GOMOKU GAME

Efficient Game Decision Making Using Minimax and Alpha-Beta Pruning

كلية الهندسة بشبرا
FACULTY OF ENGINEERING AT SHOUBRA

SUPERVISOR: DR. MOHAMED HUSSIEN

✨BY: THE LUMINARIES

GAME DESCRIPTION

- GOMOKU IS A CLASSIC TWO-PLAYER STRATEGY BOARD GAME PLAYED ON A GRID, WHERE PLAYERS TAKE TURNS PLACING THEIR PIECES (USUALLY X AND O) AIMING TO BE THE FIRST TO FORM AN UNBROKEN LINE OF FIVE CONSECUTIVE MARKS HORIZONTALLY, VERTICALLY, OR DIAGONALLY. IT IS SIMPLE IN RULES BUT DEEP IN STRATEGY, MAKING IT A POPULAR GAME FOR DEMONSTRATING ARTIFICIAL INTELLIGENCE TECHNIQUES.

PROBLEM FORMULATION

- **INITIAL STATE:** AN EMPTY 10×10 BOARD.
- **PLAYERS:** HUMAN VS COMPUTER (OR COMPUTER VS COMPUTER).
- **ACTION:** PLACING A PIECE (X OR O) IN AN EMPTY CELL.
- **RESULT:** A NEW BOARD STATE WITH THE MOVE APPLIED.
- **TERMINAL TEST:** TRUE IF A PLAYER HAS FORMED FIVE IN A ROW OR IF THE BOARD IS FULL; FALSE OTHERWISE.
- **EVALUATION FUNCTION:** ESTIMATES SCORE BASED ON OPEN SEQUENCES OF 2, 3, OR 4 CONSECUTIVE PIECES, FAVORING POTENTIAL LINES AND BLOCKING OPPONENT THREATS.
- **AI TECHNIQUE:** MINIMAX ALGORITHM WITH ALPHA-BETA PRUNING (CUTOFF AT A DEFINED DEPTH).

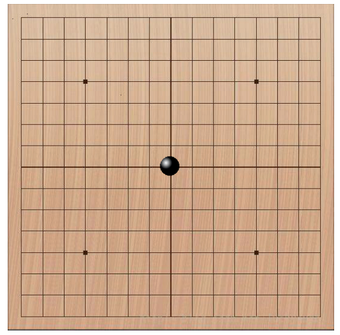
ALGORITHMIC APPROACH

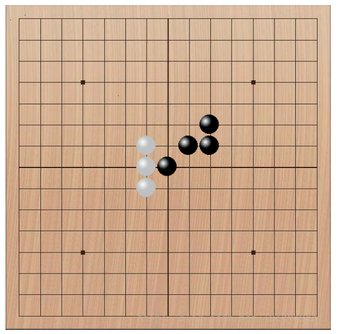
- **MINIMAX ALGORITHM:** EXPLORES POSSIBLE MOVES ASSUMING BOTH PLAYERS PLAY OPTIMALLY.
- **ALPHA-BETA PRUNING:** REDUCES THE NUMBER OF NODES EVALUATED BY PRUNING UNPROMISING BRANCHES.
- **TRANSPOSITION TABLE:** STORES PREVIOUSLY EVALUATED BOARD STATES TO AVOID REDUNDANT COMPUTATION.
- **ZOBRIST HASHING:** GENERATES FAST, UNIQUE KEYS FOR BOARD STATES USED IN CACHING.
- **HEURISTIC EVALUATION:** SCORES BOARD POSITIONS BASED ON OPEN LINES OF 2–4 MARKS TO GUIDE DECISION-MAKING.

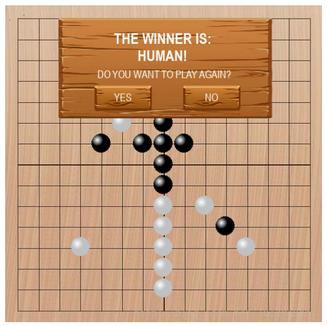
ALGORITHMIC APPROACH

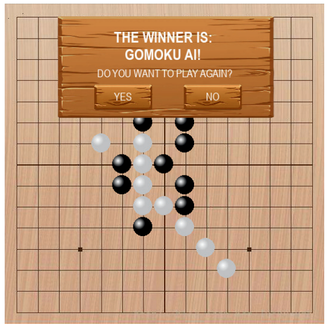
- **GOAL:** DEVELOP A HIGH-PERFORMANCE GOMOKU AI THAT AUTOMATICALLY COMPUTES WINNING MOVES USING OPTIMIZED SEARCH ALGORITHMS.
- **OPTIMAL PLAY:** ENSURE THE AI SELECTS THE SHORTEST PATH TO VICTORY OR A FORCED DRAW.
- **EFFICIENCY:** ACHIEVE REAL-TIME DECISION-MAKING THROUGH ALGORITHMIC OPTIMIZATIONS.

GRAPHICAL INTERFACE









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