CRITIQUE AND ITS DISCONTENTS: GIS AND ITS CRITICS IN POSTMILLENNIAL GEOGRAPHIES

by

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ABSTRACT

In 2000, Schuurman argued that despite a decade of critique of GIS, human geographers had little impact on the technology due to their inability to articulate critiques in a language relevant to its architectures. An assessment of what has changed in postmillennial geographies remains outstanding. This thesis argues that although critiques have moved beyond emphases on positivism, they remain epistemological in substance. This continued epistemological thrust is associated with an internal metaphysics consonant with poststructuralism that is incommensurable with ontological and epistemological commitments expressed by the discourse of GIScience. GIScience and critical/cultural geography are separated by a philosophical divide. Assessments of GIS tendered under a poststructuralist metaphysics represent a profound disconnect from the technology. This disconnect is identified as a series of logical inconsistencies - notably implication of the epistemic fallacy, and an 'undoing' of the metaphysics of presence - that incorrectly locate GIS outside of the material ontological.

Keywords: ontology; epistemology; metaphysics; formal ontology; GIS; GIScience; technology, poststructuralism; critical/cultural human geography

Subject Terms: Geography; Geographic Information Systems; Critical Realism; Technology -- Philosophy; Critical theory

For my parents,

who instilled in me, at a young age, the value of an education, and without whose unyielding support – intellectual, emotional, and financial – in all matters academic and otherwise this work would not have been possible.

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TABLE OF CONTENTS

CHAPTER 1
INTRODUCTION

1.1 Introduction

Geographic Information Science (GIScience) (Wright, Goodchild, and Proctor 1997) is the subdiscipline of geography that accounts for the theoretical, conceptual, and operational bases of geographic information technologies (GITs) and methods for addressing spatial data. Historically, there has been a profound disciplinary disjuncture between GIScience and critical/cultural (more generally, 'human') branches of academic geography (Schuurman 2000, 2002; Sheppard 2000; Pickles 1997; Wright, Goodchild, and Proctor 1997; Kwan 2004; Perkins 2003; Harvey and Chrisman 1998; St. Martin and Wing 2007).

This chasm originally emerged over the logically positivist claims advanced, and naïve empiricism espoused, by spatial science. An outgrowth of the quantitative revolution in post-war geography, spatial science represented an attempt to elevate the status of geography by making it more rigorous such that it could contribute to the scientific "search for truth in theoretical terms" (Peet 1998, p. 23). This paradigm shift was stimulated by the influence of positivism in the social sciences, and in geography was achieved by 'mathematizing' the discipline, a significant shift that allowed geographers to apply numerical (e.g. statistical) and later computing techniques to the analysis of large sets of spatial phenomena. The impetus towards mathematics, however, was manifest as a concern with quantification rather than strict adherence to exact scientific method. Although this turn away from the tenets of hard science represents a departure from positivist philosophy and distinguishes spatial science from other disciplines such as physics, as a 'S'cience, GIScience was seen as inherently positivistic in its nomothetic objectives.

In the 1990s, debate fixated upon Geographic Information Systems (GIS) (Schuurman 2000). Critical/cultural geographers objected to GIS on the basis of its purportedly positivistic tenets (Abler 1993; Aitkin and Michel 1995; Dixon and Jones 1998; Lake 1993; Pickles 1993, 1997; Taylor 1990, 1991; Taylor and Johnson 1995), which it was seen as having inherited by virtue of the inception of geographic computing in the quantitative revolution (Sheppard 2000).

Significant attention has been given to the tone and content of disagreement between these two discourses (Kwan 2002b, 2002a; O'Sullivan 2006; Pavlovskaya 2006; Pickles 1997; Schuurman 2000, 2002, 2006; Schuurman and Kwan 2004; Sheppard 2000, 2005; Sui 2004). The majority of this literature, however, emphasizes the heated exchanges of the 1990s. In 2000, Schuurman argued that despite a decade devoted to the critique of GIS, human geographers had had little impact on the ethics, epistemology, masculinism, and surveillant deployment of the technology. For her, this was the result of failure on the part of critical/cultural theorists to articulate critiques in a language relevant to GIS as a digital technical device. Moreover, human geography assessments of the technology were raised almost exclusively with respect to the epistemological paucity of its alleged positivism (Schuurman 2000; Sheppard 2000). Thus critique was voiced not only in epistemological terms, but this epistemological dissent was voiced in an esoteric language far removed from the material foundation of GIS in computing (Schuurman 2000).

GIS researchers and theorists strongly contested the charges of positivism by arguing that nothing, save for loose historical contingency, demonstrates the technology to be necessarily positivistic (Kwan 2002a, 2004; Pavlovskaya 2006; Schuurman 2000, 2002; Sheppard 2000, 2005). GIScientists did nevertheless respond to the plea, raised by critics of the technology, that they clarify the ontological and epistemological premises of GIS' information primitives and practices of representation (Pickles 1997). This response, however, has emerged as an internal theorization of GIS internal to – and using – the discourse of GIScience (Pavlovskaya 2006), and not the language of social theory.

1.2 Rationale for research

It has been nearly a decade since Schuurman (2000) invited human geography critics of GIS to adopt the discourse of GIScience in order to make their assessments meaningful to the object of critique. An assessment of what, if anything, has changed between these two discourses in postmillennial geographies is absent from the geographic literature. This research fills this void by examining whether these two discourses are any better able to communicate by addressing the following questions:

1. Have critical/cultural assessments of GIS changed since the period of intense and acrimonious debate during the 1990s?

2. If there is any difference between postmillennial and 1990s critiques,

a. What is the nature of this difference?

b. Has this difference resulted in assessments of GIS (tendered by human geographers) that are more relevant to GIS as a computing entity?

3. In the absence of a shift in assessment of GIS by its human geography critics,

   a. How is it that critiques of GIS continue to culminate to misread the technology? In other words, is there a particular discursive logic which, when applied as the basis for deconstructing the technology, seemingly overproduces extant interpretations of GIS?

   b. If such a logic may be isolated, in what ways specifically does it constitute a misapprehension of the technology?

4. What are the implications of this potentially flawed reasoning for the ability of these two discourses – critical/cultural geography and GIScience – to communicate?

   a. If the misreading of GIS is a consistent feature of critical/cultural assessments of GIS which endures in postmillennial geographies, does this demonstrate there to be a series of conditions under which an engagement of GIS may be considered legitimate?

1.3 Thesis organization

The questions posed by this research – and ensuing responses – are theoretical and philosophical in nature. Accordingly this research does not follow the format of data-methods-results as these issues will never be resolved. Rather it constitutes an effort to critically examine, contextualize, and provide novel or alternative explanations to the substance and tenor of debates between critical/cultural geographers and GIScientists.

This thesis comprises three additional chapters that follow this, the Introduction. The body of this work – Chapters 2 and 3 – is organized as two separate and distinct parts which should be read as stand-alone components as these have been written for individual publication. Chapter 2 constitutes a review of the geographic literature concerned with either critiquing or theorizing GIS within a 10-year time frame. It examines the conditions of metaphysics – interpretations of ontology and epistemology and the understanding of the relationship between them – under which these two discourses operate as an original construct for capturing the difference between critical/cultural theory in geography and GIScience.

Building on the literature review contained in Chapter 2, Chapter 3 explores the significance of the identified divergent metaphysics (internal to poststructuralism and GIScience, respectively) for the human geography critique of GIS. Using the Critical Realist critique of postmodern challenges to science, it questions whether critiques of GIS are subject to logical errors which may culminate in a profound misreading of the technology on the part of human geographers, and sets forth conditions under which any further engagement of the technology could be rendered more productive.

The findings of Chapters 2 and 3, as well as their significance, are summarized in Chapter 4, the Conclusion.

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CHAPTER 2
QUANTITATIVE LIMITS TO QUALITATIVE DISCUSSIONS: GIS, ITS CRITICS, AND THE PHILOSOPHICAL DIVIDE

The following chapter is presently under review with *The Professional Geographer* under the sole authorship of Agnieszka Leszczynski.

2.1 Abstract

The discourses of GIS and poststructuralism operate under divergent conditions of metaphysics separated by a trenchant philosophical divide across which ontological and epistemological commitments are inviolable. Stemming from competing understandings of ontology and epistemology, postmillennial assessments of GIS advanced by critical/cultural geographers continue to misapprehend the technology by emphasizing epistemology as an entry point for critique. If these discourses are ever to communicate, qualitative discussions about the ontological and epistemological tenets of GIS must reconcile with the quantitative limits to representation in a software environment. This necessitates that critique be articulated in tractable terms across the formalization boundary. Formal ontologies constitute a flexible means of mapping between philosophical and informatics interpretations of ontology. While they operationalize a new vocabulary for knowledge representation, GIS and poststructuralism remain ultimately incommensurable discourses.

2.2 Introduction

In 2000, Nadine Schuurman provided the geographic academy with a trenchant summary of the debate between geographic information science (GIS) researchers and critics of the technology. She argued that the inability of the critical establishment to leverage its critiques in a language relevant to the technical community not only made much-needed assessments of GIS from human geographers ineffective, but also widened an already existing rift within the discipline. For her, this rift is the result of an overwhelming failure of two distinct discourses - Critical GIS and GIScience - to communicate.

Much attention has been given to the tenor of early debate (Kwan 2002a, 2002b; Pavlovskaya 2006; Pickles 1997; Schuurman 2000, 2005; Schuurman and Kwan 2004; Sheppard 2005). However, it has been almost a decade since Schuurman (2000) implored human geographers to adopt the language of the technology; an examination of whether these discourses are any better able to communicate is overdue. Based on a review of the postmillennial literature critical of GIS, it is obvious that although critiques have most recently moved beyond emphases on positivism, they remain identifiably poststructuralist in substance, continuing to privilege epistemology as a basis for deconstructing the technology. This has perpetuated the debate - and the existing disciplinary fissure - because the epistemic reductionism of such critiques represents a misapprehension of the ontological and epistemological commitments latent in GIS' ultimate foundation in computing, where knowledge is explicitly ontological.

This disjuncture between critical theory and GIS is not, as argued by Curry (1998), a problem of two cultures. This suggestion oversimplifies an enduring impasse by reducing it to two literatures or two systems of pedagogy (Chrisman 2005). Nor is it a solely intellectual or cultural rift as suggested by Sheppard (2005). Although the latter is a fitting characterization, it implies that increased cross-cultural exchange or heightened understanding can lead to middle ground. Rather, critics' continued insistence upon debasing the technology on epistemological grounds signifies these differences to be ingrained beyond the cultural or intellectual levels. This divide is at its foundations a philosophical one, arising from two distinct consciousnesses - held respectively by critical theorists and GIScientists - about the conditions of 'the world' and why it must necessarily behave the way it does.

The continued discrepancy over GIS is inherently philosophical because at issue are the two central tenets of metaphysics – ontology and epistemology. For Yeung (1997), these are identifiably philosophical concerns as they pose respective questions about the nature of the social and physical worlds and the need to study them in the form of a geographic social/spatial science. This philosophical divide is characterized in terms of two very different discourses: the digital universe to which GIS belongs, and the linguistic realm of critical theory within which poststructuralism is situated. That these paradigms for organizing knowledge are separated by a trenchant boundary between the conceptual and the formal (Schuurman 2006) across which backwards translation is precluded reveals computational and discursive geographic representations to be operationalized under divergent conditions of metaphysics.[1] These distinct discourses not only commit to competing definitions of 'ontology' and 'epistemology', but understand

[1] Metaphysics as that branch of philosophy concerned with the two questions of ontology and epistemology (Wilshire 1969).

the nature of their association very differently. Poststructuralism promotes epistemology as the basis for theoretical inquiry and thereby the antecedent of ontology: the contents of the world cannot be known prior to a means made available for their discovery (Gregory 2000a). Alternatively in the informatics context of GIS, ontology is understood as a fixed universe of discourse whose contents - the objects that make up the world - are explicitly defined (Schuurman 2006).

In his review of Cloke, Philo and Sadler's (1991) volume on 1990s critical debates in geography, Hansen (1994) asserts that "[i]f Marxist and realist geographers are opponents it is not due to their conceptions of science... but to their social ontologies and theories" (213-214). The disjuncture between critiques of GIS and GIScience is similarly one across which ontological and epistemological commitments are sacrosanct. That the differences which give rise to this disciplinary fissure are philosophical in substance and thereby theoretically inviolable makes them subject to Richard Rorty's (1989) sage observation that any two discourses separated by such divergent ontological and epistemological commitments are ultimately incommensurable. I argue that this reality mandates a unique discussion of ontology and epistemology in the context of GIS independent of that occurring within critical/cultural areas of geography. Any such engagement must first and foremost recognize the philosophical commitments inherent to theorizing in - or about - a digital universe.

The continued epistemological thrust of postmillennial critiques attests to the endurance of a sustained fissure between critical/cultural geographers and GIScientists. As the persistence of this rift stems from unique conditions of metaphysics particular to poststructuralist critical geographers and GIScientists, respectively, I begin by defining ‘ontology’ and ‘epistemology’ in the contexts of these two branches of the discipline. I introduce Feuchtwanger and Poiker’s (1987) ‘infological’ and ‘datalogical’ worlds of spatial representation as a means of capturing the conditions of metaphysics under which these competing philosophical commitments are initiated. Their distinction serves as a basis for explaining how - and why - critiques on the part of human geographers continue to misread the technology. Furthermore, it provides a preliminary set of conditions under which any legitimate discussion of ontology and epistemology must take place with regards to GIS. I conclude by arguing that while the need to classify in a digital universe imposes limits upon what this discussion can look like, the need to reconcile with the ontological and epistemological commitments associated with GIS as a material computing entity does not preclude constructive exchange between the two discourses. Rather it necessitates a formalism to capture the nuance of infological geographic representation such that its integrity is maintained across the formalization boundary in the datalogical universe. I advance formal ontologies - computable, domain specific conceptual models (Gruber 1993) - as a flexible mechanism for mapping between philosophical and informatics interpretations of ontology.

2.3 The two questions of metaphysics

The quintessential question of ontology as posed by Aristotle is, ‘what exists?’ (B. Smith 2001). Bhaskar (1986) differentiates between ontology in this classical sense, which he terms ‘philosophical’ ontology, and ‘scientific’ ontology. In the philosophical tradition, ontology is the meta-theory of all the phenomena, both material and conceptual, that are seen to validly exist in the world (Agarwal 2005; Gregory 2000b; Schuurman 2006; B. Smith 2001; Sowa 2000). Variations in how the world is comprehended under this "general theory of being" are dependent upon the accepted role of science, whereas under the science model itself, 'ontology' accounts for specific phenomena and their generative practices advanced under some theoretical rubric (Bhaskar 1986, 36). Classification, which Lakoff (1987) identifies as always theory-laden, is intimately bound to with this latter definition of scientific ontology. Categories structure the kinds of entities "that exist or *may* exist" in the world: if phenomena are classifiable into *a priori* categories available for making sense of the world, then they likewise fit within that particular version of reality (Sowa 2000, 492). Ontology thus specifies what it is *possible* for reality to be – this involves not only objects and qualities in the world, but also their legitimacy. Consonant with the scientific definition of 'ontology' - where the term refers to the specific conditions of existence that underwrite the practice or execution of science (Latsis, Lawson, and Martins 2007) - 'knowledge' is but reality classified into a set of categories endorsed by those very conditions.

Conversely, the philosophical definition of ontology intimates an epistemological concern with references to 'truth' and the integrity of such claims (Latsis, Lawson, and Martins 2007). This is ultimately a commentary on what constitutes legitimate knowledge; thus, if classification is seen to sanction the existence of particular phenomena, it does so always to the exclusion of others. The ontological traditions identified above are thus seen to be underwritten by an implicit logic which functions to position respective phenomena - such as discrete entities or models - as the "ultimate objects of knowledge" (Bhaskar 1978, 24). This is the role of epistemology, the conceptual framework by which theories of the world come to be accepted as sound

(Gregory 2000a). As the second half of the metaphysical pair, it is that element which affects phenomena into ontology.

Dixon and Jones (1998) recognize three "spatial epistemologies" (2004, 90) characteristic of Western geographic inquiry prior to the 'poststructuralist intervention'[2]: i) Cartesian perspectivalism, whereby inquiry proceeds linearly and necessarily with reference to central coordinates and the objects at those locations; ii) occularcentrism, the objectivist, neutral apprehension of space supported by a masculinist gaze presuming the neutrality of observation and the empirical substance of ontology; and iii) the 'epistemology of the grid' - the isotropic zenith of a binary rationality implicated in the quantification and discretization of hierarchical space most closely affiliated with spatial science. A characteristically poststructuralist critique, this account of epistemology in humanistic research seeks to subvert geographic narratives which cast knowledge as ultimately foundational and proclaim to guarantee access to those foundations through their own theories, models, and methods. The appearance of poststructuralism in geography at the turn of the previous decade constituted a direct challenge to these very commitments best expressed by the overt ontologism implicit in claims to knowledge as "fixed, indubitable and final" expressed by the ideological 'big three' - humanism, critical realism, and most egregiously by spatial science - dominating pre-1990s geographic theory (Barnes 2000, 278; Dixon and Jones 2004; Elwood 2006; Popke 2003).

While contemporary human geography is often labelled 'critical' (Blomley 2006; Sheppard 2005), it was poststructuralism specifically which set the critical research

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[2] After Popke (2003).

agenda for the discipline at the time of its ideological penetration (Dixon and Jones 2004; Elwood 2006; Popke 2003). In holding foundational commitments to knowledge as baseless, this poststructuralist scripting of the theoretical programme for geography radicalized the traditional interpretation of ontology and epistemology as historically held by geographers. Postmillennial engagements of metaphysics in critical/cultural geography can be considered poststructuralist not only because poststructuralism maintains a dominant presence in the discipline (Elwood 2006; Jones 2003; Pickles 2005; Popke 2003), but also because epistemology and by implication ontology are central poststructuralist concerns (Jones 2003; Popke 2003). The establishment of poststructuralism not only provoked, but continues to promote, a debate which is first and foremost epistemological.

2.4 Poststructuralism and the 'culture of epistemology'[3]

Poststructuralism maintains a lack of separation between ontological and epistemological tenets; these are considered intrinsically coupled and indeed indistinguishable (Dixon and Jones 1998, 2004; Gregory 2000a). This engagement is, however, characteristically unidirectional, proceeding linearly from epistemology to ontology. The nature of this relationship is best captured by Dixon and Jones (1998), who hold that "any ontology [is] itself grounded in an epistemology about how and what we *know* 'what the world is like'; in other words, the analysis of ontology invariably shows it to rest upon epistemological priors that enable claims about the structure of the real world" (250).

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[3] Following Strohmayer's (2003) characterization of poststructuralist geography as a 'culture of epistemology'.

In pre-empting interrogation of the contents of the world independently of the premises that endow phenomena with ontological substance, this ideological position is inherently epistemologically essentialist as it reduces 'reality' to mere epistemological constructs such that ontological queries become little more than problems of knowledge (Dixon and Jones 2004; Pratt 2000; Saldanha 2006). In so doing - despite claims that ontological and epistemological questions are one and the same - poststructuralist geographers profess what Jones (2003) terms "ontological agnosticism" (516).

Despite its 'anti-ontologism',[4] a significant body of poststructuralist geography is explicitly ontological (see, for example, Bonta 2005). The epistemologically reductionist version of metaphysics is, however, advanced as an 'orthodox' interpretation of ontology and epistemology under the ideological sway of poststructuralism in geography. Indeed seminal work in this branch of the discipline, such as Doel's Poststructuralist Geographies (1999), is very much a product of this "culture of epistemology" (Strohmayer 2003). Doel's (1999) stance is intentionally a-ontological; for him, a destabilization of claims about existence in the form of ontological commitments to the endurance of entities in the world represents the very objective of poststructuralist geography, which is to assert and sustain the constant counteraction of 'spatial science', which he defines as an ideological endorsement of fixed ontological categories.

2.5 Enter GIS

Dixon and Jones (2004) maintain that poststructuralism took hold in geography because it resonated with cultural geographers' already existing repudiation of the self-

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[4] See Pratt (2000).

purported objectivity of spatial science and its automaton-like quest for regularity. The initial applications of spatial science, which included the modeling and analysis of physical phenomena in planar space, revealed a subscription to a scientific ontology of empiricism most coincident with the philosophy of positivism (Peet 1998).

Poststructuralism positioned itself as antipodal to this ingenuous empiricism of spatial science, which callously failed to differentiate between the 'lineation' of physical versus social space by way of 'the grid'. Its sanction of empiricism without exception naively suggested a likewise planar, stratified social world whose contents are similarly available to discernment by the detached, neutral gaze of 'S'cience (Dixon and Jones 1998, 2004). These problems of empiricism were, however, seen as only secondary to the positivistic epistemological antecedents from which ontological polemics are seen to arise. As the advent of spatial science was stimulated by the influence of positivism in the humanities (Peet 1998), the initiation of modern geographic and data analysis methods under its rubric led to a subsumption of geographic information systems by quantitative geography more generally (Gold 2006; Kwan 2002b, 2004; Pavlovskaya 2006; Schuurman 2000). GIS became indistinguishable from spatial analysis (cf. Dixon and Jones 1998).

The (continued) insistence upon GIS as an objectionable instrument implicated in the reproduction of an empirical social ontology where individuals and cultural phenomena exhibit spatial regularities reducible to mathematical formulas governing the full spectrum of human behaviour is premised on these quantitative roots of geographic computing (Gold 2006; Kwan 2002a, 2004; Pavlovskaya 2006). The poststructuralist theory of technology, which accepts the linkage between numerical methods and logical positivism, opposes the modernist view of science where the problem of technology is but one of (social) optimization (Harvey 2003). When interpreted by way of such a theory that fails to look beyond the failures of rationalist logic and the pursuit of "flawless engineering" most cogently expressed by modern technical devices (Harvey 2003, 535), digital statistical practices in geography, notably GIS, became overdetermined as positivist.

Charges of positivism constituted the thrust of early 1990s critiques of the technology (Schuurman 2000). As is consistent with the epistemological articulation of poststructuralist theory, this forced debates about GIS to take place on epistemological grounds (Schuurman 2000). Charges of positivism elicited a strong response from GIS researchers, who, as part of a vehement defence of the technology, positioned GIS as a *critically realist* technology that, while ontologically empiricist, was not a neopositivist reincarnation of rigid spatial analytics (Hallisey 2005; Harvey 2003; Kwan 2002a, 2002b, 2004; Raper 2005; Schuurman 2002).

Despite epistemological clarifications of the technology by GIScience researchers, references to positivism persist (see, for example, T. Ahlqvist 2000; N. Smith 2005). More recent critiques, however, generally abstain from such overdetermined essentialisms. Notable amongst these is Pickles' (2004) latest treatise on cartographic computing. Despite its nuance beyond positivistic technological determinism, it is nevertheless overwhelmingly epistemological in substance, overemphasizing the representational conventions of the technology as a source of its epistemological paucity. For Pickles (2004), the visual sophistication of modern geovisualization engenders an always increasing verisimilitude of representation, making it ever more difficult for a lay audience to distinguish between reality and its abstractions. The visual fidelity of spatial representation is associated with a scopic regime that supersedes the primitive mathematical gaze supported by the spatial analyst's 'grid', engendering what Pickles (2004) sees as unprecedented new ontologies of "abstraction upon abstraction" encoded as discrete knowledge objects - the "bits and bytes, 1s and 0s" of code (162). This ontology is premised on the aforementioned system of vision that renders the earth as transparent and penetrable: the mirror at the level of the machine. Certified by epistemologies of representation, these ontologies do not simply reflect the world inside the computer but indeed write the world in their own image. Although Pickles identifies himself as a phenomenologist (1985), his take on digital representational media in geography (2004) is characteristically poststructuralist in its epistemological momentum, the binding of ontology and epistemology into a metaphysical object, and the subservience of ontological concerns to problems of representation.

The refinement of epistemological critiques such as that advanced by Pickles (2004) notwithstanding, their rhetoric remains not only esoteric but also reductionist as they articulate objections to the technology on the basis that its epistemology begets an ontology of objectified knowledge (see also T. Ahlqvist 2000). As a digital entity, GIS belongs to the realm of computing and is ergo circumscript to the interpretation of ontology and epistemology advanced therein, a universe of discourse where knowledge is innately object-ified. In other words, GIS and its critics operate under two different conditions of metaphysics - Bhaskar's (1986) philosophical and scientific ontologies.

These entail distinct - and ultimately irreconcilable - commitments to the fabric of reality and the architectures which support particular renditions of the world.

2.6 GIS as a scientific ontology

GIScientists and practitioners see spatial representations initiated in the GIS environment as constituting a veritable link to the external world (Hallisey 2005; Mark 2005; Raper 2005; Schuurman 2002). This certification of empiricism as sound epistemology is indeed a requirement, residing at the uppermost tier of ontological commitments of GIS (Frank 2000). For something to be represented, its existence must be conceded. To argue the merits of encoding or visualization in a GIS while maintaining that 'nothing exists' as do Dixon and Jones (1998) is logically fallacious and thereby moot; if nothing exists, then there is nothing to map. Ontological empiricism does not, however, reveal the technology to be *de facto* positivistic (Kwan 2002a, 2002b, 2004; Pavlovskaya 2006; Schuurman 2002). A critical realist epistemology of science undoes the empirical-positivistic singularity of poststructuralist metaphysics by emphasizing that empirically discernible phenomena are dependent upon and genuinely result from interactions between physical forces and casual mechanisms (Raper 2005). Rather than purporting to directly mirror reality, models and maps are *expressly* understood by their authors as simplifications of the world at one particular slice of space/time, and always as abstractions (Schuurman 2002). This does not suggest that models are an accurate reflection of the empirical world, but merely conceptual tools available for enacting spatial representations in a computable environment (Feuchtwanger and Poiker 1987; Pequet 2002).

Wittgenstein (2001) famously proposed that 'all that is 'the case' is the world' - it alone is an adequate, complete representation (Schuurman 2005). For Raper (2005), this understanding as held by the GIScience community underscores that spatial representations - be they simple maps or complex virtual environments - have no epistemological value in and of themselves. Instead of implying that representations are epistemology free, this locates epistemology in the process of *initiating* these models rather than in their subsequent deployment for prediction. It further highlights that representations generated in a GIS must be initiated under the appropriate epistemological circumstances where the ensuing model complements the identified causal relationships between mapped phenomena *given a particular theory of knowledge.*

These epistemological conditions under which geovisualization and analysis proceed in a GIS environment are scientific, delimited by science at two levels: the "high level" canons of science and technology which dictate how science is 'done', and the "low level" conventions of computing and cartography particular to GIS that impose their own unique rules upon representation (Raper 2005, 63). In other words, spatial representations are explicitly *scientific* representations (Raper 2005). Accordingly they are bound to Bhaskar's (1986) scientific ontology, where the emphasis is less on the epistemological merits of science's claims to its own ontological primacy, but rather on the specific models of the world which allow for science to proceed (Latsis, Lawson, and Martins 2007).

If ontology consists of what it is possible for reality to be, then science involves an identification of the conditions under which a possible world is correct or true. This renders science explicitly ontological. The immediacy of ontology to the scientific model is supported by Bhaskar's (2007) identification of scientific ontology as "differentiated": ontology is differentiated from epistemology; scientific - or "substantive" - ontologies are differentiated from philosophical ones, ontology is differentiated from ethics, etc. (196). This description aptly captures the saliency of the distinction between questions of knowledge (epistemology) and its contents (ontology) under the scientific model, a separation internally necessary to the execution of science and its ability to admit entities into the cumulative body of scientific knowledge. Kitcher (1998) explains by way of an example from genetics. Scientists 'know' that there are 'things' called genes because controlling their arrangement in organisms leads to particular (and often expected) outcomes; such interventions would be "impossible unless there were genes and, indeed, unless our genetic maps were approximately correct" (Kitcher 1998, 35). Rather than an endorsement of bioengineering, this example both demonstrates that there is sound reason for why appeals to empirical evidence contribute to the epistemology of science, and that scientific ontology is 'substantive', consisting only of those objects of knowledge consistent with - and circumscribed by - our collective, though very limited, understanding of the empirical world. It moreover affirms a clear separation between ontological queries and questions of epistemology; science maintains their distinction. This is obviously at odds with the poststructuralist collapse of the ontology/epistemology boundary and its suggestion that there are no particulars of knowledge (Bhaskar 2007). Where poststructuralism is ontologically ambivalent, science - although overtly ontological - is epistemologically ambiguous in the sense that the objects that become part of the collective body of knowledge we call 'science' are the products of a constellation of epistemologically diverse practices.

GIS is not only 'scientific' in this way, but is moreover fundamentally computational. Computing is unequivocally of the scientific model; indeed informatics ontologies represent a literal interpretation of the scientific definition of ontology as that which is "[made] *explicit*" (Bhaskar 2007, 194). An informatics or 'formal' ontology is defined by Gruber (1993) as an "explicit specification of a conceptualization" (199). Simply, it is a machine readable model of the "definitions of classes, relations, functions, and other objects" that are seen to validly exist in the world under a set of scientific conventions (Gruber 1993, 199). These phenomena are declared into the model and the relationships between all members recursively defined. Thus in an informatics interpretation an ontology is said to constitute a 'formal universe of discourse' populated by discrete knowledge objects (Gruber 1993; Schuurman 2006). Knowledge is represented in terms of the comprehensive set of significant concepts and the relations between those entities as designated by a hierarchical nesting of entities in the model (Sowa 2000). By definition a formal ontology adheres to a taxonomic structure of concepts (entities declared into existence), their properties (or class/subclass relationships between concepts), and instances (concrete examples of objects) (Sowa 2000). While poststructuralist geographers censure GIS on the basis that it removes social phenomena from their infinite complexity only to render "objects as knowledge" (T. Ahlqvist 2000, 103), this is in ignorance of the discrete nature of digital infrastructures within which formal ontologies are implemented. While knowledge is encoded into - and gleaned from - GIS as objects, this is a function of the object-oriented architectures of formal ontologies which necessitate that knowledge be structured as such.

2.7 Crossing the formalization boundary: ontology, epistemology and representation in GIS

These material precepts which impose unique constraints upon the kinds of knowledge that can be enacted in the software environment of a GIS are made clearer using Feuchtwanger and Poiker's (1987) distinction between the 'infological' and 'datalogical' worlds of representation. Infological representations constitute semantic models of how the 'real' world is conceptualized and represented. Here, ontological commitments are made via the enumeration of the phenomena that "may exist and how they fit together" (Feuchtwanger and Poiker 1987, 148). In the datalogical world, the "same things" are defined, "but in computer terms" (Feuchtwanger and Poiker 1987, 147). Datalogical representation therefore concerns how conceptual models are organized in the computer. This includes formal schema, and the computing architectures used to actually store spatial representations.

There is a trenchant difference between the structures of the phenomena being represented - which are dependent on human cognition - and the data structures that affect the resulting spatial representation within the digital confines of GIS (Feuchtwanger and Poiker 1987). Schuurman (2006) describes this in terms of a conceptual/formal boundary. We make sense of phenomena in the infological world by discerning their characteristics, and in turn make these explicit by reifying them as code in the datalogical world. Conceptual representation in the infological world initiates spatial representation in the datalogical world. Moving from the infological to the datalogical in this way entails crossing the conceptual/formal boundary; doing so, however, requires a mechanism - formalization - for translating between the conceptual and the formal.

Formalization is the "process of rendering concepts into a form that can ultimately be represented in a digital environment" (Schuurman 2006, 730). Knowledge representation in the datalogical world is accordingly *formal*: it constitutes an effectively tractable proxy of a real-world or abstract system that both simulates intelligent reasoning in the form of proven theorems and their consequences, and represents a mapping between knowledge in a domain and its encoded reification (Sowa 2000). In short, formal knowledge comprises an internally consistent system of logic - a formal universe. The representational medium to be found herein is *formal logic*, the mechanism by which subsets of natural language are explicitly formulated and thereby rendered computable (Sowa 2000). Effectively a syntax, formal logic is composed of a small number of symbols that suffice to represent all the possible knowledge *that can be processed or computed* (Sowa 2000). A salient definition, this emphasizes that formal logic does not portend to exhaust representation; it is instead savvy to its own limitations stemming from its ability to express exclusively that which can be stated using the available axioms. This is consistent with Gödel's first Incompleteness Theorem, which maintains that any logical system cannot be simultaneously consistent *and* complete.

Modern logical notation is almost exclusively algebraic (Sowa 2000). There are multiple formal logics available - these include first order logic, description logics, modal logic and others, (almost) any of which can be used to represent a formal ontology. Importantly, formal logics are all ontologically neutral. In their uninterpreted form, they have no *a priori* maxims which express anything at all; there are only the qualifiers, operators and variables for expressing ontological commitments in the form of propositions about the world (Sowa 2000). These can be either verified or falsified against the theorems internal to that particular brand of logic (Sowa 2000). Different logics do, however, have different sets of predefined predicates, axioms, and theorems available for making statements about the things that exist in the world, where 'the world' is the application domain; these logics differ not only in their notation styles but also in their expressivity. Translations between subsets of formal logic are valid only where the conclusions - true or false - are maintained under the same conditions (Sowa 2000). We can accordingly only move from more to less expressive logical systems.

Before they can be expressed in logical form, high level concepts in the infological domain must first be abstracted in some quantitative way such that they can be transposed into logical notation in the pre-coding stage. The coding stage further reduces these interim symbolic representations to a series of numerical digits (0s and 1s). This latter process is inherently mathematical; indeed formalization is not only dependent upon concepts from mathematics, but it is quantitative *at every stage*. At the most primitive level, every concept that is expressed computationally is discretized and fixed as a series of digits. This quantitative basis of formalization only compounds the linguistic limits to representation encountered in the realm of critical theory, which Derrida (1970) identified as the "nontotalization of language" (260). Language "excludes totalization" because a syntax (for a language) can never be exhaustive - even if one could hypothetically be formalized, it would prove meaningless (Derrida 1970, 260). This is a function of the vagueness, ambiguity and underspecificity of natural language itself (Hallisey 2005). It is in this way that the limits to discussions about the ontological and epistemological tenets of GIS - discussions which are ultimately qualitative - are inescapably *quantitative*.

All representation begins in the infological world as concepts. It is only subsequently defined via translation to the datalogical universe. Spatial models are certainly circumscribed by linguistic constraints; they are not, however, like any other representation expressed in natural language by virtue of their initiation in the infological. While representation may be exclusively conceptual or linguistic in the realm of critical theory, in the digital realm it must ultimately be affected as code (Schuurman 2006). The rigid nature of informatics architectures designates that these constraints materialize in a very tangible way at the formal knowledge representation stage. Because formal logical systems are mathematical objects, they are subject to the Gödel paradox, such that the more expressive a logic, the less 'processable' it is computationally. The consequence of this tradeoff is that the 'better' a spatial representation is at capturing the world - the more expressive its logic - the greater the likelihood that the time complexity of answering questions asked of the database becomes intractable. This results in the propagation of meaningless conclusions manifest in the form of an 'infinite loop' where a programs feeds its output back into itself as input *ad infinitum*. Here limits to representation are inherent features of computing and *not* of theoretical discourse. Once we cross the formalization boundary, we are confined to the universe of informatics. Any negotiation of polemics must occur in the form of procedural, or brute force, changes to the code itself - a technical solution.

It is for this reason that Schuurman (2006) argues that 'formalization matters': data structures effectively "fix representation" (729). In the process of discretization, linguistic uncertainty becomes literally encoded into the ensuing representation, negating the possibility of discursive circumvention. Hallisey (2005) illustrates this with an example involving soil classification. Soil taxonomies – like all classification systems - are selective representations. This subjectivity is written into the digital discretization of soil types - which vary continuously along a gradient over a physical area - as distinct, finite objects (polygons) in space. The conceptual errors and semantic ambiguities of representation in the infological world become cemented when they assume permanence in the form of bits and bytes. Moving across the conceptual/formal barrier is consequently 'lossy'; as a 'smoothing' technique designed to eliminate data noise, formalization involves a reduction in conceptual complexity which cannot be regained. As a result there is no backwards engineering across the formalization boundary; to backwards traverse from the datalogical to the infological would be tantamount to ecological fallacy (EF). In remote sensing, EF is realized as a prohibition against moving from coarse to fine resolution data - in other words, one cannot 'make' high resolution data from low resolution (large ground cell dimension) imagery. This is similarly true of computational formalization, where the continuous variation and free association of natural language must be discretized and encoded as determinate data objects reified as primitive, nominal digits (0s or 1s) in an informatics ontology. Once discursive richness is lost in the process of digitization, it cannot be spontaneously recreated as the details necessary for this are lost when crossing the formalization boundary. Wittgenstein (2001) famously proposed that 'the world' is not a collection of 'things' but is itself a totality. The implication is that the entities enumerated in ontology will never be a sufficient representation of reality. We thus cannot take GIS objects that have been recursively simplified in the coding process and demand that they be equally as nuanced and elegant as sociotheoretical writings about the world.

Unlike in the infological world where meaning is inferred from context, in the infological world, meaning can only be extracted from the formalism across the formalization boundary (Schuurman 2006). Spatial representation in a software environment is possible only by forcing what is effectively a non-representational entity - code - to enact something which conforms to the traditional semiotic paradigm (Thrift and French 2002). Eliciting meaning from code is no easy task because "mathematical and computational tools, however powerful, cannot extract more information than is latent in a representation" (Miller and Wentz 2003, 574). For any extraction to be possible, everything must be made "'obvious'" (Sowa 2000, 132). At the machine level, we are limited to accomplishing this using the computational constructs for representation made available given the current state of computing. These constructs are rigid in nature, and therefore engender relatively rigid representations compared to the flexibility and malleability of representations articulated in natural language.

Whereas the emphasis of models in the datalogical world is on identifying the characteristics of phenomena, in the datalogical universe, the purpose is to declare how these concepts relate or fit together in a formal ontology (Feuchtwanger and Poiker 1987). The conditions under which these declarations occur are a product of conventions internal to a discipline or 'community of practice'. Formal ontologies are thus declarations of domain knowledge; they are always partial, user dependent accounts of reality (Agarwal 2005; Schuurman 2006; Schuurman and Leszczynski 2006).

2.8 From scientific to philosophical ontology

Although computing science co-opted the term 'ontology' from philosophy (Agarwal 2005), the two understandings of ontology afforded by both philosophy and computing science are clearly related. Philosophical ontology asks, 'what kinds of objects are seen to validly exist in the world?', and in the digital realm, these objects are made exact. In declaring entities into formal ontology, we simultaneously make ontological commitments in the philosophical sense. Indeed Frank (2000) characterizes any one formal model as a computational representation of a philosophical ontology. In this way informatics ontologies are immediately formal statements of commitments to philosophical ontology.

The self-evidence of data has long plagued the development of a more nuanced, intuitive computing. Semantics - differences in meaning and naming conventions (Bowker 2000) - often remain implicit at the level of the database. The development of formal ontology emerged precisely out of artificial intelligence research attempts to capture, at the level of the machine, the contexts from which data emerge (Schuurman and Leszczynski 2006). This recognizes that meaning is ultimately dependent on context and endeavours to engineer constructs that make it - meaning - computationally tractable. Ontologies do not facilitate semantic inference in the same way that we can make contextual inferences in conversation. If 'range' is not declared thrice into the model along with the specific conditions under which 'range' is a stove and not an area or spread of values (Schuurman 2006), then the system has no means for distinguishing between these three instances. The ability of the computer to extract meaning for each 'range' object is premised on the availability of a machine-readable separation between objects provided by *formal semantics*.

Formal semantics - defined by translation to the axioms of formal logics - is a semantics that precisely describes the meaning of knowledge; precision here refers to a 'universe of discourse' where the dimensionality of each concept is strictly defined, precluding conjecture about what individual knowledge objects represent (Antonious and van Harmelen 2004, 69; Baader, Horrocks, and Sattler 2004). Formal semantics - think of programming languages - are responsible for making ontological declarations in the datalogical realm. For example we use the existential quantifier (∃) to state that 'something exists' (Agarwal 2005). In this way "an ontology in a formal environment is equivalent to a logical theory" (Schuurman 2006, 733). The taxonomic structure of formal ontologies is salient as an explicit formalization of semantic relationships that implies context at the database level via object inheritance (O. Ahlqvist 2004; Schuurman 2006). Meaning is extracted from the database by computing the hierarchy.

2.9 We know the world is not so, we just represent it as such

The hierarchical representation of knowledge afforded by formal ontology renders the 'world as tree'.[5] This maps to a conception of the world as fixed, stable, identifiable; one where all things can be "determined without ambiguity" (Callon and Law 2004, 3) - in short, the world of rationalist science so vehemently disputed by poststructuralist philosophy. Hierarchy necessarily involves classification, and implicates its many identifiable polemics. That we represent the 'world as tree' does not, however, preclude an understanding of the world as ontologically complex (Bavington 2002). Schuurman (2005) reminds us that all classification systems are, by virtue of being classification systems, incomplete and thereby inadequate accounts of the world. In this vein, science itself can be characterized as a series of metaphors for simplifying the world (Vattimo

[5] Callon and Law (2004) characterize the 'romantic' understanding of complexity characteristic of rationalist science as "[t]he world is a hierarchical tree" (3).

1997). The 'world as tree' is only one such metaphor. As a representational construct it does not distill conceptual representation to Aristotelian categories because indeed we know the world to be otherwise. We just represent it as such because we are ultimately bound by classification in the digital universe. At the most discrete level the necessity of classification is implied by the need to reduce everything to a 1 or a 0: we compartmentalize everything into a mutually exclusive binary pair.

The discursive freedom of critical theory permits it to treat epistemology alone, but in the datalogical word, the immediacy of parametrized conceptual representation necessitates that we concern ourselves with ontology. The overtly ontological basis of GIS underscores the inappropriateness of poststructuralist deconstructions of the technology by way of its erasure of the ontology-epistemology distinction. GIScientists continue to treat these as separate questions, as indeed geographers had traditionally done (Agarwal 2005). The radicalization of metaphysics by poststructuralism has thus been to the detriment of a robust Critical GIS of the sort promoted by O'Sullivan because it pre-empts a legitimate starting point from which such engagements could begin (2006).

While modeling the 'world as tree' may contravene poststructuralist metaphysics, formalization mandates it. Representing the 'world as tree' is thus justified by the technical constraints to knowledge representation that limit our representational abilities to taxonomy. Nothing beyond the encoded objects exists. In the datalogical realm, *there is no world outside of categories*. This has ramifications for discussions of ontology and epistemology in a formal computational universe. Any legitimate engagement of GIS must take place inside the box: discourse is ultimately confined to the entities declared into ontology. We are discursively bound to the formal 'universe of discourse', denied the linguistic freedom to make reference to ideas, concepts or associations outside of the physical boundary of the computer because these have not been "[made] real in database terms" (Schuurman 2006, 731). Because digital environments are data-driven, there is no accounting for associations beyond the data itself (Schuurman 2005). Context is restricted to the recursively defined relationships between concepts of taxonomy. Any changes to context must be made procedurally as changes to concepts, their names, or properties in the knowledge representation itself.

Whereas language evades totalization, code enacts it. Code is therefore the 'discursive regime' of GIS (Dodge and Kitchin 2004; Schuurman 2006), simultaneously both the language in which philosophical concerns must be expressed and it itself the formal universe of discourse. A different discussion of ontology and epistemology in the context of GIS versus geography more broadly is not only possible but *necessary.* Any such discourse must first and foremost reconcile with the realist ratification of an external world at 'tier 0' of ontological commitments in the software realm of GIS (Frank 2000, 2001). Though they objectify knowledge, these commitments are warranted because their encoded reifications - formal ontologies - internalize the irreversibility of digital representation, an irreversibility precluded by the EF. The reality that formalization is always simultaneously classification mandates that any entity declared into formal ontology be amenable to Aristotelian reduction. At the same time, however, formal ontology serves as a mechanism for representing those "epistemologies that are structured adequately" (Schuurman 2006, 734).

Formal ontologies may be syllogistic, but as a system of representation they supersede the reductionism of raw bits and bytes. Formal ontologies provide a mechanism for working with *concepts* – rather than their numerical abstractions – in a digital environment. The ability to compute directly with concepts is a milestone development in computing science, affording great representational flexibility and nuance. Because formal semantics are ontologically neutral, competing representations – though they be underwritten by multiple and often times antithetical philosophical premises – are possible.

Thinking of information systems as ways of managing the world, then, implies that they are necessarily built on some foundational ontology, even if these ontological commitments are not explicitly disclosed (Frank 2000). Ontologies as formal knowledge representations are always understood as specific to a community of practice. The ability of different domains to render and therefore implement competing representations of the same phenomena is consonant with the poststructuralist insistence that knowledges are always partial. In the datalogical world, these knowledges become reified as formal ontologies. Formal ontologies engender 'situated knowledges'[6] at the level of the machine.

As ensconced in GIS, informatics ontology is not a grand narrative of knowledge which seeks to replace all other grand narratives, but instead a means of associating philosophical ontology and ontologies as they are understood in artificial intelligence without restructuring either the contents of spatial data or the data models underlying geographic technologies. This does not bridge the gap between the infological and datalogical worlds, however; indeed this divide is not only wide but remains incommensurable as it is separated by two discordant sets of philosophical commitments.

[6] After Haraway (1991).

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CHAPTER 3
POSTSTRUCTURALISM AND GIS: IS THERE A 'DISCONNECT'?

The following chapter has been resubmitted in revised form to *Society and Space* under the sole authorship of Agnieszka Leszczynski.

3.1 Abstract

Human geography critiques of GIS are operationalized under a unique interpretation of ontology and epistemology. Internal to poststructuralism, this metaphysics collapses the traditional separation between ontology and epistemology, reducing ontological questions to epistemological constructs. Although critiques have moved beyond an initial fixation upon positivism, critical/cultural assessments of GIS tendered within the last ten years continue to motivate epistemology as a basis for its deconstruction. The epistemological reductionism of such a reading of the technology inappropriately abstracts GIS from its ontic basis in computing, giving rise to a fundamental 'disconnect' of poststructuralist metaphysics to the technology. This disconnect is identified in terms of (1) the epistemic fallacy, which, underwritten by (2) an 'undoing' of the metaphysics of presence, culminates in (3) an effective 'de-ontologization' of an immediately ontic entity.

3.2 Introduction

The discursive separation between GIScience and critical human geography is a longstanding division within contemporary geography (Harvey and Chrisman, 1998;

Kwan, 2004; Perkins, 2003; Pickles, 1997; Schuurman, 2000, 2002a; Sheppard, 2000; St. Martin and Wing, 2007; Wright, Goodchild, and Proctor, 1997). Schuurman (2000) locates the source of this rift in the inability of the critical establishment to leverage its critiques in a language relevant to geographic information systems (GIS). The esoteric nature of critiques of GIS advanced by human geographers[7] is far removed from an ontic understanding of technology as a set of empirical devices which streamline human practices (Coyne, 1995; Feenberg, 2000; Harvey, 2003; Lawson, 2007). Rather many of these critiques are expressed in a language that uses a discursive logic frequently associated with poststructuralism.

The crux of objections to the presence of GIS in the discipline concern the knowledge acquisition and production objectives of GIS, problematized by its critics as foundational claims to truth-finding and fact creation. Initially these concerns were largely voiced in terms of a condemnation of the purported positivistic[8] tenets and practices of the technology (Abler, 1993; Aitkin and Michel, 1995; Dixon and Jones, 1998; Lake, 1993; Pickles, 1993, 1997; Taylor, 1990, 1991; Taylor and Johnson, 1995). Such assessments arose from the reification of GIS as crudely positivistic and naively empiricist by virtue of its purported emergence out of the quantitative revolution in geography, and the subsequent canonization of the linkage between numerical methods and logical positivism under a rationalist brand of science (Sheppard, 2000).

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[7] See Schuurman 2000

[8] References to 'positivism' in this manuscript are to *logical positivism*, the Vienna Circle refinement of positivism as an empirical philosophy more generally. The (logically) positivistic theory of knowledge referred to in the subsequent sentence is thereby one wherein knowledge consists of 'facts' which meet the conditions of verification (via empirical observation) and validity (demonstrably true via logical or mathematical deduction); all else (theoretical statements or cultural accounts, for example) are rendered inferior by way of their classification as 'non-knowledge' or 'metaphysics' (Ayer, 1959).

Initial fixation upon positivism reveals early critiques to constitute an epistemological challenge to the technology (Schuurman, 2000). The use of epistemology as a category for reading the technology in this manner has served to imbricate GIS and by extension GIScience into the broader contention over metaphysics[9] – specifically, philosophical disputes over the interpretation of ontology and epistemology – within the discipline (Agnew, 2006; Dixon and Jones, 2004; Elwood, 2006a; Harvey, 2003; Kwan, 2002b, 2004; Popke, 2003; Sheppard, 2005). The bulk of this debate has occurred within the realm of critical/cultural geography, and has largely been articulated along the enduring quantitative/qualitative disciplinary binary (Dear, 1988; Elwood, 2006a; Hansen, 1994; Popke, 2003; Samers, 2001; Sayer, 1993; Sheppard, 2000, 2005; St. Martin and Wing, 2007; Yeung, 1997). That this discussion is presently dominated by poststructuralism in geography (Agnew, 2006; Dixon and Jones, 2004; Elwood, 2006a; Popke, 2003) is significant because it carries implications for how GIS is understood by human geographers. The interpretation of GIS underwritten by a metaphysics internal to poststructuralism[10] differs significantly from that advanced by practitioners and theorists of the technology.

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[9] Here 'metaphysics' is used to describe that branch of philosophy concerned with offering a comprehensive account of the world in terms of both the possibilities (epistemology) and contents (ontology) of knowledge (Wilshire, 1969). Wilshire's (1969) definition has been chosen because it clearly distinguishes between metaphysics defined as traditional ontology synonymous with immediate knowledge of the world (see philosophers such as Lowe, 1998) and metaphysics as an interrogation of this knowledge, or 'what we know *about* knowledge-about-the-world,' answerable in terms of the two central questions of philosophy. I thus employ 'metaphysics' in the latter sense as shorthand for ontology and epistemology throughout this manuscript. 'Metaphysics' is furthermore to be differentiated from the 'metaphysics of presence', which is discussed in subsequent sections of this manuscript.

[10] 'Internal metaphysics' refers to an understanding of ontological commitments as particular, or internal, to the theories or ideological systems under which they are advanced. Commensurate with an 'internal' metaphysics, ontology assumes the status of the study of the content of theories, representations, philosophies, etc. This is differentiated from 'external metaphysics' which pursues ontology as the study of truth in – or about – an extra-discursive reality (B Smith, 2003).

Critical assessments of GIS have long sought to 'deconstruct' the technology (e.g. Curry, 1995, 1998; Dixon and Jones, 1998; Gregory, 1994; , 1990; Pickles, 2004, 1995; Taylor, 1990). Emphases on deconstruction in 1990s critical texts coincided with the 'poststructuralist intervention'[11] in the discipline at the start of the decade and the 'deconstructivist' agenda set for critical geography at this time (Dixon and Jones, 2004; Doel, 1999; Elwood, 2006a; Perkins, 2003; Popke, 2003). Certainly close examination of the technology by both critics and GIScience theorists has legitimately exposed many implications of GIS and its deleterious effects for society, including, but by no means restricted to: issues of surveillance and the erosion of privacy (Curry, 1998; Pickles, 1991, 1995); military deployment of the technology for warfare (Katz, 2001; Monmonier, 1996; N Smith, 1992); use of the technology to facilitate and accelerate environmental devastation (Katz, 2001), its subservience to the interests of capital and its complicity in the production of the spaces of economic growth (Goss, 1995a, 1995b; Katz, 2001; N Smith, 2005; St. Martin and Wing, 2007); masculinist premises of its algorithms (Kwan, 2002a, 2002b; McLafferty, 2005; Schuurman, 2002b; Schuurman and Pratt, 2002); as well as unequal access to both the technology and its information primitives (also known as the digital divide) (Craig, Harris, and Weiner, 2002; Elwood, 2002, 2006b; Ghose, 2001; Harris et al, 1995; Hoeschele, 2000; Pickles, 1995; Sieber, 2007).

Epistemological critiques have furthermore forced researchers of the technology to make explicit the epistemological priors that underwrite its practices and the ontological commitments that sanction ensuing representation. Charges of positivism have, however, been vehemently disputed by GIS theorists (Kwan, 2002a, 2004;

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[11] After Popke (2003).

Pavlovskaya, 2006; Schuurman, 2000, 2002a; Sheppard, 2000, 2005). To date however there has no consistent examination of the *logic* which supports – and seemingly produces – a dominant reading of GIS by critical/cultural geographers that is inherently at odds with how the technology is philosophically positioned by its own theorists. This paper explains this disjuncture by proposing that there is a fundamental 'disconnect' between the conditions of ontology and epistemology (or metaphysics) under which critics have operationalized their critiques, and the ontic dimensions of GIS as a digital object. This 'disconnect' is identified as a series of three moments which triangulate the critical geographic (mis)reading of the technology: (1) entrapment in the epistemic fallacy, which, underwritten by (2) an 'undoing' of the metaphysics of presence, (3) effectively 'de-ontologizes' an immediately ontic entity. The 'epistemic fallacy' (Bhaskar, 1986) captures the errors of reducing questions about the nature or makeup of the contents of the world to mere constructs of knowledge. An 'undoing' of the metaphysics of presence refers to a paradoxical logic which makes ontological claim as to the impossibility or absence of ontology; when operationalized as the basis of critique, it gives rise to the epistemological reductionism which is the subject of the 'epistemic fallacy.' Collectively, (1) and (2) culminate in the misguided and inappropriate imposition of an ontological ambiguity upon GIS.

These 'disconnects' emerge from the critically realist critique of postmodern challenges to science, most famously advanced by Roy Bhaskar (1978, 1986), and popularized in geography by Sayer (1985, 1992). A critical realist analysis of critiques of GIS is appropriate as it is commensurate with the positioning of GIS as realist technology by GIScience theorists and researchers (Hallisey, 2005; Mark, 2005; Perkins, 2003;

Raper, 2005; Schuurman, 2002a). Critical realist philosophy posits distinct ontological and epistemological theses: it asserts a world beyond discourse, and maintains that we can indeed know something about this extra-discursive reality (Bhaskar, 1986; Niiniluoto, 1999).

Epistemological interpretations of GIS advanced by its human geography critics are, however, operationalized under a radicalized metaphysics particular to poststructuralism where this separation between questions of ontology and epistemology is subverted. Poststructuralism's emergence in geography signalled a profound break with the traditionally maintained distinction between questions of knowledge and the nature of its contents (Agarwal, 2005; Dixon and Jones, 2004; Elwood, 2006a; Popke, 2003). Poststructuralist philosophy collapses the ontology/epistemology boundary and promotes epistemology as the privileged basis of inquiry (Dixon and Jones, 2004; Hay, 2007; Jones, 2003; Popke, 2003). In this paper I am less concerned with poststructuralism as an ideology or social theory; instead, I use 'poststructuralism' to refer to a unique brand of metaphysics which has become established as the 'orthodox' interpretation of ontology and epistemology – and the nature of their relationship – in critical geography.

Effectively, the erasure of the ontology/epistemology distinction denies a world beyond consciousness. The unfortunate consequence of this when applied as a basis for deconstructing GIS is that it has mired critiques of the technology in the epistemic fallacy by incorrectly abstracting GIS from its immediately ontological foundation in computing. By negating the need to address the technology as a material entity, the subsumption of ontological concerns by epistemology serves to dismiss the ontological consequences of GIS as a discreet, empirical technological *device* - in other words, it ignores the ontic dimensions of the technology. The ontic concerns the instantiation of GIS as a set of material and digital objects – the hardware controls, graphic user interfaces, black-boxed algorithms, data structures and data models, and data – that support and are reproduced by a myriad of socially contingent institutions, conventions and praxis. Promoting an ontic reading of GIS does not constitute an instrumentalist thesis or essentialize the technology by narrowly identifying it as a set of (supposedly) neutral tools, nor is it a narrative that runs contrary to an understanding of GIS as a unique discourse or set of practices (Chrisman, 1999; Schuurman, 2000; Sheppard, 2005; St. Martin and Wing, 2007). It instead emphasizes the material forms that these practices take.

Attempts to 'de-ontologize' GIS by way of epistemic reductionism ironically impose an (extra)ontology that is incommensurable with the object of critique. The conflation of epistemology and ontology under poststructuralism renders its metaphysics an inappropriate platform from which to lodge a critique of GIS or, by extension, GIScience. I flesh out the 'disconnects' of what I here refer to as a 'poststructuralist' metaphysics to GIS by exploring how the wider poststructuralist scripting of the domain has encouraged the deployment of a particular logic which simply does not 'fit' the object of critique. The polemics of ontological agnosticism are by no means exclusive to GIS, but are rather part of a broader 'poststructuralization' of the discipline that does violence to other theoretical movements in geography. GIS, however, deserves unique attention because, as will be demonstrated in this manuscript, its instantiation as a substantive object reveals it to be expressly ontological. This renders the errors of the aforementioned conflation more immediate than in, say, the context of literary texts where the level of discrete entities discernable via sensory observation is far less salient.

The emphasis of this work is not to defend against accusations of positivism lodged in the 1990s; this has been accomplished successfully elsewhere (Kwan, 2002a, 2004; Pavlovskaya, 2006; Schuurman, 2000, 2002a; Sheppard, 2000, 2005). Although the content and pitch of the debate over the touted philosophical deficiencies of GIS as it occurred in the 1990s has been well chronicled, an assessment of what – if anything – has changed since the turn of the millennium remains outstanding. As a result I focus on critiques tendered within the last 10 years. Challenges to the technology have demonstrably moved beyond a fixation on the positivistic tendencies of the technology. Despite the change in emphasis of criticism, however, critical assessments advanced by critical/cultural geographers not directly invested in GIS[12] continue to be articulated in exclusively epistemological terms, operationalized under the very same conditions of metaphysics which gave rise to misguided decrees of positivism. Given that the two questions of ontology and epistemology are the identified bone of contention, I begin with their interpretation under poststructuralism and then proceed to describe how they culminate in fundamental 'disconnects' to GIS.

3.3 Poststructuralism, metaphysics, and geography

Poststructuralism flourished in geography during the late 1980s and early 1990s in response to the ontological and epistemological certainties anchoring the bases of knowledge as "fixed, indubitable, and final" (Barnes, 2000, page 278; Dixon and Jones, 2004). Dixon and Jones (2004) explain poststructuralism as successfully taking hold in

[12] For a more detailed exploration of the separation between critiques voiced by theoreticians not immediately familiar with the methods and practices of GIS, versus those articulated by researchers with a firm command of the technology who have developed and contributed to Critical GIS as a subdiscipline concerned with applying the technology in critical – and reflexive - ways, refer to Perkins (2003).

geography because it resonated with human geographers' repudiation of the naïve empirical objectivism espoused by the major theoretical schema - spatial science, critical realism, and humanism - triangulating the discipline at the time (Dixon and Jones, 2004; Jones, 2003). Empiricism is objectionable not only because it positions sensory observation as the ultimate locus of knowledge and thereby grants ontological status exclusively to empirical phenomena, but also because the categories it provides for conceptually organizing the world accommodate the discretization and classification of concrete entities in physical space, thereby perpheralizing cultural accounts of abstract, non-physical objects as anecdotal at best (Jones, 2003). In more nuanced terms, it is not necessarily empiricism *per se* which is inherently problematic, but rather the deployment of a binary epistemology which exclusively endorses empirically discerned phenomena in a system of signification which equates empiricism with objectivity (Natter, Schatzki, and Jones, 1995).

Certainly not all of poststructuralism is anti-empirical. Deleuze and Guattari (1990), for example, identify themselves as 'transcendental empiricists'. Deleuze's ontological stance clarifies the role of sensation in the production of concepts, which are seen to assume meaning or substance in the form of intellectual categories that follow from experience in a kind of pre-philosophical stage untainted by epistemology (Bryant, 2000; Deleuze, 1995). It is empirical in that it does not shun assertions of reality (as an ontology of difference), and indeed experience is seen as generative of real (sensations of) time, space, etc. (Baugh, 1992; Deleuze, 2004). Nevertheless, poststructuralist philosophy is largely sceptical of empirically sanctioned entities (Pratt, 2000). Bryant (2000) describes Deleuze's epistemology as denouncing *a priori* categories for making sense of experience, necessarily eliminating empiricism defined as reliance on sensory observation as a basis for organizing knowledge. In the Derridean tradition, the indirect critique of empiricism concerns the identification of phenomena, which fundamentally involves - or represents - the very process of 'centering'. To make claims as to presence, essence, or existence is to ontologically declare entities inviolable, veritable, fixed and stable; or, to 'centre' them, an *a priori* ontological impossibility. Derrida's (1970) critique of structuralism builds on semiotics to provide an understanding of signifiers (sounds, images, etc.) as only signifying a concept in terms of difference. As presence is thus always indicative of absence, any concept, idea, entity or phenomenon necessarily bears with it a trace of its 'other', precluding the definition of exclusive (i.e. 'centered') categories.

Enshrined in discursive practices and artefacts of representation, in geography 'centering' became most closely affiliated with the empirical ontological commitments heretofore characterizing disciplinary practices (Popke, 2003). As such poststructuralist geography represents a direct challenge to the ideological privilege accorded to ontological entities on the basis that any statements about the structure and makeup of the world (ontology) immediately betray the logic or counterpart conceptual framework (epistemology) through which the contents of that world are endowed with legitimacy and acknowledged as valid or 'real' (Dixon and Jones, 2004; Gregory, 2000a). To this end poststructuralism destabilizes universal 'reality' claims by revealing them to be hegemonic outcomes of discursive practices that socially endorse the specific forms of inquiry that are considered legitimate. Identifying the epistemological priors which 'police' the boundaries of knowledge accordingly constitutes the basis of poststructuralist critique (Dixon and Jones, 2004; Gregory, 2000a; Jones, 2003; Pratt, 2000).

Dixon and Jones (1998) identify three epistemologies as historically dominating critical and cultural theory in geography: 1) Cartesian perspectivalism; 2) occularcentrism; and 3) the 'epistemology of the grid', the apex of a segmenting logic that renders the world amenable to discretization, measurement, and 'lineation', all of which are premised on a presupposed planar stability which serves to stabilize object and concept hierarchies and permit causal understandings of the world (page 251). Dixon and Jones (1998) understand these epistemologies as mapping to specific ontological traditions because the former are seen to admit particular objects into 'being', a characteristically poststructuralist account which sees any ontology to be "grounded in an epistemology about how we *know* 'what the world is like'" (Dixon and Jones, 1998, page 250). Indeed for Derrida (1970), knowledge constructs are but the products of classification schemes - into which we become socialized - deployed as 'Science'. Foucault's (1972) proposition that discourse constitutes a form of epistemological singularity which, once consistently expressed, becomes self-legitimating in positioning itself as the locus of information similarly suggests that knowledge claims are but statements of the conditions under which they are made possible or considered valid.

Gregory (2000b) describes discussions of ontology as inescapably betraying epistemology: in cognitive terms, ontology as that which we believe to be true cannot be separated from our perception of the world because we only know the world to be as we apprehend it (Agarwal, 2005). Statements about what constitutes reality are premised on assumptions about what questions are considered valid or rational; these in turn serve to structure reality because they predetermine the phenomena to be found given a specific line of inquiry. Casting ontology to be "'always already'" epistemology in this way reveals the contents of ontology to be no more than epistemological artefacts (Dixon and Jones, 2004, p. 80).

Under poststructuralism, epistemology assumes the status of a "[t]heory about how to interrogate the ontologically given world" (Rose, 2004, page 462). Ontology can thus be interrogated solely by way of epistemology, because it is the latter - the available frameworks for making sense of our collective realities - which designates and legitimizes the presence of particular entities in 'the world'. This is a linear understanding which casts ontology to be necessarily determined by epistemology; in poststructuralist terms, it is through epistemology that we lay claim to ontology. Therefore while poststructuralism represents an inherently *ontological* challenge in its subversion of geographic narratives which position knowledge as ultimately foundational and proclaim to guarantee access to those foundations through their own theories, models and methods, it is one leveraged in unequivocally epistemological terms.

Jones (2003) consequently characterizes poststructuralist geography as constituting an epistemological critique. This is not a critique which outright eschews ontological concerns, but rather one which employs epistemology as an entry point for debasing unsubstantiated presuppositions about the world – more succinctly, the assumed immutability of ontological categories. Privileging epistemology over ontology in this manner translates ontological commitments into epistemological constructs, erasing the ontology/epistemology distinction. Negating the need to theoretically engage the contents of 'the world' in their own right, however, is tantamount to epistemological reductionism:

it suggests that ontological questions can be sufficiently answered in epistemological terms alone.

The pre-eminence of this "culture of epistemology"[13] in critical branches of the discipline has led Pratt (2000) to describe poststructuralist geography as essentially "anti-ontological" (page 626). This sentiment is evident in the profound ontological agnosticism resounding in critical branches of the discipline. In perhaps the seminal volume on the subject, Doel (1999) identifies poststructuralism as the antithesis of 'spatial science,' for him a term synonymous with positivistic, empiricist geography. According to Doel, the intentional undoing of this spatial 'orthodoxy' can only be achieved through ontological nihilism. Not only does poststructuralist geography not involve or affect any ontological commitment whatsoever, the point of the "whole exercise is to affirm the becoming-otherwise of spatial science" (page 113). Doel's description of poststructuralist geography as an "affirmation of everything that defies integration and swerves away from stabilization" is commensurate with a pursuit of moments outside of ontology (p. 199). There can be no ontology, only process or 'becoming'. This 'becoming' is not teleological; rather, any entity, emotion or moment defies definition because it is in a constant state of movement, lacking any form or foundational substance.

Other poststructuralist efforts are more explicit in their attempts to 'de-ontologize' the discipline. Recently Marston et al (2005) called for a 'human geography without scale' premised on a "flat" ontology of self-generating systems supporting emergent as

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[13]After Strohmayer (2003)

opposed to *a priori* defined entities (page 422). Their interpretation of scale as an epistemological construct which stratifies the locations of knowledge - a "'looking up... spatial ontology'" (page 417) - leads the authors to suggest that scale be replaced with a series of socially contingent, simultaneously global-local, fluid-fixed malleable scalars supporting a 'flat' theory of knowledge where no one point of entry provides access to superior explanation or understanding. Their treatise is exemplary of the deployment of epistemological arguments to indirectly debase ontological polemics; indeed their tendered solution is to render scale non-ontological by simply expelling it from the geographical lexicon, a move which would strip it of its epistemological force. If scale can no longer be used to structure geographic knowledge, there can be no more products of scale-as-epistemology.

Ontological agnosticism is a definitively poststructuralist moment (Jones, 2003; Pratt, 2000; Strohmayer, 2003). Nevertheless it is important to stress that it is not characteristic of all veins of poststructuralist philosophy. Indeed Bonta (2005) identifies Deleuze and Guattari (1990) as providing a solid ontological basis for poststructuralist theory. He himself seeks to reassert ontology for poststructuralist geography by, for example, using a Deleuzian approach to explain how resistance amongst disparate groups to state/corporate driven deforestation in Honduras culminates in forest conservation (Bonta, 2005). For him, these resistance movements and their effects are 'rhizomatic'; in taking place, they actualize space. Thrift's (1996) non-representational theory, which Richard Smith (2003) considers poststructuralist, represents a more direct challenge to the anti-ontologicism of contemporary critical geography. Concerned with the practices which produce social relations, non-representational theory suggests that there are moments which elude representation; otherwise stated, there are instances of space/time which have ontological substance beyond or outside of their signification by way of representational epistemologies. The fleetingness of emotion, for example, cannot be codified, and thus disrupts mapping to an epistemologically reduced ontology.

The tendency towards extra-ontological conformity is simultaneously strongly contested by other theoretical movements in the discipline. Callard (2003) argues that the poststructuralist dominance of critical/cultural human geography - expressed as a blind faith in its tenets and celebrity theorists - is discernible in the Foucauldian correction of competing, often incompatible, philosophical narratives so as to align them with its own politics and philosophical commitments (see also Kingsbury, 2003). She maintains that the endowment of the psychoanalytic subject with political agency ontologically violates the Freudian-ascribed inertia of the human psyche. Saldanha (2006) contends that this poststructuralist abdication of ontological concerns compromises its own efficacy as a political project. He identifies the casting of 'race' as an epistemological artefact by poststructuralist-inspired theories of race, ethnicity, and (post)colonialism in geography to have had the adverse effect of confounding efforts at combating race-based prejudice. Race has no basis in biology. If however empirical visual markers are the basis of racial discrimination despite their lack of foundation in any biological science, then denying them by proclaiming them to be merely discursive constructs engenders a situation wherein racial prejudice is prevalent but its perpetration denied under the rubric of political correctness. Blindness to the immediately ontological substance of 'race' allows the perpetuation of racial subordination to be discursively circumvented.

3.4 Poststructuralist metaphysics in a digital universe

While it does not present an ethical dilemma similar to the treatment of 'race' as a purely linguistic problem, a parallel epistemically reductionist logic has been operationalized as the basis for deconstructing GIS. Critiques of GIS lodged since the 1990s are an outgrowth of the longstanding human geography critique of spatial science and its methodical pursuit of regularity (Kwan, 2004; Schuurman, 2000; Sheppard, 2000). While this is simultaneously a critique of empirical methods and theoretical schema in geography at large, it was spatial science which became the select object of "'post'-prefixed"[14] ideological attention in the discipline (Sheppard, 2000). This has been explained in terms of spatial science's affiliation with numerical methods, and the consequent equation of spatial analysis with logical positivism in the critical/cultural geographic conception (Kwan, 2004; Pavlovskaya, 2006; Sheppard, 2000). GIS became subject to the same criticism on the basis of its historical association with spatial science. Dixon and Jones (1998), for example, reify GIS to be a default extension of spatial science in that it "involves the same questions that one finds within data analysis, simulation, and optimization" (page 248).

The unequivocal rejection of positivism as a mode of inquiry which presumes the value-freedom of rationalist science and the existence of fixed social laws figures first and foremost amongst the central tenets of critical geography, poststructuralist or

[14] Trevor Barnes' (T J Barnes, 1996) catchphrase for what are colloquially referred to as the "pomos" – namely postmodernism and poststructuralism, but also more recent theoretical platforms, including branches of feminist theory, postcolonialism, etc.

otherwise (Blomley, 2006). The association of 'spatial science' with positivistic epistemology certainly precedes the rise of poststructuralism in geography. At the time of its inception, proponents of GIS readily touted the positivistic bases of the technology as a means of capitalizing on the social prestige ascribed to (any) rigorous science (Sheppard, 2000); more recent evidence of such an alignment can be seen in the re-branding of geographic information systems as a *science* (GIScience) encompassing applied branches of the discipline (Wright, Goodchild, and Proctor, 1997). The self-proclamation of GIS as positivistic by GIScientists is, however, distinct from indictment of the technology as positivistic by its critics. The latter stems from conflation of 'science' with positivism which occurs by way of inducing the positivistic basis of *all* science from the historical contingency of science with a positivistic theory of knowledge. The association between GIS and spatial science persist because, as per Gold (2006), "the distinction between GI Systems (the technology) and GI Science is a fuzzy one" (page 505). It remains difficult to separate out GIS as one particular collection of software and hardware encapsulated under the acronym 'GIS' from the scientific orientation of GIS as a praxis and form of representation – because in the beginning, "[t]he System *was* the Science" (Gold, 2006, page 505, emphasis added; Raper, 2005; Wright, Goodchild, and Proctor, 1997). The logical error, however, occurs when the leap is made from the invariable binding up of the systems in the science to an understanding of the systems - because they are predicated on the science - as positivistic.

Kwan (2004) explains the positivistic branding of GIS as a retrofitting of epistemological narratives by 'reformed' spatial scientists seeking to justify the practices and methodologies of their ideological conversions. Although the association of quantitative methods and positivism is an enduring fixture of the critical geographic imaginary (Poon, 2005; Sheppard, 2000), the mapping of a singular epistemology (positivism) onto a specific ontology (empiricism) by way of this "ex-post epistemological rationalization" served to cement the empirical-positivist object in geographic theory (Kwan, 2004, page 757). The subsequent subsumption of ontology into epistemology under a poststructuralist metaphysics created the logical grounds for reasoning that the empirical basis of the technology revealed it to be necessarily positivistic (for examples see Ahlqvist, 2000; Dixon and Jones, 1998; Gregory, 1994; N Smith, 1992; Taylor, 1990, 1991). Critical narratives of this sort, which align GIS to numerical methods, indict the technology as the superlative apex of the aforementioned 'grid epistemology' and thereby the most egregious materialization of positivism in geography. This is a unidirectional argument, summarized by Sheppard (2000) in the following terms: "Cartesianism [as extreme logical empiricism] is not peculiar to logical positivism, but logical positivism – like much natural science – adopts a Cartesian worldview" (page 542*n*8).

GIS was thus deemed positivist by virtue of its demonstrated empiricism. Critics did not rally against GIS because it was positivistic in and of itself, but rather because its positivistic epistemology (betrayed by the mapping – or representation – of visually discerned objects in space) is seen to disclose a naturalistic appreciation of 'the social' amongst GIScientists that parallels their conception of 'the spatial' and the amenability of physical phenomena to law derivation and prediction (see also Sheppard, 2000 for a similar argument). For Dixon and Jones (1998), GIS (as an extension of spatial analysis) is not reprehensible because it is epistemologically positivistic, but rather that as a positivistic technology, it is generative of a "stable, stratified, and hierarchical social ontology" (page 250) – a Cartesian world where persons behave no differently from their counterpart discrete, regular occurring physical objects in planar space.

The subject of critique is therefore *not* the (positivistic) theory of knowledge endorsed and reproduced by GIS, but rather the (social) ontological commitments which such an epistemology is seen to support. In other words, while epistemology is certainly the territory, disputes over epistemology are *really* – in human geography – about the nature of the social world (ontology) (Hansen, 1994). For critics of GIS, the issue at hand is, as identified above, empiricism.

GIScientists certify empiricism as a sound basis for geographic visualization in the sense that such an ontological commitment is both rational and *reasonable* in context: for physical phenomena to be mapped with a GIS, their existence outside the 'text' must first be acknowledged for encoding to proceed (Frank, 2000; Schuurman, 2002a). Schuurman (2002a) and Raper (2005) clarify GIS to be a critically realist positioned technology. Although GIScientists and practitioners see mapping and analysis practices initiated in the GIS environment as validly associated with the real-world objects represented in its outputs, they nevertheless understand those representations as abstractions, 'snapshots' of a slice of the world in a particular instance of space-time. Whereas materialist conceptions of the world under positivism presume the fixity of representation, GIScientists recognize their space-time contingency, as is commensurate with a critical realist theory of knowledge. A commitment to realism understands representations initiated in a GIS environment as communicating at least some portion of 'reality'(Hallisey, 2005; Mark, 2005; Raper, 2005; Schuurman, 2002a, 2006; Sismondo and Chrisman, 2001; Sullivan, 1998); this does not, however, suggest that the technology exclusively sanctions 'sense-data'. Instead a realist ontology involves an acknowledgement of a world "outside all interpretation and all the conception we have of it" (Kraft, 1992, page 960). This reality beyond 'text'[15] need not be empiricism. Indeed Sheppard (2005) attests that "GIS need have no special relationship to logical empiricism" (page 11). Critical realist philosophy recognizes causal mechanisms that simultaneously affect change and mediate our intellectual engagement with the world independent of our appropriation of the world by discourse, yet maintains that any knowledge we have of this world is necessarily theory-laden (Groff, 2004). Neither of these tenets, however, makes claim to the empirical nature of ontology.

Moreover any endorsement of the empirical nature of objects populating GIS models does not *de facto* prove GIS to be demonstrably positivist. Kwan (2002a) considers attempts to essentialize the technology by reducing it to an epistemological singularity to amount to technological determinism. For her, the reductionism of such arguments is exposed – and countered – by uses of GIS that both capture and further our understanding of "difference and subjectivities" (page 647). She herself uses GIS to perform 'feminist visualizations' that oppose the traditional masculinist utilization of the technology. While feminist GIS theorists problematize the disembodiment of the conventional deployment of GIS from a god's-eye-view, they simultaneously recognize the possibility for feminist visualization both within and beyond the confines of

[15] Here I use 'text' in the Derridean, rather than the literal, sense. Accordingly 'text' refers to not only writing and literary works, but indeed "all possible referents": the economy, social institutions, culture, etc. (Kraft, 1992, page 960). The implication of Derrida's infamous axiom 'nothing exists outside the text' (Derrida, 1976) is that while it is possible to acknowledge all possible structures ('text') and indeed to "make *reference* to" them this can only be accomplished within the confines of discourse – in other words, within the text itself (Kraft, 1992, page 960).

masculinist technoscience (Kwan, 2002a, 2002b; McLafferty, 2005; Pavlovskaya, 2006; Schuurman, 2002b; Schuurman and Pratt, 2002).

While emphases on positivism have consequently waned (Ahlqvist, 2000 notwithstanding), critiques of GIS nevertheless follow a familiar form: opposition to (empirical) ontological commitments is raised on the basis that the effects and objects of mapping and encoding practices ensconced within the technology are enabled by a contemptible epistemology systematically implicated in the networks of control that rationalize daily life, such as the economy (Pickles, 2004, 2005; N Smith, 2005), the ubiquitous surveillance grid (Curry, 1998), and the politics of representation (Pickles, 2004). The logic which underwrites these more recent assessments is furthermore enabled by the same displacement of ontology by epistemology which led critics to pronounce the inescapable positivism of GIS.

John Pickles' 2004 volume is no exception, and I choose to focus on it in this paper because his contribution constitutes perhaps the most significant contemporary human geography critique of geospatial information technologies (GITs). Despite presenting an original interpretation of the epistemological tenets of these digital devices, his argument remains exemplary of the ontology/epistemology conflation. I do not wish to essentialize Pickles' critique as an unreconstructed poststructuralism - he seminally identifies himself as a phenomenologist (see Pickles, 1985) – but rather demonstrate that the conditions of metaphysics under which he advances his challenge to GITs are aligned with the interpretation of ontology and epistemology unique to poststructuralism.

A *History of Spaces* is in many ways an extension of Brian Harley's (1988, 1989, 1990, 2001) substantial body of work on the politics of cartography. At the centre of

Pickles' critique are the "representational epistemologies" of digital computing infrastructures which exonerate the objectivity, accuracy, and neutrality of cartographic output (page 10) – what Rorty (1979) infamously termed the 'mirror of nature.' These epistemologies, articulated in the deployment of increasingly sophisticated technologies for geovisualization that eclipse the simple Cartesian perspectivalism of traditional paper maps and cartographic practices, supersede the mathematical gaze supported by the spatial analyst's 'grid' by engendering what are seen as "new ontologies and practices of transparency and malleable depth" (page 162). This ontology, which Pickles terms "investing objects in depth," is one where phenomena are severed from an economy of reflection and instead transplanted into an economy of "productive reconstructive surgery" premised upon a system of vision that renders the world as transparent and fully penetrable, and its entities as infinitely malleable and manipulable – the mirror at the level of the machine (page 163).

3.5 A series of disconnects

Pickles' 2004 book may be characterized as poststructuralist in two respects. First, he employs the use of epistemological critique to express ontological dissent as is consistent with poststructuralism as an internal metaphysics. The real issue is not the 'representational epistemologies' of geographic visualization themselves, but rather that they certify an ontological world of simulated lived experience in the form of a digital earth – and society – that can be perceived and interrogated from any position, angle, and at any scale. Second, it is exemplary of poststructuralism's use of deterministic meta-narratives which explains the state of affairs in terms of single-factor causality (Agnew, 2006); in this case, the deficiencies of the technology are reduced to its representational epistemology. This reductionist reasoning is a by-product of the nominally poststructuralist inability to adequately maintain the separation between the ontological and epistemological meta-questions of philosophy, which Bhaskar (1986) seminally identified as the *epistemic fallacy*.

The epistemic fallacy describes an effectively Cartesian logic which both begins and ends with questions of epistemology, confusing knowledge of the world for its contents. It inevitably results when questions about what the world is like are incorrectly answered in terms of why the world behaves as it does. Strohmayer (2003) describes the privilege afforded epistemology in poststructuralist critique as a "[binding of] knowledge to its objects without allowing the latter to ever be independent of the former" (page 520). This self-referential reasoning inherently suggests that everything can be explained in terms of knowledge (Van Bouwel, 2005), resulting in a failure along the metaphysical ontology/epistemology boundary. The subsumption of ontology by epistemology ultimately sanctions ontological negligence by reducing everything to a problem of framing. Following Bhaskar (1993), this "overt collapse" of the knowledge-of/substance-of-knowledge distinction is always either symptomatic of or disguised by the epistemic fallacy (page 4).

Pickles' (2004) reasoning that the technology's purported ontological defects (the ontology of represented objects) can be sufficiently accounted for solely in terms of the flawed epistemology from which they arise is epistemically erroneous in suggesting that the identified defects can be remedied by simply supplanting one epistemology - a fragmented "'guerrilla' epistemology" (page 160) in support of a "nomad cartography" (page 64) – for one less desirable (the aforementioned 'epistemology of representation').

This notion incorrectly suggests that the objects we know – for example, the people we represent – are transformed when we presume to change the filter through which we know (or, in this case, represent) them. Although the way in which people are represented – in social theory as well as GIS – has political and social implications, it is our representations that change, and *not* the individuals themselves. To suggest otherwise is to incorrectly 'undo' the metaphysics of presence.

After Derrida (1978), the 'metaphysics of presence' is the idea that phenomena in the world have endurance beyond their epistemological ratification as ontological objects. 'Reality' is taken for granted as consisting of entities which remain constant under conditions of world distortion (Kingsbury, 2002; Peet, 1998; Rose, 2004). In other words, such objects assume the status of self-evidence, explainable in abstract terms – such as "God, reason, [or] history" (Rose, 2004, page 462) – irrespective of changes in their ontological or epistemological circumstances. Poststructuralist philosophy renounces the 'metaphysics of presence' on the grounds that any acknowledgement of the endurance of entities is synonymous with discursive 'centering' (Peet, 1998). Epistemological reductionism becomes a way of discursively 'policing' ontological commitments, thereby pre-empting ontological relativism in the form of the 'metaphysics of presence'.

Indeed the abnegation of ontological 'substance' is an overt attempt, on the part of critical theorists, at evading ensnarement in the *ontic fallacy*. The counterpart to the epistemic fallacy, the ontic fallacy characterizes an equally erroneous logic whereby subjective meanings are bestowed ontological status (Bhaskar, 1989). It captures the sophistry of mistaking 'facts' to be sufficient for knowledge – what Bhaskar (1989) terms the "compulsive determination of knowledge by being" (page 181) – that plagues rationalist science (Groff, 2004). The epistemic fallacy occurs whenever we consider 'reality' to be no more than our representation (or perception) of it; its ontic parallel is implied whenever we consider our representations of reality to 'mirror nature' or to be an exhaustive reflection of it (Scollon, 2003). Accordingly the ontic fallacy is a critique of logical positivism and its presupposition of knowledge as there for the reaping in the form of 'facts' presented to us unabated by nature, and the subsequent positioning of these empirically verified entities into the realm of knowledge itself (Groff, 2004).

It is this attempt at evading the ontic fallacy of which positivism is accused that beguiles critiques of GIS in the epistemic fallacy. Kingsbury (2002) explains the paradox as follows: to 'undo' the metaphysics of presence requires first that they be acknowledged. He illustrates by way of reference to the science fiction genre of film, which involves the perturbation of our collective assumptions of the metaphysics of presence in everyday life. The regularity of quotidian settings and activities must be first cinematically reified to establish the appearance of alien objects and life forms as an oddity or anomaly. UFOs, for example, are certainly an aberration, but only in terms of their insurrection of the familiar or expected. We do not expect to see fifty foot women, but we do not anticipate them precisely because they are at odds with the uniform consistence of the world on which we depend to make sense of the reality of our lived experience. Thus metaphysics can only be negated by way of an *a priori* ontological concession: presence must be acknowledged before it can be negated. Rose (2004) likewise maintains that postmodern movements have not actually removed themselves from performing metaphysics; they have simply rhetorically and discursively repudiated it.

The incongruity of a simultaneous 'metaphysics of presence'/'pataphysics of absence'[16] lies at the heart of the epistemic reductionism of critical/cultural readings of GIS. For critics to counterclaim the ontological commitments of the technology, they must first accede the technology to be bound by (an) ontological commitment(s). If the criticism of GIS is that it is empiricist, then critics must first acknowledge a subscription to an empirical extra-textuality implied either in the inception, or more appropriately the deployment, of the technology. Similarly, Pickles' (2004) entry point for critique – representation – necessitates that he first acknowledge the 'representative' basis of digital geovisualization infrastructures. Sidestepping the pitfalls of the 'naturalization of knowledge'[17] by way of epistemic reductionism requires an initial moment wherein the ontological is bestowed the property of 'presence' such that this kernel of endurance may then be reduced to epistemological constructs. This does not suggest that Pickles' collapse of the objects of representation into their generative practices is equivalent to a certification on his part of ensuing representation(s) out the other end of cartographic visualization. Rather the implication is that deconstruction – as method, or as something to be 'done' – confines one to the centre, precisely that which is to be disrupted (Rose, 2004).

Ironically, positioning metaphysics as antithetical to deconstruction actually functions to reassert the metaphysics of presence (Rose, 2004). The abnegation of 'substance ontology' by way of the theoretical censure of the metaphysics of presence is

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[16] Kingsbury (2002) identifies the 'pataphysics of absence' as the 'anti-matter' of the metaphysics of presence. 'Pataphysics' is understood as the "'science of imaginary solutions;'" in turn, pataphysical entities are unexpected phenomena which perturb or disturb the prosaic (page 123).

[17] Bhaskar 1989, page 157.

inherently sophistic as it begets the conclusion that the objects of deconstruction[18] are ontological – i.e. they express (an) ontological commitment(s) - by virtue of subscription to some ontology. Theoretically annihilating the metaphysics of presence is epistemological reductionism manifest: if there is no ontological substance, everything *must* be interrogated and answered in terms of epistemology. Yeung (1997) sees postmodern philosophical debates in geography as caught up in this very discursive tautology. The implications of this flawed reasoning extend beyond mere inconsistency, however. Indeed the transposition of ontological commitments to epistemological constructs effectively masks what is a substantively poststructuralist (and postmodernist) argument for the ontological as *a priori*: epistemological reductionism conveniently absolves theorists from making ontological commitments, but this absolution is granted only under the condition of an implicit ontology (Bhaskar, 1993). To assert that there is no world beyond discourse, for example, is itself an ontological claim.

This contradiction reveals attempts at undoing ontology (in the form of a metaphysics of presence) to be impossible. Nevertheless this error propagates throughout critical/cultural assessments of GIS which continue to be tendered as epistemological critiques of the technology, culminating in misplaced instructions for an ontology-free geographic visualization as is mandated by Pickles (2004) in his vision for a post-representational utopia of a "de-ontologized cartography" (page 184). Underwritten by a quest to somehow reach the logical end of the metaphysics of presence, this 'undoing' in the context of GIS has served to effectively – and incorrectly – 'de-ontologize' an entity

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[18] That which is being deconstructed.

whose material substance necessitates that any legitimate engagement of its philosophical primitives recognize it as immediately ontic.

3.6 The primacy of the ontic dimension of GIS

Commanding that GIS shed itself of its ontological commitments, as do Dixon and Jones (1998) and Pickles (2004), is consistent with Derrida's poststructuralist project against metaphysics and its preclusion of the centre on the grounds that laying claim to ontology is inherently logocentric. It is in this way that Derrida (1976) maintains there to be world outside of discourse: language is a closed system; there is no correspondence between language and real-world objects. To identify non-linguistic constructs immediately implicates the metaphysics of presence (Rorty, 2005). This position permeates the poststructuralist theory of technology, which understands GIS to be radically socially constructed (Harvey, 2003; Harvey and Chrisman, 1998). Maintaining GIS to be a system of representation similar to a language certainly reveals its *syntax* to be socially constructed (Schuurman, 2002a, 2005), but it does not amount to a social constructionist argument in the vein of poststructuralism. Social constructionism casts two theses on technology: on the one hand, technology is rendered to be no more than a social construction, and thus no different from any other socially constructed entity; and on the other, it essentializes technology as an autonomous force (of surveillance, warfare, hegemony, homogenization) that exerts control over the society that produces it (Lawson, 2007). The first assertion is relativist, the second crudely (technologically) determinist. These two claims are moreover inherently contradictory: if technology lacks any intrinsic 'logic' by virtue of being purely socially contingent, then it is incapable of provoking social change (i.e. it cannot be autonomous) (Lawson, 2007). Heidegger, however, understood our encounter with technology as "[involving] the transformation of the entire world (and ourselves) into 'mere raw materials' or 'standing reserves' – objects" (Lawson, 2007, page 35). For Lawson (2007), this suggests that there are indeed certain characteristics of technology – such as its endurability or concreteness – that cannot be socially reduced.

Understanding GIS as socially and culturally embedded thus represents only half the equation. The Heideggerian rendering of technology upon which the constructivist account of technology is based entails both 'ontological' and 'ontic' definitions (Heidegger, 1977). The ontological definition ensconced within critiques of GIS, which Heidegger (1977) infamously termed 'enframing', is best described by Feenberg (2000) as "an attitude toward the world and ourselves in which everything appears as a resource… the notion that modern culture comprehends everything as a potential object of technical action" (page 446). This alone is not a sufficient narrative of technologies as it fails to account for the material basis of technology, or what Lawson (2007) refers to as technological *objects* that act in response to technological 'activity' in the ontological sense. The gap is accounted for by Heidegger in his recognition of the *ontic* substance of technology. The ontic is the "level of empirical objects" (Feenberg, 2000, page 446). Thus the ontic dimension of GIS is its constitution as a particular technological apparatus (Feenberg, 2000). Although the ontic resides in the ontological, the 'essence of the technology' should not be conflated with instances of specific devices (Coyne, 1995; Feenberg, 2000). Coyne (1995) explains this difference in the context of computing in the following terms:

> There is a world of electronic components, microchips, cables, monitors, software, and so on, of electronic communications. In [the ontological] sense, the world of electronic communications includes the abstract concepts and theories (communications theory, protocol hierarchies, and so on) we use to explore and explain it. This is the 'way of being', the ontology, of the entities of the ontic world under study.
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> 166-167

As a universe of literals, the ontic is a world of 'limited meaning' (Coyne, 1994, 1995), a definition which assumes the utmost salience with respect to discussions of GIS where its data structures – and practices of selection, generalization, and discretization – ultimately "[truncate] representation" (Schuurman and Leszczynski, 2006, page 712). In the world of critical theory, knowledge and representation are latent in holistic concepts referenced by the conventional signifiers of traditional semiotics: words, free text, images, ideas, vocal intonations, body language, sounds, associations beyond the immediate context of a conversation. The possibility of spatial representations in the software environment, however, necessities the initial serialization of these unstructured complexities into persistent, regular, discrete objects of code – in computing terms, their *formalization*. Defined as the process of transposing concepts in the theoretical or cognitive realms to computable 'packets' or entities, formalization imposes immediate limits upon representation in the digital universe that is GIS (Schuurman, 2006). Indeed the computing architectures which comprise GIS as a digital *device* (read: ontic entity) circumscribe the kinds of representations that (may) ensue (Curry, 1995). Emotion, sacredness of place, ethical judgements: these are statements that are difficult to quantify and therefore reify as a GIS re-presentation.

Critical realism as a philosophy of science maintains that social and natural kinds are, ontologically speaking, worlds apart; borrowing from Heidegger, social objects are recognized as having an "interior," or essence, that cannot be collapsed (Bhaskar, 2007, page 196). This 'orthodoxy' is implicit to how cartographic representations are understood by theorists invested in and familiar with the methods of GIScience: physical geographic phenomena are emphasized and overrepresented in the vast majority of geovisualization not because they are somehow superior to, say, cultural entities by virtue of their empirical qualities, but simply because the binary nature of brute code cannot, nor will it ever, do justice to the complexity and nuance of, for example, individual subjectivity. For this reason Schuurman (2000) locates epistemological shortcomings of GIS as residing in component architectures of the technology, and not, as Pickles (2004) maintains, in the fact that GIS 'represents'.

It is only by considering the ontic dimensions of GIS that the material limits to representation, brought on by the inherent limits of digital computing, become apparent. In denying extra-discursive entities, poststructuralist metaphysics precludes the possibility of there being "non-linguistic objects which constrain (in straightforwardly physical, causal ways) both our linguistic and non-linguistic behaviour" (Rorty, 2005, page 175). In the computational universe that is GIS, this includes the data structures which store meaning (encrypted as 1s and 0s) in the physical registers of the computer. Allowing for the ontic does not in any way absolve the hegemonic effects of GIS; rather, it correctly locates them in the material constitution of GIS as a technological device. Conflating the ontic and ontological under the combination of a poststructuralist metaphysics and radical constructivist narrative of technology erroneously locates these effects in the material production of knowledge. The invalidity of equating the ontic and the ontological is made more apparent using general terms: to say that how 'the world' is understood and subsequently represented is the result of social negotiation does not demonstrate 'the world' *itself* to be entirely a social construction (Kitcher, 1998). Concluding that the latter follows logically from the former is to instantiate a particular variant of the epistemic fallacy particular to poststructuralism (and postmodern movements more generally, as well as branches of Marxist philosophy) that Bhaskar (1993) calls the *linguistic* fallacy. It is implicated when 'the world' is rendered as purely discursive; alternatively, when 'the world' is seen to be nothing but our discourse about it.

GIS is both technological in the ontological sense, and ontic as an instance of a digital device. Therefore it is not merely a textual entity; its material foundation in computing differentiates it from other purely discursive objects of poststructuralist deconstruction.[19] Acknowledging its engineering to be socially mediated does not negate the physical substance of GIS latent in its digital makeup. Collapsing the ontic into the ontological by means of 'undoing' the metaphysics of presence, and subsequently reducing it to epistemology by means of the epistemic fallacy, is however a discursive manoeuvre without basis in a 'formal universe of discourse'[20] where the ontological is by definition ontic, a conjunction immediately apparent in the informatics interpretation of

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[19] Deconstruction was initially advanced – and popularized in the North American academy by Paul De Man – as a form of literary criticism (Rorty, 2005). Derrida was a language theorist and therefore emphasized literary texts and writing (Coyne, 1995); accordingly by the 'purely discursive objects of poststructuralist deconstruction' I mean not the texts *of* deconstruction such as Derrida, Foucault, Barthes, etc., but rather the textual objects (see *n9*, this manuscript) that have traditionally been *subject to* deconstruction. Technology may certainly be deconstructed, and legitimately so, but as Coyne (1995) argues, an unadulterated Derridean brand of deconstruction is not appropriate for such a task, as technology was not Derrida's immediate focus. Indeed the "crisis of the endless reproduction of texts, the chase of the signifier by the signified, and the elusive quest for truth and meaning are not brought about by mass media and electronic communications but are integral to our sign system, or language" (page 108). Technologies are therefore distinct from *literary* texts that have oft been the subject of deconstruction within the *texts of* deconstruction. The argument is therefore not with deconstruction as a means of destabilizing the technology, but with the form.

[20] Expression coined by Gruber (Gruber, 1993)

ontology as "an explicit specification of a conceptualization" (Gruber, 1993, page 199). In simpler terms, a formal ontology is a machine-readable model of entities that are literally encoded into existence. As a computational device, GIS is subject to this definition of ontology. Differentiating *formal* from *philosophical* ontology reclaims the ontic for GIS as a digital spatial technology: as the ontology of literals, the ontic is populated only by objects presented to the individual (Coyne, 1994). This is moreover commensurate with the discrete, empirical basis of computing wherein spatial representations become 'real' in database terms in the form of numerical abstracts serialized as objects of code (Schuurman, 2006).

3.7 Conclusion

An acknowledgement of the ontic level of GIS mandates that any discussion of the polemics of 'representation', such as that advanced by Pickles (2004), occur under an explicit recognition of the *physical* limits to representation associated with digital computing, immanent in the data structures and component architectures which discretize complexity, only to reify it as a series of 0s and 1s where meaning is tied to their combinations in blocks of code. Formalization thus imposes conditions under which any engagement of the philosophical tenets of GIS may be considered legitimate. This legitimacy is premised on a valid engagement of the metaphysical tenets of GIS. Specifically, it necessitates an *a priori* acknowledgement of the explicit commitment to ontology expressed in the codified objects that comprise the formal 'universe of discourse'. Critiques operationalized under a metaphysics internal to poststructuralism are inappropriate for such a task because as epistemological narratives, they reduce GIS to non-linguistic constructs, such as the initiation of the technology or practices of representation, thereby rendering it purely discursive. Effective 'de-ontologizing' GIS by removing it from its material constitution as a computational entity in this manner incorrectly suggests that the shortcomings of the technology can be resolved in purely theoretical terms, an epistemologically reductionist (and epistemically fallacious) claim which serves to dismiss the ontic consequences of GIS as a discreet, empirical device.

The immediacy of the ontic dimension of GIS avows that there can be no GIS of the sort envisioned by poststructuralist theoreticians such as Dixon and Jones (1998), who impress that its legitimacy as a technology may only be established in "first [rejecting] the presumption that there exists a 'field' of real world processes and objects" (page 257). For Rose (2004), solutions to remedy the ontological paucity of GIS by way of its epistemological priors constitute "false exits" (page 462), so termed because they overwhelmingly fail to position themselves outside of the 'metaphysics of presence' they seek to subvert. 'De-ontologizing' the technology is a quintessential 'false exit'. Indeed a 'false exit' is all that becomes available when the internal metaphysics of poststructuralism are applied as a basis for assessing GIS, precisely because the ontological and epistemological deficiencies cannot be remedied through discourse alone but must be simultaneously engineered at the empirical level of the machine. Schuurman's (2000) insight that "emphasis on epistemology has drawn attention away from the architecture of the technology where many shortcomings are ultimately located" attests to the failure of the critics to 'undo' the metaphysics of presence by effecting critique beyond the ontic immediacy of GIS (page 586). Instead attempts to discursively circumvent the ontological substance of the technology in this manner implicate the epistemic fallacy. The subscription to the poststructuralist conflation of ontology and epistemology renders critiques of the technology logically self-fulfilling and thereby self-negating under the weight of their own epistemological reductionism.

Critiques formulated under a poststructuralist-inspired collapse of the ontology/epistemology distinction are thus ‘disconnected’ from GIS because they are incommensurable with its demonstrably realist (ontological) essence. In this paper, I explain this fundamental ‘disconnect’. Rooting critiques in poststructuralism’s unique interpretation of metaphysics as a basis for ‘reading’ GIS, however, reveals a double-entendre of poststructuralist critique: tautological conclusions resulting from this discursive hegemony paradoxically *ontologize* the technology as an inevitable ‘gridding’. ‘Ontologizing’ the technology is equally as erroneous as its negative counterpart in that it substantiates all technological geographic devices as entities in an epistemologically-reduced ontology. Emergent interfaces for geovisualization such as Google Earth defy pigeonholing as exclusively surveillant instruments because the experiences of exhilaration, paranoia, intimacy, euphoria, and expectations of utopia enabled by new affordances for interaction in the digital realm represent a blurring of the disillusionment of boundaries, a moment which lies beyond – or escapes being represented within - the inevitability of the ‘grid’ as a conservative ontology of discrete areal definition (Kingsbury and Jones, 2007).

Discussing GIS through an alternate critically realist philosophical lens will better position critical/cultural geographers to contribute theoretically to the unprecedented transition from a definitive proprietary technology (GIS) to distributed geospatial virtual environments of the global information economy currently sweeping across GIScience. Sustaining a redefinition of the geographic information society, this shift is not only redefining the constituent technologies and praxes which define GIScience, but furthermore locating them beyond the purview of geography proper. Recently termed 'neogeography' (Turner, 2006), this new geospatial information market is being pragmatically driven not by geographers, but by computer programmers, web developers, 'mapping hacks', and members of online communities, the vast majority of whom have never used a GIS, much less engaged with geography (or GIScience for that matter) as an academic discipline. Given that this transition is being largely technology driven, constrained by available primitives for formal knowledge representation, the ontic dimensions of constituent technologies assumes an ever greater significance because it mandates that geographers understand the philosophical commitments latent in their design and expressed in their deployment. In a geospatial marketplace where feasibility of computational implementation is largely defined in terms of the bottom line, geographers must be able – and willing – to come to the table with tractable solutions to the identified polemics posed by emergent interfaces, new affordances for interaction, and the increasing verisimilitude of geospatial environments. For example, merely critiquing the use of high-resolution satellite imagery – which allows the identification of individuals – to drape digital earths is no longer sufficient. Effecting change necessitates the identification of a series of realizable protocols which mediate these polemics, such as zooming thresholds in urban or residential areas which preclude us from spying on our neighbours. Otherwise, we risk eclipsing geography from influencing what this purported 'new geography' – defined in terms of geospatial digital objects and environments – will look like.

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CHAPTER 4
CONCLUSION

4.1 Summary of arguments

This research has examined contemporary debates between GIScience theorists and critical/cultural geographers over GIS in postmillennial geographies. Motivated by Nadine Schuurman's 2000 historiography of 1990s critiques of the technology, this thesis analyzes the state of affairs since the heated exchanges of that decade.

Critiques of GIS advanced by social and cultural theorists have moved beyond a fixation on positivism, but nevertheless remain epistemological in substance. This enduring epistemological thrust is the product of the conflation of ontology and epistemology by the intervention and subsequent orthodoxy of poststructuralism in geography.

I argued that the discourses of GIS and GIScience operate under divergent conditions of metaphysics, or interpretations of ontology and epistemology and the understanding of the relationships between these two areas of philosophy. Critical/cultural geography is characterized by an internal metaphysics, most commonly associated with poststructuralism, which collapses the boundary between ontology and epistemology by reducing questions about the nature of reality (ontology) to constructs of knowledge about the world (epistemology). In social theory, ontology is the essence of being; poststructuralism however maintains that any knowledge of a reality beyond conception is impossible. Thus any ontological claim is but merely a statement of perspective or the premises under which posited ontological conditions hold.

This epistemological reductionism is inherently at odds with the discourse of GIScience, which maintains distinct ontological and epistemological theses. The ultimate foundation of GIS in computing links GIS to an informatics interpretation of ontology, understood as a fixed universe of discourse in which each variable and its relationships are precisely defined (Gruber 1993). Ontological considerations in GIS are strengthened by the primacy of the ontic dimension of the technology – the instantiation of GIS as a digital technological *device* – which necessitates that its ontological tenets be explicitly addressed. This ontology of limited meaning (Coyne 1994, 1995) fits GIS with its data structures that physically circumscribe representation.

The significance of the ontic in the context of GIS is that it demonstrates GIScience to constitute a unique discourse that provides its own theoretical and applied constructs to address the geographies of objects, fields and ontologies of digital representation that are distinctive in that they have been mediated by *formalization* – or the reification of conceptual or cognitive representations as discrete objects of code – in a computational environment.

These competing interpretations of ontology and epistemology expose the discourses of critical social theory and GIScience to be separated by what I have identified as a trenchant philosophical divide across which commitments to the structure and contents of the world and the way in which these become known in the form of a social or physical science are sacrosanct. Rorty's (1989) description of the problem of incommensurability, or philosophical divide, suggests these two discourses are ultimately irreconcilable.

This divide is demarcated by the formalization boundary between the 'infological' and 'datalogical' worlds of spatial representation (Feuchtwanger and Poiker 1987) across which concepts expressed in natural language become affected as code. As a process of reducing concepts and their interim symbolizations to a series of numeric digits (0s and 1s) in varying sequences, formalization is inherently quantitative at every stage. Moreover the inescapability of discretization, selection, and binarization needed to traverse the formalization boundary strip representations enacted in the conceptual realm of their irreducible nuance; as such, reverse engineering from the datalogical back to the infological is precluded by the ecological fallacy (EF).

The distinction between infological and datalogical paradigms of knowledge representation, which parallel Bhaskar's (1986) discrimination between philosophical and scientific ontologies, reinforces the inconsonant conditions of metaphysics under which these competing philosophical commitments are expressed. The epistemological reductionism engendered by the collapse of ontology into epistemology under a poststructuralist metaphysics incorrectly abstracts GIS from its material basis in computing by failing to contend with the limits to representation imposed by the inescapability of formalization in the digital realm.

In this thesis, I have called upon the Critical Realist critique of postmodern challenges to science in order to demonstrate that poststructuralist geography represents a profound disconnect from GITs. This disconnect is identified as a series of logical inconsistencies which result in a serious misreading of the technology: (1) entrapment in the epistemic fallacy (Bhaskar 1986), which, underwritten by an (2) undoing of the 'metaphysics of presence' (Derrida 1978), effectively (3) 'de-ontologizes' an immediately ontic entity. This orthodox critical/cultural reading of GIS erroneously suggests that the shortcomings of the technology may be resolved in exclusively theoretical terms rather than addressed at the level of component architectures where ethical inconsistencies, for example, arise (Schuurman 2000).

4.2 Significance of research

The importance of this research is that it identifies conditions under which any philosophical or theoretical engagement of GIS may be considered legitimate. First and foremost, qualitative discussions about the ontological and epistemological tenets of GIS must recognize that the limits to spatial representation in the digital realm are immediately quantitative, associated with the ultimately numerical basis of formalization. This mandates a critique that can be implemented computationally. To this end I have introduced formal ontologies as a flexible mechanism for translating between philosophical and informatics ontologies in a computing environment. The legitimacy of any engagement of the technology is furthermore conditional upon an *a priori* reconciliation with GIS as a digital, material technology. Negation of the ontic dimension of GIS by way of an attempt to reach the logical end of metaphysics implicates the epistemic fallacy, and demonstrates critiques to be not only erroneous but also disconnected from the object of critique.

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