Crazy Sequential Representations: Fill the Gaps (10)

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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]

Inder Taneja published two papers on Zenodo (combining results for 11112 up to 30000):

Date	Title
18-01-2019	Crazy Representations of Natural Numbers From 11112 to 20000 [28]
03-02-2019	Crazy Representations of Natural Numbers From 20000 to 30000 [29]

Authors published eleven 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]
28-01-2019	Crazy Sequential Representations: Fill the Gaps (03) [25]
06-02-2019	Crazy Sequential Representations: Fill the Gaps (04) [30]
07-02-2019	Crazy Sequential Representations: Fill the Gaps (05) [31]
19-07-2019	Crazy Sequential Representations: Fill the Gaps (06) [36]
23-07-2019	Crazy Sequential Representations: Fill the Gaps (07) [37]
30-07-2019	Crazy Sequential Representations: Fill the Gaps (08) [38]
02-08-2019	Crazy Sequential Representations: Simplifications (02) [39]
08-08-2019	Crazy Sequential Representations: Fill the Gaps (09) [40]

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 [16]

Authors published six papers on Figshare/Zenodo (focusing on bases 11 through 16):

Date	Title
04-01-2019	Crazy Sequential Representations: Base 11 (0000 up to AAAA) [17]
04-01-2019	Crazy Sequential Representations: Base 12 (0000 up to BBBB) [18]
04-01-2019	Crazy Sequential Representations: Base 13 (0000 up to CCCC) [19]
04-01-2019	Crazy Sequential Representations: Base 14 (0000 up to DDDD) [20]
04-01-2019	Crazy Sequential Representations: Base 15 (0000 up to EEEE) [21]
04-01-2019	Crazy Sequential Representations: Base 16 (0000 up to FFFF) [22]

Authors published one paper on Figshare/Zenodo (completing the base 11 up to 16 series):

Date	Title
09-01-2019	Crazy Sequential Representations: Base 11 up to 16 (0000 up to XXXX) [23]

Authors published one paper on Figshare/Zenodo (extending the base 16 series):

Date	Title
04-01-2019	Crazy Sequential Representations: Base 16 (-FFFFF up to FFFFF) [24]

Authors published two papers on Figshare/Zenodo (focusing on bases 17 through 62):

Date	Title
23-01-2019	Crazy Sequential Representations: Base 17 up to 36 (0000 up to ####) [26]
02-02-2019	Crazy Sequential Representations: Base 17 up to 62 (0000 up to ####) [27]

Authors published four papers on Figshare/Zenodo (focusing on bases 3 through 9):

Date	Title
13-02-2019	Crazy Sequential Representations: Base 9 (0000 up to 8888) [32]
18-02-2019	Crazy Sequential Representations: Base 8 (0000 up to 7777) [33]
18-02-2019	Crazy Sequential Representations: Base 7 (0000 up to 6666) [34]
18-02-2019	Crazy Sequential Representations: Base 3 up to 9 [35]

Examples - Decimal Crazy Sequential Representations

Two valid base 10 crazy sequential representations (increasing and decreasing):

2671_{10}	**48_{10}**
$1_{10}/2_{10}*(3_{10}-4_{10}+5_{10})\text{^}6_{10}+7_{10}*89_{10}$	$9_{10}\text{^}(8_{10}-7_{10})*6_{10}/(-5_{10}+4_{10}+3_{10})+21_{10}$

Examples - Non-Decimal Crazy Sequential Representations

Two valid base 11 crazy sequential representations, and their base 10 representation:

5491_{10} 4142_{11}	**378_{10} 314_{11}**
$-1_{11}/2_{11}*(3_{11}-4_{11}+5_{11})\text{^}6_{11}+7_{11}*89A$	$A9_{11}\text{^}(8_{11}-7_{11})*6_{11}/(-5_{11}+4_{11}+3_{11})+21_{11}$
$-1_{10}/2_{10}*(3_{10}-4_{10}+5_{10})\text{^}6_{10}+7_{10}*1077_{10}$	$119_{10}\text{^}(8_{10}-7_{10})*6_{10}/(-5_{10}+4_{10}+3_{10})+21_{10}$

Two valid base 12 crazy sequential representations, and their base 10 representation:

6853_{10} $3B71_{12}$	**419_{10} $2AB_{12}$**
$-1_{12}/2_{12}*(3_{12}-4_{12}+5_{12})\text{^}6_{12}+7_{12}*89A_{12}+B_{12}$	$B_{12}+A9_{12}\text{^}(8_{12}-7_{12})*6_{12}/(-5_{12}+4_{12}+3_{12})+21_{12}$
$-1_{10}/2_{10}*(3_{10}-4_{10}+5_{10})\text{^}6_{10}+7_{10}*1270_{10}+11_{10}$	$11_{10}+129_{10}\text{^}(8_{10}-7_{10})*6_{10}/(-5_{10}+4_{10}+3_{10})+21_{10}$

Two valid base 13 crazy sequential representations, and their base 10 representation:

8460_{10} $3B0A_{13}$	**605_{10} 377_{13}**
$-1_{13}/2_{13}*(3_{13}-4_{13}+5_{13})\text{^}6_{13}+7_{13}*89A_{13}+BC_{13}$	$CB_{13}+A9_{13}\text{^}(8_{13}-7_{13})*6_{13}/(-5_{13}+4_{13}+3_{13})+21_{13}$
$-1_{10}/2_{10}*(3_{10}-4_{10}+5_{10})\text{^}6_{10}+7_{10}*1479_{10}+155_{10}$	$167_{10}+139_{10}\text{^}(8_{10}-7_{10})*6_{10}/(-5_{10}+4_{10}+3_{10})+21_{10}$

Two valid base 14 crazy sequential representations, and their base 10 representation:

12217_{10} 4649_{14}	**302_{10} 178_{14}**
$-1_{14}/2_{14}*(3_{14}-4_{14}+5_{14})\text{^}6_{14}+7_{14}*89A_{14}+BCD_{14}$	$D_{14}-CB_{14}+A9_{14}\text{^}(8_{14}-7_{14})*6_{14}/(-5_{14}+4_{14}+3_{14})+21_{14}$
$-1_{10}/2_{10}*(3_{10}-4_{10}+5_{10})\text{^}6_{10}+7_{10}*1704_{10}+ 2337_{10}$	$13_{10}-179_{10}+149_{10}\text{^}(8_{10}-7_{10})*6_{10}/(-5_{10}+4_{10}+3_{10})+21_{10}$

Two valid base 15 crazy sequential representations, and their base 10 representation:

14221_{10} 4331_{15}	**530_{10} 255_{15}**
$-1_{15}/2_{15}*(3_{15}-4_{15}+5_{15})\text{^}6_{15}+7_{15}*89A_{15}+BCD_{15}-E_{15}$	$ED_{15}-CB_{15}+A9_{15}\text{^}(8_{15}-7_{15})*6_{15}/(-5_{15}+4_{15}+3_{15})+21_{15}$
$-1_{10}/2_{10}*(3_{10}-4_{10}+5_{10})\text{^}6_{10}+7_{10}*1945_{10}+ 2668_{10}-14_{10}$	$223_{10}-191_{10}+159_{10}\text{^}(8_{10}-7_{10})*6_{10}/(-5_{10}+4_{10}+3_{10})+21_{10}$

Two valid base 16 crazy sequential representations, and their base 10 representation:

16148_{10} $3F14_{16}$	**4402_{10} 1132_{16}**
$-1_{16}/2_{16}*(3_{16}-4_{16}+5_{16})\text{^}6_{16}+7_{16}*89A_{16}+BCD_{16}-EF_{16}$	$FED_{16}-CB_{16}+A9_{16}\text{^}(8_{16}-7_{16})*6_{16}/(-5_{16}+4_{16}+3_{16})+21_{16}$
$-1_{10}/2_{10}*(3_{10}-4_{10}+5_{10})\text{^}6_{10}+7_{10}*2202_{10}+3021_{10}-239_{10}$	$4077_{10}-203_{10}+169_{10}\text{^}(8_{10}-7_{10})*6_{10}/(-5_{10}+4_{10}+3_{10})+21_{10}$

Definition - Base 10 Crazy Sequential Representation

Valid mathematical expression, thus well-formed interpretable syntactic construct.
Evaluation results in 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	+	-	*	/	^	(	)

Digits 1 up to 9 occur in increasing or decreasing order:

-1/2*(3-4+5)^6+7*89	9^(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*89	9^(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*89	9^(8-7)*6/(-5+4+3)+21

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

-1/2*(3-4+5)^6+7*89	9^(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*89	9^(8-7)*6/(-5+4+3)+21

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

(1+2-3)*(45*-(6^7)+8-9)	(98+7*-(6^5)+4)*(3-2-1)
(1+2-3)*(45/-(6^7)+8-9)	(98+7/-(6^5)+4)*(3-2-1)
(1+2-3)*(45^-(6^7)+8-9)	(98+7^-(6^5)+4)*(3-2-1)
(-(1+2)+3)*(45^(6^7)+8-9)	(98+7^(6^5)+4)*(-(3-2)+1)
-(1-2+234*(6-(7+8-9)))	-((9-(8+7-6))*543-2+1)

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

Note

Previously, authors used ‘CSR’ to refer to crazy sequential representations that evaluate to natural numbers (as originally introduced by Inder Taneja) and ‘NCSR’ to refer to crazy sequential representations that evaluate to negative integers (as introduced by ourselves). Authors always avoided ‘PCSR’ as this might introduce ambiguity (pseudo vs. positive CSR).

From this point forward, authors will use the following:

CSR = Crazy sequential representation, evaluating to any integer
+CSR = Crazy sequential representation, evaluating to any positive integer
−CSR = Crazy sequential representation, evaluating to any negative integer

Note

As far we’re aware, our previous work [6-8,12-15,25,30,31,36-40] contains 16 invalid expressions.

Five expressions which do not contain each digit in appropriate order:

Integer	Invalid	Valid Alternative
474	9*8+7*(54+3)+2+1	98+7-6+54+321
475	9+8+5*(7+6)*(4+3)+2+1	98+76-5*4+321
512	98+7*(54+3+2)+1	9*8+765-4-321
10102	1+(2+56*(3*4))*(7+8)-9	1+(2+3*4*56)*(7+8)-9
-10102	-(1+(2+56*(3*4))*(7+8)-9)	-1-(2+3*4*56)*(7+8)+9

Eleven expressions which do not evaluate to an integer value:

Integer	Invalid		
-1124589382	9^-8-7-65^4*3*21	≈	-1124589381.999999...
-410062320	-9*((8+7)^6-5)*4+3^-21	≈	-410062319.999999...
-75499812	-9*(8^7+65)*4+3^-21	≈	-75499811.999999...
43046792	9^8+76-5+43^-21	≈	43046792.000000...
43046797	9^8+76+5/43^21	≈	43046797.000000...
43047046	9^8+7^-65+4+321	≈	43047046.000000...
43047486	9^8+765-43^-21	≈	43047485.999999...
43164370	9^8+7^6-5/43^21	≈	43164369.999999...
124571609	(1-2^-34+5*6^7)*89	≈	124571608.999999...
301327047	9^8*7+65^-4321	≈	301327047.000000...
1124589368	9^-8-7+65^4*3*21	≈	1124589368.000000...

Aim

Attempt to ‘fill the gaps’ in our previous work [6-8,12-15,25,30,31,36-40] by identifying...
- increasing genuine CSR for integers without any increasing genuine CSR.
- decreasing genuine CSR for integers without any decreasing genuine CSR.

Results

Authors identified 56954 previously unknown genuine CSR, see supplements.

	Increasing +CSR	Decreasing +CSR	Increasing −CSR	Decreasing −CSR
Genuine	12382	15941	12417	16214

Overview

Currently, within the -2147483647 up to 2147483647 range, increasing CSR are available for 1827187 integers, and decreasing CSR are available for 2596147 integers:

	Increasing +CSR	Decreasing +CSR	Increasing −CSR	Decreasing −CSR
Genuine	911655	1298775	908303	1274781
Pseudo*	2029	189	5200	22402
Total	913684	1298964	913503	1297183

*pseudo CSR in case no genuine CSR available

Note

Authors consider CSR to be proof-of-work, as identification is computationally expensive, while verification is trivial.

Authors do not guaranty:

- Published CSR are the shortest in existence.
- Published CSR are in their simplest form.
- Unavailable CSR do not exists.

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