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THE USCF RATING SYSTEM

by Prof. Mark E. Glickman

Over the past decade, it has become increasingly clear that the USCF rating system has been producing ratings that do not accurately measure playing strength. The difficulties experienced by the rating system stem arguably from one of the great successes in U.S. chess, namely the explosion in popularity among scholastic players beginning in the late 1980s.

One notable contribution of the less experienced scholastic players is that ratings below 500 became much more common. Never before had the rating system had to consider treating this pool of players as a significant part of the tournament population. However, the real difficulty for the rating system was that these players were improving in playing strength faster than their ratings could track.

The result was that these players were underrated most of the time, and then their adult opponents were faring worse than would be expected according to the ratings. This meant that ratings for adults were declining, on average, even though these adults were not becoming worse chessplayers. In fact, even among active established players aged 35 to 45, arguably the group of players with the most stable playing strength, the average rating dropped over 50 points in eight years.

The USCF has modified the rating system. The new system is intended to overcome the recent difficulties, while still adhering to the statistical principles that allow accurate measurement of chess playing strength. The new system, however, is quite complex, and it is virtually impossible to perform the computations by hand to update one's own rating after a tournament.

Fortunately, players can approximate their rating by using the formulas presented below. It should be noted that, on occasion, the formulas in this article may produce ratings considerably different from ratings calculated under the actual algorithm, so that these formulas should serve only as a rough guide. A detailed description of the system's formulas is posted at the USCF website (www.uschess.org).

PROVISIONAL AND ESTABLISHED

Players' ratings are *provisional* if they have played 25 or fewer games, or *established* if they have played more than 25. Only players who have established ratings can be on Top lists, have rating floors, or qualify for All-America teams. There are two different formulas to compute ratings.

The criterion for using the different formulas depends on whether the player has completed eight tournament games. The formula for ratings based on eight or fewer games is called the "special" rating formula, and the other is called the "standard" formula. Thus, a *provisional* rating is updated using the "special" formula if the number of completed games is eight or fewer, and the "standard formula" if the number is greater than eight. *Established* ratings are based on the standard formula.

SPECIAL RATING FORMULA

If a player has a rating based on eight or fewer games, or is unrated, then the new rating can be approximated by the old provisional rating formula:

$$R_{post} = \frac{NR_{pre} + mR_{avg} + (W-L)400}{N+m}$$

where R_{pre} is the player's pre-tournament rating, N is the number of games upon which R_{pre} is based, m is the number of games the player completes in the tournament, R_{avg} is the average of the opponents' ratings, W is the number of wins, and L is the number of losses. If the player is unrated, set N=0 and R_{pre}=0.

Example: Suppose a player rated 1500 based on six games competes against players rated 1400, 1550 and 1650, winning the first, losing the second and drawing the third. In this case, R_{avg}= (1400+1550+1650)/3 = 1533.33, m = 3, N = 6, W = 1, L = 1, and R_{pre}=1500. Then, according to the approximation,

$$R_{post} = \frac{6(1500)+3(1533.33)+(1-1)400}{6+3} = 1511$$

The formula above will work in most cases, but it has the drawback that a player could gain rating points by losing to a high-rated player, or lose rating points with a win over a low-rated player. The actual rating procedure corrects for these possibilities. Furthermore, the actual formulas first calculate ratings for unrated opponents, thereby making use of all game outcomes.

STANDARD RATING FORMULA

Two significant changes were made to the old established rating calculation (now called the standard formula), which is applied to players who have completed more than eight games. The first is that the magnitude of rating change in the rating formula (through the variable K) depends not only on the player's rating, but on the number of games completed previous to the event. The idea is that, for players who have completed a small number of games or who have a low rating, new tournament games should have a potentially large impact on their ratings. Conversely, the rating changes for well-established players should be small.

The second modification to the formulas is that if the player has an unusually strong performance, extra rating points are awarded beyond the usual formula. This aspect of the formulas will help to track quickly improving players more accurately.

To approximate one's rating using the standard formulas, a player needs to know (or approximate) the number of games played in tournaments, only if less than 50. Let N be the number of previous games, but set N to 50 if the number of games is 50 or more. Then, if the player has a pre-tournament rating less than 2200, the player computes

$$N_r = 50/\sqrt{1 + (2200-R_{pre})^2/100000}$$

If the player's rating is 2200 or greater, then set N_r=50. Finally, let N_e be the smaller of N and N_r. This number, the "effective" number of games upon which a rating is based, can be calculated before entering a tournament. Example: Suppose a player's pre-tournament rating is R_{pre}=1700, based on N=30 games. Then, according to the formula above,

$$N_r = 50/\sqrt{1 + (2200-1700)^2/100000} = 26.7$$

Because 26.7 is smaller than 30, N_e=26.7 is the effective number of games for this player.

The next step in the calculation is to determine the value of K, the value that governs the magnitude of rating changes. For a full-K event, letting m be the number of games the player completes in the tournament,

$$K = 800/(N_e + m),$$

and for half-K,

$$K = 400/(N_e + (m/2))$$

Notice that, unlike the old rating formulas, K can take on many different values, not just 32, 24 or 16 as in the old formulas. It is also worth noting that, unlike the previous rating system, the exchange of rating points is not equal. For any particular game, one player's rating may increase by 20, but the opponent's may decrease by 10. Furthermore, lower rated players will have values of K much higher than 32, the value in the old system. Similarly, values of K for stronger players (expert and master strength) will generally be lower than under the old system.

Finally, once K has been computed, the formula for updating a player's rating is given by

$$R_{post} = R_{pre} + K(S–E) + B$$

where R_{pre} is the pre-tournament rating, K is the value just computed, S is the total score in the tournament (counting one for each win, half for each draw and zero for each loss), E is the sum of winning expectancies (described below), and B is a possible bonus amount (described below). The new standard formula is the same as the old established formula, except that a bonus B may be added, and that K takes on values that are more sensible than in the old system.

To calculate E, the winning expectancy for each opponent must be calculated and then summed. The formula for the winning expectancy between a player with rating R_{pre} and an opponent with rating R_{opp} is given by

$$We(R_{pre}, R_{opp}) = \frac{1}{10^{-(Rpre–Ropp)/400}+1}$$

This is computed for each opponent, and the results are totaled to produce a value of E.

The bonus, B, is automatically 0 if the player has competed against fewer than three distinct opponents, or more than twice against any opponent. If the player has competed against three or more opponents, no more than twice against each, then a comparison is made between the value $K(S–E)$ and $16\sqrt{m'}$, where m' is the larger of m and four (in other words, 3-round events are treated as 4-round events when computing the bonus amount). If $16\sqrt{m'}$ is larger or equal, then the bonus is 0. But if $K(S–E)$ is larger, then the bonus is the difference

$$B = K(S–E) - 16\sqrt{m}.$$

EXAMPLE

Suppose a player is rated 1300 based on 45 games, and competes in a full-K event against four distinct opponents rated 1250, 1400, 1500, and 1550, winning three and drawing one. With these results, S=3.5.

First, we compute the value of N_r as

$$N_r = 50/\sqrt{1 + (2200–1300)^2/100000} = 16.57$$

so that the lower of 16.57 and 45 is $N_e = 16.57$.

The value of K for this player in this tournament is given by

$$K = 800/(N_e + m) = 800/(16.57 + 4) = 38.89.$$

The winning expectancies against the four opponents are computed as 0.571, 0.360, 0.240 and 0.192. Add these results together to obtain E=1.363.

Finally, because

$$K(S–E) = 38.89(3.5–1.363) = 83.11$$

is larger than

$$16\sqrt{m} = 16\sqrt{4} = 32,$$

the bonus is 83.11–32 = 51.11. The final approximated rating is therefore

$$R_{post} = 1300 + 38.89(3.5–1.363) + 51.11 = 1434.22$$

which is then rounded to 1434 (in the actual algorithm, the rating would be rounded up).

RATING FLOORS

Rating floors exist at 100, 1400, 1500, 1600, ..., 2200. No player's rating can drop below 100. A player's rating floor is calculated by subtracting 200 points from the highest attained established rating, and then using the floor just below. For example, if a player's highest rating was 1941, then subtracting 200 yields 1741, and the floor just below is 1700. Thus the player's rating cannot go below 1700. If a player's highest rating was 1588, then subtracting 200 yields 1388, and the next lowest floor is 100, which is this player's floor.

Under current USCF policy, a person's rating floor can also change if the individual wins a large section or class prize. If a player wins an Under-2000 prize of at least $1,000, the individual floor is 2000.

CONVERTING RATINGS

All ratings from the old system are simply carried over to the new system. For provisional players under the old system, the number of games upon which the rating is based, N, is the one used in the new system. Because the number of games for established players under the old system was not retained, the new value of N is 50 if the player's rating is 2200 or over. If the player's rating is less than 2200, then N is assigned the larger of 26 and

$$50/\sqrt{1 + (2200–R)^2/100000},$$

rounded to the nearest whole number, where R is the old rating.

HOW DOES IT WORK?

While the above formulas provide an adequate approximation to the current rating system, the actual system takes greater advantage of information about opponents' performances. In the old system, an opponent with a strong result would tend to pull down a player's rating because the opponent's pre-tournament rating would be used in the calculations. The new system addresses this issue by carrying out the rating calculations in "two passes." In the first pass, players' ratings are updated by the formulas described above, with a special set of formulas inserted for unrated players (unrated players are usually given first-pass ratings based on their age).

In the second pass, the same calculations are performed, but this time imputing the ratings derived from the first pass for the opponents. Thus if a player's opponent has had an unusually strong performance during a tournament, the first pass will calculate this opponent's rating to be substantially higher than the pre-event rating, and during the second pass the player who competed against this opponent will benefit by being rated against the improved rating.

This two-pass system therefore provides a feedback mechanism for opponents' performances during an event. The approximating formulas described above do not incorporate this feedback into the rating calculations, so that they may produce inaccurate approximations when an opponent has had an exceptional tournament.

FINAL THOUGHTS

No system can measure playing ability perfectly. However, the new formulas do address the more serious challenges a rating system can face, and can be expected to produce more meaningful evaluations of playing ability. The tendency for players' ratings to decline without a decrease in strength has been mitigated, and the ability to track quickly improving players has been greatly improved.

QUESTIONS

Please address questions to a specific department. For example:

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