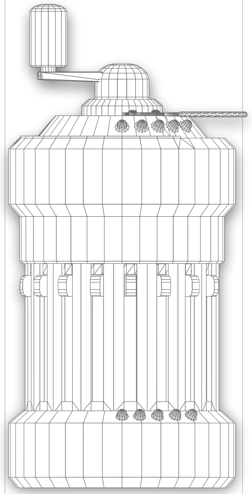
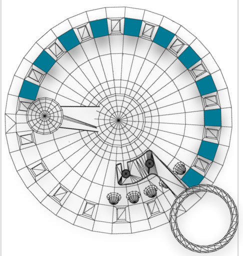
CURTA

ALGORITHMS

NUMBER GAMES





a **Collatz conjecture (Syracuse problem) (3x+1 algorithm)**

b **Golden ratio** with Fibonacci sequence

c **Multiplication** by the Vedic method

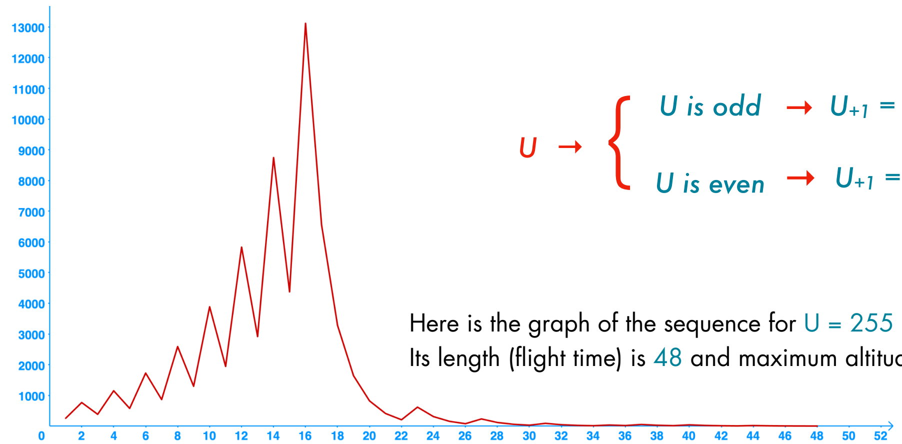
d **Converting a decimal number to binary**

e **Converting a binary number to decimal**

6a

Collatz conjecture (Syracuse problem) (3x + 1 algorithm)

The Collatz conjecture is one of the most famous problems in mathematics.
The conjecture asks whether repeating
two simple arithmetic operations will transform every positive integer into 1
It's a sequence of numbers in which each term
is obtained from the previous as follows:
if the previous term is even,
the next term is one half of the previous term.
If the previous term is odd,
the next term is 3 times the previous term plus 1.
The 3x + 1 algorithm became widespread in the 1950s and 60s.
It is a safe bet that the researchers carried out the first calculations on Curta,
like this one:



$$U \rightarrow \begin{cases} U \text{ is odd} \rightarrow U_{+1} = 3U + 1 \\ U \text{ is even} \rightarrow U_{+1} = U \div 2 \end{cases}$$

Here is the graph of the sequence for U = 255
Its length (flight time) is 48 and maximum altitude 13120

255	Setting	Carriage/Inverter	Turns	Counter	Product
	Clear	↑		Clear	Clear
First number is odd : Set and multiplie by 3	2 5 5	6 5 4 3 2 1	3 +	3	7 6 5
	8 7 6 5 4 3 2 1	▲		▲	11 10 9 8 7 6 5 4 3 2 ▲
······· Add 1. In PR: $U_{+1} = 3U + 1$	1	1	+	4	7 6 6
		↓		Clear	
····· Division by subtractive method	2	3 > 1	14 −	3 8 3	
Multiplie by 3 by bringing CR to 0	3	3 < 1	14 +	0 0 0	1 1 4 9
········ Add 1 to result	1	1	+	9 9 9 9 9 9	1 1 5 0
				Clear	
······ Division by subtractive method	2	3 > 1	17 −	5 7 5	
Multiplie by 3 by bringing CR to 0	3	3 < 1	17 +	0 0 0	1 7 2 5
········· Add 1 to result	1	1	+	9 9 9 9 9 9	1 7 2 6
				Clear	

6a ↓

6a

	Setting	Carriage/Inverter	Turns	Counter	Product
Division by subtractive method	2	3 > 1	17 –	8 6 3	
Multiplie by 3 by bringing CR to 0	3	3 < 1	17 +	0 0 0	2 5 8 9
Add 1 to result	1	1	+	9 9 9 9 9 9	2 5 9 0
				Clear	
Division by subtractive method	2	4 > > 1	17 +	1 2 9 5	
Multiplie by 3 by bringing CR to 0	3	4 < < 1	17 +	0 0 0 0	3 8 8 5
Add 1 to result	1	1	+	9 9 9 9 9 9	3 8 8 6
				Clear	
Division by subtractive method	2	4 > > 1	17 +	1 9 4 3	
Multiplie by 3 by bringing CR to 0	3	4 < < 1	17 +	0 0 0 0	5 8 2 9
Add 1 to result	1	1	+	9 9 9 9 9 9	5 8 3 0
				Clear	
Division by subtractive method	2	4 > > 1	17 +	2 9 1 5	
Multiplie by 3 by bringing CR to 0	3	4 < < 1	17 +	0 0 0 0	8 7 4 5
Add 1 to result	1	1	+	9 9 9 9 9 9	8 7 4 6
				Clear	
Division by subtractive method	2	4 > > 1	17 –	4 3 7 3	
Multiplie by 3 by bringing CR to 0	3	4 < < 1	17 +	0 0 0 0	1 3 1 1 9
Add 1 to result	1	1	+	9 9 9 9 9 9	1 3 1 2 0

	Setting	Carriage/Inverter	Turns	Counter	Product
				Clear	
Division by subtractive method	2	4 > 2	17 −	6 5 6 0	
		↑		Clear	
Even in CR: additive division. Reconstruct 6560 in PR	2	4 > 2	13 +	3 2 8 0	6 5 6 0
				Clear	Clear
Reconstruct 3280 in PR	2	4 > 2	13 +	1 6 4 0	3 2 8 0
				Clear	Clear
Reconstruct 1664 in PR	2	3 2	10 +	8 2 0	1 6 4 0
				Clear	Clear
Reconstruct 820 in PR	2	3 2	5 +	4 1 0	8 2 0
				Clear	Clear
Reconstruct 410 in PR	2	4 > > 1	7 +	2 0 5	4 1 0

Continuing, we understand that after having flown
like a leaf in the wind,
the values decrease
and whatever the starting number,
We will always obtain 1, like the leaf that lands on the ground
Then, a cycle is established between 1 and 4

Setting	Carriage/Inverter	Turns	Counter	Product
			Clear	Clear
2	1	4 +	4	8
			Clear	Clear
2	1	2 +	2	4
			Clear	Clear
2	1	+	1	2

If an 8 year old child can easily understand this problem, mathematicians remain unable to prove it...

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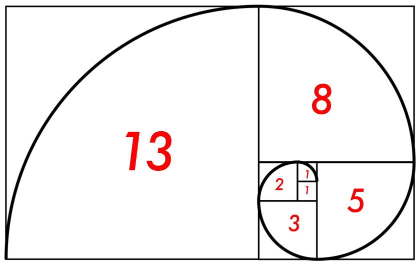
The golden ratio with the Fibonacci sequence

	Φ = ?	Carriage/Inverter	Product	Setting	Turns	Counter
		⬆	Clear	Clear		Clear
1	Exploring the Fibonacci sequence… $F_n = F_{n-1} + F_{n-2}$	8 7 6 5 4 3 2 **1** ▲	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1	1 (11 10 9 8 7 6 5 4 3 2 1)	+	1 ▲
2		1	1	1 > > > > > > 1	+	2
3		1	2	1 > > > > > 1 > > > > > > 1	+	3
4	Right of SR in left of SR	1	3	2 > > > > > 2 1	+	4
5	then Left of PR in right of SR	1	5	3 2 > > > > > > 2		
6	Same method to develop	1	5	3 > > > > > 3 2	+	5
7	the Fibonacci sequence without having to note	1	8	5 3 > > > > > > 3		
8	The golden ratio Φ is calculated	1	8	5 > > > > > 5 3	+	6
9	by dividing a number	1	1 3	8 5 > > > > > > 5		
10	in the Fibonacci sequence by the one preceding it	1	1 3	8 > > > > > 8 5	+	7
11	$\Phi = F_n = F_{n-1}$	1	2 1	1 3 8 > > > > > > 8		
12		1	2 1	1 3 > > > > 1 3 8	+	8
13	The result becomes more and more	1	3 4	2 1 1 3 > > > > > 1 3		
14	precise as we advance in the sequence	1	3 4	2 1 > > > > 2 1 1 3	+	9
15	The golden ratio is also given by the formula:	1	5 5	3 4 2 1 > > > > > 2 1		
16		1	5 5	3 4 > > > > 3 4 2 1	+	1 0
17	$\Phi = \frac{1 + \sqrt{5}}{2}$	1	8 9	5 5 3 4 > > > > > 3 4		
18		1	8 9	5 5 > > > > 5 5 3 4	+	1 1
19		1	1 4 4	8 9 5 5 > > > > > 5 5		

		Carriage/Inverter	Product		Setting		Turns	Counter
20		1	1 4 4	8 9 > > > >	8 9	5 5	+	1 2
21		1	2 3 3	1 4 4	8 9 > > > > >	8 9		
22		1	2 3 3	1 4 4 > > >	1 4 4	8 9	+	1 3
23		1	3 7 7	2 3 3	1 4 4 > > > >	1 4 4		
24		1	3 7 7	2 3 3 > > >	2 3 3	1 4 4	+	1 4
25		1	6 1 0	3 7 7	2 3 3 > > > >	2 3 3		
26		1	6 1 0	3 7 7 > > >	3 7 7	2 3 3	+	1 5
27		1	9 8 7	6 1 0	3 7 7 > > > >	3 7 7		
28		1	9 8 7	6 1 0 > > >	6 1 0	3 7 7	+	1 6
29		1	1 5 9 7	9 8 7	6 1 0 > > > >	6 1 0		
30		1	1 5 9 7	9 8 7 > > >	9 8 7	6 1 0	+	1 7
31		1	2 5 8 4	1 5 9 7	9 8 7 > > > >	9 8 7		
32		1	2 5 8 4	1 5 9 7 > >	1 5 9 7	9 8 7	+	1 8
33		1	4 1 8 1	2 5 8 4	1 5 9 7 > > >	1 5 9 7		
34		1	4 1 8 1	2 5 8 4 > >	2 5 8 4	1 5 9 7	+	1 9
35		1	6 7 6 5	4 1 8 1	2 5 8 4 > > >	2 5 8 4		
36		↓	Clear right hand		Clear left hand			Clear
37	Set the right hand of PR in right hand of SR	8 7 6 5 4 3 2 1 ▲	6 7 6 5 15 14 13 12 11 10 9 ▲ 7 6 5 4 3 2 1		4 1 8 1 11 10 9 8 7 6 5 4 3 2 1			
38	Division by subtractive method. (See 1Cc) Decimal rule for division dpPR – dpSR = dpR, 5 – 0 = 5 Result, the golden ratio: 1.618039	8 > 6 > > 3 > 1 ▲ ▲	2 6 4 1 15 14 13 12 11 10 9 ▲ 7 6 5 4 3 2 ▲		4 1 8 1 11 10 9 8 7 6 5 4 3 2 1		31 +	1.6 1 8 0 3 3 9 ▲ ▲

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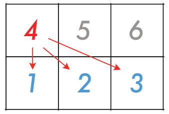
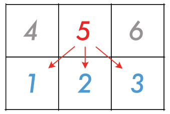
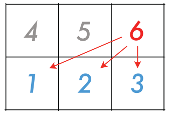
Multiplication by the Vedic method

Here is an algorithm inspired by a calculation method described in the Hindu Vedic mathematical writings.
It is certain that it becomes long beyond three digits, but we only use one cursor in SR.
In addition, the calculation with the Curta generates a curiosity with the division of the result by the figure in CR.

	456 x 123		Setting	Carriage/Inverter	Turns	Counter	Product
			Clear	⬆		Clear	Clear
1		Set the first figure of the first factor Develop the second factor in CR	4	8 < 6 5 4 3 2 1	6 +	1 2 3	4 9 2
2		Set the second figure of the first factor Develop the second factor in CR without clearing	5	8 7 > 5 4 3 2 1	3 +	1 3 5 3	5 5 3 5
3		Result: 56,088	6	8 7 6 < 4 3 2 1	3 +	1 3 6 5 3	5 6 0 8 8
4				⬇		Clear	
5		Set the figure in CR Division by subtractive method. (See 3c) We obtain a number with periodic decimal places 56088 ÷ 13653 = 4.1081081… This is because in CR we obtain the product of the multiplicand by 111 By adding the figures of the period up to the last, we will always obtain 9, (1 + 0 + 8)	1 3 6 5 3	8 > 6 > > 3 > 1	23 +	4.1 0 8 1 0 8 1	1 1 0 7

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Converting a decimal number to binary

A little revenge for Curta. It is quite easy to transform a binary number to decimal. The opposite is more complicated.
Here is an algorithm that allows Curta to do it simply.
Those who practice computing are familiar with this power of '2' sequence.

128	64	32	16	8	4	2	1

With a type II, we go up to 128, and with a type I, up to 32.

	a = 207	Setting	Carriage/Inverter	Turns	Counter	Product
		Clear	⬆		Clear	Clear
1	Determine a in binary Starting from the first number < a in the sequence: 128 Carriage 8	1 2 8 11 10 9 8 7 6 5 4 3 2 1	8 7 6 5 4 3 2 1	+	1	1 2 8 15 14 13 12 11 10 9 ▲ 7 6 5 4 3 2 1
2	Shift the next digit in the series in SR at the same time as the Carriage	1 2 8 6 4	7	+	1 1	1 9 2
3	Overflow with 32	1 9 2 3 2	6	+	1 1 1	2 2 4
4	Negative turn	3 2	6	–	1 1 0	1 9 2
5	Overflow again with 16	1 9 2 1 6	5	+	1 1 0 1	2 0 8
6	Negative turn	1 6	5	–	1 1 0 0	1 9 2
7	Continue in the same way…	1 9 2 8	4	+	1 1 0 0 1	2 0 0
8		2 0 0 4	3	+	1 1 0 0 1 1	2 0 4
9		2 0 4 2	2	+	1 1 0 0 1 1 1	2 0 6
10	Here is 207 in 8-bit binary in CR: 11001111	2 0 6 1 11 10 9 8 7 6 5 4 3 2 1	8 7 6 5 4 3 2 1	+	1 1 0 0 1 1 1 1	2 0 7 15 14 13 12 11 10 9 8 7 6 5 4 3 2 ▲

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6e

Converting a binary number to decimal

We can, of course, do the opposite

	11001111 = ?	Setting	Carriage/Inverter	Turns	Counter	Product
		Clear	↑		Clear	Clear
1	Develop the binary number in CR		8 < 6 < > 3 > 1	6 +	1 1 0 0 1 1 1 1	
2	Determine 11001111 in decimal The CR will serve as a control. Carriage 1	1	1	+	1 1 0 0 1 1 1 2	1
3	Shift the next digit in the series in SR at the same time as the Carriage	1 2	2	+	1 1 0 0 1 1 2 2	3
4		3 4	3	+	1 1 0 0 1 2 2 2	7
5		7 8	4	+	1 1 0 0 2 2 2 2	1 5
7	We have two '0' in CR, go directly to Carriage 7	1 8 6 4	7	+	1 2 0 0 2 2 2 2	7 9
8	The Result: 207	7 9 1 2 8	8 7 6 5 4 3 2 1	+	2 2 0 0 2 2 2 2	2 0 7
		11 10 9 8 7 6 5 4 3 2 1				15 14 13 12 11 10 9 ▲ 7 6 5 4 3 2 1

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