REQUEST FOR PROPOSAL

1.0   BACKGROUND

The Universities Space Research Association (**USRA**), **NASA** and **Google** are collaborating to explore the short and long term benefits of new Artificial Intelligence (AI) algorithms designed to run on hybrid quantum-classical computing machinery.

2.0   OVERVIEW

The Universities Space Research Association (**USRA**) is pleased to invite proposals for Cycle 3 of the Quantum Artificial Intelligence Laboratory Research Opportunity, which will allocate computer time for research projects to be run on the D-Wave System at **NASA** Ames Research Center (ARC).

The total allocated computer time for the research opportunity represents approximately 20% of the total available runtime during the period. Successful projects will be allowed to remotely access the quantum computer, and to run a number of jobs up to a maximum allocated runtime usage.

The Call is open to all qualified researchers affiliated to accredited universities, not-for-profit organizations, and industry (**PROPOSERs**). Exceptions to researchers unaffiliated with universities might be considered, in **USRA**'s sole discretion, in case of proposals of outstanding quality and the desire to publish the results of the investigation. The computer time will be provided free of charge. No financial support is offered for the completion of the project.

Proposals are sought for research on artificial intelligence algorithms and advanced programming (mapping, decomposition, embedding) techniques for quantum annealing, with the objective to advance the state-of-the-art in quantum computing and its application to artificial intelligence.

The D-Wave System currently features the "Whistler" chip. High-level descriptions of the computer and its programming can be found on D-Wave website http://www.dwavesys.com/resources/tutorials. The specific machine installed at ARC currently has more than 2000 qubits in the working graph.

A number of published research papers documenting the use of D-Wave processors or discussing its applications can be found at http://www.usra.edu/quantum/bibliography

For detailed information and application instructions, visit the Quantum AI Lab website at http://www.usra.edu/quantum/rfp.

3.0 QUALIFICATIONS OF THE PROVIDER:

3.1   **USRA** may make such reasonable investigations as deemed proper and necessary to determine the ability of the **PROPOSER** to perform the work.

3.2   **USRA** further reserves the right to reject any proposal if the evidence submitted by, or investigation of, such offeror fails to satisfy **USRA** that such offeror is properly qualified to carry out the obligations of the contract and to complete the work contemplated.

3.3   **Who May Propose:**

Participation in this Research Opportunity is open to scientists from all categories of accredited educational institutions, not-for-profit organizations, and industry. Exceptions to researchers unaffiliated

with universities might be considered, in **USRA**'s sole discretion, in case of proposals of outstanding quality and the desire to publish the results of the investigation.

4.0 PROPOSAL PREPARATION AND SUBMISSION REQUIREMENTS:

Proposals should be as thorough and detailed as possible so that **USRA** may properly evaluate your capabilities to conduct the proposed research. The proposal will consist of a document detailing the research project (max 5 pages), with a cover page (see Appendix A). The cover page is not included in the page count. The document will need to answer the following questions:

1. Introduce the questions under investigation and the main bibliographical references connected to the proposed research.

2. Describe the optimization problems connected to the scientific investigation that you plan to run on the D-Wave 2 machine. Please specify whether an efficient encoding of the optimization problem in the quantum hardware has been already developed.

3. Describe your objectives on how to make use of the results of your investigation. Are you planning to publish the results of these investigations, are these runs exclusively for internal use of your research group?

4. Provide a suggested timeline, including major milestones, for the proposed project.

5. Please describe the members of the project team and the collaborators (including potential collaborators) that will contribute to this research project. Specify also if you plan or desire to collaborate with researchers in the Quantum Artificial Intelligence Laboratory (see http://www.nas.nasa.gov/quantum/).

The answer to the previous questions should be framed within a 5 pages long document (minimum font size 10) and may contain equations and figures. The proposer can complement the document with additional information as well as additional documents that might or might not be considered by the review panel, under their discretion.

4.1   Ownership of Proposal Data

Ownership of all data, materials and documentation originated and prepared for **USRA** pursuant to the RFP shall belong exclusively to **USRA, unless such data, materials and documentation are clearly marked by PROPOSER as proprietary.**

- Trade secrets or proprietary information submitted by **PROPOSER** shall not be subject to public disclosure; however, **PROPOSER** must invoke the protection, in writing, either before or at the time the data is submitted in order to request confidential treatment of such information.
- The written notice must specifically identify the data or materials to be protected and state the reasons why protection is necessary. The proprietary or trade secret material submitted must be identified by some distinct and conspicuous method such as highlighting or underlining and must indicated only the specific words, figures, or paragraphs that constitute trade secret or proprietary information.
- **The classification of an entire proposal document as proprietary or trade secret is not acceptable.**

4.2   Deadline for Submission and Late Proposals

Proposals should be submitted on or before September 30, 2017 12:00 p.m. Pacific Standard Time for full consideration in the first set of proposal selections for this Cycle. The call for proposals will remain open after the due date, and applications received after the due date will also be considered, in USRA's sole discretion. USRA will preferentially approve proposals submitted before the deadline. Proposals must be submitted by email to: DVenturelli@usra.edu. Scientific Questions about this RFP can be directed to the USRA Science Operations Manager, Dr. Davide Venturelli (Dventurelli@usra.edu). Contractual questions can be directed to **USRA** Contracts Manager, Pam Henry (phenry@usra.edu).

4.3   Term the Agreements for computing time: August 2017-December 2018.

5.0 EVALUATION AND AWARD CRITERIA

Proposals submitted in response to this Call will be evaluated in a competitive peer review. The peer review panel, including its chair, will be recruited from the academic community including from the researchers of the Quantum Artificial Intelligence Laboratory from **Google**, **USRA** and **NASA**.

Based on the results of the peer review, a recommendation for the total program will be submitted to **USRA**, who will make the final proposal selection.

The following factors will be used in evaluating proposals for the QuAIL Research Opportunity:

1. The overall scientific merit of the proposed investigation.

2. The feasibility of accomplishing the objectives of the investigation.

3. The degree to which the investigation uses unique capabilities of the D-Wave System.

4. The competence and relevant experience of the Principal Investigator and any Collaborators to carry the investigation to a successful conclusion.

5. The relevance of the scientific objective for practical applications in science, engineering and industrial domains.

USRA reserves the right to select only a portion of a proposer's investigation, in which case the PI of the proposal will be given the opportunity to accept or decline the implementation of the partial selection.

6.0 SPECIFIC PROPOSAL CONSIDERATIONS:

6.1 Available Software and Technical Support

Researchers awarded with machine time will be provided the use of D-Wave API (available in python, C and Matlab) to interface the computer remotely under a uniform Third Party Researcher Agreement. This includes documentation and support from **USRA** scientists on technical issues. **NASA** Ames Research Center requires secure authentication to access the quantum front end system which will be provided upon completing **NASA** Requirements including online training for IT Security and passing NASA security reviews. The clearing procedure will be described in a PI handbook.

6.2 Subjects of research

Any scientific discipline where optimization problems arise offers potentially valid research domain for this research opportunity program. However, in case of a large number of applicants, priority will be given to research topics which can be related to the missions of **USRA**, **NASA**, and **Google**.

6.3 Education and Public Outreach

USRA reserves the option to promote briefly the project objectives and investigators on related websites and during E&PO initiatives, as well as inviting the project representatives to selected events.

6.4 Run Time Allocation

An estimation of the required computing time/cycles to conduct the research project must be provided by the PI in the proposal, including preferred periods of time for the use of the computer. Should a research project require more runs than originally requested and allocated, additional time may be awarded. The successful proposals will be assigned instructions and tokens to be able to perform calculations remotely on the hardware, as specified in the PI handbook.

7.0 AWARD:

7.1 **USRA** may cancel this Request for Proposals or reject proposals at any time, and is not required to furnish a statement of the reason why a particular proposal was not deemed to be the most advantageous.

7.2 Should **USRA** determine in writing and in its sole discretion that **PROPOSER's** proposal is acceptable; the parties will commence negotiations to put in place a research agreement which will include the requirements, terms, and conditions of the solicitation and **PROPOSER**'s proposal as negotiated. Either Party to the agreement may unilaterally terminate the Agreement by providing thirty (30) calendar days written notice to the other Parties.

7.3 Generally, intellectual property developed through research using the quantum computer will be retained by those conducting the research, subject to each individual's employer's intellectual property policies. The research agreement executed between **USRA** and successful PROPOSERs will describe the specific rights related to Intellectual Property.

7.4 **PROPOSER** shall have the right to publish results of its research in any publication, provided that **PROPOSER** shall give proper credit to **USRA** for the cooperative nature of the research, and whenever possible, give credit to **USRA** in published reports regarding the research.

8.0   REPORTING AND DELIVERY REQUIREMENTS:

SEE ATTACHED DRAFT Quantum Computer Research Agreement Exhibit A.

9.0 GENERAL TERMS AND CONDITIONS:

SEE ATTACHED DRAFT Quantum Computer Research Agreement Exhibit A.

The award of a research agreement under this RFP shall, without limitation, be subject to the terms and conditions of the attached Draft Quantum Computer Research Agreement Exhibit A. Any exceptions to these terms and conditions by PROPOSERs must be presented in detail with the proposal, with adequate rationale therefor.

10.0 SPECIAL TERMS AND CONDITIONS; PROPOSER Conduct While On Government Premises

While on Government premises or remotely using the Quantum Computer which is on Government premises, **PROPOSER** shall comply with the governing rules, regulations, and procedures. Such rules and regulations are generally set forth in Agency-wide or local installation management instructions, handbooks, or announcements. See the Quantum Computer Research Agreement Exhibit A for specific details.

10.1   Computer Job Queue Slots and Remote Access

Remote access to the computer will be subject to **NASA** policies (e.g., all users of the quantum computer will need to take IT Security Training using the **NASA** SATERN Training System).

11.0 ATTACHMENTS:

SEE ATTACHED DRAFT Quantum Computer Research Agreement Exhibit A.

APPENDIX A: Proposal Cover Page

USRA Research Opportunity – Cover Sheet

Please submit this form together with your (max 5 pages) proposal.

Title of Proposal:	
Principal Investigator (PI):	
PI Affiliation (if applicable):	
Contact Email:	
Contact Phone:	
Contact Full Address:	
Requested Number of Compute Time (D-Wave computer time, Max 100, renewable):	
Requested Number of Months (Project duration):	
Proposal Short Abstract	
Names and emails of collaborators who will be given access under this project:	
Proposal Subject Keyword (choose one or suggest a new one): QA Device Programming, QA Device Physics, Condensed Matter Physics, Network Optimization, Chemistry, Material Science, Biology, Machine Learning, Image Analysis, Mathematics, Scheduling, High Performance Computing, Computer Science, Quantum Physics, Spin Glass Physics, Finance, Logistics, Planning, Scheduling	