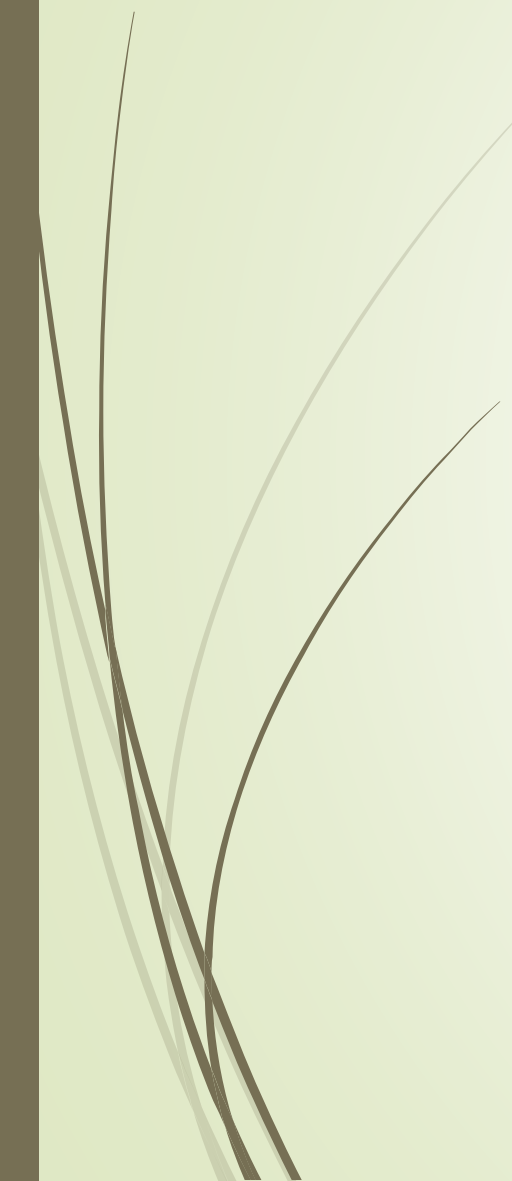# MiniMax

A game for two players

Types of Games

Game theory classifies games according to the number of players, the kinds of goal those players have, and the information each player has about the game.

Number of Players

The board games that inspired turn-based AI algorithms almost all have two players. Most of the popular algorithms are therefore limited to two players in their most basic form. They can be adapted for use with larger numbers, but it is rare to find descriptions of the algorithms for anything other than two players.

In addition, most of the optimizations for these algorithms assume that there are only two players. While the basic algorithms are adaptable, most of the optimizations can't be used as easily.

Plies, Moves and Turns

It is common in game theory to refer to one player's turn as a "ply" of the game. One round of all the players' turns is called a "move."

This originates in Chess, where one move consists of each player taking one turn. Because most turn-based AI is based on Chess-playing programs, the word "move" is often used in this context.

There are many more games, however, that treat each player's turn as a separate move, and this is the terminology normally used in turn-based strategy games. We uses the words "turn" and "move" interchangeably.

The Goal of the Game

In most strategy games the aim is to win. As a player, you win if all your opponents lose. This is known as a zero-sum game: your win is your opponent's loss. If you scored 1 point for winning, then it would be equivalent to scoring -1 for losing. This wouldn't be the case, for example, in a casino game, when you might all come out worse off.

The Goal of the Game

In a zero-sum game it doesn't matter if you try to win or if you try to make your oponent lose; the outcome is the same. For a non-zero-sum game, where you could all win or all lose, you'd want to focus on your own winning, rather than your opponent losing (unless you are very selfish, that is).

For games with more than two players, things are more complex. Even in a zero-sum game, the best strategy is not always to make each opponent lose. It may be better to gang up on the strongest opponent, benefiting the weaker opponents and hoping to pick them off later.

Information

In games like Chess, Draughts, Go, and … both players know everything there is to know about the state of the game. They know what the result of every move will be and what the options will be for the next move. They know all this from the start of the game.

This kind of game is called "perfect information." Although you don't know which move your opponent will choose to make, you have complete knowledge of every move your opponent could possibly make and the effects it would have.
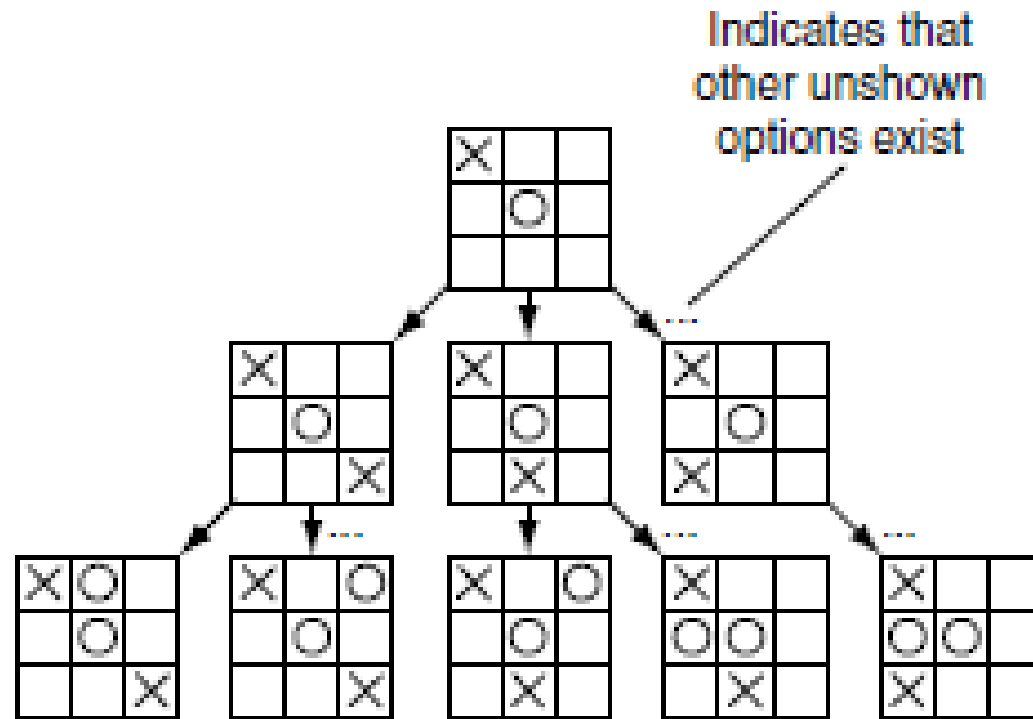
The Game Tree

Any turn-based game can be represented as a game tree. Figure shows part of the tree for a game of Tic-Tac-Toe. Each node in the tree represents a board position, and each branch represents one possible move. Moves lead from one board position to another.
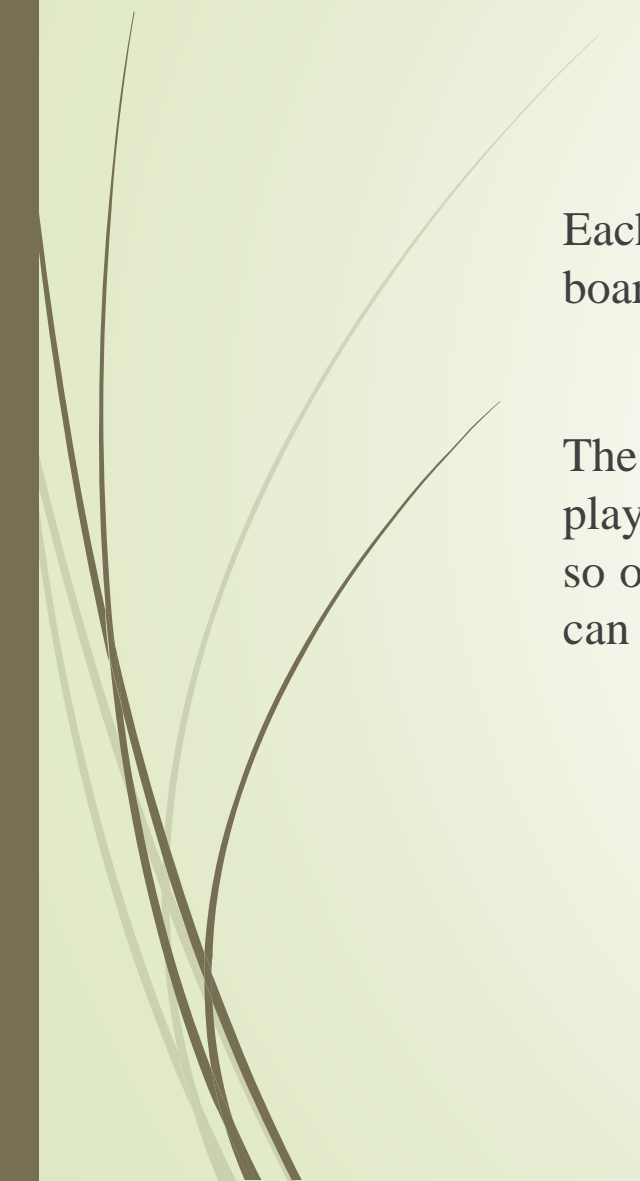
Tic-Tac-Toe

Indicates that other unshown options exist

Tic-Tac-Toe game tree

Tic-Tac-Toe

Each player gets to move at alternating levels of the tree. Because the game is turn based, the board only changes when one player makes a move.

The number of branches from each board is equal to the number of possible moves that the player can make. In Tic-Tac-Toe this number is nine on the first player's turn, then eight, and so on. In many games there can be hundreds or even thousands of possible moves each player can make.

Tic-Tac-Toe
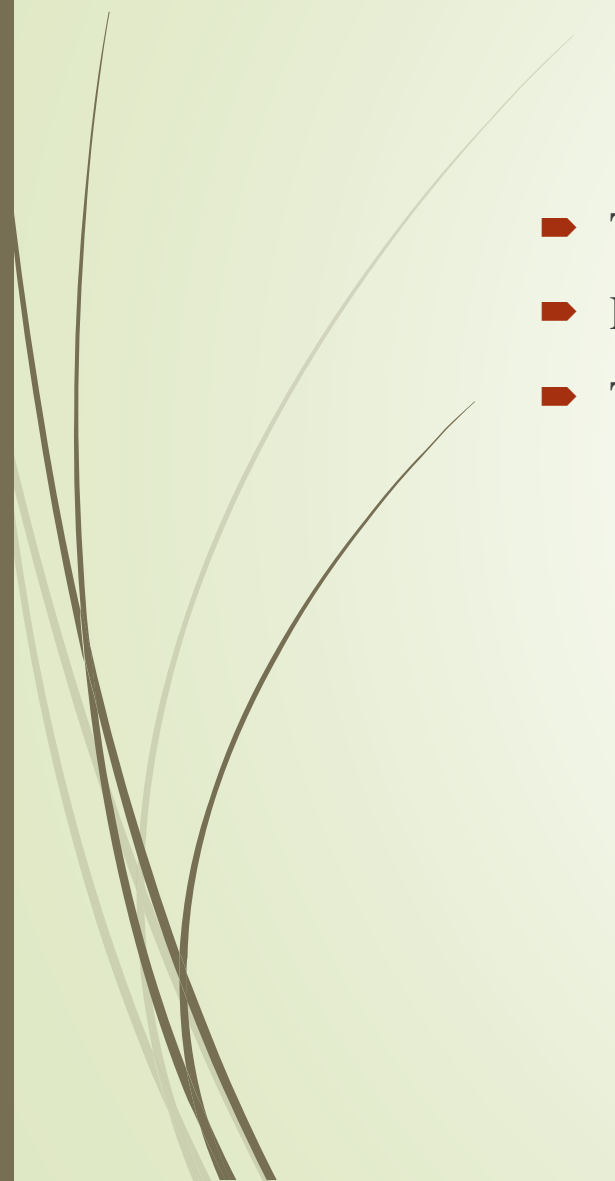
Some board positions don't have any possible moves. These are called *terminal positions*, and they represent the end of the game. For each terminal position, a final score is given to each player.

This can be as simple as +1 for a win and −1 for a loss, or it can reflect the size of the win.

Draws are also allowed, scoring 0. In a zero-sum game, the final scores for each player will add up to zero. In a non-zero-sum game, the scores will reflect the size of each player's personal win or loss.

"dots,, game

- There are two players
- Each player has their own dots' color
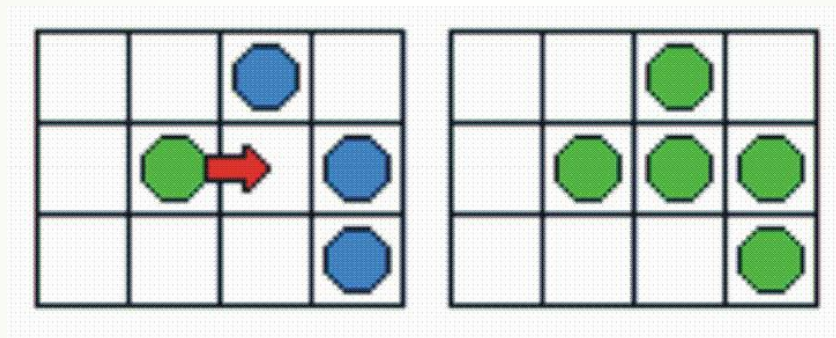- Two kinds moves are possible

"dots,, game
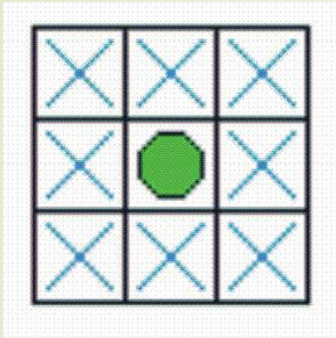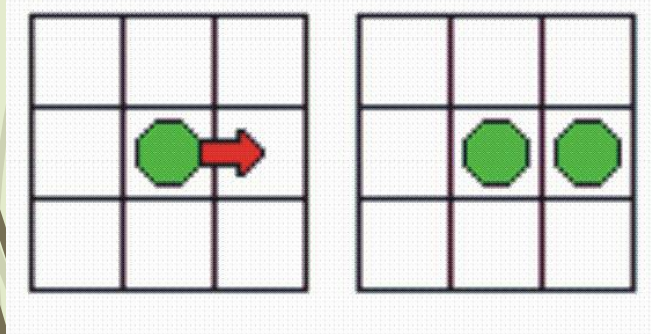
adding   jump
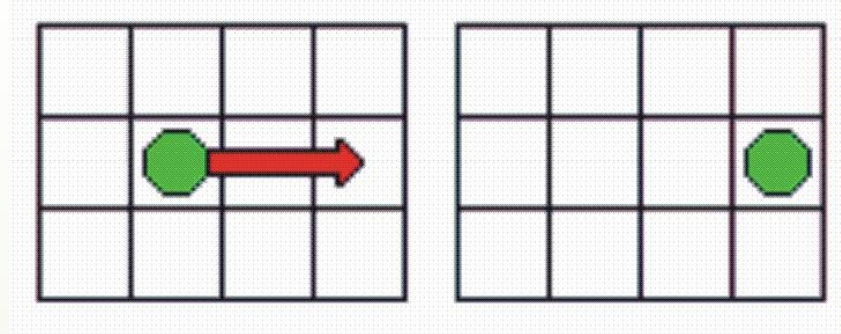
"dots,, game

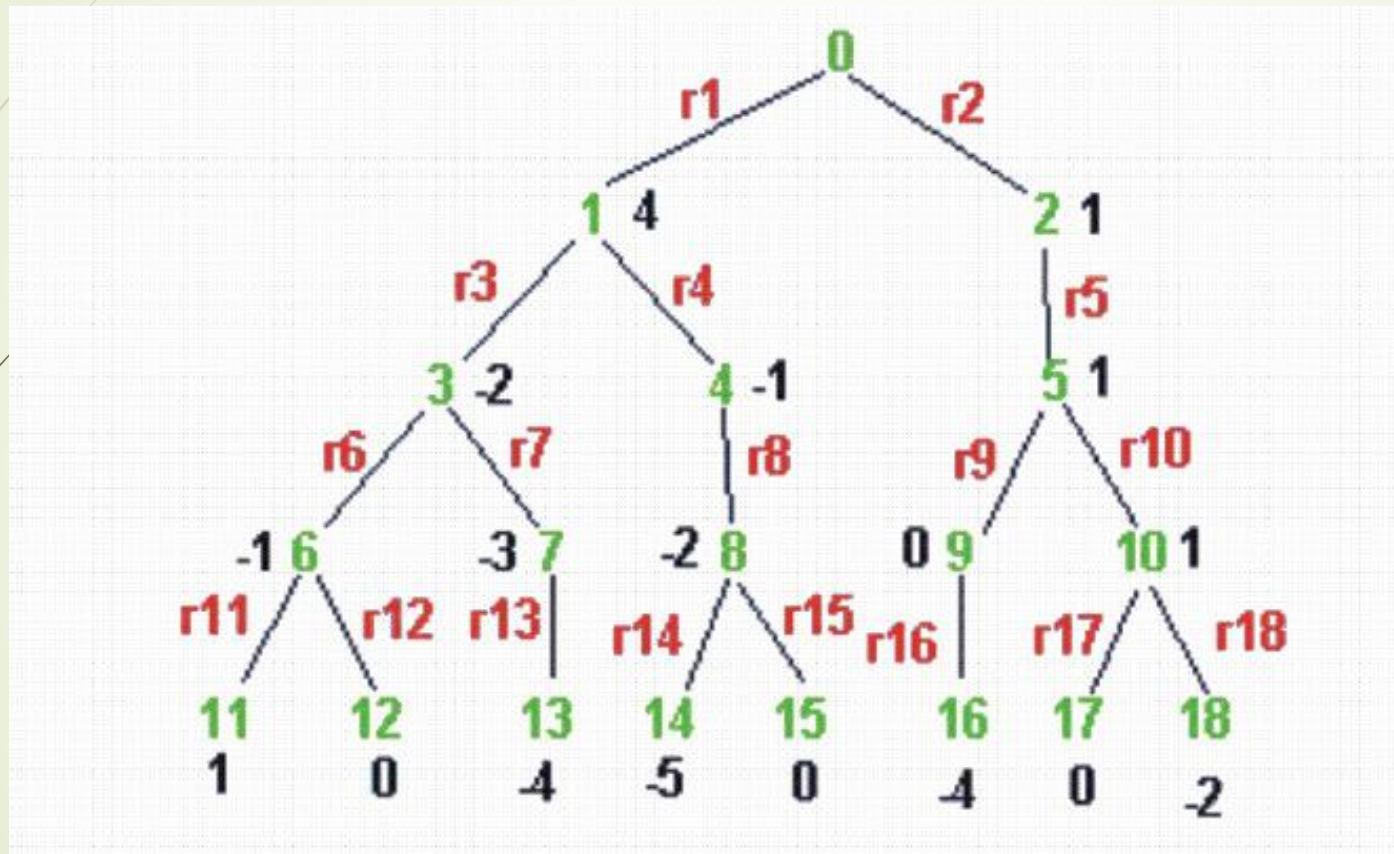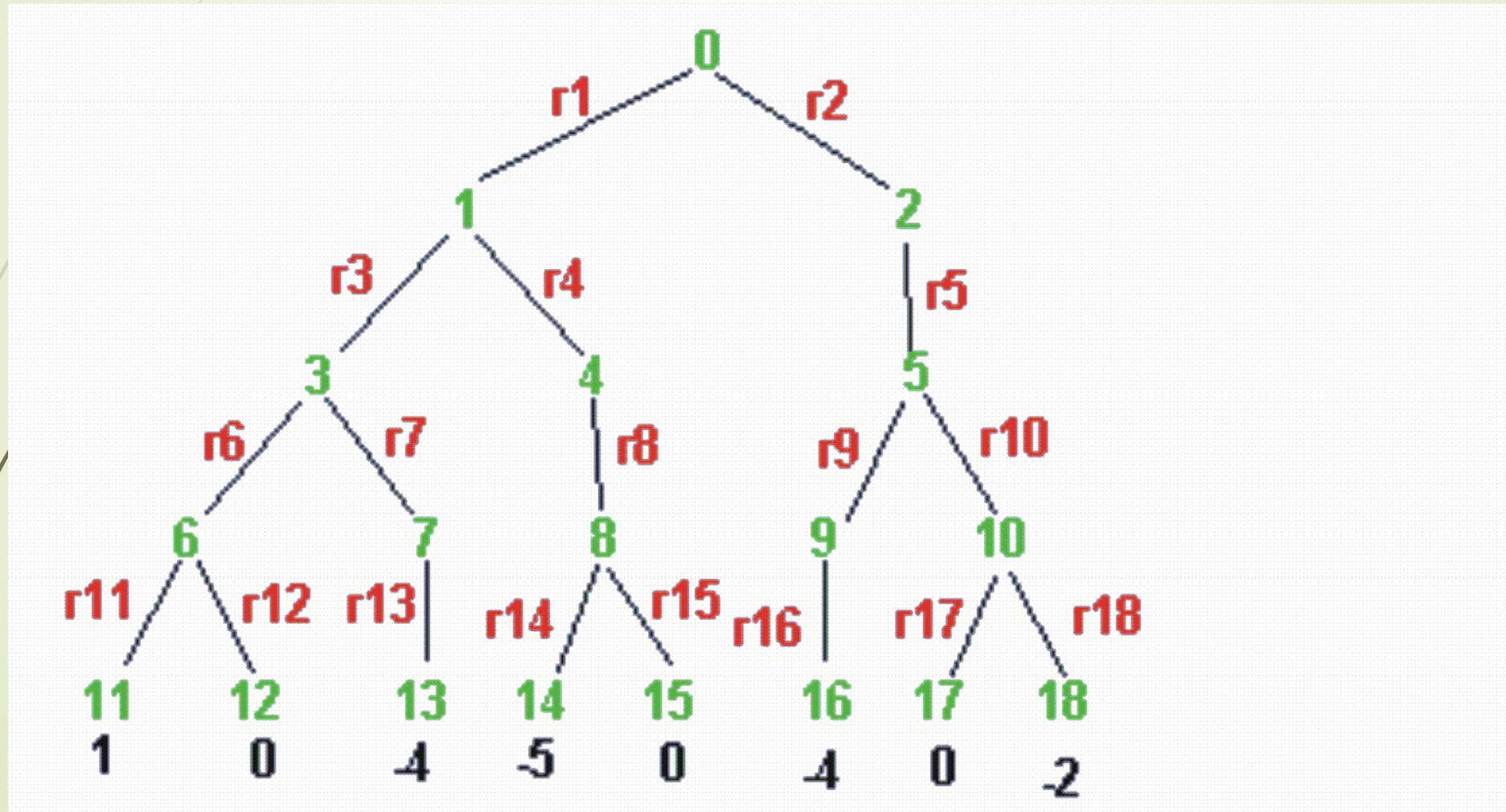If we put a dot, all adjacent dots become ours.

The number of dots Player A

-

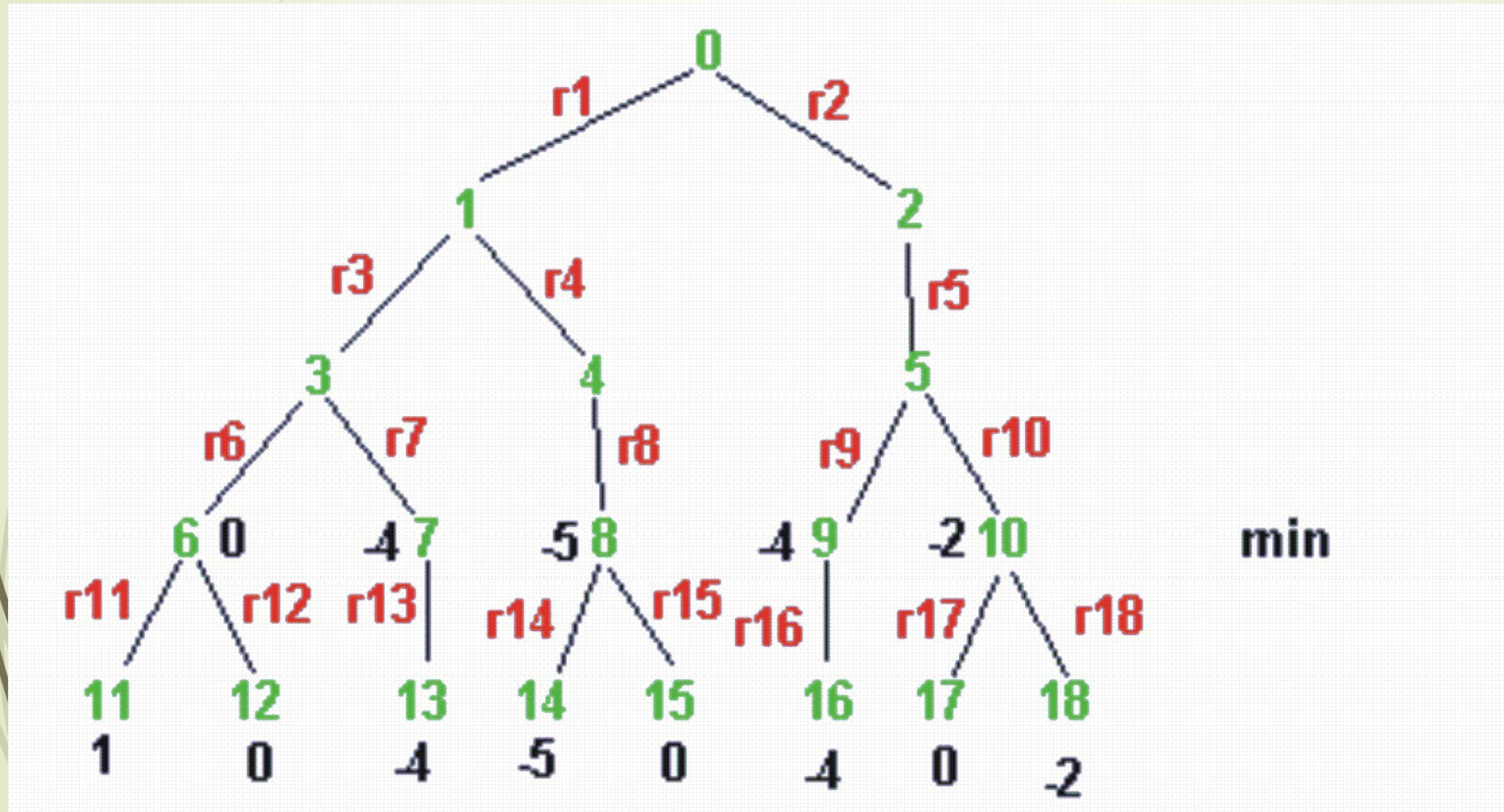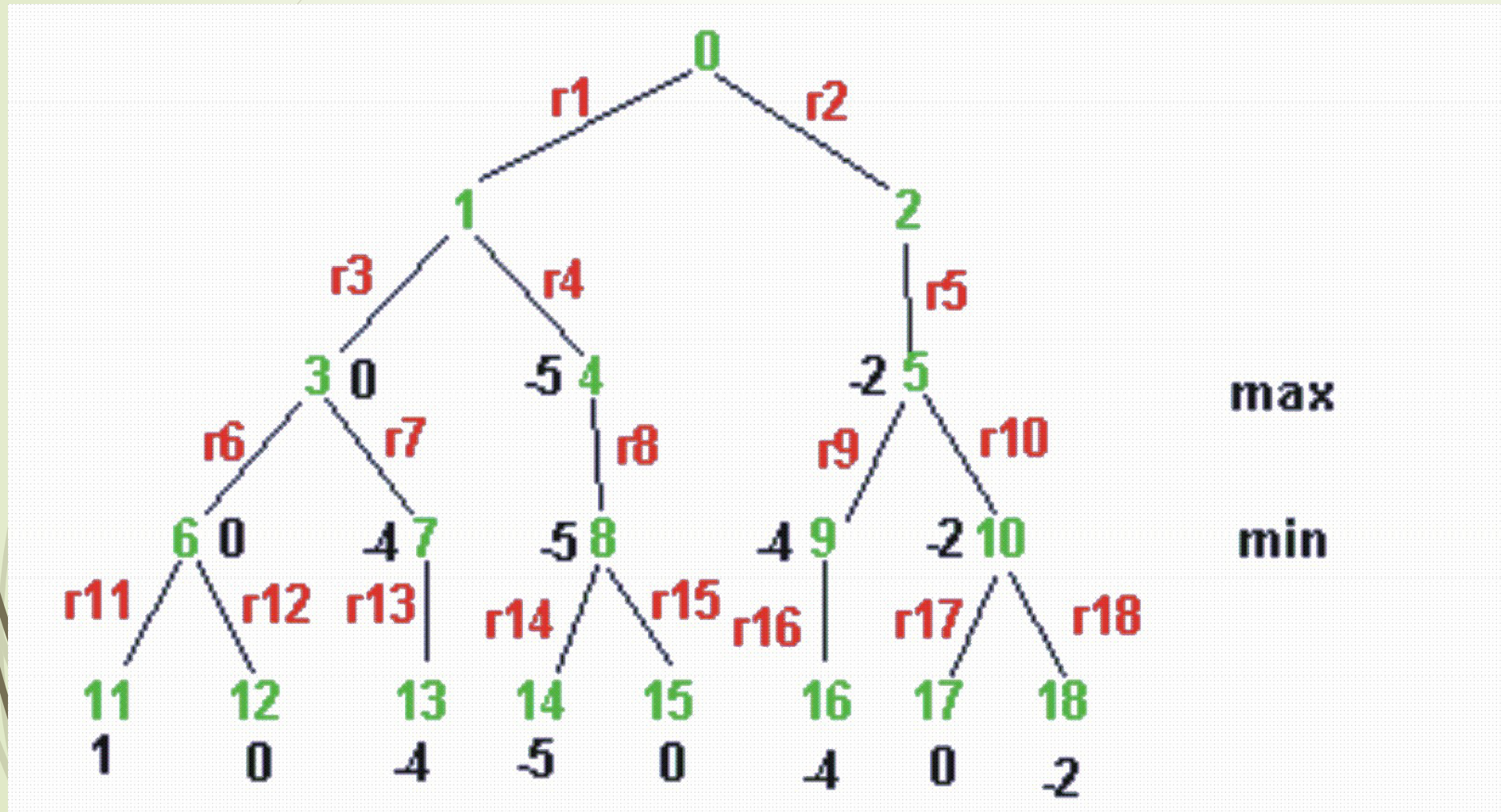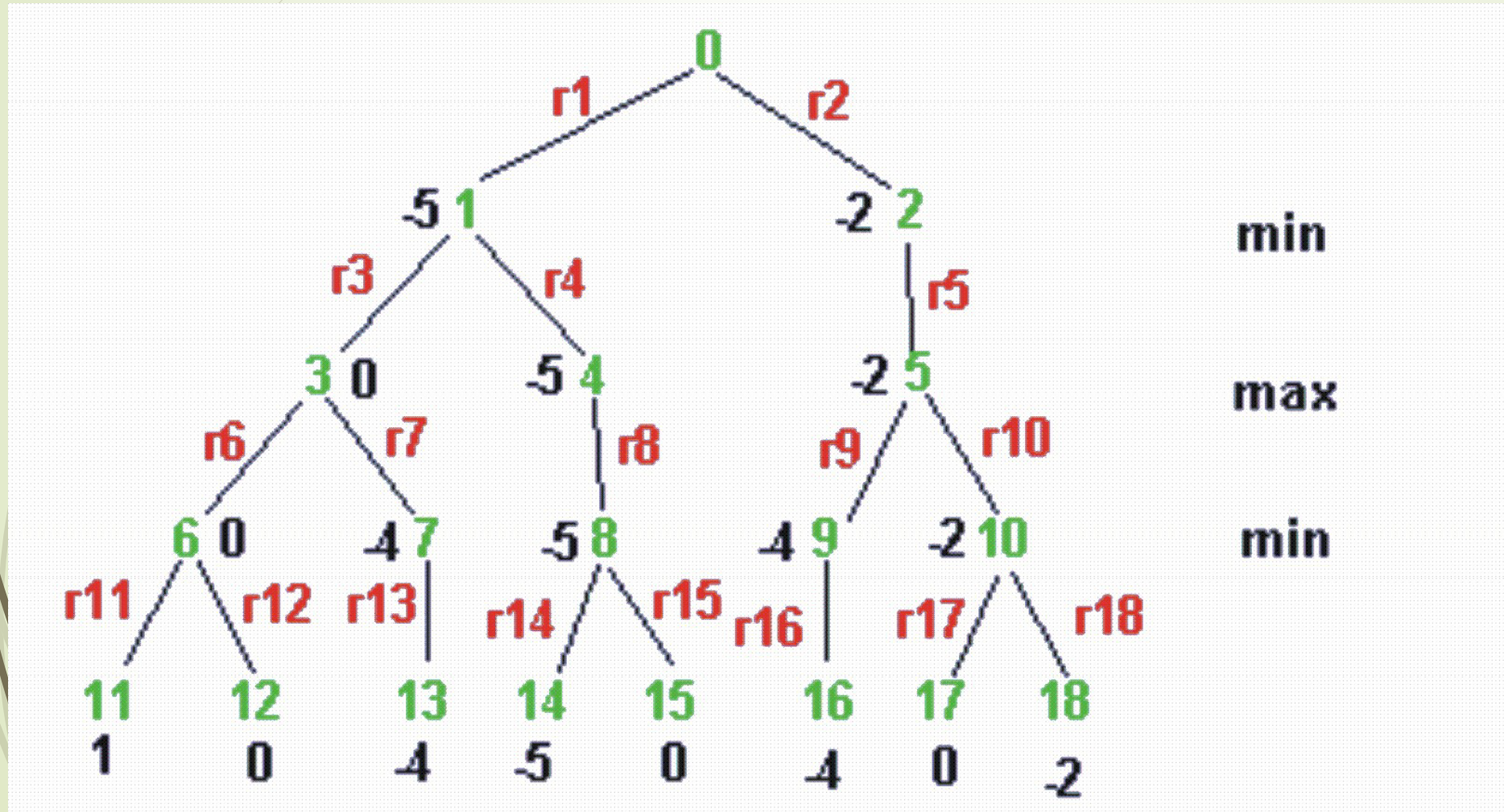# The number of dots Player B

Game tree

Game tree

Game tree

Game tree

Game tree

Game tree