How to GIS in Python

A tale of two Cities

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Who am I?

- M.Sc.EE 1989 from Technical University of Denmark
- 15 years R&D at Bang & Olufsen
- PyPy – EU Research project under FP6 – Saarbrücken, Germany
- Startup company – AI
- SW-Consultant – Vestas
- Lecturer at Aarhus University
EcoSense

- Collective Mobile Sensing
- Modeling of Emissions
  - Climate gasses
  - Pollution
- Visualization
Contents

• What is GIS
• Applications of GIS
• Data sources for GIS
• Python tools
• Python examples
• Istanbul transport model
GIS Introduction

- GIS is about maps – Simple!
- But how to make 2 dimensional maps from a sphere?
- Lots of ways!
- Which can make GIS complex
Projec4ons

• About 4000 different projection
• Mostly a solved problem
• Just use WSG84
GIS Applications

• Keep track of assets
  – Underground cabling
  – Sewage
  – Fleet management

• Zoning
• Planning
GIS Applications

• Routing (Google Maps, Tom Tom, Yandex,...)
• City planning
• Traffic modeling
GIS Data

• Open Street Map
• Google Earth
• National data centers
• Local data resources
  – Municipalities
Python tools

- QGIS
- ArcGIS
GIS tools

- Postgres/PostGIS/pgrouting
- GDAL
- OGR2OGR
Examples

• Open Street Map
Section 2

TRAFFIC MODELING
Traffic modeling

Predict traffic flows
Model how drivers choose routes
Assignment problem
Derived from econometrics
Looking for Equilibrium/Steady state solutions
Traffic modeling
Traffic model

• Congestion model
  – Travel time dependent on congestion
  – BPR formula (Bureau of Public Roads)

\[ S_a(v_a) = t_a \left( 1 + 0.15 \left( \frac{v_a}{c_a} \right)^4 \right) \]
Traffic model

- User Equilibrium
  - All drivers have the shortest travel time
  - All must have the same travel time
Traffic model

• Stochastic User Equilibrium
  – All drivers THINK they have the shortest travel time
  – Still use the BPR, but add a stochastic error term
  – Leads to GEV formulation of the assignment problem
  – I.e. Path Size Logit

\[ P_k = \frac{\exp(V_k + \beta_{PS} \cdot \ln PS_k)}{\sum_{l \in C} \exp(V_l + \beta_{PS} \cdot \ln PS_l)} \]
Istanbul case

- Data from Open Street Map
- Converted to form a topology
- 300,000 road segments (bidirectional)
- 2000 Origin Destination pairs
- Postgres/PostGIS/pgRouting
- Python for driving the Queries
- QGIS for visualization
Demo
Conclusion

• Python can definitely be used in GIS
• There are many tools (a jungle?) available
• There are many open data sources
• There is a learning curve to understand the terminology
Thank You!

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