Σp.A.C.E. Lab.

Supplementary Material

n_clusters = 2

n_clusters = 3

n_clusters = 4

n_clusters = 5

n_clusters = 6

n_clusters = 7

n_clusters = 8

n_clusters = 9

n_clusters = 10

Figure S01. Silhouette analysis: HAC-ward clustering on sample data with n_clusters.

(a)

(b)

Betweenness Centrality

— Less intermediate   — More intermediate

☐ Study region

Closeness Centrality

— Less accessible   — More accessible

(c)

(d)

Degree Centrality

— Less connected   — More connected

PageRank Centrality

— Connected to less   — Connected to more
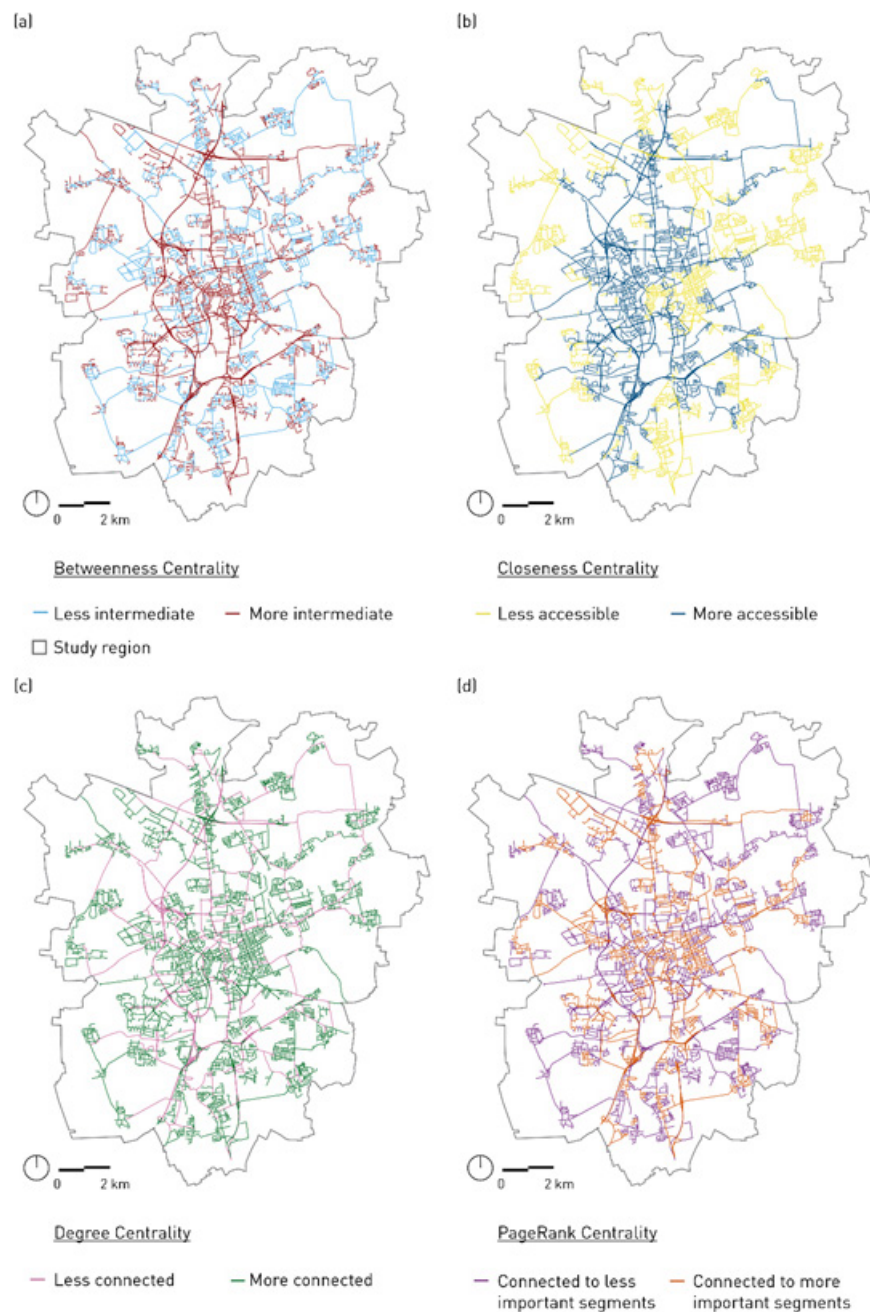   important segments   important segments

Figure S02. Spatial distribution of the four considered centrality measures: betweenness centrality, closeness centrality, degree centrality, PageRank centrality. Map Data: OpenStreetMap contributors, 2021.

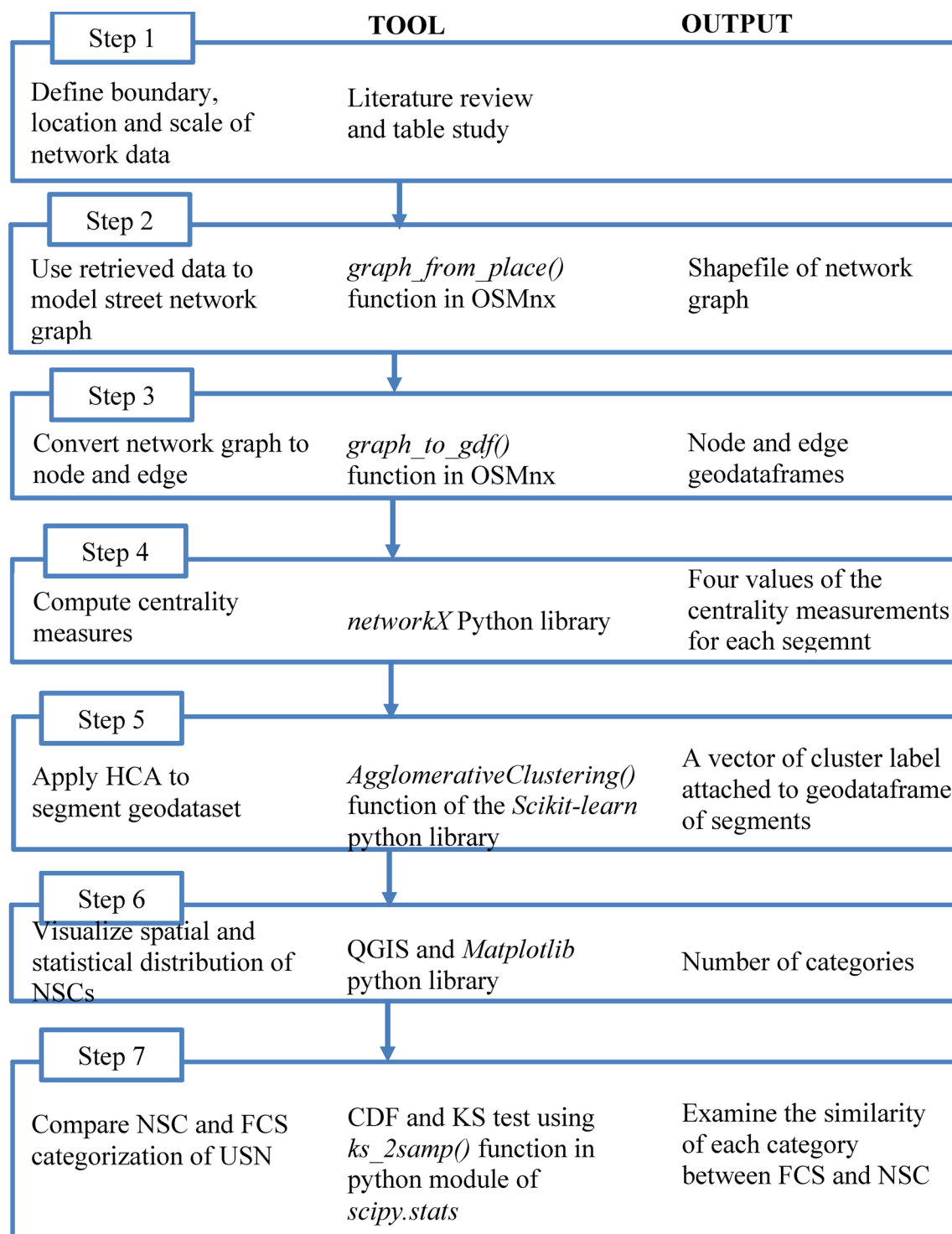|	**TOOL**	**OUTPUT**
Step 1 Define boundary, location and scale of network data	Literature review and table study	
Step 2 Use retrieved data to model street network graph	*graph_from_place()* function in OSMnx	Shapefile of network graph
Step 3 Convert network graph to node and edge	*graph_to_gdf()* function in OSMnx	Node and edge geodataframes
Step 4 Compute centrality measures	*networkX* Python library	Four values of the centrality measurements for each segemnt
Step 5 Apply HCA to segment geodataset	*AgglomerativeClustering()* function of the *Scikit-learn* python library	A vector of cluster label attached to geodataframe of segments
Step 6 Visualize spatial and statistical distribution of NSCs	QGIS and *Matplotlib* python library	Number of categories
Step 7 Compare NSC and FCS categorization of USN	CDF and KS test using *ks_2samp()* function in python module of *scipy.stats*	Examine the similarity of each category between FCS and NSC

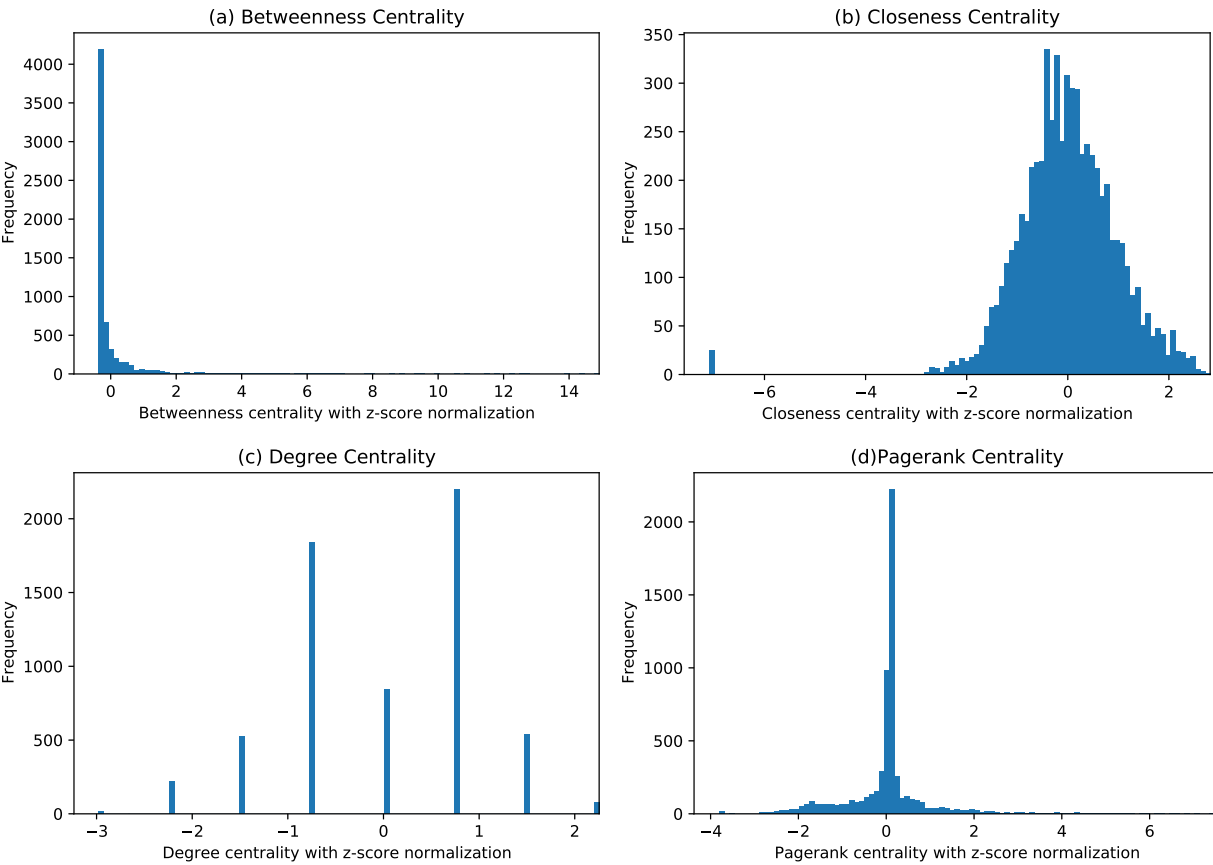Figure S03. Flow chart: Methodology and workflow of NSC method.

Figure S04. Frequency distribution of the four centrality measures normalized with z-score.
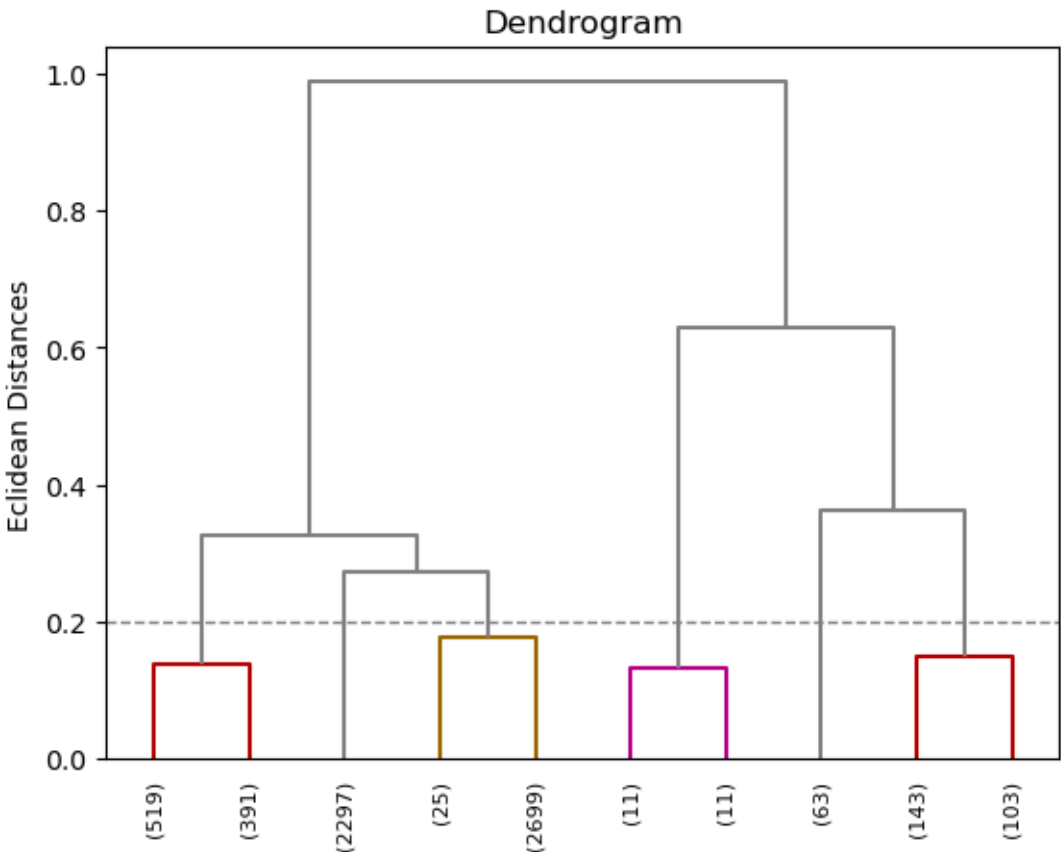

Figure S05. Dendrogram of hierarchical agglomerative clustering (HAC).

Table S01. OpenStreetMap (OSM): values key:highway, and number of segments of each value (class) in the study region Braunschweig.

OSM key:highway	Definition	Number of segments
Motorway	Highest-performing segments within the entire network and usually has at least two lanes in each traffic direction with some degree of separation. It is typically pedestrian and bicycle prohibited, free from intersection controls, accessed by a ramp and has no direct access to private properties.	295
Primary	Major segments linking large towns.	272
Secondary	Segments which are not part of a major route, but nevertheless provide a link to the national route network.	830
Tertiary	Segments connecting minor streets to primary and secondary roads with low to moderate traffic. In the outer sub-urban areas, used on segments connecting smaller settlements such as villages or hamlets. Within larger urban areas such as large towns or cities, tertiary segments link local centres of activity such as shopping areas, and schools with suburbs.	754
Residential	Low-speed segments used by local traffic within settlements to provide full access to the front of properties in the residential areas.	4,026
Unclassified	Unclassified segments are one of the following type of segments: less important than tertiary segments; considered usable by motor cars; not residential streets or agricultural tracks; of low importance within town and cities (if not residential)	94

TOTAL: 6,262

Table S02. Share of segments for each NSC category within each FCS class.

NSC Category	Motorway		Primary		Secondary		Tertiary		Residential		Unclassified	
	Count	[%]	Count	[%]	Count	[%]	Count	[%]	Count	[%]	Count	[%]
1	22	7.77	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
2	39	13.78	0	0.00	19	2.29	2	0.27	0	0.00	0	0.00
3	66	23.32	60	22.47	71	8.56	35	4.67	10	0.25	1	1.19
4	52	18.37	110	41.20	377	45.48	212	28.27	148	3.68	9	10.71
5	72	25.44	54	20.22	239	28.83	203	27.07	1,679	41.68	43	51.19
6	32	11.31	13	16.10	123	14.84	298	39.73	2,190	54.40	31	36.90
Total	283	100,00	267	100,00	829	100,00	750	100,00	4,026	100,00	84	100,00