W3C Linking Geospatial Data Workshop (LGD14)

Personalized Time-Dynamic Points of Interest - POI 2.0

Viktor Slavkovikj[1], Kevin Baker[2], Majid Alivand[3],
Pieter Colpaert[1], Erik Mannens[1], Steven Verstockt[1]

[1]Multimedia Lab – ELIS Department, Ghent University – iMinds
Gaston Crommenlaan 8, bus 201, Ledeberg-Ghent, Belgium
{viktor.slavkovikj, pieter.colpaert, erik.mannens, steven.verstockt}@ugent.be

[2]RouteYou nv, Kerkstraat 108, B - 9050 Gent (Gentbrugge), Belgium
kevin.baker@routeyou.com

[3]University of Florida, Geomatics Program, Fort Lauderdale Research and Education Center
3205 College Avenue, Fort Lauderdale, FL 33314-7719, United States
malivand@ufl.edu

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1. Motivation and significance of the topic

Where the process of mapping the Earth has been the task of a small group of people (surveyors, cartographers, and geographers) for many years, it starts to become possible now for everyone to participate in the **global geo-enrichment process**. Geotagging a point of interest (POI), for example, has become a one-click process which can easily be performed by any bystander. Furthermore, the majority of recent capture devices are able to automatically assign **geotags** (i.e., longitude and latitude location coordinates) and add **additional metadata**, such as time and date information and other **contextual data**. As such, it should be clear that a location is becoming more than just one single point of information or a pair of coordinates. We are shifting from the "geometry-driven view of the world" of traditional (sometimes out-dated) map datasets to a "**geo-semantic world**" of personalized time-dynamic POIs which have a meaning assigned to it by human activities and interactions. The static POI is changing into a contextualized point of information, i.e., the POI 2.0.

As an example of a **contextualized POI**, Figure 1 shows the St Peter's Square in the city of Ghent. First of all, this location can have **multiple (time-dependent) functions**. For example, it can serve as a full-time recreation destination for citizens, or as a weekly recurring event (e.g., markets), or as an underground car park, or even as a part-time protest site (e.g., during political unrest). In the traditional concept of POIs, typically none of these aspects would be captured. Subsequently, the square can also have many **'data providers'** (e.g., citizen journalism, transport data, geo web data, and/or business/company data) and many **'data consumers'** (tourist info, like opening hours, geo statistics and geo web data, such as visiting numbers). On

its turn, each of the data providers can use **different geotagged multimedia objects** that all together form the POIs metadata. Furthermore, each POI can be geographically or semantically related to other POIs. The square, for example, can have a statue, which can be considered a POI on its own; or it can be surrounded by streets, all of which can host separate POIs; the square can even be 'linked' to another (nearby) square which shares similar functions. Finally, a POI can have several (optional) **attributes**, such as opening/visiting hours, availability and popularity. POIs on Booking.com and Foursquare, for example, already have 'sold out' and 'open now' attributes.

Figure 1 - Contextualized POIs of St Peter's Square in the city of Ghent, Belgium; one square has many functions, attributes and geographic/semantic relations, generated by several data providers, and consumed by a variety of location-based services.

In summary, using POI 2.0 we will be able to create more than just a map with dots. By extending the pair of coordinates with its time-dependent functions, attributes and relations, we increase the **location intelligence** of our maps. Furthermore, since more and more data providers are able to publish and update the POI data, more accurate and contextualized information can be provided to each of the data consumers. In the next sections, we will go more into detail on the (semi-)automatic generation of contextualized (i.e., personalized and time-dynamic) POIs by a variety of data providers.

2. (Semi-)automatic generation of time-dynamic POIs

In order to create a POI and to keep it 'alive', one has the possibility to manually define its location and update it on change, or to make use of (semi-)automatic POI detection/authoring mechanisms. The latter one is mostly of scientific interest, as it bundles several technologies which facilitate real-time and accurate updates/annotation, e.g., when POIs change or when new POIs are found. Furthermore, contrary to the former approach, only limited manual labor is needed, which reduces the risk of errors, increases disambiguation accuracy, and so on.

One example of automatic POI generation is **time-dynamic POI detection in social media**. As more and more data on social networks is getting geotagged, it becomes easy to query for the most recent media and to use the coordinates of the multimedia objects to **detect/update current**

hotspots. Photo-sharing websites, for example, such as Flickr and Panoramio provide millions of geotagged images contributed by people from all over the world. Based on the tags/comments of the multimedia objects, and based on other geo-semantic searches with the new POIs coordinates (e.g., DBpedia SPARQL queries), the context of the POI (functions, attributes, and geographic and semantic relations) can be detected. Using the social media time-related data (e.g., Foursquare check-ins), it is even possible to identify significant trends in the POI history and to see how 'active' a particular location is.

Related to social media based POI detection, some approaches have recently been proposed in literature. In *(Van Canneyt et al., 2012)*, for example, it is shown how the large amount of geotagged data in social media can be used to complement existing place databases. A similar study is performed by *(Mamey et al., 2010)*, in which they provide Flickr based recommendations of current city hotspots. Both works focus on how geotagged media can be used to find **key locations**. To the best of our knowledge, we are the first who also take the opposite approach, i.e., **finding media for user-specific location keypoints** *(Verstockt et al., 2013a)*. Our GEO MASHUP architecture, which is discussed in more detail in the next section, is an example of **sensor-based personalized POI detection**.

3. POI personalization

The beginning of the 21st century is also characterized by a **mobile sensing (r)evolution** *(Srivastava et al., 2012)*. With the continuous improvement in sensor technology of mobile devices and web services to aggregate and interpret the logged information, people are able to create, record, analyze and share a huge amount of data about their daily activities and the places they visit. Recently, the tendency of mobile sensing has also started to occur in the domain of **geographic information systems (GIS)**. One example is the success of **collaborative geographic projects**, such as OpenStreetMap and RouteYou *(Haklay and Weber, 2008)*. These projects are built upon user generated geographic content, so called **volunteered geographic information (VGI)**. VGI makes it easier to create, combine, and share maps and supports the rapid production of geographic information.

One drawback of current GIS/VGI approaches, however, is that they only marginally consider user preferences. Within our work we focus on how mobile sensors can help to automate and facilitate the creation of (personalized) **geographic user profiles.** We investigate the ability to determine a geographic profile from 'onboard' mobile sensors (i.e., from a smartphone or gps sensor mounted on a bike or carried by a hiker), enriched with personalized geographic web data. The combination of **sensor-based geographic preferences** and the users' **social/online (geographic) preferences** *(Pippig et al., 2013)*, allows us to personalize POIs and improve future GIS and VGI applications.

Automatic GEO MASHUP generation of outdoor activities

As an example of **POI personalization**, we have developed a GEO MASHUP architecture which combines **mobile sensing** and **geo tagging** in a unique way. The proposed architecture, shown in Figure 2, automatically selects online geotagged media related to the activity that someone has performed, taking into account the route statistics of the activity and the points of interest (POI) of other users. In this way, for example, it is possible to automatically generate a personalized multimedia summary of a tourist visit to a city or to automatically retrieve someone's POI preferences.

Figure 2 - General scheme of the proposed GEO MASHUP architecture

The GEO MASHUP architecture consists of four building blocks. The **sensor data logging**, i.e., the first block, is performed using an in-house Android app, which logs the GPS coordinates, the vibration data, and the smartphone status in short intervals *(Verstockt et al., 2013b)*. Next, the second block extracts the **user-specific route keypoints**, i.e., locations of 'outlying' activity (e.g., low speed). The following block then uses the coordinates of these key points to perform a **geotagged media search** by popular social media web services. Finally, the retrieved media objects are combined in a **personalized route mashup**. For more details, we refer to *(Verstockt et al., 2014)*.

4. Conclusions and future work

On W3C LGD14 we plan to open a discussion on the proposed **contextualized points-of-interests** and how this new concept of POI 2.0 fits within the broader geo-semantic world. By extending POIs with time-dependent functions, attributes and relations, we will increase the location intelligence of our future online geographic maps. Furthermore, since more and more data providers will be able to publish and update the POI data, more accurate and contextualized information will be provided to the geo-consumers. By combining **sensor-based geographic preferences** and the users' **social/online preferences**, we will be able to improve future GIS/VGI applications with personalized POIs.

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