Semantic Categories Underlying the Meaning of 'Place'

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Abstract. This paper analyses the semantics of natural language expressions that are associated with the intuitive notion of 'place'. We note that the nature of such terms is highly contested, and suggest that this arises from two main considerations: 1) there are a number of logically distinct categories of place expression, which are not always clearly distinguished in discourse about 'place'; 2) the many *non-substantive* place count nouns (such as 'place', 'region', 'area', etc.) employed in natural language are highly ambiguous.
With respect to consideration 1), we propose that place-related expressions should be classified into the following distinct logical types: a) 'place-like' count nouns (further subdivided into abstract, spatial and substantive varieties), b) proper names of 'place-like' objects, c) locative property phrases, and d) definite descriptions of 'place-like' objects. We outline possible formal representations for each of these.
To address consideration 2), we examine meanings, connotations and ambiguities of the English vocabulary of abstract and generic place count nouns, and identify underlying elements of meaning, which explain both similarities and differences in the sense and usage of the various terms.

1 Introduction

'Place' is a basic notion in everyday communication. It is a fundamental concept in geography and plays a key role in almost every field of human enquiry (Canter 1977, Tuan 1990, Harrison and Dourish 1996, Jordan et al. 1998). Despite this ubiquity and importance, the semantics of 'place' is poorly understood and controversial (Relph 1976, Thrift 1999). Massey (1994, p22) claimed that places 'do not necessarily mean the same thing to everybody' and that 'there is an increasing uncertainty about what we mean by place and how we relate to place'.

A clear semantic model of its basic concepts is a critical condition for establishing an adequate ontology for a domain. In GIScience and related geographic discourse, the notion of place is a basic category that is employed to individuate meaningful portions of space and to describe spatial locations of physical

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objects. 'Places' are the conceptual entities that enable cognitive structuring of the spatial aspects of reality.

Previous work (Agarwal 2004, 2005a,b) has demonstrated the significance of 'place' in the development of an integrated geographic ontology and elaborated on the need to resolve the contested nature of place, which is caused primarily by the lack of a clear semantic account. Related work has also shown that disagreement in establishing the meanings or rules associated with place terminology arises primarily because the relationships and distinctions between place and other spatial concepts such as 'neighbourhood', 'region', 'area' and 'location' are not clearly defined (Agarwal 2004). The lack of consensus on the meaning of such terms is compounded by the presence of vagueness and ambiguity in place-related vocabulary (Bennett 2001a,c, Varzi 2001).

The current paper promotes the view that the notion of 'place' can only be adequately understood by examining the logical role that place-related concepts play in natural language and developing a semantic theory of place which formalises this logic. In fact, we shall see that place enters into language in a number of distinct but closely related ways, and these have to be distinguished and separately analysed before a more comprehensive theory of place can be articulated.

In addition to the various logical roles of place expressions, natural language also employs a large vocabulary of abstract and non-substantive terms for place-like entities — for instance: 'region', 'neighbourhood', 'district', 'location', 'area' etc., as well as 'place' itself. Understanding the differences between these closely related terms is critical to defining an unambiguous semantic framework that can support a general ontology of place.

The structure of the paper is as follows. In the next section we identify fundamental properties of the concept of place, which will underpin our semantic analysis. In Section 3 we consider the grammatical categories of different kinds of place terminology used in natural language, and indicate how these correspond to different logical categories of place expression. Section 4 examines semantic attributes that are relevant to the interpretation and differentiation of place-related terminology. In Section 5 the category of 'place-like' count nouns is analysed in detail. These are sub-categorised into three levels of abstraction: substantive place count nouns (such as 'church' or 'town'), primarily spatial count nouns (such as 'region' or 'neighbourhood') and abstract or generic count nouns (such as 'place' itself). This analysis also identifies typical modes of use and connotations of specific natural language terms. Finally, Section 6 concludes by considering how far the present work takes us in understanding the semantics of place and identifying directions for further work.

2 The Nature of 'Place'

2.1 Vagueness and Ambiguity in the Meaning of 'Place'

The pervasive vagueness and ambiguity of place-related terminology might lead one to the view that 'place' itself is a vague and ambiguous concept that is

not amenable to semantic analysis. In this paper we take a somewhat different view. Though we readily acknowledge that the terminology used to describe place is often vague and ambiguous, we do *not* consider this to be intrinsic to the underlying semantic relationships associated with space and place. Rather it stems from the following two considerations: 1) generic place terms ('place', 'region', 'area' etc.) are typically ambiguous in that their meaning is compounded from a number of distinct though closely related senses; 2) concepts of place are in most cases dependent on other concepts, such as geographic feature types, which are themselves vague.

Many authors have discussed the particular character of our notion of 'place' and have come to a variety of different views about what special feature is distinctive of place (Relph 1976, Massey 1994, Entrikin 1997, Canter 1997). We believe that the lack of consensus is partly due to insufficient generality in the views that have been adopted and also due to a lack of attention to the ambiguities in many concepts associated with place.

Our view is that a clear account of the nature of 'place' can be elicited from a detailed analysis of the semantic content of natural language terminology. Following the methodology for analysing vague and ambiguous concepts outlined by Bennett (2005), our approach will be to identify semantic categories and logical principles underlying the usage of place terminology, and incorporate these within a semi-formal theory encompassing the most significant semantic attributes of place-related concepts and articulating their modes of expression. Because of the ambiguity of natural language, there will not be a definite mapping between natural language terms and elements of this semantic theory. Rather, we shall find that each natural language term has a number of distinct senses, corresponding to different ways in which it can be interpreted within our semantic framework.

2.2 Similarity, Continuity and Integrity

A fundamental ingredient of our awareness of the world is our recognition of correlations between *continuity* and *similarity*. Consider our visual perception of a scene. We may conceive of this in very general terms as a distribution of colour over space. Colours are seen as more or less similar.[3] Space is manifest as having a certain continuity — we can traverse space along a line or identify connected *subspaces* of the global space. Given these fundamental aspects of perception, the recognition of correlations between continuity and similarity is the basis for our division of the world into entities. Thus (at a rather primitive level of perception) a visual scene may be divided into parts, each of which is spatially-contiguous (i.e. self-connected) and whose points are all similar in colour.

Similarity is not, of course, an absolute relationship, but is manifest to varying degrees: in some cases we find relatively sharp boundaries separating different

[3] In fact colour itself can be regarded as constituting a kind of space. This would mean that correlations between space and colour can be seen as arising from juxtaposition of two distinct kinds of space.

types or qualities of matter that occupy space; but in other cases the quality of matter varies in graduated way. For instance, the colour of (the surface of) a material object may vary continuously over its extension. This gives rise to an intrinsic vagueness in partitions of space that are dependent on similarity. Nevertheless, even where boundaries are indeterminate, similarity and continuity still impose a structure on space, such that we can, for example, distinguish dark patches on a surface whose colour varies continuously.

While similarity and continuity determine the most basic partition of space into integral units, the individuation of objects in general depends on more complex principles of integrity. Many kinds of physical object are not uniformly constituted, but rather consist of complex arrangements of heterogeneous parts. So, the objects that we consider to exist in the world are individuated according to sophisticated principles of integrity that relate to complex combinations of more basic units. Moreover, we also apprehend and individuate spatial objects in terms of their sociological or political status. Hence, 'places' may be distinguished on the basis of ownership, control or jurisdiction, which is only indirectly related to physical reality.

2.3 Locating, Hosting and Anchoring

One of the most important functions of places is to designate a *location* for other objects. This function can be achieved *via* a variety of different types of spatial constraint that can be associated with a place. Perhaps the most typical and easiest to model semantically is what we describe as *hosting*. This occurs where a place is associated with a *subspace* of a larger embedding space; and a hosting relation obtains when the spatial extension of an object is contained within this subspace.

We shall see later that there are various different ways in which a hosting region can be associated with objects of a place-like character. The simplest is where the hosting region is simply the extension of a physical object. However, this is not a typical case, since, if a physical object or person is located within a building, for example, they do not normally interpenetrate the physical material of the building, but rather their extension is within a region of free space that is circumscribed by the building. Thus, the hosting region associated with a place object may be associated with the region corresponding to the concavities in that object.[4] More generally, the means by which a place serves to locate an object may be more complex than hosting within a subspace. For example, 'on the top of the mountain' or 'on the other side of the wall' involve more subtle spatial constraints.

A further consideration, relevant to the locating aspect of places is that they are typically *anchored* in relation to objects that are more or less permanently

[4] More precisely, using an extension operator ext and a *convex-hull* operator conv one might specify that the hosting region associated with an object x is the region $\mathsf{conv}(\mathsf{ext}(x)) - \mathsf{ext}(x)$. Although, in some cases, topological containment rather then inclusion the convex-hull would be more appropriate.

fixed relative to what is taken as a global reference frame (typically the surface of the Earth).

3 Linguistic and Logical Categories of Place Terminology

Place is a notion that is manifest in a variety of different grammatical roles in natural language. For instance, we have names of places (e.g. London, Europe etc.), common nouns expressing types of place (e.g. town, forest, country etc.) and we also have spatial properties (e.g. under the table, on a train etc.). To provide a semantics of place that accounts for the natural language usage of place terminology, it is essential to distinguish these different grammatical categories. Moreover, the diverse modes of linguistic functionalty of different grammatical categories suggests that a formal theory of place should include a corresponding number of different logical categories.

Before examining them in detail, we first list what we believe to be the most important categories of linguistic expression relating to place:

- *Count Nouns.*[5] Many count nouns are used to categorise things that we regard as places. These may refer to classes of physical object (such as town, city, room, building, forest), or to types of primarily spatial entity (such as 'area' or 'neighbourhood'). We must also consider more abstract count nouns relating to place (such as 'location' or 'place' itself).
- *Locative Property Phrases.* Phrases such as 'in London', 'on the hill', 'by the sea-side' are predicative expressions that characterise the location of an object. They generally contain a preposition referring to a spatial relationship and also a reference to one or more objects which act as an *anchor* for the relation.
- *Place-Names.* Nominal terms, such as 'London', 'England', 'the Black Forest' refer to objects that are normally considered to be places.[6]
- *Definite Descriptions.* These are phrases such as 'the library', 'the shed at the end of the garden', which function as complex nominal expressions referring to places.

3.1 Place-Like Count Nouns

By count nouns we mean those expressions of natural language that characterise *types* of object. Many count nouns characterise types of object that we may consider to be places; for instance: 'room', 'town', 'forest', 'country', etc.. We

[5] These are often called 'common nouns' but we prefer the term 'count noun' as it gives an indication of the semantic character of this kind of word, since one can test if a term is a count noun by considering whether phrases of the form 'one κ', 'two κs' *etc.* make sense.

[6] It is clear that the structure of composite place names such as 'the Black Forest' has some semantic significance. However, in the present work we shall treat all place-names as atomic symbols.

shall call these *place-like* count nouns. In accordance with ordinary usages of the word 'place', such count nouns are not themselves places; rather they refer to classes of objects of a place-like nature.

A key attribute of a place-like count noun is that its instances are capable of *locating* other objects, either by *hosting* or some more complex mode of spatial constraint. Another consideration in determining whether a count noun is place-like is that its instances are objects that are fixed in space (relative to the position of the Earth). For example, a count noun such as 'tree' may also function in a place-like way. Thus, the distinction between place-like and non-place-like count nouns is not absolute. Nouns such as 'town' or 'country' are perhaps the most prototypical cases, whereas 'tree' or 'bag' have some but not all of the typical semantic attributes of a place-like count noun.

Despite this lack of precision in what constitutes a place-like count noun, we believe it is a useful sub-categorisation of count nouns and is correlated with certain objective linguistic phenomena which support this distinction and may sharpen our intuitions. One could make the classification more precise by distinguishing more refined categories of locating, hosting, anchoring (etc) count nouns, but this is beyond the scope of the present work.

A good indication of a count noun being place-like is that it is typically associated with a 'default' spatial preposition that is used much more commonly than any other to form a locative property phrase from the count noun. Typically this will be 'in' or 'at' (or possibly both of these, since they are often interchangeable without affecting the meaning of the locative phrase). One test that we can apply to identify place-like count nouns is to consider whether associated definite descriptions can be given as answers to 'Where?' questions. For instance 'library' is place-like, since the question 'Where is John', might be answered simply by 'the library'. (Of course the usage of place-like count nouns in this way may be regarded as an abbreviated or degenerate form of a more explicit place expression such as 'in the library'.)

3.2 Locative Property Phrases

Phrases such as 'in London', 'on the hill', 'by the sea-side', 'between the church and the oak tree', are predicative expressions which characterise the location of an object. We shall refer to such expressions as *locative property phrases*. A very wide variety of such phrases can be found in natural language, and in our investigations we have spent considerable effort classifying and formalising the logical structure of such phrases. But, because of their complexity and diversity, a comprehensive account of these is beyond the scope of the present work. Here, we shall consider only the most typical form of locative property phrase.

A typical locative property phrase contains a preposition referring to a (localising) spatial relation, R, and also a reference to one or more objects which act as an *anchor* for the relation. Whether a particular object x, whose spatial extension is $\mathsf{ext}(x)$, satisfies the locative property is determined according to whether the relation

$$R(\mathsf{ext}(x), s_1, \ldots, s_n)$$

is true.[7] Each anchor region s_i will typically be determined by an anchor object α_i, such that $\mathsf{ext}(\alpha_i) = s_i$.

For example, in the sentence "The villa is in Barcelona" a locative property is expressed by the phrase "in Barcelona". In this phrase, the name Barcelona is associated with a spatial extent s. The fact that Barcelona is the name of an entity of the category "city", determines the way that its spatial extent is defined (primarily in terms of the geometrical configuration of its urban fabric). Vagueness in the notion of "city" (and possibly also in the conditions of appellation of the name "Barcelona") will result in an associated vagueness in the extent s.

The place description also includes the preposition 'in', which determines the spatial relation, R. In this case we could interpret the relation as the *parthood* relation $\mathsf{P}(r, s)$, where r and s are 2-dimensional spatial regions corresponding to the *footprints* of (the spatial extensions of) the villa and Barcelona. Thus, the meaning of the sentence can be formally represented by

$$\mathsf{P}(\mathsf{footprint}(\mathsf{ext}(\mathsf{the\_villa})),\ \mathsf{footprint}(\mathsf{ext}(\mathsf{barcelona}))) \ .$$

Suppose we have a place description involving a more subtle spatial relationship — for example, "The villa is on the edge of Barcelona". Here, the place description also includes the phrase "on the edge of", which determines the spatial relation, R. In this case there is some ambiguity and vagueness in the spatial relation being referred to. To give a precise semantics, we would need to identify a well-defined spatial relationship. (For instance we might associate every region with a "thick border", whose width is proportional to the size of the region; and being on the edge of a region could be defined as lying within this border.) However, this vagueness is not essentially due to the fact that this is a locative property; but arises from the particular relation used in this case.

Natural languages contain many spatial prepositions and these often correspond to different spatial constraints according to the context in which they are employed (Vandeloise 1991). Hence a comprehensive theory of locative property phrases would require a detailed analysis and formalisation of the semantics of spatial prepositions.

3.3 Place-Names

Many proper names apply to things that are normally considered to be 'places'. Such proper names will be called *place-names*. The referent of a place-name, must be an object of a kind that can be classified by a place-like count noun. Since, names in themselves are arbitrary and do not carry any conceptual content, we suggest that the place-like character of a count noun must derive entirely from the count noun with which it is associated.

For example, Leeds is a city, so the place designated by 'Leeds' is of the type associated with cities. Thus we would represent the semantics of (e.g.) "John is

[7] In most cases there will only be a single anchor region, so the description will take the form $R(\mathsf{ext}(x), s)$.

in London" as having a form such as

$$\exists x[\mathsf{Name}(x, \texttt{"London"}) \wedge \mathsf{city}(x) \wedge \mathsf{In}(\mathsf{john}, x)] \ ,$$

where the In relation gets a specific spatial interpretation dependent on the type of place object:

$$\forall x[\mathsf{city}(x) \rightarrow \forall y[\mathsf{In}(y, x) \leftrightarrow \mathsf{P}(\mathsf{footprint}(\mathsf{ext}(y)), \mathsf{footprint}(\mathsf{ext}(x)))]]$$

3.4 Definite Descriptions

Phrases such as 'the library', 'the shed at the end of the garden' function as complex nominal expressions referring to places. These are *definite descriptions* (Russell 1905), which (within a given context) identify a unique place entity. Most definite descriptions can be paraphrased by an expression of the form 'the κ such that ϕ', where κ is a count noun. Here, it is the count noun κ that determines the place-like character of the definite description, whereas ϕ serves to identify a unique individual. We can represent the logical form of a definite description using the *iota* notation (Whitehead and Russell 1910–13).[8] If we separate the count noun from other constraints in the description, the representation will take the form:

$$\iota x[\kappa(x) \wedge \phi(x)] \ .$$

There is another form of definite description that is commonly used to refer to places. This is exhibited by phrases such as: 'the top of the hill', 'the side of the mountain', 'the middle of the ocean' and 'the edge of the table'. Such phrases include a particular kind of place-like count noun ('top', 'side', 'middle' *etc*) whose referents are derived by primarily spatial functions from place-like objects. Thus, the form of these phrases could be represented as, for example:

$$\mathsf{the\_top}(\iota x[\kappa(x) \wedge \phi(x)]) \ ,$$

where the_top is a function from place objects (of an appropriate kind) to another kind of place object corresponding to their tops.

4 Semantic Attributes of Place Concepts

In this section we present an analysis of the primary semantic attributes that are relevant to the interpretation of place-related concepts: we consider the modes by which a place may be individuated as a subspace of a global space by principles of integration and demarcation, and we also examine the ways in which a place may act as a 'host' for other objects.

[8] The meaning of the iota operator is defined as follows:

$$\Psi(\iota x[\phi(x)]) \ \equiv_{def} \ \exists x[\phi(x)] \wedge \forall y[\phi(y) \rightarrow (y = x)] \wedge \Psi(x)] \ .$$

4.1 Principles of Integration

As we argued in Section 2.2, continuity and homogeneity are two primary factors in determining the extent of a place and demarcating its boundary. However, when we are dealing with complex geographic or sociological entities, other more subtle principles of integration come into play. We have identified the following five factors as being of particular significance:

- **Homogeneity.** A region individuated on the basis of homogeneity can be formalised as a maximal connected region all of whose points satisfy a characteristic predicate.
- **Control.** This covers any integration principle based on ownership of, or jurisdiction over some subspace of the domain. The control principle is usually only relevant to geographic regions. It is typically applicable in subspaces described by the terms: region, district, domain, demesne, territory.
- **Proximity.** In addition to the purely qualitative topological notion of connectedness, metrical notions of distance also play an important role in the integrating principles used to identify places.
- **Aggregation.** Many place-like count nouns refer to aggregates of similar elements (e.g. trees make up a forest, buildings make up a town).
- **Systemic Grouping.** As noted above, we often consider complex arrangements of heterogeneous parts as constituting an integral whole (e.g. an airport or a neighbourhood within a town/city).

4.2 Principles of Integration Determined by Count Noun

The principle of integration relevant to identifying a place object will normally be determined by a count noun by which the place is described. In the case of a general question about place, one may use an abstract or non-substantive count noun (area, region, location etc.) and the connotations of this term will mean that certain integration criteria are most appropriate. For example, 'region' (in its most common sense) implies a connected geographic scale subspace, which is either homogeneous in some way or is the extent of some jurisdiction. In more specific contexts, a particular physical count noun (e.g. 'city' or 'forest') may either be given in a question or supplied by the answerer. In this case the type of count noun will determine its particular mode of integration.

4.3 Connectedness

All place terms have a very strong connotation that the subspace referred to is *connected*. More precisely, this means that any two points in the subspace can be joined by a line (not necessarily straight) that lies completely within the subspace. Typically the subspace will satisfy the stronger condition of being *interior connected* — i.e. any two interior points can be connected by a line that lies wholly within the interior of the subspace.

In rare cases some place terms (especially primarily spatial terms) may be used to refer to a disconnected (i.e. multi-piece) subspace. This could occur with a 'region', 'district', 'territory' or 'domain', which might consist of two or more separate parts. In particular if the integrating principle employed is one of ownership, control or jurisdiction then multi-piece subspaces may occur. It is a matter of taste whether a word such as 'territory' can be used in this way, or whether a multi-piece area of control should be regarded as several different territories. The word 'area' is also occasionally used to refer to a multi-piece subspace.

4.4 Modes of Partitioning

Partitioning is very similar to integration, but whereas integration focuses on determining the extent of one particular subspace, partitioning starts with the space and divides it up into different subspaces, which will be called *cells*. Certain generic place count nouns (e.g. 'zone' or 'sector') have a strong connotation of referring to a subspace within a partition. In many cases, the criteria by which a space is partitioned are closely related to the integrity criteria mentioned above. For instance, a space may be partitioned into cells such that each is more or less homogeneous, relative to some intrinsic property of points in the space, and such that neighbouring cells are distinguishable relative to this property. A partition may also be made on the basis of control (i.e. ownership and jurisdiction).

Partitioning can also be done in a way that is significantly different from integration. This is where we decompose one subspace into smaller subspaces based on structural properties of the larger subspace. The division may be in relation to the shape of the larger subspace, within which we may identify such features as (e.g.) lobes or necks; or we may divide it purely in terms of the relative positioning of its parts, such as the northern or central part.

4.5 Modes of Locating and Hosting

We noted above that there are a variety of different ways in which a place-like object can spatially constrain the location of other objects. A comprehensive theory of place would have to define these in terms of a theory of spatial relationships, such as the *Region Connection Calculus* (Randell et al. 1992) or *Region-Based Geometry* (Bennett 2001b). In the current paper we simply list a number of kinds of spatial constraint which can operate as locating relationships:

- Topological inclusion (e.g. 'in the liver'),
- Geometrical containment (e.g. 'in a building'),,
- Containment within a concavity (e.g. 'in a cup'),
- Interposition among elements of aggregate (e.g. 'in a forest' implies 'among trees')
- Location *within or among* elements of aggregate (e.g. 'in a town' implies 'within or among buildings'),

- Containment within a surface demarcation (such as a district or country) — i.e. *footprint* containment.
- Support (such as 'on a table').

5 Classification of 'Place-Like' Count Nouns

In this section we attempt to classify the semantic content of some of the most common place-related count nouns. This is not straightforward, as there are a wide variety of different terms with subtly different meanings. Because there is considerable overlap in the range of applicability of different terms, distinct terms may in some (or most) cases seem to be equivalent. Moreover, the terms themselves are in some cases ambiguous, having a number of distinct though closely related senses. Nevertheless, we shall attempt to tease out the principal semantic elements that underlie their meanings.

We start by making a high-level distinction between three categories:

- *Substantive*. By substantive, we mean those place count nouns that refer to types of entity that, in addition to their place-like characteristics, have essential properties that are non-spatial (e.g. 'town', 'cupboard', 'country', 'planet').
- *Spatial*. In this category we include terms which characterise place entities in terms of purely spatial characteristics. For example, 'region' or 'point'.
- *Abstract*. This category includes the most general place terms (such as 'location', 'position' and 'place' itself), which are themselves used to characterise the semantic nature of more specific place entities and place terminology. Thus these terms may be considered as meta-level place concepts.

Although, in terms of an idealised semantics of place terms, the distinction between these three categories is well-defined, when applied to actual natural language terms, it is often not completely clear cut. One form of blurring arises because terms which seem to be primarily abstract or spatial in nature tend to also have connotations which suggest more specific types of place entity. For instance, 'region' often refers to entities of a geographic or political nature and 'neighbourhood' is typically associated with demarcations within human settlements. Hence, in classifying natural language vocabulary, we shall identify terms that are *primarily spatial*, although they may have non-spatial connotations. The distinction between place-like and non-place-like substantive count nouns is also blurred, since almost any substantive count noun can in certain contexts be regarded as a place.

5.1 Substantive Place-Like Count Nouns

Substantive place count nouns are those whose instances have identity and individuation criteria that are not purely spatial. Although we may regard these instances as places, they also have essential properties that are physical and/or sociological.

In order to give a comprehensive theory of substantive place count nouns one would need to define their individuation and identity criteria and also define the semantics of their role in regard to place-related expressions. In particular one would need to specify how they related to hosting regions and other locating predicates formed by spatial prepositions. This would be a complex task, which is beyond the scope of the present work.

However, we believe that the task may not be quite as large as one might fear. Count nouns can be organised into a subsumption hierarchy starting with very general types and ramifying into more specific. Moreover, it seems that many of the integrating principles and other semantic attributes of place count nouns can be specified at the upper levels of the hierarchy and are thus inherited by more specific count nouns. For instance different kinds of building will share the same modes of association with places, so one does not need to specify completely separate semantics for cinemas and churches, for example.

A possible ontology of the uppermost levels of the hierarchy of substantive place count nouns is as follows:

- Geographic Features (mountains, forests)
- Material Artifacts
  - Static artifacts (buildings, roads)
  - Movable artifacts (containers, vehicles)
- Fiat entities (countries, districts) (Smith 2001)

Substantive place count nouns operate at many different levels of granularity, enabling us to refer to spatial locations more or less specifically. For instance, we may identify the following sequence, ordered in increasing granularity:

room, building, district, town, county, country, continent

When we ask a 'Where?' question (e.g. 'Where was Susan born?'), we may get an answer at one of several levels of granularity. In this case the range of legitimate answers may vary from a particular room in a building all the way to a country or even a continent (perhaps even a planet). Identifying an appropriate level of granularity is a key consideration in devising mechanisms for automated answering of 'Where?' questions, but is beyond the scope of the present work.

5.2 Primarily Spatial Place Count Nouns

We now consider what we are calling 'primarily spatial' place count nouns. Specifically, we examine following terms:

area	neighbourhood	sector	tract
district	patch	site	zone
domain	point	spot	
locality	region	territory	

We assume that all these terms refer to a type of object that is conceived of as a subspace of a more general spatial universe. Thus, we distinguish them in terms

of the character of this subspace and the criteria by which it is individuated. Let us now attempt to explain the connotations associated with the most prominent senses of each of the listed place count nouns:

'Area' is more or less neutral as to the type of subspace being referred to, although it has connotations relating to dimensionality: it is not normally applied to point-like or linear subspaces, but rather to 2D (or $2\frac{1}{2}$D) and occasionally 3D subspaces. Areas are normally self-connected, but the term may occasionally be applied multi-piece subspaces.

Areas are typically demarcated by means of the integrating principles of homogeneity (e.g. 'an arid area'), or proximity to some distinguished object (e.g. 'the area around the church'). They are also sometimes demarcated with respect to ownership or jurisdiction, or with respect to a structural decomposition of a larger subspace (e.g. 'the south eastern area of Australia').

A distinctive aspect of the term 'area' is that it is often used in cases where the boundary of the referenced subspace is poorly defined (e.g. 'a damp area on the wall', 'the loading area').

The term 'area' is strongly associated with the metrical magnitude of a subspace. Indeed, in mathematical or scientific contexts, 'area' normally refers purely to a spatial magnitude, without reference to any particular place. This is really a distinct sense of the term, which is semantically independent from the concept of place. However, when we use the term 'area' to describe a subspace, we may imply that we are also interested in the magnitude of its extension.

'District' almost always refers to geographic regions. We can distinguish two somewhat different senses of the term:

1. One sense of 'district' refers to a unit of jurisdiction smaller than (and contained within) countries.
2. In a more general sense 'district' does not necessarily refer to an actual unit of jurisdiction, but to a region of similar size with some (often vague) geographically related integrating principle.

'Domain' is one of a group of upper-level place terms which have a connotation of ownership or control. ('Domain' is of course also used in a more abstract sense to refer to a field of knowledge or expertise.)

'Locality' is very close in meaning to sense 3 of 'neighbourhood', as described below. Arguably, 'locality' typically refers to a larger geographic subspace than 'neighbourhood'; and, while 'neighbourhood' is most commonly applied to subspaces within an urban environment, 'locality' is equally applicable in rural settings.

'Neighbourhood' has a very general mathematical sense, which can be regarded as abstracting an essential ingredient of the ordinary use of the term:

1. Mathematical context: In topology, a neighbourhood of x is a subspace s of the whole space, such that x is an interior point (or possibly a set of interior points) of s. Neighbourhood is also sometimes given a metrical sense, in which it is determined by spatial proximity.

2. Ordinary langauge context: The ordinary sense of 'neighbourhood' conforms to the abstract topological or metrical sense but is typically applied to geographic or geo-political regions. Common usage also suggests some integrating property such as social unity or uniformity, or systemic integrity. (E.g. the term 'neighbourhood', applied to part of a town, typically denotes an area with a common class of inhabitants or similar standards of buildings; but it is also associated with sharing of amenities, such as a shopping outlets and entertainment venues.)

'Patch' refers to a small subspace of a surface. A patch is generally individuated in terms of its being a maximal (though small) subspace, which is more or less homogeneous with respect to some property of surface points. For instance, one may identify a coloured patch on a surface that is predominantly of a different colour.

'Point' seems to be relatively similar in meaning to the mathematical concept of a point — i.e. a zero-dimensional element of space. Thus, when we refer to something as a point, we do not consider it to have an extension in space, only a location. Nevertheless, 'point' is often used in contexts where it is clear that it cannot refer literally to a mathematical point ('I was standing at this point', 'I sharpened the point of my pencil'). Perhaps it would be more accurate to say that the natural language term 'point' refers to something whose extension in space is negligible with respect to the space (or object) under consideration.

'Point' also has a strong non-spatial connotation, in that it often refers to a sharp protrusion from a physical object. (It is also often applied to time, meaning an instant or perhaps an interval of negligible length.)

'Region' is a general term for an extended subspace (either 2 or 3-dimensional). In most usages it is very close in meaning to 'area', although in mathematical contexts the terms 'region' and 'area' are clearly distinct:

1. Mathematical context: here the term 'region' is used purely spatially to refer to an arbitrary subspace without implying any particular integrating principle, although connotations of being uniformly 2 or 3 dimensional and self-connected usually apply.
2. General context: in most ordinary language usages there is an implication of some additional non-spatial unifying property or principle associated with the region. Appropriate principles are much the same as for 'area' (possibly the connotation of having a vague boundary is less strong for 'region' than 'area'). It is very common that 'region' (more so than 'area') is applied to a subspace whose principle of integration is geographic or geo-political in nature. Structural decomposition of a larger subspace into 'regions' is also a common usage (e.g. 'the central region of Africa').

'Sector' strongly connotes that the subspace is demarcated relative to a *partition* of space. A sector is normally 2 dimensional (sometimes 3). It is often a *fiat* demarcation (in the sense of Smith (2001)) imposed to divide a larger space into roughly equal parts.

'Site' is normally used to refer to the place where something is situated. Moreover, it is typically applied to buildings and other large static artifacts. Thus, a site is usually a 2-dimensional subspace of the land surface, where a large artifact is or was situated. Site can also be used with a sense more or less equivalent to sense 2 of 'situation', as described below.

'Spot' typically refers to a subspace with the following characteristics: it is of small scale compared to its context space; its spatial extension approximates a small disc or a point; it is usually on a 2D surface but could also be within a 3D object. A spot need not have any particular intrinsic distinguishing characteristics, but may be identified solely by its relation to other fixed objects.

'Spot' is similar in meaning to 'patch', except that 'spot' implies a roughly disc-like subspace of a surface, whereas a patch can be more irregular.

'Territory' always applies to a geographic scale subspace and also has a strong connotation that the subspace is individuated on the basis of ownership or jurisdiction.

'Tract' refers to a geographic scale subspace, which is typically individuated on the basis of more or less uniform terrain type (often inhospitable). The word derives from the Latin *tractare*, to draw out or drag, which implies extension in space (or possibly in time). Consequently, there may also be a (weak) connotation that a tract refers to an elongated piece of land.

'Zone' like 'sector', refers to a cell of a partition of a reference space. Though there may be slight differences in the connotation of these terms, we assume that they have essentially the same meaning.

Having considered a wide variety of primarily spatial place count nouns, it is evident that certain connotations recur in several cases. We have identified the following as being particularly significant types of connotation:

- **Dimension.** Certain place terms imply that the designated place is (typically) of a particular dimensionality (a point, a line, a 2-dimensional regions, or a 3-dimensional volume).
- **Size.** A term may imply that a subspace is relatively large (tract) or small (spot, patch) relative to the embedding space under consideration.
- **Shape.** A term may imply a subspace of a characteristic shape (e.g. a patch is irregular, although roughly disc shaped).
- **Bounded.** Place terms may be associated with the presence of more or less definite boundaries that demarcate the designated subspace.
- **Partition.** This connotation implies that the designated place is a cell within a partition of the entire space under consideration (e.g. sector and zone).
- **Geographic.** Terms such as 'tract', 'region' (in one sense), 'district', 'domain', 'territory' imply a certain scale, and also a certain relationship with the surface of the Earth. This connotation, being not purely spatial, gives a partially substantive character to such terms.

- **Jurisdiction/Control.** This has been identified as one of the main principles of integration for places, and it is also found to be a connotation of several primarily spatial place-count nouns ('territory', 'district', one sense of 'region'). This connotation also lends a substantive aspect to these terms.

5.3 Abstract Place Count Nouns

By *abstract* place count nouns, we mean those that characterise place in terms of purely logical aspects and do not constrain any physical or spatial properties. In this category we have 'place' itself, as well as 'location', 'position' and 'situation'. Such terms can be regarded as operating at a *meta level*, in that they are often used to describe more specific place terms. For example, one might say 'London is a place' or 'Overlooking the river is a nice location'.

'Place.' We have so far used the term 'place' as if it were the most general of the abstract place concepts, and indeed it does have a very general usage. It can be employed in most contexts where any of the other non-substantive terms are used. There are two distinct modes of linguistic expression that we regard as referring to places.

1. Firstly, the term 'place' may be applied to an *object* of an appropriate type. For instance, one may assert: 'The city of Leeds is a place'. In this sense 'place' is a count noun whose extension covers all objects that are instances of some more specific place-like count noun. This includes, for instance: countries, towns, lakes, hills, buildings, rooms. Although the types of place object are diverse, they have the common feature that they provide a basis for at least one (and often all) of the functions of locating, hosting and anchoring (as identified above in Section 2.3).
2. A second mode of application of the word 'place' is to refer to locative spatial properties rather than place-like objects. Thus, expressions such as 'in England', 'on the table' and 'between the church and the town hall' are often thought of as referring to 'places'. Places in this sense correspond to *reifications* of locative property phrases. Moreover, it is places in this sense that correspond to possible answers to 'Where?' questions.

The ambiguity of 'place' with respect to these different senses is understandable, since they are semantically very closely related. In answering a 'Where?' question, it is common to give simply the name of a substantive place object (such as 'London') instead of a locative property phrase (such as 'in London').

To develop a more comprehensive formal theory of place we believe that it will be necessary to introduce a representation for reified place objects that are abstracted from locative properties. This could be done using the *lambda calculus*: if $\phi(x)$ is a predicate corresponding to a locative property, then $\lambda x[\phi(x)]$ denotes an abstract place object corresponding to the reification of this property.

'Location' is another very general term which has several distinct senses:

1. A spatial property, usually manifest at a geographic scale, which describes the spatial relation of an object to one or more other spatial objects — i.e. a geographic scale locative property phrase.
2. We may also regard the location of an object as being a combination of all spatial properties satisfied by that object. (For example, we may consider the good and bad aspects of a particular location.)
3. The term 'location' is also used to refer to a very explicit designation of the subspace occupied by an object, such as its coordinates within a numerical coordinate system.

'Position' has much in common with 'location' but does have some distinctive connotations:

1. In speaking of 'position' we often refer to the intrinsic form or orientation of an object (or person) as well as its location in space.
2. The term 'position' can be used in a sense where only the form is relevant, not the absolute location in space (e.g. 'Hold your arms in this position').
3. In small and medium scale contexts 'position' is sometimes used just to refer to the location of an object (e.g. the position of a piece on a chessboard).
4. 'Position' is commonly used an a non-spatial sense, to refer to the status of a person in relation to an institutional or social structure.

In so far as 'position' is associated with intrinsic form rather than location, it is not place-like according to the criteria (i.e. locating, hosting, anchoring) that we have suggested apply to typical place count nouns.

'Situation' has two rather different senses:

1. In a general sense, the term 'situation' can be taken as referring to a 'state of affairs' (either purely static or with respect to some on-going event). Although a situation in this sense will generally include spatial aspects, it is only indirectly relevant to the concept of place, and so will not be considered further here.
2. There is another common sense of 'situation' where it does refer to place-like entities. This occurs in contexts such as 'The house was in a beautiful situation, overlooking the lake.' Here, 'situation' refers to where an object is 'situated' and this is normally described by means of locative property phrases — i.e. phrases that locate the object in relation to its surroundings. In this sense, the meaning of 'situation' is very close to that of 'location'. Like 'location', a 'situation' in this sense could be associated with the set of spatial predicates satisfied by an object.

6 Further Work and Conclusions

When we began this work, we believed we could proceed directly to formulate a general logical theory of the concept of place. However, we soon found that

the huge variety of different ways in which place enters into language made it impossible to achieve a simple theory that covered all these modes. Thus we were driven to a detailed analysis of the many linguistic expressions of place concepts and their semantic content. We are now still a long way from having a comprehensive formal theory. Nevertheless, we do believe we have delineated a semantic framework that encompasses all the major aspects of the semantics of place and explains many of the ways in which they interact. Hence, we now have a solid basis from which we can proceed to develop a fully formal ontology of place. Clearly this will not be a simple first-order theory over a uniform domain of entities, but a rather complex multi-typed system, which can articulate place-related concepts from a number of different perspectives and levels of abstraction.

Several issues are of particular relevance to the further development of the theory. One is the details of how spatial prepositions should be encoded as spatial relations, in order to formalise the semantics of locative property phrases. Another is the reification of spatial predicates to form abstract place-like entities, which seem to be required in order to model certain natural modes of expression, where locative properties are referred to as if they were a special kind of object. A futher issue concerns the interpretation of place terms in relation to the changing configurations of real physical environments (as studied by Donnelly (2005)).

With regard to methodology, although the present work was guided by the more cognitively oriented studies of Agarwal (2004, 2005a,b), the current development has been conducted from a largely theoretical perspective. In order to establish whether the different senses and connotations of place that we have identified correspond well with the intuitions of 'naive' language users, further congnitive experimentation will be required.

A long term goal of this research is to develop a system capable of automated answering of 'Where?' questions. It is evident that these queries are highly unconstrained in that there are a huge number of ways in which answers to such questions can be stated. The current work serves to analyse the forms of possible responses and also provides a basis for a formal specification the truth conditions of place attributions. However, it does not provide a mechanism by which *appropriate* answers can be distinguished from those that are true but uninformative (e.g. Q: 'Where is John?'. A: 'Somewhere in the universe.').

The key to determining an appropriate answer seems to lie in the context within which a 'Where?' question is posed. Pragmatic considerations (such as the epistemic state of the questioner and the topic of the dialogue in which a question arises) appear to provide cues that constrain what would count as an informative answer. Hence, an approach to solving this problem would be to somehow extract semantic constraints and connotations from the context, and use these to determine the mode of expression and level of abstraction most appropriate to a sensible answer. The explication of semantic attributes and connotations of place expressions given in the current paper may provide a useful starting point for devising a mechanism that can achieve this.

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