# Art, Science and Geovisualisation

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## Section 1.1 The Quantitative Revolution and Spatial Science

This paper begins with a critical assessment the emergence of spatial science in the mid 20th century and the subsequent development of geographical information systems (GIS) in the late 20th Century. Spatial Science critiqued a regional geography associated with the work of Richard Hartshorne's *On the Nature of Geography* (1939) in particular, on the basis that it was deemed to be exceptional and idiographic (Schaeffer 1953). Whereas exceptional referred to the fact that geography (alongside history) was a non-systematic discipline, in that it engaged with a wealth of different phenomena rather than a particular group, idiographic indicated that geography dealt with specific, unique events rather than groups of data that could be used to test hypotheses (Hartshorne 1968). According to academics such as Schaeffer (1953), regional geography was thus non-scientific, according to the criteria associated with a logical positivism. As an alternative, Schaeffer offered a "spatial science" based on the formulating of hypotheses that could be tested using observable, measurable data produced under controlled conditions. This data could be analysed using statistical techniques and theoretical models imported from other disciplines such as economics, sociology and physics. This emphasis on data production and analysis was often referred to as geography's "quantitative revolution" (Burton 1963; Gould 1979). As spatial science became more prominent in the discipline, regional geography was transformed into a "regional science". Regional science allowed large datasets to be analysed and used by researchers to model and visualise entire regions in a system that was easily replicated (Burton 1963; Gould 1979).

In this paper, I begin by noting the key themes in the early commentaries put forward by Schaeffer and other advocates of spatial science in the mid-20th century. I want to contextualise these calls for a new disciplinary approach in regard to the advent of the computer age and the Cold War. I also, however, want to draw out how these advocates used particular criteria as to what was and what was not science to assert the validity of their own approach. I conclude by noting that whilst spatial science is no longer dominant across the discipline of geography, it nevertheless is important to the emergence of GIS.

## Section 1.2 The Emergence of GIS

In the late 20th century, in the wake of regional science, GIS evolved as a confluence of spatial science, the evolution of computer technology and proliferation of personal computers, and a societal need (Goodchild, 1992) to capture, store and analyse various types of geographical data. From the late 1960s onwards, GIS became more and more sophisticated and an important part of geographic information gathering. GIS's primary function became concerned with the representation of real world objects in digital form. However, a number of concerns about GIS's appropriateness for gathering and analysing geographic information began to emerge. Primarily, GIS's origins in spatial science and resultant reliance on positivistic constructions of reality, therein privileging scientifically controlled observations as the only method of knowledge gathering, troubled a number of human geographers (such as Sui, 1994; Pickles, 1995; Kitchin, 2006). Further criticism focused on its origins as a digital computerised process reliant on limited Boolean logic to represent and process geographic information (Sheppard, 1995; Schuurman, 2000). However, in opposition to these views and in defence of GIS, geographer Stan Openshaw (1997) wrote a widely cited paper calling into question the validity of such arguments and the position of geographers so opposed to a "map-related geography."

I will give a brief summary of the emergence of GIS technology and then contextualise the emergence of GIS at the beginning of the computer age. I also, however, want to draw out how, as GIS technology matured and was implemented in numerous applications, critical debates about its effectiveness for representing geographic information emerged. I will discuss arguments from both the critics and advocates of a GIS. I conclude by noting that, as vehement as these debates are, most of the literature considered when writing this essay has concluded with a strong desire to promote dialogue between the seemingly opposing poles, one side critical of what some consider positivistic approaches to geography, and the other who see GIS as more than a tool for spatial analysis.

## Section 2 – Modelling Geographic Reality

Geographic Information Systems (GIS) emerged from the quantitative revolution in geography, which advocated a more nomothetic, law-producing science in line with other systematic sciences such as physics and chemistry. The geographic matrix conceived by Berry (1964) is arguably at the heart of contemporary GIS. This model was formulated to define a version of reality by interpreting observations of the real world through the lens of logical positivism- this being the assumption that these observations allow one to know certain things about a "real world". By plotting observations on a matrix the spatial scientist can establish a geographical fact, something that is known about geographical reality. Furthermore, according to Fonseca *et al* (2002) in order to define this geographical space or reality one must define geographical objects. Once defined -usually by quantitative methods- these entities in geographical space can become objects within a GIS. This kind of conceptualisation of space is referred to by GIScience as ontology. However, one might contend, taking into consideration what human geographers understand as ontology, that what they are actually referring to is epistemology. Schuurman (2008) notes that, "ontology in a social science context refers to the essence of being of an object or phenomenon (Gregory 1994). In a computing context, ontology refers to a fixed universe of discourse (Gruber 1995; Smith and Mark 2001)"(p1539). Furthermore I infer that what human geographers refer to as ontology, as relating to the nature of being, is quite different to what GIScience refers to as ontology, as the nature of known objects within a computerised system. As ontology understood by human geographers accepts that there are unknowable qualities of objects, what GIS refers to are ultimately simulated, knowable objects.

In this section, I will discuss the key issues relating to discussions on ontology in GIS. I will assess what is meant by ontology in GIS and what are the implicit assumptions of this definition. In the following section I will think of GIS as an assemblage of a number on ontological considerations, these being categories and boundaries, scale and granularity, object-related databases, relational databases, linking databases and validity. Each of these themes will be explained and discussed.

## Section 3 - Creative Investigation of GIS Ontologies

In this section, I will problematize these themes of categories and boundaries, scale and granularity, object-relational databases, relational databases, validity and neogeography by working with different software packages and beginning to explore both the explicit representation of space but also the more implicit nuances of the software. For instance, what does the software let me do and not let me do? In carrying out this hands-on research I will reconsider the above themes and rethink what a GIS ontology is. I will characterise some of the key aspects of contemporary GIS software and discuss the origin, use and specific nature of a few GIS packages. I will then conclude by suggesting a creative approach to further exploring GIS.

## References


BERRY, B., 1964. Approaches to regional analysis: a synthesis. *Annals of the Association of American Geographers*, 14(1), pp.1–7.

BURTON, I., 1963. the Quantitative Revolution and Theoretical Geography. *The Canadian Geographer/Le Géographe canadien*, 7(4), pp.151–162.

FONSECA, F. ET AL., 2002. Using Ontologies for Integrated Geographic Information Systems. *Transactions in GIS*, 6(3), pp.231–257.

GOODCHILD, M.F., 1992. Geographical Information Science. *International journal of geographical information systems*, 6(1), pp.31–45.

GOULD, P., 1979. Geography 1957-1977: The Augean Period. *Annals of the Association of American Geographers*, 69(1), pp.139–151.

HARTSHORNE, R., 1955. "exceptionalism in geography" re-examined. *Annals of the Association of American Geographers*.

KITCHIN, R., 2006. Positivistic Geographies and Spatial Science. In S. Aitken & G. Valentine, eds. *Approaches to Human Geography*. London: Sage, pp. 20–29.

OPENSHAW, S., 1997. The Truth about Ground Truth. *Transactions in GIS*, 2(1), pp.7–24.

PICKLES, J., 1995. *Ground truth: The social implications of geographic information systems*, Guilford Press.

SCHAEFER, F.K., 1953. Exceptionalism in geography: a methodological examination. *Annals of the Association of American Geographers*, 43(3), pp.226–249.

SCHUURMAN, N., 2008. Database Ethnographies Using Social Science Methodologies to Enhance Data Analysis and Interpretation. *Geography Compass*, 2(5), pp.1529–1548.

SCHUURMAN, N., 2000. Trouble in the heartland: GIS and its critics in the 1990s. *Progress in Human Geography*, 24(4), pp.569–590.

SHEPPARD, E., 1995. GIS and Society: Towards a Research Agenda. *Cartography and Geographic Information Systems*, 22(1), pp.5–16.

SUI, D.Z., 1994. GIS and urban studies: positivism, post-positivism, and beyond. *Urban Geography*, 15(3), pp.258–278.


## Biography


*Philip J. Nicholson is a PhD candidate at the University. His PhD project, entitled Art, Science and Geovisualisation, is funded from a collaborative doctoral award from the AHRC and is co-supervised between Human Geography and GIS Consultancy, Environment Systems.*