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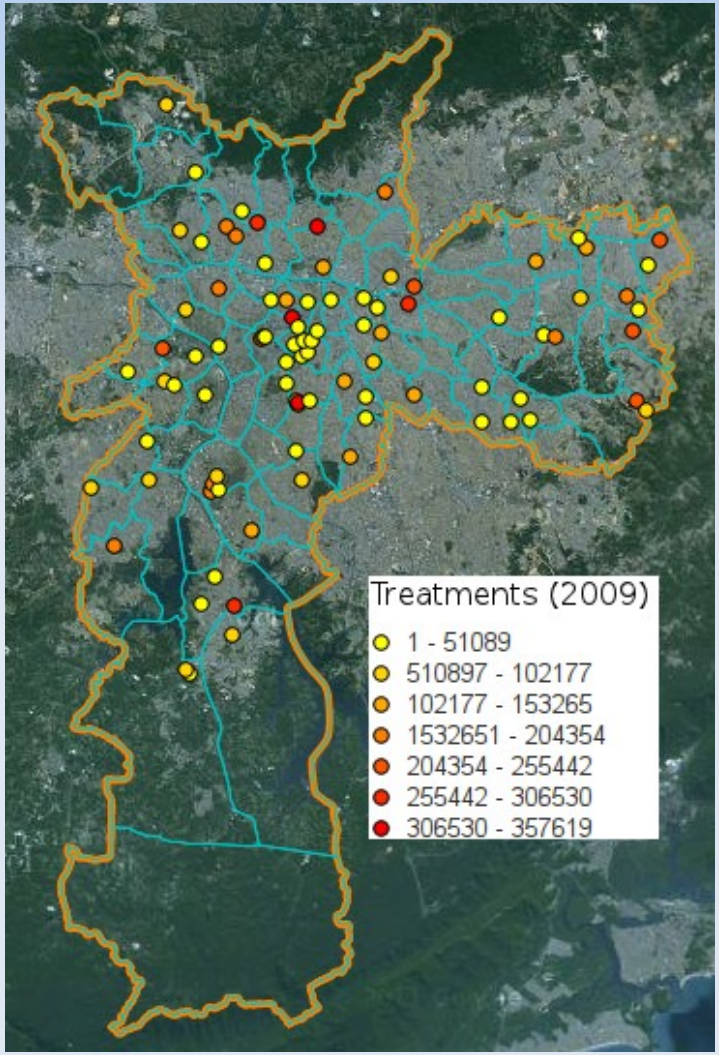
Open source implementation of the Multiplicatively Weighted Voronoi Diagram as a TerraView plugin

Eng. Maurício Carvalho Mathias de Paulo [1,2]
Dr. Antônio Miguel Vieira Monteiro [2]
Dr. Eduardo Gerbi Camargo [2]

[1] Brazilian Army – Geographic Service – DSG
[2] National Institute for Space Research – INPE
{mauricio, miguel, eduardo}@dpi.inpe.br

Region assignment problem



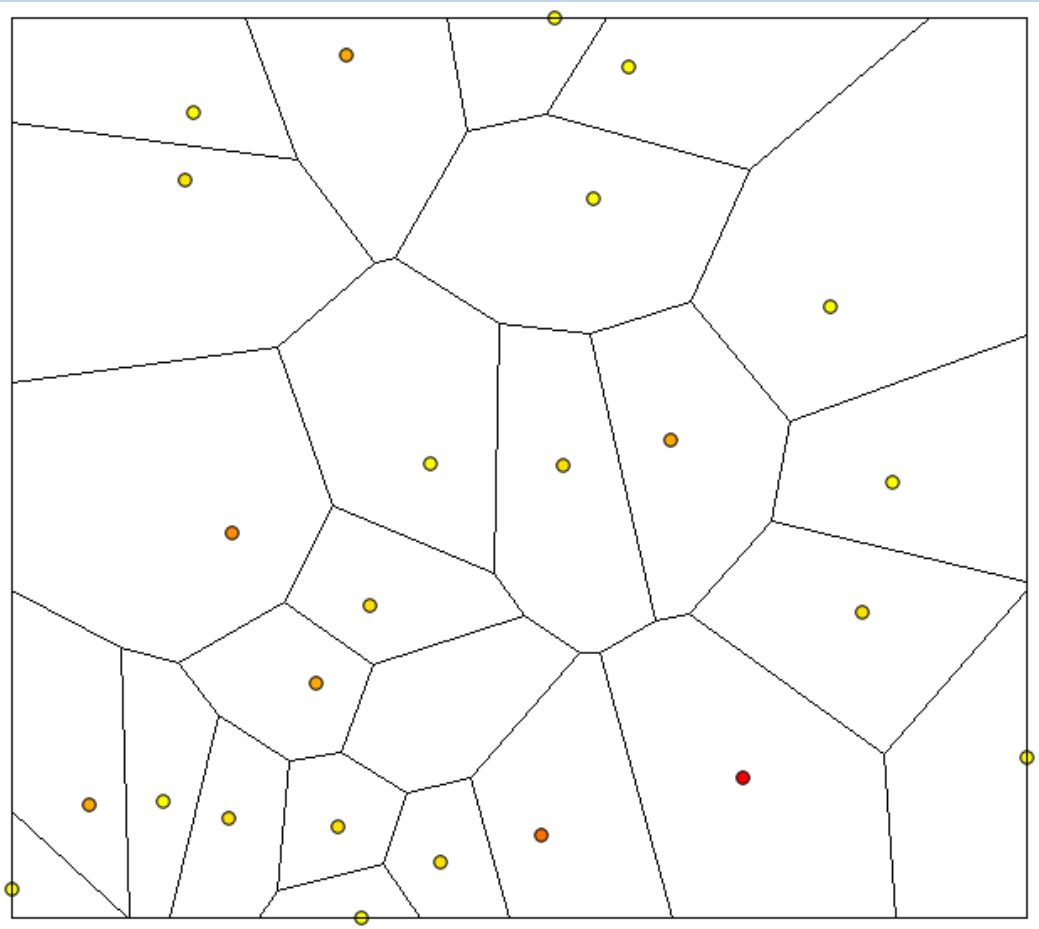
São Paulo's public health centers

- Disaggregation
  - SUS hospitals
  - São Paulo – SP
  - Emergency health care
  - Districts
- Multiplicatively Weighted Voronoi Diagram

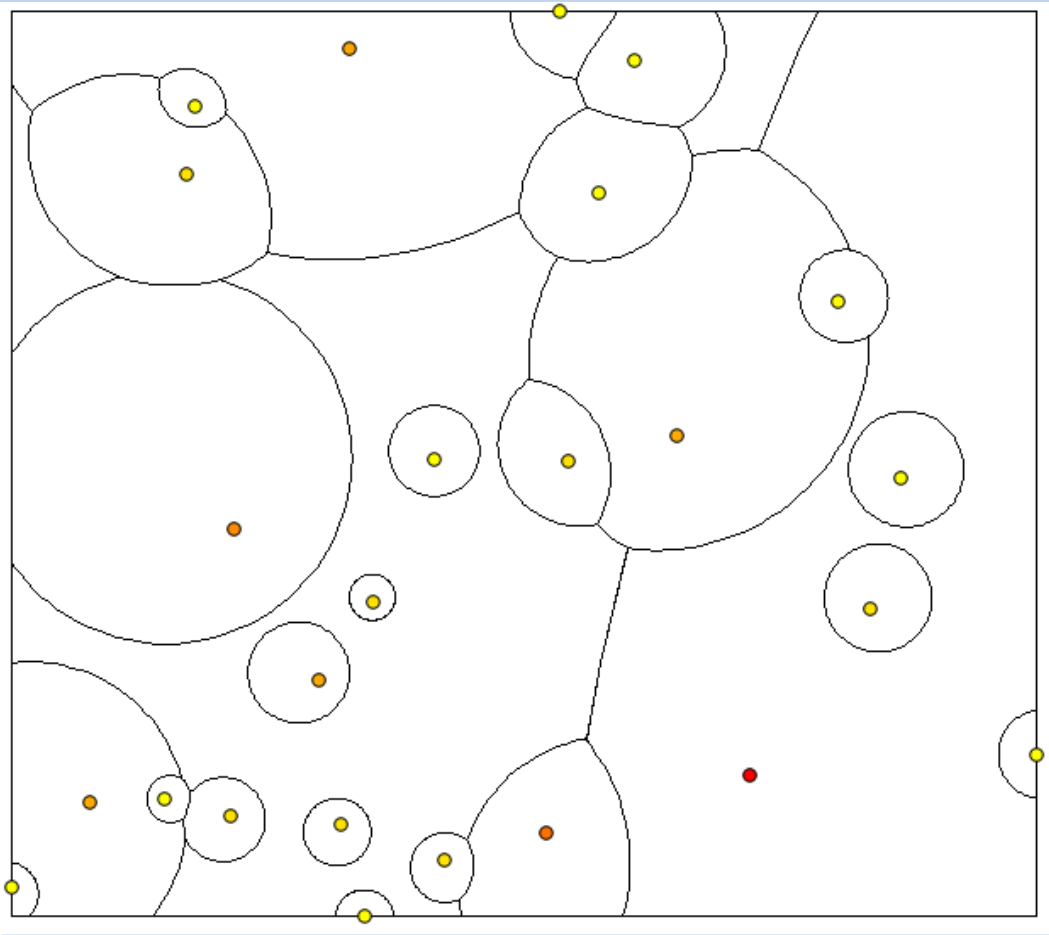
  [Rezende et al, 2000]

Weighted Voronoi Diagram

Ordinary Voronoi Diagram



Multiplicatively **Weighted** Voronoi Diagram



Applications

[Boots, 1986]

- Region assignment model
  - Educational centers
  - Logistic districting
  - Health centers
- Growth Model
  - Antenna signals
  - Quickest neighbor diagram

Weighted distance
[Aurenhammer and Edelsbrunner, 1984]

$$d_w(x, p_i) = \frac{d_e(x, p_i)}{w_i}$$

$$time = \frac{distance}{speed}$$

Appoloniu's Circle

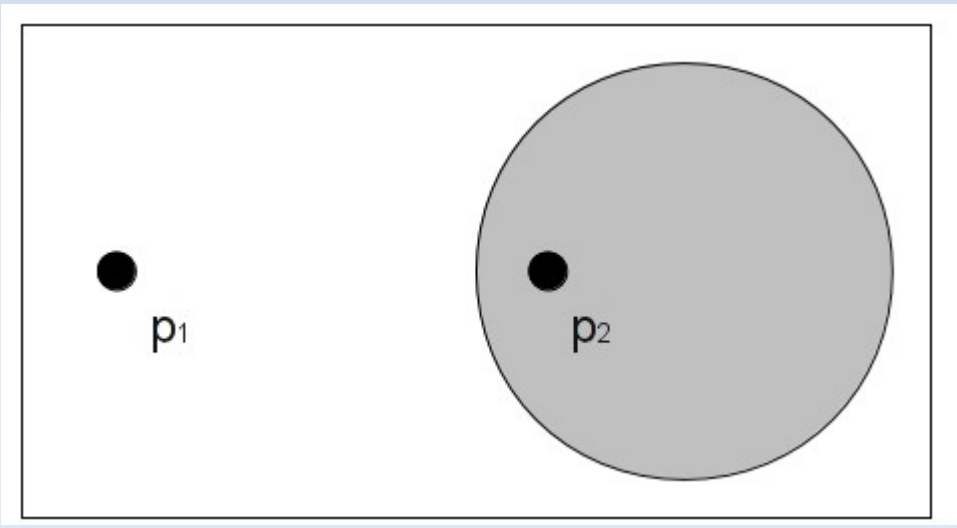
Weighted distance:

$$d_w(x, p_i) = \frac{d_e(x, p_i)}{w_i}$$

Boundaries:

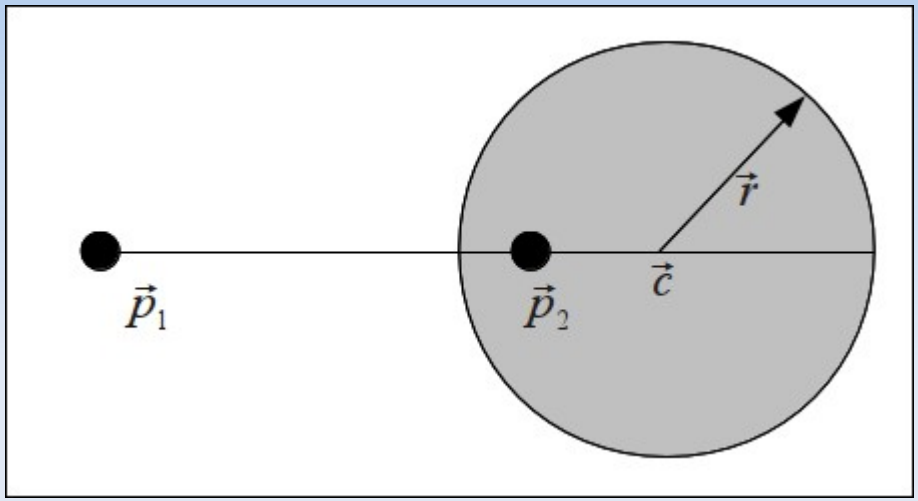
$$\frac{d_e(x, p_1)}{d_e(x, p_2)} = \frac{w_1}{w_2}$$

$w_1 > w_2 \rightarrow p_1$ *dominates* p_2



[Aurenhammer and Edelsbrunner, 1984]

Appoloniu's Circle



Center

$$\vec{c}_1 = \frac{w_2^2 \cdot \vec{p}_1 - w_1^2 \cdot \vec{p}_2}{w_1^2 - w_2^2}$$

Radius

$$|\vec{r}| = \frac{w_1 \cdot w_2 \cdot |\vec{p}_1 - \vec{p}_2|}{w_1^2 - w_2^2}$$

[Aurenhammer and Edelsbrunner, 1984]

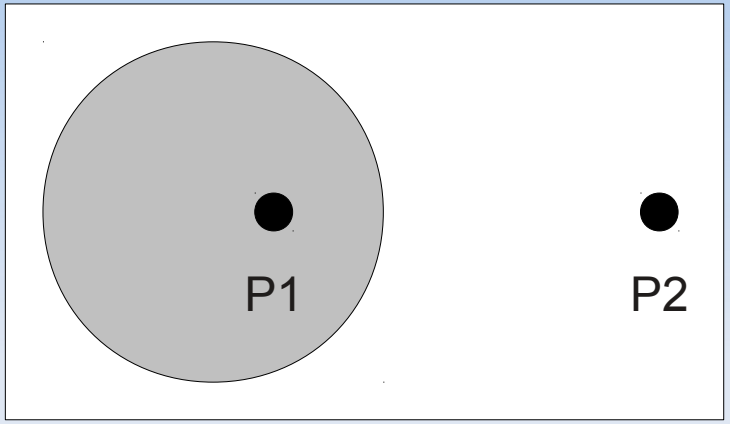
Proposed Algorithm

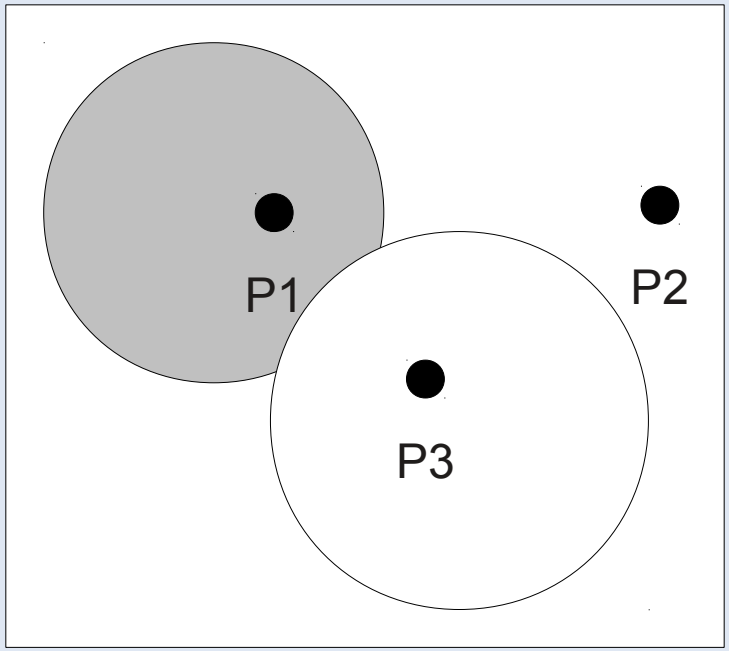
For each point

For each other point

Compute the dominance circle

Intersect with the current dominance area





Complexity

- Computational $O(n^3)$
  - $O(n^2)$ area/circle intersections
  - Each dominance area has at most n sides.

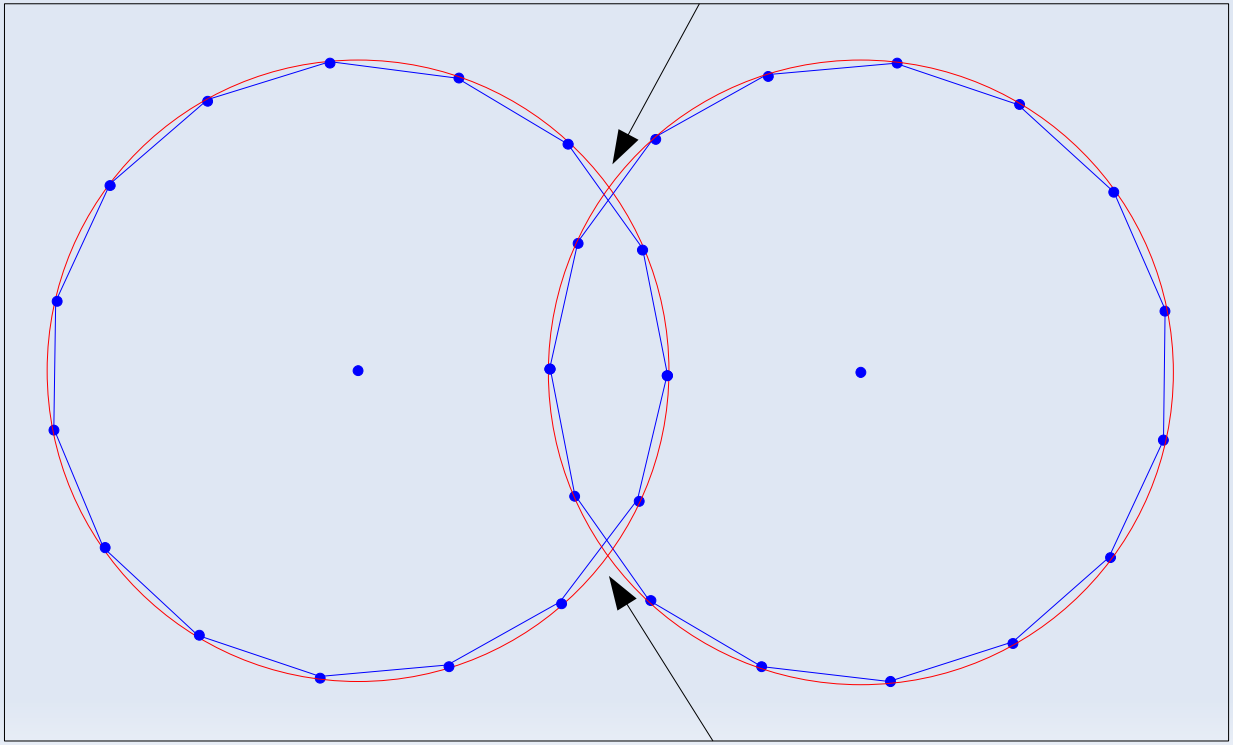
[Aurenhammer and Edelsbrunner, 1984]

- Memory
  - 1 area
  - 1 circle

Intersection of Polygons/Circles

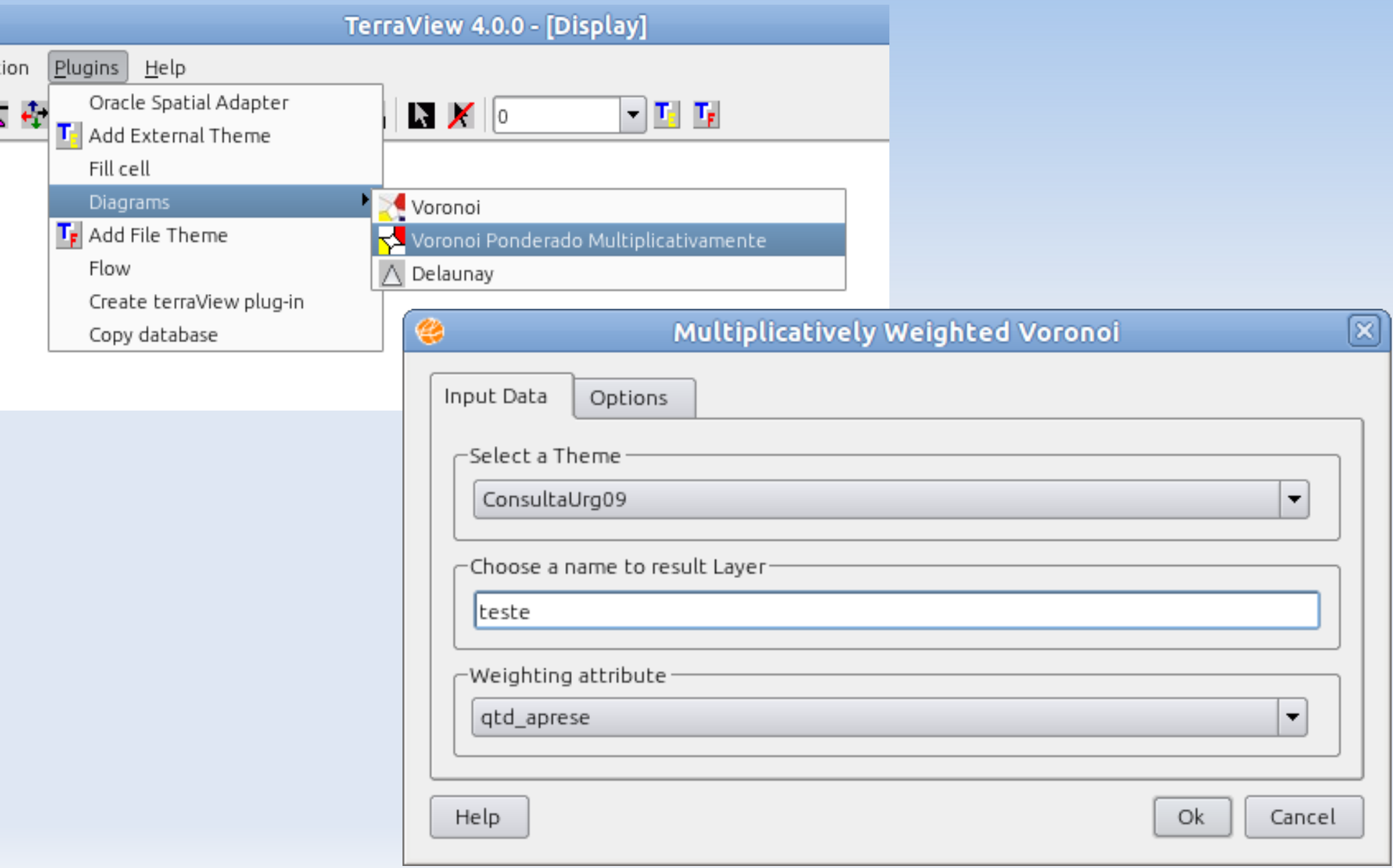
- Polygonize → Intersect
- Intersect → Polygonize

- SQL\MM
  - Polygons (360 sides)
  - CurvePolygon

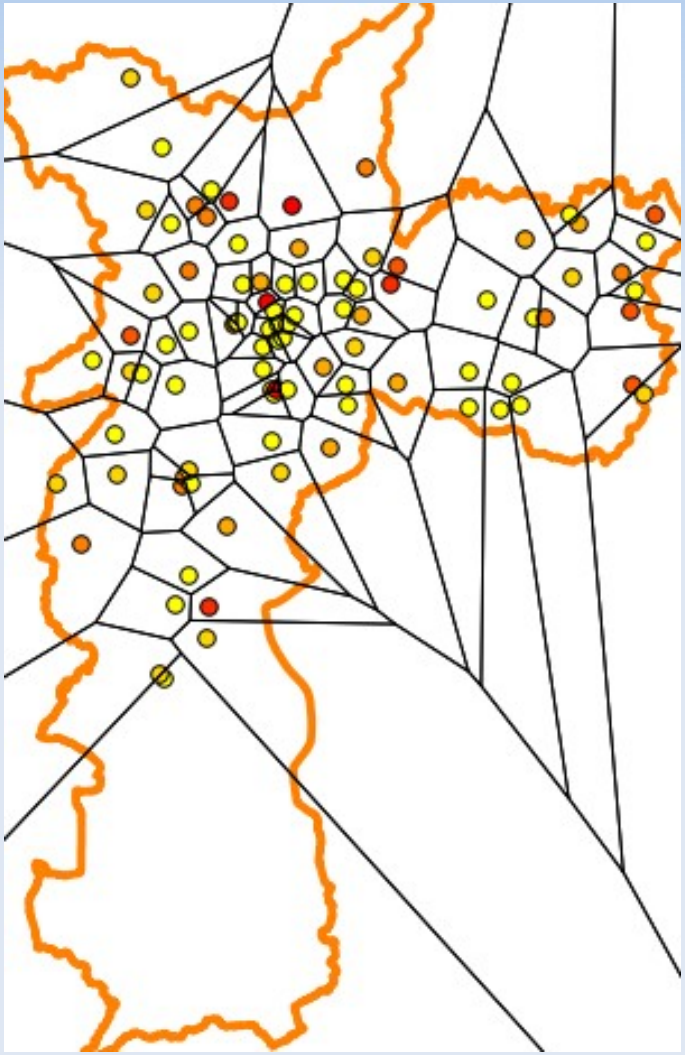


TerraLib

Interface

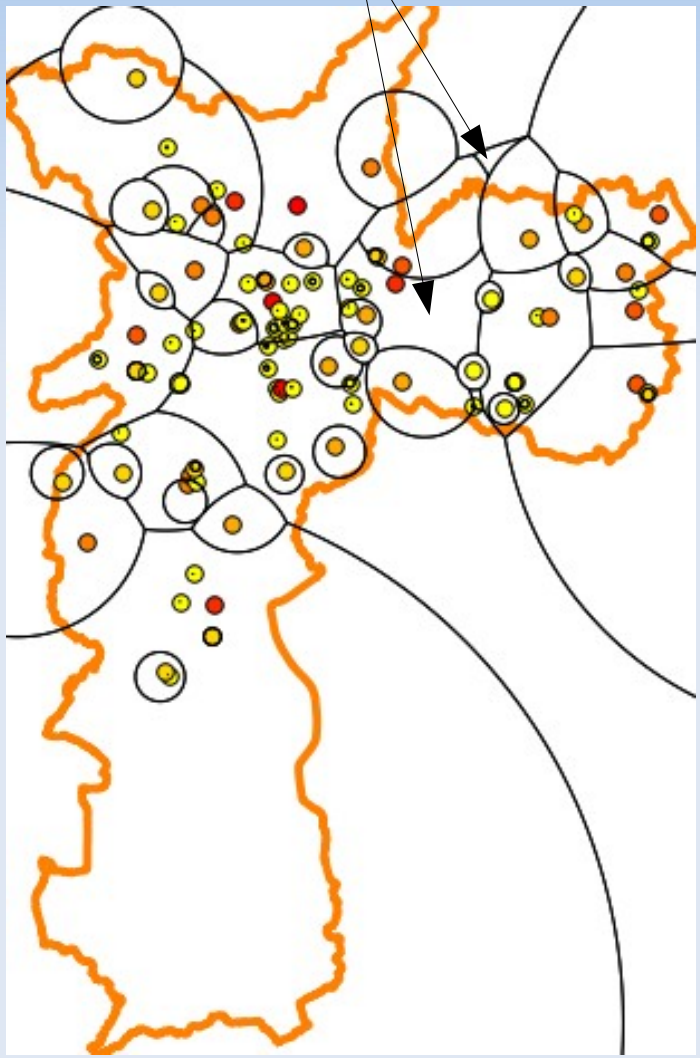

TerraView 4.0.0 - [Display]
Plugins
Help
Oracle Spatial Adapter
Add External Theme
Fill cell
Diagrams
Add File Theme
Flow
Create terraView plug-in
Copy database
Voronoi
Voronoi Ponderado Multiplicativamente
Delaunay
Multiplicatively Weighted Voronoi
Input Data
Options
Select a Theme
ConsultaUrg09
Choose a name to result Layer
teste
Weighting attribute
qtd_aprese
Help
Ok
Cancel

Results



Ordinary Voronoi

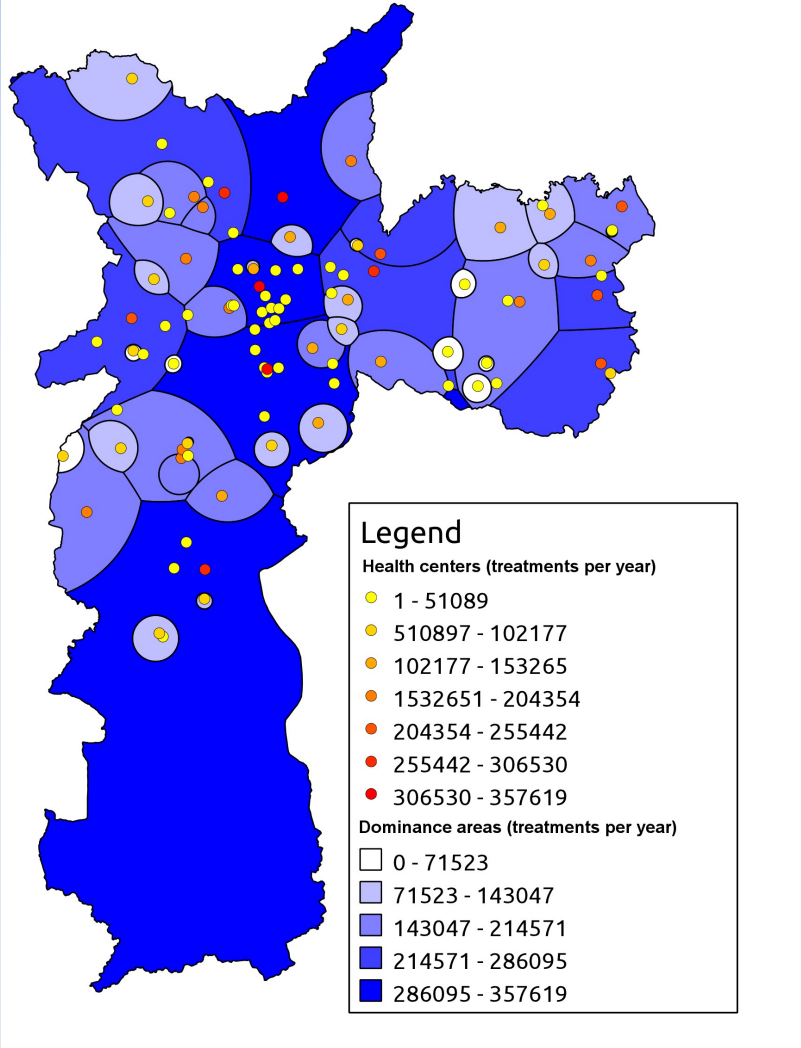
MultiPolygon Approach



Multiplicatively Weighted Voronoi
Weight: Emergency Treatments in 2009

Conclusion

- Vector-based algorithm
- Multi-part dominance
- Speed loss
- Intersection accuracy
- MultiPlatform



São Paulos' Health Centers' dominance

Acknowledgements

- National Institute for Space Research
- Brazilian Army – Geographic Service

References

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- Dong, P. (2008). **Generating and updating multiplicatively weighted Voronoi diagrams for point, line and polygon features in GIS**. Computers & Geosciences, 34(4):411–421.