Artificial Intelligence

Practical 9

19BCE248

AIM: Implement Alpha-beta pruning

Source Code:

```
import java.awt.Point;
import java.util.ArrayList;
import java.util.Scanner;


public class Prac9 {

 public static final int INFINITY = 99999;
 public static final int MAX_TRAVERSAL_DEPTH = 6;
 Scanner scanner = new Scanner(System.in);

 int getIntInput()
 {
 int i = -1;
 try{
 i = scanner.nextInt();
 scanner.nextLine();
 }catch(Exception e){
 scanner.nextLine();
 }

 return i;
 }

 void clear()
 {
 for(int i = 0; i<25; i++)
 System.out.println();
 }

 public Prac9(){
 while(true){
 startGame();
 scanner.nextLine();
 }
 }
```

```
void startGame()
{
Node root = new Node();
clear();

boolean playerMovesFirst = isPlayerMovingFirst(root);
if(playerMovesFirst)
{
root.nextPlayer = "O";
moveForPlayer(root);
}
else
{
root.nextPlayer = "X";
moveForBot(root);
}
}

boolean isPlayerMovingFirst(Node node)
{
printBoard(node);
String input = "";

do
{
System.out.println("Do you want to move first? [y/n] ['e' to exit]: ");
input = scanner.nextLine();

if(input.equalsIgnoreCase("e"))
System.exit(0);
}while(!input.equalsIgnoreCase("y") && !input.equalsIgnoreCase("n"));

if(input.equalsIgnoreCase("y"))
return true;

return false;
}

void moveForPlayer(Node node)
{
Node newNode = new Node();
ArrayList<Point> availableMoves = getAvailableMoves(node);
Point input = getInputFromPlayer(node, availableMoves);
newNode = getSuccessor(node, input);

printBoard(newNode);
System.out.println("Computer's turn, press enter to continue");
```

```
if(checkWin(newNode))
{
System.out.println("You Won! Press enter to play again");
}
else if(isLeafNode(newNode))
{
System.out.println("Draw Game! Press enter to play again");
}
else
{
scanner.nextLine();
moveForBot(newNode);
}
}

Point getInputFromPlayer(Node node, ArrayList<Point> availableMoves)
{
Point move = new Point();
do
{
int inputX, inputY;

do
{
System.out.print("Input X: [0-2]: ");
inputX = getIntInput();
}while(inputX < 0 || inputX > 2);

do
{
System.out.print("Input Y: [0-2]: ");
inputY = getIntInput();
}while(inputY < 0 || inputY > 2);

move.x = inputX;
move.y = inputY;

if(!isValidMove(move, availableMoves))
System.out.println("Your move is invalid!");

}while(!isValidMove(move, availableMoves));

return move;
}

boolean isLeafNode(Node node){
return checkWin(node) || getAvailableMoves(node).size() == 0;
```

```
 }

 boolean checkWin(Node node){
 return checkWinRow(node) || checkWinColumn(node) || checkWinDiagonal(node);
 }

 boolean checkWinRow(Node node){

 String[][] board = node.board;
 return (board[0][0] != null && board[0][0] == board[0][1] && board[0][1] ==
board[0][2]) ||
 (board[1][0] != null && board[1][0] == board[1][1] && board[1][1] ==
board[1][2]) ||
 (board[2][0] != null && board[2][0] == board[2][1] && board[2][1] ==
board[2][2]);
 }

 boolean checkWinColumn(Node node){

 String[][] board = node.board;
 return (board[0][0] != null && board[0][0] == board[1][0] && board[1][0] ==
board[2][0]) ||
 (board[0][1] != null && board[0][1] == board[1][1] && board[1][1] ==
board[2][1]) ||
 (board[0][2] != null && board[0][2] == board[1][2] && board[1][2] ==
board[2][2]);
 }

 boolean checkWinDiagonal(Node node){

 String[][] board = node.board;
 return (board[0][0] != null && board[0][0] == board[1][1] && board[1][1] ==
board[2][2]) ||
 (board[0][2] != null && board[0][2] == board[1][1] && board[1][1] ==
board[2][0]);
 }

 boolean isValidMove(Point move, ArrayList<Point> availableMoves)
 {
 for(int i = 0; i<availableMoves.size(); i++)
 {
 Point curr = availableMoves.get(i);
 if(move.x == curr.x && move.y == curr.y)
 return true;
 }
 return false;
 }
```

```
void moveForBot(Node node)
{
Node newNode = new Node();
newNode.board = node.board;
newNode.nextPlayer = "X";
newNode = nextMove(newNode);
printBoard(newNode);
System.out.println("Your turn, press enter to continue");

if(checkWin(newNode))
{
System.out.println("You lost! Press enter to play again");
}
else if(isLeafNode(newNode))
{
System.out.println("Draw Game! Press enter to play again");
}
else
{
scanner.nextLine();
moveForPlayer(newNode);
}
}

Node nextMove(Node node){
getMiniMaxAlphaBeta(node, getAlpha(node), getBeta(node));
Node newNode = getMaxNodeFromPossibleMoves();
possibleNextMoves.clear();
return newNode;
}

Node getMaxNodeFromPossibleMoves()
{
Node maxNode = possibleNextMoves.get(0);
for(int i = 0, l = possibleNextMoves.size(); i<l; i++)
{
if(maxNode.heuristicValue < possibleNextMoves.get(i).heuristicValue)
{
maxNode = possibleNextMoves.get(i);
}
}

return maxNode;
}

int getMiniMaxAlphaBeta(Node node, int alpha, int beta)
{
if(isLeafNode(node) || node.traversalDepth >= MAX_TRAVERSAL_DEPTH)
```

```
return miniMaxLeafNode(node);
else if(node.nextPlayer.equals("O"))
return minimaxAlphaBetaForMinimizer(node, alpha, beta);
else
return minimaxAlphaBetaForMaximizer(node, alpha, beta);
}

int minimaxAlphaBetaForMinimizer(Node node, int alpha, int beta)
{
ArrayList<Node> allSuccessors = getAllSuccessors(node);
for(int i = 0, l = allSuccessors.size(); i<l; i++)
{
Node s = allSuccessors.get(i);
int currMin = getMiniMaxAlphaBeta(s, alpha, beta);
beta = Math.min(beta, currMin);
node.heuristicValue = Math.min(node.heuristicValue, beta);
if(alpha >= beta)
break;
}

if(possibleNextMoves(node) != null)
possibleNextMoves.add(node);

return beta;
}

int minimaxAlphaBetaForMaximizer(Node node, int alpha, int beta)
{
ArrayList<Node> allSuccessors = getAllSuccessors(node);
for(int i = 0, l = allSuccessors.size(); i<l; i++)
{
Node s = allSuccessors.get(i);
int currMax = getMiniMaxAlphaBeta(s, alpha, beta);
alpha = Math.max(alpha, currMax);
node.heuristicValue = Math.max(node.heuristicValue, alpha);
if(alpha >= beta)
break;
}

if(possibleNextMoves(node) != null)
possibleNextMoves.add(node);

return alpha;
}

int getAlpha(Node node)
{
if(isLeafNode(node))
```

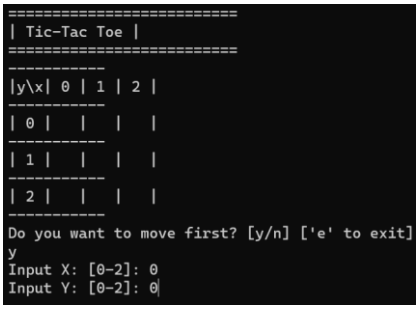
```
return evaluateHeuristicValue(node);

return -INFINITY;
}

int getBeta(Node node)
{
if(isLeafNode(node))
return evaluateHeuristicValue(node);

return INFINITY;
}

ArrayList<Node> possibleNextMoves = new ArrayList<Node>();
int miniMaxLeafNode(Node node)
{
if(possibleNextMoves(node) != null)
possibleNextMoves.add(node);

return evaluateHeuristicValue(node);
}

ArrayList<Node> getAllSuccessors(Node node)
{
ArrayList<Node> successors = new ArrayList<Node>();
ArrayList<Point> availableMoves = getAvailableMoves(node);

for(int i = 0, l = availableMoves.size(); i<l; i++)
{
successors.add(getSuccessor(node, availableMoves.get(i)));
}
return successors;
}

Node possibleNextMoves(Node node){
if(node.atDepth == 1)
return node;
else
return null;
}

ArrayList<Point> getAvailableMoves(Node node)
{
ArrayList<Point> availableMoves = new ArrayList<Point>();
for(int i = 0; i<3; i++)
{
for(int j = 0; j<3; j++)
{
```

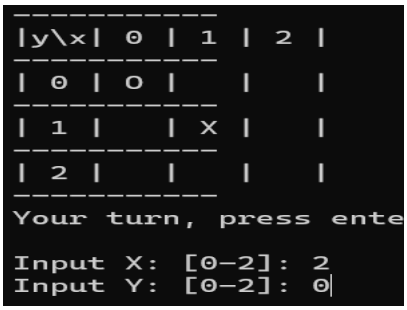
```
 if(node.board[i][j] == null)
 {
 availableMoves.add(new Point(j, i));
 }
 }
 }

 return availableMoves;
 }

 Node getSuccessor(Node node, Point p) {

 if(isLeafNode(node)) return null;

 return new Node(updateBoard(node, p), node, evaluateHeuristicValue(node),
node.atDepth+1, node.nextPlayer.equals("X") ? "O" : "X",
node.traversalDepth+1);
 }

 int evaluateHeuristicValue(Node node)
 {
 if(node.nextPlayer == "X" && this.checkWin(node)==true) return -1;
 if(node.nextPlayer == "O" && this.checkWin(node)==true) return 1;
 return 0;
 }

 String[][] updateBoard(Node node, Point p) {
 String[][] newBoard = copyBoard(node.board);
 newBoard[p.y][p.x] = node.nextPlayer;
 return newBoard;
 }

 String[][] copyBoard(String[][] aBoard) {
 int boardSize = aBoard.length;
 String[][] newBoard = new String[boardSize][boardSize];
 for(int row = 0; row < boardSize; row++) {
 for(int column = 0; column < boardSize; column++)
 newBoard[row][column] = aBoard[row][column];
 }
 return newBoard;
 }

 void printBoard(Node node){
 String board[][] = node.board;

 clear();
 System.out.println("=========================");
 System.out.println("| Tic-Tac Toe |");
```

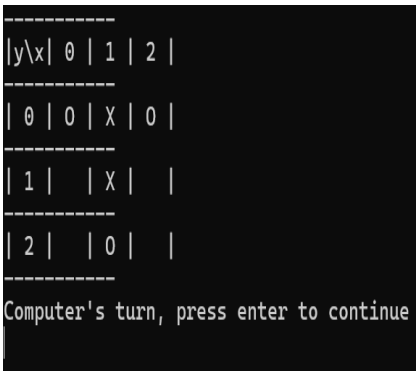
```
 System.out.println("=========================");

 System.out.println("-----------");
 System.out.println("|y\\x| 0 | 1 | 2 |");

 for(int i = 0; i<3; i++)
 {
 System.out.println("-----------");
 System.out.print("| " + i + " ");
 for(int j = 0; j<3; j++)
 {
 System.out.print("| ");
 if(board[i][j] != null)
 System.out.print(board[i][j]);
 else
 System.out.print(" ");
 System.out.print(" ");
 }
 System.out.println("|");
 }
 System.out.println("-----------");
 }

 public static void main(String[] args) {
 new Prac9();
 }
 public class Node {

 String[][] board;
 String nextPlayer;
 Node parent;
 int heuristicValue = 0;
 int atDepth = 0;
 int traversalDepth = 0;

 public Node(){
 board = new String[3][3];
 parent = null;
 }

 public Node(String[][] board, Node parent, int heuristicValue, int atDepth,
String nextPlayer, int traversalDepth){
 this.board = board;
 this.parent = parent;
 this.heuristicValue = heuristicValue;
 this.atDepth = atDepth;
 this.nextPlayer = nextPlayer;
 this.traversalDepth = traversalDepth;
```

```
 }
}
}
```

Output:


| Tic-Tac Toe |
y\x	0	1	2
0			
1			
2			
Do you want to move first? [y/n] ['e' to exit]
y
Input X: [0-2]: 0
Input Y: [0-2]: 0


y\x	0	1	2
0	O		
1		X	
2			
Your turn, press ente
Input X: [0-2]: 2
Input Y: [0-2]: 0


y\x	0	1	2
0	O	X	O
1		X	
2		O	
Computer's turn, press enter to continue


| Tic-Tac Toe |
y\x	0	1	2
0	O	X	O
1	X	X	O
2	O	O	X
Computer's turn, press enter to continue
Draw Game! Press enter to play again