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Putting Geographical Information Science in Place – Towards Theories of Platial Information and Platial Information Systems

Franz-Benjamin Mocnik ⓘ
University of Twente, Enschede, The Netherlands

Abstract
Place is a concept that can hardly be formally captured at the moment, as it is unclear how instances of places can formally be represented and how conclusions about places can practically be drawn by technological means. Geographical Information Science scholars hence tend to use the term 'Place' even when, in fact, they presume a paradigm similar to the one assumed for Geometrical Space. As a result, Space and thematic information is mostly treated separately, and the richness and variety of Place descriptions in terms of identities, affective states, affordances, and further aspects that have been discussed in Geography since a long time are not (yet) reflected well in corresponding discussions in Geographical Information Science. This article reviews the ongoing debate and outlines directions of how to extend it much beyond the currently assumed spatial paradigm towards platial information. Thereby, possible approaches and future prospects as well as limitations of Theories of Platial Information and Platial Information Systems are explored. The agenda laid out and discussed in this article aims to set a frame of reference for a re-focussing of the ongoing discourse on platial information and stimulate future developments towards a Platial Information Science.

1 Introduction

The various geographical Place[1] concepts seek to capture how we 'live' Space. While some disagreement in what makes a place exists, most of these concepts describe places by the integration of the individual perception and action with societal influences and beliefs. Thereby, places are often characterized in terms of routines and recurring patterns, in terms of the sense of being in a place, and in terms of the identity of a place. These characterizations are closely linked to everyday geographies and appear relevant even far beyond the realm of scientific discourse. Especially in times of ubiquitous Internet access and mobile devices, which offer automated ways to

Corresponding author:
Franz-Benjamin Mocnik, Faculty of Geo-Information Science and Earth Observation, University of Twente, 7500 AE Enschede, The Netherlands.
Email: franz-benjamin.mocnik@utwente.nl

deal with data at a large scale, the formal representation of and reasoning with places deserves attention.

Scholars in Geographical Information Science and cognate fields have explored approaches to represent places in diverse ways. Among others, several workshops and symposia about platial[2] information are taking and have taken place,[3] and several Special Issues have witnessed lively activity in the context of Place concepts and the representation of Place.[4] Yet, these activities restrict to a limited set of characteristics and have not yet led to a sufficient, holistic understanding of how to deal with platial information, as becomes apparent at the example of the *Café Central*, a Viennese coffee house, which is discussed in a later section in more detail. How can the particular atmosphere and spirit of this coffee house and thus the way it is different to all other coffee houses be captured by formal means? What is the sense of place we get when being in the Café Central? While the gap between what we know about Place concepts in Geography and the Social Sciences and the way we are able to capture these concepts by formal means becomes obvious in the light of this simple coffee house example already, it needs to be acknowledged that attempts to formally represent places are necessarily limited due to the complexity of Place concepts. Still, in view of the many Geography and Social Science publications in the context of specific places and Place concepts in general, it seems surprising that Geographical Information Science scholars have not yet developed stronger ties to the concepts of these disciplines.

In the light of the discussed gap between the geographical Place concepts and the formal means to represent places and their qualities,[5] the question arises as to how future attempts could successfully approach this issue. When accepting that such attempts should be considered a pragmatic endeavour, it suggests itself that they should be guided by the questions we target to answer in real-world situations, and that the lack of progress is due to the fact that we are not yet able to formulate the right questions. The currently ongoing discourse is for the most part guided (and thus limited) by the concepts that currently dominate in the context of Geographical Information Systems (GISs; for currently dominating concepts, cf. Kuhn, 2012). A re-focus on the geographical concepts of Place can help widening the ongoing discourse about platial information and guiding it towards a better understanding of which questions and qualities are relevant.

This article aims to set a frame of reference for upcoming attempts to represent places by formal means and to operationalize these representations. After highlighting the societal relevance of platial information as a motivation for the further discourse (Section II), existing approaches to platial information are discussed. More specifically, the concepts of Place that have been introduced in the context of Human Geography are briefly summarized (Section III.1) to then set into context the various research directions related to platial information (Section III.2). Subsequently, the gap between the geographical concepts of Place and current approaches to platial information is illustrated at the example of the Viennese Café Central (Section III.3); and current approaches to platial information are critically reflected to understand better what is yet missing in the ongoing discourse (Section III.4). Then, the basic notions of Theories of Platial Information and Platial Information Systems are introduced; how they relate to and build on geographical concepts of Place is discussed; and it is outlined how these theories and systems must be set apart from existing approaches and paradigms (Section IV). Based on the concepts of Theories of Platial Information and Platial Information Systems, the various challenges associated with their development are examined. In particular, it is argued that they have to deal with the high complexity inherent to platial information, reflect intrinsic and emergent qualities in multifaceted ways, and suffer from not being able to adequately convey embodied experience (Section V). In favour of this critical discourse, we deliberately refrain from pointing out possibly premature solutions for the representation of places and corresponding reasoning in the course of this article. Instead, ways to classify and assess such theories and systems are explored (Section VI). Finally, future research questions are discussed based on the work presented, and future prospects are outlined.

II The importance of platial information

This section addresses the social and individual relevance of Place, because it is this relevance that motivates the study of platial information. Places are

virtually everywhere. They constitute geographies and shape our everyday life. They are referred to in mundane language and are relevant to many practical tasks. We organize life by thinking and feeling about places. They are idiosyncratic in general but can be shared or even emerge through societal action. They are identity-forming, but can also lack an identity. The list of examples could be continued indefinitely.

The ubiquity of places illustrates their importance for many of our mundane and non-mundane activities. However, the high relevance of platial information does not follow from this fact alone, because the necessity of a formal representation is not only based on the importance of places themselves. Rather, the strong demand for such information is the main reason, which is evident in written and artistic communication and in the use of substitute concepts. Examples for the former are travel guides and travelogues, mundane narratives at the lunch table or in the bar, coffee-table books, and holiday photos; while examples for the latter include geometries represented in a GIS, places and routes in maps or in the timetable, place-name signs and addresses, which stand for places without being places themselves. These are some of the many examples.

When places are designed, as is common in urban and spatial planning, geometries are often used as a proxy for them. This often works surprisingly well but can only be an approximation of places. If we used representations of places instead of geometries together with corresponding software, the result could be expected to align better with human thinking and the planner could receive more support. This is symptomatic and could easily be applied to further examples, such as a person planning a route and route planning software, the parking spot seeker and the parking spot app, and so on. In the end, however, it is the societal developments that significantly improve the possibility of representing places and thus render replacement concepts superfluous, significantly simplify the use of these technologies, and ultimately create ever new application scenarios. In the following, we will briefly discuss these developments.

Our societies strive for more and more individuality and an ever-increasing range of information in our everyday lives (cf. Graham and Shelton, 2013; Kitchin, 2013; Miller and Goodchild, 2015). Mobile devices and, to a certain extent, wearables such as digital watches and glasses play an increasingly important role. Also, software is increasingly expected to provide personalized responses, not least in the case of Intelligent Virtual Assistants (IVA) and maps adapted to the purpose of its use. In the context of these technologies, there is a growing need for human-centric solutions rather than those that are adapted to the machine. It is not humans who should adapt – according to the currently prevailing opinion – but the machines as technological possibilities increase. This is not least evident in Smart Cities, which adapt to humans and their expectations. As humans are strongly oriented towards place and because the latter aligns well to individualized and personalized needs, place-related aspects become increasingly important and have, at least to a certain extent, found their way into the technologies mentioned.

The desire to understand ever more complex circumstances of mundane life is growing, and so is the complexity of the data available. The data collected by mobile devices and Big Data illustrate this well, because they relate to places in diverse ways. Not only the available data but also societal views and actions reflect the important role of information in the understanding of the complex circumstances of mundane life. Volunteered Geographic Information (VGI) and Participatory Geographic Information (PGI), Citizen Science, and further types of crowdsourced information show how strong the interest is not only in consuming but also in contributing to place-related data both on the individual and the collective level (cf. Mocnik et al., 2019). Similar reasons propel the study of digitization in the Social Sciences as well as the Digital Humanities.

In the long term, platial information is of great importance for addressing the Sustainable Development Goals (SDGs), because they are expressions of experienced and often socially constructed space. Without a good understanding of how we organize our living together in terms of place and place making, sustainable urban environments with respect to climate change are, for instance, hard to achieve. Climate change will alter existing places and their perception, and it can be expected that rising sea

levels and climatic conditions will have a greater impact on the design of places. Generally, mental health and well-being strongly depend on the way we shape places and our spatial environment. Further, places are often abused to create barriers between people, but they can also be used to shape our society towards equity and equality in various aspects. The coexistence of different religions in Jerusalem, for instance, leads to conflicts the peaceful solution of which strongly depends on how people live together in one place – think of places like Mount Zion, the Temple Mount, or the Chapel of Ascension. These examples demonstrate well the impact places as geographical features have on the progress towards the SDGs and why corresponding information is relevant to the design and transformation of places in relation to the SDGs.

III Existing approaches to platial information

The nature of platial information and the way it can be used has been subject to many research activities. In this section, we discuss such past and ongoing approaches to Place via the lens of Information Theory and cognate fields. First, we briefly summarize the geographical concepts of Place to then review related research in Geographical Information Science. As we then illustrate using the example of the Viennese *Café Central*, places are complex entities and their representation challenging, which is why current means of representation quickly reach their limits. To explain this, we critically examine the scientific discourse and identify corresponding flaws.

1 Geographical concepts of Place

Place as a concept has long been investigated by Geography scholars, such as Hettner, Vidal de la Blache, and Hartshorne. While, in particular for Hettner (1905), Place ('Örtlichkeit') served merely as the minimal geographical unit that represents sufficiently well geographical context, later scholars have built a more detailed understanding of Place. Based on the wide range of characteristics inherent to places, a number of **concepts of Place** – or **Place concepts** in short – have been established in the

various schools of thought in Geography as well as cognate disciplines.

In Humanistic Geography, places are conceptualized as self-contained geographical entities that shape our lives and render possible the way we live them in our contemporary societies. Tuan (1977, 1979), one of the pioneers in this school of thought, discusses the ways individuals feel about and build personal relations to places. The ways we experience these feelings and personal relations ('sense of Place') and the resulting emotional bond ('Place attachment') were discussed by many and in various contexts (e.g., Agnew and Duncan, 2015; Duncan and Ley, 1993; Kyle and Chick, 2007; Low and Altman, 1992; Smith, 2017; Tuan 1977), as well as the opposite, the absence of a sense of Place or of Place attachments ('placelessness'; Relph, 1976). The sense of Place is thereby considered to be based, among other things, on the daily routine and behaviour patterns in a place ('Space ballet'; Seamon, 1979; Seamon and Nordin, 1980). This understanding of Place has even influenced scholars beyond Humanistic Geography, such as the philosopher Malpas (1999) with respect to the experience of Place, the architect Dovey (2010) with respect to places as socio-spatial assemblages, and environmental psychologists (see Lewicka, 2011; Scannell and Gifford, 2010).

Critical Geography scholars have criticized the humanistic concept of Place. Harvey (1994, 1990) questions any absoluteness of the concept of Place and shifts the focus to the social construction of places and their resulting relational nature greatly influenced by capitalist mechanisms in Western societies. Thrift (1999, 2008), in turn, focusses on the embodied experience of places rather than their representations, a position common in Non-Representational Theory and Poststructuralism in general.

Due to the succinct nature of this text, the diversity of Place concepts cannot be presented in detail. The esteemed reader is referred to works by Cresswell (2004) and Agnew (1993) for a more thorough overview of these concepts, as well as to a work by Couclelis (1992) for a discussion of how Place relates to cognate concepts, including location, region, and space.

2 Research on platial information

Current approaches to formalizing Place and gaining a corresponding conceptual understanding of platial information can be found in Geography, Geographical Information Science, and cognate disciplines, such as the Cognitive Sciences, Environmental Psychology, and Linguistics. In this section, we summarize about the progress being made in these fields and set the various approaches into a common context.

The existing research can broadly be divided into three research strands.[6] The first of these strands deals with the **conceptualization of Place in Information Science**. In contrast to the geographical concepts of Place, such conceptualization focusses on formal aspects. For this purpose, Blaschke et al. (2018) and Papadakis et al. (2018a) have contrasted the concept of Place by the one of Space; Cho and Yuan (2019) have studied how spatial and platial concepts relate in the context of the analysis of events; and Bennett and Agarwal (2007) have studied language use to uncover the semantic categories underlying the meaning of Place. To understand better which spatial and non-spatial qualities we intuitively assign to places, Tang et al. (2020) have empirically examined sketches of places to identify such invariants. Related to this, Agarwal (2005) has empirically studied the impact that the consciousness of places has on the reasoning about Space and Time. Personalized Space–Time prisms can be expected to relate to the concept of Place, not least because Place ballets are considered relevant to Place. The role of Space–Time prisms has in this context been discussed by Miller (2007). Finally, Egenhofer and Mark ('naïve geography'; 1995) have explored 'formal models of the common-sense geographic world' to better understand what geographical concepts like Place mean in the context of everyday life.

Further research has explored the wider context of the concepts of Place with the aim of establishing more comprehensive means to deal with these. To establish such a way of thinking, Hamzei et al. (2020) and Wagner et al. (2020) have reviewed the various concepts that are borrowed from Geography and re-used by Geographical Information Science scholars in many different ways. In addition to these concepts

and by referring to existing vocabularies and ontologies, Ballatore (2016) has explored future prospects of ontologies of place, that is, the semantic setting in which Place representations operate. Acknowledging the variety of shortcomings that current means to platial information have, Purves et al. (2019) propose to re-use existing concepts of Place.

Another research strand focusses on the **representation of places**. Many of the publications related to this strand refer to intrinsic aspects of geographical concepts of Place, but focus on only one of these. Most notable, Scheider and Janowicz (2014) have approached the representation of places by constructive references, which, in turn, makes it possible to establish Place reference systems. The role of affordances has further been explored in more detail by Scheider and Janowicz (2014, 2010), Jordan et al. (1998), and Raymond et al. (2017). In contrast to this, Hu et al. (2015) and Kremer (2018) have explored how actually performed activities can be traced. Besides affordances and activities, the functions of places have been examined. Papadakis et al. (2020, 2019, 2018b, 2016) and Wang et al. (2018) have, for instance, related places to nearby Points of Interests (POIs) to infer which functions a place could serve for. Such way of thinking about activities, affordances, and functions reminds of work by Schatzki ('site ontology'; 2003). Despite not originally intended to refer to places, Hui and Walker (2018) have built on such work to describe places. Finally, Shamai (1991), Acedo et al. (2018), and Giordano and Cole (2020) have empirically approached the sense of Place and the meaning of places for social relationships using the means of quantitative and qualitative geography, potentially paving the way for a better representation of this aspect.

Qualities of places have been considered not only individually, but also in context. The number of publications that treat such combination of aspects is, however, yet modest. For instance, Vasardani and Winter (2016) and Vasardani et al. (2016) have explored how previous works of Christopher Alexander can be utilized to understand which qualities of a place are specific to it. Besides the description of existing places, Iosifescu Enescu and Hurni (2018)

and Iosifescu Enescu et al. (2020) have focussed on the qualities places can have in dreams.

In contrast to intrinsic aspects of places, also the relations to other places or geographical entities have been examined with the hope to understand the place itself better. As an example, Richter et al. (2012) have explored hierarchical, sequential, and other relations between places, which they extracted from Place descriptions. Likewise, Wu et al. (2019) have investigated hierarchical relations of places based on their location in Space; and Acedo and Johnson (2020) have approached the description of a place by investigating its relation to regions. This is in contrast to other scholars like Chen et al. (2018a,b), Hamzei et al. (2018), Kim et al. (2015, 2017a,b), Kremer (2018), and Zhu et al. (2020), who have examined how similarities between places in terms of their qualities can be used to represent and describe a place, thereby often employing a relational language. The resulting networks, often referred to as 'Place graphs', consist of places as nodes and spatial and thematic relations as edges. Winter and Freksa (2012) have even taken another approach to representing and characterizing places: instead of examining similarity relations, they describe places in contrast to other ones.

A third research strand investigates **media to represent places**. The text medium has traditionally been and still is very relevant for representing places. Most prominently, place names have acted as references to places for long, and these have been examined widely in Geographical Information Science by Jones et al. (2008), McKenzie et al. (2018), Vasardani et al. (2013), Chen et al. (2019), Goodchild and Hill (2008), and Maué (2013). Besides pure reference, the way places can be described by natural language has been investigated by Adams and McKenzie (2013), Papadakis et al. (2019), Edwardes and Purves (2007), and Hobel et al. (2016). Social Media is a special form of a text medium. In many cases, it contains only short snippets of texts, but due to its wide availability and because some of the messages are geo-referenced, it has been examined by many scholars with respect to places, among them Heikinheimo et al. (2018), Hollenstein and Purves (2010), Comber et al. (2018), Purves et al. (2011), Ostermann et al. (2015), Tear

(2020), Lai et al. (2020), Gugulica and Burghardt (2020), and Westerholt (2019).

Besides the text medium, visual media have been investigated. As places comprise spatial aspects, it suggests to explore in which ways places can be represented in a map. As traditional cartography is, however, more suited for conveying spatial phenomena, new cartographic means have been explored by Harvey (2020), Westerholt et al. (2018a), Vaughan (2018), and Gröbe and Burghardt (2018). As places are an essential part of stories and narratives, Mocnik and Fairbairn (2018), Caquard and Cartwright (2014), and Tateosian et al. (2020) have specifically investigated how cartographic means can be adapted to better reflect the ways places make a story. To set textual and cartographic representations in a common context, Mocnik and Fairbairn (2018) have even discussed their structural commonalities and differences. As an alternative to media that aim to convey factual knowledge, more artistic approaches to Place representation have been examined by Smith et al. (2019) and Casey (2002). Finally, the possibilities opened up by Volunteered Geographic Information and User Generated Content have been explored by Mayer et al. (2020), Ballatore and De Sabbata (2020), and Calafiore et al. (2018).

Remarkably, there are surprisingly few publications that provide a broader overview of existing research and future prospectives about platial information. Even if some of the publications referenced before touch upon different aspects related to platial information, they usually put a particular focus on one of these. An early overview of research perspectives has been provided by Goodchild and Li (2011) and Goodchild (2011). A review of existing means to address platial information has been published by Merschdorf and Blaschke (2018).

Besides the three research strands outlined, research about platial information reaches far into fields cognate to Geographical Information Science, such as Psychology and Cognitive Science. For instance, Davies (2020a,b, 2018) has approached conceptual aspects of platial information from a cognitive perspective, including 'Place-based information systems'. In addition, several scholars have discussed aspects of Place from a cognitive perspective. Among these are Stedman (2002) who has

explored how to measure the sense of Place in a survey; and Gao et al. (2017), Montello et al. (2003), Hobel et al. (2016), and Jones et al. (2008) who have approached the spatial aspects of places by Cognitive Science methods, because these aspects are often hard to capture. Further, Twigger-Ross and Uzzell (1996) have discussed how places can support the formation of a social identity, which is in addition to the identity of the place itself. Also, Cognitive Science aspects reach far into Linguistics. As part of the ongoing discourse, Tenbrink (2020) has outlined current opportunities and future prospects of linguistic platial cognition research. Finally, Mayer et al. (2020) have discussed the impact shared mental models have on how we represent places.

3 The example of the Café Central

The question of whether current approaches to platial information provide adequate means for representing places is pivotal for the nature of the future discourse. Current approaches often fit well the notions used in Geographical Information Science (cf., e.g., Purves et al., 2019), but it remains unclear how well they are able to capture the quality and essence of places in terms of the geographical Place concepts. This section addresses this question by investigating the example of coffee houses, a particular type of Place that illustrates well the gap between what we *know* about places and about Place concepts, and how we are currently able to *formally capture* places. It should be noted that due to the complexity of such places only selected aspects can be discussed here.

After their emergence in the 17th century in Europe, coffee houses have served several roles in society. They have been places of encounter and encouraged the exchange between intellectuals, writers, painters, and other artists time and again. Thereby, coffee houses did and still do facilitate the spread of information, for example, through offering newspapers and magazines as well as through discussions taking place. Coffee houses can thereby act as 'third places', that is, places, besides one's home and workplace, often visited and accommodated to (Oldenburg, 1989; Tjora and Scambler, 2013). Influential traditions of

Figure 1. Café Central in Vienna, around 1900. Copyright by Café Central at Palais Ferstel, Vienna.

coffee houses can be found in England (Clayton 2003; Cowan 2005; Ellis, 2004; Grafe and Bollerey 2007), Paris (Grafe and Bollerey, 2007; Rittner et al., 2013), Italy (Rittner et al., 2013), and Vienna (Ashby et al., 2013; Grafe and Bollerey, 2007; Rittner et al., 2013; Segel, 1993). The complexity of how we conceptualize coffee houses as places, including their societal role, becomes apparent at the example of the Viennese *Café Central* (Figure 1). In 1926, one of the pioneers of the *Wiener Moderne*, Alfred Polgar (1983),[7] described the social meaning of this particular coffee house in his own subjective view:

> The Café Central is indeed a coffeehouse unlike any other coffeehouse. It is instead a worldview and one, to be sure, whose innermost essence is not to observe the world at all. [...] there is nobody in the Café Central who isn't a piece of the Central [...] Whether the place adapted to the individual, or the individual to the place, is a moot point.

Despite the richness of this description, it starts with two aspects that appear familiar in the context of Geographical Information Science: a toponym as a reference to the particular coffee house, which could be stored as a text or as a (unique) identifier in a database, and the semantic category of a coffee house (cf. Jones et al., 2008; McKenzie et al., 2018). However, the substantial elements of this description can currently not be represented. This can be seen by

the fact that the uniqueness, here described as 'unlike any other coffeehouse' (Polgar, 1983), can only be formally enforced by the identifier but not be substantiated in terms of a representation of the place's qualities.

Interestingly, this first part of the description lacks any kind of reference to the location of the coffee house. At least the association with the place of Vienna becomes obvious when Polgar (1983) later speaks of the 'Viennese latitude at the meridian of loneliness', without, however, naming the exact location and the layout of the coffee house in more detail. Spatial aspects thus seem to play only a subordinate role in the characterization of this coffee house. This is despite the fact that existing Geographical Information Science literature puts a major focus on abstract space and locational aspects.

In a later part of the description, in which the location of the coffee house is indicated as discussed previously, Polgar (1983) goes on to describe the particular atmosphere of this coffee house, thereby capturing how deeply rooted the role of the Café Central is in its visitors' lives:

> If all the anecdotes related about this coffeehouse were ground up, put in a distillation chamber and gassified, a heavy, iridescent gas, faintly smelling of ammonia, would develop: the so-called air of the Café Central. This defines the spiritual climate of this space, a quite special climate in which unfitness for life, and only this one, thrives in full maintenance of its unfitness. […]

> The Café Central lies on the Viennese latitude at the meridian of loneliness. […] Helpfully, the coffeehouse steps in as an ersatz totality, inviting immersion and dissolution. […] It is a place for people who know how to abandon and be abandoned for the sake of their fate, but who do not have the nerve to live up to this fate. It is a true asylum for people who have to kill time so as not to be killed by it. […] The Café Central thus represents something of an organization of the disorganized.

This section of the description conveys a vivid impression of what defines Café Central at its core. In contrast to the ostensible function of being able to have coffee at one of the tables, perhaps in company, and thus to enjoy a few minutes of peace in a social atmosphere, a more complex picture is provided here, which refers to characteristics that go well beyond the self-evident. The formal representation of the function and the affordances of the coffee house may be possible to a certain extent (cf. Papadakis et al., 2020; Purves et al., 2019), but it will not be able to explain why Polgar preferred this particular coffee house. Most notably, the description given is more than a list of objects, functions, and affordances. It conveys an identity that is obvious to the visitor of the coffee house but yet so complex and unique that it eludes a short and formal description. It refers to emotional and affective states such as 'loneliness' and explains their role in the being of this particular coffee house. And it describes Polgar's individual experience of this place, which is even difficult to put into words. Only the context of metaphors and seemingly insignificant facts seems to provide an accurate description of this particular coffee house.

The description, like the coffee house itself, is characterized by an idiosyncratic point of view. The individually experienced sense of place and corresponding Place attachments, which are portrayed as particularly intense with the help of the metaphor of the gas, could with current means formally be represented in its strength but not in its nature. Also, hierarchical relations could reference similarities in the sense of mereology, for example, by forming part of Wiener Moderne and its in many respects socially constructed modes of creating, but it remains unclear how the essence of this place – what distinguishes the Café Central from other coffee houses – can ultimately be captured to a sufficient degree without iteratively explaining it through further mereological relations.

Going beyond these previous considerations, the Café Central can be described relationally in further ways. It would be plausible to name the visitors of this coffee house in the above description, as well as to record their presence in the coffee house in detail by means of personalized Space–Time prisms and their interaction by means of sketched seating arrangements in order to then represent human

interaction as a network (cf. Miller, 2007; Tang et al., 2020). It does not seem impossible to grasp the existence of a social identity by means of such a network, but the possibilities this opens up seem limited as they do not do due justice to the complexity of Polgar's description. Personal recommendations to visit this coffee house can be generated from the knowledge of the circle of friends of the person in question, but the question arises to what extent this characterizes the Café Central per se.

Social Media may provide access to a rich text and image-based description of a place, but this description is not readily available to methods of formal inference. The similarities and contrasts between the Café Central and other coffee houses described in Social Media provide context to the Café Central (cf. Hollenstein and Purves, 2010; Westerholt, 2019; Comber et al., 2018). Until these similarities and contrasts can, however, be fully represented and analyzed by formal means, the essence of the Café Central remains yet hidden from formal views.

Already this short excerpt of Polgar's description contains a multitude of concepts that cannot be represented in GISs and that currently used means of formal representation cannot capture, as has been argued. Any attempt to do so would hardly do justice to the true essence of this place as described by Polgar, especially because the description is rooted in the societal climate of Vienna at that time. This impression is reinforced through studying books (Ashby et al., 2013; Clayton, 2003; Cowan, 2005; Ellis, 1956, 2004; Grafe and Bollerey, 2007; Tjora and Scambler, 2013; Rittner et al., 2013; Segel, 1993) and further publications (e.g., Bar-Tura, 2011; Broadway et al., 2018; Montgomery, 1997; Sadler, 2011) about the role of coffee houses, and it also applies to many further examples of places.

4 A critical reflection of current approaches to platial information

The example of the Café Central illustrates well how challenging it is to represent places in appropriate ways, as has been discussed in the last section. This is despite the progress that is being made in Geographical Information Science and cognate fields towards a conceptual understanding and formal description of places. The present section ties in with this observation by being dedicated to the question of why there is this gap between the current means to represent places and what is needed to represent places in more adequate ways. To identify corresponding reasons, we critically reflect the predominant lines of thought in the ongoing discourse and their limitations, without, however, critiquing single publications.

Most lines of thought rely on well-established concepts. In Geographical Information Science, a number of concepts, especially geometric ones, have turned out to be particularly useful. The re-use of these concepts, therefore, seems obvious, such when using geometries to describe spatial aspects of Place (cf., e.g., Purves et al., 2019; Goodchild and Li, 2011), thus finally contributing to a representation of the locale. An epistemological reinterpretation of these concepts in the context of Place is, however, not commonly made. This manifests, among others, in the fact that the sharp dichotomy between spatial and thematic aspects typically found in Geographical Information Science remains a central part of the debate, without any room for a more interwoven understanding of these two aspects (cf., e.g., Blaschke et al., 2018; Jones et al., 2008; Hobel et al., 2016; Vasardani et al., 2013). Such an interweaving seems, however, natural as Human Geography and Social Science concepts of Space and Place are often considered to be socially constructed and thus being a relative notion (cf., e.g., Lefebvre, 1974).

Current approaches do not reflect well the geographical concepts of Place. It suggests itself that the geographical concepts of Place need to form the conceptual platform for describing common features of places as well as for understanding the effect places have on individuals and society, and on other places and geographical entities. This is why these concepts are accordingly referred to in the vast majority of publications. Yet, the geographical concepts are conceptually not well reflected in the

discourse as current means mainly engage with geometrical space and attached thematic information and thus often refer to POIs instead of places. This flaw does not come surprising in the light of Gahegan's diagnosis: 'the majority of geographical problems cannot be solved in GIS […]—the bigger agenda of enabling geographical research appears to be largely absent or in some cases still just an agenda' (Gahegan, 2018). Accordingly, current approaches to represent places and to understand platial information seem not to be *en par* with the corresponding geographical concepts. In particular, current approaches to understanding and dealing with platial information in formal ways neither adequately take into account the complexity inherent to places, which has, for example, been described by Hägerstrand (2009) in detail, nor are they able to capture well the intrinsic qualities of a place to the necessary extent.

Semantic and relational lines of thought do not reflect well what is specific to Place. Approaches related to geometrical space are commonly contrasted with approaches to achieve Place representations in new ways and thus differ from typical GIS-related means. Typically, these approaches refer to Place as a semantic concept, interpreted in the context of the Philosophy of Language. In this context, many scholars use such concepts only to provide a reference to a place, like in the case of Place names (cf., e.g., Vasardani et al., 2013; McKenzie et al., 2018), whereas others examine the ways these semantic concepts come into existence, such as via cognitive constructions (cf., e.g., Davies, 2018; 2020b). While such conceptual approaches allow to potentially better reflect the geographical concepts of Place, they currently do so only to a limited degree. The same applies to relational characterizations of places through the modelling of similarities, spatial configurations, and further links to other geographical entities, such as related to the notion of 'Place graphs' (cf., e.g., Chen et al., 2018b; Hamzei et al., 2018; Kim et al., 2017b). The question arises to what extent these notions – semantic and relational ones – are specific to Place. When referring to these approaches, it remains unclear what distinguishes Place from other geographical concepts. After all, the same or similar descriptions would apply equally to

locale, POIs, regions, and many further geographical concepts, and even beyond. The question of how to profitably characterize the identity of a place, its affordances, Place attachment, the personal experience of a place, and so forth remains yet largely open.

The existing body of publications on platial information remains yet unconnected. Although the publications to date mostly focus on individual aspects of Place, the body of literature touches upon a wide range of these. Among them are location and locale, the function of a place, and its affordances, while aspects like identity and experience seem to be essentially unaddressed so far. This is not surprising, since geographical concepts of Place also emphasize individual aspects without, however, abandoning a holistic view. It is therefore pivotal to ask how the individual approaches to platial information can be integrated to render more holistic views possible. Yet, the conceptual diversity of the approaches makes genuine integration difficult, which manifests in the fact that it is so far hard to impossible to reason beyond the boundaries of the various aspects.

The approaches to platial information referenced in Section III.3 provide solutions only within the context of their respective domains. It remains unclear to what extent the flaws outlined above can be addressed to eventually better understand and represent places as well as be able to draw appropriate conclusions about places. At the very least, a general strategy seems to be lacking and it appears questionable whether the approaches pursued so far can, in their current form, jointly lead to a suitable treatment of platial information.

IV Theories of Platial Information and Platial Information Systems

After the critical review of existing approaches to understanding platial information, the following sections are committed to future research perspectives. To provide the necessary framework and thus create common grounds for the intended discourse, we discuss in this section how theories and computational systems related to platial information can be conceptualized and integrated into the broader

context. In particular, we define the notions related to theories and systems in the context of platial information and discuss how these build on the geographical concepts of Place.

1 Theories and systems

The treatment of platial information in Geographical Information Sciences is currently still contradictory. Geographical views of place require holistic approaches that reveal the essential of a place in the interplay of its various qualities, while current approaches deal with individual qualities and often with respect to geometrical concepts. To resolve this dichotomy, it seems paramount to be clear about the conceptual objective. What should our means to treat platial information then look like?

The starting point for corresponding considerations could be the observation that places, like other geographical concepts, afford mental reasoning. We are able to argue which place we are in; we are able to describe in detail what is characteristic for a particular place; and we are often able to outline what distinguishes two places. Such mental interpretation, reasoning, and inquiring is possible because places are fundamental to our lives, making it necessary to argue about places with ease and adapt our mental reasoning capabilities to this context. The geographical discourse goes far beyond such 'naïve' approaches of everyday life. It is able to reason about a large number of places and in more complex ways by doing field work, conducting surveys, and carrying out interviews. Formal and computational approaches to Place are certainly limited in many aspects, but they can potentially support in drawing conclusions when the number of places or their complexity exceeds what we can handle with existing geographical methods.

Can and should future considerations, therefore, focus on solving practical problems? Based on the fact that the discourse is in the field of Information Science, this question needs to be answered in the negative, because first and foremost the discourse should also be about what constitutes the nature of platial information. However, since information serves the genuine function to convey mental concepts, a theory about the nature of platial information must also describe process-related aspects. In the context of formal means to address platial information, we thus introduce the term **Theories of Platial Information (ToPI)** to identify a coherent theory of how to reason with formally represented places. More specifically, we define a ToPI as a *coherent collection of formal means related to one or a combination of geographical concepts of Place to (1) conceptualize and then represent places, (2) analyze places, (3) answer questions about places, and (4) gain insights about places*. According to this definition, a loose collection of methods is not considered a ToPI, in particular, when they do not share common epistemological and conceptual grounds and do not mutually refer to each other. It should be noted that there exists potentially more than one ToPI – places can be described and handled in potentially different ways.

The practical implementation of a computer-based information system based on a ToPI should be distinguished from the latter. For both sometimes have different intentions and possibilities at their disposal. The theory lays theoretical foundations and facilitates formal considerations, whereas a system supports the practical processing of large amounts of data and thus provides answers to complex questions based on heterogeneous data. The question arises whether Geographical Information Systems are able to serve for that purpose already.

In its current form, Geographical Information Systems focus on spatial aspects and their attached thematic information,[8] which is why it would make sense to term them Geo-Spatial Information Systems instead. These do not only handle geometries with attached attributes at first hand, but also the operations implemented in these systems target geometries and spatial aspects for the most parts. The literature provided in a review article by Merschdorf and Blaschke (2018) demonstrates well that basically the same concepts found in a GIS are re-used to address platial information practically. It summarizes that '[…] place incorporates not only spatial aspects, but it is also invested with meaning' (Merschdorf and Blaschke, 2018). Further, place 'is still anchored within a spatial definition […], making it inherently derivative of space' (Merschdorf and Blaschke, 2018). Space seems to be the grounds on which

current approaches to practically deal with platial information are usually build (cf. Section lll.4).

In order to demarcate the perspective of an information system for platial information presented here from such previous mostly space-emphasizing approaches, we will employ the term **Platial Information System (PIS)**[9] in the following. Such a PIS is defined as *a system that implements a ToPI by technological means, thus allowing to capture, store, manipulate, analyze, manage, and communicate information about places*. These functions are in some sense analogous to a GIS (cf. Clarke, 1986), but they need to be implemented and interpreted in fundamentally different ways. A PIS needs to allow for semantically different paradigms in which spatial aspects do not dominate. The way it handles places must adapt to the way we think about Place, including their high complexity and the way they evade simple representation. Also, places have to be communicated in very different ways compared to how a GIS communicates geometries and its attached attributes, because it seems to be impossible to represent most aspects of a place in a traditional map or even by a geometry with attributes only. A PIS might rather communicate places and their joint context by other visual means, through audio, or even by making use of further components of the human sensory system. In this sense, PISs should probably not be contrasted by GISs as these do not intend to align well. They address different concepts with different underlying assumptions, which is why they can be expected to rather coexist and potentially complement each other.

2 Place concepts in Information Science

While the existence of Place is beyond question – they are among the fundamental units of both our lives and of modern Human Geography – there exist a number of concepts to understand these. Among the fields of enquiry that naturally engage into such concepts are Geography, because places constitute geographies; Geographical Information Science, because it concerns formal representations of geographical entities; Linguistics, in particular the Philosophy of Language and Computational Linguistics, because it reflects the way we create and use concepts; Psychology and Cognitive Science, because they examine how we react to our environment; Sociology, because it attempts to explain the social construction of places; and Philosophy, because it reflects about the fundamental units a place is constituted of. In the light of the various coexisting concepts of Place that dominate the scientific discourse, this section discusses their role with respect to ToPIs and PISs. For ultimately, these theories and systems facilitate different types of insights and task-related inferences depending on whether they are based on the sense of Place, Place attachment, or Space ballets. The same applies to the conceptualization in terms of the experience of a place, socio-spatial assemblages, and non-representational views.

Prior to proposing a ToPI, a choice needs to be made as to which concept of Place (or a combination thereof) is considered appropriate and on which concept the theory will be founded accordingly. Such a choice is crucial for the success of the theory, for it determines which qualities are reflected in it in the first place. This concerns both the qualities we need to survey in order to then make inferences by means of the theory, and the qualities about which the theory can ultimately make a statement. And it concerns the ontological and epistemological assumptions made and can lead to very different types of formal means. After a ToPI has been developed, the implementation in form of a PIS then relies on the ToPI and thus indirectly on the choice of the concept of Place. While the classical concepts of Place in Geography lend themselves – these were not proposed without reason – deviating choices might also be meaningful as long as they relate to Geography. In the end, it seems important to choose a concept that describes well what distinguishes places from other (geographical) entities and what makes places unique as a semantic category. Without assuming any particular concept of Place, approaches to platial information seem impossible, thus highlighting the need to clearly state which concepts of Place a ToPI refers to.

Different ToPIs and PISs may be developed, in particular, since different concepts of place can be assumed. The question, therefore, arises as to what extent these potentially developed theories are

compatible and in which aspects they differ. Even if several theories are founded on a single concept of Place, there is no reason not to believe that these potentially differ strongly, not least because different perspectives can be assumed with regard to semantics. Despite of this, such theories can be expected to share the epistemological foundations that the corresponding concept of Place makes. When theories, however, depend on different concepts of Place, they might reflect the similarities and differences between these concepts.

Even though the existing geographical concepts of Place partly contradict, especially with respect to their epistemological assumptions, many of these concepts can be considered being rather complementary. In that sense, they form part of a larger spectrum that focusses on different qualities of Place – they do not stay unconnected and it is often hard to demarcate them. This is why it can be conjectured that corresponding ToPIs reflect this spectrum well and are thus complementary in many cases. The analogy with vector and raster GISs is perhaps not far-fetched here, because these two flavours of GISs are fundamentally different and yet can be considered to form part of a larger conceptual framework, and the same can be expected for ToPIs.

Geography scholars often take a holistic view on Place to address its complexity. To take a similarly holistic view on platial information and ultimately be able to address places in their full complexity, a ToPI might accordingly be founded on a combination of Place concepts. In practical terms, this means that consideration must be given to which geographical and other concepts of Place can be aligned and, potentially, combined to then build theories and systems on the resulting multifaceted concept. Alternatively, several ToPIs that are founded on different concepts of Place might be combined at the level of Information Science. Yet, such an approach presumes the involved concepts of Place to be compatible with respect to their epistemic assumptions. This raises the question what the effect of such epistemic assumptions is on a ToPI and its several functions. Even more, it seems necessary to support our understanding of ToPIs by investigating how platial information is constituted and argued with, for instance, through frequent and thorough observation as is common in Human Geography, and through experiments as is common in other empirical disciplines.

3 Establishing Place as a new paradigm in Information Science

The various concepts of Place emerged as a natural necessity of the geographical discourse. Yet, they have only gradually found their way into Geographical Information Science. By that time,[10] geometrical concepts were already well established and widely used, often without questioning their limitations. In the spirit of Kuhn (1962: 43), geometrical concepts have formed a dominant paradigm that fundamentally influences the way Geographical Information Science scholars address platial information. Significant progress seems thus to be possible above all if the prevailing school of thinking is abandoned and a new paradigm established. In the following, therefore, several controversial questions will be outlined where such a new paradigm can and must set apart itself from established patterns of thought.[11]

Are places solely socially constructed while geometries are not? The ways cultural and social groups make sense of their environments and conceptualize complex geographies as places are often idiosyncratic. Based on the affordances of a place and shaped by our experiences, we get a sense of the place. Our perception is thereby not only shaped by our direct perception of the place and its qualities but also by social processes because we communicate via places and they are entering social contexts as meaningful geographical units of our mundane life. Such a social nature is also common to many geometries (cf., e.g., Smith and Mark, 2003). Not only are more complex entities such as country borders socially constructed, but even the geometries of simple geographical entities such as buildings are to some extent – social and cultural settings determine whether a geometry refers to the building footprint including cantilevered parts or to the area where the building connects to the ground, whether terraced houses are considered as a unit, and how the geometry representing the building is generalized (cf., e.g., Mayer et al., 2020). Despite this, there is a

tendency among Geographical Information Science scholars to assume that geometries are an immediate representation of physical reality, which can be seen by the way these are represented in GISs. The latter are yet highly successful despite widely ignoring the social nature of geometries when representing them. Carrying such assumptions over to the representation of places would, however, be fatal because they can basically only be understood by this idiosyncratic and social nature.

Is a notion of Place necessarily more vague than the notion used to describe geometries? It is often claimed that places are generally more vague than geometries (e.g., Blaschke et al., 2018; Gao et al., 2017; Hobel et al., 2016; Jones et al., 2008; Merschdorf and Blaschke, 2018; Montello et al., 2003; Papadakis et al., 2020; Wu et al., 2019). This circumstance stems from the observation that spatial extents of places are in many cases less clearly defined or at least fuzzy to some degree. It is thus usually implicitly assumed that places are vague in themselves, which becomes evident from the frequent reference to reasoning with vague concepts. In order to understand to which degree this is true, it is important to keep in mind that both geometries and places are entities, the conceptualizations of which allow for both clearly defined and vague examples. As will be outlined by examples in the following, all combinations of clearly defined and fuzzy geometries and places occur practically. First, the example of a city centre illustrates well that the spatial extent of a place can be fuzzy (cf. Montello et al., 2003; Hobel et al., 2016). Different people might disagree in where the city centre of a particular city is (hence the fuzziness inherent to the geometrical representation of the extent), while they might not disagree on the general idea of the city centre, assuming that they have a similar cultural background. The place itself is well defined and not very vague in this case. When, secondly, considering people who are not familiar with the idea of a city centre, the variation in how these people interpret the city centre as a place will be much larger. Thirdly, I pay my taxes in the Netherlands, which can be described well by a precisely defined (yet at least to the largest part socially constructed) boundary.[12] While virtually everyone agrees on this boundary, people have different ideas

about what it is to be like in the Netherlands and, even more important, people will not even have a conceptualization of a place matching exactly these boundaries. It is unclear whether the place they establish a mental association with stops at the geometrical boundaries, and, if allowing for some fuzziness in this aspect, people might even associate different places with the boundary: the Netherlands as a place to live in, a place to spend your holidays, or a place characterized by Dutch culture. In many cases, these places even mix to some degree. Fourthly, there are places both the conceptualization and the spatial extents of which are clearly defined. The place where you first kissed might be a table in a restaurant, in case of which there will be little doubt about how it felt to be at that place. Also, geographically, the place has a rather limited extent without much fuzziness. Summarizing and in contrast to what is often claimed, these examples demonstrate that general assertions concerning places and their vagueness are difficult to make.

The dichotomy of Place and Space. Only if the roles of Space and Place are conceptualized as being comparable, the relationship between them can be examined in a meaningful way. The examples outlined above discuss the way places are typically compared to geometries, leading to assumptions about fuzzy spatial extents and vague thematic boundaries. However, it must be questioned whether a conceptualization of such a relationship between places and spatial extents, often described as one-to-one, makes sense in general. Can places exist without a fixed spatial extent? Must a meaningful interpretation as a geographical place exist for each geometry? These questions need to be answered in the negative. Further, places and geometries are very different in the way they allow for changes of their qualities. Cruise ships as well as busses, trains, and other means of public traffic can lead to conceptualizations of non-stationary places. The same applies to places like shopping malls or even large parts of a town (e.g., Kiruna in Sweden) that are rebuilt at another location but align to the same idea of the previous place. While we would identify a particular bus (or other means of public traffic or rebuilt shopping malls) as constituting *one* place often independent of the change of its location, its orientation, or other qualities, the same does not apply to geometries in

its current form. Two geometries described by different sets of coordinates are usually interpreted as different geometries.[13] In addition, it can even be argued that there are places without any real geometrical extent, for example, in the context of books, film, computer games, or dreams (Iosifescu Enescu and Hurni, 2018; Iosifescu Enescu et al., 2020; Tateosian et al., 2020) as well as related to mediated and virtual geographies.

The dichotomy of Space and Place can be understood in at least two ways.[14] First, when talking about individual places, these are often contrasted by geometries. In this case, **Geometrical Space** as a collection of geometries needs to be contrasted with **Platial Space**, a collection of places. Secondly, Space as a concept is often contrasted with Place as a concept, in particular in the context of Geographical Information Science. Geometrical and related Spaces are the result of setting entities in mutual context by distance, and Place is the result of setting into thematic context the entities that constitute a place. When interpreted according to a Humanistic Geography paradigm, this argument acknowledges the much more complex idea of how a place comes into being through its various internal qualities and relations, making places complex on their own. Accordingly, this way of contrasting Space and Place is not symmetrical. Other interpretations, in turn, suggest that places should be conceived by their common relational context with other places – these other places are the entities that constitute the place in this case – also suggesting a more complex understanding. As outlined, the dichotomy between Geometrical and Platial Space, or between Space and Place, is more complex on closer inspection than what is commonly discussed in Geographical Information Science.

Are representations of a place necessarily communicated via maps or spatial datasets? Representations can be very diverse and information can be conveyed through a variety of media. It is reasonable to assume that representations of Space-related concepts are ideally communicated through media that are most appropriate for the representation of geometries, potentially with attached attributes. This also applies to Place when being interpreted in a Space-oriented way. A representation by means of open or closed polygonal lines of different lengths, combined with thematic attributes, seems to be

natural in this sense, thus rendering a cartographic communication of places efficient. The alignment with the Space-oriented paradigm even facilitates the re-use of existing spatial operations (e.g., union, intersection, clip, and buffer) and calculi (e.g., qualitative spatial calculi including the Egenhofer relations; Egenhofer, 1991; Egenhofer and Franzosa, 1991), as well as more complex methods based on them (cf., e.g., Albrecht, 1998). Yet, this comes at the cost of representations being less expressive with respect to non-spatial aspects. For example, maps do not have the same capabilities as narratives to tell stories involving places in such a way that deep emotions are aroused and the reader is gripped by the story (Mocnik and Fairbairn, 2018). Since ToPIs and PISs are founded on the geographical concepts of Place and therefore employ paradigms other than Space-oriented ones, new forms of representation need to be explored. Photographs, paintings, narratives, pieces of music, and other artistic media may be suitable representations of places, even if they have their own shortcomings. Which representation of a place is appropriate in the geographical context, beyond the Space-oriented paradigm often found in Geographical Information Science, remains yet to be investigated.

V Challenges to the development of Theories of Platial Information and Platial Information Systems

Obviously, it is far from trivial to develop a ToPI and establish a PIS – otherwise, they would already exist. This section reflects about the challenges such theories and systems are facing. We touch upon the complexity of platial information, intrinsic and emergent characteristics, and embodied experience.

1 Coping with the complexity of platial information

Places are complex geographical entities, and in a sense they are more complex than geometries, even if the latter are endowed with attributes (cf. Malpas, 1999: 157ff). This has many reasons. First, places emerge naturally by living them, while geometries of

human-made features are, in many cases and especially in the urban context, planned and then translated into physical features, such as in the case of squares, buildings, and roads. How such planned features are perceived, evoke emotions, create identity, and are lived in everyday life cannot be fully planned due to the nature and complexity inherent to such questions, but will only appear once the planning has been executed and the place has come alive. Secondly, geometries tend to refer to individual geographical features, whereas places typically provide reference to a collection of features and their collective characteristics. To deal with the complexity of the features involved and their mutual relationships, places are often described in more holistic ways. Thirdly, places are often to some degree idiosyncratic and individually shaped, while geometries are usually much less. All these factors contribute to the fact that geometries can be represented sufficiently well by existing means, while places tend to elude such representation.

Following this line of arguments, the complexity of places poses major challenges to the way we conceptualize Place. This complexity can be attributed in part to the number and diversity of the qualities of a place, but also relates in large part to the operations we can mentally perform with platial information. Current approaches to platial information, however, lack corresponding operations. In the light of places currently usually being represented as geometries with attached thematic information, the example of Central London and Brighton illustrates well how poorly geometrical operations such as the union operator fit approaches to platial information. The former of these places is a city global in nature facilitating a distinct urban mindset, the latter is a relatively quiet Victorian seaside resort. They differ in terms of their stress and noise levels and their man-made landscapes; as in how we experience them; and which memories we create about them. Even if the union of two geometries can easily be defined as the set of all points that are contained in either of the geometries, it is unclear what the 'union' of these two places could be. In particular, the question arises as to what constitutes 'a point in a place'. One might approach this question through the qualities of the two settlements, since they are much more than just geometries. The 'union' could be defined in reference to all locations that share qualities with either Central London or Brighton (existential quantifier), or, in analogy with the geometrical intersection, in reference to all locations that share the qualities of both Central London and Brighton (universal quantifier). Obviously, neither of these two possibilities would yield a (meaningful) place. When taking the 'union' with further places, one might, however, end up with Greater London as a metropolitan and strongly interconnected area, a place widely referred to. Intuitively, one might ascribe those qualities to Greater London that are typical for Central London or some of its neighbouring places, such as Brighton. It is, however, unclear whether Greater London can be described as some combination of Central London and its neighbouring places at all. This shows that the 'union' of two or more places is, if it can be defined in a meaningful way at all, more complex and not necessarily determined by the constituting places themselves. Such argumentation demonstrates that the structure of spatial information, including its operators, does not fit well the one of platial information, and that more sophisticated approaches are necessary to address the complexity inherent to platial information.

2 Reflecting intrinsic and emergent qualities

Places, like other entities, can in principle be represented in two ways: by external relations or internal qualities. The former refers to both mutual relationships between places and relationships to other entities, such as relations that compare. How useful this can be even in the context of internal qualities, is evident in the questions we typically ask to learn about a film: does the title remind of another film?; is the cast or the plot of the film similar to another film?; what genre is the film?; et cetera. As a result and similar to the example about films, one might expect at least some internal qualities to be encoded in external relations.

One of the reasons why external characteristics capture only a limited number of internal qualities is their large and practically unknown quantity. Relations are comparably simple to formalize, but internal qualities seem to be necessary to capture how we cognitively

relate to a place. As places are a product of human thinking and have meaning to people, it is these internal qualities that matter. Only if our representations of places include some notion of their identity and other qualities that manifest themselves in the broader context of meaning and personal importance, such representations become powerful. It is yet unclear how to represent qualities like the sense of Place, because they can, for instance, not be well reflected on a numeric scale.

Intrinsic qualities may, in turn, be explained by the interplay of the entities that constitute a place. Such strategies can, for instance, approach a characterization of the affordances and functions a place has through its relevant POIs. In the case of other internal qualities, however, it is to be assumed that these only become evident in the overall context of the place and cannot be readily explained on the basis of its individual constituents. Such *emergent* qualities play a role, for instance, in the context of shared identities, the latter of which can often only be explained by complex dynamics rather than single constituents. Also, qualities that are mainly explained by the emergence of a place are often emergent in nature, as is the case when two almost identical places develop in different ways over time.

3 Representing the multifacetedness through multiple dimensions

Places are characterized in diverse ways in mundane life and in the geographical literature. Yet, current approaches to formally represent places ignore many of its qualities but tend to focus only one of these, thus falling short of the way a human is able to reason about places. This is no coincidence, because a single dimension of characterization (apart from identifiers) is neither sufficient to uniquely identify a place nor to gain a more complex understanding of it. This raises the question of how a multifaceted representation can be achieved.

The conceptual spaces as introduced by Gärdenfors (2000) are an obvious solution to the more multifaceted representation, as they allow for the flexible combination of a host of dimensions. Other solutions of reflecting the multifacetedness in the representation might expose the single dimensions to a lesser degree and represent the various aspects only in combination, as often happens when conveying a place through the

use of language – textual descriptions tend to refer to a number of aspects, which, however, only become meaningful in combination. Regarding both possibilities, one has to ultimately ask oneself how the different aspects and relations stand in relation to each other. It is only by integrating the various aspects that they can be used efficiently to draw complex conclusions. Can, for instance, a meaningful concept of distance between two places be introduced for a conceptual or abstract space? And are there ways to draw conclusions based on a combination of aspects only, rather than referring to them individually?

4 Embodied experience and an epistemic critique to the formalization of Place concepts

The fragrant grass of a freshly mown meadow, where you sit watching the sunset towards the night. The place that means freedom and lets you feel *yourself* in every fibre of your body. The place where the sun on your body during the day makes you forget your rain-soaked hair and puts a smile on your face, knowing that you can retreat from mundane life here and only here in this my favourite place, and unfold in a way that is not possible anywhere else. I can experience and savour this atmosphere, but it is hard to put into words. Ultimately, it can be doubted whether this facet of the place can be represented by formal means at all, for instance, in the sense of being able to answer all relevant questions about this place, because it is about embodied experience.

If places only become meaningful by interacting with and experiencing them, a position favoured by many Critical Geography scholars and poststructuralists, does this not prove formal representations of places to be nothing more than an empty shell, given that embodied experience cannot be represented sufficiently well? Such thinking implies that formal representations of places are not only incomplete but also insufficient. They only represent what is obvious or not needed, but the essential characteristics of Place, that is, what makes a place, might be missed. Based on this way of thinking, it can be claimed that the currently predominant conceptualizations of Place prevailing in Geographical Information Science are in part incommensurable with those found in Geography, which makes the establishment of new perspectives indispensable.

These arguments are opposed by the fact that even a chain of arguments that refer to formal symbols, acting as references, can lead to meaningful conclusions. Consider the example of web search engines. Without understanding the content of the searched websites, these engines can identify the websites that are of interest to the user solely by matching the contained text fragments,[15] which act as references to real entities. The query 'coffee house in Vienna' returns, for instance, text extracts from websites about coffee houses in Vienna, including corresponding links. Since the texts offered on the websites have been written by humans, we can, as humans, interpret them in a meaningful way, even if they are only shown in fragments on the result page of the search engine. This illustrates well that this process of grounding symbols (like text in the above example) in meaningful entities can attach meaning to the symbols. The same mechanism applies to geometries processed in GISs. Aalbers (2014a,b,c) has indeed argued that maps can convey places to some extent, and that they have, besides descriptive and prescriptive qualities, also performative ones. Further, the success of such groundings is in line with empirical studies that have investigated the entanglement of abstract knowledge and practical experience in the context of Space and Time (Boroditsky and Ramscar, 2002).

The argument about abstract knowledge and practical experience being entangled appears, however, flimsy in that personal experience and idiosyncratic feelings do not seem to be readily inferred from the interpretation of formal symbols. Would we read only the names of the songs at a party instead of playing the music? This question demonstrates well the difference between experience and representation. Nothing stands in the way of a formalization of the concept of Place, but it needs yet to be explored to which degree in-place feelings can, if at all, be replaced by reference to prior experience or even to more abstract knowledge. Acknowledging the universal incompleteness of platial and geographical information (Couclelis 2003), it thus needs to be examined in more detail which of the many facets of the Place concepts in general and of individual places in particular elude a formal representation, and which ones can be conveyed this way.

VI Classification of Theories of Platial Information and Platial Information Systems

Now that we have introduced the notions of ToPIs and PISs as well as summarized the challenges we face when implementing such theories and systems, this section reflects how they can be put into the wider context. More specifically, we discuss ways to classify these theories and systems to then reason about how to assess their success.

1 Complexity and strength

A meaningful way to classify ToPIs and PISs is to consider the questions they are able to address.[16] To highlight the similarities to and differences from a GIS, their widely varying capabilities for addressing questions are discussed in comparison below. In most cases, GISs are able to answer simple questions that only require basic operations, such as topological relations or the distance between two geometries (see Questions Q1' and Q2' in Table 1). The same can be expected to be true for PISs, for which analogous questions exist (see Questions Q1). A corresponding Question Q2 is, however, more complex in that it asks about the qualities of a place. Even more complex questions can though involve even more entities and operations. They can, again, be answered by a GIS (see Question Q3') or a PIS (see Question Q3). The more complex the questions become, for example, in terms of the number of involved entities, the ways these relate, the length of the answer, the less obvious it seems to be whether analogies between questions for PISs and GISs exist. For instance, Question Q4 seems to lack a corresponding analogy, because concepts like 'importance to people' make less sense for geometries and are multifaceted – what importance means depends on experience, salience, identity, and many further factors. In the following, I refer to a PIS that is able to answer such complex questions as **complex,** otherwise as **simple**.

Besides the varying complexity of questions, PISs also vary with respect to the type of questions they are able to answer. In particular, some systems may

Table 1. Exemplary questions a PIS or GIS is able to answer. GIS-related questions are printed in italic.

Simple questions

Am I in Enschede?	(Q1)
Is my current position contained in the area of Enschede Municipality?	(Q1')

Medium-complex questions

I wanted to go to restaurant X, which is closed. Is there another one nearby to invite my Belgian business partners to, a restaurant that has the same cosy and intimate atmosphere and reminds me in a similar way of my last trip to Belgium, thus making me smile and being relaxed?[17]	(Q2)
Where is the Belgian restaurant closest to my current position?	(Q2')
Is Vienna's district 'Landstraße' a nice place to buy a house to live in, where I feel at home after only a short while, which allows me to overcome my bad feelings of having to move away from Münster, and which allows me to make friends easily?	(Q3)
Where in 'Landstraße' can I find a parcel of land of sufficient size and shape to place a house of a certain size in? In which orientation, what is the average income in the area, and how far away is the next underground station?	(Q3')

Complex questions

In which ways did the relative importance of the various coffee houses in Vienna to their visitors in terms of their experience, salience, and identity change over time, and why so?	(Q4)

Questions referring to internal qualities

How has the Ruhr transformed in the last 30 years?	(Q5)
Why has the Ruhr transformed in the way it did in the last 30 years?	(Q6)
Why did Polgar particularly appreciate the Café Central?	(Q7)
How did the Wiener Moderne influence the atmosphere of the Café Central?	(Q8)

be able to answer questions about external qualities only, that is, about mutual relations between places and relations to other entities represented. When two places shall be set into their mutual context, for instance, such questions arise naturally, such as the question how two coffee houses spatially relate, whether they are similar as places, or how a coffee house relates to Vienna as a place. These questions are in contrast to those that refer to internal qualities explicitly, such as many questions about changes of a place itself or about its identity (cf., Questions Q5 to Q8). While knowledge about internal qualities of a place can be helpful even in case the question refers to external qualities of the place only, such knowledge is obviously required if the question refers to internal properties. To indicate the level of representation and reasoning of a PIS, we call the PIS **weak** if it is only able to represent and handle external qualities in the reasoning process, while it is

called **strong** if it is able to handle internal qualities as well.[18]

Following the terminology introduced above, only strong PISs are able to answer questions about internal qualities. It seems, however, to be less clear at first hand whether weak and strong PISs are equally powerful in the context of questions about external qualities.[19] That is, whether weak PISs exist that are able to answer questions about external qualities equally well as strong PISs. A positive answer to this question is tantamount to the existence of translation mechanisms between two different descriptions of a place in the following sense: If places can be uniquely[20] represented by two different sets of aspects, this would mean that there exists a (unique) translation mechanism between these two sets of aspects with respect to places. Assuming that one of these sets contains internal qualities while the other does not, the PISs dealing with the respective sets are

potentially equally powerful if they provide sufficient means to reason with the aspects contained in these sets. If, however, such a unique translation mechanism and thus such equivalence in the described sense does not exist, weak and strong PISs would be differently powerful. An answer to this equivalence question might not exist in general. Rather than focussing on the general situation, one might ask whether equivalences exist with respect to certain aspects only. Is it possible, for instance, to guess, at least to some degree, the sense of a place that we know the affordances of (cf. Raymond et al., 2017)?

2 Comparison to current implementations

Current implementations of information systems can manage representations of places to some extent and answer questions using these (Figure 2). Among these are GISs, which are typically only able to answer simple questions about external qualities of spatial aspects of places. This is because they lack suitable representations of the internal qualities of places as well as more complex reasoning mechanisms. Qualitative Spatial Reasoners (QSR), in turn, provide the means to answer more complex questions based on the description of external, that is, relational, qualities of places (cf. 'Place graphs'; Chen et al., 2018a, 2018b; Hamzei et al., 2018; Kim et al., 2015, 2017a, 2017b; Kremer, 2018). However, they focus on spatial qualities and have to deal with high computational complexity (cf., e.g., Fogliaroni, 2013). Linked Open Data (LOD) is able to, in principle, provide reference to internal properties, such as formal reference to a limited set of emotions and sentiments (Sánchez-Rada and Iglesias, 2016; Westerski et al., 2011), and makes possible to draw conclusions about these by the use of formal reasoners. Despite of these theoretical capabilities, existing vocabularies and inference rules are rather limited, in particular, because theoretical foundations of how to represent and reason about places in a way compatible to the geographical concepts of Place – central aspects of a ToPI – are yet missing. In its current form, LOD seems at best to be appropriate for medium-complex questions only.;

It becomes apparent from these examples that simple, weak PISs *should* easily be possible because
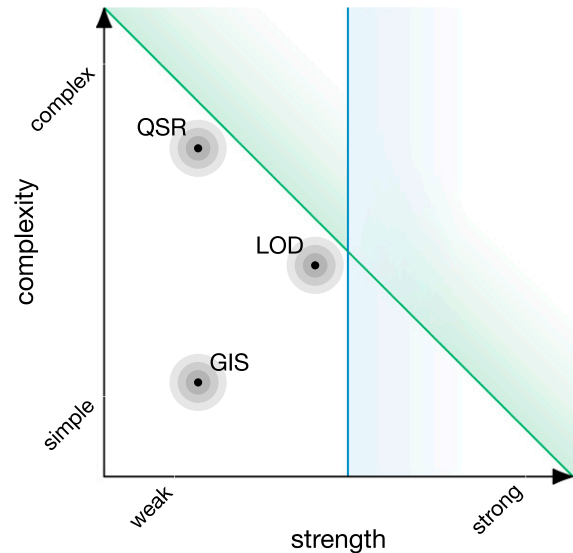
Figure 2. Complexity and strength of Platial Information Systems (PISs). Displayed are three currently available information systems, which are not PISs as they do not align well with the geographical concepts of Place: Geographical Information Systems (GIS), Spatial Qualitative Reasoners (QSR), and reasoners making use of Linked Open Data (LOD). The blue and green lines indicate the main challenges for PISs: how to improve the representation of intrinsic qualities (blue vertical line); and how to combine these with complex reasoning (green diagonal line).

they only need to offer *reference* to places. What turns out to be more difficult are approaches to enable a complex *understanding*, especially of individual places. Current implementations of information systems are still no PISs as they do not specifically relate to a geographical concept of Place, as has been argued. Extrapolating from previous and current developments, future efforts towards ToPIs and PISs thus face, besides relating to a geographical concept of Place, two main challenges: first, how to improve the representation of intrinsic qualities; and secondly, how to combine these with complex reasoning (Figure 2).

3 Assessing the success

Finally, the question arises how a ToPI can be evaluated and what it must ultimately achieve in view

of such an evaluation. The simplest level of checking how powerful a ToPI is could be to examine the answers generated by this theory for given questions (cf. Hamzei et al., 2019). The more questions can be answered in a meaningful way and the more precise and appropriate these answers are, the more powerful the ToPI. Answers alone might, however, not provide suitable means to evaluate a ToPI because the understanding of places seems to be more complex than being able to find suitable answers to questions that involve places. Another less simple test might be whether examples of special places with partly uncommon characteristics can be represented and discussed, such as places described in dreams, computer games, in TV or radio, and in books. One might even ask whether 'nowhere' has some characteristics of a place and can be approached accordingly.

Theories often provide more than predictions and answers. For instance, they can, to a varying degree, provide an understanding of *why* something is the case. This difference reminds of the thought experiment of the Chinese room (Searle, 1980) if applied to a theory instead of a human being: can the semantic and syntactic richness and corresponding abilities of a theory be understood only by answering questions? An evaluation of a ToPI should, among others, test which more complex issues the theory is able to address, such as feedback loops in the context of places and platial information. These occur, for instance, if the identity of a place highlights the importance of the place, which then makes the place become socially more salient and, in turn, strengthens the identity of that place. Can such self-enforcement of an identity be understood by means of a particular ToPI? In view of these and many other complex aspects of platial information, a ToPI faces the question of whether it can adequately deal with this complexity. Future developments will show whether ToPIs are able to address these issues in meaningful ways.

In view of a ToPI as a mediating instance between the place representations we create and the conclusions we derive from these by the means of the theory (and possibly with the help of a PIS), it seems rather complex to evaluate the theory. This can be seen by the fact that a ToPI (and a corresponding PIS) must relate to the fundamental characteristics of places – hence the central role of Place concepts – but that it can also be tested on such characteristics, especially if it is not directly based on them. For instance, one might expect that a theory provides an understanding as to which places are perceived as salient. Is there a need to provide such information to a corresponding PIS, or can the ToPI infer salience from other human-related aspects of a place? In the context of a particular ToPI, can we, for example, conclude that if slightly different places are linguistically referenced in a similar way such as with the same Place name by different people, this already indicates a higher probability that these places or their common core have high social salience?

Furthermore, a ToPI can be assessed by checking to which degree it is able to explain why some places form part of mundane life and are socially embedded while others might be irrelevant for many people except for a few due to their idiosyncratic character. Such a question might, again, relate to the characteristics we provide to the theory, or they might be inferred from the theory. In the latter case, the theory might, for instance, discuss whether some places are on the 'basic level' of cognitive classification, in the sense of Rosch (1978). Such thinking is at least suggested by Smith and Mark (2003), who describe how 'the child conceptualizes the geographic world', thus gaining an understanding of 'the environment […] that allows him or her to get from place to place'. If a ToPI refers to the dichotomy of primary and secondary theory in the sense of Horton (1993), can this even explain why some places form part of our mundane life while others do not? For instance, 'a primary theory of mountains may be absent or underdeveloped in isolated flatland communities' (Smith and Mark, 2003), which suggests that an understanding of a place and whether it is described well by primary or secondary theories depends on where people live and which culture they have. A ToPI can accordingly be assessed by checking whether it enables such lines of thought, whether these are coherent and align well to the considered concepts of Place, and what type of information a ToPI is able to infer.

VII Conclusions

How can we develop a theory that is adequate for the treatment of platial information, including formal

means expressive enough to represent places? Some solutions have been proposed in the literature without actually going beyond the status of a proposal – they do not align well with geographical concepts of Place but rely on well-established Information Science concepts and thus do not reflect what is specific to Place. More profound theories and corresponding knowledge about the nature of platial information, including the representation of places and their various qualities, appear to be still far away. The central problem seems finding a suitable language. This does not only concern the (partly known) elements of which this language should consist, but it must also describe their interrelationships, the 'inner mechanics', in a suitable way. As a result of an expressive and efficient language, Theories of Platial Information (ToPI) and corresponding Platial Information Systems (PIS), two concepts introduced in this article, might be developed.

The Café Central in Vienna is an example of a place that demonstrates well how complex a place can be, as has been discussed in this article. Not without reason is the geographical understanding of places multifaceted, a fact that is reflected in the existing variety of Place concepts. A proper understanding of places by means of a few basic properties seems therefore impossible. The situation is rather complex. Several Place concepts form part of the geographical discourse, which seem, in parts, to be incommensurable. The question therefore arises as to which geographical concepts of Place a formal representation should take into account. In view of the many good reasons to have several concepts of Place in the geographical discourse, it is difficult to imagine that a formal representation limited to only one geographical concept can be meaningful alone. At the same time, it is unclear how a formal representation can focus on several concepts if these appear to be partly incommensurable. How can corresponding ToPIs that describe places in a meaningful way and render complex considerations possible then look like? When such ToPIs have been found, they might even help to uncover epistemological contradictions when assuming several concepts of Place at the same time.

In this article, current approaches to platial information have been set into context, to then conclude why future approaches can and should be more than what is currently being discussed. In particular, it has been argued why future approaches need to refocus on the geographical concepts of place, thus making a paradigm shift from spatial towards platial information necessary. Besides such re-focussing, there are many further challenges that need to be properly addressed to eventually establish ToPIs and PISs, as has been outlined. The success of such efforts can finally be assessed in terms of complexity and strength, two dimensions of such theories and systems.

Future developments will show whether a ToPI can be meaningfully established at all and which combinations of geographical Place concepts are most adequate to build a theory on, or whether it is even more suitable to employ several such theories side by side to answer all relevant questions. Following on from this, the question arises as to which aspects of Place a ToPI needs to refer to in order to align well with the geographical concepts. For instance, does such a theory need to capture in detail how people think about places, or is it sufficient to understand which affordances a place has or how people actually act in a place? Particular attention should thereby be paid to the quality and clarity of the conceptualization of these aspects and whether it allows for hypothesis testing and empirical studies. The latter seem to be a particularly suitable means to establish firm grounds for ToPIs, because these studies are a bridge to lived Place and thus our thinking about Place. In the optimal case, ToPIs could deepen and make more detailed our understanding of the concepts of Place themselves, and, in turn, lead to a better understanding of platial information. From this, ToPIs can be expected to even lead to the implementation of PISs, allowing practical questions about places to be answered and everyday problems to be solved. In the end, the success of PISs must be judged by our human understanding of places and by how they can increase our understanding thereof. Through the effect they may have on personal life, PISs could even gain societal relevance.

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ORCID iD

Franz-Benjamin Mocnik https://orcid.org/0000-0002-1759-6336

Notes

1. To highlight the difference between concepts and instances, all concepts central to this article are capitalized in the following, such as 'Place' and 'Space'.
2. Both 'platial' and 'placial' have been used in the literature as adjectives to place (cf., e.g., Cho and Yuan, 2019), much in analogy to 'spatial' and 'spacial' as adjectives to space. In this article, we use the spelling 'platial', which was, according to Wagner et al. (2020), used by Casey (1993) for the first time in the geographical discourse about places.
3. Among others, the PLATIAL Symposium Series (PLATIAL'21; PLATIAL'19: Mocnik and Westerholt 2020; Westerholt and Mocnik, 2020; PLATIAL'18: Westerholt et al., 2018c,b), a Symposium on the Psychology of Places (https://sites.google.com/view/psychology-of-places), the IAOA Summer Institute on 'Places and Things' (http://www.geographicknowledge.de/iaoa-summer-institute), the International Workshop on 'Computational Models of Place' (COMP 2013: Scheider et al., 2014), the International Workshop on 'Place-Related Knowledge Acquisition Research' (P-KAR 2012: Vasardani et al., 2012), and the Workshop on 'Modeling Place in Information Systems' (Winter et al., 2009).
4. Among others, a Special Feature in the *Journal of Spatial Information Science* on 'interdisciplinary perspectives on place' (Mocnik and Westerholt, 2021a) and Special Issues in *Transactions in GIS* on 'modelling and analysing platial representations' (Westerholt et al., 2020), in the *MDPI International Journal of Geo-Information* on 'place-based research in Geographical Information Science and Geoinformatics', and in *Spatial Cognition and Computation* on 'computational models of place' (Winter et al., 2009).
5. In the remainder of this article, we use the term 'qualities' in the way this notion is commonly used in Philosophy, a concept ultimately having its roots in works by Aristotle (cf., e.g., Cargile, 2005).
6. Many of the publications referenced in this section refer to more than one strand.
7. Polgar's description was written in 1926 but first published in 1983. The translations of the quotations included in this article are by Segel (1993: 267f).
8. It should be noted that the roles of spatial and thematic information are an effect of their conceptualization. Geographical Information Science in its current form usually favours 'spatial information with attached thematic information' perspectives rather than 'thematic information with attached spatial information' ones, or even perspectives in which both types of information play a tantamount role.
9. Here, PIS should be understood as an *initialism* and therefore be pronounced as [pʰiːaɪɛs], much in analogy to GIS [dʒiːaɪɛs].
10. The concept of Place first attracted greater attention among Geographical Information Science scholars in the mid-2010s.
11. The fact that a dominant paradigm is unchallenged means that it is not always made explicit in the discourse. For this reason, only a limited number of references are given for the aspects outlined in the following.
12. It should be noted that the common border with Germany in the area of the Ems estuary is by no means clear. A treaty signed in 2014 merely represents a pragmatic compromise on practical issues, whereby, at the express wish of both parties, no official clarification has been made on the question of the course of the border, which thus remains unclear (König and tho Pesch, 2013; tho Pesch, 2016).
13. It needs to be noted that this only holds under the assumption that suitable local coordinate systems are

used in order to avoid plate tectonic issues. (cf., Mocnik and Westerholt 2021b; Mocnik and Raifer 2018).

14. The network model discussed by Mocnik (2015, 2018, 2020) and Mocnik and Frank (2015) establishes an alternative view on how Euclidean Space and socially constructed Space relate.

15. It needs to be acknowledged that today's web search engines make use of slightly more complex algorithms.

16. There exists a number of meaningful classifications. Here, we restrict to two important ones that allow for a comparison to existing information systems.

17. It should be noted that such type of questions cannot only be answered by 'yes' or 'no' but also by more complex answers, such as 'You might want to check Proeflokaal België, but it might not have the right atmosphere for taking out your business partners'.

18. The concepts of complexity and strength defined here also apply to ToPIs analogously.

19. This question relates, at least to some degree, to the debate on Structural Realism (e.g., Worral, 1989) and its various variants (cf. Ladyman, 1998; Frigg and Votsis, 2011).

20. The term 'uniquely' refers to the fact that the representation of the place already describes the place to its full extent in the sense that only one such place exists that can be described in this way.

References

Aalbers MB (2014a) Do maps make geography? Part 1: redlining, planned shrinkage, and the places of decline. *ACME: An International Journal for Critical Geographies* 13(4): 525–556.

Aalbers MB (2014b) Do maps make geography? Part 2: post-Katrina New Orleans, post-foreclosure Cleveland and neoliberal urbanism. *ACME: An International Journal for Critical Geographies* 13(4): 557–582.

Aalbers MB (2014c) Do maps make geography? Part 3: reconnecting the trace. *ACME: An International Journal for Critical Geographies* 13(4): 586–588.

Acedo A and Johnson PA (2020) Home range and habitat: using platial characteristics to define urban areas from the bottom up. *Transactions in GIS* 24(4): 819–841. DOI: 10.1111/tgis.12597.

Acedo A, Painho M, Casteleyn S, et al. (2018) Place and city: toward urban intelligence. *ISPRS International Journal of Geo-Information* 7(9): 346. DOI: 10.3390/ijgi7090346.

Adams B and McKenzie G (2013) Inferring thematic places from spatially referenced natural language descriptions. In: Sui DZ, Elwood S and Goodchild MF (eds) *Crowdsourcing Geographic Knowledge: Volunteered Geographic Information (VGI) in Theory and Practice*. Dordrecht, the Netherlands: Springer, 201–221. DOI: 10.1007/978-94-007-4587-2_12.

Agarwal P (2005) Operationalising 'sense of place' as a cognitive operator for semantics in place-based ontologies. In: Proceedings of the 7th Conference on Spatial Information Theory (COSIT). *Spatial Information Theory*: 96–114. DOI: 10.1007/11556114_7.

Agnew JA (1993) Representing space: space, scale and culture in social science. In: Duncan J and Ley D (eds) *Place/Culture/Representation*. London, UK: Routledge, 251–271.

Agnew JA and Duncan JS (eds). (2015) *The Power of Place: Bringing Together Geographical and Sociological Imaginations*. London, UK: Routledge. DOI: 10.4324/9781315848617.

Albrecht J (1998) Universal analytical GIS operations – a task-oriented systematization of data structure-independent GIS functionality. In: *Geographic Information Research. Transatlantic Perspectives*. London, UK: CRC, 577–592.

Ashby C, Gronberg T and Shaw-Miller S (2013) *The Viennese Café and Fin-De-Siècle Culture*. New York, NY: Berghahn.

Ballatore A (2016) Prolegomena for an ontology of place. In: Onsrud H and Kuhn W (eds.) *Advancing Geographic Information Science*, Chapter 7. Needham, MA: GSDI Association Press, 91–103.

Ballatore A and De Sabbata S (2020) Los Angeles as a digital place: The geographies of user-generated content. *Transactions in GIS* 24(4): 880–902. DOI: 10.1111/tgis.12600.

Bar-Tura A (2011) The coffeehouse as a public sphere. In: Parker SF and Austin MW (eds) *Coffee. Philosophy for Everyone. Grounds for Debate*. Malden, MA: Wiley-Blackwell, 89–99. DOI: 10.1002/9781444393385.ch7.

Bennett B and Agarwal P (2007) Semantic categories underlying the meaning of 'place'. In: Proceedings of

the 8th Conference on Spatial Information Theory (COSIT): 78–95

Blaschke T, Merschdorf H, Cabrera-Barona P, et al. (2018) Place versus space: from points, lines and polygons in GIS to place-based representations reflecting language and culture. *ISPRS International Journal of Geo-Information* 7(11): 452. DOI: 10.3390/ijgi7110452.

Boroditsky L and Ramscar M (2002) The roles of body and mind in abstract thought. *Psychological Science* 13(2): 185–189. DOI: 10.1111/1467-9280.00434.

Broadway M, Legg R and Broadway J (2018) Coffee-houses and the art of social engagement: an analysis of Portland coffeehouses. *Geographical Review* 108(3): 433–456. DOI: 10.1111/gere.12253.

Calafiore A, Boella G, Grassi E, et al. (2018) Turin's foodscapes: exploring places of food consumption through the prism of social practice theory. In: Proceedings of the 1st Workshop on Platial Analysis (PLATIAL'18): 37–43. DOI: 10.5281/zenodo.1472743.

Caquard S and Cartwright W (2014) Narrative cartography: from mapping stories to the narrative of maps and mapping. *The Cartographic Journal* 51(2): 101–106. DOI: 10.1179/0008704114Z.000000000130.

Cargile J (2005) Qualities. In: Honderich T (ed) *The Oxford Companion to Philosophy*. 2nd edition. Oxford, UK: Oxford University Press, 775.

Casey ES (1993) *Getting Back into Place: Toward a Renewed Understanding of the Place-World*. Bloomington, IN: Indiana University Press.

Casey ES (2002) *Representing Place. Landscape Painting and Maps*. Minneapolis, MN: University of Minnesota Press.

Chen H, Winter S and Vasardani M (2018a) Georeferencing places from collective human descriptions using place graphs. *Journal of Spatial Information Science* 17: 31–62. DOI: 10.5311/JOSIS.2018.17.417.

Chen H, Vasardani M, Winter S, et al. (2018b) A graph database model for knowledge extracted from place descriptions. *ISPRS International Journal of Geo-Information* 7(6): 221. DOI: 10.3390/ijgi7060221.

Chen H, Vasardani M and Winter S (2019) Clustering-based disambiguation of fine-grained place names from descriptions. *GeoInformatica* 23(3): 449–472. DOI: 10.1007/s10707-019-00341-6.

Cho S and Yuan M (2019) Placial analysis of events: a case study on criminological places. *Cartography and Geographic Information Science* 46(6): 547–566. DOI: 10.1080/15230406.2019.1578265.

Clarke CK (1986) Advances in geographic information systems. *Computers, Environments and Urban Systems* 10(3–4): 175–184. DOI: 10.1016/0198-9715(86)90006-2.

Clayton A (2003) *London's Coffee Houses. A Stimulating Story*. London, UK: Historical Publications.

Comber A, Butler A, Malleson N, et al. (2018) Quantitative platial analysis: methods for handling and representing platial heterogeneity and linking varying concepts of places. In: Proceedings of the 1st Workshop on Platial Analysis (PLATIAL'18): 7–14. DOI: 10.5281/zenodo.1472735.

Couclelis H (1992) Location, place, region, and space. In: Abler RF, Marcus MG and Olson JM (eds) *Geography's Inner Worlds. Pervasive Themes in Contemporary American Geography*. New Brunswick, NJ: Rutgers University Press, 216–233.

Couclelis H (2003) The certainty of uncertainty: GIS and the limits of geographic knowledge. *Transactions in GIS* 7(2): 165–175. DOI: 10.1111/1467-9671.00138.

Cowan B (2005) *The Social Life of Coffee: The Emergence of the British Coffeehouse*. New Haven, CT: Yale University Press.

Cresswell T (2004) *Place. A Short Introduction*. Malden, MA: Blackwell.

Davies C (2018) Place and placing locations: a cognitive perspective. In: Proceedings of the 1st Workshop on Platial Analysis (PLATIAL'18): 15–20. DOI: 10.5281/zenodo.1472737.

Davies C (2020a) Place-based knowledge systems: human and machine. In: Proceedings of the 2nd International Symposium on Platial Information Science (PLATIAL'19): 33–41. DOI: 10.5281/zenodo.3628865.

Davies C (2020b) Places as fuzzy locational categories. *Acta Psychologica* 202: 102937. DOI: 10.1016/j.actpsy.2019.102937.

Dovey K (2010) *Becoming Places: Urbanism/Architecture/Identity/Power*. London, UK: Routledge.

Duncan JS and Ley D (eds). (1993) *Place/Culture/Representation*. New York, NY: Routledge.

Edwardes AJ and Purves RS (2007) A theoretical grounding for semantic descriptions of place. *Web and Wireless Geographical Information Systems*: 106–120. DOI: 10.1007/978-3-540-76925-5_8.

Egenhofer MJ (1991) Reasoning about binary topological relations. *Proceedings of the 2nd International Symposium on Advances in Spatial Databases (SSD):* 141–160. DOI: 10.1007/3-540-54414-3_36.

Egenhofer MJ and Franzosa RD (1991) Point-set topological spatial relations. *International Journal of Geographical Information Systems* 5(2): 161–174. DOI: 10.1080/02693799108927841.

Egenhofer MJ and Mark DM (1995) Naive geography. *Proceedings of the 2nd Conference on Spatial Information Theory (COSIT):* 1–15. DOI: 10.1007/3-540-60392-1_1.

Ellis A (1956) *The Penny Universities. A History of the Coffee-Houses*. London, UK: Secker & Warburg.

Ellis M (2004) *The Coffee House. A Cultural History*. London, UK: Weidenfeld & Nicolson.

Fogliaroni P (2013) *Qualitative Spatial Configuration Queries. Towards Next Generation Access Methods for GIS*. Amsterdam, the Netherlands: IOS.

Frigg R and Votsis I (2011) Everything you always wanted to know about structural realism but were afraid to ask. *European Journal for Philosophy of Science* 1(2): 227–276. DOI: 10.1007/s13194-011-0025-7.

Gahegan M (2018) Our GIS is too small. *The Canadian Geographer/Le Géographe Canadien* 62(1): 15–26. DOI: 10.1111/cag.12434.

Gao S, Janowicz K, Montello DR, et al. (2017) A data-synthesis-driven method for detecting and extracting vague cognitive regions. *International Journal of Geographical Information Science* 31(6): 1–27. DOI: 10.1080/13658816.2016.1273357.

Giordano A and Cole T (2020) Places of the Holocaust: towards a model of GIS of place. *Transactions in GIS* 24(4): 842–857. DOI: 10.1111/tgis.12583.

Goodchild MF (2011) Formalizing place in geographic information systems. In: Burton LM, Matthews SA, Leung M, et al. (eds) *Communities, Neighborhoods, and Health. Expanding the Boundaries of Place*. New York, NY: Springer, 21–33. DOI: 10.1007/978-1-4419-7482-2_2.

Goodchild MF and Hill LL (2008) Introduction to digital gazetteer research. *International Journal of Geographical Information Science* 22(10): 1039–1044. DOI: 10.1080/13658810701850497.

Goodchild MF and Li L (2011) Formalizing space and place. In: Proceedings of the International Colloquium on Founding Territorial Sciences (CIST): 177–183.

Grafe C and Bollerey F (eds). (2007) *Cafés and Bars. The Architecture of Public Display*. Abingdon, UK: Routledge.

Graham M and Shelton T (2013) Geography and the future of big data, big data and the future of geography. *Dialogues in Human Geography* 3(3): 255–261. DOI: 10.1177/2043820613513121.

Gröbe M and Burghardt D (2018) A contribution to the visualization of the diversity of places. In: Proceedings of the 1st Workshop on Platial Analysis (PLATIAL'18): 67–73. DOI: 10.5281/zenodo.1472751.

Gugulica M and Burghardt D (2020) Affective route planning based on information extracted from location-based social media. In: Proceedings of the 2nd International Symposium on Platial Information Science (PLATIAL'19): 51–60. DOI: 10.5281/zenodo.3628877.

Gärdenfors P (2000) *Conceptual Spaces. The Geometry of Thought*. Cambridge, MA: MIT Press.

Hamzei E, Chen H, Hua H, et al. (2018) Deriving place graphs from spatial databases. In: Proceedings of the 5th Annual Conference of Research@Locate.

Hamzei E, Li H, Vasardani M, et al. (2019) Place questions and human-generated answers: a data analysis approach. *Proceedings of the 22nd AGILE Conference on Geographic Information Science:* 3–19. DOI: 10.1007/978-3-030-14745-7_1.

Hamzei E, Winter S and Tomko M (2020) Place facets: a systematic literature review. *Spatial Cognition & Computation* 20(1): 33–81. DOI: 10.1080/13875868.2019.1688332.

Harvey D (1990) Between space and time: reflections on the geographical imagination. *Annals of the Association of American Geographers* 80(3): 418–434.

Harve D (1994) The social construction of space and time: a relational theory. *Geographical Review of Japan, Series B* 67(2): 126–135. DOI: 10.4157/grj1984b.67.126.

Harvey L (2020) *Improving the Cartographic Visualization Techniques of Platial Features – the Example of London Parks*. Master's Thesis. Enschede, the Netherlands: University of Twente.

Heikinheimo V, Tenkanen H, Hiippala T, et al. (2018) Digital imaginations of national parks in different social media: a data exploration. In: Proceedings of the 1st Workshop on Platial Analysis (PLATIAL'18): 45–52. DOI: 10.5281/zenodo.1472745.

Hettner A (1905) Das Wesen und die Methoden der Geographie. *Geographische Zeitschrift* 11(10): 545–564.

Hobel H, Fogliaroni P and Frank AU (2016) Deriving the geographic footprint of cognitive regions. *Proceedings of the 19th AGILE Conference on Geographic Information Science:* 67–84. DOI: 10.1007/978-3-319-33783-8_5.

Horton R (1993) Tradition and modernity revisited. In: Horton R (ed) *Patterns of Thought in Africa and the West. Essays of Magic, Religion and Science*. Cambridge, UK: Cambridge University Press, 301–346. DOI: 10.1017/CBO9781139166232.

Hu Y, McKenzie G, Janowicz K, et al. (2015) Mining human-place interaction patterns from location-based social networks to enrich place categorization systems. In: Proceedings of the 1st International Workshop on Cognitive Engineering for Spatial Information Processes (CESIP).

Hui A and Walker G (2018) Concepts and methodologies for a new relational geography of energy demand: social practices, doing-places and settings. *Energy Research & Social Science* 36: 21–29. DOI: 10.1016/j.erss.2017.09.032.

Hägerstrand T (2009) *Tillvaroväven*. Stockholm, Sweden: Forskningsrådet Formas.

Iosifescu Enescu CM, Bär HR, Beilstein M, et al. (2020) Place cookies and setting spiders in dream cartography. *Transactions in GIS* 24(4): 944–966. DOI: 10.1111/tgis.12604.

Iosifescu Enescu CM and Hurni L (2018) Pinpointing dream settings onto place cookies. In: Proceedings of the 1st Workshop on Platial Analysis (PLATIAL'18): 21–27. DOI: 10.5281/zenodo.1472739.

Jones CB, Purves RS, Clough PD, et al. (2008) Modelling vague places with knowledge from the Web. *International Journal of Geographical Information Science* 22(10): 1045–1065. DOI: 10.1080/13658810701850547.

Jordan T, Raubal M, Gartrell B, et al. (1998) An affordance-based model of place in GIS. In: Proceedings of the 8th International Symposium on Spatial Data Quality.

Kim J, Vasardani M and Winter S (2015) Harvesting large corpora for generating place graphs. In: Proceedings of the 1st International Workshop on Cognitive Engineering for Spatial Information Processes (CESIP).

Kim J, Vasardani M and Winter S (2017a) Landmark extraction from web-harvested place descriptions. *KI - Künstliche Intelligenz* 31(2): 151–159. DOI: 10.1007/s13218-016-0467-3.

Kim J, Vasardani M and Winter S (2017b) Similarity matching for integrating spatial information extracted from place descriptions. *International Journal of Geographical Information Science* 31(1): 56–80. DOI: 10.1080/13658816.2016.1188930.

Kitchin R (2013) Big data and human geography: opportunities, challenges and risks. *Dialogues in Human Geography* 3(3): 262–267. DOI: 10.1177/2043820613513388.

Kremer D (2018) *Rekonstruktion von Orten als sozialem Phänomen. Geoinformatische Analyse semantisch annotierter Verhaltensdaten*. Bamberg, Germany: University of Bamberg Press DOI: 10.20378/irbo-51890.

Kuhn TS (1962) *The Structure of Scientific Revolutions*. Chicago, IL: University of Chicago Press.

Kuhn W (2012) Core concepts of spatial information for transdisciplinary research. *International Journal of Geographical Information Science* 26(12): 2267–2276. DOI: 10.1080/13658816.2012.722637.

Kyle G and Chick G (2007) The social construction of a sense of place. *Leisure Sciences* 29(3): 209–225. DOI: 10.1080/01490400701257922.

König D and tho Pesch S (2013) Der Festlandsockelvertrag von 1964 und seine Auswirkungen auf die deutsch-niederländische Küstenmeergrenze. *Zeitschrift für ausländisches öffentliches Recht und Völkerrecht* 73: 483–508.

Ladyman J (1998) What is structural realism? *Studies in History and Philosophy of Science Part A* 29(3): 409–424. DOI: 10.1016/S0039-3681(98)80129-5.

Lai J, Lansley G, Haworth J, et al. (2020) A name-led approach to profile urban places based on geotagged Twitter data. *Transactions in GIS* 24(4): 858–879. DOI: 10.1111/tgis.12599.

Lefebvre H (1974) *La production de l'espace*. Paris, France: Anthropos.

Lewicka M (2011) Place attachment: how far have we come in the last 40 years? *Journal of Environmental Psychology* 31(3): 207–230. DOI: 10.1016/j.jenvp.2010.10.001.

Low SM and Altman I (1992) Place attachment. A conceptual inquiry. In: Altman I and Low SM (eds) *Place*

Attachment. New York, NY: Plenum, 1–12. DOI: 10. 1007/978-1-4684-8753-4_1.

Malpas JE (1999) *Place and Experience. A Philosophical Topography*. Cambridge, UK: Cambridge University Press.

Maué P (2013) *Places in the Long Tail*. Amsterdam, the Netherlands: IOS.

Mayer M, Heck DW and Mocnik FB (2020) Shared mental models as a psychological explanation for converging mental representations of place – the example of OpenStreetMap. In: Proceedings of the 2nd International Symposium on Platial Information Science (PLATIAL'19): 43–50. DOI: 10.5281/zenodo. 3628871.

McKenzie G, Liu Z, Hu Y, et al. (2018) Identifying urban neighborhood names through user-contributed online property listings. *ISPRS International Journal of Geo-Information* 7(10): 388. DOI: 10.3390/ijgi7100388.

Merschdorf H and Blaschke T (2018) Revisiting the role of place in geographic information science. *ISPRS International Journal of Geo-Information* 7(9): 364. DOI: 10.3390/ijgi7090364.

Miller H (2007) Place-based versus people-based geographic information science. *Geography Compass* 1(3): 503–535. DOI: 10.1111/j.1749-8198.2007.00025.x.

Miller HJ and Goodchild MF (2015) Data-driven geography. *GeoJournal* 80: 449–461. DOI: 10.1007/s10708-014-9602-6.

Mocnik FB (2015) *A Scale-Invariant Spatial Graph Model*. Doctoral thesis, Vienna University of Technology, Austria.

Mocnik FB (2018) The polynomial volume law of complex networks in the context of local and global optimization. *Scientific Reports* 8(11274). DOI: 10.1038/s41598-018-29131-0.

Mocnik FB (2020) An improved algorithm for dynamic nearest-neighbour models. *Journal of Spatial Science* DOI: 10.1080/14498596.2020.1739575.

Mocnik FB and Fairbairn D (2018) Maps telling stories? *The Cartographic Journal* 55(1): 36–57. DOI: 10. 1080/00087041.2017.1304498.

Mocnik FB and Frank AU (2015) Modelling spatial structures. In: Proceedings of the 12th Conference on Spatial Information Theory (COSIT), 44–64. DOI: 10.1007/978-3-319-23374-1_3.

Mocnik FB, Ludwig C, Grinberger A, et al. (2019) Shared data sources in the geographical domain—a classification schema and corresponding visualization techniques. *ISPRS International Journal of Geo-Information* 8(5): 242. DOI: 10.3390/ijgi8050242.

Mocnik FB and Raifer M (2018) The effect of tectonic plate motion on OpenStreetMap data. Proceedings of the 21st AGILE Conference on Geographic Information Science.

Mocnik FB and Westerholt R (2020) Interdisciplinary perspectives on place. In: Proceedings of the 2nd International Symposium on Platial Information Science (PLATIAL'19). DOI: 10.5281/zenodo.3628833.

Mocnik FB and Westerholt R (2021a) Interdisciplinary perspectives on place. *Journal of Spatial Information Science* 23: 91–94. DOI: 10.5311/JOSIS.2021. 23.203.

Mocnik FB and Westerholt R (2021b) The effect of tectonic plate motion on georeferenced long-term global datasets. *International Journal of Applied Earth Observation and Geoinformation* 94: 102183. DOI: 10.1016/j.jag.2020.102183.

Montello DR, Goodchild MF, Gottsegen J, et al. (2003) Where's downtown? Behavioral methods for determining referents of vague spatial queries. *Spatial Cognition & Computation* 3(2–3): 185–204. DOI: 10. 1080/13875868.2003.9683761.

Montgomery J (1997) Café culture and the city: the role of pavement cafés in urban public social life. *Journal of Urban Design* 2(1): 83–102. DOI: 10. 1080/13574809708724397.

Oldenburg R (1989) *The Great Good Place. Cafés, Coffee Shops, Bookstores, Bars, Hair Salons and Other Hangouts at the Heart of a Community*. New York, NY: Paragon.

Ostermann FO, Huang H, Andrienko G, et al. (2015) Extracting and comparing places using geo-social media. *ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences* II-3/W5: 311–316. DOI: 10.5194/isprsannals-II-3-W5-311-2015.

Papadakis E, Baryannis G and Blaschke T (2018a) From space to place and back again: towards an interface between space and place. In: Proceedings of the 1st Workshop on Platial Analysis (PLATIAL'18): 53–59. DOI: 10.5281/zenodo.1472747.

Papadakis E, Baryannis G, Petutschnig A, et al. (2019) Function-based search of place using theoretical, empirical and probabilistic patterns. *ISPRS International*

Journal of Geo-Information 8(2): 92. DOI: 10.3390/ijgi8020092.

Papadakis E, Petutschnig A and Blaschke T (2018b) Flexible patterns of place for function-based search of space. In: Proceedings of the 10th International Conference on Geographic Information Science (GIScience). DOI: 10.4230/LIPIcs.GIScience.2018.54.

Papadakis E, Resch B and Blaschke T (2016) A function-based model of place. *Proceedings of the 9th International Conference on Geographic Information Science (GIScience):* 248–251.

Papadakis E, Resch B and Blaschke T (2020) Composition of place: towards a compositional view of functional space. *Cartography and Geographic Information Science* 47(1): 28–45. DOI: 10.1080/15230406.2019.1598894.

Polgar A (1983) Theorie des Café Central. In: Reich-Ranicki M (ed). *Kleine Schriften*. Reinbek, Germany: Rowohlt, volume 4, 254–259.

Purves R and Hollenstein L (2010) Exploring place through user-generated content: using Flickr to describe city cores. *Journal of Spatial Information Science* 1: 21–48. DOI: 10.5311/JOSIS.2010.1.3.

Purves R, Edwardes A and Wood J (2011) Describing place through user generated content. *First Monday* 16(9). DOI: 10.5210/fm.v16i9.3710.

Purves RS, Winter S and Kuhn W (2019) Places in information science. *Journal of the Association for Information Science and Technology* 70(11): 1173–1182. DOI: 10.1002/asi.24194.

Raymond CM, Kyttä M and Stedman R (2017) Sense of place, fast and slow: the potential contributions of affordance theory to sense of place. *Frontiers in Psychology* 8: 1674. DOI: 10.3389/fpsyg.2017.01674.

Relph E (1976) *Place and Placelessness*. London, UK: Pion.

Richter D, Vasardani M, Stirlng L, et al. (2013) Zooming in—zooming out hierarchies in place descriptions. *Proceedings of the 9th Symposium on Location Based Services (LBS):* 339–355. DOI: 10.1007/978-3-642-34203-5_19.

Rittner L, Haine WS and Jackson JH (eds). (2013) *The Thinking Space. The Café as a Cultural Institution in Paris, Italy and Vienna*. London, UK: Routledge. DOI: 10.4324/9781315552279.

Rosch E (1978) Principles of categorization. In: Rosch E and Lloyd B (eds) *Cognition and Categorization*. Hillsdale, NJ: Erlbaum, 27–48.

Sadler BJ (2011) Café noir. Anxiety, existence, and the coffeehouse. In: Parker SF and Austin MW (eds). *Coffee. Philosophy for Everyone. Grounds for Debate*. Malden, MA: Wiley-Blackwell, 100–112. DOI: 10.1002/9781444393385.ch8.

Scannell L and Gifford R (2010) Defining place attachment: a tripartite organizing framework. *Journal of Environmental Psychology* 30(1): 1–10. DOI: 10.1016/j.jenvp.2009.09.006.

Schatzki TR (2003) A new societist social ontology. *Philosophy of the Social Sciences* 33(2): 174–202. DOI: 10.1177/0048393103033002002.

Scheider S, Adams B, Janowicz K, et al. (2014) COMP 2013: ACM SIGSPATIAL international workshop on computational models of place 2013. *SIGSPATIAL Special* 6(1): 20–22. DOI: 10.1145/2684380.2684390.

Scheider S and Janowicz K (2010) Places as media of containment. In: Proceedings of the 6th International Conference on Geographic Information Science (GIScience).

Scheider S and Janowicz K (2014) Place reference systems. A constructive activity model of reference to places. *Applied Ontology* 9(2): 97–127. DOI: 10.3233/AO-140134.

Seamon D (1979) *A Geography of the Lifeworld*. London, UK: Croom Helm. DOI: 10.4324/9781315715698.

Seamon D and Nordin C (1980) Marketplace as place ballet. A Swedish example. *Meddelanden från Göteborgs Universitets Geografiska Institutioner. Serie B* 67: 35–41.

Searle JR (1980) Minds, brains, and programs. *Behavioral and Brain Sciences* 3(3): 417–424. DOI: 10.1017/S0140525X00005756.

Segel HB (ed). (1993) *Vienna Coffeehouse Wits, 1890–1938*. West Lafayette, IN: Purdue University Press.

Shamai S (1991) Sense of place: an empirical measurement. *Geoforum* 22(3): 347–358. DOI: 10.1016/0016-7185(91)90017-K.

Smith B and Mark DM (2003) Do mountains exist? Towards an ontology of landforms. *Environment and Planning B: Planning and Design* 30(3): 411–427. DOI: 10.1068/b12821.

Smith JS (ed). (2017) *Explorations in Place Attachment*. London, UK: Routledge. DOI: 10.4324/9781315189611.

Smith MJ, Parrott F, Monkman A, et al. (2019) 'Reading landscape': interdisciplinary approaches to understanding place. *Journal of Maps* 15(3): 57–65. DOI: 10.1080/17445647.2019.1580618.

Stedman RC (2002) Toward a social psychology of place. Predicting behavior from place-based cognitions, attitude, and identity. *Environment and Behavior* 34(5): 561–581. DOI: 10.1177/0013916502034005001.

Sánchez-Rada JF and Iglesias CA (2016) Onyx: a linked data approach to emotion representation. *Information Processing & Management* 52(1): 99–114. DOI: 10.1016/j.ipm.2015.03.007.

Tang M, Falomir Z, Freksa C, et al. (2020) Extracting invariant characteristics of sketch maps: Towards place query-by-sketch. *Transactions in GIS* 24(4): 903–943. DOI: 10.1111/tgis.12621.

Tateosian L, Glatz M and Shukunobe M (2020) Storytelling maps generated from semantic representations of events. *Behaviour & Information Technology* 39(4): 391–413. DOI: 10.1080/0144929X.2019.1569162.

Tear A (2020) Geotagging matters? The interplay of space and place in politicized online social media networks. In: Proceedings of the 2nd International Symposium on Platial Information Science (PLATIAL'19): 61–72. DOI: 10.5281/zenodo.3628879.

Tenbrink T (2020) The language of place: towards an agenda for linguistic platial cognition research. In: Proceedings of the 2nd International Symposium on Platial Information Science (PLATIAL'19): 5–12. DOI: 10.5281/zenodo.3628849.

tho Pesch S (2016) Finding a solution without addressing the problem: the 2014 Ems-Dollard treaty. In: von Arnauld A and von der Decken K (eds) *German Yearbook of International Law*. Berlin, Germany: Duncker & Humblot, volume 59, 593–601.

Thrift N (1999) Steps to an ecology of place. In: Massey D, Allen J and Sarre P (eds) *Human Geography Today*. Cambridge, UK: Polity, 295–322.

Thrift N (2008) *Non-Representational Theory. Space, Politics, Affect*. London, UK: Routledge.

Tjora A and Scambler G (eds). (2013) *Café Society*. New York, NY: Palgrave Macmillan. DOI: 10.1057/9781137275936.

Tuan YF (1977) *Space and Place. The Perspective of Experience*. Minneapolis, MN: University of Minnesota Press.

Tuan YF (1979) Space and place: humanistic perspective. In: Gale S and Olsson G (eds). *Philosophy in Geography*. Dordrecht, the Netherlands: Reidel, 387–427. DOI: 10.1007/978-94-009-9394-5_19.

Twigger-Ross CL and Uzzell DL (1996) Place and identity processes. *Journal of Environmental Psychology* 16(3): 205–220. DOI: 10.1006/jevp.1996.0017.

Vasardani M, Tomko M and Winter S (2016) The cognitive aspect of place properties. In: Proceedings of the 9th International Conference on Geographic Information Science (GIScience) 324–327. DOI: 10.21433/B3116928w12f.

Vasardani M and Winter S (2016) Place properties. In: Onsrud H and Kuhn W (eds) *Advancing Geographic Information Science*, Chapter 17. Needham, MA: GSDI Association Press, 243–254.

Vasardani M, Winter S and Richter KF (2013) Locating place names from place descriptions. *International Journal of Geographical Information Science* 27(12): 2509–2532. DOI: 10.1080/13658816.2013.785550.

Vasardani M, Winter S, Richter KF, et al. (eds) (2012) *Proceedings of the International Workshop on Place-Related Knowledge Acquisition Research (P-KAR)*.

Vaughan L (2018) *Mapping Society: The Spatial Dimensions of Social Cartography*. London, UK: UCL Press. DOI: 10.14324/111.9781787353053.

Wagner D, Zipf A and Westerholt R (2020) Place in the GIScience community – an indicative and preliminary systematic literature review. In: Proceedings of the 2nd International Symposium on Platial Information Science (PLATIAL'19): 13–22. DOI: 10.5281/zenodo.3628855.

Wang Y, Gu Y, Dou M, et al. (2018) Using spatial semantics and interactions to identify urban functional regions. *ISPRS International Journal of Geo-Information* 7(4): 130. DOI: 10.3390/ijgi7040130.

Westerholt R (2019) Methodological aspects of the spatial analysis of geosocial media feeds. *gis.Science* 2: 65–76.

Westerholt R, Gröbe M, Zipf A, et al. (2018a) Towards the statistical analysis and visualization of places. In: Proceedings of the 10th International Conference on Geographic Information Science (GIScience) 63: 1–63:7. DOI: 10.4230/LIPIcs.GISCIENCE.2018.63.

Westerholt R and Mocnik FB (2020) Introduction to the second international symposium on platial information science. In: Proceedings of the 2nd International Symposium on Platial Information Science (PLATIAL'19): 1–3. DOI: 10.5281/zenodo.3628847.

Westerholt R, Mocnik FB and Comber A (2020) A place for place: modelling and analysing platial

representations. *Transactions in GIS* 24(4): 811–818. DOI: 10.1111/tgis.12647.

Westerholt R, Mocnik FB and Zipf A (2018b) Introduction to the PLATIAL'18 workshop on platial analysis. In: Proceedings of the 1st Workshop on Platial Analysis (PLATIAL'18): 1–5. DOI: 10.5281/zenodo.1475267.

Westerholt R, Mocnik FB and Zipf A (2018c) On the way to platial analysis: can geosocial media provide the necessary impetus? In: Proceedings of the 1st Workshop on Platial Analysis (PLATIAL'18). DOI: 10.5281/zenodo.1475269.

Westerski A, Iglesias CA and Tapia Rico F (2011) Linked opinions: describing sentiments on the structured web of data. In: Proceedings of the 4th International Workshop on Social Data on the Web (SDoW).

Winter S and Freksa C (2012) Approaching the notion of place by contrast. *Journal of Spatial Information Science* 5: 31–50. DOI: 10.5311/JOSIS.2012.5.90.

Winter S, Kuhn W and Krüger A (2009) Guest editorial: does place have a place in geographic information science? *Spatial Cognition & Computation* 9(3): 171–173. DOI: 10.1080/13875860903144675.

Worrall J (1989) Structural realism: the best of both worlds? *Dialectica* 43(1–2): 99–124. DOI: 10.1111/j.1746-8361.1989.tb00933.x.

Wu X, Wang J, Shi L, et al. (2019) A fuzzy formal concept analysis-based approach to uncovering spatial hierarchies among vague places extracted from user-generated data. *International Journal of Geographical Information Science* 33(5): 991–1016. DOI: 10.1080/13658816.2019.1566550.

Zhu D, Zhang F, Wang S, et al. (2020) Understanding place characteristics in geographic contexts through graph convolutional neural networks. *Annals of the American Association of Geographers* 110(2): 408–420. DOI: 10.1080/24694452.2019.1694403.

Author Biography

Franz-Benjamin Mocnik is an Assistant Professor at the University of Twente, where he conducts research about platial information as well as structural aspects in Geographical Information Science. He received a doctoral degree from the Vienna University of Technology, worked at Heidelberg University as a postdoctoral fellow in Geography, and was a twin fellow of the Hanse-Wissenschaftskolleg, Institute for Advanced Study. He was awarded the Waldo-Tobler Young Researcher Award.