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PROJECTS & INTERESTS

My InterNet archive http://www.ingber.com contains code and reprints documenting my statements, providing my optimization and nonlinear-stochastic algorithms which have been further developed and folded into my present codes.

Theoretical Physics

My original professional experiences and publications were in theoretical nuclear physics, always focused on explaining experimentally verifiable data [1-4]. I also contributed to teaching methodologies in various disciplines, including physics [5-7].

Adaptive Simulated Annealing (ASA) & Modelling

My optimization code, Adaptive Simulated Annealing (ASA) [8], is used worldwide in many disciplines for global optimization and sampling. I have experience leading teams in several disciplines, developing some powerful models and algorithms for extracting signal out of noise for some classes of systems, e.g., that typically arise in such diverse fields as finance [9-13], neuroscience [14-24], and combat simulations [25,26], utilizing my ASA C-code [8,27].

Trading in Risk Dimensions (TRD) & Risk-Management

Some of my previous work, mostly published, developed two-shell recursive trading systems. An inner-shell of trading indicators is adaptively fit to incoming market data. A parameterized trading-rule outer-shell uses my global optimization ASA code [8] to fit the trading system to historical data. A simple fitting algorithm, usually not requiring ASA, is used for the inner-shell fit.

I have developed a recent code, Trading in Risk Dimensions (TRD) [28,29], adding an additional risk-management middle-shell to create a three-shell recursive optimization/sampling/fitting algorithm. Portfolio-level distributions of copula-transformed multivariate distributions (with constituent markets possessing different marginal distributions in returns space) are generated by Monte Carlo samplings. ASA is used to importance-sample weightings of these markets.

TRD processes Training and Testing trading systems on historical data, and consistently interacts with RealTime trading platforms -- all at minute resolutions. Faster or slower resolutions can be developed using the present structure of TRD. The code is written in vanilla C, and runs across platforms such as XP/Cygwin, SPARC/Solaris, i386/FreeBSD, i386/NetBSD, etc. TRD can be run as an independent executable or called as a DLL.

To illustrate how TRD can robustly and flexibly interact with various trading platforms, I have developed a working interface with TradeStation.

Statistical Mechanics of Neocortical Interactions (SMNI)

Over a span of three decades I have regularly developed Statistical Mechanics of Neocortical Interactions (SMNI), a theory of neocortical interactions across scales of mm to cm, with input only experimentally determined parameters of neocortex, and output detailed calculations permitting testing SMNI against data from short-term memory (STM) and electroencephalography (EEG) [30,31].

SMNI correctly calculated the stability and duration of STM, the observed 7 ± 2 capacity rule of auditory memory and the observed 4 ± 2 capacity rule of visual memory [32,33], the primacy versus recency rule [34], random access to memories within tenths of a second as observed, and Hick's law of linearity of reaction time with STM information [35].

Using the power of this formal structure, sets of EEG and evoked potential data from a separate NIH study, collected to investigate genetic predispositions to alcoholism, were fitted to an SMNI model on a lattice of regional electrodes to extract EEG brain "signatures" of STM [19,20].

Recent work develops variational Euler-Lagrange equations of the SMNI probability distribution to calculate conditions of oscillatory processing at frequencies consistent with observed EEG. A strong inference is drawn that physiological states of columnar activity receptive to selective attention support oscillatory processing in observed frequency ranges [23]. In a subsequent study, PATHINT (below) was used to evolve probability distributions of columnar activity with explicit oscillatory firings, and integrate such mesoscopic processes with global brain EEG activity [24].

Portfolio of Physiological Indicators (PPI)

Quite general portfolios of specialized constituents also can be addressed, as described in http://www.ingber.com/ingber_projects.html. For example, multiple synchronous imaging data, processed with the TRD copula analysis, and using SMNI models [30,31,36]. leads to a portfolio of physiological indicators (PPI) to enhance resolution of neocortical processing information [21].

PATHTREE, PATHINT & Options

I have developed a full suite of options codes, which may be integrated with TRD, or used independently.

In the early 1990's I developed PATHINT to evolve multivariate probability distributions, defined by general nonlinear Gaussian Markovian processes — multiplicative noise, and published applications in several disciplines. In 2000, I created a faster algorithm PATHTREE, a binomial tree to evolve such probability distributions. PATHTREE was thoroughly tested and finally published [12]. Both PATHTREE and PATHINT have been applied to options codes, e.g., delivering full sets of Greeks based on such underlying probability distributions. Because of its speed of processing, PATHTREE has been used to fit the shape of distributions to strike data, i.e., a robust bottom-up approach to modeling dependence of strikes on volatilities.

Ideas by Statistical Mechanics (ISM)

A recent paper, "Ideas by Statistical Mechanics (ISM)", integrates previous projects to model evolution and propagation of ideas/patterns throughout populations subjected to endogenous and exogenous interactions [37-39]. This product can be used for decision support for projects ranging from diplomatic, information, military, and economic (DIME) factors of propagation/evolution of ideas, to commercial sales, trading indicators across sectors of financial markets, advertising and political campaigns, etc.

Real Options for Project Schedules (ROPS)

These tools also are being applied to price complex projects as financial options with alternative schedules and strategies. PATHTREE processes real-world options, including nonlinear distributions and time-dependent starting and stopping of sub-projects, with parameters of shapes of distributions fit using ASA to optimize cost and duration of sub-projects [40].

Statistical Mechanics of Combat (SMC)

As a Professor of Physics with the US Navy, and working with the US Army, I was PI of US Army Contract RLF6L, funded by the Deputy Under Secretary of the Army for Operations Research (DUSA-OR). I led a team of Officers and contractors to successfully baseline Janus(T) — a battalion-level war game with statistical details of performance characteristics of weapons, movement of men and machines across various terrains — to National Training Center (NTC) data obtained in the field [41-44].

The ROPS project was motivated by using such simulations to develop data to develop Real Options for the massive US Army project Future Combat Systems (FCS).

Lester

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