ARTIFICIAL INTELLIGENCE

REPORT - A1

Evaluation Functions

For Chess

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CUSTY CREW

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**Evaluation Functions Available:**

**Material Evaluation (Simple Evaluation Technique):**

The material approach is the one in which the constant point values of each side are summed and evaluations are made using the sum of values. The values used for the sum are the values of each piece on each side which are predetermined. It is generally accepted that

* A Pawn is worth 1 point
* A Bishop and a Knight are worth 3 points each
* A Rook is worth 5 points
* A Queen is worth 9 Points

In order to evaluate the position, pieces of one side are assigned oppositely signed values.

**PST Evaluation (Piece Square Tables):**

Piece Square Tables provide a simple and easy way of assigning values to all the squares on the chess board and then updating them as moves are made. For each piece on each square, we can get a value for its evaluation using the sum of its material value and its location value. This is called “Lazy evaluation” which helps in improving Alpha - Beta Pruning further. Usually two sets of tables are used i.e a starting table and an ending table, the former for the midgame and the latter for the endgame phase. Material and Piece Square Tables can be used together to get a decent enough analysis of a position by using Tapered Evaluation, which is simply the interpolation of values of both the tables.

**CPW Evaluation Engine:**

The CPW evaluation engine, developed by Edmund Moshammer and Pawel Koziol, uses multiple evaluation features such as Material and PST Evaluation, Evaluation of piece pairs (bishop, knight and rook pairs), Evaluation of Patterns, Friendly King’s safety, Enemy King Tropism and Mobility. It uses a Pawn hashtable to get the score of pawns based on their position and safety i.e if they are challenged by the enemy or not or if they are surrounded with friendly Pawns. It also gives an evaluation for doubled or passed Pawns. It uses mid game and endgame scores to interpolate the possible moves based on the leftover pieces and their positions. The engine also maintains the PST values of the knights based on the number of pawns left in the game and as pawns disappear, the rooks gain value. It calculates the mobility along with the attacks the friendly king has, while also evaluating how weak the enemy king is. It also calculates when the Queen must be deployed as she should not be deployed too early in the game. The CPW Evaluation system is very complex and uses various tables which update dynamically according to defined rulesets to calculate the final evaluation of a position while also taking into account the phase of the game.

**Custy Crew (CC) Evaluation Function:**

The state of the art Custy Crew Evaluation Function is based on PeSTO which uses Piece Square Tables for all the pieces but instead of using two sets of tables i.e for game start and game end, it uses only one set of tables for mid game. The evaluation function uses the values from the mid game table in conjunction with material values to generate total values by linear summation. The material values themselves are slightly adjusted such that:

* A Bishop or Knight should not be exchanged for three Pawns
* Bishop pair is more valuable than a Knight Pair
* Two minor pieces should not exchanged for a Rook and a Pawn

This set of rules can be applied lazily by changing the material values of the Bishop and Knight to be 3.3 and 3.2 points respectively. As for the PSTs used in Custy Crew, the values of mid game PeSTO Tables have been slightly adjusted to also incorporate some endgame principles.

Additionally, the evaluation results can then be increased or decreased to make a move based on the MVV-LVA (Most Valued Victim - Least Valuable Aggressor) heuristic. This allows it to prefer the capture of a more valuable piece with a less valuable one by using a simple capture table which assigns an evaluation value to each victim-attacker pair. Finally, a simple evaluation adjustment is added to mimic “Quiescence (The technique of searching beyond max depth)” which simply decreases evaluation based on the number of captures available to the opponent and whether or not it’s the opponent's turn (to mimic tempo).

In order to improve the alpha-beta pruning used in minimax, CC sorts the moves to be searched using the above MVV\_LVA heuristic so that capturing moves are searched first, as they have a higher chance to be the best moves and thus the chance of branch pruning is increased. Further, when two evaluations have a tie between them, the MVV\_LVA can be called again to favor the best capturing move. However, in the start of the game, there will be very little capturing going on so we employ the ordering part only after a certain number of moves.

Finally, the CC evaluation function has much room for scalability, as the entirety of the CPW heuristics can be incorporated easily into it, along with the two tables of PeSTO. The only flaw in the evaluation is that doubled and passed pawns, alongwith endgame evaluation where you have to focus on getting the enemy king to a corner is not implemented yet, however, it can easily be incorporated in the future due to the scaleable nature of the function. Another flaw is the *horizon effect* whereby the “thinking” stops when max depth is reached, whereas it could be the case that a move right after that depth would upset the position greatly. This can be solved by applying a Quiescence Search for significant moves (captures and checks) at terminal nodes.