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Finish in Five Summer Grant Research Project: Artificial Intelligence in Games

Department of Computer Science
College of Science and Mathematics
California State University, Fresno

Ivan Gonzales (Computer Science major)
Supervisor: Hubert Cecotti

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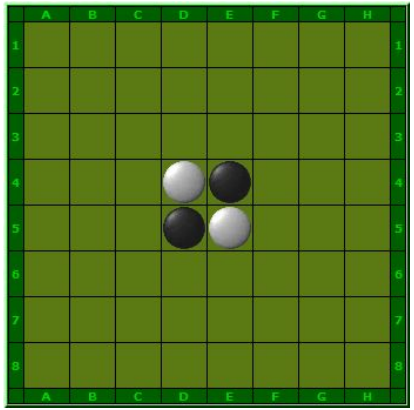
Introduction & background

- **AI in video games**
  - Non-Player-Character Behavior
    - AI controls non-player characters that provide engaging interactions.
  - Enemy AI
    - Enemy AI can adapt to player strategies, take cover, flank, and coordinate attacks for intense and different gameplay.
- **AI in board games**
  - Chess
    - IBM's Deep Blue made headlines by defeating world chess champion Garry Kasparov in 1997.
  - Checkers
    - Chinook, an AI program, solved checkers, proving that with perfect play, the game would always end in a draw.

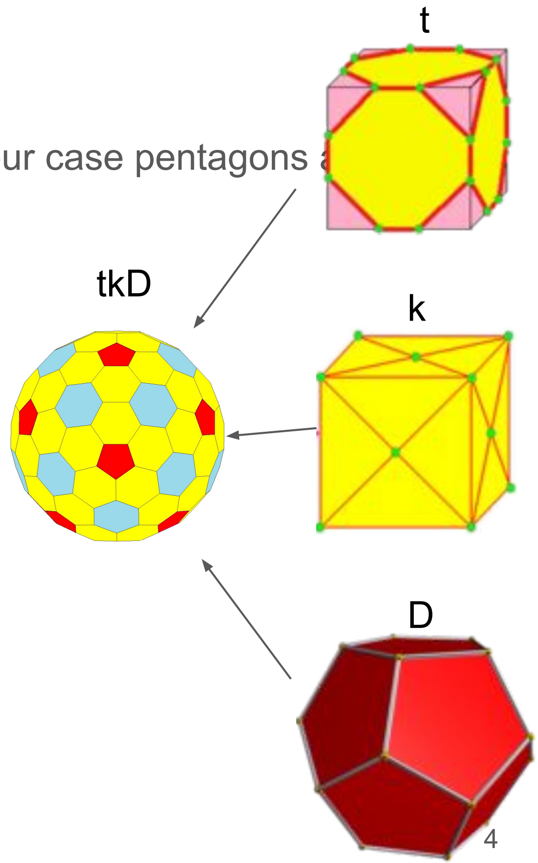
Othello and Reversi

- **Goal of Reversi and Othello**
  - Goal in both games is to have the majority of your pawns on the board by the end of the game.
- **The board: A Square**
  - The game is played on an 8x8 square grid.
    - 36 cells with 8 neighbors (up/down/left/right/2 diagonals)
    - 4 cells with 3 neighbors.
    - 24 with with 5 neighbors.
  - Each player starts with two pawns of their color.
- **Rules**
  - Reversi:
    - The game is over as soon as either player could not make a move.
  - Othello:
    - The player without a move simply passes. The other player makes as many moves as needed before the first player can make a move again. The game is over once neither player can make a move.



Hexa-versi

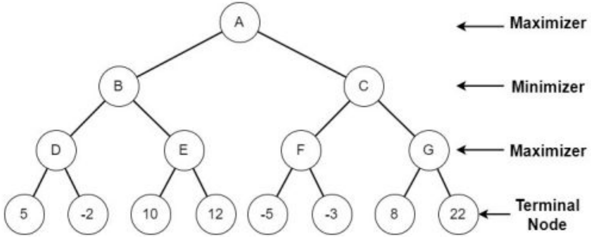
- **Proposal of the game**
  - A combination of Reversi and Othello, where players will place on tiles in our case pentagons a hexagons in a 3D world.
- **The board: The surface covering a sphere**
  - Based on the Goldberg polyhedron
    - Conway notation: tkD (t: truncate, k: kis, D: Dodecahedron)
      - Truncate cuts off the polyhedron but leaves part of its vertices .
      - Kis raises a pyramid on each face.
      - Dodecahedron is a 3-dimensional solid with 12 sides.
    - Number of faces: 92
      - 12 pentagons (5 neighbors)
      - 80 hexagons (6 neighbors)



AI algorithms and approach

Min-Max Algorithm

- Applications in two-player decision-making
- Depth of search
  - Levels into a tree and determine which decision will leave the AI with the highest score
- Works by minimizing the opponent's potential gains and maximizing its own gains.

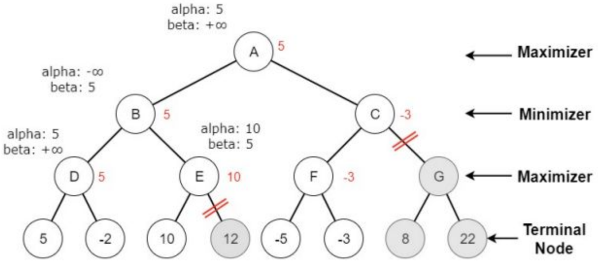


Heuristic approach

- A problem-solving strategy using practical rules, shortcuts, or educated guesses to find solutions quickly.
- Decision is NOT guaranteed to be optimal or accurate long term at low depth.
- Application in our game means the AI is beatable at a lower depth.
  - AI is looking for the most tiles to take in the current scenario.

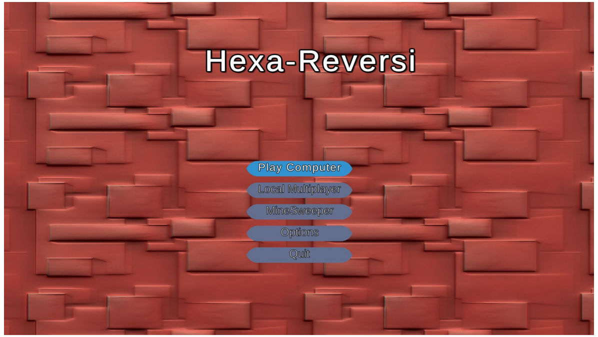
Alpha-beta Pruning Algorithm

- Optimized version of the Min-Max Algorithm
- Avoids evaluating branches of the game tree that are guaranteed to be worse than previously evaluated branches.
- The algorithm maintains two values at each node:
  - Alpha: the best value that the maximizer can currently achieve.
  - Beta: The best value that the minimizer can currently achieve.



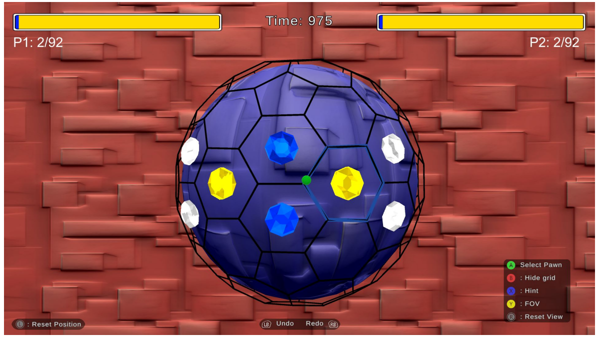
Implementation with the Unity game engine

Menu scene



- Direct control to different scenes (Options and Game scene).
- Rounded corners scripted for better aesthetics.
- Settings called to based off user selection of multiplayer or AI.

Game scene

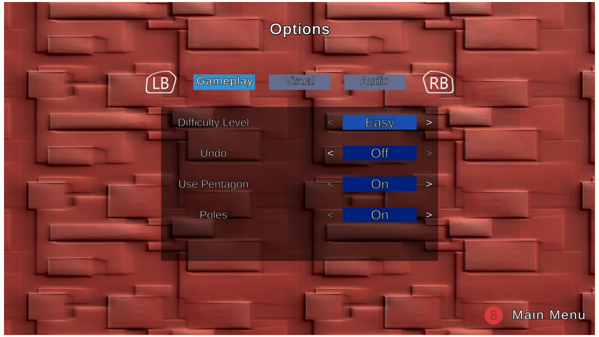

Time: 975

P1: 2/92

P2: 2/92

- Display a Goldberg Polyhedron.
- Status bars for player's knowledge of the score.
- Time limit for strategic planning.
- Collision detection of cursor and selected tile.

Option scene



Difficulty Level < Easy >

Undo < Off >

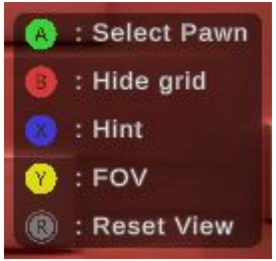
Use Pentagon < On >

Poles < On >

- Dynamically made options scene.
  - Lists of options and colors.
- Static variables to allow modifications across all scenes.
- UI additions so user understands how to navigate scenes.

Implementation with the Unity game engine (Cont.)

- **Controls: Usability and experience of the game**
    - **Right stick**
        - Controls the rotation of the sphere, clicking results in centering the cursor and sphere to the starting position.
    - **Left stick**
        - Controls the cursor to select tiles, clicking the left stick will result in the cursor centering on your screen for convenience.
    - **Buttons**
        - **A**: Selection of tile
        - **B**: Hide grid - Hide the polygon and hexagon outline.
        - **X**: Hint - Allow player to see the move that allows the most captured pieces.
        - **Y**: POV - Allows player to zoom in and out in regards to the sphere for custom visibility.
        - **RB**: Redo move - Allow the player to go forward in moves (Only if a redo was used before).
        - **LB**: Undo move - Allow the player to take back there move depending on the settings of the game.
- **Visual and auditory feedback**
    - Visual representation of selected tile, highlighting and showing tiles based on playable states.
    - Sound effects for maneuvering through option menu, clicking tiles, and clicking unselectable tiles.
    - Music for relaxed and enjoyable gameplay.



A : Select Pawn
B : Hide grid
X : Hint
Y : FOV
R : Reset View

Conclusion & Future works

- **Learning outcomes during the project**
  - Game development using the Unity framework
  - Software Engineering - Object Oriented Programing / Debugging
  - C# programming and data structures
  - Artificial Intelligence Algorithms
- **Future works**
  - Evaluation with human players
  - Evaluation with different types of AI
    - Depth of AI search algorithm
    - Statistical analysis of AI types, win/loss ratio.
  - Opening principles and strategies
  - Deployment on the Steam platform

Conclusion

- Acknowledgements
  - Thank you to the "Finish in Five" program for the opportunity and funding the research project.
  - Thank you to Professor Cecotti for the mentorship and guidance throughout the project

Questions?