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PROJECTS & INTERESTS

My InterNet archive https://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. This archive is a representative sample of over 100 publications.

Consulting

As CEO of Physical Studies Institute LLC (PSI) I consult on projects overlapping with my expertise as documented in my archive at https://www.ingber.com . Some of these projects are proprietary and cannot be made public.

Statistical Mechanics of Neocortical Interactions (SMNI)

Over a span of four 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) (Ingber, 1982; Ingber, 1983).

SMNI correctly calculates 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 (Ingber, 1984; Ingber, 1985b), the primacy versus recency rule (Ingber, 1995), random access to memories within tenths of a second as observed, time for diffusion of localized information across columns, and Hick's law of linearity of reaction time with STM information (Ingber, 1999).

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 (Ingber, 1997; Ingber, 1998b).

SMNI scales up to develop 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 (Ingber, 2009a). 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 (Ingber & Nunez, 2010).

Additional work at multiple scales includes quantum scales of neuron-astrocyte interactions into SMNI STM (Ingber, 2012b; Ingber, 2011; Ingber, Pappalepore & Stesiak, 2014; Ingber, 2015; Ingber, 2016b; Ingber, 2018a; Ingber, 2022a; Ingber, 2021b; Ingber, 2022b).

From Feb 2013 through Dec 2021, I was a Principal Investigator (PI) in the National Science Foundation resource The Extreme Science and Engineering Discovery Environment (XSEDE) [https://www.xsede.org]. The first grants for these resources were for "Electroencephalographic field influence on calcium momentum waves" (Ingber, Pappalepore & Stesiak, 2014; Ingber, 2015; Ingber, 2016b). Since Jun 2021, these projects are being continued at the Ookami supercomputer at StonyBrook.edu (SUNY SB). This work has been recognized as an important contribution to neuroscience and to computational physics. Reviews were given in https://www.ingber.com/smni14_eeg_ca_JTB_reviews.txt and include press releases such as https://www.xsede.org/mechanism-of-short-term-memory and http://ucsdnews.ucsd.edu/pressrelease/the_mechanism_of_short_term_memory . The current work expands the current SMNI model across vast scales from quantum effects at tripartite neuron-astrocyte-neuron synapses, to include probabilistic models of affective states. This project is as much about demonstrating a probabilistic model of human information processing that can be audited with respect to neocortical mechanisms, as it is about demonstrating the existence of EEG correlates to attention and affective behaviors. From Apr 2021 I am a PI on the Ookami supercomputer at SUNYSB for similar projects.

Adaptive Simulated Annealing (ASA) & Modelling

My optimization code, Adaptive Simulated Annealing (ASA) (Ingber, 1993a; Ingber, 2012a), 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 (Ingber, 1990; Ingber, 1996b; Ingber, 2000; Ingber, Chen *et al*, 2001; Ingber & Mondescu, 2003; Ingber, 2018b; Ingber, 2018c; Ingber, 2020), neuroscience (Ingber, 1991; Ingber, 1992; Ingber & Nunez, 1995; Ingber, Srinivasan & Nunez, 1996; Ingber, 1996c; Ingber, 1997; Ingber, 1998b; Ingber, 2006b; Ingber, 2009b; Ingber, 2009a; Ingber & Nunez, 2010; Ingber, 2012b; Ingber, 2012c; Nunez *et al*, 2013; Ingber, 2013; Ingber, Pappalepore & Stesiak, 2014; Ingber, 2015; Ingber, 2018b; Ingber, 2018c; Ingber, 2018a; Ingber, 2019), and combat simulations (Ingber, 1993b; Ingber, 1998a), utilizing my ASA C-code (Ingber, 1993a; Ingber, 1996a; Ingber, 2012a).

Other applications of ASA include studies of COVID-19 (Ingber, 2021a) and trading in crypto-currency markets (Ingber, 2020).

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 (Ingber, 1993a) to fit the trading system to historical data. A simple fitting algorithm, usually not requiring ASA, is used for the inner-shell fit.

Trading in Risk Dimensions (TRD) (Ingber, 2005; Ingber, 2010b), adds 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 -- at all time resolutions, e.g., including high-frequency trading (HFT), minute, daily, monthly, etc. The code is written in vanilla C, and runs across platforms such as Windows/Cygwin, SPARC/Solaris, i386/FreeBSD, i386/NetBSD, etc. TRD can be run as an independent executable or called as a DLL.

TRD can robustly and flexibly interact with various trading platforms. I have developed a working Windows interface with TradeStation and other Linux platforms.

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 (Ingber, Chen *et al*, 2001). 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. New codes, qPATHTREE and qPATHINT, have been developed for similar use in quantum complex-variable spaces under XSEDE.org and StonyBrook.edu Ookami grants for Hybrid Classical-Quantum computing (Ingber, 2016a; Ingber, 2017a; Ingber, 2017b; Ingber, 2017c; Ingber, 2018b; Ingber, 2018c; Ingber, 2018a).

These codes have broad applications, e.g., ranging from computational neuroscience to computational physics to blockchains.

Theoretical Physics

My original professional experiences and publications were in theoretical physics, always focused on explaining experimentally verifiable data (Ingber, 1968; Buchler & Ingber, 1971; Frazer *et al*, 1972; Ingber, 1986). I also contributed to teaching methodologies in various disciplines, including physics (Ingber, 1972; Assimov *et al*, 1973; Ingber, 1981a) and karate (Ingber, 1976; Ingber, 1981b; Ingber, 1985a).

Portfolio of Physiological Indicators (PPI)

Quite general portfolios of specialized constituents also can be addressed, as described in https://www.ingber.com/ingber_projects.html. For example, multiple synchronous imaging data, processed with the TRD copula analysis, and using SMNI models (Ingber, 1982; Ingber, 1983; Ingber, 2008b). leads to a portfolio of physiological indicators (PPI) to enhance resolution of neocortical processing information (Ingber, 2006b).

Ideas by Statistical Mechanics (ISM)

"Ideas by Statistical Mechanics (ISM)", integrates previous projects to model evolution and propagation of ideas/patterns throughout populations subjected to endogenous and exogenous interactions (Ingber, 2006a; Ingber, 2007a; Ingber, 2008a). 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)

Similar tools can be 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 (Ingber, 2007b; Ingber, 2010a).

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 (Ingber, 1988; Ingber, 1989a; Ingber, 1989b; Bowman & Ingber, 1997).

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).

Education

In addition to developing and teaching undergraduate and graduate courses in academic institutions, I have created opportunities and organizations to educate people outside these institutions (Ingber, 1972; Ingber, 1981a; Ingber, 1981b; Ingber, 1985a). My XSEDE.org project helped to educate volunteers in selected topics in physics and neuroscience. I regularly address technical queries on papers in my https://www.ingber.com archive. Via reviewing for scores of scientific journals, I help authors as well as publishers develop their papers.

Current Projects

The file is https://www.ingber.com/psi_computational_physics_group.html is updated with some current projects, e.g., "Synchronous Interactions Between Quantum and Macroscopic Systems".

A public 1-page resume is in https://www.ingber.com/ingber_summary_1.pdf .

Lester

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