Crazy Sequential Representations: Base 15 (0000 up to EEEE)

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Historic Overview
Decimal Crazy Sequential Representations

Inder Taneja published five papers on arXiv (for 1 up to 11111):

ARXIV Version	Evaluated Range	Allowed Operations	Missing Increasing	Missing Decreasing	Valid Representations
1 (06-02-2013)[1]	44 to 1000	+ * ^	2	10	1902 (of 1914)
2 (19-03-2013)[2]	44 to 4444	+ * ^	50	53	8699 (of 8802)
3 (05-06-2013)[3]	44 to 11111	+ * ^ ()	590	605	20941 (of 22136)
4 (05-08-2013)[4]	0 to 11111	+ * ^ () -	449	315	21460 (of 22224)
5 (08-01-2014)[5]	0 to 11111	+ * ^ () - /	9	10	22205 (of 22224)

Authors published three papers on Figshare/Zenodo (for -2147483647 up to 2147483647):

Date	Title
12-06-2018	Crazy Sequential Representations: Exhaustive Search [6]
14-06-2018	Crazy Sequential Representations: Negative Integers [7]
18-06-2018	Crazy Sequential Representations: Without Subtraction and/or Division [8]

Inder Taneja published three papers on RGMIA (for 11112 up to 30000):

Date	Title
12-09-2018	Crazy Representations of Natural Numbers From 11112 to 20000 [9]
10-11-2018	Crazy Representations of Natural Numbers From 20001 to 25000 [10]
10-11-2018	Crazy Representations of Natural Numbers From 25001 to 30000 [11]

Authors published one paper on Figshare/Zenodo (comparing results for 11112 up to 30000):

Date	Title
06-12-2018	Crazy Sequential Representations: 11112 up to 30000 [12]

Authors published three papers on Figshare/Zenodo (improving our previous work):

Date	Title
14-12-2018	Crazy Sequential Representations: Simplifications (01) [13]
24-12-2018	Crazy Sequential Representations: Fill the Gaps (01) [14]
02-01-2019	Crazy Sequential Representations: Fill the Gaps (02) [15]

Historic Overview
Non-Decimal Crazy Sequential Representations

Tim Wylie published one paper on arXiv (focusing on bases 3 through 10):

Date	Title
11-10-2018	Crazy Sequential Representations of Numbers for Small Bases

Base 15 Crazy Sequential Representation

For example, two valid base 15 crazy sequential representations:

14221_{10} 4331_{15}	530_{10} 255_{15}
$-1_{15}/2_{15}*(3_{15}-4_{15}+5_{15})\text{^}6_{15}+7_{15}*89A_{15}+BCD_{15}-E_{15}$	$ED_{15}-CB_{15}+A9_{15}\text{^}(8_{15}-7_{15})*6_{15}/(-5_{15}+4_{15}+3_{15})+21_{15}$

For clarity, the corresponding base 10 representations:

$-1_{10}/2_{10}*(3_{10}-4_{10}+5_{10})\text{^}6_{10}+7_{10}*1945_{10}+2668_{10}-14_{10}$	$223_{10}-191_{10}+159_{10}\text{^}(8_{10}-7_{10})*6_{10}/(-5_{10}+4_{10}+3_{10})+21_{10}$

Definition

Valid mathematical expression, thus well-formed interpretable syntactic construct.
Evaluation results is an integer value, thus a number without a fractional component.
Notation as used by most programming languages, thus restricted to following characters:

1	2	3	4	5	6	7	8	9	A	B	C	D	E	+	-	*	/	^	(	)

Digits 1 up to E occur in increasing or decreasing order:

-1/2*(3-4+5)^6+7*89A+BCD-E	ED-CB+A9^(8-7)*6/(-5+4+3)+21

Digits represent single-digit or multi-digit numbers (concatenation of digits is allowed):

-1/2*(3-4+5)^6+7*89A+BCD-E	ED-CB+A9^(8-7)*6/(-5+4+3)+21

Numbers occur in positive form or negative form (negation of numbers by “-” is allowed).

-1/2*(3-4+5)^6+7*89A+BCD-E	ED-CB+A9^(8-7)*6/(-5+4+3)+21

Allowed operations; addition, subtraction, multiplication, division and/or exponentiation.

-1/2*(3-4+5)^6+7*89A+BCD-E	ED-CB+A9^(8-7)*6/(-5+4+3)+21

Order of evaluation may be influenced by parentheses (also nested parentheses).

-1/2*(3-4+5)^6+7*89A+BCD-E	ED-CB+A9^(8-7)*6/(-5+4+3)+21

Representations with negation of segments in brackets are referred to as “pseudo”.

(1+2-3)*(45*-(6^7)+8-9ABCDE)	(EDCBA98+7*-(6^5)+4)*(3-2-1)
(1+2-3)*(45/-(6^7)+8-9ABCDE)	(EDCBA98+7/-(6^5)+4)*(3-2-1)
(1+2-3)*(45^-(6^7)+8-9ABCDE)	(EDCBA98+7^-(6^5)+4)*(3-2-1)
(-(1+2)+3)*(45^(6^7)+8-9ABCDE)	(EDCBA98+7^(6^5)+4)*(-(3-2)+1)
-(1-2+234*(6-(7+8-9))*ABCDE)	-(EDCBA*(9-(8+7-6))*543-2+1)

Representations without negation of segments in brackets are referred to as “genuine”.

Aim

Identify genuine base 15 crazy sequential representations for 0000_{15} up to $EEEE_{15}$

Expected number of representations = 2_{15} + $EEEE_{15}$ + $EEEE_{15}$ = 20000_{15} = 101250_{10}

Results

101207_{10} out of 101250_{10} were identified, see supplement.

Missing

Increasing	18B2, 43E7
Decreasing	5AE7, 5B1D, 682A, 71B8, 7E71, 7E80, 8090, 8160, 81C2, 8E9C, 96A3, 9E96, A1DE, A462, A58B, A718, A7D6, B19B, B4BA, BCCD, BD01, BD1B, C3DE, C4B3, C549, C5CE, C7A5, C7C9, C8BD, C948, C963, CE99, D016, D081, D39E, D66B, D818, DB11, EAAA, EB7A, EC24

Notes

Authors consider base 15 crazy sequential representations to be proof-of-work, as identification is computationally expensive, while verification is trivial. Authors did not simplify and/or optimize the crazy sequential representations.

Other Bases

Authors also identified genuine crazy sequential representations for other bases:

Date	Title
04-01-2018	Crazy Sequential Representations: Base 11 (0000 up to AAAA) [17]
04-01-2018	Crazy Sequential Representations: Base 12 (0000 up to BBBB) [18]
04-01-2018	Crazy Sequential Representations: Base 13 (0000 up to CCCC) [19]
04-01-2018	Crazy Sequential Representations: Base 14 (0000 up to DDDD) [20]
04-01-2018	Crazy Sequential Representations: Base 15 (0000 up to EEEE) [21]
04-01-2018	Crazy Sequential Representations: Base 16 (0000 up to FFFF) [22]

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