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Interference of Prime functions and Prime numbers distribution

Interference and non-interference between prime functions explain the distribution of prime numbers. We also show some cyclic paths, and some similitudes to interpret in a different way the Riemann Zeta function.

We created two parallel columns with the odd and even numbers from 1 to 500. And we created separate pair of columns for each prime numbers. For determining the prime numbers between 1 and 100 only the prime functions of 3, 5 and 7 are needed. We traced a wave function for each of those primes adding to the starting prime its same amount twice, in a periodic way. (For example, for the prime number 5, at the staring of a cycle, we add 5 and 5 to get the complete cycle ending in 15). To determine the length of each cycle for each prime function we count an N number of odd positions through the odd column, coincident with the value of the prime that rules such a function.

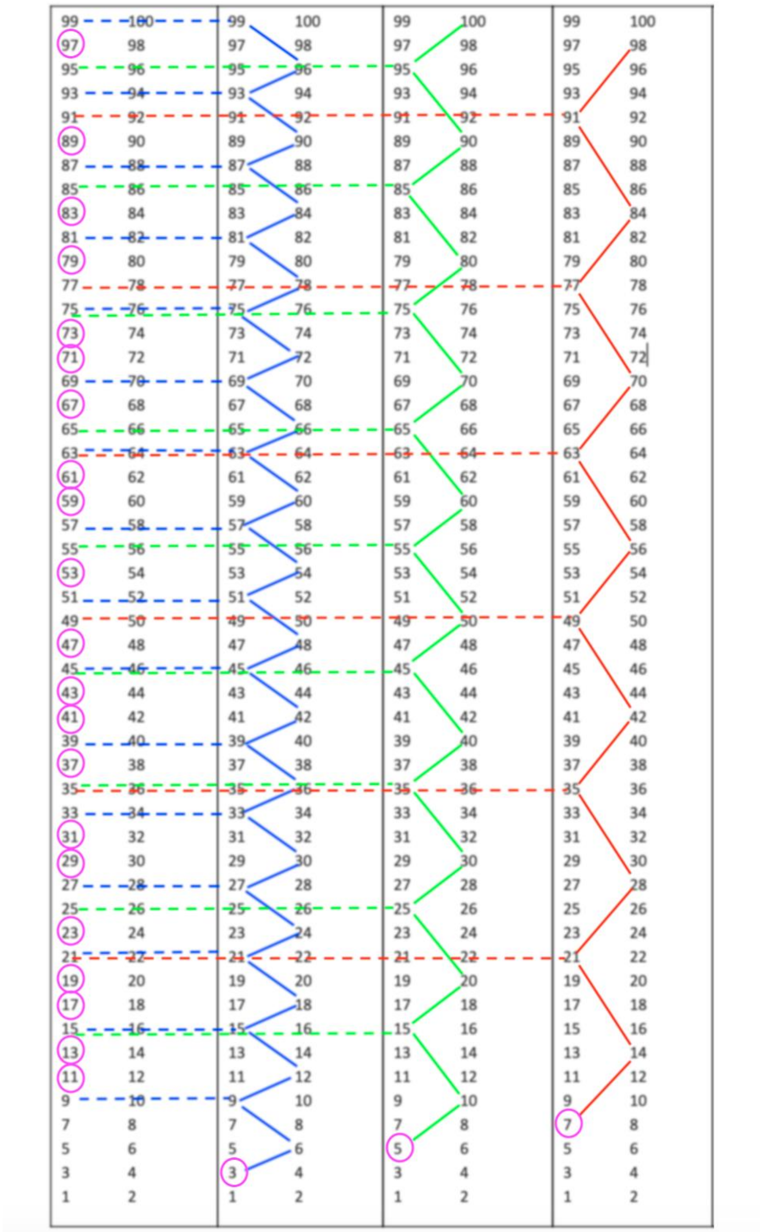
Inside of each cycle of the function of the prime 3 there is a strip with two odd numbers which is the critical strip where all primes will be placed. Some of them will be twin primes, as it happens with 11 and 13, or 17 and 19, and some of them will be single primes as it's the case of 23.

23 is not followed by a twin prime because when it comes to 25, the second cycle of the prime function 5 causes an interference in the fourth cycle of the function 3 in the position of the number 25. The number 25, so, although is inside of the critical strip of the fourth cycle is not a prime, it can be divided by 5. No other prime function interferes with 25, so 25 can only be divided by 5.

We represent the interference projecting a perpendicular dotted line from the number 25 of the function 5 to the number 25 of the function 3.

The first cycle of the prime functions different than 3 will not interfere with a critical strip of the function 3. And, without considering that first cycle to compute the further cycles, it seems the cycles that are a multiple of 3 would cause no interference on the critical strips of the function 3 either.

For example, when it comes to the function 5, its first cycle ending in 15 won't interfere with the function 3. Counting three more cycles on the function 5, we will arrive to 45 which won't cause interference either; the same will happen counting three more cycles arriving to 75, and counting three more cycles to arrive to 103.



In some cases, the interferences will affect to both the two odd numbers that are inside of a critical strip of the function 3. Those non-prime numbers are then non-prime twins. I bolded them in yellow in the diagrams below. The first non-prime twins are 119 and 121:

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Examining how some prime functions interfere, we can also see a kind of path as well.

For example, the prime function 5 interferes on 25, 35, 55, 65, 85, etc. The difference between those interfered numbers oscillates between 10, 20, 10, 20, 10, etc

The prime function 7 interferes on 49, 77, 91, 119, 133, etc. The difference between those interfered numbers oscillates between 28, 14, 28, 14, 28, etc. (except in the cases of 203 – 161 and 259 – 217, because in those cases the missing numbers 175 and 245 are firstly interfered by the prime function 5; I'm only considering the functions that firstly create the interference when they are more than 1).

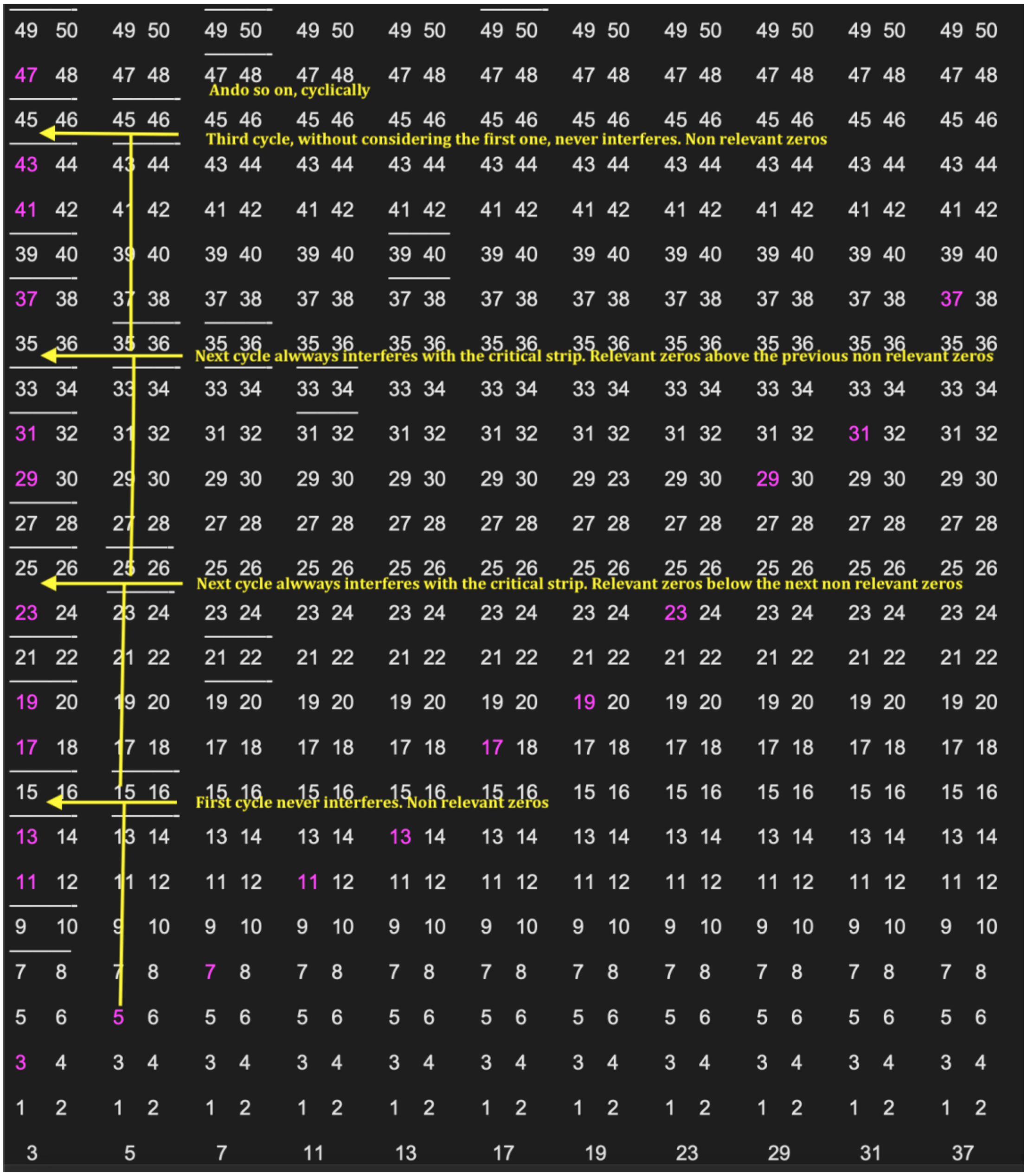
The prime function 11 interferes on 121, 143, 187, 209, 253, 275, 319, 341. The difference between those numbers always oscillate between 22, 44, 22, 44, etc.

The prime function 13 interferes 65, 169, 221, 247, 299, 377. The difference between those numbers is 104, 52, 26, 52, 78. It apparently does not follow a clear path, but 54+54 is equal 104 and 26 +78 are equal 104.

The prime function 17 interferes 289, 323, 391. The distance between those numbers are 34, 68.

Another path that seems to be followed by the interferences of the prime functions is that the first cycle never interferes with the function 3 because it's valley is going to be a multiple of 3. Without computing such a first cycle, the next cycle, that second one, will always interfere with the critical strip affecting the odd number placed below of the next odd number located outside of the critical strip (so, above of the next non relevant zeros);

The next cycle that would be for us the second one, will always interfere with the critical strip affecting the odd number placed above of the previous odd number located outside of the critical strip, so above of the previous non relevant zeros; and the next cycle, that will be in this computation the third one, will never interfere because its valley will be coincident again with the function 3 because it will be a multiple of 3.

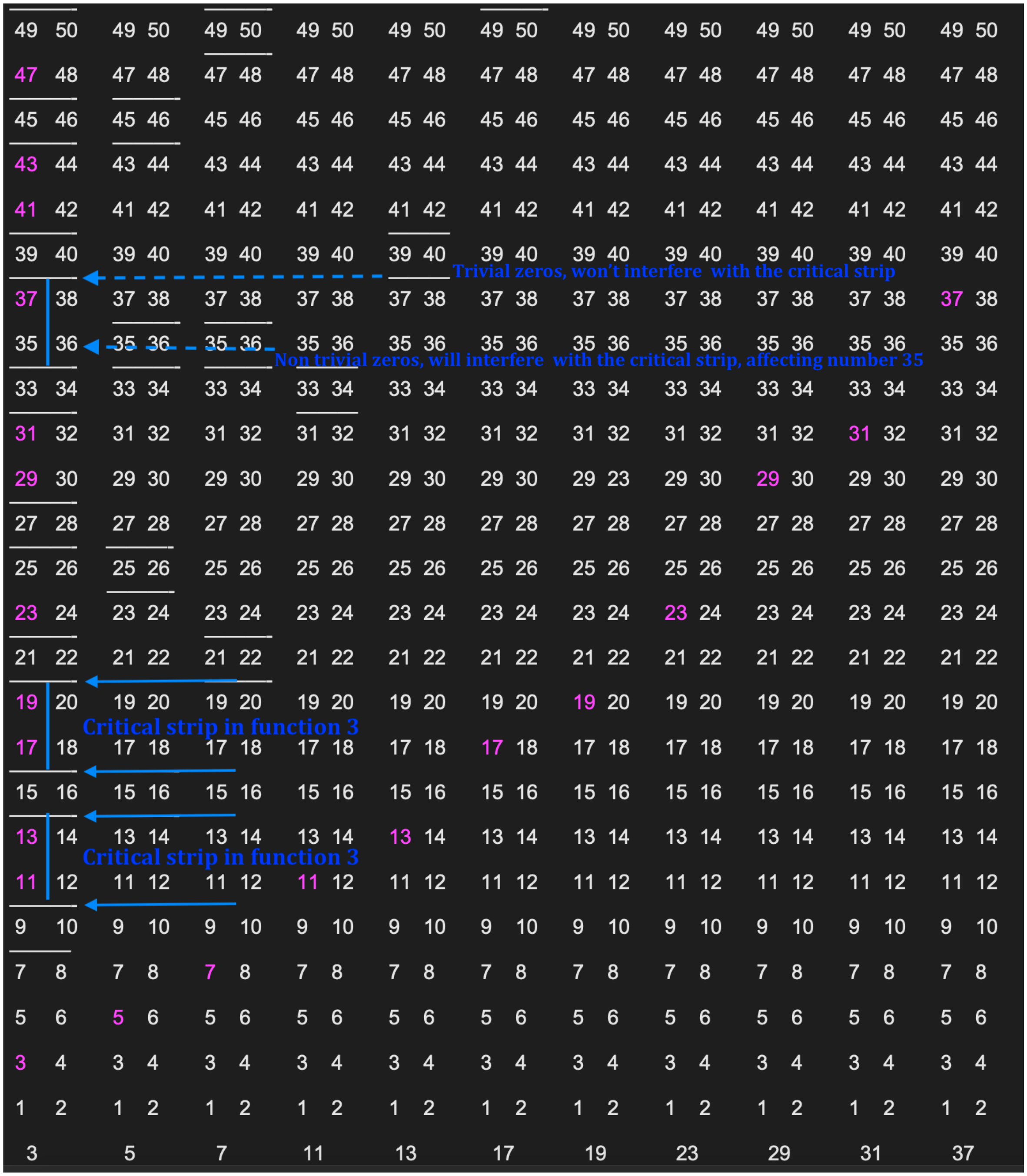


This path seems to be repeated cyclically in every prime function, and is useful to determine if the prime numbers are going to be placed above or below of the critical line, but it would need further researches.

On the other hand, it raises the question about if these functions could be a way to represent in separate functions – as we can do with the wave functions that form light – the Rieman Zeta function $\zeta(s)$ that determines the order of Prime numbers.

The Riemann Zeta function provides a critical strip with a critical line in its middle next to which the non-trivial zeros that determine the position of prime numbers are placed. But the Riemann function works with complex numbers.

Here, we do not need complex numbers to determine the position and distribution of prime numbers but we use functions to represent them more clearly. But we can use the Riemann terminology to express it because we all are working on determining the order of prime numbers by using functions. So far, I've being using the Riemannian term "critical strip" on purpose.

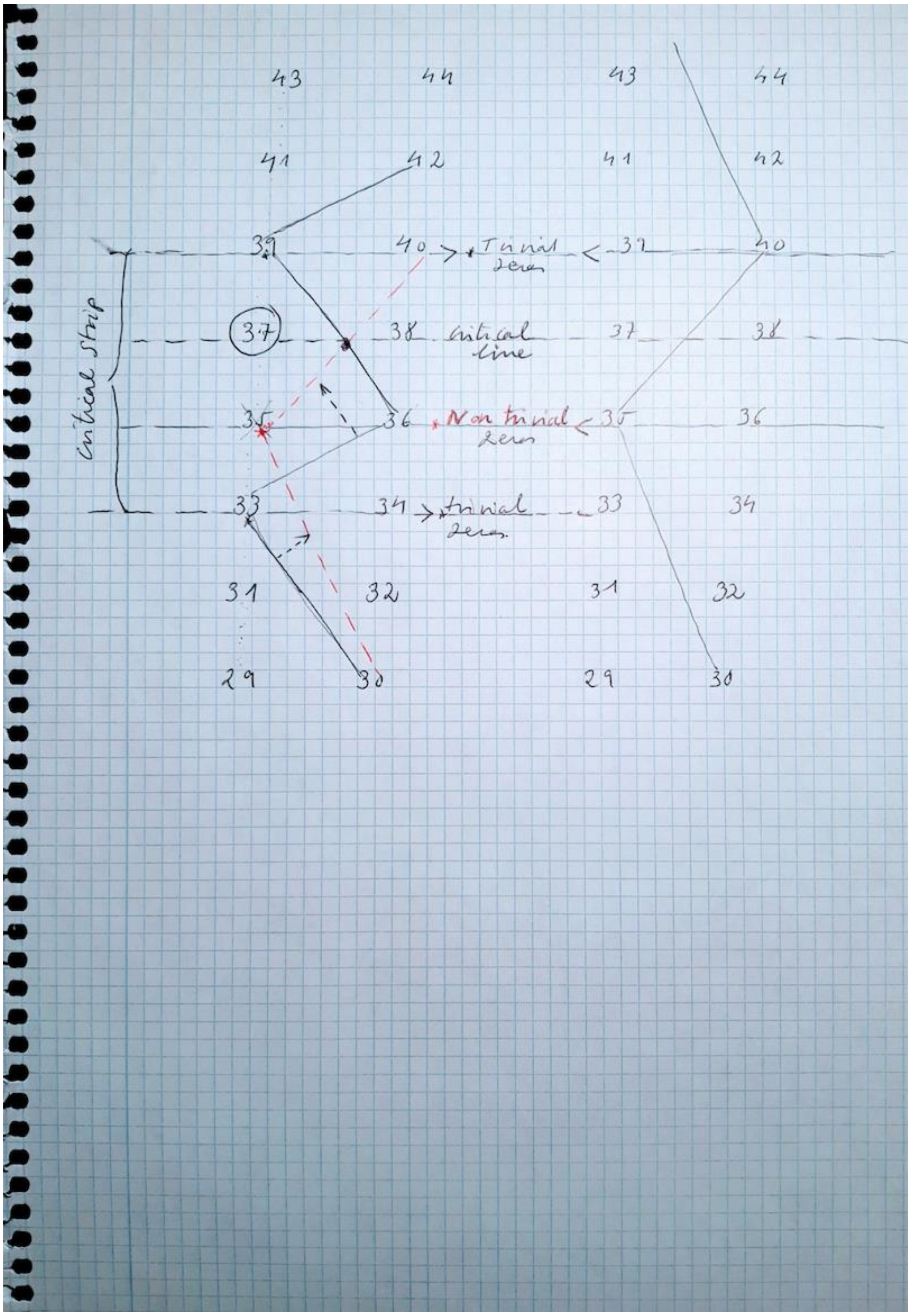


In this sense, a trivial zero in this context will be a zero projected on the function 3 from any other prime function when it will not affect the critical strip of the function 3 because it's on its left or right limits. That happens when the odd number of the prime function different than 3 is divisible by 3.

A non-trivial zero will be a zero projected on the function 3 from any other prime function when it will affect the critical strip because it's inside of that strip affecting an odd prime that will not be divisible by 3 but will be divisible by the prime or primes number of the function/s that cause the interference.

In this sense it's obvious that all prime numbers are going to be placed inside of the critical strip, next to the critical line that is placed in its center. But we are presenting the critical strip in fragmented pieces instead of a continuous strip or line, because we are separating the different prime functions that participate in the distribution of the prime numbers.

Another approach to understand the meaning of the Riemann nontrivial zeros appears when projecting on the function 3 the prime function that participates in an interference on the critical strip. From that projection we see how there is a point of intersection between the cycle of the function 3 and the cycle of the prime function that interferes, and it seems that point of intersection coincides with the critical line where the prime number not affected by the interference is located. So, we can say the nontrivial zero has a real part, the part of the valley of the cycle of the prime function that interferes, and an imaginary part that raises from the point of intersection between the function 3 and the interfering prime function. For example, I drew it here for the function 5 that interferes on 35:



Note that we start from the pair number 30 which follows a negative path when going towards the valley of the cycle being reduced to cero when arriving to the highest valley of the cycle; that zero will be nontrivial for the cycle of the function 3 because 33 is outside of the critical strip, and will be nontrivial for the cycle of the function 5 because it's placed inside of the critical strip. Once the cycle of the function 5 starts its positive trajectory to form the amplitude at the 40 point, it meets and intersects the negative trajectory of the cycle 3 that is going to form its valley at the 39 point, creating an imaginary point on the complex plane that connects both 3 and 5 functions and links the nontrivial zero related to the odd non-prime number with the prime 37.

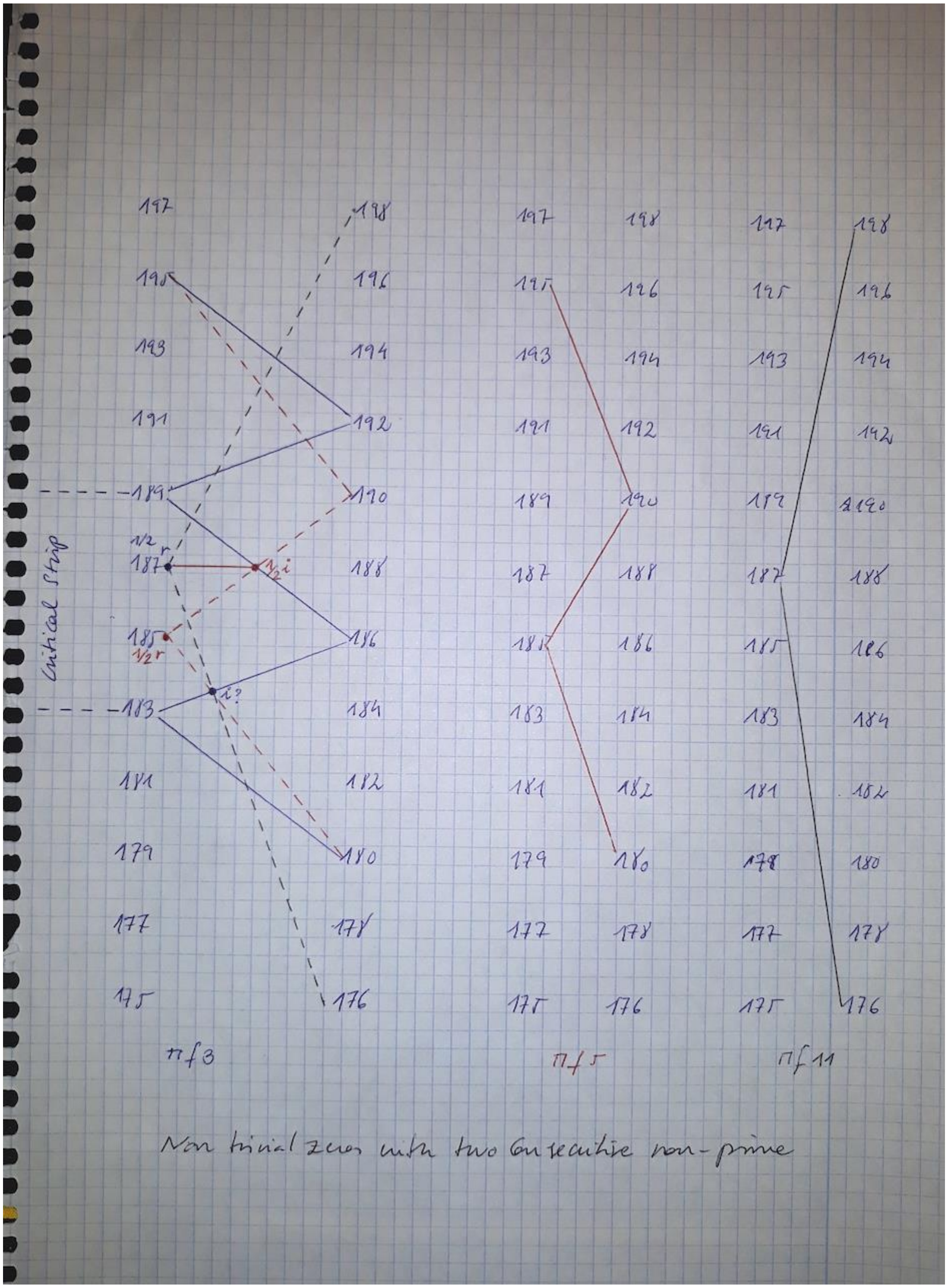
But this makes sense to me only when inside of the critical strip there's only a prime number because in that case there will be a function interfering with its nontrivial zero inside of the critical strip of the function 3. But what would it happen when inside of a critical strip of the function 3 there are two consecutive primes, two twin primes? I think in that case there would not be inside of the critical strip a nontrivial zero because there won't be interferences from any other functions. (Maybe in that case we could speculate with considering as nontrivial zeros the points where those two prime numbers are placed, and we could get an imaginary point with the intersection of some other prime function without causing interference, existing a critical line with that imaginary part in the middle of both prime numbers; but in that case it seems that there would be two real 1 parts and one imaginary part, instead of a real 1/2 part and one imaginary part, as Riemann seems to have stated. I think the real 1/2 part is related to 1 of the two positions that are inside of any critical strip). In this sense the Riemann work would be incomplete when it comes to clarify how the Z function works for determining the prime numbers distribution.

I would state then, that all trivial zeros are outside of a critical strip, that all nontrivial zeros are inside of a critical strip, and also that any prime number only can exist if it's placed inside of a critical strip. Each critical strip has space for two odd numbers. An odd number interfered by a nontrivial zero inside of a critical strip will not be prime. When there's only a nontrivial zero inside of the critical strip, there will be a prime number in the position not affected by the nontrivial zero, the nontrivial zero will have a 1/2 real part (related to the odd nonprime number) an imaginary part (related to the prime number) in the complex plane. When two nontrivial zeros interfere (are placed) inside of the critical strip, no prime numbers will be placed there; and when there are no nontrivial zeros inside of a critical strip, two consecutive or twin prime numbers will be placed there.

Anyway, I think the main problem about the Riemann hypothesis is to conceptually understand what the Riemann critical strip and lines are, and what the trivial and nontrivial zeros of the Zeta function are. And I think this approach of working with separate prime functions could clarify those terms.

So far, we saw the nontrivial zeros of the function 3 have a real part one-half.

But there's also a case where the symmetry is not clear to me. In the next diagram I drew the nontrivial zeros of the non-prime -185 and -187 in a same critical strip of the function 3:



The odd non-prime - 185 and - 187 are affected by the interference of two different prime functions, 5 and 11, so they are non-primes twins.

The function 5 creates a - 1/2 nontrivial zero at the -185 point which is a non-prime number divisible by 5. Its imaginary counterpart is located at the complex plane just above the non-prime -187.

The function 11 creates a nontrivial zero at the -187 point which is a non-prime number divisible by 11. Its imaginary counterpart is not placed above any integer odd number.

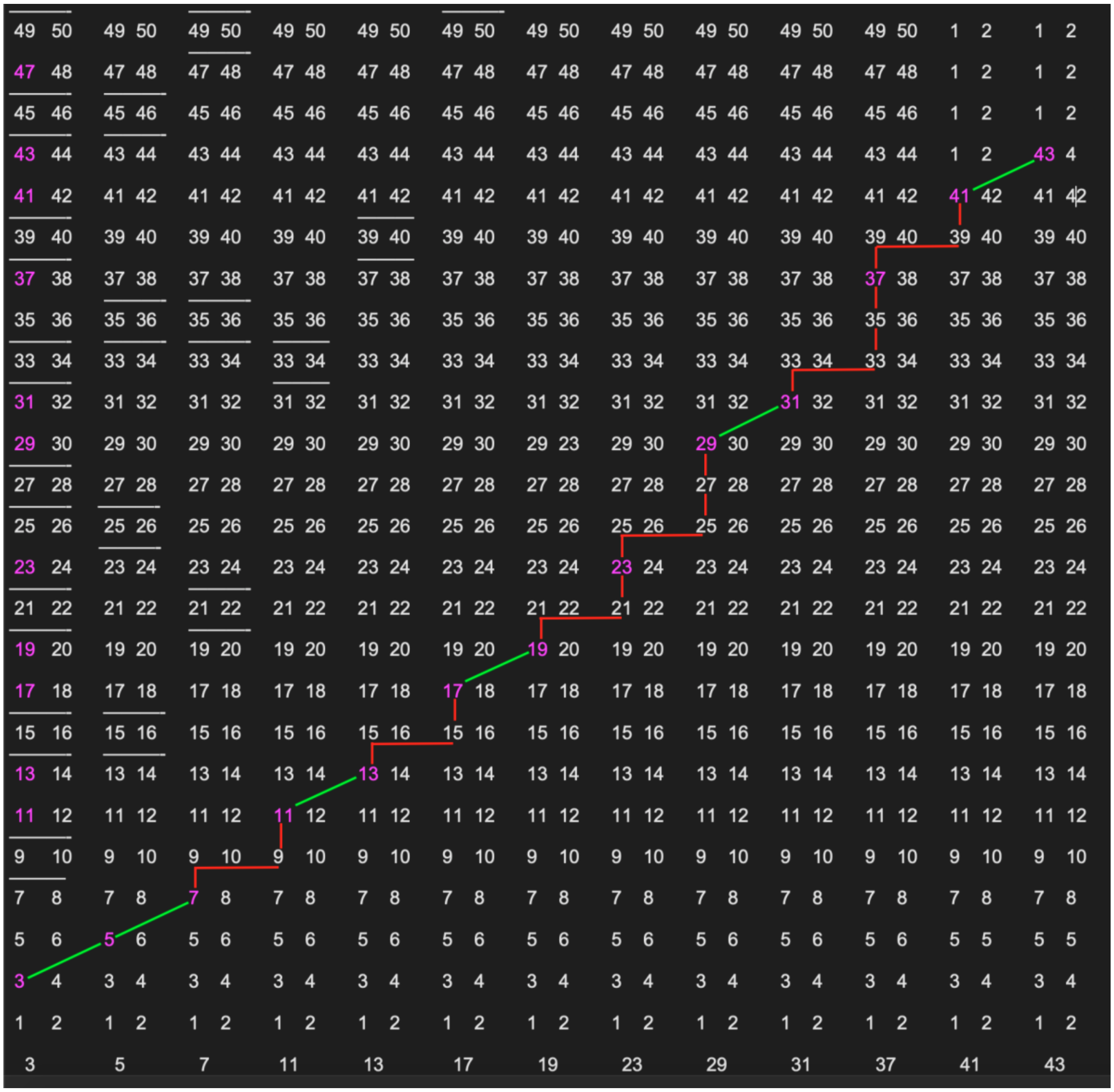
(Note that at the number -183 there's not a nontrivial zero but a trivial zero (it's placed outside of the critical strip, just in the valley of a cycle of the function 3).

With this apparently broken symmetry can it be said then that the -1/2 real nontrivial zero of the non-prime -187 has a +1/2 imaginary counterpart? An affirmative answer would corroborate the Riemann hypothesis.

(Also notice that at imaginary counterpart of - 187 zero point a double intersection seems to be placed: that's an intersection point of the positive trajectory of function 3 and the negative trajectory of function 11, but also the negative trajectory of function 5. That imaginary point of multiple intersections is placed inside of the critical strip.)

Finally, I'd like to mention that with this way of represent prime numbers we can see clearly how the prime numbers follow a diagonal path that is not a straight line because it experiences deviations every time that an interference takes place, ascending one, two or more steps. Maybe it could be related to Riemann transformations: "Riemann's system had two classes of transformations: 'Schritt' and 'Wechsel'. A Schritt transposed one triad into another, moving it a certain number of scale steps".

See https://en.wikipedia.org/wiki/Riemannian_theory



On these next diagrams I show the prime interferences for the primes between numbers 1 to 500:

Image 1/10

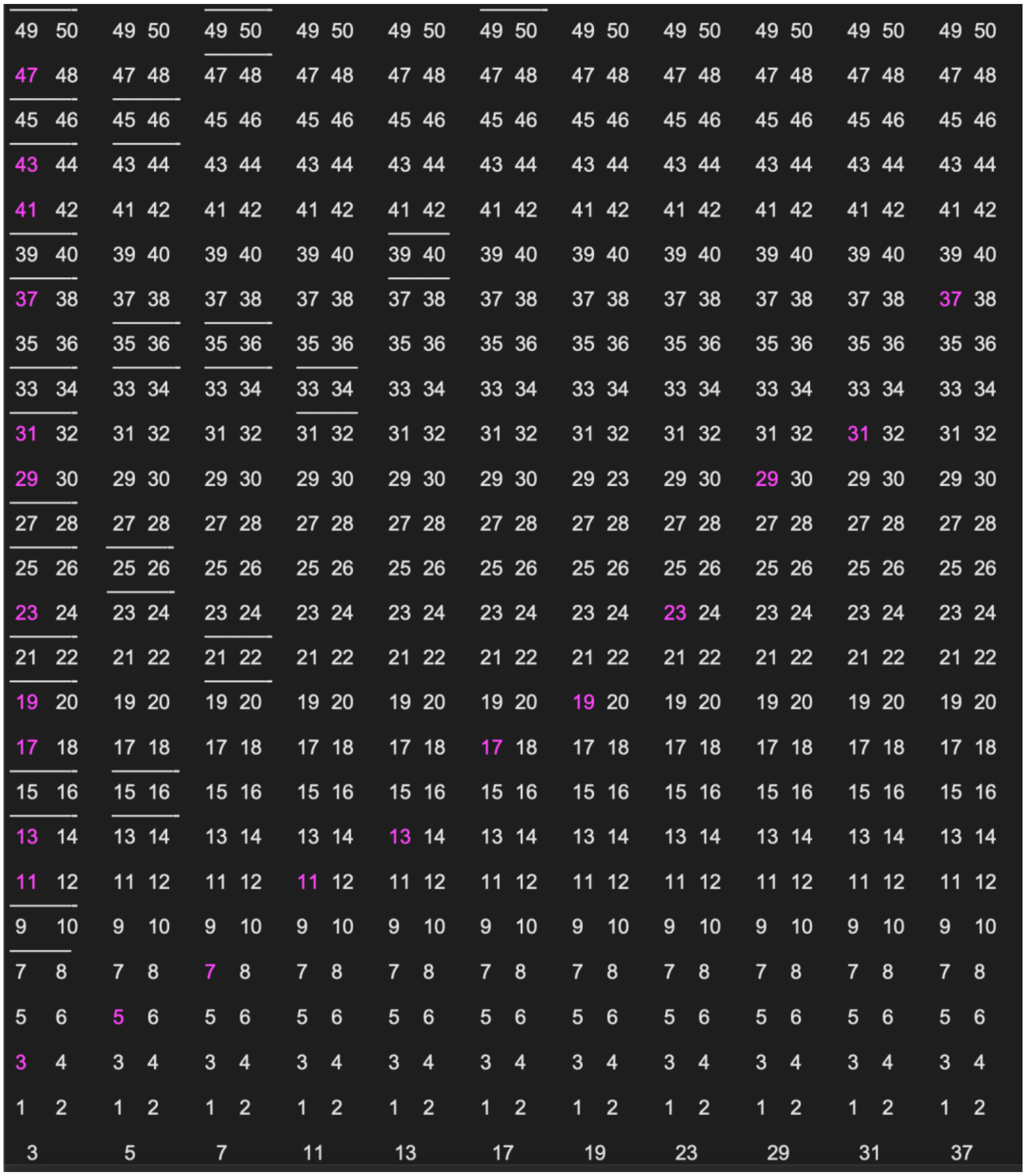

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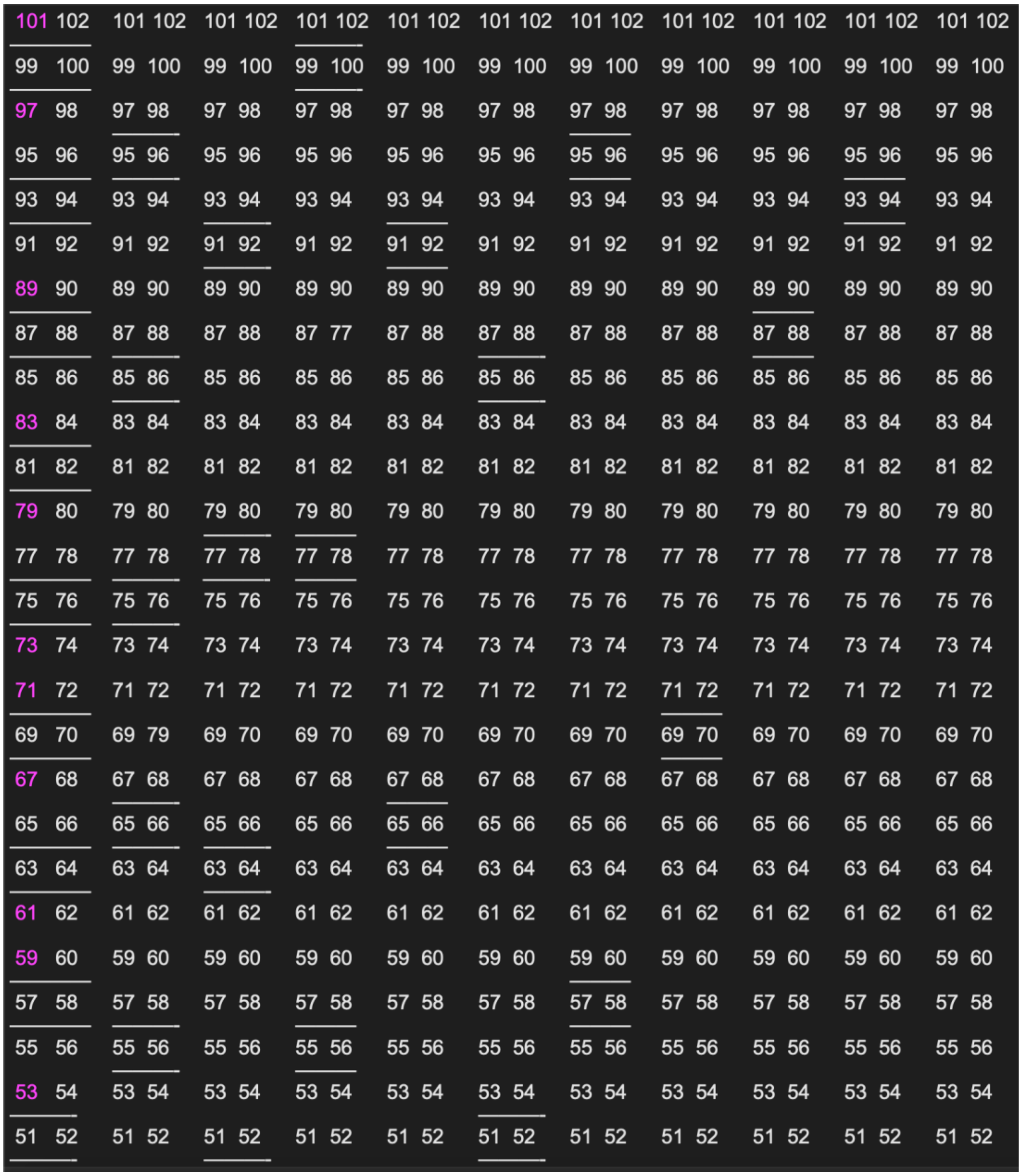
Image 2/10



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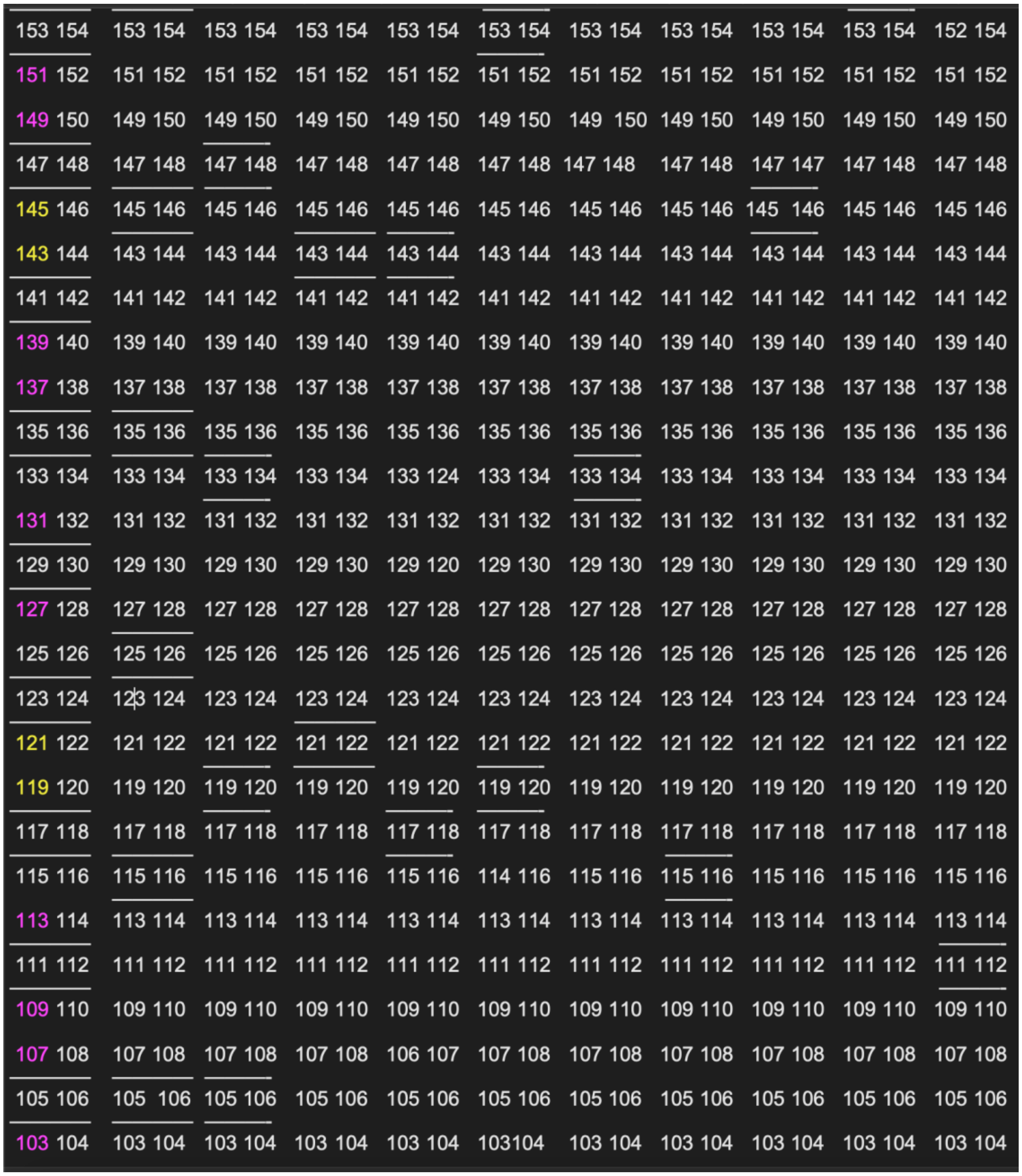

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Image 4/10

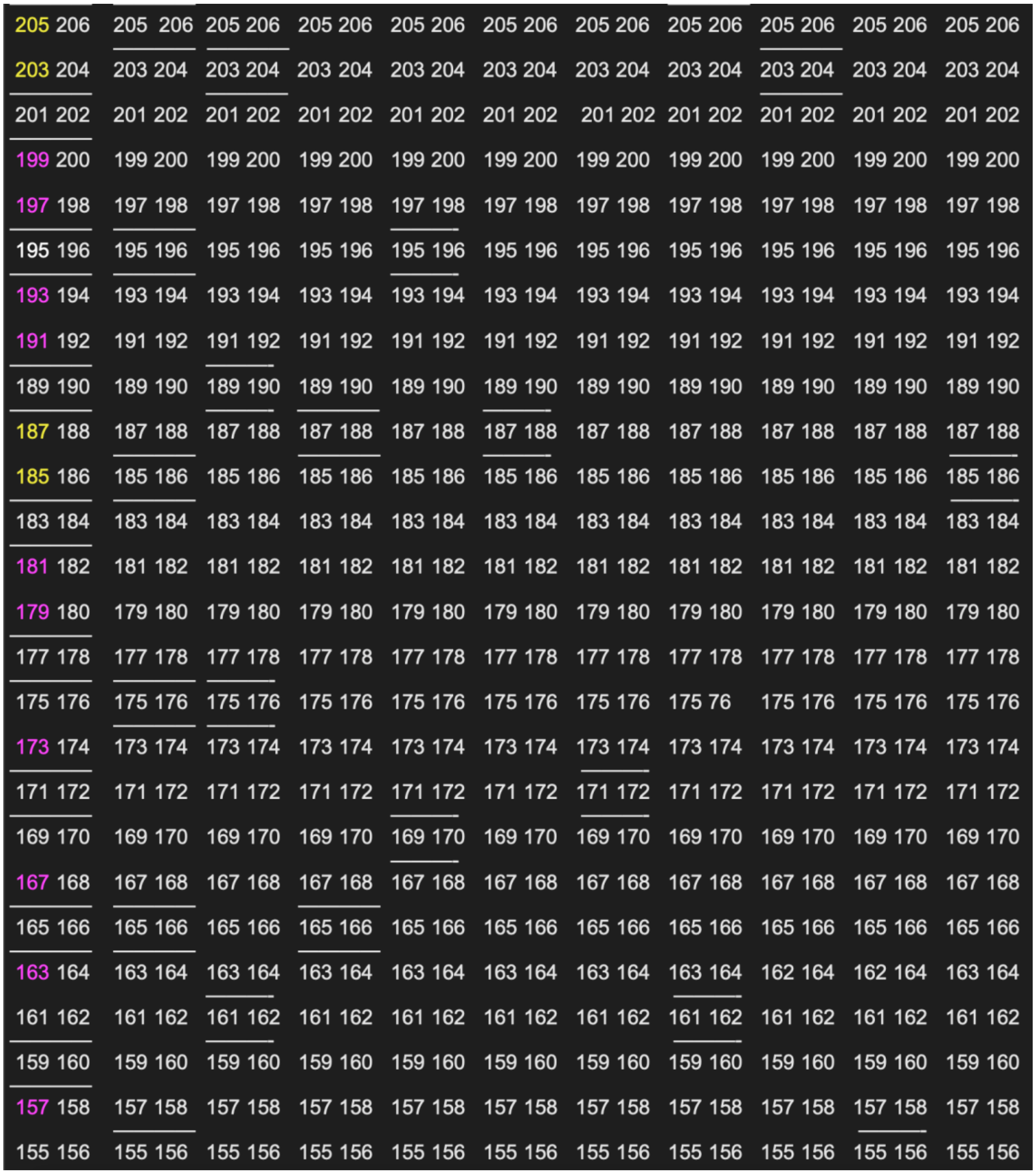

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Image 5/10

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Image 6/10

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Image 7/10

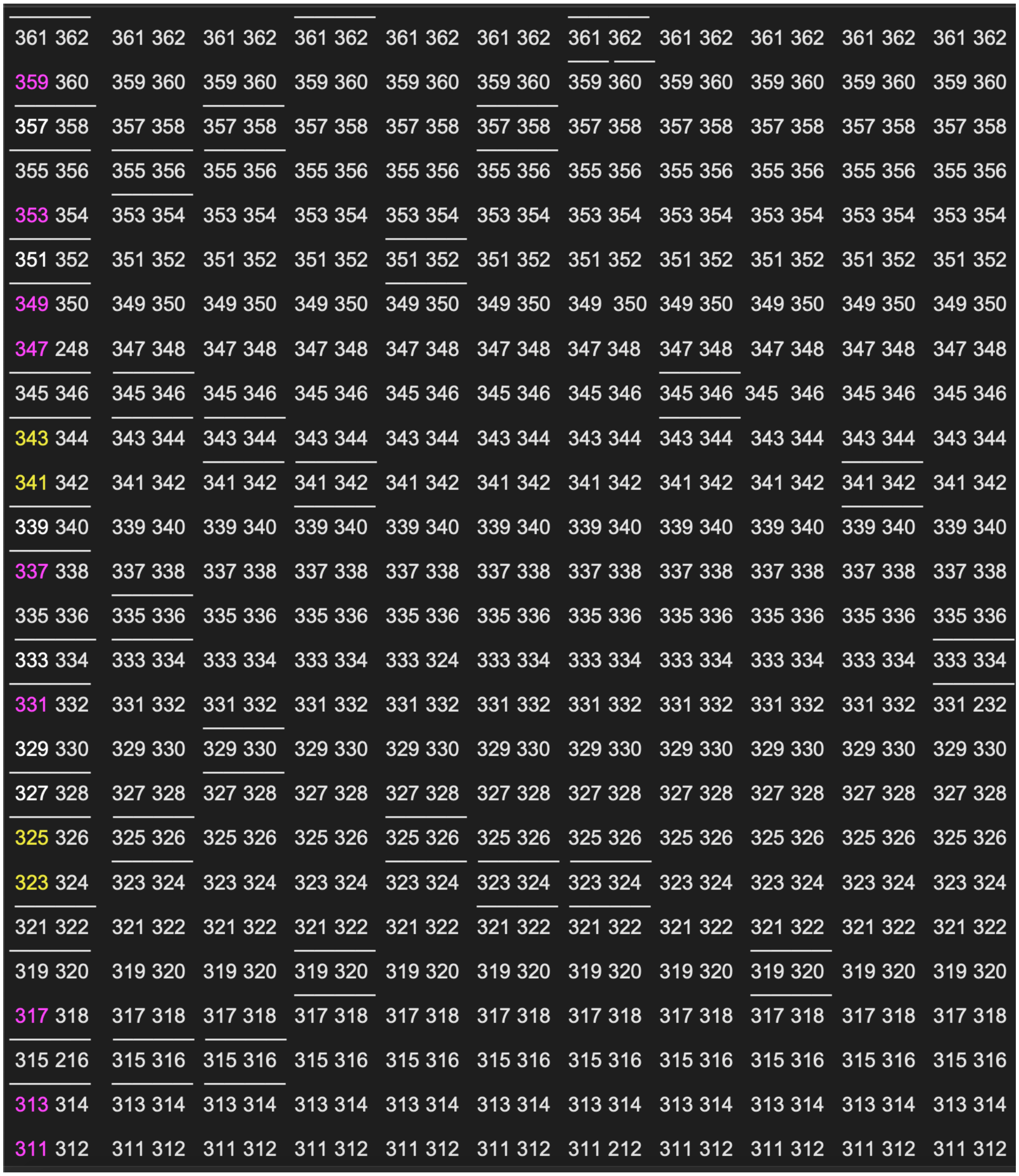

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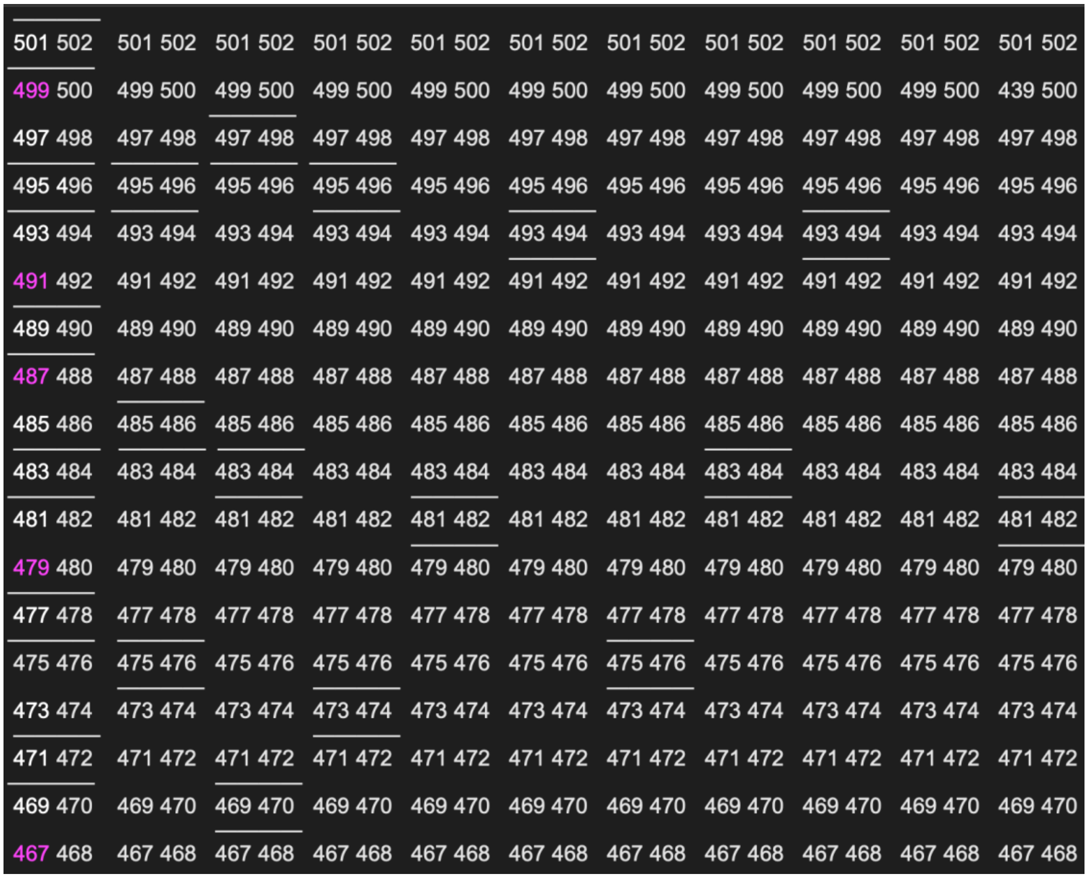
Image 10/10



Note: A similar approach was independently followed by a group of researchers of the Monash University in Australia on a work with the title " Simple wave-optical superpositions as prime number sieves" published a year ago https://arxiv.org/pdf/1812.04203.pdf

Their work was mentioned in Nature with the title "Prime Interference" https://www.nature.com/articles/s41567-019-0497-5

It would be expected that more people were being now working in these similar terms and that new works and strong advances on prime numbers theory come pretty soon.