An Approach to Data Compression in Coding Chess Positions

Bernhard Balkenhol
Universit"at Bielefeld
Fakult"at f"ur Mathematik
Postfach 100131
33501 Bielefeld
Germany

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email: bernhard@math34.mathematik.uni-bielefeld.de

Abstract

We present an algorithm to encode "typical" chess positions with a sequence of yes–no–questions. Preceding tests suggest that on average a sequence of 86 questions (bits) is sufficient to reveal a chess position.

1 Introduction

In general it is possible to encode any legal chess position using 136 bits ([Nie 77]).
In 1977 Jurg Nievergelt [Nie 77] conducted the following investigation. He chose a "typical" chess position and asked chess players to reconstruct this position by asking a sequence of yes–no–questions. It turned out that on average chess players needed about 70 yes–no–questions to reconstruct the chess position. The expression "typical" is informal and described as all the in chess–master–games possible positions.
Among all legal chess positions there are some that will – at least with a high probability – never occur in general practice. It is for example possible to construct a legal chess position in which White has four Pawns in the same column. This would be a "non–typical" position.

2 Description of the Algorithm

Our algorithm chooses a questionaire such that typical chess positions are stored with less then 136 bits, simultaneously however, we put up with the fact that non–typical positions are sometimes stored using more than 136 bits. The following algorithm, as presented in his basic mode of operation, on average needs 86 bits to encode a given typical position. This statment is made on the basis of preceding tests. Testing a game meens that each position out of the game would be stored without using informations of the other positions. Now the average code length of a game is the average code length of the positions of the game. The algorithm itself has a size of 185 kByte and is written in the functional programming language Gofer Version 2.28a. The encoding of a chess position follows in 14 sections which are not independent. This sections are

1. Preliminary Examination
2. Determination of Pieces on the Chess Board
3. Coding the White King
4. Coding the Black King
5. Coding the White Pawns
6. Coding the Black Pawns
7. Coding of the White Rooks
8. Coding of the Black Rooks
9. Coding the White Bishops
   - Asking for the White Bishop on a White Square
   - Coding the Other White Bishop on a Black Square
10. Coding the Black Bishops
    - Asking for the Black Bishop on a White Square
    - Coding the Other Black Bishop on a Black Square
11. Coding of the White Knights
12. Coding of the Black Knights
13. Coding for the White Queen
14. Coding for the Black Queen

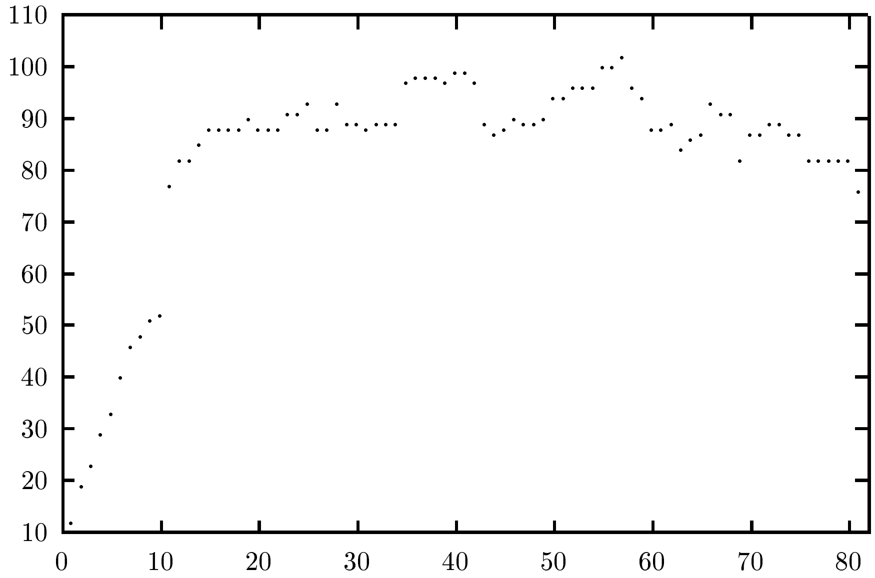
In this case we must mention, that no informations about Rochade, Enpassat and which player has made the last move would be stored. However a change of the algorithm to do this would be increase the average length of the code of about 5 Bits.

3 Results

Let the game between **B*Hitech and David Bronstein** (look at [IJ 93] Page 103) be an example, then the lengths of the codes of all positions in this game are

12, 19, 23, 29, 33, 40, 46, 48, 51, 52, 77, 82, 82, 85, 88, 88, 88, 88, 90, 88, 88, 88, 91, 91, 93, 88, 88, 93, 89, 89, 88, 89, 89, 89, 97, 98, 98, 98, 97, 99, 99, 97, 89, 87, 88, 90, 89, 89, 90, 94, 94, 96, 96, 96, 100, 100, 102, 96, 94, 88, 88, 89, 84, 86, 87, 93, 91, 91, 82, 87, 87, 89, 89, 87, 87, 82, 82, 82, 82, 82, 76.

This is illustrated by the following graphic:



The average codelength of a position out of this game is 83.

Some other results are:

Players	out of	length of the game	average code–length
Leko – Horvath	Budapest 1993	48	81
Zugzwang – John Nunn	[IJ 93]	80	84
David Bronstein – Chessmachine The King	[IJ 93]	120	83
Michiel Wind – Nimzo	[IJ 93]	44	86
John Nunn – Tasc Chess System R30	[IJ 93]	91	78
B*Hitech – David Bronstein	[IJ 93]	81	83
Chessmachine The King – Tim Krabbe'	[IJ 93]	78	82
Alexander Muenninghoff – Saitek Risc 2500	[IJ 93]	62	94
David Bronstein – Kallisto	[IJ 93]	108	90
David Bronstein – Socrates X	[IJ 93]	131	78
Guenther Loewenthal – Chessmachine The King	[IJ 93]	65	98
Chessmachine The King – Jessica Harmsen	[IJ 93]	56	97
John Nunn – Nimzo	[IJ 93]	78	73
3-Hirn – David Bronstein	[IJ 93]	103	95
Cessmachine The King – John Nunn	[IJ 93]	114	89

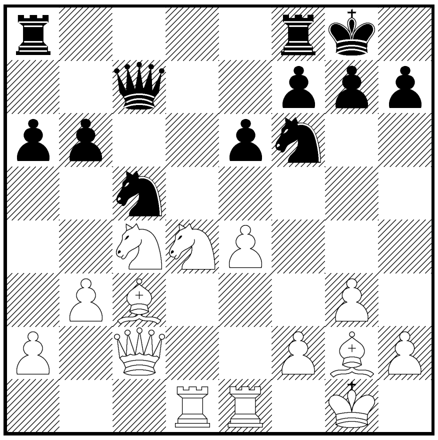
4 References

[IJ 93] ICCA JOURNAL Vol. 16 No. 2 (June 1993), 192–104.

[Nie 77] J. Nievergelt: Information content of chess positions,
ACM SIGART Newsletter 62 (April 1977), 13–14.
It is also reprinted in:
Information content of chess positions:
Implications for game–specific knowledge of chess players,
283–289 in Machine Intelligence 12,
(eds. J. E. Hayes, D. Michie, E. Tyugu),
Clarendon Press, Oxford, 1991.
email: jn@inf.ethz.ch (J. Nievergelt).

5 Appendix

This is an example of a typical chess position which is used to exhibit the operation of the algorithm.



example

Let **Q** be a sign for a question, **A** be a sign for an answer and **C** be a sign for conclusions and remarks. Then the first question with its answer is

5.1 Preliminary Examination

In the first step we ask, if we have a situation which we can have after exchanging a Pawn. (For example: White can have two Queens.)

Q1 Does White or Black have more than one Queen or more than two Rooks or more than two Knights or more than two Bishops or two Bishops positioned on squares of the same color ?

A1 No.

5.2 Determination of Pieces on the Chess Board

The determination of the pieces follows in four steps

- determination of the number of white pieces
- depending on the first the number of black pieces
- depending on the first and the second the white pieces on the board
- and at least depending on the first, the second and the third the black pieces on the board

Let w be the number of white pieces

Q2 Is $w \in \{11, 12, 13, 14\}$?

A2 Yes.

Q3 Is $w = 11$ or $w = 12$?

A3 No.

C $w = 13$ or $w = 14$

Q4 Is $w = 13$?

A4 No.

C $w = 14$

Let b be the number of black pieces.

Q5 Is $b = 13$ or $b = 14$?

A5 No.

Q6 Is $b = 12$ or $b = 15$?

A6 Yes.

Q7 Is $b = 15$?

A7 No.

C $b = 12$

Q8 Is one of the white captured pieces a Pawn ?

A8 Yes.

Q9 Is the other white captured piece a Pawn, too ?

A9 Yes.

C This implies that all white pieces on the board are known. If we evaluate a Queen with 9 points, a Rook with 5 points, Knights and Bishops with 3 points and Pawns and Kings with one point, the game value of White is equal to 38.

Let s be the game value of Black.

Q10 Is $s \in \{34, 36\}$?

A10 No.

Q11 Is $s \in \{32, 30, 28, 26\}$?

A11 Yes.

Q12 Is $s \in \{32, 30\}$?

A12 Yes.

Q13 Is $s = 32$?

A13 Yes.

Q14 Is Black missing two Pawns and at least one Bishop ?

A14 Yes.

Q15 Is Black missing two Bishops ?

A15 Yes.

C All black pieces on the chess board are known.

5.3 Coding the White King

Q16 Is the white King on square e1 or g1 ?

A16 Yes.

Q17 Is the white King on e1 ?

A17 No.

C The white King is on g1

5.4 Coding the Black King

Q18 Is the black King on g8 ?

A18 Yes.

5.5 Coding the White Pawns

Q19 Does White have no multiple Pawns ?

A20 Yes.

C This implies that the number of columns for White in which there is exactly one Pawn is equal to 6.

Q20 Does White have no Pawns in the first column or are the two columns in which White has no Pawns adjacent but not equal to column g and h at the same time ?

A20 Yes.

Q21 Has White no Pawns in the columns b and c or in the columns c and d or in the columns d and e or in the columns e and f ?

A21 Yes.

Q22 Has White no Pawn in the column c ?

A22 Yes.

Q23 Has White no Pawn in the column d ?

A23 Yes.

Coding the rows on which there are white Pawns from the left to the right.

Q24 Is Pawn 1 in row 2 ?

A24 Yes.

Q25 Is Pawn 2 in row 2 ?

A25 No.

Q26 Is Pawn 2 in row 3 ?

A26 Yes.

Q27 Is Pawn 3 in row 2 ?

A27 No.

Q28 Is Pawn 3 in row 3 ?

A28 No.

Q29 Is Pawn 3 in row 4 ?

A29 Yes.

Q30 Is Pawn 4 in row 2 ?

A30 Yes.

Q31 Is Pawn 5 in row 2 ?

A31 No.

Q32 Is Pawn 5 in row 3 ?

A32 Yes.

Q33 Is Pawn 6 in row 2 ?

A33 Yes.

5.6 Coding the Black Pawns

Q34 Does Black have no multiple Pawns and is it true for each black Pawn being in a column in which there is also a white Pawn that the row number of the black Pawn is larger than that of the white one ?

A34 Yes.

C This implies that the number of columns for Black in which there is exactly one Pawn is equal to 6.

Q35 Has Black no Pawns in the columns b and c or in the columns c and d or in the columns d and e or in the columns e and f or in the columns f and g or in the first column ?

A35 Yes.

Q36 Has Black no Pawns in the columns b and c or in the columns c and d or in the columns d and e or in the columns e and f ?

A36 Yes.

Q37 Has Black no Pawns in the columns b and c or in the columns c and d ?

A37 Yes.

Q38 Has Black no Pawns in the columns b and c ?

A38 No.

C Black has no Pawns in the columns c and d.

Coding of rows on which there are black Pawns from the left to the right.

Q39 Is Pawn 1 in row 7 ?

A39 No.

Q40 Is Pawn 1 in row 6 ?

A40 Yes.

Q41 Is Pawn 2 in row 7 ?

A41 No.

Q42 Is Pawn 2 in row 6 ?

A42 Yes.

Q43 Is Pawn 3 in row 7 ?

A43 No.

Q44 Is Pawn 3 in row 6 ?

A44 Yes.

Q45 Is Pawn 4 in row 7 ?

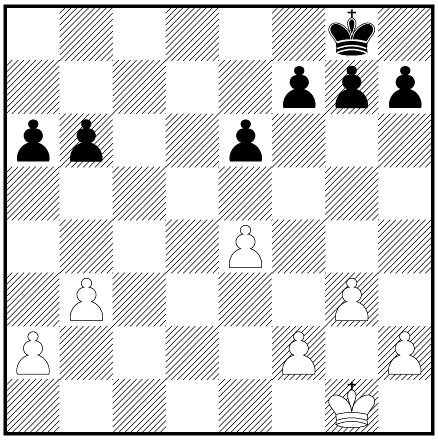
A45 Yes.

Q46 Is Pawn 5 in row 7 ?

A46 Yes.

Q47 Is Pawn 6 in row 7 ?

A47 Yes.



`Thus far, we revealed this partial position`

5.7 Coding of the White Rooks

Q48 Isn't one of the white Rooks in the first row ?

A48 No.

Q49 Is a white Rook on a1 ?

A49 No.

Q50 Is a white Rook in the column c or are the white Rooks in the columns b and d or in the columns d and e ?

A50 Yes.

Q51 Is exactly one white Rook in column c and the other in one of the columns b,d or e ?

A51 No.

Q52 Is a white Rook in the column c ?

A52 No.

Q53 Is a white Rook in the column b ?

A53 No.

C There are white Rooks on d1 and e1

5.8 Coding of the Black Rooks

Q54 Are both black Rooks in row 8 ?

A54 Yes.

Q55 Is a black Rook on a8 ?

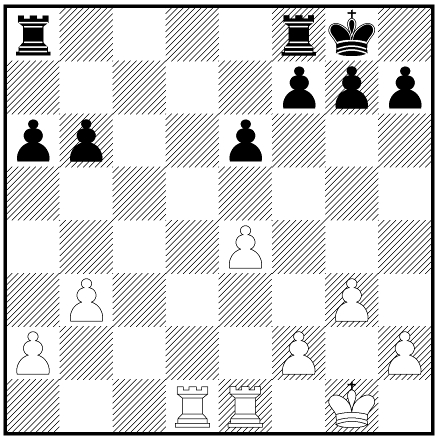
A55 Yes.

Q56 Is the other black Rook on e8 or f8 ?

A56 Yes.

Q57 Is a black Rook on f8 ?

A57 Yes.



`Thus far, we revealed this partial position`

5.9 Coding the White Bishops

From question number one follows that White has two Bishops, one of them has to be on a white square and the other on a black square.

5.9.1 Asking for the White Bishop on a White Square

Q58 Is the white Bishop in the row 3,4 or 5 ?

A58 No.

Q59 Is the white Bishop in the first or the second row ?

A59 Yes.

Q60 Is the white Bishop in the first row ?

A60 No.

C The white Bishop is in the second row.

Q61 Is the white Bishop in column e ?

A61 No.

Q62 Is the white Bishop in column g ?

A62 Yes.

5.9.2 Coding the Other White Bishop on a Black Square

Q63 Is the white Bishop in row 3,4 or 5 ?

A63 Yes.

Q64 Is the white Bishop in the third row ?

A64 Yes.

Q65 Is the white Bishop in the third column ?

A65 Yes.

C The white Bishops are on c3 and g2

5.10 Coding of the Black Bishops

We allready know, that black has no Bishop. So we haven't to encode anything.

5.11 Coding of the White Knights

Q66 Are both white Knights below the 6 th row ?

A66 Yes.

Q67 Are both white Knights above the second row ?

A67 Yes.

Q68 Are both white Knights in the third row ?

A68 No.

Q69 Is one of the white Knights in the third row ?

A69 No.

Q70 Are both white Knights in the same row ?

A70 Yes.

Q71 Are both white Knights in the fourth row ?

A71 Yes.

Q72 Is one white Knight in the third column and none in column h ?

A72 Yes.

Q73 Is a white Knight in column f ?

A73 No.

Q74 Is a white Knight in column b or d ?

A74 Yes.

Q75 Is a white Knight in column d ?

A75 Yes.

C The white Knights are on c4 and d4.

5.12 Coding of the Black Knights

Q76 Is one of the black Knights guarded by one of the black Pawns ?

A76 Yes.

Q77 Are both black Knights guarded by black Pawns ?

A77 Yes.

Q78 Are both black Knights on the King's wing or is one of the black Knights on square c5 and the other in the 6 th row ?

A78 Yes.

Q79 Are both Knights in the 6 th row or is one Knight on square f5 and the other one on square h6 ?

A79 No.

Q80 Are the black Knights on f5 and f6 or on f5 and g6 or on d5 and h6 or on d5 and f6 ?

A80 No.

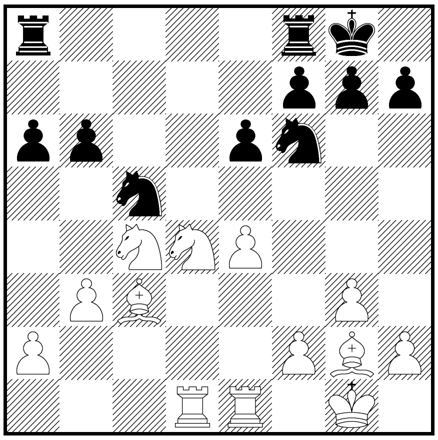
Q81 Is a black Knight on square d5 ?

A81 No.

Q82 Is a black Knight on square h6 ?

A82 No.

C The black Knights are on c5 and f6.



`Thus far, we revealed this partial position`

5.13 Coding for the White Queen

Q83 Is the white Queen in the below the 5 th row ?

A83 Yes.

Q84 Is the white Queen on the King's wing ?

A84 No.

Q85 Is the white Queen in the column a or b ?

A85 No.

Q86 Is the white Queen on square c1 ?

A86 No.

C The white Queen is on square c2

5.14 Coding for the Black Queen

Q87 Is the black Queen in the 8 th row or is she on d7 or e7 ?

A87 No.

Q88 Is the black Queen above the third row ?

A88 Yes.

Q89 Is the black Queen above the 5 th row or on d5 ?

A89 Yes.

Q90 Is the black Queen in column g or on square d6 ?

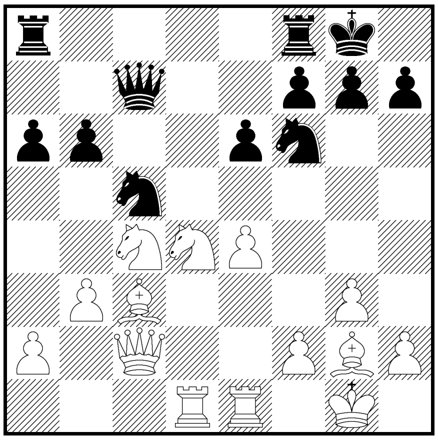
A90 Yes.

Q91 Is the black Queen on c7 or d6 ?

A91 Yes.

Q92 Is the black Queen on c7 ?

A92 Yes.



`Now the complete position is known`