

# Twin Primes and Factorization

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# Twin Primes and Factorization

## Abstract

This paper presents a new algorithm to find Twin primes in between two numbers in an execution time not related exponentially to the size of the number. The size of the number is how many digits in the number. Because this algorithm can run partially on range (from number to number) it can be executed in nonexponential time related to the number size.

**Keywords:** Twin Primes

## 1. Introduction

Any prime number is only divisible by its own and by one only. And Twin Primes are prime numbers separated by only one step. In this algorithm we are going to use a reverse way we are going to use the twin primes to get the primes and not the opposite.

We found that the primes that are not part of any twin primes like number 23, are factors for other composite primes and not part of any other twin prime pairs. They are part of pairs with perfect square numbers like These set of odd numbers of pairs [23,25] and like [47,49] and [119,121].

23, 47, 119 are not in any twin pair but they are used as a factor in other odd pairs. These prime numbers are used as bind prime numbers and odd numbers that are not primes.

Each time we increase the number of twin primes list we used to initiate our search list reduces the execution time of the algorithm. As this algorithm have only one simple loop to get the initial list using modulus operation and another two nested loops based on this initial list. The other benefit of this algorithm is that you can get the primes and their twin pairs in-between two numbers.

For example, 23 is a factor for these pairs. Starting from 1 and up until 5000.

[851, 853] 23

[941, 943] 23

[989, 991] 23

[1217, 1219] 23

[1541, 1543] 23

[1907, 1909] 23

[2369, 2371] 23

[2459, 2461] 23

[2921, 2923] 23

[3011, 3013] 23

[3149, 3151] 23

[3611, 3613] 23

[3977, 3979] 23

[4391, 4393] 23

[4439, 4441] 23

This is why in this algorithm use the twin primes to get the primes and not the other way around.

This algorithm is simply using two main conditions.

- 1- Not Odd number and perfect square at the same time.
- 2- Odd number that are not divisible by an initial limited set of elementary prime number

We are going to get a list of all pairs of odd numbers that have modulus = 0 for this number of prime twins list {[2,3], [5,7], [11,13], [17,19], [29,31]} as a beginning of an initial list of odd numbers.

Preparing a list of twin primes using these two rules will reduce the number of calculations. As we have for variations for these pairs (1 means prime, 0 means odd but not prime) [0,0], [0,1], [1,0], [1,1].

And this is the state that we start with as we know those initial pairs already and they are easy to apply to any big range of numbers list {[2,3], [5,7], [11,13], [17,19], [29,31]}.

Applying modulus check on all numbers in-between two numbers will reduce the numbers of odd pairs dramatically because it will eliminate pairs from the two other cases [0,0], [0,1] and [1,0].

And using the first rule {Not odd number and perfect square at the same time} will reduce the number of pairs for the case [0,0], [0,1] [1,0] as this rule will eliminate the numbers like 23 in the case of the pair [23,25] and like [47,49] and [119,121] that is used as bind between prime numbers and twin prime pairs.

```
start time 1690838790.9240618 2023-07-31 17:26:30.924061
```

```
=====
```

```
primes twins between 1 and 5000
```

```
[[3, 5], [5, 7], [11, 13], [17, 19], [29, 31], [41, 43], [59, 61], [71, 73], [101, 103], [107, 109], [137, 139], [149, 151], [179, 181], [191, 193], [197, 199], [227, 229], [239, 241], [269, 271], [281, 283], [311, 313], [347, 349], [419, 421], [431, 433], [461, 463], [521, 523], [569, 571], [599, 601], [617, 619], [641, 643], [659, 661], [809, 811], [821, 823], [827, 829], [857, 859], [881, 883], [1019, 1021], [1031, 1033], [1049, 1051], [1061, 1063], [1091, 1093], [1151, 1153], [1229, 1231], [1277, 1279], [1289, 1291], [1301, 1303], [1319, 1321], [1427, 1429], [1451, 1453], [1481, 1483], [1487, 1489], [1607, 1609], [1619, 1621], [1667, 1669], [1697, 1699], [1721, 1723], [1787, 1789], [1871, 1873], [1877, 1879], [1931, 1933], [1949, 1951], [1997, 1999], [2027, 2029], [2081, 2083], [2087, 2089], [2111, 2113], [2129, 2131], [2141, 2143], [2237, 2239], [2267, 2269], [2309, 2311], [2339, 2341], [2381, 2383], [2549, 2551], [2591, 2593], [2657, 2659], [2687, 2689], [2711, 2713], [2729, 2731], [2789, 2791], [2801, 2803], [2969, 2971], [2999, 3001], [3119, 3121], [3167, 3169], [3251, 3253], [3257, 3259], [3299, 3301], [3329, 3331], [3359, 3361], [3371, 3373], [3389, 3391], [3461, 3463], [3467, 3469], [3527, 3529], [3539, 3541], [3557, 3559], [3581, 3583], [3671, 3673], [3767, 3769], [3821, 3823], [3851, 3853], [3917, 3919], [3929, 3931], [4001, 4003], [4019, 4021], [4049, 4051], [4091, 4093], [4127, 4129], [4157, 4159], [4217, 4219], [4229, 4231], [4241, 4243], [4259, 4261], [4271, 4273], [4337, 4339], [4421, 4423], [4481, 4483], [4517, 4519], [4547, 4549], [4637, 4639], [4649, 4651], [4721, 4723], [4787, 4789], [4799, 4801], [4931, 4933], [4967, 4969]]
```

```
end time 1690838791.729066 2023-07-31 17:26:31.729066
```

```
=====
```

We do not loop on all numbers in our two nested loop we only loop on 4 \* the difference between the two numbers to get the prime pairs.

Example (1): - List of prime pairs in between these two numbers

```
start_from = 8974856000000000
end_at = 89748560000000999
```

```
|start time 1690845036.0091262 2023-07-31 19:10:36.009126
```

```
=====
```

```
primes twins between 8974856000000000 and 89748560000000999
```

```
[[89748560000000057, 89748560000000059], [89748560000000267, 89748560000000269], [89748560000000579, 89748560000000581], [89748560000000747, 89748560000000749], [89748560000000771, 89748560000000773]]
```

```
end time 1690845036.1416187 2023-07-31 19:10:36.141618
```

```
=====
```

This step gives us a list of prime numbers of factors for the odd numbers in-between.

This is the list of pairs that fall into state [0,1] or [1,0] where one of the odd numbers is composite prime.

```
factbefore [89748560000000279, 89748560000000281] 23
factbefore [89748560000000369, 89748560000000371] 23
factbefore [89748560000000507, 89748560000000509] 23
factbefore [89748560000000201, 89748560000000203] 37
factbefore [89748560000000717, 89748560000000719] 37
factbefore [89748560000000939, 89748560000000941] 37
factbefore [89748560000000069, 89748560000000071] 41
factbefore [89748560000000657, 89748560000000659] 43
factbefore [89748560000000741, 89748560000000743] 43
factbefore [89748560000000027, 89748560000000029] 47
factbefore [89748560000000309, 89748560000000311] 47
factbefore [89748560000000777, 89748560000000779] 47
factbefore [89748560000000951, 89748560000000953] 59
factbefore [89748560000000171, 89748560000000173] 61
factbefore [89748560000000927, 89748560000000929] 67
factbefore [89748560000000159, 89748560000000161] 71
factbefore [89748560000000651, 89748560000000653] 83
factbefore [89748560000000981, 89748560000000983] 83
factbefore [89748560000000861, 89748560000000863] 89
factbefore [89748560000000189, 89748560000000191] 109
factbefore [89748560000000549, 89748560000000551] 131
factbefore [89748560000000357, 89748560000000359] 173
factbefore [89748560000000987, 89748560000000989] 263
factbefore [89748560000000381, 89748560000000383] 281
factbefore [89748560000000567, 89748560000000569] 457
factbefore [89748560000000699, 89748560000000701] 509
factbefore [89748560000000237, 89748560000000239] 613
factbefore [89748560000000411, 89748560000000413] 617
factbefore [89748560000000111, 89748560000000113] 691
factbefore [89748560000000351, 89748560000000353] 839
factbefore [89748560000000129, 89748560000000131] 1399
```

And this is the list of odd pairs that fall in the case [0,0], [1,0], [0.1] pairs that have one prime or no primes at all but no composite primes.

```
|start time 1690845036.0091262 2023-07-31 19:10:36.009126
=====
[897485600000000027, 897485600000000029]
[897485600000000057, 897485600000000059]
[897485600000000069, 897485600000000071]
[897485600000000111, 897485600000000113]
[897485600000000129, 897485600000000131]
[897485600000000159, 897485600000000161]
[897485600000000171, 897485600000000173]
[897485600000000189, 897485600000000191]
[897485600000000201, 897485600000000203]
[897485600000000237, 897485600000000239]
[897485600000000267, 897485600000000269]
[897485600000000279, 897485600000000281]
[897485600000000309, 897485600000000311]
[897485600000000351, 897485600000000353]
[897485600000000357, 897485600000000359]
[897485600000000369, 897485600000000371]
[897485600000000381, 897485600000000383]
[897485600000000411, 897485600000000413]
[897485600000000507, 897485600000000509]
[897485600000000549, 897485600000000551]
[897485600000000567, 897485600000000569]
[897485600000000579, 897485600000000581]
[897485600000000651, 897485600000000653]
[897485600000000657, 897485600000000659]
[897485600000000699, 897485600000000701]
[897485600000000717, 897485600000000719]
[897485600000000741, 897485600000000743]
[897485600000000747, 897485600000000749]
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[897485600000000927, 897485600000000929]
[897485600000000939, 897485600000000941]
[897485600000000951, 897485600000000953]
[897485600000000981, 897485600000000983]
[897485600000000987, 897485600000000989]
end time 1690845036.1416187 2023-07-31 19:10:36.141618
=====
```

Example (2): - List of prime pairs in between these two numbers

```
start_from = 8974856000000000000
end_at =    8974856000000000999
```

It took almost 3 seconds.

```
start time 1690846262.873096 2023-07-31 19:31:02.873096
```

```
=====
primes twins between 8974856000000000000 and 8974856000000000999
[[89748560000000000129, 89748560000000000131], [89748560000000000147, 89748560000000000149], [89748560000000000261, 89748560000000000263], [89748560000000000789, 89748560000000000791],
[897485600000000001029, 897485600000000001031], [897485600000000001299, 897485600000000001301], [897485600000000001389, 897485600000000001391], [897485600000000001479, 897485600000000001481],
[897485600000000001491, 897485600000000001493], [897485600000000001689, 897485600000000001691], [897485600000000001941, 897485600000000001943], [897485600000000002217, 897485600000000002219],
[897485600000000002259, 897485600000000002261], [897485600000000003159, 897485600000000003161], [897485600000000003279, 897485600000000003281], [897485600000000003519, 897485600000000003521],
[897485600000000003987, 897485600000000003989], [897485600000000004377, 897485600000000004379], [897485600000000004809, 897485600000000004811], [897485600000000005031, 897485600000000005033],
[897485600000000005331, 897485600000000005333], [897485600000000006009, 897485600000000006011], [897485600000000006639, 897485600000000006641], [897485600000000006951, 897485600000000006953],
[897485600000000007287, 897485600000000007289], [897485600000000007989, 897485600000000007991], [897485600000000008067, 897485600000000008069], [897485600000000008319, 897485600000000008321],
[897485600000000008439, 897485600000000008441], [897485600000000008571, 897485600000000008573], [897485600000000008799, 897485600000000008801], [897485600000000008841, 897485600000000008843],
[897485600000000009177, 897485600000000009179], [897485600000000009321, 897485600000000009323]]
end time 1690846265.3023858 2023-07-31 19:31:05.302386
=====
```

This step gives us a list of prime numbers of factors for the odd numbers in-between.

This is the list of pairs that fall into state [0,1] or [1,0] where one of the odd numbers is composite prime.

[[89748560000000000369, 89748560000000000371], [23]]	[[897485600000000007497, 897485600000000007499], [23]]
[[89748560000000000459, 89748560000000000461], [23]]	[[897485600000000007959, 897485600000000007961], [23]]
[[89748560000000000507, 89748560000000000509], [23]]	[[897485600000000008097, 897485600000000008099], [23]]
[[89748560000000000921, 89748560000000000923], [23]]	[[897485600000000008649, 897485600000000008651], [23]]
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end time 1690846265.301397 2023-07-31 19:31:05.301397
```

=====

Example (3): -

```
start_from = 89748560000000000000
end_at = 89748560000000019999
```

in 7 seconds

```
start time 1690847335.5009136 2023-07-31 19:48:55.500913
=====
primes twins between 89748560000000000000 and 89748560000000019999
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end time 1690847342.9816303 2023-07-31 19:49:02.981630
=====
```

```
import logging
import time
from datetime import datetime
from logging.handlers import MemoryHandler ,RotatingFileHandler
```

```
def InitiateLogger(LoggerName , FilePath):
    lg = logging.getLogger(LoggerName)
    lg.setLevel(logging.INFO)
    hnd=logging.FileHandler(FilePath,"w")
    memory_handler = MemoryHandler(100, flushLevel=logging.INFO, target=hnd, flushOnClose=True)
    hnd.setLevel(logging.INFO)
    lg.addHandler(hnd)
    return lg , hnd
```

```
def logtime(loggername, time_name_string):
    time_value = time.time()
    loggername.info('{} {} {}'.format(time_name_string , time_value,datetime.now()))
    loggername.info('=====')
```

```
filename = "c:\\" + " " + "\pairswithcomposit.txt"
filename2 = "c:\\" + " " + "\\compositonly.txt"
filename3 = "c:\\" + " " + "\\twinprimes.txt"
```

```
lg_pairs , hnd_pairs_composit= InitiateLogger("pairs_{}".format(str(7)) , filename )
lg_composit, hnd_composit = InitiateLogger("composit_{}".format(str(7)) , filename2 )
lg_twin, hnd_pairs = InitiateLogger("twin_{}".format(str(7)) , filename3 )
```

```
def check4(x ,y):
    return False #((y+x)*0.25 ) % 4 == 0

def check2(x,y):
    return x%2 == 0 and y % 2 == 0
def check3(x ,y):
    return (x%3 == 0 or y%3 ==0) and x != 3 and y!= 3
def check5(x ,y):
    return (x%5 == 0 or y%5 ==0) and x != 5 and y!= 5
def check7(x ,y):
    return (x%7 == 0 or y%7 ==0) and x != 7 and y!= 7
def check11(x ,y):
    return (x%11 == 0 or y%11 ==0) and x != 11 and y!= 11
def check13(x ,y):
    return (x%13 == 0 or y%13 ==0) and x != 13 and y!= 13
def check17(x ,y):
    return (x%17 == 0 or y%17 ==0) and x != 17 and y!= 17
def check19(x ,y):
    return (x%19 == 0 or y%19 ==0) and x != 19 and y!= 19
def check29(x ,y):
    return (x%29 == 0 or y%29 ==0) and x != 29 and y!= 29
def check31(x ,y):
    return (x%31 == 0 or y%31 ==0) and x != 31 and y!= 31
def checkf(x,y):
    return str(x**0.5).endswith('.0') or str(y**0.5).endswith('.0')
def exists(x,y , l):
    return [x,y] in l
```

```

pair = []

start_from = 8974856000000000000
end_at = 89748560000000000000
logtime(lg_pairs , 'start time')
logtime(lg_twin , 'start time')

lg_twin.info('primes twins between {} and {}'.format(start_from , end_at) )

for i in range(start_from ,end_at):
    x = i
    y = i+2
    print("{} , {}".format(x,y) , check2(x,y) , check4(x,y) , check3(x,y)
        , check5(x,y) , check7(x,y), checkf(x,y)
        , check11(x,y), check13(x,y), check17(x,y))
    if check2(x,y) == False and check4(x,y) == False and check3(x,y) == False and check5(x,y) == False\
        and check7(x, y) == False and check11(x, y) == False and check13(x, y) == False and check17(x, y) == False\
        and check19(x, y) == False and check29(x, y) == False and check31(x, y) == False\
        and checkf(x, y) == False :
        pair.append([x,y])
        lg_pairs.info([x,y])

search_untill = pair[0][0]
l = pair.copy()

```

```

# s = 4 * difference between start and end , if not accurate data remove this divid and use full s range

search_untill = 4 * (end_at - start_from )

for n in range(1,search_untill,2):
    for i in l:
        if (i[0]%n == 0 or i[1]%n ==0) and (i[0] != n or i[1] != n) and n > 1 and exists(i[0],i[1], pair):
            lg_composit.info([[i[0],i[1]] , [n]])
            print("factbefore {} {}".format(i , n))
            if (i[0] != n and i[1] != n):
                pair.remove(i)

lg_twin.info(pair)

logtime(lg_pairs , 'end time')
logtime(lg_twin , 'end time')

```

## Conclusion

In This paper I am introducing a new algorithm that gets twin primes and prime numbers in between two numbers in a time not related exponentially to the size of the number.

I showed that, we can have a very good execution time to get prime factors for all prime numbers in between two numbers and this execution time is not related exponentially with the size of the number.

By doing modulus on odd numbers of pairs using only the list of twin primes I was able to get twin primes and prime factor for the numbers in between two numbers in an execution time not exponentially in relation to the size of the numbers.



## References

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- [3] Zhang, Yitang (2014). "Bounded gaps between primes". *Annals of Mathematics*. 179 (3): 1121–1174. doi:10.4007/annals.2014.179.3.7. MR 3171761. <https://doi.org/10.4007/annals.2014.179.3.7>