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Some Applications of Mathematical Sociology in Social Perspective

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Abstract:
Mathematics has always been used in various disciplines to solve problems. A strong tradition exists in the application of mathematics in physics. For the last 60 years, sociologists have been trying to highlight the significance and application of Mathematics in explaining Sociological theories. More and more, mathematical methods are applied in other disciplines such as biology and the humanities. It is noticed that each field demands its own type of mathematics. The question arises whether beside mathematical physics and mathematical biology a mathematical sociology can also be discerned.
Keywords: mathematical models, rational choice, social mechanisms, social process, social structure.

Introduction: The origin of Mathematical Sociology can be traced back in 1950s (Fararo2). However, Mathematics is boon for all the quantitative empirical researches. Mathematics is of great significance and use for Natural Sciences. However, it has been useful in the branches of Social Sciences such as Economics, Psychology and for the past 60 years Sociologists take advantage of Mathematical tools to develop theories. Now, we also hear the terms such as Mathematical Biology and Mathematical Biophysics. Likewise, Mathematical Sociology is treated as application of mathematics in explaining complex social realities. This essay presents an overview of Mathematical Sociology and its main approaches. There can be debate over the nature of Mathematical Sociology as to whether it is a Science or an Art. Its evolution as a Discipline or a Subject is debatable. However, this article will focus on the undeniable underlying truth of applying Mathematics in subject matters of Sociology e.g. concepts of set theory, mapping, matrix etc. can be used in representing social phenomena in human behaviour, migration, mobility etc. In this small article, we have illustrated few fundamentals of Maths which can be applied in quantitative social science research. The application may include from representing sociological phenomena or sentences in simple mathematical forms to develop models and equations.

History of Mathematical Sociology: Interest in mathematical sociology took off in the post-Second World War period. The pre-war work of Rashevsky (1939a, 1939b, 1940a, 1940b, 1941, and 1942) was emblematic of early efforts in mathematical sociology – problems were approached in a 'grand theory' fashion with little attention to relevant data.

The post-war period, the 1950s and 1960s, was a task; in the internal system, the three variables characterize interpersonal relations such as friendships. The first contribution to Mathematical Sociology can be dated back to 1785 by Condorcet when he studied possibility of transitive outcomes of voting. Poison used probability for a jury to make verdict in 1837, Watson applied stochastic process model for family line extinction study in 1874. Voltera, Lotka carried out important work in Mathematical Demography and Diffusion modelling in 1930s. Dodd (1942) attempted to explain Society with mathematical approach by using Mathematical symbols and formulas, however it was later recognized in 1955 in diffusion model as a significant contribution in the field. In 1940s Rashevesky, a Biologist and his group in University of Chicago published many articles and in 1946 probably, Rashevesky first time used the term Mathematical sociology. Some significant publications from the group are Landau's work on hierarchy (Landau, 1951) and Rapoport's model of diffusion of networks (1953). Paul Lazars-field organized a group at Columbia and his early efforts led to the publication in 1954 of a collection of papers entitled 'Mathematical Thinking in the Social Sciences' which have an everlasting impact on the field. Simon, Homan and Feininger were some significant contributors of that period.

However, major contributions to the field came between late 1950s and middle 1960s. Coleman's 'Introduction to Mathematical Sociology' provides a significant way to conceptualize social processes by using Mathematical languages. White's study on kinship using Algebra in 1963 was another major contribution.

All these works belonged to US. Outside US a pioneering effort was done in by Richardson (1960) and Paris (1955) in Britain who developed differential equation model for armed races and stochastic model on social mobility respectively. Similarly, Carlson in 1958 and Bourdon in 1960s were two other significant academicians from Scandinavia and France respectively. Later, many thinkers began to join e.g. Bell, Blalock, Doreen, Farrago, Eldritch, Anderson, Land, Spiderman, Krishnan, Hackathon, Sorensen etc. Since last few decades, Social Network Analysis has gained popularity. This is also due to the fact of easily available and reliable data to study networks on World Wide Web. The concept can be traced to the seminal study conducted by Mark Granovetter (1974), who interviewed 282 professional and managerial men in Newton, Massachusetts but never concluded a causal relationship between network ties and actors (Lin3). Later in 1978, the small world study conducted in New York gives indirect linkage between ties and status attainment by actors. This has become a discipline with Social Network Analysis becoming one of the major focus areas of it.

Some Developing Theories in Mathematical Sociology: A Markov chain or Markov process is a stochastic model describing a sequence of possible events in which the probability of each event depends only on the state attained in the previous event.[1] It is a stochastic process with a series of states that alternate between one another. Probabilities based on the current state of the Markov chain determine these transitions.

Markov chains have many applications as statistical Model of real-world processes, such as studying cruise control systems in major vehicles, queues or lines of customers arriving at an airport, currency exchange rates and animal population dynamics. The maximum probability decision rule can also be used by a Markov chain-based approach to determine the language. Empirical experiments demonstrated that, when compared to the N-gram approach, market chains could recognize languages faster and with a reduced mistake rate.

Harrison Collyer White (born March 21, 1930) is the emeritus Giddings Professor of Sociology at Columbia University. White played an influential role in the “Harvard Revolution” in social networks. He is credited with the development of a number of mathematical models of social structure including vacancy chains. He has been a leader of a revolution in sociology that is still in process, using models of social structure that are based on pattern of relations instead of the attributes and attitudes of individuals.

Mathematics in Social Relations: Sets and relation are interconnected with each other. The relation defines the relation between two given sets.

If there are two sets available, then to check if there is any connection between the two sets, we use relations. For example, an empty relation denotes none of the elements in the two sets is same.

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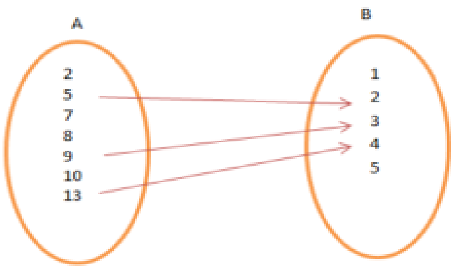
In Maths, the relation is the relationship between two or more set of values. Suppose, X and Y are two sets of ordered pairs. And set a has relation X with set Y, and then the values of set X are called domain whereas the values of set Y are called range.
Mathematically,:$f: X \rightarrow Y$, where X is domain and Y is co-domain or range.
Example: For ordered pairs = {(2, 3), (-3, 5), (6, 8), (-7, 8), (9, 8)}
The domain is = {9,-7, 6,-3, 2}
And range is = {3, 5, 6, 8}.



R = {(5, 2), (10, 3), (13, 4)}
In the above diagram: The domain is = {5, 10, 13}
Range is = {2, 3, 4}.

Example: Let X be set of Agricultural workers (elements) with a variable A (individuals under study) and Y be the set of Non-agricultural workers (elements) with variable B. If the relation between the individuals and their choices is to be shown as f, we may represent it $f: X \rightarrow Y$.

Year	1860	1870	1880	1890	1900	1910	1920	1930	1940	1950
Agricultural Workers: A (in millions)	6.2	6.9	8.6	9.9	10.9	11.6	12.5	10.5	9.8	7.8
Non-Agricultural Workers: B (millions)	4.3	6.1	8.8	13.4	18.2	24.4	30.2	36.8	43.9	52.2

Conclusion: Of course, it is not necessary that all social theories are set up as systems of equations. But we do claim that it should be required from every quantitatively oriented sociological theory that it can be translated into the language of mathematics, as this is what we actually do when we apply a statistical model. In this respect, we view mathematics as a general tool for testing the inner logic of theories. Needless to say, mathematical modeling must never become an end in itself. No mathematics in the world will make a poor theory rich. The sociological imagination must always be privileged in the process of theory construction. Mathematical model building of course has its own problems, something we have not even touched upon. For instance, the interpretation of the b-parameter in Sørensen's Vacancy Competition Model is not undisputed (see discussions in Nielsen & Rosenfeld 1981a, b; Wilson 1981; Rosenfeld & Nielsen 1984). Nevertheless, there are areas of sociology that we think would benet a great deal from explicit mathematical model specications. We consider that this is of uttermost importance for the branch of sociology that dwells within sophisticated statistical analyses of large-scale quantitative data. We rmly believe that an instance of reection on the implicit mathematics of the theory before model testing would produce sociology of higher standards.

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