Use of Mathematical Theories in understanding the Affects of Policies and their role in Strengthening the Communities: Adaptation of Fisher Information Model

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Understanding the overall performance of strategy dependents upon the consideration of the parameters of the system and the fluctuations they undergo. This paper proposes that such an understanding of systems behavior using classical physics is not adequate as the fluctuations are no longer remain linear. Hence the author presents an alternative method based on classical measurement theory originally propounded by Fisher. This paper is looking at the possibility of this application to social phenomena. For example- on the internal affects of a policy on the system (community or an organization) and its components (people in a community). Every component (entity/people) is being understood as an input signal from which data can be collected as an operation of measurement but each entity can influence the other entities output but applying peer-pressure which is common in communities. The net outcome from such analysis is a deeper understanding of the systems response to a input (here a policy or a event) and our results have shown that the influence a neighboring entity on its closest entities are far more effective than was predicted in classical studies.

Introduction: -

Creating a good and healthy society has been the dream of many and has a long history starting from the age of early tribal leaders to today's international leaders. To please everyone in the society, understanding everyone's needs and doing what is best for all (or at least for most), one needs the knowledge of human behavior, which we have not found till now and this is rightly put has '`*No man is an Island`, but how exactly are we affected by the behavior of other? Are there `Laws of Nature` that guide human affairs? Have we complete freedom in creating our societies, or are we trapped by `Human Nature`? And how in human affairs, one thing leads to another?* Scientists work on insensate things and yet through mathematics and physics make new technologies available for use and provide undeniable and unquestionable understanding of evolution and the structure of society.

However, this necessarily doesn't make mathematical-physics a candidate for understanding the societies intricate structure. Under lining all this is a more subtle and difficult question: does physics driven by abstract mathematical equations simply help us explain and understand, or can we apply to anticipate or predict outcomes from a society (organization or community) faced with a change of strategy. What we want to tell is that such physical rules can be applied in designing, managing and executing policies or strategies which can be helpful in making a better society for all of us to live. The basic aims of this paper are:

a) To introduce the mechanistic view of a society and its elements.
b) To give a feel of mathematical tools that can be used to analyse the society's features.
c) To introduce one such specific tool called as 'Fisher Information Theory'.
d) To introduce these models to policy or strategy makers in developing new policies.

The History and nature of mechanistic view of Society and its influence on Socio-Physics:-

Before I venture any further into the realms of mathematics and physics of society, it is worth considering why such a road should be taken to understand the effect of strength based practices to be used in the societies or organizations, which mainly details with the human welfare issues their mutual interactions, their responses to a global policy and so on. It must be noted that the human decisions (actions) under any given situation are unpredictable because of its complexity and numerous parameters that effect these actions and cannot be predicted accurately. But when considering the collective behavior such accuracies can be obtained not in predicting the individual's behavioral pattern or response but their collective response.

At face value it is not obvious how the science of physics, which studies properties of insensate things, will provide significant insights about complex human behavioral patterns in societies and in organizations. Yet such theories have discovered that systems whose component parts have a capacity to act collectively often show recurrent features, even though they might seem to have nothing at all in common with one another [1,2]. Even with our woeful ignorance of why humans behave the way they do when they are in a particular situation, it is possible to make some predictions about how they behave collectively, like in a organization or in a group [3,4,5].

Policy makers use findings from anthropologists and sociologists for understanding the human needs and concerns in developing a new policy. The studies they rely are often historical and offer limited scope to predict futuristic impacts of the policy that is being made for the very future. Policy makers concern themselves with what they think ought to be, while scientists (those dealing with study of nature and its laws) concentrate on the way things are. Science seeks to find description of observed phenomena (be it insensate matter or social behavior), and to understand how that phenomena might arise from simple assumptions and constraints [5]. Equipped with scientific and philosophical understanding of such theories, one can ask, what we would need to do in order to obtain a different result? For example: what should be done to increase the productivity of workers, in a organization? What should be done to make community engagement of members more cooperative? etc). Such decisions about what is desirable should properly be in the realm of public debate as they no longer are scientific questions. In this sense, then science becomes as it should be – a servant and guide to human nature and not a dictator [5-8].

Carolyn Merchant. In her book '*The Death of Nature (1983)*', argues that the notion of mechanistic, atomistic philosophy in the late seventeenth and early eighteenth century sanctioned the manipulation and violations of nature that continue to blight the world today. She also adds to it, 'It is hard to believe or even imagine how any model human social encounter, which regards, the behavior of individuals as governed by rigid mathematical and physical rules can offer as a vision of a better way to live, rather then a night marish robotic life'. This is an overkill of science and does not take into account of success of physics and mathematics in explaining the complex behaviors of nature -living and nonliving.The mechanistic natural philosophy was to have a much more central role in society and culture than even the old Aristotelian natural philosophy did, because:

- the new mechanistic world-view promised power, progress and domination of nature:
- it was of interest to states and rulers, and to those seeking to reform or modify existing social arrangements;
- it didn't supplant religion, but took a more important role, along with religion in legitimating social reality and social change.

Indeed, in a watered down 'headline' form, mechanical philosophy became the 'ideology' of modern science, down to the present day.

Name of the Philosopher	Time of living	Status
René Descartes	**1596 - 1650**	**French Catholic**
Thomas Hobbes	**1588 - 1676**	**English Protestant**
Pierre Gassendi	**1592 - 1655**	**French Catholic Priest**
Marin Mersenne	**1588 - 1648**	**French Catholic Monk**
Isaac Beekman	**1588 - 1636**	**Dutch Protestant**

Table 1: The Class of 1620 -- Creators of the Early Mechanistic Philosophy of Society[5,8].

What such priest –scientist and philosopher theorists proposed to do was to gain some understanding of how patterns of behaviour emerge, from the statistical blend of many individuals, pursuing their own idiosyncratic ways. Sometimes helping or swindling one another, cooperating or conflicting with each other. What do these models of societies inform us?: That in an interacting community collective actions and efforts are inevitable. No matter how eccentric and individualistic people behave, their actions are often the invisible details of a larger picture. This is not necessarily a description of powerlessness, but it is rather a picture of our interdependence on one another [9-12]. No scientific theory will show us how to build a paradise, but the search for a theory of social interactions will help us in making sure that we don't turn the society into a nightmare to live. Theories of such nature do not provide prescriptions but descriptions for our understanding that we might hope to make our choices and develop a clearer vision and for global good.

If you want to strengthen an organization or community, we should use the inherent properties or characteristics of the individuals that encompass their systems rather than trying to incorporate new value systems or new qualities into the system. But to use these characteristics we need to understand what those traits are, not individualised qualities but the qualities that manifest in the whole system i.e., the holistic view of the system. So, we begin local to end up global.

History and Origin of Econophysics:

Since the 1970s, a series of significant changes has taken place in the world of economics. During the past 30 years, physicists have achieved important results in the field of phase transitions, statistical mechanics, nonlinear dynamics, and disordered systems. In these fields, power laws, scaling, and unpredictable (stochastic or deterministic) time series are contained and the current interpretation of the underlying physics is often obtained using these concepts.

With this background in mind, it may surprise scholars trained in the natural sciences to learn that the first use of a power-law distribution (which are scale-free phenomena) and the first mathematical formalization of a random walk took place in the social sciences. At one time, it was imagined that the 'scale-free' phenomena are relevant to only a fairly narrow slice of physical phenomena [13]. However, the range of systems that apparently display power law and hence scale-invariant correlations has increased dramatically in recent years, ranging from base pair correlations in non-coding DNA [14,15], lung inflation [15,16] and inter-beat intervals of the human heart [17] to complex systems involving large numbers of interacting subunits that display 'free will', such as city growth [18,19], animal behavior [20], and even economics [21,22].

Could it be that somehow social systems push themselves up 'up to the limit' – just as a sand-pile is pushed to the limit before an avalanche starts, an image that has attracted recent attention in the debate between 'self-organized criticality' and 'plain old criticality' (see, e.g., Vespignani and Zapperi [23] and references therein)? For example, in economics every subunit plays according to rules and pushes itself up against the limits imposed by these rules. But social systems display a variety of rich forms of 'order', far richer than we anticipate from studies of ferromagnets and antiferromagnets (see, e.g., some of the papers appearing in Knobler et al. [24]). Could such orderings arise from the complex nature of the interactions? Or from the range of different 'sizes' of the constituent subunits as, e.g., one finds ordering in sand-piles when sand particles of two different grain sizes are dropped onto a heap – see, e.g., Refs. [23-27].

Model and its description*:

Fisher information is a physical intuitive concept, which is the measure of indeterminacy in a system. It has two basic roles to play. First, it is a measure of the ability to estimate a parameter of a given system or phenomenon. Second, it is a measure of the state of disorder of a system in statistical filed of study and latter makes it a corner stone of physical theory.

Our model is based on a simple physical measurement theory design, which isn't derived from classical information theory, but from Fisher's Extreme Physical Information theory. If Y is an observed value (let it be an overall effect of the policy on one particular train of character), and θ be the ideal value of such a trait, what we want to happen (like we want all the participants to be equally motivated or happy) is to reach this value. Now let X be the difference between these values (i.e. $X = Y - \theta$). Let us suppose that P(X) and Q(X) are assumed to be evaluated at a time T of the event, where in P(X) and Q(X) are functions of X, which describe the observed variation in X perfectly.

It is worth noting when we implement policies or plans and we expect θ, but our result is Y instead. What could be the causes that lead to such discrepancies that we end up with Y? This disparity is due to a wide range of causes.

a) Participatory nature
b) Ineffective policies
c) Non-universality of rules
d) Uncontrollable motional effects….etc.

$Y = \theta + X$ is the basic physical measurement event. Now we know the causes of the disparity but they take up so much of random space that we would call them as (human) noise.(s) And it is this noise(s) we are interested in.

Now consider Y to be a direct indication of a particular policy's effectiveness. By definition, the function P(X)is a random function, hence can be approximated (sometimes accurately represented also) by a Probability Density Function (PDF), which governs the ensemble of such events of measurement of Y's value under repeated initial conditions. Our concern is with how to evaluate P(X) so that we can predict the behavior of Y.

It is emphasized that we are interested in seeking the estimates of the P(X), rather than exact answers for P(X). The answer to problems of this kind depends intimately upon the nature of their constraints. However, the types of data that are used to define the PDF's for our problem are largely selected arbitrarily, ultimately out of our convenience, thus results are likewise arbitrary, concluding that the output PDF is by and large a manmade constructions. Hence it cannot be an absolute answer, but even societies are manmade and bear in mind that, we are seeking ian estimation or approximation and not a physical universal laws.

These effects have a direct complement in sociology, giving rise to the famous dilemma of choosing between a 'fundamentalist' and a 'technical' approach to estimation of societal parameters. Since the output PDF's of valuation are but estimates, by what measure of quality can each be judged? As mentioned above, it is generally felt that a candidate PDF should be minimally biased, i.e., maximally smooth (by what ever measure) is taken to be the main measure of quality. As Y denotes the intrinsic datum, i.e., a way of defining intrinsic fluctuations in X. The data or effects are here valuation denoted by Dm. These depend upon P(X), through relations,

D_m = integral of [dx*F_m(X)*P(X)], where m = 1,………M.

Where, Dm is the macroscopic effect of the policy, Y is the microscopic effect on each individual, F_m is the kernel functions custom built for a problem.

In all such applications, the activity of getting the data plays a vital role in initiating the EPI approach, which is the case here as well. The execution and effect of the policy of the given event during the time interval (t, t+dt) necessarily affects the PDF P(X) on its valuation. Since the interval is very short, the result is a perturbation of P(X). Therefore information I (Fisher Information) and J are perturbed, where J describes, the physical phenomenon and embody all the constraints that are imposed by the physical phenomena under measurement. Figure 2 gives the basic steps followed in this approach.

If the details of the integration and numerical analysis is told here, the paper would become inaccessible to general public (for example, you need not know the individual components and its structure in a computer to use it and we believe that some things are better kept hidden, for if they know it they no longer appreciate the simplicity of it). I took the problem of understanding the inclination of people towards any arbitrary policy which gives them a factor of advantage over the others.
The results can be summarized by figure 1.

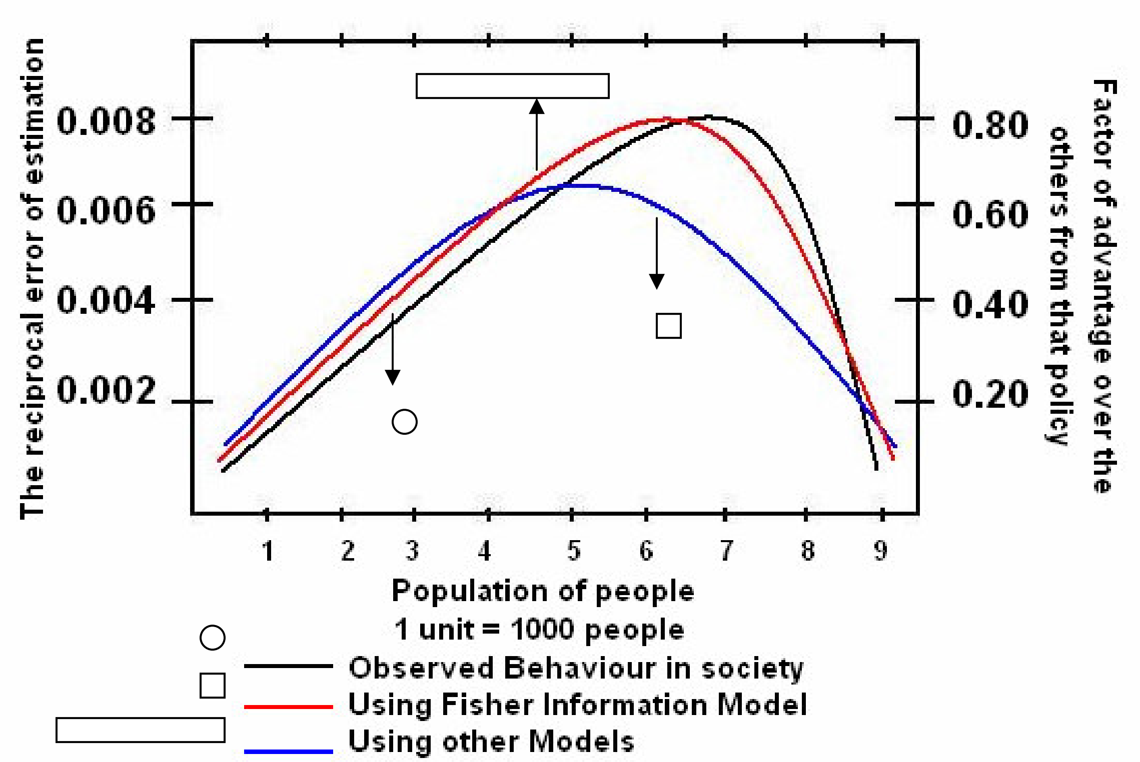

Figure 1: Flow chart diagram of EPI approach

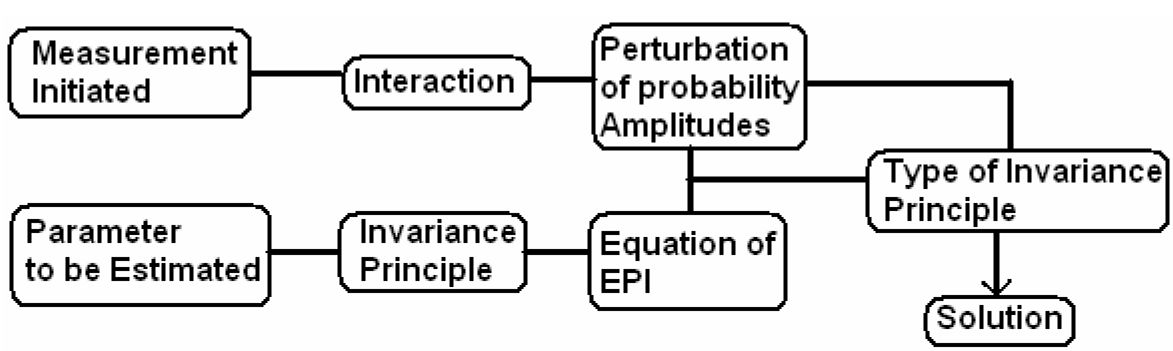

Figure 2: Flow chart diagram of EPI approach

Results and conclusions:

When observation are limited – as they often are in sociological data applications, other approaches such as smooth maximum entropy, minimum fisher information, often require strong prior knowledge, in the form of a critically chosen density function P(X), where as Fisher information theory simply imposes a continuity constraints. Using these approaches, one can deploy well-developed computational approaches from formally identical problems in community sciences. A key benefit of such approaches from the point view of mathematicis is that the output PDF's and resulting observables, i.e., the global effects have a degree of smoothness that one expects in a good estimation. By comparison, such approach is always expressed in mathematical terms (differential and integral equation on P(X)).

The aim of the approach is to place all or nearly all heterogeneous sociology agents within one stochastic and description of social dynamics that is provided by equation derived from mathematical abstractness. The real motive of this work ii not tell about a branch of some unknown physical theory and its connection with the social statistics (which can be a pure coincidence), but to tell that, physics can be helpful in someway to workers of society to help the society in a better way. The numerical results presented are based on a imaginary event or policy as such and hence can be used in any situation (suitably modified to fit the issue) and that is the beauty of the approach. There are questions that concern both the mathematicians and social workers, but they define it in different ways (like finding best solution to a social worker will be a solution acceptable to all while the same problem is defined has finding optimal solution with constraints) and these are the questions I would be delighted to discuss with any of the conference participants.

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