QUANTITATIVE REVOLUTION IN GEOGRAPHY

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The Hartshorne-Schaefer Debate

In his monumental publication "The Nature of Geography", published in 1939, Richard Hartshorne laid down his views about the way how Geography should be conducted. He mainly drew his ideas from German geographers, such as Alfred Hettner, Immanuel Kant, and Alexander von Humboldt. In his view, the goal of Geography was areal differentiation, investigating the spatial distribution of physical and human phenomena (factors) as they relate to spatial units of differing granularity like places or regions (Hartshorne, 1939). He argued that, we ought to define and delineate unit areas in which the factors are assumed to be constant, and since no two finite areas on earth will ever exhibit the same combinations of factors, such areas are unique.

A Geographer's task was to deliver a thorough description of these places, including all perceivable factors. According to Hartshorne, Geography was an idiographic discipline, describing the unique, as opposed to nomothetic disciplines, which search for universal laws. If all places are unique, there are either as many laws as there are places (which defeats the purpose of laws), or no laws at all, which was what Hartshorne advocated for. This methodological approach was what distinguished Geography from other sciences, such as Physics, Mathematics, or Chemistry, which were nomothetic - Geography was exceptional! Geographers collected facts from places around the globe and therefore, created an inventory of knowledge which could then be classified. Areal differentiation (or areal studies) was the modus operandi during that epoch, which remained unchallenged for a long time.

Fred Schaefer was the first person who challenged Hartshorne's views and who received a lot of attention for it. In his publication "Exceptionalism in Geography: A Methodological Examination" that came out one year after his death in 1953, he argued that Geography was not at all exceptional, which was one of the many points in which he disagreed with Hartshorne (Schaefer, 1953). This article is often seen as the beginning of the adoption of scientific methods in Geography, ultimately leading to the quantitative revolution (Kitchin, 2006). According to Schaefer, the process of scientific knowledge generation in Geography consists of two types of investigations: **Regional** ones aim for the gathering of facts about all aspects of a region which the author finds important enough to consider, and which can be subsequently grouped into classes. **Systematic investigations** relate regions to each other and aim for finding universal laws that govern spatial patterns of regional factor-combinations, which are realizations of these laws. Finding them enables us to formulate hypotheses which can be tested using statistical methods.

Hartshorne, in Schaefer's view, was merely concerned with the regional type of investigation. Pure description is common in fields that are in an early stage of development, so Schaefer gives examples from other sciences like biology, which was also largely descriptive and taxonomic in its infancy. Schaefer was afraid that Hartshorne was contributing to a roadblock of geographic development towards a science, which he stated was one of the main reasons for publishing his article.

Schaefer further criticizes the "exceptionalist claims" by Hartshorne, his followers, and the people he drew from. The notion that Geography is exceptional because of its methodological dualism (regional and systematic), which was formulated by Hettner and Victor Kraft, and which was later picked up by Hartshorne, is simply refused by Schaefer with reference to other sciences that showed the same characteristic. It seems like much of the disagreement between Schaefer and Hartshorne was about one important statement by Kant, which says that Geography and History are both purely descriptive with the only difference that Geography focuses on space, while History focuses on time and that it is the descriptive nature which distinguishes them from other sciences (Kant, 1802).

Schaefer argues that this statement is wrong because other sciences, such as Astronomy make use of descriptions of space and time too, which disqualifies any exceptionalist claim. Furthermore, the text that contains it was compiled from Kant's notes in his early career, which Schaefer calls his "pre-critical period", while Kant's philosophical authority stems from his "critical period", later in his life (his major work, "Critique of Pure Reason" stems from that time, 1781). Since other sciences were in the stage of their infancy around that time (Biology), being purely descriptive seemed to be completely natural and so was writing the same about Geography.

Lastly, Schaefer challenged the authenticity of the document, arguing that the handwriting was not Kant's, implying that one of his students could have written the majority of it. Schaefer goes on and explains that Hartshorne has misunderstood the works of Hettner, and accuses the latter of supporting and spurring the exceptionalist claim. Hettner stated that Geography and History are chorologic, examining causal relationships between phenomena within regions, and integrating phenomena heterogeneous among themselves. Both fields aim for explaining the unique, which does not know any laws. According to Schaefer, Hartshorne misunderstood Hettner because of the German word "Wissenschaft", which has a much broader meaning than the English word “science”, and denotes any organized body of knowledge, such as Rechtswissenschaft (law-”wissenschaft”).

Schaefer also accused Hartshorne of citing Hettner very selectively, as some of his other work can be quoted as supporting the nomothetic position. This is a point that Hartshorne later accused Schafer of contradicting himself (first saying Hettner is wrong, and then saying he is partly right, Hartshorne, 1954).

Hartshorne was not amused, his response to Schaefer’s article was fierce. As a first reaction, he immediately published a short comment about the matter (Hartshorne, 1954), discrediting Schaefer’s work as non-scholarly due to a lack of evidence, omitted citations, and the misinterpretation of statements from other authors. He announced two publications that would clear things up that Schaefer had clouded:

First, a line-by-line correction of all omitted citations and falsehoods in Schaefer’s essay, like the summary of passages that contradict the meaning of their author. This would prove him wrong and re-establish the status within the Geographic community as if “Exceptionalism in Geography” was never published.

Second, he would publish a statement on half a dozen questions about the character of Geography that should clarify what many Geographers obviously were confused about. Hartshorne’s ““Exceptionalism in Geography” re-examined” was published in 1955, in which he comes to the conclusion that: “The title of the critique lead the reader to follow the theme of an apparent major issue, “exceptionalism”, which proves to be non-existent.” (Hartshorne, 1955).

Theoretical Geography emerged under the lead of William Garrison and his group, who were highly influenced by him and other Geographers who sought for laws governing spatial patterns like Walter Christaller, Johann Heinrich von Thunen and August Losch. William Bunge pointed out that “Hartshorne was highly pessimistic about our ability to produce geographic laws, especially regarding human behavior. Schaefer has done us a great service in sweeping away our excuses and thereby freeing us from self-defeat.” (Martin, 1989).

The Quantitative Revolution and Spatial Science

Positivism is a set of approaches aiming for the application of scientific principles and methods drawn from the natural sciences to social phenomena in order to explain them (Kitchin, 2006). **August Comte** (1798 - 1857) postulated Positivism, which focuses on facts and truths that are empirically observable rather than on speculation, objective data collection through common methods of observation, the formulation of theories which can be tested, and the development of laws that explain and predict human behavior.

Positivism has 6 assumptions:

- First, human decisions have a determinable cause that is identifiable and verifiable.
- Second, these decisions follow a set of laws to which individuals conform.
- Third, there is an objective world that compromises individual behavior that can be observed objectively on universally agreed criteria.
- Fourth, scientists are disinterested observers, standing outside their subject matter, taking a position of neutrality and reaching dispassionate conclusions.
- Fifth, there is a structure to human society.
- Sixth, the application of laws of positivist social science can be used to alter societies (Kitchin, 2006).

Positivism follows a deductive approach for knowledge discovery: Theories are developed and hypotheses formulated in order to be tested empirically. If data do not support the hypotheses, the theory is modified and new hypotheses are formulated for testing. Objectivity through independence of scientists is preserved through conformity to five premises: Originality, communality, disinterestedness, universalism, and organized skepticism. This means that the goal of Positivism is the advancement of new knowledge, which is shared if its provenance is fully recognized. Scientists are interested in knowledge for its own sake and judge on academic grounds only.

Knowledge is advanced by constructive criticism (Kitchin, 2006). In the 1950s, geographers started to express the need for more scientific methods in their field, in order to find laws that govern spatial patterns and processes. Therefore, they started to look for quantitative methods in fields like Mathematics or Physics in order to apply them to their problems (Burton, 1963). Up to that point, Geography had been an entirely descriptive discipline. Fred Schaefer drew his arguments from Positivism, and challenged the dominating view of Geography as an idiographic discipline (Kitchin, 2006).

The quantitative revolution that followed, and that replaced description with explanation, individual understanding with general laws, and interpretation with prediction (Kitchin, 2006) is very well described by the following statement: "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 which we had never been properly introduced…" (Gould, 1979).

Quantitative Geography, also known as Spatial Science, is defined as Geography relying on accurate measurement for searching statistical regularities and associations. It focuses on what is observable and measurable, in order to formulate hypotheses which are testable. It's goal is to gather evidence as a basis of judgment about reality that most people would accept. Therefore, it has many commonalities with a positivist approach (Fotheringham, 2006). Marxist geographers criticized that Spatial Science was able to answer a very limited scope of questions, and did little to solve real-world problems, whereas a radical Geography should aim for changing the world (Castree 2003). In addition, humanist geographers criticized that Spatial Science was people less and that it did not incorporate people's beliefs and emotions, while feminist geographers argued that it was underpinned by a masculinist rationality. They rejected the "man's quest for a gods eye-view of the world", and advocated for focusing on power relations within the research process and more self-reflection with respect to personality, expertise and influence on the production of knowledge (Kitchin, 2006).

what about Positivism and Spatial Science today? Many of the methodologies that were developed during the quantitative revolution are still widely used today. Spatial analysis that makes use of Geographical Information Systems (GIS) are basically a direct legacy of that time.

Many studies in Biogeography utilize positivist approaches:

First, theory is examined, hypotheses formulated, then, data collected during the field season. Trees are identified, counted and measured, disease symptoms documented, birds are spotted and all the information is then related to space.

Next, variables such as temperature, humidity, slope, and topographic wetness index are extracted from readily available datasets at the sample locations in order to feed them into a regression model. Spatial autocorrelation is accounted for using methods which are adopted from Mathematics and Statistics and finally, the hypothesis is either rejected or confirmed which leads to another advancement in theory. Predicting human behavior, which Auguste Comte stated as one of the goals of Positivism (Kitchin, 2006) is not possible nowadays, at least not at an individual level. Group behavior can be predicted to some degree for certain situations, which is shown by decision making based on crowd simulations (Shendarkar, 2006), but extracting human thoughts and opinions still proves to be difficult.

Neo Positivism arises out of the analogy between physical and social phenomena. Auguste comte made philosophical positivism the cornerstone of his sociological thought. But the school of neo-postivisim traces the origin to statistical tradition rather than Comte's philosophical positivism. Neo positive takes phenomena form the physical world as models for social events and uses the laws of the former to explain the latter. It asserts that sociology should be a science and its methods should follow these of the natural especially physical sciences.

Neo positivists consider sound scientific methodology to be the first principle of sociological analysis. For them sound scientific methodology involves mathematical and other formal models that incorporate formalization of variables. Computer techniques and language, experimental logics, laboratory experiments and computer simulation of human behaviour. Among early thinkers Pareto and Giddings stressed the scientific nature of sociology and recommended the use of methods commonly adopted in the natural sciences. Dodd, Ogburn, Zipf are considered to the leading exponents of neo-positivism.

Positivistic epistemology: Neo positivism rejects a priori definitions of the essential nature of society, culture, social structure and institutions and insists on operational definition of concrete phenomena. The sequence of observable consequences that form a cluster of sense impressions is treated as the proper subject matter of sociology.

Operationalism: Neo positivist are not satisfied with the vague definitions of theoretical constructs and concepts. Each term must be defined precisely and translated in measurable variables. For Neo positivists sociological theory is a systematic collection of concepts useful in the interpretation of statistical findings.

Quantitavism: Statistical analysis which incorporates enumeration and measurement is basic to neo positivism. Due to the advances in computer technology a variety of methods and techniques are available .Hence the need is to put together the pieces of information pertaining to units of social structure into formal and mathematical system so that the relationship between different variables may be attained.

Empiricism: Whether it is survey research or experimental observation ,the empirical work falls into a standard pattern. Place a problem that can be investigated by a fact finding inquiry. Formulation of a set of hypothesis that can be tested on the basis of individual responses to a set of questions. Collection of answers on an interview schedule, structured questionnaire .

Behaviourism: Because of the emphasis on operationalsim and quantitativsm ,neo postivists tend to study observable behaviour pattern. they concentrate on specific instances of interaction, sometimes counting the frequency and patterns of repetition. Substantive problems of social structure and the history of institutions and ideas are often ignored,concrete behaviour of individuals become the focus of sociological inquiry. Neo positivists develop non subjective and non voluntaristic theories of action and interaction. Based on mechanistic and field theoretical conceptions, extreme variants of neo-postivism may border behavioural determinism.

Mathematical theory construction: Neo positivists have commitment for formal theory construction. They claim that the strong symbolic representation of a theory in terms of the formal logic of mathematics necessarily increases the precision of theoretical propositions. The system of formal logic in mathematics enables substantive propositions to be couched in terms of exactly defined concepts and to state them with logical coherence. Formal theory construction appears in two different contexts first there is the formalization of well developed substantive theories. Second specific findings of particular empirical research are codified in mathematical terms and then organized into a formal theoretical system which established the mathematical relationship between variable in symbolic terms. Most of the empirical studies undertaken by sociologists fall in this category .However impact of mathematical sociology has been limited to few areas.

Criticism of Neo-Positivism

The critics of Neo positivism call the scientific sociology as meaningless jumble of numbers and formulas. Because of their dependence on frequency and measurement ,neo positivists tend to study social situations an problems which are recurrent.

They also display a strong historical bias because their techniques permit them to study only contemporary social problems and not historical social events.

They tend to choose those areas that lend themselves most readily to mathematical formulations ,to the virtual neglect of more substantive areas of theoretical significance. Neo positivism is often critised as devoid of any substantive propositions and theories. The claims of Neo positivists are rejected by Mills on the ground that social science should not be treated as a storage building block endeavour.

Quantitative Revolution.

The shift of focus of geographical studies during mid 1950s and early 1960s inevitably involved a revolution in the nature of geographical work. It was clear that the new concept of geography as the science of spatial analysis of phenomena on the earth's surface with a pronounced commitment to theory, needed a new set of methodologies for explanation. In the initial stages of the changeover, few attempts were made at programmatic statement on how research should be conducted, even though there was a widely felt need of a hand book on quantitative models of explanation based on mathematical and statistical procedures. These were being increasingly made use of in the new researches coming from the leading centres of quantitative spatial geography.

Ackerman (1958) in his essay Geography as a Fundamental Discipline, observed that the single theme used to characterize the developments in contemporary geography, will be illuminating covariant relations among earth features. Ackerman conceded that much fundamental research in geography could not be low giving. It was, rather, required to be concerned with a high level of generalization in order that its result could give meaning to other research efforts that may follow it. All geographic research must have a 'block building character'. The requirement is thus to make geography more precise and accurate and accurate study depends on quantification.

In sum, the all important instrument for bringing about the required change in perspectives in geographical work from regional-idiographic to systematic nomothetic was quantification. It meant increased use of advanced mathematical and statistical techniques. Hence the mid 1950's changeover in the philosophy and methodology of geography has been generally referred to as Quantitative Revolution. Quantification was the key to the radical transformation of spirit and purpose. This disciplinary transformation of geography was part of process shared by many other disciplines where established order had been overthrown by rapid conversion to a mathematical approach (Ian Burton, Canadian Geographer).

The movement that led to the quantitative revolution in geography was initiated by physicists and mathematicians. It first transformed the physical and then biological sciences and by 1950's was strongly represented in social sciences. This movement towards quantification was part of the general spread and growth of modes of scientific analysis into a world formerly dominated by a concern with the exceptional and the unique. Burton outlines that geography was a 'following' discipline rather than 'leading'. Thus the mechanistic approach in the 19th century found expression in a deterministic cause and effect approach to study man-environment inter relation. Quantification in geography led to the use of new techniques which were drawn from statistics, which replaces the concept of inevitable effect by that of probable trend. As the revolution progressed, the use of quantification became more and more in deterministic.

The movement towards quantification began in 1940s. It gained momentum following the classical statements of Ackerman and Schaefer in favour of making geography more theoretical and systematic in nature. It reached its culmination between 1957 and 1960 and was over by 1965.

Hartshorne in 1959 strongly advocated that geographic work needed generic concepts and that it needed to determine correlation of phenomena with maximum level of certainty. Both these purposes could be best accomplished, if the phenomena can be fully and correctly described by quantitative measurements and these can be subjected to statistical comparisons through the logic of mathematics. Spate in his 1960 paper on 'Quantity and Quality in Geography' in the Annals of Association of Geography (AAG) referred the statistical techniques restricts the basic unity of the discipline.

While quantification was easily adopted in the study of physical geography – geomorphology, climatology and biogeography – considerable resistance was encountered in the field of human geography, as the revolution ran up against the notion of unpredictably of human behaviour. By end of 1950s however, wide recognition that, a social science which identified random behaviour at micro cosmic level and predictable order at macrocosmic level is a logical outgrowth of the quantitative revolution.

The revolution was inspired by a genuine need to make geography more scientific and theoretical in orientation. Dissatisfaction with ideographic geography at areal differentiation lay at its root and the development of a theoretically oriented geography was its major consequence. It thus was true that the need to develop theory preceded the quantitative revolution but quantification had added point to the need and it offered a technique whereby theory could be developed and improved.

Though the quantitative revolution had been over by early 1960s, there had been few focused discussions on the philosophy and methods of new geography that could serve as a guide for the new practitioners. Bunge's 1962 monograph on Theoretical Geography was the first to fulfill the need. Bunge identified geometry as the mathematics of space and hence the language of new geography as spatial science. This text remained the standard reference on the subject until Harvey's Explanation in Geography was published in 1969.