Opportunity Title: Quantum Advantage and Computational Tractability
Opportunity Reference Code: ICPD-2023-13

Organization Office of the Director of National Intelligence (ODNI)

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How to Apply **Create and release your Profile on Zintellect** – Postdoctoral applicants must create an account and complete a profile in the on-line application system. **Please note: your resume/CV may not exceed 2 pages.**

Complete your application – Enter the rest of the information required for the IC Postdoc Program Research Opportunity. The application itself contains detailed instructions for each one of these components: availability, citizenship, transcripts, dissertation abstract, publication and presentation plan, and information about your Research Advisor co-applicant.

Additional information about the IC Postdoctoral Research Fellowship Program is available on the program website located at: https://orise.orau.gov/icpostdoc/index.html.

If you have questions, send an email to ICPostdoc@orau.org. Please include the reference code for this opportunity in your email.

Application Deadline 2/28/2023 6:00:00 PM Eastern Time Zone

Description **Research Topic Description, including Problem Statement:**

Classical computers have reached performance limits in some applications largely due to restrictions caused by current architectures and the algorithms on which they rely. As a result, a number of efforts have focused over the last few years in achieving the “quantum advantage”, i.e., the ability of quantum computers to outperform classical computers. To be clear, there are also limits on the performance of quantum computers, such as being difficult to build, engineer and program. Physical resource limitations such as available bandwidth, energy, and volume, in particular, induce error rates that typically grow as the requirements for more qubits grow. Herein lies one of the chief challenges, i.e., qubits are fragile and prone to errors. In quantum computing, error correction efforts are a necessity that usually begin with encoding information over a system of multiple redundant qubits. In addition, quantum computing algorithms generally have qubit resource requirements that far exceed the current scale at which quantum computers can be built. The diverse and dynamic applications of the Intelligence Community (IC) demand a new perspective in terms of how we assess the physical systems that can define mission strategies and impact mission outcomes. The radically different computational parallelism offered by the superposition principle in quantum systems may extend the range of tractable computations beyond those achievable by classical computation. However, there continues to be a need to be practical in balancing the costs of quantum computing versus classical computing with respect to ROI. Quantum computing is not economically feasible or practical in some cases in which classical computing performs well. However, the continued interest in solutions of NP-complete problems are expected to keep quantum computing at the forefront of future discussions. Most often, conversations are focused on the impact of quantum computing on the performance of algorithms, in particular, and data science, in general. However, less attention is placed

on the ability of data science to impact and advance quantum computing, though more attention is surely deserved.

Example Approaches:

Examine computational tasks with known inputs; Examine learning tasks in which the goal is to learn about an a priori unknown physical system; Expand the problems that can be mapped directly onto quantum architectures; Identify and assess hybrid classical/quantum approaches and their potential impact; Examine the potential of data science to advance quantum computing.

Relevance to the Intelligence Community (IC):

Problems to be Considered:

- Quantum computing systems from the perspective of differentiated organizational structures instead of the current emphasis on undifferentiated qubit arrays.
- Algorithms and applications that can offer useful speedups on quantum machines.
- Use of supervised and unsupervised machine learning (ML) models to predict properties and underlying structure in physical systems beyond the scope of conventional experiments.
- Hybrid classical/quantum approaches and their potential impact.

Qualifications

Postdoc Eligibility

- U.S. citizens only
- Ph.D. in a relevant field must be completed before beginning the appointment and within five years of the application deadline
- Proposal must be associated with an accredited U.S. university, college, or U.S. government laboratory
- Eligible candidates may only receive one award from the IC Postdoctoral Research Fellowship Program

Research Advisor Eligibility

- Must be an employee of an accredited U.S. university, college or U.S. government laboratory
- Are not required to be U.S. citizens
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Key Words: #Classical computing, #Quantum computing, #Quantum Advantage, #Computational Tractability, #Qubits, #Error Correction, #NP-Complete Problems, #Data Science.

Eligibility Requirements

- **Citizenship:** U.S. Citizen Only
- **Degree:** Doctoral Degree.
- **Discipline(s):**
  - **Chemistry and Materials Sciences** (12 👁)
  - **Communications and Graphics Design** (6 👁)
  - **Computer, Information, and Data Sciences** (17 👁)
  - **Earth and Geosciences** (21 👁)

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- **Engineering** (27 👁)
- **Environmental and Marine Sciences** (14 👁)
- **Life Health and Medical Sciences** (48 👁)
- **Mathematics and Statistics** (11 👁)
- **Other Non-Science & Engineering** (2 👁)
- **Physics** (16 👁)
- **Science & Engineering-related** (1 👁)
- **Social and Behavioral Sciences** (29 👁)