Comparative Integration Potential Analyses of OSM and Wikidata

The case study of Railway Stations

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State of the Map 2022

Florence, Italy

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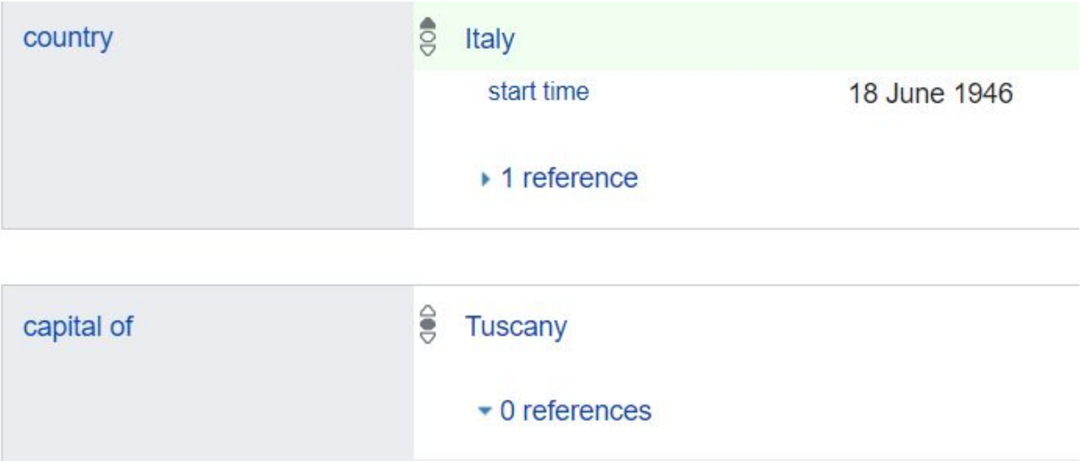
Knowledge Graphs (KGs)

- Rich source of semantic information
- Contain semantic information regarding real-world entities, their types and properties
  - Generic KGs: Wikidata, DBpedia, Yago
  - Geographic KGs: LinkedGeoData, Yago2Geo, WorldKG
- Problem:
  - Few geographic entities are present in generic KGs
  - Few geographic classes are present in specialized geographic KGs

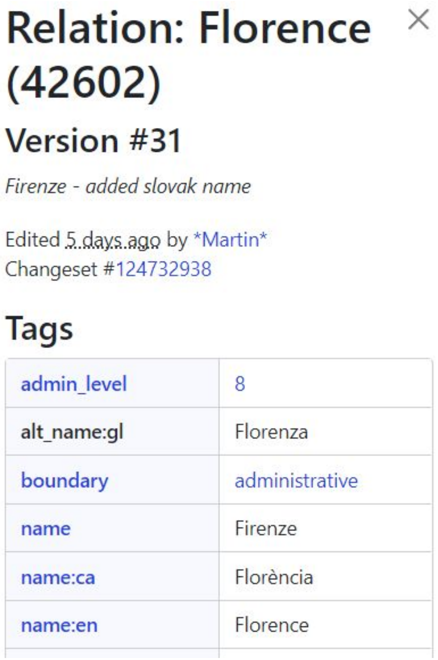
Wikidata Knowledge Graph

- Wikidata: Open Source General purpose KG of Wikimedia foundation
- Edited and used by Humans and Machines
  - Eg: “CyclingInitBot”: bot for initializing cycling related items
- Provides Semantic Representation
- Represented in the triple format
  - Subject – Predicate – Object
  - Eg: Florence – capital of – Tuscany



country	Italy	
	start time	18 June 1946
	▸ 1 reference	
capital of	Tuscany	
	▾ 0 references	

OpenStreetMap VS Wikidata



Relation: Florence (42602)

Version #31

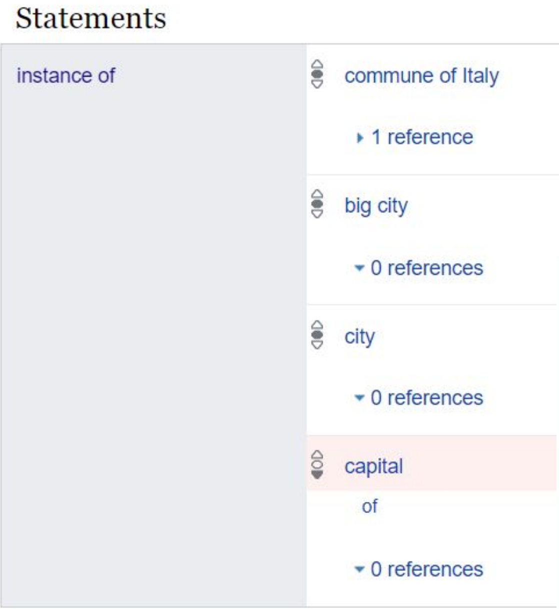
Firenze - added slovak name

Edited 5 days ago by *Martin*
Changeset #124732938

Tags

admin_level	8
alt_name:gl	Florenza
boundary	administrative
name	Firenze
name:ca	Florència
name:en	Florence

- Rich but heterogeneous schema
  - No fixed tags for a type
- Not directly accessible for semantic applications



Statements

instance of	commune of Italy 1 reference big city 0 references city 0 references capital of 0 references

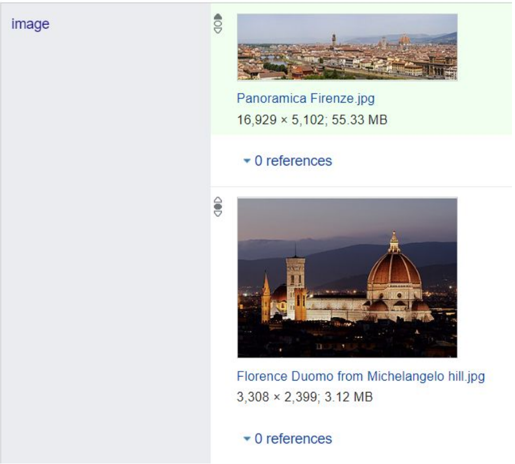


image	Panoramica Firenze.jpg 16,929 × 5,102; 55.33 MB 0 references Florence Duomo from Michelangelo hill.jpg 3,308 × 2,399; 3.12 MB 0 references

- Fixed Schema
- Class hierarchy

OpenStreetMap linking Wikidata

- OSM links to Wikidata with “wikidata” tag
  - Over 2.5 million entities linked from OSM to Wikidata

- Wikidata links to OSM with OpenStreetMap object (P10689) property
  - Only ~1000 entities linked from Wikidata to OSM

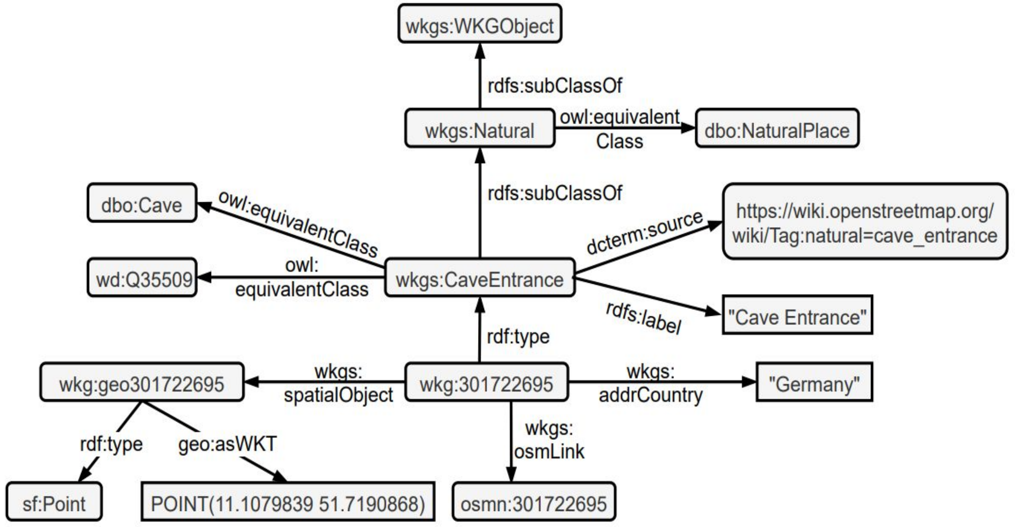
Entities linked from OSM to Wikidata i.e. linking from geodatabase (OSM) to an information source (KG)

Integrating OSM and KGs

- Linking schema elements
  - Align OSM tags to KG classes [1]
  - Eg: “natural”=“peak” (OSM) → “mountain” (Wikidata)
- Linking entities
  - Already existing links between OSM and KGs
  - Find new links using existing links [2, 3]
- Integration
  - Integrate the schema and entities
  - OSM can benefit from wide semantic information
    - Geographic information retrieval, Question Answering, Visualization
  - Wikidata can benefit from the precise geoinformation
  - Beneficial for both sources in terms of completeness and correctness

WorldKG Knowledge Graph

- OSM data in a knowledge graph format [3]
    - Semantic representation
- Overcomes the class hierarchy issue
- Currently contains Nodes from OSM
- Accessible at: www.worldkg.org



Goal of the analyses

- OSM and Wikidata are comparable
  - Community structure
  - Free and open
  - Simple contribution
- Comparative data insights
  - Potential and implications of integration between KGs and OSM
- Integration of OSM and KGs:
  - Closer step toward completeness and correctness
  - Integration of data also means integration of communities and working styles

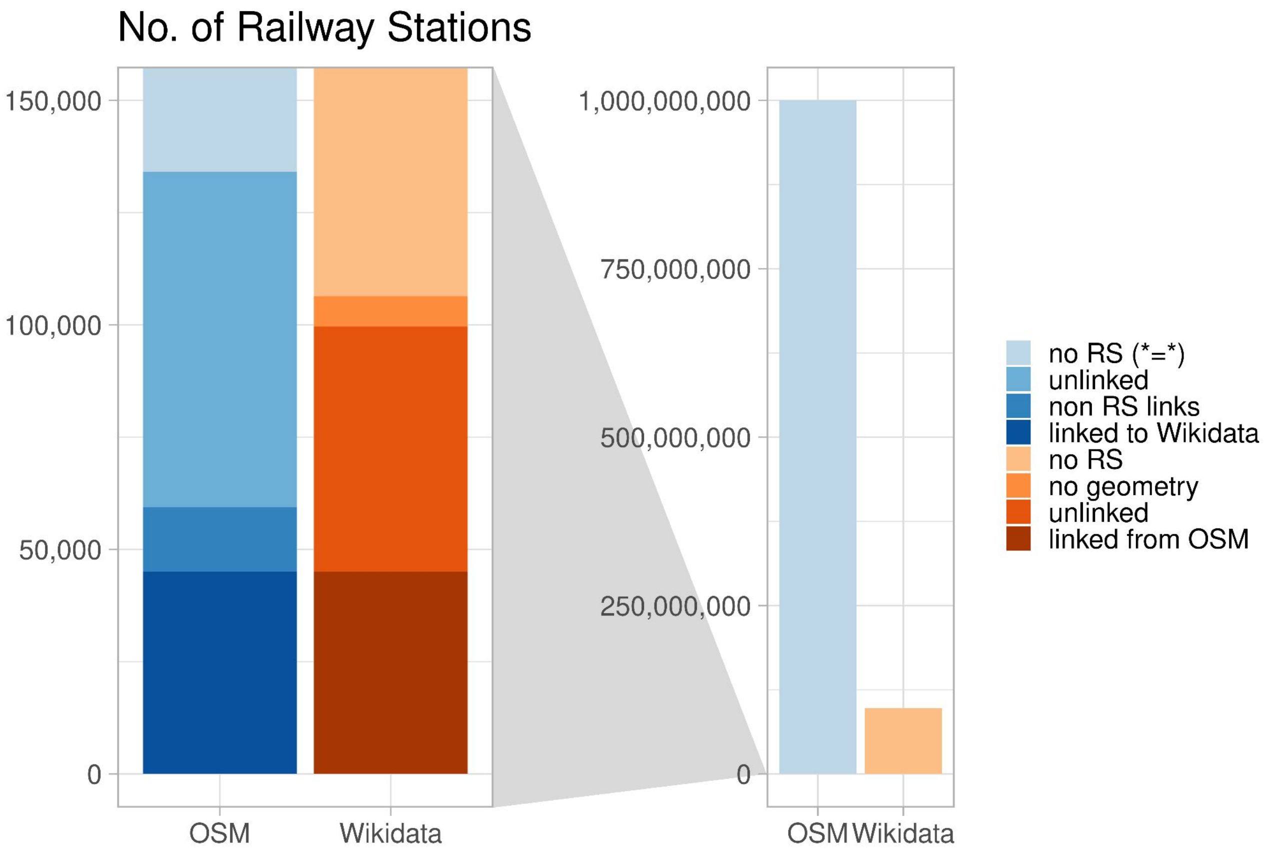
Case Study of Railway Stations

- Comparable definition in both datasets
  - 'railway=station' or 'railway=halt'
  - 'instance of Q55488’ (railway station)

- Well represented in both datasets
  - ~130,000 objects in OSM and ~100,000 objects in Wikidata
    - Indicates integration potential

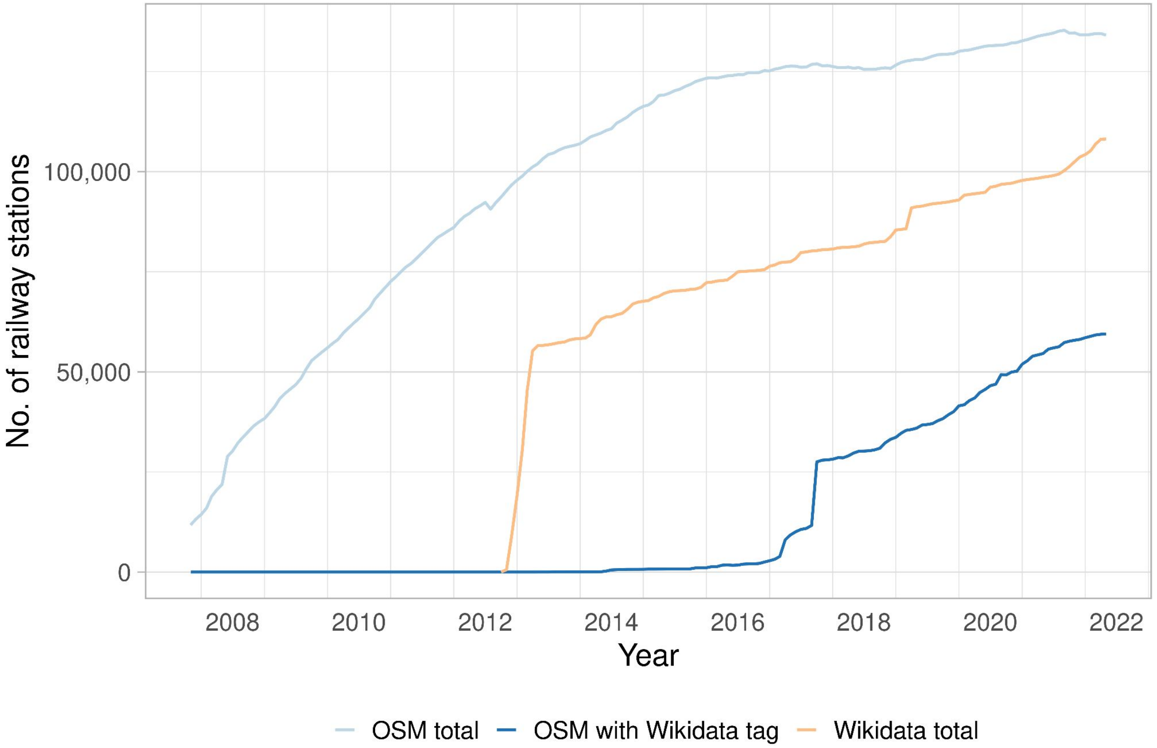
General Comparison Statistics

- OSM contains 26% more entities
- Division into 6 categories
  - Not all wikidata=* tags refer to railway stations
  - wikidata without geometry can only be linked manually (wikidata tag) or semantically (e.g. name)
- High linking potential
  - Necessary for “safe” integration



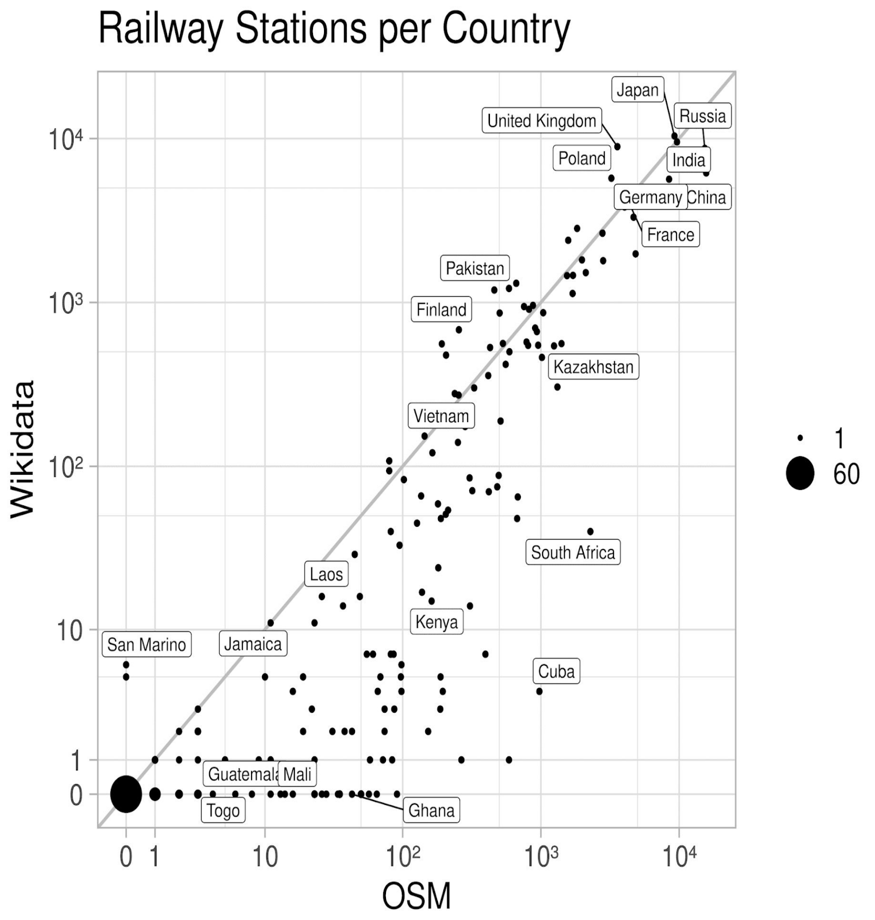
Growth Rate Analysis

- OSM is reaching a saturated state
- Wikidata sees steady growth
- No obvious correlation between OSM and Wikidata
    - Independent communities!?
- Links to Wikidata added much later than the launch of Wikidata
    - Integration potential is rising



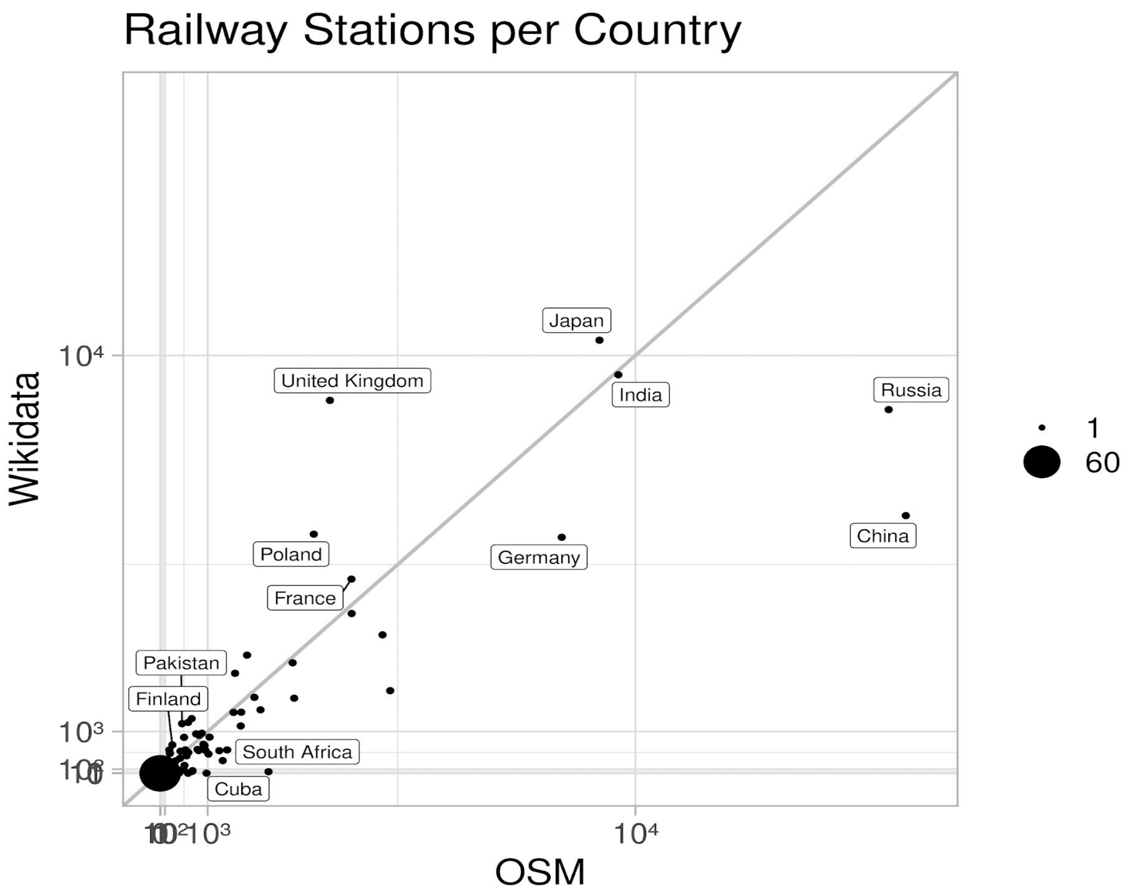
Regional Distribution (log)

- OSM overabundance for countries with little to medium railway infrastructure
    - Wikidata requires more data before linking is possible



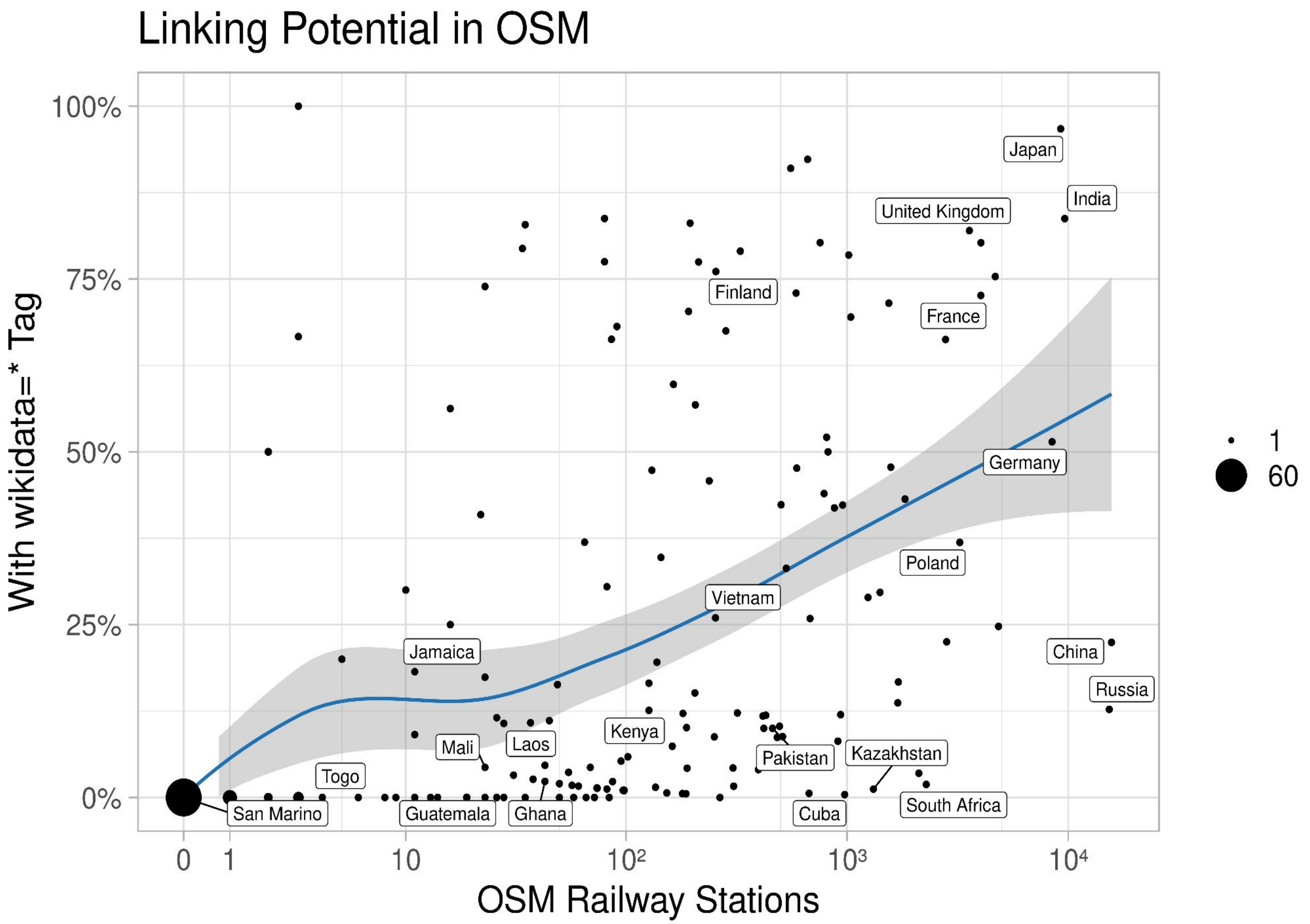
Regional Distribution (linear)

- Discrepancy for large railway infrastructures
    - UK, Poland
    - China, Russia
- Sources of discrepancy
    - Unequal completeness
    - Historic elements in Wikidata
- Data errors (e.g. mistagged tram stations)
- Good (India) does not equal linkage



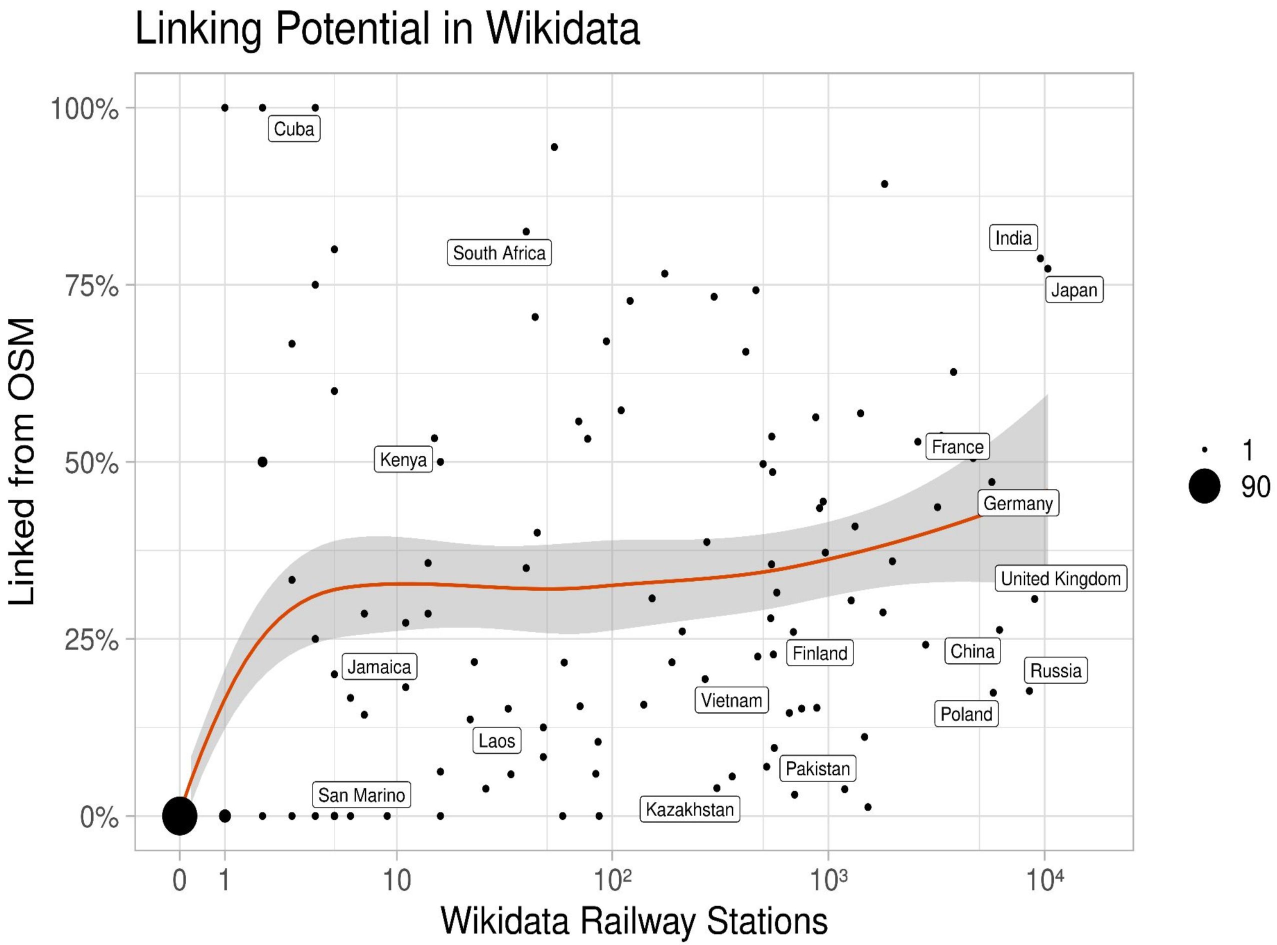
Linking Potential OSM

- Especially high for many small railway infrastructures
- Russia, China show low linkage
- High potential/low linking percentage hinders integration



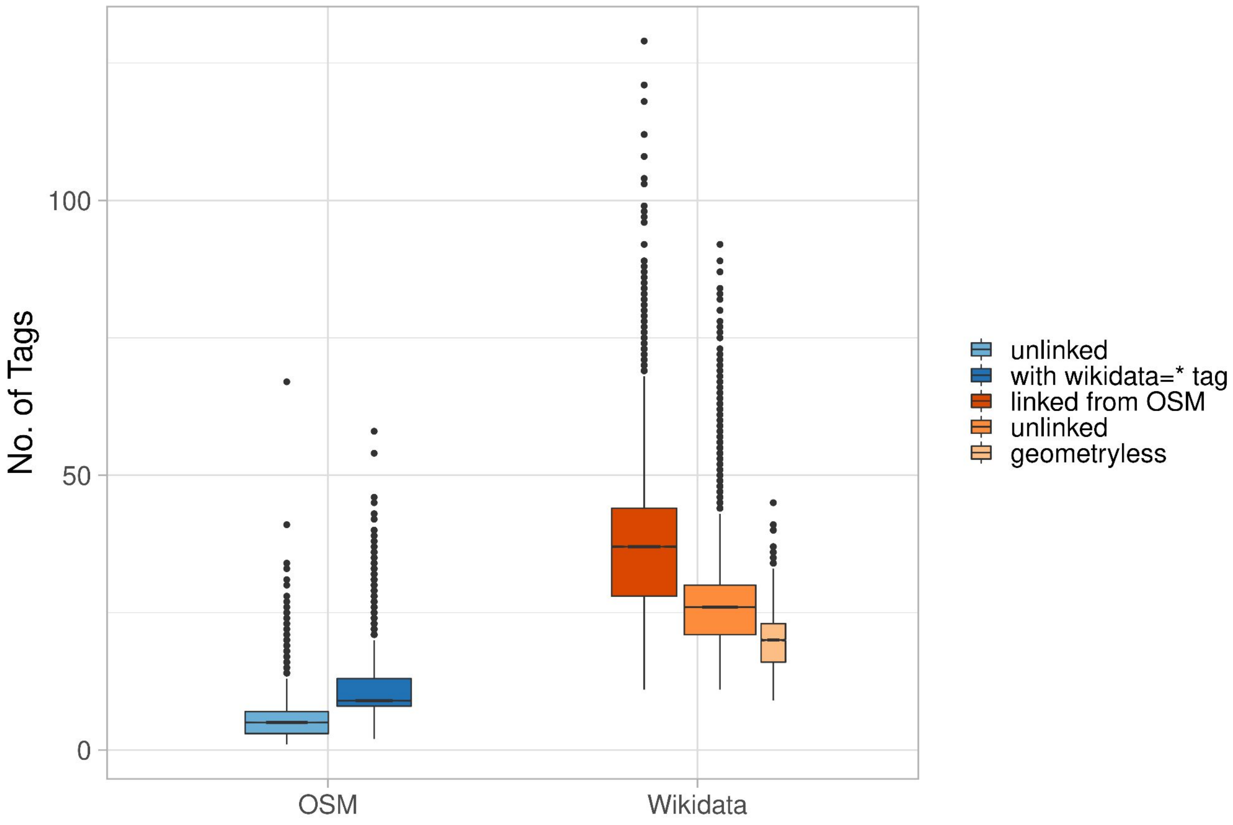
Linking Potential Wikidata

- Quasi independent of railway infrastructure size
    - Many “unmapped” countries



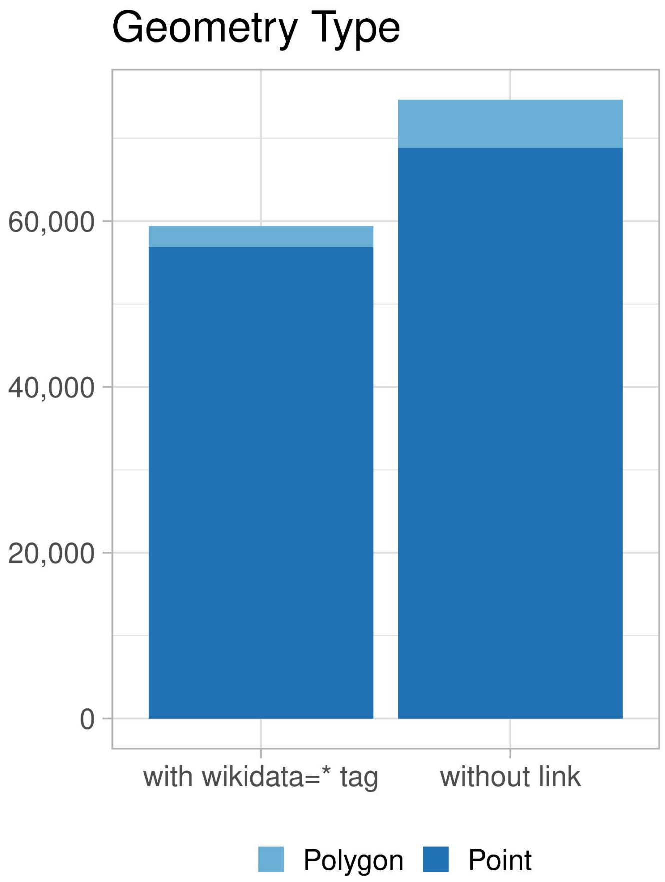
Semantic Information

- Wikidata
  - Average: 30
  - Potential multiplication through KG links
- OSM
  - Average: 7.6
- linked objects
  - "Main Stations"
- Low quality of non-geographic Wikidata and unlinked entities
  - Automated integration may overcome this problem



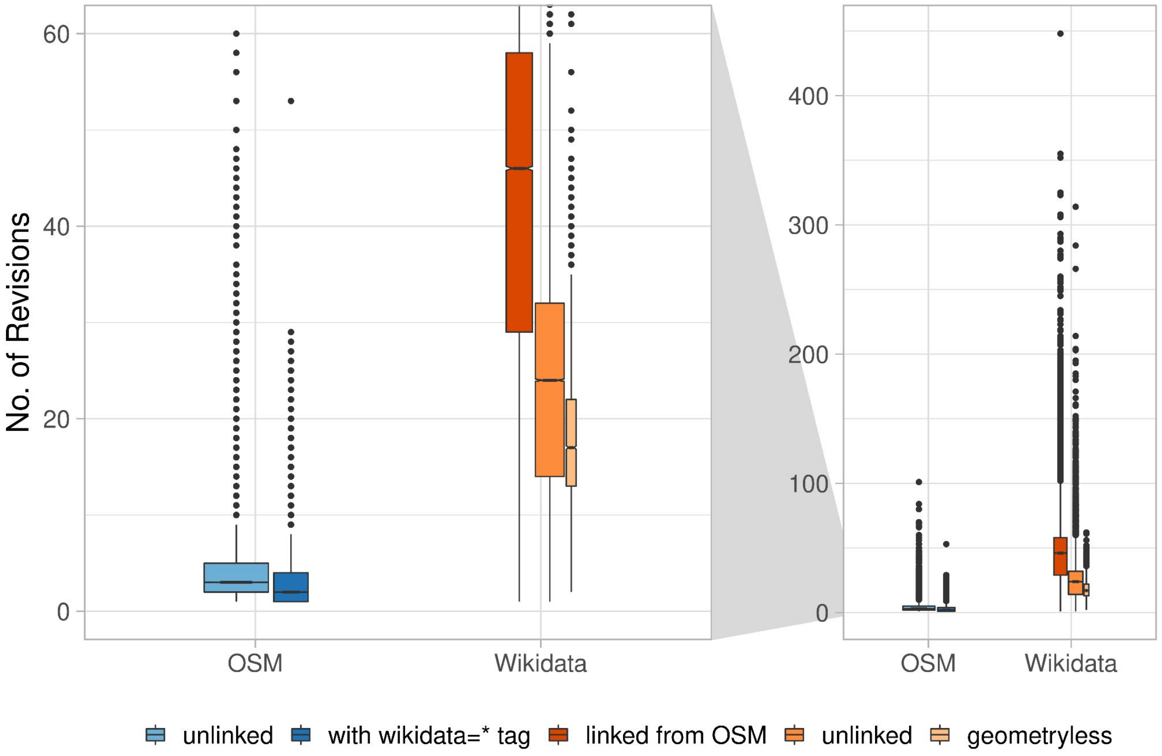
Geometric Information

- Share of polygons
  - 4% for linked elements
    - Despite being “main” stations?
    - Mapping scheme continues to evolve/disputed
    - Point location may be arbitrary
  - 8% for unlinked elements
- “no” polygons in Wikidata
  - Integration potential reduced by OSM mapping scheme



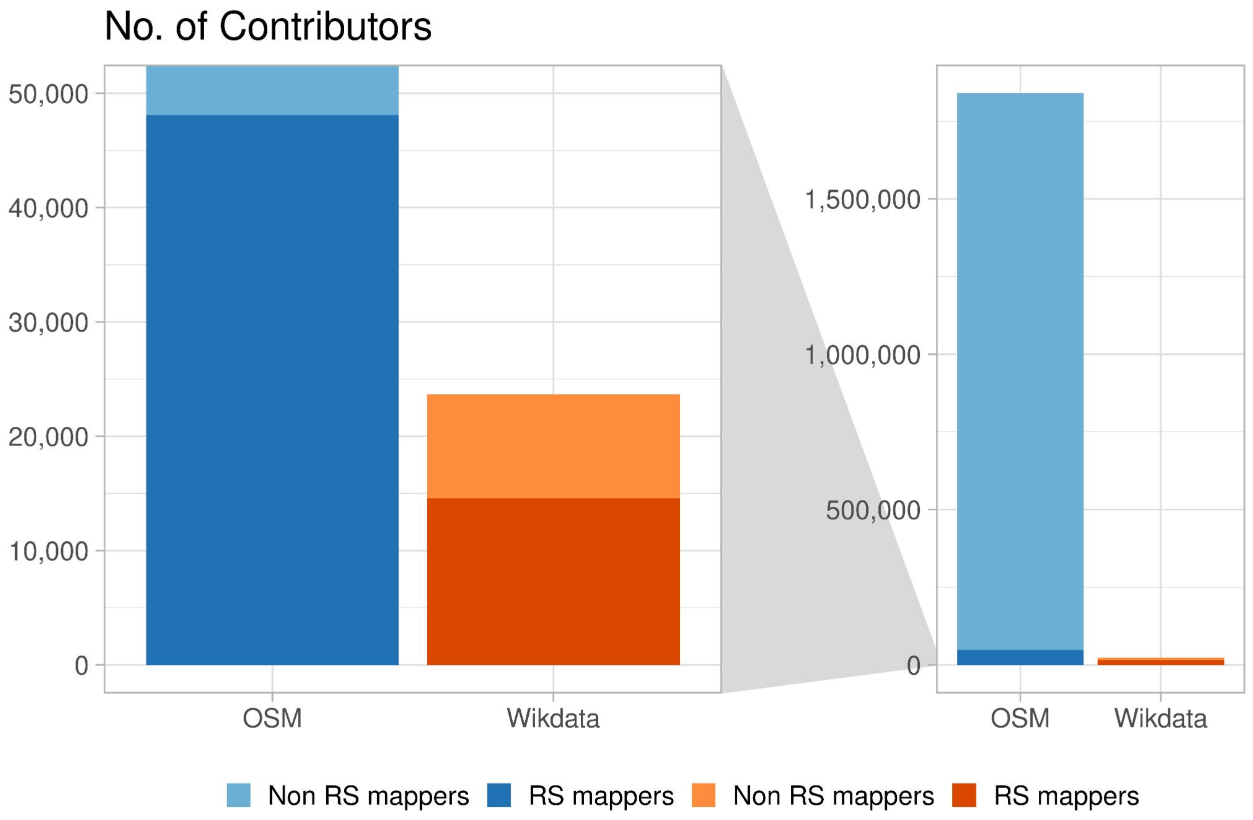
Object History

- Very high number of revisions in Wikidata
  - Data maintenance
  - More tags = more revisions
  - Developing scheme -> is subject to changes
- OSM
  - Data creation may take priority over data maintenance
  - Little real world changes (stable tags and geometry)
- Up-to-dateness?



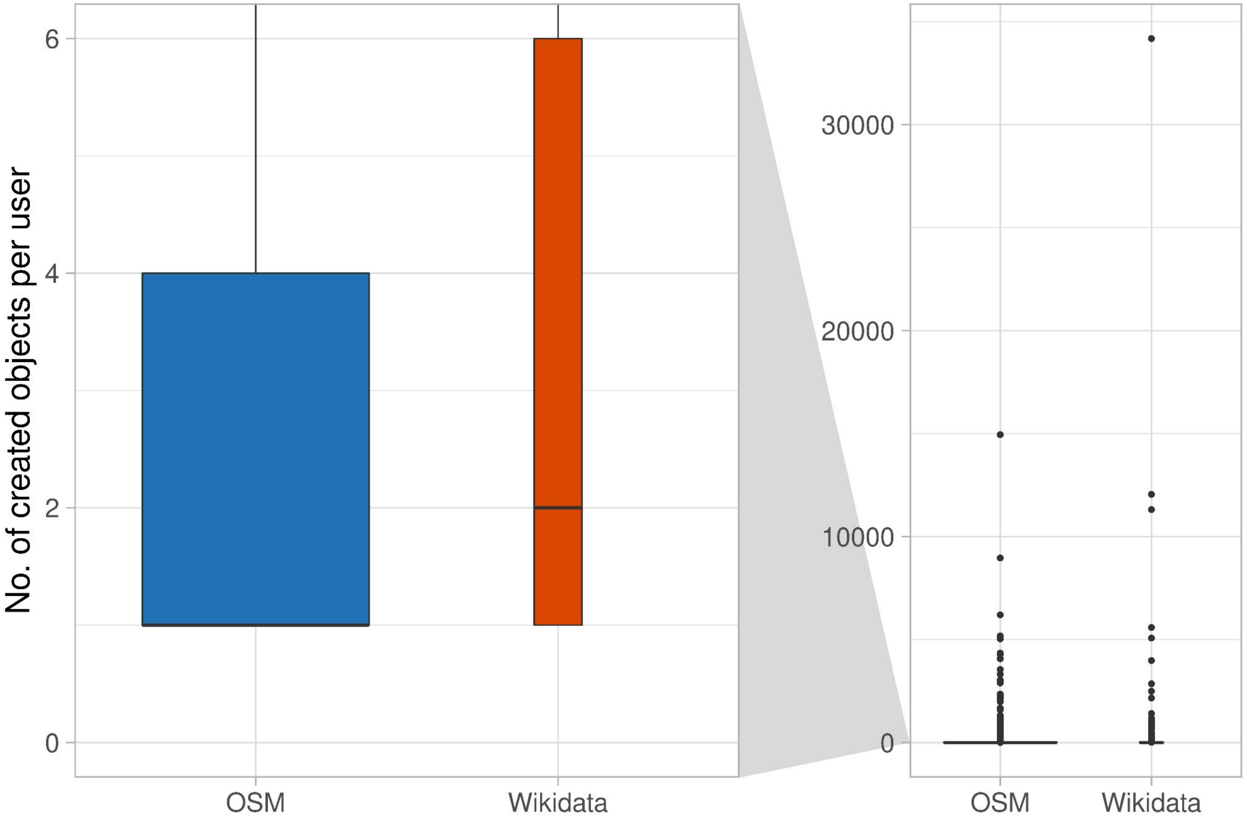
Community Size

- Relatively small Wikidata Community
- Limited to railway “station” mappers
  - Wikidata users/bots edit multiple topics
  - RS makes up only small part of OSM



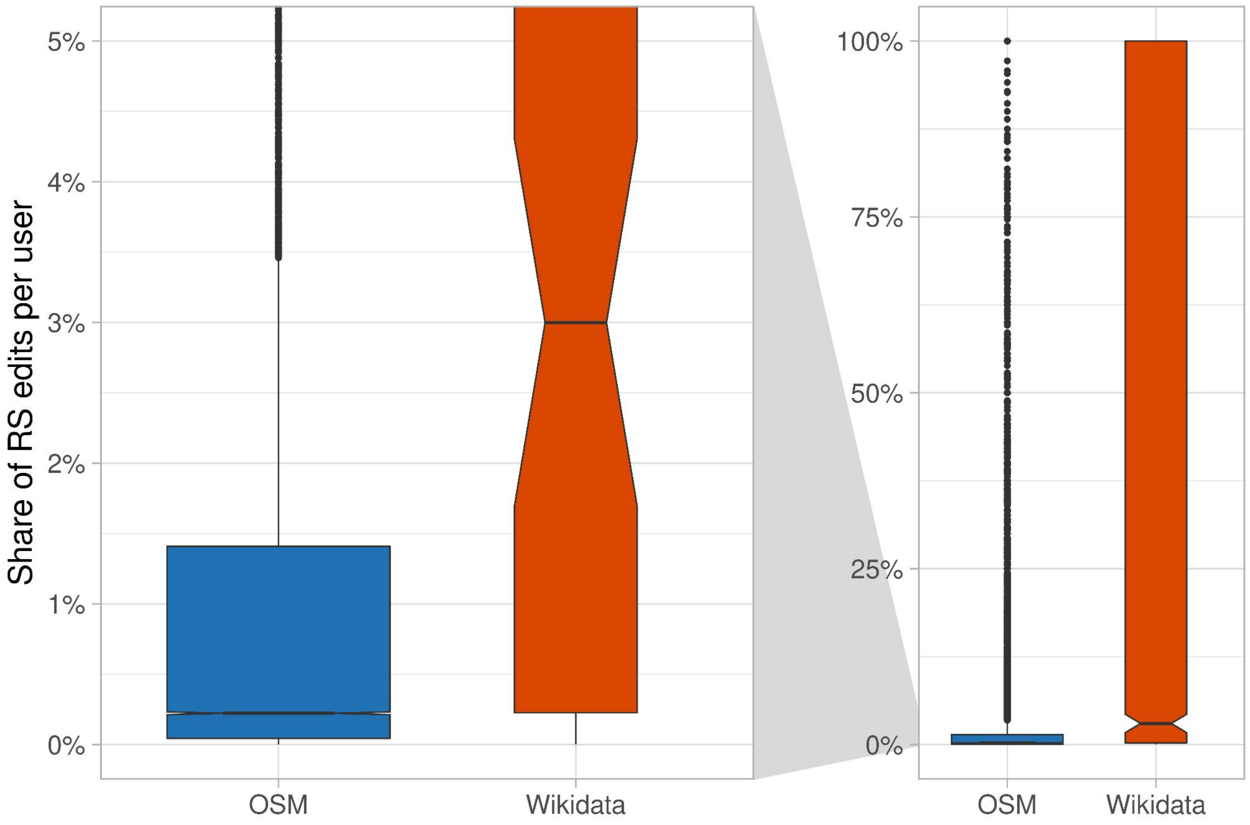
User Activeness

- Wikidata
  - High number of “power users”
  - Multiple RS from one source
- OSM
  - Many one-time users
  - Possibly limited to a certain area (only one RS present)
  - Localised mapping styles
- OSM community wary towards bots



User Diversity

- Wikidata
  - Relatively many user with high specialisation
  - Possibly topic dependent bots
- OSM
  - Railway stations are only one topic of many



Outlook

- Manual and automated linking are progressing well
    - Still much work to do
- If you map, think of wikidata=*!
    - If Wikidata is missing: you are welcome to add data to Wikidata!
- Open Questions
    - Regional data trends
    - Integration potential of other classes
- Future Work
    - Extend schema alignment to keys and properties
    - Actual integration of OSM and Wikidata

References

[1] Alishiba Dsouza, Nicolas Tempelmeier, and Elena Demidova. 2021. Towards Neural Schema Alignment for OpenStreetMap and Knowledge Graphs. In Proc. of the ISWC 2021 (LNCS). Springer.

[2] Daria Gurtovoy, and Simon Gottschalk. Linking Streets in OpenStreetMap to Persons in Wikidata. (2022). In Proc. of WWW.

[3] Tempelmeier, N., & Demidova, E. (2021). Linking OpenStreetMap with knowledge graphs—Link discovery for schema-agnostic volunteered geographic information. Future Generation Computer Systems, 116, 349-364.

[4] Alishiba Dsouza, Nicolas Tempelmeier, Ran Yu, Simon Gottschalk, Elena Demidova. WorldKG: A World-Scale Geographic Knowledge Graph. 30th ACM International Conference on Information and Knowledge Management (CIKM), 2021.

[5] Schott, M., Herfort, B., Troilo, R., & Raifer, M. (2022, January 20). A basic guide to OSM data filtering. [web log]. Retrieved May 19, 2022, from http://k1z.blog.uni-heidelberg.de/2022/01/20/a-basic-guide-to-osm-data-filtering/

[6] Schott, M., Grinberger, A. Y., Lautenbach, S., & Zipf, A. (2021). The Impact of Community Happenings in OpenStreetMap—Establishing a Framework for Online Community Member Activity Analyses. ISPRS International Journal of Geo-Information, 10(3), 164.

[7] Schott, M., Größchen, L., & Lautenbach, S. (2022, April 20). Version (0.1). OSM Element Vectorisation. Retrieved May 19, 2022, from https://gitlab.gistools.geog.uni-heidelberg.de/giscience/ideal-vgi/osm-element-vectorisation.