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Online Supplement to "An Open Source Desktop Application for Generating Arc Routing Benchmark Instances"

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1. Additional Figures

In this Online Supplement, we provide several figures that give a more detailed illustration of the OAR Bench work flow. An example of a Cytoscape project is shown in Figure 1. The map of Tokyo's metro is plotted on a Cytoscape canvas. The vertices represent stops. The user interface for extracting street networks from the Open Street Maps database is shown in Figure 2. This map is interactive and supports panning and zooming to any location in the world. At the top right of this map, the user can toggle between satellite imagery and street map tiles. We show satellite imagery in Figure 2.

In order to generate the street network file, the user must specify the geographic region of interest. By default, the entire area on the screen is designated as the region of interest. The user may navigate using the map to bring the desired area onto the screen. If the user wants to specify a different bounding box (e.g., with a different aspect ratio), the button on the left of the map allows the user to select a subset of the region to display on screen.

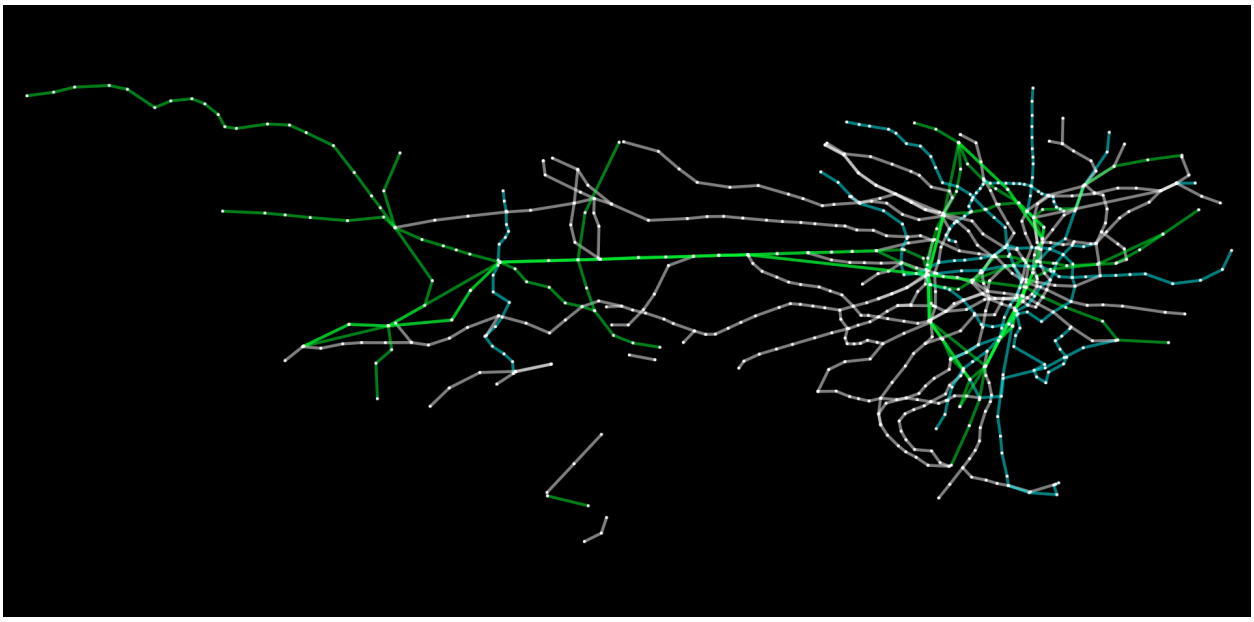

Figure 1 **A map of the Tokyo railway system recreated using Cytoscape (Franz 2016).**

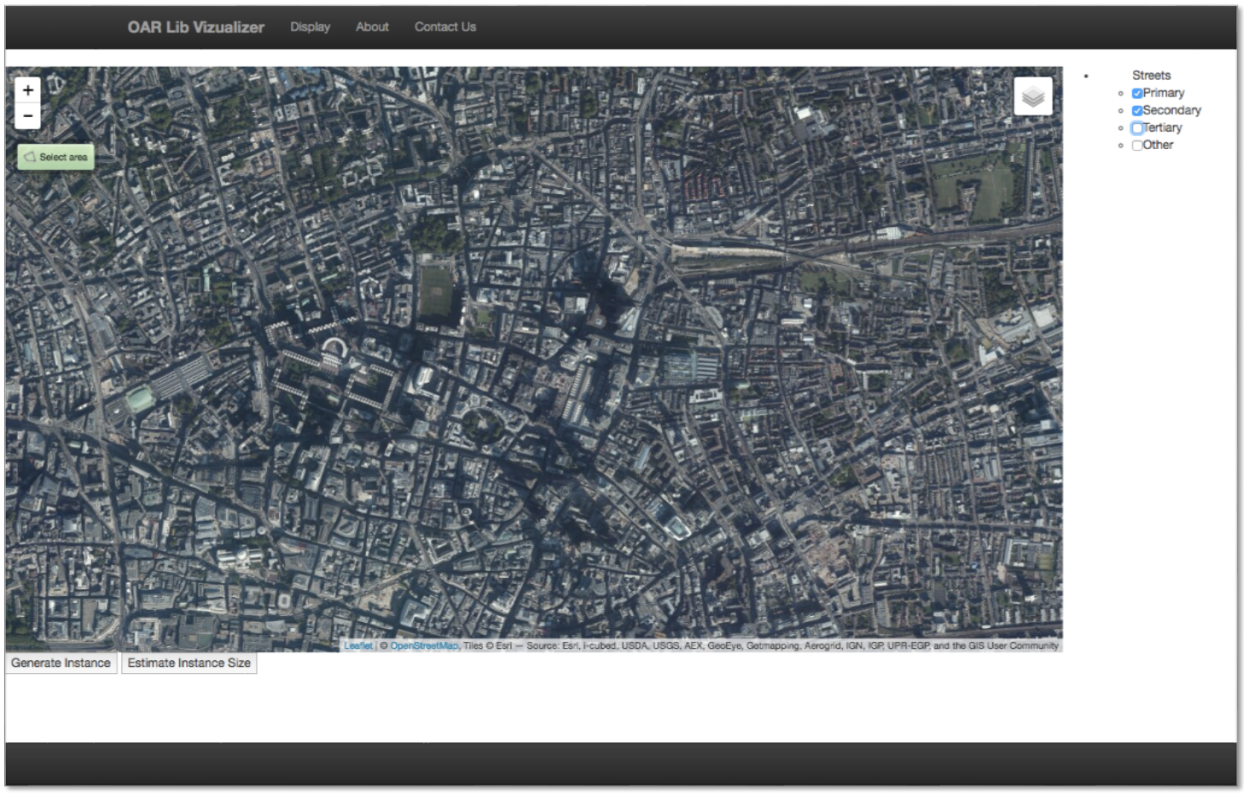

Figure 2 **The OAR Bench UI for the network generation phase. The Leaflet map pane is used to select the geographic region that provides the underlying street network. Satellite imagery and a cleaner street map layer are available.**

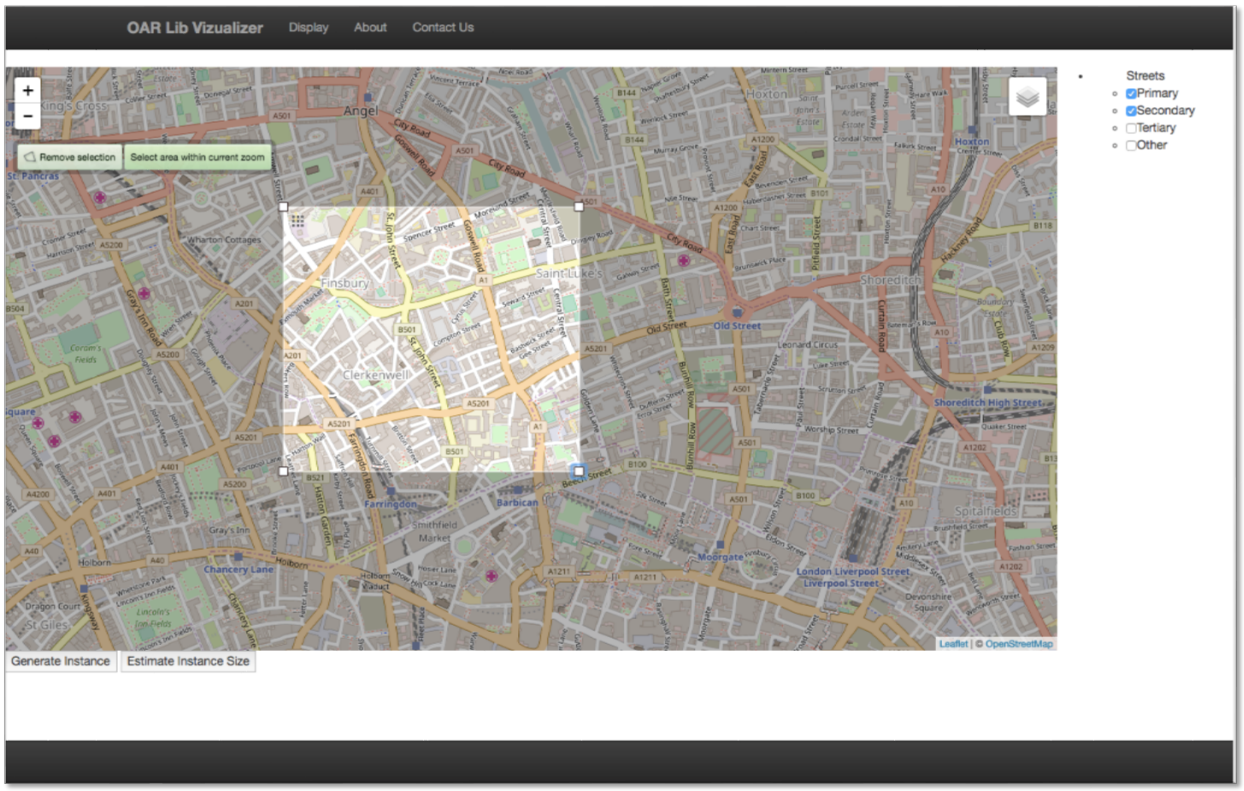

Figure 3 **The user can query OSM for a subset of the visible area by specifying a bounding box.**

This is shown in Figure 3. If the user exports the street network in Figure 3, only streets within the brighter area in the center of the screen will be included in the output.

By default, all streets are included in the exported network. However, depending on the region, the network can include many side streets that are not of interest. Therefore, OAR Bench allows the user to select streets with particular priorities to include in the exported network. An example is shown in Figure 4.

2. Detailed Example Using OAR Bench

In this section, we show how to use OAR Bench to generate an instance. Suppose we want to generate an instance based on a portion of the street network of the city of Amsterdam. In Figure 5, we show the screen when OAR Bench is first opened. The search bar on the map is used to find Amsterdam. The result of the search is shown in Figure 6. We then zoom in so that the portion of the street network that we want is on screen. In Figure 7, after clicking the Estimate Instance Size button, the streets found in the OSM database are drawn on the map in red. The green notification box displays how many edges were returned. After clicking the Generate Instance button, the street network is saved to a file.

(a) (b)

Figure 4 **During the generate phase, there are filters (highlighted in the red box) that can be set to include or exclude certain types of data from the OSM query. In (a), all street priorities are checked. Exported streets are in red. In (b), unchecking all priorities below secondary excludes those streets from the generated network. The result of using filters is reflected in the red overlay from estimating the instance.**

In Figure 8, we switch to the Display tab and load the network. This network has 1034 nodes and 1396 edges. We use the Auto-Trim procedure to delete disconnected nodes and edges. The network after Auto-Trim is applied is shown in Figure 9; it has 992 nodes and 1353 edges. Notice that a cluster of streets in the top right of Figure 8 has been eliminated from the network. Finally, we use the Randomize button to set some of the streets as required. In Figure 10, the interface that specifies the probability that an edge is required depending on its priority is shown. The final instance is shown in Figure 11. The final instance can be exported as a text file (Figure 12) that can be parsed by a solver and exchanged freely among researchers.

References

Franz, Max. 2016. Tokyo railways. `http://js.cytoscape.org/demos/f64e811fc3311414e083/`. Accessed: 2017-04-03.

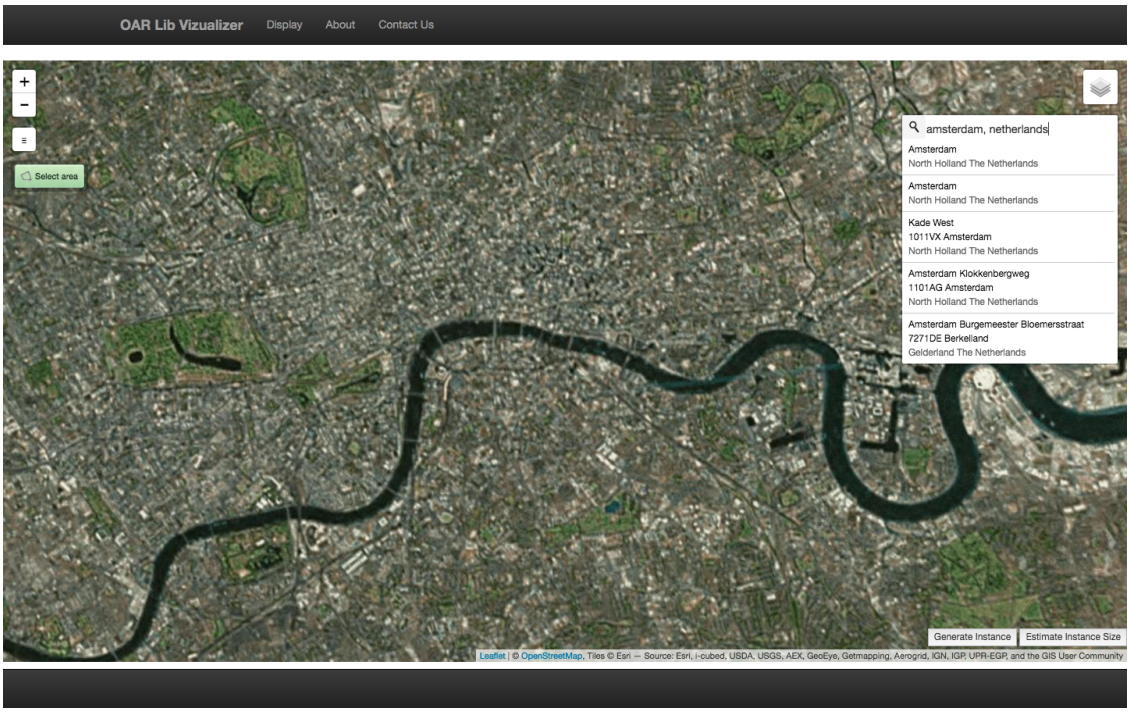

Figure 5 Map search

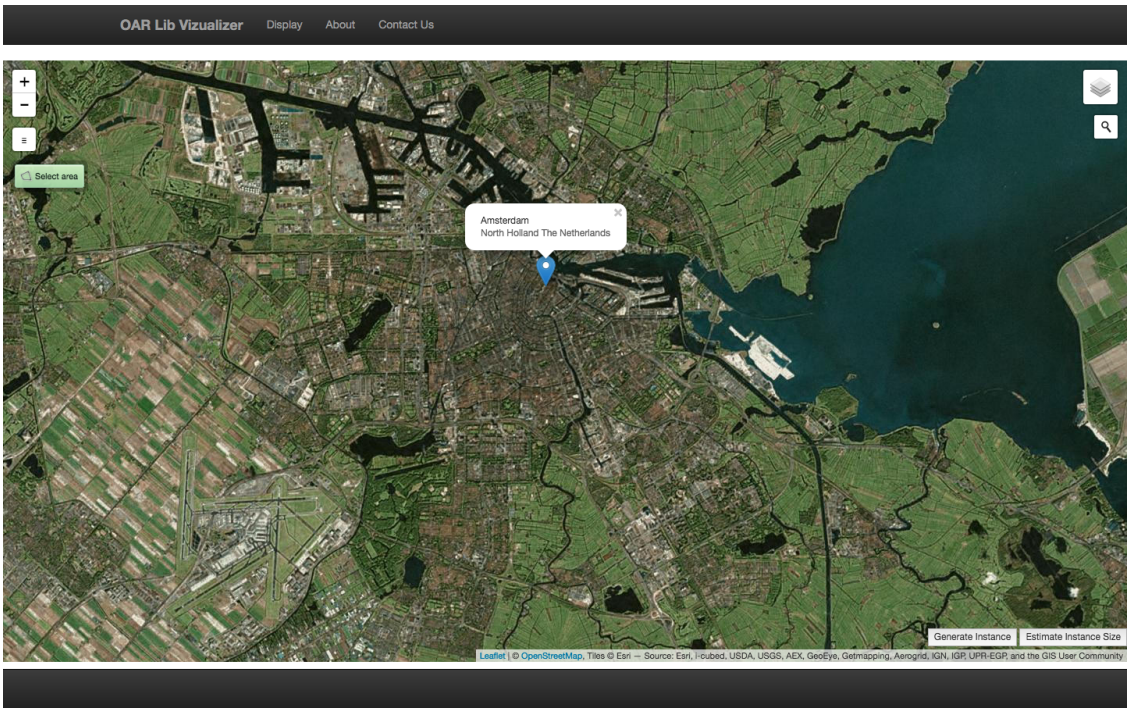

Figure 6 Map centered on the city of Amsterdam

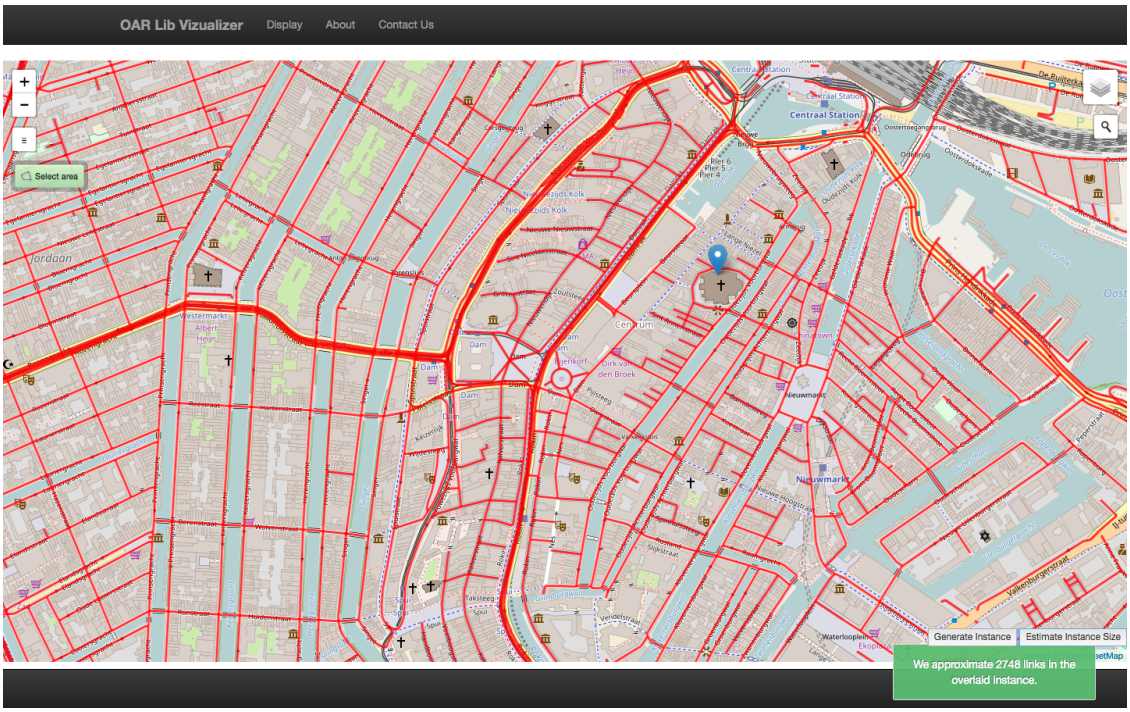

Figure 7 **Instance estimated**

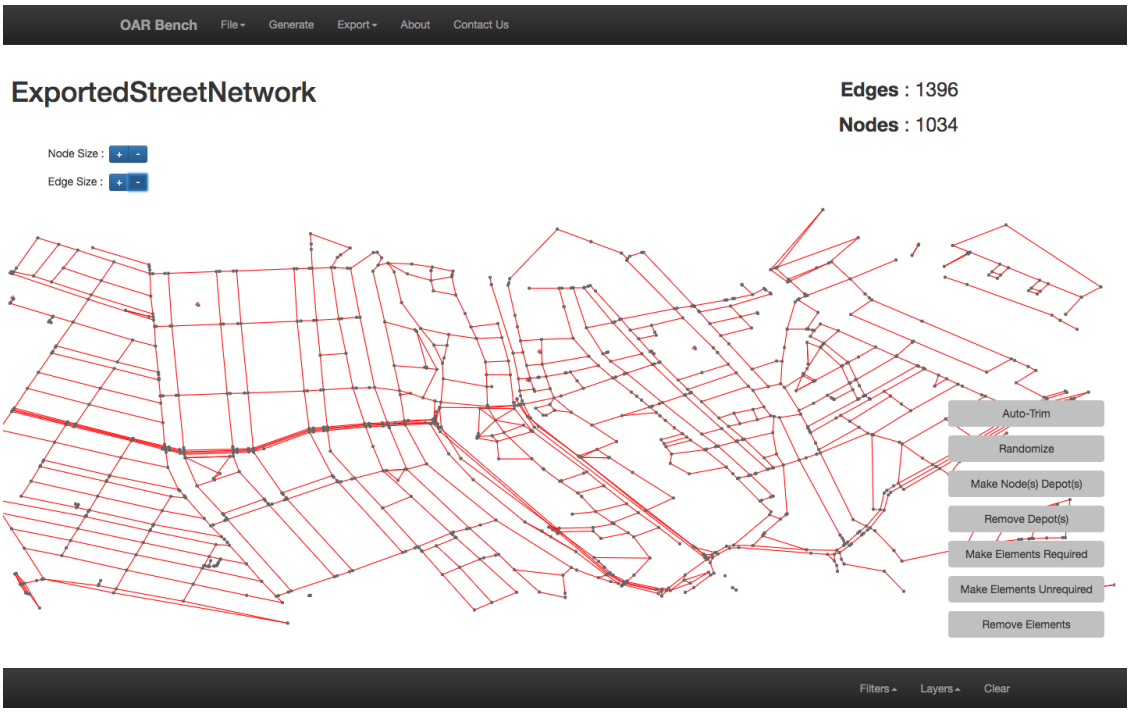

Figure 8 **Importing the Amsterdam instance**

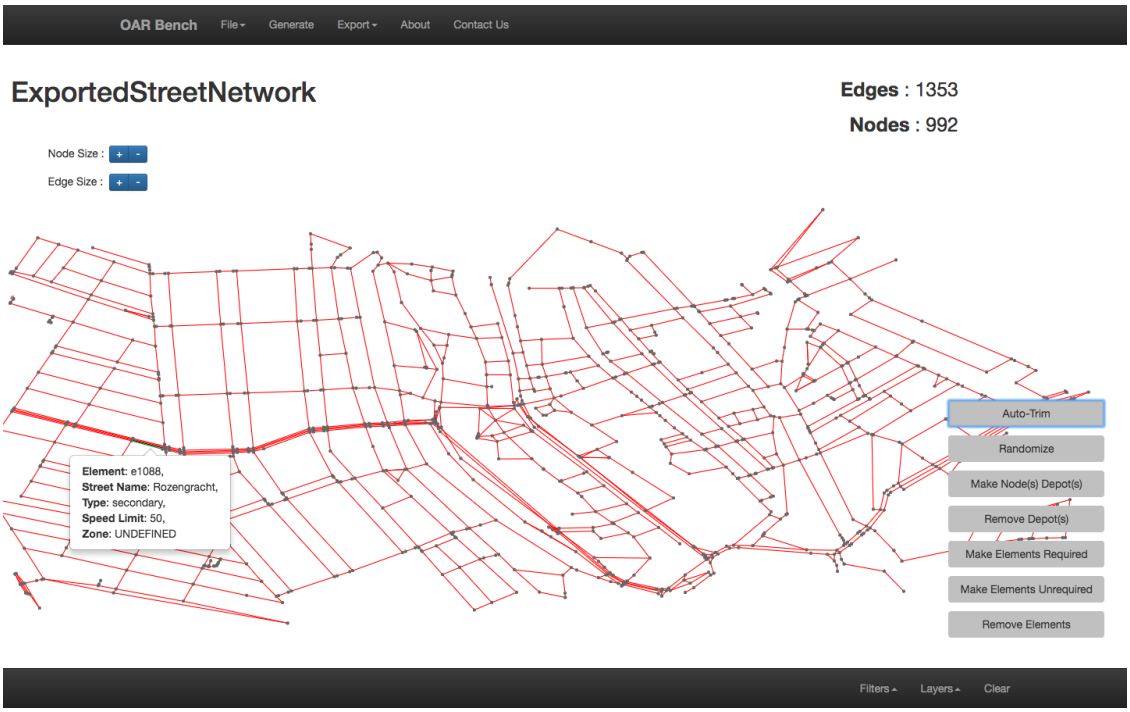

Figure 9 Network after applying the Auto-Trim procedure

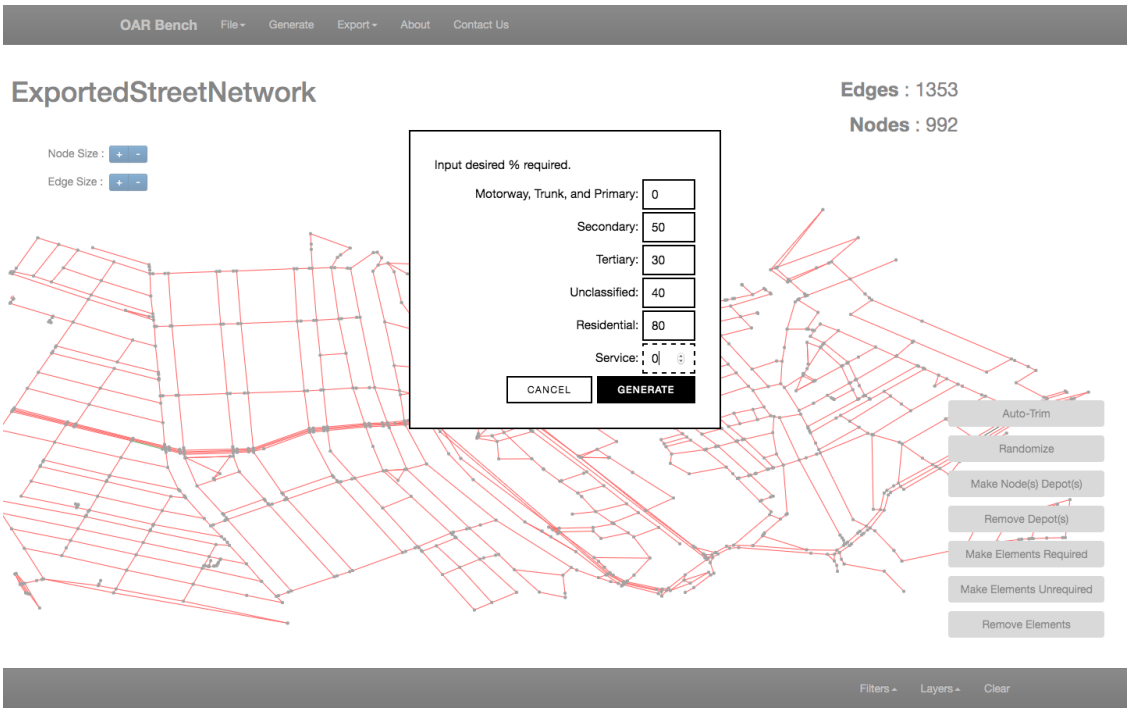

Figure 10 Randomizing required streets by type of street

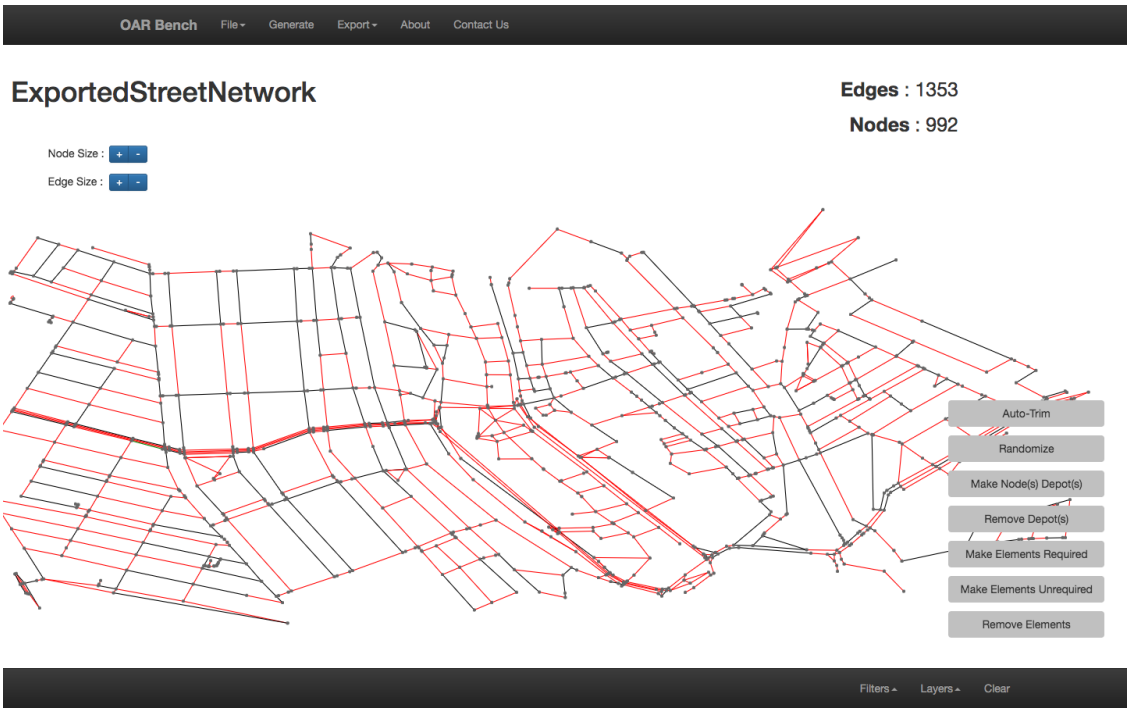

Figure 11 **Amsterdam instance after randomization. Black edges are required; red edges are not required.**

```
1024, 12476, 4518
1025, 12422, 4513
1026, 15980, 9096
1027, 16255, 9270
1028, 16237, 9282
1029, 1738, 3086
1030, 1671, 3172
1031, 615, 2566
1032, 549, 2652
1033, 6761, 9536
1034, 6677, 9447
================================
EDGES: ID, V1, V2, DIST, REQUIRED, DIRECTED, TYPE, NAME, MAX_SPEED, ZONE
================================
e1363, 1016, 288, 39.44616584663204, true, true, unclassified, Tweede Leliedwarsstraat, NaN, UNDEFINED
e1368, 1019, 1017, 96.25487000666512, false, false, pedestrian, Beurspassage, NaN, UNDEFINED
e1369, 282, 1018, 46.84015371452148, false, false, pedestrian, Beurspassage, NaN, UNDEFINED
e1370, 1018, 1019, 671.3784327784144, false, false, pedestrian, Beurspassage, NaN, UNDEFINED
e1324, 1002, 1003, 531.6483800407935, false, false, pedestrian, undefined, NaN, UNDEFINED
e1322, 1000, 1001, 369.6281915655244, false, false, pedestrian, undefined, NaN, UNDEFINED
e1337, 992, 877, 67.7421582177598, true, true, secondary, Nieuwezijds Voorburgwal, 50, UNDEFINED
e1359, 1010, 1009, 53.009433122794285, false, true, unclassified, Prins Hendrikkade, NaN, UNDEFINED
e1320, 1005, 1002, 574.5441671447027, false, false, pedestrian, Keizersstraat, NaN, UNDEFINED
e1313, 997, 998, 142.41137595009747, true, false, unclassified, undefined, NaN, UNDEFINED
e1312, 998, 694, 23.600847442411894, true, false, unclassified, undefined, NaN, UNDEFINED
e1326, 104, 711, 619.7757659024754, false, false, pedestrian, J.W. Siebbeleshof, NaN, UNDEFINED
```

Figure 12 **Text file of the Amsterdam instance**