The 16th Top Chess Engine Championship: TCEC16

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TCEC Season 16 started on July 14th 2019 with a revised structure as active engine authors are forming a longer queue to join the action. 'Divisions' are now 'leagues': divisions 4 and 3 were replaced by a larger Qualification League. Leagues 1 and 2 with 16-18 engines were double the size of their predecessors. Fig. 1 and Table 1 provide the logos and details on the enlarged field of 46 engines. Elo figures seem to be getting higher but it is of course only the Elo differences that are significant.

Fig. 1. Logos for the TCEC 16 engines (CPW, 2019) as in their original leagues and divisions.

Promotion/relegation rules have changed but otherwise the rules are as for TCEC15. In the event of network breaks, if both engines were in the 7-man and/or TCEC win (or draw) zone, the game was

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adjudicated as a win or draw. Otherwise, TCEC resumed games with extra initialisation time rather than restarting them: this welcome innovation has clearly been a success.

The common platform for TCEC16, as for TCEC15, consisted of two computers. One was the established, formidable 44-core server of TCEC11-15 (Intel, 2017) with 64GiB of DDR4 ECC RAM and a Crucial CT250M500 240 GB SSD for the EGTs. The 'GPU server' was the Quad Core i5 3570k with 32GiB DDR3 RAM, sported Nvidia (2018) GeForce RTX 2080 Ti and 2080 GPUs.

Table 1. The TCEC16 engines (CPW, 2019), details, authors and progress.

#	Engine		Initial			thr.	proto-	Hash	EGTs	Authors	Country	Final
	ab	Name	Version	ELO	Set		col	Kb			Codes	Set
01	AS	AllieStein	v0.5-dev_1359f44-n10	2557	P	?	uci	7,168	Syz.	Adam Treat and Mark Jordan	US	→P
02	An	Andscacs	0.95123	3469	1	43	uci	8,192	—	Daniel José Queraltó	AD	→1
03	Ar	Arasan	TCEC16	3652	2	43	uci	16,384	Syz.	Jon Dart	US	↗↘2
04	At	Asymptote	0.6.2	3328	Q	43	uci	16,384	—	Maximillian Lupke	DE	→Q
05	Ba	Bagatur	1.5f	2888	Q	43	uci	?	Syz.	Krasimir Topchiyski	BG	↘
06	Bo	Booot	6.3.1	3407	1	32	uci	16,384	—	Alex Morozov	UA	↘2
07	Cs	Cheese	2.1	3380	Q	8	uci	16,384	—	Patrice Duhamel	FR	↘
08	Cb	ChessbrainVB	3.74	3342	1	43	xboard	1,200	—	Roger Zuehlsdorf	DE	→1
09	c22	chess22k	1.12	3518	Q	16	uci	4,096	—	Sander Maassen vd Brink	NL	↗↘Q
10	Cf	ChessFighterNN	2.1-n8x128c_7411	3051	Q	?	uci	—	—	Alexander Lim		↘
11	Ch	Chiron	TCEC16	3411	1	43	uci	8,192	Syz.	Ubaldo Andrea Farina	IT	→1
12	Et	Ethereal	11.57	3483	1	43	uci	16,384	Syz.	Andrew Grant	US	→1
13	Fi	Fire	NNb-n07-20-2019	3488	1	43	uci	—	Syz.	Norman Schmidt	US	↘2
14	Fz	Fizbo	2	3419	1	43	uci	16,384	Syz.	Youri Matiounine	US	→1
15	Fr	Fritz	16.10	3549	2	43	uci	16,384	Nal?	Vasik Rajlich	CZ/US	→2
16	Gi	Ginkgo	S16	3440	1	43	uci	16,384	Syz.	Frank Schneider	DE	→1
17	Gu	Gull	3	3600	2	43	uci	16,384	—	Vadim Demichev	RU	→2
18	Ho	Houdini	6.03	3571	P	43	uci	16,384	Syz.	Robert Houdart	BE	→P
19	Ig	Igel	1.8.1	3245	Q	43	uci	16,384	Syz.	Volodymyr Shcherbyna	UA	→Q
20	Jo	Jonny	8.1	3400	1	43	uci	16,384	Syz.	Johannes Zwanzger	DE	→1
21	Ju	Jumbo	0.6.117	2983	Q	43	xboard	16,384	Gav.	Sven Schüle	DE	↘
22	Ko	Komodo	2381.00	3486	P	43	uci	16,384	Syz.	Don Dailey, Larry Kaufman, Mark Lefler	US	→P
23	Km	Komodo MCTS	2381.00	3487	P	43	uci	16,384	Syz.	Mark Lefler	US	↘1
24	La	Laser	230319	3444	1	43	uci	16,384	Syz.	Jeffrey An, Michael An	US	→1
25	Lc	LCZero	v0.22.0-nT40B.4-160	3603	P	3	uci	—	Syz.	UCT/NN AI Community	—	→P
26	Lu	LCZeroCPU	0.21.2-nLD2	3805	Q	33	uci	—	Syz.	LCZero Community	—	—
27	Ma	Marvin	3.4.0	3544	Q	43	uci	16384	Syz.	Martin Danielsson	SE	↗↘Q
28	Mi	Minic	0.76	3331	Q	43	xboard	16384	—	Vivien Clauzon	FR	↘
29	Ne	Nemorino	5.17	3586	2	43	uci	16,384	Syz.	Christian Günther	US	→2
30	Ni	Nirvana	2.4	3426	2	32	uci	16,384	—	Thomas Kolarik	US	↘Q
31	Pe	Pedone	230719	3561	2	43	uci	16,384	Syz.	Fabio Gobbato	IT	↗↘2
32	pi	pirarucu	3.0.7	3477	2	43	uci	1,024	—	Raoni Campos	BR	↘Q
33	Ro	Rodent III	0.287	3501	Q	43	uci	16,384	Syz.	Pawel Koziol	PL	→Q
34	rf	rofchade	2.105	3290	1	43	uci	16,384	Syz.	Ronald Friederich	NL	→1
35	Ru	RubiChess	1.5	3495	2	43	uci	16,384	Syz.	Andreas Matthies	DE	→2
36	Sn	ScorpioNN	2.9.1-n_maddex_INT8	3632	Q	—	xboard	—	—	Daniel Shawl	ET	↗↗ ↗↘1
37	St	Stockfish	190826	3603	P	43	uci	16,384	Syz.	Tord Romstad, Marco Costalba, Joona Kiiski, Gary Linscott	NO/IT/ FI/CA	→P
38	Sv	StoofVlees II	a10	3820	Q	?	uci	8,192	Syz.	Gian-Carlo Pascutto	BE	↗↗↗P
39	Te	Texel	1.08a13	3610	2	43	uci	16,384	Syz.	Peter Österlund	SE	→2
40	Tb	The Baron	3.44.1	3534	Q	42	uci	16,384	Syz.	Richard Pijl	NL	→Q
41	To	Topple	0.7.2_dev	3219	Q	43	uci	16,384	Syz.	Vincent Tang	UK	↗↘Q
42	Tu	Tucano	7.07	3459	Q	43	xboard	16,384	—	Alcides Schulz	BR	↘
43	Va	Vajolet2	2.7	3597	2	43	uci	16,384	Syz.	Marco Belli	IT	→2
44	Wa	Wasp	3.68	3602	Q	43	uci	8,192	Syz.	John Stanback	US	↗↘Q
45	Wi	Winter	0.6	3572	Q	43	uci	16,384	—	FM Jonathan Rosenthal	CH	→Q
46	Xi	Xiphos	0.5.3	3449	1	43	uci	16384	Syz.	Milos Tatarevic	RS	→1

Four engines of different kinds were taking part in a TCEC event for the first time: ASYMPTOTE, LCZEROCPU, CHESSFIGHTERNN and STOOFVLEES II. The latter two are neural network engines utilizing GPUs. LCZEROCPU is a non-GPU version of LCZERO running on conventional CPUs: it was participating only for demonstration purposes: its results were not ultimately considered.

1 Qualification league: 1 DRR phase, 2 RRs, 34 rounds, 306 games @ 30′+5″/m

This time, each engine played both White and Black from four-ply openings defined by the second author here using random choice from an opening book. The results are as in Table 2: 'P%' is the %-score before LCZEROCPU's results were discounted. Generic stats are in Tables 9 and 10: the Elo difference of 932 between highest- and lowest-rated heralded many decisive results and 2-0 scores.

The non-GPU LCZEROCPU performed remarkably well, seemingly evaluating well with low node-counts. It sustained only one loss, to STOOFVLEES II, and made third place its own. While it may have affected the authors psychologically if not their engines, the removal of its results did not change the list of promotees: SCORPIONN, STOOFVLEES II, MARVIN, WASP, TOPPLE and CHESS22K. Would they finish in this order in League 2? Wool (2019) covered this tournament overture somewhat lightly but notes that SCORPIONN and TOPPLE seem to have improved on their TCEC15 performances. Would the march of the neurons continue?

Table 2. The TCEC16 Qualification League cross-table: one DRR phase, 2 RRs, 34 rounds, 306 games.

#	Engine	Elo	Pts	%P	SB	nSB	X	Elo ±	Sn	Sv	Lu	Ma	Wa	To	c22	At	Wi	Ro	Tb	Ig	Mi	Cs	Tu	Cf	Ba	Ju
01	ScorpioNN v2.9.1-n_maddex_INT8	3632	29.5	86.8	456.50	77.40	0	+163		==	==	11	11	11	1=	=1	=1	11	11	1=	11	=1	11	11	11	11
02	StoofVlees II a10	3820	29.0	85.3	438.00	74.26	0	-021	==		=1	=0	=1	=1	=1	11	11	1=	11	11	11	11	11	11	11	11
03	LCZeroCPU v0.21.2-nLD2	3805	26.5	77.9	405.25	68.71	0	-090	==	=0		11	1=	=1	11	=1	11	==	=1	1=	1=	1=	=1	11	11	11
04	Marvin 3.4.0	3544	23.0	67.6	329.25	55.82	0	+055	00	=1	00		1=	==	==	10	11	=1	=1	11	==	=1	=1	11	11	11
05	Wasp 3.68	3602	23.0	67.6	317.75	53.87	0	-012	00	=0	0=	0=		11	=1	1=	==	11	=1	==	1=	=1	11	11	11	11
06	Topple 0.7.2_dev	3299	20.0	58.8	273.25	46.33	0	+246	00	=0	=0	==	00		=1	01	==	1=	=1	11	01	1=	11	01	11	11
07	chess22k 1.12	3518	19.0	55.9	253.50	42.98	1	-042	0=	=0	00	==	=0	=0		01	==	1=	1=	0=	=1	=1	1=	11	11	11
08	Asymptote 0.6.2	3328	17.5	51.5	254.00	43.07	0	+135	=0	00	=0	01	0=	10	10		01	==	1=	11	=0	11	=1	01	0=	11
09	Winter 0.6	3572	17.0	50.0	224.75	38.11	0	-170	=0	00	00	00	==	==	==	10		==	==	==	=1	1=	1=	=1	1=	11
10	Rodent III 0.287	3501	15.5	45.6	208.00	35.27	0	-134	00	0=	==	=0	00	0=	0=	==	==		1=	=0	=1	==	10	10	11	11
11	The Baron 3.44.1	3534	15.0	44.1	195.75	33.19	0	-189	00	00	=0	=0	=0	=0	0=	0=	==	0=		=1	1=	1=	=1	=1	=1	1=
12	Igel 1.8.1	3245	15.0	44.1	198.25	33.61	0	+143	0=	00	0=	00	==	00	1=	00	==	=1	=0		==	==	==	11	11	1=
13	Minic 0.76	3331	14.0	41.2	195.25	33.10	0	+019	00	00	0=	==	0=	10	=0	=1	=0	=0	0=	==		11	0=	0=	11	1=
14	Cheese 2.1	3380	13.5	39.7	167.75	28.44	0	-053	=0	00	0=	=0	=0	0=	=0	00	0=	==	0=	==	00		1=	11	11	11
15	Tucano 7.07	3459	12.5	36.8	146.00	24.75	0	-179	00	00	=0	=0	00	00	0=	=0	0=	01	=0	==	1=	0=		11	=1	11
16	ChessFighterNN v2.1-n8x128c_7411	3051	7.5	22.1	94.00	15.94	0	+067	00	00	00	00	00	10	00	10	=0	01	=0	00	1=	00	00		00	11
17	Bagatur 1.7b	2888	6.5	19.1	66.50	11.28	0	+128	00	00	00	00	00	00	00	1=	0=	00	=0	00	00	00	=0	11		=1
18	Jumbo 0.6.117	2983	2.0	05.9	25.25	04.28	0	-065	00	00	00	00	00	00	00	00	00	00	0=	0=	0=	00	00	00	=0	

2 League 2: 1 DRR phase, 2 RRs, 30 rounds, 240 games @ 30′+5″/m

League 2 games were launched with random 4-move rather than 2-move openings. The two neural network engines here, STOOFVLEES II and SCORPIONN continued on to League 1 but in different ways. SCORPIONN was stolid, unbeaten but relatively win-shy. STOOFVLEES II won seven more games but clearly has its vulnerabilities, losing games 27, 39 and 192. In the last, **40…Ng4** against lowly MARVIN is inexplicable, maybe a last but tardy attempt at complication. (The second author exclaimed in chat that STOOFVLEES' defeats were "sudden and violent".) The lack of QPP-Q endgame table support for GULL in game 63 was decisive.

PEDONE and a greatly improved ARASAN occupied the other promotion spots. FRITZ, though unbeaten, missed out because it fell short on the tiebreaker, number of wins. TOFFLE, MARVIN and CHESS22K returned to the Qualification League with PIRARUCU in attendance. The remaining promotee, WASP, made the grade reasonably comfortably. Wool (2019) commented lightly on games 22, 26, 27, 39, 63, 84 and 108 from the first round robin.

Table 3. The TCEC16 League 2 cross-table: one DRR phase, 2 RRs, 30 rounds, 240 games.

#	Engine	Elo	Pts	P%	SB	nSB	X	Elo ±	Sv	Sn	Pe	Ar	Fr	Ne	Te	Va	Gu	Ru	Wa	Ni	c22	pi	Ma	To
01	StoofVlees II a11	3715	22.5	75.0	319.50	69.58	0	+019		==	11	1=	==	0=	11	11	11	01	=1	1=	=1	11	10	11
02	ScorpioNN v2.9.1-n_maddex_INT8	3619	20.5	68.3	290.00	63.16	0	+075	==		1=	==	==	=1	==	==	11	==	1=	11	=1	=1	=1	=1
03	Pedone 230719	3561	19.0	63.3	249.75	54.39	0	+106	00	0=		=1	=0	11	0=	10	==	11	==	11	==	11	11	11
04	Arasan TCEC16	3652	18.0	60.0	243.00	52.92	0	-048	0=	==	=0		==	10	==	1=	1=	0=	==	1=	11	1=	1=	11
05	Fritz 16.10	3549	18.0	60.0	263.50	57.38	0	+091	==	==	=1	==		==	=1	==	==	1=	1=	==	==	11	==	==
06	Nemorino 5.17	3586	17.5	58.3	237.00	51.61	0	+024	1=	=0	00	01	==		=0	==	10	=1	01	=1	11	1=	1=	11
07	Texel 1.08a13	3610	17.0	56.7	237.00	51.61	0	-025	00	==	1=	==	=0	=1		==	=0	1=	=1	=1	=1	=1	=1	==
08	Vajolet2 2.7	3597	15.5	51.7	215.25	46.88	0	-055	00	==	01	0=	==	==	==		=1	==	1=	==	==	=0	11	1=
09	Gull 3	3600	15.0	50.0	197.75	43.07	0	-075	00	00	==	0=	==	01	=1	=0		10	=1	=1	0=	=1	1=	11
10	RubiChess 1.5	3495	14.5	48.3	203.25	44.26	0	+053	10	==	00	1=	0=	=0	0=	==	01		==	01	=1	1=	==	=1
11	Wasp 3.69	3551	13.5	45.0	186.50	40.62	0	-056	=0	0=	==	==	0=	10	=0	0=	=0	==		=1	10	==	=1	1=
12	Nirvana 2.4	3426	12.0	40.0	157.00	34.19	0	+063	0=	00	00	0=	==	=0	=0	==	=0	10	=0		1=	11	11	=0
13	chess22k 1.13	3426	11.0	36.7	156.75	34.14	2	+031	=0	=0	==	00	==	00	=0	==	1=	=0	01	0=		=0	==	1=
14	Pirarucu 3.0.7	3477	9.5	31.7	124.75	27.17	0	-083	00	=0	00	0=	00	0=	=0	=1	=0	0=	==	00	=1		==	1=
15	Marvin 3.4.0	3506	9.0	30.0	133.75	29.13	0	-138	01	=0	00	0=	==	0=	=0	00	0=	==	=0	00	==	==		==
16	Topple 0.7.2_dev	3337	7.5	25.0	104.25	22.70	0	+021	00	=0	00	00	==	00	==	0=	00	=0	0=	=1	0=	0=	==	

3 League 1: 1 DRR phases, 30 rounds, 240 games @ 45′+5″/m

And so we arrived at the third all-play-all, newly renamed 'League 1'.[2] In a large field of 16 engines, would STOOFVLEES II and SCORPIONN continue their upwardly mobile transit of TCEC? Perhaps we should apologise now that, faced with such large divisions, we are almost certainly missing excellent performances by many engines: a set of event-triggers would be useful. Because of the enlarged field, TCEC introduced a 4-way play-off for the two promotion spots, not quite the EFL's way but close. Table 4 covers the league results and Table 5, the play-off.

In the first half, STOOFVLEES II beat ETHEREAL, ETHEREAL beat LASER: SCORPIONN lost to both. XIPHOS did not make hay against what became the back end of the field. PEDONE's win over STOOFVLEES II was a clear outlier which kept things close at the top. In the second half, little changed at the top though SCORPIONN beat STOOFVLEES II in the return game. Down the field, CHIRON, ANDSCACS and GINKGO shipped some unexpected losses to back-markers from CHESSBRAINVB to ARASAN. So, with all games played, there was a clear gap between the top four heading for the play-off, and XIPHOS, CHIRON and ANDSCACS in the next places. The neural network version of FIRE, replacing its venerable Shannon-AB namesake, was a disappointment. Whether this was due to neural net immaturity or some other defect is unclear. It was demoted to League 2 with PEDONE and ARASAN. There were six technical defaults, always anticlimactic; three by BOOOT led to its automatic demotion, saving ROFCHADE from relegation.

In the play-off, two double round robins, 24 games, STOOFVLEES II won three games, defaulted once but still won. SCORPIONN came second by virtue of losing only one game whereas ETHEREAL and LASER lost three each. So, STOOFVLEES II and SCORPIONN march on from the Qualification League to the Premier Division: the audience was keen to know if they would stay there.

'Kingscrusher' (2019a-2019d), aka CM Tryfon Gavriel and a fount of contextual knowledge in his amiable video coverage is particularly following the 'new machines'. He commentated on ARASAN–STOOFVLEES II game 73, STOOFVLEES II–SCORPIONN g88 and STOOFVLEES II–ETHEREAL, both g103 and play-off g24): he was inspired to conjecture new opening and middle-game theory. Assaf Wool

[2] The 'EFL' English Football League now has 'League Division 1' - which used to be League Division 3.

(2019), or should that be 'Assaf Wool',[3] opens doors onto quite a few games.[4] It is worth following this blog: it is an easy introduction to the games played.

Table 4. The TCEC16 League 1 cross-table: two DRR phases, 28 rounds, 112 games.

#	Engine	Elo	Pts	%P	SB	nSB	X	Elo ±	Sv	La	Et	Sc	Xi	Ch	An	Gi	Fz	Jo	Cb	Bo	ro	Ar	Pe	Fi
01	StoofVlees II a12	3759	20.5	68.3	292.75	63.75	0	+078		==	1=	10	1=	==	==	11	0=	=1	11	1=	==	11	01	11
02	Laser 230319	3724	18.5	61.7	255.00	55.53	1	+064	==		0=	==	0=	==	==	0=	=1	11	==	=1	=1	1=	11	11
03	Ethereal 11.57	3767	18.0	60.0	260.25	56.68	0	-013	0=	1=		1=	==	==	0=	=1	1=	==	==	=1	==	11	==	1=
04	ScorpioNN v2.9.2-n_maddex_INT8	3655	18.0	60.0	255.25	55.59	0	+146	01	==	0=		==	==	==	==	==	=1	1=	=1	==	11	1=	1=
05	Xiphos 0.5.3	3746	16.5	55.0	237.50	51.72	0	-031	0=	1=	==	==		==	==	==	==	=1	0=	==	1=	==	=1	=1
06	Chiron TCEC16	3606	16.0	53.3	225.75	49.16	0	+151	==	==	==	==	==		1=	==	=0	0=	=0	=0	=1	==	11	11
07	Andscacs 0.95123	3691	16.0	53.3	229.00	49.87	0	+031	==	==	1=	==	==	0=		==	==	==	==	=0	==	==	1=	11
08	Ginkgo S16	3712	15.5	51.7	217.00	47.26	2	-015	00	1=	=0	==	==	==	==		1=	1=	==	01	=0	=0	1=	11
09	Fizbo 2	3639	15.0	50.0	218.00	47.48	0	+073	1=	=0	0=	==	==	=1	==	0=		=0	1=	0=	==	==	1=	=1
10	Jonny 8.1	3616	14.5	48.3	204.75	44.59	0	+089	=0	00	==	=0	=0	1=	==	0=	=1		==	=1	=1	==	==	=1
11	ChessBrainVB 3.74	3653	14.5	48.3	211.00	45.95	0	+037	00	==	==	0=	1=	=1	==	==	0=	==		==	==	=1	==	==
12	Booot 6.3.1	3685	14.5	48.3	209.00	45.52	3	-008	0=	=0	=0	=0	==	=1	=1	10	1=	=0	==		==	01	=1	01
13	rofChade 2.105	3686	14.0	46.7	204.25	44.48	0	-026	==	=0	==	==	0=	=0	==	=1	==	=0	==	==		==	==	=1
14	Arasan TCEC16	3668	12.5	41.7	170.25	37.08	0	-048	00	0=	00	00	==	==	==	=1	==	==	=0	10	==		1=	=1
15	Pedone 230719	3634	9.5	31.7	142.00	30.92	0	-096	10	00	==	0=	=0	00	0=	0=	0=	==	==	=0	==	0=		==
16	Fire v_NNb-n07-20-2019	3806	6.5	21.7	92.75	20.20	0	-433	00	00	0=	0=	=0	00	00	00	=0	=0	==	10	=0	=0	==	

Table 5. The TCEC16 League 1 Play-off cross-table: two DRR phases, 12 rounds, 24 games.

#	Engine	Elo	Pts	%P	SB	nSB	X	Elo ±	Sv	Sn	Et	La	RR1	..2	..3	..4
01	StoofVlees II a12	3788	7.0	58.3	38.75	52.74	1	-028		0===	=1=1	1===	1½	2	1½	2
02	ScorpioNN v2.9.2-n_maddex_INT8	3694	6.5	54.2	38.25	52.06	0	+052	1===		=0==	1===	2½	1	1½	1½
03	Ethereal 11.57	3761	5.5	45.8	33.25	45.26	0	-001	=0=0	=1==		0==1	1	1½	1½	1½
04	Laser 230319	3730	5.0	41.7	31.25	42.53	0	-022	0===	0===	1==0		1	1½	1½	1

4 Division P, three DRR phases, 42 rounds, 168 games, tempo 90′+5″/m

The Premier Division featured a minority of classic Shannon-AB engines for the first time. SCORPIONN and STOOFVLEES II have joined LEELA CHESS ZERO, ALLIESTEIN and KOMODOMCTS. These engines have come through the ranks remarkably quickly and now challenge for podium places. As a result, there is some interest in every game. Would the engines STOCKFISH and LC0 take their burgeoning relationship to the next step or would one of the more recent arrivals make it to the Superfinal? How would the Shannon-AB engines fare against the new wave of Monégasque 'MCTS-ers' and 'Neural Networks', sometimes in combination? We give the headlines on each of the three 'DRR' double round robins in turn.

DRR1: STOCKFISH beat STOOFVLEES II in game 2, SCORPIONN in g9 and ALLIESTEIN in g46 – the longest 1-0 win in the division. Meanwhile KOMODOMCTS beat ALLIESTEIN in g6 and ALLIESTEIN beat KOMODO in g52. STOCKFISH's only loss was a technical default in a defensible position to HOUDINI, g51: half a point gone. Despite this, STOCKFISH and LEELA led after 14 games with ALLIESTEIN, KOMODO and STOOFVLEES II in joint third, one point behind. KOMODOMCTS and SCORPIONN were well tailed off with no wins against the other engines.

[3] The Assaf is an Israeli breed of sheep: https://www.israeldairy.com/assaf-sheep/.
[4] http://mytcecexperience.blogspot.com/. League games: 17, 18, 21, 31, 35, 43, 48, 88, 90, 93-95, 103, 106, 112, 118, 130, 151, 159, 179, 189, 208 & 218. Play-off games: 1, 2, 4, 5, 9, 12, 16, 20, 21 & 24.

DRR2 very much belonged to ALLIESTEIN with an outstanding +7 score. LEELA was the only other net-positive scorer with +2. STOCKFISH had another 'technical' in g74 against ALLIESTEIN, another blocked and defensible position, another half-point gone. Even the best athletes break down occasionally. Games 64, 103 and 109 all deserve further study and Kingscrusher (2019g-2019i) helps here. At the end of DRR2, LEELA and STOCKFISH were sharing second place. LEELA had no losses but was win-shy; STOCKFISH, the multiple TCEC champion, was one game away from disqualification. KOMODOMCTS and SCORPIONN continued to languish, 3½ points adrift.

DRR3 was STOCKFISH's turn to be the big mover with +6 but the aforementioned second default on game 74 cast a foreboding cloud over its prospects of survival. What was it to be: Division 1 or the Superfinal? No matter: it beat ALLIESTEIN, STOOFVLEES II, and HOUDINI twice, games 114, 135, 158 and 163. LEELA scored +2 in this third phase, was undefeated throughout and the only engine to beat STOCKFISH head-to-head. None of this was enough to overtake ALLIESTEIN so, to the surprise and anguish of many, it did not make the Superfinal. LEELA was not incisive enough against the weaker opposition, maybe playing 'too safe' and thereby not creating enough opportunities. Congratulations to ALLIESTEIN for reaching the Superfinal in only its second TCEC season.

Table 6. The TCEC16 Premier Division cross-table: three DRR phases, 42 rounds, 168 games.

#	Engine	Elo	Pts	%P	SB	nSB	X	Elo ±	St	AS	Lc	Ko	Sv	Ho	Km	Sn
01	Stockfish 190826	3895	26.5	63.1	522.25	58.03	2	+019		=101=1	==0===	======	1=1=1=	10==11	=1==1=	1=1==1
02	AllieStein v0.5-dev_1359f44-n10	3812	26.0	61.9	504.00	56.00	0	+179	=010=0		======	=1==0=	==1111	===111	1=11==	==11==
03	LCZero v0.22.0-nT40B.4-160	3907	25.5	60.7	507.75	56.42	0	-038	==1===	======		=====1	======	===1=1	11====	1===11
04	Komodo 2381.00	3827	22.0	52.4	447.50	49.72	0	+019	======	=0==1=	=====0		======	======	1=====	1=1===
05	StoofVlees II a12	3787	19.0	45.2	377.50	41.94	0	+009	0=0=0=	==0000	======	======		======	1=====	=1=1==
06	Houdini 6.03	3833	18.5	44.0	372.75	41.42	0	-106	01==00	===000	===0=0	======	======		==1===	===1==
07	KomodoMCTS 2381.00	3796	16.5	39.3	340.75	37.86	0	-090	=0==0=	0=00==	00====	0=====	0=====	==0===		=1====
08	ScorpioNN v3.0.1-n_maddex_INT8	3710	14.0	33.3	299.50	33.28	0	+007	0=0==0	==00==	0===00	0=0===	=0=0==	===0==	=0====	

Table 7. The TCEC16 Premier Division figures: head-to-head and round-by-round scores.

#	Engine	Elo	Pts	%P	SB	nSB	X	Elo ±	St	AS	Lc	Ko	Sv	Ho	Km	Sn	RR1	..2	..3	..4	..5	..6	DRR1	+DRR2
01	Stockfish 190826	3895	26.5	63.1	522.25	58.03	2	+019		4	2½	3	4½	4	4	4½	5	4	3½	4	5	5	9	16½
02	AllieStein v0.5-dev_1359f44-n10	3812	26.0	61.9	504.00	56.00	0	+179	2		3	3	5	4½	4½	4	4	3½	5½	5	4	4	7½	18
03	LCZero v0.22.0-nT40B.4-160	3907	25.5	60.7	507.75	56.42	0	-038	3½	3		3½	3	4	4	4½	4½	4	4	4	4	5	8½	16½
04	Komodo 2381.00	3827	22.0	52.4	447.50	49.72	0	+019	3	3	2½		3	3	3½	4	4½	3	4	3½	4	3	7½	15
05	StoofVlees II a12	3787	19.0	45.2	377.50	41.94	0	+009	1½	1	3	3		3	3½	4	3½	4	2½	3½	2½	3	7½	13½
06	Houdini 6.03	3833	18.5	44.0	372.75	41.42	0	-106	2	1½	2	3	3		3½	3½	3	4	4	3	2½	2	7	14
07	KomodoMCTS 2381.00	3796	16.5	39.3	340.75	37.86	0	-090	2	1½	2	2½	2½	2½		3½	1½	3	2½	3	3	3½	4½	10
08	ScorpioNN v3.0.1-n_maddex_INT8	3710	14.0	33.3	299.50	33.28	0	+007	1½	2	1½	2	2	2½	2½		2	2½	2	2	3	2½	4½	8½

TCEC themselves chose g113, LEELA's win over SCORPIONN, as their top game here – 122 moves closed out by a 6-man 'endgame adjudication' in a position a novice could have won. ALLIESTEIN–STOOFVLEES II, g123, was an important 1-0 win, unusually ending in two rooks mating a lone King.

Kingscrusher's (2019e-2019k) video commentaries covered games 01, 22, 50, 64, 103, 109 and 123.[5] Perhaps to correct the apparent bias towards STOOFVLEES II above, he featured LEELA CHESS ZERO, SCORPIONN, KOMODOMCTS and ALLIESTEIN, sometimes facing each other, at other times, victorious over the Shannon-AB engines, the three amigos as it were. Wool (2019) featured the key 1-0 wins,

[5] In the shorthand of Table 1, these games were LC0-SN, LC0-KO, KM-LC0, LC0-ST, LC0-HO, SN-AS & AS-SV. Games 22, 64 and 109 were also TCEC's top three picks.

games 02, 52, 64, 102, 136 and 158.[6] He also provided brief notes on a further 44 games, a prodigious contribution which was much appreciated.[7]

5 The TCEC16 Superfinal match: 100 games, tempo 120′+10″/m

STOCKFISH stepped on stage having barely avoided disqualification: its supporters breathed again. Entr'acte change can increase technical risk. A defective .dll was not in the recompile.

We can identify three dimensions today in the chess engine space:

1) the engine: code driving (CPU, GPU, TPU …) servers and neural network topology,
2) the search algorithm: minimax/alpha-beta or some form of Monte Carlo Tree-Search,
3) the training regime used, both data and process:
   data - *tabula rasa* null input or some selection of previously played games,
   process – the sequencing and batching of input, aspects of the training code.

It is worth re-introducing ALLIESTEIN in this 3D-content, particularly as the engine is only in its second TCEC season. It is a synergy of ALLIE from Adam Treat and STEIN, a neural network trained by Mark Jordan in a supervised learning process,[8] in this case on $3m^+$ CCRL and $40m^+$ LCZERO self-play games. The excellent Chessprogramming Wiki site on ALLIE (CPW, 2019b) and Chessdom's (2019) interview with Adam and Mark provide useful graphics and more information.

With regard to the second dimension, search, ALLIESTEIN can use either MCTS or minimax/alpha-beta to search for and decide its move. Both approaches have their merits, one taking the broader view, the other betting the house on a narrow and possibly treacherous path. Perhaps MCTS and minimax can be used in conjunction in some future engine.

The training process relies on the quality of the input and some aspects of the training itself. For example, is the choice of CCRL games as input not only to avoid human fallibility over the board but to inherit some tactical sharpness from decades of Shannon-AB evaluation functions honed on the experience of classical minimax/alpha-beta search?

Both engines came to the Superfinal in new versions, STOCKFISH with code improvements and ALLIESTEIN two weeks older and wiser. ALLIESTEIN played as White first. Kibitzing on the match, we had two engines, REDFISH[9] (stronger than the competing STOCKFISH) and BLUELEELA.[10] For the first time, we include in our report the evaluation graphs for the decisive games. STOCKFISH's evaluations may be benchmarked against those of REDFISH, and ALLIESTEIN's against those of BLUELEELA. Readers are invited to provide feedback as to the specific value of these evaluation graphs.

Also, for the first time, we can defer to GM Matthew Sadler's (2019) perspective which is written in his inimitably accessible style. He provides rich insight and context, including the 2018 ALPHAZERO–STOCKFISH match, for this event. His focus is particularly on games 3, 5-6, 14, 24, 25-26, 41-42, 75 and 100. As usual, we commend the 'My Experience' blog (Wool, 2019) which covered all the decisive games in some detail and touched on others. In his TCEC16 Superfinal playlist, 'GM Thechesspuzzler'

[6] These games were ST-SV, AS-KO, LC0-ST, ST-AS, KO-AS and ST-AS.
[7] Wool also provided brief notes on games (DRR1) 1-3, 6, 9, 17, 23, 25, 34, 41, 46, & 49-52, (DRR2) 58, 62, 65, 67, 69, 73-4, 78, 81, 88-90, 95, 100, 103 & 109, (DRR3) 113-4, 116, 123, 135, 139, 141, 144, 149-151, 159 & 163.
[8] DEUSX was the first neural network employing supervised learning to compete in TCEC (Season 13).
[9] Shannon-AB STOCKFISH 2019100810, 256 threads on 8 Xeon Scalable 8168s, plus sub7man EGTs.
[10] NN-based LEELA CHESS ZERO v0.22.0-dev-nJ13B.2-136 (24x320) on NVIDIA GPU 2080 TI with s8man EGTs.

(2019) covered games 6, 14, 19, 20 and 100. Other commentators – 'Agadmator', 'ElzChess' and Jozarov are getting involved and all are welcome, especially if they make it clear where their TCEC videos are!

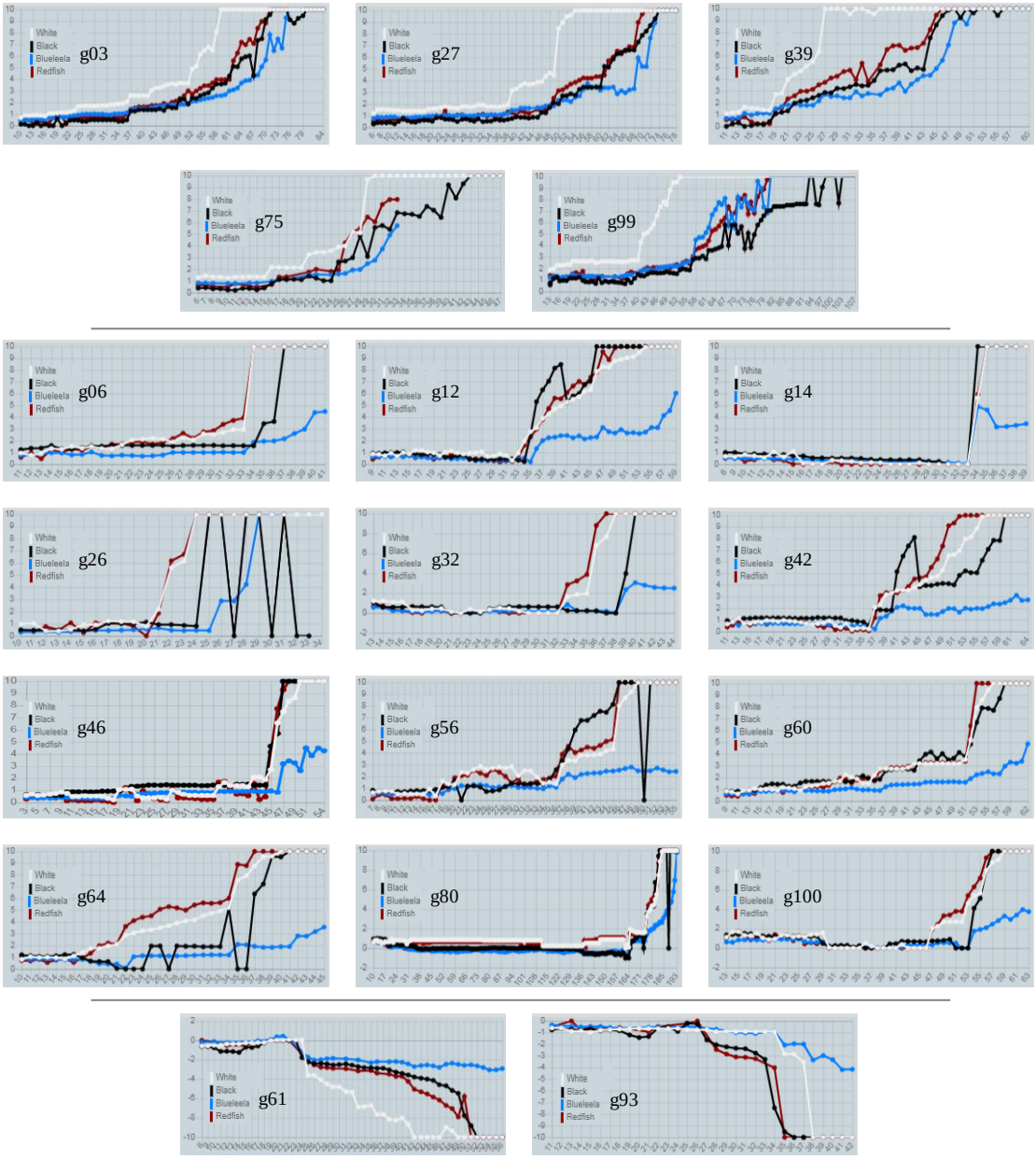

Fig. 3. The decisive games' evaluation graphs: ALLIESTEIN's 5 wins, all 1-0, games 03, 27, 39, 75 & 99; STOCKFISH's (a) 12 1-0 wins, games 06, 12, 14, 26, 32, 42, 46, 56, 60, 64, 80 & 100 and (b) 2 0-1 wins, games 61 & 93.

The contestants stood +3=2-1 in their Premier Division head-to-head: advantage STOCKFISH. This did not make ALLIESTEIN the favourite for the title and there was some concern that STOCKFISH would soon be well ahead on the scoreboard. It was not to be.

After two draws, first blood went to ALLIESTEIN in game three. It was already more confident of a win than the kibitzing BLUELEELA at move 23 when STOCKFISH apparently eased its grip on the position. Evaluations increased and by move 36, all engines were seeing the first result of the match. ALLIESTEIN exploited its space advantage, created a passed a-pawn, and STOCKFISH, in an unavailing defence, found itself down rook-vs-knight and on the wrong end of a TCEC adjudication. Nevertheless, it would have been good to see the terminal, pawnful position played out for a few more moves. It has been: our Superfinal pgn file provides plausible continuations of the decisive games.

The 19-ply opening of games five and six favoured White but STOCKFISH found a perpetual check in game 5 with its rook-sac **17…Rxb2**. Game 6 (Sadler, 2019) went away from ALLIESTEIN by move 22 and was a done deal by move 33. Honours even: 1-1.

Table 8. The TCEC 16 Superfinal match of 100 games: the decisive games, Black wins underlined.

#	Superfinal	Elo	Pts	P%	Elo ±	# of	games won (underline = '0-1')	Openings	# of	win-pairs
1	Stockfish 19092522	3892	54½	54.5%	-170	14	06, 12, 14, 26, 32, 42, 46, 56, 60, 61, 64, 80, 93, 100	B48, A65, C19, E16, C27, D70, A10, B06, C75, A45, C11, C96, D35, B35	1	99-100 (1-0, 1-0)
2	AllieStein v0.5-dev_7b41f8c-n11	3823	45½	45.5%	+170	05	03, 27, 39, 75, 99	E98, B01, C11, B07, B35		

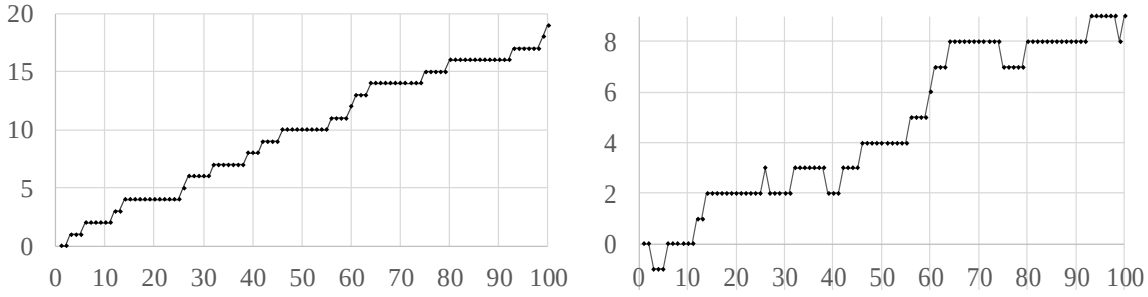

Fig. 2. The TCEC 16 Superfinal: the incidence of decisive results and STOCKFISH's lead.

Game 12 was even until ALLIESTEIN, after running down its thinking time, lost the plot with **33…Kf1** and **34…Nd6**. GM Matthew Sadler covers STOCKFISH's wins in game 14 (resulting from **33…Qc6?**) and game 26, a rare and dramatic mate on move 34, so we skip to game 27. On move 39, ALLIESTEIN's confidence in a result really rockets but the other engines do not see anything at all. By the way, Chessbomb's (2019) kibitzing STOCKFISH 10 is not the best engine to spot the affine and DNA-adjacent TCEC STOCKFISH's errors: the game was lost before any 'red moves' were flagged there.

Game 32 was a STOCKFISH win and here Chessbomb (2019) puts big question marks against Black's **5…Nc6** which was actually in the provided opening. ALLIESTEIN seems at odds with these first few moves and there are questions about its **12…h5** and **18…f4**. Opportunity comes over the horizon for STOCKFISH after ALLIESTEIN played **32…Kc7** without much thought: time-management was beginning to look like an issue. It remained blissfully unaware of problems until move 39 when it realised that its three connected passed pawns were not enough.

In game 39, after the defined opening of ten moves, ALLIESTEIN's prescience was never matched by the kibitzers but proved justified: confidence was high by move 19. This game saw White use the 'thorn pawn' strategy – pawn to h6, see various Kingscrusher videos – and reduced the efficacy of Black's two

bishops. It all worked: 1-0. So, after the first 40 games, the score was 21-19, an Elo difference of only 18.

However, after this, STOCKFISH went on a roll – six wins without reply starting with game 42 where Sadler (2019) made comparison with ALPHAZERO's play (DeepMind, 2018; Sadler and Regan, 2019, esp. p230). The other wins were in games 46, 56, 60, 61 (as Black) & 64.[11]

In game 46, STOCKFISH's attack centred on its e-pawn and both engines had no doubts on move 45 that **44. e7 Qa2** sealed the game for White. In game 56, ALLIESTEIN was curiously ahead of STOCKFISH in thinking it was lost. It happens: these engines think they are playing themselves and that they're the only ones in the room. Game 60 was in some ways similar to game 46: STOCKFISH pushed a passed pawn to the seventh rank and tied up valuable ALLIESTEIN resources in defence. Again, it was shortly after move 40 that both engines saw the game as decisive. Game 61 was the second half of a combination punch, the only case of two wins in a row and the first win for Black. Jozarov (2019b) covers this game. Here, a turning point was **24. a4 Bxf4** where ALLIESTEIN missed STOCKFISH's decisive discovered attack and mate threat.

Jozarov (2019c) covers game 64. Here again, ALLIESTEIN missed another Bishop-sac with benefits, this time a confident **23. Bxh7+** which started a classic assault on the Black castle, admittedly from a position of strength. ALLIESTEIN won in game 75, see Sadler (2019). Game 80 looked drawish for 160 moves until STOCKFISH's **164. Ree1** seduced Black's wandering king one further step into **164…Kxf3**. Further mistakes by ALLIESTEIN simply shortened a well-fought game which ended with unbalanced heavy artillery, QR-vs-RR, on the field. The match was formally over scorewise after STOCKFISH's second win as Black in game 93.

Jeroen Noomen chose the exciting Sicilian Dragon opening to end the Superfinal and we were rewarded for the first time with two wins by White, a triumphant climax to this festival of chess. Sadler and Jozarov (2019d) both cover game 100.

6 In conclusion

Congratulations are once again due to the STOCKFISH team as their engine in its various versions has become TCEC Grand Champion for the seventh time. The trophies for seasons 6, 9, 11-14 and 16 should make a fine sight in their cabinet. Plaudits should also go to ALLIESTEIN's team as their engine did far better than expected. ALLIESTEIN's Superfinal performance rating is only some 31 Elo points behind STOCKFISH: as it is relatively new out of the box, it presumably has some potential. We imagine this is not ALLIESTEIN's last TCEC Superfinal.

As ever, we thank the small TCEC team who keep everything together with increasing success: their success is inversely proportional to their visibility. We thank all participants in this season's events, both the leading TCEC commentators and the chat room. So much good chess would go by, especially in the drawn games, without getting the appreciation it deserves if the online audience was not kibitzing and sharing their perspectives. Even at Rapid tempo as in the early leagues here, in TCEC Cup 4 (Haworth and Hernandez, 2019b) and arguably at Blitz tempo, most if not all of the TCEC engines are playing at super-GM levels. All the games and supplementary data can be revisited at leisure (Haworth and Hernandez, 2019a) with key decisive ones, including all those in the Superfinal, played out. Some

[11] Some ALLIESTEIN parameters were discovered around game 45 to be in error: it's not clear what the effect was.

of these completions are less obvious than others. The generic stats and shortest/longest games are in Tables 9 and 10.

With such an excess of riches, it would be useful to have some tools to alert us to the events that we variously look forward to – specific engines and contests, opening novelties, minor exchanges, sacrifices, unbalanced forces, the leaps in the evaluation curves, endgames, unexpected results and so on. What toolkit is to hand today? Is there a new AI challenge here? We end with that thought while looking forward to Season 17.

Table 9. Generic statistics for each phase of TCEC16: results, terminations and average game-length.

	TCEC 16	**Qualification**		**League 2**		**League 1**		**L 1 Playoff**		**Division P**		**Superfinal**		**Overall**	
		#	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**	**#**	**%**
	# games	306		240		240		24		168		100		1078	
Results	Draws	101	33.0	120	50.0	150	62.5	16	66.7	120	71.4	81	81.0	572	53.1
	Wins	205	67.0	120	50.0	90	37.5	8	33.3	48	28.6	19	19.0	482	44.7
	1-0	114	37.3	75	31.3	61	25.4	5	20.8	35	20.8	17	17.0	307	28.5
	0-1	91	29.7	45	18.8	29	12.1	3	12.5	13	7.7	2	2.0	183	17.0
	White performance	164.5	53.8	135.0	56.3	136.0	56.7	13.0	54.2	95.0	56.5	57.5	57.5	601	55.8
	Black performance	141.5	46.2	105.0	43.8	104.0	43.3	11.0	45.8	73.0	43.5	42.5	42.5	477	44.2
Terminations	TCEC draw	34	11.1	62	25.8	70	29.2	8	33.3	41	24.4	21	21.0	236	21.9
	3x repetition	28	9.2	20	8.3	38	15.8	3	12.5	30	17.9	20	20.0	139	12.9
	50-move rule	4	1.3	3	1.3	1	0.4	0	0.0	8	4.8	14	14.0	30	2.8
	Stalemate	0	0.0	0	0.0	0	0.0	0	0.0	1	0.6	0	0.0	1	0.1
	EGT adj., 'draw'	35	11.4	35	14.6	41	17.1	5	20.8	40	23.8	26	26.0	182	16.9
	EGT adjudication	110	35.9	70	29.2	64	26.7	7	29.2	56	33.3	26	26.0	333	30.9
	TCEC win	94	30.7	74	30.8	54	22.5	3	12.5	20	11.9	18	18.0	263	24.4
	EGT adj., 'win'	75	24.5	35	14.6	23	9.6	2	8.3	16	9.5	0	0.0	151	14.0
	Tech. default	1	0.3	2	0.8	6	2.5	1	4.2	2	1.2	0	0.0	12	1.1
	Manual adj.	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
	Mate	33	10.8	8	3.3	5	2.1	1	4.2	4	2.4	1	1.0	52	4.8
	Loss on time	2	0.7	1	0.4	0	0.0	0	0.0	0	0.0	0	0.0	3	0.3
	Resignation	0	0.0	0	0.0	2	0.8	1	4.2	6	3.6	0	0.0	9	0.8
Length	Moves	69.0		69.4		66.6		71.5		83.5		89.0		72.7	
	Time-budget (h)	1.19		1.19		1.69		2.20		3.23		4.49		1.95	
	Clock-time used (h)	1.024	85.9	1.04	87.2	1.43	84.9	1.97	89.6	2.95	91.3	3.88	86.3	1.70	87.5
	C-time not used (h)	0.17	14.1	0.15	12.8	0.26	15.1	0.23	10.4	0.28	8.7	0.61	13.7	0.24	12.5

Table 10. The shortest and longest 1-0, drawn and 0-1 games in each phase of TCEC16.

	1-0						**½-½**						**0-1**					
Div.	**Shortest**			**Longest**			**Shortest**			**Longest**			**Shortest**			**Longest**		
	Game		**#mv**	**Game**		**#mv**	**Game**		**#mv**	**Game**		**#mv**	**Game**		**#mv**	**Game**		**#mv**
Q	120/14.3	At-Tb	38	74/9.2	Ig-c22	151	101/12.2	Tu-Tb	19	212/24.5	Wa-Lu	269	18/2.9	At-Ba	33	264/30.3	Cf-Ma	180
2	113/15.1	Ne-c22	33	107/14.3	Ni-Ma	106	90/12.2	To-Ma	22	46/6.6	Fr-Gu	197	15/2.7	To-Ar	44	171/22.3	Ni-Gu	130
1	191/24.7	Sn-Bo	16	112/14.8	Jo-Ch	184	18/3.2	Xi-Et	13	179/23.3	Cb-Sn	224	188/24.4	Fi-Ch	36	121/16.1	Ar-Et	238
1 (P)	20/10.2	Et-La	59	09/5.1	Et-Sn	101	13/7.1	Sv-Sn	37	07/4.1	Sn-Sv	109	05/3.1	La-Sn	89	01/1.1	Sv-Sn	90
P	17/5.1	Ko-Sn	44	46/12.2	St-AS	173	87/22.3	Km-Ko	20	47/12.3	Lc-Ho	222	139/35.3	Km-St	39	144/36.4	Ho-AS	180
SF	26	St-AS	34	80	St-AS	193	19	AS-St	16	54	St-AS	242	93	AS-St	42	61	AS-St	56
O'all	1, 24.7	Sn-Bo	16	1, 14.8	Jo-Ch	184	1, 3.2	Xi-Et	13	Q, 4.5	Wa-Lu	269	Q, 2.9	At-Ba	33	1, 16.1	Ar-Et	238

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