Inter-Dependability of Computer and Mathematics in Modern Age

Amit Kumar[1†], Aklesh Kumar[2††], Dr. Sunil Kumar Sah[3†††]

Research Scholar & Programmer Govt. Polytechnic Jamui T.M B. U, Bhagalpur (Bihar),India T.M.Bhagalpur University
Research Scholar & Assistant Professor Dept of Mathematics S.S.V. College Kahalgoan (Bihar) India Bhagalpur
SPM, Jharkhand, India & Ex-Faculty Member, UDCA, Computer CentreT.M B. U, Bhagalpur (Bihar), India, , Bihar India

Summary
Computer science is a modern science but mathematics is an ancient art, while we are discussing its dependability to each other both may find many new paths to solve many problems of each other. Unfortunately, in the learning of Mathematics and Computer Science, they appear often as disconnected areas, when they are indeed two necessary and complementary branches of the same tree. Either of them alone produces only ethereal structures, or routines and ad-hoc programs. For this reason, it would be preferable to study, progressively, from the lower educational levels, both disciplines as naturally linked. So, it will be overrated the pure mechanistic of only give informatics to usury level, as mere blind instructions, either too abstract pure mathematical constructs. Foundation and origin of computer science is a mathematical application, we can see it in algorithm, Boolean algebra, formal language, database, data mining, machine learning and many more. It is a well known fact but computer science helps mathematics in many ways like solving definite Integration, finding roots of linear and solution of nonlinear equation, participation in statistics and probability, matrices problem and solution and many more. We can find its journey from classical Greece to 17th century and then all application of their combined journey. Computers & Mathematics with Applications provides a medium of exchange for those engaged in fields where there exists a non-trivial interplay between mathematics and computers. Thus, the three present principal areas of interest of the modern system of academic world
1. Computers in mathematical research (e.g. numerical analysis, number theory, probability theory).
2. Mathematical models of computer systems.
3. Interactive applications - essentially the utilization of a (non-trivial) combination of classical mathematics and computer science in the solution of problems arising in other fields.

Key words:
Mathematics development, computer and Mathematics, Numerical analysis, simulation, cryptography, Big Data.

1. Introduction

Journey of Mathematics

Human beings are investigating in nature; it can be proven by the story of Adam and Eve. A mythological character, they can taste a prohibited fruit even though they were warned by God. Mathematics is a great example of evolution and evolutionary nature of human beings.[2] Humans discovered numbers but an Indian astrologer and mathematician Brahmagupta discovered 'ZERO' in AD 628 and this discovery became a great foundation of current mathematics.

Sumerian civilization flourished before 3500 BC, an advanced civilization building cities and supporting the people with irrigation systems, a legal system, administration, and even a postal service. Writing developed and counting was based on a sexagesimal system, that is to say base 60. Around 300 BC, the Akkadians invented the abacus as a tool for counting and they developed methods of arithmetic with addition, subtraction, multiplication and division and known as first computing device ever. Around 2000 BC, Sumerians had developed an abstract form of writing based on cuneiform i.e. wedge-shaped symbols. Their symbols were written on wet clay tablets which were baked in the hot sun and many thousands of these tablets have survived to this day.

The Babylonians appear to have developed a placeholder symbol that functioned as a zero by the 3rd century BC, but its precise meaning and use is still uncertain. They had no mark to separate numbers into integral and fractional parts as with the modern decimal point.

Berggren, J.L., 2004,[6] describes that the Greeks divided the field of mathematics into arithmetic i.e. the study of multitude or discrete quantity and geometry i.e. the study of magnitude or continuous quantity and considered both to have originated in practical activities. Proclus, in his Commentary on Euclid, observes that geometry, literally, "measurement of land," first arose in surveying practices among the ancient Egyptians, for the flooding of the Nile compelled them each year to redefine the boundaries of properties. Similarly, arithmetic started with the commerce and trade of Phoenician merchants.

Pythagoras[3] of Samos is often described as the first pure mathematician. He is an extremely important figure in the development of mathematics yet we know relatively little about his mathematical achievements. The society which he led, half religious and half scientific, followed a code of secrecy which certainly means that today Pythagoras is a mysterious figure. Pythagoras held that at its deepest level, reality is mathematical in nature.

Manuscript received January 5, 2020
Manuscript revised January 20, 2020

Posy points out three important Pythagorean beliefs: (1) they agree with Babylonian assumption of commensurability that any geometric measurement will be some rational multiple of the standard unit; (1) they think that space is ultimately discrete or separable that there is nothing between 1 and 2 and everything had to have atomic parts; and (3) they believe that continuity implied infinite divisibility.
O'Connor, J.J and Robertson, E.F., 1999,[3] note that in the British museum, it was found one of four Babylonian tablets, which flourished in Mesopotamia between 1900 BC and 1600 BC, which has a connection with Pythagoras's theorem.
Around 300 BC, Euclid was studying geometry in Alexandria and wrote a thirteen-volume book that compiled all the known and accepted rules of geometry called The Elements. Euclid believes in absolute separation of discrete mathematics and magnitudes. Of the Element, for example, Books 5 and 6 states the theory of proportion for magnitudes, while Book 7 states the theory of proportion for numbers. In these Elements, Euclid attempted to define all geometrical terms and proposed five undefined geometric term that are the basis for defining all other geometric terms as follows: "point", "line", " lie on", " between", and "congruent". Because mathematics is a science where every theorem is based on accepted assumptions, Euclid first had to establish some axioms with which to use as the basis of other theorems. Posy, C., 1992, indicates that Elements is full of difficulties due to absolute separation resulted in a great deal of repetition and there are actual gaps and perceived gaps. "If we continuously mark off segment AB in the direction of C, eventually we'll pass C".
The 17th century, the period of the scientific revolution, witnesses the consolidation of Copernican heliocentric astronomy and the establishment of inertial physics in the work of Kepler, Galileo, Descartes, and Newton. This period is also one of intense activity and innovation in mathematics. Advances in numerical calculation, the development of symbolic algebra and analytic geometry, and the invention of the differential and integral calculus resulted in a major expansion of the subject areas of mathematics. By the end of the 17th century a program of research based in analysis had replaced classical Greek geometry at the centre of advanced mathematics. In the next century this program would continue to develop in close association with physics, more particularly mechanics and theoretical astronomy. The extensive use of analytic methods, the incorporation of applied subjects, and the adoption of a pragmatic attitude to questions of logical rigor distinguished the new mathematics from traditional geometry.
Calculus is properly the invention of two mathematicians, the German Gottfried Wilhelm Leibniz and the Englishman Isaac Newton. Both men published their researches in the 1680s, Leibniz in 1684 in the recently founded journal Acta Eruditorum and Newton in 1687 in his great treatise Principia Mathematica. The essential insight of Newton and Leibniz was to use Cartesian algebra to synthesize the earlier results and to develop algorithms that could be applied uniformly to a wide class of problems. The formative period of Newton's researches was from 1665 to 1670, while Leibniz worked a few years later, in the 1670s. Newton deals calculus with the analysis of motion. On the other hand, Leibniz's notation:dy/dx, dy and dx are both very small that they are insignificant, however, their ratio is a number; thus ratios were stressed, not the individual components.
In the late 18th century Bolzano and Cauchy, instead of talking about infinitely small quantities, think of a sequence of smaller and smaller quantities approaching a number and define the Limit. Cauchy defines the Limit as, when the successive values attributed to a variable approach indefinitely a fixed value so as to end by differing from it as little as one wishes. This last is called the limit of all the others.
Most of the powerful abstract mathematical theories in use today originate in the 19th century. Mathematics grew so much during this period. This period comes together through the pioneering work of Georg Cantor on the concept of a set. He began to discover unexpected properties of sets. For example, he describes that the set of all algebraic numbers and the set of all rational numbers are countable in the sense that there is a one-to-one correspondence between the integers and the members of each of these sets. It means that any member of the set of rational numbers, no matter how large, there is always a unique integer it may be placed in correspondence with. But, more surprisingly, he could also show that the set of all real numbers is not countable. So, although the set of all integers and the set of all real numbers are both infinite, the set of all real numbers is a strictly larger infinity. This is incomplete contrast to the prevailing orthodoxy, which proclaims that infinite could only mean "larger than any finite amount."

Journey of Computing

Since World War II 'information' has emerged as a fundamental scientific and technological concept applied to phenomena ranging from black holes to DNA, from the organization of cells to the processes of human thought, and from the management of corporations to the allocation of global resources. In addition to reshaping established disciplines, it has stimulated the formation of panoply of new subjects and areas of inquiry concerned with its structure and its role in nature and society (Machlup and Mansfeld 1983). Theories based on the concept of 'information' have so permeated modern culture that it now is widely taken to characterize our times. We live in an 'information society', an 'age of information'. Indeed, we look to models of information processing to explain our own patterns of thought. The computer has played the central role in that transformation, both accommodating and encouraging ever broader views of 'information' and of how it can be transformed and communicated over time and space. Since the 1950s the computer has replaced traditional methods of accounting and record-keeping by a new industry of data processing. As a primary vehicle of communication over both space and time, it has come to form the core of modern information technology. What the English-speaking world refers to as "computer science" is known to the rest of western Europe as informatique (or Informatik or informatica). Much of the concern over information as a commodity and as a natural resource derives from the computer and from computer-based communications technology. Hence, the history of the computer and of computing is central to that of information science and technology, providing a thread by which to maintain bearing while exploring the ever-growing maze of disciplines and sub-disciplines that claim information as their subject.

The computer is not one thing, but many different things, and the same holds true of computing. There is about both terms a deceptive singularity to which we fall victim when, as is now common, we prematurely unite its multiple historical sources into a single stream, treating Charles Babbage's analytical engine and George Boole's algebra of thought as if they were conceptually related by something other than 20th-century hindsight. Whatever John von Neumann's precise role in designing the "von Neumann architecture" that defines the computer for the period with which historians are properly concerned, it is really only in von Neumann's collaboration with the ENIAC team that two quite separate historical strands came together: the effort to achieve high-speed, high-precision, automatic calculation and the effort to design a logic machine capable of significant reasoning

The dual nature of the computer is reflected in its dual origins: hardware in the sequence of devices that stretches from the Pascaline to the ENIAC, software in the series of investigations that reaches from Leibniz's combinatorics to Turing's abstract machines. Until the two strands come together in the computer, they belong to different histories, the electronic calculator to the history of technology, the logic machine to the history of mathematics,and they can be unfolded separately without significant loss of fullness or texture. Though they come together in the computer, they do not unite. The computer remains an amalgam of technological device and mathematical concept, which retain separate identities despite their influence on one another.

That tripartite structure shows up in the three distinct disciplines that are concerned with the computer: electrical engineering, computer science, and software engineering. Of these, the first is the best established, since it predates the computer, even though its current focus on microelectronics reflects its basic orientation toward the device. Computer science began to take shape during the 1960s, as it brought together common concerns from mathematical logic (automata, proof theory, and recursive function theory), mathematical linguistics, and numerical analysis (algorithms, computational complexity), adding to them questions of the organization of information (data structures) and the relation of computer architecture to patterns of computation. Software engineering, conceived as a deliberately provocative term in 1967 (Naur and Randell 1969), has developed more as a set of techniques than as a body of learning. Except for a few university centers, such as Carnegie-Mellon University, University of North Carolina, Berkeley, and Oxford, it remains primarily a concern of military and industrial R&D aimed at the design and implementation of large, complex systems, and the driving forces are cost and reliability.

Nathan Rosenberg said, whereby "... technological improvement not only enters the structure of the economy through the main entrance, as when it takes the highly visible form of major patentable technological breakthroughs, but that it also employs numerous and less visible side and rear entrances where its arrival is unobtrusive, unannounced, unobserved, and uncelebrated" (Rosenberg 1979, p.26). Viewing computing both as a system in itself and as a component of a variety of larger systems may provide important insights into the dynamics of its development and may help to distinguish between its internal and its external history.

Seen in that light, the relation between hardware and software is a question not so much of driving forces, or of stimulus and response, as of constraints and degrees of freedom. While in principle all computers have the same capacities as universal Turing machines, in practice different architectures are conducive to different forms of computing. Certain architectures have technical thresholds (e.g. VSLI is a prerequisite to massively parallel computing), others reflect conscious choices among equally feasible alternatives; some have been influenced by the needs and concerns of software production, others by the special purposes of customers.

At present, the evolution of computing as a system and of its interfaces with other systems of thought and action has yet to be traced. Indeed, it is not clear how many identifiable systems constitute computing itself, given the diverse contexts in which it has developed. We speak of the computer industry as if it were a monolith rather than a network of interdependent industries with separate interests and concerns.

The recent volume by Charles Bashe et al. on IBM's Early Computers illustrates the potential fruitfulness of that suggestion for the history of computing. In tracing IBM's adaptation to the computer, they bring out the corporate tensions and adjustments introduced into IBM by the need to keep abreast of fast-breaking developments in science and technology and in turn to share its research with others. Howard Rheingold (1985) has described in Tools for Thought the government was quick to seize on the interest of computer scientists at MIT in developing the computer as an enhancement and extension of human intellectual capabilities. In general, that interest coincided with the needs of national defense in the form of interactive computing, visual displays of both text and graphics, multi-user systems, and inter-computer networks. The Advanced Research Projects Agency (later DARPA), soon became a source of almost unlimited funding for research in these areas, a source that bypassed the usual procedures of scientific funding, in particular peer review. Much of the early research in artificial intelligence derived its funding from the same source and its development as a field of computer science surely reflects that independence from the agenda of the discipline as a whole.

2. The Sole of Paper

As we have seen all as visitor to the world of mathematics and computer science and we found a strong connection between computer science and mathematical science.

3. Foundation of computer

Mathematics is a foundation of many streams like astrophysics, astrology, computer science, physics and many others.

A start of computer basics based on mathematical calculation invented by Akkadians mathematician called abacus. The English mathematician George Boole (1815–1864), who is largely responsible for its beginnings, was the first to apply algebraic techniques to logical methodology. He showed that logical propositions and their connectives could be expressed in the language of set theory. Thus, Boolean algebra is also the algebra of sets. Algebra is that branch of mathematics which is concerned with the relations of quantities.

The earliest large-scale electronic digital computers, the British Colossus (1944) and the American ENIAC (1945), did not store programs in memory. Turing's abstract 'universal computing machine' of 1936, soon known simply as the universal Turing machine, consists of a limitless memory, in which both data and instructions are stored, and a scanner that moves back and forth through the memory, symbol by symbol, reading what it finds and writing further symbols. Turing proposed a mathematical model of computing and designed automata machine, compiler both context free and context sensitive.

The world's first large-scale electronic digital computer, Colossus, was designed and built during 1943 by Flowers and his team at Dollis Hill, in consultation with the Cambridge mathematician Max Newman, head of the section at Bletchley Park known simply as the 'Newmanry'.

4. Database Design

Set theory, as a separate mathematical discipline, begins in the work of Georg Cantor. One might say that set theory was born in late 1873, when he made the amazing discovery that the linear continuum, that is, the real line, is not countable, meaning that its points cannot be counted using the natural numbers. So, even though the set of natural numbers and the set of real numbers are both infinite, there are more real numbers than there are natural numbers, which opened the door to the investigation of the different sizes of infinity.

Database is an application of set theory in computer science. It describes table of data as a set and relation of sets. Database also uses basic operation of set theory like union, intersection, complement, join, minus etc.

5. Cryptography

The order in which subjects follow each other in our mathematical education tends to repeat the historical stages in the evolution of mathematics. In this scheme, elementary algebra corresponds to the great classical age of algebra, which spans about 300 years from the sixteenth through the eighteenth centuries. It was during these years that the art of solving equations became highly developed and modern symbolism was invented.

The word “algebra”—al jebr in Arabic—was first used by Mohammed of Kharizm, who taught mathematics in Baghdad during the ninth century. The word may be roughly translated as “reunion,” and describes his method for collecting the terms of an equation in order to solve it. It is an amusing fact that the word “algebra” was first used in Europe in quite another context. In Spain barbers were called algebristas, or bonesetters (they reunited broken bones), because medieval barbers did bonesetting and bloodletting as a sideline to their usual business.

The origin of the word clearly reflects the actual context of algebra at that time, for it was mainly concerned with ways of solving equations. In fact, Omar Khayyam, who is best remembered for his brilliant verses on wine, song, love, and friendship which are collected in the Rubaiyat—but who was also a great mathematician—explicitly defined algebra as the science of solving equations.

The setting is Italy and the time is the Renaissance—an age of high adventure and brilliant achievement when the wide world was reawakening after the long austerity of the middle Ages. America had just been discovered, classical knowledge had been brought to light, and prosperity had returned to the great cities of Europe. It was a heady age when nothing seemed impossible and even the old barriers

of birth and rank could be overcome. Courageous individuals set out for great adventures in the far corners of the earth, while others, now confident once again of the power of the human mind, were boldly exploring the limits of knowledge in the sciences and the arts. The ideal way to be bold and many-faceted, to “know something of everything, and everything of at least one thing.” The great traders were patrons of the arts, the finest minds in science were adepts at political intrigue and high finance. The study of algebra was reborn in this lively milieu.
There are many concepts given by abstract algebra like a set, matrices, rings, Euclidian sets, and operation, etc are the basis of the public and private key of cryptography.
Kudaskar R.G 2011 presented the hardware implementation of the Rivest-Shamir-Adleman (RSA) algorithm is presented. Among the various techniques found in the cryptographic realm, the RSA algorithm constitutes the most widely adopted public-key scheme. The performance of most crypto systems is primarily determined by an efficient implementation of arithmetic operations. The RSA algorithm entails a modular exponentiation operation on large integers, which is considerably time-consuming to implement. Hailiza Kamarulhaili 2010 discussed basic concepts of elliptic curves, from the definition of the elliptic curve defined by the Weierstrass equation up to its application to cryptography. The discussion includes the group operations on the curves, the addition law as well as the doubling formulas and how to generate a good curve cryptographically. These important properties come with some examples with the direction towards illustrating the use of elliptic curves in cryptography with the help of the Mathematica software.

6. Artificial Intelligence

Among the things that AI needs to implement a representation are Categories, Objects, Properties, and Relations and so on. All them are connected to Mathematics, as well as being very adequate illustrative examples. For instance, showing Fuzzy Sets together with the usual Crisp or Classical Sets, which are a particular case of the previous; or introducing concepts and strategies from Discrete Mathematics, as the convenient use of Graph Theory tools on many fields.
Angel Garrido 2010[16] The problems in AI can be classified in two general types, Search Problems and Representation Problems. Then, we have Logics, Rules, Frames, Nets, as interconnected models and tools. All they are very mathematical topics. Between the Nets, the more recent studies to deal with Bayesian Nets, or Networks. Before than its apparition, the purpose was to obtain useful systems for medical diagnosis, by classical statistical techniques, such as the Bayes Rule. A Bayesian Net is represented as a pair (G, D), where G is a directed, acyclic and connected graph, and D will be a probability distribution, associated with random variables. The Inference in BNs consists in establish on the Net, for the known variables, their values, and for the unknown variables, their respective probabilities.

7. Mathematics in Modern Age

As we know mathematics is all about calculations and proving of concepts and theorem. But at same place we know that computer has done their presence all the places like medicine, finance, entertainment, science, astrology and mathematics also. Computer-based technologies are now commonplace in classrooms, and the integration of these media into the teaching and learning of mathematics is supported by government policy in most developed countries. By analyzing a series of conceptual frameworks for assessing the use of computer-based technologies to support school learning become a main tool.
The theoretical frameworks that we use in our attempts to understand and to evaluate educational practice can be seen as lenses that are selective in their point of focus, that impose boundaries on what we see, that afford particular points of view, and that foreground some aspects of the scene while obscuring others. This article examines a range of lenses, starting first with frameworks used by researchers working in the general field of educational computing, and then moving to work undertaken in mathematics education research on the conceptualization of technology usage as instrumental genesis (Artigue, 2002). The discussion of these frameworks draws on Wagner's (1993) assertion that educational research ought to generate new knowledge. Wagner argued that "ignorance is a better criterion than truth for determining the usefulness of knowledge generated through different forms of educational research" (p. 15). In his analysis of ignorance, he distinguishes between what he calls blank spots and blind spots. Such metaphors have been used by others: Arnold (2004)[18] uses "blindspots" to refer to areas of the school mathematics curriculum which have not received their due attention in terms of the nature and effects of handheld technology usage. Arnold's blindspots can be seen as a subset of those discussed by Wagner. Wagner's use of this term is quite specific and potentially more powerful than everyday understandings in that he challenges researchers to question their most basic assumptions, not only about the object of study, but those assumptions which underpin the research questions that seem most obvious and urgent to us.
A.B.Samokhin 1996[14] formulates the method of minimal discrepancies for solving some linear equations with a non-self-adjoint operator and proves the theorem which determines the conditions for the convergence of the iterations to the solution. In particular, this method can be applied to solve integral equations with a dissipative

operator. Volume integral equations (singular equations for electromagnetic problems and Fredholm equations of the second kind for acoustic problems) which describe three-dimensional scattering problems from penetrable inhomogeneous bodies are considered. With the help of energetic inequalities the feasibility of the iterative method to obtain a solution of such integral equations is demonstrated. To approximate these equations the moment and collocation methods are applied. They prove that the approximate solution converges to the exact solution of the integral equations as the number of basis functions or collocation points tends to infinity.

C.H.Choi 1990[22] developed numerical methods for solving matrix Riccati differential equations (RDEs) arising in optimal control, filtering, and estimation is presented. The following algorithms for solving RDEs are described: the direct integration method; the Davison-Maki method; a negative exponential method; the automatic synthesis program (ASP) matrix iteration procedure; the Schor method for Riccati differential equations; the Chandrasekhar method; a method using an algebraic Riccati solution; Leipnik's method; a square-root algorithm; an almost analytic approximation; and a matrix-valued approach.

Sampling big data

The name big data itself contains a term related to size and this is an important characteristic of big data. But Sampling (statistics) enables the selection of right data points from within the larger data set to estimate the characteristics of the whole population[20]. For example, there are about 600 million tweets produced every day. Is it necessary to look at all of them to determine the topics that are discussed during the day? Is it necessary to look at all the tweets to determine the sentiment on each of the topics? In manufacturing different types of sensory data such as acoustics, vibration, pressure, current, voltage and controller data are available at short time intervals. To predict downtime it may not be necessary to look at all the data but a sample may be sufficient. Big Data can be broken down by various data point categories such as demographic, psychographic, behavioral, and transactional data. With large sets of data points, marketers are able to create and utilize more customized segments of consumers for more strategic targeting.

8. Conclusion

Not only may be these techniques very useful into the class-room, because through them Mathematics obtain a support on the aforementioned Games (Chess, Checkers, Stratego, Sudoku, …), but also our students can be introduced in more subtle analyses, as may be the Prissoner´s Dilemma. Also it will be disposable any information about games as Chess, Go, …, its Rules, Tricks, Hints, and so, in the Web pages, being as well possible to play with them. And we can obtain information of papers, web explanations, etc., about the history of such games, which will be very illustrative and motivating for the students. All these techniques has been implemented in the class-room with students of secondary level, increasing with them its interest in Mathematics and simultaneously, in TIC new technologies and its fundamental basis. Furthermore, with students of undergraduate university level, in studies of Mathematics and Computer Science, reaching a very positive reaction, which increments their interest and results.

Mathematics and its applied field uses computer science as a tool of learning, proving theorem, simulations of many unsolved and to create their concept as an automatic execution system. An important research question that can be asked about big data sets is whether you need to look at the full data to draw certain conclusions about the properties of the data or is a sample good enough.

References

[1] Reed, I., 1998,An overview of Babylonian mathematics, The Math Forum, Retrieved 2004

[2] Berggren, J.L., 2004, The Foundation of Mathematics: Mathematics in ancient Mesopotamia, Encyclopaedia Britannica, Retrieved 2004

[3] O’Connor, J.J and Robertson, E.F., 1999, Pythagoras of Samos, Retrieved 2004

[4] Posy, C., 1992, “Philosophy of Mathematics” Retrieved 2004

[5] Posy, C., 1992, “Philosophy of Mathematics”, Retrieved 2004

[6] Berggren, J.L., 2004, The Foundation of Mathematics

[7] Berkeley, Edmund C. 1949. Giant Brains or Machines That Think. New York, John Wiley & Sons.

[8] Nora, Simon and Alain Minc. 1978. L'Informatisationde la société. Paris, La documentation française Translated into English under the title The Computerization of Society. Cambridge, MA, MIT Press, 1980.

[9] Bolter, J. David. 1984. Turing's Man. Chapel Hill, University of North Carolina Press.

[10] Backus, John. 1977. "Can Programming Be Liberated from the von Neumann Style? A Functional Style and Its Algebra of Programs." (ACM Turing Award Lecture for 1977). Communications of the ACM, 21,8, pp. 613-641.

[11] Bashe, Charles J., Lyle R. Johnson, John H. Palmer, and Emerson W. Pugh. 1986. IBM's Early Computers. Cambridge, MA, MIT Press.

[12] T uring, A. M. 'On Computable Numbers, with an Application to the Entscheidungsproblem', Proceedings of the London Mathematical Society, Series 2, vol. 42 (1936-37), pp. 230-265. Included in Copeland, B. J. The Essential Turing (Oxford and New York: Oxford University Press, 2004).

[13] Randell, B. 'Colossus', in Metropolis, N., Howlett, J., Rota, G. C. eds A History of Computing in the Twentieth Century (New York: Academic Press, 1980);

[14] Kuaskar R. G. 2011, ‘A New Architecture for RSA Algoritmm Using Vedic Mathematics’, IEEE 4th conference on emerging trends

[15] Hailiza Kamarulhaili 2010, 'Generating Elliptic Curves Modulo p for Cryptography Using Mathematica Software' IEEE Seventh International Conference on Computer Graphics, Imaging and Visualization
[16] Angel Garrido, 2010, 'Mathematics and Artificial Intelligence, two branches of the same Tree', 2010 Elsevier
[17] Artigue, M. (2002). Learning mathematics in a CAS environment: The genesis of a reflection about instrumentation and the dialectics between technical and conceptual work.International Journal of Computers for Mathematical Learning, 7(2), 245–274.
[18] Wagner, J. (1993). Ignorance in educational research: or, how can you not know that?Educational Researcher, 22(5), 15–23.
[19] Arnold, S. (2004). Mathematics education for the Third Millenium: Visions of a future for handheld classroom technology. In I. Putt, R. Faragher, & M. McLean (Eds.),Mathematics education for the third millennium: Towards 2010, (Proceedings of the 27th annual conference of the Mathematics Education Research Group of Australasia, Townsville, Vol. 1, pp. 16–28). Sydney: MERGA.
[20] Dr. Sunil Kumar Sah, Amit Kumar, 2016,'Inadequate use of patterns derived from data mining techniques leads to the ineffective Performance', IOSR-JCE Journals, Vol-18, Issue-6, Ver-5, Nov-Dec 2016.
[21] A.B.Samokhin, 1996 'Numerical method for solving of three-dimensional scattering problems from penetrable body', IEEE MMET '96. VIth International Conference on Mathematical Methods in Electromagnetic Theory. Proceedings
[22] C.H. Choi , 1990 'numerical methods for solving matrix Riccati differential equations', IEEE Proceedings on Southeastcon