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KHAMARU-SINHA PRIMALITY TEST, A NEW WAY FOR PRIME NUMBER TESTING

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ABSTRACT

In the infinite set of Natural Numbers there are countable infinite prime numbers exists. We do not know exactly how many are there but, what we can do to create a sub-set to put all the prime numbers from the Natural Number set into the Prime Number sub-set. Therefore, there are some prime number testing methodologies are required and eventually there are many Primality testing methods are available. But, all this existing methods are very slow to process for the computers here we will see how a fast and easy method can be implemented in this paper by using only the digit sum(s) of the input or, given number. Our goal is not only the fast computers but also a common man can say that if a number is prime or not by simple usage of pen and paper within no time and very few steps.

Keywords: *Primarilty Test, Prime Number Checking, How to check a number is prime, Fastest Prime Number Checking, Lowest Complexity for Prime Number Checking, K-S Primality Test, KSPT.*

1. INTRODUCTION

There is lots of prime number checking algorithms are available in the world of mathematics and they are fully functional. So, the first question will rise why we should introduce a new? We believe that all the existing algorithms are slower than our new algorithm. As per the existing algorithms the fastest algorithm takes the time Big O $(\log(n)^6)$ but, in the rapidly used techniques drops the complexity into Big O ($\sqrt{n}$).

2. IMPORTANT DEFINITIONS:

1.1. Natural Number: Non-Negative and Non-Fractional Numbers are called the Natural Numbers. Example: 0, 1, 2, 3, 4, 5…

1.2. Prime Number: A prime number is a natural number which can only divided by 1 or the number itself. Example: 2, 3, 5, 7, 11, 23, 29, 103, 227, 29, 607, etc.

1.3. Harshad Number: A Harshad number (or Niven number) in a given number base, is an integer that is divisible by the sum of its digits when written in that base. Example: The number 18 is a Harshad number in base 10, because the sum of the digits 1 and 8 is 9 (1+8=9), and 18 is divisible by 9 (since 18÷9=2 and 2 is a whole number)

3. RENAISSANCE

As we know apart from the single digit prime numbers
3.1. Algorithm:

Input: A Natural Number

Output: Checked result if the Input is prime or, Composite.

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Step1: First of all we have to make the digit sum of the given number of which we are going to check the primality.

Step2: Now divide the taken number with the digit sum

Step3: If the taken number is divided by the digit sum it is A Harshad Number and surely a composite
Else

Step4: Now we have to take 3 consecutive prime number(s) greater and smaller than the digit sum.

Step5: Now try to divide the taken number with these Prime Numbers.
If
The number is divisible by the prime(s) the number is a composite number.
Else If
There are remainders at every division we need to go to the next step.

Step6: We need to make digit sum of the digit sum and divide the taken number with the new digit sum.

Step7:
If
The number is divisible by the new digit sum. The taken number is composite
Else

Now we have to take 3 consecutive prime number(s) greater and smaller than the new digit sum.

Step8:
Now try to divide the taken number with these Prime Numbers.
If
The number is divisible by the prime(s) the number is a composite number.
Else If
The taken number is Prime.

STOP

3.2. Example or, Detailed Explanation of the Algorithm:

a) A number where the last digit is 9.

Input: 1109

Step1: Digit-sum of the number in first round: 1+1+0+9=11

Step1b: 1109÷11= 100.8181 here we can see that the input 1109 is not divisible by the digit-sum 11

Step2: Now we have to select the three consecutive prime numbers of eleven both larger and smaller. The larger three consecutive prime numbers are 13, 17, 19 and the smaller three consecutive prime numbers are 7, 5, and 3.

Step3: 1109÷3=369.66 1109÷5=221.8 1109÷7=158.4285714
1109÷13=85.30769231 1109÷17=65.23529412 1109÷19=58.36842105

Step 4: Now as per process said above we need to repeat the digit-sum and here we get 1+1=2.
There is no less prime number than 2 therefore, we need to take the above numbers 3, 5 and 7 and we need to ensure the checking of the number whether it is prime or, Composite.
1109÷3=369.66 1109÷5=221.8 1109÷7=158.4285714

Here we can see 1109 is not divisible by the proposed numbers so, that it is said that the taken number 1109 is prime.

STOP

b) Taking another number where the last digit is 9.

Input: 69

Step1: Digit-sum of the number in first round: 6+9=15

Step1b: 69÷15=4.6 here we can see that the input 69 is not divisible by the digit-sum 15.

Step2: Now we have to select the three consecutive prime numbers of eleven both larger and smaller. The larger three consecutive prime numbers are 17, 19, 23 and the smaller three consecutive prime numbers are 13,11,7.

Step3: 69÷7=9.85714 69÷11=6.2727 69÷13= 5.307692308
69÷17=4.058823529 69÷19=3.631578947 69÷23=3

Step4: Here we can see 69 is divisible by the proposed number(s) here 23 so, that it is said that the taken number 69 is composite.

STOP

c) A number where the last digit is 7.

Input: 1187

Step1: Digit-sum of the number in first round: 1+1+8+7=17

Step1b: 1187÷17= 69.82352941 here we can see that the input 1187 is not divisible by the digit-sum 17

Step2: Now we have to select the three consecutive prime numbers of eleven both larger and smaller. The larger three consecutive prime numbers are 19, 23, 29 and the smaller three consecutive prime numbers are 13, 11, and 7.

Step3: 1187÷19=62.47368421 1187÷23=51.60869565 1187÷29=40.93103448
1187÷13=91.30769231 1187÷11=107.90909 1187÷7=169.5714285

Step4: Now as per process said above we need to repeat the digit-sum and here we get 1+7=8.

Now, we have to take 11, 13, 17 as larger prime and 7, 5, 3 as smaller prime than 8.
1187÷17= 69.82352941 1187÷13=91.30769231 1187÷11=107.90
1187÷7=169.5714285 1187÷5=237.4 1187÷3=395.6

Here we can see 1187 is not divisible by the proposed numbers so, that it is said that the taken number 1187 is prime.

STOP

d) Taking another number where the last digit is 7.

Input: 1227

Step1: Digit-sum of the number in first round: 1+2+2+7=12

Step1b: 1227÷12=102.25 here we can see that the input 1227 is not divisible by the digit-sum 12.

Step2: Now we have to select the three consecutive prime numbers of twelve both larger and smaller. The larger three consecutive prime numbers are 13, 17, 19 and the smaller three consecutive prime numbers are 11, 7, and 5.

Step3: 1227÷19=64.57894737 1227÷17=72.17647059 1227÷13=94.38461538
1227÷11=111.5454 1227÷7=175.2857143 1227÷5=245.4

Step4: Now as per process said above we need to repeat the digit-sum and here we get 1+2=3.

Now, we have to take 5,7,11 as larger prime and 2 is the only smaller prime than 3.

But, first we can try with the new digit-sum 3.
1227÷3=409.

Here we can see 1227 is divisible by the proposed number so, that it is said that the taken number 1227 is not prime.

STOP

e) A number where the last digit is 3.

Input: 1033

Step1: Digit-sum of the number in first round: 1+0+3+3=7

Step1b: 1033÷7= 147.5714286 here we can see that the input 1033 is not divisible by the digit-sum 7

Step2: Now we have to select the three consecutive prime numbers of seven both larger and smaller. The larger three consecutive prime numbers are 11, 13, 17 and the smaller three consecutive prime numbers are 5, 3 and 2.

Step3: 1033÷17=60.76470588 1033÷13=79.46153846 1033÷11=93.9090
1033÷5=206.6 1033÷3=344.33 1033÷2=516.5

Here we can see 1033 is not divisible by the proposed numbers so, that it is said that the taken number 1033 is prime.

STOP

f) Taking another number where the last digit is 3.

Input: 623

Step1: Digit-sum of the number in first round: 6+2+3=11

Step1b: 623÷11=56.6363 here we can see that the input 623 is not divisible by the digit-sum 11.

Step2: Now we have to select the three consecutive prime numbers of eleven both larger and smaller. The larger three consecutive prime numbers are 13, 17, 19 and the smaller three consecutive prime numbers are 11, 7, and 5.

Step3: 623÷19=32.78947368 623÷17=36.64705882 623÷13=47.92307692
623÷3=207.66 623÷5=124.6 623÷7=89

Here we can see 623 is divisible by the proposed number so, that it is said that the taken number 623 is not prime.

STOP

g) Taking another number where the last digit is 1.

Input: 821

Step1: Digit-sum of the number in first round: 8+2+1=11

Step1b: 821÷11=74.6363 here we can see that the input 821 is not divisible by the digit-sum 11.

Step2: Now we have to select the three consecutive prime numbers of eleven both larger and smaller. The larger three consecutive prime numbers are 13, 17, 19 and the smaller three consecutive prime numbers are 11, 7, and 5.

Step3: 821÷19= 43.21052632 821÷17=48.29411765 821÷13=63.15384615
821÷3=273.66 821÷5=164.2 821÷7=117.2857143

Step4: Now as per process said above we need to repeat the digit-sum and here we get 1+1=2.

There is no less prime number than 2 therefore, we need to take the above numbers 3, 5 and 7 and we need to ensure the checking of the number whether it is prime or, Composite.

821÷3=273.66 821÷5= 164.2 821÷7=117.2857143

Here we can see 623 are not divisible by the proposed number so, that it is said that the taken number 623 is prime.

STOP

h) A number where the last digit is 1.

Input: 1041

Step1: Digit-sum of the number in first round: 1+0+4+1=6

Step1b: 1041÷6= 173.5 here we can see that the input 1041 is not divisible by the digit-sum 6

Step2: Now we have to select the three consecutive prime numbers of six both larger and smaller. The larger three consecutive prime numbers are 7, 11,13 and the smaller three consecutive prime numbers are 5, 3 and 2.

Step3: 1041÷7=148.7142857 1041÷11=94.6363 1041÷13=80.07692308
1041÷5=208.2 1041÷3=347 1041÷2=520.5

Here we can see 1033 is divisible by the proposed numbers so, that it is said that the taken number 1033 is not prime.

STOP

3.3. Some information on Harshad Sankhya or, Harshad Number:

On the Natural number set the Harshad Sankhya holds a very important role to differ prime numbers from the composites as it can take on the odd numbers and calculate weather the number is prime or not by simply making a digit-sum of the number and try to divide the taken number with the digit-sum.

Stated mathematically, let X be a positive integer with m digits when written in base n, and let the digits be a_i (i = 0, 1, ..., m − 1). (It follows that a_i must be either zero or a positive integer up to n − 1.) X can be expressed as

$$X = \sum_{i=0}^{m-1} a_i n_i$$

If there exists an integer A such that the following holds, then X is a Harshad number in base n:

$$X = A\sum_{i=0}^{m-1} a_i$$

A number which is a Harshad number in any number base is called an all-Harshad number, or an all-Niven number. There are only four all-Harshad numbers: 1, 2, 4, and 6(The number 12 is a Harshad number in all bases except octal).

For Example:
6408→ 6+4+0+8=18 → 6408÷18= 356
21→ 2+1=3→ 21÷3=7

Here we have introduced the Harshad Number to eliminate some Odd Natural Numbers which can be easily detectible by using the above logics so that we will have to make our calculations on a quite smaller range of numbers.

Here we can also say that we need not take any Odd Natural Numbers which ends with 5 too as every numbers end with 5 are divisible by 5.

3.4. Some common Divisibility Rules of few numbers:

Divisor	Divisibility condition	Examples
1	No special condition. Any integer is divisible by 1.	2 is divisible by 1.
3	Sum the digits. If the result is divisible by 3, then the original number is divisible by 3	405 → 4 + 0 + 5 = 9 and 636 → 6 + 3 + 6 = 15 which both are clearly divisible by 3. 16,499,205,854,376 → 1+6+4+9+9+2+0+5+8+5+4+3+7+6 sums to 69 → 6 + 9 = 15 → 1 + 5 = 6, which is clearly divisible by 3
7	Form the alternating sum of blocks of three from right to left. Subtract 2 times the last digit from the rest. (Works because 21 is divisible by 7.) Or, add 5 times the last digit to the rest. (Works because 49 is divisible by 7.)	1,369,851: 851 − 369 + 1 = 483 = 7 × 69 483: 48 − (3 × 2) = 42 = 7 × 6. 483: 48 + (3 × 5) = 63 = 7 × 9.

	Or, add 3 times the first digit to the next. (This works because $10a + b - 7a = 3a + b -$ last number has the same remainder) Multiply each digit (from right to left) by the digit in the corresponding position in this pattern (from left to right): 1, 3, 2, -1, -3, -2 (repeating for digits beyond the hundred-thousand place). Then sum the results.	483: 4×3 + 8 = 20 remainder 6, 6×3 + 3 = 21. 483595: (4 × (-2)) + (8 × (-3)) + (3 × (-1)) + (5 × 2) + (9 × 3) + (5 × 1) = 7.
9	Sum the digits. If the result is divisible by 9, then the original number is divisible by 9.	2,880: 2 + 8 + 8 + 0 = 18: 1 + 8 = 9.

Here we have specified these 4 numbers because, - most prime numbers apart from single digits the prime numbers end with either 1 or 3 or 7 or 9. This way by checking only the digit in the Unit's place of a number we can say the number is prime or, not while the number is an odd number as there is only one even Prime Number exist in the world and that is 2.

3.5. Complexity Calculations:

According to the Domains of Attractions and Starting Number we have reached to the resultant calculation according to our Algorithm written above, we can say our Worst Case Complexity is O (26) [Big Oh of 26] and The Best Case Complexity is O (1) [Big Oh of 1 Here the number can be determined as Harsh ad Number] and the Average Case Complexity belong into O (2) to O (25) [Big Oh of 2 to 25]

Here we can go for an Example which is following:

For a Number N=1097 we can say Digit-sum of the number in first round: 1+0+9+7=17

If 1097 is dividing by 17 then we can say The Complexity is O (1)
1097÷17=64.52941176

As there is a reminder exists for 1097 divide by 17, we need to go to the next rounds of calculations.

The 3 larger Primes are 19, 23 and 29 lets divide 1097 by the prime numbers
1097÷19= 57.73684211
1097÷23= 47.69565217
1097÷29= 37.82758621

The Smaller Primes are 13, 11 and 7 lets divide 1097 by the prime numbers
1097÷13=84.38461538
1097÷11=99.727272
1097÷7=156.7142857

Now as per process said above we need to repeat the digit-sum recursively until we get a single digit number and here we get 1+7=8.

Now, we have to take 11, 13, and 17 as larger prime.
1097÷17=64.52941176
1097÷13=84.38461538
1097÷11=99.727272
7, 5, 3 are smaller prime than 8.
1097÷7=156.7142857
1097÷5=219.4
1097÷3=365.666667
According to this example for the checking of Primality of 1097 is O(26) [Big Oh of 26]

3.6. Diagram Representation of Prime Number and Khamaru-Sinha Primality Test:

Here in the following figure we can represent the Natural Numbers into a single diagram where different colors were introduced to represent Harshad Number and Prime Numbers.

According to the picture we can say the White Space indicates the Natural numbers without any Prime Number, here we are discarding the only even prime number 2 to implement this diagram and we are also discarding 5 and all the numbers ending with 5 because every number ends with 5 is divisible by 5. We are also discarding 1 as 1 is neither prime nor composite.

Here white spaces indicates Natural numbers which are composite, the Bluish Section indicates the probable sections of Prime Numbers and the Yellow portion indicates the Harshad Numbers which can be both, Even Number and Odd Number so, we have placed this portion in between the even number and odd numbers for indication.

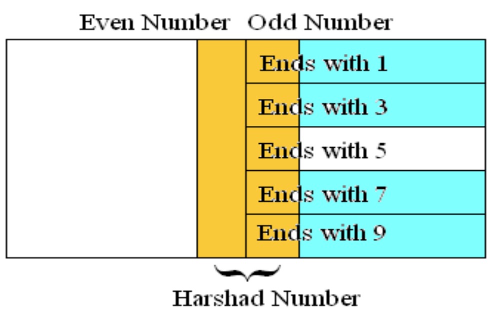

Fig-1

4. CONCLUSION

As per our Algorithm and Diagram we can say that a set of Natural Number can be represented as a single set and if we take two subsets one for Even and one for Odds there can be another intermediate subset can be drawn for Harshad Number since, a Harshad Number can be Both Even and Odd. Moreover, we can say every Odd number Ending with 5 better say any numbers Unit Places digit is 5 that number can be divided by 5 [5n Mod 5=0].

So, if we can take out all the numbers in these distinct subsets the only thing the Odd numbers subset will contain the numbers ending with 1, 3, 7 and 9 [Unit places digits are 1, 3, 7 and 9]

Now, on the subset of Odd numbers if we apply our Algorithm we can easily determine which is Prime and which is composite.

There is another thing we have skipped in the above that how we will generate the prime numbers to be used in this algorithm to run.

Here we suggest to use the Prime numbers which resides in the residue class like the following:

$2n+1$: 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43, 47, 53
$4n+1$:5,13,17,29,37,41,53, 61, 73, 89, 97, 101, 109, 113, 137
$4n+3$:3,7,11,19,23,31,43,47, 59, 67, 71, 79, 83, 103, 107
$6n+1$: 7, 13, 19, 31, 37, 43, 61, 67, 73, 79, 97, 103, 109, 127, 139

There is one more thing to add. This idea has some limitations. The problem is it can measure and stands corrected for 2 digit, 3 digit and 4digit numbers but, it starts to fail from 5 or 6 digit numbers depending on the Unit places digit. We have found that with the increasing digits in a number the numbers behave radically, for example, for some instance a number taken as input which last digit is 3 or, 9 sometimes we do not get the correct result for that particular number better say for that size of that number. For example, for a 9 digit number ending with 9 [unit place is 9] may not provide the correct result while checked through this Algorithm but add an extra 9 and the number turn into a 10 digit number then we can see again our Algorithm working. The same things happens while using 3, may be they are related, this a part for future scope. If a number ending with 1 or 7 this Algorithm worked so far perfectly.

5. FUTURE SCOPE

All the Primality Test are available in the Mathematical world are effectively slower and their complexity increases rapidly as per the digits of the numbers increase, here in our new research results indicates that the Worst Case Complexity can be decreased easily.

The only problem in this new set is for some excessively large numbers our Algorithm might look failing but, for some upgrade that problem can easily solved.

The problems were arising for large numbers ending with 3 and 9 but, as we know a number which is divisible by 9 is also divisible by 3. There is some contextual problem we had faced due to in-efficient computing capability for some Natural Numbers ending with 3 and 9 we were unable to successfully predict whether the number was prime or, composite.

Therefore, here a modification can be done to increase the correctness of the Algorithm.

The Usage of prime numbers are extremely useful in the Internet Security or any other security mechanisms the prime numbers are also very useful.

There are also many other usage of prime numbers like coding and encoding uniquely of any person or anything.

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