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Mathematics and Decision Science

Cardiac Conduction System

Goldbach's Twin Prime Conjecture

Highlights

Theory of the Varieties Cantors

Analysis on the Covid-19 Transmission

Discovering Thoughts, Inventing Future

VOLUME 20 ISSUE 3 VERSION 1.0

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A Regression Analysis on the Covid-19 Transmission

By Gregory L. Light
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Abstract- This note applies least-squares regression to a cross-section comparison of the total infection numbers of COVID-19 as of a particular date among the fifty states of America to investigate any underlying factors; we also check the Gaussian normality of the time progression of the infection rate.

Keywords: *corona transmission causes, gaussian epidemic curve, epidemic statistical regression.*

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A Regression Analysis on the Covid-19 Transmission

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Abstract- This note applies least-squares regression to a cross-section comparison of the total infection numbers of COVID-19 as of a particular date among the fifty states of America to investigate any underlying factors; we also check the Gaussian normality of the time progression of the infection rate.

Keywords: corona transmission causes, gaussian epidemic curve, epidemic statistical regression.

I. Introduction

This paper applies the least-squares regression to an analysis of the transmission of COVID-19 (cf. Kubiak, Arinaminpathy and McLean, 2010, for new infectious diseases). We first examine how the virus spread out (cf. Kraay, 2018, for movements of disease) by taking a sample of n =50 USA states' cumulative cases of infection Vas of March 26, 2020, against four independent variables: dummy variable B (=1) for a state containing a top-ten city in USA, dummy variable S (=1) for any state of more than 16.5% of its population of age 65 or higher, U = the number of universities/colleges in the state, and C = the number of (a popular national-chain) coffee shops in the state. We then examine the fitness of normal (Gaussian) distribution for the time progression of daily new cases as presented in the media (for a time-series cross-section treatment, see., e.g., Sharmin and Rayhan, 2012).

For the examination of the causes of the spread of the virus, we hypothesize: (1) if a state contains a big metropolitan city, then it generates more cases, (2) if a state has more than 16.5% of its residents of age sixty-five or higher, then due to seniors' vulnerability to diseases higher incidents occur, (3) the more universities/colleges there are in a state, the more the cases there are, and (4) the more "hub-coffee-shops" there are in a state, the more the transmission there is (cf. Romanescu and Deardon, 2017, Welch, 2011, for network models).

As the expression "flattening the curve" has become ubiquitous, we are motivated to see if the curve is a normal distribution (cf. e.g., Shao, 2020, for dynamic modeling). Our sample here is the daily new cases from March 1 to April 14in the State of Rhode Island of the USA, where the Author teaches, with the current students of Statistics contributing to the candidate independent variablesas well as their values for an explanation of V.

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II. Analysis

a) Factors Contributing to the Transmission

We show the regression output below:

Regression Statistics						
Multiple R	0.74					
R Square	0.55					
Adjusted R Square	0.51					
Standard Error	3245					
Observations	50					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	4	584930295.6	1E+08	13.88707	1.8704E-07	
Residual	45	473855589.2	1E+07			
Total	49	1058785885				
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	154	809.1	0.2	0.85	-1476	1784
U	4	2.9	1.5	0.15	-2	10
B	-4861	1910.5	-2.5	0.01	-8709	-1013
C	12	2.1	5.9	4E-07	8	16
S	-1477	936.2	-1.6	0.12	-3362	409

with the underlying input displayed as follows:

States:	V	U	B	C	S
Alabama	386	129	0	37	1
Alaska	59	35	0	2	0
Arizona	401	155	0	71	1
Arkansas	306	108	0	9	0
California	2982	1246	1	376	0
Colorado	1086	171	0	40	0
Connecticut	875	114	0	465	1
Delaware	119	23	0	4	1
Florida	1861	439	1	1037	1
Georgia	1441	210	0	208	0
Hawaii	76	43	0	17	1
Idaho	123	33	0	9	0
Illinois	1865	391	1	707	0
Indiana	477	175	0	16	0
Iowa	145	107	0	10	1
Kansas	98	99	0	21	0
Kentucky	198	165	1	20	0
Louisiana	1946	173	0	7	0
Maine	147	60	0	20	1
Maryland	580	148	0	20	0
Massachusetts	1838	261	1	1178	1
Michigan	2294	302	0	74	1

Notes

Minnesota	346	169	0	19	0
Mississippi	485	69	0	8	0
Missouri	356	242	0	36	1
Montana	65	54	0	5	1
Nebraska	64	68	0	24	0
Nevada	321	77	0	13	0
New Hampshire	137	43	0	19	1
New Jersey	4402	207	1	913	0
New Mexico	112	61	0	13	1
New York	32966	632	1	1562	0
North Carolina	636	188	0	345	0
North Dakota	45	30	0	22	0
Ohio	704	386	0	74	1
Oklahoma	223	158	0	21	0
Oregon	266	125	0	1	1
Pennsylvania	1128	544	1	517	1
Rhode Island	132	37	1	264	1
South Carolina	424	97	0	53	1
South Dakota	41	33	0	4	1
Tennessee	784	191	0	39	0
Texas	974	506	1	187	0
Utah	346	60	0	7	0
Vermont	123	32	0	34	1
Virginia	460	222	0	45	0
Washington	2580	164	0	2	0
West Virginia	51	99	0	5	1
Wisconsin	585	132	0	23	1
Wyoming	44	17	0	8	1

Thus, our hypotheses were moderately supported, but with surprises about the directions of the effect of B and S. A possible explanation of the negative effect of B on V may be because "big states" have better health infrastructure, and the negative coefficient of S may have the argument that seniors are less mobile. However, the most distinct observation is the p = 0.0000004 of C; we surmise the reason being people taking out food/beverages to their workplaces and spread out the virus.

b) The Fitness of Normal Distribution for Daily New Cases

We begin with a derivation of the least-squares linear regression equation (cf. e.g., Grassly and Fraser, 2008).

Let $E(x) \equiv$ the expected daily new cases; then

$$E(x) = \frac{N}{\sigma\sqrt{2\pi}} e^{-0.5\left(\frac{t-\mu}{\sigma}\right)^2},$$

where $N \equiv$ the total infection number under the density curve, $t \equiv$ date, with $t = 1$ corresponding to March 1, 2020,

and $$y \equiv \ln E(x) = \ln\left(\frac{N}{\sigma\sqrt{2\pi}}\right) - 0.5\left(\frac{\mu}{\sigma}\right)^2 + \left(\frac{\mu}{\sigma^2}\right)t - \frac{0.5}{\sigma^2}t^2,$$

so that $\hat{y} = a + b_1 t + b_2 t^2$, with $-\left(\frac{b_1}{2b_2}\right) = \hat{\mu}$, $\hat{\sigma} = \sqrt{\frac{\hat{\mu}}{b_1}}$,

$$and\ \hat{N} = \sigma\sqrt{2\pi}\exp\left(a + 0.5\left(\frac{\hat{\mu}}{\hat{\sigma}}\right)^2\right).$$

Because prior to March 16 there had been the occurrences of x = 0, we select the input x from t = 16 until t = 43 (April 12) with n = 28 with the following input data:

x	lnx	t	t^2
1	0.0	16	256
2	0.7	17	289
10	2.3	18	324
11	2.4	19	361
10	2.3	20	400
12	2.5	21	441
17	2.8	22	484
23	3.1	23	529
18	2.9	24	576
8	2.1	25	625
33	3.5	26	676
38	3.6	27	729
36	3.6	28	784
55	4.0	29	841
108	4.7	30	900
87	4.5	31	961
77	4.3	32	1024
91	4.5	33	1089
52	4.0	34	1156
97	4.6	35	1225
116	4.8	36	1296
160	5.1	37	1369
148	5.0	38	1444
220	5.4	39	1521
277	5.6	40	1600
288	5.7	41	1681
334	5.8	42	1764
316	5.8	43	1849

The regression output is as follows:

Notes

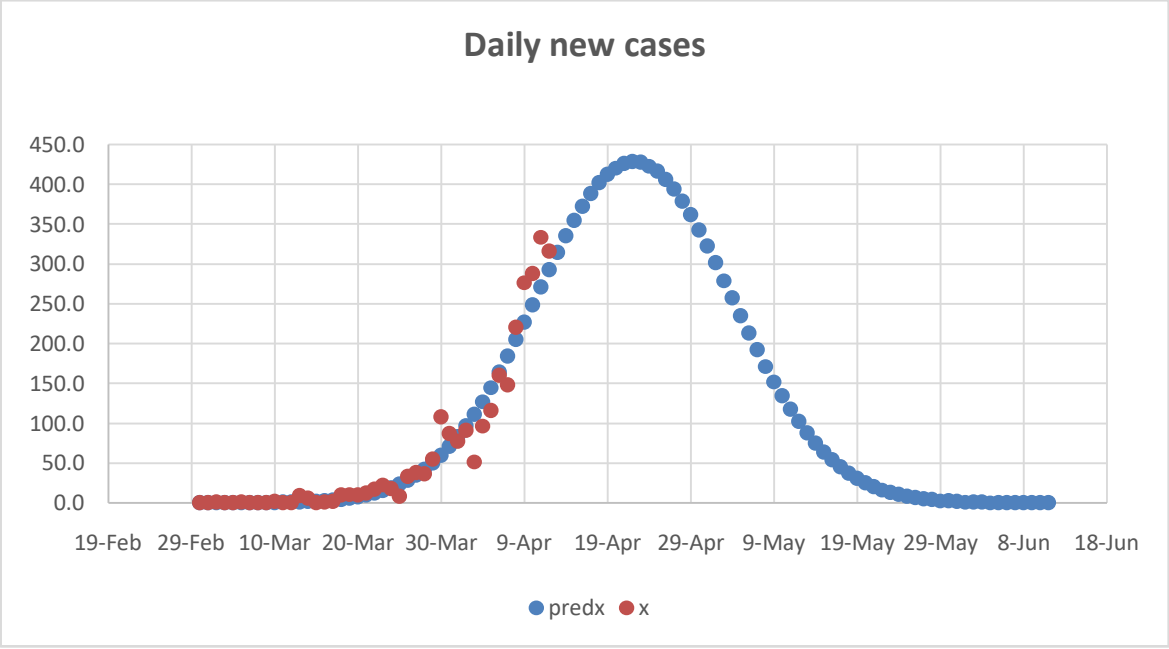
Notes

Regression Statistics						
Multiple R	**0.96**					
R Square	**0.92**					
Adjusted R Square	**0.91**					
Standard Error	**0.46**					
Observations	**28**					
ANOVA						
	df	***SS***	***MS***	***F***	***Significance F***	
Regression	**2**	**56.24430511**	**28.12215**	**135.4814**	**3.8352E-14**	
Residual	**25**	**5.189303157**	**0.207572**			
Total	**27**	**61.43360826**				
	Coefficients	***Standard Error***	***t Stat***	***P-value***	***Lower 95%***	***Upper 95%***
Intercept	**-4.298**	**1.234**	**-3.5**	**0.0018**	**-6.839**	**-1.757**
t	**0.389**	**0.088**	**4.4**	**0.0002**	**0.208**	**0.570**
t^2	**-0.004**	**0.001**	**-2.5**	**0.0204**	**-0.007**	**-0.001**

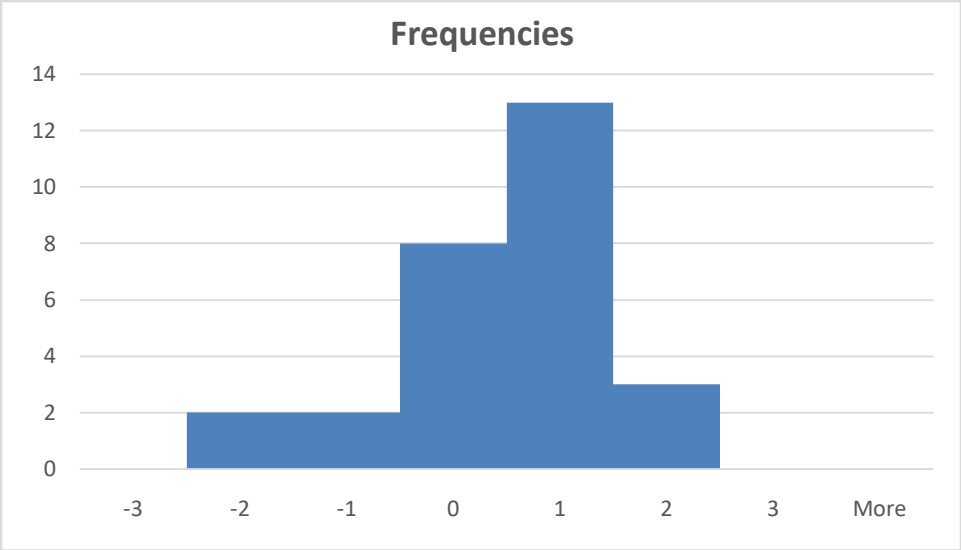
Then the above coefficients render the following estimates:

$$\hat{\mu} = 53.2 \text{ (= April 22, 2020)}, \hat{\sigma} = 11.7, \textit{and } \hat{N} = 12549,$$

with the following plot:



and the standardized residuals have the following histogram:



III. Summary

From the above analysis, we gather the following observations: (1) The medical/health/hygiene infrastructure is essential, which authorities need to improve. (2) Seniors were not the originators of the transmission; on the contrary they tend to slow down the spread. (3) College students in the USA during their Spring Break probably propelled the transmission. (4) Hubs of mass gathering, such as coffee shops, must be vigilant in observing health protocol. (5) The normal distribution of the daily new infection rates appears to be a good fit. We reason that the infection probability depends on two factors, personal immune degrees, and the external environment. The latter may have offsetting factors that tend to cancel one another (cf. Lafferty and Holt, 2003): the more rampant the cases, the more the pre-caution (as friction in mechanics). As such, individual immune degrees, which follow the normality of biology, take a normal distribution, with lower degrees of immunity occurring earlier and higher degrees later.

References Références Referencias

1. Kubiak, R. J., Arinaminpathy, N., and McLean. A. R., Insights into the evolution and emergence of a novel infectious disease, *PLoSComput. Bio.,* 6(9), 2010, 22364-22376.
2. Kraay, A. N. M., et al, Determinants of short-term movement in a developing region and implications for disease transmission, *Epidemiology,* 29(1), 2018, 117-125.
3. Sharmin, S. and Rayhan, M. I., Spatio-temporal modeling of infectious disease dynamics, *J. Appl. Stat.*, 39(4), 2012, 875-882.
4. Romanescu, R. G. and Deardon, R., Fast inference for network models of infectious disease spread, *Scand. J. Stat.*, 44(3), 2017, 666-683.
5. Welch, D., Is network clustering detectable in transmission trees? *Viruses,* 3(6), 2011, 659-676.
6. Shao, N., Dynamic models for Coronavirus Disease 2019 and data analysis, *Math. Meth. Appl. Sci.*, 43(7), 2020, 4943-4949.
7. Grassly, N. C. and Fraser, C., Mathematical models of infectious disease transmission, *Nat. Rev.Microbio.,* 6(6), 2008, 477-487.
8. Lafferty, K. D. and Holt, R. D., How should environmental stress affect the population dynamics of disease? *Ecology Lett.,* 6(7), 2003, 654-664.

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Splitting Goldbach's Twin Prime Conjecture Asunder for Even Numbers

By Kwesi Atta Sakyi
ZCAS University

Abstract- The Goldbach Conjecture remains one of the several unsolved mathematical problems today, along with the Twin Prime Conjecture. It is said to be one of the simplest mathematical problems to state yet the most difficult to prove. In this paper, the author explores a few even numbers about the problem, and, using them as his sample size, juxtaposes his ideas with those of others through literature review. The author explores a solution to the Goldbach conjecture which was put forward about 275 years ago, by a German mathematician, Christian Goldbach, who was a contemporary of the genius German mathematician, Leonhard Euler. Euler in a letter to Goldbach, had confessed at the time that unfortunately, he (Euler) could not prove Goldbach's mathematical poser. Through fundamental analysis and critical thinking, this author attempts to share his thoughts on how to resolve this long-standing mathematical debacle. The methodology used is basic, experimental, and exploratory, with the use of inferences through recognition of number patterns. We hope that this paper will make a small contribution to the discourse on Goldbach's conjecture, whose solution has eluded mathematicians for about 275 years.

Keywords: *euler, goldbach, prime numbers, twin primes, even numbers, twin prime conjugates.*

GJSFR-F Classification: *MSC 2010: 11A41*

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Keywords: *euler, goldbach, prime numbers, twin primes, even numbers, twin prime conjugates.*

I. Introduction

Goldbach's twin prime conjecture states that an even number is the sum of two prime numbers (Kiersz, 2018; Linkletter, 2019). The Goldbach Conjecture dates back to a German/Prussian, Christian Goldbach, who was tutor to the young Csar II. In a letter to Leonhard Euler in 1742, Goldbach had made his conjecture known to the celebrated German mathematical prodigy, Euler, who in history is one of the most-gifted mathematicians ever to walk this earth (Linkletter, 2019).

Prime numbers are part of natural number integers, as whole or counting numbers, excluding zero. A prime number is one that cannot be divided by any other number except itself and one. All prime numbers tend to end with only four digits, namely 1, 3, 7, and 9, and this also applies to twin primes, which are a subset of prime numbers (Sakyi, 2020). Twin primes are prime numbers that are close to each other with a difference of two, of the general form p, and p+2. Examples are (3, 5), (5, 7), (11, 13), (17, 19) and (29, 31), among many others (Sakyi, 2020a). Even numbers are numbers that are divisible by two, and they always end with the digits 0, 2, 4, 6, and 8.

Goldbach's statement of the second twin prime conjecture is directly related to, and conjoined with, the Twin Prime Conjecture which, was posed in 1849 by the Frenchman, Polignac, and which, in ancient Greece, had been alluded to in Euclid and Eratosthenes' sieves of elimination (Murthy, n.d.; Sha, 2016). Goldbach's mathematical poser statement looked paradoxically simple yet complex, in that, every even number

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has many permutations and combinations of twin prime conjugates, some of which are twin prime number conjugates, while others are not so, because many large even numbers have several composite permutations of numbers that make them up, and some of these conjugates, are even and composite.

However, the hidden catch to the mathematical poser is that those even composite conjugates can be decomposed into factors of prime numbers, hence the poser. In a practical sense, the way to proceed on this problem is to break up an even number through the middle, and, through a listing process, isolate all twin conjugates below it that are truly prime, hence the title of this paper. The approach that we propose thus works for smaller numbers, and by extension, and deductive logic, it should work for all even numbers. However, for huge numbers, it becomes tedious, ludicrous, and cumbersome to proceed in that manner, unless an algorithm is made for the computer to automate the procedure.

We think that we would restate the Goldbach conjecture problem that every even number is, at least, a composite sum of, at least, two prime numbers. However, be that as it may, we will use a few examples to examine the problem in some detail, to bring clarity to the issue, and to show that sampling is the way to go in dealing with such an intractable, elusive, and humungous problem.

II. Literature Review

Sampling is a method of choosing a representative size from a given population of discourse to be able to predict characteristics of the given phenomenon of inquiry (Spiegel, 1975; Saunders et al., 2016; Bryman & Bell, 2015). In 1966, Chen provided a proof of Goldbach's conjecture (Plus Magazine, n.d.; Curiosity, 2017). Further progress was made in 1998 when the problem of proving Goldbach's conjecture was subjected to a computer programme that solved an even number to the tune of 4×10^{14} (Plus Magazine, n.d.). Terence Tao had a crack at proving Goldbach's conjecture in 1996 (Curiosity, 2017).

An even number can be expressed in the form 2^{n-1} where $n > 1$. An odd number on the other hand, can be expressed in the form $2^{n-1} - 1$. We can also derive even numbers from the expression $(-2)^n$ where n is an even integer. Where n is odd, the expression $(-2)^n$ becomes a negative number and not applicable to this discussion.

In the past several mathematicians have made many propositions towards the solution of Goldbach's conjecture. We make the submission and observation that the mathematical complexity of the solutions which these mathematicians have contributed are beyond the bounds of this paper, hence we shall not discuss them. We rather propose a fundamental arithmetic approach that is a novelty and also basic. Some of the great mathematicians who have made attempts to solve Goldbach's conjecture include Wang (1984), Richstein (2001), Wu (2007), Chen (1995), Ramare (1995), Marshall (2017), Helfgott (2013), Hardy-Littlewood (1966), Zhou (2019), Melfi (1996) and Vinogradov (n.d.). We have admired the presentations of Wu and Ramare considerably, though we submit that their presentations are extremely intricate and hard for us to follow through the formidable mathematical arguments. We have included in the references many claims to the solution of the problem for the convenience of those who will be interested in looking at hard mathematical arguments.

We recognize what the famous English mathematician and physicist, Isaac Newton, said many years ago that if he had seen further than other men, it was because he had been standing on the shoulders of titans. We are also aware of what Archimedes

said when he figured out how to catch the thieving goldsmith who had stolen part of gold that was given to him by his king to make a crown. Archimedes ran naked from his bath to the town square shouting, 'Eureka!' meaning, 'I have found out'. Finally, we are told an anecdote that Einstein said if you cannot explain a complex concept to a five year old, then you do not understand it yourself.

Notes

III. Methodology

A paper of this nature does not require primary or field research. Therefore, the approach we have chosen here is by secondary research or desk analysis, logical reasoning, and both deductive and inductive methods of validating results through the use of basic arguments.

IV. Findings and Analysis

For purposes of building arguments from the ground up, using an exploratory method, let us take the even number 32, and find its twin conjugates. When we split 32 into two, we obtain 16 + 16.

Table 1: Sample 1 Even number 32

N+1	N-1
17	15
18	14
19	13
20	12
21	11
22	10
23	9
24	8
25	7
26	6
27	5
28	4
29	3
30	2
31	1
32	0

We can see that the even number 32 has three sets of twin prime conjugates, one of which is trivial (31+1). These pairs are (19, 13) (29, 3) and (31, 1). The set of prime sets for a small number such as 32 proves that every even number has pairs of twin prime conjugates. We see arithmetic series patterns emerging from these three pairs, namely, 1, 31, 61, 91, 121, 151 ……., whereby we find out that 91 and 121 are not prime numbers. The general term is 30n-29. We also see the pattern 3, 13, 23, 33, 43……., of the general form 10n-7. We see another series as 19, 29, 39, 49, 59, ……., with the general form 10n+9. Some of these patterns have the common difference between them as 10 and 30, respectively.

We line up the terms generated so far as 30n-29, 10n-7, and 10n+9.

We can also take, for example, the number 64, that is an even and composite number that is 2^6. We can start our method by dividing 64 by 2 that, is 32 + 32. We line up 32 in two columns, and subtract 1 from one column, and add 1 to the other column, thus

Table 2: Sample 2 Even number 64

N+1	N -1
33	31
34	30
35	29
36	28
37	27
38	26
39	25
40	24
41	23
42	22
43	21
44	20
45	19
46	18
47	17
48	16
49	15
50	14
51	13
52	12
53	11
54	10
55	9
56	8
57	7
58	6
59	5
60	4
61	3
62	2
63	1
64	0

(Source: Author)

We group the highlighted twin prime conjugate pairs as
(41, 23), (47, 17), (53, 11), (59, 5) and (61, 3)

We see a pattern of a difference of 6 emerging from 41, 47, 53, and 59 on the one hand, and 5, 11, 17, and 23 on the other hand, giving us the arithmetic series of the form 6n-1, and 6n+1, respectively. The composite sums that are not highlighted can be seen as trivial cases, because they can further be factorized into prime factors. The example of the even number, 64, shows us that it has five pairs or sets of additive or conjugate composite prime numbers, which when rearranged, form patterns of the general form 6n+1, and 6n-1 that can be used to generate twin primes.

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Table 3: Sample 3 Even number 144 (abridged)

N+1	N-1
73	71
83	61
97	47
101	43
103	41
113	31
127	17
131	13
137	7
139	5
143	1

(Source: Author)

From Table 3 above, we can see that the even number 144 has eleven pairs of twin prime conjugates. We can see that the larger the even number, the greater the number of twin prime conjugates that we can derive. The evidence from this analysis is that, so far as even numbers are infinite, so far will twin prime conjugate numbers and twin prime numbers be found (proof by fractal geometry, self-similarity, set theory, and by induction). From Table 3 above, we see arithmetic series patterns emerge as (7, 37, 67, 97, 127……..) (11, 41, 71, 101, 131…..) and (13, 43, 73, 103,……..) of the general forms 30n-23, 30n-19 and 30n-17, respectively (cf. Sakyi, 2020a)

We can extend the same analysis to a higher even number, such as 4096, that is 2^{12}. We divide 4096 into two and, add 1 continuously to one half of it till it reaches 2048 (half of 4096), and continuously subtract 1 from the other half until it reaches zero. The two lists should be scanned for prime numbers below 2048 on the one hand, and those from 2048 up to 4096 on the other hand. In effect we list all prime numbers below 4096, and then find their conjugates by subtracting each of these prime numbers from 4096, and checking whether the resultant is composite or prime. Table 4a below is a list of all twin prime numbers below the even number 4096, while Table 4b is a list of all the prime numbers below the even number 4096.

Table 4a: Twin Prime numbers below 4096

3, 5 7, 11, 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, 821, 823, 827, 829, 857, 859, 881, 883, 1019, 1021, 1031, 1033, 1049, 1051, 1061, 1063, 1091, 1093, 1151, 1153, 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.

Table 4b: Listing of prime numbers below the even number 4096

2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89, 97, 101, 103, 107, 109, 113, 127, 131, 137, 139, 149, 151, 157, 163, 167, 173, 179, 181, 191, 193, 197, 199, 211, 223, 227, 229, 233, 239, 241, 251, 257, 263, 269, 271, 277, 281, 283, 293, 307, 311, 313, 317, 331, 337, 347, 349, 353, 359, 367, 373, 379, 383, 389, 397, 401, 409, 419, 421, 431, 433, 439, 443, 449, 457, 461, 463, 467, 479, 487, 491, 499, 503, 509, 521, 523, 541, 547, 557, 563, 569, 571, 577, 587, 593, 599, 601, 607, 613, 617, 619, 631, 641, 643, 647, 653, 659, 661, 673, 677, 683, 691, 701, 709, 719, 727, 733, 739, 743, 751, 757, 761, 769, 773, 787, 797, 809, 811, 821, 823, 827, 829, 839, 853, 857, 859, 863, 877, 881, 883, 887, 907, 911, 919, 929, 937, 941, 947, 953, 967, 971, 977, 983, 991, 997, 1009, 1013, 1019, 1021, 1031, 1033, 1039, 1049, 1051, 1061, 1063, 1069, 1087, 1091, 1093, 1097, 1103, 1109, 1117, 1123, 1129, 1151, 1153, 1163, 1171, 1181, 1187, 1193, 1201, 1213, 1217, 1223, 1229, 1231, 1237, 1249, 1259, 1277, 1279, 1283, 1289, 1291, 1297, 1301, 1303, 1307, 1319, 1321, 1327, 1361, 1367, 1373, 1381, 1399, 1409, 1423, 1427, 1429, 1433, 1439, 1447, 1451, 1453, 1459, 1471, 1481, 1483, 1487, 1489, 1493, 1499, 1511, 1523, 1531, 1543, 1549, 1553, 1559, 1567, 1571, 1579, 1583, 1597, 1601, 1607, 1609, 1613, 1619, 1621, 1627, 1637, 1657, 1663, 1667, 1669, 1693, 1697, 1699, 1709, 1721, 1723, 1733, 1741, 1747, 1753, 1759, 1777, 1783, 1787, 1789, 1801, 1811, 1823, 1831, 1847, 1861, 1867, 1871, 1873, 1877, 1879, 1889, 1901, 1907, 1913, 1931, 1933, 1949, 1951, 1973, 1979, 1987, 1993, 1997, 1999, 2003, 2011, 2017, 2027, 2029, 2039, 2053, 2063, 2069, 2081, 2083, 2087, 2089, 2099, 2111, 2113, 2129, 2131, 2137, 2141, 2143, 2153, 2161, 2179, 2203, 2207, 2213, 2221, 2237, 2239, 2243, 2251, 2267, 2269, 2273, 2281, 2287, 2293, 2297, 2309, 2311, 2333, 2339, 2341, 2347, 2351, 2357, 2371, 2377, 2381, 2383, 2389, 2393, 2399, 2411, 2417, 2423, 2437, 2441, 2447, 2459, 2467, 2473, 2477, 2503, 2521, 2531, 2539, 2543, 2549, 2551, 2557, 2579, 2591, 2593, 2609, 2617, 2621, 2633, 2647, 2657, 2659, 2663, 2671, 2677, 2683, 2687, 2689, 2693, 2699, 2707, 2711, 2713, 2719, 2729, 2731, 2741, 2749, 2753, 2767, 2777, 2789, 2791, 2797, 2801, 2803, 2819, 2833, 2837, 2843, 2851, 2857, 2861, 2879, 2887, 2897, 2903, 2909, 2917, 2927, 2939, 2953, 2957, 2963, 2969, 2971, 2999, 3001, 3011, 3019, 3023, 3037, 3041, 3049, 3061, 3067, 3079, 3083, 3089, 3109, 3119, 3121, 3137, 3163, 3167, 3169, 3181, 3187, 3191, 3203, 3209, 3217, 3221, 3229, 3251, 3253, 3257, 3259, 3271, 3299, 3301, 3307, 3313, 3319, 3323, 3329, 3331, 3343, 3347, 3359, 3361, 3371, 3373, 3389, 3391, 3407, 3413, 3433, 3449, 3457, 3461, 3463, 3467, 3469, 3491, 3499, 3511, 3517, 3527, 3529, 3533, 3539, 3541, 3547, 3557, 3559, 3571, 3581, 3583, 3593, 3607, 3613, 3617, 3623, 3631, 3637, 3643, 3659, 3671, 3673, 3677, 3691, 3697, 3701, 3709, 3719, 3727, 3733, 3739, 3761, 3767, 3769, 3779, 3793, 3797, 3803, 3821, 3823, 3833, 3847, 3851, 3853, 3863, 3877, 3881, 3889, 3907, 3911, 3917, 3919, 3923, 3929, 3931, 3943, 3947, 3967, 3989, 4001, 4003, 4007, 4013, 4019, 4021, 4027, 4049, 4051, 4057, 4073, 4079, 4091, 4093.

(Source: factors-of.com)

We found five hundred and sixty eight (568) prime numbers below the number 4096 out of which 210 were twin prime numbers (36.9 %). We have highlighted the twin prime numbers in yellow in Table 4a above. This confirms that prime numbers and twin primes are everywhere dense in number space.

Notes

Table 5: Sample of Twin Prime Conjugates of the even number 4096

4049	47
3929	167
3917	179
3853	241
3539	557
3527	569
3299	797
3119	977
2999	1097
2789	1307
2729	1367
2309	1787
2657	1439
2027	2069
1997	2099
1889	2207
1823	2273
1787	2309
1697	2399
1637	2459
1619	2477
1553	2543
1487	2609
1439	2657
1433	2663
1409	2687
4093	3
4091	5
4079	17
4073	23
4049	47
4013	83
4007	89

We take note from Table 5 above that majority of the twin prime conjugates of the number 4096 mostly end with the digits 3, 7, and 9 as discussed earlier. We also look at the lower numbers from Table 5 from the bottom upwards, and discern patterns of the series 17, 47, 77, ……., with the general form, 30n-13; then the series 23,53, 83,……., with the general form, 30n-17; then the series 29, 59, 89,……..with the general form, 30n-1.

V. Proof

We can prove the Goldbach conjecture in the sense that, given any even number, to find its twin prime conjugates, we can recommend the following steps

1. List down all the prime numbers below that even number
2. After listing down all the prime numbers below it, eliminate all primes ending with certain digits according to the ending digit of the even number chosen, for even number ending with 0, maintain all the prime numbers generated from the list

Notes

3. For an even number that ends with the digit two, eliminate all listed prime numbers that end with seven, because seven subtracted from twelve is five, that gives us a non-prime number
4. For an even number that ends with the digit four, eliminate all primes that end with nine, because 9 taken from 14 leave us with five, like it applies to number three above
5. For an even number that ends with six, eliminate all primes that end with one, because one from six gives us five
6. For an even number that ends with eight, eliminate all primes that end with three because three from eight leave us with five
7. Examine for patterns of arithmetic series in the numbers so generated of the twin conjugates
8. Use the general arithmetic series of terms generated to produce twin prime numbers that are greater than the even number you chose to work on
9. Add one to all the numbers produced from those terms to obtain even numbers greater than the one you worked on. For example, for the terms 30n-1, 30n+1, 30n-13, 30n-17, 30n-19, 30n-29, 30n-23, 10n-7, 10n+9, 6n+1, and 6n-1 we can generate twin primes to infinity, as we derived these terms from the common patterns among all twin prime numbers (Sakyi, 2020). These general terms appear when we analyse any even number by listing all prime numbers below it, and we can use the sieve we have prescribed here above to reduce the list of prime numbers with which to deal
10. These general terms can generate twin primes to infinity. That, being the case, for any twin numbers that we generate, we can add 1 to each of them to obtain an even number, because twin primes always end with the digits 1, 3, 7, and 9. Therefore, there is an infinitude of twin primes, and also an infinitude of even numbers (Sakyi, 2020).
11. The probability of choosing an even number is 50 percent (0.5) and an odd number is also 50 percent (0.5).
12. The probability of choosing a prime number is 36.8 percent (see above)
13. The probability of choosing a twin prime number is 3.49 percent (Sakyi, 2020)
14. Finally, so far as we can generate an infinite series of twin primes from the terms we have produced herewith, so also can we state categorically that all even numbers have at least two prime conjugates. The larger the even number, the greater the number of twin prime conjugates that are there. Statistically speaking, from the samples referred to here, it is self-evident from the statistical point of view that what applies to small samples in number theory also apply to the infinitude of numbers. From our discussion so far, we have seen even numbers such as 32, 64, 144, and 4096 as numbers that already have sets of twin prime conjugates. We also submit that this elemental question can be solved in a common sense manner, which we have demonstrated here beyond all reasonable doubt. The Goldbach Conjecture can therefore be put to rest after 275 years. Table 6 below shows the distribution of twin prime conjugates for our convenient sample of seven chosen even numbers, namely 8, 16, 32, 64, 128, 144, and 4096. The evidence we adduce here is that as we choose higher even numbers, we observe that the number of twin prime conjugates rise exponentially to infinity by extrapolation.

Notes

Table 6: Frequency of twin prime conjugates in a sample of even numbers

Number	Frequency of twin prime conjugates
8	1
16	2
32	3
64	5
128	4
144	10
4096	33

VI. Discussion

We are informed by sampling in statistics that to know the characteristics of a large population, we can choose a random sample, convenient sample, stratified sample, or any type of sampling method which is justified by the circumstance and purpose intended (Saunders et al., 2016; Bryman & Bell, 2015; Spiegel, 1974). We have here demonstrated that we do not have to break all the millions of eggs in a shopping mall to prove that the eggs which are being sold have salmonella or Corona virus (COVID-19). We can use a scientifically-selected sample size to analyse in order to predict, through sample statistics, the true population parameters or characteristics in an efficient and effective manner (Yamane, 1970; Spiegel, 1975; Kwak, 2017)

We found out that every even number has many prime numbers below it, and in fact, a few steps down from the even number lurk twin primes. Besides that, we made the following observations or discoveries.

1. If an even number ends with the digit two, we list all prime numbers below it and eliminate those that end with the digit seven, because seven subtracted from an even number that ends with two will always result in a number with five at the end, which is a composite number that can further, be factorized. Therefore, the prime numbers below it, that end with one, three, and nine are to be considered as twin prime conjugates for the even number under consideration. This applies to all even numbers to infinity
2. If an even number ends with the digit four, then consider all prime numbers that end with the digits one, three, and seven as prime candidates of prime conjugates of that even number. All prime numbers below it that end with the digit nine are to be eliminated because nine taken away from fourteen leave us with the number five at the end. It is the same as even numbers that end with the digit two discussed above. This also applies to all even numbers up to infinity
3. An even number minus an even number results in another even number. However, an even number minus an odd number can either give you an odd prime number or an odd composite number. For example, 36 - 17 = 19, 72 – 29 = 43, and 74 – 29 = 45. So, in our discussion, we have to eliminate all odd numbers which are composite by concentrating on odd prime numbers whose subset is the set of twin primes.
4. If an even number ends with the digit six, then prime numbers below it that end with one should be eliminated because six minus one leave us with five. Therefore, we have to consider only all prime numbers below that even number that end with digits three, seven, and nine.
5. If an even number ends with the digit eight, then consider eliminating prime numbers below it which end with the digit three because eight minus three leave us

with five. Therefore, prime numbers that end with the digits one, seven, and nine are candidates for prime conjugates of that even number under consideration

6. However, if an even number ends with the digit zero, then all prime numbers below it that end with digits one, three, seven, and nine are all prime number conjugates. This shows us that zero is a neutral digit and operator, above all the other digits

We further our discussion of prime conjugates of even numbers with more examples.

Table 7a below shows the frequency of prime conjugates found in the even numbers 12, 24, 48, 96, 192, and 384. We can see that each preceding number is twice the next number. We can clearly see the trend of prime conjugates as the numbers get bigger. The frequency shows a steady upward trend at first followed by an exponential growth later. The frequency intervals are 2, 2, 2, 4, and 9. Cumulatively, this shows an exponential growing curve. Table 7b shows the occurrence of twin conjugates in the even numbers 12, 24, 48, 96, 192, and 384.

Table 7a: Sample even numbers frequency

Even Number	Frequency of Twin Prime Conjugates below even number
12	1
24	3
48	5
96	7
192	11
384	20

Table 7b: Sample even numbers distribution of twin conjugates

Even Number	Distribution of Twin Prime Conjugates below even number
12	(5, 7)
24	(5,19) (11, 13) (7, 17)
48	(19, 29) (5, 43), (7, 41) (11, 37) (17, 31)
96	(7, 89) (13, 83) (17, 79) (23, 73) (29, 67) (37, 59) (43, 53)
192	(29, 163) (11, 181) (19, 173) (13, 179) (53, 139)(61, 131)(43, 149)(41, 151) (89, 103)(83, 109)(79,113)
384	(5, 379)(11, 373) (17, 367) (31, 353)(37, 347) (47, 337)(53, 331)(67, 317)(71, 313)(73, 311) (101, 283)(103, 281)(107, 277)(113, 271)(127, 257)(133,251)(151, 233)(157, 227)(173, 211)(191,193)

Notes

Notes

VII. Flowchart Towards Solution of Goldbach's Twin Prime Conjecture

1. We assume an even number, V
2. We eliminate all even numbers that end with digits 0, 2, 4, 6, and 8, and that are less than V, because an even number minus an even number produces another even number.
3. With the remaining odd numbers, we go to the list of prime numbers that are less than V by eliminating all odd numbers that are composite or divisible or are squares. For example, the number 1681 has root 41, and 2401 has root 49.
4. Depending on the last digit of V, we do the following. We let V_0, V_2, V_4, V_6, and V_8 represent even numbers that end with the digits 0, 2, 4, 6, and 8 respectively. For all even numbers that end with zero, V_0, we maintain all prime conjugates that we listed as R + p = V. For all even numbers that end with 2, V_2, we eliminate all R values that end with 7, because 12 minus 7 will give a number that ends with a digit 5. For all even numbers that end with 4, V_4, we eliminate all R values that end with 9. For all V_6, we eliminate all numbers that end with the digit 1. For all V_8, we eliminate all listed values of R which end with the digit 3.
5. From step 4, we subtract remaining prime numbers, p from V, and let (V-p) be equal to R.
   V-p = R. Therefore R + p = V (a constant, K)
6. We check all results for the expression R + p =V to ensure that we only remain with results where both R and p are prime conjugates that add up to V. To check all Rs, we apply divisibility rules for 3 and 7, and check that R is neither a square nor a composite number that can further be factorized
7. We list out all R + p that are prime conjugates, and look out for patterns of arithmetic series by observing the numbers vertically and horizontally for patterns in order to generate infinite series of twin primes of the general forms 6n-1, 6n+1, 30n-23, 30n-17, 30n-19, 30n-29, 10n-7, and 10n+9, among others (Sakyi, 2020) that are greater than V
8. We use our series derived from the arithmetic series to generate twin prime numbers that are greater than V by adding 1 to the terms we obtained in order to obtain even numbers greater than V
9. Having gone through this cycle to generate higher even numbers, we go back in a loop to the starting point in step 1 above to repeat the whole process

We have proved by the above flowchart and analysis of samples of even numbers that every even number is made up of two twin prime conjugates, a mathematical poser which was first put forward by Christian Goldbach in 1742 in a letter to his fellow celebrated German mathematician, Leonhard Euler (Curiosity, 2017)

VIII. Applications of Twin Prime Conjugates

While twin prime numbers have constant distance of two between them, twin prime conjugates have variable distances between them due to discrete accretion or discrete increment. All twin prime conjugates of a particular even number have a constant sum or total while twin prime numbers have a constant difference between them, but not their total. We can apply many uses and applications to the twin prime conjugates of even numbers that were referred to in Goldbach's conjecture.

According to Merriam-Webster's Dictionary (4th ed.) a dyad is a pair or two items that occur simultaneously and are regarded as one unit, always conjoined like Siamese twins. Dyads occur in governance as diarchy or governance by two rulers as we

have in Libya or in some unstable countries in Africa such as South Sudan, where we have government in exile, and de facto government in power on the ground. In biology, Webster dictionary states that we can refer to the division of a tetrad in meiosis into a double chromosome as a dyad or as prime conjugates.

In sociology, we can refer to a social relationship as a dyad or a twin prime conjugate, and we can code the partners with twin prime conjugate numbers. In mathematics, we have binary number system based on two digits of zeros and ones, which is used in electrical alternating currents as well as in computer science as signals of zeros and ones for calculations, data processing, sending messages, storing information as electrical impulses, and in Boolean algebra matrices and calculations.

Furthermore we can apply the bi-numerals for coding pairs of human organs such as the eyes, ears, lungs, ovaries, brain lobes, testicles, vagina lobes, pair of limbs, kidneys, the buttocks, and the breasts, among others. All these organs that come in pairs need coding and we can code them by using prime number conjugates when doing surgery or recommending treatment and therapy. We can have many applications in optometry, ophthalmology, psychology, pharmacology, optics and waves in physics, musical chords and scales in music, use of transistors and chips in electronics, in cadastral mapping we can employ prime conjugates in triangulation, and taking cadastral readings and coordinates as prime conjugates. We can use them in random statistical selection of items to include in a survey; we can apply prime dyads in seed multiplication, in chromatography in differentiating colour hues in the spectrum; we can apply in molecular biology and physics; in nanotechnology; and in virology in naming viruses such as SARS, MERS, CORONA virus, and Ebola strains, among many other applications. We can apply prime conjugates to the study of astronomy where binary stars can be named by prime conjugates. For example, according to Webster, binary stars that occur in certain constellations are

Table 8: Binary stars and their constellations (adapted from Webster Dictionary)

Binary star	Constellation
Aldebaran	Taurus
Adhara	Canis Major
Spica	Virgo
Rigel	Orion
Procyon	Canis Minor
Capella	Auriga
Acrux	Crux
Sirius	Canis Major
Canopus	Carina

IX. Conclusion

We consider the proof of Goldbach's Conjecture a corollary of the Twin Prime Conjecture, in that we observed that you cannot deal with one and leave out the other. They are like conjoined Siamese twins. Our earlier paper on the Twin Prime Conjecture is therefore germane to have a look at it (Sakyi, 2020). We finally conclude that all even numbers end with the digits 0, 2, 4, 6, and 8 and that every even number apart from two, has at least two prime conjugates which form arithmetic series that can be used to generate twin primes that are higher than a chosen even number. When we add one to the twin primes that we have generated, we derive higher even numbers. Since in an earlier paper we proved twin prime numbers to be infinite, by the same argument,

Notes

we stand by our earlier assertion that twin primes, twin prime conjugates, and in fact the natural numbers are all infinite (Sakyi, 2020) We also made the discovery that the bigger an even number that we analyze for twin prime conjugates, the higher the amount of twin prime conjugates that we find.

References Références Referencias

Notes

1. AoPS (2020) Goldbach's Conjecture [Online] artofproblemsolving.com/wiki/index.php/Goldbach-conjecture
2. Bryman, A. & Bell, E. (2007) Business Research Methods USA: Oxford University Press
3. Caldwell, C.K. (2020) Goldbach's Conjecture [Online] Prime Pages-Prime Glossary
4. Castelvecchi (2012) In Their Prime: Mathematicians Come Closer to Solving Goldbach's Weak Conjecture
5. Curiosity (2017) The Goldbach Conjecture is a Simple Problem That's Never Been Solved [Online] https://curiosity.com/topics/the-goldbach-conjecture-is-a-simple-problem-thats-never-been-solved-curiosity
6. Factors-of.com (n.d.) List of prime numbers before 4096 http://www.factors-of.com/prime-numbers-before/List-of-prime-numbers-before_4096_
7. Helfgott (2013) Major arcs for Goldbach Theorem
8. Helfgott (2012) Minor arcs for Goldbach Theorem
9. Kiersz, A. (2018) Here are 4 Crazy Prime Number Problems No Mathematician Has Yet Solved ScienceAlert: Business Insider 17 March, 2018
10. Kwak, S.G. & Kim, J.H. (2017) Central Limit Theorem: the cornerstone of modern statistics *Korean Journal of Anaesthesiology* April 2017 Vol. 70, No. 2 pp. 144-156 doi: 10.4097/kjae2017.70.2.144
11. Linkletter, D. (2019) (The) Hardest Math Problems That Remain Unsolved *Popular Mechanics Getty Creative Commons* September 26, 2019
12. Marshall, S. (2017) Elementary proof of the Goldbach Conjecture [Online] vixra.org/pdf/1702.0150vl.pdf
13. Murty, M.R. (n.d.) The Twin Prime Problem and Generalizations [Online] Queen's University, Canada
14. Plus Magazine (n.d.) Gold for Goldbach [Online]
15. Quora.com (n.d.) Is there any proof for Goldbach's conjecture? [Online] quora.com/Is-there-any-proof-for-Goldbachs-conjecture
16. Sakyi, K.A. (2020) Triple Reflections- A Discourse on Twin Prime Conjecture, Pascal's Triangle, and Euler's *E Global Journal of Science Frontier Research* Vol. XX Issue II Version 1 2020
17. Ramare, O. (1995) Ramare [Online] en.wikipedia.org/wiki/Olivier-Ramare
18. Saunders, M., Lewis, P. & Thornhill, A. (2009) Research Methods for Business Students London: Pearson Education
19. Sha, Y. Y. (2016) Polignac's Conjecture with New Prime Number Theorem [Online] *Journal of Physical Mathematics* sha, J Phys Math 2016, 7.4 Doi: 10.4172/2090-0902.1000201
20. Spiegel, M. (1975) *Probability and Statistics*- Schaum Series Singapore: McGraw Hill1. WIMS (1999) Goldbach [Online] http://wims.unice.fr/wims/wims.cgi?

session=36691FD763.6&+lang=en&+module=tool%2Fnumber%2Fgoldbach.en&+cmd=reply&+n=4096&+start=281
21. Vinogradov, I. (n.d.) Vinogradov [Online] en.wikipedia.org/wiki/ivan-vinogradov
22. Wu, J. (2007) Chen's double sieve Goldbach's conjecture and the twin prime problem 2 [Online] researchgate.net/publication/1766542/chens-double-sieve-goldbachs-conjecture-and-the-twin-prime-problem-2/
23. Yamane, T. (1970) *Statistics.* New York, N.Y: Harper & Rowe
24. Zhou, P. (2019) A Solution of Goldbach Conjecture Arising from the Largest Strong Goldbach Number

Notes

Bibliography

1. Deshouillers, J.M. te Riele, H.J.J. and Saouter, Y. (1998) *New experimental results concerning the Goldbach conjecture*. In "Proc. 3rd Int. Symp. on Algorithmic Number Theory," Lecture Notes in Computer Science Vol, 1423, 1998. pp. 204--215,
2. Fliegel, H. F. and Robertson, D. S. (1989) "Goldbach's comet: the numbers related to Goldbach's conjecture," *J. Recreational Math.*, 21:1 (1989) 1--7.
3. Granville, A. te Riele, H.J.J. & van de Lune, J. (1989) "Checking the Goldbach conjecture on a vector computer" in *Number theory and its applications.* R. A. Mollin editor, Kluwer, Dordrect, 1989. pp. 423--433,
4. Hardy, G.H. & Littlewood, J.E. (1966) "Some problems of 'partitio numerorum' : III: on the expression of a number as a sum of primes," *Acta Math.*, 44 (1923) 1-70. Reprinted in "Collected Papers of G. H. Hardy," Vol. I, pp. 561-630, , Oxford: Clarendon Press
5. Ramaré O. (1995) "On Schnirelmann's constant," *Ann. Sc. Norm. Super. Pisa*, 22:4 (1995) 645-706.
6. Ribenboim, P. (1995) *The new book of prime number records*, 3rd edition, Springer-Verlag, New York, NY, 1995. pp. xxiv+541
7. Richstein, J. (2001) "Verifying the goldbach conjecture up to $4\cdot 10^{14}$," *Math. Comp.,* 70:236 (2001) 1745—1749
8. Sinisalo, M. (1993) "Checking the Goldbach conjecture up to $4\cdot 10^{11}$," *Math. Comp.,* Vol.61:204 (1993) 931--934.
9. Wang, Y. (editor) (1984) Goldbach conjecture *Series in Pure Mathematics* Vol, 4, World Scientific, Singapore, 1984. pp. xi+311

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Recent Publications

1. Sakyi, K. A. (2020) Migration Trends in Sub-Saharan Africa-Domestic and International Socio-Politico-Economic Repercussions: Implications for Zambia (Chapter 17 in Springer book published by Springer, Switzerland, 2020)
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3. Sakyi, K.A. (2019) Negotiation Failure- Case of Daimler- Chrysler *ASSRJ* 2019 116.203.177.230
4. Sakyi, K.A. (2019) Global Operations Innovativeness and Entrepreneurship at 3M Company *ASSRJ* 2019 116.203.177.230
5. Sakyi, K.A. (2019) Sustainable Supply Chain Management at Clif Bar *ASSRJ* 2019 116.203.177.230
6. Sakyi, K.A.(2019) PR Management of BP Oil Spill on Gulf of Mexico- A Strategic Communication Approach *ASSRJ* 2019-116.203.177.230
7. Sakyi, K.A., Katebe, M., Mweemba, B. & Mukosa, F. (2019) Opportunities Threats and Challenges in Anarchistic and Autarkic states- Utopian versus Dystopian States 2019 41.63.8.17 www.scholink.org
8. Sakyi, K.A. (2019) Public Corporation Monopolies- Case Study of Sale of Electricity Corporation of Ghana ASSRJ 2019 116.203.177.230
9. Sakyi, K.A. (2020) Smart Cities-A Compendious and Multidisciplinary Approach: Issues and Opportunities (yet to be published in IGI Book chapter)
10. Mweshi, G. K. & Sakyi, K. A. (2020) Building Sustainable Supply Chain Investment Decisions Through Financial Analysis- Case Study of Lusaka SMEs American Scientific Research Journal for Engineering, Technology and Sciences (*ARSJETS*) February 2020
11. Mweshi, G.K. & Sakyi, K. A. (2019) Management of Transparency in Outsourcing- A Case Study of ZCAS American Scientific Research Journal for Engineering, Technology and Sciences (*ARSJETS*) November 2019
12. Sakyi, K.A. (2020) Triple Reflections- A Discourse on Twin Prime Conjecture, Pascal's Triangle, and Euler's e. *Global Journal of Science Frontier Research* Mathematics and Decision Science Vol. 20, Issue 2, pp.21-34.pdf DOI:10.17406/GJSFR
13. Sakyi, K.A. (2017) Artificial Intelligence and potential future possibilities. *International Journal of Development Research* Vol. 7, Issue 2, February 2017, pp. 11608-11611
14. Sakyi, K.A. (2017) Early Childhood Education: Penetrating the impenetrable issues *African Educational Research Journal* Vol. 5 No. 1 January 2017, pp. 18-31

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On the Theory of the Varieties Cantor's Many

By E. A. Tsarev & F. F. Mende

Abstract- Theory of sets (varieties) this one of the divisions of mathematics. In it they are studied the general properties sets are determined properties and characteristics, that possess what that general by property. Georg Cantor is considered the father of theory rightfully, which helped Richard Dedikind. The author of theory proposed the new concept of understanding nature of infinity, but the substantiation of theory itself is not entirely correct, which gave birth to logical contradictions both in theory itself and in those following, on its osnove. Iznachalnaya form of theory was called subsequently name *naive set theory*. In the indicated in the bibliography monograph daN the thorough analysis of set theory. In its time set theory it underwent rigid criticism from the side the well-known mathematicians: Henri Poincare, Luitzen Weyl and Herman Weyl and even associate of Cantor Richard Dedikind. They asserted that to Cantor all put outting themselves of mathematics, considered urgent infinity not scientific concept and this was error. Scientific disputes apropos of naive set theory it does not cease up to now. In the article possible inaccuracies and even errors in the theory of Cantor's varieties are examined.

Keywords: *set, power, interval, length.*

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On the Theory of the Varieties Cantor's Many

E. A. Tsarev [α] & F. F. Mende [σ]

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I. Introduction

Cantor, after continuing the transactions of Riemann in the works on the theory of trigonometric series, understood, that one should be determined with points and many afore-mentioned, with sizes and quantity. After interesting in power and their comparisons, in 1873 the year Cantor reveals the denumerability of the sets of rational numbers, but cannot solve a question about the equal power of integers. The first results, obtained by Cantor, were accepted favorably by Dedikind and Weierstrass and in the period 1879-1884 of year were published six articles in Mathematische Annalen.

Foggily formulated concept set in the naive theory, that was being rested only on the sign of the collection of all objects according to any properties, it provoked to the detection of a series of contradictions, namely paradox To Burali-Forti, the discrepancy of universe, Russell's paradox, the paradox of Richard, Berry's paradox, the Grellinga-Nelson paradox. The attempts to solve privately these paradoxes led to the creation of new direction in mathematics-of intuitionism and formalization of set theory by means of the selection of axioms. On this worked as Zermelo, Gilbert, Bernays, Hausdorff, Brouwer, Poincare, Lebesgue, Borel, by Weyl. Nevertheless, the general principle of permission contradictions (fundamental errors in the basis of theory) so they did not find.

II. General Concepts

This is set mathematical object , most being been collection, totality, meeting of any objects, which are called elements of this set and possess general for all their characteristic property.

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Point- this is the abstract object, which does not have the measuring characteristics: neither height nor length nor radius.

Line is area and volume are divided to the points, but they do not individually have the identical properties (characteristics).

Therefore the determination of set relates only to the inverse sets.

Reversed set is - this set, the sum of elements of which is equal to the base of set.

Not reversed (associated) set is - this set, the sum of elements of which is not equal to the base of set.

For example, section (base of set), divided in the infinitely small sections (elements of set). All sections have one property- length. Set is reversed. The points are located between the sections, they in this case are the boundaries between the sections. And it is possible to define the set of these points as the sum of end-points, but this sum does not have a property of length, i.e., set is not reversed relative to section.

That is the base of set, which can be divided to the elements of set.

Base can be finite and infinite, fixed and not fixed.

For example, the set of integers infinite value, many infinitely small sections in the sum of those giving the section of finite quantity, certainly (length of base it is final).

Simple set is this set, which they consist of the uniform elements (elements with the identical characteristics).

Complex set consists of certain quantity of simple.

It does not change during division and multiplication of infinite set (set with an infinite quantity of elements) by the finite number, the cardinal number of set, and also it does not change, if we add a final quantity of elements or to take away.

Variety (Cantor) synonym is set (conventional).

The cardinal number of set this is value (order) of infinity.

Finite sets, i.e., calculating possess the zero power (value of infinity).

Many one order (power) these are those sets, which are more either less into a final quantity of times or less or more to the finite quantity and with the division for each other result will be the finite number.

Identical power, these are those power, with division of which into each other, result one on the module.

Those sets, which less or more into an infinite quantity of times are the sets of different value.

But if power are more or less to the infinite value, then for determining the relationship of the amounts of power additional mathematical operations require.

Addition, what or finite numbers as both subtraction and multiplication by the finite numbers do not change the order of finite sets, with exception of multiplication by zero.

Division on any the finite number except zero does not change the order of finite set.

The same is correct for the sets of other power.

The indeterminate sets these are those sets, in which it cannot be determined power, in particular because of the absence of properties, according to which it is possible to determine power.

Without the comparison of the elements of a set and their quantity it cannot be compared and power.

Infinitesimal quanitiies are positive and are negative - this of value, the value (module) of one of the parameters which the aim is zero.

Notes

Simple sets this of the sets, in which all elements are characterized by the identical properties (identical property).
Complex sets this of set, that consist of their several simple sets.

III. Procedures of Determination and Comparison of the Cardinal Numbers (Quantity of Elements) of the Sets

Notes

For the fact that to determine and to compare a quantity of elements of different sets, is required to determine the order of tendency toward infinity through the formulas, expressed algebraically.

Interval widely adapts, i.e., the fixed value of anything and can be used both the basis and as element of set.

For example, it is necessary to compare the set of integers and fractional. Both and other set can be represented as the sum of intervals. We take the interval between zero and one (0,1) - in that case interval and the base of subset, and element of set. A quantity of integers is equal to two, a quantity of fractional of infinity. Hence it follows that the cardinal number of the set of the fractions is more than of integers.

Interval it is possible to use and as an element. For example, how are compared two sections? Lengthwise measure (standard) and to a quantity of measures in the section. The simplest version this when the length of measure one for both compared sections and then it is compared with respect to a quantity and if a quantity is equal, then the lengths of sections are identical. However, in the cases when standard different are compared the works of the lengths of standards to a quantity.

This procedure is applicable for those cases, when the lengths of sections by means of the comparison of the cardinal numbers of the set of points of those belonging to the specific sections compare. It is taken the interval (linear interval) (a,b) of infinitely small length (standard) and sections are divided into this interval.

$$M(L) = L/(a,b),$$

where $M(L)$ a quantity of points in the section L , length of which (a,b) interval.

Then a quantity of sections is compared and the conclusion about equality or inequality is done from this.

Sizes are compared with respect to two parameters - lengthwise of interval and quantity of intervals themselves, mentally applied to the measured objects, correspondingly, size this to the work of interval to the quantity

$$L = (a,b) \times M(L),$$

where L the length of section, $M(L)$ a quantity of points on section (a,b) interval.

With the comparison of identical sections, are obtained the identical sets of points (associating of set). With the comparison of the sections, whose length is more or less into a final quantity of times of the cardinal number of the sets of points of one order.

IV. Comparison of the Cardinal Number of the Sets of the Elements of the Components the Space

Let us take the elements of the space: point, line, plane, volume.

It follows from that state aboved that a quantity of points on the line is infinite, nevertheless, there is a formula, making it possible to determine the relativity of power in the cases not of arbitrary taking for the basis of a quantity of points. So it follows

that the cardinal number of the sets in the section of one order for the sections of finite length.

Plane can be represented as the set of infinitely small areas, which are divided by lines. In that case the set of the lines, which divide plane into the set of elements of set, it will also be irreversible (associating). Each line consists of the infinite set accordingly, plane consists so of an infinite quantity of points, but the cardinal number of this irreversible set is more than the cardinal number of the set on the line.

Volume is divided by planes to an infinite quantity infinite small volumes, respectively in such cases:

1. Many planes are not reversed (associating).
2. The point set in the final volume possesses larger power than the point set on the final plane and in the final section.
3. The cardinal number of the set of lines in the final volume is more than on the final plane.

V. Cantor's Errors

Main error of Cantor, which involved certain quantity of insoluble paradoxes - this taking for the basis of an arbitrary quantity of points. Because an arbitrary quantity is this uncertainty.

"As it will be shown in our study, the elements of n- multiple of that extended continuous variety it will be possible to unambiguously and fully determine even with the aid of the one- only real continuous coordinate t". (end of quotation, p. 24) [1].

The main thing was be defined, what to compare as to compare and for which this to make.

For guaranteeing the continuity to not logically use the arbitrary sizes of elements of set this leads to the uncertainties and because of this to the insoluble paradoxes.

We will use the procedure of checking results in mathematics. i.e., let us conduct operations with the reverse actions. That to obtain, for example the infinite set from the line it is necessary to divide line from some parameter after obtaining the element of set, which they will be the infinitesimal quanitiy (there are no different versions). For the checking should be multiplied or added the elements of set, in addition from the specific parameter. In our case the infinite sum of the elements of infinitesimal quanitiy. If the orders of infinity of sum and elements are not determined, then as a result is obtained uncertainty, which contradicts the finite quantity of the length of section.

In the dry residue it is it turns out that necessary two parameters - the specific values of infinity of sum and elements, and not one, as the author asserts.

"Hence then it follows that if we about the nature of correspondence make no assumptions, then the number of independent continuous real coordinates, which require for the single-valued and total determination of the elements of the n- multiply extensive continuous variety, can be taken by arbitrary, but it means, it cannot be considered as the constant sign of the assigned variety." (end of quotation, p. 24) [1]. It is not possible to take the number of independent continuous coordinates by arbitrary, because contradiction is obtained.

"It turned out that to the presented by me question about that, is it possible continuous variety I measurements to unambiguously and fully reflect to the continuous variety only one measurement, so that to each element of one of them corresponds one

Ref

1. Георг Кантор. Труды по теории множеств. Москва, Наука, 1985.

and *only* one element of another, it is necessary to answer affirmatively." (end of quotation, p. 24) [1]. It is incorrect assumption.

"Therefore, using the expression introduced above, we can say that the power of any continuous n- multiply extensive means *is equal* to the thickness of the once extensive continuous variety of the, for example, limited continuous section of straight line." (end of quotation, p. 25) [1].

This assertion is not correct, since. power are not equal.

The author so was not dismantled with the following questions.

What such is point? What dimensions of point in the different regularities? Procedure of the determination of a quantity of points?Cardinal number of sets?

"If two well-defined varieties M N can be unambiguously and fully elementwise compared with each other (which is always possible and by many other methods, if this is made any), then it is further convenient to indicate that these varieties have equal power or that they are equivalent". (end of quotation, p. 22) [1].

For this exactly is suitable the procedure, described by me above, however, the author allows procedure with one coordinate (parameter).

"Thus, continuous surface can be unambiguously and fully reflected to the continuous line; it is also correct for continuous bodies and continuous means of any number of measurements." (end of quotation, p. 24)[1].

So cannot be acted, since the cardinal numbers of sets are different.

"Therefore, using the expression introduced above, we can say that the power of any n- multiply of that extended means *it is equal* to the power of the once extensive continuous variety, for example the limited section of straight line." (end of quotation, p. 24-25) [1].

Here also power are not equal.

"When the varieties in question are final, i.e. they consist of the finite number of elements, as can easily be seen, the concept of power corresponds to the concept of number, and, therefore, to the concept positive integer number, since in two such varieties power are equal then only then, when the number of their elements it is identical." (end of quotation, p. 22) [1].

Power in finite sets zero, in the infinitely large sets their power are determined by approach speed to infinity, not by number, i.e., if two sets are compared, then not the infinite difference in the number has values.

"If M it is the variety of the power of the sequence positive integer numbers, that each infinitely component M has the same power as M.¸ (end of quotation, p. 23) [1].

Assertion is incorrect, since. power in the infinitely small part M it will be less than u M.

"If, M', M", M"' ... - the finite or simply infinite sequence of the varieties, each of which has a power of the sequence positive integer numbers, then the varietyM, obtained from the association M', M", M"' has the same power." (end of quotation, p. 23) [1].

In this assertion also there is an error. During the addition of the finite number of varieties (sets) the obtained set there will be the same power, during the addition of the infinite number of varieties (sets) the obtained set there will be larger power. Here

Ref

1. Георг Кантор. Труды по теории множеств. Москва, Наука, 1985.

the author contradicts himself, earlier it asserted that the infinite large set has the large power, than final.

VI. Conclusion

From the aforesaid it is possible to make the conclusion that some conclusions, conducted by Cantor, are erroneous because of the incorrect systematic approach. In the article is carried out the analysis on the basis of the existing knowledge and the existing contradictions in the very theory of Cantor and subsequent theories on this basis. The approach regarding the elements of sets examined makes it possible to solve the significant number of contradictions both in the very theory of Cantor and the subsequent theories on this basis.

Notes

References Références Referencias

1. Георг Кантор. Труды по теории множеств. Москва, Наука, 1985.

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Impulse Delay in the Cardiac Conduction System

By Nzerem, F. E & Ugorji H. C
University of Port Harcourt

Abstract- The physiology or otherwise of blood circulation is predicated on the electrical conduction of the heart. As a rule electrical impulse suffusing the cardiac cells, just like all time-dependent phenomena, transmits with a modicum of time delay. Such delay may be physiological (benign) or pathological; the later is seen as a cardiac liability. This paper treated impulse conduction delay in the cardiac system. A set of matrices resulting from the graph theoretic description of the conduction system was generated and fitted into a continuous time invariant state-space delay equation, and a state-transition matrix solution was sought. An input control-based minimization scheme by which ensuing deleteriousness of pathological delay could be assuaged was proposed.

Keywords: *current, physiological, matrices, graph theory, minimization.*

GJSFR-F Classification: *MSC 2010: 97K80*

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Keywords: *current, physiological, matrices, graph theory, minimization.*

I. Introduction

Impulse transmission is a notable neuronal and cardiac occurrence. In fine, the overall vivacity of animated cells is attributable to a balanced electrical impulse budget. The cardiac conduction system (CCS) is a network of bio-electric process. In effect, the impulse under consideration is electrical. The physiology of blood circulation is based on the electrical conduction of the heart. As a rule, electrical phenomena bear on bio-electric structures, and therefore the similitudes of electrical events bring to bear on the cardiac cells. Beck[1] was right: *The reason a heart beats is simple: electricity.* It is no secret that ionic concentration gradient constitutes a major source of bio-electric impulse drive around cells. Basically, all time-based events such as electrical impulse have some element of time delay. Delays are a crucial element of physiological phenomena. This can only be said about benign or a physiological delay. In neurology such delay may be normal in axonal conduction time when an action potential (AP) travels from an active site near the neuronal soma to the axon terminals [2,3].Such conduction delays may be created by several different factors, such as variation in membrane time constants, number of synapses, and some associated length scales[4]. In pharmacokinetics drug delivery experiences normal equilibration delay between pharmacologic response and plasma drug concentrations [5]. In the cardiac conduction system (CCS), the onset of each phase of AP is preceded by a benign impulse transmission delay. This is the refractory period of the AP. However, while cell-to-cell benign delays are recorded within transmission time (such as seen during impulse transmission at atrioventricular (AV) junction so as to enhance full contraction of the a trial chambers [6,7]), pathological delays are observable in the event of cardiac anomalies. From the aforesaid, pathological delay is noticeable either during refractoriness or (at any region) during transmission or at both times. It is of note that

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despite their so called bad reputation [8, 9], physiological delay may have a stabilizing effect. Minimizing conduction delays is evidently beneficial since hurried conduction is, more or less, a cardiac liability. Pathological delays are implicated in a group of deleterious cardiac events.

Dynamics of electric networks with spatially distributed delays have been recently studied in the past [10, 11]. In [9] the critical point at which time delay is beneficial in a communication network was analysed in terms of a linear-quadratic performance measure. In a rather non-specific treatment of any physical system, Chen and Zhang [12] considered two types of delayed impulses: the destabilizing delayed impulses and the stabilizing delayed impulses. In a more precise analysis Saleh *et al* [13] studied failures in transmission systems of electric power networks. The study showed the effect of a single line failure of electric flow on the other lines. This is similar to any arc/nodal transmission failure in the cardiac conduction system. The graph theoretic analysis employed in the work was no less desirable. The CCS is, to all intents and purposes analogous to electrical networks discussed. Since the input and output of the system obeys Ohm's law, (see [7]), their relationship may be represented by a linear proportionality. Therefore the control of the system may be of a linear control type.

II. Model of Network Topology

The CCS network system was treated in [7].This section draws largely from it for some details on the present work. Consider the conduction schematic (Fig.1) below.

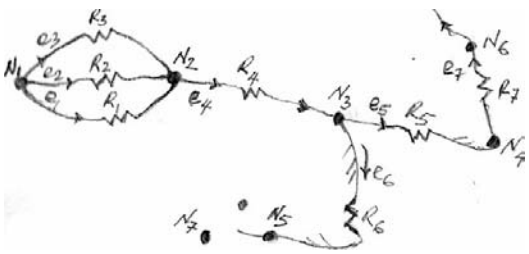

Fig. 1: Schematic of the CCS nodes (N_i), arcs (e_i) and resistors (R_i)

The nodes $N_1, N_2,\ldots,N_n$ are specified as follows: the SAN,N_1;the AVN,N_2; the point of bifurcation of the bundle of His,N_3; the left bundle branch, N_5; the right bundle branch, N_6.

The network constraints associated with the conduction system are the branch (edge) constraints, arising from Kirchhoff's Current Law (KCL),and the non-element based topological constraints, arising from Voltage Law (KVL). In the cardiac network the arcs have the semblance of electric wires, and therefore they have specific resistance. The linear relationship between current (I) and voltage (V) is expressed on the network by *Ohm's law*.

In a node where branch currents $x_1, \ldots, x_n$ enter (i.e. the currents are a form of input to the inactive nodes), Kirchhoff's current law (KCL) gives the total current as

$$x_1 + \cdots + x_n = 0. \tag{1}$$

Similarly, by Kirchhoff's voltage law (KVL)

$$v_1 + \cdots + v_n = 0. \tag{2}$$

Ref
9. Jean-Pierre Richard, Linear time delay systems: Some recent advances and open problems, www.elsevier.com/locate/ifac

where v_i denote the voltage drop in the circuit. The CCS is a structure with many nodes and many circuits. It requires the application of KCL and the KVL, together with Ohm's law for the network equations.

a) Potential difference across edges

The edges (arcs)of cardiac network, analogous to an electric wire, has an Ohmic resistance. Let r_0 be a voltage source, and let $R_1, \ldots, R_7$ be resistances (see fig.1). The potential difference, v_i, across each of the resistances measured across each arc, e_i is:

$$\begin{aligned} v_1 &= N_1\text{-}N_2 \quad v_3 = N_1\text{-}N_2 \quad v_5 = N_3\text{-}N_4 \\ v_2 &= N_1\text{-}N_2\, v_4 = N_2\text{-}N_3\, v_6 = N_3\text{-}N_5 \\ v_7 &= N_4\text{-}N_{6,} \end{aligned} \tag{3}$$

where, in the above, N_i (i=1,2,…,6) represents the nodes. (It shall be noted that there is infinite number of in-degree nodes N_j in the CCS that satisfy $d^-(N_i)=0$. For any arc e_j dispensing from the Purkinje fibre and any infinitely large number of nodes N_∞, $d^-(N_\infty)=0$.).

The vector form of (3) gives

$$\begin{bmatrix} v_1 \\ v_2 \\ v_3 \\ v_4 \\ v_5 \\ v_6 \\ v_7 \end{bmatrix} = \begin{bmatrix} 1 & -1 & 0 & 0 & 0 & 0 \\ 1 & -1 & 0 & 0 & 0 & 0 \\ 1 & -1 & 0 & 0 & 0 & 0 \\ 0 & 1 & -1 & 0 & 0 & 0 \\ 0 & 0 & 1 & -1 & 0 & 0 \\ 0 & 0 & 1 & 0 & -1 & 0 \\ 0 & 0 & 0 & 1 & 0 & -1 \end{bmatrix} \begin{bmatrix} N_1 \\ N_2 \\ N_3 \\ N_4 \\ N_5 \\ N_6 \end{bmatrix} \tag{4}$$

Take N_2 as the reference node. The incidence matrix the CCS, with N_2 grounded, is [7]

$$\mathrm{B} = \begin{array}{c} \begin{matrix} e_1 & e_2 & e_3 & e_4 & e_5 & e_6 & e_7 \end{matrix} \\ \begin{pmatrix} 1 & 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & -1 \end{pmatrix} \end{array} \begin{matrix} N_1 \\ N_3 \\ N_4 \\ N_5 \\ N_6 \end{matrix} \tag{5}$$

where e_i are the edges.With N_2 as the reference node we have, from (5)

$$\begin{bmatrix} v_1 \\ v_2 \\ v_3 \\ v_4 \\ v_5 \\ v_6 \\ v_7 \end{bmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 \\ 0 & 1 & -1 & 0 & 0 \\ 0 & 1 & 0 & -1 & 0 \\ 0 & 0 & 1 & 0 & -1 \end{pmatrix} \begin{pmatrix} N_1 \\ N_3 \\ N_4 \\ N_5 \\ N_6 \end{pmatrix}, \tag{6}$$

which is of the vector form

Ref

7. Nzerem F. E. and Ugorji H.C.,Cardiac conduction system: the graph theoretic approach, J. Math. Comput. Sci. 9 (2019), No. 3, 303-326 https://doi.org/10.28919/jmcs/4027

$$v = DN. \tag{7}$$

In (6), D is the matrix network's connectivity matrix.

Ohm's Law "$I = V/R$" is now used in relating the current to voltage drop across each resistor. At each of the resistors Ohm's Law gives,

$$x_j = v_j/R_j, \qquad j = 1, \ldots, 7. \tag{8}$$

with the matrix-vector form

$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \\ x_6 \\ x_7 \end{bmatrix} = \begin{pmatrix} 1/R_1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1/R_2 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1/R_3 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1/R_4 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1/R_5 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1/R_6 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1/R_7 \end{pmatrix} \begin{pmatrix} v_1 \\ v_2 \\ v_3 \\ v_4 \\ v_5 \\ v_6 \\ v_7 \end{pmatrix}. \tag{9}$$

The above has the matrix equation

$$x = Kv. \tag{10}$$

The matrix K describes the physics of the network. By KCL we get

$$\begin{pmatrix} 1 & 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & -1 \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \\ x_6 \\ x_7 \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}. \tag{11}$$

i.e.

$$D^T x = 0. \tag{12}$$

III. CCS Conduction Delay

A typical electrical conduction through the cardiac muscle takes ananticipated pathway. It travels from the sinoatrial node to the AVN and gets to the *bundle of His*. It then travels to the left and right bundle branches until it eventually terminates in the *Purkinje fibres*. As usual with cardiac electrophysiology, conduction travels from left to right, basically stimulating the left bundle, and left ventricle first. AV nodal blocks may well have an inherent delayed firing or a restriction to firing down the Purkinje system and consequently may cause bradycardias and hypo-perfusion to essential organs. Pathological delay in the conduction pathway is always implicated in bundle branch blocks. Clinical studies posit that patients' underlying aetiology who present with branch blocks may be determined to a high degree [14].

The diseases of the CCS (such as MI, pulmonary HTN, digoxin toxicity, etc.) are often precipitated by conduction delays. In the event of blockage of either bundle branch the electrical impulse travels directly from one cardiac myocyte to the other. The journey takes a much slower process than traveling via the ordinary low-resistance pathways. This pathophysiology prolongs the conduction time through the ventricles, resulting in widening of the QRS complex (¿ 120 m/sec).This QRS complex is the electrical impulse spreading through the ventricles, indicative of ventricular

Ref

14. Restivo A., Haughey M., MD and Chrisina H.D.O: Edited by Julianne Jung, Conduction Abnormalities, *https://www.saem.org/group-electrocardiogram-(ecg)-rhythm-recognition.*

depolarization. A study of CCS impulse delay is essential to clinical intervention. It is not unusual, however that a system could be unstable without delay, and could be stable with some delay. A careful distinction should therefore be made between essential (benign) delay and a pathological delay.

Many conducting bioelectric mediums have distributed resistances, capacitances, batteries, and extends continuously [15], the CCS may well be modelled as a system with distributed impulse delays. As treated in [16], the nodes are current sources and sinks. The main actors of the conduction system are the SAN, AVN, His bundle branches (HBB), Purkinje's fibres together with their conduction paths (edges). Any pathological conduction delay into an i-th node results in delay to subsequent nodes. The question of stabilising such delay by employing clinical intervention as a control input is one that requires attention.

a) Conduction impulse function

We assume a linear the spatial-temporal system under consideration. The CCS transmission is marked by an extremely short duration, and thus, the pulse may be seen to approximate an impulse. True impulse functions may be a wishful thinking in nature. However, its bio-physiological approximation may be found in very high velocity vascular pulse waves, blood vessel spasm, and spasmy muscular tetanisation, not to exclude the CCS in the main. The CCS conduction pathways may, in the limit, be approximated to rectangles. Thus, we conceive of a rectangular pulse function - a *unit pulse* function $\delta_T(t)$, of duration T, which has a constant amplitude $1/T$ over its range:

$$\delta_T(t) = \begin{cases} 0 & \text{for } t \le 0 \\ 1/T & 0 < t \le T \\ 0 & \text{for } t > 0 \end{cases} \tag{13}$$

Take the limit of the unit pulse $\delta_T(t)$ as the duration T approaches zero:

$$\delta(t) = \lim_{T \to 0} \delta_T(t) \quad . \tag{14}$$

The limiting form of many functions may be used to approximate the impulse. Any impulse occurring at some $t = a$is $\delta(t-a)$.

b) Impulse-response causality

Now, consider the continuous-time bio-electrical system (here, the CCS) with input $x(t)$, and the associated response $y(t)$, at a nodal point of interest. We suppose that the system is momentarily at rest, that is all initial conditions are zero at time $t = 0$. This condition corresponds to the resting phase after ionic depolarization.

Let the continuous input function $x(t)$ be approximated by a *staircase* function [23] $\hat{x}(t) \approx x(t)$, consisting of a series of piecewise constant sections each of an arbitrary fixed duration, T, where

$$\hat{x}_T(t) = x(nT) \qquad \text{for} \quad nT \le t \le (n+1)T \qquad \forall n, \tag{15}$$

and thus,

$$x(t) = lim\hat{x}_T(t) \tag{16}$$

The totality of non-overlapping delayed pulses, $p_n(t)$, each of which is with duration T, as represented by the staircase approximation $\hat{x}_T(t)$ is

$$\hat{x}_T(t) = \sum_{-\infty}^{\infty} p_n(t) \tag{17}$$

where

$$p_n(t) = \begin{cases} x(nT) & nT \le t < (n+1)T \\ 0 & \text{elsewhere} \end{cases} . \tag{18}$$

If each component pulse $p_n(t)$ is written in terms of a delayed unit pulse $\delta_T(t)$ we get

$$p_n(t) = x(nT)\delta_T(t - nT)\,T, \tag{19}$$

andtherefore (17) reads:

$$\hat{x}_T(t) = \sum_{n=-\infty}^{\infty} x(nT)\delta_T(t-nT)T \ . \tag{20}$$

Suppose $q_T(t)$ is the system response to the impulse $\delta_T(t)$. For a linear and time-invariant system, the response to a delayed unit pulse, happening at time nT, is tantamount to a delayed form of the pulse response:

$$y_n(t) = q_T(t - nT). \tag{21}$$

The superposition of the sum of the responses to all of the component weighted pulses in (20) is given by

$$\hat{y}_T(t) = \sum_{n=-\infty}^{\infty} x(nT)q_T(t-nT)T \tag{22}$$

For the system being considered the pulse response $qT(t)$ is zero for time $t<0$, and forthcoming input components do not add to the sum. Therefore the upper limit of the summation may read:

$$\hat{y}_T(t) = \sum_{n=-\infty}^{N} x(nT)q_T(t-nT)T \ \text{ for } NT \le t<(N+1)T. \tag{23}$$

The above encodes the system response to the said staircase approximation of the input in terms of the system pulse response $qT(t)$. Let T become very small, and let $nT = \tau$, $T = d\tau$, and take $lim\delta_T(t) = \delta(t)$ as $T \to 0$, then we have :

$$y_T(t) = \lim_{T\to 0} \sum_{n=-\infty}^{N} x(nT)q_T(t-nT)T \tag{24}$$

Equation (24) above yields the convolution or super position integral,

$$\int_{-\infty}^{t} x(\tau)q(t-\tau)d\tau = x(t) \otimes q(t) \tag{25}$$

where $q(t)$ is encodes the system *impulse response,*

$$q(t) = \lim_{T \to 0} q_T(t) \tag{26}$$

Equation (19) shows that the system is totally characterized by its response to the impulse function $\delta(t)$, since the forced response to any arbitrary input $x(t)$ may becomputed from knowledge of the impulse response alone.

Now consider the CCS topology (Fig.1).The SAN-AVN impulse is a parallel arrangement shown in Fig.2 below.

Fig. 2: Schematic of SAN-AVN current (I)and resistors (R) in parallel

The non-delayed impulse response, $q(t)$ of the arrangement within this section of the CCS, with state delay, is

$$q(t) = x(t-\tau) \otimes (q_1(t) + q_2(t) + q_3(t)) \tag{27}$$

The series connection has the response,

$$q(t) = x(t-\tau) \otimes (q_1(t) \otimes q_2(t) \otimes \ldots q_n(t)), \tag{28}$$

and as found along the *His bundle branch* (HBB) that contains R_5 and R_7,

$$q(t)_{HBB} = x(t-\tau) \otimes [q_1(t) \otimes q_2(t)] = [x(t-\tau) \otimes q_1(t)] \otimes q_2(t). \tag{29}$$

c) Conduction delay equation

To begin with, we take a look at the delay systems with multiple point wise incommensurate delay equation given by

$$\dot{x}(t) = A_0 x(t) + \sum_{k=1}^{m} A_k x(t-\tau_k), \quad \tau_{k\geq 0}, \tag{30}$$

where the delays τ_k may possibly be independent of each other. A special case is the system with single delay (viewing all delays as multiples of a single one) is the continuous time-invariant state-space equation of the form

$$\dot{x}(t) = A_0 x(t) + A_1 x(t-\tau), \tag{31}$$

with the initial condition of the form

$$x_t = \varphi, \tag{32}$$

where A_0 is the system matrix and A_1 is the system matrix for the state delay, both of which are given $\mathbb{R}^{m\times n}$ constant matrices; $x \epsilon \mathbb{R}^n$, is the state of the system.

Special note: Matrices arising from applicable systems are largely non-square ($\mathbb{R}^{m\times n}$, $m \neq n$). Those generated and considered here are non-square, except otherwise indicated. Therefore, each matrix here is presupposed Moore-Penrose invertible. Details on Moore-Penrose pseudoinverse of matrices may be found in [17, 18] and in profuse literatures. *The beauty of non-square systems is their less amenability to modelling errors*[19].

We relate equation (31) with the conduction matrix already generate by letting D^{T} (in (12)) = A_0, and A_1 can be obtained from the description of the delay. Let us, painstakingly, construct a prototype of A_1this way: Consider Fig. 1, and assume here that impulse conduction delay is observed from N_3 (corresponding to the *His bundle branch*); the delay has a cascading effect on the spectrum of subsequent nodes and edges. Let

$$A_1 = a_{ij} = \begin{cases} 1 & \text{if } N_i \text{ is a terminal node of } e_j, \text{ with conduction delay} \\ -1 & \text{if } N_i \text{ is an initial node of } e_j, \text{without conduction delay} \\ 0 & \text{otherwise} \end{cases}. \quad (33)$$

We ground$N_3$to get the state delay matrix

$$A_1 = \begin{pmatrix} -1 & -1 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix}. \quad (34)$$

With this, a particular case of, the delay equation (31) takes the form

$$\dot{x}(t) = \begin{pmatrix} 1 & 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 1 & 1 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & -1 \end{pmatrix} x(t) + \begin{pmatrix} -1 & -1 & -1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix} x(t-\tau) \quad (35)$$

Note that A_1 so obtained defines a region where multiple delay is experienced, which includes the considered point of initial delay.

i. *State-transition matrix solution*

Using (31) or (35) we set the following Cauchy problem:

$$\begin{aligned} \dot{x}(t) &= A_0 x(t) + A_1 x(t-\tau) + g(t), \quad t \geq 0 \\ x(t) &= \varphi(t), \quad -\tau \leq t \leq 0, \end{aligned} \quad (36)$$

where $x(t) = (x_1(t), x_2(t), \ldots, x_n)^{T}$is a vector of states of the system, $g(t) = (g_1(t), \ldots, g_n(t))^{T}$is a function that denotes disturbance signal, A_0, A_1 are constant matrices $\tau > 0$ is a constant delay. The state-transition matrix equation, with the ideal disturbance response $g(t) = 0$ (since disturbance acts on controller output), is

$$\dot{X}(t) = AX(t) + AX(t-\tau), \quad t \geq 0 \quad (37)$$

with the initial condition

$$X(t) = I, \quad -\tau \leq t \leq 0, \quad (38)$$

where I is the identity matrix. The solution of (37) with (38) is of the form [28]

$$X_{k+1}(t) = e^{A_0(t-k\tau)} X_k(k\tau) + \int_{k\tau}^{t} e^{A_0(t-s)} A_1(s-\tau) ds, \quad (39)$$

with $X_k(t)$ is defined on the interval $(k-1)\tau \leq t \leq k\tau$, $k = 0, 1, \ldots$

Ref

28. Baštinec J., Piddubna G., Solution of matrix linear delayed system. In XXIX International Colloquium on the Management on the Educational Process aimed at current issues in science, education and creative thinking development. Brno. 2011. p. 51 - 60.

It was shown in [28] that the fundamental solution matrix of equation (37) with identity initial conditions (38) has the form

$$X_0 = \begin{cases} \Phi, & -\infty \le t < -\tau \\ I, & -\tau \le t < 0 \\ e^{A_0 t} + g_1(t), & 0 \le t \le \tau \\ e^{A_0 t} + eA^0(t-\tau) g_1(\tau) + g_2(\tau), & \tau \le t \le 2\tau \\ \dots & \\ \sum_{m=0}^{k-1} e^{A_0(t-m\tau)} g_m(m\tau) + g_k(t), & (k-1)\tau \le t < k \\ & k = 3, 4, \dots \end{cases} \tag{40}$$

where Φ is the zero matrix and

$$g_p(t) = \sum_{\sum i_j = 1}^{p} \prod_{j=p}^{1} \left(\sum_{k_j=0}^{\infty} A_0^{k_j} A_1^{i_j} \right) \frac{(t-(p-1)\tau)^{K(p)}}{K(p)!} \prod_{s=p-1}^{1} \frac{\tau^{(1-i_{s+1})K(s)}}{(1-i_{s+1})!},$$

$$i_p = 1, i_j \in \{0, 1\}.$$

IV. Input Control

In this section we will study the possibility of optimizing a *control* that would keep the transmission of impulse within reasonable physiological window, or mitigate the deleteriousness of pathological time delay. If the control is drug-based, then there is an associated equilibration delay which does not constitute a component of the impulse delay.

Let Z be the state space of an impulsive system and U the set of control functions. Let $u \in U$ be the control function. $z \in Z$: $z = z(z_0, u, t)$ is a vector depicting the state of the system at the instant t, with the initial state $z_0 = z(t_0)$. Let X denote a subspace of Z and $x = x(z_0, u, t)$ be the projection of the state vector $z(z_0, u, t)$ onto X.

Definition 1. The state z_0 is said to be controllable in the class U if there exist such control $u \in U$ and the number T, $t_0 \le T \le \infty$ such that $z(z_0, u, T) = 0$.

If every state $z_0 \in Z$ of an impulsive system is controllable, then the system is said to be controllable.

Consider the Cauchy problem

$$\begin{aligned} &\dot{x}(t) = A_0 x(t) + A_1 x(t-\tau) + Bu(t), \quad t \in [0, T], \quad T < \infty, \\ &x(0) = x_0, \quad x(t) = \varphi(t), \quad -\tau \le t < 0, \end{aligned} \tag{41}$$

where $x = (x_1(t), \dots, x_n(t))^{\mathrm{T}}$ is a vector, $x \in X$, $u(t) = (u_1(t), \dots, u_r(t))^{\mathrm{T}}$ is the control function, $u \in U$. U is the set of piecewise-continuous functions and A_0, A_1, B are constant matrices of appropriate dimensions, $\tau > 0$ is as defined.

The state space Z of this system is the set of n-dimensional functions

$$\{x(\xi), \quad t - \tau \le \xi \le t\}, \tag{42}$$

And the initial state z_0 of the system (41) is determined by conditions

$$z_0 = \{x(\xi) = \varphi(\xi), \quad -\tau \le \xi < 0, \quad x(0) = x_0\}. \tag{43}$$

Ref

28. Baˇstinec J., Piddubna G., Solution of matrix linear delayed system. In XXIX International Colloquium on the Management on the Educational Process aimed at current issues in science, education and creative thinking development. Brno. 2011. p. 51 - 60.

In accordance with (38) the system (41) is controllable if there exists a control $u \in U$ such that $x(t) \equiv 0, T\text{-}\tau \leq t \leq T; T < \infty$.

Lemma1 [see 30] If the linear system with delay (41) is controllable in the interval $\in[(k-1), k\tau]$, then rank $(R_k) = n$, where R_k is the augmented matrix given by

$$R_k = \{B \quad e^{-A_0\tau}A_1B \quad e^{-2A_0\tau}A_1^2B \quad \ldots \quad e^{-(k-1)A_0\tau}A_1^{k-1}B\}. \tag{44}$$

A control may be constructed for the control problem with delay (41). Let Q be an augmented matrix satisfying

$$Q = \{B \quad A_0B \;\; A_1B \;\; A_0^2B \;\; (A_0A_1 + A_1A_0)B \;\; A_1^2B \;\; A_0^3B(A_0^2A_1 + A_0A_1A_0 + A_1A_0^2)B \ldots A_0^{n-1}A_1^pB\} \tag{45}$$

For controllability of the delay system (41) it is sufficient that for $(p-1)\tau \leq t \leq p\tau$, with rank$(Q) = n$ [31].

With the sufficient conditions for controllability employed for:det$(Q) = n$, for $t_1 \geq (k-1)\tau$w here the matrix Q was defined in (45) the control function can takes the form [30]

$$u(\eta) = \left[X_0(t_1 - \tau - \eta)B\right]^T \left[\int_0^{t_1} X_0(t_1 - \tau - \zeta)BB^T\left[X0(_1 - \tau - \zeta)\right]^T d\zeta\right]^{-1} \lambda, \quad 0 \leq \eta \leq t_1$$

where

$$\lambda = x_1 - X_0(t_1)\varphi(-\tau) - \int_{-\tau}^{0} X_0(t_1 - \tau - \zeta)\varphi'(\zeta)d\zeta, \tag{46}$$

And X_0 is the fundamental matrix of solutions (40) on time interval $t \geq (k-1)\tau$.

Consider, for a state feedback control, the linear time-delay system with both state and input delays given by

$$\dot{x}(t) = A_0x(t) + A_1x(t-\tau) + B_0u(t-\tau_1), \quad t \geq t_0, \tag{47}$$

where $u(t)$ is the control input and B_0 is the input matrix and τ_1 is the input delay. The pair A_0, B_0 are assumed controllable. The case with no control input delay is

$$\dot{x}(t) = A_0x(t) + A_1x(t-\tau) + B_0u(t), \quad t \geq t_0, \tag{48}$$

Suppose there exists a bounded Lipschitz continuous function,

$$\mathrm{f} : \square^{\mathrm{n}} \times U \to \square^{\mathrm{n}}, \tag{49}$$

with U as compact subset of $\square^m$, say.

The delay equation (48) maybe put in the form

$$\left.\begin{aligned} \dot{\mathrm{x}}(s) &= \mathrm{f}(\mathrm{x}(s), \mathrm{u}(s)) \qquad (t-\tau < s < t_f) \\ \mathrm{x}(t-\tau) &= \boldsymbol{x} \end{aligned}\right\}, \tag{50}$$

where

$t\text{-}\tau \geq 0$ is a given initial time,

$t_f > 0$ is a fixed terminal time,

$x \in \mathcal{R}^n$ is a prescribed initial point,

$\mathrm{u}(.) \in U$ is the *control*.

$\mathrm{x}(s)$ is the state of the system at time s

Ref
31. GannaPiddubna, Controllability Criterion for Linear Delayed Differential Equation,The Sixth International Workshop on Differential Equations and Applications, September 11-14, 2013

Each solution $x_i(.)$, (i =1, 2, 3,…,n) of (50) evolves at some succeeding time $t_i > t$-σ in the prescribed time interval. For any set of controls $u_i(.)$ (i =1, 2, 3,…,n), the set of permissible controls reads

$$U \square \{u:[t-\sigma, t_f] \to U \,|u(.) \text{ is measurable}\}. \tag{51}$$

Each permissible control has its degree of optimality. Since

$$|f(x,c)| \le C, \quad |f(x,c)-f(y,c)| \le C|x-y| \qquad (x, y \in \square^n, c \in U), \tag{52}$$

for some constant C, then for each control $u(.) \in U$ equation (50) has a unique Lipschitz continuous solution $x(.) = x^{u(.)}(.)$ on the time interval [t-σ, t_f]. The equation (50) may be solved *a.e.* on $t-\sigma < s < t_f$. We seek a control $u^*(.)$, for $x \in \square^n$ and $t-\tau \in (t-\sigma, t_f)$, among all other permissible controls which minimizes the impulse delay (as in our present case) functional

$$G_{x,t-\tau}[u(.)] = \int_{t-\tau}^{t_f} \chi(x(s),u(s))ds + \omega(x(t_f)), \tag{53}$$

where $x(.) = x^{u(.)}(.)$ is the solution of (50) and

$$\chi : \square^n \times U \to \square, \qquad \omega : \square^n \to \square$$

are given functions. From expenditure-based control systems, χ could be considered as the *running cost per unit time* and ωthe *terminal cost*. From the physiological perspective, χ could be seen as the cost of minimizing or mitigating impulse delay per unit time, andωis the terminal effect of mitigating the delay. Any least cost $V(x, t-\tau)$ is such that

$$V(x,t-\tau) = \inf_{u(.)\in U} G_{x,t}[u(.)] \quad (x \in \square^n, \quad t-\tau \in [t-\sigma, t_f]). \tag{54}$$

V. Optimality Criterion

First we state, without proof, the following:

Theorem 1 (Optimal controller (see [32]). Suppose that u(t-τ), t-τ ϵ [t-σ, t_f] minimizes*

$$G[u(.),x,t-\sigma] = \int_{t-\sigma}^{t_f} \chi(x(s),u(s))ds + \omega(x(t_f)), \tag{55}$$

subject to $x^*(t-\sigma) = x$ and $x^*(t-\sigma)$ is the related state trajectory. Let the minimum delay attained by $u^*(t-\tau)$ be:

$$G^*(x,t-\sigma) = \arg \min_{u(\beta),\beta\in[t-\sigma,t_f]} G(u(.),x^*,t-\sigma,t_f). \tag{56}$$

Then, for any t-τ∈[t-σ, t_f], the restriction of $u^*(\beta)$ optimal over the sub-interval [t-τ,t_f] minimizes

$$G[u(.),x(t-\tau),] = \int_{t-\tau}^{t_f} \chi(x(s),u(s))ds + \omega(x(t_f)),$$

subject to the initial condition $x(t-\tau) = x^*(t-\tau)$; u^* is optimal over [t-τ, t_f].

For the purpose of optimality the *value function* $V(x, t\text{-}\tau)$ shall be considered. In what follows, we fix $x\in\mathbb{R}^n$, $t\text{-}\sigma\leq t\text{-}\tau< t_f$

Theorem 2 (Optimality (see Lawrence [33]). For each $\sigma > 0$ sufficiently small that $t-(\tau-\sigma)\leq t_f$,

$$V(\boldsymbol{x},t\text{-}\tau)=\inf_{\mathbf{u}(.)\in U}\int_{t-\tau}^{t-(\tau-\sigma)}\chi[\mathrm{x}(s)+\mathrm{u}(s)]ds+V(\mathrm{x}(t-(\tau-\sigma)),t-(\tau-\sigma))], \tag{57}$$

where $\mathrm{x}(.)=\mathrm{x}^{\mathrm{u}(.)}(.)$ is the solution of (50) for the control $\mathrm{u}(.)$.

Proof. Let $u_1(.)$ be any chosen control. We set an ODE analogous to (50) in the form

$$\left.\begin{aligned}\dot{\mathrm{x}}_1(s)&=\mathrm{f}(\mathrm{x}_1(s),\mathrm{u}_1(s))ds \quad (t-\tau<s<t-(\tau-\sigma))\\ \mathrm{x}_1(t-\tau)&=x.\end{aligned}\right\} \tag{58}$$

For a fixed $\varepsilon > 0$ choose $\mathrm{u}_2(.)\in U$ so that

$$V(\mathrm{x}_1(t-(\tau-\sigma)),t-(\tau-\sigma))+\varepsilon\geq\int_{\tau-(\tau-\sigma)}^{t_f}g(\mathrm{x}_2(s),\mathrm{u}_2(s))ds+\omega(\mathbf{x}_2(t_f)), \tag{59}$$

where

$$\left.\begin{aligned}\dot{\mathrm{x}}_2(s)&=\mathrm{f}(\mathrm{x}_2(s),\mathrm{u}_2(s) \quad (t-(\tau-\sigma)<s<t_f)\\ \mathrm{x}_2(t-(\tau-\sigma))&=\mathrm{x}_1(t-(\tau-\sigma)).\end{aligned}\right\} \tag{60}$$

Describe the control

$$\mathrm{u}_3(s):=\begin{cases}\mathrm{u}_1(s) & \text{if } t-\tau\leq s<t-(\tau-\sigma)\\ \mathrm{u}_2(s) & \text{if } t-(\tau-\sigma)\leq s\leq t_f,\end{cases} \tag{61}$$

and let

$$\left.\begin{aligned}\dot{\mathrm{x}}_3(s)&=\mathrm{f}(\mathrm{x}_2(s),\mathrm{u}_2(s) \quad (t-\tau<s<t_f)\\ \mathrm{x}_3(t-\tau)&=x.\end{aligned}\right\} \tag{62}$$

The uniqueness of solutions of the equation (50) enables us to write

$$\mathrm{x}_3(s)=\begin{cases}\{\mathrm{x}_1(s) & \text{if } t-\tau\leq s\leq t-(\tau-\sigma)\\ \mathrm{x}_2(s) & \text{if } \mathrm{t}-(\tau-\sigma)\leq s\leq t_f\end{cases}. \tag{63}$$

By definition (54) we have

$$\begin{aligned}V(\boldsymbol{x},t-\tau)&\leq G_{x,t-\tau}[\mathrm{u}_3(.)]\\ &=\int_{t-\tau}^{t_f}g(\mathrm{x}_3(s),\mathrm{u}_3(s))ds+\omega(\mathrm{x}_3(t_f))\\ &=\int_{t-\tau}^{t-(\tau-\sigma)}g(\mathrm{x}_1(s),\mathrm{u}_1(s))ds+\int_{t-(\tau-\sigma)}^{t_f}g(\mathrm{x}(s),\mathrm{u}_2(s))ds+\omega(\mathrm{x}(t_f))\\ &\leq\int_{t-\tau}^{t-(\tau-\sigma)}g(\mathrm{x}_{\mathbf{1}}(s),\mathrm{u}_{\mathbf{1}}(s))ds+V(\mathrm{x}_1(t-(\tau-\sigma)),t-(\tau-\sigma))+\varepsilon,\end{aligned} \tag{64}$$

where the last inequality above resultsfrom (59). Since $u_1(.) \in U$ was arbitrarily chosen we infer that

$$V(\boldsymbol{x}, t-\tau) \leq \inf_{u(.)\in U} \left\{ \int_{t-\tau}^{t-(\tau-\sigma)} g(\mathrm{x}(s), \mathrm{u}(s)) ds + V(\mathrm{x}(t-(\tau-\sigma)), t-(\tau-\sigma)) \right\} + \varepsilon . \tag{65}$$

Continuing, choose $u_4(.)$, for a fixed $\varepsilon > 0$, such that

$$V(x, t-\tau) + \varepsilon \geq \int_{t-\tau}^{t_f} g(\mathrm{x}_4(s), \mathrm{u}_4(s)) ds + \omega(\mathrm{x}_4(t_f)), \tag{66}$$

where

$$\left.\begin{aligned} \dot{\mathrm{x}}_4(s) &= \mathrm{f}(\mathrm{x}_4(s), \mathrm{u}_4(s) \quad (t-\tau < s < t_f) \\ \mathrm{x}_4(t-\tau) &= x. \end{aligned}\right\} \tag{67}$$

From (54) we have

$$V(\mathrm{x}_4(t-(\tau-\sigma)), t-(\tau-\sigma)) + \varepsilon \leq \int_{t-(\tau-\sigma)}^{t_f} g(\mathrm{x}_4(s), \mathrm{u}_4(s)) ds + \omega(\mathrm{x}_4(t_f)), \tag{68}$$

and thus

$$V(\boldsymbol{x}, t-\tau) + \varepsilon \geq \inf_{\boldsymbol{u}(.)\in U} \left\{ \int_{t-\tau}^{t-(\tau-\sigma)} g(\mathbf{x}(s), \boldsymbol{u}(s)) ds + V(\mathbf{x}(t-(\tau-\sigma)), t-(\tau-\sigma)) \right\}, \tag{69}$$

noting that $\mathrm{x}(.) = \mathrm{x}^{\mathrm{u}(.)}(.)$ solves (50). Thus, (69) and (65) complete the proof of (57)

a) Multiple Time Delays

Let us return to the case with multiple time delays is described by equation (30)

$$\begin{aligned} \dot{x}(t) &= A_0 x(t) + \sum_{k=1}^{m} A_k x(t-\tau_k), \quad \tau_{k\geq 0} \\ x(t) &= \varphi(t), \ t \in [-\tau, 0], \end{aligned} \tag{70}$$

where $\tau = \max\{\tau_k : k = 1,2,\ldots,m\}$, $A_k \in M^{n\times n}$ are constant matrices. $\varphi(t) \in C([-\tau, 0], \mathbb{R}^n)$. Here $C([-\tau, 0], \mathbb{R}^n)$ represents the Banach space of all piecewise continuous vector-valued functions mapping $[-\tau, 0]$ into $\mathbb{R}^n$. The goal here is to convert the system with multiple time delays to a stable system with single time-delay. When this is done, the multiple time delay case may be handled as a single delay system, as was done in Ordokhani *et al.*[37].

Consider the system (70).Convert the matrices, A_k, k=1,2,..., $m$to diagonal form and subtract γ>0 from each diagonal entry. Pick the matrix with maximum norm and designate it by $M\gamma$ and denote the remaining matrix is by $A\gamma$. Using (70) we have

$$\begin{aligned} \dot{x}(t) &= A_0 x(t) + (M_\gamma + mA_\gamma) x(t-\tau), \quad t \in \mathbb{R}^+ \\ x(t) &= \varphi(t), \quad t \in [-\tau, 0], \end{aligned} \tag{71}$$

where the matrix functions A_0, ($M\gamma$+$mA\gamma$) are constant matrices. The system (71) is the conversion of the system with multiple time delays (70) to a system with single time-delay.

b) Stability criterion

Lemma 2[38] *The system (70) is said to be exponentially stable with decay rate* α, *if there is a function* ζ: $\mathbb{R}^n \to \mathbb{R}^n$ *such that for each* $\varphi(t) \in C([-\tau, 0], \mathbb{R}^n)$ *the solution* $x(t,\varphi)$ *of the system satisfies* $\|x(t,\varphi)\| \leq \zeta(\|A\|)e^{-\alpha t}$, $\forall t \in \mathbb{R}^+$.

Lemma3 [37] System (70) is uniformly asymptotically stable independent of delay if

$$\mu(A_0) + \sum_{k=1}^{m} \|A_k\| < 0. \tag{72}$$

The stability of the system (71) can be seen from the time delay system described by (70). Change the matrices A_k, k=1,2,..., , m, are to diagonal form and subtract $\gamma > 0$ from each diagonal entry. Assume the stability of the system with multiple time delay (70) satisfies (72). Now, transform the system with multiple time delays to a stable system with single time-delay (71). Since

$$\|M_\gamma + mN_\gamma\| \leq \|M_\gamma\| + m\|N_\gamma\| < \|M_{1\gamma}\| + \|M_{2\gamma}\| + \ldots + \|M_{m\gamma}\| + m\|N_\gamma\|, \tag{73}$$

By Theorem 1? we get

$$\mu(A_0) + \|M_\gamma + mN_\gamma\| < \mu(A_0) + \sum_{r=1}^{m} \|A_r\| = \mu(A_0) + \sum_{r=1}^{m} \|M_{r\gamma} + mN_\gamma\| < 0\,. \tag{74}$$

Therefore system (71) is uniformly asymptotically stable independent of delay.

Theorem 3: The system (71) is exponentially stable with decay rate α, *if there exists symmetric and positive-definite matrices* $P > 0$ and $Q > 0$ *such*

$$\begin{pmatrix} -I & \tau e^{\alpha\tau} A^T \\ \tau e^{\alpha\tau} A & -I \end{pmatrix} < 0 \tag{75}$$

$$\begin{pmatrix} \hat{A}^T P + P\hat{A} + \tau Q & \tau e^{\alpha\tau} \hat{A}^T PA \\ \tau e^{\alpha\tau} A^T P\hat{A} & -\tau Q \end{pmatrix} < 0 \tag{76}$$

where $\hat{A} = A_0 + A_1 e^{\alpha\tau}$.

The inequalities (75) and (76) are *linear matrix inequalities* (LMIs). This is in line with the standard Riccati equation

$$PA_0 + A_0^T P + PA_1 Q^{-1} A_1^T P + Q + R = 0 \tag{77}$$

consisting of triple matrices P, Q, R assumed to be positive definite, and where in the present case A_0 and A_1 are Moore-Penrose invertible [18, 19, 20]). Therefore:

Theorem 4: The time-delay system (70, 71) *is asymptotically stable for any* $\alpha \geq 0$ *if there exist matrices* $P > 0$, $Q > 0$ *and* R *such that*

$$\begin{bmatrix} A_0 P + PA_0^T + \alpha Q & A_1 P \\ PA_1^T & -\alpha Q \end{bmatrix} < 0 \tag{78}$$

Let ρ be a positive scalar such that

Ref
38. Ren F., Cao J., "Novel ∝ -stability criterion of linear systems with multiple time delays", J. Comput. Math. Appl. 181, 2006, 282-290.

$$Q = \frac{1}{\rho} A_1^T P A_1 . \tag{79}$$

Then the Riccati equation (77) reduces to the Sylvester equation

$$A_0^T P + P A_0 \frac{1}{\rho} A_1^T P A_1 + \rho A_1 + R = 0 \quad . \tag{80}$$

The sufficient conditions for Riccati Stability is given by the following Lemma:

Lemma 4[26] *Iffor some ρ¿0, the matrix* $M = (A_0 + \frac{\rho}{2} I) \otimes I + I \otimes (A_0 + \frac{\rho}{2} I) + \frac{1}{\rho} A_1 \otimes A_1$ *is Hurwitz, then the pair* (A_0, A_1) *is Riccati stable.*

c) Stabilization of delayed system

Now suppose (as in Theorem 4) that there exists a scalar $\alpha > 0$, and asymmetric matrix P such that

$$\begin{bmatrix} A_0 P + P A_0^T + \alpha P & A_1 P \\ P A_1^T & -\alpha P \end{bmatrix} < 0 \tag{81}$$

for which (70,71) is asymptotically stable [27]. Consider, for stabilization, the linear time-delay system (48)

$$\dot{x}(t) = A_0 x(t) + A_1 x(t-\tau) + B_0 u(t), \quad t \geq t_0, \tag{82}$$

We seek a state feedback controller of the form

$$u(t) = K_0 x(t) + K_1 x(t-\tau) \tag{83}$$

such that the closed loop system

$$\dot{x}(t) = (A_0 + BK_0) x(t) + (A_1 + BK_1) x(t-\tau) \tag{84}$$

is stable independent of delay. Using (81) we have to satisfy

$$\begin{pmatrix} (A_0 + BK_0)P + P(A_0 + BK_0)^T + \alpha P & (A_1 + BK_1)P \\ P((A_1 + BK_1)^T & -\alpha P \end{pmatrix} < 0 . \tag{85}$$

Using the variable transformation

$$V_0 = K_0 P$$
$$V_1 = K_1 P$$

Equation (85) becomes

$$\begin{pmatrix} A_0 P + B V_0 + P A_0^T + V_0^T B^T + \alpha P & A_1 P + B V_1 \\ ((A_1 P + B V_1)^T & -\alpha P \end{pmatrix} < 0 . \tag{85}$$

The knowledge of V_0, V_1 and the other determiners in (85) will supply the computational scheme for the inequality (85).

VI. Discussion and Summary

Delay is obviously triggered in a system by the presence of a time lag between the control action and its stimulus on the system. In the same way, delay occurs in an observable way if substantial measurement processing time is taken into account. The

Ref

27. Keqin G., Vladimir L. K., Jie C., (2013), Stability of Time-Delay Systems, Springer-Verlag

CCS is a sequence of electrical impulse-based cardiac activation. Physiological delays in the CCS are observable during the following events [34]:

(i) The *SAN* produces action potentials which diffuse through the atria via cell-to-cell conduction at a rate of about 0.5 m/sec.

(ii) The AVN slows the impulse conduction considerably to about 0.05 m/sec in order to allow satisfactory time for complete a trial depolarization and contraction.

(iii) The left and right bundle branches transmit impulses at a speedy velocity of about 2 m/sec.

(iv) A trial activation ends within about 0.09 sec after SAN firing. After a delay at the AV node, the septum becomes activated (about 0.16 sec). The entire ventricular mass is activated by about 0.23 sec.

Any further delay arising in any of the conduction times above may be considered a pathological event. Notably, the system may be fraught with multiple delay, depending on the source or aetiology of the delay. Any delay arising from the SAN or AVN is most likely to induce a cascading multiple delay. This work considered delays arising from *His bundle branch* delay. Electrical input delay to the His bundle nodal point has the effect of delayed depolarization of all other surrogates in the conduction grid. This is a case of multiple system delay. A typical example of system delay is the *QT prolongation* in which ventricular repolarisation is delayed. This pathophysiology is observed when the heart muscle takes abnormally long time to recharge between beats. Undue *QT* prolongation is implicated in tachycardias such as *Torsades de Pointes* (TdP) [35, 36], (meaning *twisting of the peaks,* as seen in undulated complexes or twist around an EKG baseline). TdP patients may have a heart rate of 200 to 250 beats/minute as against the physiologic 60 to 100bpm range. Such patients may present with palpitations or syncope [35]. There is the need to assuage pathological delay in the CCS if the culprit cannot be censored. To do this, a critical input control stabilizing measure is put into effect. Here the input control measure by means of therapeutics, preferably by drug regimented delivery is suggested. In the clinical sense, if an initial therapy s_b at time t_0 say, could be successfully regulated to meet therapeutic gains *up to approximately a final time* t_f at which the adverse effect, if any, of the final therapy $s_b(t_f)$ will be ineffectual, then a condition is *controllable*. Put succinctly, a clinical condition is *controllable* if it responds favourably to a target treatment. Such therapies are, in mathematical esoteric, the *input sequence* u_n*, which transfers* $s_b(t_0)$ *to* $s_b(t_f)$ *for some initial and finite time,* t_0 *and* t_f respectively. If the response holds, then the next goal is to seek a control for which it is at optimal. *If the state equation (41) (or the pair [A, B]) is non-controllable then it is pathologically unstable, and therefore defies clinical remedy.*

A notable point of this discussion is the understanding that non-square matrices are rife in application, albeit sparse in relation to the preponderance of square matrices in literature. A judicious use of the singular value decomposition (SVD) ensures that each matrix $A \in \mathbb{R}^{m \times n}$ can be decomposed into $A = U \Sigma V^T$, where $U \in \mathbb{R}^{m \times m}$ and $V \in \mathbb{R}^{n \times n}$ are orthogonal matrices and $\Sigma \in \mathbb{R}^{m \times n}$ is a diagonal matrix with nonnegative entries, which are singular values of A.

We saw that there is a general system response $q(t)$ to any impulse given in(25)

$$\int_{-\infty}^{t} x(\tau) q(t-\tau) d\tau = x(t) \otimes q(t) .$$

Ref
34. Richard E. K.,Normal Impulse Conduction [in Cardiovascular physiology concepts], https://www.cvphysiology.com/Arrhythmias/A003

This response, when considered in the context of the optimal control, in line with the limit of integration, takes the form

$$\int_{t-\tau}^{t-(\tau-\sigma)} x(t-\tau)q(t-\tau)d\tau = x(t)\otimes q(t)$$

But since a positive outcome is desired, the system response may possibly have no time delay; so we have

$$\int_{t-\tau}^{t-(\tau-\sigma)} q(t)x(t-\tau)d\tau = x(t)\otimes q(t)\,.$$

At the His bundle branch (HBB) that contains R_5 and R_7 the quantity $q(t)$, is given by

$$q(t)_{HBB} = x(t-\tau)\otimes[q_1(t)\otimes q_2(t)] = [x(t-\tau)\otimes q_1(t)]\otimes q_2(t)$$

Conflicts of Interest

None.

References Références Referencias

1. Beck, Kevin. Phases of the Cardiac Action Potential, sciencing.com, https://sciencing.com/phases-cardiac-action-potential-6523692.html. 6 September 2019.
2. Petkoski S, Jirsa V.K. 2019, Transmission time delays organize the brain network synchronization, Phil. Trans. R. Soc. A377: 20180132. http://dx.doi.org/10.1098/rsta.2018.0132
3. Harvey A. Swadlow and Stephen G. Waxman, Axonal conduction delays, Scholarpedia, 7(6), 2012,145
4. Catherine E. C. and Masakazu K.N, Axonal delay lines for time measurement in the owl's brainstem, Proc. Nadl. Acad. Sci. Vol. 85, pp. 8311-8315.
5. Nzerem, F.E. and Ugorji H.C,A model of oral and parenteral drug administration with control, General Letters in Mathematics, Vol. 4, No.3 , 2018, pp.120 -130 https://doi.org/10.31559/glm2018.4.3.5
6. H. Jan van Weerd and V. M. Christoffels, The formation and function of the cardiac conduction system, Development 143, 197-210, 2016, doi:10.1242/dev.124883
7. Nzerem F. E. and Ugorji H.C.,Cardiac conduction system: the graph theoretic approach, J. Math. Comput. Sci. 9 (2019), No. 3, 303-326 https://doi.org/10.28919/jmcs/4027
8. Olbrot, A.W.,A sufficiently large time delay in feedback loop must destroy exponential stability of any decay rate. IEEE Trans. Aut.Control29, 1984, 367- 368.
9. Jean-Pierre Richard, Linear time delay systems: Some recent advances and open problems, www.elsevier.com/locate!ifac
10. Junqi Liu, Azwirman G., Dragan O., Hirche S., Study on the effect of time delay on the performance of distributed power grids with networked cooperative control, IFAC Proceedings Volumes, Volume 42, Issue 20, September 2009, 168-
11. Hasan A, Dipankar D. Effects of Time Delays in the Electric Power Grid. 6th International Conference on Critical Infrastructure Protection (ICCIP), Mar 2012, Washington, DC, United States. pp.139-154, 10.1007/978-3-642-35764-0˙11. hal-01483810
12. Wu-Hua C., Wei X. Z.,The Effect of Delayed Impulses on Stability of Impulsive Time-Delay Systems, IFAC Proceedings Volumes, Volume 44, Issue 1, January 2011, pp.6307-6312, https://doi.org/10.3182/20110828-6-IT-1002.02984

13. Saleh Soltan, Dorian Mazauric, Gil Zussman, Cascading failures in power grids analysis and algorithms, e-Energy'14 Proceedings of the 5th international conference on Future energy systems, Pages 195-206
14. Restivo A., Haughey M., MD and Chrisina H.D.O: Edited by Julianne Jung, Conduction Abnormalities, *https://www.saem.org›group-electrocardiogram-(ecg)-rhythm-recognition.*
15. Malmivuo J., and R. Plonsey (1995), Bioelectromagnetism Principles and Applications of Bioelectric and Biomagnetic Fields, Oxford University Press.
16. Nzerem F. E. and Ugorji H. C., Bio-electric potential field and current source distribution about feasible automatic volume conduction system, Commun. Math. Biol. Neurosci. 2019, 2019:32, https://doi.org/10.28919/cmbn/4236
17. R. Penrose, "A generalized inverse for matrices", Proc. Cambridge Philos. Soc. 51(1955), U06-U13.
18. Marek K. and Witold C., On Moore-Penrose pseudoinverse computation for stiffness matrices resulting from higher order approximation, Mathematical problem in engineering, Volume 2019, pp. 1-16 https://doi.org/10.1155/2019/5060397.
19. Vinayambika S. B., Priya S. S., and Thirunavukkarasu I., A comparative Study on control techniques of non-square matrix distillation column, IJCTA, 8(3), 2015, pp. 1129-1136
20. Joshi V.N., A determinant for rectangular matrices, Bull. Austral. Math. Soc., 21 (1 9 8 0), 137-146.
21. J. C. A. Barata1 and M. S. Hussein, The Moore-Penrose Pseudoinverse. A Tutorial Review of the Theory https://arxiv.org/abs/1110.6882v1
22. Samuel Bernard, Sufficient conditions for stability of linear differential equations with distributed delay discrete and continuous dynamical systems–series B, 1(2), may 2001
23. The Dirac Delta Function and Convolution, web.mit.edu › www › Handouts › Convolution
24. E.I. Verriest (2004), "Riccati Stability," in Unsolved problems in mathematical systems and control theory, (V. Blondel and A. Megretski, eds.), Princeton University Press
25. E.I. Verriest, "Robust Stability and Stabilization: From Linear to Nonlinear," Proceedings of the 2nd IFAC Workshop on Linear Time Delay Systems, Ancona, Italy, pp.184-195, (September 2000).
26. Erik I. Verries, Riccati Equations in Delay Systems, pdfs.semanticscholar.org
27. Keqin G., Vladimir L. K., Jie C., (2013), Stability of Time-Delay Systems, Springer-Verlag
28. Baˇstinec J., Piddubna G., Solution of matrix linear delayed system. In XXIX International Colloquium on the Management on the Educational Process aimed at current issues in science, education and creative thinking development. Brno. 2011. p. 51 - 60.
29. Dibl´ık J., Baˇstinec J., Khusainov D., Baˇstincovja A.: Exponential stability and estimation of solutions of linear differential systems of neutral type with constant coefficients. Boundary Value Problems. 2010. 2010(1). Article ID 956121, doi: 10.1155/2010/956121. p.1-20. ISSN 1687-2762.
30. Baˇstinec J.; Piddubna G.: Controllability of stationary linear systems with delay. In 10th International conference APLIMAT. Bratislava, FME STU. 2011. p. 207 - 216. ISBN978-80-89313-51-8.

Notes

31. GannaPiddubna, Controllability Criterion for Linear Delayed Differential Equation,The Sixth International Workshop on Differential Equations and Applications, September 11-14, 2013
32. Linear Quadratic Optimal Control, automatica.dei.unipd.it›utenti›Lab˙Controlli› Chapter 6 LQ Control
33. C.E. Lawrence (1997), Partial Differential Equations, https://klevas.mif.vu.lt /˜algirdas/Evans.pdf
34. Richard E. K.,Normal Impulse Conduction [in Cardiovascular physiology concepts], https://www.cvphysiology.com/Arrhythmias/A003
35. Drug-induced QT prolongation, en.wikipedia.org › wiki › Drug-induced˙ QT˙ prolongation.
36. Dan M. R.,A current understanding of drug-induced QT prolongation and its implications for anticancer therapy Cardiovascular Research, 115(5), 2019, 895–903, https://doi.org/10.1093/cvr/cvz013
37. Ordokhani Y., Taghizadeh E., Behmardi D., Matin Far M., Exponential Stability of Linear Systems with Multiple Time Delays, Mathematical Researches 2(1), 2016, 69-78.
38. Ren F., Cao J., "Novel ∝ -stability criterion of linear systems with multiple time delays", J. Comput. Math. Appl. 181, 2006, 282-290.

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On the Theory of the Varieties Cantor's Many

By E. A. Tsarev & F. F. Mende

Abstract- Theory of sets (varieties) this one of the divisions of mathematics. In it they are studied the general properties sets are determined properties and characteristics, that possess what that general by property. Georg Cantor is considered the father of theory rightfully, which helped Richard Dedikind. The author of theory proposed the new concept of understanding nature of infinity, but the substantiation of theory itself is not entirely correct, which gave birth to logical contradictions both in theory itself and in those following, on its basis. The original form of the theory was later called the naive set theory. The monograph indicated in the list of literature provides a thorough analysis of set theory. At one time, set theory was severely criticized by well-known mathematicians: Henri Poincaré, Leutzen Weil and Hermann Weil, and even Cantor Richard Dedekind's associate.

They asserted that to Cantor all put outting themselves of mathematics, considered urgent infinity not scientific concept and this was error. Scientific disputes apropos of naive set theory it does not cease up to now. In the article possible inaccuracies and even errors in the theory of Cantor's varieties are examined.

Keywords: *set, power, interval, length.*

GJSFR-F Classification: *MSC 2010: 03C13*

Strictly as per the compliance and regulations of:

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I. Introduction

Cantor, after continuing the transactions of Riemann in the works on the theory of trigonometric series, understood, that one should be determined with points and many afore-mentioned, with sizes and quantity. After interesting in power and their comparisons, in 1873 the year Cantor reveals the denumer ability of the sets of rational numbers, but cannot solve a question about the equal power of integers. The first results, obtained by Cantor, were accepted favorably by Dedikind and Weierstrass and in the period 1879-1884 of year were published six articles in Mathematische Annalen.

Foggily formulated concept set in the naive theory, that was being rested only on the sign of the collection of all objects according to any properties, it provoked to the detection of a series of contradictions, namely paradox To Burali-Forti, the discrepancy of universe, Russell's paradox, the paradox of Richard, Berry's paradox, the Grellinga-Nelson paradox. The attempts to solve privately these paradoxes led to the creation of new direction in mathematics - of intuitionism and formalization of set theory by means of the selection of axioms. On this worked as Zermelo, Gilbert, Bernays , Hausdorff, Brouwer, Poincare, Lebesgue, Borel, by Weyl. Nevertheless, the general principle of permission contradictions (fundamental errors in the basis of theory) so they did not find.

II. General Concepts

This is set mathematical object , most being been collection, totality, meeting of any objects, which are called elements of this set and possess general for all their characteristic property.

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Point- this is the abstract object, which does not have the measuring characteristics: neither height nor length nor radius.

Line is area and volume are divided to the points, but they do not individually have the identical properties (characteristics).

Therefore the determination of set relates only to the inverse sets.

Reversed set is - this set, the sum of elements of which is equal to the base of set.

Not reversed (associated) set is - this set, the sum of elements of which is not equal to the base of set.

For example, section (base of set), divided in the infinitely small sections (elements of set). All sections have one property- length. Set is reversed. The points are located between the sections, they in this case are the boundaries between the sections. And it is possible to define the set of these points as the sum of end-points, but this sum does not have a property of length, i.e., set is not reversed relative to section.

That is the base of set, which can be divided to the elements of set.

Base can be finite and infinite, fixed and not fixed.

For example, the set of integers infinite value, many infinitely small sections in the sum of those giving the section of finite quantity, certainly (length of base it is final).

Simple set is this set, which they consist of the uniform elements (elements with the identical characteristics).

Complex set consists of certain quantity of simple.

It does not change during division and multiplication of infinite set (set with an infinite quantity of elements) by the finite number, the cardinal number of set, and also it does not change, if we add a final quantity of elements or to take away.

Variety (Cantor) synonym is set (conventional).

The cardinal number of set this is value (order) of infinity.

Finite sets, i.e., calculating possess the zero power (value of infinity).

Many one order (power) these are those sets, which are more either less into a final quantity of times or less or more to the finite quantity and with the division for each other result will be the finite number.

Identical power, these are those power, with division of which into each other, result one on the module.

Those sets, which less or more into an infinite quantity of times are the sets of different value.

But if power are more or less to the infinite value, then for determining the relationship of the amounts of power additional mathematical operations require.

Addition, what or finite numbers as both subtraction and multiplication by the finite numbers do not change the order of finite sets, with exception of multiplication by zero.

Division on any the finite number except zero does not change the order of finite set.

The same is correct for the sets of other power.

The indeterminate sets these are those sets, in which it cannot be determined power, in particular because of the absence of properties, according to which it is possible to determine power.

Without the comparison of the elements of a set and their quantity it cannot be compared and power.

Infinitesimal quanitiies are positive and are negative - this of value, the value (module) of one of the parameters which the aim is zero.

Notes

Simple sets this of the sets, in which all elements are characterized by the identical properties (identical property).
Complex sets this of set, that consist of their several simple sets.

III. Procedures of Determination and Comparison of the Cardinal Numbers (Quantity of Elements) of the Sets

Notes

For the fact that to determine and to compare a quantity of elements of different sets, is required to determine the order of tendency toward infinity through the formulas, expressed algebraically.

Interval widely adapts, i.e., the fixed value of anything and can be used both the basis and as element of set.

For example, it is necessary to compare the set of integers and fractional. Both and other set can be represented as the sum of intervals. We take the interval between zero and one (0,1) - in that case interval and the base of subset, and element of set. A quantity of integers is equal to two, a quantity of fractional of infinity. Hence it follows that the cardinal number of the set of the fractions is more than of integers.

Interval it is possible to use and as an element. For example, how are compared two sections? Lengthwise measure (standard) and to a quantity of measures in the section. The simplest version this when the length of measure one for both compared sections and then it is compared with respect to a quantity and if a quantity is equal, then the lengths of sections are identical. However, in the cases when standard different are compared the works of the lengths of standards to a quantity.

This procedure is applicable for those cases, when the lengths of sections by means of the comparison of the cardinal numbers of the set of points of those belonging to the specific sections compare. It is taken the interval (linear interval) (a,b) of infinitely small length (standard) and sections are divided into this interval.

$$M(L) = L/(a,b),$$

where $M(L)$ a quantity of points in the section L, length of which (a,b) interval.

Then a quantity of sections is compared and the conclusion about equality or inequality is done from this.

Sizes are compared with respect to two parameters - lengthwise of interval and quantity of intervals themselves, mentally applied to the measured objects, correspondingly, size this to the work of interval to the quantity.

$$L = (a,b) \times M(L),$$

where L the length of section, $M(L)$ a quantity of points on section (a,b) interval.

With the comparison of identical sections, are obtained the identical sets of points (associating of set). With the comparison of the sections, whose length is more or less into a final quantity of times of the cardinal number of the sets of points of one order.

IV. Comparison of the Cardinal Number of the Sets of the Elements of the Components the Space

Let us take the elements of the space: point, line, plane, volume.

It follows from that state aboved that a quantity of points on the line is infinite, nevertheless, there is a formula, making it possible to determine the relativity of power

in the cases not of arbitrary taking for the basis of a quantity of points. So it follows that the cardinal number of the sets in the section of one order for the sections of finite length.

Plane can be represented as the set of infinitely small areas, which are divided by lines. In that case the set of the lines, which divide plane into the set of elements of set, it will also be irreversible (associating). Each line consists of the infinite set accordingly, plane consists so of an infinite quantity of points, but the cardinal number of this irreversible set is more than the cardinal number of the set on the line.

Volume is divided by planes to an infinite quantity infinite small volumes, respectively in such cases:

1. Many planes are not reversed (associating).
2. The point set in the final volume possesses larger power than the point set on the final plane and in the final section.
3. The cardinal number of the set of lines in the final volume is more than on the final plane.

V. Cantor's Errors

Main error of Cantor, which involved certain quantity of insoluble paradoxes - this taking for the basis of an arbitrary quantity of points. Because an arbitrary quantity is this uncertainty.

"As it will be shown in our study, the elements of n- multiple of that extended continuous variety it will be possible to unambiguously and fully determine even with the aid of the one- only real continuous coordinate t". (end of quotation, p. 24) [1].

The main thing was be defined, what to compare as to compare and for which this to make.

For guaranteeing the continuity to not logically use the arbitrary sizes of elements of set this leads to the uncertainties and because of this to the insoluble paradoxes.

We will use the procedure of checking results in mathematics. i.e., let us conduct operations with the reverse actions. That to obtain, for example the infinite set from the line it is necessary to divide line from some parameter after obtaining the element of set, which they will be the infinitesimal quanitiy (there are no different versions). For the checking should be multiplied or added the elements of set, in addition from the specific parameter. In our case the infinite sum of the elements of infinitesimal quanitiy. If the orders of infinity of sum and elements are not determined, then as a result is obtained uncertainty, which contradicts the finite quantity of the length of section.

In the dry residue it is it turns out that necessary two parameters - the specific values of infinity of sum and elements, and not one, as the author asserts.

"Hence then it follows that if we about the nature of correspondence make no assumptions, then the number of independent continuous real coordinates, which require for the single-valued and total determination of the elements of the n- multiply extensive continuous variety, can be taken by arbitrary, but it means, it cannot be considered as the constant sign of the assigned variety." (end of quotation, p. 24) [1].

It is not possible to take the number of independent continuous coordinates by arbitrary, because contradiction is obtained.

"It turned out that to the presented by me question about that, is it possible continuous variety I measurements to unambiguously and fully reflect to the continuous variety only one measurement, so that to each element of one of them corresponds one

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and *only* one element of another, it is necessary to answer affirmatively." (end of quotation, p. 24) [1]. It is incorrect assumption.

"Therefore, using the expression introduced above, we can say that the power of any continuous n- multiply extensive means *is equal* to the thickness of the once extensive continuous variety of the, for example, limited continuous section of straight line." (end of quotation, p. 25) [1].

This assertion is not correct, since. power are not equal.

The author so was not dismantled with the following questions.

What such is point? What dimensions of point in the different regularities? Procedure of the determination of a quantity of points? Cardinal number of sets?

"If two well-defined varieties M N can be unambiguously and fully elementwise compared with each other (which is always possible and by many other methods, if this is made any), then it is further convenient to indicate that these varieties have equal power or that they are equivalent". (end of quotation, p. 22) [1].

For this exactly is suitable the procedure, described by me above, however, the author allows procedure with one coordinate (parameter).

"Thus, continuous surface can be unambiguously and fully reflected to the continuous line; it is also correct for continuous bodies and continuous means of any number of measurements." (end of quotation, p. 24) [1].

So cannot be acted, since the cardinal numbers of sets are different.

"Therefore, using the expression introduced above, we can say that the power of any n- multiply of that extended means *it is equal* to the power of the once extensive continuous variety, for example the limited section of straight line." (end of quotation, p. 24-25) [1].

Here also power are not equal.

"When the varieties in question are final, i.e. they consist of the finite number of elements, as can easily be seen, the concept of power corresponds to the concept of number, and, therefore, to the concept positive integer number, since in two such varieties power are equal then only then, when the number of their elements it is identical." (end of quotation, p. 22) [1].

Power in finite sets zero, in the infinitely large sets their power are determined by approach speed to infinity, not by number, i.e., if two sets are compared, then not the infinite difference in the number has values.

"If M it is the variety of the power of the sequence positive integer numbers, that each infinitely component M has the same power as M.¸ (end of quotation, p. 23) [1].

Assertion is incorrect, since. power in the infinitely small part M it will be less than u M.

"If, M', M'', M''' ... - the finite or simply infinite sequence of the varieties, each of which has a power of the sequence positive integer numbers, then the variety M, obtained from the association M', M'', M''' has the same power." (end of quotation, p. 23) [1].

In this assertion also there is an error. During the addition of the finite number of varieties (sets) the obtained set there will be the same power, during the addition of the infinite number of varieties (sets) the obtained set there will be larger power. Here the author contradicts himself, earlier it asserted that the infinite large set has the large power, than final.

Ref

1. Георг Кантор. Труды по теории множеств. Москва, Наука, 1985.

VI. Conclusion

From the aforesaid it is possible to make the conclusion that some conclusions, conducted by Cantor, are erroneous because of the incorrect systematic approach. In the article is carried out the analysis on the basis of the existing knowledge and the existing contradictions in the very theory of Cantor and subsequent theories on this basis. The approach regarding the elements of sets examined makes it possible to solve the significant number of contradictions both in the very theory of Cantor and the subsequent theories on this basis.

Notes

References Références Referencias

1. Георг Кантор. Труды по теории множеств. Москва, Наука, 1985.

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Problems and Prospects for Girls' Primary Education in the Char Area: An Observational Study of the School Managing Committee Members

By Dr. Prosannajid Sarkar, Mst. Anowary Parvin, Md. Rafiqul Islam & Supti Ray

Begum Rokeya University

Abstract- In this study, data related to the physical activities of the primary elementary school of the area, teaching methods, use of educational materials, library, toilets, teacher-student boundary wall etc were collect. Data were collected through direct interviews with the respondents in the light of the questionnaire. The results are presented by applying different statistical methods in processing and analyzing the data collected for the study. Data were collected separately from schools of different grades (A and B). As a result, there is an opportunity to analyze the data of government primary schools in different grades of grades separately. In order to carry out the research work, eight government primary schools were selected out of 16 schools in different char area of Gangachara Upazila under Rangpur district administrative areas. Of them, 4 were selected from Lohani char, 3 from Binabina char and 1 from Mutukpur char. The data were collected from selected 8 government primary school teacher were selected 16 primary teachers by using snowball sampling technique. The results showed that the physical infrastructure of the government primary schools in the char area is underprivileged. No separate modern facilities for girl students have been added to government primary schools in the char area. The required number of female teachers was not recruited in the government primary schools in the char area. Not all the combined efforts and initiatives of primary education of girl students were seen in the government primary schools of the Char region. The government primary schools in the Char region have not yet been converted into a sanctuary for female students, considering the overall aspect.

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Dr. Prosannajid Sarkar [α], Mst. Anowary Parvin [σ], Md. Rafiqul Islam [ρ] & Supti Ray [ω]

Abstract - In this study, data related to the physical activities of the primary elementary school of the area, teaching methods, use of educational materials, library, toilets, teacher-student boundary wall etc were collect. Data were collected through direct interviews with the respondents in the light of the questionnaire. The results are presented by applying different statistical methods in processing and analyzing the data collected for the study. Data were collected separately from schools of different grades (A and B). As a result, there is an opportunity to analyze the data of government primary schools in different grades of grades separately. In order to carry out the research work, eight government primary schools were selected out of 16 schools in different char area of Gangachara Upazila under Rangpur district administrative areas. Of them, 4 were selected from Lohani char, 3 from Binabina char and 1 from Mutukpur char. The data were collected from selected 8 government primary school teacher were selected 16 primary teachers by using snowball sampling technique. The results showed that the physical infrastructure of the government primary schools in the char area is underprivileged. No separate modern facilities for girl students have been added to government primary schools in the char area. The required number of female teachers was not recruited in the government primary schools in the char area. Not all the combined efforts and initiatives of primary education of girl students were seen in the government primary schools of the Char region. The government primary schools in the Char region have not yet been converted into a sanctuary for female students, considering the overall aspect.

I. Background of the Study

Education helps people become real man. Man gives Humanity; he gives skill to develop production. Education gives persons courage and tactics to counter social evils and makes them cultural. That is why the right to education is human and that right is universal. Although the scheme of education is planned for everyone in fact, all citizens of the country have no right to education. Poor laborers and their children are not entitled to education. However, without an education, the development of a nation cannot be imagined. There is no way other than education if a nation is steadily on the path of improvement and reaching its peak. However, the most important for national development is quality education. This quality elementary education is essential for the nation's future formation and development. Primary education is the basis of the

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education system. For this reason, primary education was made unpaid and compulsory in the year 1992 and the government took various encouraging steps for primary students, including centenary scholarships and mid-day mills. On the other hand, foreign organizations, including various organizations, are carrying out various activities to bring the country's education to the doorstep of every human being. The role of primary education is immense in all the socio-economic and national development of this country. Nevertheless, even after taking so many initiatives, the basic education in this country is still facing many problems. Especially girls are different based on the area of children. Identifying the problems of remote areas of the country, including the char area, by acting appropriately, by providing state facilities at the primary education level and maximizing the allocation, it is possible to expand the primary education and ideally practiced primary education is essential so that the children are the wealth of the country. Through primary education, children will become wealth of the country and will change the nation and country. Therefore, the country and nation can never be changed except the education of the backward-chartered area. On the other hand, every primary school has a school management committee. Most of the members of the School Management Committee were unaware of the responsibilities and duties assigned to them. They has to supervise the activities in a variety of ways, including school teaching. If all the students of the schools of the area have problems in different ways, then the school management committee has to solve and play an important role in the promotion of the elementary education of the area. As a result, the opinion of the members of the Primary School Management Committee on the issues and causes of girls' primary education in the char area is very important.

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II. Problems of the Study

Bangladesh is one of the most populous countries in the world. Due to the increasing land crisis and river breakdown of the population, the people of this country have been trying to make livelihoods for long time by settling in pastures to settle the housing crisis. Residents of char area spend most of their time struggling to survive in adverse weather conditions and disaster in the nature of the lands. The quality of life of people in the char area is very low. Child labor is a common occurrence in the char area. The man of char area themselves, as laborers, employ their children as their assistants, in the name of acquiring their professional skills before they become old. Moreover, the lack of schooling, transportation problems, various constraints of education administration due to lack of appropriate activities due to lack of proper activities impedes the speed of primary education in the char area. This problem is more pronounced in the case of daughters' children. The feminist aspect deprives the children of the education of the girls of the char area, and in addition to the family discrimination, including the marriage of the Children; the children who are able to go to primary school in the char area have to live. Due to the many adverse circumstances of the school, daughter children have to be educated in primary education. Which interrupted for implementation of compulsory primary education. On the other hand, the implementation of national women's development policies, including international ones, is a difficulty.

III. Rational of the Study

Primary education is the foundation of all education. If the foundation is weak, build such high buildings cann't. Likewise, it is important to strengthen the foundation of the early soft-minded children, especially the daughters. If girls and children are left

behind in primary education, the country will be left behind as an educated nation. Currently the need for women's education in Bangladesh is unlimited. At present, the female literacy rate in the region is 30 percent. The present study has the rationale for bringing about the companionship of female students who are left behind in the char area. Find out what kind of problems and possibilities are there for the girl students of char area to fall behind in primary education. On the other hand, a retrospective study based on the opinion of school managing committee members of the real problems of girls in the char area for the sake of retreat.

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IV. Objectives of the Study

i. To identify the problems and perspects of girls in the char area in primary education based on the views of the school managing committee members.
ii. To assess the religious and social barriers in the education of the children of the girls of the char area.
iii. To provide important recommendations for future planning for improving the primary education activities of the girls of the area.

V. Related Literature Review

Prior research and literature review is very important in any one study. The subject of research that the researcher has to review related research and literature before choosing. According to the researchers, no research has been published on the Internet or national books directly related to issues related to the primary education of the children of the region of char and the subject of doing research. In this regard, the research work is completely new. However, the principal researcher in connection with this study conducted an observational study based on the perception of school teachers' on the issues and causes of girls' primary education in the char area.

VI. Methods and Methodology

The survey method followed in carrying out the research work. In this study, data related to the physical activities of the primary elementary school of the region, teaching methods, use of educational materials, library, toilets, teacher-student boundary wall etc. were collected. Data also collected from direct interviews with the SMC members in the light of the questionnaire. The results presented by applying different statistical methods in processing and analyzing the data collected for the study. Data were collected separately from schools of different grades (A and B). As a result, there is an opportunity to analyze the data of government primary schools in different grades of grades separately.

VII. Sample Selection of Research

Generally, the number of educational institutes in the char area is short. In order to carry out the research work, eight government primary schools were selected out of 16 schools in different char area of Gangachara Upazila under Rangpur district administrative areas. Of them, 4 were selected from Lohani char, 3 from Binabina char and 1 from Mutukpur char. The data were collected from selected 8 government primary school SMC members were selected 80 SMC members by using snowball sampling technique.

VIII. Results and Discussions

An analysis of the data and data obtained from the study on the issues and reasons for primary education of girls of the char area.

a) School Manageing Committee (SMC) meeting

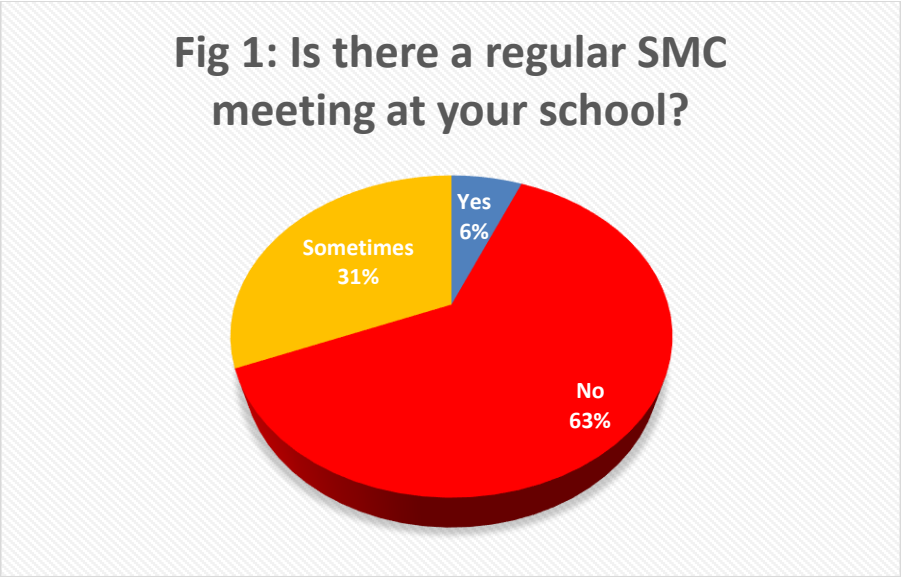

Fig. 1: Is there a regular School Manageing Committee (SMC) meeting at your char area school?

The statistics for the answer to this question are shown in the above pie chart in Fig-1 and it represented that 63 percent of char area primary schools does not do school manageing committee meetings regularly.

b) Attend SMC meetings

Table 1: Are School Manageing Committee (SMC) member attend meetings regularly?

Regular	Irregular	Is sometimes
5 (6.25)	55 (68.75)	20 (25.00)

The answer to this question is shown through the Table 1. The study exposed that 68.75 percent school manageing committee members of char area does not attend meeting regularly only 6 percent attend meetings regularly.

c) Textbook-related educational materials

Table 2: Does your school have textbook-related educational materials?

Neither	There are rough
55 (68.75)	25 (31.25)

The indicators for the answer to this question are shown in the Table 2 displayed that about 69 percent of char area schools do not have textbook related educational materials for girl students.

Notes

d) Sparate Religious prayers rooms for girl students.

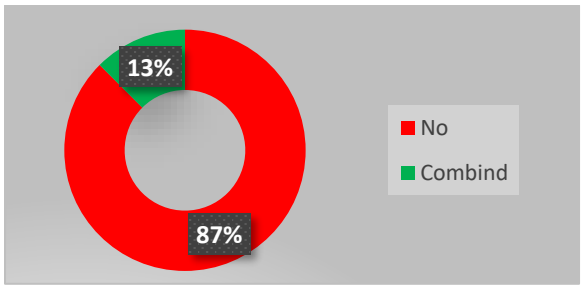

Fig. 2: Are there any rooms for separate religious prayers for girl students?

The statistics for the answer to this question are shown in the doughnut chart in figure 2 and illuastrated that 87 of schools of char area have no separate religious prayer room for girl students. There are 13 percent combind prayer room.

e) Presence of female students at char area school.

Table 3: How is the presence of female students at your school?

Good	Not good	Satisfactory
10 (12.50)	50 (62.50)	20 (25.00)

Table 3 indicated that about 63 percent of girls do not attend school well.

f) Employed as garment workers

Table 4: Is girl students of char area school engaged in garment works?

Employed as garment worker	Number (Percentage)
Being	25 (31.50)
Not being	15 (18.75)
Being rough	40 (50.00)

The answer to this question is shown through the Table 4. The study showed that 50 percent of girl students at char area school are engaged in garment works as a garments worker.

g) Increase the attendance of female students

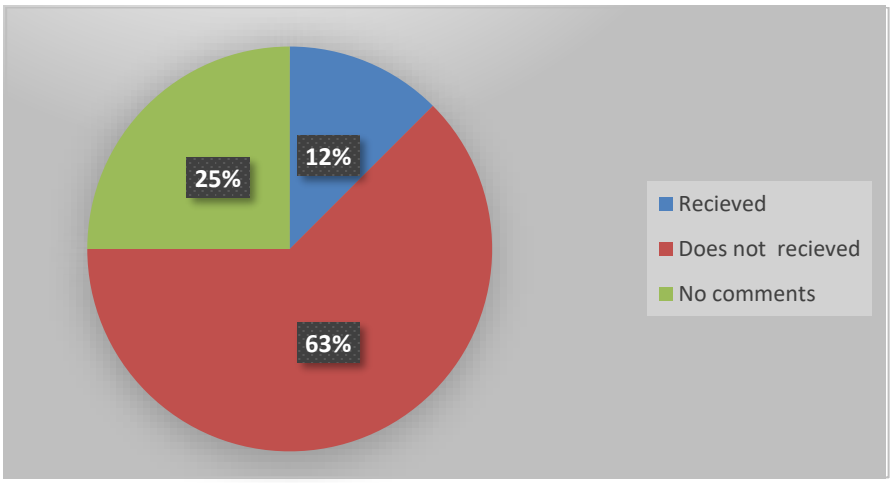

Fig. 3: Do your teachers accept your advice to increase the attendance of female students?

The answer to this question is shown through the doughnut chart in figure 3. The study illuastrated that 63 percent teachers do not accept the advice of the members of the SMC to increase the attendance of the girl students in the char area school.

h) Steps for the presence of a longtime absent girl student

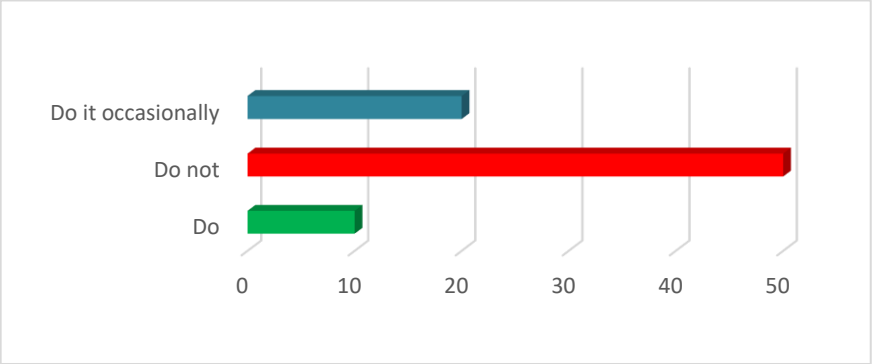

Fig. 4: Have you taken any steps for the presence of a longtime student who is absent from school?

The answer to this question is shown through the Clustered Bar in figure 4. The study showed that fifty (63 percent) of girl students in eighty do not take any action to attend her if she is absent from school for a long time.

i) Initiative to improvement the primary education

Table 5: Have you taken any initiative to improvement the primary education of your daughter students?

Have taken initiative	Did not take the initiative	Try to take initiative
40 (25.00)	35 (43.75)	25 (31.25)

The answer to this question is shown through the Table 5 and it displayed that 43.75 percent of the girl's students do not take any initiative for the development of primary education.

j) Prevention of early marriage of girl students

Table 6: Do you oppose the prevention of early marriage of girl students?

Do	Don't do	Inform the administration
15 (18.75)	55 (68.75)	10 (12.50)

The answer to this question is shown through the pie diagram and the above Table 5 revealed that about 69 percent of girls do not object to preventing child marriages.

Notes

k) Taken any measures to stop the disruption of the girls' travel

Table 6: Have you taken any measures to stop the disruption of the girls' travel to school?

Have taken any measures to stop the disruption of the girls' travel to school	Number (Percentage)
Did	15 (18.75%)
Did not do	40 (50.00%)
Socially aware	25 (31.25)

The answer to this question is shown through the Table 6 and it revealed that 50 percent of the girls did not take any measures to stop the disruption of the students to school.

IX. Conclusion and Recommendations

The study not only examined the problems and causes of primary education of the girls of the government primary schools in the char area but also highlighted the overall condition of the girls in all primary schools of the country. The study shows that there is no room for separate religious prayers for girl students at the school in 87 percent of the area. Although there are religious rooms, it is prayed by both boys and girls. The presence of girl students is not good in 62.5 percent of schools in char area. About 50 percent of their female students are employed as garment workers. The study also shows that most (63 percent) schools in the char area do not hold regular school management committee meetings and about 69 percent SMC members do not attend their meetings regularly. They do not know the responsibility assigned to the members of the school's managing committee of schools in the char area. About 63 percent of girls do not take any action to attend the school if they are absent for a long time at school. Members of the school's managing committee of schools in the char area do not oppose child marriage by about 69 percent of girls.

In this regard, the members of the school managing committee play no role. The members of the school managing committee of the char area did not take any action to stop the disruption of 50 poercent of the girl students in their schools. This is one of the special reasons for the girls to have a storm. About 69 percent of char area schools do not have any textbook-related educational materials for girl's students.

The members of the school managing committee of the char area do not take any initiative to improve the quality of primary education for girls students in the about 44 percent school. The study also shows that in 63 percent of char area primary schools, SMC members do not take any initiative to increase the attendance of girl students. The physical infrastructure of the government primary schools in the char area is weak and no modern facilities have been developed for the girl students so it needs to be upgraded. For the equality of men, the required number of female teachers should be appointed in the government primary schools of the char area. The school should be equipped with materials that attract the girl child and maintain a friendly relationship with the student and teacher. The authorities should take immediate steps to remove any difficulty, fearing that the school may be in the midst of a girl child. Considering the holistic aspects of all, the concerted efforts and initiatives of all girls, including the girls' education, can be transformed into a timely proper education. Finally, by analyzing the results, it can be said that overall, each student will remain in a

spontaneous position in the school and every student will be surrounded by his or her classmates' education and have a dream for their future. In order to make that dream a reality, every person living in the society today should give priority to the education where the light is spread. The innocent child should be given the maximum opportunity to smooth the path of growth. This requires the development of appropriate schools in the char area. All children must be made school-oriented to ensure quality basic education. Parents, including SMC members, must be aware of the importance of primary education. This importance is especially widespread, especially for children of daughters. Our country and nation will be educated if the daughter children and future mothers are educated.

Notes

References Références Referencias

1. Dr. Sarkar et al. (2020). Problems and Doings of Elementary Education for Girls in the Char Region: An Observational Study from the Teacher's Perspective. Global Journal of Human-Social Science: H Interdisciplinary. Volume 20 Issue 1. Version 1.0 Year 2020. International Research Journal Publisher: Global Journals Online ISSN: 2249-460x & Print ISSN: 0975-587X.

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The primary objective is to recognize the leaders in research and scientific fields of the current era with a global perspective and to create a channel between them and other researchers for better exposure and knowledge sharing. Members are most eminent scientists, engineers, and technologists from all across the world. Associate membership can later be promoted to Fellow Membership. Associates are elected for life through a peer review process on the basis of excellence in the respective domain. There is no limit on the number of new nominations made in any year. Each year, the Open Association of Research Society elect up to 12 new Associate Members.

Benefit

To the institution

Get letter of appreciation

Global Journals sends a letter of appreciation of author to the Dean or CEO of the University or Company of which author is a part, signed by editor in chief or chief author.

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Career | Credibility | Exclusive | Reputation

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Financial

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Organize seminar/conference

Associates are authorized to organize symposium/seminar/conference on behalf of Global Journal Incorporation (USA). They can also participate in the same organized by another institution as representative of Global Journal. In both the cases, it is mandatory for him to discuss with us and obtain our consent. Additionally, they get free research conferences (and others) alerts.

Career | Credibility | Financial

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Exclusive | Financial

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Associate members are eligible to join as a paid peer reviewer at Global Journals Incorporation (USA) and can get a remuneration of 15% of author fees, taken from the author of a respective paper.

Financial

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All members get access to 2 selected scientific museums and observatories across the globe. All researches published with Global Journals will be kept under deep archival facilities across regions for future protections and disaster recovery. They get 5 GB free secure cloud access for storing research files.

Associate	Fellow	Research Group	Basic
$4800 **lifetime designation**	$6800 **lifetime designation**	$12500.00 **organizational**	APC **per article**
Certificate, LoR and Momento **2** discounted publishing/year **Gradation** of Research **10** research contacts/day **1 GB** Cloud Storage **GJ** Community Access	**Certificate,** LoR and Momento **Unlimited** discounted publishing/year **Gradation** of Research **Unlimited** research contacts/day **5 GB** Cloud Storage **Online Presense** Assistance **GJ** Community Access	**Certificates,** LoRs and Momentos **Unlimited** free publishing/year **Gradation** of Research **Unlimited** research contacts/day **Unlimited** Cloud Storage **Online Presense** Assistance **GJ** Community Access	**GJ** Community Access

Preferred Author Guidelines

We accept the manuscript submissions in any standard (generic) format.

We typeset manuscripts using advanced typesetting tools like Adobe In Design, CorelDraw, TeXnicCenter, and TeXStudio. We usually recommend authors submit their research using any standard format they are comfortable with, and let Global Journals do the rest.

Alternatively, you can download our basic template from https://globaljournals.org/Template.zip

Authors should submit their complete paper/article, including text illustrations, graphics, conclusions, artwork, and tables. Authors who are not able to submit manuscript using the form above can email the manuscript department at submit@globaljournals.org or get in touch with chiefeditor@globaljournals.org if they wish to send the abstract before submission.

Before and during Submission

Authors must ensure the information provided during the submission of a paper is authentic. Please go through the following checklist before submitting:

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2. Authors must accept the privacy policy, terms, and conditions of Global Journals.
3. Ensure corresponding author's email address and postal address are accurate and reachable.
4. Manuscript to be submitted must include keywords, an abstract, a paper title, co-author(s') names and details (email address, name, phone number, and institution), figures and illustrations in vector format including appropriate captions, tables, including titles and footnotes, a conclusion, results, acknowledgments and references.
5. Authors should submit paper in a ZIP archive if any supplementary files are required along with the paper.
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7. Manuscript submitted *must not have been submitted or published elsewhere* and all authors must be aware of the submission.

Declaration of Conflicts of Interest

It is required for authors to declare all financial, institutional, and personal relationships with other individuals and organizations that could influence (bias) their research.

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Plagiarism is not acceptable in Global Journals submissions at all.

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Authors are solely responsible for all the plagiarism that is found. The author must not fabricate, falsify or plagiarize existing research data. The following, if copied, will be considered plagiarism:

- Words (language)
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- Printed material
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2. Drafting the paper and revising it critically regarding important academic content.
3. Final approval of the version of the paper to be published.

Changes in Authorship

The corresponding author should mention the name and complete details of all co-authors during submission and in manuscript. We support addition, rearrangement, manipulation, and deletions in authors list till the early view publication of the journal. We expect that corresponding author will notify all co-authors of submission. We follow COPE guidelines for changes in authorship.

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Unless specified in the notification, the Editorial Board's decision on publication of the paper is final and cannot be appealed before making the major change in the manuscript.

Acknowledgments

Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

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Global Journals is in partnership with various universities, laboratories, and other institutions worldwide in the research domain. Authors are requested to disclose their source of funding during every stage of their research, such as making analysis, performing laboratory operations, computing data, and using institutional resources, from writing an article to its submission. This will also help authors to get reimbursements by requesting an open access publication letter from Global Journals and submitting to the respective funding source.

Preparing your Manuscript

Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.

Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11'", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

a) A title which should be relevant to the theme of the paper.
b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
d) An introduction, giving fundamental background objectives.
e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
f) Results which should be presented concisely by well-designed tables and figures.
g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
j) There should be brief acknowledgments.
k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.

Format Structure

It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

Title

The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, “What words would a source have to include to be truly valuable in a research paper?” Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

Preparation of Eletronic Figures for Publication

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

Color charges: Authors are advised to pay the full cost for the reproduction of their color artwork. Hence, please note that if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a Color Work Agreement form before your paper can be published. Also, you can email your editor to remove the color fee after acceptance of the paper.

Tips for Writing a Good Quality Science Frontier Research Paper

Techniques for writing a good quality Science Frontier Research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of science frontier then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.

6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

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	A-B	**C-D**	**E-F**
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Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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