

QUANTUM CONCEPT ANALYSIS

REPORT

I. Overall Summary

- **Total Matches Found:** 558
- **Unique Files with Matches:** 241
- **Unique Concepts Matched:** 115
- **Total Patterns Defined:** 28
- **Total Patterns Found:** 25
- **Average Similarity Score:** 0.8950

II. Match Type Breakdown

Match Type Counts

match_type	count
name	373
summary	185

Average Score by Match Type

match_type	similarity_score
name	0.9931
summary	0.6971

III. Source Framework & Target Project Breakdown

Matches by Source Framework

framework	count
classiq	343
qiskit	112
pennylane	103

Matches by Target Project

project	count
classiq-library	309
Qualtran	63
amazon-braket-examples	40
Cirq	19
qiskit-machine-learning	19
Qrisp	18
amazon-braket-algorithm-library	14
qiskit-finance	13
catalyst	10
tensorcircuit	9
qiskit-algorithms	8
quimb	7
ProjectQ	4

project	count
qiskit-nature	4
qibo	4
torchquantum	4
guppylang	3
thewalrus	2
Perceval	2
qiskit-optimization	2
ReCirq	1
qiskit-addon-cutting	1
OpenFermion	1
grove	1

IV. Cross-Framework Pattern Analysis

Table 4.1: Source Pattern Analysis (Where patterns originate)

pattern	Total Matches	Source Frameworks
Basis Change	154	classiq, pennylane, qiskit
Quantum Phase Estimation (QPE)	57	classiq, pennylane
Quantum Arithmetic	40	classiq, pennylane, qiskit

pattern	Total Matches	Source Frameworks
Data Encoding	35	classiq, pennylane, qiskit
Quantum Singular Value Transformation	34	classiq
Circuit Construction Utility	33	classiq, qiskit
Oracle	29	classiq, pennylane, qiskit
Amplitude Amplification	25	classiq
Hamiltonian Simulation	20	classiq, pennylane, qiskit
Initialization	17	classiq, qiskit
Variational Quantum Algorithm (VQA)	13	classiq, pennylane, qiskit
Quantum Logical Operators	13	qiskit
Quantum Neural Network (QNN)	11	pennylane
Quantum Approximate Optimization Algorithm (QAOA)	10	classiq, pennylane, qiskit
Grover	10	classiq, pennylane, qiskit
Quantum Amplitude Estimation (QAE)	9	pennylane
Linear Combination of Unitaries	7	classiq
SWAP Test	6	classiq
Quantum Singular Value Transformation (QSVT)	5	pennylane
Variational Quantum Eigensolver (VQE)	5	pennylane

pattern	Total Matches	Source Frameworks
Creating Entanglement	5	classiq
Controlled Linear Rotation	5	classiq
Phase Shift	4	classiq, pennylane
Quantum Amplitude Estimation	1	classiq
Linear Combination of Unitaries (LCU)	1	pennylane

Table 4.2: Adoption Pattern Analysis (Where patterns are used)

pattern	Project Coverage	Found In Projects
Circuit Construction Utility	9	Cirq, OpenFermion, Qualtran, ReCirq, amazon-braket-algorithm-library, amazon-braket-examples, classiq-library, qiskit-optimization, thewalrus
Quantum Phase Estimation (QPE)	8	ProjectQ, Qrisp, Qualtran, amazon-braket-algorithm-library, amazon-braket-examples, classiq-library, guppylang, qiskit-finance
Basis Change	8	Cirq, Qrisp, Qualtran, amazon-braket-algorithm-library, amazon-braket-examples, catalyst, classiq-library, qibo
Oracle	7	Cirq, Qualtran, amazon-braket-algorithm-library, amazon-braket-examples, classiq-library, qiskit-algorithms, quimb
Quantum Arithmetic	7	

pattern	Project Coverage	Found In Projects
		Cirq, Qrisp, Qualtran, amazon-braket-examples, catalyst, classiq-library, qiskit-finance
Quantum Approximate Optimization Algorithm (QAOA)	6	ProjectQ, catalyst, classiq-library, qiskit-machine-learning, quimb, tensorcircuit
Variational Quantum Algorithm (VQA)	6	Perceval, classiq-library, qiskit-addon-cutting, qiskit-finance, qiskit-nature, torchquantum
Amplitude Amplification	5	Qrisp, amazon-braket-examples, classiq-library, grove, qiskit-algorithms
Quantum Singular Value Transformation	5	Qualtran, amazon-braket-algorithm-library, amazon-braket-examples, classiq-library, guppylang
Data Encoding	5	Cirq, Qualtran, catalyst, classiq-library, qiskit-machine-learning
Grover	5	amazon-braket-algorithm-library, catalyst, classiq-library, qiskit-algorithms, qiskit-optimization
Quantum Neural Network (QNN)	5	Cirq, classiq-library, qiskit-machine-learning, quimb, tensorcircuit
Quantum Amplitude Estimation (QAE)	5	Qrisp, amazon-braket-examples, classiq-library, qibo, qiskit-finance
Initialization	4	Perceval, ProjectQ, amazon-braket-examples, classiq-library
Quantum Logical Operators	3	Qualtran, amazon-braket-examples, classiq-library

pattern	Project Coverage	Found In Projects
Variational Quantum Eigensolver (VQE)	3	amazon-braket-examples, classiq-library, qiskit-nature
Hamiltonian Simulation	2	classiq-library, qiskit-algorithms
Controlled Linear Rotation	2	Qualtran, classiq-library
Phase Shift	2	catalyst, classiq-library
Quantum Amplitude Estimation	1	classiq-library
Linear Combination of Unitaries (LCU)	1	classiq-library
Linear Combination of Unitaries	1	classiq-library
Creating Entanglement	1	classiq-library
Quantum Singular Value Transformation (QSVT)	1	classiq-library
SWAP Test	1	classiq-library

V. Quantum Pattern Analysis

Patterns by Match Count (Overall)

pattern	count
Basis Change	154
Quantum Phase Estimation (QPE)	57
Quantum Arithmetic	40
Data Encoding	35
Quantum Singular Value Transformation	34
Circuit Construction Utility	33
Oracle	29
Amplitude Amplification	25
Hamiltonian Simulation	20
Initialization	17
Quantum Logical Operators	13
Variational Quantum Algorithm (VQA)	13
Quantum Neural Network (QNN)	11
Grover	10
Quantum Approximate Optimization Algorithm (QAOA)	10
Quantum Amplitude Estimation (QAE)	9
Linear Combination of Unitaries	7
SWAP Test	6
Variational Quantum Eigensolver (VQE)	5

pattern	count
Controlled Linear Rotation	5
Creating Entanglement	5
Quantum Singular Value Transformation (QSVT)	5
Phase Shift	4
Linear Combination of Unitaries (LCU)	1
Quantum Amplitude Estimation	1

Average Score by Pattern

pattern	similarity_score
Quantum Amplitude Estimation	1
Initialization	0.9848
Hamiltonian Simulation	0.9826
Phase Shift	0.9595
Linear Combination of Unitaries	0.9547
SWAP Test	0.9546
Basis Change	0.9538
Variational Quantum Algorithm (VQA)	0.952
Quantum Singular Value Transformation (QSVT)	0.9369
Quantum Logical Operators	0.9211
Circuit Construction Utility	0.9175
Data Encoding	0.9076
Amplitude Amplification	0.9054

pattern	similarity_score
Oracle	0.9023
Creating Entanglement	0.8982
Controlled Linear Rotation	0.8897
Grover	0.8831
Variational Quantum Eigensolver (VQE)	0.8698
Quantum Phase Estimation (QPE)	0.822
Quantum Arithmetic	0.8112
Quantum Approximate Optimization Algorithm (QAOA)	0.8017
Quantum Singular Value Transformation	0.798
Quantum Neural Network (QNN)	0.7971
Linear Combination of Unitaries (LCU)	0.72
Quantum Amplitude Estimation (QAE)	0.6705

All Patterns within each Source Framework (Sorted by Frequency)

Classiq

pattern	count
Basis Change	107
Quantum Phase Estimation (QPE)	56
Quantum Singular Value Transformation	34
Amplitude Amplification	25
Circuit Construction Utility	17

pattern	count
Hamiltonian Simulation	15
Quantum Arithmetic	14
Initialization	11
Data Encoding	10
Oracle	9
Linear Combination of Unitaries	7
Grover	6
SWAP Test	6
Controlled Linear Rotation	5
Creating Entanglement	5
Phase Shift	3
Variational Quantum Algorithm (VQA)	2
Quantum Amplitude Estimation	1
Quantum Approximate Optimization Algorithm (QAOA)	1

Pennylane

pattern	count
Basis Change	21
Oracle	16
Quantum Neural Network (QNN)	11
Data Encoding	9
Quantum Amplitude Estimation (QAE)	9

pattern	count
Quantum Arithmetic	7
Quantum Approximate Optimization Algorithm (QAOA)	6
Quantum Singular Value Transformation (QSVT)	5
Variational Quantum Algorithm (VQA)	5
Variational Quantum Eigensolver (VQE)	5
Hamiltonian Simulation	4
Grover	2
Linear Combination of Unitaries (LCU)	1
Phase Shift	1
Quantum Phase Estimation (QPE)	1

Qiskit

pattern	count
Basis Change	26
Quantum Arithmetic	19
Circuit Construction Utility	16
Data Encoding	16
Quantum Logical Operators	13
Initialization	6
Variational Quantum Algorithm (VQA)	6
Oracle	4
Quantum Approximate Optimization Algorithm (QAOA)	3

pattern	count
Grover	2
Hamiltonian Simulation	1

VI. Top Matched Concepts

Top 20 Most Frequently Matched Concepts

Framework	Concept	Matches
Classiq	...hadamard_transform	52
Classiq	...qpe	30
Classiq	...qpe_flexible	26
Classiq	...qft	26
Qiskit	...QFT	24
Pennylane	...QFT	21
Classiq	...qsqt	19
Classiq	...apply_to_all	16
Classiq	...suzuki_trotter	15
Qiskit	...AND	11
Classiq	...phase_oracle	9
Pennylane	...QuantumMonteCarlo	9
Classiq	...grover_operator	8
Qiskit	...z_feature_map	8

Framework	Concept	Matches
Classiq	...qft_no_swap	8
Qiskit	...zz_feature_map	8
Classiq	...amplitude_amplification	7
Classiq	...qsvt_inversion	7
Classiq	...qct_qst_type2	7
Qiskit	...Permutation	7

VII. Unmatched Pattern Analysis

The following **3** patterns from the source files were **NOT found** in any project:

- Dynamic Circuit
- Function Table
- Schmidt Decomposition