What is Q#?

Q# [1] is a hybrid quantum-classical programming language from Microsoft. It supports execution on existing quantum hardware using Azure Quantum, but is also designed for future large-scale, fault-tolerant quantum computing. Its key features include:

- Classical computation and control flow can be freely mixed with quantum gates and measurements. For example, see the `if` statements and `repeat` loop below.
- Classical functions in Q# are generated from their counterparts in Q#.
- Quantum operations are controlled by classical operations and measurements. For example, see the `ApplyCNOTChain` statement.

### Grammar

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<tr>
<th><code>cmd-GateApRef</code></th>
<th><code>cmd-GateAp</code></th>
<th><code>cmd</code></th>
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<tr>
<td><code>gateapr</code></td>
<td><code>GateAp</code></td>
<td><code>cmd</code></td>
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<td><code>ctrlapr</code></td>
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<td><code>bind</code></td>
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### Statics

- Typing rules for gate application:
  - `cmd-GateApRef`:
    - `gateapr [cmd `e`]`:
  - `cmd-GateAp`:
    - `cmd gateap [cmd `e`]`:
    - `cmd gateap [cmd `e`]`

### Dynamics

- `trsm-GateApRefInstr`:
  - `gateap [cmd `e`]`
  - `gateap [cmd `e`]`

### References


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**Toward Formalizing the Q# Programming Language**

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