

A NEW CLASS OF PRIME NUMBERS BASED ON TWO DISTINCT REGULAR ALTERNATING GAP SEQUENCES AND THEIR PREDICTIVE PROPERTIES.

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Abstract.

Prime numbers have fascinated mathematicians for centuries due to their inherent unpredictability and fundamental role in number theory. Despite extensive research into their distribution and patterns, primes continue to surprise and challenge scholars. The Riemann Hypothesis, one of the most famous unsolved problems in mathematics, is a prime example of this unpredictability. This paper introduces a newly discovered class of prime numbers which under two distinct alternating gap sequences – 2,4,2 and 12,14,12 - predict the occurrence of six additional primes, either forward or in reverse, a phenomenon previously unknown in the study of prime numbers. This work offers not only a novel approach to prime generation but also introduces the idea that primes themselves can act as building blocks for other primes, leading to new methods of understanding prime distribution and its profound implications for both theoretical and applied mathematics.

1. Introduction

The search for regularities in prime numbers has led to several well-known results, such as the Prime Number Theorem and conjectures like the twin prime conjecture. However, few discoveries have revealed such precise, reproducible patterns in the gaps between primes.

In this work, we present a class of primes exhibiting two alternating gap sequences — 2,4,2 and 12,14,12 — that allow for the prediction of six additional primes from certain “seed” primes. These primes are extremely rare: among approximately one billion primes analyzed, only 66 ending in 9 and 61 ending in 1 exhibited the dual-gap behavior.

The remarkable property of these prime numbers is that, knowing the specific conditions under which the alternating patterns occur, one can easily predict an additional six prime numbers. This discovery reasserts the fact that prime numbers are the building blocks of other numbers.

2.Theoretical Background

Primes exhibiting these alternating gap sequences show distinct structural characteristics:

[i] Primes that follow the alternating gap pattern of 2, 4, 2 will always have a constant truncated value, forming a specific condition for their occurrence.

[ii] Prime numbers that follow an alternating sequence of 12, 14, 12 (in their differences) will always exhibit a constant increase of 1 in their truncated values forming a clear arithmetic progression (AP), forming a specific condition for their occurrence.

This dual pattern allows each “seed prime” to predict six additional primes either forward or in reverse – a phenomenon that is, to the best of our knowledge not previously documented in the history of number theory.

3.Methodology

To investigate these rare primes, we analyzed a dataset of one billion prime numbers, focusing on those that fit the criteria for the 2–4–2 and 12–14–12 alternating gap patterns.

The computational analysis involved identifying prime numbers whose successive gaps alternated between the two sequences, with the final digit being either 1 or 9.

4.Results

4.1 Primes ending in 9(Reverse prediction)

A total of 66 primes ending in 9 were identified that form both the 2,4,2 and 12,14,12 alternating patterns in reverse. Examples:

Example 1:109

The 2,4,2 regular alternating pattern – 101,103,107,109

The 12,14,12 regular alternating pattern – 71, 83, 97, 109

As shown, knowing the specific conditions under which the 2,4,2 and 12,14,12 alternating pattern, one can use these special primes to predict an additional six primes in reverse.

Example 2:19429

The 2,4,2 regular alternating pattern – 19421,19423,19427,19429

The 12,14,12 regular alternating pattern – 19391,19403,19417,19429

Here, 19429 produces six new additional primes.

Example 3:869734429

The 2,4,2 regular alternating pattern – 869734421,869734423,869734427,869734429

The 12,14,12 regular alternating pattern – 869734391,869734403,869734417,869734429

In a non-trivial kind of way, 869734429 will also produce six new primes in reverse.

Full list of the 66 primes:

Found rare prime in reverse: 109

Found rare prime in reverse: 19,429

Found rare prime in reverse: 978,079

Found rare prime in reverse: 2,470,339

Found rare prime in reverse: 3,586,909

Found rare prime in reverse: 5,839,579

Found rare prime in reverse: 6,616,789

Found rare prime in reverse: 7,641,379

Found rare prime in reverse: 7,734,829

Found rare prime in reverse: 8,621,869

Found rare prime in reverse: 18,916,489

Found rare prime in reverse: 20,062,459

Found rare prime in reverse: 24,538,609

Found rare prime in reverse: 24,808,879

Found rare prime in reverse: 30,046,069

Found rare prime in reverse: 33,683,059
Found rare prime in reverse: 38,784,799
Found rare prime in reverse: 39,533,239
Found rare prime in reverse: 45,578,089
Found rare prime in reverse: 47,331,379
Found rare prime in reverse: 50,693,059
Found rare prime in reverse: 56,902,129
Found rare prime in reverse: 62,582,419
Found rare prime in reverse: 76,244,809
Found rare prime in reverse: 94,791,799
Found rare prime in reverse: 98,915,989
Found rare prime in reverse: 100,005,469
Found rare prime in reverse: 127,656,169
Found rare prime in reverse: 131,118,859
Found rare prime in reverse: 132,929,059
Found rare prime in reverse: 145,836,709
Found rare prime in reverse: 146,779,189
Found rare prime in reverse: 184,957,189
Found rare prime in reverse: 221,428,309
Found rare prime in reverse: 223,136,659
Found rare prime in reverse: 247,438,909
Found rare prime in reverse: 247,811,659
Found rare prime in reverse: 249,679,609
Found rare prime in reverse: 255,476,659
Found rare prime in reverse: 279,328,459
Found rare prime in reverse: 295,452,259

Found rare prime in reverse: 313,106,749
Found rare prime in reverse: 342,235,639
Found rare prime in reverse: 372,628,309
Found rare prime in reverse: 395,869,219
Found rare prime in reverse: 418,689,709
Found rare prime in reverse: 434,056,039
Found rare prime in reverse: 444,427,939
Found rare prime in reverse: 446,609,419
Found rare prime in reverse: 449,347,609
Found rare prime in reverse: 483,224,389
Found rare prime in reverse: 528,124,699
Found rare prime in reverse: 528,544,069
Found rare prime in reverse: 549,774,859
Found rare prime in reverse: 557,655,739
Found rare prime in reverse: 565,204,819
Found rare prime in reverse: 567,580,969
Found rare prime in reverse: 568,705,729
Found rare prime in reverse: 580,877,119
Found rare prime in reverse: 586,925,749
Found rare prime in reverse: 612,886,999
Found rare prime in reverse: 646,616,149
Found rare prime in reverse: 648,503,419
Found rare prime in reverse: 660,329,779
Found rare prime in reverse: 697,547,869
Found rare prime in reverse: 756,395,749
Found rare prime in reverse: 761,085,049

Found rare prime in reverse: 764,757,319

Found rare prime in reverse: 804,156,679

Found rare prime in reverse: 829,852,279

Found rare prime in reverse: 842,263,069

Found rare prime in reverse: 846,759,169

Found rare prime in reverse: 869,734,429

Found rare prime in reverse: 912,685,099

Found rare prime in reverse: 920,310,409

Found rare prime in reverse: 953,941,699

4.2 Primes ending in 1(Forward prediction)

A total of 61 primes ending in 1 were identified that form both the 2,4,2 and 12,14,12 patterns.

Examples:

Example 1:101

The 2,4,2 regular alternating pattern – 101,103,107,109

The 12,14,12 regular alternating pattern – 101,113,127,139

In a striking and non-trivial way, the new six numbers are prime. 101 in this case has produced an additional six prime numbers.

Example 2:536,441

The 2,4,2 regular alternating pattern – 536441, 536443, 536447, 536449

The 12,14,12 regular alternating pattern – 536441, 536453, 536467, 536479

In a striking way, the new six numbers are prime. 536,441 in this case has produced an additional six prime numbers.

Example 3:881,940,881

The 2,4,2 regular alternating pattern – 881,940,881, 881940883, 881940887, 881940889

The 12,14,12 regular alternating pattern – 881940881, 881940893, 881940907, 881,940,919

Again, all new six numbers are prime.881940881 in this case has produced an additional six prime numbers.

Full list of the 61 primes:

Found prime: 101

Found prime: 536,441

Found prime: 1,063,961

Found prime: 4,042,601

Found prime: 4,740,641

Found prime: 7,960,151

Found prime: 9,508,061

Found prime: 10,676,711

Found prime: 17,946,281

Found prime: 18,916,481

Found prime: 20,247,041

Found prime: 31,563,941

Found prime: 36,985,301

Found prime: 38,773,451

Found prime: 52,097,951

Found prime: 56,150,531

Found prime: 60,168,461

Found prime: 62,000,291

Found prime: 81,063,881

Found prime: 90,256,421

Found prime: 90,326,141
Found prime: 102,151,871
Found prime: 112,217,381
Found prime: 127,570,271
Found prime: 142,515,551
Found prime: 143,731,871
Found prime: 152,574,551
Found prime: 157,204,631
Found prime: 162,072,011
Found prime: 162,793,991
Found prime: 182,412,821
Found prime: 190,504,751
Found prime: 232,409,621
Found prime: 269,893,361
Found prime: 290,181,251
Found prime: 325,586,621
Found prime: 340,212,281
Found prime: 353,159,621
Found prime: 366,297,221
Found prime: 408,001,961
Found prime: 411,454,781
Found prime: 452,354,801
Found prime: 456,181,631
Found prime: 460,011,191
Found prime: 469,431,371
Found prime: 469,545,821

Found prime: 506,911,541
Found prime: 508,721,111
Found prime: 570,492,821
Found prime: 570,599,921
Found prime: 592,854,671
Found prime: 617,299,511
Found prime: 620,162,441
Found prime: 626,864,591
Found prime: 663,217,691
Found prime: 668,063,651
Found prime: 699,234,581
Found prime: 702,035,771
Found prime: 731,801,171
Found prime: 739,969,331
Found prime: 742,912,271
Found prime: 759,417,641
Found prime: 772,792,121
Found prime: 789,461,501
Found prime: 792,439,931
Found prime: 809,895,131
Found prime: 834,358,661
Found prime: 866,144,261
Found prime: 879,567,041
Found prime: 881,940,881
Found prime: 901,951,151
Found prime: 918,492,011

Found prime: 934,222,271

Found prime: 943,478,441

Found prime: 953,725,181

5. Discussion

This discovery represents a rare and previously undocumented structure in prime numbers.

The dual alternating sequences reveal predictive properties that suggest primes can generate or “build” other primes.

The 2,4,2 pattern maintains a constant truncated value.

The 12,14,12 pattern forms a clear arithmetic progression in truncated values.

Together, these sequences create a mechanism to predict additional primes, a breakthrough that could inspire further investigations into prime distribution, potential connections to Riemann Hypothesis, and applications in cryptography or computational mathematics.

6. Conclusion

This study introduces a new class of prime numbers that follow specific alternating gap sequences and predict six additional primes. This discovery represents insight into prime number behavior and could inspire further investigations into the structure of primes. Future research may explore the connection between these primes, potentially paving the way for new breakthroughs in understanding the distribution of prime numbers.