

24th R. C. Gupta Endowment Lecture (webinar)-2020: Think and grow Rich: In a Mathematical Way

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Introduction:

What is thought?

“Thought is action in rehearsal” – Sigmund Freud

“We are what we think. All that we are arises with our thoughts. With our thoughts, we make the world” – Lord Buddha

The theory of relativity is regarded as the pinnacle of mathematical elegance. Einstein’s Special theory of Relativity published in 1905 was the bolt from the blue to many renowned scientists and mathematicians as it was a radical rethinking in physics and mathematics. Einstein’s theory of gravity has been invoked as a successful example of achieving unattainable goals throughout the history of thinking. Einstein’s Special theory of relativity as well as the General theory of relativity initialized two revolutionary trends of thought which are regarded as the two intellectual monuments of 20th century mathematics and physics. Because, gravity is the manifestation of curved space-time; so all the familiar axioms of Euclidean geometry cease to be valid on curved space, for instance that of Parallel line and triangles on spheres have to be rethought.

What is Mathematics?

• Russel says– “Mathematics may be defined as the subject in which we never know what we are talking about, nor what we are saying is true.”

• R. Courant and H. Robbins in their book ‘What is Mathematics’ said that “Formal mathematics is like spelling and grammar – a matter of the correct application of logical rules. Meaningful mathematics is like journalism – it tells an interesting story.”

Plato identified Mathematics with the highest idea of civilization and claimed that Mathematics is one of the finest flowering of human spirit, a cathedral of enduring knowledge, built piece by piece over the ages.

Brief history

19th Century Mathematics:

The development of Mathematics in the 19th century grew in two different directions. It transformed the tools of Calculus into system of analysis from which powerful theories of Mathematical Physics are born; ultimately these theories led to quantum mechanics and the theory of relativity.

Another great achievement of 19th century mathematics was the discovery that Euclidean geometry was not the only possible geometry. It was Carl Friedrich Gauss who discovered and established ‘Non-Euclidean Geometry’ by challenging that the crucial 5th (or Parallel) Postulate in Euclidean system need not be true in every geometry. The major achievements of 19th Century Mathematics illustrate the symbiosis between pure and applied Mathematics. Purely abstract consid-

eration of non-Euclidean geometry led to models essentials for relativity theory. Other important contributions are Group theory, Boolean Algebra and Algebra of Matrices.

20th Century Mathematics:

One major influence on 20th Century mathematics was Cantor's inventions of Set theory. Many long standing problems of moving objects could be solved. Another important hallmark of 20th century is the concept of modern Algebra. The Common Structure of matrices, groups and sets led to the subject known as modern or abstract algebra. Lynn Arthur Steen says, "These three disciplines algebra, analysis and topology – represent the common culture of modern mathematician. So one can consider himself truly literate in mathematics, if he can read mathematics as written in the language of algebra, analysis and topology."

This 20th century may also be called 'the era of unification', where borders are crossed over, techniques have been moved from one field into the other and things have been moved from one field into the other and things have become hybridized to an enormous extent.

One such hybrid branch of science is Nanotechnology, which includes Physics, Chemistry, Electronics Computer Science, Biotechnology, and information technology. Nanotechnology is a broad and interdisciplinary area of research and development (R&D) which is growing very fast worldwide.

Scientists have built a molecular machine that can move objects millions of times larger than itself. The machine is 80,000 times smaller than that of width of a human hair. The nanomachine could control the movement of drugs around the body so that may reach exact point where it is needed. Due to the advent of nanotechnology, we are now in position to measure molecules and cells.

21st Century Mathematics:

The 21st century is the Century of revolution. The Digital Revolution which is the output of human thought. We can term it as the 4th Industrial Revolution. The fourth Industrial Revolution Charactered by the fusion of technologies blurring lines intersect the physical, digital, and biological spheres, and is collectively referred to as a cyber-physical system. This new revolution opens multiple challenges like robotics, artificial intelligence, data science, business informatics, nano-technology, quantum computing, biotechnology, the internet of things, 5G and 3D printing, etc. Due to this digital revolution, a paradigm shift is noticed to outdate our present job-system.

By the end of 2021, the scientific world will have a computer which can perform 10 lakh crore calculations per second, which will be equivalent to human brain. And by 2029, the world will have a modern computer which will be equivalent to 10 thousands human brains and will perform like efficiently. So, Ray Kurzweil proclaimed that in future, i.e. by 2045, the neuroscientists would be able to construct Robot with artificial intelligence (AI) which will work more efficiently than human and would set aside the mankind.

Some Applications:

Geometry in Neurophysiology:

Geometry is about space. Geometry helps to bring together both sides of human brain. In other words, not just be a left brain thinker, but also a right brain thinker. In spite of going in details, we shall discuss in a nutshell, the function of vision of the brain.

Our brains have been constructed in such a way that they are extremely concerned with vision. Vision uses up something like 80 or 90 percent of the cortex of the brain. There are about 17 different centers in the brain each of which is specialized in a different part of the process of vision, some parts are concerned with vertical, some parts are

with horizontal, some parts are with colour or perspective, and finally some parts with meaning and interpretation. Understanding and making sense of, the world that we see, is a very important part of our evolution. Therefore, spatial intuition or spatial perception is an enormously powerful tool and that is why geometry is actually such a powerful part of mathematics.

OR and mathematical Economics:

Operation Research is concerned with maximization or minimization of some objective function representing some profits or losses subject to some limitations of resources. Many of the optimization problems of OR fall within the scope of ‘finite’ or ‘discrete’ mathematics.

Main Aim of OR – Objective is to reduce decisions to a math model and identify one more Optimal Solutions. OR is concerned with determining the maximization (of Profit, perform, or yield) or minimization (of loss, risk, or cost) of objects.

What is Game theory?

Game theory is the study of the ways in which interacting choices of economic agents produced outcomes in question might have been intended by none of this agents. More loosely, we can say that, game theory is the process of modeling the strategic interaction between two or more players in a situation containing set of rules and outcomes. While used in a number of disciplines, game theory is the most notably used as a tool within the study of economics. The applications of game theory in economics can be a valuable tool to aide in the fundamental analysis of industries, sectors & any strategic interaction between two or more firms.

One of the pioneers of Game theory and also one of the greatest mathematicians of the twentieth century, John Von Neumann along with Oskar Morgenstern published the book ‘Theory of Games & Economic Behaviour’ (1944), which is considered the groundbreaking text that created the interdisciplinary research field of game theory.

Theory of Games is one of the important subjects in Modern Economics and very useful in analysis of strategic choices. Apart from economics, game theory enters in different fields like Evolutionary Biology, Sociology, Political Science, etc. Here, I would like to mention some of the Nobel Laureates who received in Mathematical Programming (OR) or in Game theory. They are Paul A. Samuelson (1970), S. Kuznets (1971), W. Leontief (1973), John Nash & Others (1994), Robert Aumann & Thomas Schelling (2005), Alvin Roth & Lloyd Shapley (2012).

In the context of Game theory, a well-known game named ‘Prisoner’s Dilemma’ is a standard example of a game that shows why two completely rational individuals might not cooperate even if it appears that it is in their best interest to do so. Thus we can say, it is a paradox in decision analysis in which two individuals acting in the own self-interest’s do not produce the optimal outcome.

Summary:

During the Last decade, a research on Upanishad’s vāni – “Yad Bhāvam, Tad Bhavati” – You are, what you think, went on at the University of Wisconsin, USA. Similarly, Mathematician Descartes remarked – “Cogito ergo Sum”, i.e. “I think, therefore I exist.” There is a saying on Descartes’ invention of Cartesian Co-ordinate Geometry: Once he saw a spider on a ceiling while he was lying down on a bed. He wanted to find out the location of the spider, which led him to discover Co-ordinate Geometry. This is one of the finest flowering of thought.

It is not how great one’s thought is, but how great he wants to think. This is the moot point of the talk – “Think and Grow rich or enlighten”. The Purpose of this talk is a humble demonstration – How to flourish one’s critical abilities in order to enable him to appreciate the excellence of a work.

(This article has been edited for language, clarity and authenticity.)