SCIENCE and its methods allow us to study and understand nature. Mathematics stretches it further, helping us to build simple analytical models that describe how some of these patterns, processes or the outcomes can be predicted. With such an extraordinary ability, science and mathematics have become essential and inseparable parts of all human endeavour.

Sir Isaac Newton was the first to revolutionize our thinking power and bring out the amazing power of mathematics in natural processes. His famous gravitational law, so simple and elegant in terms of mathematics, is a key to many of our activities. And though nobody has been able to prove it as yet, it works; we use it so extensively and had our successful mission to Moon, Chandrayaan, based on it. This power of mathematics is also exploited in sports, hobbies and games. The Elo rating system in Chess is one such useful product.

Chess is a popular game, played all across India for hundreds of years. It is a good entertainer where many onlookers join the players, suggesting better moves, in effect converting it into virtually a team game. This popularity is probably due to its inherent low resource requirement. All it needs is a small desk-top board, chess coins and two players. Often when the coins are missing, they are substituted by small household objects, sometimes even by stone pieces and sand granules.

The game is played between two opponents and replicates the battlefield situation prevailing in war. The field is simulated by board with 64 squares coloured black and white alternately. Each player has an army of 16 pieces, a king, a queen, 2 rooks, 2 bishops, 2 knights and 8 pawns, placed on opposite sides of the board to start with. Each piece has to follow certain pre-determined ways of movement. The aim of the game is to capture the opponent’s king, which results in a win. The game can often result in a draw offering equal scores for both players, by certain rules or by mutual agreements.

A quick game can end in about 25 moves but some games could even extend to over 80 moves. Though the numbers
The game was taken to Persia thousands of years ago (acquiring the name ‘shatranj’), from where it slowly moved to Europe and then to Russia. Over the years, traditional chess has become an international game.

The number of pieces, their power and movement laws have essentially remained the same over centuries. Nevertheless, rules for the international games have undergone many modifications over the game played in traditional India. The king’s position, the double move option for pawn, the castling and choice of wide option on pawn reaching the eighth rank are the major differences.

The names of the pieces are now Rook, Bishop and Queen rather than Elephant (Hathi), Camel (Oont) and Minister (Wazir). The original boards of plain squares are now changed to chequered ones, making it easy for the bishop’s movement. To accelerate the game time limits are set. On average, a player needs to make 20 moves in an hour.

The Britishers took keen interest in chess, promoted it and had the first international (actually European) event when we were fighting our first war of independence in 1857. It is the national sport in Russia and is more popular than football. Russian chess players have dominated world chess after the Second World War for over 60 years.

The game of chess combines elements of technique, theory and intuition. Today, it is one of the world’s most frequently played indoor games. It is also the one practiced most widely, has the most documented results, most written books and theories to help practitioners. One can also find records of games played over a century ago. This popularity is due to its simplicity and low resource requirements and also intellectual excitement and stimulation that it offers. The game has no place for luck unlike card games.

Not only for players, even for a follower, analyzing a good chess game is very stimulating and is an exercise in logic. Chess is said to improve one’s intelligence. So much so that many a computer algorithms are tried on chess routine first. In fact, chess programs are used to incorporate artificial intelligence and to test their robustness. Finally, it is a mind game and helps one to keep the mind active, especially in old age, lowering risks of memory degeneration and Alzheimer.

Today, chess is a well organized game at the state, national and international level. At the international level, the World Chess Federation (Federation Internationale des Echecs, known as FIDE from its French acronym) organises chess championships. FIDE also maintains a record of all events, gives ratings to all players and updates these ratings regularly. This rating, known as the Elo rating, helps organises to sort players in different categories or classes and arrange the events accordingly.

FIDE implemented the Elo system in 1970, to track the relative strength of all chess masters worldwide.
This revolutionary rating system was devised by Prof. Arpad Emrick Elo. He was born in Hungary, but moved to the United States in his early days. A professor of physics, he was a devoted chess player and won the State Championship several times. As the chairman of the rating committee, he proposed a system of rating, which was adopted by the US Chess Federation in 1960.

Further, he applied this rating system to tournament results dating back to the last century, making it possible to compare the relative strength of any two chess players operating over different time periods. Now this rating system is also practiced in many other competitive games.

Elo made very simple assumptions in the model proposed, which made the calculations leading to rating changes very easy, one of the greatest assets of this system. A chess participant can himself calculate what his next officially published rating will be, with a pocket calculator based on the result of tournaments he has played. This brought transparency to the rating system thereby making it quite popular.

Elo’s system is based on probabilistic approach. It is assumed that the mean of the performances of a player is stable but varies from game to game as a normally distributed variable. Performance is inferred from results of the games he played and the ratings of the opponents.

Assume two new players are playing a chess game. When a player wins, he gets a higher rating, if he loses his rating is lowered and if the game is a draw, the two players would have the same rating. The expectancy of win depends on the difference between the ratings of the two players and is given by normal distribution (Figure 1).

As far as the actual number scale is concerned, the Elo system has three basic premises. First is about the initial ratings presumed. A good beginner would start with a rating of 1000 and a regular, competitive player can have a rating up to 1800. The second is about the class or category concept. Here 200 point difference is defined as a class, meaning a player with rating of 200 points higher than his opponent has 75% probability of winning a game or a set of games. The third premise was on the maximum weightage per game, called K value, which was set to 32.

Let us take a simple example to understand the concept. Say, Two players A and B play six matches and A wins five of them. Now the current rating for each player, based on his past performances, should be known at the beginning of the tournament. Assume they are new entrants, and the committee has allotted them rating of 1400 each. This means they are expected to win three games each.

Now we use the rating formula,
For A, $D_a = (A_w - A_e) \times 32$, where
$D_a$ is the change in rating of A
$A_w$ is the number of wins by A and
$A_e$ is the expected wins of A

And then, $\text{New Rating} = \text{Old Rating} + D_a$
This gives us $D_a = (5-3)\times32=64$

So after this event the rating of A becomes 1464 and that of B becomes 1336.

Based on this simple theory, a detailed procedure is followed by FIDE to update the ratings after every major tournament: start with individual’s ratings, find his expected score against each opponent, input the actual score, use

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appropiate K value and derive the new ratings. The expectancy of winning, based on the normal distribution assumed, depends on the difference in the rating and can be calculated easily (Table 1). The actual K value used is rather dynamic, ranging from 32 for beginners to 16 for masters and 10 for grandmasters, making it harder and harder to gain points as you climb up.

A further example may help to clarify more complex situations. Suppose three players A, B and C with ratings of 2000, 2050, 2100 respectively, play a two-round tournament. And each scores a win and loss against the other two, scoring two points each. K value assigned is 10. For A, actual score is 2.

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His expected score = 2(0.43+0.36) = 1.58
Change in the rating, Da = 10 (2- 1.58) = 4.8 ~ 5
Therefore his new rating will be 2005.

Here rating of A has improved since he played better than expected; he got equal scores with higher rated players. On the same account, rating of C will go down by 5 points and that of B will remain same as a result of this tournament.

The Elo rating system does have its weaknesses. The values in the numerical scales are assigned ones and hence differ from organization to organization. Further, it gives no advantage to white, though it is known to have distinct advantage in the real world. The system also has a problem of tackling rating inflation taking place due to increased knowledge, documentations and use of computers. The main weakness arises from the fact that the ratings are relative to your competitors and can be boosted by tournaments within a controlled group or weaker players. However, with all these, the system on the whole has stood the test of time for the last 50 years and is considered the best rating system so far.

The primary goal of giving Elo ratings is to rate, rank and classify the players. For top players, this rating is very important. FIDE updates the ratings list four times a year. The categories include World Championship Contenders, Grandmasters, International Masters, National Masters, Candidate Masters, Experts, Amateurs and Novices. There are about 20 players in the top most category (rating above 2700), 150 player-grandmasters above rating of 2600 and about 20000 rated as candidate masters (rating above 2200). Only four players, Garry Kasparov, Vladimir Kramnik, Veselin Topalov and Viswanathan Anand have exceeded a rating of 2800 in the history of chess.

In India, Viswanathan Anand’s records and achievements are simply extraordinary. He was India’s first Grandmaster (1987), he was the youngest Grandmaster in the world, he was the World Junior title holder, he is the only person in the history of chess to become the winner in all formats of the game, and to top it all that he is the World Chess Champion since 2007. His achievements have brought attention, recognition and prestige to the game in India. Today, India has over 30 Grandmasters, and about 100 International Masters waiting to become Grandmasters.

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