

KM4city URBAN GRAPH REPRESENTATION

Author - Disit Lab

Starting from the OSM data and the KM4City Ontology (<http://www.disit.org/km4city/schema>), the Florence Graph has been created by Disit Lab. In this document some details are described.

A road network is studied as a directed graph composed by arcs that meet at some nodes, corresponding to road junctions. The urban roads' characteristics are stored in the OpenStreetMap database, for example:

- road type <https://wiki.openstreetmap.org/wiki/Key:highway>
- road lanes <https://wiki.openstreetmap.org/wiki/Key:lanes>
- etc.

Each road admits an initial node and an end node in order to determine the corresponding directed arc in the graph. In the following we consider an example.

Road 1 (labelled with OS00030031299SR, in OSM: <https://www.openstreetmap.org/way/30031299>):

The screenshot displays the OpenStreetMap interface for the road 'Piazza Francesco Ferrucci' (OSM ID: 30031299). The map shows the road network in Florence, Italy, with the road highlighted in orange. The sidebar on the left provides the following metadata:

Percorso: Piazza Francesco Ferrucci (30031299)	
Roads and buildings adjusted/added in Florence, Italy	
Modificato 3 mesi fa da mau59	
Versione #13 · Gruppo di modifiche #94271672	
Etichette	
highway	primary
lanes	2
name	Piazza Francesco Ferrucci
oneway	yes
surface	asphalt

Parte di

- Relazione ATAF C4, Pecori Duomo - Ferrucci (8378133)
- Relazione ATAF 23 B, Nuova Scuola Carabinieri - Croce a Varilano (2721396)
- Relazione ATAF 23 A, Nuova Scuola Carabinieri - Sorgane (2721395)
- Relazione ATAF 41 A, Ferrucci - Pietriboni (8228213)
- Relazione ATAF 41 Z, Ferrucci - Pietriboni (8228215)
- Relazione ATAF 41, Ferrucci - Pietriboni (8228214)
- Relazione ATAF 41 L, Ferrucci - Cascine del Riccio

Road 2 (labelled with os00026943048SR):

OpenStreetMap Modifica Cronologia Esporta Traccianti GPS Diari degli utenti Copyright Aiuto

Cerca Dove lo trovi? Vai

Percorso: Piazza Francesco Ferrucci (26943048)

Avanzamento linee autobus ATAF 8, 12, 13, 14, 23
Firenze

Modificato 5 mesi fa da hypersciocco
Versione #13 - Gruppo di modifiche #62010403

Etichette

highway	primary
lanes	2
name	Piazza Francesco Ferrucci
oneway	yes

Parte di

- Relazione ATAF C4, Presidio Ospedaliero Palagi - Pecori Duomo (8478638)
- Relazione ATAF 12, Piazzale Michelangelo - Il Prato Barbelli (2737049)
- Relazione 7410682 (come from)

Road 3 (labelled with os00205385722SR):

OpenStreetMap Modifica Cronologia Esporta Traccianti GPS Diari degli utenti Copyright Aiuto

Cerca Dove lo trovi? Vai

Percorso: Piazza Francesco Ferrucci (205385722)

Avanzamento linee autobus ATAF 8, 12, 13, 14, 23
Firenze

Modificato 5 mesi fa da hypersciocco
Versione #4 - Gruppo di modifiche #62010403

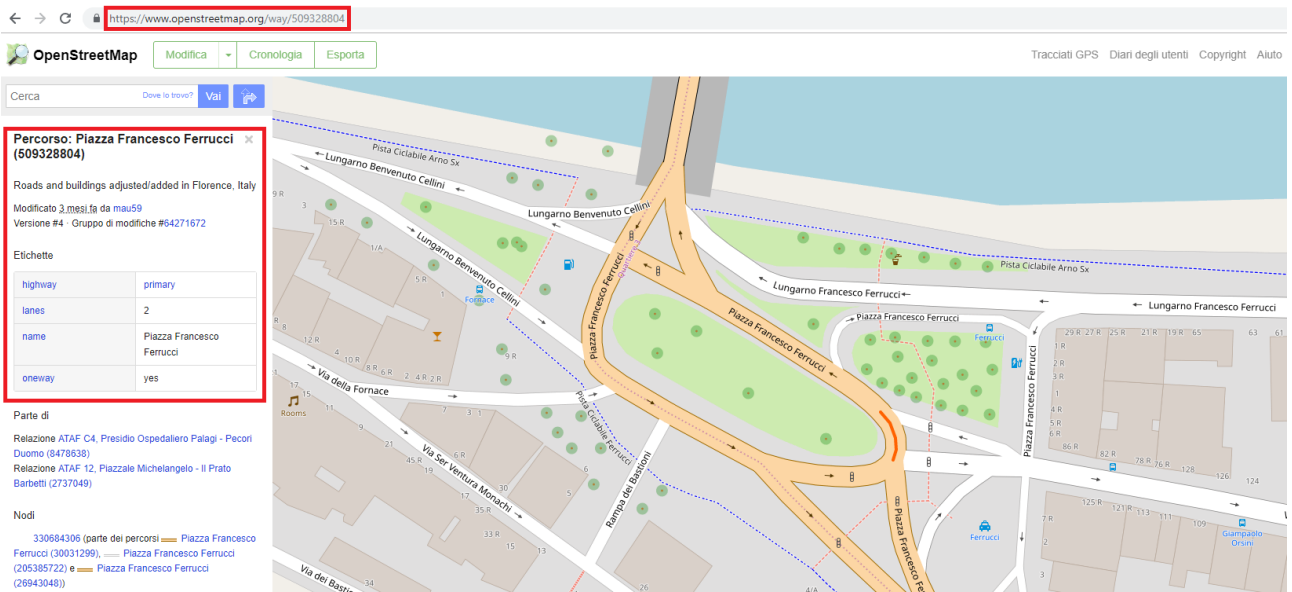
Etichette

highway	tertiary
name	Piazza Francesco Ferrucci
oneway	yes

Parte di

- Relazione ATAF C4, Pecori Duomo - Ferrucci (8378133)
- Relazione ATAF 23 B, Nuova Scuola Carabinieri - Croce a Variano (2721396)
- Relazione ATAF 23 A, Nuova Scuola Carabinieri - Sorgane (2721395)
- Relazione ATAF 41 A, Ferrucci - Pietriboni (8228213)
- Relazione ATAF 41 Z, Ferrucci - Pietriboni (8228215)
- Relazione ATAF 41 F, Ferrucci - Pietriboni (8228214)
- Relazione ATAF 41 L, Ferrucci - Cascine del Riccio (8228212)

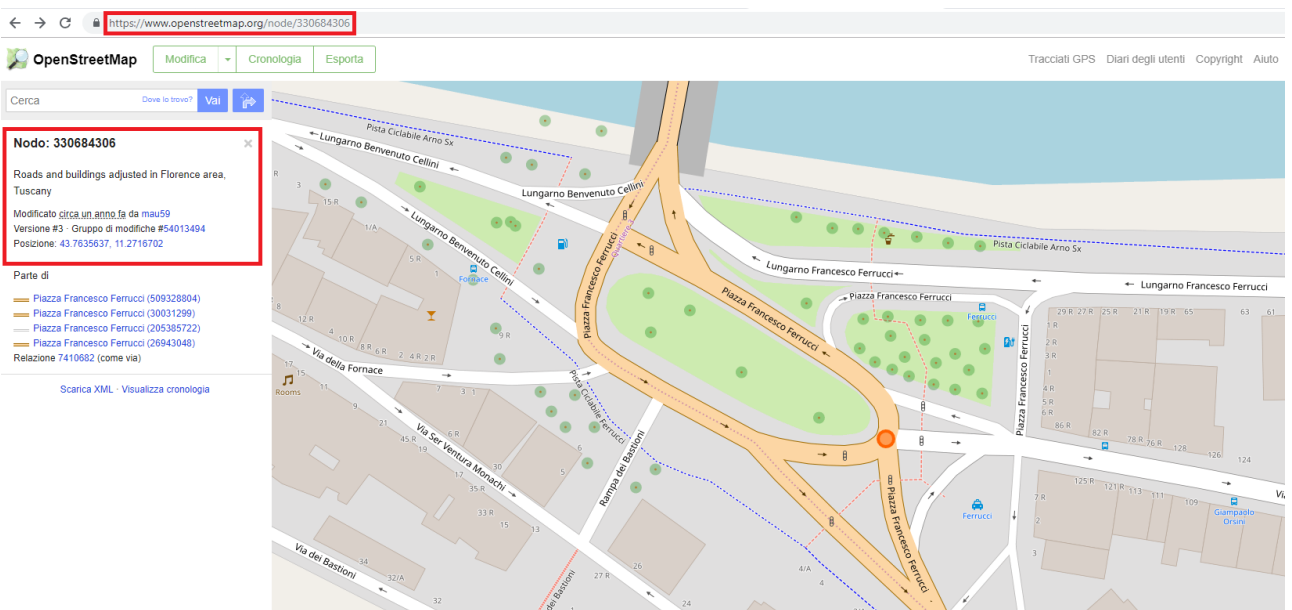
Road 4 (labelled with OS00509328804SR):



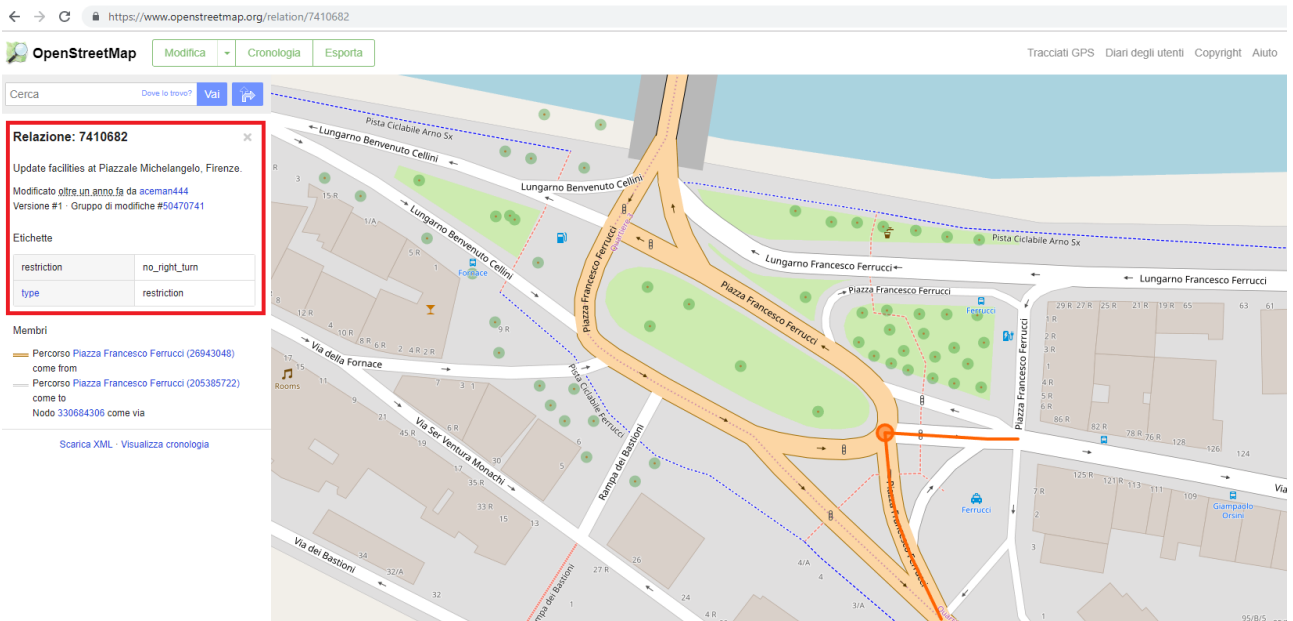
Listing the previous road-segments with their initial (nodeA, see the following table) and end node (nodeB, see the following table), the related road junction J (labelled with OS00330684306NO) is implicitly determined by means of the corresponding incoming and outgoing road-segments. In particular, the incoming road-segments in the road junction J are the road-segments having J as their end node, while the outgoing road-segments in the road junction J are the road-segments having J as their initial node (road details can be found in *roadDetails.xlsx* file coming from the ingestion process).

nodeA	segment	length	road	nodeB
OS01344583128NO	OS00030031299RE/4	4	OS00030031299SR	OS00330684306NO
OS00295213650NO	OS00026943048RE/5	8	OS00026943048SR	OS00330684306NO
OS00330684306NO	OS00205385722RE/0	29	OS00205385722SR	OS04985765666NO
OS00330684306NO	OS00509328804RE/0	3	OS00509328804SR	OS05200009916NO

Road Junction node (labelled with OS00330684306NO):



Moreover, further relations can be considered at the given junction (for example, representing the related turn restriction <https://wiki.openstreetmap.org/wiki/Relation:restriction>). In the example, *no_right_turn* restriction from road-segment labelled with **26943048** to road-segment labelled with **205385772** is considered.



node	from	to	restriction
OS00330684306NO	OS00026943048RE/5	OS000205385722RE/0	no_right_turn

Mapping KM4city - OSM

Author - Disit Lab

The following aspects are at the basis of the street path description:

- roads type (motorway, trunk, primary, secondary, tertiary, unclassified, residential, service),
- number of roads lanes,
- maximum flux permitted in the roads
- turn restrictions
- restricted traffic zone
- speed limit
- roads access restriction
- bidirectional traffic roads
- presence of designated lanes for public transport

In the following table it is possible to find the relation of these aspects with the Open Street Map Model

KM4City - Traffic model	OSM Model	Relevance
road type (motorway, trunk, primary, secondary, tertiary, unclassified, residential, service)	https://wiki.openstreetmap.org/wiki/Key:highway	high
roads lanes (number)	https://wiki.openstreetmap.org/wiki/Key:lanes	high
presence of designated lanes for public transport	https://wiki.openstreetmap.org/wiki/Key:lanes public service vehicles (PSV) (eg: Bus lanes ,)	medium
maximum flux permitted in the roads		low (it is deduced by the traffic flow model from the road lanes)
turn restrictions	https://wiki.openstreetmap.org/wiki/Relation:restriction	high
restricted traffic zone	Ask to municipality (shape fiel or path)	high
speed limit	https://wiki.openstreetmap.org/wiki/Speed_limits	high
roads access restriction	https://wiki.openstreetmap.org/wiki/Key:access	High, if the restrictions are present in the roads (only for pedestrian, only for bikes, etc.)
bidirectional traffic roads	https://wiki.openstreetmap.org/wiki/Key:oneway	high (if the street is open in only one direction)

Crossing Roads in Km4city Knowledge Base

nodeA	g1	segment	length	d1F	road	nodeB	g2	n1Lat	n1Long	n1Lat	n1Long	type	e1emType	total_lanes	designated_lanes	forward_lanes	designated_forward_lanes	backward_lanes	designated_backward_lanes
05019458128NO	POINT(11.271626472473 43.763538360590)	05000500312998E/4	4	4	tratto stradale aperto nella direzione positiva (da giunzione NOD_IN a giunzione NOD_FIN)	05000300312999R	0500330684308NO	POINT(11.271666126794 43.7635650634)	43.76353836	11.27162647	43.76356506	11.27166613	primary	0	0	0	0	0	0
0500292912850NO	POINT(11.27167701712 43.76349638826)	05000269430488E/5	8	8	tratto stradale aperto nella direzione positiva (da giunzione NOD_IN a giunzione NOD_FIN)	05000269430488R	0500330684308NO	POINT(11.271666126794 43.7635650634)	43.7634964	11.27167702	43.76356506	11.27166613	primary	2	0	0	0	0	0
0500330684308NO	POINT(11.271666126794 43.763565063477)	050002051857228E/0	29	29	tratto stradale aperto nella direzione positiva (da giunzione NOD_IN a giunzione NOD_FIN)	050002051857228R	0504985765668NO	POINT(11.27202129364 43.763549899)	43.76356506	11.271676653	43.76354599	11.27202129	primary	1	0	0	0	0	0
0500330684308NO	POINT(11.271666126794 43.763565063477)	05000500328608E/0	3	3	tratto stradale aperto nella direzione positiva (da giunzione NOD_IN a giunzione NOD_FIN)	05000500328608R	0500330009918NO	POINT(11.271676065318 43.76358116)	43.76356506	11.27166653	43.76358114	11.27167606	primary	2	0	0	0	0	0

Mapping in Km4City ontology (<http://www.dit.it.org/km4city/schema>)

Columns (referred to the previous tab): [Km4City Ontology/KB](#)

nodeA	dct:identifier of km4c:Node
g1	geo:geometry of km4c:Node
segment	dct:identifier of km4c:RoadElement
length	km4c:length of km4c:RoadElement
d1F	km4c:trafficDir of km4c:RoadElement
road	dct:identifier of km4c:Road
nodeB	dct:identifier of km4c:Node
g2	geo:geometry of km4c:Node
n1Lat	geo:lat of km4c:Node
n1Long	geo:long of km4c:Node
n2Lat	geo:lat of km4c:Node
n2Long	geo:long of km4c:Node
type	km4c:highwayType of km4c:RoadElement
e1emType	km4c:elementType of km4c:RoadElement
total_lanes	km4c:RoadElement -- km4c:lanes --> km4c:lanes -- km4c:lanesCount --> km4c:lanesCount -- sum values on km4c:* properties, each of which takes its name to a type of vehicle or user category (e.g. km4c:taxi, km4c:emergency, km4c:priv, ...) and km4c:undesigned for those lanes that can be traversed by any vehicle/user category --> total_lanes
designated_lanes	See the mapping for total_lanes, but exclude the value of km4c:undesigned from the count
forward_lanes	km4c:RoadElement -- km4c:lanes --> km4c:lanes -- discard km4c:Lane resources that have km4c:direction set to something other than "forward" --> km4c:lanes of your interest -- km4c:lanesCount --> km4c:lanesCount -- sum values on km4c:* properties, each of which takes its name to a type of vehicle or user category (e.g. km4c:taxi, km4c:emergency, km4c:priv, ...) and km4c:undesigned for those lanes that can be traversed by any vehicle/user category --> total_lanes
designated_forward_lanes	See the mapping for forward_lanes, and also exclude the value of km4c:undesigned from the count
backward_lanes	km4c:RoadElement -- km4c:lanes --> km4c:lanes -- discard km4c:Lane resources that have km4c:direction set to something other than "backward" --> km4c:lanes of your interest -- km4c:lanesCount --> km4c:lanesCount -- sum values on km4c:* properties, each of which takes its name to a type of vehicle or user category (e.g. km4c:taxi, km4c:emergency, km4c:priv, ...) and km4c:undesigned for those lanes that can be traversed by any vehicle/user category --> total_lanes
designated_backward_lanes	See the mapping for backward_lanes, and also exclude the value of km4c:undesigned from the count

Relations of interest

km4c:Road resources are linked to segments of road (each represented through a km4c:RoadElement resource) through the km4c:containsElement property
 each km4c:RoadElement resource is linked to the km4c:Node resource that represents the point where the road element starts, through the km4c:startsAtNode property
 each km4c:RoadElement resource is linked to the km4c:Node resource that represents the point where the road element ends, through the km4c:endsAtNode property

Namespaces of interest:

Prefix	Namespace
km4c	http://www.dit.it.org/km4city/schema#
dct	http://purl.org/dc/terms/
geo	http://www.w3.org/2003/01/geo/wgs84_pos#