A Systematic and Discrete View of Aesthetics in Chess

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Introduction

Chess is a very old but popular board game for two players. There are many variants played all over the world including Shogi (Japan) and Xiangqi (China) but the most widely recognized is known as Western or international chess. Often regarded as both a sport and an art, chess is well known for its aesthetic qualities. Most people would agree that there is certain artistry to chess and this can be found primarily in the world of chess problem composition (Ravilious, 1994). However, chess problem compositions have their own conventions, which include other factors besides aesthetics. Most of the time, aesthetics in compositions is simply assumed to be synergetic of certain conventions or based purely on taste. (Wilson, 1978; Troyer, 1983)

This fact does not preclude aesthetics from regular over-the-board (OTB) games, however. Some people contend that since chess is primarily a game or sport where the main objective is to win, it cannot be considered an art form but even they concede to the presence of aesthetics at least within the domain of composed problems (Lord, 1985). Nevertheless, aesthetics outside that domain has been verified experimentally (Margulies, 1977) and also acknowledged by master players (Lasker, 1947), (Kasparov, 1987), (Levitt and Friedgood, 1995). So the question that remains is what exactly done we mean by aesthetics in chess? This paper elucidates some of the discrete principles of aesthetics that are not exclusive to chess problem composition or OTB games but are native to chess itself, as a whole. Clear definition of aesthetics is important to the development of computational models of aesthetics (Walls, 1997), (Iqbal1, 2006) that contribute to the field of artificial intelligence and also because similar parameters have been defined in even less amenable domains such music (McClain, 2003), (Golub 2000), art (Machado, 1998) and even literature (Bringsjorf, 1998); so what more chess which happens to be a zero-sum perfect information game with precise rules in a finite domain?

This paper is divided into 4 sections. The first covers chess problem composition and its conventions, including the idea of aesthetics in problems. Section 2 explores the principles of beauty in regular chess games. Also included is a discussion on the aesthetics of brilliant games. Section 3 bridges both problems and over-the-board games with the general principles of aesthetics that apply to both, hence providing a clear set of ideas to

work with when addressing the question of aesthetics in chess, as a whole. Finally, the conclusion sums up the basic ideas of this paper.

1. Chess Problem Composition

Chess problem composition is the primary domain in chess where it gets its reputation of being an art form albeit a minor one (Humble, 1993). That distinction in turn naturally implies the presence of aesthetics or beauty. Problem composition dates back to over a thousand years but the foundation of problems today was established only about 150 years ago. Problems that use the same pieces as the regular game are termed orthodox and this is the kind I wish to discuss here. There are other types such as fairy chess that include unconventional pieces, studies which are mostly of the endgame variety where white is to win or draw but not force checkmate, selfmates in which white forces black to deliver mate and helpmates where black and white cooperate to achieve checkmate for white (McDowell, 2005). All varieties of chess composition pertaining to whatever variant of chess have aesthetic qualities but they are not exactly the same or even close in some cases because the rules differ. This is why I wish to discuss specifically orthodox problems, in particular the direct-mate variety, which covers the majority of problem compositions and is similar in every way to the widely played version of international chess as we know it.

Problem competitions are often held where both exclusive composers and even highly rated players compete to create the best compositions. Grandmaster John Nunn and International Master David Friedgood are examples of professional players who are also great problem composers. Not very many professional players are also composers, though. This is usually because they focus on either the competitive aspect of the game or the artistic one and not both, at least not at the same point in their careers. It is theoretically for a chess composition to occur in a real game but unlikely because composers often place the pieces so strategically that the theme or idea they wish to illustrate can be demonstrated well. The basic idea behind a chess problem is that it typically challenges the solver to find a checkmate within a specific number of moves against any defense (Howard, 1967). So how are chess compositions judged? Is it purely based on subjective beauty? There is no fixed set of items judges must look at in a problem but Howard provides a rather comprehensive set of guidelines, perfectly valid even today, in the following. A chess problem should:

1. illustrate some particular powers of the chessmen in their interaction with one another
2. possess a solution that is difficult rather than easy
3. contain no unnecessary moves to illustrate a theme
4. contain more variety in the defenses available to the opposing side (black) but they must be related to the thematic content of the problem
5. possess complexity of variations
6. have white move first and mate black
7. have a starting position that absolutely must be possible to achieve in a real game, however improbable

8. contain only pieces present on the board at the beginning of the game, i.e., no more than 1 queen, 2 rooks, 2 bishops (of opposite colour squares), 2 knights and naturally 8 pawns however, pawns may be promoted to any piece in the actual solution
9. not allow en passant moves unless they take place as legitimate moves in the solution or have them functioning as a key (the first move) unless retrograde analysis shows black's last move to permit it
10. avoid castling moves because it cannot be proved legal
11. have a key move that appears aimless or inconspicuous, i.e., violates chess heuristics meaning that strong moves (checking, captures, limiting the mobility of black etc.) are undesirable.
12. possess more moves in the solution that are also of the 'quiet' type
13. possess only one unique key move that will solve the problem, otherwise it is 'cooked' (invalidated)
14. have a definite solution in the stipulated number of moves immune to any unexpected defenses by black
15. preferably not contain duals or triples (more than one valid continuation after any of black's replies) but this cannot be entirely elimated from compositions so the issue is usually explored in greater detail and may vary depending on the judge
16. feature economy, i.e., the relation between the number of men used and the results obtained (based on complexity or variety in lines of play); a problem is considered uneconomically when the same result could be obtained with fewer men or less powerful ones so a piece should be made to use as much of its power as possible with more emphasis given to the white forces in this respect
17. create a deceptive setting for the solver (makes it look like a different theme is at play) so to lend more satisfaction when the real solution is discovered
18. not be 'dressed' (placing unnecessary pieces to mimic the conditions of a real game) which used to be the practice of earlier composers but today interferes with the concept of economy
19. have the chessmen spaced over the entire board rather than just in one section as too many pieces close to each other depict clutter
20. avoid using too many pawns, especially mutually blocking white and black ones; doubled and tripled pawns are objectionable, except when used thematically
21. not place pieces in 'unnatural' positions for a skilled composer endeavors to keep his positions from appearing this way

These guidelines and rules are confirmed and reiterated in other sources dealing with problem compositions as well (Albrecth, 1993), (Morse, 1995) and give the layman quite a good idea about what constitutes a good or even acceptable direct-mate orthodox chess problem. It should be clear however that not all of the things listed above pertain to aesthetics or beauty in chess in any universal sense. Many (e.g. 2, 4-10, 15, 20, 21) are merely conventions, sensible as they may be, established by earlier composers (known as

the 'Old School') and those who followed and improved on them. The most beautiful problem (from anyone's point of view) does not necessarily win composition tournaments nor is it even regarded as a good example. This is why evaluating problems purely from an aesthetic viewpoint is an issue for both composers and judges. Wilson lists the items judges generally look at (subjectively) when deciding on a composition if only from an aesthetic standpoint, notably:

1. quality of the key move and where it points
2. preferred themes
3. originality of the idea
4. detrimental effect of a bad dual (if it exists)
5. detrimental effect of unused major pieces in the solution
6. permission of checking moves as keys and if so, to what extent
7. optional penalization of symmetry on the board

He also adds that based on 'rules' like this, judges often completely disagree with each other about which composition should win. Anyone can see that while items 1 through 7 above can relate to aesthetics in some composition-related way, there is nothing there that treats the concept of aesthetics in chess as stemming from anything more than purely subjective taste and personal knowledge, however inadequate that may be. This is the perception of many problem composers and even players. They really have little idea how to approach the element of aesthetics in any way other than being completely arbitrary about it (as conventional wisdom dictates) or based on their personal taste and perhaps even mood, at the time. This may be why many of the conventions mentioned by Howard are in fact quite objective and provide some rational basis for composing and eventually judging good problems. These conventions are considered objective because they are quantifiable to an extent (Fainshtein, F. and HaCohen-Kerner, Y, 2006) without the involvement of personal taste.

Wilson proposed a method of evaluating chess problems using reference tables by attributing integer values to strategies like checks, blocks, castling and also to individual themes in the hope of providing a fair basis for comparing one composed chess problem to another (Wilson 1969). This was intended to provide a more objective method for evaluating chess problems. The method produced a numeric score for individual chess problems that could be used to compare one against another. It was even reasonably accurate by some standards. However, his proposal to use the method to replace human judges in chess problem composition contests was universally rejected (Grand 1986) and probably because it failed to account for the aesthetic aspect of problems that cannot be accounted for as easily or was just assumed to be synergetic of the limited conventions and things he did account for.

One might now be tempted to ask how many things there are to consider in a chess problem. We know that conventions are important and so is aesthetics. Everything else most likely falls under one of these two. For example, Morse states that problems have 'art' and 'puzzle' elements. The former refers to aesthetics and the latter, difficulty (Morse,

1995). Troyer, in talking about the aesthetic aspect of chess problems mentions even the history behind a problem and how that might contribute to its appreciation (Troyer, 1983). Nonetheless, he is referring to the aesthetic component pertaining to problems. Any systematic approach to problem composition or evaluation can only take into account the objective and quantifiable aspects and not aesthetics because we have yet to define it ourselves. Does this mean that aesthetics in a given domain is beyond explicit or even reasonable definition? Once again conventional wisdom will tell us it probably is but unfortunately we cannot rely on conventional wisdom very much. I will explain more about this in the following section.

Aesthetics, we must remember, is also an element in over-the-board games where most conventions of problem composition do not apply even though the rules of the game are exactly the same. In fact, the rules of chess have not really changed in over 500 years with the last major introduction being the en passant pawn move in the 15th century that allows a pawn on the fifth rank to capture an enemy pawn moving two squares on an adjoining file as if it had only moved one square (Hoopers and Whyld, 1996). This is why some games from distant history can be appreciated aesthetically even today for the rules have not changed.

In this section we have seen the many conventions of chess problem composition and how some of them relate to aesthetics. In my opinion, it is wrong to conflate conventions that are typically objective (e.g. no duals, no dressing of the board etc.) with aesthetics that is rather subjective. In fact, since aesthetics has no explicit definition in chess composition, it is often assumed to arise synergitically from the amalgam of conventions mixed with dash of personal taste. This need not be the case since aesthetics has been more accurately defined in OTB games. Their relation to problem composition is also clear given that the rules of the game are the same in both cases. So, it stands to reason that aesthetics exists in both regular chess games and problems in a way that bridges the two. It can be argued that aesthetic perception in compositions might differ from that in real games but this is due to the aforementioned conflation of problem conventions and aesthetics. There is nothing much about beauty in chess itself (pertaining to the common ground between problems and regular games) that somehow requires aesthetics in either to be redefined. No matter how you slice it, both are still very much the game of chess and abide by the same rules so blurring the concept aesthetics that apply to both is unnecessary.

2. Principles of Beauty in Regular Games

When referring to aesthetics in chess, people are usually talking about something that appeals to them in a certain way. It is true that this can be different from person to person but there are things about the rules of chess that dictate one should have reasonable basis before saying something about the game is beautiful. Beauty in chess as it turns out, is not wholly in the eye of the beholder. For example, the shape and size of the chess pieces (or even the hand that moves it) are irrelevant and not deemed worthy of being called beautiful in a way that relates to the game itself. Stuart Margulies, a psychologist, in an

attempt to understand aesthetic principles in other more amorphous areas, derived 8 principles of aesthetics in chess from the judgement of expert chess players. The principles of beauty are as follows:

1. successfully violate heuristics
2. use the weakest piece possible
3. use all of the piece's power
4. give more aesthetic weight to critical pieces
5. use one giant piece in place of several minor pieces
6. employ chess themes
7. avoid bland stereotypy
8. neither strangeness nor difficulty produces beauty (i.e. wildly improbable positions and difficult ones do not lead to judgements of beauty)

His results have nothing to do with chess problem composition in particular and is referring strictly to beauty or aesthetics in chess. This means that it pertains to aesthetics of over-the-board games and problem composition. Perhaps even to any other form of the game that applies exactly the same rules. His research only further confirms what chess problem composers and professional players have been saying for a long time about beauty in the game (Lionnais, 1951), (Osborne, 1964), (Bronstein, 1983). Most of these principles exist in some form or other in problem conventions but they also apply wholly to real games.

Successful violation of heuristics has been explained but to clarify even further, it means anything that goes against traditional chess practices of good play (e.g. keep your king safe, protect your chessmen, capture enemy material etc.) yet results in an achievement of some kind. The 2nd principle places emphasis on using a weaker piece over a more powerful one either in the move sequence. It is considered more beautiful for example, to checkmate using a knight than a queen since the latter has a piece value 3 times the former yet achieves the same goal. Piece values (Q = 9, R = 5, B = 3, N = 3, P = 1) were set by Claude Shannon in his seminal paper on programming a computer to play chess and have been widely accepted today as a means of comparing material value on the chessboard (Shannon, 1950). Margulies' 3rd principle refers to the power of each piece such as the ability to traverse the entire board in a single move. The power of a piece relates directly to the number of squares it controls (Euwe, 1982).

In principle 4, more aesthetic weight is ascribed to critical pieces. This refers to the piece that is essential to the combination played. The one that checkmates the enemy king is usually critical so aesthetic considerations are severely affected should this piece hypothetically be replaced with a different one. The 5th principle of using a giant piece in place of minor ones used imaginary pieces to illustrate the concept of power utilization on the board. It is considered more aesthetic to have one piece do the job of many. The 6th principle of employing chess themes is very broad and covers many themes in chess such as the fork, pin and discovered attack. Chess problems employ all the themes used in OTB chess but also include more exotic ones (e.g. Novotny, Bristol etc.) that are less common in regular games. Principle 7 suggests that common positions are less beautiful than rare ones. This relates to the concept of originality. Finally, principle 8 states that strange

positions (awkward in a sense) or difficult ones, are not necessarily beautiful. In compositions, difficulty is valued so this is a specific example of a problem convention that cannot be taken as a prerequisite to aesthetics in chess as a whole.

Brilliancy prizes are awarded to certain games (usually on the grounds of a particular move combination in the game) at some chess tournaments based on principles that are very similar to those just discussed (Damsky, 2002). Damsky states that brilliance-another term often used when referring to aesthetics or beauty in chess-in tournament games involves expediency, disguise, sacrifice, correctness, preparation (when referring to a complete game rather than a particular combination), paradox and originality.

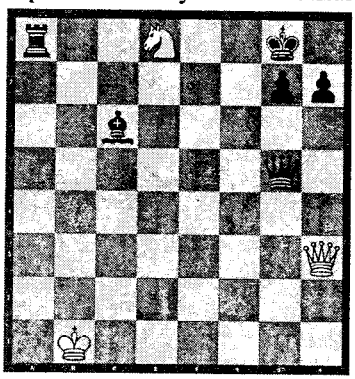
Expediency implies effectiveness in the sense that the move achieves something tangible like a checkmate, decisive material gain or forcing a draw in a seemingly lost position. Disguise suggests a violation of heuristics because the key move played (for a particular combination, usually) should not lend itself to the solution immediately. It is not something that appears obvious, so to speak. Sacrifices, especially significant ones, are often treasured because in real games it is not something players seriously consider unless there is some tangible benefit within a calculable distance ahead. They are also a form of heuristic violation and paradoxical in nature. Correctness is essential because the move sequence should not have succeeded due to chance or unsound play by the opponent. Just like in chess problems, a move sequence is considered beautiful if and only if there is no way the opponent could have successfully defended against it and no way the objective could have been achieved more quickly through a different maneuver. Amateur players are often quite pleased with themselves after executing what they think is a fantastic combination during a game but upon closer analysis, particularly with the aid of computers, it is very common that they realize it could have been done sooner or better in some way if not that the opponent simply missed a viable defense to their attack.

Preparation is a term that refers to when a beautiful move sequence in a certain position of the game was achieved in great part due to the strategic play preceding it that lead to the favourable arrangement of pieces in said position. Under these circumstances, the whole game may be considered beautiful and awarded a brilliancy prize. In most cases however, brilliancy can be pinned down to a particular move sequence or combination that shines in a game. Paradoxes as mentioned earlier, are not confined to sacrifices. They also include anything that goes against preconceived notions in chess. For example, it is taught in chess that you should always keep your king safe. However, there are positions where the king if turned into an attacking piece moving right through the centre of the board, might actually force checkmate. The concept of paradoxes in chess is explored in some detail by Levitt and Friedgood in their book on 'spectacular' chess (Levitt and Friedgood, 1996). Finally, we have originality. This is hard to objectively ascertain because it refers to something the observer has not seen before and relies on his experience. In some ways it can be tied to the concept of rarity but not strangeness.

There are also other aspects of beauty in chess that have been described by master players based on their experience with the game. Lasker wrote of achievement, which is actually a very fundamental principle of beauty in chess (Lasker, 1947). Whether we are talking about beauty in regular games, brilliancy prizes or even problem composition,

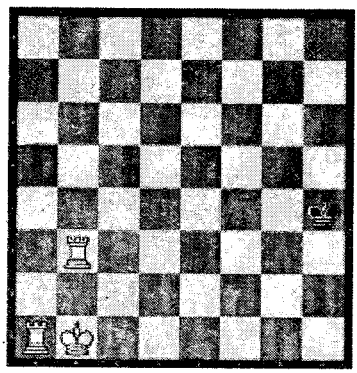
unsound play is unforgivable aesthetically. Another important aesthetic element that applies to regular games is the principle of economy (Levitt and Friedgood, 1995), (Humble, 1993), (Troyer, 1983). It is more or less equivalent to its counterpart in problem composition. Whilst it is understandable that composed problems have an advantage here since the composer can make certain no stray pieces are on the board, for OTB games it is still considered aesthetic-perhaps even more so given the inherent lack of control over what happens-when a checkmate occurs using all available resources as efficiently as possible. Amateur games for example, will often feature superfluous material used to checkmate (e.g., a queen and two rooks) due to the players' lack of skill whereas master games tend to achieve mate with more finesse. This is not done intentionally in master tournaments but arises naturally from the soundness of their play. The idea of beauty in chess leading to or following from effectiveness has even been applied to computer chess heuristics where it outperformed regular heuristics in certain tests (Walls, 1997).

Levitt and Friedgood add to our list of aesthetic principles the concept of geometry on the chessboard. Unlike the other principles, there is nothing inherently sound about geometry on the board but it is certainly one of the things we would first notice about a chess position. What is meant here by geometry is when the pieces on the board are arranged in such a way so as to form recognizable shapes (e.g., squares, triangles, rectangles, alphabets). Obviously such things are very rare especially in OTB games but simpler geometric shapes like 3 or 4 pieces in a single row, column or diagonal are equally noticeable and geometric in nature. Detailed specifics aside that are about all there is in common about aesthetics in chess as both a game and an art. In the next section, this common ground is charted and its importance explained. Before that however, the following two chess positions in Figure 1 illustrate how a combination of aesthetic principles can render one position clearly more beautiful than another.



(a)

1. Qe6+ Kh8 2. Nf7+ Kg8 3. Nh6+ Kh8 4. Qg8+ Rxg8 5. Nf7++



(b)

1. Ra4+ Kg5 2. Rb5+ Kf6 3. Ra6+ Ke7 4. Rb7+ Ke8 5. Ra8++

(Figure 1)

Both positions (a) and (b) are forced mates in 5 moves. Neither are in any 'composed' fashion but instead come from what could easily arise in a real game. In (a), white performs what is known as a 'smothered' mate by sacrificing his queen (despite already being a rook down) so the black king is cornered by his own pieces. All the while white forsakes the 'obvious' capturing of the bishop on c6 or queen on g5 in favour of checkmating the king. The final position is breathtaking. Black would probably not have seen it coming so easily.

However in figure (b), we also have a forced checkmate in 5 moves. This one unfortunately holds no surprise and black would probably resign immediately. White is significantly ahead in material and his rooks simply force the enemy king back one rank at a time until there is nowhere else left to go. Any chess player worth his salt would consider (a) more beautiful than (b) because of the aesthetic principles present namely winning with less material (paradox), violation of heuristics, sacrifice and execution of themes (smothered mate, fork, double check). Position (b) coincidentally has none of these things. Although it might be considered an extreme example, it should be noted that there are also more beautiful positions in chess than (a) and those considered even less appealing than (b). The distinction may not be linear, but nevertheless it is there.

3. Aesthetic of Chess in General

The previous two sections explored the idea of aesthetics in chess and how it applies to both the world of chess composition and regular over-the-board games. With the exception of certain problem composition conventions, everything that is deemed beautiful in OTB games, is also considered beautiful in problems. The items listed below are the common ground of aesthetics in chess as a whole and which applies to both domains.

1. achievement
2. violation of heuristics (paradox, sacrifice etc.)
3. use of all of the piece's power
4. use of the weakest piece possible
5. economy
6. originality
7. employment of chess themes
8. geometry

Looking closely at both problem conventions and aesthetics (brilliance) in OTB games, we can see that all these principles apply to both domains. Rather than taking problem conventions and trying to apply all of them to regular games which is impossible, the correct approach is taking the recognized aesthetic principles from regular games and letting them overlap with the problem conventions where possible. This can be done quite easily for none of these principles really go against the rules of problem composition. One of the benefits of this overlap is that we now have something tangible to work with when

evaluating aesthetics in chess problems. Previously, it was based purely on taste or subjective assessment of conventions (e.g. effect of bad duals, preferred themes) that in truth have little to do with beauty in chess holistically.

This does not mean that aesthetics in chess composition is now somehow limited to these principles. It only means that a certain level of objectivity with regard to aesthetics can be obtained by relying on these principles, and not just for chess composition but also when it comes to appreciating brilliance in OTB games. When speaking of aesthetics in chess (without being specific about problems or regular games), these principles are the most reliable because people tend to unequivocally conflate, often to a mystical degree, what they think synergitically emerges from problem conventions with the general concept of 'beauty' in chess.

Most chess problems can be recognized as compositions by experienced players and composers. However, once they are convinced of this their idea of what constitues beauty automatically falls back on the dictates of problem conventions. For example, if a straightforward checkmate (without much complexity and using the castling move in its solution) was 'composed', it would most likely be deemed 'not beautiful' because it did not obey or went against certain problem conventions when in fact, it could easily have been called, 'brilliant' in a real game. The irony is that regardless of being a composition or occuring in a real game, they are exactly the same thing, i.e., chess but viewed as beautiful only if seen through a particular lens. Fortunately, many people who do not adhere religiously to either camp will be able to recognize this beauty for its own sake and perhaps get some enjoyment out of it.

It is because of this enjoyment of chess that most people including experts, continue to play (Kasparov, 1987) and even devote their life to it. This fact has recently piqued the interest of computer scientists looking for something new to explore in the domain of chess (Iqbal2, 2006) given that machines can already quite effectively outplay humans but cannot for the life of them, appreciate or recognize beauty in the game as we do. Research into such things requires the kind of clear definition of aesthetics like has just been presented. Otherwise, the closest we have come to conquering this facet of the game is through automatic problem composition (Schlosser , 1988), (Watanabe, 2000), (Fainshtein, 2006) which uses heuristics that have very little to do with what is inherently beautiful about chess itself. For the most part, they rely on a few quantifiable chess conventions and arbitrary values attributed to specific themes by master players. They also admit to being unable to quantify the aspect of beauty in chess problems.

Based on the arguments presented thus far, the following diagram (Figure 2) illustrates the concept of beauty in chess in a manner that is supported by research and chess literature. It also represents principles (provided earlier) that are generally amenable to scientific investigation with regard to aesthetics in chess.

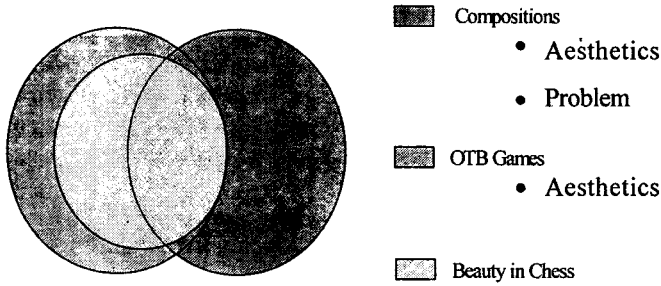


Figure 2: Aesthetic perception in chess

We can see from the diagram that compositions are usually perceived by humans from the standpoint of aesthetics and problem conventions. Often, composers and those who enjoy chess problems find the two difficult to tell apart. OTB games on the other hand do not particularly feature problem conventions even though some of them might exist as heuristics of sound play. However, aesthetics in OTB games is more easily recognized and forms much of the basis used to determine brilliancy. Beauty in chess as a whole therefore includes the bulk of what we perceive as aesthetic in regular games but only part of aesthetic perception in compositions. Usually this means the part that excludes conventions unique to problems.

The benefit of this compartmentalization is that we now have something tangible to work with when addressing the concept of beauty in chess without making the usual mistake of conflating it with problem conventions or personal taste. This is important because many people refer to beauty in chess as if it was something clearly defined when in truth they are probably referring to the former or the latter and this in turn does not translate to anything of value since it is inaccurate or utterly ambiguous. Fortunately, beauty in chess can indeed be defined to a reasonable degree and since the rules are the same be it in composition or regular games, it must apply to both in a way that is not necessarily adherent to problem conventions or personal taste but rather based on the idea of achievement and sound play. This is not to say that there is no room for personal taste in the aesthetic appreciation of chess but only that such definition is not tangible enough and therefore not helpful to research in the area.

4. Conclusion

Beauty or aesthetics in chess is a recognized and acknowledged concept in the game. However, no formal definition of beauty is given and therefore it often falls back onto the conventions of problem composition where aesthetics is commonly referred to. Even so, the fact remains that conventions themselves are not necessarily aesthetic because

few actually apply to real chess games where aesthetics is also recognized as brilliancy. Additionally, research has shown that there are principles of aesthetics that are not limited to compositions but apply to chess in general. Over the decades, master players have also identified similar principles of beauty based on their experience in regular games and problem composition. This leads to a much clearer idea of aesthetics in chess as something not native to either problems or regular games but applicable to the game as a whole. It also makes amenable to scientific research an interesting facet of the game which computers currently have no grasp of. While the prospects of this are certainly intriguing, it should be noted that such principles do not conclusively define beauty in chess and can only serve as the basis for aesthetic models that would be of benefit to humans not only in terms of aesthetic appreciation but also in improving game playing heuristics, problem composition algorithms and artificial intelligence in general.

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