

AI and Ideas by Statistical Mechanics

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INTRODUCTION

A briefing (Allen, 2004) demonstrates the breadth and depth complexity required to address real diplomatic, information, military, economic (DIME) factors for the propagation/evolution of ideas through defined populations. An open mind would conclude that it is possible that multiple approaches may be required for multiple decision makers in multiple scenarios. However, it is in the interests of multiple decision-makers to as much as possible rely on the same generic model for actual computations. Many users would have to trust that the coded model is faithful to process their inputs.

Similar to DIME scenarios, sophisticated competitive marketing requires assessments of responses of populations to new products.

Many large financial institutions are now trading at speeds barely limited by the speed of light. They co-locate their servers close to exchange floors to be able to turn quotes into orders to be executed within msecs. Clearly, trading at these speeds require automated algorithms for processing and making decisions. These algorithms are based on "technical" information derived from price, volume and quote (Level II) information. The next big hurdle to automated trading is to turn "fundamental" information into technical indicators, e.g., to include new political and economic news into such algorithms.

BACKGROUND

The concept of "memes" is an example of an approach to deal with DIME factors (Situngkir, 2004). The meme approach, using a reductionist philosophy of evolution among genes, is reasonably contrasted to approaches emphasizing the need to include relatively global influences of evolution (Thurtle, 2006).

There are multiple other alternative works being conducted world-wide that must be at least kept in mind while developing and testing models of evolution/propagation of ideas in defined populations: A

study on a simple algebraic model of opinion formation concluded that the only final opinions are extremal ones (Aletti et al., 2006). A study of the influence on chaos on opinion formation, using a simple algebraic model, concluded that contrarian opinion could persist and be crucial in close elections, albeit the authors were careful to note that most real populations probably do not support chaos (Borghesi & Galam, 2006). A limited review of work in social networks illustrates that there are about as many phenomena to be explored as there are disciplines ready to apply their network models (Sen, 2006).

Statistical Mechanics of Neocortical Interactions (SMNI)

A class of AI algorithms that has not yet been developed in this context takes advantage of information known about real neocortex. It seems appropriate to base an approach for propagation of ideas on the only system so far demonstrated to develop and nurture ideas, i.e., the neocortical brain. A statistical mechanical model of neocortical interactions, developed by the author and tested successfully in describing short-term memory (STM) and electroencephalography (EEG) indicators, is the proposed bottom-up model. Ideas by Statistical Mechanics (ISM) is a generic program to model evolution and propagation of ideas/patterns throughout populations subjected to endogenous and exogenous interactions (Ingber, 2006). ISM develops subsets of macrocolumnar activity of multivariate stochastic descriptions of defined populations, with macrocolumns defined by their local parameters within specific regions and with parameterized endogenous inter-regional and exogenous external connectivities. Parameters of subsets of macrocolumns will be fit to patterns representing ideas. Parameters of external and inter-regional interactions will be determined that promote or inhibit the spread of these ideas. Fitting such nonlinear systems requires the use of sampling techniques.

The author's approach uses guidance from his statistical mechanics of neocortical interactions (SMNI),

developed in a series of about 30 published papers from 1981-2001 (Ingber, 1983; Ingber, 1985; Ingber, 1992; Ingber, 1994; Ingber, 1995; Ingber, 1997). These papers also address long-standing issues of information measured by electroencephalography (EEG) as arising from bottom-up local interactions of clusters of thousands to tens of thousands of neurons interacting via short-ranged fibers), or top-down influences of global interactions (mediated by long-ranged myelinated fibers). SMNI does this by including both local and global interactions as being necessary to develop neocortical circuitry.

Statistical Mechanics of Financial Markets (SMFM)

Tools of financial risk management, developed to process correlated multivariate systems with differing non-Gaussian distributions using modern copula analysis enables bona fide correlations and uncertainties of success and failure to be calculated. Since 1984, the author has published about 20 papers developing a Statistical Mechanics of Financial Markets (SMFM), many available at <http://www.ingber.com>. These are relevant to ISM, to properly deal with real-world distributions that arise in such varied contexts.

Gaussian copulas are developed in a project Trading in Risk Dimensions (TRD) (Ingber, 2006). Other copula distributions are possible, e.g., Student-t distributions. These alternative distributions can be quite slow because inverse transformations typically are not as quick as for the present distribution. Copulas are cited as an important component of risk management not yet widely used by risk management practitioners (Blanco, 2005).

Sampling Tools

Computational approaches developed to process different approaches to modeling phenomena must not be confused with the models of these phenomena. For example, the meme approach lends it self well to a computational scheme in the spirit of genetic algorithms (GA). The cost/objective function that describes the phenomena of course could be processed by any other sampling technique such as simulated annealing (SA). One comparison (Ingber & Rosen, 1992) demonstrated the superiority of SA over GA on cost/objective functions used in a GA database. That study used Very Fast

Simulated Annealing (VFSR), created by the author for military simulation studies (Ingber, 1989), which has evolved into Adaptive Simulated Annealing (ASA) (Ingber, 1993). However, it is the author's experience that the Art and Science of sampling complex systems requires tuning expertise of the researcher as well as good codes, and GA or SA likely would do as well on cost functions for this study.

If there are not analytic or relatively standard math functions for the transformations required, then these transformations must be performed explicitly numerically in code such as TRD. Then, the ASA_PARALLEL_OPTIONS already existing in ASA (developed as part of the 1994 National Science Foundation Parallelizing ASA and PATHINT Project (PAPP)) would be very useful to speed up real time calculations (Ingber, 1993). Below, only a few topics relevant to ISM are discussed. More details are in a previous report (Ingber, 2006).

SMNI AND SMFM APPLIED TO ARTIFICIAL INTELLIGENCE

Neocortex has evolved to use minicolumns of neurons interacting via short-ranged interactions in macrocolumns, and interacting via long-ranged interactions across regions of macrocolumns. This common architecture processes patterns of information within and among different regions of sensory, motor, associative cortex, etc. Therefore, the premise of this approach is that this is a good model to describe and analyze evolution/propagation of ideas among defined populations.

Relevant to this study is that a spatial-temporal lattice-field short-time conditional multiplicative-noise (nonlinear in drifts and diffusions) multivariate Gaussian-Markovian probability distribution is developed faithful to neocortical function/physiology. Such probability distributions are a basic input into the approach used here. The SMNI model was the first physical application of a nonlinear multivariate calculus developed by other mathematical physicists in the late 1970s to define a statistical mechanics of multivariate nonlinear nonequilibrium systems (Graham, 1977; Langouche et al., 1982).

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