STREET NETWORK MODELS AND INDICATORS
FOR EVERY URBAN AREA IN THE WORLD

Geoff Boeing
Department of Urban Planning and Spatial Analysis
University of Southern California
https://geoffboeing.com/
Talk Overview

■ Why analyze street networks
■ New tools
■ Street network models and indicators
■ Analytical findings
MOTIVATION
OSMnx
**OSMnx**

- **OpenStreetMap + NetworkX**
- Software package to easily download, model, analyze street networks
- **Key features:**
  1. Download and model OSM street networks
  2. Algorithmic correction and processing of network topology
  3. Also download building footprints, points of interest, elevation data
  4. Analysis: calculate routes, project and visualize, calculate geometric and topological network indicators
ox.graph_from_place("Los Angeles, CA", type="drive")
ox.graph_from_place("Modena, Italy")
MODELS AND INDICATORS
Recent Work

- Model street network of entire US at multiple scales
- Each city, urban area, county, census tract, Zillow neighborhood
- Calculate dozens of indicators for each
- Deposit models + indicators in open data repository
Current Work

- Model street networks of every urban area in the world
- Each urban area in GHSL database
- Calculate dozens of indicators for each
- Deposit models + indicators in open data repository
Worldwide Street Networks

- Each urban area in GHSL database
- Use OSMnx to download and model street network
- Deposit code/models in public repository
Worldwide Street Networks

- Attach elevation to every node and calculate edge grades
- Sources: ASTER, SRTM3, Google Elevation API
- Imperfect data = trade-offs
- Elevation value selection rules
Worldwide Street Networks

- Calculate network indicators for every urban area
- Transport, urban design, network science
  - intersection density
  - block lengths
  - circuity/straightness
  - orientation entropy
  - many more
Intersection Density
Intersection Density

- Points overcount 16% on average compared to topological method
- Worst regions: Australia/New Zealand and Southern Europe (>29%)
- Worst countries: Australia, Spain, Israel (>33%)
- Bias: 1% ↑ in urban GDP (PPP) per capita, 0.25% ↑ in overcount
Transport CO$_2$ Emissions

Response = total transport co2 emissions (ln)
$R^2 = 0.54$

|                        | coef   | std err | t      | P>|t|     | [0.025 | 0.975 |
|------------------------|--------|---------|--------|---------|--------|-------|
| const                  | -6.9001| 0.523   | -13.181| 0.000   | -7.926 | -5.874|
| k_avg ln               | -3.1321| 0.219   | -14.325| 0.000   | -3.561 | -2.703|
| straightness ln        | -5.1467| 0.678   | -7.596 | 0.000   | -6.475 | -3.819|
| intersect_density_topo_build ln | -0.1540| 0.015   | -10.067| 0.000   | -0.184 | -0.124|
| length_total_percap ln | 0.4519 | 0.035   | 12.800 | 0.000   | 0.383  | 0.521 |
| gdp_ppp_percap ln      | 0.2656 | 0.022   | 12.053 | 0.000   | 0.222  | 0.309 |
| night_light_em_percap ln | 0.3996 | 0.016   | 19.825 | 0.000   | 0.279  | 0.340 |
| grade_median ln        | -0.6217| 0.043   | -14.327| 0.000   | -0.707 | -0.537|
| built_up_area ln       | 0.4367 | 0.014   | 30.836 | 0.000   | 0.409  | 0.464 |
| pct_open_space ln      | 0.8062 | 0.075   | 10.711 | 0.000   | 0.659  | 0.954 |
| intersect_count_clean_topo ln | 0.2827| 0.013   | 21.930 | 0.000   | 0.257  | 0.308 |
| has_airport            | -0.0310| 0.050   | -0.614 | 0.539   | -0.130 | 0.068 |
| has_waterport          | -0.1728| 0.135   | -1.282 | 0.200   | -0.437 | 0.091 |
| LDCL                   | -0.8496| 0.066   | -12.969| 0.000   | -0.978 | -0.721|
| MDR                    | 0.0922 | 0.050   | 1.826  | 0.068   | -0.007 | 0.191 |
Transport CO$_2$ Emissions

- 1% ↑ in avg node degree, 3.1% ↓ CO$_2$
- 1% ↑ in straightness, 5.1% ↓ CO$_2$
- 1% ↑ in intersect density, 0.15% ↓ CO$_2$
- 1% ↑ in per capita street length, 0.45% ↑ CO$_2$
CONCLUSION
Questions?

Geoff Boeing
University of Southern California
boeing@usc.edu
https://geoffboeing.com/