

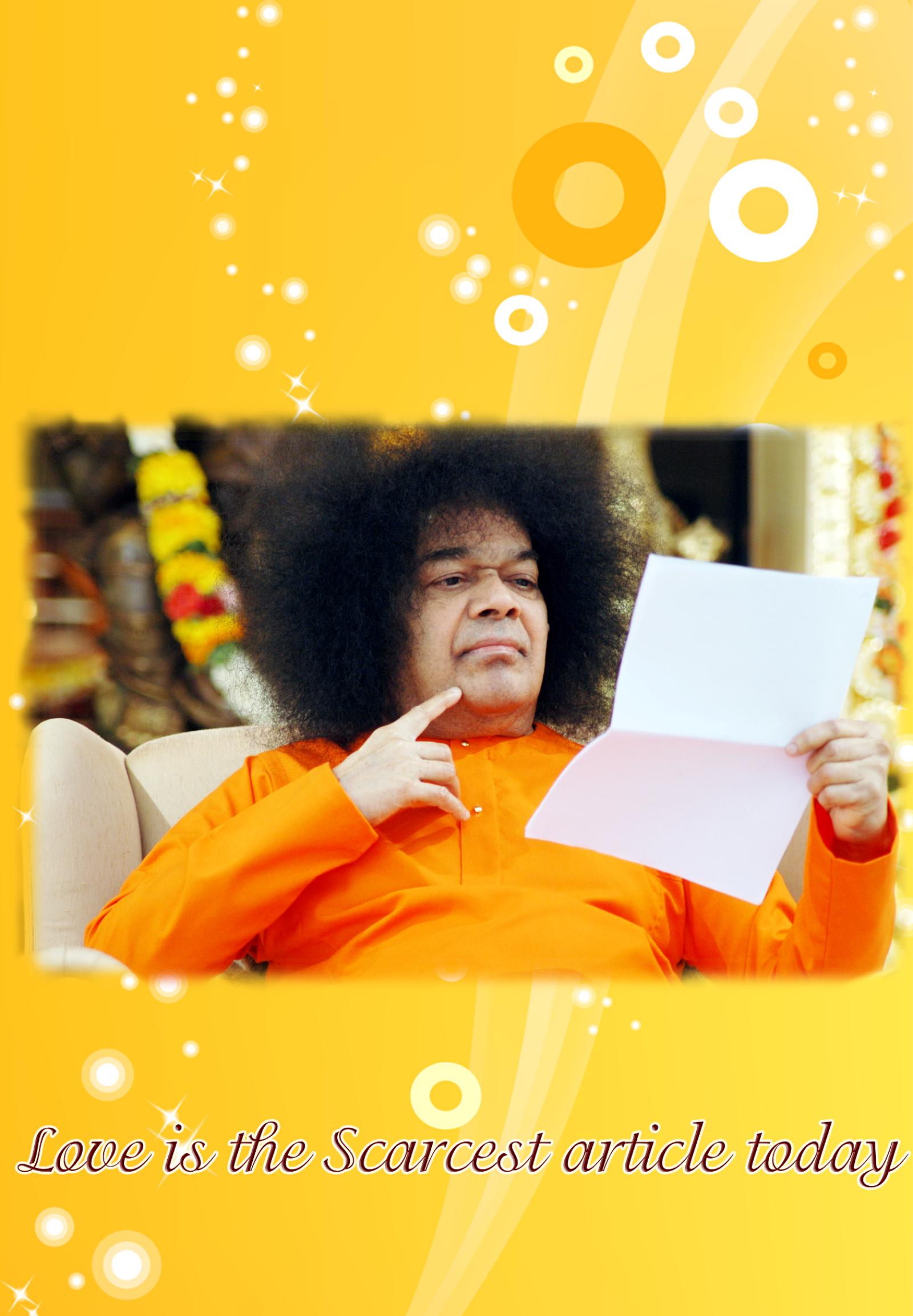


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DMACS
Newsletter

Summer Issue - 2012



Love is the Scarcest article today

An Offering
At the Lotus Feet of

OUR MOST BELOVED MOTHER SAI

From the Desk of HOD.....

In 2004, when I joined the DMACS to be with Swami and His Institute, I had a vision that one day SSSIHL will be an abode for excellence in education and research in which DMACS will be like a pole star. I dreamt that all those seeking to join elite institutions like MIT, Harvard, etc. will be turning their sight towards SSSIHL as their future place to be. Eight years have passed since then and I now reflect upon my dream and the growth of DMACS. I see ever **enthusiastic and talented** younger team members working tirelessly to bring glory to this Institute and to the department. In the last five years our record of publications runs more than 111. Niche areas like High Performance Computing, Differential Equations, Cryptography and Computer Vision are all being researched upon with an attitude of "We can do" and "Nothing is impossible for us".

Himalayan aspirations, notable achievements in academic and research together with the **expansion of love** have taken every one of us to much more fulfilling and most cherished moments of our lives. At this moment, I would like to take a pause and contemplate on a spark of truth that has sprung in my heart. All the glory in the past was and in the future will be possible only due to the hard work, total dedication, and love exhibited by our students for Swami. They have translated their love in action as an **offering to Swami**. Since nothing short of perfection can be offered at the Lotus feet, our motto crystallizes into "Excellence in everything we do" with purity as the foundation.

I can see more and more active participation from our students and our alumni brothers and sisters to help us grow stronger in the years to come. DMACS Newsletter initiative is just to showcase our capability and also document our dreams. Many years from now, when we sit and read the same articles, poems and reflections, we will know for sure that our dreams have indeed become a reality. When GOD is on OUR side, what is NOT possible?

- *Prof. V. Chandrasekaran*

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How REAL is the Real Line?

Dr. C. Jagan Mohan Rao
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I. INTRODUCTION

NATURAL numbers were natural to our ancestors as they needed to count their sheep. But the discovery of **zero** had to wait till the concept of “*Shunya*” of Hindu Philosophy could sink into human psyche. The negative numbers emerged so that $x + 1 = 0$ could be solved. This created an **Integral** domain. In an integral domain, there are balances and counter balances, pluses and minuses, where punya and papa co-exist, just as day and night, bright and darkness – equal but opposite.

A bitter truth:

The development did not stop there. The next rational step was the Rational numbers. Rational numbers were introduced to solve the multiplication problem $2x - 1 = 0$. **Caution:** DO NOT divide by zero. But rationals could not solve other multiplication problems such as $x^2 - 2 = 0$, exploding the myth of rational thinking!

Thus **irrationals** came flooding in, filling in every bit of gap in the real line. The two together became **REAL**. Now we have a real number for each point on the real line and a point on the real line for each real number. But in this world of the real line, there are overwhelmingly more irrationals than rationals! A bitter truth, we are forced to live with.

II. ALGEBRAIC COMPLETENESS

The next logical question is “Are the real numbers **complete**?” i.e., are these real numbers sufficient to solve all problems? The real world still does not have a solution to the problem $x^2 + 1 = 0$, as square of every real number is non-negative. So imagine an imaginary number i , where $i^2 = -1$. Strange as it may sound, it solves all problems. Every polynomial has a root and in fact, a polynomial of degree n has exactly n roots, if a root is counted to its multiplicity. This is algebraic completeness. This put a stop to the extensions of real numbers. Every type of completeness that needs to be attained has been attained.

So, is the real world Incomplete?

Does that mean the real numbers are not so real after all? Well, not if we tackle the issue of completeness in the following two perfectly mathematical ways.

III. TOPOLOGICAL COMPLETENESS

- We introduce a metric on the real numbers through the norm, $\|x\| = |x|$. Under this metric, real numbers are complete: *Every Cauchy sequence of real numbers converges.*
- A *Cauchy sequence* is one whose members ultimately get closer to each other.
- A sequence *converges* if all the members ultimately get closer to some **ONE**.
- In essence, topological completeness says: **Loving thy neighbour is loving GOD.**

IV. ORDER -THEORETIC COMPLETENESS

- We introduce an order on the real numbers as $x \geq y$ if $x - y$ is non-negative. The order is reflexive, anti-symmetric and transitive. It is a total order which is complete: *Every bounded subset has a supremum.*
- *Supremum* is an upper bound of any bounded set.
- Supremum is closest to the bounded set among all upper bounds.
- In essence, Order-theoretic completeness says: **If one remains within bounds, he is protected by the Supreme, the ONE beyond him but closest to him.**

V. CONCLUSION

For the real numbers the above two types of completeness are equivalent, which is to say,

“You can love your neighbour if and only if you remain within your bounds”.

This is the reality that we need to realize from the real line.

Google . . . *the Modern Oracle!*

Sri Sai Shyam Sharma, Assistant Professor, DMACS, SSSIHL

Hand written letters, birthday cards, knowledge gathering and knowledge transfer, photographs developed from a film - everything today is in the digital format; emotions, knowledge, information, memories are all now in various forms and “formats”. Digital media is the only soul of the world today. I remember a friend of mine tell me, “If today you want to rage a war between nations or want the world to come to an end, make the Google search engine crash. It will be all over.” Looks like there is one super human brain and the name of that brain is GOOGLE!

Google is not just a multinational company making billions of dollars. It is not just a company providing technical solutions to the world. It is not just a search engine to find information content on the world wide web. Google today is a friend who is there all round the clock for anyone. It is a guide whom one places faith in. Look at some of the things that this particular software giant has given to man and made life more than easy for everyone today.

GOOGLE IMAGES AND GOOGLE VIDEOS

Have you heard of a name but do not recognize the face? Want to see how the person looks? Google Images is there for you. Want a picture of one of your childhood heroes? Google Images! Want to see how the Niagara falls looks like? Google Images! Want to see if your friend’s picture is over the net? Google Images! Want to learn how to make a tasty Shahi Paneer and impress your friends? Google Videos! Want to give a good massage to your friend but do not know how to do it well? Google Videos! Want to learn how to dance on your own? Google Videos! Anything that can be saved in a frame or frames put together can be found here.

GOOGLE MAPS AND GOOGLE EARTH

This is amongst the most amazing technological developments ever made by man. Sitting in a country miles, continents and even seas away from your brother’s house you can track down and see his house, Credit? Google Maps. Want to find the shortest route to move from one place to another? Google Maps! A friend is lost in an unknown place and wants help desperately, his best friend in such times can be Google Maps. Want to look at the terrain or the surface of the Earth in 3D? Google Earth!

GOOGLE TRANSLATE

Today, most of the people in the world (at least in India) do not get to speak their mother tongue. Their mother tongue is English. For such people and also many who want to learn other languages, the easiest way to do so today is Google Translate.

GOOGLE BOOKS

I remember a time when going to library, issuing a book and returning it on time to avoid paying fine was the normal way of the day. Even in that, there were always defaulters. Making these books available in a soft copy was a brilliant idea. One did not have to carry heavy books all around. It started with carrying the soft copy to a place where one could read it. There are millions of books available in Google Books - all kinds of them. In fact, today, with the help of the PDF readers like KINDLE, even that struggle can be avoided. So this mind blowing idea of making knowledge available in this format has not just dramatically but also drastically changed the life of every person searching for knowledge!

GOOGLE TALK

Remembered a friend suddenly and want to chat: Irrespective of time zones and physical distance? There is just one thing you have to check , are you online? As if typing messages and receiving instant replies within a matter of micro seconds was not enough, GTalk implemented a calling facility along. Today GTalk is still the fastest way to communicate, even though the number of such technologies is plenty in number.

GMAIL

The total number of Gmail users in the world are 350 million as on January 2012! (Source: Wikipedia). The total number of users is also an indication to the kind of service and satisfaction that it provides to its customers. The amount of space available for each user is huge, the various themes offered is an attraction. All the other Google Apps getting associated with a Google ID is again a huge benefit. The applications like Google Docs, Picasa Web Albums, Google+ all these and much more are available to a user having a Google ID.

GOOGLE SCHOLAR

The amount of research development happening all around the globe is tremendous. Great minds are all over the world (God had to take care of this). Different regions specialize in different fields. To put all this kinds of knowledge, wisdom and skill in one place and make it available to anyone in search for it, is a noble endeavor.

The difference that this particular word “GOOGLE” has made in the lives of people today and also possibly for generations to come is like the beginning of a new civilization - *A new world, a new life!*. Children today teach their parents about Google. Hope their children will still teach them about Google. Long live the king, they said; I say, “Long live Google!”.

The Drunkard's Streetlight: How (Not) to use Statistics

KVS Dileep, *Research Scholar, Artificial Intelligence and Databases Lab, IIT Madras*

I. INTRODUCTION

LET me start off with a quote to set the tone for the rest of the article and also explain the title. “***Do not use statistics the way, a drunkard uses a streetlight – for support rather than for illumination***”. There has been quite a disturbing trend among researchers, who use a suite of statistical tools to cover up lacunae in their results/experimentation. The basic purpose of statistics is to provide some insight into regularities that exist in data and test the efficiency of the model. But unfortunately most people use it to cover their inefficiencies with statistical jargon. The rest of the article will be to give an intuitive understanding into statistics and probability keeping mathematical rigor at bay.

No description of statistics is complete without probability. First of all, what is probability? Maybe it is a means to measure uncertainty. Ok, then what is uncertainty. I am not so certain myself. But here is what I think. There are mainly 2 types of uncertainty:

- Uncertainty in Time
- Uncertainty in Measurement.

Uncertainty w.r.t. Time means that at this instant we are not able to judge the outcome of an event but given time we can have a clear idea. In the famous tossing of coin experiment all you have to do is wait till the experiment is completed to get the result of an outcome you are waiting for. This sort of study is probability theory.

What about uncertainty in measurement? Consider that you have just received a greenish-yellow T-shirt. Even if you stare at it for an infinite amount of time, you will never be able to tell if it is completely green or yellow. The uncertainty is not with time but with the imprecise measuring instrument. Study of such uncertainty comes under the auspices of possibility theory also called fuzzy theory. But there is still a raging debate in the community, whether we need two different schools of thought to study uncertainty. Once we have an idea what uncertainty pertains to our experiments, we can do the relevant analysis.

II. SCHOOLS OF STATISTICS

A. What is probability?

Before we go into the difference schools of thought let us have a relook into what probability means. Even till date, there has been no consensus on what the right definition of probability is. Is it a subjective degree of belief or an objective long-run frequency? Consider the coin tossing experiment – an unbiased coin tossed 1000 times. The subjective belief tells you that the probability of heads is 0.5, but at the end of 1000 tosses if there are 600 heads and 400 tails, will the probability

change based on the objective frequency? This is something to ponder about.

B. Bayesian Statistics

Bayesian statistics is the oldest school of statistics founded by Rev. Thomas Bayes with the Bayes theorem. Without going into the math, let us look into the intuitive definition of Bayesian statistics. It is all about taking the results of an experiment which is the *likelihood*, and combining it with personal knowledge about a phenomenon called *prior*, and then obtaining the result called *posterior* probability.

Prior is the value where we can inject the experience or previous belief about the experiment. So this means, for different priors, we get different probabilities in the case of Bayesian. Another way is to generate the prior from the data itself where the subjectivity disappears. Again, the problem of subjective vs. objective comes into play.

Though earlier, Bayesian was kept aside, because analysis was very difficult with hand, it has again found new interest with the advent of computers. Moreover, interest in finding patterns in large data ala Machine Learning/ Data Mining has lead to resurgence and new avenues for application.

C. Frequentist

The statistics that is generally taught in college level is the frequentist statistics. This very briefly involves proposing a null hypothesis (H_0), saying there is no relationship or effect and an alternative hypothesis (H_1) which is opposite of that. Next, an alpha level or threshold is fixed and a statistical test is performed. A p -value is calculated and if the p -value is smaller than the alpha level then the results are said to be “statistically significant”.

The obvious problem with this is that the prior information is not taken into account. It only tells the probability of the data given H_0 or H_1 , while the interesting thing to observe is probability of H_0 or H_1 given the data.

So in frequentist statistics, the model remains the same while the data keeps changing, and in Bayesian, the model keeps changing while data remains the same.

There is also an information theoretic look at statistics based on ideas from thermodynamics. But I am refraining from going into that for the sake of brevity.

III. CONCLUSION

So the concluding note is this. Know when statistics need to be applied and where. Remember these are tools to gain newer insights rather than support your results. Therefore, it is important to know the fundamentals carefully so that when a majority of researchers apply them in the right way – the idiom “Lies. Damn Lies. Statistics” can be changed into something more respectful that the field deserves.

Use of Fibonacci Numbers and Matrices in Coding Theory

Dr. Rita Gupta, Associate Professor, DMACS, SSSIHL

I. INTRODUCTION

FIBONACCI numbers $F(n)$ (for $n = 0, \pm 1, \pm 2 \dots$) are defined by the recurrence relation

$$F(n+1) = F(n) + F(n-1)$$

with initial terms $F(0) = 0, F(1) = 1$.

The above relation can also be used to find the Fibonacci numbers for negative values of n . It is well known that $F(-n) = (-1)^{n+1}F(n)$. The ratio of the successive Fibonacci numbers is $\frac{F(n+1)}{F(n)}$. This tends to Golden

ratio $\varphi = \frac{1+\sqrt{5}}{2}$ as $n \rightarrow \infty$. The Fibonacci sequence and the Golden ratio have appeared in many fields of science including high energy physics, cryptography and coding.

Fibonacci p- numbers are defined similarly by the recurrence relation:

$$F_p(n) = F_p(n-1) + F_p(n-p-1) \text{ where } n > p+1,$$

With the initial conditions:

$$F_p(0) = 0, F_p(1) = F_p(2) = \dots, F_p(p) = 1.$$

For $p=0$: it generates binary numbers 1, 2, 4, 8, 16.....

For $p = 1$ it generates classical Fibonacci sequence 1, 1, 2, 3, 5, 8, 13....

II. FIBONACCI CODING OF NUMBERS

Every positive integer can be uniquely expressed as sum of Fibonacci numbers. Fibonacci coding encodes positive integers into binary codes. Each code ends with “11” and contains no other instances of “11”.

Let N be a positive integer. If $d(0), d(1), \dots, d(k)$ digits of the code word represent N , then:

$$N = \sum_{i=0}^{k-1} d(i)F(i+2), \text{ and } d(k) = d(k-1) = 1.$$

Number	Fibonacci representation	Fibonacci code
1	$F(2)$	11
2	$F(3)$	011
3	$F(4)$	0011
4	$F(2)+F(4)$	1011
5	$F(5)$	00011
6	$F(2)+F(5)$	10011
7	$F(6)$	000011

Procedure to encode an integer in Fibonacci code:

- Find the largest Fibonacci number equal to or less than N : subtract this number from N keeping track of the remainder.

- If the number subtracted was the i^{th} Fibonacci number $F(i)$ put a 1 in place $i-2$ in the code word (counting the left most digit at the place 0).
- Repeat the steps 1 and 2 substituting the remainder for N until a remainder of 0 is reached.
- Place an additional 1 after the rightmost digit in the code word.

Example: Let us consider the number $N = 75$,
 $75 = 55 + 13 + 5 + 2 = F(10) + F(7) + F(5) + F(3)$

The following table shows the representation of number 75 in Fibonacci codes. The first two Fibonacci numbers ($F(0)$ and $F(1)$) are not used, and an additional 1 is always appended.

0	1	1	2	3	5	8	13	21	34	55	-
$F(0)$	$F(1)$	$F(2)$	$F(3)$	$F(4)$	$F(5)$	$F(6)$	$F(7)$	$F(8)$	$F(9)$	$F(10)$	pad
-	-	0	1	0	1	0	1	0	0	1	1

Hence the Fibonacci representation of 75 is 0101010011.

Fibonacci coding is a self-synchronizing code, which makes it attractive compared to other universal codes. In most of the universal codes, if a single bit is altered none of the data that comes after it is correctly read; whereas in case Fibonacci coding, it is easy to detect the error and recover data from the damaged stream.

Matrices can be used for encoding and decoding of messages. For encoding the message it is converted into blocks of decimal numeral square matrices. Then a non-singular matrix of the same order is used as encoding matrix. Each block is multiplied by encoding matrix and sent through the communication channel. On the other end message is decoded by multiplying it by decoding matrix, which is the inverse of encoding matrix.

III. FIBONACCI Q-MATRIX

Fibonacci Q- matrix is defined by $Q = \begin{pmatrix} 1 & 1 \\ 1 & 0 \end{pmatrix}$

A. Properties of Q-matrix

- $Q^n = \begin{pmatrix} F(n+1) & F(n) \\ F(n) & F(n-1) \end{pmatrix}$
- $\text{Det } Q^n = F(n+1)F(n-1) - F^2(n) = (-1)^n$
- The inverse of the matrix Q^n :

(a) If n is an *even* number the inverse matrix Q^{-n} is of the form

$$Q^{-n} = \begin{pmatrix} F(n-1) & -F(n) \\ -F(n) & F(n+1) \end{pmatrix}$$

(b) If n is an *odd* integer the inverse matrix Q^{-n} is of the form:

$$Q^{-n} = \begin{pmatrix} -F(n-1) & F(n) \\ F(n) & -F(n+1) \end{pmatrix}$$

Fibonacci Q – matrix can be generalized to Q_p matrix. Fibonacci Q_p matrix is a $(p+1) \times (p+1)$ matrix, which contains a $p \times p$ unit matrix, bordered by last row of 0's and first column of 0's bordered by 1's.

The first few Q_p matrices are given below

$$Q_1 = \begin{pmatrix} 1 & 1 \\ 1 & 0 \end{pmatrix}, Q_2 = \begin{pmatrix} 1 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \end{pmatrix}, Q_3 = \begin{pmatrix} 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 \end{pmatrix} I$$

For $p = 1$, $Q_p = Q$. It can be easily proved that,

$\text{Det } Q_p = (-1)^p$. For a given positive integer $p = 0, 1, 2, 3 \dots$ there exist simple formulas to calculate Q_p^n and Q_p^{-n} .

B. Fibonacci Coding

Fibonacci Q_p matrices can be used in Coding Theory. If we represent the initial message in the form of the square matrix M of order $(p+1)$, where $p = 0, 1, 2, 3 \dots$ We take the Fibonacci matrix Q_p^n of order $p+1$ as a coding matrix and its inverse Q_p^{-n} as a decoding matrix. The transformation $M \times Q_p^n = E$ is called Fibonacci coding and the transformation $E \times Q_p^{-n} = M$ as Fibonacci decoding.

Example: Let our message in decimal numeral form be 1469. We can represent this message in matrix form as

$$M = \begin{pmatrix} 1 & 4 \\ 6 & 9 \end{pmatrix}.$$

Let us take the matrix $Q_1^3 = \begin{pmatrix} F(4) & F(3) \\ F(3) & F(2) \end{pmatrix} = \begin{pmatrix} 3 & 2 \\ 2 & 1 \end{pmatrix}$ as encoding matrix.

Then

$$E = \begin{pmatrix} 1 & 4 \\ 6 & 9 \end{pmatrix} \begin{pmatrix} 3 & 2 \\ 2 & 1 \end{pmatrix} = \begin{pmatrix} 11 & 6 \\ 36 & 21 \end{pmatrix}.$$

The encoded message is sent across the communication channel.

The decoding matrix is

$$Q_1^{-3} = \begin{pmatrix} -F(2) & F(3) \\ F(3) & -F(4) \end{pmatrix} = \begin{pmatrix} -1 & 2 \\ 2 & -3 \end{pmatrix}$$

The message matrix can be obtained as

$$M = E \times Q_1^{-3} = \begin{pmatrix} 11 & 6 \\ 36 & 21 \end{pmatrix} \times \begin{pmatrix} -1 & 2 \\ 2 & -3 \end{pmatrix} = \begin{pmatrix} 1 & 4 \\ 6 & 9 \end{pmatrix}$$

Relation between the message matrix M and the code matrix is as follows:

$$E = M \times Q_p^n$$

$$\text{Det } E = \text{Det}(M \times Q_p^n) = \text{Det } M \times \text{Det } Q_p^n = \text{Det } M \times (\text{Det } Q_p)^n = \text{Det } M \times (-1)^{pn} \dots (1)$$

The coding and decoding method described above gives the possibility to detect and correct errors in the code message E . The main idea of error detection and correction is based on the determinant of the matrices M and E .

The determinant of the initial message matrix M is calculated and sent to the communication channel right after the code matrix elements. $\text{Det } M$ plays a role of checking element of the code matrix E received from the communication channel. After receiving the code matrix E and checking element $\text{Det } M$. If the Equation (1) is satisfied, then the elements of E are transmitted through the communication channel without errors, if not then there are some errors either in the elements of E or checking element. For $p = 1$, the correct ability of the method is 93.33%. For $p = 1$ it can correct single, double and triple errors in E . Theory of Diophantine equations can be used to detect and correct errors. For $p = 2$, the correct ability of this method is 99.80%. Correct capability increases with increasing value of p .

IV. CONCLUSION

Fibonacci encoding decoding method is easier compared to other matrix coding methods as there exists simple formulas to calculate the inverse and powers of Fibonacci Q-matrices. Its correct capacity is higher than other similar methods.

1729

Dr. Lakshmi Naidu, *Assistant Professor, DMACS, SSSIHL*

I. INTRODUCTION

WITHIN a short life span of 32 years 123 days, Sri Srinivasa Ramanujan made amazing contributions to mathematics. His contribution, particularly to Number theory of mathematics, was highly remarkable. Besides, Sri Ramanujan came up with lot of new results while working with Hardy at Cambridge University between 1913 and 1918. Hardy went to see Sri Srinivasa Ramanujan who was hospitalized for a continued spell of sickness. During the course of conversation in the hospital, Hardy told Ramanujan that he came by a private taxi whose number was “1729”, which was a very dull number and might prove to be inauspicious. For this Ramanujan shot back saying 1729 was a very interesting number as it possessed a lot of properties.

The following are the important properties that are possessed by 1729:

- Consists of all prime factors
- Taxicab number
- Charmichael number
- Zeisel Number
- Centered Cube number
- Has a property with exp (1).
- 12-gonal, 24-gonal number and 84-gonal number.
- Harshad number or Niven number.

II. PRIME FACTORS

The prime factors of 1729 are 7, 13 and 19.

III. TAXICAB NUMBER

A *Taxicab number* is denoted by Ta (n) or Taxicab (n), and is defined as the least number, which can be expressed as a sum of two positive cubes in n distinct ways. A few taxicab numbers are 9, 1729, 87539319, 6963472309248 etc.

$$\text{Taxicab (1)} = 9 = 1^3 + 2^3$$

$$\begin{aligned} \text{Taxicab (2)} &= \mathbf{1729} = 1^3 + 12^3 \\ &= 9^3 + 10^3 \end{aligned}$$

$$\begin{aligned} \text{Taxicab (3)} &= 87539319 = 167^3 + 436^3 \\ &= 228^3 + 423^3 \\ &= 225^3 + 414^3 \end{aligned}$$

$$\begin{aligned} \text{Taxicab (4)} &= 6963472309248 = 2421^3 + 19083^3 \\ &= 5436^3 + 18948^3 \\ &= 10200^3 + 18072^3 \\ &= 13322^3 + 16630^3 \end{aligned}$$

IV. CHARMICHAEL NUMBER

A *Charmichael number* is a composite positive integer ‘n’ which satisfies the congruence $a^n \equiv a \pmod{n}$ for all integers ‘a’ which are relatively prime to n.

The first few Charmichael numbers are 561, 1105, 1729, 2465, 2821, 6601, 8911.....

Charmichael number n	Factors			Relatively prime number to Charmichael number		
	F_1	F_2	F_3	$F_1-1/n-1$	$F_2-1/n-1$	$F_3-1/n-1$
561	3	11	17	2/560	10/560	16/560
1105	5	13	17	4/1104	12/1104	16/1104
1729	7	13	19	6/1728	12/1728	18/1728
2465	5	17	29	4/2464	16/2464	28/2464
2821	7	13	31	6/2820	12/2820	30/2820
6601	7	23	41	6/6600	22/6600	40/6600
8911	7	19	67	6/8910	18/8910	66/8910

V. ZEISEL NUMBER

A *Zeisel number* is a square –free integer k with at least three prime factors which fall into the pattern

$P_x = (a \times P_{x-1}) + b$, where a and b are fixed constants and x is the index of each prime factor in the factorization, sorted from lowest to highest. It is very important to note that $P_0 = 1$.

The first few Zeisel numbers are: 105, 1419, **1729**, 1885, 4505, 5719, 15387, 24211, 25085, 27559, 31929, 54205, 114985, 207177, 208681, 233569, 287979 and so on.

$P_0=1$	$P_x = (a \times P_{x-1}) + b$	Factors	Prime Numbers
$a=1, b=2$ (105)	$P_1 = 3$ $P_2 = 5$ $P_3 = 7$	3, 5, 7, 15, 21, 35.	3 5 7
$a=4, b = -1$ (1419)	$P_1 = 3$ $P_2 = 11$ $P_3 = 43$	3, 11, 33, 43, 129, 473.	3 11 43
$a=1, b = 6$ (1729)	$P_1 = 7$ $P_2 = 13$ $P_3 = 19$	7, 13, 19, 91, 133, 247	7 13 19

VI. CENTERED CUBE NUMBER

A *centered cube number* is a central figurate number that represents a cube. The centered cube number n is given by the equation $n^3 + (n + 1)^3$.

The first few centered cube numbers are 1, 9, 35, 91, 189, 341, 559, 855, 1241, **1729**, 2331, 3059, 3925, 4941, etc.

Value of n	$n^3 + (n + 1)^3$	Centered Cube Number
0	$0^3 + 1^3$	1
1	$1^3 + 2^3$	9
2	$2^3 + 3^3$	35
3	$3^3 + 4^3$	91
4	$4^3 + 5^3$	189
5	$5^3 + 6^3$	341
6	$6^3 + 7^3$	559
7	$7^3 + 8^3$	855
8	$8^3 + 9^3$	1241
9	$9^3 + 10^3$	1729
10	$10^3 + 11^3$	2331

VII. PROPERTY WITH e^1

As we know that the exponential value of “+1” is an irrational number i.e.

$$e^1 = 2.7182818284590452353602874 \dots \dots$$

In the above value, the 1729th decimal place is the beginning of the first occurrence of all ten digits consecutively.

VIII. 12-GONAL, 24-GONAL, 84-GONAL NUMBER

A 12-gonal number is a number that can be arranged in the shape of a 12-gone. Examples: 1, 12, 33, 64, 105, 156, 217, 288, 369, 460, 561, 672, 793, etc.

A 24-gonal number is a number that can be arranged in the shape of a 24-gone. Examples: 1, 24, 69, 136, 225, 336, 469, 624, 801, 1000, 1221, 1464, **1729**, 2016, 2325, etc.

An 84-gonal number is a number that can be arranged in the shape of an 84-gone. Examples: 1, 84, 249, 496, 825, 1236, **1729**, 2304, 2961, 3700...

If s is the number of sides in a polygon, the formula for the n^{th} s-polygon number is

$$\frac{1}{2}n[(s - 2)n - (s - 4)].$$

Thus in 12-gonal, for $n = 19$, $\frac{1}{2} \times 19[190 - 8] = 1729$.

In 24-gonal, for $n = 13$, we will get 1729 and for an 84-gonal for $n = 7$ it is **1729**.

IX. HARSHAD NUMBER (OR) NIVEN NUMBER

A *Harshad number*, or *Niven number*, is an integer that is divisible by the sum of its digits in a given number base. The first few Harshad numbers with more than one digit in base 10 are 10, 12, 18, 20, 21, 24, 27, 30, 36, 40, 42, 45, 48, 50, 54, 60, 63, 70, 72, 80, 81, 84, 90, 100, 102, 108, etc.

The number **1729** is a Harshad number since it is divisible by 19 ($1 + 7 + 2 + 9 = 19$).

The Divine Proportion in God's Creation

Students of III B.Sc.(Maths), Anantapur Campus, DMACS, SSSIHL

I. INTRODUCTION

“THE subject in which we can never know what we are speaking about or what we are speaking is true”. This witty summation of mathematics by Bertrand Russell is one of the favorite definitions of all the mathematicians. ‘Arithmophobia’ haunts almost all the young minds of world today. But, when analyzed closely, one finds a beautiful relation between nature and mathematics. Nature has been delighted in the creation of varied geometrical shapes. Its figures come in circles, triangles, rectangles and even stars. Nature has never been content with these simple shapes, but has created all kinds of intricate mathematical designs including a variety of spirals. This phenomenon is made all the more mysterious by its relationship with a certain mathematical sequence known as the Fibonacci.

II. FIBONACCI NUMBERS

The Fibonacci sequence starts with a 0 and 1; and is obtained by adding previous numbers together. The next few numbers in the sequence are $1+1=2$; $2+1=3$; $3+2=5$; $5+3=8\dots$. Thus, the sequence looks like 0, 1, 1, 2, 3, 5, 8, 13, 21, ... This sequence was discovered by the great European mathematician of middle ages, Leonardo Fibonacci (1170 AD–1240 AD). These Fibonacci numbers were first introduced in his famous book called “Books of calculations” or Book of ABACUS. These Fibonacci numbers are found in nature, art, architecture, music and many other fields.

A. In Nature

It is quite amazing that the Fibonacci numbers are nature’s numbering system that appear everywhere in nature. This phenomenon appears to be one of the principle laws of nature, from leaf arrangement in plants to the pattern of florets of a flower. Probably, most of us have never taken time to examine very carefully the number of arrangements of petals on a flower. If we were to do so, we would find that most of the flowers have 1-petal, 2-petals, 3-petals, 5-petals and so on which are all Fibonacci numbers. E.g. White Calla Lilly – 1 petal, Euphorbia-2 petals. Inside fruits of many plants also we observe the presence of Fibonacci order. For e.g. Banana has 3-sections and apple has 5-sections. Fibonacci numbers appear in biological settings like branching in trees and leaf arrangement. Another area of great interest is the occurrence of Fibonacci numbers in spiral arrangement of leaves around plants stem called phyllotaxis. This spiral pattern is observed by viewing the stem from directly above and noting that the

arc of the stem from one leaf base to the next to the fraction of the stem’s circumference inscribed is in the Fibonacci numbers. For eg. the arc of the stem in elm is $\frac{1}{2}$ of the circumference and it is $\frac{2}{5}$ in bleach. Why did God arrange them in this way? This pattern assures that each leaf will attain maximum exposure to sunlight and air without shading or over-crowding with other leaves.

B. In Human Hand

Every human has 2 hands. Each hand has 5 fingers and each finger has 3-parts separated by 2-knuckles, which are all Fibonacci numbers.

C. In Music

Music has foundation on the Fibonacci series as musical scales are based on Fibonacci numbers. A musical scale consists of 8 notes of which 5th and 3rd note create the basic foundation of all chords. A piano keyboard scale of c-c consists of 5 black and 8 white keys split into groups of 3 and 2, which are all Fibonacci numbers.

D. In very small and very large things

In the world of atoms, there are four fundamental asymmetries and it is significant that the numbers forming these values are near Fibonacci numbers.

In the area of very large phenomenon, when the time period of each planet’s revolution around the sun is compared in round numbers to the one adjacent to it, their fractions are Fibonacci numbers. Beginning with Neptune and moving inward towards the sun, the ratios are $\frac{1}{2}$, $\frac{1}{3}$, $\frac{2}{5}$, $\frac{3}{8}$, $\frac{5}{13}$, $\frac{8}{21}$, $\frac{13}{34}$. These are the same as the spiral arrangement of leaves on plants.

A most interesting divergence in the chart is that of the earth. As the next planet in the series after Mars, its number should be $\frac{8}{21}$, but it isn’t. The number skips over earth and connects to Venus. Even with this divergence, we find that the earth’s period compared to Mars and Venus are Fibonacci numbers ($\frac{8}{13}, \frac{13}{21}$). This anomaly is evidence of God showing uniqueness of planet earth in relationship to the whole of cosmos.

III. THE GOLDEN RATIO

When we observe the Fibonacci numbers more closely, we observe that the ratio between any two consecutive Fibonacci numbers seems to converge at 1.618 as we move to larger numbers. This number 1.618 is known as golden number. It is denoted by a Greek letter, phi ϕ . The ratio 1:1.618 is known as the golden ratio. Why is it called the golden ratio? It is because it is found in almost all of creation. For the same

reason, the ratio is also known as divine proportion. This ratio is found in many geometrical forms like circle, triangles, pentagon, decagons, but notably in rectangles. It is called the golden rectangle having its width and length in the golden ratio. Golden ratio is observed in nature, human body, art and architecture etc.

A. In Nature and Human Body

1. The golden ratio is found in the structure of birds, bees, peacock feathers, stem of leaves, flowers and also in the human body, wherein the golden ratio can be seen from head to toe in various parts of human body.
2. The ratio of distance from tip of fingers to elbow and from waist to elbows is in the golden ratio.
3. Distance from navel to top of the head and shoulder to top of the head is in golden ratio.
4. In the human face, length of face over length from eyebrows to tip of jaw, length of mouth over width of nose, width of nose over the distance between the nostrils are proportioned in the golden ratio.

B. In Music, Art and Architecture

Fibonacci and φ relationships are often found in the timing of musical compositions. The climax of most of the songs is often found at roughly the φ point as opposed to middle or end of the song. The golden ratio was also used by many musicians while composing music. For e.g., the famous composer, Beethoven used the golden ratio in his fifth symphony. Mozart, a prolific Austrian composer used the golden ratio while composing music. Another musician, Baginsky used the golden ratio to construct the contour and arch of violins. Why this golden ratio? It implies growth, power and movement. It gives animation and life to an artist's work. Artists such as Leonardo Da Vinci employed the golden proportion in many of their works. The painting of Mona Lisa represents a golden rectangle around her face.

A famous painter, Michelangelo's holy family is notable for positioning of the principal figures in alignment with a pentagram (or) golden star. Also, Raphael's crucifixion is another well known example of art, wherein the principal figures outline a golden triangle.

Some examples of architecture where we find the golden ratio are the Tajmahal in India, the CN Tower in Toronto (the world's tallest), The Baghdad city gate, the Great wall of China, Lincoln's Memorial in Washington and the Great Pyramid in Egypt. In the pyramid, the perimeter divided by twice its vertical height gives the value of φ . Sculptors often used the golden ratio as they found the objects made in such a fashion is pleasing to the human eye. Golden ratio is also used in financial markets, web designing and in many other fields. Many of the things we use such as credit cards, playing cards, post cards etc., are patterned after the golden rectangle. The popularity of this number has grown so much that we find it printed even on T-shirts, cups, toys etc.

IV. THE GOLDEN SPIRAL

A golden spiral is constructed by drawing a golden rectangle and then drawing in it maximum possible squares of 1,2,3,5,8 units respectively. When the diagonals of all the squares are joined with arcs each being $\frac{1}{4}$ of a circle forming the continuous line, a golden spiral is obtained.

Golden spiral occurs frequently in nature. If we look close enough, we might find golden spiral in head of daisy, spirals of a pine cone from the center have 5 and 8 arms respectively and in a sunflower the rows of seeds or floret form two sets of spirals spiraling in opposite directions.

V. CONCLUSION

Everything about us, our world as well as the universe involves mathematics. Absolutely everything can be broken down into a mathematical equation. The existence of math is in itself an act of creation. Where did math come from? The famous physicist Galileo said, "Mathematics is the language of God." God is a mathematician of the highest degree. The presence of Fibonacci numbers, spirals and the divine proportion through all of creation argues against their having occurred by blind chance or evolutionary processes. The only rational conclusion is that the creator of the universe is an intelligent being, whose creation is a visible fingerprint of His invisible existence.

Mathematics in Ancient Indian Scriptures

Sri. G. R. Praveena, *Lecturer, Department of Biology,
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VEDAS designate the sacred lore as revealed by God to the consciousness of the seers and sages. They are the treasure house of knowledge. In the recitation of Sanskrit mantras, the sound is very important, for it can bring transformation in us while leading to confer power and strength. Different sounds have different effects on human psychology. A Vedic word distorted by faulty pronunciation, emphasis, misapplication of alphabets does not convey true meaning.

The profound teachings of the Vedas are taught to common man in the form of stories by the Puranas. They were written to impress the teaching of the Vedas on to the masses and generate devotion to God in them. Shastras constitute the treatise or text written in explanation of some idea, especially in matters involving religion.

Sutra in Hinduism denotes a distinct type of literary composition based on short aphoristic statements, generally using various technical terms. Sutras although based on the ‘Sruthi’ (Vedas), composed by human authors. The ‘Suthra period’ forms the connecting link between the Vedic and later Sanskrit.

‘Akshara Yaksha Shastra’ deals with the branches of mathematics namely algebra, arithmetic, geometry, trigonometry and applied mathematics. Consisting of about fifty chapters the book also deals with geography, air, electricity, mineralogy etc. The authorship of this science is attributed to sage Valmiki.

Voltaire, the famous French writer and philosopher stated that “Pythagoras” went to Ganges to learn geometry. Abraham Seidenberg, author of the authoritative “History of Mathematics” credits the ‘sulabha suthra’ as inspiration of all the mathematics of the ancient world. ‘Baudhayana sulbha sutra’ gives the construction of geometric shapes such as square and rectangles. It also gives geometric area preserving transformations from one geometric shape to another. These include transforming a square into a rectangle an isosceles trapezium, an isosceles triangle, a rhombus and a circle, also transforming a circle into a square.

The theorem bearing the name of the Greek mathematician Pythagoras is found in the ‘Shathapatha Brahmana’ as well as ‘sulbha sutra’, written centuries before Pythagoras was born. The decimal system based on power of ten, where the

remainder is carried over to the next column was first mentioned in the “Taittiriya Samhitha” of the “Krishna Yajur Veda”. The binary number system essential for computers was used in Vedic verse meters.

Verses in Krishna Yajurveda display the knowledge of mathematic progression as “*eka cha me, thisrascha me, panch cha me and so on thriyathrischa me*” (like 1, 3, 5 33) and “*chatscrscha me, asto cha meastachatwarescha* ... (like 4, 8, 12... 48).

A reference to decimal number system in “shukla yajur Veda” reads as

“*eka cha, dasha cha, dasha cha, shathancha shathan cha, sahasram cha sahasram chayutham cha, aayuthamcha neyuthamcha*” (like 1, 10, 100, 1000 ...i.e. $10^0, 10^1, 10^2$ and so on...)

Arithmetic properties of infinity are mentioned as follows - “if we add infinity to infinity we get infinity only, if we subtract infinity from infinity, we get infinity only. Similarly, if we multiply or divide infinity with infinity we get infinity only”

The meaning of infinity of infinity is ‘anantha’ which has no end. The property of infinity is completeness (Poornathwa). This concept is well brought in Upanishads which have revealed first time the concept of infinity.

“*purana madhaha, purna midhah, purnath purnamudhchayathe / purnasaya purnamadaya purnamevavashishyathe*”. i.e. “Out of infinite potential atman, the infinite universe emerged leaving the original infinity unchanged”

Pingala (400 – 200 BC) was a scholar and musical theorist who authored ‘Chhandah Shashtra’. His contribution to mathematics includes the formation of a matrix, invention of the binary number system, the concept of binary code the first use of Pascal’s triangle which he refer to as “meru prastaara” and he used a dot (.) to denote zero. His work along with Panini’s work was fundamental to the development of computing.

“*Vaishali ganitha*” (300 BC) is a book that discusses the basic calculations of mathematics, the numbers based on ten fractions, squares, cubes and questions on purchase and sale.

‘*Sthananga sutra*’ (300-200 BC) gave classifications of the five types of infinities, linear equations (yavat-tavat), quadratic equations (varga), cubic equations (Ghana) and biquadratic equations (varga – varga).

Lord Vishnu is referred to as *Spashtakshara* in “*Vishnu sahasra nama*” (30th verse) The 80th verse which reads
“*sumedha medhajo dhanyah sathya medha dharadharah*”.

Here Sumedha refers to Lord possessing excellent memory. ‘*Sathya medha*’ refers to “*He possessing*” non-erasable memory.

The 72nd verse says:

“*maha kramo maha karmo maha tejo maharagah*”

Here ‘*kramaha*’ refers to ‘*programmer*'; ‘*Maha kramaha*' is the excellent programmer. References are also made in *mimamsa* and *nyaya shastras* as *mahaprakarana* and *avaantha prakrana* i.e. main programmer and sub programmer respectively.

Computerized horoscope is software where vast amount of data in Vedic astrology is stored and downloaded to effective use. In July 1987, Forbes magazine published news, which surprised even the Sanskrit pundits. It said that “*Sanskrit is the most convenient language for computer software programming*”.

A paper published by Dr. Rick Briggs in ‘Artificial Intelligence’ magazine talks about using Sanskrit in natural language processing (NLP). Its grammar can be easily translated to a form understandable by a computer. NASA, the most advanced research center in the world for cutting edge technology has discovered that Sanskrit the world’s oldest spiritual language is the only unambiguous spoken language on this planet.

Most of the evidence given here is for the *apara vidya or material knowledge* of the Vedic literature. The Vedas however are more renowned for their *para vidya or spiritual knowledge*. And even superior us the realized knowledge of the Vedic rishis or saints that which is beyond the objective knowledge of modern science. That is the knowledge of the eternal realm of *sat, chit and ananda*, which is true divine bliss.

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Unix Hacks

Sri Shiva Sundar, I M.Sc., DMACS, SSSIHL

INTRODUCTION

Hacks/ Kludges are snippets or a piece of script which forms solution to bugs which we commonly encounter. According to Wikipedia, hacks are work around, clumsy yet effective solutions to the problems we encounter.

Based on the architecture and environment, these hacks can be categorized into different families including Google Hacks, Windows Hacks and Unix Hacks. Many a times we spend a substantial amount of time in figuring out small issues in Linux with the help of forums. I take this opportunity to thank the people in Open source forums who are ever active and are always willing to help. This article is a humble attempt to present hacks associated with the situations which I encountered on my journey to be close to the architecture. I hope this will be useful to a newbie.

HACKS

1) **What happens to UBUNTU when we install WINDOWS?**

If we try to install WINDOWS after UBUNTU installation, the process erases LINUX loader (GRUB or LILO) and installs WINDOWS loader without linking LINUX OS along with it. That is the reason why even though we have carefully chosen a different partition which doesn't belong to UBUNTU for installation of WINDOWS, we do not have an option to choose UBUNTU.

2) **Do we need to install UBUNTU again?**

Here are few solutions

- If we have planned to have both OS in advance, it's better to install WINDOWS first and LINUX later,
- Reinstall LINUX again.
- Better option would be reinstall GRUB.

3) **How do we reinstall GRUB ?**

The following is the procedure to reinstall GRUB (GRand Unified Bootloader):

- Boot the system with UBUNTU live CD/DVD.
- Mount the partition in which UBUNTU is installed before i.e. the root partition (old).
- After we mount the partition which has folders like boot, home, root, usr, bin, tmp. Find the mount point of root partition. You can find it in /media (for example: /media/disk1 or /media/234efsdfgg5dg435gh/ anything like this) and the device name, default name is /dev/sda . If we have more than one HD, we can find that by typing sudo blkid in terminal (applications → accessories → terminal). It shows

all the partitions with its device name, UUID. Now consider only the partitions of the form /dev/sda or /dev/sdb.

- Final step is to open terminal and type `sudo <space> grub-install <space> --root-directory=/media/<mount name> <space><device name>` At this point a message will appear saying grub-installed without any error. Example : `sudo grub-install --root-directory=/media/disk1/dev/sda` If we restart, we get the boot menu showing both the OS.

4) **Can we disable normal user from using pen drive or DVD drive to keep system secure?**

Here is the way. We need to mount necessary partitions in the boot time (location other than /media, because by default pen drive will get mounted in /media). To change /media file permissions we need to login as root. Type `sudo chmod 700 /media` in the terminal to make sure that only root has permissions to read, write and execute. Normal user will not be able to access the mounted drive automatically. We can ensure data security in this way. Nevertheless , user can access partitions mounted in other partitions.

5) **How to remove Linux safely ?**

If we don't want Linux in our system, it's not enough to format that partition using Windows disk management. Once we restart we will encounter a real problem. Grub Loader which gets to have information about the MBR no longer exists. Now here is the situation where we cannot get into the WINDOWS.

Inorder to overcome this situation, we need to follow the following steps.

- If the system has XP, then boot the system with a Windows XP CD and go to repair.
In the command prompt type `fixmbr` and enter. Now type `y` to continue. Restart the system to see Windows loading without any grub. Linux is fully gone and the Windows is back.
- If it is Vista or higher , boot with Windows 7 DVD and select repair, in the tools, select command prompt , and type `bootrec/fixmbr` and restart.

6) Error: NTLDR is missing in Windows?

Boot with XP CD and in the command prompt type
copy ntldr c:
and copy ntdetect.com c:

7) Error: bootmgr is missing/error loading operating system in Windows?

Boot with Windows 7 DVD and in the command prompt type bootsect.exe/nt60 c:

8) Remote desktop connection to Linux from Windows system

There are so many complicated ways of achieving this which can be found on internet. But here are the simpler solutions.

- Use putty. It is only for command line usage.
- Xming is a free X-server for Windows through which one can get Linux GUI. Download and install it in Windows XP or Windows 7. After that open XLaunch to give a name for the window. Set the program name to be “GNOME-Session”. Set the host IP and use putty.

9) Remote Desktop of Windows from Linux:

Use rdesktop command with -f option for full screen and “Ctrl+Alt+Enter” to toggle between full screen and desktop. Remote desktop should be allowed in the destination host. Check man rdesktop for details. For example:

```
rdesktop -f -u admin@10.0.2.31
```

10) Connecting from one Linux system to another Linux system

Use ssh with a -X option for GUI display.

For example : ssh -X imsc@10.0.2.31

To open the file browser type

```
imsc@10.0.2.31$nautilus
```

Poems

IF...

(with undue apology to Kipling!)

If the orbital motion of the earth's moon,
Inspires you to describe a continuous change,
Which in turn measures the gain-loss of a concern,
And, yet, demystifies a varying stock-exchange.

If the shape of shells as well the path of planets
Impels you to codify these intrinsic properties,
Which in turn are stretched many dimensions
And, yet, lays bare an atom's mechanics.

If the compulsions of complex computations
Induces to create an automated device,
Which in turn seeks to replace a human's functions
And, yet, ushers in riches, comfort and ease.

If the world around you and beyond your ken,
If the nature's vagaries and vague human thinking
Increases your urge to decipher their mystery,
In equations and concepts of bewildering variety,
Which in turn invest great power in you,
Which in turn drive you to imitate God,
And, yet, open your eyes to the Creator's Glory,
And, yet, fill you with humility and surrender.

If this broad spectrum of human knowledge,
Makes you realize your role in creation,
Then, more than a Mathematician or a Computer engineer,
You are a thinker and a wise man, my dear!

- Sri R. Subramaniam,
Associate Professor, DMACS, SSSIHL.

AN OCEAN CALLED MATHEMATICS

I jumped into a small pool named Maths,
and with the help of many, learnt the art of swimming.
Diving in and out and reaching newer depths,
I was the one with utmost joy brimming.

Many a strokes I did learn as the years passed by,
until a day when I somehow reached the other end.
It was then I realized, I had to let this all go by,
for, all this was only PRIMARY and not the end.

Feeling fully equipped, I let myself flow along
a small stream, that I saw leaving the pool.
To realize my foolishness it didn't take very long,
for, I was led into an ocean and not a small pool.

This is the ocean from which many a hinterlands did gain.
This is where many a sunken treasure chests were unearthed.
Life, for some, is living in these waters and diving deeper,
For others, life, without these waters, ceases to exist.

- Sri O. Sai Prudhvi,
III B.Sc (Maths), DMACS, SSSIHL.

Poems Continued . . .

STORY OF A POLYNOMIAL

Kernel like powers I can wield,
Yes, I am an irreducible polynomial over an F field.

It all began when someone performed F's finite extension,
Hah! They got only one root of mine; no apprehension.

For all my roots they required to do an extension of factorial n,
Not an easy task for the wavering minds of men.

Suddenly Galois got the splitting field K for me to linearly factorize,
It was a normal extension to my immense surprise.

I truly appreciate the genius of Galois though with feelings mixed,
For he saw automorphs of K permuting my roots keeping F fixed.

Anytime to observe a property is what is important,
Try to develop this or you will remain ignorant.

I, but no longer, can continue with these digressions,
For Galois forged Galois group to rob my irreducibility possessions.

Subfields of K containing F and subgroups of G(K,F) simply followed,
The normality preserving & inclusion reversing relations hallowed.

My solvability by radicals was clearly Galois' design,
What men can't do when Divine Grace is benign?

For $n \geq 5$, I was not solvable by radicals, thus saved from insult,
Men too were satisfied when Galois gave this result.

- Sri Aditya Prakash,
I M.Tech., DMACS, SSSIHL.

INNERVIEW			
	Dr. Bala Subramanian		Sri. N. Uday Kiran
<i>Most Inspiring teacher of my life</i>	Prof. Ramesh Sharma	My 12th class chemistry teacher (Satyanarayana sir).	
<i>Most valuable lesson from my experience in teaching</i>	Prepare well and work hard and be sincere - You'll gain students' love and respect.	Teaching is a best way of learning any subject. If you want to learn something, try teaching it to somebody.	
<i>One tip for young faculty</i>	Put yourself in the shoes of students and think before taking any crucial decisions	N/A ☺	
<i>Most inspiring quote</i>	This too shall pass.	Bhagavad Gita (one long quote).	
<i>One dream I would like to chase</i>	Publish as many M.Tech project works of my students in top journals like IEEE Trans and give them satisfaction.	Obviously, Fields medal!	
<i>One tip for time management</i>	Start early (prepare well in advance), drive the concepts slowly and steadily and finish the syllabus safely.	Don't 'manage' time! Do the right thing at the right time and give your best.	
<i>My perspective on research</i>	Research is always ongoing and it is for passionate ones. Right ambience and infrastructure have to be provided for such passionate ones to bring laurels to the organization he is working and for himself.	Research is a process of discovering the same concept again and again with newer insights and with 'Aha!' moments.	
<i>One quality I admire in a student</i>	Their faith in their teacher.	Love for subject.	
<i>One value I cherish</i>	Love	$e^{i\pi} + 1$	
<i>Best memory of DMACS</i>	Sitting with Raghu sir for days together in DMACS and breaking our heads regarding our PHD work. Innumerable times we changed gears! Unforgettable are those days.	DMACS has not yet become a memory for me! I am enjoying every moment of my stay here - learning and laughing.	

		
Prof.V.Chandrasekaran	Prof. K. S. Sridharan	Dr. Raghunatha Sarma
Mathematics teacher in my school who kindled my passion for mathematics.	Spiritual: Bhagawan Sri Satya Sai Baba Academic: Prof. K. Radhakrishna Rao, EE Dept, IIT Madras.	Prof C.J. M. Rao ; For his passion in subject and compassion for students.
Learning never stops even while teaching	To get a rapport with students on the subject taught followed by injection of human values/teachings of Bhagawan into minds of students.	Passionately prepare for the class... Dispassionately deliver... Answer the questions with energy and spring!
Never say die attitude.	To go inward, experience divinity, develop self confidence and bring in the window of love or God: discharge the duties assigned.	Make students see how the author went about developing the subject in the course you are teaching.
The one who dares to teach must never cease to learn	Love of God is supreme; Love of any other individual will take undesirable form. -Baba	"Alalu vadalu... Raallu kadalavu" The waves of the ocean don't give up thrashing, neither the stones budge an inch on the shore! Never Give up -- Baba
The world within and Without	To go in for total resonance with Divinity and achieve excellence both professional and spiritual.	To be at least a small part of Bhagawan's dream.
Prioritize , Perform and Persevere	Take guidance from experience s and intuitive mind. Prioritize the activities.	Be friend people who respect their time.!
Unfolding the mysteries of God's creation	Research is unending, make efforts consistently for good contribution and share the same with younger people.	Constant hunger to know more... more the merrier
Curiosity	Sincerity in learning and hardwork.	"Ye dil mange more!" attitude
Excellence in all that I do	Selflessness	To be sad you need a reason; to be happy you don't need a reason.....
Energetic, Enthusiastic and Enlightening Family	Love and Cooperative minds and heart	The day when I joined dept... 5th July 1995... Loving invitation into the fold of DMACS.

M.Tech. Projects 2012

I. CONTEXT AWARE HADOOP SCHEDULER

(**Arun Kumar K**, Prof. G.V. Prabhakar Rao)

Hadoop was originally designed to handle the execution of MapReduce type of applications along with an infrastructure to support distributing it over multiple machines in large physical datacenter. Hadoop's performance is due to its Task Scheduler but the Task Scheduler assumes homogeneity across nodes and the workloads. There is an increase in the heterogeneity of the clusters due to replacement of the failure nodes and upgrading of the existing nodes. Existing Hadoop schedulers assume homogeneity in cluster and don't consider the workload types and the node heterogeneity. So, these schedulers can cause severe performance degradation in heterogeneous environments.

The design of our scheduler is based on the following two key insights:

- 1) a large percentage of the MapReduce jobs that are run are periodic in nature. That is, these jobs execute at the same time and roughly have the same characteristics with respect to their CPU, network and disk resource requirements.
- 2) The nodes in a Hadoop cluster over time become heterogeneous in nature as failed and old nodes are replaced by newer ones.

We have implemented CASH algorithm in both a simulator and also in a real Hadoop MapReduce cluster. We quantitatively compare CASH with the existing Hadoop FIFO scheduler and our results show significant improvement in the overall execution time of a set of MapReduce jobs. Additionally, we also extend our task placement enhancement to the existing Hadoop Capacity scheduler, and show that the benefits of our insights can also be realized in the existing Hadoop Capacity scheduler.

II. EXPLOITING MULTIPLE CONTEXTUAL SOURCES TO PERSONALIZE WEB SEARCH USING A COMBINATION OF ASSOCIATION RULE MINING AND STATISTICAL LANGUAGE MODELLING

(**Anil Sriharsha. B**, Dr. S. Balasubramanian, Prof. V. Chandrasekaran.)

With the proliferation of the Internet and the advent of search engines like Google, Bing and Yahoo, smart Information retrieval technologies that are highly adaptable with respect to user information needs and preferences are in high demand. User satisfaction has become the prime concern for developing search technologies. Thus there is a need for a shift from a generic approach towards information retrieval to a suite of personalized approaches that are context sensitive in nature. These approaches enhance the quality of search results

returned by a search engine for a query issued by the user and helps the user in finding relevant information in a faster and efficient way.

We evaluated the contribution of multiple contextual sources and a combination of them in personalizing web search results. We installed the Lemur Query Log toolbar, an add-on for Mozilla Firefox to capture the behavioural patterns of the users during their search activities. We generated our own real world data set for carrying out our experimental study. We probed deep into the search histories of the users to identify the most related past queries using an improved Association rule mining technique. We leveraged the most appropriate short-term and long-term history for the current input query of a user to construct strong query context models using statistical language modelling.

We performed a rigorous analysis on the re-ranking scores generated by each of the models. We observed substantial performance gains with respect to a class of standard and novel metrics defined by us. From our investigations it was observed that identifying the most related past queries for the current query is a very valuable operation. We also observed that the best performance with respect to the class of metrics was achieved when the most appropriate contextual source and a combination of the most appropriate contextual sources were leveraged for constructing query context models.

III. AUTOMATIC PREDICTION OF UNROLL FACTOR USING SUPPORT-VECTOR CLASSIFICATION

(**Dibyam Pradhan**, Dr. S. Balasubramanian)

An optimizing compiler depends heavily on its internal heuristics for the choice of the degree of optimizations. Many times the decision of a compiler may not be an optimal one for a particular optimization. This study focuses on one such optimization technique, called as loop unrolling. Loop unrolling is a very complex optimization technique due to the various factors involved in making the unrolling decision. This study aims at the automatic prediction of loop unroll factor using Support Vector Classification.

This study presents an in-depth analysis of the features that affect the unrolling decision and their inclusion in the feature set. The main focus is on gcc-Xeon compiler-architecture pair. We follow a hybrid approach to unrolling factor prediction which consists of prediction of optimal unroll factor by first external unrolling of loops and then by compiler's internal unrolling of loops. We also follow an intuitive approach to feature selection. We create three models during the study. On an average, the three models predict within 13.56%, 11.16% and 12.67% of optimal performance respectively while gcc predicts within 41.75% of optimal performance. Also, the three

model's prediction falls within 10% of optimal performance 77.5%, 77.5% and 79.5% of the times respectively while gcc's prediction falls within 10% of optimal performance only 61.9% of the times. The hope is that future compiler writers would incorporate such machine learning models in the compiler code itself so that the compiler can make its decisions based on the output of the machine learning model and hence, can make better optimization decisions.

IV. PERFORMANCE ENHANCEMENT OF V8 JAVASCRIPT ENGINE USING LLVM AS A BACK-END

(**Dusi Sarath Chandra**, Dr. S. Balasubramanian)

In the modern world, internet is a need rather than a luxury. With the ever increasing rate of internet connectivity speeds, the modern day web browsers need to load web pages faster. Traditional compilation strategies opted by the web browser engines achieved performance gain, but sadly consumes unusual amount of compilation time. This leads to the investigation of sophisticated compilation strategies.

Low Level Virtual Machine (LLVM) is a compiler framework that aims at lifelong program analysis and transformation for arbitrary programs, by providing high-level information to the compiler transformations at compile-time, link-time, runtime, and in idle time between runs. LLVM compiler framework is proven to be effective for both statically and dynamically typed languages. JavaScript is one such dynamically, weakly typed, object oriented language. V8 is the Google's open source JavaScript engine that implements ECMAScript as specified in ECMA-262, 5th edition. It currently powers the Google Chrome Browser. This study aims to use LLVM as a back-end for V8 JavaScript engine to examine the performance of arbitrary JavaScript programs.

We have implemented and examined the following set of JavaScript operators: Division, Modulo Division, Shift Left, Shift Right, Bit-wise AND, Bit-wise OR, Bit-wise XOR and Two dynamic typing mechanisms: Staged Tags and Tagged Pointer Variation. Both the implementations are space and time efficient. The results and analysis obtained suggest the usage of LLVM as a back-end for V8 JavaScript Engine to enhance the performance.

V. PRIVACY PRESERVING DATA MANAGEMENT IN OUTSOURCED ENVIRONMENTS: A GRAPH COLORING BASED APPROACH

(**K.N. Sai Krishna R**, Dr. Pallav Kumar Baruah)

With the increasing cost of maintaining IT centers, there is a trend among organizations to outsource data management functions to a third-party service provider to reduce storage and computational cost. However, this opens the door for privacy violations. Existing approaches for protecting data confidentiality are based on encryption and fragmentation.

In this work, we propose an approach based only on fragmentation. In particular, we discuss the issue of employing

both vertical and horizontal fragmentation to a database relation so that minimum amount of data is stored at the owner. We represent the privacy (confidentiality) constraints as a graph. The constraint graph may have some cycles. We employ the two-coloring technique for the acyclic portion of the graph. We propose some heuristic algorithms to eliminate cycles and complete the coloring of all the nodes in the graph. This leads to an effective fragmentation process. The algorithm assigns one set of nodes to owner and the other to the external server.

The proposed scheme considers both data dependent and data independent confidentiality constraints in the case of single relation as well as multiple relations. In addition, it considers dependency constraints. We illustrate the proposed schemes using examples. We provide detailed analysis and experimental results to prove the efficiency and correctness for a single relation. We provide proof of correctness for the proposed scheme.

VI. ANALYSIS OF STRATEGIES FOR PERFORMANCE ENHANCEMENT OF APPLICATIONS ON GPUS

(**Kolluru Vamshi Krishna**, Dr. Pallav Kumar Baruah)

Graphics Processing Unit(GPU) have become extremely popular for applications from various domains due to its massive computing ability. The application programmer creates these applications with the help of existing kernels. The increase in size and complexity of the applications leads to an increase in the number of possible optimizations. Most of the existing methods developed can be used to manually hand tune the code or individual kernels which becomes a horrendous task with the increase in number of kernels.

We developed and proposed strategies to enhance the performance of applications on the single GPU. We demonstrated these strategies on a molecular dynamics code by refactoring the kernels through merging. We also showed that these strategies performed showed a 50-70% improvement on synthetic kernels. We developed a tool which takes the CUDA source code as the input and outputs an optimized CUDA code.

There has been a need to shift from a single GPU to Multiple GPU due to the requirement of higher computational power to handle applications for very large size. There is a difficulty of scaling the applications from single GPU to Multiple GPU. We study one such factor which plays an important role in an application on multiple GPU i.e communication strategy. We conclude that the Peer to Peer communication strategy performs the best on the CUDA 4.0. We also analyzed the importance of handling multiple GPUs using multiple CPU Threads due to the additional overhead of the GPU Context Switching.

VII. SIMULATING LTE-RLC SUBLAYER(TM/UM) IN OMNET++ USING MIXIM FRAMEWORK

(**Nagarajan R**, Dr. R. Raghunatha Sarma)

In this work, we have presented the work done to simulate part of the LTE RLC sublayer. The RLC entity is positioned

between the PDCP layer and the MAC layer. Its responsibility is re-formating PDCP PDUs in order to fit them into the size indicated by the MAC layer. Accordingly depending on the situation RLC at the transmitting side segments and(or) concatenates the PDUs received from the PDCP layer above. The RLC entity at the receiving side reassembles the RLC PDUs to reconstruct the PDCP PDUs. This layer guarantees in-order delivery of upper layer PDUs (UM/AM), duplicate detection (UM/AM), rejection of received packets which are incomplete (UM/AM) and retransmission of lost PDUs (Only in AM).

The simulation is carried out in the OMNeT++ simulator using MiXiM framework. In particular, we have completely simulated the Transparent Mode(TM) and Unacknowledged Mode(UM) way of communication between transmitting side and the receiving side of an RLC entity. For creating the working module, we have built a dummy Transport layer. We have also simulated the VOIP/VIDEO traffic which are delay sensitive application at the Application layer for exposing the RLC layer with the different traffic flows. We have substituted CSMA MAC layer available in MiXiM framework for LTE MAC sublayer to demonstrate RLC functionality in both TM and UM.

VIII. SCALING DOWN TLB MISS PENALTY THROUGH MMU CACHES

(**Naveen M.**, Dr. S. Balasubramanian)

Modern architectures and operating systems provide an implementation called paging to support large address spaces. Also, to speed up the address translation processors come with a hardware called Translation Lookaside Buffer(TLB) that caches the page mappings. All is well as long as the translations are directly served by the TLB. But in case of a TLB miss, the penalty incurred to obtain the translation could be very expensive. For example, in the case of a 4-level hierarchical page table organization, there would be an overhead of four memory accesses per miss. And, this overhead would only increase with the increase in the depth of the page table organization.

In the current work, we have simulated five different designs of an on-chip cache called the MMU cache that caches the upper level page table entries. Further, we have investigated the efficacy of MMU caches in its ability to reduce the rate of TLB miss penalty. These caches come in different flavours including physically indexed and virtually indexed as well in the unified and partitioned form. Being an on-chip hardware, size is an important factor to be investigated. Further, as applications could be dense or sparse, replacement policy is another important attribute to be investigated. On these grounds, our analysis reports that an unified cache with variable insertion LRU is the appropriate MMU cache design that could be deployed. MMU caches aim at reducing TLB miss penalty. But, TLB misses themselves could be reduced. Towards this end we implemented a TLB prefetching called Distance Prefetching(DP). We observed a 4DP.

IX. PARALLELIZATION OF DERIVATIVE PRICING USING GPU

(**Phani Krishna K.**, Dr. Pallav Kumar Baruah)

Computing option price of a given asset plays vital role in hedging risk. There are many methods proposed in literature to compute the same. Calculating option price is a highly compute intensive process and will immensely benefit from parallelization. Existing work in parallelizing the computation of option price have been successfully performed on multi-core processors achieving moderate accuracy.

We successfully parallelized the Binomial method, Monte Carlo method and Statistical based approach (actuarial approach) to compute the option price using GPUs. From our observations, we have found that utilization of GPUs have reduced the time required for computation of the option price from hundreds of seconds to milliseconds. This feature is highly essential and relevant in the field of computational finance since the option price of a particular asset is required to be computed very fast. We have also achieved better accuracy of estimating the option premium by increasing the number of time steps. In terms of estimation accuracy, the actuarial method gave the best estimate of the option price against the real market price when compared to the other two implementations.

X. AUTOMATIC LOOP TILE SIZE SELECTION USING K-NEAREST NEIGHBORS ALGORITHM

(**Praveen K.**, Dr. S. Balasubramanian)

Most of the code optimization techniques involve static examination of the code to find certain interesting aspects of it and then, making a decision on what to optimize using certain internal heuristics. Loop tiling is a complex optimization technique due to the various factors which affect the optimal tile size for a given problem. Tile Size Selection is the key step in effective use of tiling. Existing works in literature have proposed various TSS models using different heuristics but, have not addressed the question "*Given a kernel, does it benefit from tiling?*"

Instead of performing tiling for any arbitrary code in a blind fold manner, we build a composite model which not only addresses the aspect of optimal TSS, but also identifies the necessity whether a particular kernel requires tiling. We propose a set of programmatic features that can identify the necessity of a code to be tiled. We subsequently build a Machine Learning Model based on the features to predict the optimal tile size. The model is trained using Instance Based Learning (IBk), an implementation of the k-nearest neighbor technique in Weka and evaluated using leave-one-out-cross-validation on nine different architecture/compiler combinations. Our model performs consistently (on an average, within 21.28% of the optimal) well for various architecture/compiler combinations. We demonstrate the robustness of our model in tile size prediction when the problem size for a given kernel is varied. Even here, our model is able to predict the optimal tile size within 24.15% optimality range.

We also compared the performance of our model against the compiler's native tiling. We are able to obtain a maximum of 135.59% performance enhancement against GCC's native tiling for those kernels which benefits from tiling in the Polybench suite. We also obtained substantial performance improvement under other architectures against GCC's native tiling.

XI. SIMULATION OF RLC SUBLAYER(AM-MODE)IN OMNET++ USING MiXiM FRAMEWORK

(R Arun Sathyaranayanan, Dr. R. Raghunatha Sarma)

In today's world of technology, the ever increasing demand for mobile data consumption has made the world seek 4G technology that promises to provide ultra-fast broadband and ubiquitous Internet Access. Realizing this steep growth of mobile data consumption, the mobile operators are moving directly to 4G technologies. LTE seems to be a clear winner among the other 4G technologies that exist today. It has taken the first position among the other 4G technologies because of its ability to offer higher data rates, spectral efficiency, high cell capacity at lower cost and to operate at lower bandwidths.

We have simulated part of the LTE RLC sublayer functionality in this thesis work. The RLC entity is placed between the PDCP layer and the MAC layer. This layer guarantees in-order delivery of upper layer PDUs (UM/AM), duplicate detection(UM/AM), rejection of received packets which are incomplete(UM/AM) and also retransmission of lost packets(only in AM). The core responsibility of transmitting RLC entity is re-formatting PDCP PDUs in order to fit them into the size indicated by the MAC layer. Accordingly, depending on the situation, the RLC at the transmitting side segments and(or) concatenates the PDUs received from the PDCP layer above. The RLC entity at the receiving side reassembles the RLC PDUs to reconstruct the PDCP PDUs.

The simulation is carried out in the MiXiM framework of OMNeT++ simulator. In particular, we have completely simulated the Acknowledged Mode(AM) way of communication between the transmitting side and the receiving side of RLC entity. This mode is more advanced than other RLC modes such as Transparent mode(TM) and Unacknowledged Mode(UM), as it guarantees retransmission of the lost PDUs. It is typically used by loss-sensitive applications such as ftp, http, etc. and thus needs sophisticated mechanisms to assure reliable data delivery. For creating the working module, we have built a dummy Transport layer. We have also simulated the http/ftp traffic at the Application layer for exposing the RLC layer with different traffic flows. We have substituted CSMA MAC layer available in MiXiM framework for LTE MAC sublayer and added additional functionality in CSMA MAC to demonstrate the working of RLC sublayer in AM mode.

XII. EFFICIENT PRIVACY PRESERVING DATA DISTRIBUTION IN OUTSOURCED ENVIRONMENTS USING CLUSTERING TECHNIQUE

(T. J. V. R. K. M. K. Sayi, Dr. Pallav Kumar Baruah)

With the increasing costs of running independent data centers, and with increasing opportunities to outsource data at cheaper costs, more and more organizations are looking at outsourcing their data to larger data centers outside their environments. However, guaranteeing security and privacy of the outsourced data is a challenge. In this thesis, we primarily look at the privacy aspect. Here, data privacy is defined in terms of privacy(confidentiality) constraints—which is the set of attributes that together compromise the privacy of the entity that they describe. In such a case, we need to partition the attributes of the data (say a relation) into two parts so that the group of attributes that together compromise the privacy are in different parts. Since obtaining optimal fragments is NP-hard, we suggest several heuristic algorithms using the clustering techniques that are popular in data mining. Here, our objective is to cluster the data attributes into two clusters so that one cluster is outsourced (i.e., server cluster) and the other one is stored at the data owner (i.e., owner cluster). While the owner cluster is not subjected to any privacy constraints, the server cluster must ensure that it does not violate any privacy constraints enforced by the owner.

The main objective is to minimize the owner cluster size, and thereby maximize the server cluster size. We employ both horizontal and vertical fragmentation using clustering technique so that minimum amount of data is stored at the owner and none of the privacy constraints are violated by the server fragment. We extend this work to multi-owner scenario where parts of the data are now owned by several data owners with possibly independent privacy constraints. So while certain subset of attributes do not violate the privacy of one data owner, they could violate other owner's privacy constraints. In other words, the partitioning needs to be done in an integrated way among the sites rather than repeating the earlier one-data owner algorithm repeatedly for all data owners. We propose a heuristic algorithm for data partitioning in multi-owner scenario. We provide proof of correctness for the proposed algorithms and also present experimental results to prove their efficiency.

XIII. GRAY-SCALE VIDEO SUPER RESOLUTION USING ADAPTIVE WEINER FILTER

(Umar Ali Nagoor Saheb. Shaik, Prof. V. Chandrasekaran)

The term "Super-Resolution (SR)" refers to the process of reconstructing an High-Resolution (HR) image from a multiple Low-Resolution (LR) images of the same scene to overcome the limitations of an imaging system. This technique tries to take advantage of the additional spatio-temporal data available in the sequence of LR frames. Super- Resolution technique can be interpreted as inverse problem , where multiple LR images of same scene are combined to reconstruct the original HR image. The quality improvement is caused by sub-pixel movement between the LR frames.

In many applications, both military and civilian , the imaging systems have very poor resolution images as outputs. Super-Resolution technique is useful when the resolution of an imaging system can not be enhanced by replacing sensors, either because of hardware limits or cost, we can make

use of SR algorithms. Even when the imaging system with high resolution is available, SR techniques are inexpensive alternative.

In the first part of the thesis, we presented a comprehensive literature review of all the existing SR techniques and the respective the pros and cons. Next, we proposed a technique for real-time video sequences along with the AWF approach for SR reconstruction problem.

In the second part of the thesis, a novel SR technique based on multi-resolution approach has been proposed. In this method, it is demonstrated that the hierarchical evolution of HR frames result much improved quality albeit these are computationally expensive. Considering the nature of computing, it is possible to implement this technique in HiPC platform with GPGPUs to speedup the computation. At the end, we highlight the future research challenges.

XIV. IMPLEMENTATION AND EVALUATION OF SCALABLE DATA STRUCTURE OVER HBASE

(Vamshi Krishna Konishetty, Prof. G. V. Prabhakar Rao)

With the emergence of commodity hardware architectures and distributed open source software, users are performing analytics on more types of data. Web 2.0 applications like social networking sites faceBook, Twitter, Drop- Box, LinkedIn are building scalable applications that have to deal with a lot of meta-data. It is increasingly becoming hard for the programmers of these applications to store the meta-data in a relational database, and then subsequently load/unload it from main memory. The amount of meta-data in some cases is in the order of hundreds of terabytes, and thus, it can't fit into main memory. Currently, it is the responsibility of the application programmers to manually map these in-memory data structures into persistent storage systems like a database or file system. Ideally, the application programmers would like the underlying programming language/middleware software to seamlessly manage the scalable data structures. It is increasingly becoming hard to use the traditional database or storage controller systems to store this meta-data because of cost and scale reasons. Thus, new NoSQL database architectures are emerging that are built on commodity hardware architectures and they can scale to large sizes in an incremental manner. Thus, there is an opportunity for the builders of NoSQL systems to provide scalable in-memory data structures. Some NoSQL database vendors are starting to provide these scalable data structures on top of NoSQL storage architectures. However, currently, these types of data structure interfaces are not available in the popular Hadoop NoSQL infrastructure. Here, we show how to implement the Set data structure in a scalable manner on top of Hadoop HBase.

We first describe the characteristics of NoSQL databases and how they are different than traditional relational databases. Subsequently, we provide a survey of some existing NoSQL systems. We then show how to implement the Set data structure in a scalable manner on top of Hadoop HBase/HDFS ecosystem. We then propose and implement optimizations for the Set Union, Intersection and Difference operators. We also discuss the limitations of implementing this data structure in

the Hadoop ecosystem. We evaluated our algorithms and optimizations on a real Hadoop cluster. Our primary conclusion is that the Hadoop ecosystem provides an excellent framework to implement scalable data structures.

XV. AN APPROACH TO ONTOLOGY DEVELOPMENT FOR INDIAN SCHOOL EDUCATION DOMAIN

(V R K H Sailesh Vasa, Dr. K. S. Sridharan)

The vision of the Semantic Web is to transfer the web's data into one single structure and making it processable by machines. This will result in better understanding of the data and its interpretation. If the machines interpret the data on the web, then many complex things like personalised and semantic search can be easily achieved. To achieve this, we need an ontology-based search system which is tailor made for the application at hand. For instance, the problem of capturing the content from Education domain, the semantic web should consider the various aspects of the curriculum-syllabi structure currently prevalent. Given the heterogeneous standards in the education system, this is a herculean task. One common approach to handle this issue is through domain-ontologies, which capture a given domain in its entirety.

There have been many ontologies that are constructed for certain domains like E-commerce, Bio-informatics and so on. But with regard to School Education domain, there is very less work done before. Especially in the Indian context which has many dimensions like different Boards, different media of instructions, different syllabi structure, developing an ontology capturing the relations between the curricula and defining a common structure may help the students across the country in many ways. We proposed an approach to define an ontology for the Indian school Education domain.

Given the magnitude of task, we confine ourselves to building a prototype ontology for subdomain. The sub domain we have considered is the discipline of Mathematics and we have captured the relations between five Indian Education Boards, namely Andhra Pradesh Board, NCERT, Tamil Nadu Board, Kerala Board, and Karnataka Board. To evaluate the ontology we have developed an application to classify mathematics web pages into subcategories. We implemented the Trie data structure for simple search and compare operations in the application. The work contributes to the list of domain ontologies that helps the vision of the Semantic Web. We have undertaken this work in collaboration with Sri Sathya Sai Vidya Vahini, an on-going project for web-based e-learning to provide teachers and students in rural areas with necessary content to enhance their teaching and learning.

Recent Publications

IN CONFERENCES

- 1) D. H. R. Naidu, S. Srinivasan, "A Bayesian framework for robust speech enhancement under varying contexts", in IEEE International Conference on Acoustics, Speech, and Signal Processing(ICASSP 2012), March 25-30, 2012, Kyoto, Japan.
- 2) Rakesh K Tripathi, Vivek V. Raich, Kumar Dookhitram, Dr. Sanat K. Dalal, Sai Hareesh.A "Similarity between Max Min and $\langle R|V \rangle$ technique with reference to two diseases diarrhea and diabetes" - in IEEE National Conference on Computational Intelligence and Signal Processing, March 2-3, 2012, Assam, India.
- 3) T. Aditya, P K Baruah and Ravi Mukkamala, "Employing Bloom Filters for Enforcing Integrity of Outsourced Database in Cloud Environments", ACM-SPRINGER International Conference on Advances in Computing and Communications (ACC-2011), July 22-24, 2011, Kochi, India.
- 4) Prabhakar Akella, Sai Hareesh Anamandra, "Role of neutral element in Absorption equation" - in International Summer School on Aggregation Operators (AGOP 2011), July 11-15, 2011, Benevento, Italy, pp 111-116.
- 5) D. Hanumantha Rao Naidu, G. V. Prabhakara Rao, Sriram Srinivasan, "Speech Enhancement Using Speaker Dependent Codebooks", Proceedings of the 17th International Conference on Digital Signal Processing, 2011" (DSP2011) July 6-8, 2011 Corfu, Greece. pp. 1-6.
- 6) T Aditya, P K Baruah and Ravi Mukkamala, "Space-efficient Bloom Filters for Enforcing Integrity of Outsourced Data in Cloud Environments", , in 4th International Conference on Cloud Computing (IEEE CLOUD 2011), July 4-9, 2011, Washington DC, USA. pp. 292-299.
- 7) Dibyam Pradhan, Naveen M, Sai Hareesh A, P.K.Baruah, V. Chandrasekaran, "A Computationally Efficient Approach for Exemplar-based Color Image Inpainting using GPU" - 'Best Presentation Award' in 8th Annual IEEE International Conference on High Performance Computing: Student Research Symposium (HiPC 2011), December 18-21, 2011, Bengaluru.
- 8) T.J.V.R.K.M.K. Sayi, R.K.N. Sai Krishna, R. Mukkamala, P.K. Baruah, "Privacy Preserving Data Distribution in Outsourced Environments", in 8th Annual IEEE International Conference on High Performance Computing: Student Research Symposium (HiPC 2011), December 18-21, 2011, Bengaluru.
- 9) Praveen K, Kolluru Vamshi Krishna, Bandhakavi Anil Sri Harsha, S Balasubramanian, Pallav Kumar Baruah, "Cost Efficient PageRank Computation using GPU", in 8th Annual IEEE International Conference on High Performance Computing: Student Research Symposium (HiPC 2011), December 18-21, 2011, Bengaluru.

- 10) T.J.V.R.K.M.K. Sayi, R.K.N. Sai Krishna, R. Mukkamala, P.K. Baruah, "Data Outsourcing in Cloud Environments: A Privacy Preserving Approach", in 9th International Conference on Information Technology : New Generations, (ITNG 2012), April 16-18, 2012, Las Vegas, Nevada, USA.

- 11) R.K.N. Sai Krishna, T.J.V.R.K.M.K. Sayi, R. Mukkamala, P.K. Baruah, "Privacy-Preserving Data Management in Mobile Environments: A Partial Encryption Approach", in 13th International Conference on Mobile Data Management, (IEEE MDM2012). July 23-26, 2012, Bengaluru, India.

IN JOURNALS

- 1) D. K. K. Vamsi and Pallav Kumar Baruah, "Existential Results for Nonlinear Sturm-Liouville Singular Interface Problems", International Journal of Mathematics Research, Vol. 4, No. 1, 2012, pp. 1-14.
- 2) D. K. K. Vamsi and Pallav Kumar Baruah, "Existential Results for Nonlinear Singular Interface Problems Involving Second Order Nonlinear Dynamic Equations Using Picards Iterative Technique", The Journal of Nonlinear Analysis and Applications, Vol. 4, No. 3, 2011, pp. 200-209.
- 3) D. K. K. Vamsi and Pallav Kumar Baruah, "Disconjugacy(D) and Non-Oscillation(N) Domains for Nonlinear Singular Interface Problems on Semi Infinite Time Scales", ISRN Mathematical Analysis, Vol. 2011, pp. 1-23.
- 4) Y. Laxmi Naidu, "Minimum Global dominating set of an Interval Graph", International Journal of mathematical Sciences and Engg. Applications(IJMSEA), Vol.5.No IV, 2011, pp. 265-269.
- 5) N. Uday Kiran, Ramesh Sharma and M. S. Srinath, "Normal Vector As An Eigenvector Of The Weingarten Matrix", International Electronic Journal of Geometry (IEJG), Volume 4, No. 1 (2011), pp. 125-128.

AS BOOK CHAPTERS

- 1) T. Aditya, P K Baruah and Ravi Mukkamala, "Employing Bloom Filters for Enforcing Integrity of Outsourced Databases in Cloud Environments", Advances in Computing and Communications, Springer Berlin Heidelberg, Vol. 190, Part 5 (2011), pp. 446-460.

Workshops Conducted

WORKSHOP ON ANALYSIS AND DIFFERENTIAL EQUATIONS

Duration: February 17-18, 2012.

This workshop was conceptualised to interface with eminent people in the analysis and differential equations area in India and to know from them directly the emergence and essentiality of various facets of this field.

LIST OF SPEAKERS & THEIR TITLES

- 1) Prof C. Jagan Mohan Rao, SSSIHL, India: "*Inaugural Address*"
- 2) Prof V. Raghavendra, IIT-Kanpur, India: "*Partial Differential Equations (PDE) : Levy's Non-existence Theorem*"
- 3) Prof. Amiya K. Pani, IIT-Mumbai, India: "*Numerical Approximations*"
- 4) Prof D. Bahuguna, IIT-Kanpur, India: "*Theory and Methods for the First Order PDE*"
- 5) Prof. B. V. Rathish Kumar, IIT-Kanpur, India: "*Spectral Methods for PDE*"
- 6) Prof V. Raghavendra, IIT-Kanpur, India : "*A Quick Review of Sobolev Spaces*"
- 7) Prof D. Bahuguna, IIT-Kanpur, India: "*Classification of Second Order Partial Differential Equations*"
- 8) Prof. Amiya K. Pani, IIT-Mumbai, India: "*Finite Difference Methods*"
- 9) Prof V. Raghavendra, IIT-Kanpur, India: "*Linear Elliptic Dirichlet Boundary Value Problems*"
- 10) Prof D. Bahuguna, IIT-Kanpur, India: "*Theory and Methods for the Second Order Partial Differential Equations*"
- 11) Prof V. Raghavendra, IIT-Kanpur, India: "*Is One-Oneness Equivalent to Onto?*"
- 12) Prof. Amiya K. Pani, IIT-Mumbai, India: "*Navier Stokes Equations: A Million Dollar Open Problem*"

WORKSHOP ON PRINCIPLES AND PRACTICES OF SOFTWARE ENGINEERING

Duration: March 10, 2012.

The motivation behind this workshop is to provide a comprehensive view and in depth knowledge in various domains pertaining to Computer Science/IT including software, hardware, business intelligence from a practitioner perspective in the industry.

The workshop basically focused on bringing out clarity on different domains of specialization and how they are inter-linked. The alumni gave real world examples from their own work experience to illustrate the scope and the principles of several domains such as Telecom-networks, storage systems, systems engineering, services etc. They also highlighted on how the value based training of our university is so very important in the outside world. The punch line for the workshop came from the alumni who said, " There is no version control for truth", which actually summarized the need and importance of integrity in any organization. The question and answer session of the workshop inspired the students and filled them with confidence.

LIST OF SPEAKERS

- 1) Sri Manoj, Staff Software Engineer, IBM.
- 2) Sri R. Praveen, Technical Lead, McAfee.
- 3) Sri Pandurangan N., Technical Architect, Infosys.
- 4) Sri Prem Kumar C G, Business Analyst & Project Manager, D & B Transunion.
- 5) Sri Praveen Sachwani, Technical Lead, Verifone.
- 6) Sri Sai Swaminathan, Senior Architect-Technology, D & B Transunion.
- 7) Sri N. Subramaniam, Principal Engineer, Yahoo!
- 8) Sri Chandrasekhar M, Engineering Manager, Impetus.
- 9) Sri Krishnamoorthy B, Specialist, Hewlett Packard.

Kindly Look Forward to:

Workshop On Image Processing,

December 21-23, 2012.



Workshop on Analysis and Differential Equations



Perspective
Completeness
Confidence

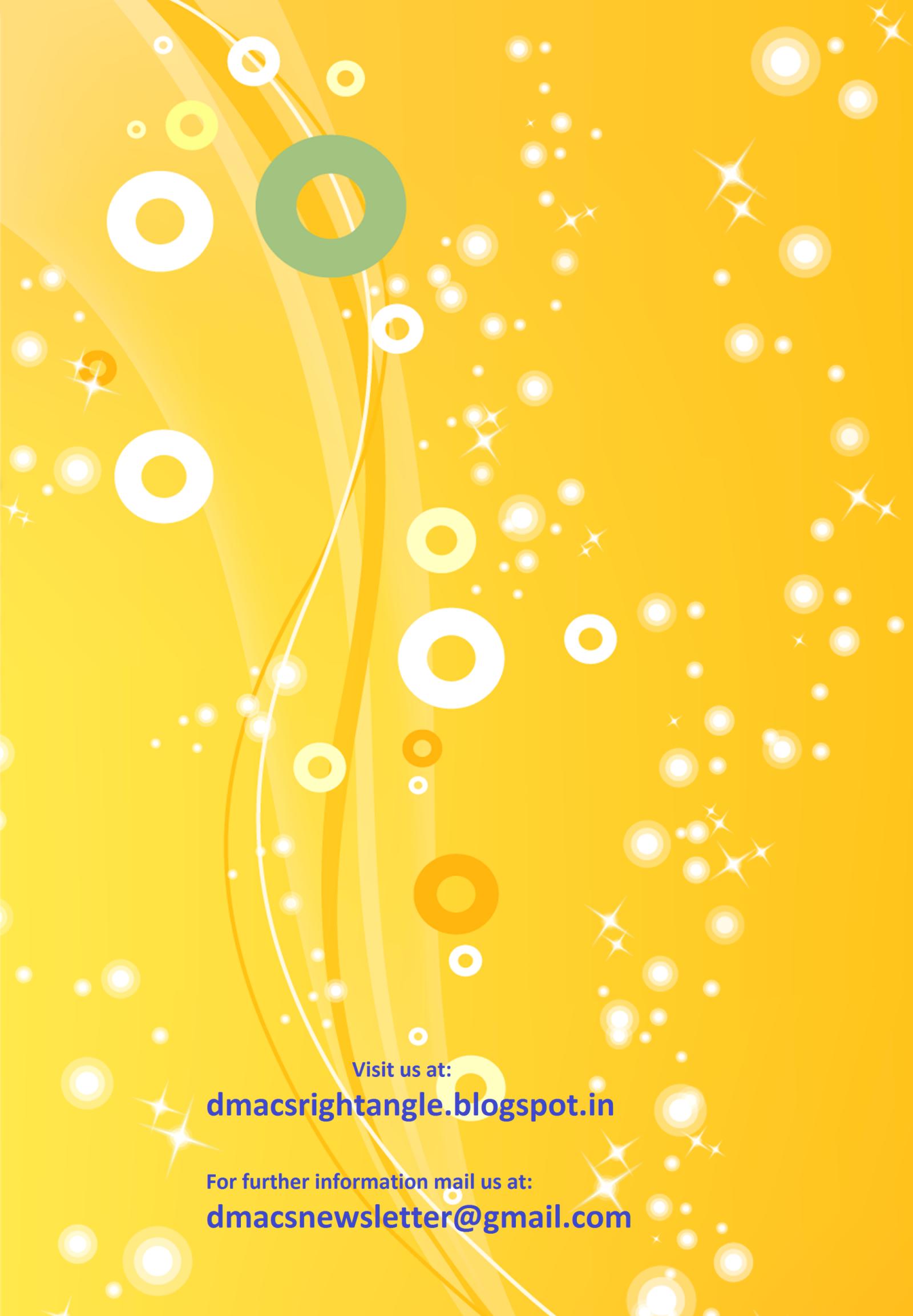
Perspective
Completeness
Confidence

Workshop on Practice of Software Engineering Principles



Release of the First Issue on 23rd November, 2011





A vibrant yellow background featuring a central vertical axis of concentric circles in various sizes and colors (white, light green, orange). From this axis, thin, curved lines radiate outwards towards the edges. Scattered throughout the background are numerous small, glowing white circles of different sizes, some with starburst effects, resembling distant stars or particles.

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*The joy that we cause
in the Heart of God is
the only worthwhile achievement*

