Author/s:
Hamzei, E;Winter, S;Tomko, M

Title:
Place facets: a systematic literature review

Date:
2020

Citation:
Hamzei, E., Winter, S. & Tomko, M. (2020). Place facets: a systematic literature review. Spatial Cognition and Computation, 20 (1), pp.33-81. https://doi.org/10.1080/13875868.2019.1688332.

Persistent Link:
https://hdl.handle.net/11343/233431

ARTICLE TEMPLATE

Place Facets: A Systematic Literature Review

Ehsan Hamzei , Stephan Winter and Martin Tomko[a]

[a]The University of Melbourne

ARTICLE HISTORY
Compiled December 5, 2019

ABSTRACT
Place is a central concept in geography and a topic of interest in the social sciences, urban planning, architecture, and most recently in information science. The notion of place has therefore been studied with different foci of interest. Consequently, heterogeneous terminologies, conceptualizations, models, and ontologies have been proposed to capture this elusive concept. Yet these studies complement each other. Utilizing the concept of place facet as a particular type of information about place, in this review paper we bridge these multidisciplinary studies about place. We collect the different facets of place introduced in the literature and synthesize place characteristics by categorizing the identified facets. Finally, we discuss future directions for place-related research.

KEYWORDS
notion of place; place facets; space and place

1. Introduction

Place has been defined as space overlaid with meaning (Relph, 1976; Tuan, 1977) and attachment to individuals (Cresswell, 2004, 2014) or groups of people (Turner & Turner, 2006). The difference between the notions of place and space has been studied in geography and captured in the space-place continuum, with space and place at the respective extremes (Couclelis, 1992; Edwardes, 2007). Space is an abstract concept (Couclelis, 1992) suitable to be formalized in a computer-based environment, while place is related to human experiences of the world in a common sense manner (Cresswell, 2004) and its formal modelling is thus challenging (Purves, Winter, & Kuhn, 2018). Due to multi-disciplinary interests in the notions of space and place, several definitions of these terms have been proposed in the literature (Edwardes & Purves, 2007b; Turner & Turner, 2006). For example, Harrison and Dourish (1996) described the difference between space and place similar to the difference between a house (the abstract) and a home (the personal), while Tuan (1977) has called this difference equivalent to the difference between freedom (openness) and security (stability). Alternatively, in architecture and urban planning, space is regarded as the raw material which turns to place after design is introduced to it (Hillier, 2007).

In addition to these diverse definitions, the notion of place has also been conceptualized differently, depending on the emphasis of the distinct perspectives on place (Turner & Turner, 2006). In particular, phenomenological (Relph, 1976), sociological (Gustafson, 2001), and psychological (Canter, 1977) perspectives have contributed to

the fundamental conceptualizations of the notion of place in human geography, social science, and environmental psychology, respectively (Turner & Turner, 2006). These conceptualizations differ in their shifting emphasis between the social (e.g., functional differentiation (Canter, 1997)) and individual meaning of place (e.g., sense of place (Agnew, 2011)), as well as between objective (e.g., location (Agnew, 2011)) and subjective aspects of place (e.g., attachment (Relph, 1976)). These conceptualizations are complementary, yet manifest also unresolved conceptual overlaps.

Apart from the conceptualizations of the notion of place, several attempts have been made for modelling information about (specific) places (ElGindy & Abdelmoty, 2014a; Papadakis, Resch, & Blaschke, 2016; Scheider & Janowicz, 2014), to the end of capturing this information in (geographic) information systems (Jonietz, 2016). While the conceptualizations are not primarily interested in formalizations, the information models are presented to capture information about places in a formalized manner. Two major and divergent views on modelling places in GIScience view places *as objects* with identities (Purves et al., 2018; Scheider & Janowicz, 2014; Scheider & Purves, 2013), or in contrast, *as emergent aggregates* of spatial units with similar themes (Ballatore, 2014; Jonietz, 2016; Papadakis et al., 2016). In addition to the conceptual differences between these views, the individual models differ in the types of information stored. For example, gazetteers mainly capture names, types, and locations of geographical objects (Hill, Frew, & Zheng, 1999). More recently, refined models were presented to capture also the affordances and equipment of places (Goldberg, Wilson, & Knoblock, 2009; Scheider & Janowicz, 2014). However, what should be included in a place information model itself and what is domain-dependent information remains unclear (Ballatore, 2016).

The diversity of the multidisciplinary perspectives on definitions, conceptualizations and models of places motivates this study. Its primary aim is to report on the current state of place-related research, by systematizing these perspectives. In this survey, we focus only on geographic places from a room-level scale to the scale of the Earth itself. Other types of places, such as virtual places (e.g., a Web-based chat room), imaginary places (e.g., cloud-cuckoo-land), smaller places (e.g., table-tops) and mystic places (e.g., Heaven) are not within the scope of this study.

In order to extract, categorize, and report on the results of previous studies, we focus on facets of place, rather than an entire conceptualization or information model. A facet of place is here defined as a particular type of information about (geographic) place that has been defined, described, or formalized in the literature and at the same time can be used to differentiate places from each other. Here, facet is defined and used as a general and inclusive term that supersedes terms such as properties (e.g., good shape which is a property of place), attribute and characteristics (e.g., type), and aspects (e.g., social aspect, or functional aspect). For example, *location* can be considered as a place facet because it is a type of information about places, and places may be differentiated based on their locations. Facets can thus be considered as units with which the models and conceptualizations of place can be constructed. The term *facet*, as it is defined in facet theory (Canter, 2012), has an additional criterion of being mutually exclusive from each other. The facets of place extracted from the literature are, however, not necessarily mutually exclusive. Therefore, the contributions of this study are the attempts to systematize the facets in order to remove duplications and deriving categories of facets which are mutually exclusive as far as possible. As such, the mutual exclusion criterion is only aspirational in this study and treated in a relaxed manner using hierarchical categorization of facets. Consequently, the deeper the level in the hierarchical categorization, the less valid are the categories in terms of mutual

exclusivity.

2. Research questions and rationale

Providing a systematic review of place in the scientific literature enables to capture what is already known about the notion of place, and what the similarities and differences in previous work are. Diversity in terminologies and different levels of formalisms in place-related research contribute to confusions in understanding place and in scholarly communication about the notion of place. In order to address these issues, we bridge the different perspectives by categorizing the identified facets of place.

Place is a prototypical case of an *essentially contested concept* (Gallie, 1955). Such concepts are commonly recognized by people, used in communication and discussed. Yet, they are inescapably subject to disagreement about others' definitions of their precise meaning, along with an agreement that a single precise meaning is likely impossible (often referred to as *skepticism* and *eclecticism* in philosophy, respectively) (Cresswell, 2014). Hence, defining place as a concept is a challenge beyond the scope of one discipline or one view; and would require thorough definitional study of the terms, conceptualizations and models across disciplines. Yet, it is doubtful that a single central definition would be possible or even useful. The purpose of our study is distinct from such ontological inquiry into the concept of *place*. Our aim is the identification, extraction, and categorization of place facets, thus cataloging the richness with which place is reflected in discourse in a particular subset of disciplines. In addition to reporting the current state of discourse about the notion of place, this study addresses the following research questions:

(1) What are the facets of place documented in the literature?
(2) What are the similarities and differences of these facets?
(3) How to derive categories of place facets that are mutually exclusive (as far as possible), yet enable to characterize place comprehensively (i.e., form a conceptual partition)?

3. Methodology

This paper realizes a *systematic literature review* (SLR) aiming at reviewing, synthesizing, and reporting results in a reproducible manner (Okoli, 2015). An SLR is grounded in four phases (Okoli, 2015):

(1) A **planning phase** includes defining the purpose of the review, and the design of a protocol determining the procedure for applying selection, extraction, and execution phases. In our planning phase we defined the purpose of the review through the research questions above.
(2) The **selection phase** of a SLR defines how papers are selected and how screening is done for excluding publications that are out of the scope of the SLR. We describe the applied protocol in the forthcoming section, supporting a reproducible review procedure.
(3) The **extraction phase** includes an appraisal of the quality and the extraction of data from the selected papers. The extraction of facets is presented in here as well.

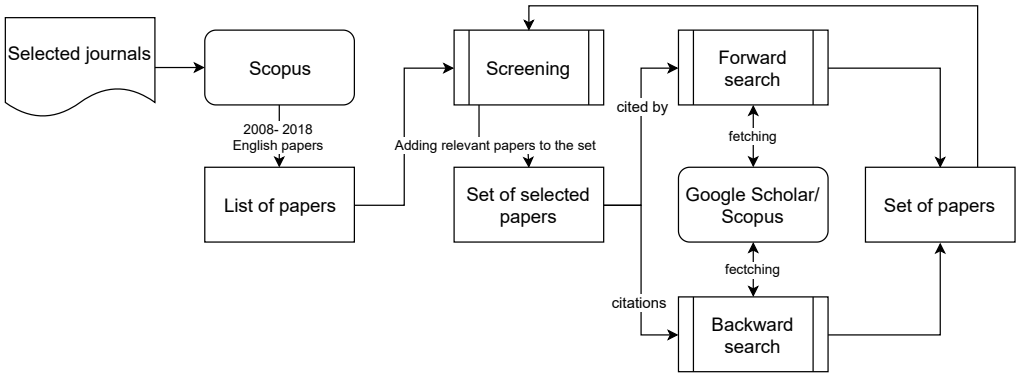

Figure 1. Selection and screening process.

(4) The **execution phase** defines how the extracted data are synthesized and how the results are reported. We describe our approach of a card-sorting and subsequent hierarchical clustering.

3.1. Selection phase

Figure 1 shows the process of selection and screening used in this study. First, a set of journals in different disciplines are subjectively selected for finding *seed papers* that are chosen based on their relevance to facets of place (Table 1). There are two reasons to limit seed journals to a few disciplines. First, it is not feasible to capture all of these disciplines in one paper. Second, this survey is aiming at facets of place to serve the community of information science and consequently not every view to the notion of place is relevant to the purpose of the review.

The seed journals are the high-quality journals (based on impact factors) in Human Geography, GIScience and Environmental Psychology. The focus on these disciplines sources from the purpose of this review to serve the community of information science for enriching current conceptualizations and models of place. The title, abstracts, authors, and citations of all papers published in the selected journals are extracted using the Scopus API, limiting ourselves to English publications between 2008 and 2018. Keyword-based criteria are not used in this selection process due to the possible interchangeable usages of the term *place* with other related terms in the literature, such as *landscape*, *region*, and even *location* (Bennett & Agarwal, 2007; Cresswell, 2004).

Table 1. Selected journals

Journal name	Field of study
Progress in Human Geography	Human Geography
International Journal of Geographical Information Science	GIScience
Journal of Spatial Information Science	GIScience
Spatial Cognition and Computation	GIScience; Psychology
Journal of Environmental Psychology	Psychology

The selection of a refined list of publications is accomplished by exclusion of irrelevant publications, in three iterations: based on the title, the abstract, and in some cases

based on the content of the publications themselves (using subject headings and the conclusion sections). Only publications with the main scope of *place*, *region*, and *human geographical knowledge*, or with a focus on a specific place facet (e.g., affordances) are retained for analysis and review.

During the selection process, the irrelevant publications are (manually) removed from the selection list due to the out-of-scope reason. Specifically, three generic rules are followed in exclusions of unwanted publications. First, if the publication is not about place in any sense it is not relevant to the purpose of this review – e.g., miscellaneous topics such as spatial data infrastructure or spatial algorithms. Second, if the publication is related to place, but place is only a case study or of a secondary interest then the publication is unwanted – e.g., investigation of political issues in different places. Third, if the publication is about place but it is not directly related to facets of place, then it is considered as out-of-scope and, consequently removed from the list – e.g., publications in 'placemaking'.

This selection process is designed to avoid possible bias to a specific view to the notion of place. It enables to select publications with different objectives, from proposals of formal place models (e.g., Scheider & Janowicz, 2014) to explorations of the concept of place by discussion of examples (e.g., Capineri, 2016). In addition, publications about an individual facet of place (e.g., Galton, 2010) to a conceptualization (e.g., Agnew, 2011), an ontology (e.g., C. B. Jones, Alani, & Tudhope, 2001) or a model of place (e.g., Jordan, Raubal, Gartrell, & Egenhofer, 1998) are included in the review process.

After selecting this set of seed papers from the seed journals, two iterations of forward and backward searches are undertaken. In the forward and backward searches the *cited-by* and *citations* of the selected seed papers are analyzed with the same screening criteria, using Scopus and Google Scholar. Books and dissertations were excluded from the backward and forward search (e.g., Cresswell, 2004; Tuan, 1977) due to their broad scope and large numbers of cited-by and citations. The reason to include Google Scholar as a tool for finding new papers stems from the lack of sufficient coverage of a number of relevant journals, conferences, and books in Scopus.

3.2. Extraction phase

In this phase, the selected publications are read, and place facets are extracted from text. For each facet, its name, definition, and examples are collected from text. The facets with the same name and similar definition are merged into one facet. In addition, the publications that the facets are extracted from their content are recorded. The results of this phase address the first research question. In order to present a comprehensive list of facets, in addition to explicitly-defined facets, implicitly-defined facets are extracted as well. This is done based on the best judgment of the first author, using the following definitions:

- **Explicitly-defined facets** are facets named and defined in a relatively formal manner in the source paper(s). Some of these facets are part of a conceptualization, a formal ontology or a model (e.g., *affordance* in the model presented in (Scheider & Janowicz, 2014)), and the others are defined separately in the literature (e.g., *spirit of place* (Vanclay, 2008)).
- **Implicitly-defined facets** are those that are not defined formally in the sourced paper(s), but their informal definitions may still be found (e.g., *saliency* as presented in (Winter & Freksa, 2012)). These facets may sometimes not be

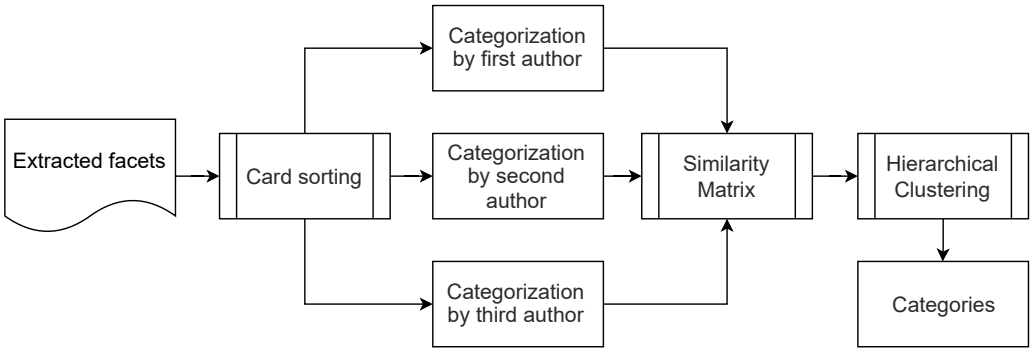

Figure 2. Process of synthesizing place facets in categories.

named but are discussed through examples (e.g., *spatial reference* as presented in (Winter & Freksa, 2012)). We acknowledge a level of subjectivity in the process of extracting implicitly-defined facets compared to explicitly-defined facets.

3.3. Execution phase

As shown in Figure 2, the final categories of place facets are the results of synthesis of the extracted facets using card sorting (Spencer, 2009) and hierarchical clustering (Johnson, 1967) techniques. The extracted facets names, definitions, and examples had been written on cards, and handed out to three researchers to independently organize them.

The open card sorting strategy (Spencer, 2009) is used by the authors to establish their own subjective groupings of facets assisted by the definitions extracted in the previous step. In open card sorting, no predefined set of categories are available, and the participants are free to make and label their own groupings. Hence, the results usually contain different numbers of groupings and meanings (group labels).

A convenient way to combine the results of card sorting experiments is to use hierarchical clustering (Spencer, 2009). To utilize hierarchical clustering, a similarity matrix is constructed, capturing agreements where a pair of facets belongs to same group. The results of the card sorting by the participants are thus combined in a similarity matrix capturing whether facets are categorized under the same category in individual groupings. In other words, the similarity matrix captures the count of groupings where two facets belong to the same category. Hierarchical clustering (Johnson, 1967; Maechler, 2018) is then applied on the similarity matrix and different cut-offs of the categorization are derived to extract a small number of meaningful higher-level groups. The cut-offs of hierarchical clustering determine the categories of facets derived by different groupings. The relation between the derived categories of different cut-offs is thus a parent-child relation. Finally, the results of hierarchical clustering are interpreted and reported.

4. Findings and Discussion

In this section, the results of the selection, extraction, and execution phases are reported and discussed. The selected publications, their type, publication dates, and citations are investigated in the first section. Next, the extracted facets, and derived

categories of facets are discussed. Finally, possible application of the results of this study are discussed, pointing to future directions in place-related research.

4.1. Place-related research: Results of selection

Based on the selection and screening criteria, 72 publications were selected for identifying and extracting place facets[1]. The complete list of selected publications (see References in Supplementary material) contains 13 seed papers, and 59 publications found through backward and forward search. The list of selected publications includes books, book sections, conference papers, journal papers, and theses (Table 2).

Table 2. Type of publications.

Type	Number of publications
Books	7
Book sections[2]	7
Conference papers	20
Journal papers	34
Theses and dissertations	4

One way to analyze the selected publications is based on the publication date. Figure 3 shows aggregated counts of place-related publications across disciplines from the 1970s to present. In the selected publications, a trend of increasing scientific interest in place facets is observable. In a discipline-based interpretation, the early research in the seventies to the nineties are landmark publications in human geography (e.g., Buttimer, 1976; Relph, 1976; Tuan, 1977) and environmental psychology (e.g., Canter, 1977; Gibson, 1979). Later, we find several publications from sociologists (e.g., Gieryn, 2000; Gustafson, 2001) in the list, and recently, attempts to formalize and to model the notion of place in the information science community (e.g., Adams, 2015; Papadakis et al., 2016; Vasardani & Winter, 2016). Hence, following our screening we note a salient sequence of scientific work progressing from initial explanations, through conceptualizations to computational models and formalizations.

While a citation analysis of scientific publications cannot comprehensively evaluate the quality of the academic works (MacRoberts & MacRoberts, 1989), citation counts are often used as a rough quantitative measure to evaluate the impact of publications. Figure 4 shows the seventy-two publications selected in this review, ordered by citations counts [3]. Four of the top-five most cited publications (Cresswell, 2004; Gibson, 1979; Massey, 1994; Relph, 1976; Tuan, 1977) are all books, with the only exception (Cresswell, 2004), representing an accessible summary work written a relatively long time ago. On the other hand, the five publications without any citation, (Almuzaini, 2017; Calafiore, 2016; Mennis & Mason, 2016; Papadakis et al., 2016; Vasardani, Tomko, & Winter, 2016) are all conference papers and a thesis that have been written very recently. Hence, the relatively large differences (in orders of magnitude) between the citation frequencies of publications stem from "variation in citation rate with type of publication, nationality, time period, and size and type specialty" as outline in (MacRoberts & MacRoberts, 1989), in addition to the differences in importance of their scientific contributions.

[1]The detailed results of the selection process are provided in Supplementary material

[3]The citations are collected from Google Scholar at 09/07/2018

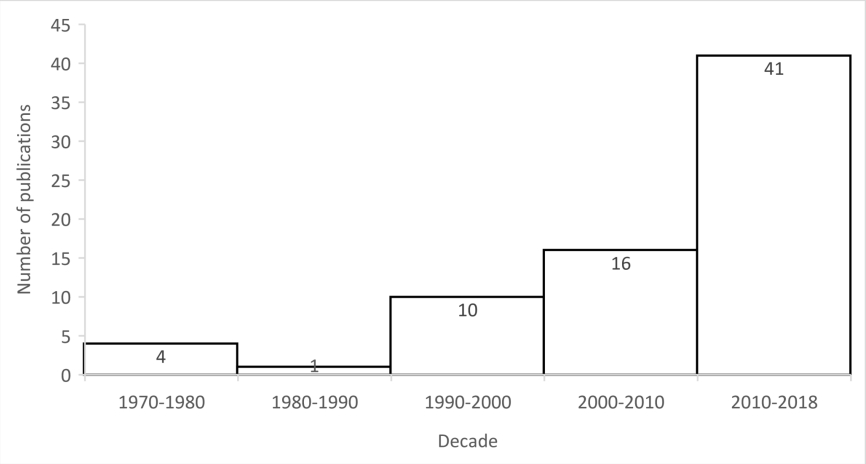

Figure 3. Publication date analysis of the selected publications, by decade.

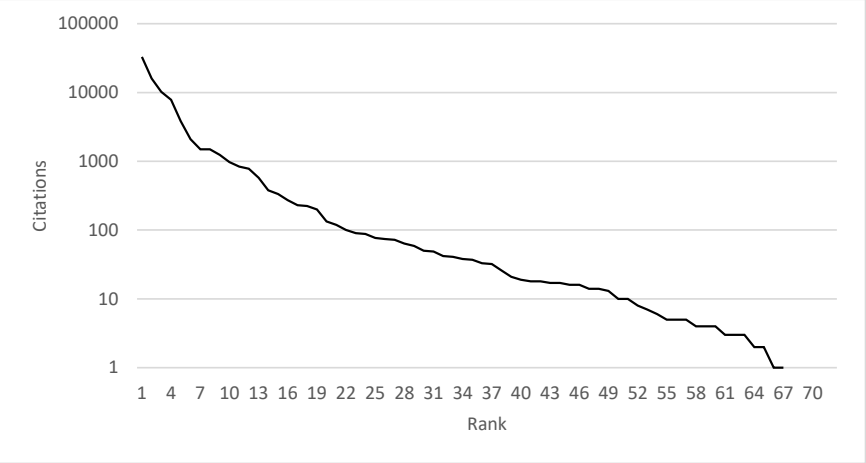

Figure 4. Citations of the papers selected for this literature review (log scale).

4.2. Place facets: Results of extraction

Using the extraction strategy, 116 place facets[4] are extracted from the selected literature. For each facet we selected its name, the facet's definition/description, an example of the facet use, and a list of publications where the facet is referenced. The analysis of the reference list of extracted facets shows that *name*, *type*, and *location* are mentioned in all of the selected publications. Beyond the aforementioned three facets, the top-five frequently mentioned facets are *affordance* (e.g., Gibson, 1979; Jordan et al., 1998), *activity* (e.g., ElGindy & Abdelmoty, 2014b; Purves, Edwardes, & Wood, 2011), *meaning* (e.g., Relph, 1976; Tuan, 1977), *place identity* (e.g., Cresswell, 2004, 2014; Entrikin, 1991), and *sense of place* (e.g., Buttimer, 1976; Massey, 1994).

In several cases place facets with similar or even same names are defined with irreconcilable definitions. For example, *sense of place* is defined by Agnew (2011) as a part of a place conceptualization, while Vanclay (2008) defined sense of place as personal feeling, relating to individuals rather than places themselves. Vanclay (2008) suggested to use the term of *spirit of place* instead of sense of place for describing how a place can evoke feelings. Hence, in the extracted list of facets two different facets are listed as sense of place. The same issue exists for *place identity*. While Relph (1976) defined place identity as "persistent sameness and unity which allows that thing to be differentiated from others", Vanclay (2008) has considered place identity as a part of his notion of sense of place, which is still a part of individuals' thought about a specific place. The issue of facets with the same name and different definitions is only observed for *sense of place*, *place identity*, *place attachment*, and *qualities*.

4.3. Categories of facets: Results of execution

The execution phase resulted into 1- three individual groupings of facets, based on the card sorting method, 2- a hierarchical clustering based on these individual groupings and 3- a curated set of categories of facets. The detailed results of the first two steps are presented in the supplementary material, while the third step, pertaining to the main results of this review is described here in detail. The resulting categories of place facets are the results of our interpretation of the hierarchical clustering. The proposed categorization differentiates between three types of facets: *primitive facets*, *derived facets*, and *linguistic facets*.

The rationale behind this typology is the fact that while 'primitive' facets are about particular aspects of place (e.g., its relation to people), 'derived' facets have mixed meanings in a way that they can be derived from a combination of primitive facets. On the other hand, linguistic facets such as *place names* have different objectives (i.e., referring and describing) compared to primitive and derived facets. Consequently, due to their differences as references to places compared to properties of places, they should be categorized in a different category. In the reminder of this section, the primitive, derived, and linguistic facets are discussed.

4.3.1. Primitive facets

The hierarchical groups of primitive facets were derived by interpretation of the hierarchical clustering. The two upper levels of categorization for primitive facets are shown in Figure 5. Here, the similarities and differences between the identified sibling categories of facets are discussed.

[4]The list extracted facets are provided in the supplementary material

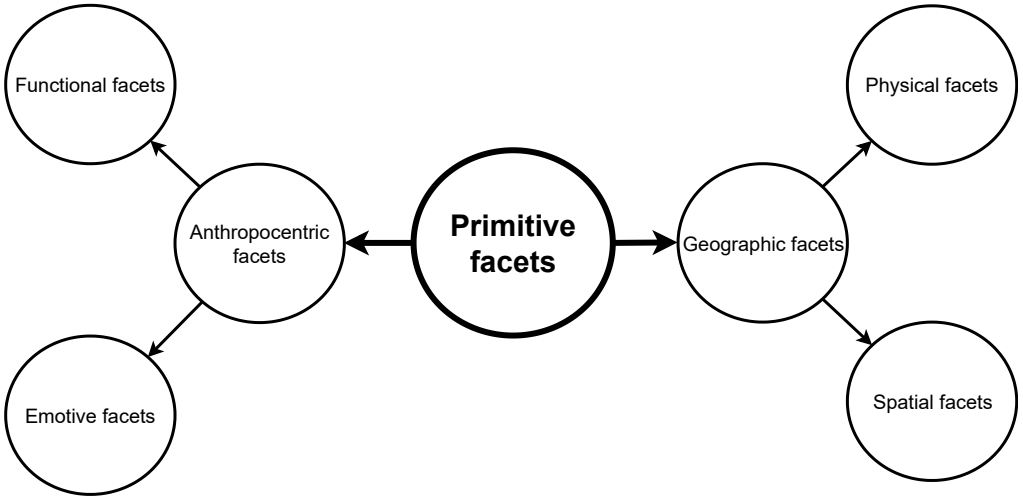

Figure 5. The result of hierarchical clustering of primitive facets.

The defining distinction between anthropocentric facets and geographic facets (Figure 5) arises from the perspective on the notion of place. The anthropocentric group contains facets that capture the relationships of individuals, or groups of people with places; while the geographic group captures facets describing spatial and physical properties of places. In addition, this division reflects the discipline-specific perspectives on place: while selected publications in human geography and social science literature are usually primarily studying facets in the anthropocentric group, publications selected from architecture and geospatial science primarily (but not exclusively) focus on facets in the geographic group.

4.3.1.1. Anthropocentric facets. The relation between people and places underpins this grouping of facets. In her ontologies of geographic information (Couclelis, 2010), Couclelis named the facets of an agent-environment relationship as agentive dimension. In Gustafson (2001)'s conceptualization, *self*, *other*, *self-other*, *self-environment*, *other-environment*, and *self-other-environment* are all related to the facets in this category. According to Gustafson's definition, the difference between the *self* and the *other* is the difference between individual's feelings and thoughts, and social roles and functions. Here, the sub-division between the individual and the social perspective is made after differentiating anthropocentric facets into functional facets, and emotive facets. Functional and emotive facets are differentiated by the distinction between what potential activities a place can afford as opposed to what emotional attachments and feelings it triggers amongst people.

4.3.1.2. Anthropocentric functional facets. This category can be further subdivided into two sub-categories: affordance and activity, and function. The contrast rule that is used for structuring this category to sub-categories stems from differentiating between the relation of people and places and (social) groups of people and places. While affordances are referring to individual-based answers to what a place can afford; function is defined as a less subjective answer to this same question (Papadakis et al., 2016).

The term *affordance* was first introduced by Gibson (1979) to describe the relation between an agent and an environment, defining affordance as a perceivable action offered by an environment to an agent. While the concept of affordance was conceptualised for generic notions of environment and agent; it fits well for describing the potential interactions of a person and a place (Jonietz & Timpf, 2015). Affordance is thus one of the ways to explore the relation of people and places i.e., investigating a place as somewhere in the world where specific *actions* and *behaviors* are afforded. The term affordance has been used as a component of place models (e.g., Alazzawi, Abdelmoty, & Jones, 2012; Jordan et al., 1998) and formal ontologies (e.g., Ballatore, 2016; Scheider & Janowicz, 2014). The affordance itself has been investigated and modelled, and ontologies have been proposed to capture affordance information (e.g., Galton, 2010; Ortmann & Kuhn, 2010).

Activity and *locale* are terms with relatively similar meaning to affordance in the context of place. While these terms have been observed less frequently in the literature compared to affordance, they are still amongst the top-ten frequently mentioned facets. While locale and affordance have different meanings in common language, 'locale' is defined and used interchangeably with affordance by some scholars (Agnew, 2011; Purves & Derungs, 2015). Unlike locale, the meaning of 'activity', is differentiated from affordance in the literature. Activity and affordance are different, reflecting what action is actually performed in a place, as opposed to what actions are possible or supported by a place. Researchers argue that the difference between activity and affordance is related to whether the actions are performed or only potentially achievable (e.g., Ortmann & Kuhn, 2010; Scheider & Janowicz, 2014). Note, however, that these terms are often used interchangeably and readers are encouraged to critically evaluate what authors mean (e.g., Alazzawi et al., 2012). Models and ontologies designed for activity (e.g., Das & Winter, 2016; Kuhn, 2001) often manifest similar design patterns with models and ontologies of affordance, e.g., complex affordances or activities are modelled as a combination of more primitive affordances or activities (Das & Winter, 2016; Kuhn, 2001; Ortmann & Kuhn, 2010).

Action and *behavior* belong to the sub-category of affordance within the functional facets group. Jonietz (2016) discussed the relation of activity, action, and behavior based on definitions from Werlen (2003). The term *behavior* denotes activities that are related to mechanical movement, while actions are the activities that are intentional and goal-oriented (Jonietz, 2016; Werlen, 2003). Furthermore, Jonietz (2016) formalized activities by considering *feasibility* of an activity in a place in conjunction with taking the *suitability* of the place for the activity into account. Moreover, he argued that *quality of a place* is directly influenced by feasibility and suitability of place for different activities (Jonietz, 2016; Jonietz & Timpf, 2015). Analogically to Jonietz (2016), Hockenberry (2006) formalized the notion of place by modelling activities, by considering *valuation* and *object of activities* for capturing information about places. For example, eating as an activity which can be performed in a restaurant is supported by objects such as meal or food, and the valuation is modelled as a rating which defines how well the activity is performed in the restaurant from a subjective view of a person (Hockenberry, 2006).

Function (Markus, 1987; Papadakis et al., 2016; Sabbata, Mizzaro, & Reichenbacher, 2015) is a facet of place describing what a place can afford to a group of people (Papadakis et al., 2016). Hence, function, as a facet of place, conveys shared meaning compared to activities and affordances. Several scholars have used other terms, such as *service* (Alazzawi et al., 2012; Winter & Truelove, 2013), *functional properties* (Vasardani et al., 2016), *functional differentiation* (Canter, 1997), and *event* (Roche, 2015)

with relatively equivalent meanings to function. *Social role*, and *social dimension* of place are other terms used to describe impacts and contributions of places on social groups (Ballatore, 2016; Calafiore, 2016). For example, a shopping mall as an urban place provides a social role of trading to people in the society (Calafiore, 2016).

One way to model functions and social roles of places is to investigate the interaction between people and place in terms of time (Adams & Janowicz, 2015; Janowicz, 2012; Janowicz, Scheider, & Adams, 2013; Ye, Janowicz, Mülligann, & Lee, 2011). The *temporal band*, as defined by Ye et al. (2011), relates to temporal patterns of visiting specific places for particular activities. Accordingly, the functional differentiation of places can be derived from temporal patterns, e.g., the temporal pattern of visiting a restaurant to eat is different from the temporal pattern of going to a bar based on days of the week, and hours of the day (McKenzie & Adams, 2017; Ye et al., 2011).

4.3.1.3. Anthropocentric emotive facets. The shared meanings of numerous facets relating places to people's feelings and emotions underpins the differentiation of the group of *emotive facets*. By studying the definitions of these facets, we identify a noticeable differentiation among them i.e., whether the purpose of the facet is to capture place-related emotions as a purely subjective (individual) relationship, or to capture a more shared, objectivisable relationship between the place and a group of people. Hence, similarly to the division of functional facets, emotive facets can be subdivided into two groups: 1- attachment and sense of place, capturing the subjective emotional relationship between a single person and a place (e.g., home for the owner); and 2- theme, social bonding, and cultural attachment, with its facets capturing emotional bonding of a group of people to a place (e.g., country for citizens).

Sense of place and *attachment* are the main facets of the subjective subgroup of the emotive category. While sense of place captures *how* a place feels to an individual (Agnew, 2011; Cresswell, 2004), attachment is related to *positive feelings and bonding* of a person to a particular place (Scannell & Gifford, 2010). Hence, attachment and sense of place contrast: attachment captures positive feelings, while sense of place describes a less structured range of emotions from positive to negative through neutral or hard to categorise ones. This underspecification of these two facets leads to a lack of solid agreement on the relationship between these two facets. For example, the definition of sense of place by Vanclay (2008) encompasses *attachment*, *dependence*, *familiarity*, *commitment*, and even *place identity*; while we observe an overlap of meanings between attachment and sense of place by Scannell and Gifford (2010).

In the literature, alternative terms have been proposed for describing emotional relationships between a person and a place such as *spirit of place* (Vanclay, 2008), and *sentiment* (ElGindy & Abdelmoty, 2014a, 2014b) related to sense of place, and *topophilia* (Tuan, 1990), *emotional attachment* (Mennis & Mason, 2016), *bonding* (Alazzawi et al., 2012; Kyle, Graefe, & Manning, 2005), and *place affect* (Kyle et al., 2005) similar to the attachment. Consequently, the emotional bonding and attachment of a person to a place can be related to *saliency* in a personal view (Almuzaini, 2017). The impact of attachment in saliency, as the importance of a place to an individual, have been studied and reported in several studies (e.g., Jorgensen & Stedman, 2001; Kyle, Bricker, Graefe, & Wickham, 2004).

Several scholars have investigated the emotional relations between society and places by generalizing the facets of attachment and sense of place from individuals to higher social groupings. They thus investigated shared feelings between a group of people to specific places. The terms proposed are *spatial value* (Quesnot & Roche, 2015), as

the value of a location to a society, *social elements* (Scannell & Gifford, 2010), and *specificity* (Scannell & Gifford, 2010). Spatial value was defined as the total value of a location to people (Lussault, 2003; Quesnot & Roche, 2015). In the same view, the terms *social elements* and *specificity* were defined as descriptions of social prominence of a place. They have considered a direct relationship between prominence and people's feeling to a place (Scannell & Gifford, 2010). While the term *social elements* is defined as prominence of a place at societal levels, *specificity* is denoted as a measure of how a place is differentiated from other places with respect to people's attachment to the place (Scannell & Gifford, 2010).

Social bonding and cultural attachment lead to *prominence* and *saliency* (Almuzaini, 2017) of places. One way to think of saliency is to view it as an answer to how successful a place is in initiating emotional bonding of people to the place, compared to other places (Almuzaini, 2017). While saliency is categorized as an emotive facet, the cause of a place's saliency can be rooted in other facets of the place, such as physical attractiveness (e.g., aspect of design for a church), functional aspects (e.g., the function of a hotel), and even spatial properties (e.g., height for a building) (Nothegger, Winter, & Raubal, 2004).

4.3.1.4. Geographic facets. This category, the other top-level category in Figure 5, encompasses physical, and spatial properties of places. The facets in this group are related to *where* a place is, and what does a place *look like*. The category of geographic facets comprises characteristics of place described as *environment*, *physical setting*, *physical elements*, *structural properties*, and *formal dimension* in the conceptualizations of place proposed by Gustafson (2001), Relph (1976), Scannell and Gifford (2010), Vasardani and Winter (2016), and Couclelis (2010), respectively.

The group of geographic facets can be further divided based on the concepts underpinning its facets i.e., whether the facet is related to form and material properties such as *physical features* and *form* (e.g., Jordan et al., 1998; Vasardani et al., 2016; Vasardani & Winter, 2016), or associated with spatial properties such as *location* and *boundary* (e.g., Montello, Goodchild, Gottsegen, & Fohl, 2003; Vasardani & Winter, 2016; Winter & Freksa, 2012). Several facets, such as *positive space*, *local symmetries*, *the void*, *alternating repetition*, *good shape*, *strong center*, and *echoes* which are all parts of the place properties model (Vasardani et al., 2016; Vasardani & Winter, 2016), cannot be assigned to one of the sub-categories due to their mixed spatial and physical meaning. For example, *local symmetries* can be evaluated based on form, from an architectural perspective, and at the same time *local symmetries* may relate to particular spatial properties in spatial information sciences. The aforementioned facets therefore belong to this level of categorization and can currently not be sub-divided into finer levels.

4.3.1.5. Geographic physical facets. Physical facets have been referred with different terminologies such as *physical dimension* (Ballatore, 2016), *physical features* (Jordan et al., 1998), *material form* (Gieryn, 2000), and *aspect of design* (Canter, 1997). Physical facets can be defined as any type of information related to structure, material, form and architectural style of a place (Ballatore, 2016; Vasardani et al., 2016). Physical facets thus capture *what a place looks like based on the common senses*. While the question can be answered in different ways, two noticeable types are observed in the literature: referring to style and form, and structure and parts. For example, the possible answers to the specific question: "What does your home look

like?" can be answered by relating to style and form: "It is an old Victorian building"; or in terms of parts and structure: "It is spacious, it has three bed rooms, a hall, and a big kitchen".

Form (Canter, 1997; Markus, 1987) is a facet describing how a place looks like with respect to architectural and morphological aspects. One of the properties of place is known as *not separateness* (Alexander, 2002; Vasardani & Winter, 2016). The *not separateness* assures the coherence of the whole (Alexander, 2002). While *not separateness* is not only about morphological aspects of a place, it can be applied to the notion of form. The previous example, "an old Victorian building", is grounded in 'not separateness' i.e., in a way that the *home* is referred to as a single object (a whole) with shared properties that apply to the whole: the age of the building, and its Victorian architecture. *Roughness* (Alexander, 2002; Vasardani & Winter, 2016) is another facet relating to form. It is defined as imperfections in a way that one can notice similarity but not identicality of form within a place as a whole (Alexander, 2002) – e.g., a wooden fence around a suburban house constructed from woods with different colors and different wood types, but captured and perceived as a whole.

Parts (Tversky & Hemenway, 1983), *constitutive dimension* (Couclelis, 2010), and *composition* (Papadakis et al., 2016) are facets with similar meanings related to the internal structure of a place. Thus, a place be considered as a container of other places (Scheider & Janowicz, 2010) (e.g., a home has rooms, and a country has states or provinces), and consequently what does a place look like can be answered through references to its parts. Despite using *not separateness* for determining a place based on form, here *contrast* and *gradient* (Alexander, 2002; Vasardani & Winter, 2016) are used for describing a place based on its parts. *Contrast* is defined as variation of properties between elements or parts of a place, and *gradient* is referred to gradual changes which one can observe in the structure of a place from one part to another (Alexander, 2002). Analyzing a place based on its part can be evaluated through *simplicity and inner calm*, and *deep interlock and ambiguity* (Alexander, 2002; Vasardani & Winter, 2016). A place in which its parts can be simply linked and understood is a coherent whole supporting the criteria of *simplicity and inner calm*, and on the other hand, when the parts interpenetrate in linking together, it is described as *deep interlock and ambiguity* (Alexander, 2002).

4.3.1.6. Geographic spatial facets. Spatial facets anchor a place in space. *Spatial band* (Janowicz et al., 2013), *spatial properties* (Vasardani et al., 2016; Vasardani & Winter, 2016), and *space* (Markus, 1987) are generic terms proposed for any type of properties describing relationships between places and space. These spatial facets can be further divided into sub-groups that can be used to investigate 1- a place located in space, 2- the meaning of place in relation to space, and 3- the spatial relationships between places. While the first sub-group of facets describes places in isolation and captures mostly *at which locations the place is found* (e.g., Agnew, 2011; Goodchild, 2011), the second sub-group refers to facets that focus on generic relation of place and space such as *scale of interaction* (Canter, 1997). Finally, the third sub-group includes facets about spatial relationships between places, often conceptualized as objects, such as *containment* (Scheider & Janowicz, 2010; Scheider & Purves, 2013; Winter & Freksa, 2012), and *equipment* (Scheider & Janowicz, 2014).

Location is one of the facets mentioned in all publications. Locational information of a place is the answer to *where-questions* that are asked in a wide range of situations, from our everyday life to human-machine interactions. It is therefore no

surprise that locational information is the primary part of different place models. *Localization* (Scheider & Janowicz, 2014), *footprint* (Goodchild, 2011), and *geographic location* (Gieryn, 2000) are terms related to location. Localization is closely associated with another facet of place, i.e., *boundary* (Vasardani et al., 2016; Vasardani & Winter, 2016; Winter & Freksa, 2012). Based on the Jordan curve theorem, a boundary partitions space into three segments, the boundary itself, an inside, and an outside (Hales, 2007). However, unlike mathematical geometries, places in the geographical world do not necessarily have well-defined, crisp boundaries (Montello et al., 2003; Winter & Freksa, 2012). Unlike administrative places which are defined by crisp boundaries, people have vague and subjective perceptions of boundaries for the socially-constructed places such as downtown (Hollenstein & Purves, 2010; Montello et al., 2003; Smith & Varzi, 2000), for natural places such as a mountain (S. B. Jones, 1959), and in natural communication where boundaries are often irrelevant.

The second subcategory of spatial facets are related to the notion of scale. *Scale of interaction* (Canter, 1997), *spatial level* (Scannell & Gifford, 2010), and *level of scale* (Vasardani et al., 2016; Vasardani & Winter, 2016) are terms for capturing the meaning and even the existence, of the scale of places. Due to aggregation and abstraction, places do exist only in certain scales or levels of detail. For example, when investigating global trading behavior places such as shopping malls or grocery stores are irrelevant, even though they are perfectly matched with the functional purpose of the study. In addition, people's bonding to places is scale dependent: There seems to be a U-shaped relationship between the strength of attachment and scale of interaction (Lewicka, 2010). In other words, (Lewicka, 2010) has found that for five types of places (i.e., apartment, building, neighborhood, city district, and city) the attachment to apartment and city are higher than the building, neighborhood, and district.

Due to the importance of scale for the analysis of places, multiple scale schemas were developed to formalize qualitative ordinal progressions of scale through a finite set of levels grounded in human relationships with objects and environments (e.g., Montello, 1993; Richter, Winter, Richter, & Stirling, 2013). For example, the schema of scale presented by (Richter et al., 2013) includes seven levels from the finest level of furniture, through room, building, street, district, city, and finally with the coarsest level country.

The last sub-category of spatial facets is related to spatial relationships between places. These facets are not properties of an isolated place but focus on the relationships of places with each other. *Containment* (Scheider & Janowicz, 2014; Winter & Freksa, 2012) and other mereological (part-of) and topological relationships, other qualitative relationships (e.g., nearness, cardinal directions), and metric relationships (e.g., distances) belong to this category (Kim, Vasardani, & Winter, 2016; Vasardani, Timpf, Winter, & Tomko, 2013). In addition, *equipment* (Scheider & Janowicz, 2010, 2014) is categorized as a spatial facet here. Equipment of a place determines what are the things associated with the place, in terms of spatial relationships, often in form of things contained in/at a place with a purpose to facilitate specific activities (Scheider & Janowicz, 2010, 2014). As an example, a laboratory at the University is equipped with computers.

Spatial properties of a place with respect to other places project into a facet known as *accessibility* (Ingram, 1971; Winter & Freksa, 2012), or *spatial accessibility* (Carmona, Heath, Oc, & Tiesdell, 2012; Jonietz, 2016). In geography, accessibility has often been evaluated by mathematical methods based on mutual spatial relationships of places. Ingram (1971) distinguishes two types of accessibility, 1- the relative accessibility which is a measure related to accessibility of a location in space with respect

to another location, and 2- the total, or integral accessibility of a location in space which is the integration of relative accessibilities to all other locations. Despite the sophisticated mathematical formalizations of accessibility, people's choices for movement from one place to another are also influenced by their experiential knowledge of places' accessibility (Mondschein, Blumenberg, & Taylor, 2010). Due to importance of accessibility in human experiences of space, Jonietz (2016) considered accessibility of places as one of the major factors in evaluating their qualities.

4.3.2. Derived facets

Derived facets are the result of integration of primitive place facets. A facet such as *meaning* (e.g., Buttimer, 1976; Canter, 1997; Gustafson, 2001) can be interpreted in a multitude of ways, for example as its functional role for a person, or a society, or as the strength of attachment for the place with regard to a person, or a part of the society. The part of meaning that is specifically related to people-place relations has also been called *investment of meaning and value* (Gieryn, 2000; Vanclay, 2008). However, physical and spatial facets of a place all have impacts on meaning. Physical facets capture the visual attractiveness and distinctiveness of a place, and accessibility and geographic location determine how easy it is to be inside or nearby of the place. Hence, when place is defined as part of space with shared meaning (Cresswell, 2004), meaningfulness is derived from a combination of primitive facets related to objective and subjective nature of the place. For example, the meaning of a 'home', a 'restaurant', a 'mountain', and a 'path' are related mostly to their emotive, functional, physical and spatial facets, respectively. In addition, sometimes, specifically for landmarks, the meaning of a place may be related to its *symbolic representation* (Jordan et al., 1998), e.g., the Statue of Liberty as an icon of freedom.

Identity (e.g., Entrikin, 1994; Relph, 1976; Tuan, 1977) is another derived facet frequently mentioned in the literature. Shared identity of a part of space enables the emergence of a place in a process of place-making. *Spatial identity* (Quesnot & Roche, 2015), and *identification* (Scheider & Janowicz, 2014) are other terms with equivalent meanings to identity. Identity and meaning relate to each other like cause and effect. For a specific part of space, shared identity leads to a specific meaning, and same meaning creates a particular sense of identity (Entrikin, 1996). Using the aforementioned examples provided for *meaning*, the relation between meaning and identity are discussed. The shared identity of a 'path' is mostly rooted in the spatial configuration of connecting two other places. Similarly, for a mountain the shared identity is primarily related to morphological properties and physical settings which lead to contrasts of shape and form with its surroundings. In the same way, a restaurant has a shared identity noticeably grounded in its function providing food to customers compared to a nearby school. Finally, a person's home has different identity compared to other buildings in terms of feeling safe, secure, and comfortable. As a result, place is also defined as a part of space with shared identity (Relph, 1976).

In the same way, we categorize *telic dimension* (Couclelis, 2010), *place objectives* (Canter, 1997), and *purpose* (Papadakis et al., 2016) as derived facets. These facets have a similar meaning with respect to objectives that people have with a place. Consequently, they can be derived from a mixture of emotive, functional, physical, and spatial facets. For example, the Avenue des Champs-Élysées in Paris may have different purposes from the perspective of a French citizen, a tourist, a refugee, an urban planner, and a foreign worker, all at the same time.

Derived facets of place are also used in place formalizations and models. *Type* (e.g.,

Goodchild, 2011), *typology* (Jordan et al., 1998), *classification* (Scheider & Janowicz, 2014), and *thematic band* (Adams & Janowicz, 2015) are the facets proposed in the different place models for a similar purpose. These facets are defined to differentiate generic kinds of places from each other. Consequently, street, house, restaurant, and even country are valid examples of place types. There is a direct relationship between the type of place and its purposes and goals it affords to a person or a society. Hence, a mixture of emotive, functional, physical, and spatial facets ground the characterisation of a place as a particular *type of place*.

4.3.3. Linguistic facets

Linguistic facets are the manifestations of place in language. The difference between linguistic facets of place, and the primitive and derived facets is similar to the difference between a reference to a place with the place itself. Linguistic facets enable us to communicate and to share our knowledge of places, and perhaps this is the reason why in the literature they are often confounded with the characteristics of the places themselves. Place is a special case of a broader notion of named entities in language. Named entities includes abstract and physical entities that can be referred to by names (Nouvel, Ehrmann, & Rosset, 2016). In models and formalizations of place, names are called *place names* or *toponyms*. Toponyms are direct references to places. Even such direct references to places are, however, often ambiguous (Leidner, 2007). The ambiguity of toponyms stems from the facts that a place can have multiple names, including vernacular and historic names, and that a single place name can be used to refer to different places (Leidner, 2007).

Verbal reference (Montello et al., 2003; Purves & Derungs, 2015; Purves, Edwardes, & Sanderson, 2008; Winter & Freksa, 2012) is a linguistic facet of place that includes direct references by toponyms as well as complex place descriptions (Winter & Freksa, 2012). For example, *Mitchell Library* and *the library on Macquarie Street in Sydney* are both valid references to the same place, one by place name and one by place description. The primitive types of verbal references have been discussed in a number of publications (Edwardes & Purves, 2007a, 2007b; Scheider & Purves, 2013). These publications have defined *semantic relation to objects* (also known as *elements* (Edwardes & Purves, 2007a, 2007b)), *semantic relation to activities*, *semantic relation to qualities*, *spatial relation to other places* as fundamental ways a place can be described and even localized via language (Edwardes & Purves, 2007a, 2007b; Scheider & Purves, 2013). Such linguistic facets are related to physical, functional, emotive, and spatial categories of facets, respectively. These primitive types of verbal references can be combined in complex verbal references known as *narrative descriptions* (Entrikin, 1997; Jordan et al., 1998) including place descriptions (Vasardani et al., 2013), route descriptions (Winter, Hamzei, Van de Weghe, & Ooms, 2018), and destination descriptions (Tomko & Winter, 2009).

Spatial references (e.g., Vasardani et al., 2013; Winter & Freksa, 2012), also called *spatial relations to other places* (Scheider & Purves, 2013), are specific types of verbal references. In a spatial reference, the location of a place is described with respect to other places using qualitative spatial relationships, including topological, directional, and qualitative distance relationships (Egenhofer, 1991; Frank, 1992). A specific type of spatial references are *addresses* (Almuzaini, 2017). Western-style addresses describe the location of a place in space in terms of hierarchical (containment) relationship. Extracting and formalizing spatial references from textual information have been studied by several scholars. The proposed models for capturing the information in spatial refer-

ences are built-upon three elements which are known as a triplet i.e., locatum, spatial relationship, and relatum (Kordjamshidi, Otterlo, & Moens, 2011; Vasardani et al., 2013).

5. The road ahead: Recommendations

The analysis of the categories of primitive facets reveals a diversity related to conceptualizations and subsequent formalizations. While in the list of spatial facets a balance between conceptualizations and formalizations can be noted, in the emotive facets the dominant theme is conceptualization with no formalism. In other words, the current inadequacy of state-of-the-art computational models of place to handle emotive facets is evident. Consequently, there is currently no noticeable difference in how geospatial databases handle places such as *the Sistine Chapel*, as an example of sacred and iconic place for large group of people, with the representation of *a small shopping mall*, which has at most a local influence to a limited number of individuals. While for different groups of individuals these places have different meanings in terms of the emotive, functional, and physical facets, in geospatial databases these places are modelled as geometries with clear boundaries and a set of attributes. The current focus of place formalisms on pragmatic applications, such as finding similar places and differentiating contrasting places (from a small set of well defined, utilitarian types of places) is evident. Here, the spatial facets of place are dominant. Consequently, a possible direction for research is to investigate place similarity measures which take the emotive, functional and physical facets of place into account. This direction is of increasing importance as people's interaction with each other is increasingly mediated by computers and often the natural language interaction with intelligent spatial assistant systems may be the only interaction desired.

The differences between people's knowledge of places, and the information stored in computers has been investigated based on the differences between the qualitative configurational knowledge of environments captured in human place-based knowledge, contrasting with quantitative measurements stored as geometrical coordinates in computers (e.g., Vasardani et al., 2013; Winter, 2009; Winter & Freksa, 2012). Importantly, these differences can be viewed as the contrast between the subjective nature of human experiences in terms of physical, functional, and emotive aspects and the purely spatial, reductionist views manifested by maps. The gap between place in information systems and people's experiential knowledge increasingly leads to unsatisfactory and troublesome interaction of human and machines, e.g., in geographic Web search (Ballatore, 2014). Hence, computational models for emotive, functional, and physical facets of place present an important direction of future research.

Modelling places, i.e., whether place can be modelled by information science or not, is a current topic of debate in GIScience (Goodchild, 2011; Merschdorf & Blaschke, 2018; Purves et al., 2018). While some researchers have considered place as a concept with intrinsic complexity that cannot be captured and formalized unless in case of very narrowly defined circumstances (Goodchild, 2011), recently Purves et al. (2018) developed a grounding to formalize places in information science, based on core concepts of spatial information (Kuhn, 2012). Here, we have presented a systematic review to facets of place which can be used to extend that grounding (Purves et al., 2018) to fit a specific purpose. In other words, the facets, extracted from the literature and categorized in this paper, can be used as a list of terminologies to extend the current grounding and to design place models for different applications.

Current interactions about place between humans and computers (e.g., geographic Web search) are still limited to gazetteer information lookup (*name*, *type*, *location*), however, research can progress by exploring the importance of multi-faceted perspective on place for place-related human computer interaction presented here. Rich corpora of verbal descriptions of places available from diverse sources such as social media and blogs can be used for improving the current state-of-the-art in place-related human-computer interaction. The extraction, formalization, and processing of place information is therefore a promising direction for future place-related research. The extracted platial information can be used in computers to imitate and support human communication about places. In addition, the issue of modelling place can be tackled in a divide-and-conquer approach by extending a multi-faceted view to the notion of place and developing partial computational models for each facet.

Another observation of this review is the notable capability of language to convey meaning of primitive and derived facets of place. In contrast to map visualizations which are designed to convey spatial information, language is a channel to express emotive meaning, or to talk about functional and physical characteristics of places (Derungs & Purves, 2014). A verbal place description (e.g., *a fantastic Gothic church in the South of France*) can include references to diverse facets of places, while maps are limited to purely spatial features. However, linguistic facets are yet underexplored. For example, linguistic facets describing tactile, sensual, and auditory experiences of place (e.g., *a quiet place*) have not been studied sufficiently in comparison to visual experiences (Chesnokova, Taylor, Gregory, & Purves, 2018). Hence, the linguistic facets can be used and extended for developing a schema for extracting platial information from place descriptions. Evidently, further development in language processing techniques is the primary prerequisite for this purpose.

6. Conclusion

The notion of place as a multidisciplinary topic of interest has been investigated in the literature through different disciplines and focal perspectives. Consequently, different terminologies, conceptualizations and models of place have been proposed so far. In this survey paper, the notion of place in geography, social science, architecture and GIScience is reviewed. Using the concept of facets, these terminologies, conceptualizations and models have been extracted from the literature. In addition, hierarchical categories of facets are derived using a card sorting game and hierarchical clustering. Finally, the future direction of modelling places in information science are discussed.

Our extraction of place facets from the literature leads to a set of 116 facets. The extracted facets have been categorized into primitive, derived, and linguistic facets. The primitive facets have been systematized hierarchically. In the first level of subdivision, primitive facets were categorized into anthropocentric and geographic facets. The anthropocentric facets were then sub-divided into emotive and functional facets, and geographic facets were sub-divided into physical and spatial facets. Furthermore, the list of facets in emotive and functional categories was discussed based on their capture of the individual vs. social relationship with places. The physical facets have been divided into facets related to style and form, and structure and parts. Spatial facets have been further discussed in terms of their capture of spatial properties, generic relations to space (scale), and spatial relations between places. The relation between linguistic facets, derived facets, and primitive facets has been introduced and discussed, outlining our reasons for the distinction of linguistic facets in particular. Finally, the potential

future work on formalizing emotive, functional, and physical facets has been noted and the potential of linguistic approaches in extracting platial information discussed.

This systematic review has potential limitations. First, the meaning of place as an interdisciplinary concept is reduced into geographic places and consequently non-geographic places (e.g., virtual places) and their facets are not included. Secondly, the review is biased to the literature in Geography, Geospatial Science, Social Sciences and Environmental Psychology. Consequently, place as defined in computer science (e.g., Harrison & Tatar, 2008), anthropology (e.g., Coleman & Collins, 2006), digital humanities (e.g., Dunn, 2017), public health (e.g., Cummins, Curtis, Diez-Roux, & Macintyre, 2007) and philosophy (e.g., Casey, 1997) are not covered. Hence, a richer view to the notion of place considering the literature in the aforementioned disciplines still remains as future work.

Based on the systematically-selected publications, we have found that publications contributing to the anthropocentric facets mostly belong to Human Geography, Social Sciences and Environmental Psychology, while the facets in geographic facets are mostly extracted from publications belonging to GIScience and Architecture. In anthropocentric facets, the emotive facets are much under-investigated in terms of formal models compared to the facets in the functional group. In addition, the facets in the spatial group are mostly formalized into computational models while the facets in the physical group are less developed in terms of formalization.

Acknowledgements

The support by the Australian Research Council grant DP170100109 is acknowledged. We also thank the anonymous reviewers for their constructive comments which helped to improve the quality of this paper.

References

Adams, B. (2015). Finding similar places using the observation-to-generalization place model [Journal Article]. *Journal of Geographical Systems*, *17*(2), 137-156.

Adams, B., & Janowicz, K. (2015). Thematic signatures for cleansing and enriching place-related linked data [Journal Article]. *International Journal of Geographical Information Science*, *29*(4), 556-579.

Agnew, J. A. (2011). Space and Place [Book Section]. In *The SAGE Handbook of Geographical Knowledge* (p. 316-330). London: SAGE Publications Ltd.

Alazzawi, A. N., Abdelmoty, A. I., & Jones, C. B. (2012). What can I do there? Towards the automatic discovery of place-related services and activities [Journal Article]. *International Journal of Geographical Information Science*, *26*(2), 345-364.

Alexander, C. (2002). *The nature of order: An essay on the art of building and the nature of the universe, book 1- the phenomenon of life* [Book]. Routledge.

Almuzaini, K. O. S. (2017). *Qualitative Modelling of Place Location on the Linked Data Web and GIS* (Thesis). Computer Science & Informatics.

Ballatore, A. (2014). The search for places as emergent aggregates [Conference Proceedings]. In *Spatial Search-Specialist meeting. Center for Spatial Studies, University of California, Santa Barbara. Santa Barbara (CA), USA.*

Ballatore, A. (2016). Prolegomena for an ontology of place [Book Section]. In *Advancing Geographic Information Science: The Past and Next Twenty Years* (p. 91-103). GSDI Association Press Needham, MA.

Bennett, B., & Agarwal, P. (2007). Semantic Categories Underlying the Meaning of Place' [Conference Proceedings]. In S. Winter, M. Duckham, L. Kulik, & B. Kuipers (Eds.), *Spatial Information Theory* (p. 78-95). Springer Berlin Heidelberg.

Buttimer, A. (1976). Grasping the Dynamism of Lifeworld [Journal Article]. *Annals of the Association of American Geographers*, *66*(2), 277-292.

Calafiore, A. (2016). Designing an Ontology of Social Place [Conference Proceedings]. In *DC@AI*IA*.

Canter, D. (1977). *The Psychology of Place* [Book]. Architectural Press.

Canter, D. (1997). The Facets of Place [Book Section]. In *Toward the Integration of Theory, Methods, Research, and Utilization* (p. 109-147). Boston, MA: Springer US.

Canter, D. (2012). *Facet theory: Approaches to social research* [Book]. Springer Science & Business Media.

Capineri, C. (2016). Kilburn High Road Revisited [Journal Article]. *Urban Planning*, *1*(2), 13.

Carmona, M., Heath, T., Oc, T., & Tiesdell, S. (2012). *Public places-Urban spaces* [Book]. Routledge.

Casey, E. (1997). *The fate of place: A philosophical history.* University of California Press.

Chesnokova, O., Taylor, J. E., Gregory, I. N., & Purves, R. (2018). Hearing the silence: finding the middle ground in the spatial humanities? Extracting and comparing perceived silence and tranquillity in the English Lake District [Journal Article]. *International Journal of Geographical Information Science*, 1-25.

Coleman, S., & Collins, P. (2006). *Locating the field: space, place and context in anthropology.* Berg.

Couclelis, H. (1992). Location, place, region, and space [Book Section]. In *Geography's inner worlds* (Vol. 2, p. 15-233). Rutgers University Press, New Jersey.

Couclelis, H. (2010). Ontologies of geographic information [Journal Article]. *International Journal of Geographical Information Science*, *24*(12), 1785-1809.

Cresswell, T. (2004). *Place: a short introduction* [Book]. John Wiley & Sons.

Cresswell, T. (2014). *Place : An Introduction.* Hoboken, United Kingdom: John Wiley & Sons, Incorporated.

Cummins, S., Curtis, S., Diez-Roux, A. V., & Macintyre, S. (2007). Understanding and representing place' in health research: A relational approach. *Social Science & Medicine*, *65*(9), 1825–1838.

Das, R. D., & Winter, S. (2016). A context-sensitive conceptual framework for activity modeling [Journal Article]. *Journal of Spatial Information Science*, *12*(1), 45-85.

Derungs, C., & Purves, R. (2014). From text to landscape: locating, identifying and mapping the use of landscape features in a Swiss Alpine corpus [Journal Article]. *International Journal of Geographical Information Science*, *28*(6), 1272-1293.

Dunn, S. (2017). Praxes of The Human and The Digital: Spatial Humanities and the Digitization of Place. *GeoHumanities*, *3*(1), 88–107.

Edwardes, A. J. (2007). *Re-placing location: Geographic perspectives in location based services* (Thesis). Faculty of Science.

Edwardes, A. J., & Purves, R. (2007a). Eliciting concepts of place for text-based image retrieval [Conference Proceedings]. In *Proceedings of the 4th ACM workshop on Geographical Information Retrieval* (p. 15-18). ACM.

Edwardes, A. J., & Purves, R. (2007b). A Theoretical Grounding for Semantic Descriptions of Place [Conference Proceedings]. In J. M. Ware & G. E. Taylor (Eds.), *Web and Wireless Geographical Information Systems* (p. 106-120). Springer Berlin Heidelberg.

Egenhofer, M. J. (1991). Reasoning about binary topological relations [Conference Proceedings]. In *Symposium on Spatial Databases* (p. 141-160). Springer.

ElGindy, E., & Abdelmoty, A. (2014a). Capturing Place Semantics on the GeoSocial Web [Journal Article]. *Journal on Data Semantics*, *3*(4), 207-223.

ElGindy, E., & Abdelmoty, A. (2014b). Enriching user profiles using geo-social place semantics in geo-folksonomies [Journal Article]. *International Journal of Geographical Information*

Science, *28*(7), 1439-1458.
Entrikin, J. N. (1991). The Betweenness of Place [Book Section]. In *The Betweenness of Place: Towards a Geography of Modernity* (p. 6-26). London: Macmillan Education UK.
Entrikin, J. N. (1994). Place and Region [Journal Article]. *Progress in Human Geography*, *18*(2), 227-233.
Entrikin, J. N. (1996). Place and Region 2 [Journal Article]. *Progress in Human Geography*, *20*(2), 215-221.
Entrikin, J. N. (1997). Place and Region 3 [Journal Article]. *Progress in Human Geography*, *21*(2), 263-268.
Frank, A. U. (1992). Qualitative spatial reasoning about distances and directions in geographic space [Journal Article]. *Journal of Visual Languages & Computing*, *3*(4), 343-371.
Gallie, W. B. (1955). Essentially contested concepts. *Proceedings of the Aristotelian Society*, *56*, 167–198.
Galton, A. (2010). The formalities of affordance [Conference Proceedings]. In *Proceedings of ECAI2010 Workshop on Spatio-Temporal Dynamics* (p. 1-6).
Gibson, J. J. (1979). *The Ecological Approach to Visual Perception.* Boston: Houghton Mifflin Company.
Gieryn, T. F. (2000). A Space for Place in Sociology [Journal Article]. *Annual Review of Sociology*, *26*(1), 463-496.
Goldberg, D. W., Wilson, J. P., & Knoblock, C. A. (2009). Extracting geographic features from the Internet to automatically build detailed regional gazetteers [Journal Article]. *International Journal of Geographical Information Science*, *23*(1), 93-128.
Goodchild, M. F. (2011). Formalizing Place in Geographic Information Systems [Book Section]. In *Communities, Neighborhoods, and Health: Expanding the Boundaries of Place* (p. 21-33). New York, NY: Springer New York.
Gustafson, P. (2001). Meanings of place: Everyday experience and theoretical conceptualizations [Journal Article]. *Journal of Environmental Psychology*, *21*(1), 5-16.
Hales, T. C. (2007). The Jordan Curve Theorem, Formally and Informally [Journal Article]. *The American Mathematical Monthly*, *114*(10), 882-894.
Harrison, S., & Dourish, P. (1996). Re-place-ing Space: The Roles of Place and Space in Collaborative Systems. In *Proceedings of the 1996 ACM Conference on Computer Supported Cooperative Work* (pp. 67–76). New York, NY, USA: ACM.
Harrison, S., & Tatar, D. (2008, apr). Places: People, Events, Loci – the Relation of Semantic Frames in the Construction of Place. *Computer Supported Cooperative Work (CSCW)*, *17*(2), 97–133.
Hill, L., Frew, J., & Zheng, Q. (1999). *Geographic Names: The Implementation of a Gazetteer in a Georeferenced Digital Library* (Tech. Rep.).
Hillier, B. (2007). *Space is the machine: a configurational theory of architecture* [Book]. Space Syntax.
Hockenberry, M. C. (2006). *Grounding for a computational model of place* (Thesis). School of Architecture and Planning.
Hollenstein, L., & Purves, R. (2010). Exploring place through user-generated content: Using Flickr tags to describe city cores [Journal Article]. *Journal of Spatial Information Science*, *1*(1), 21-48.
Ingram, D. R. (1971). The concept of accessibility: A search for an operational form [Journal Article]. *Regional Studies*, *5*(2), 101-107.
Janowicz, K. (2012). Observation-driven geo-ontology engineering [Journal Article]. *Transactions in GIS*, *16*(3), 351-374.
Janowicz, K., Scheider, S., & Adams, B. (2013). A Geo-semantics Flyby [Book Section]. In *Reasoning Web. Semantic Technologies for Intelligent Data Access: 9th International Summer School 2013, Mannheim, Germany, July 30 August 2, 2013. Proceedings* (p. 230-250). Berlin, Heidelberg: Springer Berlin Heidelberg.
Johnson, S. C. (1967). Hierarchical clustering schemes [Journal Article]. *Psychometrika*, *32*(3), 241-254.

Jones, C. B., Alani, H., & Tudhope, D. (2001). Geographical Information Retrieval with Ontologies of Place. In D. R. Montello (Ed.), *Spatial Information Theory* (pp. 322–335). Berlin, Heidelberg: Springer Berlin Heidelberg.

Jones, S. B. (1959). Boundary concepts in the setting of place and time [Journal Article]. *Annals of the Association of American Geographers*, *49*(3), 241-255.

Jonietz, D. (2016). *From Space to Place: A Computational Model of Functional Place* (Thesis). Faculty of Applied Computer Science.

Jonietz, D., & Timpf, S. (2015). On the relevance of Gibson's affordance concept for geographical information science (GISc) [Journal Article]. *Cognitive Processing*, *16*(1), 265-269.

Jordan, T., Raubal, M., Gartrell, B., & Egenhofer, M. (1998). An affordance-based model of place in GIS [Conference Proceedings]. In *8th International Symposium on Spatial Data Handling, SDH* (Vol. 98, p. 98-109).

Jorgensen, B. S., & Stedman, R. C. (2001). Sense of place as an attitude: Lakeshore owners attitudes toward their properties [Journal Article]. *Journal of Environmental Psychology*, *21*(3), 233-248.

Kim, J., Vasardani, M., & Winter, S. (2016). From descriptions to depictions: A dynamic sketch map drawing strategy. *Spatial Cognition & Computation*, *16*(1), 29-53.

Kordjamshidi, P., Otterlo, M. V., & Moens, M.-F. (2011). Spatial role labeling: Towards extraction of spatial relations from natural language [Journal Article]. *ACM Transactions on Speech and Language Processing (TSLP)*, *8*(3), 1-36.

Kuhn, W. (2001). Ontologies in support of activities in geographical space [Journal Article]. *International Journal of Geographical Information Science*, *15*(7), 613-631.

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

Kyle, G., Bricker, K., Graefe, A., & Wickham, T. (2004). An Examination of Recreationists' Relationships with Activities and Settings [Journal Article]. *Leisure Sciences*, *26*(2), 123-142.

Kyle, G., Graefe, A., & Manning, R. (2005). Testing the dimensionality of place attachment in recreational settings [Journal Article]. *Environment and Behavior*, *37*(2), 153-177.

Leidner, J. L. (2007). Toponym resolution in text: annotation, evaluation and applications of spatial grounding [Conference Proceedings]. In *ACM SIGIR Forum* (Vol. 41, p. 124-126). ACM.

Lewicka, M. (2010). What makes neighborhood different from home and city? Effects of place scale on place attachment [Journal Article]. *Journal of Environmental Psychology*, *30*(1), 35-51.

Lussault, M. (2003). Valeur Spatiale [Book Section]. In *Dictionnaire de géographie et de l'espace des sociétés* (p. 973-974). La Documentation Française.

MacRoberts, M. H., & MacRoberts, B. R. (1989). Problems of Citation Analysis: A Critical Review [Journal Article]. *Journal of the American Society for Information Science*, *40*(5), 342-349.

Maechler, M. (2018). "Finding Groups in Data": Cluster Analysis Extended Rousseeuw et. al [Journal Article]. *Documentation for software package. The Comprehensive R Archive Network (CRAN): Wien.*

Markus, T. A. (1987). Buildings as Classifying Devices [Journal Article]. *Environment and Planning B: Planning and Design*, *14*(4), 467-484.

Massey, D. (1994). *Space, Place, and Gender* (Vol. 35) [Book]. University of Minnesota Press.

McKenzie, G., & Adams, B. (2017). Juxtaposing thematic regions derived from spatial and platial user-generated content [Conference Proceedings]. In *Proceedings of the 13th International Conference on Spatial Information Theory* (Vol. 86). Schloss Dagstuhl-Leibniz-Zentrum fuer Informatik.

Mennis, J., & Mason, M. J. (2016). Modeling Place as a Relationship between a Person and a Location. In *International Conference on GIScience.*

Merschdorf, H., & Blaschke, T. (2018). Revisiting the Role of Place in Geographic Information Science [Journal Article]. *ISPRS International Journal of Geo-Information*, *7*(9), 364.

Mondschein, A., Blumenberg, E., & Taylor, B. (2010). Accessibility and cognition: the effect of transport mode on spatial knowledge [Journal Article]. *Urban Studies*, *47*(4), 845-866.

Montello, D. R. (1993). Scale and multiple psychologies of space [Conference Proceedings]. In *European Conference on Spatial Information Theory* (p. 312-321). Springer.

Montello, D. R., Goodchild, M. F., Gottsegen, J., & Fohl, P. (2003). Where's Downtown?: Behavioral Methods for Determining Referents of Vague Spatial Queries [Journal Article]. *Spatial Cognition & Computation*, *3*(2-3), 185-204.

Nothegger, C., Winter, S., & Raubal, M. (2004). Selection of Salient Features for Route Directions [Journal Article]. *Spatial Cognition & Computation*, *4*(2), 113-136.

Nouvel, D., Ehrmann, M., & Rosset, S. (2016). *Named Entities for Computational Linguistics* [Book]. John Wiley & Sons.

Okoli, C. (2015). A Guide to Conducting a Standalone Systematic Literature Review [Journal Article]. *Communications of the Association for Information Systems*, *37*.

Ortmann, J., & Kuhn, W. (2010). Affordances as qualities. In *Proceedings of the 2010 Conference on Formal Ontology in Information Systems: Proceedings of the Sixth International Conference (FOIS 2010)* (pp. 117–130). Amsterdam, The Netherlands, The Netherlands: IOS Press.

Papadakis, E., Resch, B., & Blaschke, T. (2016). A Function-based model of Place [Conference Proceedings]. In *GIScience* (Vol. 1).

Purves, R., & Derungs, C. (2015). From Space to Place: Place-Based Explorations of Text [Journal Article]. *International Journal of Humanities and Arts Computing*, *9*(1), 74-94.

Purves, R., Edwardes, A., & Sanderson, M. (2008). Describing the where-improving image annotation and search through geography [Conference Proceedings]. In *Proceedings of the workshop on Metadata Mining for Image Understanding (MMIU 2008).* Sheffield.

Purves, R., Edwardes, A., & Wood, J. (2011). Describing place through user generated content [Journal Article]. *First Monday*.

Purves, R., Winter, S., & Kuhn, W. (2018). Places in information science [Journal Article]. *Journal of the Association for Information Science and Technology*.

Quesnot, T., & Roche, S. (2015). Platial or Locational Data? Toward the Characterization of Social Location Sharing [Conference Proceedings]. In *48th Hawaii International Conference on System Sciences* (p. 1973-1982).

Relph, E. (1976). *Place and placelessness* [Book]. London: Pion.

Richter, D., Winter, S., Richter, K.-F., & Stirling, L. (2013). Granularity of locations referred to by place descriptions [Journal Article]. *Computers, Environment and Urban Systems*, *41*, 88-99.

Roche, S. (2015). Geographic information science II: Less space, more places in smart cities [Journal Article]. *Progress in Human Geography*, *40*(4), 565-573.

Sabbata, S. D., Mizzaro, S., & Reichenbacher, T. (2015). Geographic dimensions of relevance [Journal Article]. *Journal of Documentation*, *71*(4), 650-666.

Scannell, L., & Gifford, R. (2010). Defining place attachment: A tripartite organizing framework [Journal Article]. *Journal of Environmental Psychology*, *30*(1), 1-10.

Scheider, S., & Janowicz, K. (2010). Places as media of containment. In *International Conference on GIScience.*

Scheider, S., & Janowicz, K. (2014). Place reference systems: A constructive activity model of reference to places [Journal Article]. *Applied Ontology*, *9*(2), 97-127.

Scheider, S., & Purves, R. (2013). Semantic Place Localization from Narratives. In *Proceedings of The First ACM SIGSPATIAL International Workshop on Computational Models of Place* (pp. 16–19). New York, NY, USA: ACM.

Smith, B., & Varzi, A. C. (2000). Fiat and bona fide boundaries [Journal Article]. *Philosophical and Phenomenological Research*, 401-420.

Spencer, D. (2009). *Card sorting: Designing usable categories* [Book]. Rosenfeld Media.

Tomko, M., & Winter, S. (2009). Pragmatic Construction of Destination Descriptions for Urban Environments [Journal Article]. *Spatial Cognition & Computation*, *9*(1), 1-29.

Tuan, Y.-F. (1977). *Space and place: The perspective of experience* [Book]. University of

Minnesota Press.
Tuan, Y.-F. (1990). *Topophilia: A study of environmental perceptions, attitudes, and values* [Book]. Columbia University Press.
Turner, P., & Turner, S. (2006). Place, sense of place, and presence [Journal Article]. *Presence: Teleoperators & Virtual Environments*, *15*(2), 204-217.
Tversky, B., & Hemenway, K. (1983). Categories of environmental scenes [Journal Article]. *Cognitive Psychology*, *15*(1), 121-149.
Vanclay, F. (2008). Place matters [Book Section]. In *Making Sense of Place : Exploring Concepts and Expressions of Place through Different Senses and Lenses* (p. 3-11). National Museum of Australia Press, Canberra.
Vasardani, M., Timpf, S., Winter, S., & Tomko, M. (2013). From descriptions to depictions: A conceptual framework [Conference Proceedings]. In T. Tenbrink, J. Stell, A. Galton, & Z. Wood (Eds.), *Spatial Information Theory* (p. 299-319). Springer International Publishing.
Vasardani, M., Tomko, M., & Winter, S. (2016). The Cognitive Aspect of Place Properties. In *International Conference on GIScience.*
Vasardani, M., & Winter, S. (2016). Place properties [Book Section]. In *Advancing Geographic Information Science: The Past and Next Twenty Years* (p. 243-254). GSDI Association Press Needham, MA.
Werlen, B. (2003). *Society, action and space* [Book]. Routledge.
Winter, S. (2009). Spatial Intelligence: Ready for a Challenge? [Journal Article]. *Spatial Cognition & Computation*, *9*(2), 138-151.
Winter, S., & Freksa, C. (2012). Approaching the notion of place by contrast [Journal Article]. *Journal of Spatial Information Science*, *5*(1), 31-50.
Winter, S., Hamzei, E., Van de Weghe, N., & Ooms, K. (2018). A Graph Representation for Verbal Indoor Route Descriptions. In *Spatial Cognition XI* (pp. 77–91). Cham: Springer International Publishing.
Winter, S., & Truelove, M. (2013). Talking About Place Where it Matters [Book Section]. In *Cognitive and Linguistic Aspects of Geographic Space: New Perspectives on Geographic Information Research* (p. 121-139). Berlin, Heidelberg: Springer Berlin Heidelberg.
Ye, M., Janowicz, K., Mülligann, C., & Lee, W.-C. (2011). What you are is when you are: the temporal dimension of feature types in location-based social networks [Conference Proceedings]. In *Proceedings of the 19th ACM SIGSPATIAL International Conference on Advances in Geographic Information Systems* (p. 102-111). ACM.

Appendix A. Selected Papers

Table A1 shows the number of selected papers in each iteration.

Table A1. Number of selected papers in each iteration

Iteration	#Publications	#Unique Publications[5]	#Selected
Seed Papers	2560	2560	13
1st iteration (backward/forward)	1491	1005	38
2nd iteration (backward/forward)	1821	489	21
All	5872	4056	72

Appendix B. Extracted facets

The extracted facets from the literature are presented in Table B1. Table B2 shows the definitions of the facets which are extracted from the literature.

Table B1. Extracted facets from the literature

Facet name	References
Accessibility	(Winter and Freksa, 2012; Ingram, 1971)
Action	(Das and Winter, 2016; Entrikin, 1997; Hockenberry, 2006; Jonietz, 2016; Jordan et al., 1998; Kuhn, 2001)
Activity	(Almuzaini, 2017; Calafiore, 2016; Couclelis, 1992; Das and Winter, 2016; Edwardes, 2007; Edwardes and Purves, 2007b; ElGindy and Abdelmoty, 2014b; ElGindy and Abdelmoty, 2014a; Jonietz, 2016; Kuhn, 2001; Relph, 1976; Tuan, 1977; Tversky and Hemenway, 1983)
Address	(Almuzaini, 2017)
Affordance	(Alazzawi et al., 2012; Almuzaini, 2017; Ballatore, 2016; Das and Winter, 2016; Edwardes, 2007; ElGindy and Abdelmoty, 2014b; ElGindy and Abdelmoty, 2014a; Galton, 2010; Gibson, 1979; Harrison and Dourish, 1996; Hockenberry, 2006; Jonietz and Timpf, 2015; Jordan et al., 1998; Kuhn, 2001; Ortmann and Kuhn, 2010; Sabbata et al., 2015; Scheider and Janowicz, 2014; Scheider and Krzysztof, 2010; Scheider and Purves, 2013; Winter and Freksa, 2012)
Agentive Dimension	(Couclelis, 2010)
Alternating Repetition	(Vasardani et al., 2016; Vasardani and Winter, 2016)
Aspect of Design	(Canter, 1997)
Attributes (Features)	(Tversky and Hemenway, 1983)
Behaviour	(Buttimer, 1976; Edwardes, 2007; Jonietz, 2016)
Boundaries	(Couclelis, 1992; Montello et al., 2003; Vasardani et al., 2016; Vasardani and Winter, 2016; Winter and Freksa, 2012)
Classification	(Scheider and Janowicz, 2014; Scheider and Purves, 2013; Tversky and Hemenway, 1983)
Composition	(Papadakis et al., 2016)
Constitutive Dimension	(Couclelis, 2010)
Containment	(Scheider and Janowicz, 2014; Scheider and Krzysztof, 2010; Scheider and Purves, 2013; Winter and Freksa, 2012)
Contrast	(Vasardani et al., 2016; Vasardani and Winter, 2016)
Deep Interlock and Ambiguity	(Vasardani et al., 2016; Vasardani and Winter, 2016)
Echoes	(Vasardani et al., 2016; Vasardani and Winter, 2016)
Elements	(Edwardes and Purves, 2007a; Edwardes and Purves, 2007b)
Emotional Attachments	(Mennis and Mason, 2016)
Environment	(Gustafson, 2001)
Environment-Self	(Gustafson, 2001)
Equipment	(Scheider and Janowicz, 2014; Scheider and Purves, 2013)
Event	(Roche, 2015)
Feasibility (of an activity)	(Jonietz, 2016)
Footprint	(Derungs and Purves, 2014; Goodchild, 2011)
Form	(Canter, 1997)

Formal Dimension	(Couclelis, 2010)
Function	(Canter, 1977; Papadakis et al., 2016)
Functional Differentiation	(Canter, 1997)
Functional Properties	(Vasardani et al., 2016)
Generalized Properties (Place Properties)	(Adams, 2015)
Geographic Location	(Adams, 2015)
Good shape	(Vasardani et al., 2016; Vasardani and Winter, 2016)
Gradients	(Vasardani et al., 2016; Vasardani and Winter, 2016)
Identification	(Scheider and Janowicz, 2014; Scheider and Purves, 2013)
Investment with Meaning and Value	(Gieryn, 2000)
Level of Scale	(Richter et al., 2013a; Richter et al., 2013b; Vasardani et al., 2013; Vasardani et al., 2016)
Local Symmetries	(Vasardani et al., 2016; Vasardani and Winter, 2016)
Locale	(Agnew, 2011; Capineri, 2016; Cresswell, 2004; Hollenstein and Purves, 2010; Jonietz, 2016; Massey, 1994; Purves and Derungs, 2015)
Localization	(Scheider and Janowicz, 2014; Scheider and Purves, 2013)
Location	All
Material Form (Physicality)	(Gieryn, 2000)
Meaning	(Buttimer, 1976; Canter, 1977; Canter, 1997; Couclelis, 1992; Edwardes, 2007; Entrikin, 1991; Entrikin, 1994; Entrikin, 1996; Harrison and Dourish, 1996; Jonietz, 2016; Massey, 1994; Relph, 1976; Tuan, 1977; Turner and Turner, 2006; Vanclay, 2008; Capineri, 2016)
Narrative Descriptions	(Jordan et al., 1998)
Not Separateness	(Vasardani et al., 2016; Vasardani and Winter, 2016)
Object of Action	(Hockenberry, 2006)
Observed Properties (Environment Properties)	(Adams, 2015)
Others	(Gustafson, 2001)
Others-Environment	(Gustafson, 2001)
Parts	(Tversky and Hemenway, 1983)
Physical Dimension	(Ballatore, 2016)
Physical Elements	(Scannell and Gifford, 2010)
Physical Features	(Jordan et al., 1998; Turner and Turner, 2006)
Physical Landscape	(Cresswell, 2004)
Physical Setting	(Relph, 1976)
Place Affect	(Almuzaini, 2017; Cresswell, 2004)
Place Attachment (1)	(Scannell and Gifford, 2010; Tuan, 1977)
Place Attachment (2)	(Vanclay, 2008)
Place Commitment	(Vanclay, 2008)
Place Dependence (1)	(Almuzaini, 2017)
Place Dependence (2)	(Vanclay, 2008)
Place Familiarity	(Vanclay, 2008)

Place Identity (1)	(Canter, 1977; Cresswell, 2004; Entrikin, 1991; Entrikin, 1996; Entrikin, 1997; Gustafson, 2001; Jonietz, 2016; Massey, 1994; Relph, 1976; Scannell and Gifford, 2010; Tuan, 1977; Turner and Turner, 2006)
Place Identity (2)	(Vanclay, 2008)
Place Name (Toponym)	All
Place Objectives	(Canter, 1997)
Place Reference (Verbal Reference)	(Alazzawi et al., 2012; Almuzaini, 2017; Bennett and Agarwal, 2007; Montello et al., 2003; Purves and Derungs, 2015; Winter and Freksa, 2012)
Place Social Bonding	(Almuzaini, 2017)
Positive Space	(Vasardani et al., 2016; Vasardani and Winter, 2016)
Purpose	(Papadakis et al., 2016)
Qualities (1)	(Edwardes and Purves, 2007a; Edwardes and Purves, 2007b; Purves et al., 2011)
Qualities (2)	(Ortmann and Kuhn, 2010)
Quality of Place	(Jonietz, 2016)
Roughness	(Vasardani et al., 2016; Vasardani and Winter, 2016)
Salience of Place (Absolute view)	(Almuzaini, 2017)
Salience of Place (Personal view)	(Almuzaini, 2017)
Saliency	(Almuzaini, 2017; Richter et al., 2013a; Richter et al., 2013b; Winter and Truelove, 2013; Winter and Freksa, 2012)
Scale of Interaction	(Canter, 1997; Goldberg et al., 2009; Purves and Derungs, 2015; Richter et al., 2013a; Richter et al., 2013b)
Self	(Gustafson, 2001)
Self-Others	(Gustafson, 2001)
Self-Others-Environment	(Gustafson, 2001)
Semantic Relation to Activities	(Scheider and Purves, 2013)
Semantic Relation to Objects	(Scheider and Purves, 2013)
Semantic Relation to Qualities	(Scheider and Purves, 2013)
Sense of Place (1)	(Buttimer, 1976; Canter, 1977; Capineri, 2016; Cresswell, 2004; Edwardes, 2007; Entrikin, 1991; Harrison and Dourish, 1996; Massey, 1994; Purves and Derungs, 2015; Purves et al., 2008; Tuan, 1977)
Sense of Place (2)	(Vanclay, 2008)
Sentiment (Individual Reflection)	(ElGindy and Abdelmoty, 2014b; ElGindy and Abdelmoty, 2014a)
Service	(Alazzawi et al., 2012; Winter and Truelove, 2013)
Simplicity and Inner Calm	(Vasardani et al., 2016; Vasardani and Winter, 2016)
Social Elements	(Scannell and Gifford, 2010)
Social Role (Social Dimension)	(Ballatore, 2016)
Social Role Characteristics	(Calafiore, 2016)

Socioeconomic and Cultural Factors	(Jordan et al., 1998)
Space	(Canter, 1997)
Spatial Accessibility	(Jonietz, 2016; Winter and Freksa, 2012)
Spatial Band	(Adams, 2015; Janowicz, 2012; Janowicz et al., 2013; McKenzie and Adams, 2017)
Spatial Identity	(Quesnot and Roche, 2015; Roche, 2015)
Spatial Level	(Scannell and Gifford, 2010)
Spatial Properties	(Papadakis et al., 2016)
Spatial Reference	(Adams, 2015; Alazzawi et al., 2012; Almuzaini, 2017; Bennett and Agarwal, 2007; Jones et al., 2001; Kim et al., 2016; Montello et al., 2003; Richter et al., 2013b; Vasardani et al., 2013; Winter, 2009; Winter and Freksa, 2012)
Spatial Relation to Other Places	(Scheider and Purves, 2013)
Spatial Value	(Quesnot and Roche, 2015)
Specificity	(Scannell and Gifford, 2010)
Spirit of Place	(Vanclay, 2008)
Strong Centres	(Vasardani et al., 2016; Vasardani and Winter, 2016)
Structural Properties	(Vasardani et al., 2016; Vasardani and Winter, 2016)
Suitability (of an activity)	(Jonietz, 2016; Jonietz and Timpf, 2015)
Symbolic Representation	(Jordan et al., 1998)
Telic Dimension	(Couclelis, 2010)
Temporal Band	(Adams and Janowicz, 2015; Janowicz, 2012; Janowicz et al., 2013)
The Void	(Vasardani et al., 2016; Vasardani and Winter, 2016)
Thematic Band	(Janowicz, 2012; Janowicz et al., 2013; McKenzie and Adams, 2017)
Type	All
Typologies/Categorisations	(Jordan et al., 1998; Tversky and Hemenway, 1983)
Valuation (of an action)	(Hockenberry, 2006)

Table B2. Extracted facets from the literature with their definitions

Facet name	Definition
Accessibility	"In one sense the word 'accessibility' means capable of being reached, thus, implying a measure of the proximity between two points. Alternatively, 'accessibility' is related to the ability of a transportation system to provide a low cost and/or quick method of overcoming the distance between different locations" (Ingram, 1971). Accessibility is a term related to the spatial configuration of places with a focus on connectivity of places, whether places are connected or disconnected and an agent can move from one place to another. Accessibility is a contextual property of places – i.e., in some context, a place can be accessible from another place, while in other contexts it may not be accessible (Winter and Freksa, 2012). Accessibility is highly related to the mode of transportation, and the contextual information about the agents.

Action	Action is defined as a type of activity that is intentional and conscious and oriented towards the fulfillment of a particular goal. In Jordan's place model, it is defined as: "People perform actions in places. As we have seen, actions are one of the most important aspects that give meaning to a place. Personal actions can create personal histories. Personal actions allow users to participate in accepted patterns of behavior, as well as to personalize the place by performing individualizing actions. For example: Whenever I'm at this mall, I go to store X because I always found nice and cheap clothes there" (Jordan et al., 1998).
Activity	Activity is defined as a behavior or action from an agent in a specific place. As a part of a model (attributes, activities, and parts) for describing environmental scenes (Tversky and Hemenway, 1983), activities are defined as what people can do in the scenes such as 'shopping' for stores.
Address	Address is a reference to a place which describes where the place is in (usually hierarchically organized based on the part-of relationship).
Affordance	Affordance is described as what an environment (e.g., a place) can afford to an agent (e.g, human, animal). By capturing affordance in a place, one can consider the following questions to be answered: What can be done (even potentially) in the place? What can a place afford to a human?
Agentive Dimension	Agentive dimension is one of the four dimensions of objects of discourse (Couclelis, 2010). The four dimensions can be considered as dimensions of place as an object of discourse. It is defined as: "The processes by which things come to be or their roles as agents in other processes or their function relative to some end" (Couclelis, 2010). For example, stopping illegal immigration is the agentive dimension of Gibraltar (Couclelis, 2010).
Alternating Repetition	"Alternating repetitions are common in places with self-similarity patterns such as coastal places or forests." This property is one of the six properties (good shape, local symmetries, echoes, roughness, alternating repetitions, and positive space) about the internal structural organization of places which makes places distinctive. (Vasardani and Winter, 2016)

Aspect of Design	Aspect of design is a facet of place about physical characteristics of a place. It is defined as a fact that "gives rise to a whole basket of hypotheses about how the structure of place experience may take on different forms in relation to the aspects of design that are being considered. For example personal comfort at the immediate scale, say in a room, may be most clearly revealed by examining the functions of a particular space and how readily these are achieved. This is probably what most building evaluations seek to do. To take another example, the form (or style) of a place may be examined to see whether it reveals emphases at the personal, social or cultural level of differentiation" (Canter, 1997).
Attributes (Features)	It is a part of a place model (attributes, activities, and parts) for describing environmental scenes (Tversky and Hemenway, 1983). Attributes are described as features of the scenes. For example, 'high' can be considered as one of the attributes describing mountains.
Boundaries	Boundary defines which part of space belong a place. Places have boundaries, either crisp or fuzzy.
Classification	In place reference system (Scheider and Janowicz, 2014), classification is described as kind of places and wants to answer: "what kind of place it is".
Composition	"The dimension of composition illustrates the constitution level, representing the spatial organization of a place as a composite object formed by simple interrelated components" (Papadakis et al., 2016). Composition is related to spatial objects with specific spatial associations which enables some functions for that place and build specific spatial properties to the place.
Constitutive Dimension	Constitutive dimension is one of the four dimensions of objects of discourse. The four dimensions can be considered as dimensions of place as an object of discourse. It is defined as: "The constitutive dimension has to do with what the object is made of and in particular, its parts (material or abstract), and how these are connected" (Couclelis, 2010). For example, rock is related to the constitutive dimension of mountains.
Containment	In place reference system, things (places and other objects) that exist in a place are described as place containment. They defined this element as "An essential function of places is that they serve to localize other things" (Scheider and Janowicz, 2014).

Contrast	Contrast is a way that people differentiate places from each other and at the same time is a way to capture the notion of place (Winter and Freksa,2012). Contrast is one of the properties mentioned and defined by Vasardani and Winter (2016): "as a whole then, the entities that form a place and places themselves, exhibit centres, that can be contrasted to each other, may have distinct boundaries or gradients that create harmonious transitions between contrasting centres and they all belong to the same whole structure..."
Deep Interlock and Ambiguity	Deep interlock is related to ambiguity between boundaries of elements (parts) that constitute the whole (place). In case of deep interlock and ambiguity, the navigation from one part of a place to another part is not an abrupt transition and it is not clear that exactly when and where the person moves from one part to its adjacent part.
Echoes	"Echo is the property of a place when its whole structure is reminiscent of another place, or the sense of familiarity that people some times experience in a place, even when they visit it for the first time, due to its similarity with other places of similar properties. Echoes can be internal, as similarity of the elements within a place, or external, characterizing a place as a whole when compared with other places" (Vasardani and Winter, 2016).
Elements	Places can be described by the elements they are belonging to (e.g., a city has elements such as church and school). People use these elements as descriptive terms to describe a place using natural languages. Elements can be extracted from place descriptions. Elements are part of a place model which includes three parts: 1- elements, 2- qualities, and 3- activities (Edwardes and Purves, 2007a; Edwardes and Purves, 2007b).
Emotional Attachments	"Place can be understood, and represented, not only as an attribute of a location but also as the emotional attachments that characterize a relationship between an individual and a location". Emotional attachment can be modeled as a combination of mood state, behaviors, and social interactions (Mennis and Mason, 2016).
Environment	Environment is a part of a three-pole model which is presented by Gustafson (2001). Environment related to physical characteristics and natural conditions. "Very often, meanings of place depend neither on the self, nor on the relations with or perceptions of others. I have tentatively labelled this pole 'environment'". This pole includes "the physical environment, including the natural environment and various natural conditions (weather, seasons), as well as the built environment" (Gustafson, 2001).

Environment-Self	Environment-Self is part of Gustafson (2001) model which is defined in the relation between a person and a place. "Meanings of place may also concern the relationship between self and environment. This relationship is often based on the respondents' knowledge of the place. Some refer to a formal knowledge (geographical, historical), others value their familiarity with their lived-in physical environment" (Gustafson, 2001).
Equipment	Equipment described as objects associated with a place. This object can be inside or outside of the place, but they play a role in the activities related to the place. For example, a place to see a specific statue, the statue may not be in the place, but the act of seeing is doable in that place. This part of the model answers the following question: What is a place equipped with?
Event	"Roche (2012) formalizes this conception of place with this function: P = f (N, E, L), where P is the place, N the Name, E the Event, and L the Location." "Event refers to a large spectrum of meanings, the space within which humans carry out habitual aspects of their lives, such as shopping, work, recreation, and sleeping" (Roche, 2015).
Feasibility (of an activity)	Feasibility of an activity is related to whether the activity can be done in any quality or not. Feasibility of activities are mostly restricted to binary statements, either activity is feasible or not in a place.
Footprint	Footprint is the location of a place in the space. Footprint is one part of the gazetteers' model. Footprint of a place defines where the place is.
Form	Introduced as a part of an architectural view to place which includes 1-function, 2- form, and 3- space. Form is related to geometric properties and styles in buildings (places) (Canter, 1997).
Formal Dimension	Formal dimension is one of the four dimensions of objects of discourse. The four dimensions can be considered as dimensions of place as an object of discourse. It is defined as: "What kind of object something is: it is concerned with those properties that distinguish one category of things from another" (Couclelis, 2010). For example, the formal dimension of "Perejil is 'a tiny, uninhabited island near Ceuta'" (Couclelis, 2010).
Function	"The functional perspective points to the semantic level of functions that provides a sense of context by depicting the set of operations that the place supports" (Papadakis et al., 2016). Function is determining the agentive dimension of place as an object of discourse. In other words, a function suggests a specific composition for a place and determines the functionality of the place. Also, defined as part of architectural aspects of building (function, form, and space). This aspect is directly related to activities that happen in buildings.

Functional Differentiation	This facet is related to activities that happen in places –e.g., home: eating, resting
Functional Properties	Functional properties are defined as an affordance that a place can afford (Vasardani et al., 2016).
Generalized Properties (Place Properties)	"A generalized property is a place property that is assigned to the place as a whole. Generalized attribute values result from some kind of inferential process, such as a statistical inference on a sample, simulation, or algorithm, performed on place observations or other interpreted data" (Adams, 2015). The properties can be inferred based on the observed properties of the location. Are stored as a set of key/value pairs. "A generalization is similar to an observation with the following exceptions. A generalization is associated with one and only one place, unlike observations which can have multiple place associations. Instead of an observation procedure, a generalization is generated by an inference mechanism. Generalizations do not have a location, only a place association" (Adams, 2015) – e.g., Population count, temperature seasonality, median income.
Geographic Location	"A place is a unique spot in the universe. Place is the distinction between here and there, and it is what allows people to appreciate near and far. Places have finitude, but they nest logically because the boundaries are (analytically and phenomenologically) elastic. A place could be your favourite armchair, a room, building, neighbourhood, district, village, city, county, metropolitan area, region, state, province, nation, continent, planetor a forest glade, the seaside, a mountaintop" (Gieryn, 2000). Geographic location is part of a model introduced by Gieryn (2000) which includes: 1- geographic location, 2- material 3- form, and 4- invested meaning and value.
Good shape	"The property of good shape of a place is the result of the cumulative good shape of its parts, such that if the individual centres and their surroundings are characterized by good shape by experiencing a few or all the aforementioned properties, then a place as the sum of its parts is also in good shape" (Vasardani and Winter, 2016).
Gradients	Gradient or graded variations are related to a change or a contrast which is happening in a smooth way. It is a part of place properties introduced by Vasardani and Winter (2016), and described as "[...] gradients that create harmonious transitions between contrasting centres and they all belong to the same whole structure".
Identification	In place reference system, place identification is described as a part of the model which can be used as an id to determine whether an object is a place or not. The id can be used to check whether two places are the same. This part of the model answers these two questions: Is it a place? Are these places the same? (Scheider and Janowicz, 2014)

Investment with Meaning and Value	"Without naming, identification, or representation by ordinary people, a place is not a place. Places are doubly constructed: most are built or in some way physically carved out. They are also interpreted, narrated, perceived, felt, understood, and imagined". "[...], the meaning or value of the same place is labileflexible in the hands of different people or cultures, malleable over time, and inevitably contested" (Gieryn, 2000).
Level of Scale	"Formations within and across places can exhibit different scales" (Vasardani and Winter, 2016).
Local Symmetries	"Local symmetries are experienced in both natural and artificial places where different foci create symmetrical neighborhoods around them" (Vasardani and Winter, 2016).
Locale	"Locales are effectively affordances, that is to say the properties of a location which allow a particular activity to take place. Locales need not be tied to a fixed location, for example a bus or train allows particular sets of activities and interactions, in the same way as a church or indeed a mountain" (Purves and Derungs, 2015). "Apart from the location of a place, however, one of its most apparent and observable characteristics is its material content, also referred to as its landscape, materiality, setting or locale" (Jonietz, 2016).
Localization	In place reference system, localization is described as the location of a place at a certain time. This part aimed at answering the following 'where question': Where is a place? (Scheider and Janowicz, 2014)
Location	"Location is defined as a location in space which can be named and thus, at least implicitly, assigned coordinates" (Purves and Derungs, 2015). "A place and its location are inseparably connected. A location can be interpreted as an absolute point in space which can be clearly determined by an x, y, z coordinate tuple and allows geometrical analysis such as measurements of distances to other locations" (Jonietz, 2016).
Material Form (Physicality)	"Place has physicality. Whether built or just come upon, artificial or natural, streets and doors or rocks and trees, place is stuff. It is a compilation of things or objects at some particular spot in the universe. Places are worked by people: we make places and probably invest as much effort in making the supposedly pristine places of Nature as we do in cities or buildings" (Gieryn, 2000). Material form is part of a model introduced by Gieryn (2000) which includes: 1- geographic location, 2- material 3- form, and 4- invested meaning and value.
Meaning	"Individual and group meanings (of a place) created through people's experience and intentions in regard to that place" (Relph, 1976).

Narrative Descriptions	"Stories are told in order to help characterize the uniqueness of a place as well as to define normative/acceptable behavior, by revealing the past actions of others. On a continuum with a place defined by an extensive narrative history, is a place defined by a single event (e.g. Chernobyl, Lockerbee, Three Mile Island)" (Jordan et al., 1998). Narrative descriptions is part of a model which includes: 1- physical features, 2- actions, 3- narrative descriptions, 4- symbolic representation, 5- socioeconomic and cultural factors, 6- typologies/categorisations.
Not Separateness	Not separateness is defined as "some of them (borders of places) distinct, some others gradient, but together they blend in, creating non-separated places" (Vasardani and Winter, 2016).
Object of Action	Object of action is a part of an experiential account for place which includes 1- action, 2- objects of action, and 3- valuation (Hockenberry, 2006). This part of the model defines what objects are related to a specific action. For example, the action of drinking happens in a bar, and objects of action such as beer can be found in the place.
Observed Properties (Environment Properties)	"An observed property is the result of a measurement of the environment by a sensor, whether it be a mechanical sensor such as a temperature gauge or a human sensor who records a written description of a place, at a specific location and time" (Adams, 2015).
Others	Others is a part of a three-pole model which is presented by Gustafson (2001). Others is a facet that is related to social relations and norms. "Places may also be associated with 'others' without reference to any social relations or encounters. In these cases, places are attributed meaning through the perceived characteristics, traits and behaviours of their inhabitants" (Gustafson, 2001).
Others-Environment	Others-environment is rarely mentioned in Gustafson's empirical study. He described it as meanings related to place regarding others and environments such as the atmosphere of a place, and street-life of a place (Gustafson, 2001).
Parts	Parts is introduced in a place-related model which includes: 1- attributes, 2- activities, and 3- parts (Tversky and Hemenway, 1983). Parts are described as elements of the scenes such as 'bird', 'sand' for describing beaches.
Physical Dimension	A dimension of place that represents the physical structure of the place – e.g., a shopping mall: a set of buildings
Physical Elements	Places have physical elements which have an impact on the bonding of people to them. The dimension of places in place attachment is measured by the prominence of social and physical elements – e.g., density, proximity, presence of amenities.

Physical Features	Physical features can be described as a collection of objects. "Places consist of collections of objects. Each person perceives some set of affordances for a given small-scale object (e.g., a cup, a door handle, or a coffee pot) or collection of objects in large-scale space (e.g., a room, a house, or a restaurant)" (Jordan et al., 1998). Physical features is part of a model which includes: 1- physical features, 2- actions, 3- narrative descriptions, 4- symbolic representation, 5- socioeconomic and cultural factors, 6- typologies/categorisations.
Physical Landscape	Physical landscape is a part of place elements (location, physical landscape, and sense of place). Physical landscape is described as the total sum of material (both natural and cultural).
Physical Setting	Physical setting is described as answers to the following questions: Where is it? What are the place physical characteristics?
Place Affect	"Reflecting the importance of social relationships and the context within which they occur. The specific settings of the place share the meanings attributed to them by the individual's social environment" (Almuzaini, 2017).
Place Attachment (1)	Place attachment is the bonding that occurs between individuals and their meaningful environments (places). Place attachment has three dimensions: person (an individual or a group), place (with spatial level, specificity, and prominence of social and physical elements), and process (which can view as affective, cognitive, and behavioural processes) (Scannell and Gifford, 2010).
Place Attachment (2)	Place attachment is the closest component part of a sense of place. "It has often been said that place attachment is the environmental psychologist's term for the geographer's concept of sense of place" (Vanclay, 2008). "Place attachment refers specifically to the extent to which an individual has positive feeling about their local environment and/or community" (Vanclay, 2008). Place attachment is also called place connectedness, connection to place, or place bonding. Here, place attachment is considered as a component part of a sense of place.
Place Commitment	"Place commitment refers to the extent to which individuals are willing to contribute to their local place" (Vanclay, 2008) –e.g., contribution such as repairing houses in a neighbourhood
Place Dependence (1)	"How far the place satisfies the individual's behavioural goals as compared to other alternative" (Almuzaini, 2017)
Place Dependence (2)	"I consider place dependence to be more-or-less similar (to place identity), although strictly speaking it might be seen as the self-perceived strength of association between an individual and a specific place" (Vanclay, 2008). Here, place dependence is defined as a component of a sense of place.

Place Familiarity	"Place familiarity and place awareness are similar concepts which relate to the extent of knowledge an individual has about a specific place or local environment" (Vanclay, 2008). Here, it is defined as a part (component) of a sense of place.
Place Identity (1)	Relph (1976) has defined identity of place as "persistent sameness and unity which allows that [place] to be differentiated from others." "There are three aspects which determine a place's identity: its physical setting, the particular actions which can be conducted there, and any additional meaning which it is allocated, such as shared cultural values or personal memories" (Jonietz, 2016).
Place Identity (2)	Place identity is defined as a component part of a sense of place that "refers more specifically to the extent to which a person's identity is vested in the local place" (Vanclay, 2008).
Place Name (Toponym)	A name or names associated with a place. It can be an official name or a vernacular one. A place can have one or more names which can be used a reference to the place. A name of a place can be changed during the time.
Place Objectives	The facet is about "individual, social and cultural aspects of place" (Canter, 1997). "In other words, different aspects of the goals that a person has in a place. The distinct constituents each lead to a proposed distinct element i.e., individual, social and cultural" (Canter, 1997).
Place Reference (Verbal Reference)	"Verbal reference to named and unnamed places, or more complex verbal place descriptions containing several such references linked by spatial relationships are different from the common localization approach of geographic information systems and spatial databases" (Winter and Freksa,2012). "People may refer to locations by places' names, such as 'Cardiff University', or by associating different references with spatial relationships explicitly, such as 'in front of the cinema', or implicitly: 'Hilton, Cardiff' implying the Hilton hotel in Cardiff. 'In front of the cinema' is a directional relationship with the place, while 'Hilton, Cardiff' has a topological relationship that implies hierarchy. People can also refer to location by providing relatively exact descriptions of locations, for example, by stating an address, for example, 'the place is at 5 High St., near Liberty Square', or pin point it on a map" (Almuzaini, 2017).
Place Social Bonding	Place social bonding is defined as "reflecting the emotional or affective bond between an individual and a place" (Almuzaini, 2017).
Positive Space	"Positive spaces are what differentiate the figure from the ground in Gestalt theory and they are usually associated with the convex footprints of spatial features especially in the built environment, vs. the background space that surrounds them" (Vasardani and Winter, 2016).

Purpose	Purpose is determining the telic dimension of place as an object of discourse. In other words, it defines why a place as an object of discourse exists. Considering places as objects of discourse one may consider the purpose as a facet which defines why the place exists.
Qualities (1)	A place can be described using adjective terms defining the qualities about the place. People use the qualities as descriptive terms to describe a place using natural languages. Qualities are introduced as part of a model for place descriptions, i.e., elements, qualities, and activities (Edwardes and Purves, 2007a; Edwardes and Purves, 2007b). Qualities are related to the sense of the place or the subjective idea of a person regarding the place.
Qualities (2)	Qualities are defined as a superset of affordances. It includes observations (producing values), and affordances (producing actions). While Ortmann and Kuhn (2010) define qualities and affordances not only for places but for objects. However, it can be used as a part of place definition.
Quality of Place	The quality of a place is defined as a combination of two factors, spatial accessibility, and suitability of the place for a specific activity (Jonietz, 2016).
Roughness	Roughness is defined as "Roughness has to do with the irregularities and imperfections in any place configuration, as the result of organic generative process of development that do not adhere to perfect geometric symmetries" (Vasardani and Winter, 2016).
Salience of Place (Absolute view)	"On an absolute level, the salience of a place can be defined as being irrelevant to the attachment to specific individuals" (Almuzaini, 2017). Hence, the salience of place in absolute level is an objective measure that defines how important a place is.
Salience of Place (Personal view)	"The salience of a place can be described from a personal or from an absolute point of view. On a personal level, many factors can influence the importance of a place to an individual. This includes: place dependence, place affect, and place social bonding" (Almuzaini, 2017).
Salience	"Several properties contribute to the salience of an object: its singularity, its prominence, its accessibility, its meaning or cultural significance, and prototypicality. This element helps to distinguish landmarks in an environment" (Almuzaini, 2017).
Scale of Interaction	Scale of interaction is related to the scale in which the place belongs to (in which people interact with places).
Self	Self is a part of a three-pole model which is presented by Gustafson (2001). Self is related to personal meaning about a place and the place's self identification. The theme of 'life-path', 'emotion', and 'activity' belongs to this pole (Gustafson, 2001).

Self-Others	Self-others is related to a type of information that their meaning is related to both self and others. "Places often become meaningful because of the respondents' relations with people living there - friends, acquaintances, relatives - and the sense of community that such social relations create" (Gustafson, 2001).
Self-Others-Environment	Meaning related to places which involve self, others, and environment. "Traditions, festivals and anniversaries often implicate self, others and various environments (local as well as national). Similarly, when the respondents' membership in spatially defined associations or organizations makes the place meaningful, it is clear that self, others (other members) and the environment (geographical and sometimes institutional) contribute to the overall meaning of place" – e.g., citizenship (Gustafson, 2001).
Semantic Relation to Activities	Semantic relation to activities is part of a model designed to capture references to places in textual information (Scheider and Purves, 2013). Activities can be used in/as a reference to localize places in a description – e.g., a biking site.
Semantic Relation to Objects	Semantic relation to objects is part of a model designed to capture references to places in textual information (Scheider and Purves, 2013). Objects can be used in/as a reference to localize places in a description – e.g., a coffee place.
Semantic Relation to Qualities	Semantic relation to objects is part of a model designed to capture references to places in textual information (Scheider and Purves, 2013). Qualities can be used in/as a reference to localize places in a description – e.g., a warm place.
Sense of Place (1)	"Sense of place relates to the ways in which we might (or indeed might not) identify with a place and is necessarily based on our associations and experiences, or lack thereof, of a place" (Purves and Derungs, 2015). "In general, however, the notion of a sense of place involves, apart from its activities, additional associations to place which are typically of affective and intangible nature" (Jonietz, 2016).
Sense of Place (2)	Sense of place is defined by its components such as place attachment, place identity, place dependence, place familiarity, place commitment, and place satisfaction (Vanclay, 2008).
Sentiment (Individual Reflection)	An individual reflection is defined as a part of a place model which clarifies what people feel about a specific place (ElGindy and Abdelmoty, 2014b; ElGindy and Abdelmoty,2014a).
Service	Service is defined as an answer to what kind of services a place provides for an individual person.

Simplicity and Inner Calm	"This property is a more abstract one perhaps, but one well understood and agreed upon, nonetheless, when describing places of preference, of which it more often than not, is a characteristic. It abides to the notion that simplicity offers a feeling of calmness, or that places function better when they are not overloaded with elements or functions, or both. Think of the words one uses when describing shopping malls. Usually, and depending on the previous experiences, expressions such as 'crowded', 'busy', 'difficult to navigate through', 'confusing', or 'tiring', often appear in the descriptions for such places where many needs and many functions are attempted to be accommodated, such as shopping for various categories, eating, resting, recreation and others in one single place" (Vasardani and Winter, 2016).
Social Elements	Place plays a key role in human social life, and consequently place attachment is the results of this relationship between people and places. Place attachment is measured by the prominence of social and physical elements. Hence, this property is related to the social aspects of place attachment.
Social Role (Social Dimension)	"Representing what patterns of social interaction occurs there" (Ballatore, 2016) – e.g., a shopping mall: trading activities.
Social Role Characteristics	The social role characteristics are related to activities happen in a place. For example, one may consider the role of a beach as Place-Where-Sun-Bathing. The social role characteristics of a place are anti-rigid, emergent, and dynamic.
Socioeconomic and Cultural Factors	"People identify themselves with places socioeconomically. For example, sea ports are special socioeconomic places since they afford transportation and trading, therefore, they afford a certain type of economic climate. Ports need people to work there (e.g., loading and unloading ships), but at the same time they attract those who are buying and selling goods. Similarly, different cultures afford different behaviour in places. For example, black is the colour of mourning in the west, whereas in China it is white. Williams (1981) views culture as a system through which a certain order is communicated and experienced" (Jordan et al., 1998). Socioeconomic and cultural factors is part of a model which includes: 1- physical features, 2- actions, 3- narrative descriptions, 4- symbolic representation, 5- socioeconomic and cultural factors, 6- typologies/categorisations.
Space	Space is the term used as a part of place (building) model based on an architectural view. The model includes 1- function, 2- form, and 3- space. Space is related to the location of the places (buildings) (Canter, 1977).

Spatial Accessibility	"The relative accessibility of a place's location, which can be defined as the inherent characteristic (or advantage) of a place with respect to overcoming some form of spatially operating source of friction (for example, time and/or distance) is of relevance. In fact, a place's central location in the movement network might be a better indicator for high usage frequencies than its design" (Jonietz, 2016).
Spatial Band	Spatial band is part of a model which includes: 1- spatial band, 2- temporal band, and 3- thematic band (Janowicz, 2012). Spatial band represents the spatial patterns of a place. A specific place type has a specific spatial pattern (considering the other place with similar and different type).
Spatial Identity	"A place has to be identifiable to exist: it has a spatial identity that allows it to differentiate itself from other Places. This first definition of spatial identity is associated with the Relph's 'identity of Place', who explains that some Places may share joint attributes. The spatial identity of a Place may also be shared by a number of individuals. On the other hand, spatial identity can also be defined as the identification of an operator in a particular Space. This second acceptance refers to Relph's 'identity with Place'. As highlighted by Stock, identity is 'an arbitrary link between Place and people' and 'is not only linked to representations but also related to the practice of Places'" (Quesnot and Roche, 2015).
Spatial Level	Spatial level determines the scale of interaction in which the people are bonded to places –e.g., home, neighbourhood, city.
Spatial Properties	"The dimension of spatial properties reflects the semantic level of classification, describing place as a set of properties (e.g., geometries)" (Papadakis et al., 2016). Spatial properties of a place define spatial patterns which describe the relationship between the place and space.
Spatial Reference	"Spatial references are locating something in the world, as in 'I am at the bus stop'" (Winter, 2009). Spatial reference is one of the ways to describe a place in a place description.
Spatial Relation to Other Places	Spatial relation to other places is part of a model designed to capture references to places in textual information (Scheider and Purves, 2013). Other places can be used in/as a reference to localize a place in a description – e.g., "the location of land parcels may be described by relative spatial relations to surviving buildings, such as churches" (Scheider and Purves, 2013).

Spatial Value	"Lussault defines the spatial value as the totality of socially valuable qualities of a space" . "Within the field of geography, the value of a Place is defined by its relationships maintained with individuals. These relations are both physical (i.e. concrete practices) and philosophical (i.e. everything that is related to the imagination and representations)". "This notion of spatial identity is closely linked to the spatial value" (Quesnot and Roche, 2015).
Specificity	Specificity is a measure which is defined to answer: how a place, in the sense of attachment, is different from other places in the same type.
Spirit of Place	"Spirit of place, or genius loci, is a more appropriate (compared to sense of place) term when referring to the qualities of a place that make it special" (Vanclay, 2008). This definition is similar to the definition of sense of place in human geography literature. In here, the author claims that sense of place is more about individuals rather than places. He also mentioned that spirit of place is similar to the term 'topophilia' (love of place) mentioned by Yi-Fu Tuan.
Strong Centres	"In any 'place' formation, there exists at least one, and in most cases multiple centres of varying sizes, which support each other. This concept is clear in the central-place theory in geography and its later modifications" (Vasardani and Winter, 2016) – e.g., central district for a city.
Structural Properties	Structural properties includes 15 properties of place: 1- level of scale, 2- boundaries, 3- positive space, 4- local symmetries, 5- contrast, 6- roughness, 7- the void, 8- not separateness, 9- strong centres, 10- alternating repetition, 11- good shape, 12- deep interlock and ambiguity, 13- gradients, 14- echoes, 15- simplicity and inner calm (Vasardani et al., 2016).
Suitability (of an activity)	Suitability of activities is related to "influences the allocation of place utility, the level of satisfaction expected from interacting with this particular place, which correlates with the probability of it being selected and actually used". "[...] its [a place's] suitability, meaning its appropriateness with regards to a particular activity, tend to vary among its prospective users" (Jonietz, 2016).
Symbolic Representation	"Certain places are referenced by symbols (e.g., New York City is often referenced as the 'Big Apple') having symbolic and/or mythical meanings. Similarly, the Statue of Liberty is a common symbol for New York, related to its history as point of entry for many U.S. immigrants" (Jordan et al., 1998). Symbolic representation is part of a model which includes: 1- physical features, 2- actions, 3- narrative descriptions, 4- symbolic representation, 5- socioeconomic and cultural factors, 6- typologies/categorisations.

Telic Dimension	Telic dimension is one of the four dimensions of objects of discourse. The four dimensions can be considered as dimensions of place as an object of discourse. It is defined as "The purpose of things or the reasons why things happen" (Couclelis, 2010).
Temporal Band	Temporal band is part of a model which includes: 1- spatial band, 2- temporal band, and 3- thematic band (Janowicz, 2012). Temporal band represents the temporal behaviour of a place as a pattern – e.g., a restaurant is crowded in specific hours in a day (around 12 pm, and 8 pm).
The Void	"The property of void is the one that exists in all places, natural and artificial, rural or urban, in micro- or macro-scales. It is that of empty space, a requirement for any place configuration through which people can move around, where space is not completely filled. It is also one of the properties that allows for people to use each place according to their needs at any given context." "The void, emptiness or openness of the space in such places allows for its creative and individualized use, be it for recreation, sport, a meeting, or a picnic among others" (Vasardani and Winter, 2016).
Thematic Band	Thematic band is part of a model which includes: 1- spatial band, 2- temporal band, and 3- thematic band (Janowicz, 2012). Thematic band represents the theme or non-spatiotemporal aspects of a place.
Type	Type of a place is a part of a gazetteer's model. The type of place defines what kind of place it is.
Typologies/Categorisations	"People categorize places in order to understand what is new, in terms of what is already understood. This represents an important mental strategy for dealing with complexity and new situations." "Our model of place would allow for comparisons of places based on the means-end hierarchy. If two places have very different physical features, and yet provide the required affordances for a given agent and task, then they can be classified as similar places" (Jordan et al., 1998). Typologies/Categorisations is part of a model which includes: 1- physical features, 2- actions, 3- narrative descriptions, 4- symbolic representation, 5- socioeconomic and cultural factors, 6- typologies/categorisations.
Valuation (of an action)	Valuation of action is a part of the experiential model for place which contains (action, objects of action, and valuation) designed by Hockenberry (2006). This part of model defines the quality of an action which happens in a place – e.g., either 'good', 'greater than average' or 'not bad' for a meal at a restaurant.

Appendix C. Card Sorting Experiment

C.1. Individual Groupings

Table C1 shows the results of individual groupings.

Table C1. Authors' groupings of the extracted facets

Participants	Group Name (Frequency)
First Author	Identity and Purpose (6)
	References and Descriptors (13)
	Physical Character (38)
	Place in Relation to Human (46)
	Type (8)
	Place and Space (3)
	Properties (2)
Second Author	Top Level Ontology (3)
	Type/Identity/Referencing (13)
	Location in Space (11)
	Form (19)
	Boundaries/Path (12)
	Purpose/Affordance (20)
	Access (2)
	Social (36)
Third Author	Top Level (2)
	Behavior (6)
	Individuals (14)
	Groups (10)
	Space (7)
	Time (3)
	Location (11)
	Function (15)
	Classification (9)
	Relation to Other Places (5)
	Physical Properties (25)
	Identity (9)

C.2. Pairwise Comparison

Pairwise comparison of authors' groupings using the Dice similarity coefficient are shown in Figure C1, Figure C2, and Figure C3.

The comparisons are based on the groups derived from open card sorting, and consequently there are one-to-one, one-to-many, and many-to-many relations between the groups. As a result, in case that cardinality of relationships is greater than one, the Dice similarity coefficient would be low. However, this issue sources from the granularity in different groupings, not a disagreement between the participants. For example, in pairwise comparison of first and second authors' categorization, several one-to-many relationships are noticeable such as: first author: {physical character} -related to- second author: {form, location in space, boundaries/path, access}; first author: {place in relation to human} -related to- second author: {social, purpose/affordance}.

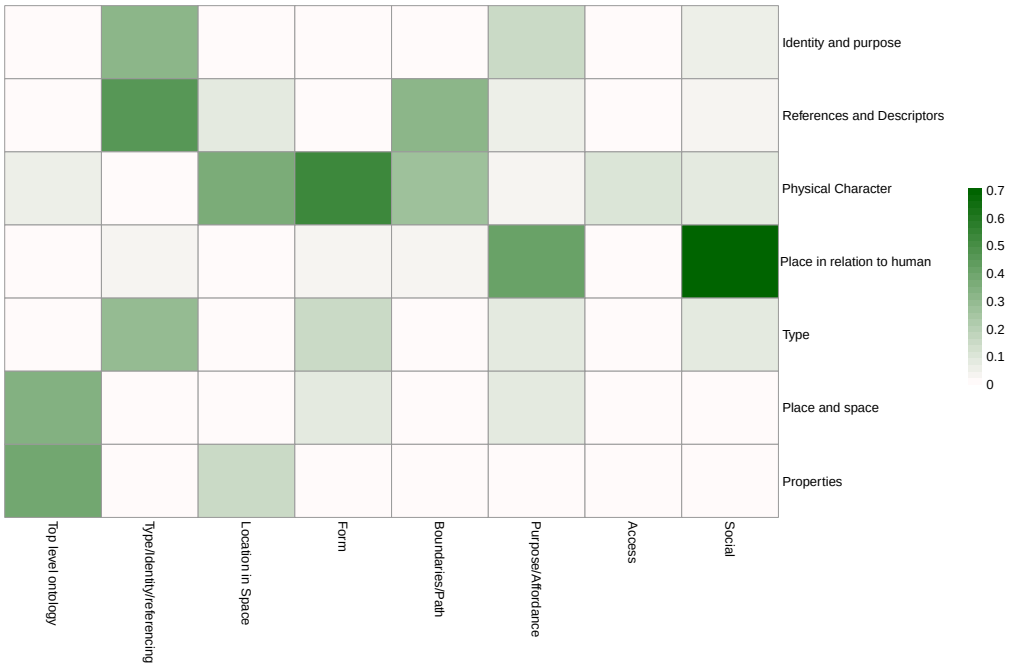

Figure C1. Pairwise comparison of grouping by first and second authors.

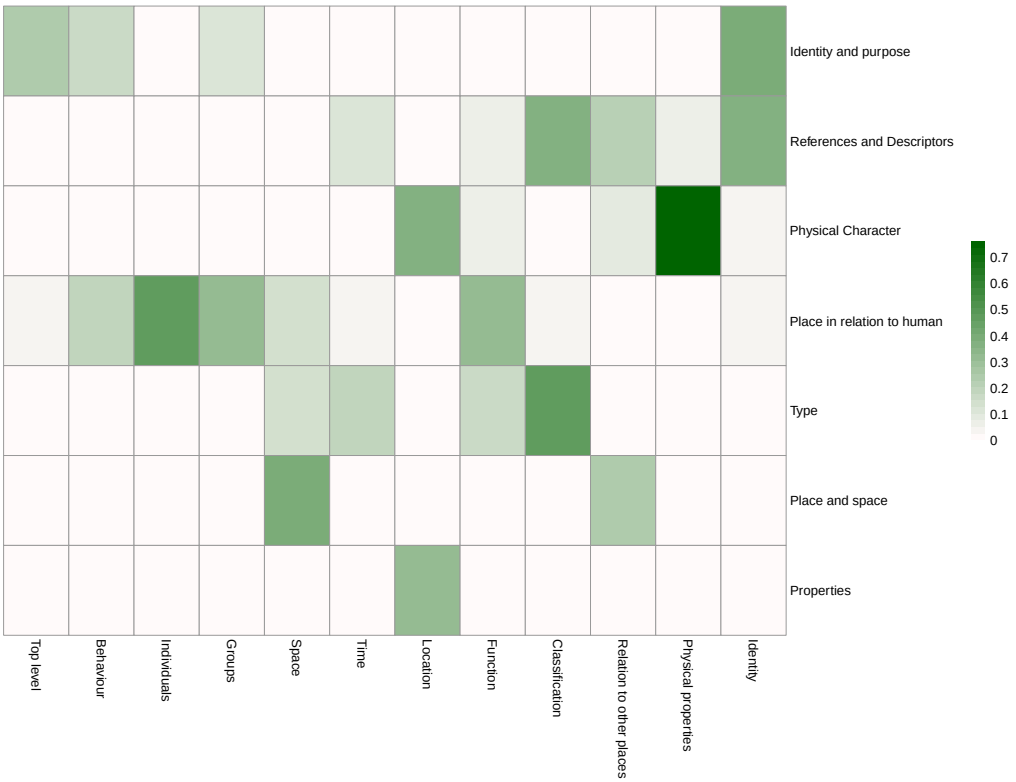

Figure C2. Pairwise comparison of grouping by first and third authors.

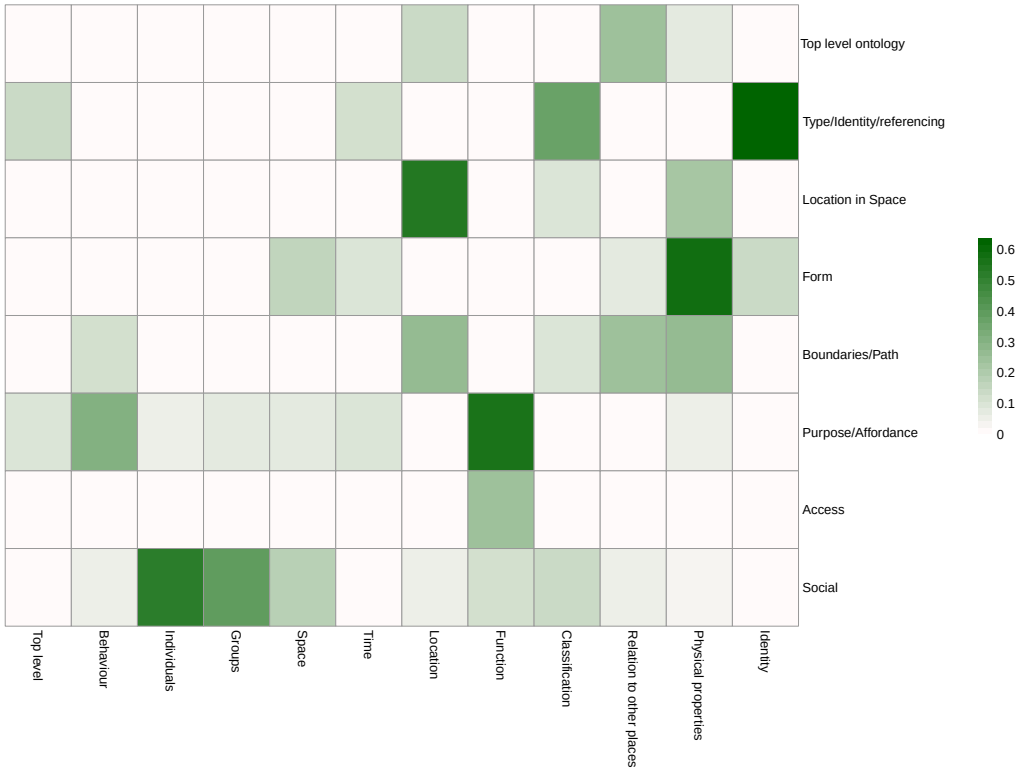

Figure C3. Pairwise comparison of grouping by second and third authors.

Appendix D. Hierarchical clustering

Table D1 shows the parameters of the clustering including the clustering method and the distance metric which is used to extract clusters of facets.

Table D1. Hierarchical clustering parameters

Parameter	Value
Method	Agglomerative clustering (Complete)
Distance	Count: 0 if the pair of facets are not in same category in any of individual groupings; 1 if the pair of facets are in same category only in one of the individual groupings; 2 if the pair of facets are in same category in two individual groupings; 3 if the pair of facets are in same category in all (three) individual groupings

D.1. Hierarchical clustering and categorization

The ordered similarity matrix of facets is illustrated in Figure D1. The figure shows a square matrix in the dimension of 116 (the number of extracted facets). The cell (i,j) in the matrix belongs to ith and jth facets, and the value could be 0, 1, 2, 3.

If the value is 0, it means that ith facet and jth facet was not in the same group based on the authors' grouping. If the value is 1, it means that the facets were in the same group only in one of the groupings and so on. Consequently, the value '3' shows two facets that all authors agreed that they belong to the same group. Here, we have used matrix reordering to show how the final categorization (1- primitive, 2- derived, and 3- linguistic) relates to agreements between the individual groupings. On the left side of the figure, one can observe the relationship between proposed categorization and the agreement on authors grouping for each category using the three vertical indicators – i.e., level1 (1- primitive, derived and linguistic), level2 (geographic and anthropocentric) and level3 (spatial, physical, functional and emotive).

Appendix E. Categories of facets

The proposed categorization of facets is shown in Figure E1.

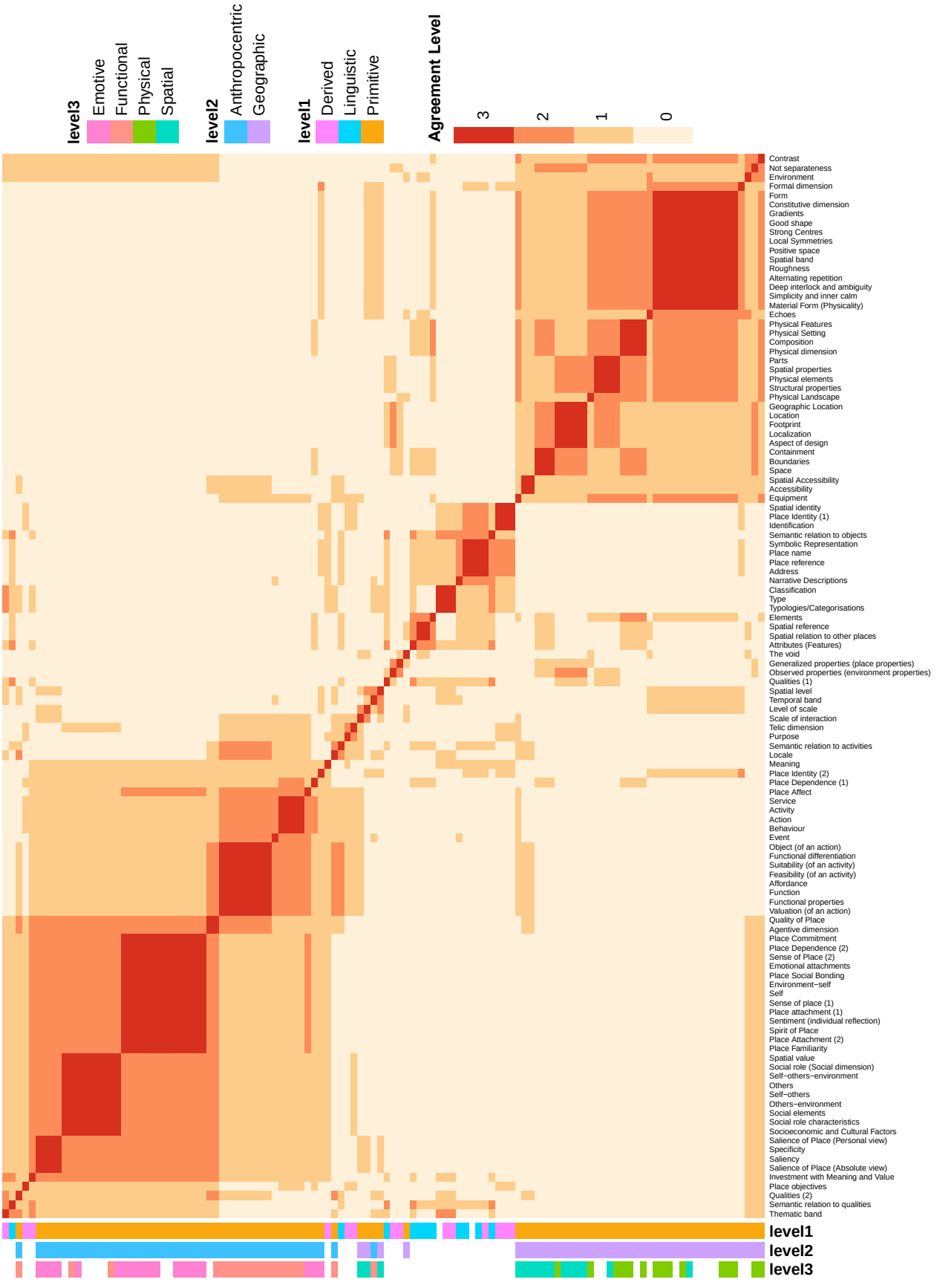

Figure D1. Ordered similarity matrix and its relation to the proposed categorization.

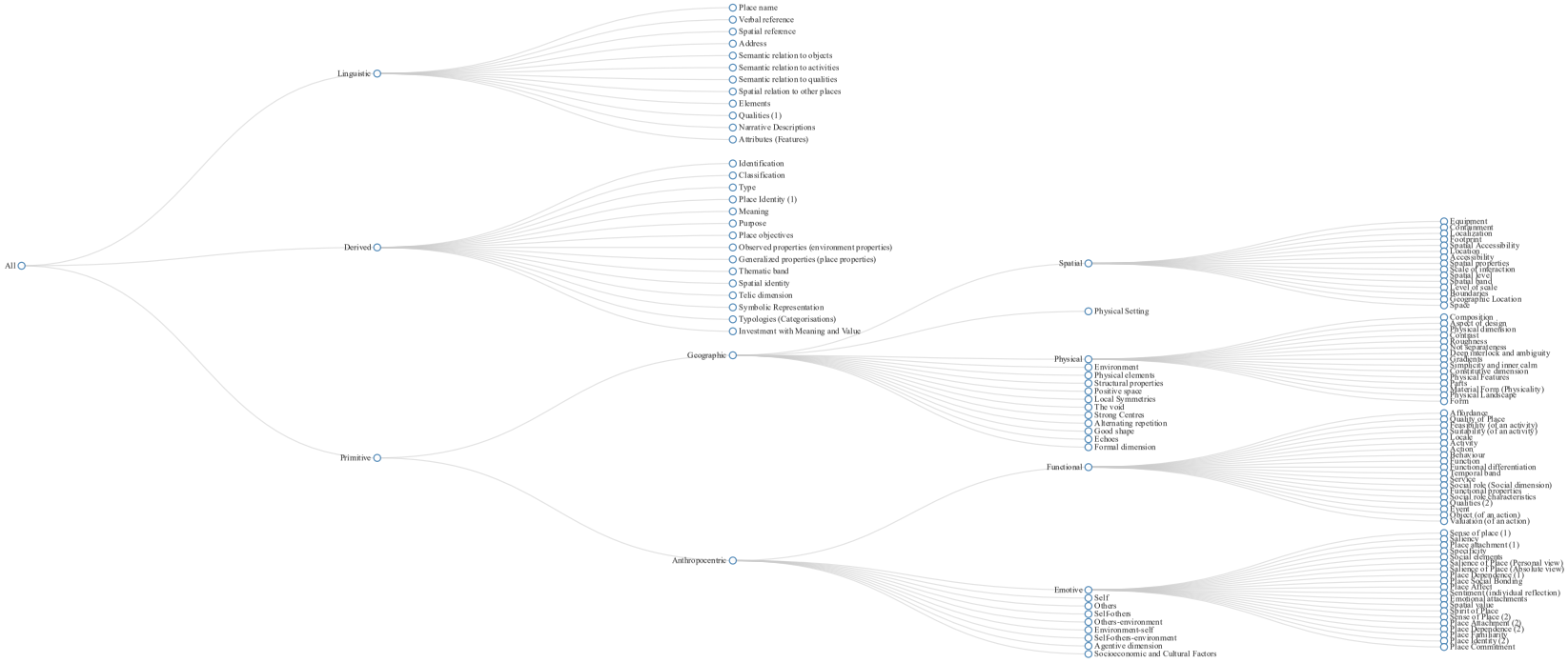

Figure E1. The proposed categorization of facets.