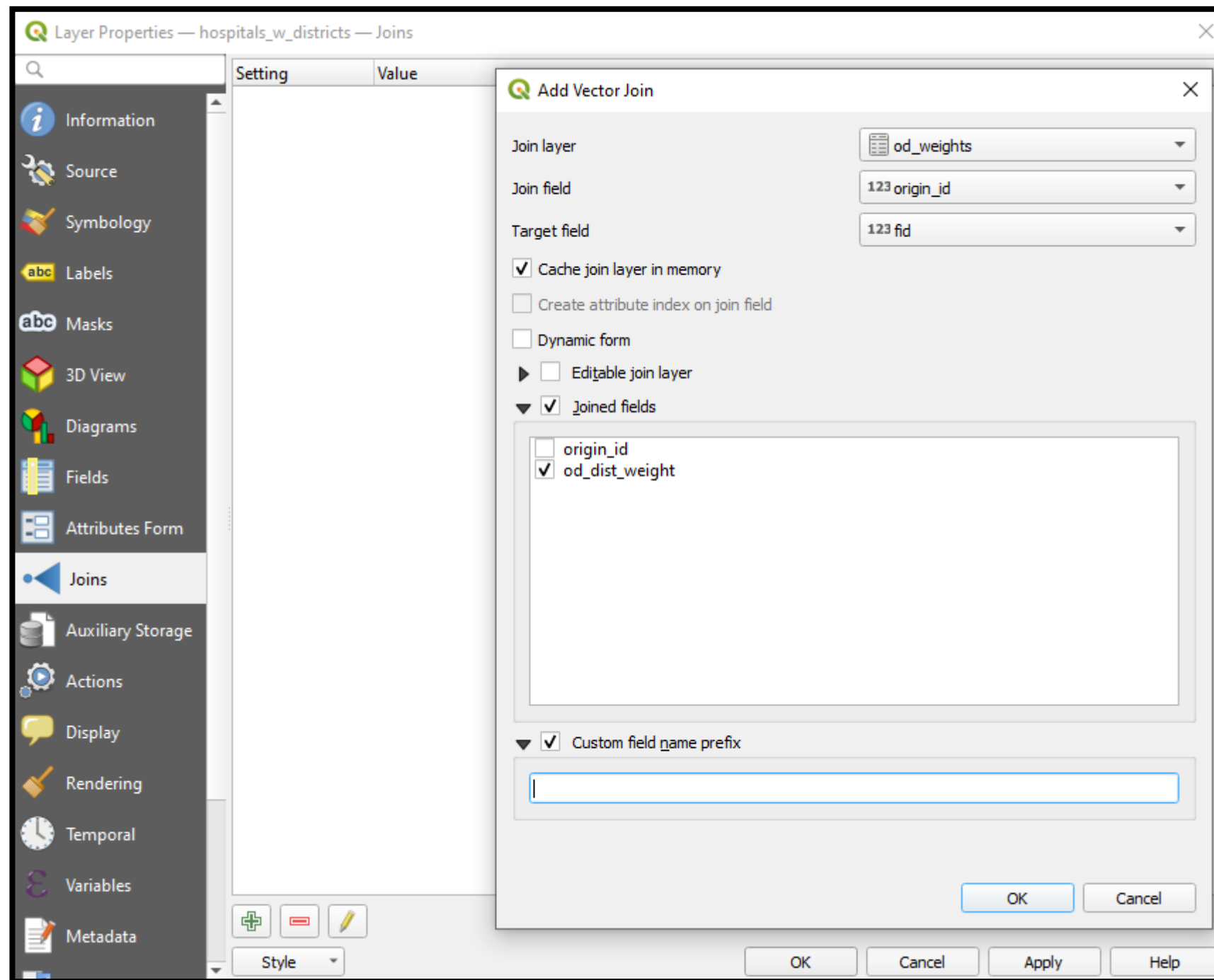
☒ Load as new layer

☒ Column(s) with unique values origin_id ☐ Geometry column Retrieve columns

Layer name (prefix) od_weights Set filter

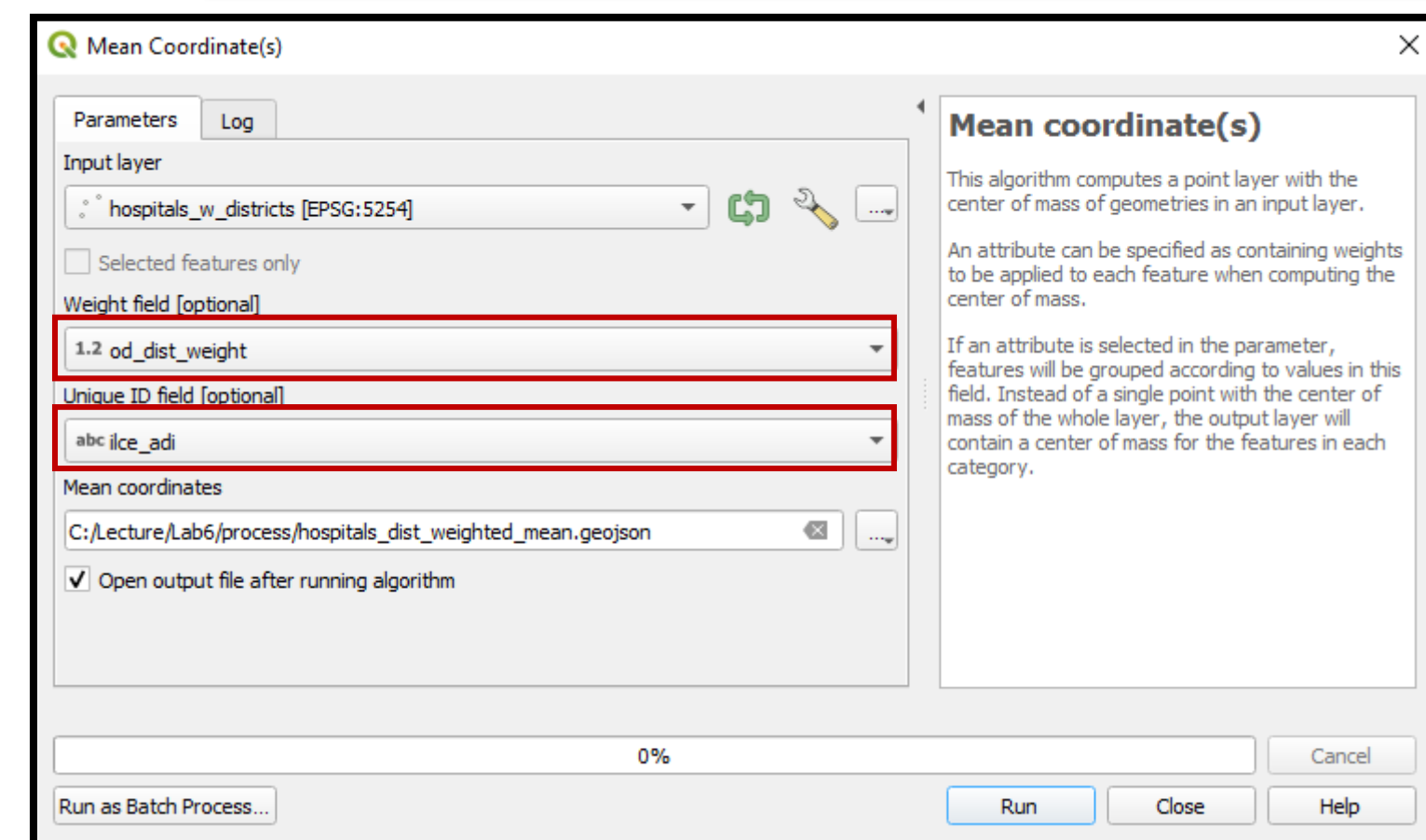
☐ Avoid selecting by feature id Load Cancel

Join Result

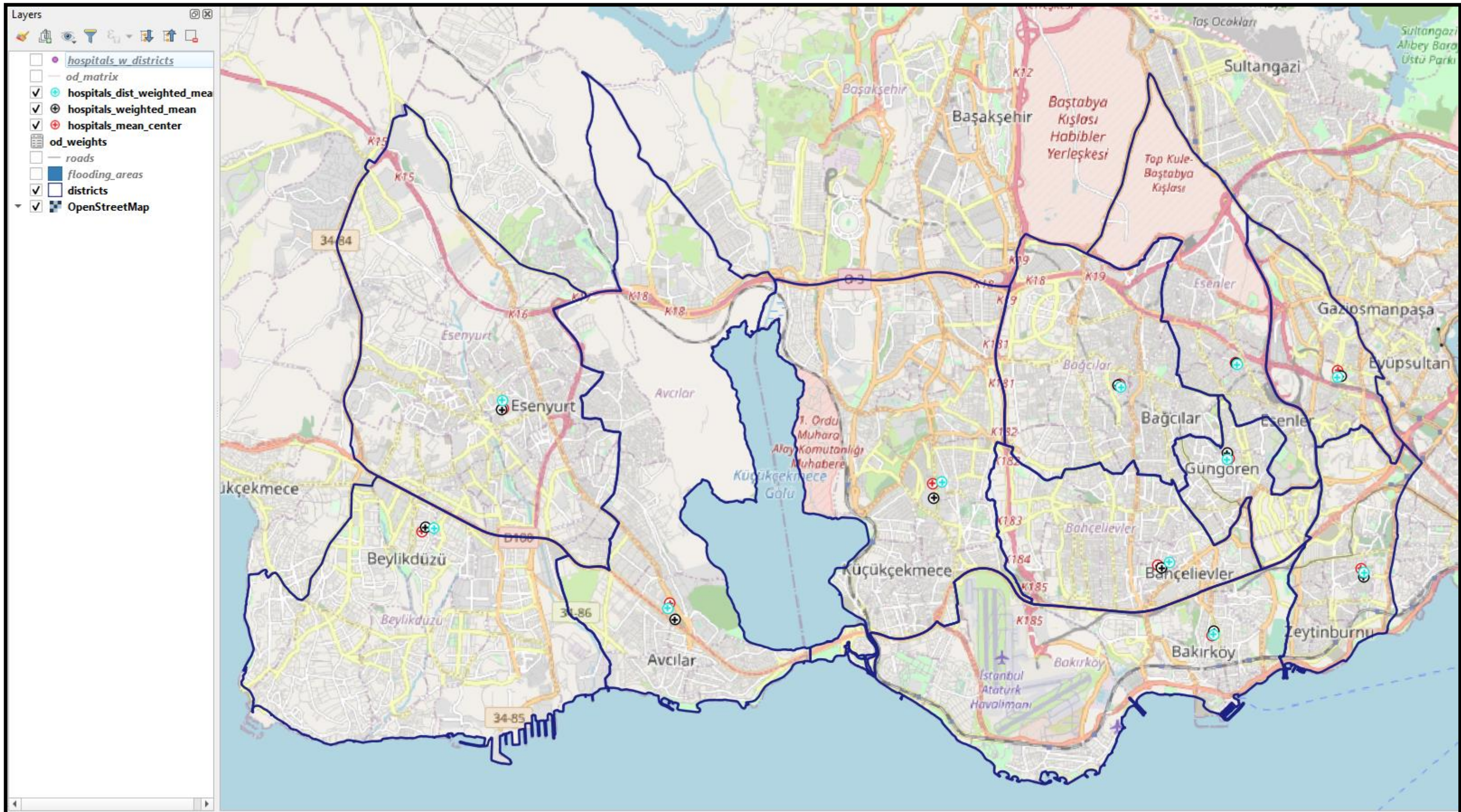


	fid	name	fclass	ilce_adi	dist_weight	od_dist_weight
1	1	zel Vital Hosp...	hospital	Bahçelievler	0.562	0.47440500000000...
2	2	Aydın niver...	hospital	Bahçelievler	0.57	0.31242000000000...
3	3	SB Ba c lar...	hospital	Güngören	0.799	0.2263266331658...
4	4	Bak rk y Prof...	hospital	Güngören	0.756	0.23273500000000...
5	5	SB Ba c lar...	hospital	Bağcılar	0.339	0.23264000000000...
6	6	BB Tozkopara...	hospital	Güngören	0.418	0.18277500000000...
7	7	zel lgi Hast...	hospital	Güngören	0.67	0.215515
8	8	zel Huzur T...	hospital	Güngören	0.538	0.20652499999999...
9	9	zel Meltem H...	hospital	Güngören	0.46	0.26128999999999...
10	10	zel Gong re...	hospital	Güngören	0.823	0.22721000000000...
11	11	zel Maximed ...	hospital	Esenler	0.353	0.17489500000000...
12	12	zel Memorial ...	hospital	Bahçelievler	0.424	0.04199999999999...
13	13	zel Bah eliev...	hospital	Bahçelievler	0.568	0.54691000000000...

Join the od_matrix results into hospitals and calculate mean centers by using **od_dist_weight** column



Evaluate the Results





Contact:

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