Digits in Units Place of 3-PrimeFactors Numbers till 1 Trillion

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Abstract *- Owing to unknown pattern of occurrence of primes and numbers based on them, the digits occurring in them at various places have been subject to investigation. In this work, '3-PrimeFactors numbers' which have exactly 3 prime divisors, are considered for digits in their units place. All 3-PrimeFactors numbers less than 1 trillion are analyzed for digit occurrence at units place.*

Keywords - *Prime number, k-PrimeFactors number, 3-PrimeFactors number, Digits in units place.*
Mathematics Subject Classification (2010) — *11A51, 11N05, 11N80*

I. Introduction

More is known with less certainty and less is known with more certainty about prime numbers! Approximations allowed through big O notation, asymptotic values dictate limitation of our understanding about them [1].

As there are different types of prime numbers, there are different types of numbers whose classification is based upon prime numbers. One such recently identified class of numbers is that of *k*-PrimeFactors numbers [6].

Definition (*k*-PrimeFactors Number) : For any integer $k \geq 0$, a positive integer having *k* number of prime divisors, not necessarily distinct, is called as *k*-PrimeFactors number.

This term has generalized prime numbers on which it is itself based! A prime number happens to be 1-PrimeFactor number under this. In fact, in the study of prime numbers, all natural numbers are covered except 0. This concept covers that also as a unique number of type 0-PrimeFactors number.

For the very reason stated in first paragraph, prime numbers are needed to be exhaustively inspected individually in higher and higher ranges [3]. This requires good generating sieve-algorithms [2]. For different types of prime numbers also, such method becomes necessary [4]. Modern age of advanced computers allows todo these tasks at incredible speed. High level object oriented languages likemakes programming a fun [5].

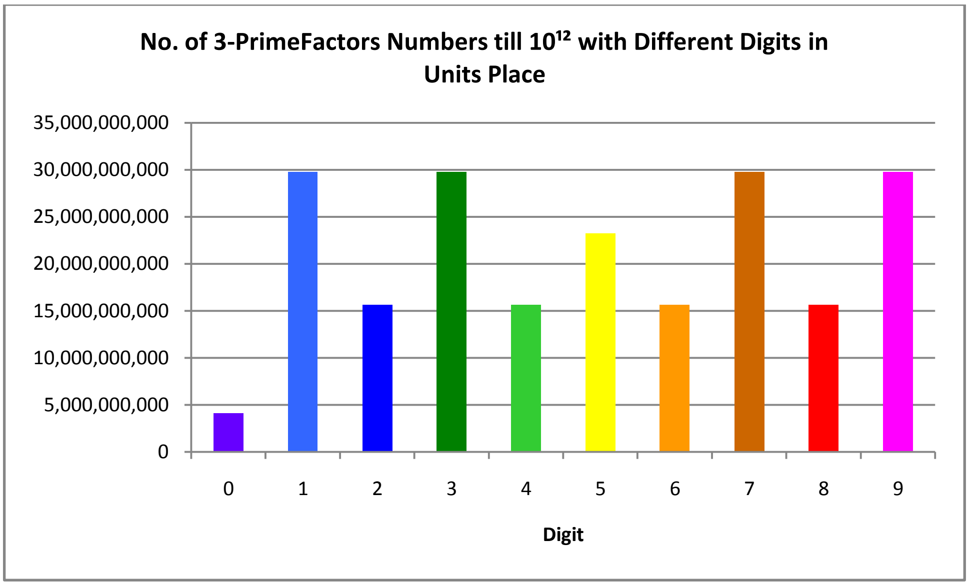
Such approach has consistently been taken.Examples are study of 2-PrimeFactors numbers when their lowest [6] and highest densities [7] were investigated, maximum [8] and minimum spacings [9] between successive 2-PrimeFactors numbers were analysed, digits in their units place [10] and units & tens places [11] were surveyed; similarly when lowest [12] & highest densities [13] of 3-PrimeFactors numbers and minimum [14] &maximumspacings [15] between them were analysed. We take 3-PrimeFactors numbers here for digits in units place.

II. Digits in Units Place of 3-PrimeFactors Numbers

Owing to the base 10 of widely used decimal number system across the globe, in this work, we have determined decimal digits in units places of all 3-PrimeFactors numbers less than 10^{12}.

Sr. No.	*The Digit in Units Place*	*Number of 3-PrimeFactors Numbers Less than 1012 with that Digit in Units Place*
1	0	4,118,054,813
2	1	29,792,496,592
3	2	15,664,986,961
4	3	29,792,575,660
5	4	15,664,929,868
6	5	23,266,828,517
7	6	15,664,924,331
8	7	29,792,632,560
9	8	15,664,999,329
10	9	29,792,554,280

These values compare with each other graphically as follows .



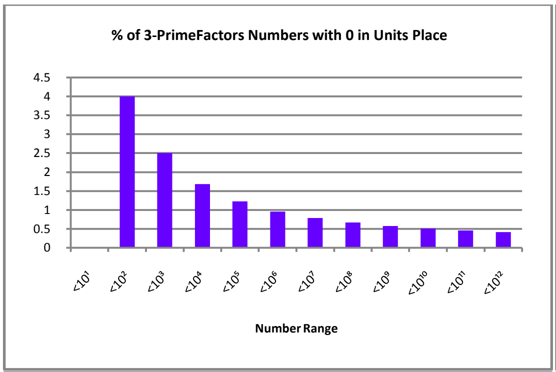
III. RANGE-WISE DIGITS IN UNITS PLACE OF 3-PRIMEFACTORS NUMBERS

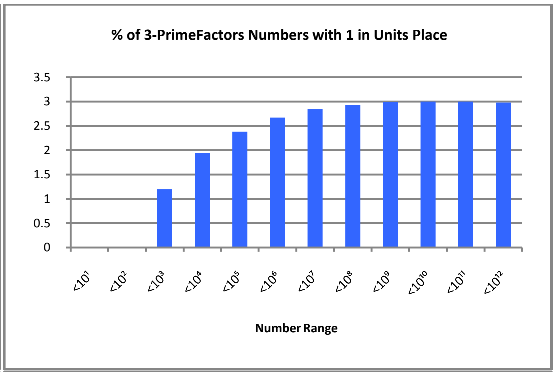
The values given in the previous table are for the scenarios after spanning of the complete range of 1 trillion. In next tabulation, their gradual appearance in growing ranges is presented.

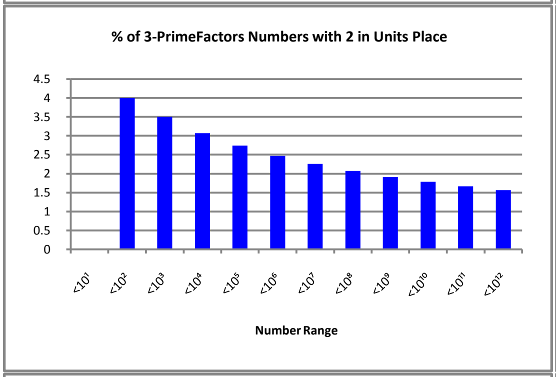
Sr. No.	*Range*	*Number of 3-PrimeFactors Numbers with Digit in Units Place*				
		0	*1*	*2*	*3*	*4*
1	$<10^1$	0	0	0	0	0
2	$<10^2$	4	0	4	1	1
3	$<10^3$	25	12	35	14	30
4	$<10^4$	168	195	307	205	293
5	$<10^5$	1,229	2,381	2,740	2,418	2,705
6	$<10^6$	9,592	26,680	24,684	26,814	24,627
7	$<10^7$	78,498	283,977	225,428	284,182	225,056
8	$<10^8$	664,579	2,936,050	2,068,822	2,937,573	2,068,666
9	$<10^9$	5,761,455	29,846,825	19,136,727	29,849,269	19,133,962
10	$<10^{10}$	50,847,534	300,125,938	178,070,867	300,142,326	178,063,372
11	$<10^{11}$	455,052,511	2,997,134,467	1,666,172,768	2,997,121,697	1,666,146,067
12	$<10^{12}$	4,118,054,813	29,792,496,592	15,664,986,961	29,792,575,660	15,664,929,868

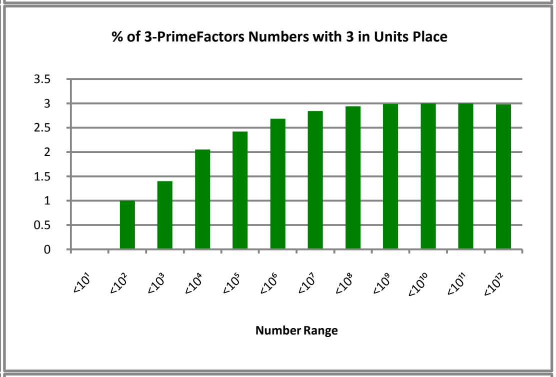
Sr. No.	*Range*	*Number of 3-PrimeFactors Numbers with Digit in Units Place*				
		5	*6*	*7*	*8*	*9*
1	$<10^1$	0	0	0	1	0
2	$<10^2$	2	2	1	6	1
3	$<10^3$	37	29	19	34	12
4	$<10^4$	409	287	198	310	197
5	$<10^5$	3,852	2,699	2,418	2,737	2,377
6	$<10^6$	35,638	24,694	26,740	24,729	26,655
7	$<10^7$	328,786	224,929	284,343	225,363	283,797
8	$<10^8$	3,039,761	2,068,645	2,937,254	2,069,858	2,936,097
9	$<10^9$	28,231,262	19,132,818	29,848,856	19,137,154	29,846,039
10	$<10^{10}$	263,471,079	178,067,070	300,135,262	178,072,999	300,125,549
11	$<10^{11}$	2,470,551,647	1,666,145,840	2,997,148,380	1,666,152,044	2,997,122,488
12	$<10^{12}$	23,266,828,517	15,664,924,331	29,792,632,560	15,664,999,329	29,792,554,280

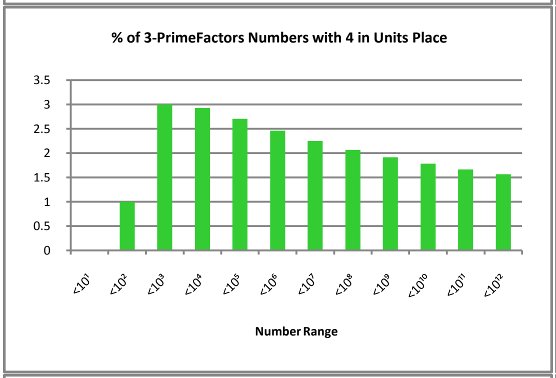
These values were considered as percentage with respect to the total number of numbers with no restriction on digits in units places and then plotted graphically.

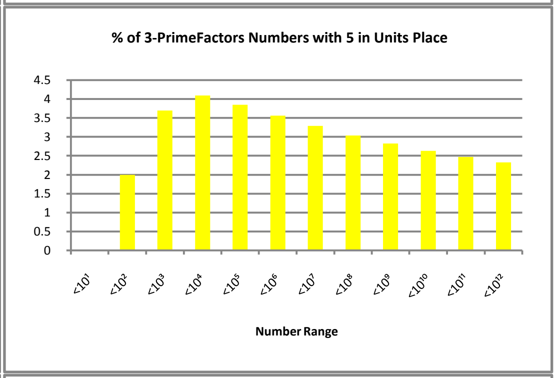

% of 3-PrimeFactors Numbers with 0 in Units Place
Number Range

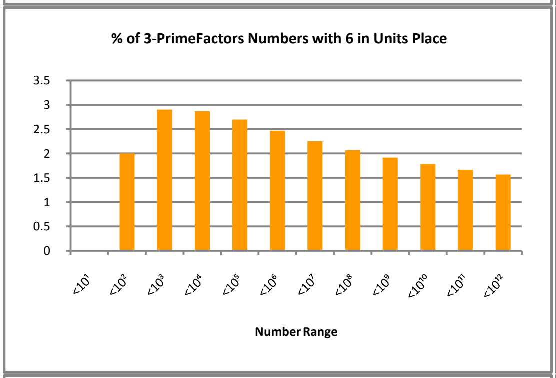

% of 3-PrimeFactors Numbers with 1 in Units Place
Number Range

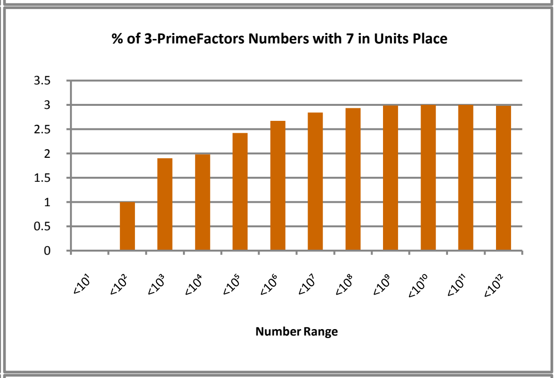

% of 3-PrimeFactors Numbers with 2 in Units Place
Number Range

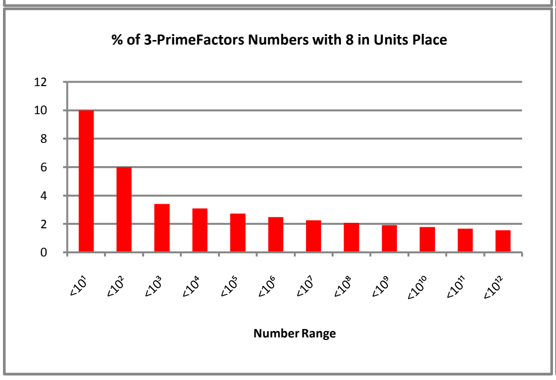

% of 3-PrimeFactors Numbers with 3 in Units Place
Number Range

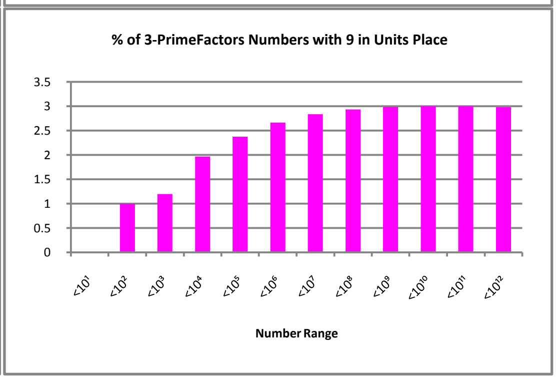

% of 3-PrimeFactors Numbers with 4 in Units Place
Number Range


% of 3-PrimeFactors Numbers with 5 in Units Place
Number Range


% of 3-PrimeFactors Numbers with 6 in Units Place
Number Range


% of 3-PrimeFactors Numbers with 7 in Units Place
Number Range


% of 3-PrimeFactors Numbers with 8 in Units Place
Number Range


% of 3-PrimeFactors Numbers with 9 in Units Place
Number Range

As far as the units place digit occurrence is considered in 3-PrimeFactors numbers, odd ones 1, 3, 7, 9 dominate all even ones. The remaining odd digit 5 also dominates even digits but with a lesser intensity. Amongst even digits, 0 lags behind the most. We judge this situation.

The most occurring digits in units place of primes are 1, 3, 7, 9; whereas least occurring, in fact, occurring only once are 2 and 5.So when we consider 3-PrimeFactors numbers, we must inspect the outcome of product of 3 of them at time.

There are only 2 prime numbers with 2 and 5 in units place. So in following multiplicative combinations, wherever 2 or 5 is used, there is no chance of using many different numbers, in fact there is unique choice(!).

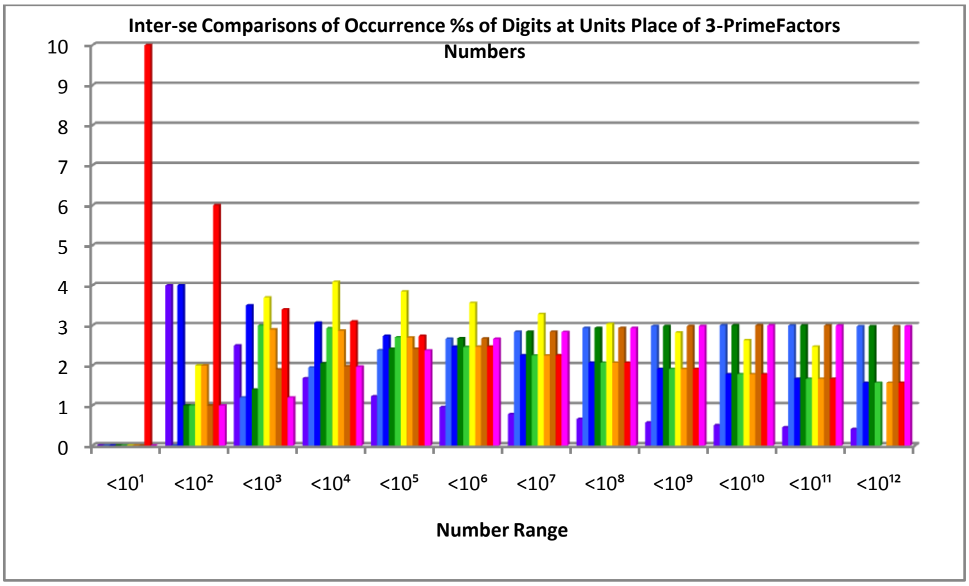
Units Place Digit in			
1st Prime	2nd Prime	3rd Prime	Product 3-PrimeFactors Number
2	2	2	8
		5	0
		1	4
		3	2
		7	8
		9	6
	5	5	0
		1	0
		3	0
		7	0
		9	0
	1	1	2
		3	6
		7	4
		9	8
	3	3	8
		7	2
		9	4
	7	7	8
		9	6
	9	9	2
5	5	5	5
		1	5
		3	5
		7	5
		9	5
	1	1	5
		3	5
		7	5
		9	5
	3	3	5
		7	5
		9	5
	7	7	5
		9	5
	9	9	5

Those combinations which are totally limited due to no choice in all 3 positions are coloured dark red, those with no choice in 2 positions are coloured in light red and those in which there is no choice in one position are coloured yellow.

Now, if we talk about multiplicative combinations of other odd digits in units place, there is ample of choice at all 3 positions and naturally we get multitude of numbers compared to above combinations.

Units Place Digit in			
1^{st} Prime	2^{nd} Prime	3^{rd} Prime	Product 3-PrimeFactors Number
1	1	1	1
		3	3
		7	7
		9	9
	3	3	9
		7	1
		9	7
	7	7	9
		9	3
	9	9	1
3	3	3	7
		7	3
		9	1
	7	7	7
		9	9
	9	9	3
7	7	7	3
		9	1
	9	9	7
9	9	9	1

All possible 20combinationsof 1, 3, 7, and 9 at all positions yield those only.
Due to this the dominance trend at the tail is bound to be found in all higher ranges.



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REFERENCES

[1] Benjamin Fine, Gerhard Rosenberger, Number Theory: An Introduction via the Distribution of Primes, (Birkhauser, 2007).

[2] Neeraj Anant Pande, Improved Prime Generating Algorithms by Skipping Composite Divisors and Even Numbers (Other Than 2), Journal of Science and Arts, Year 15, No.2 (31), 2015, 135-142.

[3] Neeraj Anant Pande, Analysis of Primes Less Than a Trillion, International Journal of Computer Science & Engineering Technology, Vol. 6, No. 06, 2015, 332-341.

[4] Neeraj Anant Pande, Analysis of Twin Primes Less Than a Trillion, Journal of Science and Arts, Year 16, No.4 (37), 2016, 279-288.

[5] Herbert Schildt, Java : The Complete Reference, 7th Edition (Tata Mc-Graw Hill 2007)

[6] Neeraj Anant Pande, Low Density Distribution of 2-PrimeFactors Numbers till 1 Trillion, Journal of Research in Applied Mathematics, 2017, Volume 3 ~ Issue 8 (2017) pp: 35-47.

[7] Neeraj Anant Pande, High Density Distribution of 2-PrimeFactors Numbers till 1 Trillion, American International Journal of Research in Formal, Applied & Natural Sciences, 2017, Communicated.

[8] Neeraj Anant Pande, Minimum Spacings between 2-PrimeFactors Numbers till 1 Trillion, Journal of Computer and Mathematical Sciences, Vol. 8 (12), 2017, 769-780.

[9] Neeraj Anant Pande, Maximum Spacings between 2-PrimeFactors Numbers till 1 Trillion, International Journal of Mathematics Trends and Technology, Volume 52, Issue 5, December 2017, 311-321.

[10] Neeraj Anant Pande, Digits in Units Place of 2-PrimeFactors Numbers till 1 Trillion, International Journal of Mathematics And its Applications, 2017, Accepted.

[11] Neeraj Anant Pande, Digits in Units and Tens Place of 2-PrimeFactors Numbers till 1 Trillion, International Journal of Engineering, Science and Mathematics, Volume 6, Issue 8, 2017, 254-273.

[12] Neeraj Anant Pande, Low Density Distribution of 3-PrimeFactors Numbers till 1 Trillion, International Journal of Latest Engineering Research and Applications, 2017, Accepted.

[13] Neeraj Anant Pande, High Density Distribution of 3-PrimeFactors Numbers till 1 Trillion, International Journal of Mathematics and Statistics Invention, 2017, Communicated.

[14] Neeraj Anant Pande, Minimum Spacings between 3-PrimeFactors Numbers till 1 Trillion, Journal of Research in Applied Mathematics, 2017, Communicated.

[15] Neeraj Anant Pande, Maximum Spacings between 3-PrimeFactors Numbers till 1 Trillion, Journal of Computer and Mathematical Sciences, 2017, Communicated.