

Collections of Points of Interest: How to Name Them and Why it Matters

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Abstract

The Web-accessible of large, global-coverage databases of Points of Interest (POI) as well as social sensing techniques to study how humans behave towards these POI, i.e., when they visit them, how they write about them, the sequences in which they visit these POI, and so forth, have lead to researchers and companies utilizing POI to represent regions and their affordances. For instance, one can characterize neighborhoods by the types of POI they contain as well as their frequency or try to extract spatial footprints of functional regions based on the spatial patterns in which these POI are distributed over geographic space. Such perspectives, however, ignore the spaces and places in-between these POI as well as the transportation infrastructure that defines many kinds of regions and their interaction. Consequently, it is often more beneficial to take a step back and explicitly state that one considers collections of POIs to delineate an area, e.g., to associate it with activity types such as tourism. To give a concrete example, the area enclosed by the locations from which people are frequently taking pictures in a city such as New York may be characterized as an area of interest (e.g., Time Square) to differentiate it from a merely point-based perspective. Unfortunately, the community has not yet agreed on a common term for such areas and instead uses similar terms from domains such as human geography or remote sensing as proxies. While they often have overlapping meanings, we believe that it would be beneficial to discuss the similarities and differences of terms such as neighborhood, functional region, vague cognitive region, and so forth as compared to areas of interest and other POI collections.

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1 Introduction

Points of interest (POIs) refer to point locations in urban or rural environments that support human activities or attract the attentions of people. POIs have been widely used in academic research and industrial applications as a proxy to understand human activities in an area. However, POIs are also criticized because they force the spatial footprints of geographic features to be points, thereby essentially ignoring their extent. This geometric generalization

works in many applications but can also cause problems especially at large cartographic scales. In addition, it often makes sense to study collections of Points of Interest and their spatial distribution. These collections necessarily cover an area and this area may be of interest in various contexts such as reasoning about the activity spaces of people, delineating regions frequented by tourists, estimating the boundaries of neighborhoods and functional regions and so on. Such POI collections, however, can only act as proxy for the above mentioned concepts and therefore it is often beneficial to talk about POI collections and explain how they are used to derive further information. Recently, the term *area of interest* (AOI) has been used [6, 5] to describe one kind of POI collections, namely areas that attract and support various human interests and activities. At a first glance, AOI seems to be a simple extension of POI by enabling polygon representations of spatial footprints. However, POIs and AOIs do not have a one-to-one mapping relationship. For example, an AOI can be defined as a concave polygon containing locations photographed by tourists. Another example would be an AOI formed by all POI within a certain area that afford nightlife activities. Clearly, while such an area is a worthwhile nit of study, it should not be confused with concepts such as neighborhood.

AOI is also related to some other spatial concepts, and their distinctions are not always clear. One of such concepts is *administrative region* which is often defined by governments and used for various socioeconomic and political purposes. The well-defined semantics and the clearly-delineated boundaries make it easy to distinguish one administrative region from another. While administrative regions are defined in a top-down manner by authorities, other spatial concepts have been proposed to represent geographic regions extracted in a data-driven manner or from a community/culture-centered perspective. Examples include (*vague*) *neighborhoods* [2], *functional regions* [3], and *vague cognitive regions* (VCR) [7]. Vague cognitive regions, for instance, emphasize the cognitive aspect of places and reflect informal ways people organize their knowledge about places and how they share common attitudes towards them [7]. Functional regions focus on one or multiple functions provided by a specific area and model the (often hierarchical) spatial interactions among the places within this area. Neighborhoods are used to represent the structure and composition of the urban space in social perspectives such that spatial units within the same neighborhood share a similar character [1]. Neighborhoods also have a strong historical perspective as they often arise by smaller communities being incorporated.

AOI is also a type of data-driven geographic regions [6, 5], and some similarities can be found between AOI and other concepts. Similar to *vague cognitive regions*, AOIs exist in people's perception and have vague boundaries. Different AOIs may also support different activities (e.g., recreational areas for entertainments and commercial centers for shopping activities) and provide different functions similar to *functional regions*. The spatial units within an AOI can also share similar attributes such as the concept of *neighborhood* (e.g., higher housing price for commercial centers). Another concept that is similar to AOI are *regions of interest* (ROI) which is a term frequently used in remote sensing and other domains to refer to the study regions defined by researchers. These similarities makes it difficult to distinguish AOI from other concepts. An even more important question is whether AOI is a trivial concept that can be simply replaced by other terms or whether it adds something that cannot be expressed otherwise. This paper is intended to start a discussion around this topic by reviewing the similarities and differences between AOI and related concepts.

2 Comparison of AOI and Related Concepts

In this section, we review AOI and related spatial concepts and discuss their similarities and differences. Table 1 provides a comparative summary of concepts from six important perspectives: 1) *Consensus*: are the semantics and spatial footprints of these concepts commonly agreed among people? 2) *Footprints*: which type of geometry is typically used to represent this concept? 3) *Boundary*: does this concept have a vague or crispy boundary? 4) *Relatively static*: is this extent of the region relatively static or does it change frequently over time? 5) *Spatial Interaction*: is this concept defined based on the interactions among the places within this area? 6) *Named region*: it naming a key aspect of this type of region? While the concepts of *POI* and *administrative region* are also compared in the table, they are not discussed in separate sections since they have clear distinction with AOI outlines before.

Table 1 A comparison among different spatial concepts. (Yes(Y)/No(N))

	Consensus	Footprints	Boundary	Relatively static	Spatial Interaction	Named Place
Administrative Region	Semantics and footprints	Polygons	Crispy	Y	N	Y
Point Of Interest	Semantics and footprints	Points	-	Y	N	Y
Vague Cognitive Region	Semantics	Polygons	Vague	Y	N	Y
Functional Region	Applications dependent	Polygons	Crispy/Vague	Y/N	Y	N
Neighborhood	Applications dependent	Polygons	Crispy/Vague	Y/N	N	Y/N
Region Of Interest	Applications dependent	Polygons	Crispy	-	N	N
Area Of Interest	Applications dependent	Polygons	Vague	N	N	N

2.1 Vague Cognitive Regions

While AOI is also a cognitive concept since the word "interest" can refer to various themes and the same theme can be interpreted or perceived differently by different people, it embodies less cognitive flavor compared with VCR [7]. VCRs are driven by individual and cultural beliefs about thematic properties of geographic places. VCR as a term is strongly tied with the intrinsic vagueness and fuzziness of many geographic concepts, such as "downtown Santa Barbara" and "Southern California". Each VCR refers to a named cognitive geographic region which is commonly agreed on by some part of the population whereas the vagueness or disagreement arises when it comes to the regions spatial boundary. In contrast, since each AOI it not necessarily associated with a name, AOIs are not formed by consensus or common reference, let alone consensus on their spatial representations. Another distinction is that VCRs are relatively static whereas people will be interested in different areas at different times of the day which forms different AOIs. Note that terms such as *activity spaces* typically refer to a single-persons perspective and are mostly defined by travel patterns.

2.2 Functional Regions

The concept of *functional region* has different definitions in the literature of regional science and urban geography studies. One popular definition is that *functional regions* are usually characterized by connections or spatial interactions between different areas and locational entities. Another one is from Hartshorne [4] with emphasis on supporting the particular set of activities and depending on the structure of the area. The functions of certain (sub)regions are originally defined in urban planning and then reshaped by needs arising from human activities. Researchers use POIs that afford specific types of human activities as a proxy to delineate functional regions with various co-location patterns of place types from a bottom-up perspective [3]. Because of the uncertainty in this bottom-up process, the boundaries of functional regions can be also vague. The distinctive character of functional regions is that

they focus on the (often hierarchical) spatial interactions between places within them and different combinations of functions which are not captured by any other concepts (and cannot be fully represented by collections of POI).

2.3 Neighborhoods

Neighborhood is a phrase frequently used in our everyday life. In most cases, administrative units at the country, state, and city level are well defined, but sub-city level tends to be where hard geospatial boundaries fall apart. Neighborhoods have become a common term used to describe an urban region that shares a similar *character*. In this way they can be considered areas of interest with specific focus on aspects of an urban setting that often differentiate parts of a city. Features such as socioeconomic status, demographics, housing prices, or even crime rate all play a role in how neighborhoods are perceived. There is a deluge of work exploring this topic, with many researchers focusing on a combination of characteristics as the basis for setting a boundary. For instance, work by Cranshaw et al. [2] explored the use of social media check-ins for clustering Points Of Interest which they refer to as *livehoods*. Neighborhood boundaries are a contentious issue in many parts of the world and have been historically used for redlining or other means of separating groups of people. One clear distinction between AOIs and neighborhoods is that the last mentioned captures the general characters of certain range of space in a slowly evolving, cultural, and history-based fashion, while AOIs are more similar to perspectives or views on space that highlight aspects along one or a few dimension. Their cultural relevance stems from usage patterns (e.g., sightseeing), not the historical development of an urban area.

2.4 Regions Of Interest

Region of interest is a general concept for describing a subset of data that is under study or serve some specific purposes. It is commonly used in domains such as medical imaging and computer vision. In geography, ROI is used to analyze remotely sensed imagery, and has been widely accepted as term in most commercial remote sensing software like ENVI. Compared to other concepts, ROI is usually defined by researchers from a perspective of data processing and analysis rather than conceptualization. Therefore, it is difficult and sometimes meaningless to have a consensus on the identification of ROI. Furthermore, most ROIs have crispy boundaries which makes them different from AOIs (which have rather vague boundaries). Nonetheless, researchers that delineate a specific area based on a type of human activity also define a region of interest, thereby showing similarities between the terms ROI and AOI. Put differently, an AOI sits in between areas merely selected for the purpose of a study, e.g., during sampling, and the shared experience of place associated with other terms such as vague cognitive regions. To refer back to the tourism and photography example, AOI can be defined by researchers based on geo-tagged images but are also experienced by citizens seeing how places attract tourists and the activities associated with tourism.

2.5 Areas Of Interest

The concept of AOI has two major emphases: *area* and *interest*. The first emphasis suggests that an AOI is geometrically represented as an *area* rather than a *point*. Based on this emphasis, AOI can be considered as an extension of the concept of POI. Meanwhile, an AOI is more than a collection of spatially co-located POIs. An AOI may also include regions that do not have any POI in the classical (static) sense but simply provide a scenic view [5]. Thus,

an AOI may also include the reversed viewshed of a POI. The second emphasis is on *interest*. This emphasis adds a layer of human cognition: an AOI does not refer to any geographic region but regions that can attract attention from people, e.g., by affording certain activities. Thus, an AOI may be an attractive regions that contain landmarks, commercial centers, and recreational areas as well as famous natural tourism resorts in a rural area, such as nature parks and famous mountains. Given its cognitive emphasis, AOI can be subjective: for a geographic region, different people may have different lists of AOI in mind due to their different cultures, education backgrounds, and personal interests, and so forth. In addition, agreement on the existence of an AOI does not mean agreement on their spatial extents nor the need for a name. Clearly, a town may have a region that is often included in the routes of bikers and runners without them sharing a name for this common path-fragment.

3 Conclusion

It is good scientific practice to question the necessity of a new concept. In this paper, we looked into the question whether the concept of AOI can be simply replaced by other existing spatial concepts. To do so, we compared the similarities and differences between AOI and related concepts from six perspectives, namely consensus, footprint, boundary, dynamics, spatial interaction, and name. Although some concepts like administrative region, ROI, and POI have rather clear distinctions from AOI, it is easy to confuse AOI with other concepts like VCR, functional regions, and neighborhoods, which are often extracted in a similar data-driven manner by researchers interested in Big Data. We believe that AOI (and other types of POI collections) is a unique concept which cannot be simply replaced by others, most importantly because it may lead to an oversimplification or even misrepresentation of other types of regions. AOI, for example, can be used as means of approximation of these other concepts. AOIs do not necessarily have names (compared with VCR), do not necessarily focus on spatial interactions (compared with functional regions), and have dynamic patterns (compared with neighborhoods). We hope that this comparison can provide a useful discussion starter for future studies to select the most suitable term.

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