International Journal of Engineering Science Invention (IJESI)
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org ||Volume 6 Issue 12|| December 2017 || PP. 82-85

Golden ratio prime numbers

József Bölcsföldi[1], György Birkás[2]
[1](Eötvös Loránd University Budapest and Perczel Mór Secondary Grammar School Siófok, Hungary)
[2](Baross Gábor Secondary Technical School Siófok, Hungary)

Abstract: *After defining, the golden ratio prime numbers will be presented from 13 to 1987. How many golden ratio prime numbers are there in the interval (10^{n-1}, 10^n) (where n≥2 integer number)? On the one hand, it has been counted by computer among the prime numbers with up to 8-digits. On the other hand, the function (1) gives the approximate number of golden ratio prime numbers in the interval (10^{n-1},10^n). The function (2) gives the approximate number of golden ratio prime numbers where all digits are 3 or 7 in the interval (10^{n-1},10^n). Near-proof reasonig has emerged from the conformity of Mills' prime numbers with golden ratio prime numbers. The set of golden ratio prime numbers is probably infinite.*

Date of Submission: 24-11-2017 Date of acceptance: 14-12-2017

I. Introduction

The sets of special prime numbers within the set of prime numbers are well-known. For instance, the Erdős-primes (the sum of the digits is prime) [8], Fibonacci-primes ($F_0=0$, $F_1=1$, $F_n=F_{n-1}+F_{n-2}$), Gauss-primes (in the form 4n+3), Leyland-primes (in the form x^y+y^x, where $1\leq x\leq y$), Pell-primes ($P_0=0$, $P_1=1$, $P_n=2P_{n-1}+P_{n-2}$), Bölcsföldi-Birkás primes (all digits are prime the number of digits is prime and the sum of digits is prime),, etc. Question: Which further sets of special prime numbers are there within the set of prime numbers? We have found a further set of special prime numbers within the set of prime numbers. It is the set of golden ratio prime numbers.

II. Golden ratio prime numbers

The definition of the golden ratio:
the numbers m and n (where m>n) are in golden ratio, if (m+n)/m=m/n=c $c = 1{,}618\ldots$ irrational

Definition: the prime number p is golden ratio prime number, if
$|p/c - q| < k$, where q is a positive integer number and
$|p/c^2 - r| < k$, where r is a positive integer number,
and k=0,05 or k=0,01 or k=0,001.
The positive integer numbers p, q, r are in golden ratio.

1.1 If k=0,05:

p	p/c	p/c²	Golden ratio
13	8,03	4,96	13, 8, 5
47	29,05	17,95	47, 29, 18
89	55	33,99	89, 55, 34
131	80,96	50,04	131, 81, 50
157	97,03	59,97	157, 97, 60
191	118,05	72,96	191, 118, 73
199	122,99	76,01	199, 123, 76
233	144,00	89,00	233, 144, 89
419	259	160,05	419, 259, 160
479	296,04	182,97	479, 296, 183
487	330,98	186,03	487, 331, 186,
521	322	199,01	521, 322, 199
563	347,96	215,05	563, 348, 215
631	389,99	241,03	631, 390, 241
733	453,03	279,99	733, 453, 280

809	500	309,02	809, 500, 309
877	542,03	334,99	877, 542, 335
911	563,04	347,99	911, 563, 348
919	567,99	351,04	919, 568, 351
953	588,99	364,03	953, 589, 364

The golden ratio prime numbers are as follows:
13, 47, 89,
131, 157, 191, 199, 233, 419, 479, 487, 521, 563, 631, 733, 809, 877, 911, 919, 953,
1021, 1063, 1097, 1453, 1487, 1597, 1699, 1741,1783, 1877, 1987, etc.

G(n) is the factual frequency of golden ratio prime numbers in the interval (10^{n-1}, 10^n), where n≥2 prime number.
G(2)=3, G(3)=17, G(4)=102 , G(5)=828, G(6)=6836 , G(7)=58667, G(8)=510259.
H(n) function gives the number of golden ratio prime numbers in the interval (10^{n-1}, 10^n), where n≥2 prime number.
The function H(n) is

$H(n)=0,51x10^{n-2}$ where n≥2 integer **(1)**

The factual number of golden ratio prime numbers and the number of golden ratio prime numbers calculated according
to function H(n) are as follows:

Number of digits	The factual number of golden ratio primes in the interval (10^{n-1}, 10^n)	The number of golden ratio primes calculated according to function $H(n)=0,51x10^{n-2}$	
n	G(n)	H(n)	G(n)/H(n)
2	3	0,51	5,88
3	17	5,1	3,33
4	102	51	2,00
5	828	510	1,62
6	6836	5100	1,34
7	58667	51000	1,15
8	510259	510000	1,00

The golden ratio prime numbers, where all digits are 3 or 7, are as follows:
733, 7333,
3333773, 3773773, 7737733,
37373773, 73377377, 73773373, 77733377, etc. 3337333777, 3337737373, 3337737737, 3377337373, etc.
P(n) is the factual frequency of golden ratio prime numbers in the interval (10^{n-1}, 10^n), where all digits are 3 or 7.
P(2)=0, P(3)=1, P(4)=1, P(5)=0, P(6)=0, P(7)=3, P(8)=4, P(9)=6, P(10)=15, P(11)=18, P(12)=22, P(13)=54, P(14)=95, P(15)=134, P(16)=289, P(17)=1633, P(18)=3800, P(19)=5102, P(20)=10957 .
Q(n) function gives the number of golden ratio prime numbers in the interval (10^{n-1}, 10^n), where all digits are 3or 7.

$Q(n)=2,65x1,55^{n-2}-33$ where n≥9 integer **(2)**

The P(n) factual numbers of golden ratio prime numbers and the number of golden ratio prime numbers calculated according the function Q(n) (where all digits are 3 or 7) are as follows:

Number of digits n	The factual number in the interval (10^{n-1}, 10^n) P(n)	The number calculated according to function $Q(n)=2{,}65x1{,}55^{n-2}-33$ Q(n)	P(n)/Q(n)
9	4	3,75	1.06
10	6	23,96	0.25
11	15	55,29	0,27
12	18	103,85	0,17
13	22	179,11	0,12
14	54	295,77	0,18
15	95	476,60	0,19
16	134	756,87	0,18
17	289	1191,30	0,24
18	1633	1864,67	0,87
19	3800	2908,39	1,31
20	5102	4526,16	1,13
21	10957	10920,38	1,00

1.2 If k=0.01, the golden ratio prime numbers are:

89, 233, 521,

1453, 1597, 1741, 2029, 2063, 2207, 2351, 3571, 4003, 5113, 5689, 5867, 6011, 6299, 7841, 8273, 9349, 9781, etc. 37373773, 73377377, etc.

1.3 If k=0,001, the golden ratio prime numbers are:

1597, 3571, 9349,

11933, 15737, 25463, 26683, 28657, 30631, 37019, 38993, 40213, 42187, 44771, 49939, 50549, 55717,

67273, 69247, 69857, 80803, 85361, 91139, etc.

3337737737, 733777737733, 7737373337333, etc.

Number of the elements of the set of golden ratio prime numbers [3], [9],[10], [11], [12].

Let's take the set of Mills' prime numbers! Definition: The number m=[M ad 3^n] is a prime number, where M=1,3063778838630806904686144926O2 is the Mills' constant, and n=1,2,3,… is an arbitrary positive integer number. It is already known that the number of the elements of the set of Mills' prime numbers is infinite. The Mills' prime numbers are the following: m=2, 11, 1361, 2521008887,…

The connection n→m is the following:1→2, 2→11, 3→1361, 4→2521008887,… The Mills' prime number m=[M ad 3^n] corresponds with the interval (10^{m-1},10^m) and vice versa. For instance:2→(10, 10^2), 11→(10^{10},10^{11}), 1361→(10^{1360},10^{1361}), etc. and vice versa. The number of the elements of the set of Mills' prime numbers is infinite. As a consequence, the number of the intervals (10^{m-1}, 10^m) that contain at least one Mills' prime number is infinite. The number of golden ratio primes in the interval (10^{m-1},10^m) is H(m)=0,51x10^{m-2} . The number of golden ratio prime numbers is probably infinite: $\lim_{n\to\infty} G(n)=\infty$ and $\lim_{n\to\infty} D(n)=\infty$ are probably where n is positive integer.

III. Conclusion

Countless different sets of special prime numbers have been known. We have found the following set of special prime numbers within the set of prime numbers. There may be further sets of special prime numbers that we do not know yet. Finding them will be task of researchers of the future.

Acknowledgements

The authors would like to thank you for publishing this article.

References

[1]. http://oeis.org/A019546
[2]. Freud, Robert – Gyarmati, Edit: *Number theory* (in Hungarian), Budapest, 2000
[3]. http://ac.inf.elte.hu → VOLUMES → VOLUME 44 (2015)→ VOLLPRIMZAHLENMENGE→FULL TEXT
[4]. http://primes.utm.edu/largest.html
[5]. http://mathworld.wolfram.com/SmarandacheSequences.html
[6]. Dubner, H.:"Fw:(Prime Numbers) Rekord Primes All Prime digits" Februar 17. 2002
[7]. http://listserv.nodak.edu/scripts/wa.exe?A2=ind0202&L=nmbrthry&P=1697
[8]. Harman, Glyn: Counting Primes whose Sum of Digits is Prime.
[9]. Journal of Integer Sequences (2012. , Vol. 15, 12.2.2.)
[10]. ANNALES Universitatis Scientiarum Budapestiensis de Rolando Eötvös Nominate Sectio Computatorica, 2015, pp 221-226
[11]. International Journal of Mathematics and Statistics Invention, February 2017: http://www.ijmsi.org/Papers/Volume.5.Issue.2/B05020407.pdf
[12]. International Organisation of Scientific Research, April 2017 http://www.iosrjournal.org/iosr-jm/pages/v13(2)Version-4.html
[13]. DIGITEL OBJECT IDENTIFIER NUMBER (DOI), May 2017 http://dx.doi.org or www.doi.org
[14]. Article DOI is: 10.9790/5728-1302043841

József Bölcsföldi "Golden ratio prime numbers." International Journal of Engineering Science Invention(IJESI), vol. 6, no. 12, 2017, pp. 82-85.