OOKAMI PROJECT APPLICATION

Date: 05/03/2021

Project Title: Hybrid Classical-Quantum Fitting Attention States to Statistical Mechanics of Neocortical Interactions

Usage:

☒ Testbed

☐ Production

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Names & Email of initial project users:

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Usage Description:

Hybrid Classical-Quantum computing has already arrived at several commercial quantum computers, offered to researchers and businesses. Here, application is made to a classical-quantum model of human neocortex, Statistical Mechanics of Neocortical Interactions (SMNI), which has had its applications published in many papers since 1981. However, this project only uses Classical (super-)computers. Since 2015, a path-integral algorithm, PATHINT, used previously to accurately describe several systems in several disciplines, has been generalized from 1 dimension to N dimensions, and from classical to quantum systems, qPATHINT. Published papers have described the use of qPATHINT to neocortical interactions and financial options. The classical space described by SMNI applies nonlinear nonequilibrium multivariate statistical mechanics to synaptic neuronal interactions, while the quantum space described by qPATHINT applies synaptic contributions from Ca2+ waves generated by astrocytes at tripartite neuron-astrocyte-neuron sites. Previous SMNI publications since 2013 have calculated the astrocyte Ca2+ wave synaptic interactions from a closed-form (analytic) expression derived by the author. However, more realistic random shocks to the Ca2+ waves from ions entering and leaving these wave packets should be included using qPATHINT between electroencephalographic (EEG) measurements which decohere the quantum wave packets. This current project extends calculations to multiple scales of interaction between classical events and expectations over the Ca2+ quantum processes to include these random shocks in previous codes used to fit EEG data to the SMNI model, that included the analytic forms for the quantum processes but now replaced by qPATHINT. The author's Adaptive Simulated Annealing (ASA) importance-sampling optimization code is used for fitting the combined classical-quantum system. Gaussian Quadratures is used for numerical calculation of momenta expectations of the astrocyte processes that contribute to SMNI synaptic

interactions. This project thereby demonstrates how some hybrid classical-quantum systems may be calculated quite well using only classical (super-)computers.
Note that a running draft/preprint describing this project is at
https://www.ingber.com/smni21_hybrid_smni.pdf

Computational Resources:

Total node hours per year: 15,000

Size (nodes) and duration (hours) for a typical batch job:
Nodes: 128
Hours: 48

Disk space (home, project, scratch):
Home: 100 GB
Project: 100 GB
Scratch: 1000 GB

Personnel Resources (assistance in porting/tuning, or training for your users**): -**

Required software:
SLURM, GCC, tcsh-shell

If your research is supported by US federal agencies:

Agency: N/A

Grant number(s): N/A

Production projects:

Production projects should provide an additional 1-2 pages of documentation about how
(a) the code has been tuned to perform well on A64FX (ideally including benchmark data comparing performance with other architectures such as x86 or GPUs)
(b) it can make effective use of the key A64FX architectural features (notably SVE, the high-bandwidth memory, and NUMA characteristics)
(c) it can accomplish the scientific objectives within the available 32 Gbyte memory per node