

Designing a Language for Spatial Computing



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L I S B O N A.

"A Cidade das Sete Colinas"

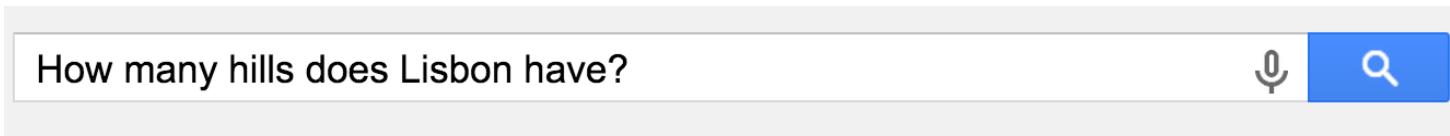


1572

The City of Seven Hills



How many hills does Lisbon have?



Web

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Shopping

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Search tools

About 13,600,000 results (0.58 seconds)

But in fact there are many cities claiming to have been built around or on **7 hills** – at the last count Wikipedia was listing more than 50 such locations amongst which we can highlight Jerusalem, Istanbul and Budapest, apart from the aforementioned Lisbon and Rome. Jun 16, 2009

[The 7 Hills of Lisbon - Lisbon Apartments](#)

www.lisbonapartments.com/lisbon/2009/06/16/the-7-hills-of-lisbon/

Feedback

[http://en.wikipedia.org/wiki/
List_of_cities_claimed_to_be_built_on_seven_hills](http://en.wikipedia.org/wiki/List_of_cities_claimed_to_be_built_on_seven_hills)

How many hills does Lisbon have?



How many hills does Lisbon have?



[Examples](#) [Random](#)

! Wolfram|Alpha doesn't understand your query



Showing instead result for query: [Lisbon](#)

Other queries to try: [hills](#)

A GIS answer.

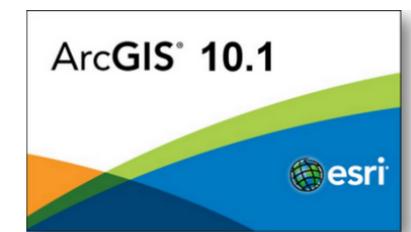
“Lisbon”: gadm.org

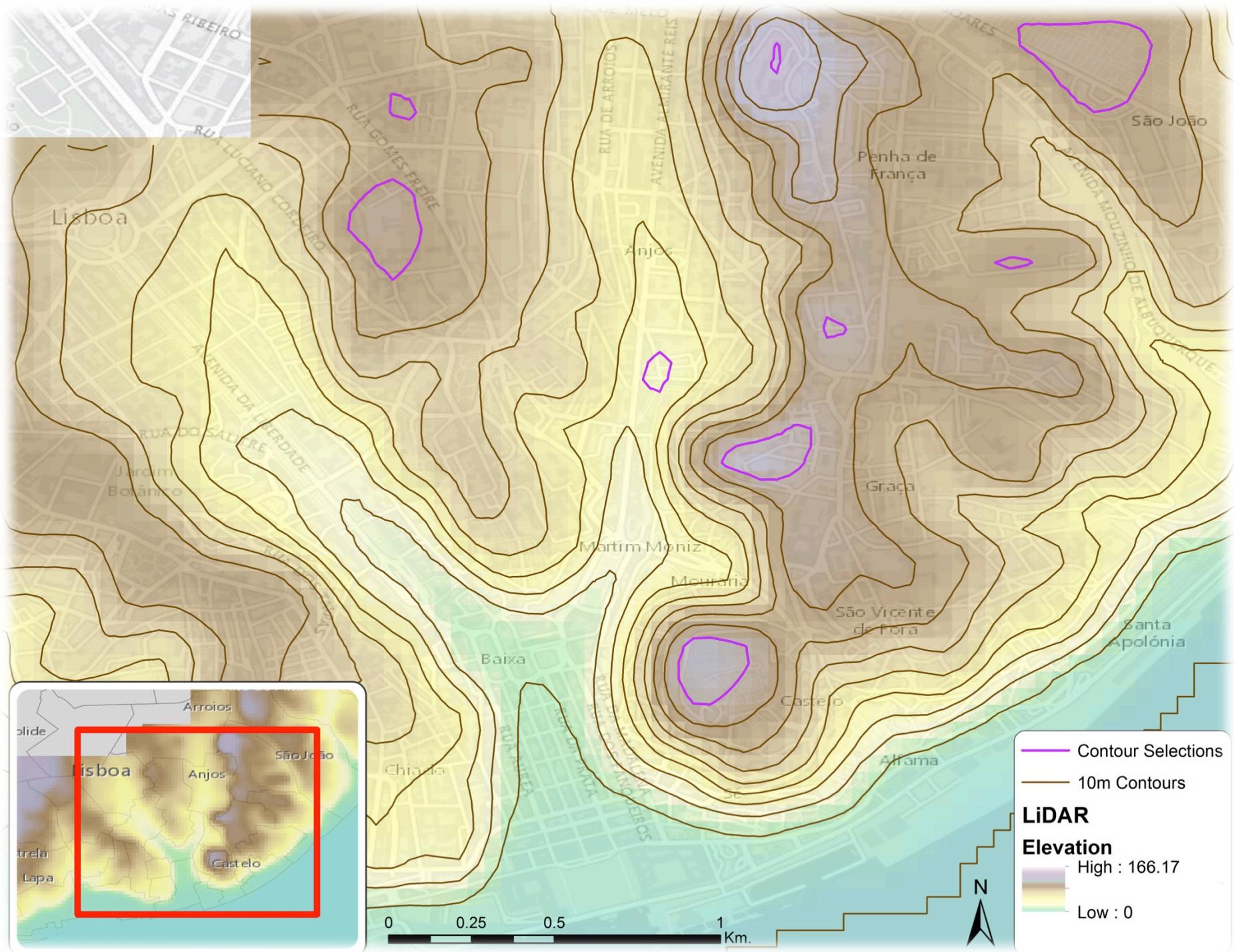
“Hill”: Chaudhry and Mackaness (2008)

Data: digital elevation model (DEM)



ArcGIS ModelBuilder





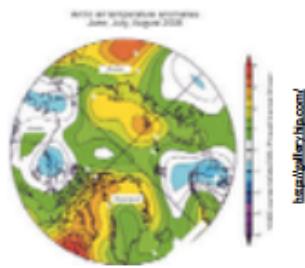
Outline

1. Spatial questions
2. A GIS answer
3. Core concepts of spatial information
4. Core computations: An example

Core concepts of spatial information



location



field



object



network



event



granularity



accuracy

The Core Concepts Cube

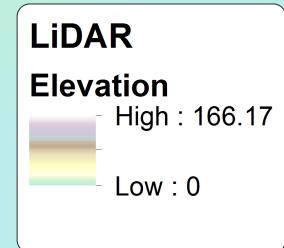
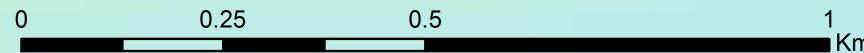


Field

Get value

Local, zonal, focal

Bounds



Object

Is in relation with

São Roque

Santa Catarina

Chagas

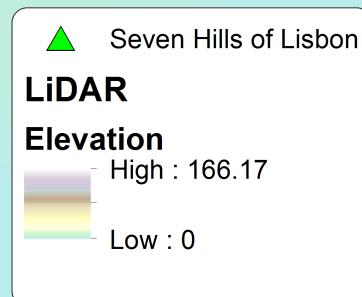
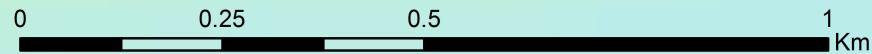
Sant'Ana

São Jorge

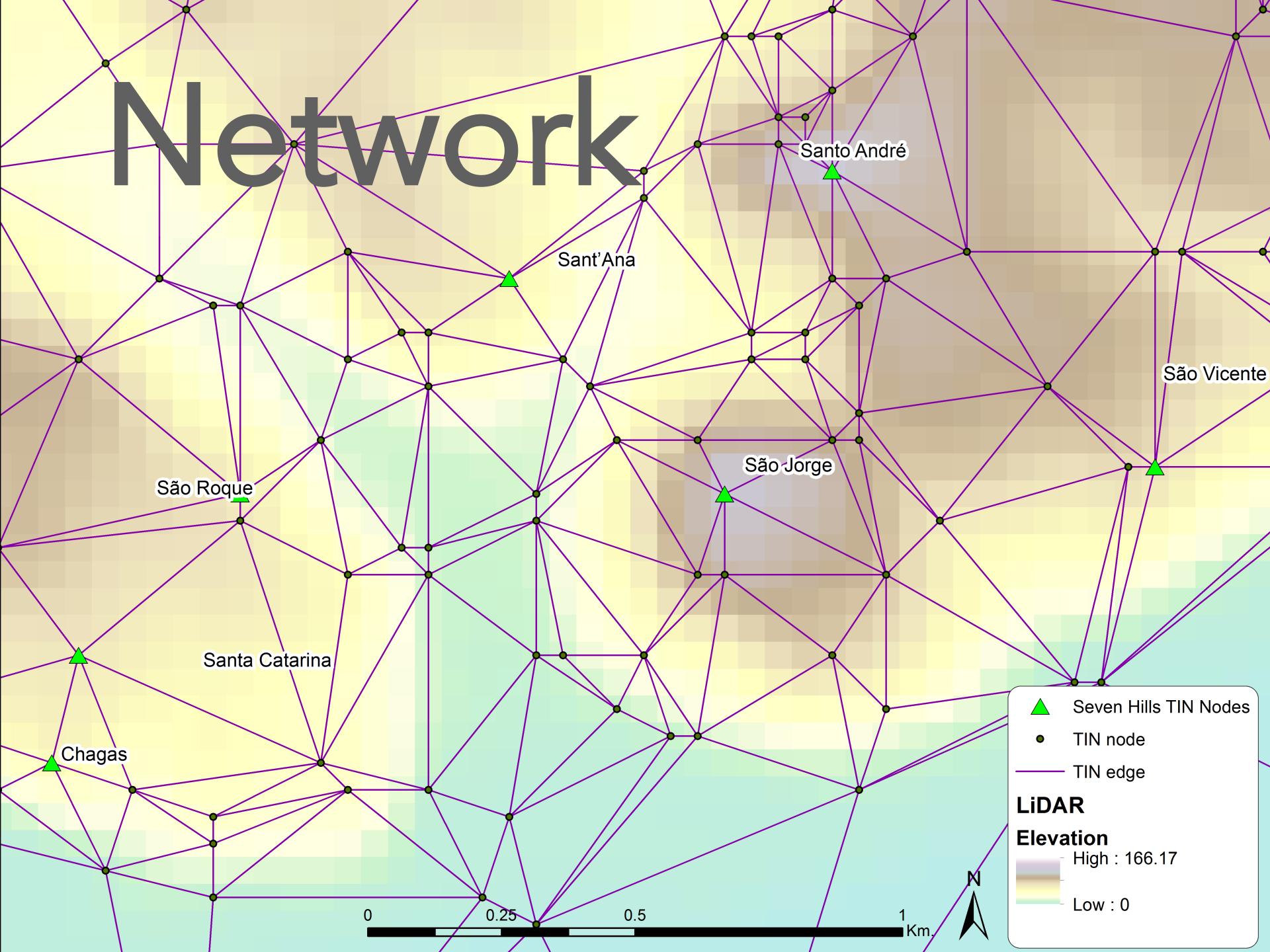
São Vicente

Is it same

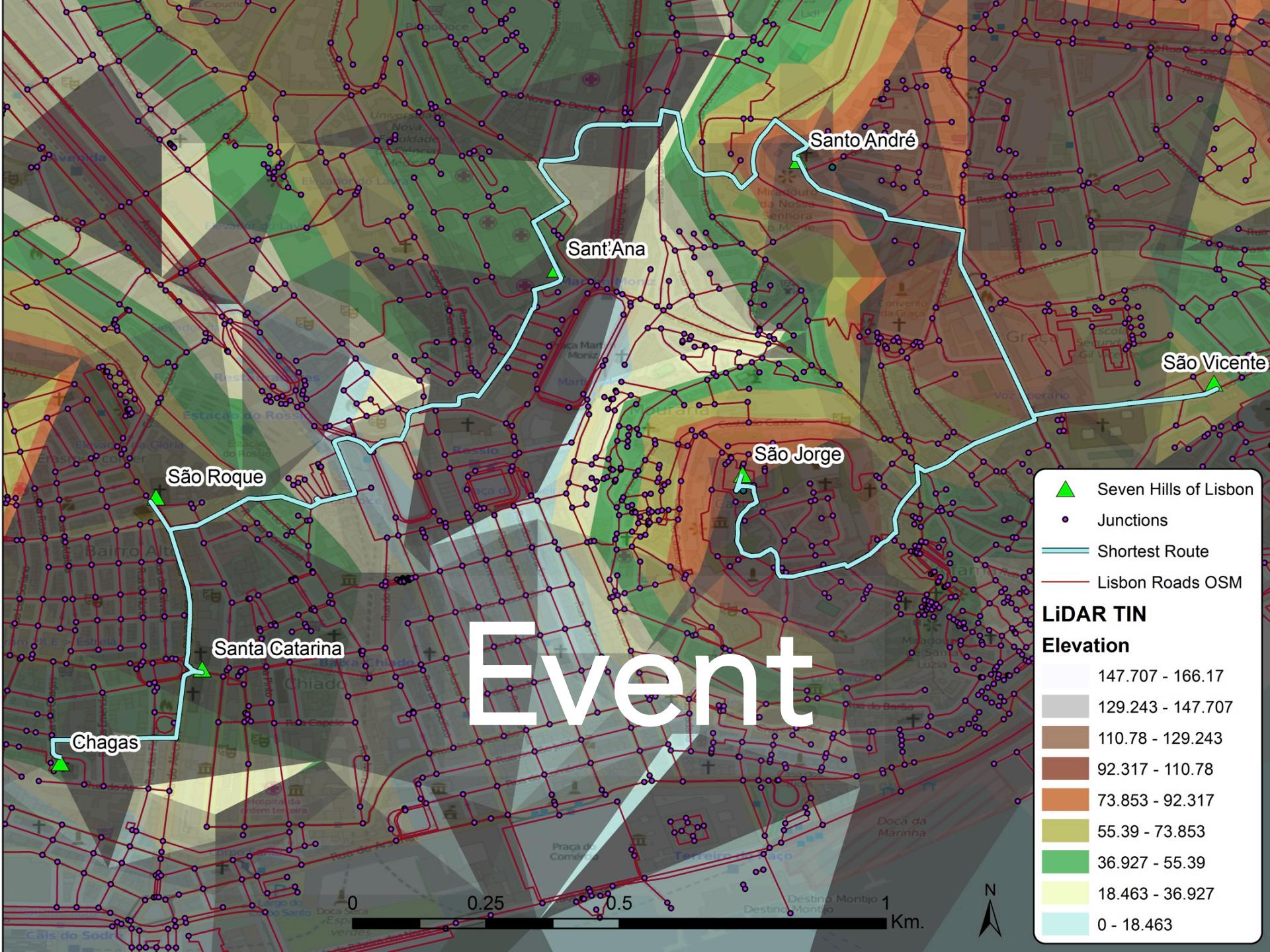
Get property



Network



Event





How long
will it take?

(Another)
Cultural
Walk

São Roque

Santa Catarina

Chagas

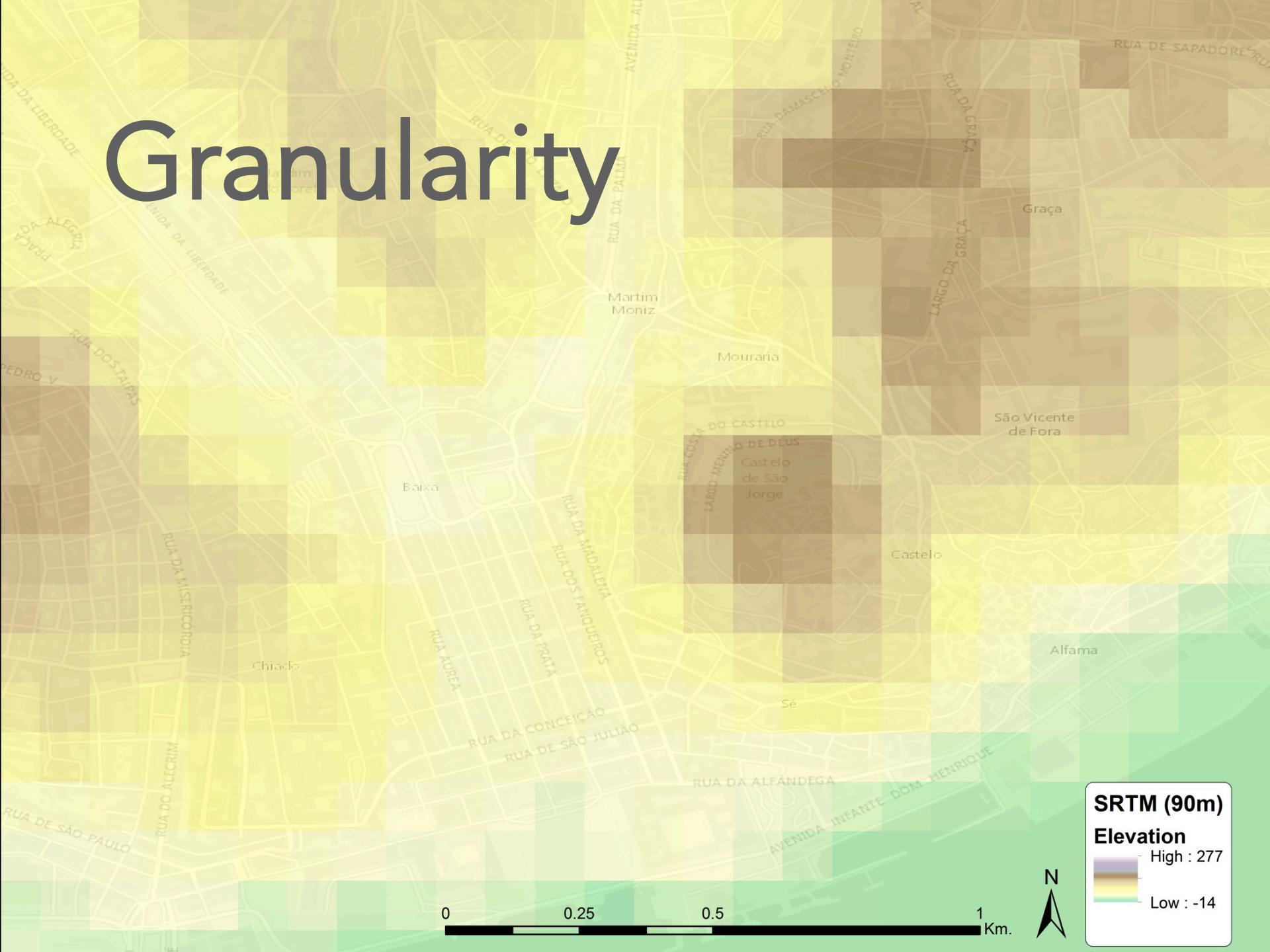
Sant'Ana

Santo André

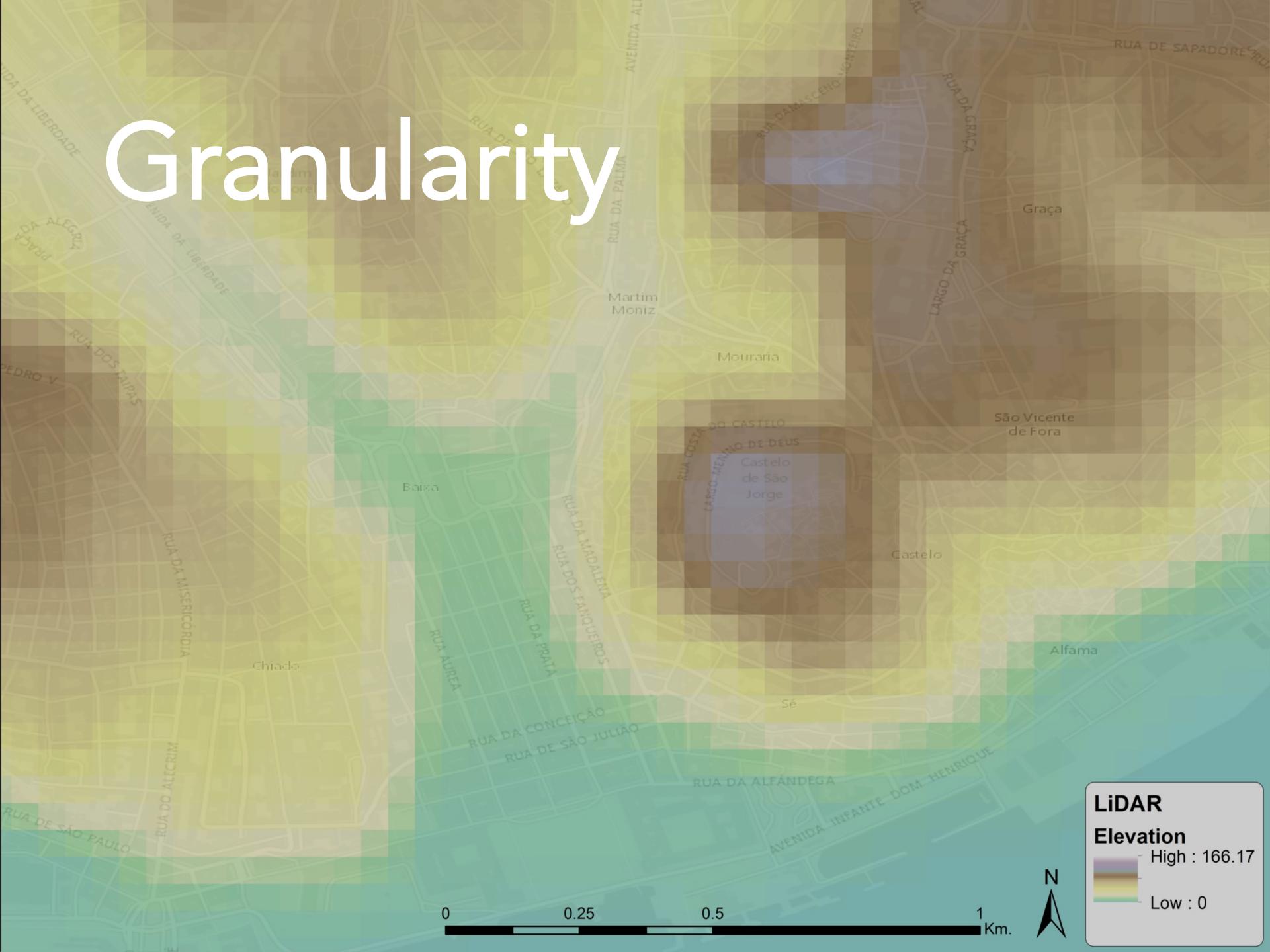
São Vicente

São Jorge

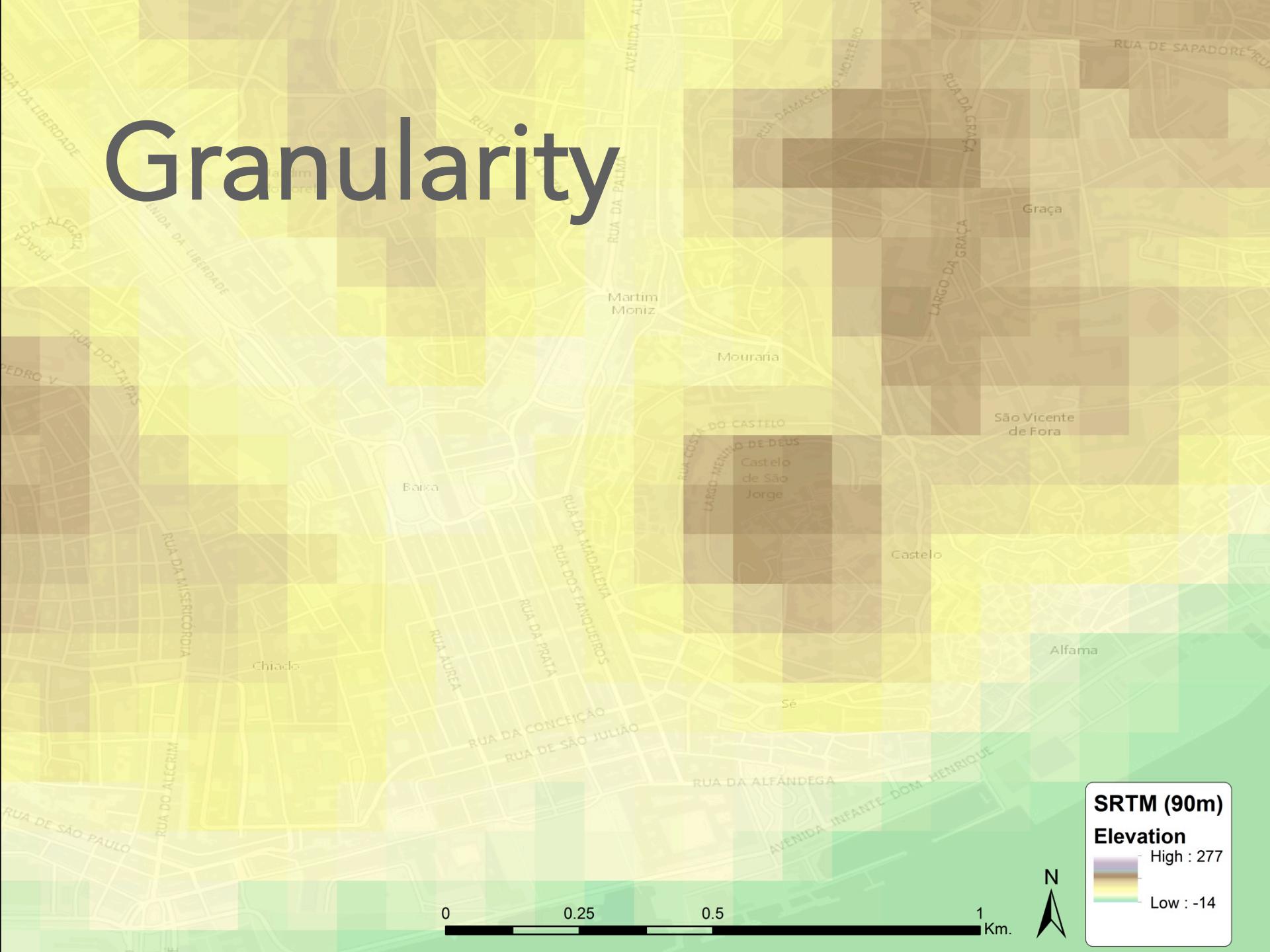
Granularity



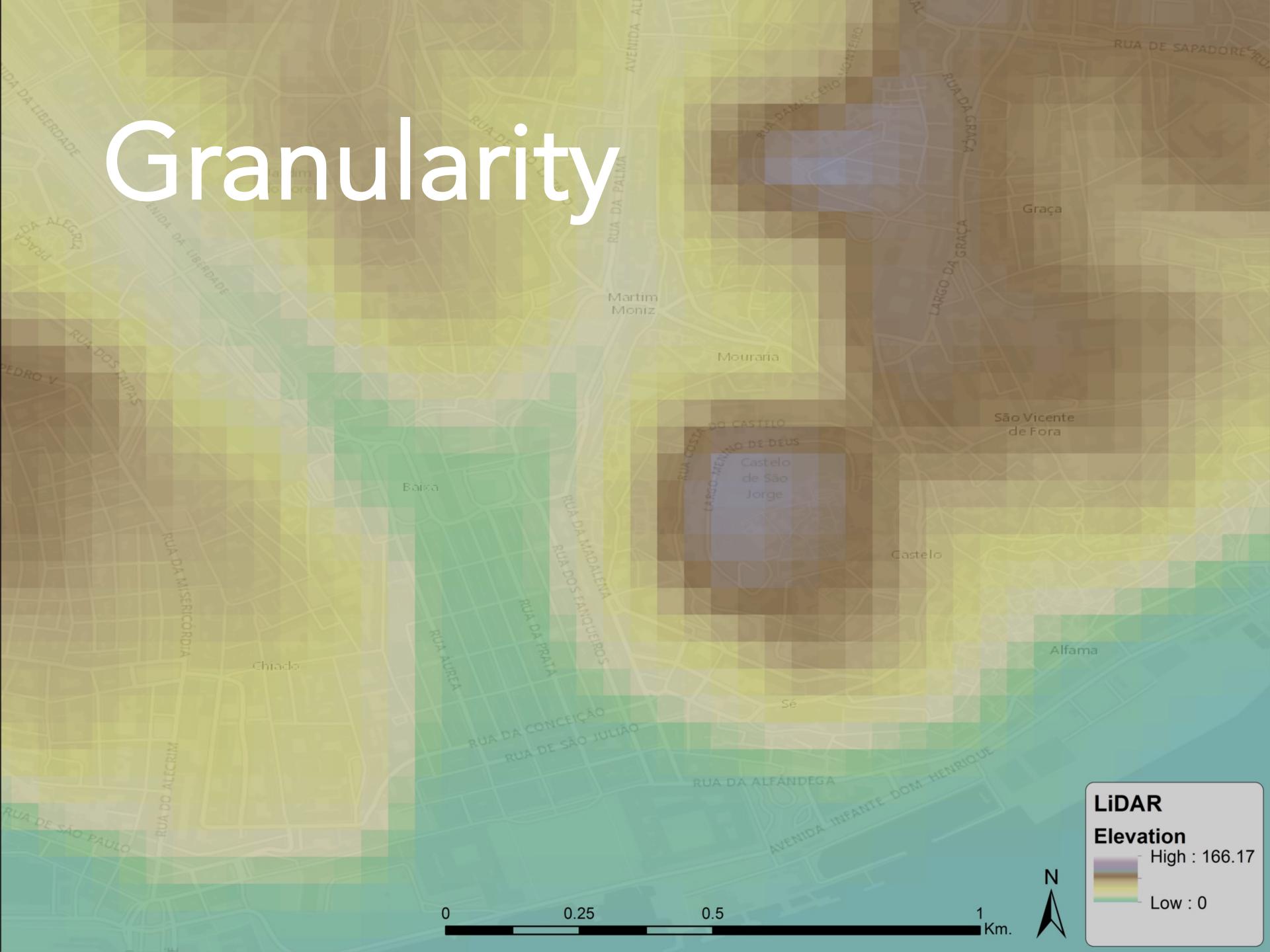
Granularity



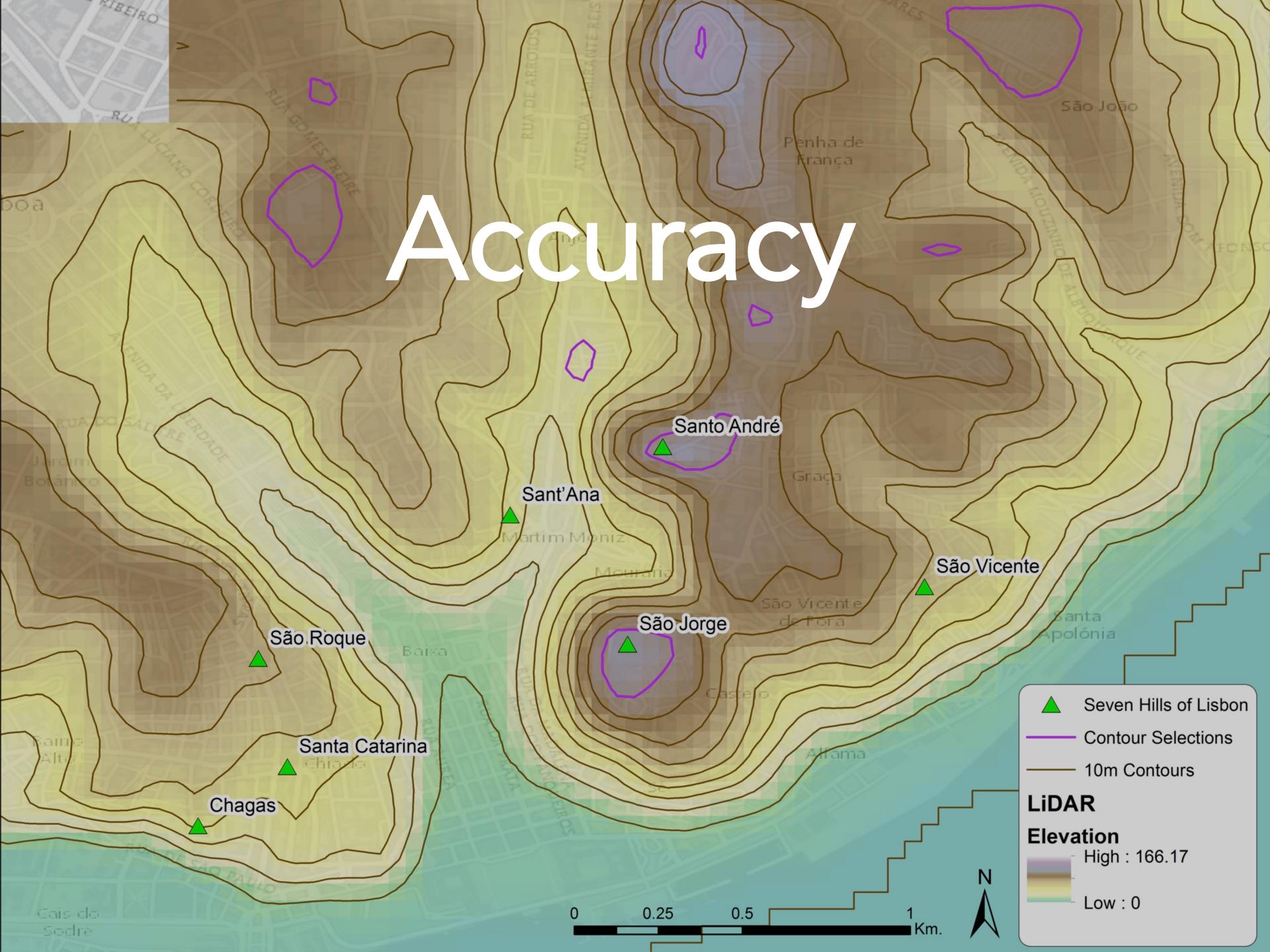
Granularity



Granularity



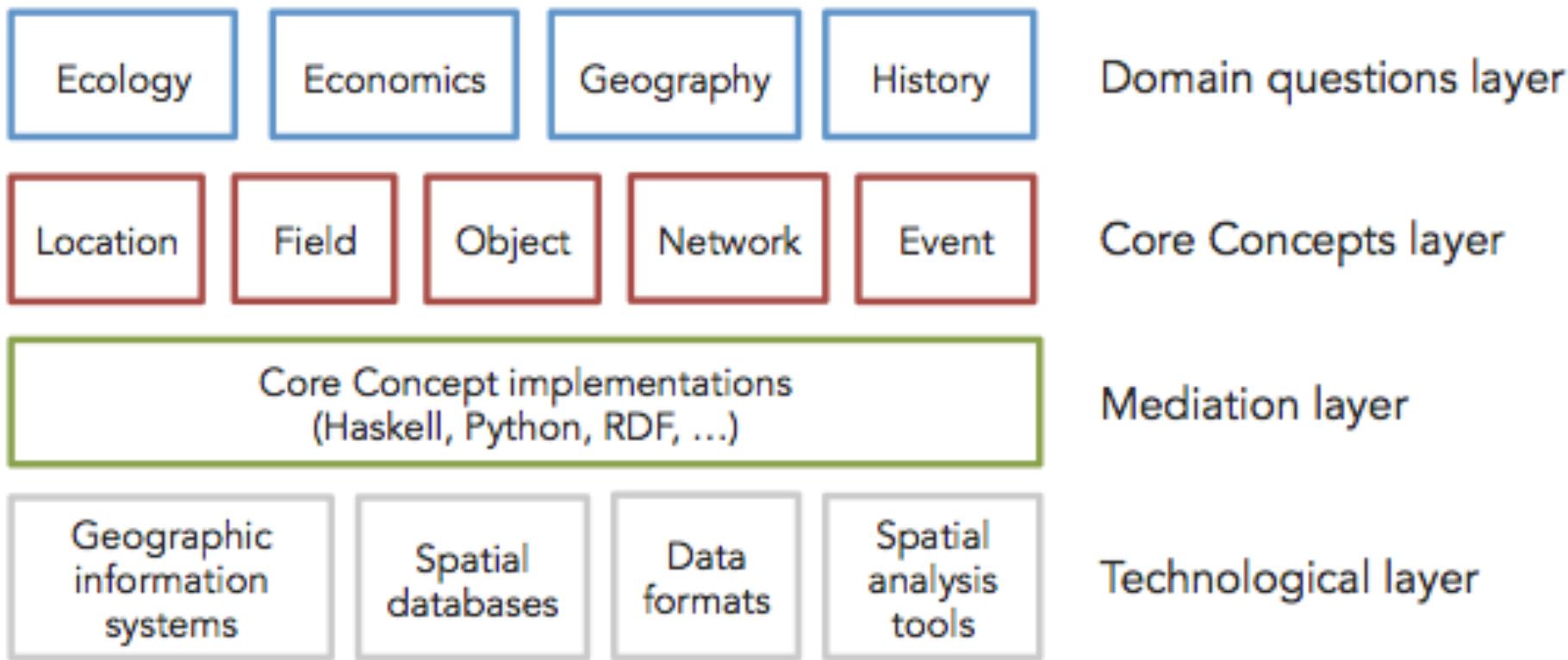
Accuracy

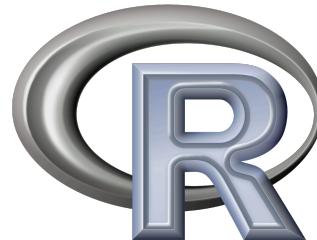


From spatial questions

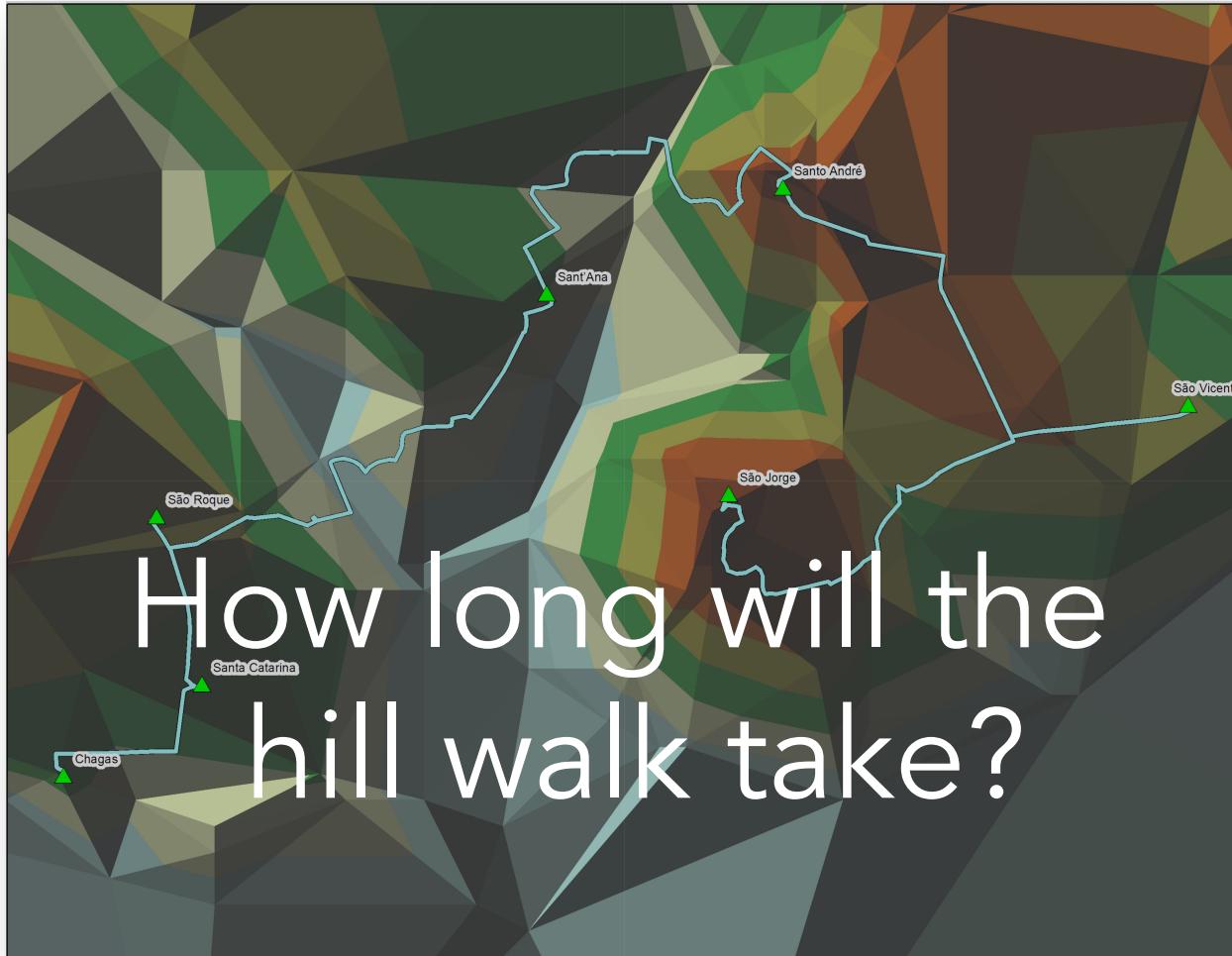


Architecture





An example in python™



An example in python™

```
01. """
02. What is the expected walking time to walk across all hills?
03. """
04.
05. import coreconcepts
06.
07. # Load road network as a network
08. road_network = cc_load_network("data/lisbon_road_network.gml", ...)
09.
10. # Load hills as an array of objects
11. lisbon_hills = cc_load_objects("data/lisbon_hills.shp", ...)
12.
13. # Load DEM as a field
14. lisbon_elevation = cc_load_field("data/lisbon_lidar_dem.asc", ...)
```

```
16. # Find shortest path between hills using the road network
17. spath = cc_load_network()
18. for i in range(lisbon_hills)-1:
19.     edges = road_network.shortestPath( lisbon_hills[i], lisbon_hills[i+1] )
20.     for e in edges: spath.addEdge(e)
21.
22. # weight path edges based on slope
23. timeH = 0
24. for edge in spath.edges():
25.     startEl = lisbon_elevation.getValue( edge.start.location() )
26.     endEl = lisbon_elevation.getValue( edge.end.location() )
27.     # Estimate of vertical walking speed: 300m/h
28.     edgeTimeHeightH = abs( endEl - startEl ) / 300
29.     # Estimate of horizontal walking speed: 5000m/h
30.     edgeTimeDistanceH = edge.length / 5000
31.     timeH += edgeTimeH + edgeTimeDistanceH
32.
33. # calculate time
34. print "Expected time (hours):",timeH
```

Next steps

1. High-level query operators
2. Validation in GIS projects
3. Generic and domain spatial computing APIs
4. Question answering API



<http://github.com/spatial-ucsb/ConceptsOfSpatialInformation>

Thanks!

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Credits:

- Analysis and maps by Sara Lafia (UCSB)
- DTM from Gonçalo Crisóstomo, DG Territorio, Portugal