X Quantum: evaluation of LLM improved explanations

Give a score to each LLM improved explanation for each quantum algorithm

* Required

Demographic Information

Expertise in Software Engineering and Quantum Programming

1.	Indi	cate your expertise in Software Engineering in terms of number of years *
	\bigcirc	Zero
	\bigcirc	Under a year
	\bigcirc	1-2 years
	\bigcirc	3-4 years
	\bigcirc	5-10 years
	\bigcirc	10-15 years
	\bigcirc	Over 15 years

2. Indicate your expertise in Quantum Programming in terms of number of years ³
○ Zero
Under a year
1-2 years
3-4 years
5-10 years
10-15 years
Over 15 years

Amplitude Estimation

Algorithm Code

1. OPENQASM 2.0; 2. include "qelib1.inc"; 3. qreg eval[4]; 4. greg q[1]; 5. creg meas[5]; 6. u2(0,-pi) eval[0]; 7. u2(0,-pi) eval[1]; 8. u2(0,-pi) eval[2]; 9. u2(0,-pi) eval[3]; 10. u3(0.9272952180016122,0,0) q[0]; 11. cx eval[0],q[0]; 12. u(-0.9272952180016122,0,0) q[0]; 13. cx eval[0],q[0]; 14. u3(0.9272952180016122,0,0) q[0]; 15. cx eval[1],q[0]; 16. u(-1.8545904360032244,0,0) q[0]; 17. cx eval[1],q[0]; 18. u3(1.8545904360032244,0,0) q[0]; 19. cx eval[2],q[0]; 20. u(-3.7091808720064487,0,0) q[0]; 21. cx eval[2],q[0]; 22. u3(2.574004435173138,-pi,-pi) q[0]; 23. cx eval[3],q[0]; 24. u(-7.4183617440128975,0,0) q[0]; 25. cx eval[3],q[0]; 26. h eval[3]; 27. cp(-pi/2) eval[2],eval[3]; 28. cp(-pi/4) eval[1],eval[3]; 29. cp(-pi/8) eval[0],eval[3]; 30. h eval[2]; 31. cp(-pi/2) eval[1],eval[2]; 32. cp(-pi/4) eval[0],eval[2]; 33. h eval[1]; 34. cp(-pi/2) eval[0],eval[1]; 35. h eval[0]; 36. u(7.4183617440128975,0,0) q[0]; 37. barrier eval[0],eval[1],eval[2],eval[3],q[0]; 38. measure eval[0] -> meas[0]; 39. measure eval[1] -> meas[1]; 40. measure eval[2] -> meas[2]; 41. measure eval[3] -> meas[3]; 42. measure q[0] -> meas[4];

Ground Truth Description

AE aims to find an estimation for the amplitude of a certain quantum state.

3. A *

Link to the explanation: https://drive.google.com/file/d/12D5qmsqWtLCKctWNtzgb68RPkjZ2XTBK/view? usp=drive link

1 2 3 4 5

Wrong Explanation

4

5

		https://drive.goog	gle.com/file/d/12	D05Glo-GV5yBVwC	OTf8mrrjd5n9ySaAd/view?
	1	2	3	4	5
Wro	ong Explanation				Perfect Explanation
5. C *					
	to the explanation: = <u>drive_link</u>	https://drive.goog	gle.com/file/d/12	BYgFjBGM99vfMBM	14JQO3FEFjyZTn5km/view

Wrong Explanation Perfect Explanation

3

2

Deutsch-Jozsa

Algorithm Code

1. OPENQASM 2.0; 2. include "qelib1.inc"; 3. qreg q[10]; 4. creg c[9]; 5. u2(0,0) q[0]; 6. u2(0,0) q[1]; 7. h q[2]; 8. u2(0,0) q[3]; 9. h q[4]; 10. u2(0,0) q[5]; 11. u2(0,0) q[6]; 12. h q[7]; 13. u2(0,0) q[8]; 14. u2(-pi,-pi) q[9]; 15. cx q[0],q[9]; 16. u2(-pi,-pi) q[0]; 17. cx q[1],q[9]; 18. u2(-pi,-pi) q[1]; 19. cx q[2],q[9]; 20. h q[2]; 21. cx q[3],q[9]; 22. u2(-pi,-pi) q[3]; 23. cx q[4],q[9]; 24. h q[4]; 25. cx q[5],q[9]; 26. u2(-pi,-pi) q[5]; 27. cx q[6],q[9]; 28. u2(-pi,-pi) q[6]; 29. cx q[7],q[9]; 30. h q[7]; 31. cx q[8],q[9]; 32. u2(-pi,-pi) q[8]; 33. barrier q[0],q[1],q[2],q[3],q[4],q[5],q[6],q[7],q[8],q[9]; 34. measure q[0] -> c[0]; 35. measure q[1] -> c[1]; 36. measure q[2] -> c[2]; 37. measure q[3] -> c[3]; 38. measure q[4] -> c[4]; 39. measure q[5] -> c[5]; 40. measure q[6] -> c[6]; 41. measure q[7] -> c[7]; 42. measure q[8] -> c[8];

Ground Truth Description

This algorithms determines, whether an unknown oracle mapping input values either to 0 or 1 is constant (always output 1 or always 0) or balanced (both outputs are equally likely).

1	2	3	4	5
Wrong Explanation				Perfect Explanation
B *				
Link to the explanation usp=drive link	n: <u>https://drive.goo</u>	<u>ogle.com/file/d/12</u>	<u>9Riyg Aas LOmil Olx</u>	s8RxK5URGvcHWwY/v
1	2	3	4	5
Wrong Explanation				Perfect Explanation
C *				
Link to the explanation usp=drive link	n: <u>https://drive.goc</u>	<u>gle.com/file/d/12</u>	<u>7oIUTdEIRUq0w-0</u>	<u>UfozClgplFwn9Gfz/vie</u>
1	2	3	4	5

Grover

Algorithm Code

- 1. OPENQASM 2.0;
- 2. include "qelib1.inc";
- 3. qreg q[2];
- 4. greg flag[1];
- 5. creg meas[3];
- 6. h q[0];
- 7. h q[1];
- 8. x flag[0];
- 9. cp(pi/2) q[1],flag[0];
- 10. cx q[1],q[0];
- 11. cp(-pi/2) q[0],flag[0];
- 12. cx q[1],q[0];
- 13. cp(pi/2) q[0],flag[0];
- 14. u2(0,0) q[0];
- 15. u1(-pi) q[1];
- 16. cx q[0],q[1];
- 17. u2(-pi,-pi) q[0];
- 18. u1(-pi) q[1];
- 19. barrier q[0],q[1],flag[0];
- 20. measure q[0] -> meas[0];
- 21. measure q[1] -> meas[1];
- 22. measure flag[0] -> meas[2];

Ground Truth Description

One of the most famous quantum algorithm known so far, Grover's algorithm finds a certain goal quantum state determined by an oracle. In our case, the oracle is implemented by a multi-controlled Toffoli gate over all input qubits. In this no ancilla version, no ancilla qubits are used during its realization.

9. A * Link to the explanation: https://drive.google.com/file/d/122-iRUpmwgssY4K1D1VYa4K59Ry0U0Pz/view?usp=drive.link 1 2 3 4 5 Wrong Explanation Perfect Explanation

10. B *

Link to the explanation: https://drive.google.com/file/d/11zQ32YAWpqh1DS2VvyCFdbgo-eZwvGb1/view?usp=drive_link



Wrong Explanation

11. C *

Link to the explanation: https://drive.google.com/file/d/11zCQ6T6jHNBhAqKgL0_gSqA77ORh9UNe/view?usp=drive_link

Wrong Explanation

Quantum Fourier Transform

Algorithm Code

- 1. OPENQASM 2.0;
- 2. include "gelib1.inc";
- 3. qreg q[10];
- 4. creg c[10];
- 5. creg meas[10];
- 6. h q[9];
- 7. cp(pi/2) q[9],q[8];
- 8. h q[8];
- 9. cp(pi/4) q[9],q[7];
- 10. cp(pi/2) q[8],q[7];
- 11. h q[7];
- 12. cp(pi/8) q[9],q[6];
- 13. cp(pi/4) q[8],q[6];
- 14. cp(pi/2) q[7],q[6];
- 15. h q[6];
- 16. cp(pi/16) q[9],q[5];
- 17. cp(pi/8) q[8],q[5];
- 18. cp(pi/4) q[7],q[5];
- 19. cp(pi/2) q[6],q[5];
- 20. h q[5];
- 21. cp(pi/32) q[9],q[4];
- 22. cp(pi/16) q[8],q[4];
- 23. cp(pi/8) q[7],q[4];
- 24. cp(pi/4) q[6],q[4];
- 25. cp(pi/2) q[5],q[4];
- 26. h q[4];
- 27. cp(pi/64) q[9],q[3];
- 28. cp(pi/32) q[8],q[3];
- 29. cp(pi/16) q[7],q[3];
- 30. cp(pi/8) q[6],q[3];
- 31. cp(pi/4) q[5],q[3];
- 32. cp(pi/2) q[4],q[3];
- 33. h q[3];
- 34. cp(pi/128) q[9],q[2];
- 35. cp(pi/64) q[8],q[2];
- 36. cp(pi/32) q[7],q[2];
- 37. cp(pi/16) q[6],q[2];
- 38. cp(pi/8) q[5],q[2];
- 39. cp(pi/4) q[4],q[2];
- 40. cp(pi/2) q[3],q[2];
- 41. h q[2];
- 42. cp(pi/256) q[9],q[1];
- 43. cp(pi/128) q[8],q[1];
- 44. cp(pi/64) q[7],q[1];
- 45. cp(pi/32) q[6],q[1];
- 46. cp(pi/16) q[5],q[1];
- 47. cp(pi/8) q[4],q[1];
- 48. cp(pi/4) q[3],q[1]; 49. cp(pi/2) q[2],q[1];
- 50. h q[1];
- 51. cp(pi/512) q[9],q[0];
- 52. cp(pi/256) q[8],q[0];
- 53. cp(pi/128) q[7],q[0];
- 54. cp(pi/64) q[6],q[0];
- 55. cp(pi/32) q[5],q[0];
- 56. cp(pi/16) q[4],q[0];
- 57. cp(pi/8) q[3],q[0]; 58. cp(pi/4) q[2],q[0];
- 50. cp(pi/¬) q[Δ],q[0], ε0 cp/p:/2) α[1] α[0].

59. cp(pi/2) q[1],q[v];	
60. h q[0];	
61. swap q[0],q[9];	
62. swap q[1],q[8];	
63. swap q[2],q[7];	
64. swap q[3],q[6];	
65. swap q[4],q[5];	
66. barrier q[0],q[1],q[2],q[3],q[4],q[5],q[6],q[7],q[8],	q[9];
67. measure q[0] -> meas[0];	
68. measure q[1] -> meas[1];	
69. measure q[2] -> meas[2];	
70. measure q[3] -> meas[3];	
71. measure q[4] -> meas[4];	
72. measure q[5] -> meas[5];	
73. measure q[6] -> meas[6];	
74. measure q[7] -> meas[7];	
75. measure q[8] -> meas[8];	
76. measure q[9] -> meas[9];	

Ground Truth Description

QFT embodies the quantum equivalent of the discrete Fourier transform and is a very important building block in many quantum algorithms.

12. A *

Link to the explanation: https://drive.google.com/file/d/11kdVDqenMC-ISjAcWnLz8KRYdBcKw4TG/view? usp=drive link

1 2 3 4 5

Wrong Explanation

Perfect Explanation

13. B *

Link to the explanation: $\underline{https://drive.google.com/file/d/11kIdwGog-j3YO-Ksc446vR3gTQ4apDz0/view?}$ $\underline{usp=drive\ link}$

1 2 3 5

Wrong Explanation

Perfect Explanation

14. C *

Link to the explanation: https://drive.google.com/file/d/11k-5472PXC3cW4CPTI_NCGw0MFv8DfbW/view?usp=drive_link

1 2 3 4 5

Wrong Explanation

Quantum Fourier Transform with entanglement

Algorithm Code

- 1. OPENQASM 2.0;
- 2. include "qelib1.inc";
- 3. qreg q[5];
- 4. creg meas[5];
- 5. h q[4];
- 6. cx q[4],q[3];
- 7. cx q[3],q[2];
- 8. cx q[2],q[1];
- 9. cx q[1],q[0];
- 10. h q[4];
- 11. cp(pi/2) q[4],q[3];
- 12. h q[3];
- 13. cp(pi/4) q[4],q[2];
- 14. cp(pi/2) q[3],q[2];
- 15. h q[2];
- 16. cp(pi/8) q[4],q[1];
- 17. cp(pi/4) q[3],q[1];
- 18. cp(pi/2) q[2],q[1];
- 19. h q[1];
- 20. cp(pi/16) q[4],q[0];
- 21. cp(pi/8) q[3],q[0];
- 22. cp(pi/4) q[2],q[0];
- 23. cp(pi/2) q[1],q[0];
- 24. h q[0];
- 25. swap q[0],q[4];
- 26. swap q[1],q[3];
- 27. barrier q[0],q[1],q[2],q[3],q[4];
- 28. measure q[0] -> meas[0];
- 29. measure q[1] -> meas[1];
- 30. measure q[2] -> meas[2];
- 31. measure q[3] -> meas[3];
- 32. measure q[4] -> meas[4];

Ground Truth Description

This algorithms applies regular QFT to entangled qubits.

15. A *

Link to the explanation: https://drive.google.com/file/d/11swBJByTNvJjtQ96b rPjH0TCDz2W4vO/view? usp=drive link



Wrong Explanation

4

16. E	B *				
	ink to the explanat usp=drive link	ion: <u>https://drive.go</u>	oogle.com/file/d/11	<u>1m O3 34DsmTsuon</u>	d9xZC5h-5CilPxh9/view?
	1	2	3	4	5
١	Wrong Explanation				Perfect Explanation
17. (C *				
	ink to the explanat Link to the explanat	ion: <u>https://drive</u> .gc	oogle.com/file/d/11	IIIHdJUmWRKofDk7	vORIdbi5lxv5gFBw/view?

3

Wrong Explanation

2

Perfect Explanation

5

Quantum Phase Estimation

Algorithm Code

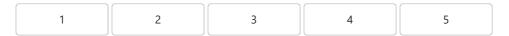
- 1. OPENQASM 2.0;
- 2. include "qelib1.inc";
- 3. qreg q[4];
- 4. greg psi[1];
- 5. creg c[4];
- 6. h q[0];
- 7. h q[1];
- 7.11 9[1]
- 8. h q[2];
- 9. h q[3];
- 10. x psi[0];
- 11. cp(-7*pi/8) psi[0],q[0];
- 12. cp(pi/4) psi[0],q[1];
- 13. cp(pi/2) psi[0],q[2];
- 14. swap q[1],q[2];
- 15. cp(pi) psi[0],q[3];
- 16. swap q[0],q[3];
- 17. h q[0];
- 18. cp(-pi/2) q[1],q[0];
- 19. h q[1];
- 20. cp(-pi/4) q[2],q[0];
- 21. cp(-pi/2) q[2],q[1];
- 22. h q[2];
- 23. cp(-pi/8) q[3],q[0];
- 24. cp(-pi/4) q[3],q[1];
- 25. cp(-pi/2) q[3],q[2];
- 26. h q[3];
- 27. barrier q[0],q[1],q[2],q[3],psi[0];
- 28. measure q[0] -> c[0];
- 29. measure q[1] -> c[1];
- 30. measure q[2] -> c[2];
- 31. measure q[3] -> c[3];

Ground Truth Description

QPE estimates the phase of a quantum operation and is a very important building block in many quantum algorithms. In the exact case, the applied phase is exactly representable by the number of qubits.

18. A *

Link to the explanation: https://drive.google.com/file/d/11jw7hnCwKk1f18fkSQ6tz|R4fFk7d6xl/view? usp=drive link

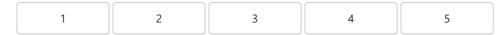


Wrong Explanation

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<u>usp=dı</u>	<u>rive_link</u>					
	1	2		3	4	5
Wrong	Explanation					Perfect Explanation

20. C *

Link to the explanation: https://drive.google.com/file/d/11bbFb1lyOLMjT14NLWW2UDws-KQs5l6p/view? usp=drive link



Wrong Explanation

Quantum walk

Algorithm Code

- 1. OPENQASM 2.0;
- 2. include "qelib1.inc";
- 3. qreg node[2];
- 4. greg coin[1];
- 5. creg meas[3];
- 6. h coin[0];
- 7. ccx coin[0],node[1],node[0];
- 8. cx coin[0],node[1];
- 9. x node[1];
- 10. x coin[0];
- 11. ccx coin[0],node[1],node[0];
- 12. cx coin[0],node[1];
- 13. x node[1];
- 14. u2(-pi,-pi) coin[0];
- 15. ccx coin[0],node[1],node[0];
- 16. cx coin[0],node[1];
- 17. x node[1];
- 18. x coin[0];
- 19. ccx coin[0],node[1],node[0];
- 20. cx coin[0],node[1];
- 21. x node[1];
- 22. u2(-pi,-pi) coin[0];
- 23. ccx coin[0],node[1],node[0];
- 24. cx coin[0],node[1];
- 25. x node[1];
- 26. x coin[0];
- 27. ccx coin[0],node[1],node[0];
- 28. cx coin[0],node[1];
- 29. x node[1];
- 30. x coin[0];
- 31. barrier node[0],node[1],coin[0];
- 32. measure node[0] -> meas[0];
- 33. measure node[1] -> meas[1];
- 34. measure coin[0] -> meas[2];

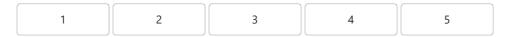
Ground Truth Description

Wrong Explanation

Quantum walks are the quantum equivalent to classical random walks. In this no ancilla version, no ancilla qubits are used during its realization.

21. A *

Link to the explanation: https://drive.google.com/file/d/11b8-JFveDgOMetmMFqDwXYdWdRS5-tVM/view?usp=drive-link



22.	B *					
	Link to the explanati <u>usp=drive_link</u>	ion: <u>https://drive.god</u>	<u>ogle.com/file/d/11</u>	<u>b7oL59PgW4paVNF</u>	⁻⁸ Yf6 L8WzxGb4Xj/vi	<u>iew:</u>
	1	2	3	4	5	
,	Wrong Explanation			1	Perfect Explanation	

23. C *

Link to the explanation: https://drive.google.com/file/d/11XIIOGgiW7oYG53ZutP-vbxeWw-rsnvZ/view? usp=drive link

1 2 3 4 5

Wrong Explanation

Perfect Explanation

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