

Comparative Analysis

Score metric:

1 line cleared: +40 points

2 lines cleared: +100 points

3 lines cleared: +300 points

4 lines cleared (Tetris): +1200 points

Combos have a 1.25x multiplier. For example,

- **1st consecutive line clear:** Normal base score (no combo multiplier).
- **2nd consecutive line clear:** Apply a combo multiplier, say, 1.25x the base score.
- **3rd consecutive line clear:** Apply a combo multiplier of 1.5x, and so on.

- Both models are essentially given unlimited time
- Both models are essentially given an unlimited frame rate
- Both models are provided the 7-bag system to ensure perfectly even tetrimino generation

 = Max  = Min

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ROUND 1

Classical-Computed Heuristic Model

Run #	Time (s)	Score	# of Combos	# of Lines Cleared
1	14.36	84,640	502	789
2	6.16	49,510	282	460
3	102.59	627,320	3,554	5,734
4	5.86	33,260	204	320
5	64.39	176,940	1,044	1,643
6	19.58	92,760	548	870
7	6.76	43,840	225	381
8	14.86	88,440	506	809
9	30.70	181,460	1,071	1,687
10	27.30	167,560	954	1,534

Average:

Time (s)	Score	# of Combos	# of Lines Cleared
29.26	154,573	889	1,423

Max:

Run #	Time (s)	Score	# of Combos	# of Lines Cleared
3	102.59	627,320	3,554	5,734

Min:

Run #	Time (s)	Score	# of Combos	# of Lines Cleared
4	5.86	33,260	204	320

Average Score per Second: 5,284

Quantum-Computed QAOA Model

Run #	Time (s)	Score	# of Combos	# of Lines Cleared
1	124.85	746,570	4,276	6,886
2	130.59	789,080	4,651	7,356
3	165.08	999,050	5,782	9,266
4	204.24	1,217,430	7,074	11,274
5	14.79	87,950	537	829
6	46.16	281,720	1,644	2,620
7	65.50	394,570	2,352	3,690
8	227.76	1,389,720	7,943	12,785
9	31.69	199,060	1,146	1,843
10	176.92	1,093,940	6,311	10,066

Average:

Time (s)	Score	# of Combos	# of Lines Cleared
118.76	719,909	4,172	6,662

Max:

Run #	Time (s)	Score	# of Combos	# of Lines Cleared
8	227.76	1,389,720	7,943	12,785

Min:

Run #	Time (s)	Score	# of Combos	# of Lines Cleared
5	14.79	87,950	537	829

Average Score per Second: 6,062

Quantum Model Wins! +778 points/sec

ROUND 2

Classical-Computed Heuristic Model

Run #	Time (s)	Score	# of Combos	# of Lines Cleared
1	125.80	771,490	4,439	7,116
2	40.21	238,320	1,443	2,236
3	285.07	1,750,080	10,130	16,179
4	4.74	27,430	181	270
5	97.62	590,350	3,363	5,424
6	147.40	906,120	5,217	8,374
7	4.31	25,730	143	235
8	79.51	482,080	2,798	4,458
9	51.92	308,130	1,811	2,871
10	120.18	722,360	4,213	6,705

Average:

Time (s)	Score	# of Combos	# of Lines Cleared
95.68	582,209	3,374	5,387

Max:

Run #	Time (s)	Score	# of Combos	# of Lines Cleared
3	285.07	1,750,080	10,130	16,179

Min:

Run #	Time (s)	Score	# of Combos	# of Lines Cleared
7	4.31	25,730	143	235

Average Score per Second: 6,085

Quantum-Computed QAOA Model

Run #	Time (s)	Score	# of Combos	# of Lines Cleared
1	10.69	64,740	384	612
2	41.78	263,050	1,513	2,403
3	54.97	364,200	2,031	3,327
4	41.18	266,840	1,537	2,477
5	8.39	52,470	274	462
6	73.39	456,320	2,642	4,231
7	23.91	149,660	856	1,369
8	20.02	123,790	679	1,123
9	13.92	83,910	508	789
10	31.68	197,520	1,125	1,816

Average:

Time (s)	Score	# of Combos	# of Lines Cleared
31.99	202,250	1,155	1,860

Max:

Run #	Time (s)	Score	# of Combos	# of Lines Cleared
6	73.39	456,320	2,642	4,231

Min:

Run #	Time (s)	Score	# of Combos	# of Lines Cleared
5	8.39	52,470	274	462

Average Score per Second: 6,321

Quantum Model Wins! +236 points/sec

ROUND 3

Classical-Computed Heuristic Model

Run #	Time (s)	Score	# of Combos	# of Lines Cleared
1	25.84	163,870	952	1,525
2	118.97	714,870	4,217	6,687
3	6.05	35,510	218	342
4	18.32	108,830	643	1,015
5	85.69	532,060	3,135	4,945
6	9.39	64,850	381	599
7	31.38	200,550	1,142	1,855
8	123.05	759,830	4,290	6,957
9	23.59	144,560	840	1,340
10	15.02	93,520	534	867

Average:

Time (s)	Score	# of Combos	# of Lines Cleared
45.73	281,845	1,635	2,613

Max:

Run #	Time (s)	Score	# of Combos	# of Lines Cleared
8	123.05	759,830	4,290	6,957

Min:

Run #	Time (s)	Score	# of Combos	# of Lines Cleared
3	6.05	35,510	218	342

Average Score per Second: 6,164

Quantum-Computed QAOA Model

Run #	Time (s)	Score	# of Combos	# of Lines Cleared
1	75.29	492,720	2,838	4,557
2	67.91	432,820	2,414	3,953
3	64.54	399,260	2,340	3,730
4	171.38	1,049,890	6,172	9,775
5	48.95	301,810	1,723	2,775
6	15.40	91,200	567	863
7	69.25	423,670	2,539	3,982
8	28.11	175,170	991	1,590
9	81.79	501,130	2,924	4,656
10	80.93	497,020	2,873	4,632

Average:

Time (s)	Score	# of Combos	# of Lines Cleared
70.36	436,469	2,538	4,051

Max:

Run #	Time (s)	Score	# of Combos	# of Lines Cleared
4	171.38	1,049,890	6,172	9,775

Min:

Run #	Time (s)	Score	# of Combos	# of Lines Cleared
6	15.40	91,200	567	863

Average Score per Second: 6,203

Quantum Model Wins! +39 points/sec

Observations & Conclusions:

- Both models last much longer at higher speeds when provided the 7-bag system instead of pseudorandom tetrimino generation
- The quantum model's score per second is approximately **1.06 times higher** than the heuristic model, representing an approximate **6.01% increase** in scoring efficiency per second.
- Overall, while the quantum model shows an edge in scoring efficiency, neither model consistently outperforms the other in speed across all rounds.
- There does not seem to be a similar stack pattern in either of the models' failures
- The quantum model won all 3 rounds with a slight edge in each of them
- On average, the quantum model scored higher per second in each round showing its more efficient performance
- The quantum model better handled higher stacks
- *Heuristic model*
 - Lowest time: 4.31s, Lowest score: 25,730, Lowest # of combos: 143, Lowest # of lines cleared: 235
 - Highest time: 285.07s, Highest score: 1,750,080, Highest # of combos: 10,130, Highest # of lines cleared: 16,179
- *QAOA model*
 - Lowest time: 8.39s, Lowest score: 52,470, Lowest # of combos: 274, Lowest # of lines cleared: 462
 - Highest time: 227.76s, Highest score: 1,389,720, Highest # of combos: 7,943, Highest # of lines cleared: 12,785
- Looking at the extremes, the heuristic model had the lowest floors and the highest ceilings, implying its higher dexterity
- On the other hand, the quantum model consistently scored above average
- The heuristic model scored over a million just *1 time*
- The quantum model scored over a million *4 times*
- Both models lasted over 100 seconds *7 times*

	Lasted > 30s	Lasted > 60s	Scored > 200,000	Scored > 500,000
Heuristic Model	15	11	13	9
QAOA Model	21	15	20	8

	> 1,000 Combos	> 2,000 Combos	> 1,000 Lines Cleared	> 2,000 Lines Cleared
Heuristic Model	15	10	19	12
QAOA Model	22	16	25	20

- Looking at the tables, the heuristic model was more consistent across the board

Heuristic Model Demo:

<https://drive.google.com/file/d/1afc2SpINrN9uBNpFqoyMIHcONP11joHW/view?usp=drive>

QAOA Model Demo:

https://drive.google.com/file/d/1dMLNnMebTxetOxSiy7rTS1YspTLkK3KK/view?usp=drive_link_link