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The NEASQC Benchmark Suite

The NEASQC (NExt ApplicationS of Quantum Computing) project investigates and develops Quantum-enabled applications that can take advantage of NISQ (Noise Intermediate-Scale Quantum) systems in fields such as drug discovery, CO2 capture, smart energy management, natural language processing, breast cancer detection, probabilistic risk assessment for energy infrastructures or inventory management.

One of the results of the project is The NEASQC Benchmark Suite (TNBS) which will evaluate the capability of current and future quantum hardware to execute typical QC workloads. The suite is still in development, but the benchmarking methodology has already been stated. The proposed methodology divides the suite into several benchmarks covering tasks that are common in one or several domains where QC is currently used. Each benchmark consists of:
- A kernel or task that needs to be performed often in QC applications. The definition of this kernel is done mathematically or procedurally. This intends to avoid linking the definition of the kernel to any algorithmic approach or codification.
- A test case, where this kernel plays a central role and whose output can be verified analytically or using a simulation performed in a classical environment.
The methodology also defines other aspects of the benchmark definition, such as:
- The performance of the quantum platform can be measured using the execution time of both the classical and the quantum parts of the test case.
- The quality of the output can be evaluated with respect to the non-quantum-generated output using statistical instruments. These instruments can be benchmark dependent.
- The definition of the benchmark must contain a detailed description of its execution procedure, as it can be different for each benchmark.
- The TNBS may provide a reference implementation of the benchmark using the QML environment.

As a proof of concept, two complete benchmarks have been developed so far following this methodological framework:
- The Quantum Amplitude Estimation (QAE) benchmark, where the kernel is the QAE itself and the test case is the calculation of the integral of a sine function within a given interval. The QC approach to calculate this integral implies using the QAE kernel, and its output can be easily calculated using a direct formula which enables easy verification of the output of the quantum circuit.
- The Probability Loading (PL) benchmark is based on the kernel of the same name, based on loading a probability distribution in a quantum circuit. The test case consists of loading a random uniform distribution with a particular mean and standard deviation generating values within a given interval. The output of the quantum circuit can be easily verified using these statistical properties of the distribution used to generate the loaded probabilities.

The project is still looking for new benchmarks inside its own use cases.

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