Zintellect
climb higher

Opportunity Title: Debugging for Quantum Computers
Opportunity Reference Code: ICPD-2021-19

Organization Office of the Director of National Intelligence (ODNI)

Reference Code ICPD-2021-19

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 2/26/2021 6:00:00 PM Eastern Time Zone

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

There have been many schemes developed for secure multiparty computations, and an election is one of the most important types of multiparty computations that takes place. The requirements for secure elections are manifold and clear delineation of these requirements is complicated. The sorts of cryptography that would be applicable needs to be investigated and the computational requirements need to be accurately estimated. Furthermore, a security model needs to be written and implemented. This may require a policy definition language, a way to parse it, and a way to insert it into a secure program. In addition to simple security in the form of keeping all votes secret while publicly reporting the tally, it will be necessary to provide zero-knowledge proofs that the protocol was correctly executed. In addition to simply writing out the requirements, a systems engineering approach needs to be adopted to show all the moving parts and how they need to fit together. It will also be necessary to develop some exploratory software so election officials can play out a number of “what if” scenarios.

Example Approaches:

To date, very minimal effort has focused on quantum debugging. What little effort has been dedicated to this area has focused largely on implementing measures to assure, such as type correctness in software, or imposing assertions about quantum state properties at various points throughout the program. As of yet, there is no clear method of systematically identifying and discriminating hardware faults from software faults in a quantum program. Generally, the topic's challenge rests with determining efficient methods that characterize and benchmark multiqubit systems for the purposes of fault diagnostics. Among methods for characterizing qubit operations, quantum tomography has grown in importance for its capacity to diagnose errors, yet it suffers quickly from the so-called curse of dimensionality, where the number of parameters that need to be characterized grows exponentially with the number of qubits. Alternatively, benchmarking methods present a far more scalable option when only a single overall performance metric is desired. Nevertheless, even these methods have not been successfully implemented on more than five qubits. We are thus encouraging the identification of new and efficient methods that can characterize multiqubit systems for the purposes of quantum debugging as outlined. The use of tomographic information selectively and predictively could form one of the many possible approaches to this relatively unexplored topic.

Relevance to the Intelligence Community:

As expressed through its research programs in quantum computing, the Intelligence Community continues to be interested in understanding how to characterize multiqubit operations and predict their performance in real systems made from compromises and imperfect devices. In this topic, we consider errors more generally from a full-stack computing approach, to include, under the heading of “debugging,” the errors brought by incorrect transcriptions of high-level directions to the constraints of real hardware. Along with possibly identifying a new class of error, we expect the excursion into debugging will reveal alternative and efficient ways to characterize multiqubit systems.

Key Words: Quantum Computing, Debugging, Quantum Characterization, Quantum Tomography, Multiqubit Systems, Fault Diagnostics

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

Eligibility Requirements

- **Citizenship:** U.S. Citizen Only
- **Degree:** Doctoral Degree.
- **Discipline(s):**
  - **Chemistry and Materials Sciences** (12)
  - **Communications and Graphics Design** (2)
  - **Computer, Information, and Data Sciences** (17)
  - **Earth and Geosciences** (21)
  - **Engineering** (27)
  - **Environmental and Marine Sciences** (14)
  - **Life Health and Medical Sciences** (45)
  - **Mathematics and Statistics** (10)
  - **Other Non-Science & Engineering** (2)
  - **Physics** (16)
  - **Science & Engineering-related** (1)
  - **Social and Behavioral Sciences** (27)