

US Naval Nuclear Laboratory <> Womanium

Quantum+AI for Climate1. Project Overview:

High performance modeling and simulation is central to many fields of science and engineering. Geophysical systems, ranging from microscopic models of light transport through clouds, to global models of the interactions between the Earth's climate and ecosystems, present some of the most complex modeling and simulation problems known to science. As the importance of these calculations grows, so too does the need to perform them quickly and efficiently, as their results are used to inform scientists and policy-makers on the potential impacts of climate change on human activities (and vice-versa).

In this project, your goal will be to apply **AI/ML** and/or **Quantum Computing** techniques to solving any computational or data science problem of your choosing that addresses topics related to weather, climate, geophysical systems, clean energy, and mitigation of carbon emissions. Some ideas include:

- AI or quantum-accelerated computations of atmospheric flow and circulations (e.g. Navier-Stokes and CFD).
- Use historical climate data and public simulation outputs to create a fast-running AI model of the Earth's climate that runs on a laptop or PC.
- Develop a quantum algorithm for simulating battery or photovoltaic materials.
- Model the interaction of light with water droplets and clouds using quantum computing or AI.

These are only a small sampling of possible ideas. Feel free to be creative and choose a problem that interests you the most!

2. Project Duration:

- 4 weeks
- Teams start working on July 5, 2024
- Teams submit their project solutions on August 9, 2024

3. Team Guidelines:

- Team size - Maximum 4 participants per team.
- All team participants must be enrolled in [Womanium Quantum+AI 2024](#).
- Everyone is eligible to participate in this project and win Womanium grants.
- Get selected for Womanium QSL fellowships with *NNL.

4. Project Tasks/ Deliverables:

- 1) Each project submission (as a short presentation and/or writeup) should include:
 - a) A short statement of the problem and background. Explain why the problem you picked is important or interesting to your team and why you are interested in solving it. (10 points)
 - b) A short description of background research and literature reviews that your team did. What have others done in the past to try to solve the problem, what advantages and disadvantages are there to different approaches? List all the references you used. (15 points)
 - c) Describe how AI or Quantum methods can be used to help solve your problem. Give a detailed description of the algorithms involved and how they work. Discuss any results that you obtained or that you read in your literature review. Also, comment on the computational resources needed to run your solution. What kind of advantages does AI or quantum provide? (25 points)
 - d) If your team has time, work towards developing a small demo app of the method. You can use existing code and data if needed. If the problem is too big to run on the hardware you have access to, that's ok! (+15 points)
- 2) To pass, each team should submit a short presentation or write up that fulfills items a-c above. Task d should be considered as a bonus challenge! Scores of 30 points or higher will be considered passing.
- 3) High-quality submissions should demonstrate:
 - a) A good discussion of the problem being researched.
 - b) Thorough execution and description of background research.
 - c) Good understanding of the quantum or AI solution method being used. What are the benefits and drawbacks? How does it provide an advantage? What can you say about its explainability or accuracy?
 - d) A clear communication of the team's findings to an audience of their peers.
 - e) For demo applications, you should present the source code you used, and describe how you set up the problem and what kind of

runtime performance you saw (speed, accuracy, memory, etc.). Also show any outputs, plots, or animations.

5. Quantum Hardware Credits / Platform:

- Participants may use any quantum SDK or platform of their choice.
- Participants may choose to develop Quantum solutions or completely classical solutions using any classical AI/ML tech stack of their choice.

6. Judging Criteria:

- Scores of 30 points or higher will be considered as passing the project, and will be awarded the Womanium Quantum+AI Project Certificate.
- All successful project submissions on Github and Canvas will be considered for Womanium Grants.
- Completing all tasks makes you eligible to compete for QSL fellowships. Only US citizens will be eligible for QSL fellowships with NNL. Finalists for QSL fellowships will be decided on the basis of Highest cumulative scores from all tasks, Technical Merit, Novelty, Communication and Presentation Skills.

7. Resources:

- <https://arxiv.org/list/physics.ao-ph/recent>

* Only participants who are *US citizens* will be eligible for QSL fellowships with NNL.