Chess Engine

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Namespace Documentation

5.1 Hash Namespace Reference

Functions

- uint64_t generatePosKey (const Board &pos)

  Gets the position hash key for the current position.
- void hashPce (uint32_t pce, uint32_t sq, Board &pos) noexcept

  Hashes in/out a piece on a given square.
- void hashCa (Board &pos) noexcept

  Hashes in/out the castle permissions.
- void hashSide (Board &pos) noexcept

  Hashes in/out the side to move.
- void hashEP (Board &pos) noexcept

  Hashes in/out the enPassant square.

Variables

- std::array< std::array< uint64_t, kBoardArraySize >, kNumPceTypes > **PieceKeys**
- uint64_t **SideKey**
- std::array< uint64_t, 16 > **CastleKeys**

5.1.1 Detailed Description

This namespace provides various functions related to manipulating the board's hashkey

5.1.2 Function Documentation

5.1.2.1 generatePosKey()

```
uint64_t Hash::generatePosKey (
            const Board & pos )
```

Gets the position hash key for the current position.

Parameters

pos	The current board state.

Returns

The 64 bit position key.

Definition at line 12 of file hash.cc.

5.1.2.2 hashCa()

```
void Hash::hashCa (
            Board & pos )  [inline], [noexcept]
```

Hashes in/out the castle permissions.

Parameters

pos	The current board state.

Returns

None.

Definition at line 46 of file hash.h.

5.1.2.3 hashEP()

```
void Hash::hashEP (
            Board & pos )  [inline], [noexcept]
```

Hashes in/out the enPassant square.

Parameters

pos	The current board state.

Returns

None.

Definition at line 66 of file hash.h.

5.1.2.4 hashPce()

```
void Hash::hashPce (
            uint32_t pce,
            uint32_t sq,
            Board & pos )  [inline], [noexcept]
```

Hashes in/out a piece on a given square.

Parameters

pce	The piece to hash in/out.
sq	The square that the piece is/will be on
pos	The current board state

Returns

None

Definition at line 36 of file hash.h.

5.1.2.5 hashSide()

```
void Hash::hashSide (
            Board & pos )  [inline], [noexcept]
```

Hashes in/out the side to move.

Parameters

pos	The current board state.

Returns

None.

Definition at line 56 of file hash.h.

5.2 Init Namespace Reference

Provides methods to initialize the non constant arrays used throughout the engine.

Functions

- void initAll () noexcept

  Calls all of the other 'init' methods.
- void initSq120ToSq64 () noexcept

  Fills in the arrays that convert between array-120 to array-64 representations.
- void initBitMasks () noexcept

  Fills in the arrays used for setting/clearing bits in bitboards.
- void initHashKeys () noexcept

  Fills in the hashkeys arrays that will be used to for getting the board's hashkey.
- void initFileRankBrd () noexcept

  Fills in the arrays that return the file/rank # for a given square.
- void initEvalMasks () noexcept

  Fills in the arrays used for evaluating pawn structure during evaluation.
- void initMvvLva () noexcept

  Fills in the arrays to determine most valuable victim least valuable attacker priority.

5.2.1 Detailed Description

Provides methods to initialize the non constant arrays used throughout the engine.

5.2.2 Function Documentation

5.2.2.1 initAll()

```
void Init::initAll ( )  [noexcept]
```

Calls all of the other 'init' methods.

Parameters

None	

Returns

None.

Definition at line 197 of file init.cc.

5.2.2.2 initBitMasks()

```
void Init::initBitMasks ( )  [noexcept]
```

Fills in the arrays used for setting/clearing bits in bitboards.

Parameters

None	

Returns

None.

Definition at line 97 of file init.cc.

5.2.2.3 initEvalMasks()

```
void Init::initEvalMasks ( )  [noexcept]
```

Fills in the arrays used for evaluating pawn structure during evaluation.

Parameters

None	

Returns

None.

Definition at line 122 of file init.cc.

5.2.2.4 initFileRankBrd()

```
void Init::initFileRankBrd ( )  [noexcept]
```

Fills in the arrays that return the file/rank # for a given square.

Parameters

None	

Returns

None.

Definition at line 54 of file init.cc.

5.2.2.5 initHashKeys()

```
void Init::initHashKeys ( )  [noexcept]
```

Fills in the hashkeys arrays that will be used to for getting the board's hashkey.

Parameters

None	

Returns

None.

Definition at line 106 of file init.cc.

5.2.2.6 initMvvLva()

```
void Init::initMvvLva ( )  [noexcept]
```

Fills in the arrays to determine most valuable victim least valuable attacker priority.

Parameters

None	

Returns

None.

Definition at line 186 of file init.cc.

5.2.2.7 initSq120ToSq64()

```
void Init::initSq120ToSq64 ( )  [noexcept]
```

Fills in the arrays that convert between array-120 to array-64 representations.

Parameters

None	

Returns

None.

Definition at line 73 of file init.cc.

5.3 IO Namespace Reference

Various functions to print out engine data structures.

Functions

- void printBoard (const Board &pos) noexcept
  Prints out the board to stdio.
- void printBitBoard (const uint64_t bb) noexcept
  Prints out the bitboard to stdio.
- void printMoveList (const MoveList &list) noexcept
  Prints out the MoveList to stdio.
- void printSearchDetails (const SearchInfo &info, int32_t curDepth, int32_t bestScore, PvTable &pv, int32_t pvMoves) noexcept
  Prints out the search details to stdio.
- void printBestMove (Board &pos, const SearchInfo &info, const Move &bestMove) noexcept
  Prints out the best move stdio for the protocol manager.
- Move parseMove (std::string input, const Board &pos) noexcept
  Reads in a move string and converts it to the internal representation.

Variables

- const std::string PceChar = ".PNBRQKpnbrqk"
- const std::string SideChar = "wb-"
- const std::string RankChar = "12345678"
- const std::string FileChar = "abcdefgh"
- const std::unordered_map< uint32_t, std::string > epstr

5.3.1 Detailed Description

Various functions to print out engine data structures.

5.3.2 Function Documentation

5.3.2.1 parseMove()

```
Move IO::parseMove (
            std::string input,
            const Board & pos )  [noexcept]
```

Reads in a move string and converts it to the internal representation.

Parameters

input	The move that was read in (e.g e2e4).
pos	The current board state.

Returns

The internal representation of the input move.

Definition at line 122 of file io.cc.

5.3.2.2 printBestMove()

```
void IO::printBestMove (
            Board & pos,
            const SearchInfo & info,
            const Move & bestMove )  [noexcept]
```

Prints out the best move stdio for the protocol manager.

Parameters

pos	The current board state.
info	The engine's searchInfo struct.
bestMove	The best move that was found.

Returns

None.

Definition at line 103 of file io.cc.

5.3.2.3 printBitBoard()

```
void IO::printBitBoard (
            const uint64_t bb )  [noexcept]
```

Prints out the bitboard to stdio.

Parameters

bb	The bitboard to print.

Returns

None.

Definition at line 18 of file io.cc.

5.3.2.4 printBoard()

```
void IO::printBoard (
            const Board & pos )  [noexcept]
```

Prints out the board to stdio.

Parameters

pos	The current board state.

Returns

None.

Definition at line 33 of file io.cc.

5.3.2.5 printMoveList()

```
void IO::printMoveList (
            const MoveList & list )  [noexcept]
```

Prints out the MoveList to stdio.

Parameters

list	The MoveList to print.

Returns

None.

Definition at line 61 of file io.cc.

5.3.2.6 printSearchDetails()

```
void IO::printSearchDetails (
            const SearchInfo & info,
```

```
            int32_t curDepth,
            int32_t bestScore,
            PvTable & pv,
            int32_t pvMoves )  [noexcept]
```

Prints out the search details to stdio.

Parameters

info	The engine's searchInfo struct
curDepth	The current search depth.
bestScore	The evaluation of the current board state
pv	The transposition table.
pvMoves	The length of the Pv line
pos	The current board state.

Returns

None.

Definition at line 73 of file io.cc.

5.3.3 Variable Documentation

5.3.3.1 epstr

```
const std::unordered_map<uint32_t, std::string> IO::epstr
```

Initial value:

```
=
    {{71,"a6"}, {72,"b6"}, {73,"c6"}, {74,"d6"}, {75,"e6"}, {76,"f6"}, {77,"g6"}, {78,"h6"},
     {41,"a3"}, {42,"b3"}, {43,"c3"}, {44,"d3"}, {45,"e3"}, {46,"f3"}, {47,"g3"}, {48,"h3"}, {99, "None"}}
```

Dictionary to provide string representations of enPassant sq's

Definition at line 40 of file io.h.

5.3.3.2 FileChar

```
const std::string IO::FileChar = "abcdefgh"
```

Dictionary to provide string representations of files

Definition at line 36 of file io.h.

5.3.3.3 PceChar

```
const std::string IO::PceChar = ".PNBRQKpnbrqk"
```

Dictionary to provide string representations of piecess

Definition at line 24 of file io.h.

5.3.3.4 RankChar

```
const std::string IO::RankChar = "12345678"
```

Dictionary to provide string representations of ranks

Definition at line 32 of file io.h.

5.3.3.5 SideChar

```
const std::string IO::SideChar = "wb-"
```

Dictionary to provide string representations of sides

Definition at line 28 of file io.h.

5.4 MoveFlags Namespace Reference

This namespace stores flags used to extract parameters from a move.

Variables

- constexpr int32_t **SQ** = 0x7F
- constexpr int32_t **EP** = 0x40000
- constexpr int32_t **PS** = 0x80000
- constexpr int32_t **CA** = 0x1000000
- constexpr int32_t **CAP** = 0x7C000
- constexpr int32_t **PROM** = 0xF00000

5.4.1 Detailed Description

This namespace stores flags used to extract parameters from a move.

5.5 MvvLva Namespace Reference

Variables

- std::array< std::array< int32_t, kNumPceTypes >, kNumPceTypes > **MvvLvaScore**
- constexpr std::array< int32_t, kNumPceTypes > **victimScore** {0, 100, 200, 300, 400, 500, 600, 100, 200, 300, 400, 500, 600}

5.5.1 Detailed Description

used in move ordering. MostValuableVictim-LeastValuableAttacker

5.6 PolyKeys Namespace Reference

Variables

- constexpr std::array< uint64_t, 781 > **Random64**

5.6.1 Detailed Description

This namespace holds all 781 polyglot hashkeys for use in the opening credits to http://hgm.nubati.↩net/book_format.html

5.7 Value Namespace Reference

Provides several constant values used for evaluating the board state.

Variables

- constexpr int32_t kInfinity = 30000

  Highest possible score.
- constexpr int32_t kMateScore = 29000

  Score for a Checkmate.
- constexpr int32_t kIsolatedPawn = -10

  Score bonus for isolated pawns (no same color pawn on adjacent files)
- constexpr int32_t kOpenRookFile = 10

  Score bonus for a Rook on an open file (no pawns)
- constexpr int32_t kSemiOpenRookFile = 5

  Score bonus for a Rook on a semi-open file (no same color pawn)
- constexpr int32_t kOpenQueenFile = 5

  Score bonus for a Queen on an open file (no pawns)
- constexpr int32_t kSemiOpenQueenFile = 3

  Score bonus for a Queen on a semi-open file (no same color pawn)

- constexpr int32_t kEndGameThreshold = PieceInfo::PieceVal[wR] + 2 * PieceInfo::PieceVal[wB] + 2 * PieceInfo::PieceVal[wP]

  Material threshold to determine when the endgame starts.
- constexpr int32_t kBishopPair = 30

  Score bonus for the Bishop pair.
- constexpr std::array< int32_t, kNumFilesRanks > passedPawnScore {0, 5, 10, 20, 35, 60, 100, 200}

  Score bonus for Passed pawns based on distance.
- constexpr std::array< int32_t, kChessboardSize > PawnTable

  Scores the position of the Pawns.
- constexpr std::array< int32_t, kChessboardSize > KnightTable

  Scores the position of the Knights.
- constexpr std::array< int32_t, kChessboardSize > BishopTable

  Scores the position of the Bishops.
- constexpr std::array< int32_t, kChessboardSize > RookTable

  Scores the position of the Rooks.
- constexpr std::array< int32_t, kChessboardSize > KingEndGame

  Scores the king in the late game. Prioritizes the center.
- constexpr std::array< int32_t, kChessboardSize > KingOpening

  Scores the king for the earlygame. Prioritizes staying safe.

5.7.1 Detailed Description

Provides several constant values used for evaluating the board state.

5.7.2 Variable Documentation

5.7.2.1 BishopTable

```
constexpr std::array<int32_t, kChessboardSize> Value::BishopTable
```

Initial value:

```
{
        0   ,   0   ,   -10 ,   0   ,   0   ,   -10 ,   0   ,   0   ,
        0   ,   0   ,   0   ,   10  ,   10  ,   0   ,   0   ,   0   ,
        0   ,   0   ,   10  ,   15  ,   15  ,   10  ,   0   ,   0   ,
        0   ,   10  ,   15  ,   20  ,   20  ,   15  ,   10  ,   0   ,
        0   ,   10  ,   15  ,   20  ,   20  ,   15  ,   10  ,   0   ,
        0   ,   0   ,   10  ,   15  ,   15  ,   10  ,   0   ,   0   ,
        0   ,   0   ,   0   ,   10  ,   10  ,   0   ,   0   ,   0   ,
        0   ,   0   ,   0   ,   0   ,   0   ,   0   ,   0   ,   0
    }
```

Scores the position of the Bishops.

Definition at line 96 of file eval.h.

5.7.2.2 KingEndGame

```
constexpr std::array<int32_t, kChessboardSize> Value::KingEndGame
```

Initial value:

```
= {
        -50 ,   -10 ,   0   ,   0   ,   0   ,   0   ,   -10 ,   -50 ,
        -10,    0   ,   10  ,   10  ,   10  ,   10  ,   0   ,   -10 ,
        0   ,   10  ,   15  ,   15  ,   15  ,   15  ,   10  ,   0   ,
        0   ,   10  ,   15  ,   20  ,   20  ,   15  ,   10  ,   0   ,
        0   ,   10  ,   15  ,   20  ,   20  ,   15  ,   10  ,   0   ,
        0   ,   10  ,   15  ,   15  ,   15  ,   15  ,   10  ,   0   ,
        -10,    0   ,   10  ,   10  ,   10  ,   10  ,   0   ,   -10 ,
        -50 ,   -10 ,   0   ,   0   ,   0   ,   0   ,   -10 ,   -50
    }
```

Scores the king in the late game. Prioritizes the center.

Definition at line 123 of file eval.h.

5.7.2.3 KingOpening

```
constexpr std::array<int32_t, kChessboardSize> Value::KingOpening
```

Initial value:

```
= {
        0   ,   5   ,   5   ,   -10 ,   -10 ,   0   ,   10  ,   5   ,
        -30 ,   -30 ,   -30 ,   -30 ,   -30 ,   -30 ,   -30 ,   -30 ,
        -50 ,   -50 ,   -50 ,   -50 ,   -50 ,   -50 ,   -50 ,   -50 ,
        -70 ,   -70 ,   -70 ,   -70 ,   -70 ,   -70 ,   -70 ,   -70 ,
        -70 ,   -70 ,   -70 ,   -70 ,   -70 ,   -70 ,   -70 ,   -70 ,
        -70 ,   -70 ,   -70 ,   -70 ,   -70 ,   -70 ,   -70 ,   -70 ,
        -70 ,   -70 ,   -70 ,   -70 ,   -70 ,   -70 ,   -70 ,   -70 ,
        -70 ,   -70 ,   -70 ,   -70 ,   -70 ,   -70 ,   -70 ,   -70
    }
```

Scores the king for the earlygame. Prioritizes staying safe.

Definition at line 137 of file eval.h.

5.7.2.4 KnightTable

```
constexpr std::array<int32_t, kChessboardSize> Value::KnightTable
```

Initial value:

```
{
        0   ,   -10 ,   0   ,   0   ,   0   ,   0   ,   -10 ,   0   ,
        0   ,   0   ,   0   ,   5   ,   5   ,   0   ,   0   ,   0   ,
        0   ,   0   ,   10  ,   10  ,   10  ,   10  ,   0   ,   0   ,
        0   ,   0   ,   10  ,   20  ,   20  ,   10  ,   5   ,   0   ,
        5   ,   10  ,   15  ,   20  ,   20  ,   15  ,   10  ,   5   ,
        5   ,   10  ,   10  ,   20  ,   20  ,   10  ,   10  ,   5   ,
        0   ,   0   ,   5   ,   10  ,   10  ,   5   ,   0   ,   0   ,
        0   ,   0   ,   0   ,   0   ,   0   ,   0   ,   0   ,   0
    }
```

Scores the position of the Knights.

Definition at line 82 of file eval.h.

5.7.2.5 PawnTable

```
constexpr std::array<int32_t, kChessboardSize> Value::PawnTable
```

Initial value:

```
{
        0   ,   0   ,   0   ,   0   ,   0   ,   0   ,   0   ,   0   ,
        10  ,   10  ,   0   ,   -10 ,   -10 ,   0   ,   10  ,   10  ,
        5   ,   0   ,   0   ,   5   ,   5   ,   0   ,   0   ,   5   ,
        0   ,   0   ,   10  ,   20  ,   20  ,   10  ,   0   ,   0   ,
        5   ,   5   ,   5   ,   10  ,   10  ,   5   ,   5   ,   5   ,
        10  ,   10  ,   10  ,   20  ,   20  ,   10  ,   10  ,   10  ,
        20  ,   20  ,   20  ,   30  ,   30  ,   20  ,   20  ,   20  ,
        0   ,   0   ,   0   ,   0   ,   0   ,   0   ,   0   ,   0
    }
```

Scores the position of the Pawns.

Definition at line 68 of file eval.h.

5.7.2.6 RookTable

```
constexpr std::array<int32_t, kChessboardSize> Value::RookTable
```

Initial value:

```
{
        0   ,   0   ,   5   ,   10  ,   10  ,   5   ,   0   ,   0   ,
        0   ,   0   ,   5   ,   10  ,   10  ,   5   ,   0   ,   0   ,
        0   ,   0   ,   5   ,   10  ,   10  ,   5   ,   0   ,   0   ,
        0   ,   0   ,   5   ,   10  ,   10  ,   5   ,   0   ,   0   ,
        0   ,   0   ,   5   ,   10  ,   10  ,   5   ,   0   ,   0   ,
        0   ,   0   ,   5   ,   10  ,   10  ,   5   ,   0   ,   0   ,
        25  ,   25  ,   25  ,   25  ,   25  ,   25  ,   25  ,   25  ,
        0   ,   0   ,   5   ,   10  ,   10  ,   5   ,   0   ,   0
    }
```

Scores the position of the Rooks.

Definition at line 110 of file eval.h.

Chapter 6

Data Structure Documentation

6.1 Board Class Reference

`#include <board.h>`

Public Member Functions

- **Board** (const std::string &fen) noexcept
- void parseFEN (const std::string &) noexcept

  Set up the Board representation of the calling Board object.
- uint32_t sqAttacked (const uint32_t sq, const uint32_t side) const noexcept

  Gets the number of times a square is attacked by a given side.
- MoveList getAllMoves () const noexcept

  Gets all the possible moves, including ones that happen during check.
- MoveList getAllCaptureMoves () const noexcept

  Get all possible moves that involve capture, including ones that happen during check.
- void flipBoard () noexcept

  Flips the internal Board representation along the central file.
- bool inCheck () noexcept

  Checks if the current side is in check.

Data Fields

- std::vector< uint32_t > **pieces**
- std::vector< uint64_t > **pawns**
- std::vector< int32_t > **king_sq**
- uint32_t **side_to_move**
- uint32_t **en_pas**
- uint32_t **fifty_move**
- int32_t **ply**
- int32_t **hist_ply**
- uint64_t **pos_key**
- uint32_t **castle_perm**
- std::vector< std::vector< uint32_t > > **piece_list**
- std::vector< uint32_t > **big_pce**
- std::vector< uint32_t > **maj_pce**
- std::vector< uint32_t > **min_pce**
- std::vector< uint32_t > **material**
- std::vector< UndoMove > **history**
- std::vector< std::vector< int32_t > > **search_hist**
- std::vector< std::vector< Move > > **search_killers**

Private Member Functions

- void resetBoard (void) noexcept

  Resets all board variables to default values.
- void updatePieceLists (void) noexcept

  Updates all internal Board vectors related to pieces.
- void setUpPieces (const std::string &pieces) noexcept

  Parses the first FEN argument and places the pieces on the board as indicated.
- void setUpCastlePerm (const std::string &perm) noexcept

  Parses the castle argument of the FEN.
- void getEnPassant (const std::string &enPas) noexcept

  Parses the enPassant argument of the FEN.
- void setUpMoveCounters (std::istringstream &stream, std::string &section) noexcept

  Parses the ply counter argument(s) of the FEN if they exist.

6.1.1 Detailed Description

Handles the entire board representation and all information regarding the board.

Definition at line 22 of file board.h.

6.1.2 Member Function Documentation

6.1.2.1 flipBoard()

```
void Board::flipBoard ( )  [noexcept]
```

Flips the internal Board representation along the central file.

Parameters

None	

Returns

None

Definition at line 355 of file board.cc.

6.1.2.2 getAllCaptureMoves()

```
MoveList Board::getAllCaptureMoves ( ) const  [noexcept]
```

Get all possible moves that involve capture, including ones that happen during check.

Parameters

None	

Returns

A MoveList with all possible capture moves.

Definition at line 347 of file board.cc.

6.1.2.3 getAllMoves()

```
MoveList Board::getAllMoves ( ) const  [noexcept]
```

Gets all the possible moves, including ones that happen during check.

Parameters

None	

Returns

A MoveList with all possible moves

Definition at line 340 of file board.cc.

6.1.2.4 getEnPassant()

```
void Board::getEnPassant (
            const std::string & enPas )  [private], [noexcept]
```

Parses the enPassant argument of the FEN.

Parameters

None	

Returns

None

Definition at line 176 of file board.cc.

6.1.2.5 inCheck()

```
bool Board::inCheck ( )  [noexcept]
```

Checks if the current side is in check.

Parameters

None	

Returns

true if the current side to move is in check, false otherwise.

Definition at line 385 of file board.cc.

6.1.2.6 parseFEN()

```
void Board::parseFEN (
            const std::string & fen )  [noexcept]
```

Set up the Board representation of the calling Board object.

```
Example: rnbqkbnr/pppppppp/8/8/8/8/PPPPPPPP/RNBQKBNR w KQkq - 0 1
                           ^                         ^  ^   ^ ^ ^
                           1                         2  3   4 5 6
```

1. Piece locations
2. Current side to move
3. Castling permissions
4. EnPassant square
5. Halfmove clock (fifty move count)
6. Fullmove number

Parameters

fen	The Forsyth-Edwards Notation string

Returns

None

Definition at line 202 of file board.cc.

6.1.2.7 resetBoard()

```
void Board::resetBoard (
            void  )  [private], [noexcept]
```

Resets all board variables to default values.

Parameters

None	

Returns

None

Definition at line 72 of file board.cc.

6.1.2.8 setUpCastlePerm()

```
void Board::setUpCastlePerm (
            const std::string & perm )  [private], [noexcept]
```

Parses the castle argument of the FEN.

Parameters

None	

Returns

None

Definition at line 150 of file board.cc.

6.1.2.9 setUpMoveCounters()

```
void Board::setUpMoveCounters (
            std::istringstream & stream,
            std::string & section )  [private], [noexcept]
```

Parses the ply counter argument(s) of the FEN if they exist.

Parameters

None	

Returns

None

Definition at line 186 of file board.cc.

6.1.2.10 setUpPieces()

```
void Board::setUpPieces (
            const std::string & pieces )  [private], [noexcept]
```

Parses the first FEN argument and places the pieces on the board as indicated.

Parameters

None	

Returns

None

Definition at line 110 of file board.cc.

6.1.2.11 sqAttacked()

```
uint32_t Board::sqAttacked (
            const uint32_t sq,
            const uint32_t side ) const  [noexcept]
```

Gets the number of times a square is attacked by a given side.

Parameters

sq	The target square.
side	The attacking side

Returns

The number of times the target square is attacked by the given side

Definition at line 262 of file board.cc.

6.1.2.12 updatePieceLists()

```
void Board::updatePieceLists (
            void  )  [private], [noexcept]
```

Updates all internal Board vectors related to pieces.

Parameters

None	

Returns

None

Definition at line 232 of file board.cc.

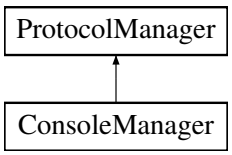
The documentation for this class was generated from the following files:

- /home/michael/Documents/Projects/C++/Chess-Engine/include/board.h
- /home/michael/Documents/Projects/C++/Chess-Engine/src/board.cc

6.2 ConsoleManager Class Reference

```
#include <console.h>
```

Inheritance diagram for ConsoleManager:



Public Member Functions

- void loop () override

  Starts the protocol loop.
- int32_t getProtocol () override

  Returns the protocol identifier for the current protocol.

Additional Inherited Members

6.2.1 Detailed Description

See ProtocolManager documentation

Definition at line 14 of file console.h.

6.2.2 Member Function Documentation

6.2.2.1 getProtocol()

```
int32_t ConsoleManager::getProtocol ( )  [override], [virtual]
```

Returns the protocol identifier for the current protocol.

Parameters

None	

Returns

The protocol identifier

Implements ProtocolManager.

Definition at line 191 of file console.cc.

6.2.2.2 loop()

```
void ConsoleManager::loop ( )  [override], [virtual]
```

Starts the protocol loop.

Parameters

None	

Returns

None

Implements ProtocolManager.

Definition at line 22 of file console.cc.

The documentation for this class was generated from the following files:

- /home/michael/Documents/Projects/C++/Chess-Engine/include/console.h
- /home/michael/Documents/Projects/C++/Chess-Engine/src/console.cc

6.3 Engine Class Reference

Public Member Functions

- **Engine** (const Engine &)=delete
- void **operator=** (const Engine &)=delete
- void **start** () noexcept

Static Public Member Functions

- static Engine & getInstance ()

  Gets the instance of the Engine singleton.
- static EngineConfig & getConfig ()

  Gets the instance of the Engine config.
- static PolyBook & getBook ()

  Gets the Polyglot opening book that is being used by the engine.

Private Member Functions

- void **printGreeting** () const noexcept

Private Attributes

- std::unique_ptr< ProtocolManager > **protocol**
- EngineConfig **config**
- PolyBook **book**

6.3.1 Detailed Description

Definition at line 22 of file engine.h.

6.3.2 Member Function Documentation

6.3.2.1 getBook()

```
static PolyBook& Engine::getBook ( )  [inline], [static]
```

Gets the Polyglot opening book that is being used by the engine.

Parameters

None	

Returns

The Polyglot opening book that the engine is using.

Definition at line 49 of file engine.h.

6.3.2.2 getConfig()

```
static EngineConfig& Engine::getConfig ( )  [inline], [static]
```

Gets the instance of the Engine config.

Parameters

None	

Returns

The Engine config

Definition at line 40 of file engine.h.

6.3.2.3 getInstance()

```
static Engine& Engine::getInstance ( )  [inline], [static]
```

Gets the instance of the Engine singleton.

Parameters

None	

Returns

The Engine instance

Definition at line 30 of file engine.h.

The documentation for this class was generated from the following files:

- /home/michael/Documents/Projects/C++/Chess-Engine/include/engine.h
- /home/michael/Documents/Projects/C++/Chess-Engine/src/engine.cc

6.4 EngineConfig Struct Reference

Stores the flags for the engine.

`#include <engine.h>`

Data Fields

- bool **useBook**

6.4.1 Detailed Description

Stores the flags for the engine.

Definition at line 16 of file engine.h.

The documentation for this struct was generated from the following file:

- /home/michael/Documents/Projects/C++/Chess-Engine/include/engine.h

6.5 Evaluator Class Reference

Public Member Functions

- int32_t evaluatePosition (const Board &pos) noexcept
  Evaluates the score for the current board position for the side to move.

Private Member Functions

- int32_t evalPawns (const Board &pos) noexcept
  Evaluates the strength of the Pawns.
- int32_t evalBishops (const Board &pos) noexcept
  Evaluates the strength of the Bishop.
- int32_t evalRooks (const Board &pos) noexcept
  Evaluates the strength of the Rook.
- int32_t evalKnights (const Board &pos) noexcept
  Evaluates the strength of the Knights.
- int32_t evalQueens (const Board &pos) noexcept
  Evaluates the strength of the Queens.
- int32_t evalKings (const Board &pos) noexcept
  Evaluates the strength of the Kings.
- bool drawnMaterial (const Board &pos) noexcept
  Determines if there is enough material to end in checkmate.

6.5.1 Detailed Description

Definition at line 159 of file eval.h.

6.5.2 Member Function Documentation

6.5.2.1 drawnMaterial()

```
bool Evaluator::drawnMaterial (
            const Board & pos )  [private], [noexcept]
```

Determines if there is enough material to end in checkmate.

Parameters

pos	The current board state.

Returns

true if there is enough material on either side to lead to checkmate, false otherwise.

Definition at line 188 of file eval.cc.

6.5.2.2 evalBishops()

```
int32_t Evaluator::evalBishops (
            const Board & pos )  [private], [noexcept]
```

Evaluates the strength of the Bishop.

Parameters

pos	The current board state.

Returns

The score attributed to the Bishop.

Definition at line 52 of file eval.cc.

6.5.2.3 evalKings()

```
int32_t Evaluator::evalKings (
            const Board & pos )  [private], [noexcept]
```

Evaluates the strength of the Kings.

Parameters

pos	The current board state.

Returns

The score attributed to the Kings.

Definition at line 142 of file eval.cc.

6.5.2.4 evalKnights()

```
int32_t Evaluator::evalKnights (
            const Board & pos )  [private], [noexcept]
```

Evaluates the strength of the Knights.

Parameters

pos	The current board state.

Returns

The score attributed to the Knights.

Definition at line 171 of file eval.cc.

6.5.2.5 evalPawns()

```
int32_t Evaluator::evalPawns (
            const Board & pos )  [private], [noexcept]
```

Evaluates the strength of the Pawns.

Parameters

pos	The current board state.

Returns

The score attributed to the Pawns.

Definition at line 14 of file eval.cc.

6.5.2.6 evalQueens()

```
int32_t Evaluator::evalQueens (
            const Board & pos )  [private], [noexcept]
```

Evaluates the strength of the Queens.

Parameters

pos	The current board state.

Returns

The score attributed to the Queens.

Definition at line 108 of file eval.cc.

6.5.2.7 evalRooks()

```
int32_t Evaluator::evalRooks (
            const Board & pos )  [private], [noexcept]
```

Evaluates the strength of the Rook.

Parameters

pos	The current board state.

Returns

The score attributed to the Rook.

Definition at line 72 of file eval.cc.

6.5.2.8 evaluatePosition()

```
int32_t Evaluator::evaluatePosition (
            const Board & pos )  [noexcept]
```

Evaluates the score for the current board position for the side to move.

Parameters

pos	The current board state.

Returns

The overall score of the position

Definition at line 243 of file eval.cc.

The documentation for this class was generated from the following files:

- /home/michael/Documents/Projects/C++/Chess-Engine/include/eval.h
- /home/michael/Documents/Projects/C++/Chess-Engine/src/eval.cc

6.6 MM Class Reference

Static Public Member Functions

- static bool makeMove (Board &pos, const Move &moveInfo) noexcept
  Makes the provided move (move piece/capture/update board)
- static void takeMove (Board &pos) noexcept
  Undos the last move that was made which is stored in Board::history.
- static void makeNullMove (Board &pos) noexcept
  Similar in concept to Make move, but gives the opposing side a free move.
- static void takeNullMove (Board &pos) noexcept
  Undos the last null move.

Static Private Member Functions

- static void clearPiece (const uint32_t sq, Board &pos) noexcept
  Removes the piece on the given square from the internal board representation.
- static void addPiece (const uint32_t sq, Board &pos, const uint32_t pce) noexcept
  Adds the piece on the given square to the internal board representation.
- static void movePiece (const uint32_t src, const uint32_t dest, Board &pos) noexcept
  Moves the piece from the source square to the dest square and performs capture if applicable.

6.6.1 Detailed Description

Definition at line 34 of file movemaker.h.

6.6.2 Member Function Documentation

6.6.2.1 addPiece()

```
void MM::addPiece (
            const uint32_t sq,
            Board & pos,
            const uint32_t pce )  [static], [private], [noexcept]
```

Adds the piece on the given square to the internal board representation.

Parameters

sq	The square to add the piece to.
pos	The current board state.
pce	The piece to add to the target square

Returns

None

Definition at line 45 of file movemaker.cc.

6.6.2.2 clearPiece()

```
void MM::clearPiece (
            const uint32_t sq,
            Board & pos )  [static], [private], [noexcept]
```

Removes the piece on the given square from the internal board representation.

Parameters

sq	The square to clear.
pos	The current board state.

Returns

None

Definition at line 18 of file movemaker.cc.

6.6.2.3 makeMove()

```
bool MM::makeMove (
            Board & pos,
            const Move & moveInfo )  [static], [noexcept]
```

Makes the provided move (move piece/capture/update board)

Parameters

pos	The current board state.

Returns

true if move was successfully made (legal), false otherwise

Definition at line 90 of file movemaker.cc.

6.6.2.4 makeNullMove()

```
void MM::makeNullMove (
            Board & pos )  [static], [noexcept]
```

Similar in concept to Make move, but gives the opposing side a free move.

Parameters

pos	The current board state.

Returns

None

Definition at line 249 of file movemaker.cc.

6.6.2.5 movePiece()

```
void MM::movePiece (
            const uint32_t src,
            const uint32_t dest,
            Board & pos )  [static], [private], [noexcept]
```

Moves the piece from the source square to the dest square and performs capture if applicable.

Parameters

src	The square the piece starts on.
dest	The square the piece is moving to.
pos	The current board state.

Returns

None

Definition at line 71 of file movemaker.cc.

6.6.2.6 takeMove()

```
void MM::takeMove (
            Board & pos )  [static], [noexcept]
```

Undos the last move that was made which is stored in Board::history.

Parameters

pos	The current board state.

Returns

None

Definition at line 179 of file movemaker.cc.

6.6.2.7 takeNullMove()

```
void MM::takeNullMove (
            Board & pos )  [static], [noexcept]
```

Undos the last null move.

Parameters

pos	The current board state.

Returns

None

Definition at line 272 of file movemaker.cc.

The documentation for this class was generated from the following files:

- /home/michael/Documents/Projects/C++/Chess-Engine/include/movemaker.h
- /home/michael/Documents/Projects/C++/Chess-Engine/src/movemaker.cc

6.7 Move Class Reference

Public Member Functions

- **Move** (uint32_t from, uint32_t to, uint32_t captured, uint32_t prom, uint32_t flag) noexcept
- **Move** (uint32_t _move, int32_t _score) noexcept
- **Move** (uint32_t _move) noexcept

- **Move** (const Move &o) noexcept
- **Move** (Move &&o) noexcept
- constexpr uint32_t from () const

  Gets the square that the move is starting from.
- constexpr uint32_t to () const

  Gets the square that the move is ending on.
- constexpr uint32_t captured () const

  Gets the piece That was captured.
- constexpr uint32_t enPassant () const

  Checks if the move was an EnPassant move.
- constexpr uint32_t pawnStart () const

  Checks if the move was a pawn start (pawn double move).
- constexpr uint32_t promoted () const

  Gets the piece that was promoted to if any.
- constexpr uint32_t castle () const

  Checks if the move was a castle move.
- constexpr bool isNull () const

  Checks if the move was NULLMOVE.
- constexpr bool wasCapture () const

  Checks if the move was a capture.
- constexpr bool wasPromotion () const

  Checks if the move was a promotion.
- const std::string toString () const noexcept

  Gets the string representation of a move (e.g "e2e4").
- Move & **operator=** (const Move &o) noexcept
- Move & **operator=** (Move &&o) noexcept
- bool **operator==** (const Move &rhs) const noexcept
- bool **operator!=** (const Move &rhs) const noexcept

Data Fields

- uint32_t **move**
- int32_t **score**

6.7.1 Detailed Description

Definition at line 40 of file move.h.

6.7.2 Member Function Documentation

6.7.2.1 captured()

```
constexpr uint32_t Move::captured ( ) const  [inline]
```

Gets the piece That was captured.

Parameters

None	

Returns

The piece that was captured.

Definition at line 69 of file move.h.

6.7.2.2 castle()

```
constexpr uint32_t Move::castle ( ) const  [inline]
```

Checks if the move was a castle move.

Parameters

None	

Returns

true if there was a castle move, false otherwise.

Definition at line 93 of file move.h.

6.7.2.3 enPassant()

```
constexpr uint32_t Move::enPassant ( ) const  [inline]
```

Checks if the move was an EnPassant move.

Parameters

None	

Returns

true if there was EnPassant, false otherwise.

Definition at line 75 of file move.h.

6.7.2.4 from()

```
constexpr uint32_t Move::from ( ) const  [inline]
```

Gets the square that the move is starting from.

Parameters

None	

Returns

The source square

Definition at line 57 of file move.h.

6.7.2.5 isNull()

```
constexpr bool Move::isNull ( ) const  [inline]
```

Checks if the move was NULLMOVE.

Parameters

None	

Returns

true if (∗this) == NULLMOVE, false otherwise.

Definition at line 100 of file move.h.

6.7.2.6 pawnStart()

```
constexpr uint32_t Move::pawnStart ( ) const  [inline]
```

Checks if the move was a pawn start (pawn double move).

Parameters

None	

Returns

true if there was a pawn start, false otherwise.

Definition at line 81 of file move.h.

6.7.2.7 promoted()

```
constexpr uint32_t Move::promoted ( ) const  [inline]
```

Gets the piece that was promoted to if any.

Parameters

None	

Returns

The piece that was promoted to if any.

Definition at line 87 of file move.h.

6.7.2.8 to()

```
constexpr uint32_t Move::to ( ) const  [inline]
```

Gets the square that the move is ending on.

Parameters

None	

Returns

The destination square

Definition at line 63 of file move.h.

6.7.2.9 toString()

```
const std::string Move::toString ( ) const  [noexcept]
```

Gets the string representation of a move (e.g "e2e4").

Parameters

None	

Returns

The string representation of a move.

Definition at line 35 of file move.cc.

6.7.2.10 wasCapture()

```
constexpr bool Move::wasCapture ( ) const  [inline]
```

Checks if the move was a capture.

Parameters

None	

Returns

true if there was a capture, false otherwise.

Definition at line 106 of file move.h.

6.7.2.11 wasPromotion()

```
constexpr bool Move::wasPromotion ( ) const  [inline]
```

Checks if the move was a promotion.

Parameters

None	

Returns

true if there was a promotion, false otherwise.

Definition at line 112 of file move.h.

The documentation for this class was generated from the following files:

- /home/michael/Documents/Projects/C++/Chess-Engine/include/move.h
- /home/michael/Documents/Projects/C++/Chess-Engine/src/move.cc

6.8 MoveList Class Reference

Public Member Functions

- **MoveList** (const MoveList &o)
- **MoveList** (MoveList &&o) noexcept
- void generateAllMoves (const Board &pos) noexcept

  Add all possible moves to the MoveList.
- void generateAllCaptureMoves (const Board &pos) noexcept

  Add all possible capture moves to the MoveList.
- void reorderList (int32_t idx) noexcept

  Reorders the movelist to maximize alpha-beta hits.
- uint32_t size () const noexcept

  Get the number of possible moves int he MoveList.
- const Move & **operator[ ]** (const int idx) const noexcept
- Move & **operator[ ]** (const int idx) noexcept

Static Public Attributes

- static constexpr uint32_t **kPvMoveBonus** = 2000000

Private Member Functions

- void addQuietMove (const Board &pos, Move &&move) noexcept

  Add a move that does not capture to the MoveList.
- void addCaptureMove (const Board &pos, Move &&move) noexcept

  Add a move that does capture to the MoveList.
- void addEnPasMove (const Board &pos, Move &&move) noexcept

  Add a move that performs enPassant to the MoveList.
- void addPawnMove (const Board &pos, uint32_t from, uint32_t to, uint32_t side) noexcept

  Add a move that involves a pawn.
- void addPawnCaptureMove (const Board &pos, uint32_t from, uint32_t to, uint32_t cap, uint32_t side) noexcept

  Add a capture move that involves a pawn.
- void generatePawnMoves (const Board &pos, uint32_t side) noexcept

  Add all Pawn moves to the MoveList.
- void generateBishopMoves (const Board &pos, uint32_t side) noexcept

  Add all Bishop moves to the MoveList.
- void generateRookMoves (const Board &pos, uint32_t side) noexcept

  Add all Rook moves to the MoveList.
- void generateQueenMoves (const Board &pos, uint32_t side) noexcept

  Add all Queen moves to the MoveList.
- void generateKnightMoves (const Board &pos, uint32_t side) noexcept

  Add all Knight moves to the MoveList.
- void generateKingMoves (const Board &pos, uint32_t side) noexcept

  Add all King moves to the MoveList.
- void generateSlidingMoves (const Board &pos, uint32_t side) noexcept

  Add all Rook/Bishop/Queen moves to the MoveList.
- void generateNonSlidingMoves (const Board &pos, uint32_t side) noexcept

  Add all Knight/King moves to the MoveList.
- void generateCastlingMoves (const Board &psd, uint32_t side) noexcept

  Add all Castling moves to the MoveList.

Private Attributes

- std::vector< Move > **moves**

Static Private Attributes

- static constexpr uint32_t **kMaxPossibleMoves** = 256
- static constexpr uint32_t **kCaptureBonus** = 1000000
- static constexpr uint32_t **kPrimaryKillerBonus** = 900000
- static constexpr uint32_t **kSecondaryKillerBonus** = 800000

6.8.1 Detailed Description

Definition at line 24 of file movelist.h.

6.8.2 Member Function Documentation

6.8.2.1 addCaptureMove()

```
void MoveList::addCaptureMove (
            const Board & pos,
            Move && move )  [private], [noexcept]
```

Add a move that does capture to the MoveList.

Parameters

pos	The current board state.
move	The move to add.

Returns

None

Definition at line 41 of file movelist.cc.

6.8.2.2 addEnPasMove()

```
void MoveList::addEnPasMove (
            const Board & pos,
            Move && move )  [private], [noexcept]
```

Add a move that performs enPassant to the MoveList.

Parameters

pos	The current board state.
move	The move to add.

Returns

None

Definition at line 47 of file movelist.cc.

6.8.2.3 addPawnCaptureMove()

```
void MoveList::addPawnCaptureMove (
            const Board & pos,
            uint32_t from,
            uint32_t to,
            uint32_t cap,
            uint32_t side )  [private], [noexcept]
```

Add a capture move that involves a pawn.

Parameters

pos	The current board state.
from	The source square.
to	The destination square.
cap	The piece that was captured.
side	The side to move.

Returns

None

Definition at line 86 of file movelist.cc.

6.8.2.4 addPawnMove()

```
void MoveList::addPawnMove (
            const Board & pos,
            uint32_t from,
            uint32_t to,
            uint32_t side )  [private], [noexcept]
```

Add a move that involves a pawn.

Parameters

pos	The current board state.
from	The source square.
to	The destination square.
side	The side the pawn belongs to

Returns

None

Definition at line 54 of file movelist.cc.

6.8.2.5 addQuietMove()

```
void MoveList::addQuietMove (
            const Board & pos,
            Move && move )  [private], [noexcept]
```

Add a move that does not capture to the MoveList.

Parameters

pos	The current board state.
move	The move to add.

Returns

None

Definition at line 24 of file movelist.cc.

6.8.2.6 generateAllCaptureMoves()

```
void MoveList::generateAllCaptureMoves (
            const Board & pos )  [noexcept]
```

Add all possible capture moves to the MoveList.

Parameters

pos	The current board state.

Returns

None

Definition at line 376 of file movelist.cc.

6.8.2.7 generateAllMoves()

```
void MoveList::generateAllMoves (
            const Board & pos )  [noexcept]
```

Add all possible moves to the MoveList.

Parameters

pos	The current board state.

Returns

None

Definition at line 367 of file movelist.cc.

6.8.2.8 generateBishopMoves()

```
void MoveList::generateBishopMoves (
            const Board & pos,
            uint32_t side )  [private], [noexcept]
```

Add all Bishop moves to the MoveList.

Parameters

pos	The current board state.
side	The side to move.

Returns

None

Definition at line 118 of file movelist.cc.

6.8.2.9 generateCastlingMoves()

```
void MoveList::generateCastlingMoves (
            const Board & psd,
            uint32_t side )  [private], [noexcept]
```

Add all Castling moves to the MoveList.

Parameters

pos	The current board state.
side	The side to move.

Returns

None

Definition at line 317 of file movelist.cc.

6.8.2.10 generateKingMoves()

```
void MoveList::generateKingMoves (
            const Board & pos,
            uint32_t side )  [private], [noexcept]
```

Add all King moves to the MoveList.

Parameters

pos	The current board state.
side	The side to move.

Returns

None

Definition at line 249 of file movelist.cc.

6.8.2.11 generateKnightMoves()

```
void MoveList::generateKnightMoves (
            const Board & pos,
            uint32_t side )  [private], [noexcept]
```

Add all Knight moves to the MoveList.

Parameters

pos	The current board state.
side	The side to move.

Returns

None

Definition at line 224 of file movelist.cc.

6.8.2.12 generateNonSlidingMoves()

```
void MoveList::generateNonSlidingMoves (
            const Board & pos,
            uint32_t side )  [private], [noexcept]
```

Add all Knight/King moves to the MoveList.

Parameters

pos	The current board state.
side	The side to move.

Returns

None

Definition at line 270 of file movelist.cc.

6.8.2.13 generatePawnMoves()

```
void MoveList::generatePawnMoves (
            const Board & pos,
            uint32_t side )  [private], [noexcept]
```

Add all Pawn moves to the MoveList.

Parameters

pos	The current board state.
side	The side to move.

Returns

None

Definition at line 276 of file movelist.cc.

6.8.2.14 generateQueenMoves()

```
void MoveList::generateQueenMoves (
            const Board & pos,
            uint32_t side )  [private], [noexcept]
```

Add all Queen moves to the MoveList.

Parameters

pos	The current board state.
side	The side to move.

Returns

None

Definition at line 170 of file movelist.cc.

6.8.2.15 generateRookMoves()

```
void MoveList::generateRookMoves (
            const Board & pos,
            uint32_t side )  [private], [noexcept]
```

Add all Rook moves to the MoveList.

Parameters

pos	The current board state.
side	The side to move.

Returns

None

Definition at line 144 of file movelist.cc.

6.8.2.16 generateSlidingMoves()

```
void MoveList::generateSlidingMoves (
            const Board & pos,
            uint32_t side )  [private], [noexcept]
```

Add all Rook/Bishop/Queen moves to the MoveList.

Parameters

pos	The current board state.
side	The side to move.

Returns

None

Definition at line 217 of file movelist.cc.

6.8.2.17 reorderList()

```
void MoveList::reorderList (
            int32_t idx )  [noexcept]
```

Reorders the movelist to maximize alpha-beta hits.

Parameters

idx	The index to start reordering the list at.

Returns

None

Definition at line 385 of file movelist.cc.

6.8.2.18 size()

```
uint32_t MoveList::size ( ) const  [noexcept]
```

Get the number of possible moves int he MoveList.

Parameters

None	

Returns

The size of the MoveList.

Definition at line 402 of file movelist.cc.

The documentation for this class was generated from the following files:

- /home/michael/Documents/Projects/C++/Chess-Engine/include/movelist.h
- /home/michael/Documents/Projects/C++/Chess-Engine/src/movelist.cc

6.9 PerftTester Class Reference

Public Member Functions

- int perftTest (uint32_t depth, Board &pos, bool print) noexcept
- void perftTestAll (Board &pos) noexcept

Private Member Functions

- void perft (uint32_t depth, Board &pos) noexcept

  Recursive helper method that backtracks through all possible moves and counts the number of leaf nodes (final positions) reached.

Private Attributes

- const uint32_t **depth_limit** = 6
- uint64_t **leafNodes**

6.9.1 Detailed Description

Definition at line 13 of file tester.h.

6.9.2 Member Function Documentation

6.9.2.1 perft()

```
void PerftTester::perft (
            uint32_t depth,
            Board & pos )  [private], [noexcept]
```

Recursive helper method that backtracks through all possible moves and counts the number of leaf nodes (final positions) reached.

Parameters

depth	Current search depth.
pos	The current board state.

Returns

None

Definition at line 19 of file tester.cc.

6.9.2.2 perftTest()

```
int PerftTester::perftTest (
            uint32_t depth,
            Board & pos,
            bool print = true )  [noexcept]
```

Calls the perft helper function to count number of leaf nodes reached. If print is enabled then the engine will also output the time taken and total number of positions reached from each possible initial move from the starting position

Parameters

depth	Desired search depth.
pos	The current board state.
print	Print enabled

Returns

Total number of leaf nodes reached

Definition at line 38 of file tester.cc.

6.9.2.3 perftTestAll()

```
void PerftTester::perftTestAll (
            Board & pos )  [noexcept]
```

Loops through all provided positions in the perftsuite.epd file and automatically performs a perft test to depth 5 (depth 6 takes too long for some positions) and verifies the results with the provided number in the file.

Parameters

depth	Desired search depth.
pos	The current board state.

Returns

None

Definition at line 70 of file tester.cc.

The documentation for this class was generated from the following files:

- /home/michael/Documents/Projects/C++/Chess-Engine/include/tester.h
- /home/michael/Documents/Projects/C++/Chess-Engine/src/tester.cc

6.10 PolyBook Class Reference

`#include <polyglot.h>`

Public Member Functions

- bool readBook ()

  Reads in from lib/polyglot-collection/Performance.bin.
- Move getBookMove (Board &pos)

  Randomly returns one of the possible opening book moves for the given position.

Private Member Functions

- bool enPasPossible (const Board &pos)

  Checks if enPassant is possible and there is a pawn in pace to perform the capture.
- uint64_t polyKeyFromBoard (const Board &pos)

  Generates the polyglot hashkey from the current board state.
- uint16_t endian_swap_u16 (uint16_t bigEnd)

  Returns the little-endian value of the big-endian input.
- uint32_t endian_swap_u32 (uint32_t bigEnd)

  Returns the little-endian value of the big-endian input.
- uint64_t endian_swap_u64 (uint64_t bigEnd)

  Returns the little-endian value of the big-endian input.
- Move convertPolyMove (uint16_t polyMove, const Board &pos)

  Converts a polyglot move to the internal move representation.

Private Attributes

- std::vector< PolyglotEntry > book

Static Private Attributes

- static constexpr std::array< int32_t, 13 > polyPiece { -1, 1, 3, 5, 7, 9, 11, 0, 2, 4, 6, 8, 10}

6.10.1 Detailed Description

This class holds the in memory representation of the polyglot book

Definition at line 26 of file polyglot.h.

6.10.2 Member Function Documentation

6.10.2.1 convertPolyMove()

```
Move PolyBook::convertPolyMove (
            uint16_t polyMove,
            const Board & pos )  [private]
```

Converts a polyglot move to the internal move representation.

Parameters

polyMove	The book move in Polyglot form.
pos	The current board state

Returns

The internal representation of the poly move.

Definition at line 136 of file polyglot.cc.

6.10.2.2 endian_swap_u16()

```
uint16_t PolyBook::endian_swap_u16 (
            uint16_t bigEnd )  [private]
```

Returns the little-endian value of the big-endian input.

Parameters

bigEnd	The bigEndian 16 bit number

Returns

The little-endian value of the input number.

Definition at line 108 of file polyglot.cc.

6.10.2.3 endian_swap_u32()

```
uint32_t PolyBook::endian_swap_u32 (
            uint32_t bigEnd )  [private]
```

Returns the little-endian value of the big-endian input.

Parameters

bigEnd	The bigEndian 32 bit number

Returns

The little-endian value of the input number.

Definition at line 114 of file polyglot.cc.

6.10.2.4 endian_swap_u64()

```
uint64_t PolyBook::endian_swap_u64 (
            uint64_t bigEnd )  [private]
```

Returns the little-endian value of the big-endian input.

Parameters

bigEnd	The bigEndian 64 bit number

Returns

The little-endian value of the input number.

Definition at line 123 of file polyglot.cc.

6.10.2.5 enPasPossible()

```
bool PolyBook::enPasPossible (
            const Board & pos )  [private]
```

Checks if enPassant is possible and there is a pawn in pace to perform the capture.

Parameters

pos	The current board state.

Returns

true if enPassant is possible with capture, false otherwise.

Definition at line 19 of file polyglot.cc.

6.10.2.6 getBookMove()

```
Move PolyBook::getBookMove (
            Board & pos )
```

Randomly returns one of the possible opening book moves for the given position.

Parameters

pos	The current board state.

Returns

A possible book move for the position.

Definition at line 161 of file polyglot.cc.

6.10.2.7 polyKeyFromBoard()

```
uint64_t PolyBook::polyKeyFromBoard (
            const Board & pos )  [private]
```

Generates the polyglot hashkey from the current board state.

Parameters

pos	The current board state.

Returns

The polyglot hashkey for a given board position.

Definition at line 41 of file polyglot.cc.

6.10.2.8 readBook()

```
bool PolyBook::readBook ( )
```

Reads in from lib/polyglot-collection/Performance.bin.

Parameters

None	

Returns

true if the book was successfully read into memory, false otherwise.

Definition at line 79 of file polyglot.cc.

6.10.3 Field Documentation

6.10.3.1 book

```
std::vector<PolyglotEntry> PolyBook::book  [private]
```

Provides a buffer to read in the polyglot entries

Definition at line 75 of file polyglot.h.

6.10.3.2 polyPiece

```
constexpr std::array<int32_t, 13> PolyBook::polyPiece { -1, 1, 3, 5, 7, 9, 11, 0, 2, 4, 6, 8,
10}  [static], [private]
```

Since the polyglot book uses different values for the pieces, this array provides a conversion

Definition at line 32 of file polyglot.h.

The documentation for this class was generated from the following files:

- /home/michael/Documents/Projects/C++/Chess-Engine/include/polyglot.h
- /home/michael/Documents/Projects/C++/Chess-Engine/src/polyglot.cc

6.11 PolyglotEntry Struct Reference

```
#include <polyglot.h>
```

Data Fields

- uint64_t **key**
- uint16_t **move**
- uint16_t **weight**
- uint32_t **learn**

6.11.1 Detailed Description

This Struct represents how the polyglot entries are layed out in memory

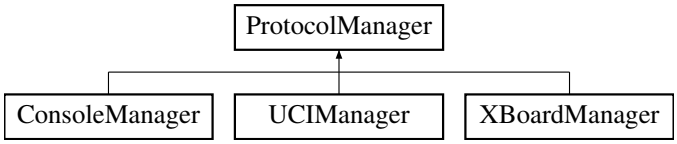
Definition at line 15 of file polyglot.h.

The documentation for this struct was generated from the following file:

- /home/michael/Documents/Projects/C++/Chess-Engine/include/polyglot.h

6.12 ProtocolManager Class Reference

Inheritance diagram for ProtocolManager:



Public Member Functions

- virtual void loop ()=0

  Starts the protocol loop.
- virtual bool isOver ()

  Checks if the engine has recieved a stop signal from the GUI.
- virtual int32_t getProtocol ()=0

  Returns the protocol identifier for the current protocol.

Static Public Attributes

- static constexpr int32_t **kUCI** = 0
- static constexpr int32_t **kXBoard** = 1
- static constexpr int32_t **kConsole** = 2

Protected Attributes

- Board **pos**
- SearchInfo **info**
- SearchAgent **sa**

6.12.1 Detailed Description

Definition at line 15 of file protocol.h.

6.12.2 Member Function Documentation

6.12.2.1 getProtocol()

```
virtual int32_t ProtocolManager::getProtocol ( )  [pure virtual]
```

Returns the protocol identifier for the current protocol.

Parameters

None	

Returns

The protocol identifier

Implemented in UCIManager, ConsoleManager, and XBoardManager.

6.12.2.2 isOver()

```
virtual bool ProtocolManager::isOver ( )  [inline], [virtual]
```

Checks if the engine has recieved a stop signal from the GUI.

Parameters

None	

Returns

true if a stop command has been sent, false otherwise

Definition at line 37 of file protocol.h.

6.12.2.3 loop()

```
virtual void ProtocolManager::loop ( )  [pure virtual]
```

Starts the protocol loop.

Parameters

None	

Returns

None

Implemented in UCIManager, ConsoleManager, and XBoardManager.

The documentation for this class was generated from the following file:

- /home/michael/Documents/Projects/C++/Chess-Engine/include/protocol.h

6.13 PvEntry Class Reference

`#include <pvtable.h>`

Public Member Functions

- **PvEntry** (uint64_t key, Move _move, int32_t _score, int32_t _depth, int32_t _flags) noexcept
- **PvEntry** (uint64_t key, Move move) noexcept
- **PvEntry** (const PvEntry &o) noexcept
- **PvEntry** (PvEntry &&o) noexcept
- PvEntry & **operator=** (const PvEntry &o) noexcept
- PvEntry & **operator=** (PvEntry &&o) noexcept

Data Fields

- uint64_t **pos_key**
- Move **move**
- int32_t **score**
- int32_t **depth**
- int32_t **flags**

6.13.1 Detailed Description

This class holds the cached info of our searches for use with the Principal Variation Table

Definition at line 18 of file pvtable.h.

The documentation for this class was generated from the following files:

- /home/michael/Documents/Projects/C++/Chess-Engine/include/pvtable.h
- /home/michael/Documents/Projects/C++/Chess-Engine/src/pvtable.cc

6.14 PvTable Class Reference

`#include <pvtable.h>`

Public Member Functions

- Move get (const Board &pos) noexcept

  Get the best move previously found for this position.
- void insert (const Board &pos, const Move &move) noexcept

  Stashes the move associated with this position into the hash map.
- void insert (const Board &pos, const Move &move, int32_t score, int32_t depth, int32_t flags) noexcept

  Stashes the move associated with this position into the hash map.
- int32_t size () const noexcept

  Gets the number of entries in the transposition table.
- void clear () noexcept

  Clears all entries in the transposition table.
- int32_t getPvLine (Board &pos, const uint32_t depth) noexcept

  Fills in the pv array with the searched pv moves and returns the length of the line.
- bool getHashEntry (Board &pos, Move &pvMove, int32_t &score, int32_t alpha, int32_t beta, int32_t depth) noexcept

  Checks the alpha beta bounds and returns if a better, previously cached move is found.

Data Fields

- std::vector< Move > **pv_arr**

Private Attributes

- std::unordered_map< uint64_t, PvEntry > **pv_table**

6.14.1 Detailed Description

This class holds all info for a given position with the best move found. Serves as a cache to improve evaluation speed. Also called a transposition table.

Definition at line 40 of file pvtable.h.

6.14.2 Member Function Documentation

6.14.2.1 clear()

```
void PvTable::clear ( )  [noexcept]
```

Clears all entries in the transposition table.

Parameters

None	

Returns

None

Definition at line 89 of file pvtable.cc.

6.14.2.2 get()

```
Move PvTable::get (
            const Board & pos )  [noexcept]
```

Get the best move previously found for this position.

Parameters

pos	The current board state.

Returns

The best move previously found for this position.

Definition at line 58 of file pvtable.cc.

6.14.2.3 getHashEntry()

```
bool PvTable::getHashEntry (
            Board & pos,
            Move & pvMove,
            int32_t & score,
            int32_t alpha,
            int32_t beta,
            int32_t depth )  [noexcept]
```

Checks the alpha beta bounds and returns if a better, previously cached move is found.

Parameters

pos	The current board state.
pvMove	The move to store the found move in if found.
score	The score buffer to store the found score in if found
alpha	The alpha cutoff
beta	The beta cutoff
depth	The desired search depth

Returns

true if the position has an applicable cached move.

Definition at line 112 of file pvtable.cc.

6.14.2.4 getPvLine()

```
int32_t PvTable::getPvLine (
            Board & pos,
            const uint32_t depth )  [noexcept]
```

Fills in the pv array with the searched pv moves and returns the length of the line.

Parameters

pos	The current board state.
depth	The search depth.

Returns

The number of moves in the Pv line

Definition at line 94 of file pvtable.cc.

6.14.2.5 insert() [1/2]

```
void PvTable::insert (
            const Board & pos,
            const Move & move )  [noexcept]
```

Stashes the move associated with this position into the hash map.

Parameters

pos	The current board state.
move	The move to store for this position.

Returns

None

Definition at line 64 of file pvtable.cc.

6.14.2.6 insert() [2/2]

```
void PvTable::insert (
            const Board & pos,
            const Move & move,
            int32_t score,
            int32_t depth,
            int32_t flags )  [noexcept]
```

Stashes the move associated with this position into the hash map.

Parameters

pos	The current board state.
move	The move to store for this position.
score	The evaluation of this position.
depth	The depth that this position was previously searched to.
flags	The flags that are associated with the move.

Returns

None

Definition at line 70 of file pvtable.cc.

6.14.2.7 size()

```
int32_t PvTable::size ( ) const  [noexcept]
```

Gets the number of entries in the transposition table.

Parameters

None	

Returns

The number of entries in the transposition table.

Definition at line 84 of file pvtable.cc.

The documentation for this class was generated from the following files:

- /home/michael/Documents/Projects/C++/Chess-Engine/include/pvtable.h
- /home/michael/Documents/Projects/C++/Chess-Engine/src/pvtable.cc

6.15 SearchAgent Class Reference

```
#include <search.h>
```

Public Member Functions

- void searchPosition (Board &pos, SearchInfo &info) noexcept

  Performs iterative deepening alpha-beta search on the position.
- bool isGameOver (Board &pos) noexcept

  Checks if there is checkmate, stalemate, insufficient material, or threefold repetition.

Data Fields

- Evaluator **eval**
- PvTable **pv**

Private Member Functions

- int32_t isRepetition (const Board &pos) noexcept

  Checks if the position has happened before.
- void checkStop (SearchInfo &info)

  Checks if the time limit has been passed.
- void clearForSearch (Board &pos, SearchInfo &info) noexcept

  Clears the board's search_hist and search_killers vectors.
- int32_t alphaBeta (int32_t alpha, int32_t beta, uint32_t depth, Board &pos, SearchInfo &info, bool doNull) noexcept

  Recursively performs the mini-max algorithm with alpha-beta pruning. If doNull is set, considers making a null move to improve search time.
- int32_t quiescenceSearch (int32_t alpha, int32_t beta, Board &pos, SearchInfo &info) noexcept

  Searches similarly to alpha-beta but only on capture moves. Used to avoid the horizon effect.
- bool threeFoldRepetition (const Board &pos) noexcept

  Checks if threefold repetition has occurred.
- bool drawnMaterial (const Board &pos) noexcept

  Checks if there is sufficient material to checkmate either side.

Static Private Attributes

- static constexpr uint32_t kInterval = 0x7FF

6.15.1 Detailed Description

This class provides functions to search through the board state

Definition at line 20 of file search.h.

6.15.2 Member Function Documentation

6.15.2.1 alphaBeta()

```
int32_t SearchAgent::alphaBeta (
            int32_t alpha,
            int32_t beta,
            uint32_t depth,
            Board & pos,
            SearchInfo & info,
            bool doNull )  [private], [noexcept]
```

Recursively performs the mini-max algorithm with alpha-beta pruning. If doNull is set, considers making a null move to improve search time.

Parameters

pos	The current board state.
alpha	The alpha cutoff
beta	The beta cutoff
depth	The current depth of the search
pos	The current board state
info	The engine's searchInfo object
doNull	Null move flag

Returns

The evaluation of the current position

Definition at line 152 of file search.cc.

6.15.2.2 checkStop()

```
void SearchAgent::checkStop (
            SearchInfo & info )  [private]
```

Checks if the time limit has been passed.

Parameters

None	

Returns

None

Definition at line 114 of file search.cc.

6.15.2.3 clearForSearch()

```
void SearchAgent::clearForSearch (
            Board & pos,
            SearchInfo & info )  [private], [noexcept]
```

Clears the board's search_hist and search_killers vectors.

Parameters

pos	The current board state.
info	The engine's searchInfo object.

Returns

None

Definition at line 126 of file search.cc.

6.15.2.4 drawnMaterial()

```
bool SearchAgent::drawnMaterial (
            const Board & pos )  [private], [noexcept]
```

Checks if there is sufficient material to checkmate either side.

Parameters

pos	The current board state

Returns

true if there is sufficient material on either side to cause checkmate.

Definition at line 34 of file search.cc.

6.15.2.5 isGameOver()

```
bool SearchAgent::isGameOver (
            Board & pos )  [noexcept]
```

Checks if there is checkmate, stalemate, insufficient material, or threefold repetition.

Parameters

pos	The current board state

Returns

true if the game has concluded in one way or other, false otherwise

Definition at line 59 of file search.cc.

6.15.2.6 isRepetition()

```
int32_t SearchAgent::isRepetition (
            const Board & pos )  [private], [noexcept]
```

Checks if the position has happened before.

Parameters

pos	The current board state.

Returns

true if the current position has happened before, false otherwise

Definition at line 47 of file search.cc.

6.15.2.7 quiescenceSearch()

```
int32_t SearchAgent::quiescenceSearch (
            int32_t alpha,
            int32_t beta,
            Board & pos,
            SearchInfo & info )  [private], [noexcept]
```

Searches similarly to alpha-beta but only on capture moves. Used to avoid the horizon effect.

Parameters

alpha	The alpha cutoff
beta	The beta cutoff
pos	The current board state
info	The engine's searchInfo object

Returns

The evaluation of the current position

Definition at line 303 of file search.cc.

6.15.2.8 searchPosition()

```
void SearchAgent::searchPosition (
            Board & pos,
            SearchInfo & info )  [noexcept]
```

Performs iterative deepening alpha-beta search on the position.

Parameters

pos	The current board state
info	The engine's searchInfo object

Returns

None

Definition at line 367 of file search.cc.

6.15.2.9 threeFoldRepetition()

```
bool SearchAgent::threeFoldRepetition (
            const Board & pos )  [private], [noexcept]
```

Checks if threefold repetition has occurred.

Parameters

pos	The current board state

Returns

true if threefold repetition has occurred, false otherwise.

Definition at line 21 of file search.cc.

6.15.3 Field Documentation

6.15.3.1 kInterval

```
constexpr uint32_t SearchAgent::kInterval = 0x7FF  [static], [private]
```

Bitmask to check search flags every 2048 positions

Definition at line 26 of file search.h.

The documentation for this class was generated from the following files:

- /home/michael/Documents/Projects/C++/Chess-Engine/include/search.h
- /home/michael/Documents/Projects/C++/Chess-Engine/src/search.cc

6.16 SearchInfo Struct Reference

Data Fields

- uint64_t **startTime**
- uint64_t **stopTime**
- bool **timeLimit**
- uint32_t **depth**
- uint32_t **depthLimit**
- uint32_t **nodes**
- uint32_t **movesLeft**
- bool **infinite**
- bool **quit**
- bool **stopped**
- float **fh**
- float **fhf**
- int32_t **protocol**
- bool **doPrint**

6.16.1 Detailed Description

Definition at line 11 of file searchinfo.h.

The documentation for this struct was generated from the following file:

- /home/michael/Documents/Projects/C++/Chess-Engine/include/searchinfo.h

6.17 Stopwatch Class Reference

Public Member Functions

- void start () noexcept

  Starts the internal timer.
- float stop () noexcept

  Stops the internal timer and returns the time elapsed.

Static Public Member Functions

- static uint64_t getTimeInMilli () noexcept

  Get the time since the epoch in milliseconds.

Static Public Attributes

- static constexpr int32_t **kMilliPerSecond** = 1000
- static constexpr int32_t **kSecondsPerMinute** = 60

Private Types

- typedef std::chrono::high_resolution_clock **Time**
- typedef std::chrono::milliseconds **ms**

Private Attributes

- Time::time_point **start_time**

6.17.1 Detailed Description

Definition at line 13 of file stopwatch.h.

6.17.2 Member Function Documentation

6.17.2.1 getTimeInMilli()

```
uint64_t Stopwatch::getTimeInMilli ( )  [static], [noexcept]
```

Get the time since the epoch in milliseconds.

Parameters

None	

Returns

Get the time since the epoch in milliseconds

Definition at line 28 of file stopwatch.cc.

6.17.2.2 start()

```
void Stopwatch::start ( )  [noexcept]
```

Starts the internal timer.

Parameters

None	

Returns

None

Definition at line 16 of file stopwatch.cc.

6.17.2.3 stop()

```
float Stopwatch::stop ( )  [noexcept]
```

Stops the internal timer and returns the time elapsed.

Parameters

None	

Returns

The time elapsed since start() was called in milliseconds.

Definition at line 21 of file stopwatch.cc.

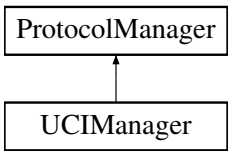
The documentation for this class was generated from the following files:

- /home/michael/Documents/Projects/C++/Chess-Engine/include/stopwatch.h
- /home/michael/Documents/Projects/C++/Chess-Engine/src/stopwatch.cc

6.18 UCIManager Class Reference

```
#include <uci.h>
```

Inheritance diagram for UCIManager:



Public Member Functions

- void **parseGoCmd** (const std::string &cmd)
- void **parsePosition** (const std::string &input)
- void loop () override

  Starts the protocol loop.
- int32_t getProtocol () override

  Returns the protocol identifier for the current protocol.

Additional Inherited Members

6.18.1 Detailed Description

See ProtocolManager documentation

Definition at line 15 of file uci.h.

6.18.2 Member Function Documentation

6.18.2.1 getProtocol()

```
int32_t UCIManager::getProtocol ( )  [override], [virtual]
```

Returns the protocol identifier for the current protocol.

Parameters

None	

Returns

The protocol identifier

Implements ProtocolManager.

Definition at line 203 of file uci.cc.

6.18.2.2 loop()

```
void UCIManager::loop ( )  [override], [virtual]
```

Starts the protocol loop.

Parameters

None	

Returns

None

Implements ProtocolManager.

Definition at line 134 of file uci.cc.

The documentation for this class was generated from the following files:

- /home/michael/Documents/Projects/C++/Chess-Engine/include/uci.h
- /home/michael/Documents/Projects/C++/Chess-Engine/src/uci.cc

6.19 UndoMove Class Reference

This class stores info needed to undo a move that was made.

`#include <move.h>`

Public Member Functions

- **UndoMove** (int32_t _move, const Board &pos)

Data Fields

- int32_t **move**
- int32_t **castle_perm**
- int32_t **en_pas**
- int32_t **fifty_move**
- uint64_t **pos_key**

6.19.1 Detailed Description

This class stores info needed to undo a move that was made.

Definition at line 17 of file move.h.

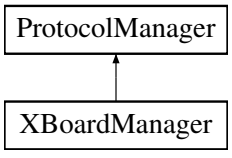
The documentation for this class was generated from the following files:

- /home/michael/Documents/Projects/C++/Chess-Engine/include/move.h
- /home/michael/Documents/Projects/C++/Chess-Engine/src/move.cc

6.20 XBoardManager Class Reference

`#include <xboard.h>`

Inheritance diagram for XBoardManager:



Public Member Functions

- void loop () override

  Starts the protocol loop.
- int32_t getProtocol () override

  Returns the protocol identifier for the current protocol.

Additional Inherited Members

6.20.1 Detailed Description

See ProtocolManager documentation

Definition at line 14 of file xboard.h.

6.20.2 Member Function Documentation

6.20.2.1 getProtocol()

```
int32_t XBoardManager::getProtocol ( )  [override], [virtual]
```

Returns the protocol identifier for the current protocol.

Parameters

None	

Returns

The protocol identifier

Implements ProtocolManager.

Definition at line 163 of file xboard.cc.

6.20.2.2 loop()

```
void XBoardManager::loop ( )  [override], [virtual]
```

Starts the protocol loop.

Parameters

None	

Returns

None

Implements ProtocolManager.

Definition at line 19 of file xboard.cc.

The documentation for this class was generated from the following files:

- /home/michael/Documents/Projects/C++/Chess-Engine/include/xboard.h
- /home/michael/Documents/Projects/C++/Chess-Engine/src/xboard.cc

Chapter 7

File Documentation

7.1 /home/michael/Documents/Projects/C++/Chess-Engine/include/bitboard.h File Reference

Contains declarations of functions that manipulate bitboards.

```
#include "defs.h"
```

Functions

- int BB::popBit (uint64_t &bb) noexcept
  Sets the highest order 1 bit to 0.
- int BB::countBits (uint64_t bb) noexcept
  Counts the number of 1's in the bitboard.
- void BB::setBit (uint64_t &bb, int index) noexcept
  Sets the bit at index to 1.
- void BB::clearBit (uint64_t &bb, int index) noexcept
  Sets the bit at index to 0.

Variables

- constexpr std::array< int32_t, kChessboardSize > BB::BitTable
- std::array< uint64_t, kChessboardSize > **BB::SetMask**
- std::array< uint64_t, kChessboardSize > **BB::ClearMask**

7.1.1 Detailed Description

Contains declarations of functions that manipulate bitboards.

Author

Michael Lee

Date

1/9/2019

7.1.2 Function Documentation

7.1.2.1 clearBit()

```
void BB::clearBit (
            uint64_t & bb,
            int index )  [noexcept]
```

Sets the bit at index to 0.

Parameters

bb	The desired bitboard.
index	The index to set to 0.

Returns

None.

Sets the bit at index to 0

Definition at line 45 of file bitboard.cc.

7.1.2.2 countBits()

```
int BB::countBits (
            uint64_t b )  [noexcept]
```

Counts the number of 1's in the bitboard.

Parameters

bb	The desired bitboard

Returns

The number of 1's in the bitboard.

Returns the number of 1's in the bitboard

Definition at line 27 of file bitboard.cc.

7.1.2.3 popBit()

```
int BB::popBit (
            uint64_t & bb )  [noexcept]
```

Sets the highest order 1 bit to 0.

Parameters

bb	The desired bitboard

Returns

The index of the bit that was flipped

Sets the highest order bit to 0 Returns the value after the operations

Definition at line 16 of file bitboard.cc.

7.1.2.4 setBit()

```
void BB::setBit (
            uint64_t & bb,
            int index )  [noexcept]
```

Sets the bit at index to 1.

Parameters

bb	The desired bitboard
index	The index to set to 1

Returns

None.

Sets the bit at index to 1

Definition at line 37 of file bitboard.cc.

7.1.3 Variable Documentation

7.1.3.1 BitTable

```
constexpr std::array<int32_t, kChessboardSize> BB::BitTable
```

Initial value:

```
{
      63, 30, 3, 32, 25, 41, 22, 33, 15, 50, 42, 13, 11, 53, 19, 34, 61, 29, 2,
      51, 21, 43, 45, 10, 18, 47, 1, 54, 9, 57, 0, 35, 62, 31, 40, 4, 49, 5, 52,
      26, 60, 6, 23, 44, 46, 27, 56, 16, 7, 39, 48, 24, 59, 14, 12, 55, 38, 28,
      58, 20, 37, 17, 36, 8
    }
```

Magic numbers used for pop/set bit in bitboard

Definition at line 18 of file bitboard.h.

7.2 /home/michael/Documents/Projects/C++/Chess-Engine/include/board.h File Reference

Defines the internal Board representation used by the engine.

```
#include "defs.h"
#include "move.h"
#include "pvtable.h"
#include <string>
#include <vector>
#include <sstream>
```

Data Structures

- class Board

7.2.1 Detailed Description

Defines the internal Board representation used by the engine.

Author

Michael Lee

Date

1/9/2019

7.3 /home/michael/Documents/Projects/C++/Chess-Engine/include/console.h File Reference

Contains declarations of functions for the console protocol.

```
#include "protocol.h"
```

Data Structures

- class ConsoleManager

7.3.1 Detailed Description

Contains declarations of functions for the console protocol.

Author

Michael Lee

Date

1/9/2019

7.4 /home/michael/Documents/Projects/C++/Chess-Engine/include/debug.h File Reference

Defines an assert function for debugging.

```
#include <stdlib.h>
```

Macros

- #define **ASSERT**(n)

7.4.1 Detailed Description

Defines an assert function for debugging.

Author

Michael Lee

Date

1/9/2019

7.5 /home/michael/Documents/Projects/C++/Chess-Engine/include/defs.h File Reference

Contains declarations of various constant arrays used throughout the engine.

```
#include "debug.h"
#include "move.h"
#include <string>
#include <array>
#include <cstddef>
```

Macros

- #define **STARTFEN** "rnbqkbnr/pppppppp/8/8/8/8/PPPPPPPP/RNBQKBNR w KQkq - 0 1"

Enumerations

- enum {
  EMPTY, **wP**, **wN**, **wB**,
  wR, **wQ**, **wK**, **bP**,
  bN, **bB**, **bR**, **bQ**,
  bK }
- enum {
  FILE_A, **FILE_B**, **FILE_C**, **FILE_D**,
  FILE_E, **FILE_F**, **FILE_G**, **FILE_H**,
  FILE_NONE }
- enum {
  RANK_1, **RANK_2**, **RANK_3**, **RANK_4**,
  RANK_5, **RANK_6**, **RANK_7**, **RANK_8**,
  RANK_NONE }
- enum { **WHITE**, **BLACK**, **BOTH** }
- enum {
  A1 = 21, **B1**, **C1**, **D1**,
  E1, **F1**, **G1**, **H1**,
  A2 = 31, **B2**, **C2**, **D2**,
  E2, **F2**, **G2**, **H2**,
  A3 = 41, **B3**, **C3**, **D3**,
  E3, **F3**, **G3**, **H3**,
  A4 = 51, **B4**, **C4**, **D4**,
  E4, **F4**, **G4**, **H4**,
  A5 = 61, **B5**, **C5**, **D5**,
  E5, **F5**, **G5**, **H5**,
  A6 = 71, **B6**, **C6**, **D6**,
  E6, **F6**, **G6**, **H6**,
  A7 = 81, **B7**, **C7**, **D7**,
  E7, **F7**, **G7**, **H7**,
  A8 = 91, **B8**, **C8**, **D8**,
  E8, **F8**, **G8**, **H8**,
  NO_SQ, **OFFBOARD** }
- enum { **WKCA** = 0b0001, **WQCA** = 0b0010, **BKCA** = 0b0100, **BQCA** = 0b1000 }
- enum { **HFNONE**, **HFALPHA**, **HFBETA**, **HFEXACT** }

Functions

- const Move **NOMOVE** (0)

Variables

- constexpr uint32_t **kMaxSearchDepth** = 64
- constexpr uint32_t **kMoveLimit** = 2 << 10
- constexpr uint32_t **kBoardArraySize** = 120
- constexpr uint32_t **kChessboardSize** = 64
- constexpr uint32_t **kNumPlayers** = 2
- constexpr uint32_t **kNumFilesRanks** = 8
- constexpr uint32_t **kNumPceTypes** = 13
- const std::string **kAppName** = "ChessEngine"
- constexpr std::array< bool, kNumPceTypes > **PieceInfo::PieceBig** { false, false, true, true, true, true, true, false, true, true, true, true, true }
- constexpr std::array< bool, kNumPceTypes > **PieceInfo::PieceMaj** { false, false, false, false, true, true, true, false, false, false, true, true, true }
- constexpr std::array< bool, kNumPceTypes > **PieceInfo::PieceMin** { false, false, true, true, false, false, false, false, true, true, false, false, false }
- constexpr std::array< uint32_t, kNumPceTypes > **PieceInfo::PieceVal** { 0, 100, 325, 325, 550, 1000, 50000, 100, 325, 325, 550, 1000, 50000 }
- constexpr std::array< uint32_t, kNumPceTypes > **PieceInfo::PieceCol** { BOTH, WHITE, WHITE, WHITE, WHITE, WHITE, WHITE, BLACK, BLACK, BLACK, BLACK, BLACK, BLACK }
- constexpr std::array< bool, kNumPceTypes > **PieceInfo::PieceSlides** { false, false, false, true, true, true, false, false, false, true, true, true, false }
- constexpr std::array< bool, kNumPceTypes > **PieceInfo::PiecePawn** { false, true, false, false, false, false, false, true, false, false, false, false, false }
- constexpr std::array< bool, kNumPceTypes > **PieceInfo::PieceKing** { false, false, false, false, false, false, true, false, false, false, false, false, true }
- constexpr std::array< bool, kNumPceTypes > **PieceInfo::PieceRookQueen** { false, false, false, false, true, true, false, false, false, false, true, true, false }
- constexpr std::array< bool, kNumPceTypes > **PieceInfo::PieceBishopQueen** { false, false, false, true, false, true, false, false, false, true, false, true, false }
- constexpr std::array< bool, kNumPceTypes > **PieceInfo::PieceKnight** { false, false, true, false, false, false, false, false, true, false, false, false, false }
- constexpr std::array< int32_t, 2 > **Attack::wPCap** { -11, -9 }
- constexpr std::array< int32_t, 2 > **Attack::bPCap** { 11, 9 }
- constexpr std::array< int32_t, 2 > **Attack::PnMoves** { -10, 10 }
- constexpr std::array< int32_t, 8 > **Attack::KnMoves** { -8, -19, -21, -12, 8, 19, 21, 12 }
- constexpr std::array< int32_t, 4 > **Attack::RkMoves** { -1, -10, 1, 10 }
- constexpr std::array< int32_t, 4 > **Attack::BiMoves** { -9, -11, 11, 9 }
- constexpr std::array< int32_t, 8 > **Attack::KiMoves** { -1, -10, 1, 10, -9, -11, 11, 9 }

7.5.1 Detailed Description

Contains declarations of various constant arrays used throughout the engine.

Author

Michael Lee

Date

1/9/2019

7.6 /home/michael/Documents/Projects/C++/Chess-Engine/include/engine.h File Reference

Defines the central engine data structure.

```
#include <memory>
#include "protocol.h"
#include "polyglot.h"
```

Data Structures

- struct EngineConfig

  Stores the flags for the engine.
- class Engine

7.6.1 Detailed Description

Defines the central engine data structure.

Author

Michael Lee

Date

1/9/2019

7.7 /home/michael/Documents/Projects/C++/Chess-Engine/include/eval.h File Reference

Contains declarations of functions that determine the strength of a given position.

```
#include "board.h"
#include "defs.h"
```

Data Structures

- class Evaluator

Namespaces

- Value

  Provides several constant values used for evaluating the board state.

Variables

- constexpr int32_t Value::kInfinity = 30000

  Highest possible score.
- constexpr int32_t Value::kMateScore = 29000

  Score for a Checkmate.
- constexpr int32_t Value::kIsolatedPawn = -10

  Score bonus for isolated pawns (no same color pawn on adjacent files)
- constexpr int32_t Value::kOpenRookFile = 10

  Score bonus for a Rook on an open file (no pawns)
- constexpr int32_t Value::kSemiOpenRookFile = 5

  Score bonus for a Rook on a semi-open file (no same color pawn)
- constexpr int32_t Value::kOpenQueenFile = 5

  Score bonus for a Queen on an open file (no pawns)
- constexpr int32_t Value::kSemiOpenQueenFile = 3

  Score bonus for a Queen on a semi-open file (no same color pawn)
- constexpr int32_t Value::kEndGameThreshold = PieceInfo::PieceVal[wR] + 2 ∗ PieceInfo::PieceVal[wB] + 2 ∗ PieceInfo::PieceVal[wP]

  Material threshold to determine when the endgame starts.
- constexpr int32_t Value::kBishopPair = 30

  Score bonus for the Bishop pair.
- constexpr std::array< int32_t, kNumFilesRanks > Value::passedPawnScore {0, 5, 10, 20, 35, 60, 100, 200}

  Score bonus for Passed pawns based on distance.
- constexpr std::array< int32_t, kChessboardSize > Value::PawnTable

  Scores the position of the Pawns.
- constexpr std::array< int32_t, kChessboardSize > Value::KnightTable

  Scores the position of the Knights.
- constexpr std::array< int32_t, kChessboardSize > Value::BishopTable

  Scores the position of the Bishops.
- constexpr std::array< int32_t, kChessboardSize > Value::RookTable

  Scores the position of the Rooks.
- constexpr std::array< int32_t, kChessboardSize > Value::KingEndGame

  Scores the king in the late game. Prioritizes the center.
- constexpr std::array< int32_t, kChessboardSize > Value::KingOpening

  Scores the king for the earlygame. Prioritizes staying safe.
- std::array< uint64_t, kNumFilesRanks > **EvalBB::FileMask**
- std::array< uint64_t, kNumFilesRanks > **EvalBB::RankMask**
- std::array< uint64_t, kChessboardSize > **EvalBB::whitePassedMask**
- std::array< uint64_t, kChessboardSize > **EvalBB::blackPassedMask**
- std::array< uint64_t, kChessboardSize > **EvalBB::isolatedMask**

7.7.1 Detailed Description

Contains declarations of functions that determine the strength of a given position.

Author

Michael Lee

Date

1/9/2019

7.8 /home/michael/Documents/Projects/C++/Chess-Engine/include/hash.h File Reference

Contains declarations of functions that manipulate the board position key.

```
#include "board.h"
#include "defs.h"
#include <array>
```

Namespaces

- Hash

Functions

- uint64_t Hash::generatePosKey (const Board &pos)

  Gets the position hash key for the current position.
- void Hash::hashPce (uint32_t pce, uint32_t sq, Board &pos) noexcept

  Hashes in/out a piece on a given square.
- void Hash::hashCa (Board &pos) noexcept

  Hashes in/out the castle permissions.
- void Hash::hashSide (Board &pos) noexcept

  Hashes in/out the side to move.
- void Hash::hashEP (Board &pos) noexcept

  Hashes in/out the enPassant square.

Variables

- std::array< std::array< uint64_t, kBoardArraySize >, kNumPceTypes > **Hash::PieceKeys**
- uint64_t **Hash::SideKey**
- std::array< uint64_t, 16 > **Hash::CastleKeys**

7.8.1 Detailed Description

Contains declarations of functions that manipulate the board position key.

Author

Michael Lee

Date

1/9/2019

7.9 /home/michael/Documents/Projects/C++/Chess-Engine/include/init.h File Reference

Contains declarations of functions that fill the non static constant arrays used throughout the engine.

Namespaces

- Init

  Provides methods to initialize the non constant arrays used throughout the engine.

Functions

- void Init::initAll () noexcept

  Calls all of the other 'init' methods.
- void Init::initSq120ToSq64 () noexcept

  Fills in the arrays that convert between array-120 to array-64 representations.
- void Init::initBitMasks () noexcept

  Fills in the arrays used for setting/clearing bits in bitboards.
- void Init::initHashKeys () noexcept

  Fills in the hashkeys arrays that will be used to for getting the board's hashkey.
- void Init::initFileRankBrd () noexcept

  Fills in the arrays that return the file/rank # for a given square.
- void Init::initEvalMasks () noexcept

  Fills in the arrays used for evaluating pawn structure during evaluation.
- void Init::initMvvLva () noexcept

  Fills in the arrays to determine most valuable victim least valuable attacker priority.

7.9.1 Detailed Description

Contains declarations of functions that fill the non static constant arrays used throughout the engine.

Author

Michael Lee

Date

1/9/2019

7.10 /home/michael/Documents/Projects/C++/Chess-Engine/include/io.h File Reference

Contains declarations of functions that print the various Engine data structures.

```
#include "board.h"
#include "move.h"
#include "movelist.h"
#include "searchinfo.h"
#include <string>
```

Namespaces

- IO

  Various functions to print out engine data structures.

Functions

- void IO::printBoard (const Board &pos) noexcept

  Prints out the board to stdio.
- void IO::printBitBoard (const uint64_t bb) noexcept

  Prints out the bitboard to stdio.
- void IO::printMoveList (const MoveList &list) noexcept

  Prints out the MoveList to stdio.
- void IO::printSearchDetails (const SearchInfo &info, int32_t curDepth, int32_t bestScore, PvTable &pv, int32_t pvMoves) noexcept

  Prints out the search details to stdio.
- void IO::printBestMove (Board &pos, const SearchInfo &info, const Move &bestMove) noexcept

  Prints out the best move stdio for the protocol manager.
- Move IO::parseMove (std::string input, const Board &pos) noexcept

  Reads in a move string and converts it to the internal representation.

Variables

- const std::string IO::PceChar = ".PNBRQKpnbrqk"
- const std::string IO::SideChar = "wb-"
- const std::string IO::RankChar = "12345678"
- const std::string IO::FileChar = "abcdefgh"
- const std::unordered_map< uint32_t, std::string > IO::epstr

7.10.1 Detailed Description

Contains declarations of functions that print the various Engine data structures.

Author

Michael Lee

Date

1/9/2019

7.11 /home/michael/Documents/Projects/C++/Chess-Engine/include/move.h File Reference

Defines the custom internal move representation.

```
#include <string>
```

Data Structures

- class UndoMove

  This class stores info needed to undo a move that was made.
- class Move

Namespaces

- MoveFlags

  This namespace stores flags used to extract parameters from a move.

Variables

- constexpr int32_t **MoveFlags::SQ** = 0x7F
- constexpr int32_t **MoveFlags::EP** = 0x40000
- constexpr int32_t **MoveFlags::PS** = 0x80000
- constexpr int32_t **MoveFlags::CA** = 0x1000000
- constexpr int32_t **MoveFlags::CAP** = 0x7C000
- constexpr int32_t **MoveFlags::PROM** = 0xF00000

7.11.1 Detailed Description

Defines the custom internal move representation.

Author

Michael Lee

Date

1/9/2019

7.12 /home/michael/Documents/Projects/C++/Chess-Engine/include/movelist.h File Reference

Custom data structure to store possible moves.

```
#include "defs.h"
#include "board.h"
#include "move.h"
```

Data Structures

- class MoveList

Namespaces

- MvvLva

Variables

- std::array< std::array< int32_t, kNumPceTypes >, kNumPceTypes > **MvvLva::MvvLvaScore**
- constexpr std::array< int32_t, kNumPceTypes > **MvvLva::victimScore** {0, 100, 200, 300, 400, 500, 600, 100, 200, 300, 400, 500, 600}

7.12.1 Detailed Description

Custom data structure to store possible moves.

Author

Michael Lee

Date

1/9/2019

7.13 /home/michael/Documents/Projects/C++/Chess-Engine/include/movemaker.h File Reference

Contains declarations of functions that manipulate the position of pieces on the internal board.

```
#include "defs.h"
#include "board.h"
```

Data Structures

- class MM

Variables

- constexpr std::array< int32_t, 120 > CastlePerm

7.13.1 Detailed Description

Contains declarations of functions that manipulate the position of pieces on the internal board.

Author

Michael Lee

Date

1/9/2019

7.13.2 Variable Documentation

7.13.2.1 CastlePerm

```
constexpr std::array<int32_t,120> CastlePerm
```

Initial value:

```
{
    15, 15, 15, 15, 15, 15, 15, 15, 15, 15,
    15, 15, 15, 15, 15, 15, 15, 15, 15, 15,
    15, 13, 15, 15, 15, 12, 15, 15, 14, 15,
    15, 15, 15, 15, 15, 15, 15, 15, 15, 15,
    15, 15, 15, 15, 15, 15, 15, 15, 15, 15,
    15, 15, 15, 15, 15, 15, 15, 15, 15, 15,
    15, 15, 15, 15, 15, 15, 15, 15, 15, 15,
    15, 15, 15, 15, 15, 15, 15, 15, 15, 15,
    15, 15, 15, 15, 15, 15, 15, 15, 15, 15,
    15,  7, 15, 15, 15,  3, 15, 15, 11, 15,
    15, 15, 15, 15, 15, 15, 15, 15, 15, 15,
    15, 15, 15, 15, 15, 15, 15, 15, 15, 15
}
```

Indicates the change in castle permissions if a given square moves. Used with bitwise &

Definition at line 18 of file movemaker.h.

7.14 /home/michael/Documents/Projects/C++/Chess-Engine/include/polyglot.h File Reference

Contains declarations for the Polyglot Book class.

```
#include "defs.h"
#include <vector>
```

Data Structures

- struct PolyglotEntry
- class PolyBook

7.14.1 Detailed Description

Contains declarations for the Polyglot Book class.

Author

Michael Lee

Date

1/9/2019

7.15 /home/michael/Documents/Projects/C++/Chess-Engine/include/polyglotkeys.h File Reference

Contains all 781 polyglot hashkeys used in the opening.

```
#include "defs.h"
```

Namespaces

- PolyKeys

Macros

- #define **U64**(u) (u##ULL)

Variables

- constexpr std::array< uint64_t, 781 > **PolyKeys::Random64**

7.15.1 Detailed Description

Contains all 781 polyglot hashkeys used in the opening.

Author

Michael Lee

Date

1/9/2019

7.16 /home/michael/Documents/Projects/C++/Chess-Engine/include/protocol.h File Reference

Contains declaration of base class for default protocal functionality.

```
#include "board.h"
#include "searchinfo.h"
#include "search.h"
#include "movemaker.h"
```

Data Structures

- class ProtocolManager

7.16.1 Detailed Description

Contains declaration of base class for default protocal functionality.

Author

Michael Lee

Date

1/9/2019

7.17 /home/michael/Documents/Projects/C++/Chess-Engine/include/pvtable.h File Reference

Contains declarations for the Principal Variation/transposition table class used for caching.

```
#include "move.h"
#include <unordered_map>
#include <vector>
```

Data Structures

- class PvEntry
- class PvTable

7.17.1 Detailed Description

Contains declarations for the Principal Variation/transposition table class used for caching.

Author

Michael Lee

Date

1/9/2019

7.18 /home/michael/Documents/Projects/C++/Chess-Engine/include/search.h File Reference

Contains declarations of functions to search through the board state.

```
#include "defs.h"
#include "board.h"
#include "searchinfo.h"
#include "eval.h"
#include "polyglot.h"
#include "pvtable.h"
```

Data Structures

- class SearchAgent

7.18.1 Detailed Description

Contains declarations of functions to search through the board state.

Author

Michael Lee

Date

1/9/2019

7.19 /home/michael/Documents/Projects/C++/Chess-Engine/include/searchinfo.h File Reference

Contains information about the search constraints provided by the engine.

Data Structures

- struct SearchInfo

7.19.1 Detailed Description

Contains information about the search constraints provided by the engine.

Author

Michael Lee

Date

1/9/2019

7.20 /home/michael/Documents/Projects/C++/Chess-Engine/include/stopwatch.h File Reference

Contains declarations of functions for basic benchmarking and timing.

```
#include <chrono>
#include <unistd.h>
```

Data Structures

- class Stopwatch

7.20.1 Detailed Description

Contains declarations of functions for basic benchmarking and timing.

Author

Michael Lee

Date

1/9/2019

7.21 /home/michael/Documents/Projects/C++/Chess-Engine/include/tester.h File Reference

Contains declarations of functions used for Perft testing for testing accuracy of move generation and move making.

```
#include "board.h"
#include <string>
```

Data Structures

- class PerftTester

7.21.1 Detailed Description

Contains declarations of functions used for Perft testing for testing accuracy of move generation and move making.

Author

Michael Lee

Date

1/9/2019

7.22 /home/michael/Documents/Projects/C++/Chess-Engine/include/uci.h File Reference

Contains declarations of functions for the UCI protocol.

```
#include "protocol.h"
#include <string>
```

Data Structures

- class UCIManager

7.22.1 Detailed Description

Contains declarations of functions for the UCI protocol.

Author

Michael Lee

Date

1/9/2019

7.23 /home/michael/Documents/Projects/C++/Chess-Engine/include/utils.h File Reference

Contains declarations of functions that perform various miscellaneous actions in the engine.

```
#include "defs.h"
#include "board.h"
#include "searchinfo.h"
#include "move.h"
#include <string>
```

Functions

- bool sqOnBoard (uint32_t sq) noexcept

  Checks if a square number in array-120 form is on the array-64 board representation.
- int fileRankToSq (int32_t file, int32_t rank) noexcept

  Gets the array-120 square number of a given file and rank number.
- uint64_t randU64 () noexcept

  Generates a uniformally-distributed random 64-bit number.
- bool isPiece (int32_t piece) noexcept

  Generates a uniformally-distributed random 64-bit number.
- void showAttackedSqs (const int side, Board &pos) noexcept

  Prints the 8x8 board with numbers indicating how many times each square is attacked by the provided side.
- std::string sqToString (const int sq) noexcept

  Returns the string representation of the square.
- void stringToLower (std::string &str) noexcept

  Changes the given string to lowercase.
- int InputWaiting ()

  Checks if the GUI interface has sent an interrrupt.
- void ReadInput (SearchInfo &info)

  Reads in the GUI signal from stdin.

Variables

- std::array< int32_t, kBoardArraySize > **BoardUtils::Sq120ToSq64**
- std::array< int32_t, kChessboardSize > **BoardUtils::Sq64ToSq120**
- std::array< int32_t, kBoardArraySize > **BoardUtils::FileBrd**
- std::array< int32_t, kBoardArraySize > **BoardUtils::RankBrd**
- constexpr std::array< int32_t, kChessboardSize > BoardUtils::WhiteToBlack

7.23.1 Detailed Description

Contains declarations of functions that perform various miscellaneous actions in the engine.

Author

Michael Lee

Date

1/9/2019

7.23.2 Function Documentation

7.23.2.1 fileRankToSq()

```
int fileRankToSq (
            int32_t file,
            int32_t rank )  [noexcept]
```

Gets the array-120 square number of a given file and rank number.

Parameters

file	FILE_A <= file <= FILE_H
rank	RANK_1 <= rank <= RANK_8

Returns

The array-120 square number of the given file and rank number

7.23.2.2 InputWaiting()

```
int InputWaiting ( )
```

Checks if the GUI interface has sent an interrrupt.

Parameters

None	

Returns

true if there was a GUI interrupt, false otherwise.

Definition at line 91 of file utils.cc.

7.23.2.3 isPiece()

```
bool isPiece (
            int32_t piece )  [noexcept]
```

Generates a uniformally-distributed random 64-bit number.

Parameters

piece	A piece, OFFBOARD, EMPTY, or NO_SQ

Returns

true if wP <= piece <= bK, false otherwise

7.23.2.4 randU64()

```
uint64_t randU64 ( )  [noexcept]
```

Generates a uniformally-distributed random 64-bit number.

Parameters

None	

Returns

A random 64 bit number

Definition at line 54 of file utils.cc.

7.23.2.5 ReadInput()

```
void ReadInput (
            SearchInfo & info )
```

Reads in the GUI signal from stdin.

Parameters

info	The engine's searchInfo instance

Returns

None

Definition at line 125 of file utils.cc.

7.23.2.6 showAttackedSqs()

```
void showAttackedSqs (
            const int side,
            Board & pos )  [noexcept]
```

Prints the 8x8 board with numbers indicating how many times each square is attacked by the provided side.

Parameters

side	The attacking side
pos	The board state

Returns

None

Definition at line 65 of file utils.cc.

7.23.2.7 sqOnBoard()

```
bool sqOnBoard (
            uint32_t sq )  [noexcept]
```

Checks if a square number in array-120 form is on the array-64 board representation.

Parameters

sq	The square number in array-120 form.

Returns

true if the square is on the array-64 board, false otherwise.

Definition at line 29 of file utils.cc.

7.23.2.8 sqToString()

```
std::string sqToString (
            const int sq )  [noexcept]
```

Returns the string representation of the square.

Parameters

sq	A square in array-120 form.

Returns

The string representation of the square (e.g "A1").

Definition at line 45 of file utils.cc.

7.23.2.9 stringToLower()

```
void stringToLower (
            std::string & str )  [noexcept]
```

Changes the given string to lowercase.

Parameters

str	the string to change to lower.

Returns

None

Definition at line 84 of file utils.cc.

7.23.3 Variable Documentation

7.23.3.1 WhiteToBlack

```
constexpr std::array<int32_t, kChessboardSize> BoardUtils::WhiteToBlack
```

Initial value:

```
{
        56  ,   57  ,   58  ,   59  ,   60  ,   61  ,   62  ,   63  ,
        48  ,   49  ,   50  ,   51  ,   52  ,   53  ,   54  ,   55  ,
        40  ,   41  ,   42  ,   43  ,   44  ,   45  ,   46  ,   47  ,
        32  ,   33  ,   34  ,   35  ,   36  ,   37  ,   38  ,   39  ,
        24  ,   25  ,   26  ,   27  ,   28  ,   29  ,   30  ,   31  ,
        16  ,   17  ,   18  ,   19  ,   20  ,   21  ,   22  ,   23  ,
        8   ,   9   ,   10  ,   11  ,   12  ,   13  ,   14  ,   15  ,
        0   ,   1   ,   2   ,   3   ,   4   ,   5   ,   6   ,   7
    }
```

Gives the corresponding square to the Black side from the White side

Definition at line 27 of file utils.h.

7.24 /home/michael/Documents/Projects/C++/Chess-Engine/include/xboard.h File Reference

Contains declarations for the XBoard protocol.

```
#include "protocol.h"
```

Data Structures

- class XBoardManager

7.24.1 Detailed Description

Contains declarations for the XBoard protocol.

Author

Michael Lee

Date

1/9/2019

7.25 /home/michael/Documents/Projects/C++/Chess-Engine/src/bitboard.cc File Reference

Contains definitions of functions declared in bitboard.h.

```
#include "bitboard.h"
#include "defs.h"
#include "utils.h"
#include <cstdio>
```

7.25.1 Detailed Description

Contains definitions of functions declared in bitboard.h.

Author

Michael Lee

Date

1/9/2019

7.26 /home/michael/Documents/Projects/C++/Chess-Engine/src/board.cc File Reference

Contains definitions of functions declared in board.h.

```
#include "board.h"
#include "defs.h"
#include "debug.h"
#include "hash.h"
#include "utils.h"
#include "bitboard.h"
#include "movelist.h"
#include <string>
#include <sstream>
#include <cstdio>
```

7.26.1 Detailed Description

Contains definitions of functions declared in board.h.

Author

Michael Lee

Date

1/9/2019

7.27 /home/michael/Documents/Projects/C++/Chess-Engine/src/console.cc File Reference

Contains definitions of functions declared in console.h.

```
#include "console.h"
#include "stopwatch.h"
#include "defs.h"
#include "movemaker.h"
#include "io.h"
#include "searchinfo.h"
#include "polyglot.h"
#include "engine.h"
#include <iostream>
#include <sstream>
```

7.27.1 Detailed Description

Contains definitions of functions declared in console.h.

Author

Michael Lee

Date

1/9/2019

7.28 /home/michael/Documents/Projects/C++/Chess-Engine/src/engine.cc File Reference

Contains definitions of functions declared in engine.h.

```
#include "engine.h"
#include "defs.h"
#include "init.h"
#include "uci.h"
#include "xboard.h"
#include "console.h"
#include "protocol.h"
#include <iostream>
```

7.28.1 Detailed Description

Contains definitions of functions declared in engine.h.

Author

Michael Lee

Date

1/9/2019

7.29 /home/michael/Documents/Projects/C++/Chess-Engine/src/eval.cc File Reference

Contains definitions of functions declared in eval.h.

```
#include "eval.h"
#include "defs.h"
#include "utils.h"
#include <iostream>
#include <cmath>
```

7.29.1 Detailed Description

Contains definitions of functions declared in eval.h.

Author

Michael Lee

Date

1/9/2019

7.30 /home/michael/Documents/Projects/C++/Chess-Engine/src/hash.cc File Reference

Contains definitions of functions declared in hash.h.

```
#include "defs.h"
#include "hash.h"
#include "utils.h"
#include "board.h"
```

7.30.1 Detailed Description

Contains definitions of functions declared in hash.h.

Author

Michael Lee

Date

1/9/2019

7.31 /home/michael/Documents/Projects/C++/Chess-Engine/src/init.cc File Reference

Contains definitions of functions declared in init.h.

```
#include "defs.h"
#include "utils.h"
#include "init.h"
#include "hash.h"
#include "bitboard.h"
#include "io.h"
#include "stopwatch.h"
#include "movelist.h"
#include <vector>
#include <iostream>
```

Namespaces

- Hash
- MvvLva

7.31.1 Detailed Description

Contains definitions of functions declared in init.h.

Author

Michael Lee

Date

1/9/2019

7.32 /home/michael/Documents/Projects/C++/Chess-Engine/src/io.cc File Reference

Contains definitions of functions declared in io.h.

```
#include "io.h"
#include "pvtable.h"
#include "defs.h"
#include "stopwatch.h"
#include "utils.h"
#include "protocol.h"
#include "movemaker.h"
#include <bitset>
#include <iostream>
#include <sstream>
```

7.32.1 Detailed Description

Contains definitions of functions declared in io.h.

Author

Michael Lee

Date

1/9/2019

7.33 /home/michael/Documents/Projects/C++/Chess-Engine/src/main.cc File Reference

Entry point of the engine.

```
#include "engine.h"
#include "tester.h"
#include "stopwatch.h"
#include "polyglot.h"
#include "bitboard.h"
#include <iostream>
```

Functions

- void **runTest** ()
- int **main** ()

7.33.1 Detailed Description

Entry point of the engine.

Author

Michael Lee

Date

1/9/2019

7.34 /home/michael/Documents/Projects/C++/Chess-Engine/src/move.cc File Reference

Contains definitions of functions declared in move.h.

```
#include "move.h"
#include "defs.h"
#include "board.h"
#include "utils.h"
#include <iostream>
#include <sstream>
#include <utility>
```

7.34.1 Detailed Description

Contains definitions of functions declared in move.h.

Author

Michael Lee

Date

1/9/2019

7.35 /home/michael/Documents/Projects/C++/Chess-Engine/src/movelist.cc File Reference

Contains definitions of functions declared in movelist.h.

```
#include "movelist.h"
#include "utils.h"
#include <bitset>
#include <iostream>
#include <utility>
#include <algorithm>
```

7.35.1 Detailed Description

Contains definitions of functions declared in movelist.h.

Author

Michael Lee

Date

1/9/2019

7.36 /home/michael/Documents/Projects/C++/Chess-Engine/src/movemaker.cc File Reference

Contains definitions of functions declared in movemaker.h.

```
#include "movemaker.h"
#include "defs.h"
#include "bitboard.h"
#include "debug.h"
#include "utils.h"
#include "move.h"
#include "hash.h"
#include <cstdio>
#include <algorithm>
```

7.36.1 Detailed Description

Contains definitions of functions declared in movemaker.h.

Author

Michael Lee

Date

1/9/2019

7.37 /home/michael/Documents/Projects/C++/Chess-Engine/src/polyglot.cc File Reference

Contains definitions of functions declared in polyglot.h.

```
#include "defs.h"
#include "polyglotkeys.h"
#include "polyglot.h"
#include "board.h"
#include "io.h"
#include "move.h"
#include "utils.h"
#include <sstream>
#include <fstream>
#include <iostream>
```

7.37.1 Detailed Description

Contains definitions of functions declared in polyglot.h.

Author

Michael Lee

Date

1/9/2019

7.38 /home/michael/Documents/Projects/C++/Chess-Engine/src/pvtable.cc File Reference

Contains definitions of functions declared in pvtable.h.

```
#include "pvtable.h"
#include "defs.h"
#include "board.h"
#include "movemaker.h"
#include "utils.h"
#include "eval.h"
#include <utility>
```

7.38.1 Detailed Description

Contains definitions of functions declared in pvtable.h.

Author

Michael Lee

Date

1/9/2019

7.39 /home/michael/Documents/Projects/C++/Chess-Engine/src/search.cc File Reference

Contains definitions of functions declared in search.h.

```
#include "search.h"
#include "stopwatch.h"
#include "movelist.h"
#include "utils.h"
#include "searchinfo.h"
#include "engine.h"
#include "movemaker.h"
#include "io.h"
#include <sstream>
#include <iostream>
#include <cstdio>
```

7.39.1 Detailed Description

Contains definitions of functions declared in search.h.

Author

Michael Lee

Date

1/9/2019

7.40 /home/michael/Documents/Projects/C++/Chess-Engine/src/stopwatch.cc File Reference

Contains definitions of functions declared in stopwatch.h.

```
#include "stopwatch.h"
```

7.40.1 Detailed Description

Contains definitions of functions declared in stopwatch.h.

Author

Michael Lee

Date

1/9/2019

7.41 /home/michael/Documents/Projects/C++/Chess-Engine/src/tester.cc File Reference

Contains definitions of functions declared in tester.h.

```
#include "defs.h"
#include "tester.h"
#include "io.h"
#include "movelist.h"
#include "movemaker.h"
#include "move.h"
#include <fstream>
#include <iostream>
#include <sstream>
```

7.41.1 Detailed Description

Contains definitions of functions declared in tester.h.

Author

Michael Lee

Date

1/9/2019

7.42 /home/michael/Documents/Projects/C++/Chess-Engine/src/uci.cc File Reference

Contains definitions of functions declared in uci.h.

```
#include "uci.h"
#include "defs.h"
#include "io.h"
#include "move.h"
#include "utils.h"
#include "stopwatch.h"
#include "engine.h"
#include <iostream>
#include <sstream>
```

7.42.1 Detailed Description

Contains definitions of functions declared in uci.h.

Author

Michael Lee

Date

1/9/2019

7.43 /home/michael/Documents/Projects/C++/Chess-Engine/src/utils.cc File Reference

Contains definitions of functions declared in utils.h.

```
#include "utils.h"
#include "defs.h"
#include "io.h"
#include "movelist.h"
#include "movemaker.h"
#include <unistd.h>
#include <random>
#include <sstream>
#include <iostream>
#include <string>
#include <algorithm>
#include <cstring>
#include "sys/time.h"
#include "sys/select.h"
#include "string.h"
```

Functions

- bool sqOnBoard (uint32_t sq) noexcept

  Checks if a square number in array-120 form is on the array-64 board representation.
- int **fileRankToSq** (int file, int rank) noexcept
- bool **isPiece** (int piece) noexcept
- std::string sqToString (const int sq) noexcept

  Returns the string representation of the square.
- uint64_t randU64 () noexcept

  Generates a uniformally-distributed random 64-bit number.
- void showAttackedSqs (const int side, Board &pos) noexcept

  Prints the 8x8 board with numbers indicating how many times each square is attacked by the provided side.
- void stringToLower (std::string &str) noexcept

  Changes the given string to lowercase.
- int InputWaiting ()

  Checks if the GUI interface has sent an interrrupt.
- void ReadInput (SearchInfo &info)

  Reads in the GUI signal from stdin.

7.43.1 Detailed Description

Contains definitions of functions declared in utils.h.

Author

Michael Lee

Date

1/9/2019

7.43.2 Function Documentation

7.43.2.1 InputWaiting()

```
int InputWaiting ( )
```

Checks if the GUI interface has sent an interrrupt.

Parameters

None	

Returns

true if there was a GUI interrupt, false otherwise.

Definition at line 91 of file utils.cc.

7.43.2.2 randU64()

```
uint64_t randU64 ( )  [noexcept]
```

Generates a uniformally-distributed random 64-bit number.

Parameters

None	

Returns

A random 64 bit number

Definition at line 54 of file utils.cc.

7.43.2.3 ReadInput()

```
void ReadInput (
            SearchInfo & info )
```

Reads in the GUI signal from stdin.

Parameters

info	The engine's searchInfo instance

Returns

None

Definition at line 125 of file utils.cc.

7.43.2.4 showAttackedSqs()

```
void showAttackedSqs (
            const int side,
            Board & pos )  [noexcept]
```

Prints the 8x8 board with numbers indicating how many times each square is attacked by the provided side.

Parameters

side	The attacking side
pos	The board state

Returns

None

Definition at line 65 of file utils.cc.

7.43.2.5 sqOnBoard()

```
bool sqOnBoard (
            uint32_t sq )  [noexcept]
```

Checks if a square number in array-120 form is on the array-64 board representation.

Parameters

sq	The square number in array-120 form.

Returns

true if the square is on the array-64 board, false otherwise.

Definition at line 29 of file utils.cc.

7.43.2.6 sqToString()

```
std::string sqToString (
            const int sq )  [noexcept]
```

Returns the string representation of the square.

Parameters

sq	A square in array-120 form.

Returns

The string representation of the square (e.g "A1").

Definition at line 45 of file utils.cc.

7.43.2.7 stringToLower()

```
void stringToLower (
            std::string & str )  [noexcept]
```

Changes the given string to lowercase.

Parameters

str	the string to change to lower.

Returns

None

Definition at line 84 of file utils.cc.

7.44 /home/michael/Documents/Projects/C++/Chess-Engine/src/xboard.cc File Reference

Contains definitions of functions declared in xboard.h.

```
#include "xboard.h"
#include "io.h"
#include "stopwatch.h"
#include <iostream>
#include <sstream>
#include <cstdio>
#include "searchinfo.h"
```

7.44.1 Detailed Description

Contains definitions of functions declared in xboard.h.

Author

Michael Lee

Date

1/9/2019

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