Endgame tablebase

An endgame tablebase is a computerized database that contains precalculated exhaustive analysis of chess endgame positions . It is typically used by a computer chess engine during play , or by a human or computer that is retrospectively analysing a game that has already been played .
The tablebase contains the game @-@ theoretical value (win , loss , or draw) of each possible move in each possible position , and how many moves it would take to achieve that result with perfect play . Thus , the tablebase acts as an oracle , always providing the optimal moves . Typically the database records each possible position with certain pieces remaining on the board , and the best moves with White to move and with Black to move .
Tablebases are generated by retrograde analysis , working backwards from a checkmated position . By 2005 , all chess positions with up to six pieces (including the two kings) had been solved . By August 2012 , tablebases had solved chess for every position with up to seven pieces (the positions with a lone king versus a king and five pieces were omitted because they were considered uninteresting) .
The solutions have profoundly advanced the chess community 's understanding of endgame theory . Some positions which humans had analyzed as draws were proven to be winnable ; the tablebase analysis could find a mate in more than five hundred moves , far beyond the horizon of humans , and beyond the capability of a computer during play . For this reason , they have also called into question the 50 move rule since many positions are now seen to exist that are a win for one side but would be drawn because of the 50 move rule . Tablebases have enhanced competitive play and facilitated the composition of endgame studies . They provide a powerful analytical tool .
While endgame tablebases for other board games like checkers , chess variants or Nine Men 's Morris exist , when a game is not specified , it is assumed to be chess .

Background

Physical limitations of computer hardware aside , in principle it is possible to solve any game under the condition that the complete state is known and there is no random chance . Strong solutions , i.e. algorithms that can produce perfect play from any position , are known for some simple games such as Tic Tac Toe / Noughts and crosses (draw with perfect play) and Connect Four (first player wins) . Weak solutions exist for somewhat more complex games , such as checkers (with perfect play on both sides the game is known to be a draw , but it is not known for every position created by less @-@ than @-@ perfect play what the perfect next move would be) . Other games , such as chess (from the starting position) and Go , have not been solved because their game complexity is too vast for computers to evaluate all possible positions . To reduce the game complexity , researchers have modified these complex games by reducing the size of the board , or the number of pieces , or both .
Computer chess is one of the oldest domains of artificial intelligence , having begun in the early 1930s . Claude Shannon proposed formal criteria for evaluating chess moves in 1949 . In 1951 , Alan Turing designed a primitive chess playing program , which assigned values for material and mobility ; the program " played " chess based on Turing 's manual calculations . However , even as competent chess programs began to develop , they exhibited a glaring weakness in playing the endgame . Programmers added specific heuristics for the endgame ? for example , the king should move to the center of the board . However , a more comprehensive solution was needed .
In 1965 , Richard Bellman proposed the creation of a database to solve chess and checkers endgames using retrograde analysis . Instead of analyzing forward from the position currently on the board , the database would analyze backward from positions where one player was checkmated or stalemated . Thus , a chess computer would no longer need to analyze endgame positions during the game because they were solved beforehand . It would no longer make mistakes because the tablebase always played the best possible move .
In 1970 , Thomas Ströhlein published a doctoral thesis with analysis of the following classes of endgame : KQK , KRK , KPK , KQKR , KRKB , and KRKN . In 1977 Thompson 's KQKR database

was used in a match versus Grandmaster Walter Browne .

Ken Thompson and others helped extend tablebases to cover all four- and five @-@ piece endgames , including in particular KBBKN , KQPKQ , and KRPKR . Lewis Stiller published a thesis with research on some six @-@ piece tablebase endgames in 1995 .

More recent contributors have included the following people :

Eugene Nalimov , after whom the popular Nalimov tablebases are named ;

Eiko Bleicher , who has adapted the tablebase concept to a program called " Freezer " (see below) ;

Guy Haworth , an academic at the University of Reading , who has published extensively in the ICGA Journal and elsewhere ;

Marc Bourzutschky and Yakov Konoval , who have collaborated to analyze endgames with seven pieces on the board ;

Peter Karrer , who constructed a specialized seven @-@ piece tablebase (KQPPKQP) for the endgame of the Kasparov versus The World online match ;

Vladimir Makhnychev and Victor Zakharov from Moscow State University , who completed 4 + 3 DTM @-@ tablebases (525 endings including KPPPKPP) in July 2012 . The tablebases are named Lomonosov tablebases . The next set of 5 + 2 DTM @-@ tablebases (350 endings including KPPPPKP) was completed during August 2012 . The high speed of generating the tablebases was because of using a supercomputer named Lomonosov (top500) . The size of all tablebases up to seven @-@ man is about 140 TB .

The tablebases of all endgames with up to six pieces are available for free download , and may also be queried using web interfaces (see the external links below) . Nalimov tablebase requires more than one terabyte of storage space .

= = Generating tablebases = =

= = = Metrics : Depth to conversion and depth to mate = = =

Before creating a tablebase , a programmer must choose a metric of optimality ? in other words , he must define at what point a player has " won " the game . Every position can be defined by its distance (i.e. the number of moves) from the desired endpoint . Two metrics are generally used :

Depth to mate (DTM) . A checkmate is the only way to win a game .

Depth to conversion (DTC) . The stronger side can also win by capturing material , thus converting to a simpler endgame . For example , in KQKR , conversion occurs when White captures the Black rook .

Haworth has discussed two other metrics , namely " depth to zeroing @-@ move " (DTZ) and " depth by the rule " (DTR) . A zeroing @-@ move is a move which resets the move count to zero under the fifty @-@ move rule , i.e. mate , a capture , or a pawn move . These metrics support the fifty @-@ move rule , but DTR tablebases have not yet been computed . As of April 1 , 2013 , 5- and 6 @-@ man DTZ tablebases have been generated by Ronald de Man ; both tablebases and generation code are available for download .

The difference between DTC and DTM can be understood by analyzing the diagram at right . How White should proceed depends on which metric is used .