Place and Placing Locations: A Cognitive Perspective

Clare Davies⬤

Department of Psychology, University of Winchester, UK

Understanding and modelling places is an interdisciplinary problem, and one relevant but easily overlooked discipline is cognitive science. Many of the findings and intuitions that geographers and geographic information scientists have developed imply that places (at least, those that subtend a geographic area and do not have sharply defined boundaries) have a specific role and structure in human cognition: one of *categorizing* contiguous and semantically related locations, to optimize cognitive economy and efficiency. Thus "place", in this sense, is a classification heuristic. This short paper will outline some of the new research questions that arise if we take this perspective on places, and suggest that computational and/or statistical models will need to be supplemented and "ground truthed" by human-participants work for useful progress to be made.

Keywords: classification; location; place cognition; semantic memory; research agenda

1   Introduction: Why Modelling Places Matters

Geographic information is ubiquitous and has increasingly become richer and more automatically updated. Modelling metric geographic space as objectively measured by science, however, can only take us so far. Our understanding of space in our human cognitive systems has many peculiar aspects that make it quite different from the space of a GIS, and the brain often does not seem that interested in accurately modelling space at all, preferring instead to prioritize what is visibly, semantically or emotionally significant (Davies and Peebles, 2010), and to simplify "uninteresting" aspects of the space between key vistas (Meilinger et al., 2014). Thus we know, from decades of research, that human spatial cognition closely links "what" and "where", distorts distance and direction (and seems to record it non-transitively; Lloyd and Heivly 1987), and at the same time apparently imposes some kind of vague grouping and naming upon the space (Montello, 2003) to create (and usually to name) areas which we might think of as "places".

Of course, "place" is more ambiguous and hence problematic as a term in English than "space" is. We talk loosely of "place" in smaller-scale spaces, in ways that are often synonymous with "location" (such as "my place at the table", or "his place in the line"). We also use "place" to mean single functional buildings or locations in our environment: "come down to my place" (home); "that place on South Street" (shop, restaurant or bar); and "the place where he's buried" (grave site). However, for the remainder of this paper, I will focus on the larger-sized meaning of "place" – an area of geographic space that is larger than one can see from a single point and thus is at least within the scale of what Montello called "environmental space" (Montello, 1993). Thus the focus will primarily be on urban or suburban localities – named but non-administrative "neighbourhoods" or districts within a city. The insights to be explored probably also apply to regions at the next scale up in Montello's definitions, "geographic" space. Montello has also argued elsewhere that the geography of cognitive regions, as apparent groupings of locations in people's minds, is distinctive from other types (Montello, 2003).

We already know, but it is worth restating, that understanding places of this kind is crucial for building a workable data model of urban (and often also of rural) geographic information. This, in turn, could greatly aid many organizations whose role forces them to liaise between formal spatial data and its associated professional expertise, and the messy, less easily predicted place-based geographies of the general public (Davies et al., 2009). Lives could be saved if ambulances avoided going to the wrong suburb or park. Location-based services would be far more accessible to users if intuitive notions of local place were included, rather than relying on formal addressing systems. Planners and military intelligence specialists would have a better understanding of public discourse, attitudes, and affiliations (the so-called "hearts and minds" knowledge) if they could model how a community divides and evaluates its local environment. These understandings might even allow all of these professionals to *predict* how people (en masse) might behave and move in crisis scenarios.

In 21st century society such professionals, unlike a hundred or even forty years ago, tend to be remote from the community they must support or protect and thus do not already share its understanding or knowledge. Place, then, is not a mere qualitative fancy for humanities scholars to muse about. Lack of understanding of it is costing lives and creating poorer-quality environments, here and now.

2   Geographic Information Science: Vague Vernacular Places

A key insight which GIScience has grappled with for some years is the notion that many places have vague, or fuzzy, boundaries. Web-sourced and other "big" data has allowed numerous demonstrations of this to be published in the past twenty years. Relatively few, however, have managed to check that the mappings they produced corresponded to human intuitions of the same places' edges, rather than being artifacts of human error under particular circumstances (see Brindley et al. (2018) as a welcome exception). Underpinning much of this work appears to be an assumption that, if we capture enough geotagged data for a given area and solve the tricky problem of representing its vagueness within GIS, stable datasets of vaguely bounded places will eventually be produceable and usable.

So far, no work has established the speed with which vague boundaries may shift over time or even be contested between different subsets of the community in the first place, as is often been implied by much of the more qualitative human and social geographical research (Cresswell, 2014). Thus, major questions of quality, representativeness, timeliness, accuracy, and relevance are left unanswered. Whenever a new research study is published showing, typically, a kernel density model mapping some internet-sourced geotagged point data to establish vague place boundaries, at least ten research questions look beyond its findings:

1. Whose data does this represent, and which community members does it exclude?

2. Would the included community members be consistent about these boundaries in *other* situations?

3. When and why might people change their minds about placing a location within a named area?

4. How can we estimate a non-captured location's probability of being in place X versus place Y?

5. What can we predict about the boundaries of a place for which we cannot gather enough data?

6. When do "hard" (crisp) boundaries apply instead – where a locality borders a highway or watercourse? (Always? When does it spill beyond the linear feature, and why?)

7. Are all of the places we have modelled at the same hierarchical level? Are there other vague named regions which subsume or encompass them?

8. Are there any apparently *unnamed* places that people might also reference in ways missed by the usual data capture methods – e.g., localities referred to by a major street name? How do we identify and capture those?

9. How do people learn, decide upon, and perhaps evolve their shared communal knowledge of vague place extents?

10. Why does all of this happen in the first place?

The lack of theoretical grounding leaves us unable to answer a final, very basic, question about such work: is building a one-time dataset actually what we need to do? What if, instead, we need to generate predictive models specific to a given context and community, based on establishing certain parameters on an ad hoc basis? We may only be able to answer this when we understand better what feature of human cognition is producing the effect of vagueness and ambiguity in place understandings, what factors influence it, and the extent to which it depends on dynamically situated processes in a specific context rather than stable representations in memory. Thus we need to identify the fundamental psychological processes that create "place".

3   Places as Semantic-Spatial Categories

Fuzziness is already a long-recognized feature of one particular area of human cognition: the concepts and categories we hold in semantic memory. Half a century or more of research in this field has established many often conflicting and unexpected aspects of how people choose to categorize objects and concepts into larger groupings (Murphy, 2002). The reason *why* they do so, however, is universally accepted: it is far more cognitively efficient to think of the world in terms of a smaller, organized set of concepts and types of object (or scenario, person, job, and so on) than to try to cope with the many thousands of individual items which we encounter over a lifetime (Bower, 1970). Thus categorization is part of the set of tools we use for heuristic – fast and simplified – cognitive reasoning and decision-making (Kahneman, 2011).

As I have pointed out elsewhere (Davies, 2009; Davies and Tenbrink, 2018), it makes sense to consider places in the same light. Grouping and naming an area of our city makes spatial problem-solving and language, and the retrieval of stored spatial knowledge relating locations together, far simpler and more efficient. Often, this simplification may come at the cost of precise metric spatial accuracy, but in many circumstances this does not actually matter. If I tell somebody that my grandmother lives in a given locality, it does not matter that their notion of that locality may be vague and different from mine, until they rely on the information to actually go there (at which point, we usually switch to more precise addressing notations). Where it *does* matter, as explained earlier, is where our human notions of place have to be interpreted by metric-space-only geographic information systems, and their less locally informed users.

Human-participants research, aiming to reapply some of the more complex insights about categorization to people's local place knowledge, appears to support the basic claim that places are, mentally, a form of semantic category of locations, which happen to have spatial contiguity as a major (but by no means the only) dimension of similarity that links them together (Davies et al., 2018). There is also some suggestion from neuroscience that, although the two research domains almost never mention each other, semantic cognition and place knowledge (as a particular aspect of environmental-scale spatial cognition) are processed in contiguous and closely related areas of the human brain, specifically the anterior and medial temporal lobe (see, e. g., Lambon Ralph 2014; Lengen and Kistemann 2012). Other evidence suggests that place knowledge (especially of place names) gets damaged in semantic dementia along with recognition of objects and faces (Simmons and Martin, 2009; Snowden et al., 1994).

Thus we can tentatively conceive of places as categories that are partly spatial, but largely also semantic. Some fundamental insights that arise from this (based on insights from the semantic memory literature cited above) include:

1. Like concepts, places may be not just fuzzy at the edges, but show "graded membership" (often referred to as "typicality" – where every location may differ in the degree to which it is considered a good or typical exemplar of the place).

2. Most if not all places will have a common "core" area, which is less dependent on perceptual information and more semantically salient. (It will not necessarily be at or near the spatial centroid, however.)

3. There may be a degree of hierarchy, with larger places encompassing smaller ones, but some levels of the hierarchy may be privileged: for instance, one level (e. g., city) may be used in daily

life more often than the other levels, and people may be quicker to categorize a location into that level than into the smallest-scale level (e. g., neighbourhood).

4. Like categories, learning to identify a place may be gradual and incremental or may happen abruptly (e. g., from viewing a map).

Moreover, we have been able so far to show that places also conform to some of the less stable and challenging aspects of categories, investigated since the 1980s by cognitive scientists such as Barsalou (1985) and Hampton (2007). Thus, we have shown that the precise definition of a particular place may be sensitive to varying goals and contexts. Its boundaries (and the criteria used for judging them) may vary depending on the purpose and expertise of an individual thinker, and they can be influenced by cues from information sources such as maps (e. g., the precise cartographic placement of locality names).

This implies that to accurately represent places computationally, a stable spatial dataset may never completely suffice. Instead, we may need a dynamic, learned, context-adaptable *model*.

4   What Kind of Model?

Switching from talk of "mapping" to a requirement for partly semantic *classification* of locations into places raises a range of research questions. After all, at the time of writing Wikipedia was listing some 81 different algorithm types for classification of entities. Where to start?

First, we may consider the problem as one of clustering. If we took a hierarchical approach, should we take an agglomerative approach – locations get clustered together incrementally so that the number of divisions decreases over time? Or should we assume that the clusters are mostly already known – since childhood – and new residents in an area are likely to have heard of most local place names before they know exactly where they are? The latter insight would assume an approach analogous to partitional ("k-means") clustering.

Second, individual locations are usually not independently "placed" (categorized); the placement of one location will influence the likelihood that the next remembered scene or landmark along its street will be similarly placed. However, the interdependencies are likely to be complex. Can we apply a "Dirichlet allocation"-style approach to model these? Similarly, where a boundary is "fuzzy", which statistical distributions (probability curves) best represent that fuzziness? When is the slope gentler or steeper, or maybe even stepped? For example, perhaps sometimes the boundary between two localities will be conceived as the end of either one urban block or else the next; in more regular grid-pattern cities people's assumptions may be less "fuzzy" than in other environments.

Third, places at the same granularity (e. g., urban localities or suburbs) appear to overlap in web-sourced data. Do they overlap in an individual's mind too, or do people just assume that they are unclear about the boundary (but that there is one)? If overlap is accepted at some level, when does this happen (and not happen), and are people consciously aware of it – perhaps more so in some cultures or circumstances than others?

Fourth, supposing we build a place model by categorizing individual geotagged locations, as a number of studies have done in the past decade or so. How well does this reflect what people mean when they refer to that place as a whole (usually by uttering its toponym), rather than trying to classify locations into (or out of) it? In other words, how well is the concept or "essence" of the place reflected in the collection of locations that are probabilistically linked to it by such modelling? This is a question for qualitative, as well as quantitative, research.

Other questions relate to the details of how we categorize – which features and criteria we take into account other than the spatial contiguity of locations. In a particularly wealthy suburb, e. g., we may exclude a peripheral street because its housing units are smaller or of lower quality. A given position of a landmark within the street topology may sometimes matter more than its absolute spatial location, in deciding which place it "belongs" to. How far do the criteria vary with context and with which "crowd" (community) is being sampled? Can we abstract some general approximate "rules" or principles for a given type of geographic feature, so that criteria can be applied beyond spatial contiguity? These could help us to improve a machine learning algorithm trying to approximate locals' understanding of place.

Finally, we need research to "ground truth" all such computational work. We have to ensure that the data we gather from "Big Data" or VGI sources, useful as it is, does correspond to the realities

of local people (and indeed, non-local visitors) for a given type of place. Some work already looks promising in this direction as mentioned earlier (see Brindley et al. 2018), but "where do you think you live?" is only one question among many which people have to consider about local places. Such work requires at least the three disciplines of psychology, geography, and computer science to work more closely together, possibly with additional insights from others, such as linguistics and sociology. There is plenty more place work to do.

5   References

Acknowledgements

ORCID

Clare Davies   https://orcid.org/0000-0003-0261-2353

References

Barsalou, Lawrence W: *Ideals, central tendency, and frequency of instantiation as determinants of graded structure in categories*. Journal of Experimental Psychology: Learning, Memory, and Cognition, 11(4), 1985, 629–654. doi: 10.1037/0278-7393.11.1-4.629

Bower, Gordon H: *Organizational factors in memory*. Cognitive Psychology, 1(1), 1970, 18–46. doi: 10.1016/0010-0285(70)90003-4

Brindley, Paul; Goulding, James; and Wilson, Max L: *Generating vague neighbourhoods through data mining of passive web data*. International Journal of Geographical Information Science, 32(3), 2018, 498–523. doi: 10.1080/13658816.2017.1400549

Cresswell, Tim: *Place. An introduction*. Hoboken, NJ, USA: Wiley & Sons, 2014

Davies, Clare: *Are places concepts? familarity and expertise effects in neighborhood cognition*. Proceedings of the 9th International Conference on Spatial Information Theory (COSIT), 2009, 36–50. doi: 10.1007/978-3-642-03832-7_3

Davies, Clare; Battye, Emilia; and Engelbrecht, Paula: *Places as fuzzy locational categories*, 2018. In preparation

Davies, Clare; Holt, Ian; Green, Jenny; Harding, Jenny; and Diamond, Lucy: *User needs and implications for modelling vague named places*. Spatial Cognition and Computation, 9(3), 2009, 174–194. doi: 10.1080/13875860903121830

Davies, Clare and Peebles, David: *Spaces or scenes: map-based orientation in urban environments*. Spatial Cognition & Computation, 10(2–3), 2010, 135–156. doi: 10.1080/13875861003759289

Davies, Clare and Tenbrink, Thora: *Place as location categories: learning from language*. Proceedings of Workshops and Posters at the 13th International Conference on Spatial Information Theory (COSIT 2017), 2018, 217–225. doi: 10.1007/978-3-319-63946-8_37

Hampton, James A: *Typicality, graded membership, and vagueness*. Cognitive Science, 31(3), 2007, 355–384. doi: 10.1080/15326900701326402

Kahneman, Daniel: *Thinking, fast and slow*. NYC, NY: Farrar, Straus and Giroux, 2011

Lambon Ralph, Matthew A: *Neurocognitive insights on conceptual knowledge and its breakdown*. Philosophical Transactions of the Royal Society B, 369(1634), 2014, 20120392. doi: 10.1098/rstb.2012.0392

Lengen, Charis and Kistemann, Thomas: *Sense of place and place identity: review of neuroscientific evidence*. Health and Place, 18(5), 2012, 1162–1171. doi: 10.1016/j.healthplace.2012.01.012

Lloyd, Robert and Heivly, Christopher: *Systematic distortions in urban cognitive maps*. Annals of the Association of American Geographers, 77(2), 1987, 191–207. doi: 10.1111/j.1467-8306.1987.tb00153.x

Meilinger, Tobias; Riecke, Bernhard E; and Bülthoff, Heinrich H: *Local and global reference frames for environmental spaces*. Quarterly Journal of Experimental Psychology, 67(3), 2014, 542–569. doi: 10.1080/17470218.2013.821145

Montello, Daniel R: *Scale and multiple psychologies of space*. Proceedings of the 1st International Conference on Spatial Information Theory (COSIT), 1993, 312–321. doi: 10.1007/3-540-57207-4_21

——— *Regions in geography: process and content*. In: Duckham, Matt; Goodchild, Michael F; and Worboys, Michael F (eds.), *Foundations of geographic information science*, London, UK: Taylor & Francis, 2003. 173–189

Murphy, Gregory L: *The big book of concepts*. Cambridge, MA: MIT Press, 2002

Simmons, W Kyle and Martin, Alex: *The anterior temporal lobes and the functional architecture of semantic memory*. Journal of the International Neuropsychological Society, 15(5), 2009, 645–649. doi: 10.1017/S1355617709990348

Snowden, Julie; Griffiths, Helen; and Neary, David: *Semantic dementia: autobiographical contribution to preservation of meaning*. Cognitive Neuropsychology, 11(3), 1994, 265–288. doi: 10.1080/02643299408251976