Quantitative Geographical Analysis
Week 2: The History and Present Condition of Quantitative Geography.
Background Paper.
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A Short History of Quantitative Geography

"To dictate definition is to wield cultural power. Definitions of a discipline's cognitive domain are thus frequently less an ontological exercise about the piece of reality that the subject has a rightful claim upon, than a strategy for delimiting the scope of vocabulary that will be allowed as good currency within that professional division of labor."[1]

ontology: *ontos* (being), *logos* (word, discourse); the branch of metaphysics concerned with the essence of things; the study of being.

Kant, Hartshorne, and Schaefer

Richard Hartshorne wrote *The Nature of Geography* (1939), in large part as an attempt to define the essence of the field in terms of "the empirical *contingencies* of intellectual history"[2] -- as a museum of set pieces of what previous generations of geographers chose to do. Hartshorne privileged a view of the geographer's task as that of areal differentiation or chorology[3] (a tradition that goes back to Strabo's *Geography*, 8 BC-18 AD), and tried to develop a formal, rigorous definition of "region." Later critics of Hartshorne maintain that his work was little more than a catalogue built from the philosophy of Immanuel Kant (1724-1804), whose influence on geography could be felt in three areas:

> 1. The identification of two synthetic fields of knowledge: history (concerned with phenomena that occur together in time) and geography (concerned with phenomena that occur together in space). The corollary of this distinction was to separate the geographical locations of objects from their essence, process, or meaning.
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> > *History differs from geography only in the consideration of time and space. The former is a report of phenomena that follow one another and has reference to time. The latter is a report of phenomena beside each other in space. History is a narrative, geography a description.*
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> > *Geography and history fill up the entire circumference of our perceptions: geography that of space, history that of time.*

[1] Livingstone, 1992, p. 304.
[2] Livingstone, 1992, p. 306.
[3] From the Greek *chorographein*, 'to describe the parts of the Earth."

2. A subjective (albeit deterministic) theory of space. In the *Critique of Pure Reason* (1781), he maintained that

> *Space is not something objective and real, nor is it a substance or an accident, or a relation, but it is subjective and ideal and proceeds from the nature of mind by an unchanging law, as a schema for coordinating with each other absolutely all things externally sensed.*

3. The rise of Neo-Kantianism, a movement that emerged in Germany in the 1880s and 1890s. Neo-Kantians replaced Kant's single, "unchanging law" of a unitary scientific method with a distinction between

> a) the cultural and historical sciences, which dealt with 'non-sensuous objects of experience' which had to be *understood* (*verstehen*), and which were therefore idiographic, and
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> b) the natural sciences, which dealt with the sensible world, which could be *explained*, and were therefore concerned with the nomothetic.
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> This Neo-Kantian distinction is sometimes linked to a broader Enlightenment move in the Eighteenth and Nineteenth Centuries to divide all knowledge into three autonomous domains, each with their own ends and means:

science	truth and knowledge cognitive-instrumental rationality
morality	norms and justice moral-practical rationality
art	authenticity and beauty aesthetic-expressive rationality

Hartshorne's argument installed geography's task as a Kantian enterprise (in the sense of the first and second points above), and later critics have interpreted *The Nature of Geography* as an influential rationale for the idiographic. Livingstone (1992, p. 311) concludes: "For all the grand rhetoric...the manner in which the regional undertaking was conducted by and large failed to deliver the subject from its definitional neuroses. For too many practitioners it degenerated into a plodding enumerative exercise lacking both the intellectual vigor and moral zest of its earlier champions."

These disputes had considerable significance. The Geography Program at Harvard was terminated in 1948, prompting a sense of crisis throughout the field that lasted for years. The relationship between human and physical geography exacerbated the situation: some geographers sought to develop an autonomous field concerned only with human geography, but the move was attacked by influential figures as unscientific, descriptive, and fragmentary. One

such figure was Isaiah Bowman, who pointedly stood by without expressing any support when Geography died at Harvard.

It was in this context that Fred Schaefer, a geographer at the University of Iowa, wrote a scathing attack on Hartshorne in 1953 that became more influential than anyone, least of all the author, anticipated. The article was published posthumously, and attacked the historicism and the focus on the unique that marked the field at the time. Schaefer advocated a search for law-like statements to explain spatial patterns, the nomothetic (the Greek *nomos*, law). The goal, Schaefer maintained, was not to celebrate regional distinctiveness or trivial oddities, but to use general laws to explain local uniqueness. Whether the particulars of Schaefer's reasoning (discussed at length in Livingstone's chapter) held up under scrutiny is largely beside the point; but Hartshorne spent the next twenty years fighting with Schaefer's ghost in a number of books and articles.

Livingstone (1992, p. 316) concludes, "...advocates of a more scientific geography found in Schaefer a hero, and in Hartshorne the personification of, as one observer puts it, 'what we struggled against.'"

Schaefer's piece ignited an incendiary debate over the direction of the discipline, which underwent changes in the 1950s and 1960s that were nothing short of astonishing. The label usually attached to these years is the "quantitative revolution," but many argue that the key change was not so much about quantification, but about the organizing framework of scientific knowledge -- positivism. We'll get to positivism in a bit, along with other epistemologies. But *verstehen* first.

Gould's view of the Augean[4] Period

> The two decades 1957-1977 were the "best of times and the worst of times," and Dickens's phrase captures exactly the ambivalence and ambiguity of any truly revolutionary period. It was a time of great intellectual excitement, the sort of excitement that can only come from seeing new paths opening up, new connections being made, and real challenges to be met. There was a sense of discovery, and forging, of breaking out of the banal, factual boxes erected by the old men, and a sense of reaching out to scholars in fields to which we had never been properly introduced, but which seemed friendly enough if you were prepared to learn. It was a precious and memorable time, one that was probably impossible to sustain at such a high pitch for too long...
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> Looking back on my early graduate days in the fall of 1956 at Northwestern, I feel incredibly lucky and privileged. Challenges were there, not the least the presence of Ed Thomas, a third-year doctoral student, who traveled down to Chicago for a weekly liaison with...a *computer*! Multiple regression...*four* variables...urban relationships...explained variance.

[4] In Greek mythology, the Augean stables were the stalls in which King Augeas of Elis kept 3,000 oxen. They had not been cleaned out for years. Hercules had to do it as one of his twelve labors. He did the job in one day, by diverting the River Alpheus to wash out the stalls. [The Roman demigod *Hercules* is usually identified with the Greek *Heracles*.]

> "Ah yes,...variance" we repeated, furrowing our brows with the profundity of the concept. And then, when he was out of earshot, "What the hell is *variance*?" for we would have impaled ourselves on our soil augers before admitting that we did not know. Hurried consultations that night; frantic scanning of Croxton and Cowden; what on earth did Snedecor say? But the next day we casually dropped a few beta coefficients of our own.
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> *The old establishment, geographers in the regional and cultural traditions, were*
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> ...faced with a new generation, one that was both sick and ashamed of the bumbling amateurism and antiquarianism that had spent nearly half a century of opportunity in the university piling up a slagheap of unstructured factual accounts. It was a generation that, without exception, was completely conventionally trained, but one that knew in its bones that there was something better, more challenging, more demanding of the human intellect than riffling through the factual middens and learning the proper genuflections from *The Nature of Geography*.[5]

Quantitative Geography as the Positivist Turn

Gould paints a vivid portrait of years of discovery, measurement, modeling, and the search for fundamental processes that could explain spatial patterns. Studies sought to understand why the spatial patterning of cities and towns seemed to obey some unwritten law of regularity in size and spatial distribution. There was research into the relationship between population growth, transportation, and economic development. There was a wave of "modernization" studies to evaluate the prospects for newly-independent countries in Africa. There were attempts to quantify the carrying capacity of certain natural environments, to measure the pace and extent of desertification and deforestation. There were all sorts of models of urban structure, industrial change, innovation diffusion, and epidemiology. The new methods were spurred on by the development of the digital computer as well as the increasing availability of large data sets.

This era is now generally seen as the 'quantitative revolution,' when the field was redefined as an endeavor of 'spatial science.' In addition to Northwestern, the University of Washington, Seattle was an important origin. In 1957, the Geography department began a concerted attempt to recruit a top-notch cohort of new graduate students with quantitative potential; among this first cohort were Brian J.L. Berry, Duane Marble, and John Nystuen, all of whom worked with William Garrison. The key strategy of Garrison and his students was to draw on 'new' methods of analysis (inferential statistics and multivariate models) to test an earlier generation of geographical theories -- especially the works by Von Th nen, Christaller, and L sch.

The earliest contributions were, in many respects, inductive and descriptive, working out the complications of techniques that were genuinely new (as well as some methods that were

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[5] Gould, Peter R. 1979. "Geography 1957-1977: The Augean Period." *Annals of the Association of American Geographers* 69, 139-151.

new only to geographers). Soon, however, quantitative geography was joined to a coherent philosophical rationale: a *positivist epistemology*.

Epistemology: the study of what constitutes valid knowledge. How do we know what is true and what is not?

Greek episteme (*knowledge*), logos (*word, discourse*)

Positivism: a philosophy of science proposed by Auguste Comte (1798-1857), as an attempt to distinguish science from metaphysics and religion. In *The Course of Positivist Philosophy* (6 volumes, published between 1830 and 1842), he elaborated five core principles for scientific inquiry:

1. Scientific claims are to be based on a direct, immediate and empirically accessible experience of the world; observation statements are thus privileged over theoretical ones.

2. Scientific statements must be repeatable, and based on a unitary scientific method accepted by the entire scientific community.

3. Scientific advances occur through the formal construction of theories; repeated empirical verification elevates theories to the status of scientific laws.

4. Scientific theories and laws take the form of statements of the necessity, but not the desirability of specific events or relationships. Value statements do not count as scientific.

5. Scientific statements are progressively unified and integrated into a single system of knowledge and truth.

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Criticism of Comte's "brute empiricism" led to several alternatives. The most influential was proposed by a group of mathematicians, philosophers, and natural scientists who met regularly in Vienna in the 1920s and 1930s. The Vienna Circle's "**logical positivism**" drew a distinction between:

analytic statements: a priori propositions that are true by virtue of internal definitions and connections; for these statements, empirical validation is neither necessary nor possible (i.e., logic, mathematics).

empirical or synthetic statements: statements whose truth must be established empirically through hypothesis testing.

In turn, logical positivism was attacked by Karl Popper in the 1930s, who rejected the notion of empirical validation. Instead, Popper maintained that scientific hypotheses must be continually subject to attempts at falsification: only those

propositions that withstood attempts to disprove them could be regarded as valid -- at least for the time being. The epistemological literature inspired by Popper's work is known as ***critical rationalism***, and its influence on the expanding body of work in inferential statistics in the 1930s explains the prevalence of "null hypotheses" in statistical applications.

Alan Wilson, a prominent mathematical geographer, summed up the general approach this way:

> The essence of the scientific method is the construction of theories and the continual testing of these by comparing them with observation. The essence of such testing is an attempt to disprove a theory -- to marshal observations which contradict the predictions of the theory. In this sense, theories are never proved to be generally true. The ones in which we believe represent the best approximations to truth at any one time.... We expect, then, that theories will be subject to constant development and refinement: sometimes a falsified theory can be patched up; sometimes, radically different theory is needed.[6]

The irony of the positivist turn in geography was that the movement coincided with a broader rejection of positivism in much of philosophy and the sciences. And much of the interesting research was, in any event, not as tightly scripted as the positivist program said it should be. Nevertheless, most of the new stuff coming out in the 1960s was premised on key axioms of a 'scientific' flavor that had gained wide currency in the postwar academy, especially in the United States. Indeed, David Harvey, who advocated a comprehensive historical-materialist geography in *Social Justice and the City* (1973) only a few years after penning the definitive positivist tract (*Explanation in Geography*, 1969), suggested that the McCarthy scare, and the broader assault on the left played an important role in encouraging a retreat to the 'safety' of neutral statistics and mathematical models. This is not a conspiracy theory, and it is still an important legacy in how science is conducted.

In any event, the positivist turn swept the discipline rapidly, such that by the late 1960s the "quantitative revolution" was no longer revolutionary, but was itself viewed by many as the *status quo*. Like all revolutions, it generated its own backlash and challenges. Why did positivist research take root so quickly to become the dominant approach? Consider three alternative explanations:

1. Positivist geographical research was better at explaining the facts; it performed better empirically. This is the 'pure science' explanation, and it is the explicit and sometimes implicit assumption of most of the research that could be called positivist. The pure science explanation has generated fierce debate, some of which is evident in Livingstone's chapter. The key words are 'explanation' and 'facts': positivism is always superior if "unobservable" phenomena are excluded from the realm of legitimate knowledge, and if explanation is defined as the ability to express the relations between

[6] Wilson, Alan G. 1972. "Theoretical Geography: Some Speculations." *Transactions of the Institute of British Geographers* 57: 31-44.

observable phenomena according to mathematical functions or principles of statistical inference. Not all philosophers, scientists, or geographers accept these premises.

2. It was perceived to help geography "catch up" with other disciplines. This is the "sociology of science" explanation. Livingstone (1992, p. 326) makes the case:

"What I want to suggest is that in the wake of geography's demise at Harvard and the ensuing sense of disciplinary marginalization in an increasingly specialized academy, numerical language was adopted by practitioners lusting after scientific credibility. Consider, for instance, the judgements of Peter Gould. For him the label "quantitative revolution" was just simply 'a disastrous misnomer.' 'It was not the numbers that were important,' Gould confessed, 'but a whole new way of looking at things geographic that can be summed up in Whitehead's definition of scientific thought, "To see what is general in what is particular and what is permanent in what is transitory."

3. The positivist approach was important to broader societal goals, such as the expansion of large-scale rational planning and policy analysis after World War II. According to this explanation, positivist approaches won out not because of their absolute 'truth' or validity, but because they provided the kinds of answers required by the state and private industry at a time when rapid economic growth and the expansion of higher education gave research universities a new mission. For the social sciences, positivism replaced the notion of "social planning" (with its Soviet connotations) with the legitimacy of scientific explanation, even while philosophers of science (not to mention physicists, astronomers, and others) had moved beyond the narrow logical positivism gaining credence in economics, geography, and political science. We might call this explanation the "societal/materialist" argument.

Challenges

Since the 1970s, three main challenges to positivism have emerged in human geography. Physical geography has been largely unaffected by most, but not all, of these epistemological debates, and thus their growth has exacerbated longstanding divisions between the human and physical sides of the field. The appearance of these alternatives was neither neat nor coordinated, and in many respects the arguments resuscitated earlier ideas that had been suppressed in the 1950s and 1960s. These traditions continue today, in an uneasy coexistence with positivist quantitative geography -- which has itself evolved considerably.

1. The behavioral revolution. The behavioral school, which flourished for a brief period in the 1970s, attacked positivist spatial science as an unrealistic representation of how human beings actually think and operate. Consider the gravity model, which portrays spatial interaction between two places (travel, communications, etc.) through the analogy of Newtonian laws of gravity; do people really behave like planets or asteroids? How about protons and electrons? The behavioral alternative, best illustrated by Hagerstrand's time-geography or the mental-mapping approaches of Gould and White, emerged to give a more realistic model of how people actually perceived places and made locational decisions.

2. The radical challenge. The quantitative geography created a strange picture. In the late 1960s and early 1970s, when crowds were in the streets demanding an end to the Vietnam War, marches in the South and Washington, DC pushed for voting rights, desegregation, and civil rights, African countries were finally gaining independence from Britain and France, and while all this was happening the very best minds in geography were ... calibrating entropy-maximizing spatial interaction models; testing bid-rent models of urban structure; pouring data into the computer to generate factor analyses and endless reams of output.

   The radical challenge advanced along several fronts, but the key point was to question the positivist separation between objective statements and value judgements. David Harvey argued that although some of the best contributions of the positivist movement may have provided adequate explanation of the world as it was, they failed to even ask how things could be different. It's not that the models were wrong, but rather that we as enlightened scientists and as human beings wanted the models to be not true: what good is an accurate model of why urban poverty is so severe and concentrated if you can't do anything about it? For Harvey, the solution was found in Marx's historical materialism. Harvey's work launched a generation of inquiry into an alternative to the quantitative positivist revolution.

3. The humanist alternative. Humanist perspectives flourished along with behavioral studies, but moved well beyond them. The essential point of departure was the insight that quantitative methods were fundamentally inappropriate when applied to thinking, acting human beings. Analogies were often drawn from quantum theory: how can you observe something when the simple act of observation changes the phenomenon under investigation? The humanistic alternative drew inspiration from the humanities, and led to research on peoples' sense of place, to the analogy of landscapes as "texts" that could be read, and research in historical geography that involved systematic attempts to "get inside the mind" of the individuals, groups, and institutions responsible for geographic patterns and processes. The humanistic critique was often seen as neo-Kantian (see above). In the 1980s and 1990s, the humanistic tradition inspired a revival of cultural geography, and the expansion of feminist geography, postcolonial studies, postmodernism and other poststructuralist theories.

Livingstone's chapter provides a detailed narrative of these challenges, and the contributions of analysts working in different traditions. What is key for us here is to note that positivism was by no means the last word on how to do science; indeed, although positivist research is alive and well today, relatively few geographers use the label to describe what they do. "Positivism" has become a caricature of naive empiricism, mechanical views of society, and unthinking acceptance of computer-generated output. Human geographers usually avoid the label, even when they do quantitative research; physical geographers see much, but not all of the epistemological debate as obtuse and confused -- most physical geographers are broadly positivist in how they conduct research, but are by no means naive empiricists; there is heavy

emphasis on a theoretical understanding of process, mechanism, and uncertainty -- in ways that do not conform too closely with the caricatures of logical positivism.

In any event, the behavioral, radical, and humanist challenges found philosophical justification in alternative epistemologies; recall the essence of positivism, and note its differences with the alternatives:

Positivism: attempt to explain causal links between observed phenomenon. Truth claims are validated by empirical tests.

Structuralism: an attempt to explain causal linkages by investigating unobserved, structural causes that are responsible for observed phenomenon. Structuralists reject what they see as a naive empiricism on the part of positivist researchers: particularly in the social sciences, the translation between 'scientific theory,' 'empirical measurement,' and the specific 'things' chosen for measurement is very difficult. How do you "observe" gender relations? How do you measure class inequality? Structuralists emphasize the underlying relations, links that may not always be easy to observe; structuralist theories are evaluated according to the theoretical logic, consistency, and empirical testing. Many of the most influential structuralist contributions came from anthropology and linguistics, and in the social sciences many structuralists also advocated Marxist social theory.

Phenomenology: a philosophy that is not intended to provide definitive explanations. Phenomenology, rooted in medieval attempts to interpret the Bible and related scriptures, emerged again in the twentieth century as an attempt to gain *understanding*. Phenomenological science is not about causality, but about interpretation and understanding; in this framework, truth claims are validated by shared understandings and meanings. Phenomenology became very influential in anthropology, where the litmus test was: would the society you are studying agree with your interpretation, based on their knowledge of the world?

Coda

By the middle of the 1980s, geography was being rocked by vibrant debates over what could, or should, be accomplished by the quantitative tradition. Structuralist and postructuralist challenges had created a fairly broad set of alternatives for inquiry, especially for the geographical study of economic processes, urban problems, and political themes. But towards the end of the decade the dramatic expansion of Geographic Information Systems -- computer-assisted methods and techniques that represented, in many ways, a full-fledged realization of the possibilities only dreamed of by the space cadets of the 1950s and 1960s -- had changed the terrain once again. Advocates claimed that GIS would finally allow geography to be integrated once again ; there was even the possibility of integrating human and physical geography, a division that goes back a century to the days of environmental determinism. Stan Openshaw, for one, used the metaphor of Humpty Dumpty; GIS is the only way of unifying a fragmented discipline, he claimed, and anyone who disagreed was immediately labeled as computer-illiterate or retro. Critics see the rise of GIS as the triumph of the button-pushers, or as the victory of a

technocratic geography that exists solely to provide business and government with the kinds of answers to the kinds of questions it wants.

It's a fascinating debate, incendiary at times. There are many combatants, including the authors we'll read for next week: Fotheringham made his career early on by pioneering studies of the spatial biases embedded in traditional spatial interaction models; he is extraordinarily optimistic about the possibilities for contemporary spatial analysis and GIScience, and some of this will be evident as we go through the chapters of *Quantitative Geography*. Doreen Massey is famous for exposing the flaws of a "spatial fetishism" in industrial geography in the 1960s and 1970s; she questioned the prevailing view of industrial decline in Britain during those years (which tried to explain the fortunes of places simply by looking at what was happening inside those places), and suggested instead that we were seeing "spatial relations stretched out over space." You had to understand what was happening in London as well as continental Europe and the U.S. (that is, you had to understand global capitalism) in order to understand the deindustrialization of Birmingham. Gillian Rose is an emerging voice in feminist geography, who has written devastating critiques of the preconceptions and assumptions we bring to the study of space, place, and landscapes. Is an "objective" map of a city really accurate if it does not show the likelihood of rape (for heterosexual women), surveillance (for young black men), or beatings (for gays and lesbians)? Peter Gould was a prominent figure in the years of the quantitative revolution, but also advocated the behavioral turn, and then engaged with humanist and structuralist work in the 1980s and 1990s, and ... well, he's hard to pigeonhole. Read and see for yourself.

So that's a very short summary of a rich, complex history of quantitative geography. Read Livingstone, Fotheringham, Massey, Driver, Rose, and Gould, and tell me what you think.

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