

# QUANTUM CONCEPT ANALYSIS REPORT

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## I. Overall Summary

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- **Total Matches Found:** 573
- **Unique Files with Matches:** 251
- **Unique Concepts Matched:** 117
- **Total Patterns Defined:** 24
- **Total Patterns Found:** 22
- **Average Similarity Score:** 0.8951

## II. Match Type Breakdown

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### Match Type Counts

match_type	count
name	384
summary	189

### Average Score by Match Type

match_type	similarity_score
name	0.9927
summary	0.6967

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### III. Source Framework & Target Project Breakdown

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#### Matches by Source Framework

framework	count
classiq	344
qiskit	118
pennylane	111

#### Matches by Target Project

project	count
classiq-library	309
Qualtran	63
amazon-braket-examples	41
Cirq	22
qiskit-machine-learning	19
Qrisp	18
amazon-braket-algorithm-library	14
qiskit-finance	13
catalyst	10
tensorcircuit	9
qiskit-algorithms	8
covalent	7
torchquantum	7

project	count
quimb	7
qibo	5
qiskit-nature	4
ProjectQ	4
guppylang	3
thewalrus	2
Perceval	2
qiskit-optimization	2
qiskit-addon-cutting	1
grove	1
ReCirq	1
OpenFermion	1

## IV. Cross-Framework Pattern Analysis

**Table 4.1: Source Pattern Analysis (Where patterns originate)**

pattern	Total Matches	Source Frameworks
Basis Change	161	classiq, pennylane, qiskit
Quantum Phase Estimation (QPE)	57	classiq, pennylane
Domain Specific Application	53	classiq, pennylane

pattern	Total Matches	Source Frameworks
Quantum Arithmetic	43	classiq, pennylane, qiskit
Circuit Construction Utility	40	classiq, pennylane, qiskit
Data Encoding	37	classiq, pennylane, qiskit
Amplitude Amplification	26	classiq
Initialization	26	classiq, pennylane, qiskit
Hamiltonian Simulation	20	classiq, pennylane, qiskit
Variational Quantum Algorithm (VQA)	19	classiq, pennylane, qiskit
Quantum Logical Operators	13	qiskit
Oracle	13	classiq, qiskit
Quantum Neural Network (QNN)	11	pennylane
Quantum Approximate Optimization Algorithm (QAOA)	10	classiq, pennylane, qiskit
Grover	10	classiq, pennylane, qiskit
Linear Combination of Unitaries	7	classiq
Dynamic Circuit	6	pennylane
SWAP Test	6	classiq
Creating Entanglement	5	classiq

pattern	Total Matches	Source Frameworks
Variational Quantum Eigensolver (VQE)	5	pennylane
Phase Shift	4	classiq, pennylane
Quantum Amplitude Estimation	1	classiq

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

pattern	Project Coverage	Found In Projects
Circuit Construction Utility	11	Cirq, OpenFermion, Perceval, Qualtran, ReCirq, amazon-braket-algorithm-library, amazon-braket-examples, classiq-library, covalent, qiskit-optimization, thewalrus
Variational Quantum Algorithm (VQA)	8	Perceval, amazon-braket-examples, classiq-library, covalent, qiskit-addon-cutting, qiskit-finance, qiskit-nature, torchquantum
Domain Specific Application	8	Qrisp, Qualtran, amazon-braket-algorithm-library, amazon-braket-examples, classiq-library, guppylang, qibo, qiskit-finance
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

pattern	Project Coverage	Found In Projects
Quantum Arithmetic	7	Cirq, Qrisp, Qualtran, amazon-braket-examples, catalyst, classiq-library, qiskit-finance
Amplitude Amplification	6	Cirq, Qrisp, amazon-braket-examples, classiq-library, grove, qiskit-algorithms
Quantum Approximate Optimization Algorithm (QAOA)	6	ProjectQ, catalyst, classiq-library, qiskit-machine-learning, quimb, tensorcircuit
Data Encoding	6	Cirq, Qualtran, catalyst, classiq-library, covalent, 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
Initialization	5	ProjectQ, Qualtran, amazon-braket-examples, classiq-library, covalent
Quantum Logical Operators	3	Qualtran, amazon-braket-examples, classiq-library
Oracle	3	Cirq, classiq-library, qiskit-algorithms
Dynamic Circuit	3	Cirq, classiq-library, quimb
Variational Quantum Eigensolver (VQE)	3	amazon-braket-examples, classiq-library, qiskit-nature
Phase Shift	2	catalyst, classiq-library
	2	classiq-library, qiskit-algorithms

pattern	Project Coverage	Found In Projects
Hamiltonian Simulation		
Quantum Amplitude Estimation	1	classiq-library
Linear Combination of Unitaries	1	classiq-library
SWAP Test	1	classiq-library
Creating Entanglement	1	classiq-library

## V. Quantum Pattern Analysis

### Patterns by Match Count (Overall)

pattern	count
Basis Change	161
Quantum Phase Estimation (QPE)	57
Domain Specific Application	53
Quantum Arithmetic	43
Circuit Construction Utility	40
Data Encoding	37
Amplitude Amplification	26
Initialization	26

pattern	count
Hamiltonian Simulation	20
Variational Quantum Algorithm (VQA)	19
Oracle	13
Quantum Logical Operators	13
Quantum Neural Network (QNN)	11
Grover	10
Quantum Approximate Optimization Algorithm (QAOA)	10
Linear Combination of Unitaries	7
Dynamic Circuit	6
SWAP Test	6
Variational Quantum Eigensolver (VQE)	5
Creating Entanglement	5
Phase Shift	4
Quantum Amplitude Estimation	1

### Average Score by Pattern

pattern	similarity_score
Quantum Amplitude Estimation	1
Dynamic Circuit	1
Oracle	0.994
Hamiltonian Simulation	0.9826
Initialization	0.9617



pattern	similarity_score
Phase Shift	0.9595
Linear Combination of Unitaries	0.9547
SWAP Test	0.9546
Basis Change	0.9434
Variational Quantum Algorithm (VQA)	0.9383
Quantum Logical Operators	0.9211
Amplitude Amplification	0.909
Creating Entanglement	0.8982
Data Encoding	0.8969
Circuit Construction Utility	0.893
Grover	0.8831
Variational Quantum Eigensolver (VQE)	0.8698
Quantum Phase Estimation (QPE)	0.822
Quantum Arithmetic	0.8082
Quantum Approximate Optimization Algorithm (QAOA)	0.8017
Quantum Neural Network (QNN)	0.7971
Domain Specific Application	0.7876

## All Patterns within each Source Framework (Sorted by Frequency)

### Classiq

pattern	count
Basis Change	107
Quantum Phase Estimation (QPE)	56
Domain Specific Application	38
Amplitude Amplification	26
Initialization	18
Circuit Construction Utility	17
Quantum Arithmetic	17
Hamiltonian Simulation	15
Data Encoding	10
Oracle	9
Linear Combination of Unitaries	7
Grover	6
SWAP Test	6
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	28
Domain Specific Application	15
Data Encoding	11
Quantum Neural Network (QNN)	11
Variational Quantum Algorithm (VQA)	10
Quantum Arithmetic	7
Dynamic Circuit	6
Quantum Approximate Optimization Algorithm (QAOA)	6
Variational Quantum Eigensolver (VQE)	5
Hamiltonian Simulation	4
Circuit Construction Utility	3
Grover	2
Initialization	1
Phase Shift	1
Quantum Phase Estimation (QPE)	1

## Qiskit

pattern	count
Basis Change	26
Circuit Construction Utility	20
Quantum Arithmetic	19

pattern	count
Data Encoding	16
Quantum Logical Operators	13
Initialization	7
Variational Quantum Algorithm (VQA)	7
Oracle	4
Quantum Approximate Optimization Algorithm (QAOA)	3
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	...qft	26
Classiq	...qpe_flexible	26
Qiskit	...QFT	24
PennyLane	...QFT	21
Classiq	...qsvt	19
Classiq	...apply_to_all	16

Framework	Concept	Matches
Classiq	...suzuki_trotter	15
Qiskit	...AND	11
PennyLane	...QuantumMonteCarlo	10
Classiq	...grover_operator	9
Qiskit	...Permutation	9
Classiq	...phase_oracle	9
Qiskit	...zz_feature_map	8
Qiskit	...z_feature_map	8
PennyLane	...RandomLayers	8
Classiq	...qft_no_swap	8
PennyLane	...GQSP	7
Classiq	...qct_qst_type2	7

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## VII. Unmatched Pattern Analysis

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The following **2** patterns from the source files were **NOT found** in any project:

- Function Table
- Schmidt Decomposition