Fourth Power Algorithm III Using polynomials

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The discovery of a new algorithm, which went unnoticed for centuries, now comes to light to show its characteristics and its contribution to the use of polynomials.

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Abstract: This document develops and demonstrates the discovery of a new potentiation algorithm that works absolutely with all the numbers using the formula of the square of a binomial, trinomial, tetranomial and pentanomial.

Chapter 1: Fourth powered of a binomial, trinomial, tetranomial and pentanomial.

Example nº1 Binomial

$$(a+b)^4 = (a+b)*(a+b)*(a+b)*(a+b)$$

Right distribution of terms

$$a^4 + 4a^3b + 6a^2b^2 + 4ab^3 + b^4$$

Coefficient of terms

1 4 6 4 1

Pascal Triangle

$(a+b)^0$					1				
$(a+b)^1$				1		1			
$(a+b)^2$			1		2		1		
$(a+b)^3$		1		3		3		1	
$(a+b)^4$	1		4		6		4		1

Example $(15)^4 = 50.625$

1=a
5=b

$$1^4 + 4*1^{3}*5 + 6*1^2*5^2 + 4*1*5^3 + 5^4$$

1+20+150+500+625

	1					10.000
	2	0				1.000
	1	5	0			100
+		5	0	0		10
			6	2	5	1
	5	0	6	2	5	Result

The figure is a pattern that will be present in all the numbers of two digits fourth.
We multiply the first term by 10.000, the second term by 1.000, the third term by 100, the forth term by 10 and the fifth term by 1.

Example n°2 Trinomial

$$(a+b+c)^4 = (a+b+c)*(a+b+c)*(a+b+c)*(a+b+c)$$

Right distribution of terms

$$a^4 + 4a^3b + 4a^3c + 6a^2b^2 + 12\ a^2bc + 6a^2c^2 + 4b^3a + 12\ ab^2c + 12\ abc^2 + 4ac^3 + b^4 + 4b^3c + 6b^2c^2 + 4bc^3 + c^4$$

Coefficient of terms

1 4 4 6 12 6 4 12 12 4 1 4 6 4 1

$(a+b)^0$					1					1
$(a+b)^1$				1		1				4
$(a+b)^2$			1		2		1		X	6
$(a+b)^3$		1		3		3		1		4
$(a+b)^4$	1		4		6		4		1	1

$(a+b+c)^4$	1	4	4	6	12	6	4	12	12	4	1	4	6	4	1

Example $(211)^4$= 1.982.119.441

$$2^4 + 4*2^3*1 + 4*2^3*1 + 6*2^2*1^2 + 12\ *2^2*1*1 + 6*2^2*1^2 + 4*1^3*2 + 12\ *2*1^2*1 + 12*2*1*1^2 + 4*2*1^3 + 1^4 + 4*1^3*1 + 6*1^2*1^2 + 4*1*1^3 + 1^4$$

16+32+32+24+48+24+8+24+24+8+1+4+6+4+1

2=a
1=b
1=c

1	6									100.000.000
	3	2								10.000.000
		3	2							1.000.000
		2	4							1.000.000
			4	8						100.000
				2	4					10.000
				8						100.000
				2	4					10.000
					2	4				1.000
							8			100
					1					10.000
						4				1.000
							6			100
		+						4		10
									1	1
1	9	8	2	1	1	9	4	4	1	Result

The figure that is formed here is a pattern that will always be repeated when we have three digits to the fourth.

Example nº3 (Tetranomial)

$$(a+b+c+d)^4= (a+b+c+d)*(a+b+c+d)*(a+b+c+d)*(a+b+c+d)$$

Right distribution of terms

$a^4+ 4a^3b+ 4a^3c+ 4a^3d+6a^2b^2+ 12a^2bc+ 12a^2bd+ 6a^2c^2+12a^2dc+ 6a^2d^2+ 4ab^3+12acb^2+ 12ab^2d+ 12ac^2b+ 24abcd+ 12abd^2+4ac^3+12adc^2+12ad^2c+ 4ad^3+ b^4+4cb^3+ 4b^3d+ 6c^2b^2+12b^2cd + 6b^2d^2+ 4bc^3+ 12bdc^2 + 12bd^2c+ 4bd^3+ c^4+ 4dc^3+6d^2c^2+ 4cd^3+ d^4$

Coefficient of terms

1 4 4 4 6 12 12 6 12 6 4 12 12 12 24 12 4 12 12 4 1 4 4 6 12 6 4 12 12 4 1 4 6 4 1

$(a+b+c)^0$	1		1
$(a+b+c)^1$	1 1 1		4
$(a+b+c)^2$	1 2 2 1 2 1	X	6
$(a+b+c)^3$	1 3 3 3 6 3 1 3 3 1		4
$(a+b+c)^4$	1 4 4 6 12 6 4 12 12 4 1 4 6 4 1		1

1	4	4	4	6	12	12	6	12	6	4	12	12	12	24	12	4	12	12	4	1	4	4	6	12	6	4	12	12	4	1	4	6	4	1

Example $(2111)^4$ **=19.858.796.855.041**

a=2
b=1
c=1
d=1

$2^4+ 4*2^3*1 + 4*2^3*1 + 4*2^3*1 + 6*2^2*1^2 + 12*2^2*1*1 + 12*2^2*1*1 + 6*2^2*1^2 + 12*2^2*1*1 + 6*2^2*1^2+ 4*2*1^3 + 12*2*1*1^2 +12*2*1^2*1 +12*2*1^2*1 +24*2*1*1*1 +12*2*1*1^2 +4*2*1^3 + 12*2*1*1^2 + 12*2*1^2*1 + 4*2*1^3+ 1^4+ 4*1*1^3+ 4*1^3*1 + 6*1^2*1^2+ 12*1^2*1*1 + 6*1^2*1^2+ 4*1*1^3 + 12*1*1*1^2 + 12*1*1^2*1+ 4*1*1^3 + 1^4+ 4*1*1^3+ 6*1^2*1^2+ 4*1*1^3+ 1^4$

16+32+32+32+24+48+48+24+48+24+ 8+24+24+24+48+24+8+24+24+8+
1+4+4+6+12+6+4+12+12+4+1+4+6+4+1

																$*10^n$
	1	6													*1.000.000.000.000	10^{12}
		3	2												*100.000.000.000	10^{11}
			3	2											*10.000.000.000	10^{10}
				3	2										*1.000.000.000	10^{9}
			2	4											*10.000.000.000	10^{10}
				4	8										*1.000.000.000	10^{9}
					4	8									*100.000.000	10^{8}
					2	4									*100.000.000	10^{8}
						4	8								*10.000.000	10^{7}
							2	4							*1.000.000	10^{6}
					8										*1.000.000.000	10^{9}
					2	4									*100.000.000	10^{8}
						2	4								*10.000.000	10^{7}
						2	4								*10.000.000	10^{7}
							4	8							*1.000.000	10^{6}
								2	4						*100.000	10^{5}
								8							*1.000.000	10^{6}
								2	4						*100.000	10^{5}
									2	4					*10.000	10^{4}
											8				*1.000	10^{3}
						1									*100.000.000	10^{8}
							4								*10.000.000	10^{7}
								4							*1.000.000	10^{6}
								6							*1.000.000	10^{6}
								1	2						*100.000	10^{5}
										6					*10.000	10^{4}
									4						*100.000	10^{5}
									1	2					*10.000	10^{4}
										1	2				*1.000	10^{3}
												4			*100	10^{2}
										1					*10.000	10^{4}
											4				*1.000	10^{3}
												6			*100	10^{2}
+													4		*10	10^{1}
														1	*1	10^{0}
	1	9	8	5	8	7	9	6	8	5	5	0	4	1	Result	

The figure that is formed here is a pattern that will always be repeated when we have four digits to the fourth.

Table 1

Fourth	Number of terms	Number of Coefficients	Quantity = Pentatope numbers	Sum of the coefficients Sum= x^4
$(a)^4$	**1**	**1**	1	1
$(a+b)^4$	**2**	**14641**	5	16
$(a+b+c)^4$	**3**	**1 4 4 6 12 6 4 12 12 4 1 4 6 4 1**	15	81
$(a+b+c+d)^4$	**4**	**1 4 4 4 6 12 12 6 12 6 4 12 12 12 24 12 4 12 12 4 1 4 4 6 12 6 4 12 12 4 1 4 6 4 1**	35	256

Curiosity	
If we place the numbers 14641 = $\mathbf{11^4}$ in each of the squares and multiply the squares that intersect, we obtain a square that adds 256 = $\mathbf{4^4}$	see square below

1	4	6	4	1
4	16	24	16	4
6	24	36	24	6
4	16	24	16	4
1	4	6	4	1

Inside the square the following numbers are formed

$\mathbf{4 * 4^2 + 6^2 + 6 * 4 * 4}$ = **64 + 36 + 96 = 196**

$8^2 + 2*6*8 + 6^2 = a^2 + 2ab + b^2$

Table 2 Coefficients

The table seems to be better ordered if you put all the numbers to the left as we are used to, but in this case I keep this position since the coefficients are arranged in this way and when we expand them, they increase their digits to the left and not to the right .

Table 3

																																		1
																														1	4	6	4	1
																				1	4	4	6	12	6	4	12	12	4	1	4	6	4	1
1	4	4	4	6	12	12	6	12	6	4	12	12	12	24	12	4	12	12	4	1	4	4	6	12	6	4	12	12	4	1	4	6	4	1

Table 4 Sectors

1	4	4	4	6	12	12	6	12	6	4	12	12	12	24	12	4	12	12	4	1	4	4	6	12	6	4	12	12	4	1	4	6	4	1

Sector 3 Sector 2 Sector 1 S 0

Sector 0	1
Sector 1	1 4 6 4
Sector 2	1 4 4 6 12 6 4 12 12 4
Sector 3	1 4 4 4 6 12 12 6 12 6 4 12 12 12 24 12 4 12 12 4

Table 5 Total of number 4 by sector

1	4	4	4	6	12	12	6	12	6	4	12	12	12	24	12	4	12	12	4	1	4	4	6	12	6	4	12	12	4	1	4	6	4	1

Sector 3	Sector 2	Sector 1	S 0
6	4	2	0

Table 6 Total of number 6 by sector

1	4	4	4	6	12	12	6	12	6	4	12	12	12	24	12	4	12	12	4	1	4	4	6	12	6	4	12	12	4	1	4	6	4	1

Sector 3	Sector 2	Sector 1	S 0
3	2	1	0

Table 7 Total of number 12 by sector

1	4	4	4	6	12	12	6	12	6	4	12	12	12	24	12	4	12	12	4	1	4	4	6	12	6	4	12	12	4	1	4	6	4	1

Sector 3	Sector 2	Sector 1	S 0
9	3	0	0

Table 8 Exponents y coefficients

The coefficients are the necessary numbers that allow ordering the numbers to achieve the appropriate sum in columns. A070771 https://oeis.org/

																																		0
																														4	3	2	1	
																				8	7	6	6	5	4	5	4	3	2					
12	11	10	9	10	9	8	8	7	6	9	8	7	7	6	5	6	5	4	3															
																																		1
																														1	4	6	4	1
																				1	4	4	6	12	6	4	12	12	4	1	4	6	4	1
1	4	4	4	6	12	12	6	12	6	4	12	12	12	24	12	4	12	12	4	1	4	4	6	12	6	4	12	12	4	1	4	6	4	1

If we take the rows that are repeated in the previous table and delete them, we can form another type of table.

Table 9

Coefficients																				1
																1	4	6	4
											1	4	4	6	12	6	4	12	12	4
	1	4	4	4	6	12	12	6	12	6	4	12	12	12	24	12	4	12	12	4

Following the criteria of the previous table, the exponents are also ordered in columns with ascending values. There are some variables in the rows.

Table 10 Coefficients ordered

Coeficients

$(a)^4 = S0$
$(a+b)^4 = S0+S1$
$(a+b+c)^4 = S0+S1+S2$
$(a+b+c+d)^4 = S0+S1+S2+S3$
$(a+b+c+d+e)^4 = S0+S1+S2+S3+S4$

S= Sector

Places: The spaces where the steps are formed coincide with the triangular numbers.

Places			10										6						3			1	
Triangular numbers																							
																						0	S0
																			4	3	2	1	S1
													8	7	6	6	5	4	5	4	3	2	S2
			12	11	10	9	10	9	8	8	7	6	9	8	7	7	6	5	6	5	4	3	S3
10	9	8	13	12	11	10	11	10	9	9	8	7	10	9	8	8	7	6	7	6	5	4	S4
		5- n					1- n			n=n			3- n			n=n			1- n				

Sequence

A070771 https://oeis.org/

0, 1, 2, 3, 4, 2, 3, 4, 5, 4, 5, 6 , 6, 7, 8, 3, 4, 5, 6, 5, 6, 7, 7, 8, 9, 6, 7, 8, 8, 9, 10, 9, 10, 11, 12, 4, 5, 6, 7, 6, 7, 8, 8, 9, 10, 7, 8, 9, 9, 10, 11, 10, 11, 12, 13, 8, 9, 10, 10, 11, 12, 11, 12, 13, 14, 12, 13, 14, 15, 16, 5, 6, 7, 8, 7, 8, 9, 9, 10, 11, 8, 9, 10, 10, 11, 12,.....

Another way to distribute the exponents to understand them better

Table 11

Sector 0	0					
Sector 1	1	2	3	4		
Sector 2	2	3	4	5		Number ordered
	4	5	6			In columns
	6	7	8			2 in 2
Sector 3	3	4	5	6		Number ordered
	5	6	7			In columns
	7	8	9			2 in 2 to red numbers
	6	7	8			(Red numbers rest 1)
	8	9	10			
	9	10	11	12		Blue numbers sum 1
Sector 4	8	9	10			Number ordered
	10	11	12	13	14	In columns
	12	13	14	15	16	2 in 2

Representation of the previous model with the exponents for:

$(a+b+c+d)^4 = S0+S1+S2+S3+S4$

	Floor										
S0	0					0					a^4
S1	1		1		2		3		4		$(a+b)^4$
S2	2		2		3		4		5		$(a+b+c)^4$
	3			4		5		6			
	4			6		7		8			
S3	5		3		4		5		6		$(a+b+c+d)^4$
	6			5		6		7			
	7			7		8		9			
	8			6		7		8			
	9			8		9		10			
	10		11		12		13		14		
S4	11		4		5		6		7		$(a+b+c+d+e)^4$
	12			6		7		8			
	13			8		9		10			
	14			7		8		9			
	15			9		10		11			
	16		10		11		12		13		
	17			8		9		10			
	18			10		11		12			
	19		11		12		13		14		
	20	12		13		14		15		16	

Representation of the previous model with the coefficients for:

$(a+b+c+d)^4 = S0+S1+S2+S3+S4$

Floor										
0					1					a^4
1		4		6		4		1		$(a+b)^4$
2		4		12		12		4		$(a+b+c)^4$
3			6		12		6			
4			4		4		1			
5		4		12		12		4		$(a+b+c+d)^4$
6			12		24		12			
7			12		12		4			
8			6		12		6			
9			12		12		6			
10		4		4		4		1		
11		4		12		12		4		$(a+b+c+d+e)^4$
12			12		24		12			
13			12		12		4			
14			12		24		12			
15			24		24		12			
16		12		12		12		4		
17			6		12		6			
18			12		12		6			
19		12		12		12		6		
20	4		4		4		4		1	

Conclusion

This new algorithm presents a surprising precision, which transforms it into a reliable system or method for performing cube number operations.
This is simply different, it is a novel and interesting alternative.
The correct setting of the coefficients of the terms is fundamental to reselect the final addition operations.
This potentiation algorithm opens the door for the development of polynomials elevated to the fourth, fifth, etc.
The geometric representations of the coefficients developed in this document are novel and show a predictable, calculable and amazing expansion.
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