Derivatives and its Applications in Real Field

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Introduction

The derivative originated from a problem in geometry -the problem of finding the tangent line at a point of a curve. Newton and Leibniz independently of one another gives the idea of derivatives. But the concept was not formulated until early in the 17^{th} Century when the French mathematician Pierre de Fermat, attempted to determine the maxima and minima of certain special functions. Leibnitz referred to the derivative $\frac{dy}{dx}$ as a differential quotient and Newton used the notation $\dot{y}$ .The derivative of a function f has been denoted by f' or y' , a notation introduced by J. L. Lagrange (1736-1813) late in 18th century. Geometrically, derivatives of a function at a point represents the slope or gradient of the tangent line at that point. The process or operation by which one can obtain the derivatives of a function is called differentiation.

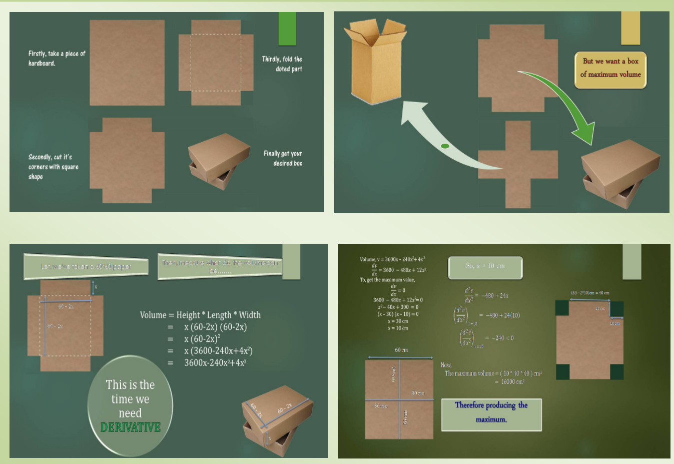
Definition: *The derivative $f'(x)$ is defined by the equation*

$$f'(x) = \lim_{h\to 0}\frac{f(x+h)-f(x)}{h}$$

provided the limit exists. The number $f'(x)$ is also called the rate of change of f at x.

Applications

Optimization Problem
Industry of Packets



In Physics:

Yes!! We know that you are thinking about the Newton's second law of motion. The law says that,

Rate of change of momentum i.e. time derivative of momentum of a body is propotional to the impressed force and takes place in the direction of the straight line in which the force acts.

If m denotes the mass and v the velocity, mv is the momentum. If P denotes the force acting on the mass m, then by the first part of this law, we have

$$P = k\frac{d}{dt}(mv)$$

To get some understanding of the derivative consider the odometer and speedometer in a car. The odometer can be considered to measure the distance that the car travels as a function of time i.e. the odometer has one value for each time. The speedometer measures how fast the car is traveling as a function of time. The speedometer reading can then be interpreted as how fast the distance is changing in time. So where as the odometer measures in miles, the speedometer measures in miles per hour which is the rate of change of distance with respect to time.

In Biology:

To find out population growth rate, derivatives are used in Biology.
For example, Suppose that a population of bacteria doubles its population, n, every hour. Denote by n_0 the initial population

$$i.e.\ n(0) = n_0 .$$

In general then, $n(t) = 2^t n_0$.

Thus the rate of growth of the population at time t is:

$$\frac{dn}{dt} = 2^t n_0 \ln 2$$

Derivatives are also used to calculate:

1. Rate of heat flow in Geology,
2. Rate of improvement of performance in psychology,
3. Rate of the spread of a rumor in sociology,
4. Rate of reaction and compressibility in Chemistry,
5. Marginal profit, Marginal cost, Marginal revenue etc in Economics.

Conclusion:

We have studied on derivatives of a function and we see that it has lots of application in various fields. We can easily say that the formulation of derivatives is one of the turning points of Mathematics and it plays an important role to develop the socio-economic condition.

References:

Mathematical Analysis by T. M. Apostol; Calculus (Vol I & II) by T. M. Apostol; Analytical Dynamics of Particle and Rigid Bodies by S. R. Gupta; Wikipedia.

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Fibonacci Sequence and Golden Ratio

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What is Fibonacci Sequence!!??

Sequence with the terms $f_0 = 0, f_1 = 1, f_2 = 1$ and $f_{n+1} = f_n + f_{n-1}$ for $n \geq 2$ is said to be a ***Fibonacci sequence***. That is the members are

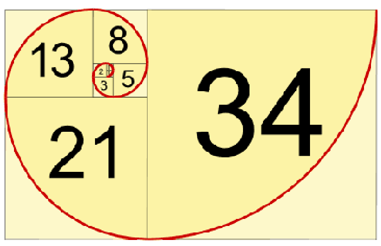
0, 1, 1, 2, 3, 5, 8, 13, 21,...

History:

Phidias (500 B.C. - 432 B.C.) was a Greek sculptor and mathematician who is thought to have applied phi to the design of sculptures for the Parthenon. Later, Euclid (365 B.C. - 300 B.C.) linked the Golden ratio to the construction of a pentagram. Around 1200, mathematician Leonardo Fibonacci discovered the unique properties of the Fibonacci sequence. As well as being famous for the Fibonacci Sequence, he helped spread Hindu-Arabic Numerals (present numbers 0,1,2,3,4,5,6,7,8,9) through Europe in place of Roman Numerals (I, II, III, IV, V, etc).

Fibonacci Spiral:

When we make squares with those widths, we get a nice spiral:



Do you see how the squares fit neatly together?

Golden Ratio:

Two quantities are said to be in the golden ratio if their ratio is the same as the ratio of their sum to the larger of the two quantities.

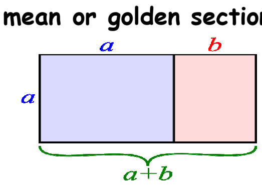
for quantities a and b with $a > b > 0$,

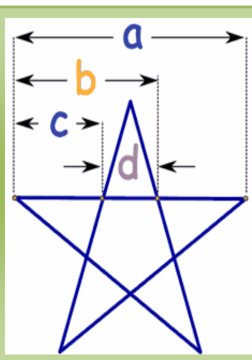
$$\frac{a+b}{a} = \frac{a}{b} = \varphi$$

φ is an irrational number with a value of:

$$\varphi = \frac{1+\sqrt{5}}{2} = 1.6180339887$$

The golden ratio is also called the golden mean or golden section.





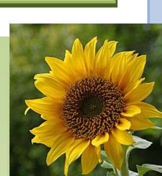
Pentagram

No, not witchcraft! The pentagram is more famous as a magical or holy symbol. And it has the Golden Ratio in it:

- a/b = 1.618...
- b/c = 1.618...
- c/d = 1.618...

Relation between G. R. and F. S.????

When we take any two successive Fibonacci Numbers, **their ratio is very close to the Golden Ratio**.



a	b	a/b
3	2	1.5
5	3	1.666666666...
8	5	1.6
13	8	1.625
...	...	...
233	144	1.618055556...
377	233	1.618025751...
...	...	...

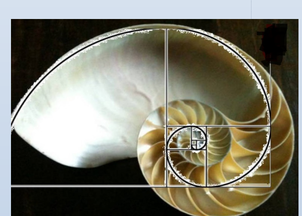
Leaves, branches and petals can grow in spirals, too. Why? So that new leaves don't block the sun from older leaves, or so that the maximum amount of rain or dew gets directed down to the roots.

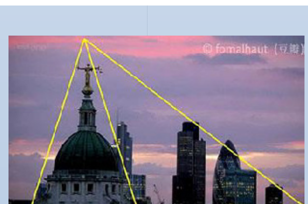
Here is a daisy with 21 petals (but expect a few more or less, because some may have dropped off or be just growing)

A DNA molecule measures 34 angstroms by 21 angstroms at each full cycle of the double helix spiral. In the Fibonacci series, 34 and 21 are successive numbers.

The Milky Way has a number of spiral arms, each of which has a logarithmic spiral of roughly 12 degrees. The shape of the spiral is identical to the Golden spiral, and the Golden rectangle can be drawn over any spiral galaxy.

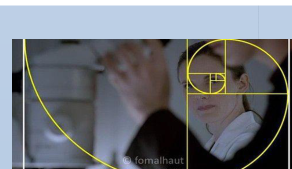
Snail shells and nautilus shells follow the logarithmic spiral, as does the cochlea of the inner ear. It can also be seen in the horns of certain goats, and the shape of certain spider's webs.





The hidden golden triangle are being applied in two stage photos. The application of the golden triangle also brings the sense of beauty to the pictures.

The starting pt. of Fibonacci spiral highlights the girl's eye, and the arm of the man helps to form the spiral.



Conclusion:

Fibonacci sequence and Golden ratio have been discussed here and we see that a large number of situations can be explained with these two mathematical terms. Both exist in every creation of this world and make it beautiful. Obviously, discovery of this topic is one of the turning points in the subject Mathematics.

References:

'Fibonacci numbers in daily life' by Y. Lin, W. Peng, H. Chen & Y. Liu.; 'Fibonacci Sequence Appreciation' by Zhenkui Wu, HIT, 2012; 'Fibonacci in everywhere' by H. Gao, Journal of Yulin College, Vol 12(a) 2002; Wikipedia

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Symmetric and Symmetry Groups

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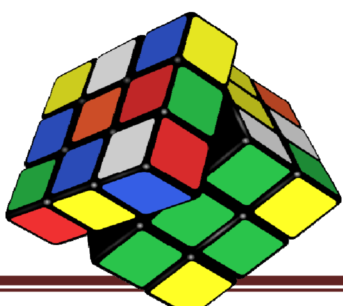
Introduction:

Group theory occupies an important space in the abstract algebra. Here, our object is to make a brief discussion on symmetric and symmetry groups and their applications in various fields such as Physics, Chemistry, Cryptography etc. This theory arose mainly from attempts to find the roots of a polynomial in terms of its coefficients. In early 19th century in the works of Augustin Louis Cauchy (1789-1857) and Evariste Galois (1811-1832) we get the concepts of groups. But the core idea of group theory was used by Lagrange (1736-1813) in 1770 for the investigation of the roots of a polynomial.

Applications in Real Field:

A. Symmetric Group S_n:

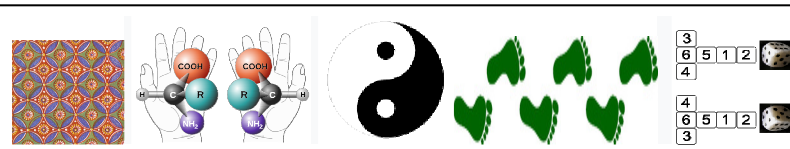
Let S be a non-empty finite set. A bijective mapping $f: S \to S$ is said to be a permutation on S. If S be the set of all permutations on the set {1, 2,…, n} then S forms a group w.r.t "multiplication of permutations". Subgroups of a symmetric group is called a permutation group.



The popular Rubik's cube invented in 1974 by Erno Rubik has been used as an illustration of permutation groups. Each rotation of a layer of the cube results in a permutation of the surface colors and is a member of the group. The permutation group of the cube is called the Rubik's cube group.

B. Symmetry Group:

Not to be confused with Symmetric group. In group theory, the symmetry group of an object (geometric figures image, signal, patterns etc.) is the group of all transformations under which the object is invariant with composition as the group operation. The symmetry group is sometimes also called ***full symmetry group*** in order to emphasize that it includes the orientation-reversing isometries (like reflections, glide reflections and improper rotations) under which the figure is invariant. The subgroup of orientation-preserving isometries (i.e. translations, rotations, and compositions of these) that leave the figure invariant is called *its* ***proper symmetry group***. The proper symmetry group of an object is equal to its ***full symmetry group*** if and only if the object is ***chiral*** (and thus there are no orientation-reversing isometries under which it is invariant). Chiral, point, Lattice, Space, Wallpaper are some symmetry groups.



1. Example of an Egyptian design with wallpaper group p4m.
2. Two enantiomers of a generic amino acid that is chiral.
3. The Yin and Yang symbol has C2 symmetry of geometry with inverted colors.
4. Footprint figure is chiral, as it is not identical to its mirror image
5. Pair of chiral dice (enantiomorphs).

Conclusion:

From the above discussion we can conclude that a number of physical phenomena can be explained by the symmetric and symmetry group theory. Invention of this branch of Mathematics has given solutions of the problems related to the humankind and has also developed our socio-economic status.

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Fundamentals of Abstract Algebra by D. S. Malik, J. M. Morderson and M. K. Sen.; An Introduction to matrix groups and their applications by Andrew Baker; Higher Algebra Abstract and Linear by S. K. Mapa; Abstract Algebra by I. N. Herstein; Wikipedia


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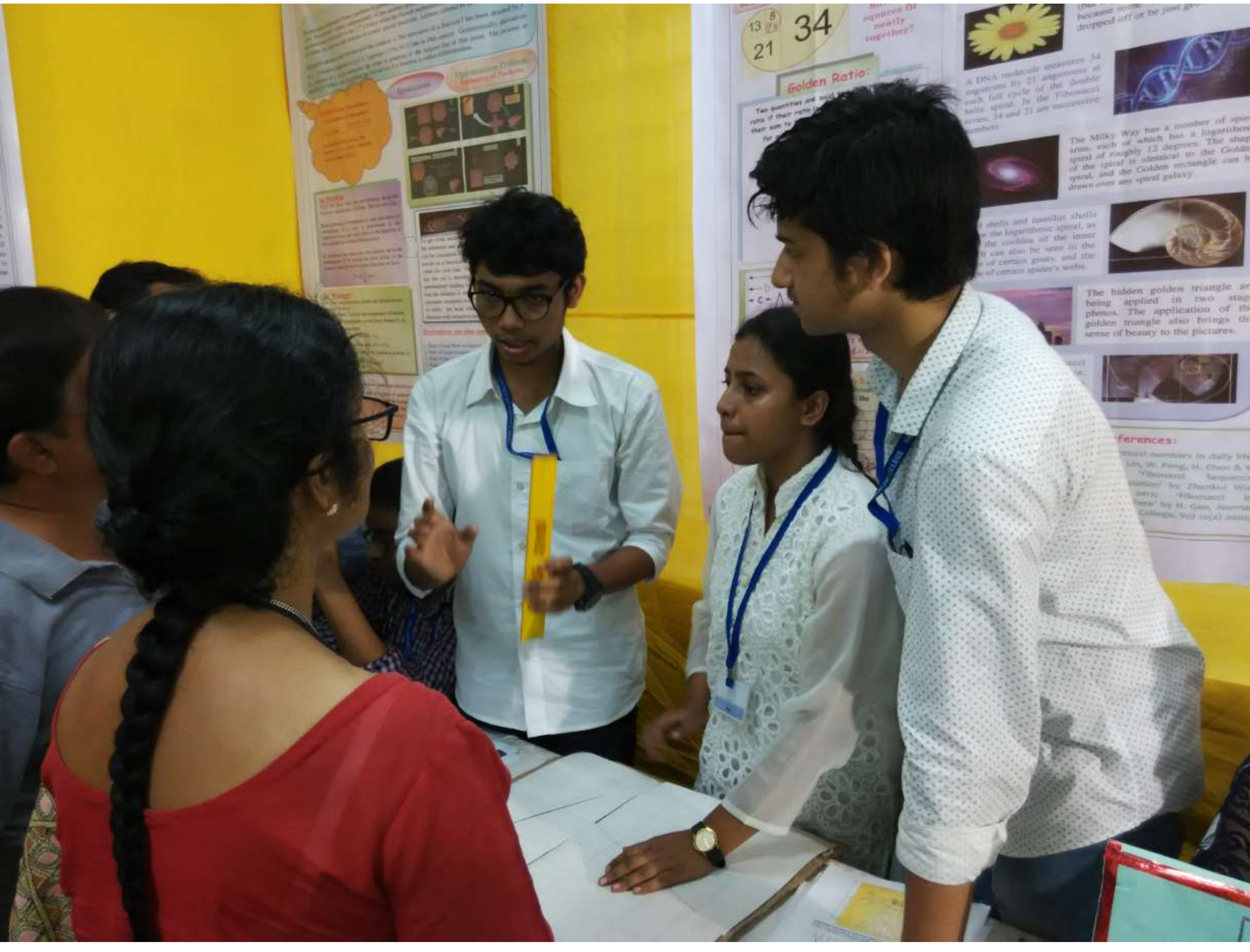

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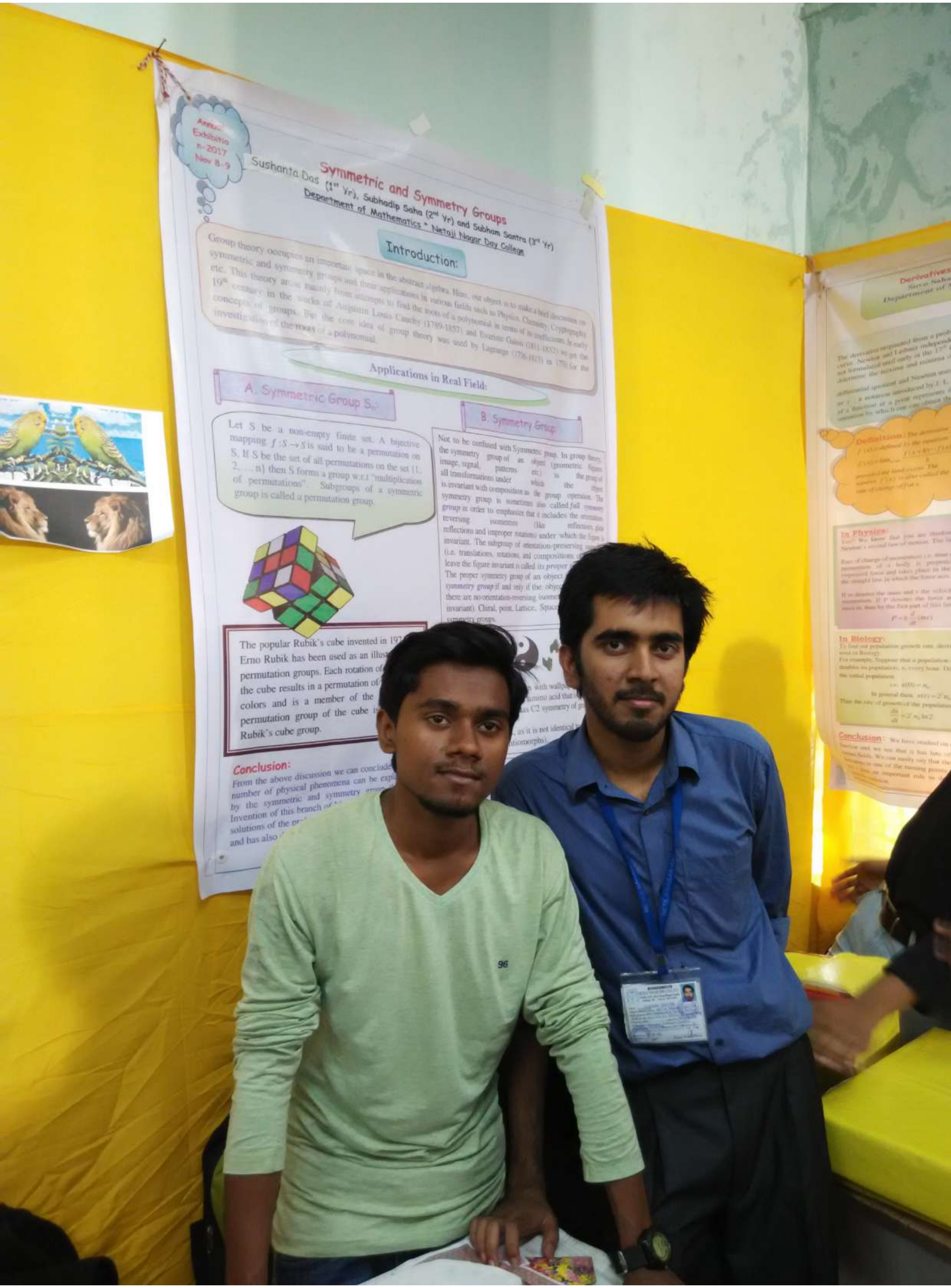
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Rubik's cube group.
Conclusion:
In Physics:
In Biology:
Conclusion:


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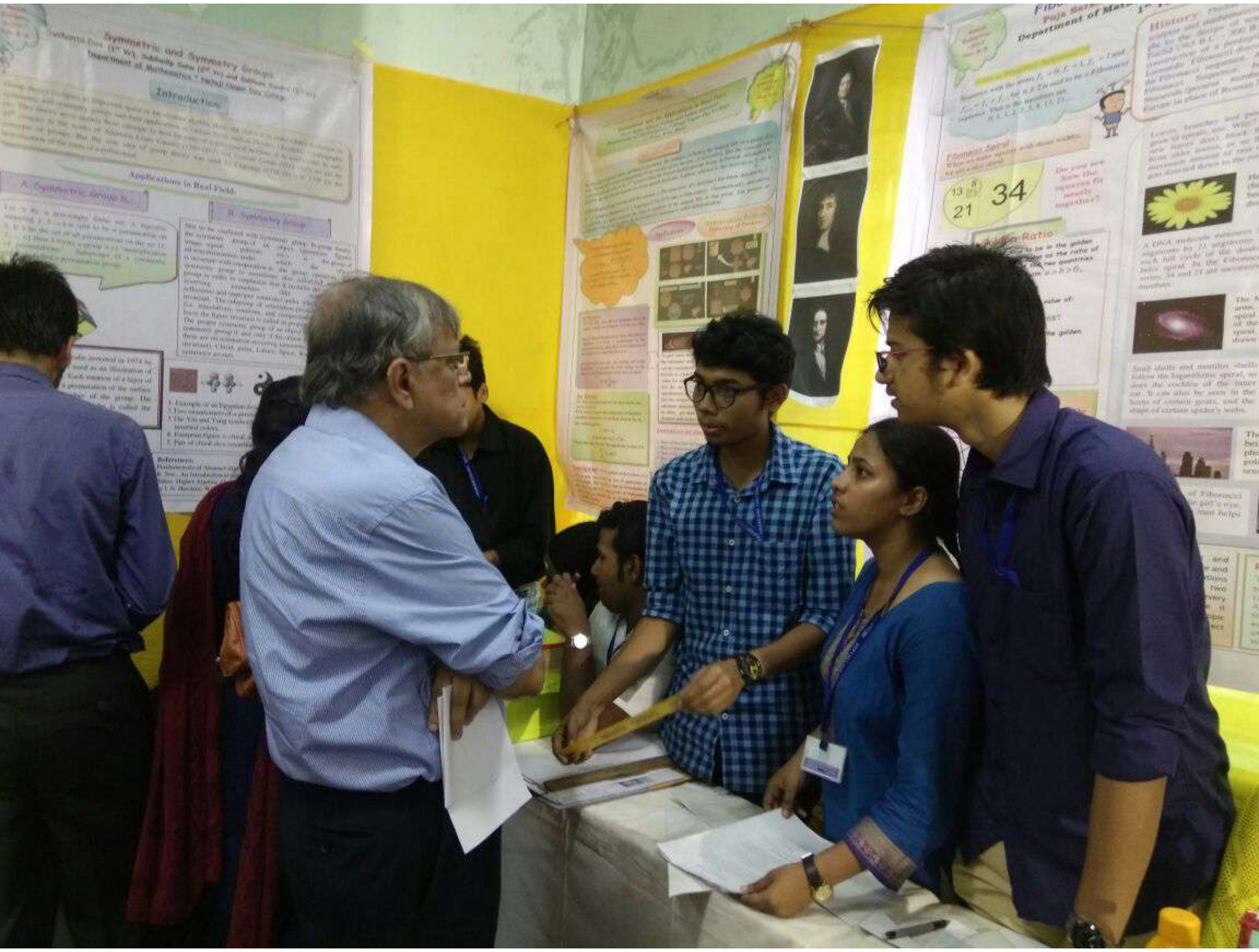
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