

Analyzing the OpenStreetMap History with the ohsome Platform

Lukas Loos, Fabian Kowatsch

Lab Program

- Introduction
 - Who we are
 - Motivation for developing ohsome platform
- Ohsome Platform
 - OhsomeHeX
 - Dashboard
 - ohsome API
 - OSHDB API
 - OSHDB
- Hands-On Examples

Who we are

Heidelberg Institute for Geoinformation Technology
at Heidelberg University

GIScience / Geoinformatics Research Group
at Heidelberg University



Prof. Dr. Alexander Zipf

Focus Areas:



**Smart Location-based
Services and Navigation**



**Geoinformation for
Humanitarian Aid**



Big Spatial Data Analytics

Who we are

Heidelberg Institute for Geoinformation Technology
at Heidelberg University

GIScience / Geoinformatics Research Group
at Heidelberg University



Prof. Dr. Alexander Zipf

Focus Areas:



**Smart Location-based
Services and Navigation**



**Geoinformation for
Humanitarian Aid**



Big Spatial Data Analytics

The Team



Big Spatial Data Analytics



Michael Auer
Research Associate



Fabian Kowatsch
Research Associate



Lukas Loos
Research Associate



Martin Raifer
Research Associate

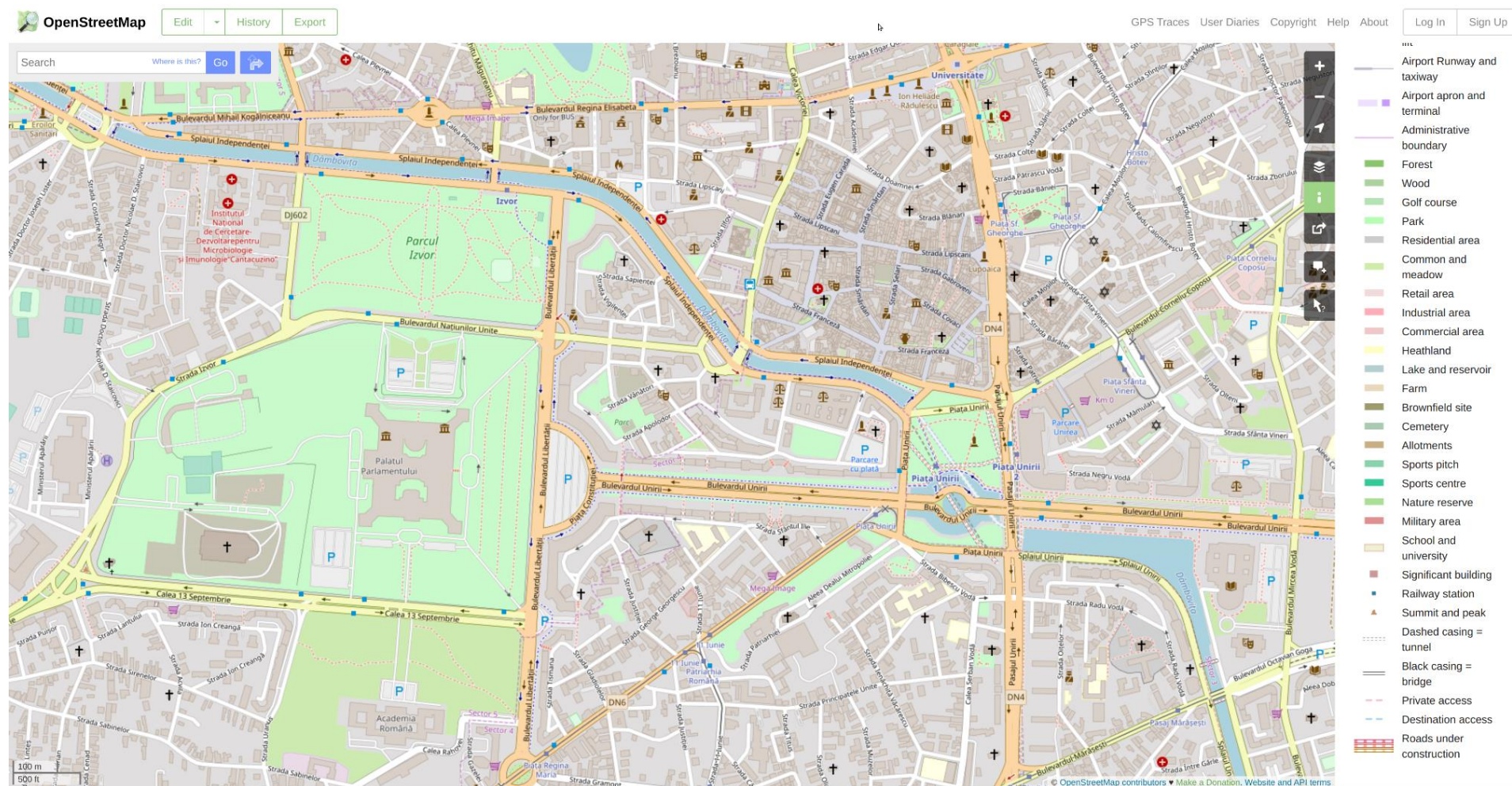


Rafael Troilo
Research Associate / System Administration



Johannes Visintini
Research Associate

OpenStreetMap



<https://www.openstreetmap.org/#map=16/44.4285/26.0946>, accessed: 18.08.2019

OpenStreetMap



Use cases in various Fields e.g.



Smart Location-based
Services and Navigation

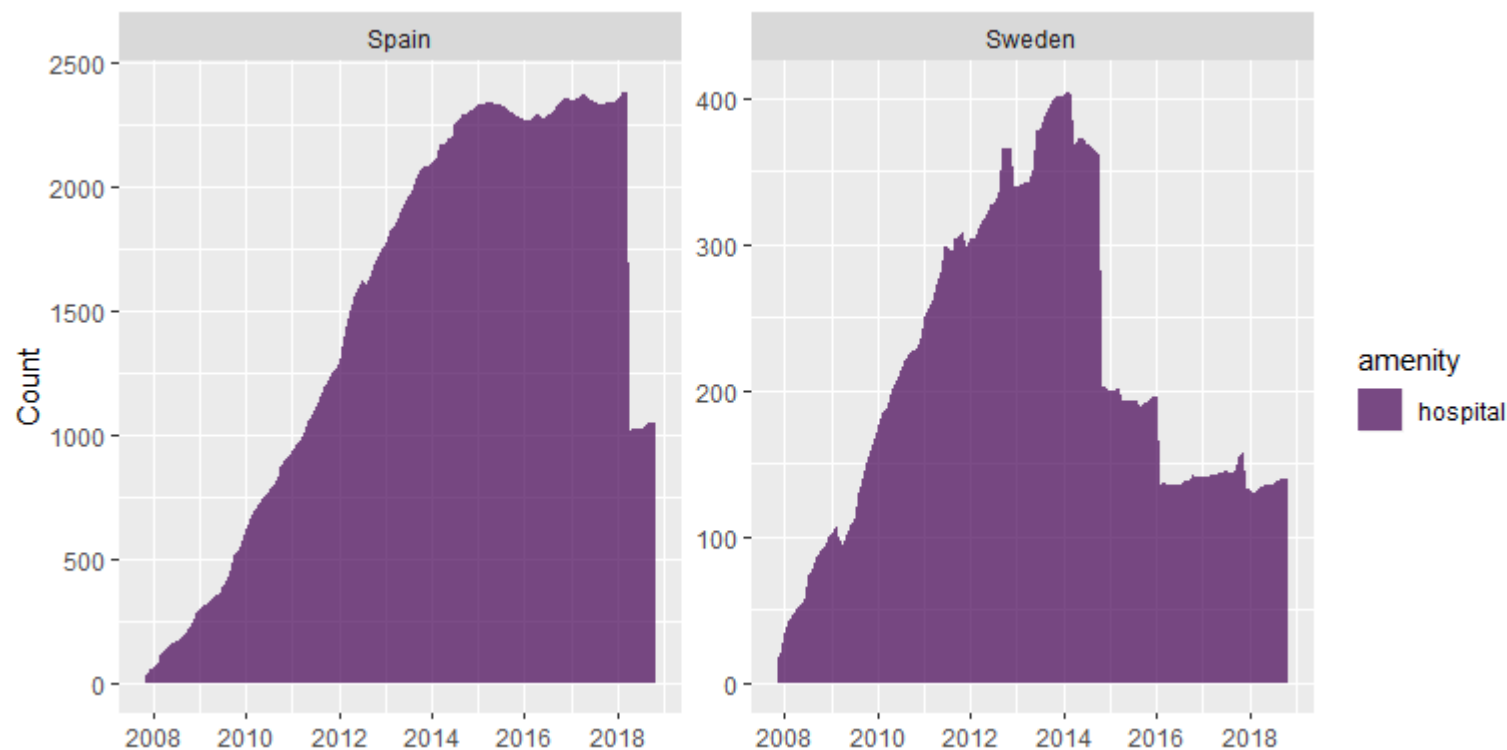


Geoinformation for
Humanitarian Aid



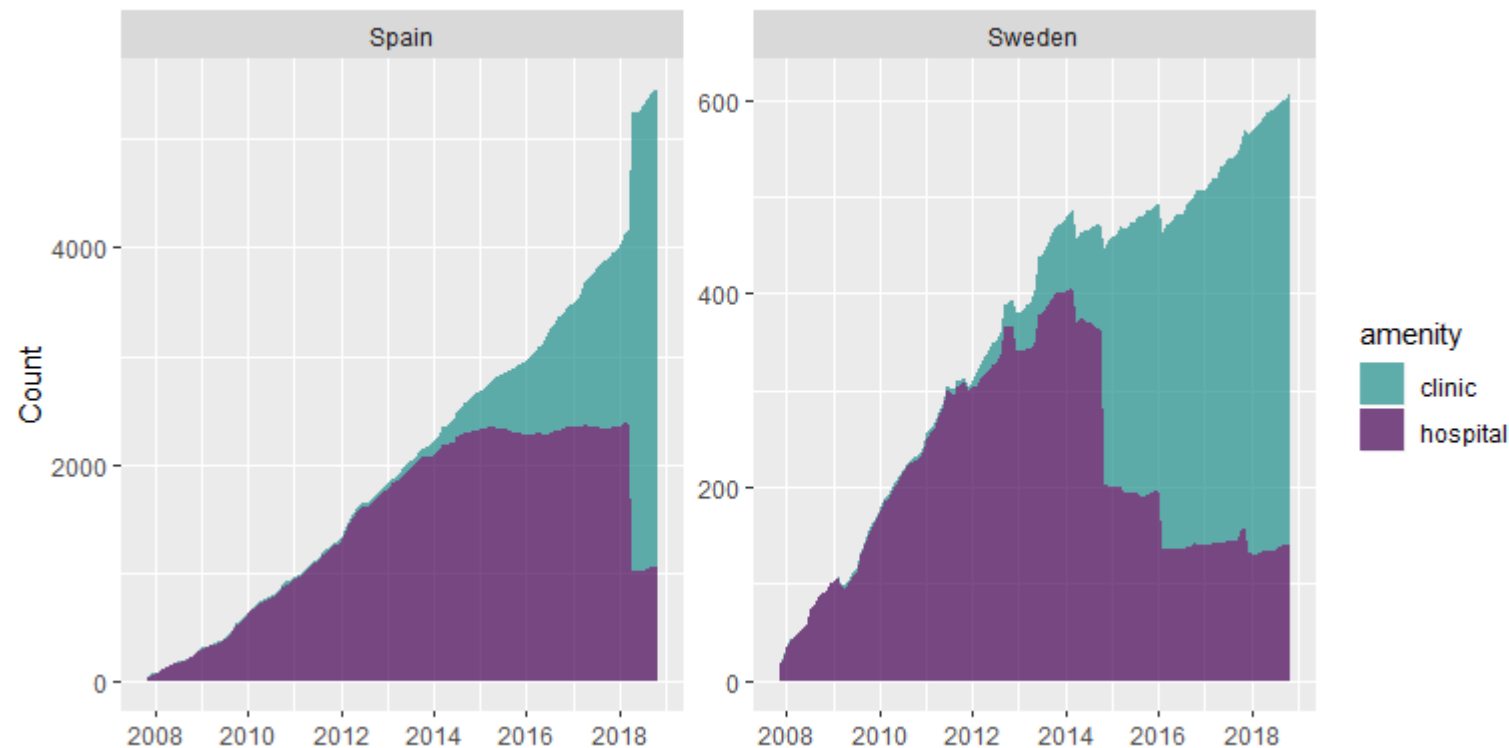
Big Spatial Data Analytics

OSM Data Quality Research



Source: <http://k1z.blog.uni-heidelberg.de/2019/05/16/exploring-osm-history-the-example-of-health-related-amenities/>, Blog post by Sven Lautenbach, Data: Michael Auer, Lukas Loos, Sven Lautenbach

OSM Data Quality Research



Source: <http://k1z.blog.uni-heidelberg.de/2019/05/16/exploring-osm-history-the-example-of-health-related-amenities/>, Blog post by Sven Lautenbach, Data: Michael Auer, Lukas Loos, Sven Lautenbach

All Charts can be found at
https://ohsome.org/reports/healthcare/osm_health_amenities_all_cntys-1.html

OSM Planet history file



Planet OSM

The files found here are complete copies of the OpenStreetMap.org database, including editing history. These are published under an Open Data Commons Open Database License 1.0 licensed. For more information, [see the project wiki](#).

Complete OSM Data History Using The Data

[Latest Full History Planet XML File](#)
121 GB, created 3 days ago.
md5: 4913706523c0d0809724cc7fa4be5be8.

[Latest Full History Planet PBF File](#)
76 GB, created 3 days ago.
md5: 78e86c473aab0d4732136d6fad4a1908.

The full history planet file contains the full editing history of the OpenStreetMap database in both XML and custom PBF formats.

You are granted permission to use OpenStreetMap data by [the OpenStreetMap License](#), which also describes your obligations.

You can [process the file](#) or extracts with a variety of tools, although some tools for processing OSM data will only work on 'current' planets and will not process a 'history' planet available here.

Extracts & Mirrors

The complete history planet is extremely large, so you may prefer to use one of [the available extracts](#) (individual countries or states) from third parties.

- Full history of OSM data
 - ~120 GB packed ~ 1TB unpacked
 - Complicated to handle
 - But: contains the historic Evolution of OpenStreetMap data
- Usefull for Quality Research

If you find data within OpenStreetMap that you believe is an infringement of someone else's copyright, then please make contact with the [OpenStreetMap Data Working Group](#).

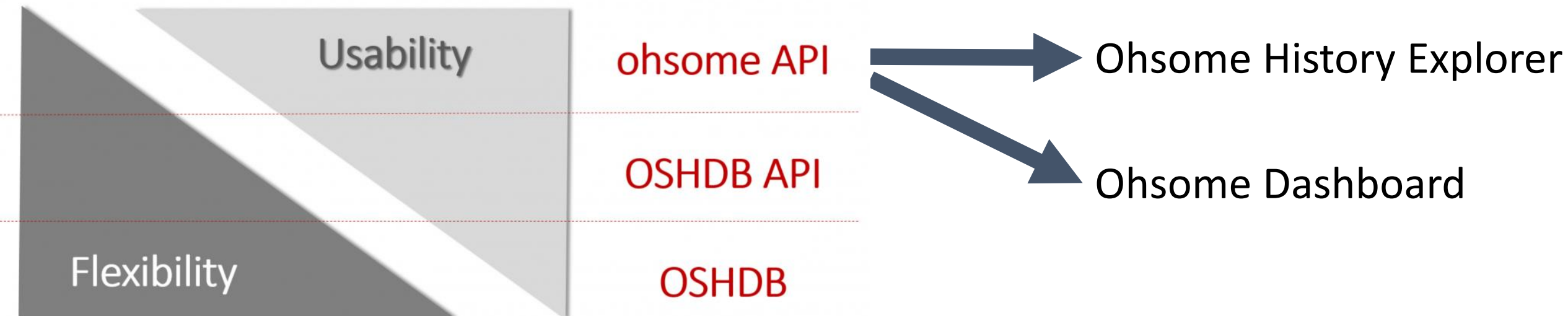
Name	Last modified	Size	Description
Parent Directory		-	
2019/	2019-08-15 02:52	-	
2018/	2019-02-04 03:46	-	
2017/	2018-04-23 10:05	-	
2016/	2017-01-17 22:49	-	
2015/	2016-04-11 10:54	-	
2014/	2016-04-11 10:37	-	
2013/	2013-02-08 18:20	-	
history-latest.osm.bz2.md5	2019-08-15 02:52	57	
history-latest.osm.bz2	2019-08-15 02:24	1216	

Apache/2.4.29 (Ubuntu) Server at planet.openstreetmap.org Port 443

<https://planet.openstreetmap.org/planet/full-history/>, accessed: 18.08.2019



OpenStreetMap History Data Analytics Platform



OSHDB: a framework for spatio-temporal analysis of OpenStreetMap history data



Martin Raifer* , Rafael Troilo, Fabian Kowatsch, Michael Auer , Lukas Loos ,
Sabrina Marx, Katharina Przybill, Sascha Fendrich, Franz-Benjamin Mocnik and Alexander Zipf

Abstract

OpenStreetMap (OSM) is a collaborative project collecting geographical data of the entire world. The level of detail of OSM data and its data quality vary much across different regions and domains. In order to analyse such variations it is often necessary to research the history and evolution of the OSM data.

The OpenStreetMap History Database (OSHDB) is a new data analysis tool for spatio-temporal geographical vector data. It is specifically optimized for working with OSM history data on a global scale and allows one to investigate the data evolution and user contributions in a flexible way. Benefits of the OSHDB are for example: to facilitate accessing OSM history data as a research subject and to assess the quality of OSM data by using intrinsic measures.

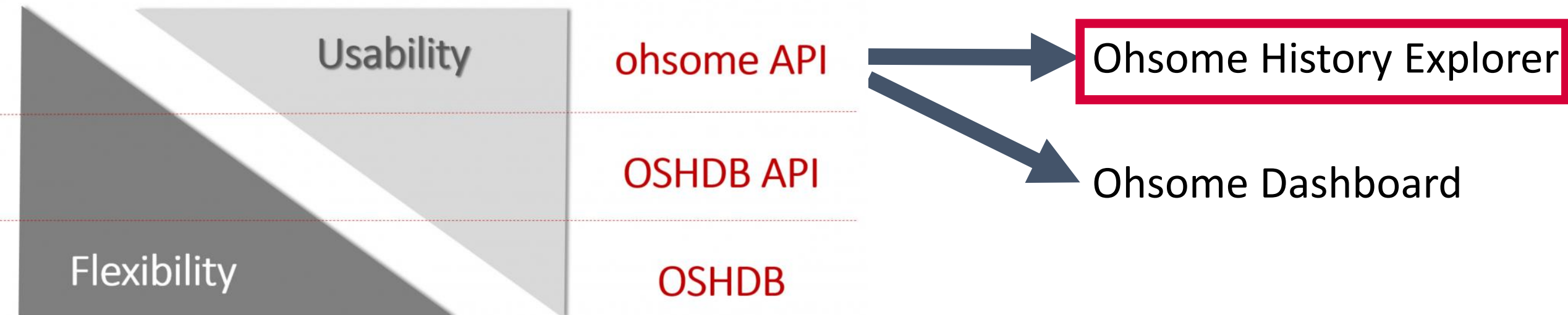
This article describes the requirements of such a system and the resulting technical implementation of the OSHDB: the OSHDB data model and its application programming interface.

Keywords: OpenStreetMap (OSM), OpenStreetMap history data, Data analysis, Data quality assessment, Volunteered Geographic Information (VGI)

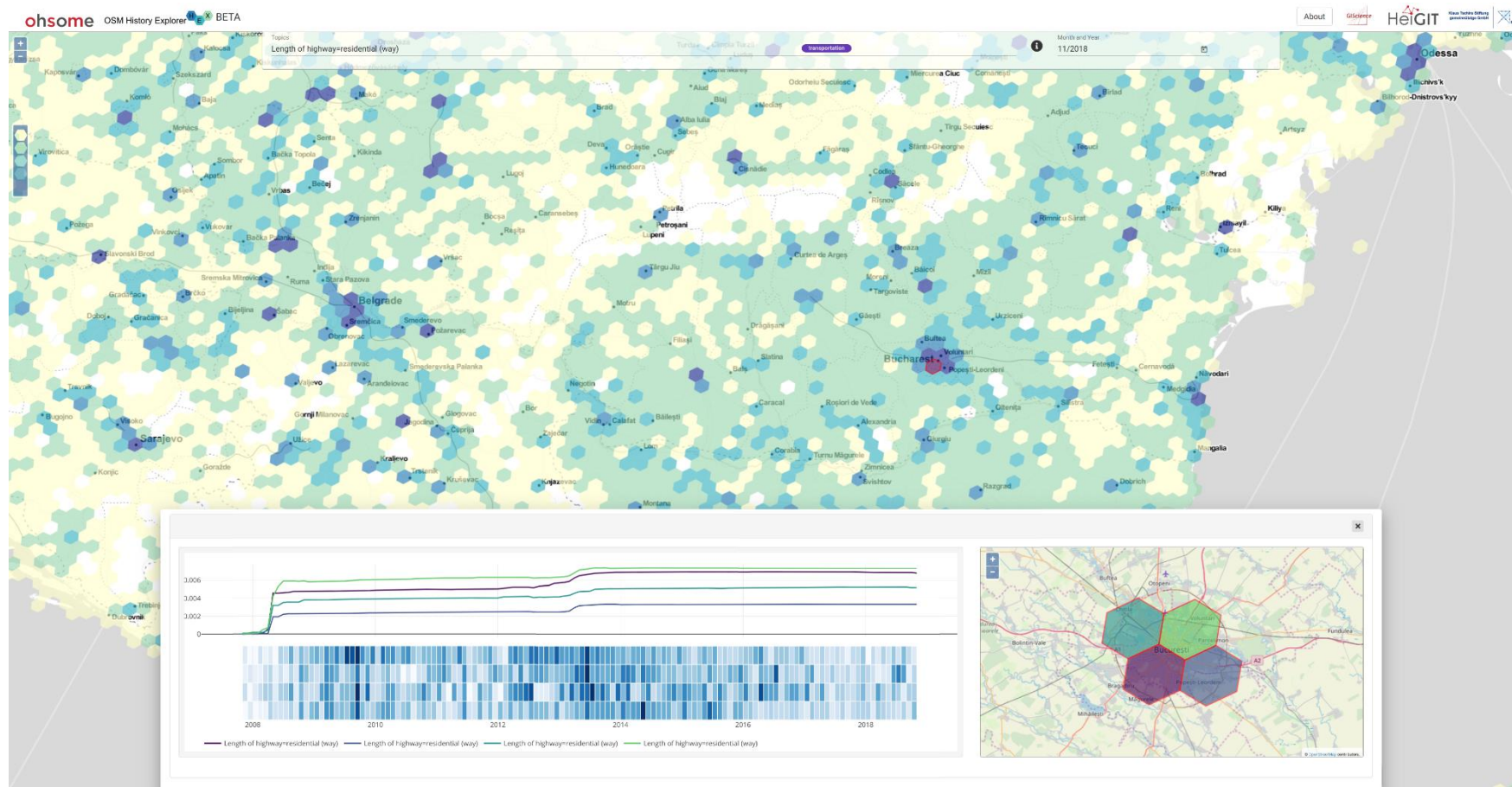
Raifer, M., Troilo, R., Kowatsch, F., Auer, M., Loos, L., Marx, S., Przybill, K., Fendrich, S., Mocnik, F.-B. & Zipf, A. (2019): OSHDB: a framework for spatio-temporal analysis of OpenStreetMap history data. *Open Geospatial Data, Software and Standards* 2019 4:3. <https://doi.org/10.1186/s40965-019-0061-3>.

ohsome
'ɒːsəm

OpenStreetMap History Data Analytics
Platform



OSM History eXplorer



Allows spatio-temporal exploration of OSM data on a global scale

Via

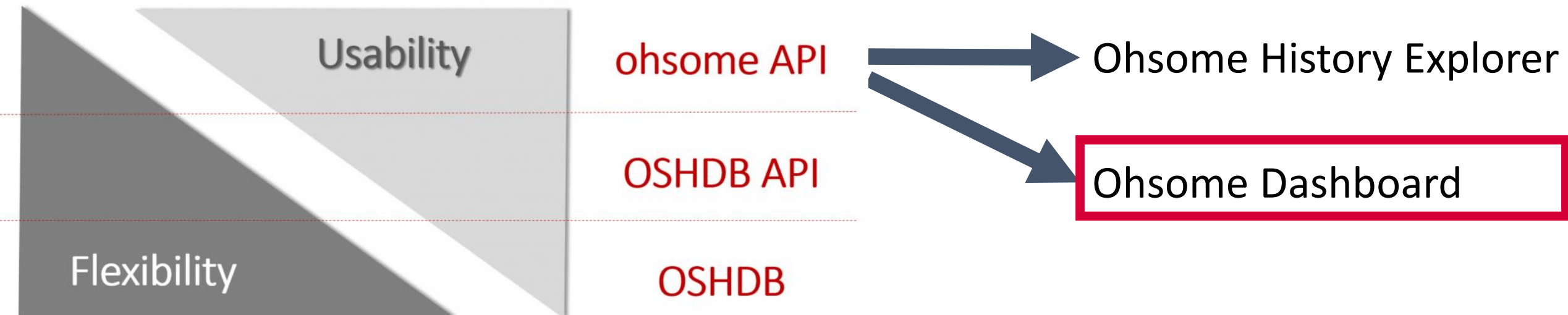
data aggregation of selected features into a set of world spanning hexagonal grids.

(Grid: ISEA3H, DGGRID
www.discreteglobalgrids.org)

www.ohsome.org/apps/osm-history-explorer; in addition to the HeiGIT Team Members Rizwan Khan and Zhaobin Zhu

ohsome
'ɒːsəm

OpenStreetMap History Data Analytics
Platform



Ohsome Dashboard

OSM tag filter

Key

Value

highway

residential

(leave blank to query all values)

?

OSM type

way x

Measure

☒ count

☐ length

☐ area

☐ perimeter

Group Results By ...

☒ none

☐ OSM type

☐ boundary

☐ tag

☐ key

Time period

Start

End

Interval

2007-10-08T02:00:00Z

2019-07-25T22:00:00Z

monthly

Send Request

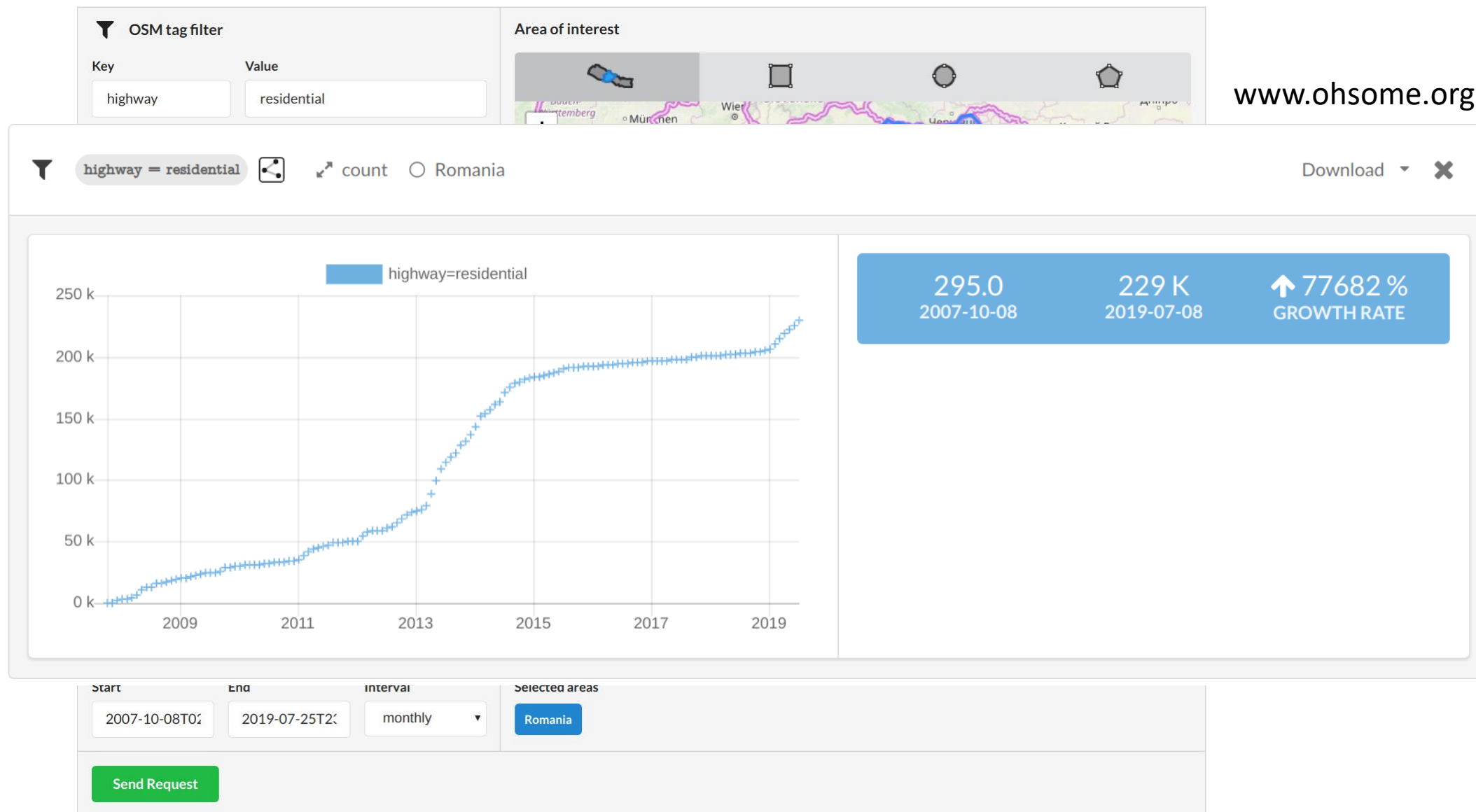
Area of interest

<

www.ohsome.org/apps/dashboard

Ohsome Dashboard

www.ohsome.org/apps/dashboard



Excursion:

Explosion of building-count in old town of Bucharest?

count and area of buildings*

timestamp	count	area (m ²)
2018-12-23	673	439020.37
2018-12-24	924	455867.25
2018-12-25	1405	466395.5
2018-12-26	1855	472352.25
2018-12-27	2718	476710.1
2018-12-28	2980	481701.47
2019-07-25	2785	470623.58

*building = OSM feature of type *way* or *relation* having a *building* tag

check on [OSM website](#)

- roof structure mapped with tag building=yes

→ detailed display on osm.org website

- not conform with mapping standards as it's „mapping for the renderer“

feedback on mapping of old town

Very nicely detailed. However it is not recommended to end buildings at roof alignment. Please try to end buildings at the end of the ownership boundaries.

comment of user JJJWegdam

Further explanation:

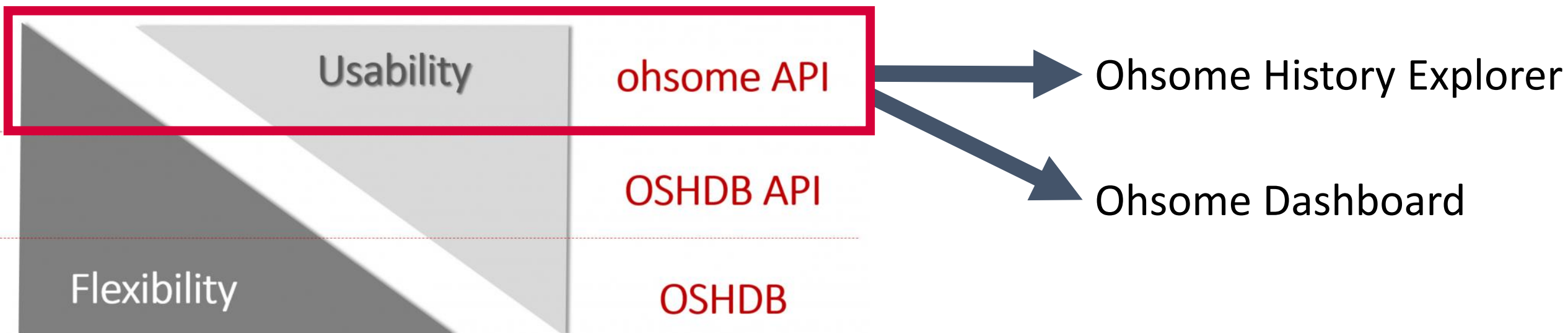
[https://wiki.openstreetmap.org/wiki/Buildings#Don.27t tag for the render](https://wiki.openstreetmap.org/wiki/Buildings#Don.27t_tag_for_the_renderer)
[er](#)

Best practice example:

<https://www.openstreetmap.org/#map=18/52.37361/4.90184>

ohsome
'ɒːsəm

OpenStreetMap History Data Analytics
Platform



ohsome API

- REST-based serving of data aggregation + extraction functions
- accessible via HTTP (GET and POST)
- response formats: JSON, CSV, GeoJSON
- will be used in the hands-on part after the presentation

ohsome API request

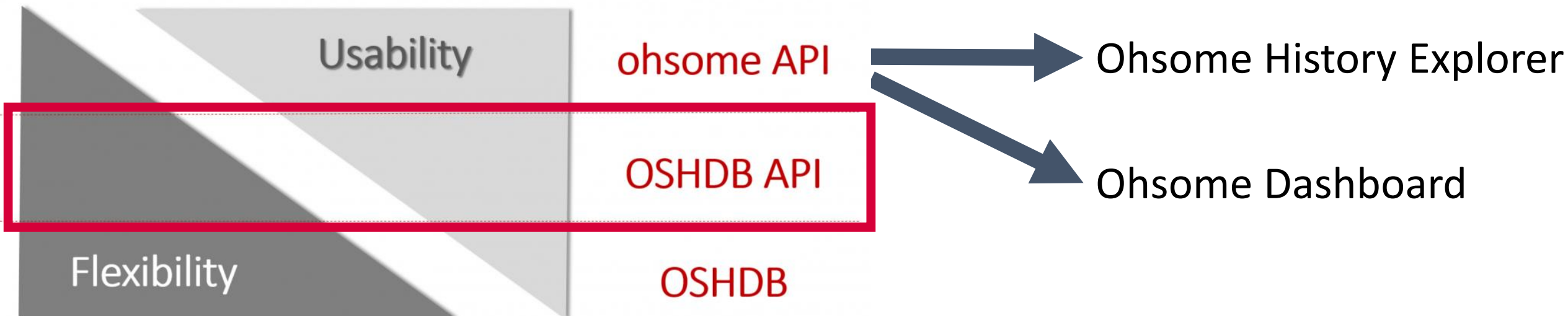
```
https://api.ohsome.org/v0.9/elements/length?  
bboxes=25.9178,44.3248,26.2721,44.5628  
&time=2008-07-01,2019-07-01  
&types=way  
&keys=highway  
&showMetadata=true
```

ohsome API response

```
{
  "attribution": {
    "url": "https://ohsome.org/copyrights",
    "text": "© OpenStreetMap contributors"
  },
  "apiVersion": "0.9",
  "metadata": {
    "executionTime": 2108,
    "description": "Total length of items in meters.",
    "requestUrl": "https://api.ohsome.org/v0.9/elements/length?bboxes=25.9178,44.3248,26.2721,44.5628&time=2008-01-01,2019-07-01&types=way&keys=highway&showMetadata=true"
  },
  "result": [
    {
      "timestamp": "2008-01-01T00:00:00Z",
      "value": 455078.29
    },
    {
      "timestamp": "2019-07-01T00:00:00Z",
      "value": 7268827.76
    }
  ]
}
```

ohsome
'ɔːsəm

OpenStreetMap History Data Analytics
Platform



OSHDB API

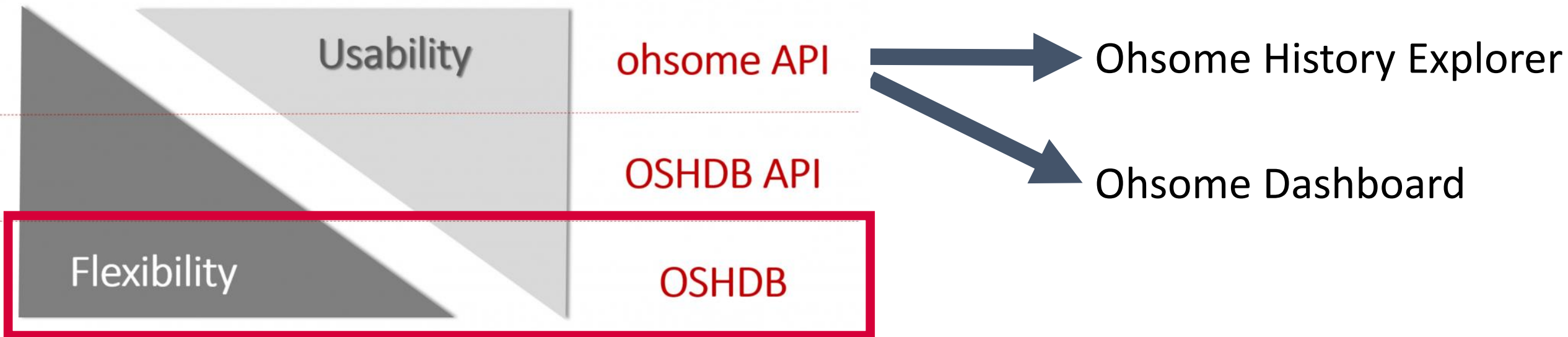
- accessible via Java
- provides different views on the data
 - snapshots vs. contributions
- offers diverse aggregation functions
- based on MapReduce programming model
 - enables efficient parallel processing of (big) data sources

OSHDB API Example

```
OSMEntitySnapshotView.on(oshdb)
    .areaOfInterest(new OSHDBBoundingBox(25.9178,44.3248,26.2721,44.5628))
    .timestamps("2008-07-01", "2019-07-01")
    .osmType(OSMType.WAY)
    .osmTag("highway")
    .aggregateByTimestamp()
    .count()
    .forEach((t, count) -> System.out.println("time: " + t + " count: " + count));
```

ohsome
'ɔːsəm

OpenStreetMap History Data Analytics
Platform



OSHDB

- foundation of the ohsome platform
- based on four central ideas:
 - lossless information: full OSM history including erroneous and incomplete data
 - simple, generic API: OSHDB API
 - high performance: efficient data storage and access
 - local and distributed deployment: appropriate scaling of processing of queries

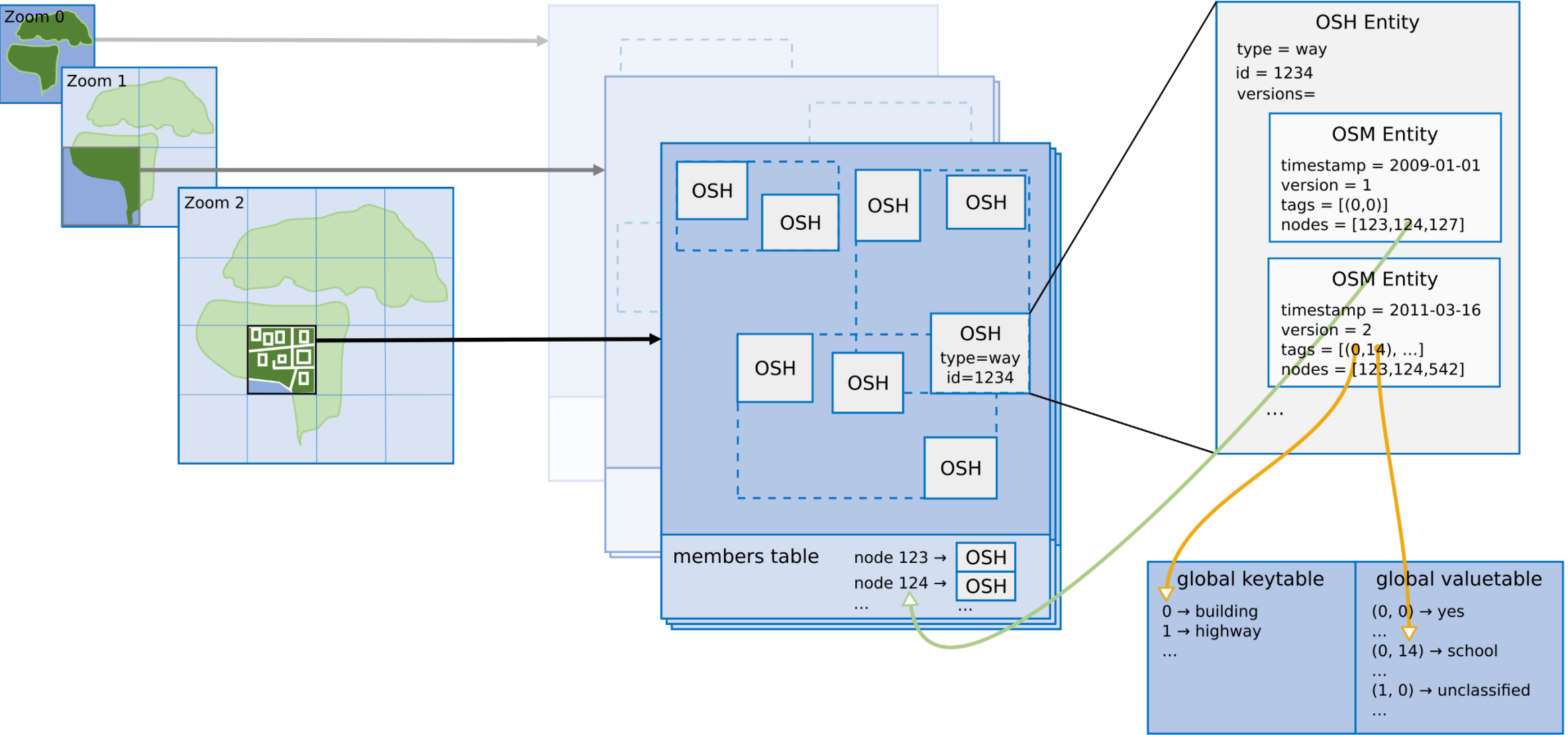
OSHDB data model

- combines historical OSM-objects based on their object-ID
- applies a 1st spatial indexing based on 15 zoom-levels
→ foundation of parallel data-processing
- applies a 2nd spatial indexing (r-tree) based on the OSHEntity objects
- can be stored in any key-value database
 - e.g.: Apache Ignite, JDBC

Spatial Partitioning

Grid Cells with local spatial index

OSH Data Entity



future plans

- more efficient data storage/filtering (attributive indices)
- ohsome platform as quality analysis tool
 - analyzing certain regions
 - analyzing data collection in case of emergency response (promptly)
 - including research on data quality in our software stack
- increasing stability and usability

September 2019 in Heidelberg



19th & 20th of September



21st – 23rd of September

publications and presentations

- Raifer, Martin; Troilo, Rafael; Kowatsch, Fabian; Auer, Michael; Loos, Lukas; Marx, Sabrina; Przybill, Katharina; Fendrich, Sascha; Mocnik, Franz-Benjamin; Zipf, Alexander (2019): [OSHDB: a framework for spatio-temporal analysis of OpenStreetMap history data](#). Open Geospatial Data, Software and Standards.
- Auer, Michael; Eckle, Melanie; Fendrich, Sascha; Kowatsch, Fabian; Marx, Sabrina; Raifer, Martin; Schott, Moritz; Troilo, Rafael; Zipf, Alexander (2018): [Comprehensive OpenStreetMap History Data Analyses- for and with the OSM community](#). Talk at the State of the Map conference 2018, Milan.
- Auer, Michael; Eckle, Melanie; Fendrich, Sascha; Kowatsch, Fabian; Loos, Lukas; Marx, Sabrina; Raifer, Martin; Schott, Moritz; Troilo, Rafael; Zipf, Alexander (2018): [Ohsome – eine Plattform zur Analyse raumzeitlicher Entwicklungen von OpenStreetMap-Daten für intrinsische Qualitätsbewertungen](#). AGIT – Journal für Angewandte Geoinformatik.
- Auer, Michael; Eckle, Melanie; Fendrich, Sascha; Griesbaum, Luisa; Kowatsch, Fabian; Marx, Sabrina; Raifer, Martin; Schott, Moritz; Troilo, Rafael; Zipf, Alexander (2018): [Towards Using the Potential of OpenStreetMap History for Disaster Activation Monitoring](#). Conference: Proceedings of the 15th ISCRAM Conference 2018, Rochester.
- Raifer, Martin (2017): [OSM history analysis using big data technology](#). Talk at the State of the Map conference 2017, Aizuwakamatsu.

Analyzing the OpenStreetMap History with the ohsome Platform

Lukas Loos, Fabian Kowatsch

Practical Part using the ohsome API

- example 1: <https://gitlab.gistools.geog.uni-heidelberg.de/snippets/23>
- example 2: <https://gitlab.gistools.geog.uni-heidelberg.de/snippets/24>

Additional Materials

Data-views

- 2 different types of viewing the OSM data
 - snapshot-view
 - gives results to exact timestamps
 - counting of elements
 - length, area computations
 - contribution-view
 - gives results about changes in time periods
 - counting of OSM contributors

Data-views Examples

- *snapshot-view*
 - How did the **number of buildings** in **region xy** develop within the **last five years**?
- *contribution-view*
 - What is the **number of OSM-users** in region **xy** and how many of them were active in the **last six months**?

Ohsome-API: Parameters

- spatial:
 - bounding-boxes
 - points + radius (bounding-circles)
 - polygons
 - GeoJSON as input possible
- temporal
 - ISO-8601 conform timestamp(s)
 - time period(s)
- attributional
 - OSM type (*node, way, relation*)
 - OSM tags (*building=residential*)

Ohsome-API Response

- JSON/CSV format
- aggregated on time
- aggregated on types/tags/boundary (specific resources)
- metadata
 - API version
 - copyright information
 - processing time (optional)
 - request URL (optional; only included in GET requests)
 - short description of the result values (optional)

House numbers Request-URL

- <https://api.ohsome.org/elements/count/ratio?types=way&time=2010-07-01/2019-07-01/P7D&keys=building&keys2=addr:housenumber&showMetadata=true>
- <http://localhost:8080/elements/count?types=node&time=2010-01-01/2018-01-01/P7D&keys=addr:housenumber&showMetadata=true>

Completeness of House numbers

- Parameter
 - weekly from 2010-01-01 to 2018-01-01
 - *addr:housenumber* (for OSM-types *node* and *way*)
 - Africa, Tanzania, Daressalam
- Data
 - osh-pbf file from Africa (3,4 GB)*
 - transformed in OSHDB data format (21,5 GB)

* <http://download.geofabrik.de/>

House numbers: Heidelberg

```
{
  "attribution": {
    "url": "https://ohsome.org/copyrights",
    "text": "© OpenStreetMap contributors"
  },
  "apiVersion": "0.9",
  "ratioResult": [
    {
      "timestamp": "2010-01-01T00:00:00Z",
      "value": 505,
      "value2": 238,
      "ratio": 0.471287
    },
    {
      "timestamp": "2014-01-01T00:00:00Z",
      "value": 18541,
      "value2": 5631,
      "ratio": 0.303705
    },
    {
      "timestamp": "2018-01-01T00:00:00Z",
      "value": 26224,
      "value2": 17763,
      "ratio": 0.677357
    }
  ]
}
```

ways

```
{
  "attribution": {
    "url": "https://ohsome.org/copyrights",
    "text": "© OpenStreetMap contributors"
  },
  "apiVersion": "0.9",
  "ratioResult": [
    {
      "timestamp": "2010-01-01T00:00:00Z",
      "value": 505,
      "value2": 629,
      "ratio": 1.245545
    },
    {
      "timestamp": "2014-01-01T00:00:00Z",
      "value": 18541,
      "value2": 2262,
      "ratio": 0.122
    },
    {
      "timestamp": "2018-01-01T00:00:00Z",
      "value": 26224,
      "value2": 2406,
      "ratio": 0.091748
    }
  ]
}
```

nodes