Properties of minimax → Complete — Yes (If tree is finite)
Optimal — Yes against optimal opponent
Time Complexity — $O(b^m)$
Space Complexity — $O(bm)$

•— Adversarial Search

	deterministic	Chance
perfect information	Chess	monopoly
imperfect information	battleships	poker.

• Types of games → a) deterministic or → game outcomes depend on
   stochastic   players actions   or
   ↓   there is other Chance
   involves randomness.

b) one, two or
   more players

c) Zero Sum → One players win is equal to
              other player loss.

d) Perfect information → whether all players
                        can see entire state of game.

• Deterministic game

   States → game begins with specific state (S_0)
   players → 2 or more players mostly $(P = \{1 \cdots N\})$
   actions → depend upon player/state (A)
   transition function → how state changes when action is taken $(S \times A \to S)$
   terminal test → whether game is ended $(S \to \{t, f\})$
   terminal utilities → outcome values of each player $(S \times P \to R)$
   Solution → policy mapping from states (S) to actions (A)
              to guide each player moves. $(S \to A)$

• Zero - Sum Games   General games

a) Agents have opposite outcomes   Agents have independent outcomes

b) Single value that one   indifference, competition, cooperation
   maximizes & other minimizes   all are possible.

c) Adversial, pure competition.

~~Alpha Trees / Branching~~

Q. Why we do not use BFS in game playing?
Bcz It follow level by level.

→ Minimax Algorithm:
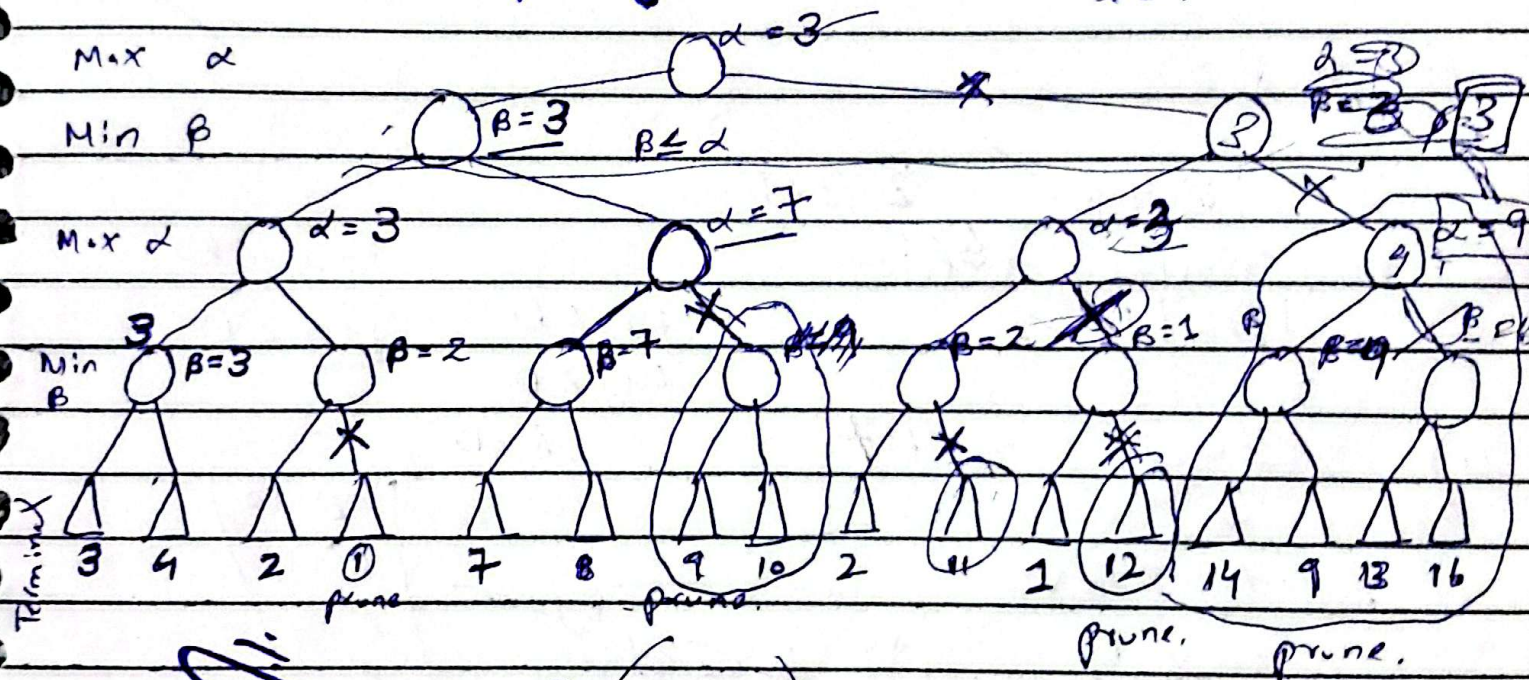
- Backtracking algorithm
- Best move
- Max will try to maximize its utility
- Min will try to minimize its utility
- 2 player zero-sum games

Max
Min
Max

Game tree
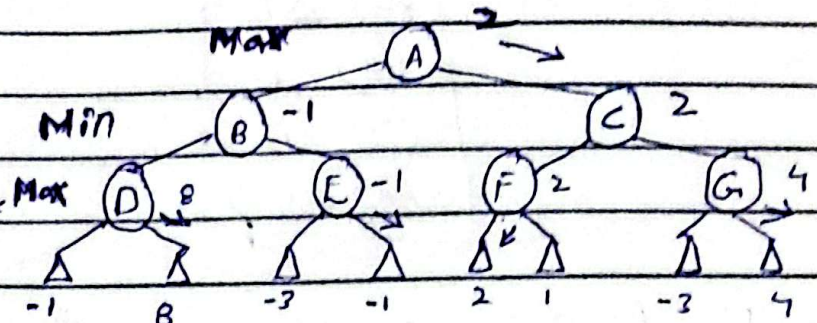
→ Alpha-Beta pruning (optimization technique)
$$\alpha \geq \beta$$

Max α
Min β

$\alpha = 3$

$\beta = 3$ $\beta \leq \alpha$

$\beta = 3$ $p = 3$ 3

Max α $\alpha = 3$ $\alpha = 7$ $\alpha = 3$ 4 $\alpha = 9$

Min β $\beta = 3$ $\beta = 2$ $\beta = 7$ $\beta = 2$ $\beta = 1$ $\beta = 9$

Terminal
3 4 2 ① 7 8 9 10 2 11 1 12 14 9 13 16
   prune   prune   prune   prune

$\alpha \geq \beta$ (prune)

$\beta \leq \alpha$ (prune)