Designing measures for urban attractiveness using VGI and Open Data - a case study in Augsburg

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1. Introduction

Since 2006, it is possible to contribute freely accessible and usable geodata. OSM is a typical example for VGI (Goodchild 2007) and is used in many recent online routing applications as in the OpenRouteService (Neis and Zipf 2008). Keler and Mazimpaka (2016) use volunteered geographic information (VGI), governmental open data, and historical crime data for deducting the information how dangerous some urban areas are. Freely available information on the road network is accessible via OpenStreetMap (OSM) and often of different origin. There are the outcomes of the mapping process by numerous volunteers, but also contributions by governments and NGOs. OSM has besides data on transportation infrastructure also information on points of interest (POIs), land use and buildings, always specified by user-contributed feature tags (Aliakbarian and Weibel 2016).

It is possible to use VGI feature tags for computing a safety index based on generated surfaces from functional point features (Keler and Mazimpaka 2016). This shows that the distribution of selected features in urban environments may indicate local knowledge and changes in urban inhabitant’s behaviour. One example for the latter is the perceived danger in selected parts of cities, where streetlights are missing (Farrington and Welsh 2002). This is the reason VGI, open data and, in some cases, linked data (Kuhn et al. 2014) might help understanding complex context in different perspectives in urban environments. This freely accessible type of data might benefit the connection of urban mobility, demographics and quality of life. Besides OSM, there are photo-sharing websites such as Panoramio and Flickr, which provide accessible VGI as geo-tagged photos. These may contribute advanced applications (Keler and Mazimpaka 2016) as detecting the most scenic routes for tourists (Alivand and Hochmair 2013).

Context, especially from social sciences, which is difficult to understand, can originate from massive user-generated data. In the possibly most suitable way, this data is georeferenced. This allows a clear association with geo-space and possible assigning with the built infrastructure elements. Additionally, it is possible to associate temporal components, which also allows, in case of social media data, to create time series.

Keeping the mentioned observations in mind, our aim is to test VGI and open data by a spatial analysis approach for defining aggregated semantic information and extracting local knowledge in urban environments. This knowledge consists of measures for urban attractiveness. One starting point for designing these measures is applying the approach of Long (2016) on data extracts from Augsburg (Germany). The inferred information might serve as input for location-based services allowing users to become familiar with unknown environments by making use of estimated local knowledge. As part of the knowledge extraction, we evaluate our first outcomes with results of a questionnaire about Augsburg locals' perception on selected areas of the city.

2. Case study and description of the test data sets

Our case study consists of testing the approach of Long (2016) of inferring the vitality of whole cities for the city of Augsburg (Germany). We change the scale of the spatial analysis from entire China to a city with much less spatial extent and compute the measure for city vitality as urban district vitality for Augsburg. For the calculation, we select comparable data coming from three different data sources, as explained in Table 1.

Table 1. Data extracts of user-generated content for the case study in Augsburg.

Source	Type	n features
Panoramio	Geotagged photographs	3,467
Wikipedia	Locations of articles	61
OpenStreetMap (OSM)	Nodes of road segments	368,953
OpenStreetMap (OSM)	Points of interest & places	9,781
OpenStreetMap (OSM)	Areas of interest & places	4,286

Figure 1 shows the spatial distribution of the two first mentioned data sets in Table 1 for the city centre of Augsburg.

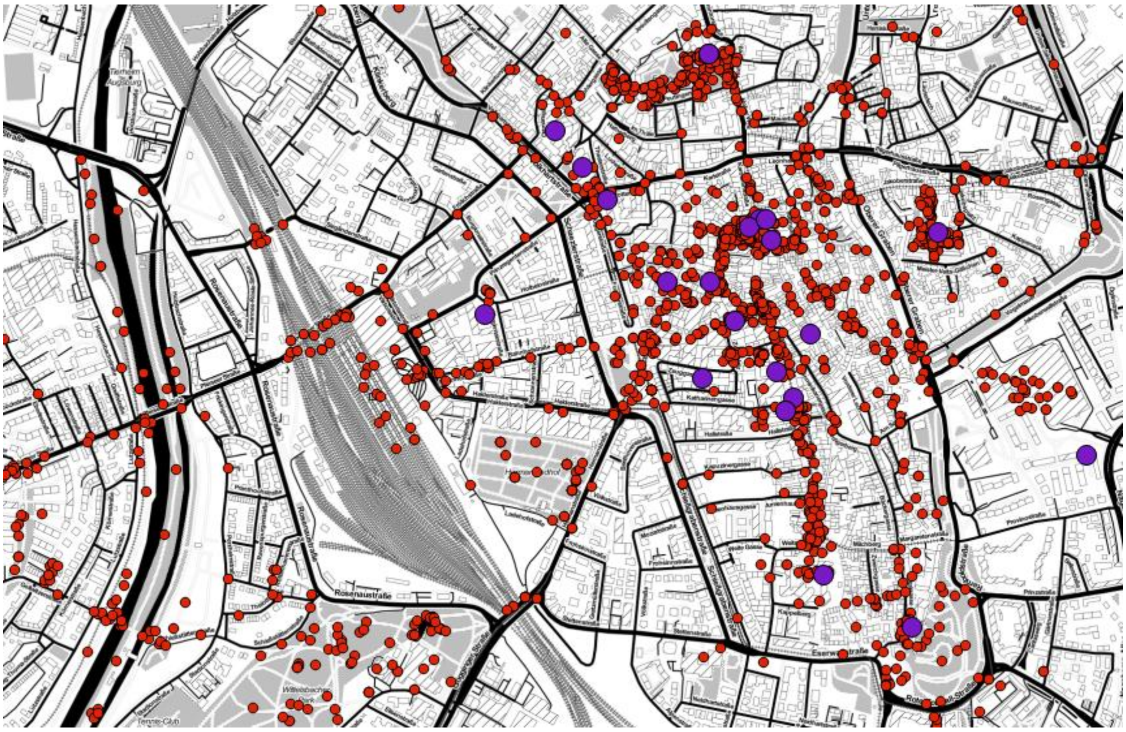

Figure 1. Spatial distribution of geotagged photographs from Panoramio (red) and locations of Wikipedia articles (violet) in the inner city of Augsburg.

As intended, data from Panoramio and Wikipedia are weighted higher in the definition of urban vitality, as this data can be associated with touristic activities or established knowledge originating from local knowledge. This is valuable data, since Panoramio is no longer available after November 4, 2016[1] and data extraction is only possible until November 2017. The reason is the association of this data to a specific social network user group separable from Google users.

Data from OSM is included as node extracts from road segments with all road intersection points and as additional points and areas of interest, together with selected places. POIs and places serve as additional information for verifying data from Panoramio and Wikipedia. A cutout of the spatial distribution of OSM POIs and places is pictured in Figure 2.

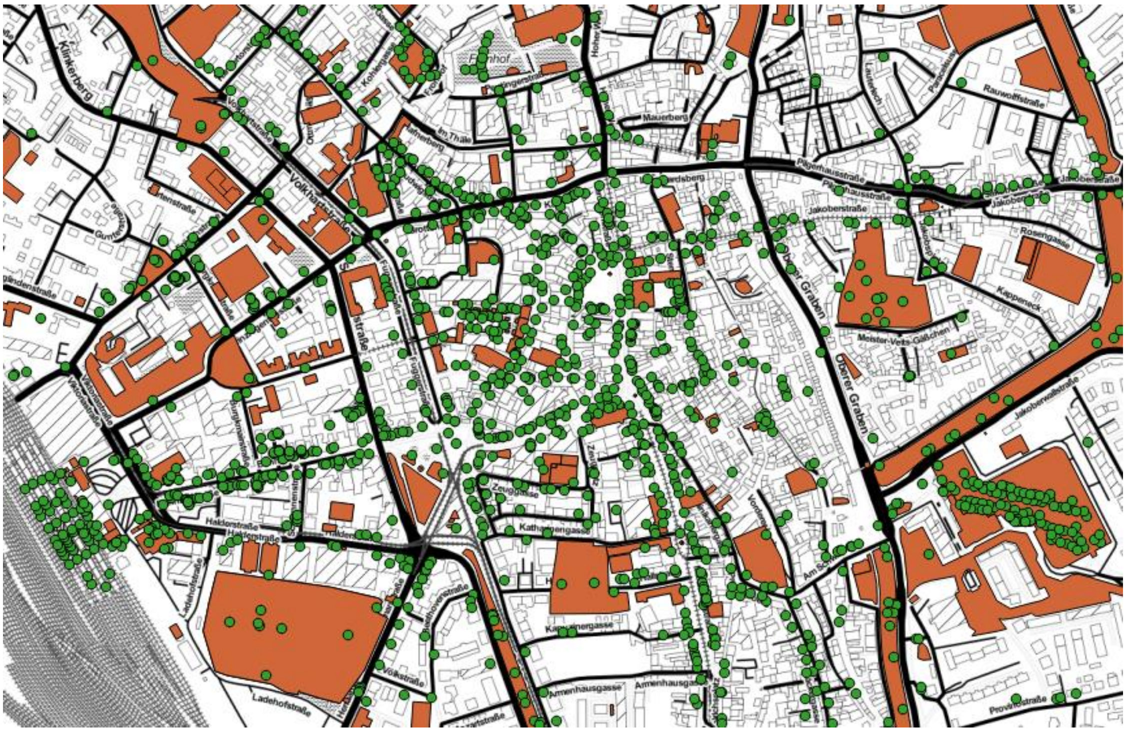

Figure 2. Spatial distribution of punctual (green) and areal (brown) points of interest and places from OSM in the inner city of Augsburg, Germany.

3. Designing an urban attractiveness measure for Augsburg

By testing the formula for urban vitality (Long 2016) with the data sets from Augsburg, we introduce several adaptations, especially due to the smaller spatial scale of the investigation area. The term urban vitality originates from Lynch (1984), where it consists of the three components urban form, urban function and urban activity. Long (2016) associates these components with open data, mainly VGI of different sources, and introduces the following formula of urban vitality:

$$\text{Urban vitality (V)} = \ln (J * P * L)$$

The urban form is assigned to the road junction density J, the urban function to the points of interest (POIs) density P, and the urban activity to the LBS density L. In the

[1] https://www.panoramio.com/

case study of Long (2016), the latter originates from extractable social media data of Baidu[2]. Our equivalents of L for Augsburg are the mentioned Panoramio and Wikipedia data. POIs density P can come from previous point density estimations or density-based point clustering steps. As in Long (2016) only the road junction densities J are used, as smaller scale might include all extracted road segment nodes.

The subsequent steps are influenced by inspecting the outcomes, which are in our case point clusters or aggregated polygons. This includes reasoning on place-related semantics, which is possible by inspecting user-contributed feature tags in the way of defining folksonomies (Aliakbarian and Weibel 2016). More specifically, we aim to adjust urban vitality definition on a city scale by testing different road segment density, together with respecting different types of geotagged photos. Urban vitality is then altered into an urban attractiveness measure for cities, since various modifications are introduced in the mentioned formula. One central aspect here is an information fusion step of geotagged photos with OSM POIs, and linked online article information (Wikipedia). The latter has higher weighting in the computation, since linked articles are assumed to be more visible by internet users and search engine applications.

We evaluate urban attractiveness values for the city of Augsburg with outcomes of a questionnaire assessing locals on their perceived attractiveness for tourists of selected areas of the city. First results show specific relations between computed urban attractiveness and local knowledge for specific areas of Augsburg.

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[2] http://www.baidu.com/