QUAFEL: Quantum Framework Evaluation

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- Motivated by the amount of available quantum simulators
- Project to evaluate scalability of quantum frameworks w.r.t. Number of Qubits, Circuit Depth, Number of Shots
- QUAFEL utilizes Kedro for Data management, Structuring code into individual nodes, Node dependency management
- Easily extendable by other frameworks
- Each combination from configuration becomes a partition to be executed

**Concept**

<table>
<thead>
<tr>
<th>Frameworks</th>
<th>Gather Configuration &amp; Generate Partitions</th>
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</thead>
<tbody>
<tr>
<td>Num. Qubits</td>
<td></td>
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<tr>
<td>Circuit Depth</td>
<td></td>
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<tr>
<td>Number of Shots</td>
<td></td>
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<tr>
<td>Number of Evaluations</td>
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</table>

**Execution**

- Unique IDs allow identifying and resuming the evaluation
- Circuits described by QASM language
- Statistics for each configuration
- Utilization of single- and multiprocessing
- Execution time is measured using
  - CPU (no acceleration)
  - perf_counter and process_time
- Randomly generated circuits

**Visualization**

- Plots show the evaluation time (30 evaluations each)
- Left plot visualizes runtime for using 16 qubits and 4066 shots
- Right plot shows results for using a circuit depth of 1024 and 4066 shots

**Experiment environment:**

- 48x Intel(R) Xeon(R) Gold 5118 CPU @ 2.30GHz
- Cirq: 1.2.0 | Pennylane: 0.33.1 | Qibo: 0.2.2
- Qiskit: 0.45.0 | Qulacs: 0.6.2 | Qrisp: 0.3.0
- If available, frameworks are configured to not use acceleration

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**Gather Configuration Parameters & Generate Partitions**

- Gather configuration parameters
- Generate partitions

**Generate Circuit**

- Qasm

**Evaluate Partition**

- Qasm

**Aggregate Results & Experiment Versioning**

- Exemplary Kedro Pipeline
  - D: Data
  - N: Node

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**Visualization Results & Export Plots**