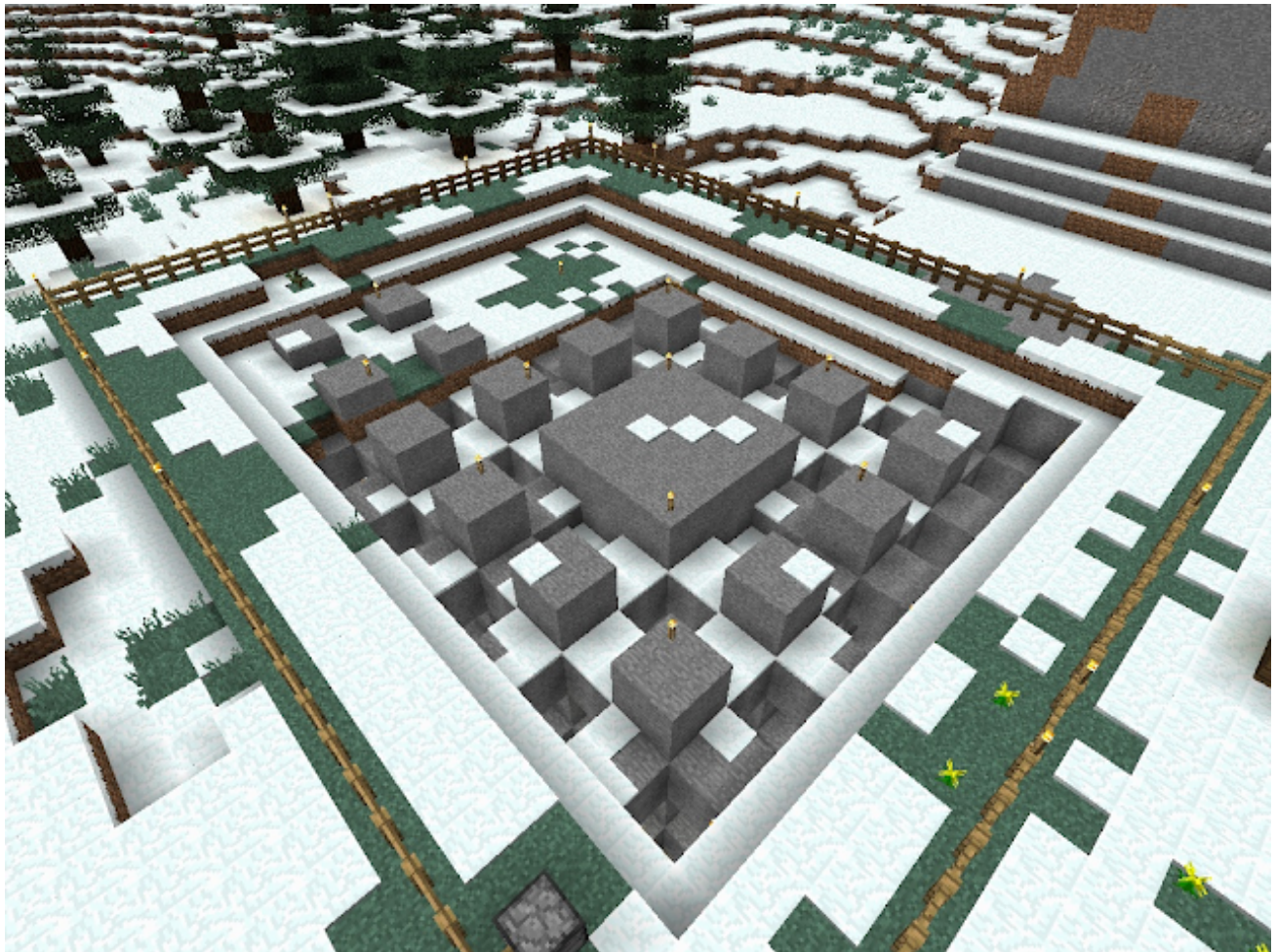


# Cinquante signes

## A fractal sequence by GK



octobre 28, 2023



Giorgos **Kalogeropoulos**:

> Hi Eric,

> yesterday I was trying to make sense of the following sequence that I found.

> I'm sending you some details as I think that you'll enjoy some of the visuals that it produces.

$$a(1) = 1 \text{ and } a(n) = \text{prime}(a(n-1)+n) \bmod (a(n-1)+n)$$

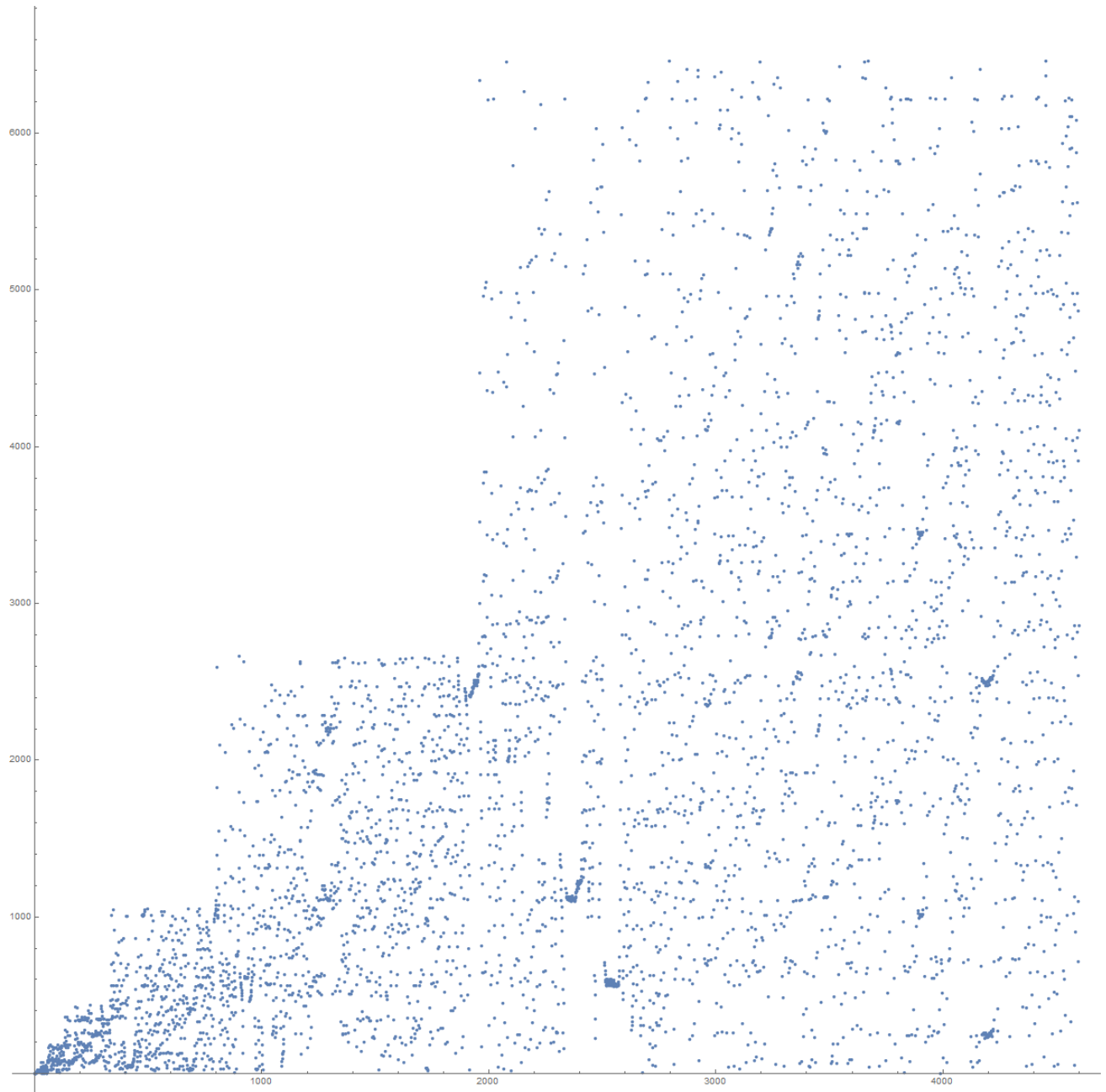
So, in its step we take the  $(a(n-1)+n)$ th prime and we find the remainder when we divide it with  $a(n-1)+n$ .

Here are the first few terms:

1, 2, 1, 1, 1, 3, 9, 8, 8, 7, 7, 10, 14, 23, 11, 22, 11, 22, 15,  
9, 23, 17, 13, 9, 3, 22, 31, 41, 69, 28, 41, 2, 9, 19, 35, 69, 47,  
14, 29, 2, 19, 39, 11, 37, 11, 41, 17, 53, 47, 24, 4, 39, 19, 2,  
41, 24, 14, 71, 83, 108, 164, 73, 89, 118, 178, 85, 121, 184, 89,  
142, 25, 24, 24, 31, 47, 62, 102, 169, 83, 152, 73, 132, 29, 52,  
88, 163, 83, 164, 89, 168, 83, 164, 79, 166, 97, 13, 51, 114, 25,  
66

Here are some plots that indicate a fractal pattern as we get more terms.

As the number of terms increase, we get the same pattern with more detail:



I don't really know how these boxes are shaped and why (and when) the modulo seems to "jump" to a bigger "box".

Of course, this has nothing to do with primes (most of the times the primes are not responsible for the patterns).

So, I started searching what other functions (that have similar plots with primes) produce the same results and where those boxes come from.

Lets call  $f(n)$  those functions:  $a(n) = f(a[n-1]+n) \bmod (a[n-1]+n)$

For example if  $f(n) = n \log(n)$  then we get some similar patterns as  $n \log n$  resembles the primes.

The boxes were still there...

Then I thought about using the simplest function that can gradually produce those squares:  
Of course this function is  $f(n) = n^x$ .

When  $x$  takes values little more than 1, then  $f$  behave "like" the prime function  
So, I computed 2000 different sequences  $a(n)$  for the values of  $x = 1.0001, 1.0002, 1.0003, \dots, 1.2000$  and animated them to a video.

In the video below, you will see 2000 frames:  
Every frame is a different sequence ( $x$  changes, so  $f$  changes) and you are seeing 100.000 terms of that specific sequence.

All these 2000 seqs behave like fractals seqs. (I stopped at 2000 because it takes a lot of time to compute...)

As the video evolves and  $x$  reaches a value that is close to the prime function you will see the fractal of the original sequence.

The boxes at first have a distance and they are joined with a curve, but soon they overlap.

Here is the vid (at around the first min we get our original pattern):



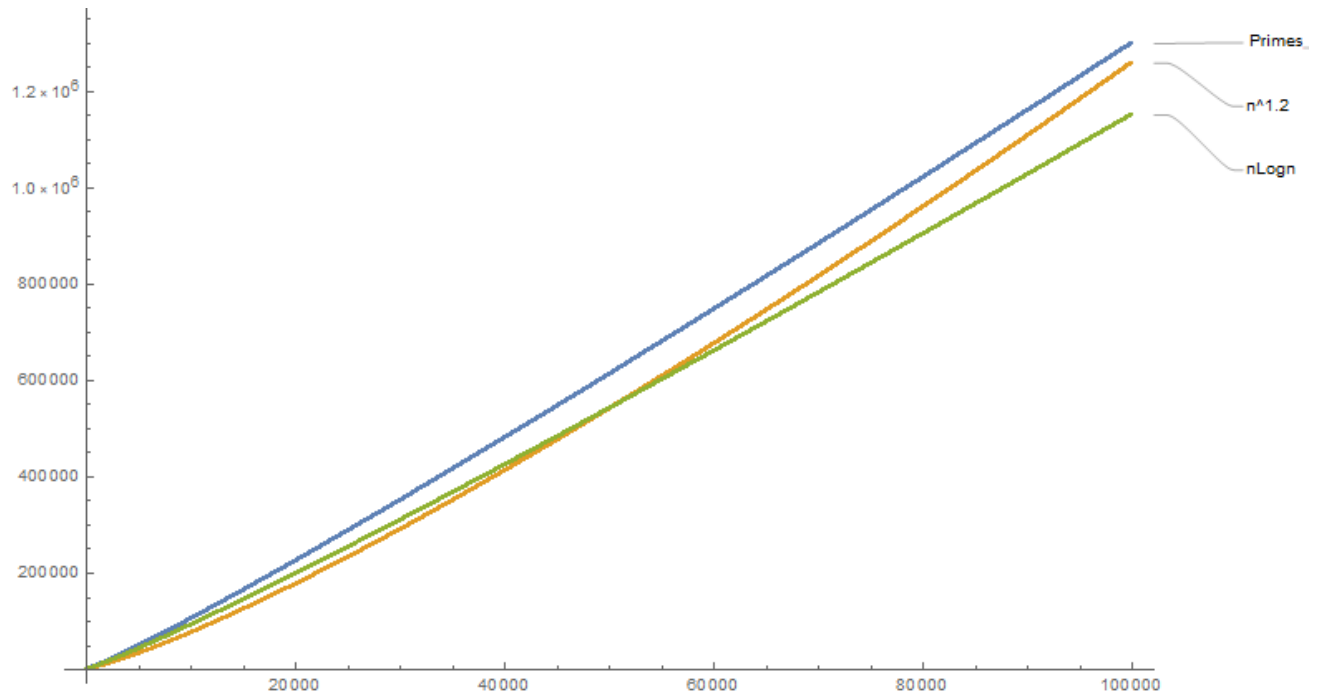
comb

Grandom Art

01:07

The above video imitates the behavior of the sequence, although it is made out of a function that resembles the prime function.

Look – here is the prime function in blue, the  $n^x$  function in orange (video), and the  $n\text{Log}n$  function in green:



The purpose of the video is to show where these rectangles come from by using the function

$n^x$ .

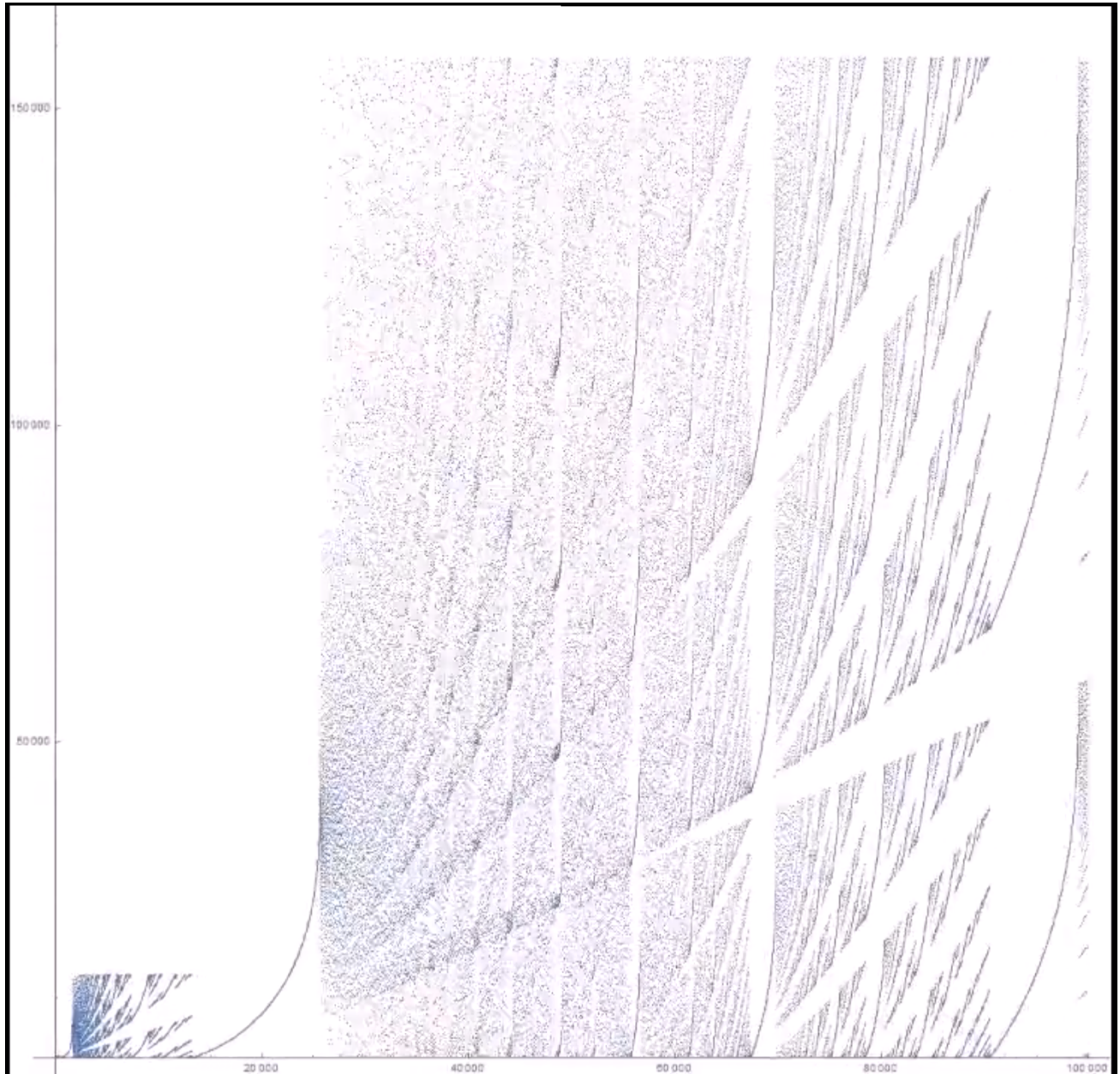
Best,

**GK.**

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ÉA:

Many thanks for this post, **Giorgos** – and what a beautiful video!





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### Posts les plus consultés de ce blog

## A square for three (chess)

juin 22, 2024



(English translation after the French text) Voici cinq problèmes d'échecs disjoints : a ) combien faut-il de coups au minimum pour que trois pions soient capturés sur la même case ? b ) trois tours c ) trois c ...

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## Le tripalin se présente

avril 11, 2024



Un tripalin est constitué de trois images. Chaque image illustre un substantif. Accolés, ces trois substantifs forment une chaîne palindromique. Laquelle nous vous invitons à trouver. Exer ...

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## Some strings au cinéma Galeries

juillet 19, 2024

Lettre ouverte au cinéma Galeries Bonsoir à tous, Je viens de voir pour la seconde fois chez vous le beau film de Léos Carax (la première fois c'était le 26 juin en présence du réalisateur, au BRIFF). Apparus à l'écran aujourd'hui, avant la projection propre ...

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