Automated Street Network Analysis for Urban Planners with OSMnx

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Street network modeling has become ubiquitous in urban planning for analyzing transportation infrastructure, household travel behavior, accessibility and social equity, location centrality, walkability, and indicators of the urban fabric including block sizes, intersection density, and connectivity. However, straightforward, scalable tools for professional planners to automatically acquire and analyze detailed street networks have been few and far between.

Planners typically rely on large shapefiles, such as US Census TIGER/Line roads data, loaded into software like ArcGIS to analyze local or metropolitan street networks. Unfortunately, TIGER/Line contains substantial spatial inaccuracies, emphasizes drivable roads over paths available for active travel, and has limited coarse-grained metadata. OpenStreetMap—an open-source, collaborative, worldwide mapping project inspired by Wikipedia—has emerged as a major player for mapping and acquiring spatial data. Though coverage varies somewhat worldwide, its US data are high quality. OpenStreetMap imported the TIGER/Line roads in 2007 and since then its community has made millions of corrections and improvements. Many of these additions go beyond TIGER/Line's scope, including passageways between buildings, footpaths through parks, bike routes, and detailed attributes such as fine-grained street classifiers, speed limits, etc. This presents a fantastic data source to answer urban planning questions, but OpenStreetMap's data have been difficult to work with due to its Byzantine query language and coarse-grained bulk extracts provided by third-parties.

OSMnx offers an easier way. It is a new, free, open-source tool that allows anyone to download walkable, drivable, or bikeable urban networks from OpenStreetMap for any city name, address, or polygon

in the world, then automatically analyze and visualize them. OSMnx democratizes these data and methods to help technical and non-technical planners use OpenStreetMap data to model urban form, circulation, accessibility, and resilience. It allows us to automatically:

- Download walkable, bikeable, or drivable street networks anywhere in the world
- Download other networked infrastructure types such as electrical grids and rail lines (where available)
- Download by city name, polygon, bounding box, or address + network distance
- Load street network data from a local .osm file
- Visualize street networks as static plots or interactive web maps
- Simplify and consolidate intersections for accurate counts/densities
- Conduct topological and spatial analyses to automatically calculate dozens of indicators
- Plot figure-ground diagrams of street networks and/or building footprints
- Download elevations to calculate street grades and assess flooding vulnerability

- Calculate and plot shortest-path routes with various impedances
- Visualize travel distance and travel time with isoline and isochrone maps
- Calculate and visualize street bearings and orientations

OSMnx is written in Python and requires minimal technical experience to use. In just two lines of code we can download and calculate any city's intersection density, average block length, street circuitry, distribution of intersection types, and dozens more variables. Instead of a city name, we could pass in a list of polygons such as neighborhood shapes, addresses and buffer distances, etc. Or we could pass in a list of 100 (or 100,000) city names or polygons to automatically download all of their street networks, analyze them, and create a table of variables.

We are not limited to drivable networks: we can instead get walkable, bikeable, or everything all together. Given OpenStreetMap's vast repository of walking paths and bike routes, we can easily model how trip distances and times, routing options, and accessibility change from one mode to another. OSMnx has built-in shortest path calculators to

find the network distance between any two addresses or points. Beyond the basic network stats common in urban morphology and design, we can just as easily calculate advanced topological measures such as closeness centralities, clustering coefficients, PageRanks, etc. Such measures have arisen recently from the study of complex networks in statistical physics, and provide insight into a street network's structure, performance, and resilience.

OSMnx can help easily communicate urban design decisions and alternative street layouts. Allan Jacobs' classic book *Great Streets* featured dozens of hand-drawn figure-ground diagrams depicting one square mile of cities' street networks. Holding these cities at the same scale provides a revealing spatial objectivity in comparing their street networks and urban forms. We can automatically re-create these with OpenStreetMap data for any city in the world, using OSMnx. These visualizations show us how different urbanization patterns and paradigms compare at the same scale. This can serve both as a tool for comprehending the physical outcomes of planning and informal urbanization, as well as a tool for communicating urban planning and design in a clear and immediate manner to laymen.

OSMnx unlocks new data for walkability studies, circulation modeling, and computational urban design. Even if you are new to Python, OSMnx offers an easy way to start working with this rich dataset. To get started, visit <https://github.com/gboeing/osmnx>. For an example study using OSMnx in action, visit <https://arxiv.org/pdf/1705.02198>.

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