Evaluate the sessions

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Open Source Tools for Spatial Optimization

Alan Glennon
@glennon

Carlos Baez
@prdctblyirrtnl

Optimization is about balance: maximizing an objective within constraints

Optimization is crazy useful. It is a way to solve many high-impact real world problems

Lots of general open source optimization tools available, but many algorithms still need spatialization.

Points

prime location

Lines

choice path

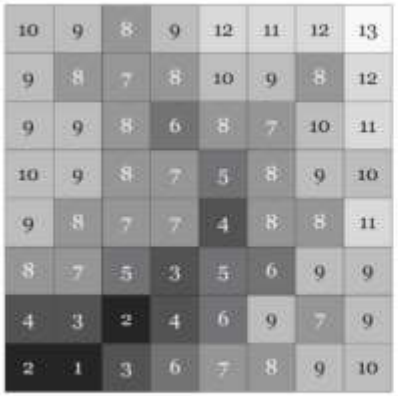
Areas

elegant configuration

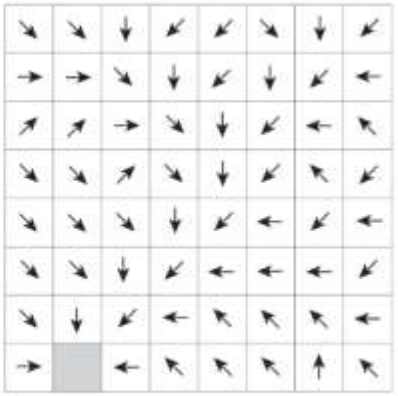
Time

scheduling

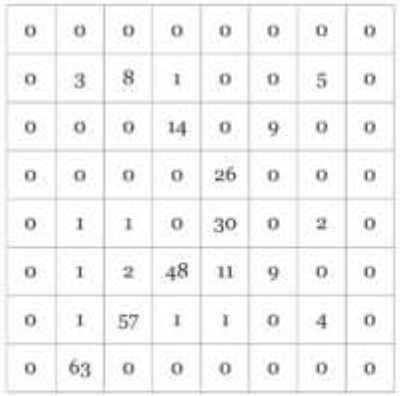
GIS is very good at overlay, measurement, select, and comparison



(a)



(b)



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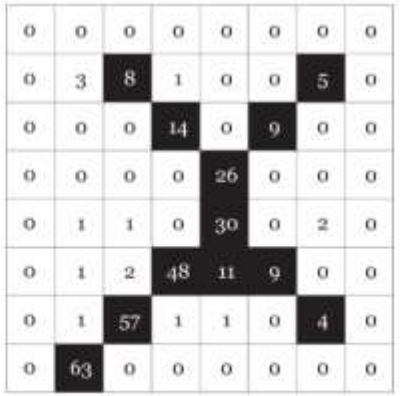


(d)

Optimization

is about balance

You have an objective –
to minimize or maximize something, like utility, cost, profit, effort, energy

but have constraints –
budget, supply, energy, attention, network, attention, time

So why not just add optimization to GIS?

Good News. Bad News.

Good. The things that GIS does well are often good enough

Good. Existing GIS covers some optimization cases

Neutral. Optimization requires different thinking

Bad. Many of the problems cannot be solved in reasonable amounts of time. Typically, each addition to the problem creates a exponentially larger computational burden

More Good News!

Good. You are smart & computers are ever faster.

Good. There's also more than one way to approach geospatial problems: Shortcuts (i.e., heuristics) may be used that solve a problem to a near optimum solution – but in a fraction of the time. Use crafty precomputation.

Opportunities! For geospatial analysis, there's lots of workflows & heuristics that still need to be formulated and evaluated.

Opportunities! Many associated open source libraries exist; they just need to be spatially enabled.

Example Optimization Problems

Routing

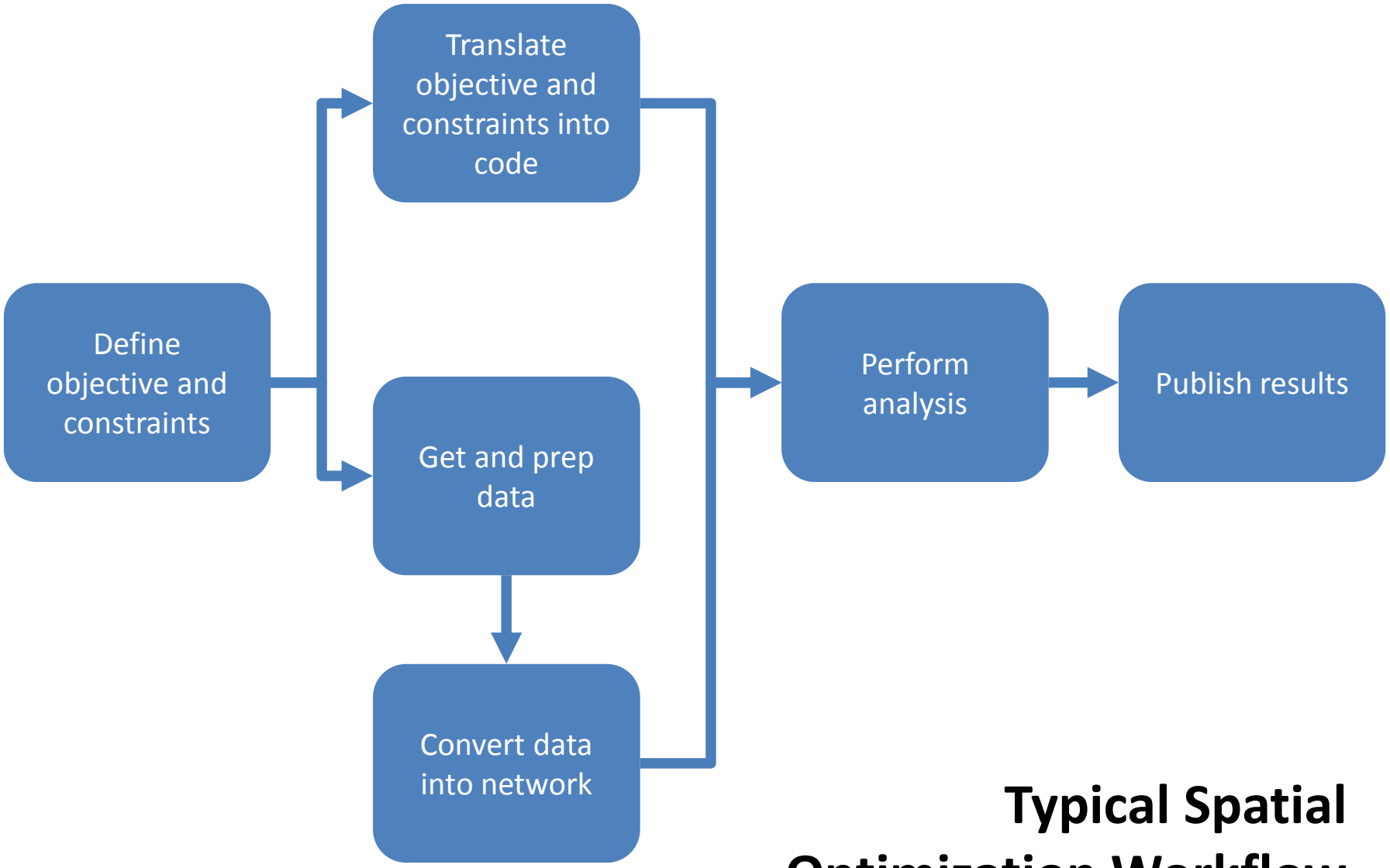
Corridor Location

Classical Transportation (Flows)

Facility Location

Zone configuration

Disruption, Fortification, and Resiliency



Typical Spatial Optimization Workflow

The traditional objective-constraint approach looks like this:

$$\text{Maximize} \qquad z = \sum_{i \in I} a_i y_i$$

$$\text{S.T.} \qquad \sum_{j \in N_i} x_j \geq y_i \qquad \text{for all } i \in I$$

$$\sum_{j \in J} x_j = P$$

$$x_j = (0, 1) \qquad \text{for all } j \in J$$

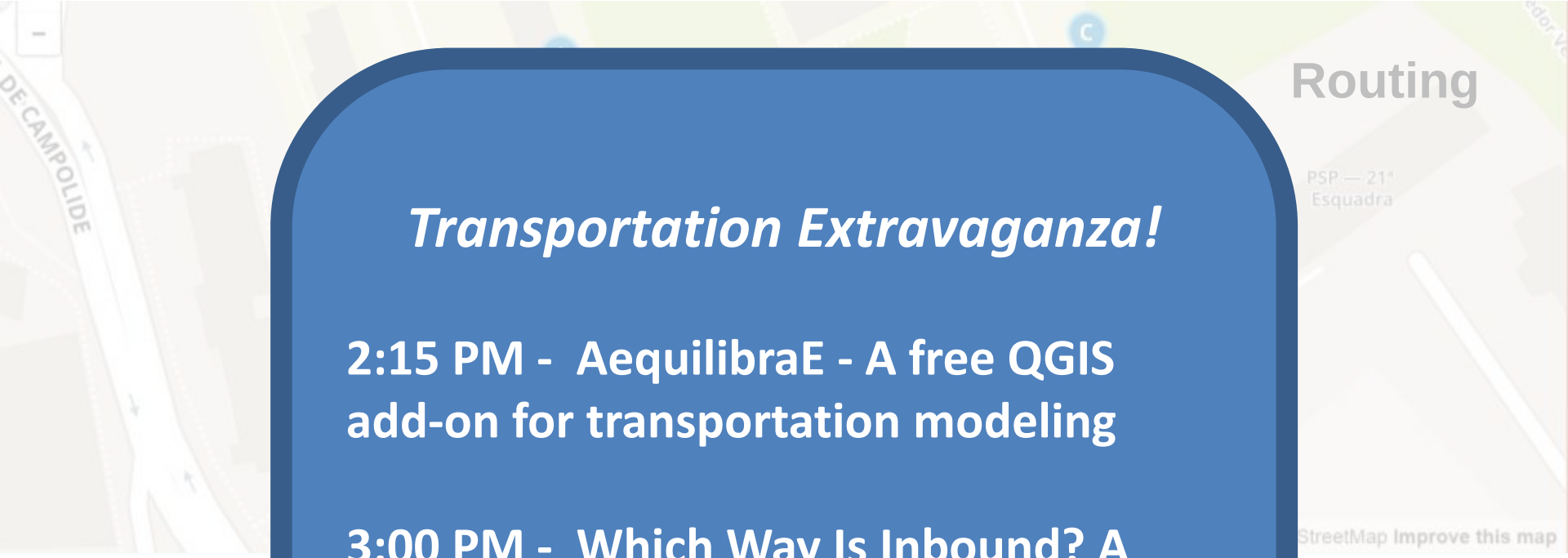
$$y_i = (0, 1) \qquad \text{for all } i \in I$$

From: Church and ReVelle, 1971

Code and data: https://github.com/glennon/redlandspath

Many, many specialty, open source routing libraries.

- http://wiki.openstreetmap.org/wiki/Routing
- http://en.wikipedia.org/wiki/Category:Routing_algorithms
- http://www.opentripplanner.org
- http://pgrouting.org (extension for PostGIS)
- http://project-osrm.org (super fast via contracted hierarchies)



Transportation Extravaganza!

2:15 PM - AequilibraE - A free QGIS add-on for transportation modeling

3:00 PM - Which Way Is Inbound? A Journey with SF Muni and Directional Statistics

4:15 PM - Beyond routing with OSRM: Network analysis and complex spatial queries

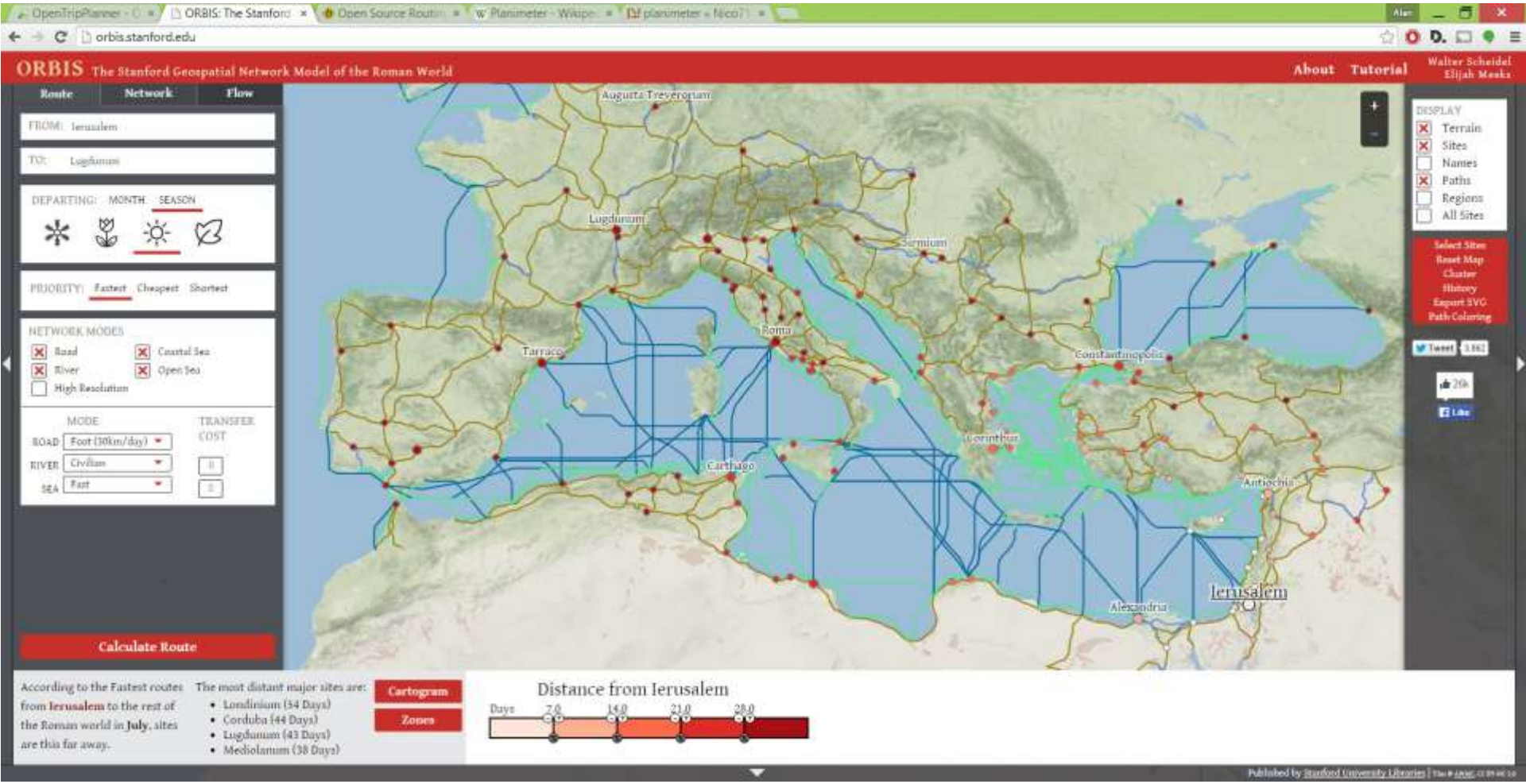
Code and data: http

Many, aries.

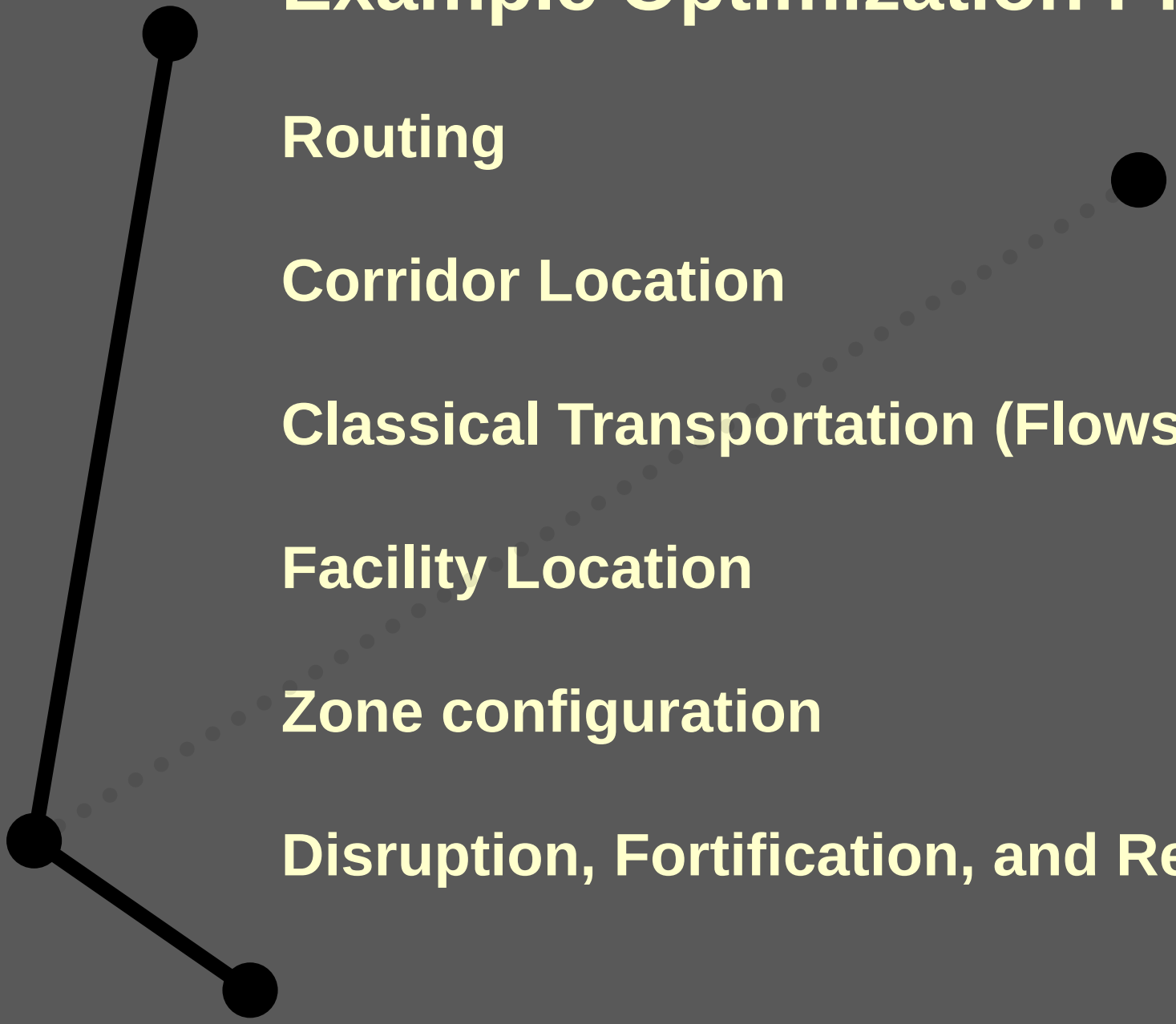
- http:/
- http:/ hms
- http:/
- http://
- http://p erarchies)

Corridor Location – ORBIS, Stanford's Geospatial Model of the Roman World; *orbis.stanford.edu*

ORBIS code: https://github.com/emeeks/orbis_v2
Recast: https://github.com/memononen/recastnavigation



Example Optimization Problems



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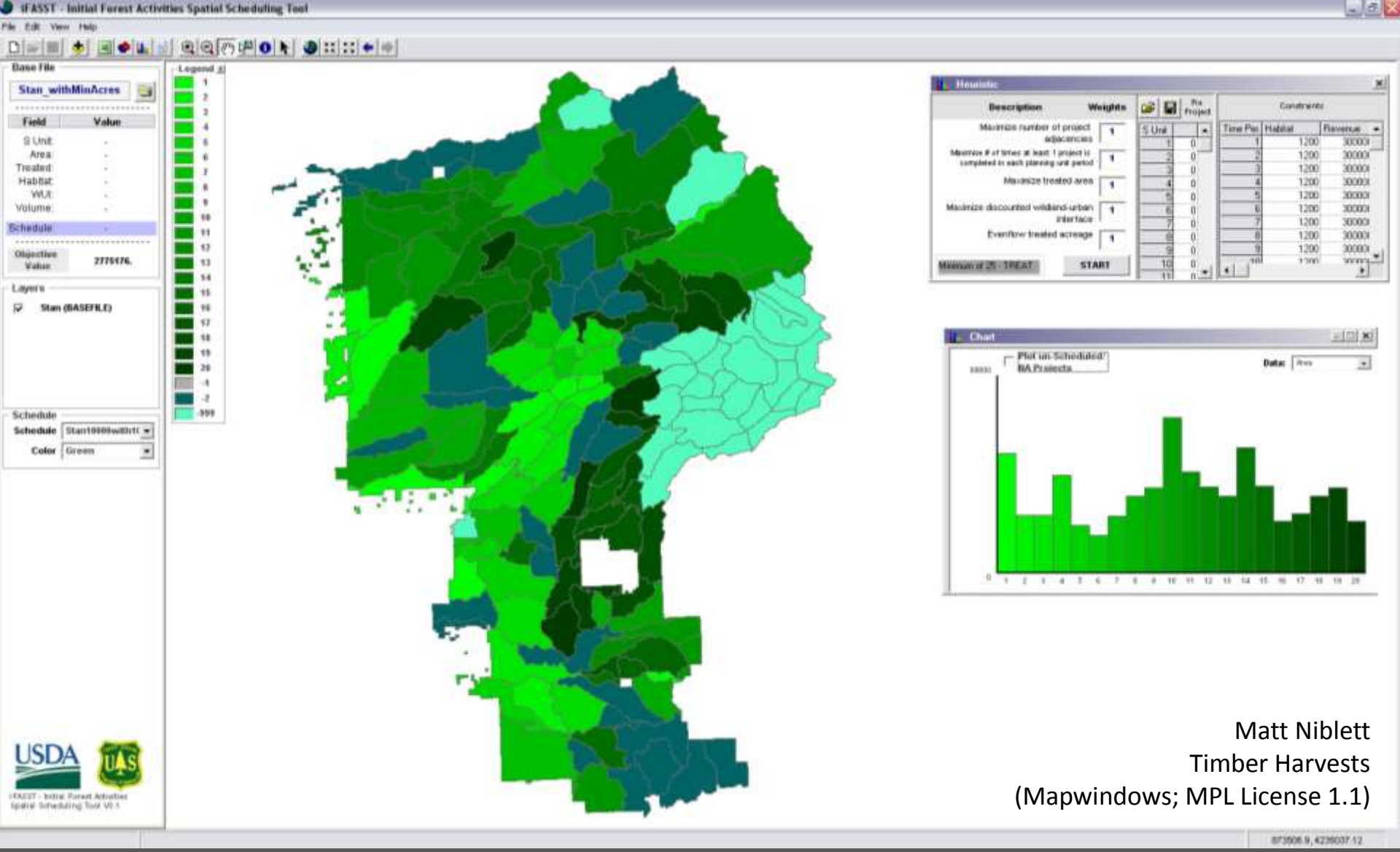
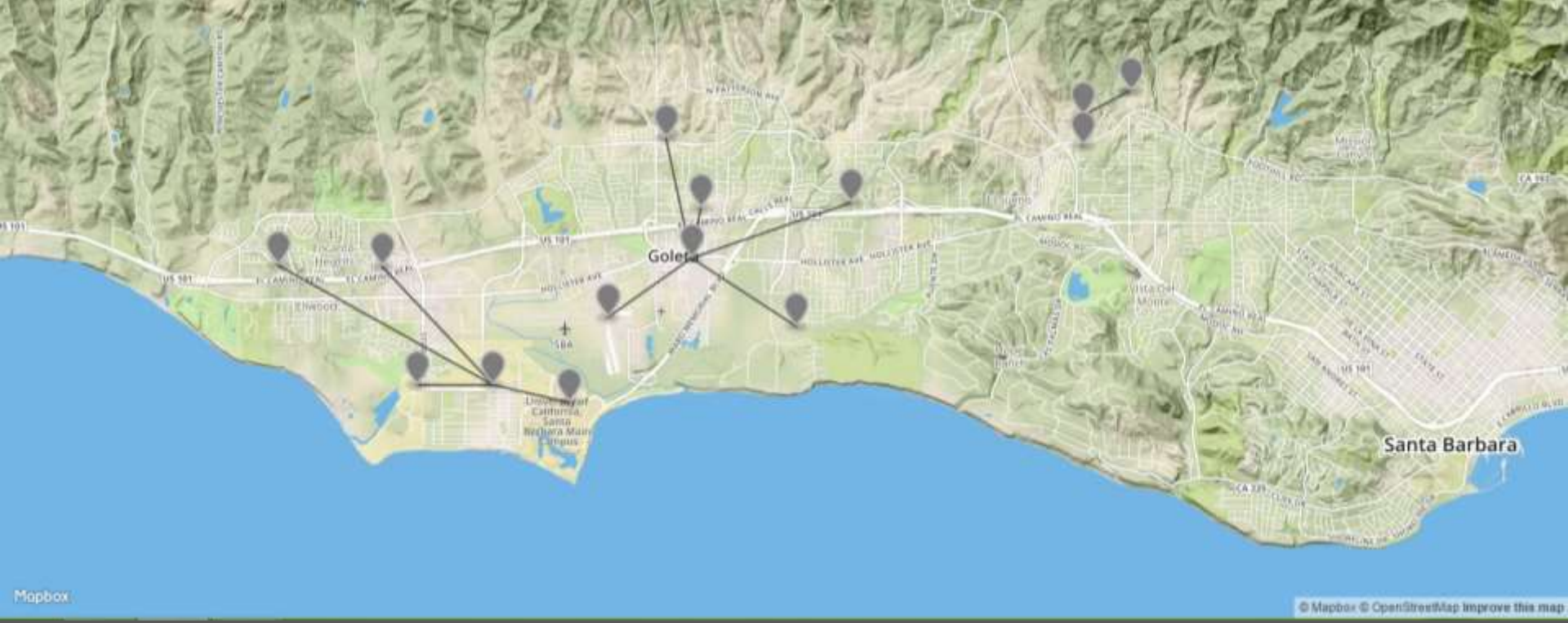


Matt Niblett
Timber Harvests
(Mapwindows; MPL License 1.1)

Google Operation Research Tools (Apache License 2.0)

Gnu Linear Programming Kit (GNU General Public License 3)



Sample p-median demo
http://data-doc.geog.ucsb.edu/MapBoxPM4.php

Other spatial examples within the repo:
https://github.com/google/or-tools

Applied Research on Geographic Information
@arogi

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