NVIDIA Workshop
Session 2: Hands-on examples

CUDA Quantum Highlights

Overview

HPC Focused

- Supports GPU Supercomputing with Multi-Node Multi-GPU Circuit Simulation

QPU Integration

- Agnostic to quantum hardware type - compatible with superconductor, trapped-ion, etc.
- Integration with several hardware partners such as Quantinuum, IonQ, IQM, etc.

Future of Computing

- Distributed quantum co-processing model (multiple QPUs)
- Integrating quantum computers with classical computers
  - CPU, QPU and GPUs working in tandem

User-Friendly

- Low-level details abstracted away from the user
- Easy to experiment with different backends
- Performant Python API

Algorithmic primitives

1. Expectation value
   - To compute the expected values wrt a spin operator, there is the algorithmic primitive, the cudaq::observe function
   - observe()
   - observe_n()
   - observe_async()
     - Multiple QPUs where each GPU acts as the QPU

   The CUDA Quantum also provides an asynchronous version of the sampling function.

2. Hamiltonian term parallelism
   - The terms in the Hamiltonian are distributed across different QPUs.

3. Interoperability and integration with other libraries
   - psycf, openfermion
   - User can leverage the GPU acceleration available in other libraries - pytorch (quantum neural net)

4. Mid-circuit measurement


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Thank you!