Computer Simulation (2)
Game Playing

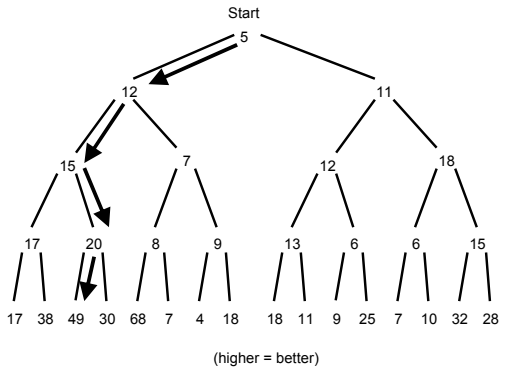
Different Types of Games

- How many players?
  - One
  - Two
- Element of chance?
  - Deterministic
  - Nondeterministic
- Outcome
  - Zero sum (what one player wins, the other loses)
  - Non-zero sum

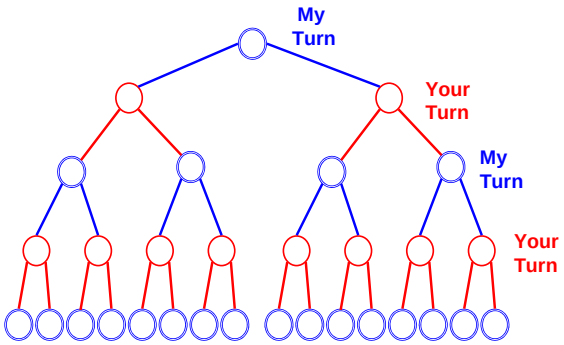
Different types of Games

	Deterministic	Nondeterministic
One Player	Tower of Hanoi	Solitaire
Two Player	Chess Tic-Tac-Toe Go	Backgammon Poker

Using hill climbing for one player games

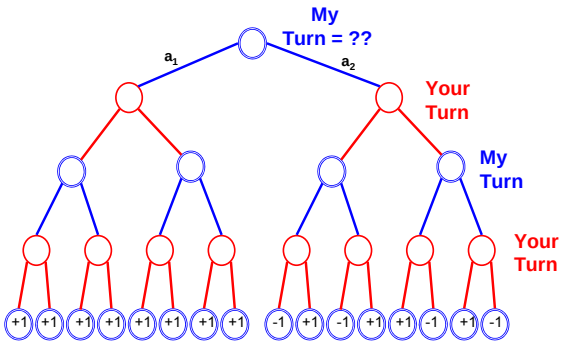


Game Tree for two person game



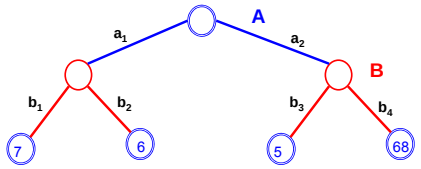
Game Tree

+1 = I win -1 = you win



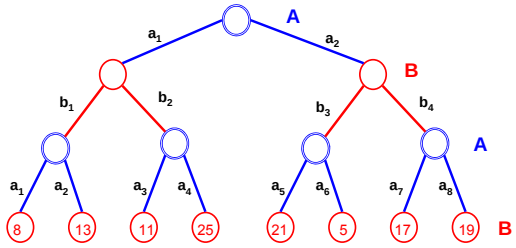
Perfect decisions with two player games

- Each player will make the best decisions possible:
  Player A: maximize score (higher scores better for A)
  Player B: minimize score (lower scores better for B)

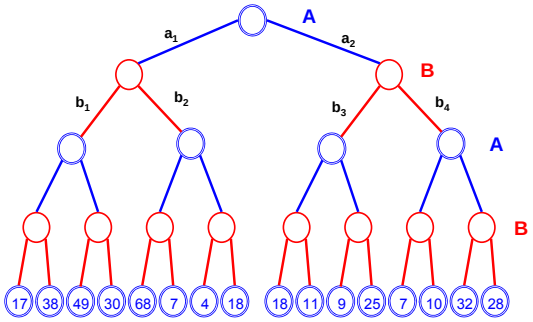


The Minimax Procedure

1) Work upwards, 2) B will always pick minimum, and 3) A will always pick maximum



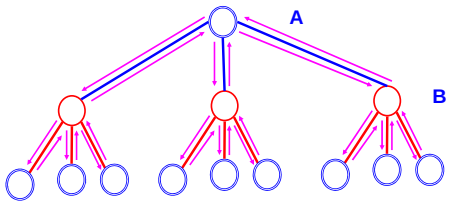
What does Minimax predict A will do?



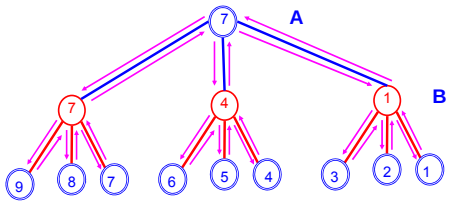
Fighting Combinatorial Explosion

- → limit branching factor
- → pruning the search tree

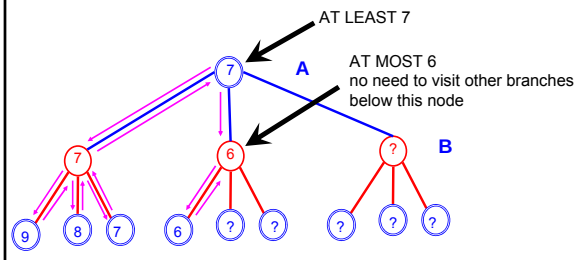
Depth-First Search



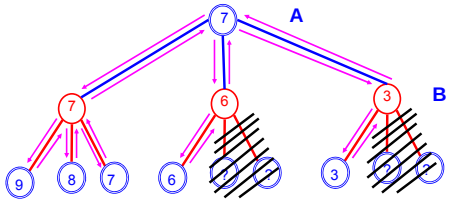
Depth-First Search & Minimax



Alpha-Beta Pruning



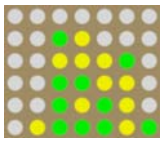
Alpha-Beta Pruning



Some states do not need to be searched!
The alpha-beta method cleverly eliminates large part of the search space

Perfect Play with Connect 4

- Play the game against the computer
  - http://www.farfarfar.com/games/connect_four/
  - http://www.pomakis.com/c4/
- Perfect play – the game of Connect 4 can be planned to the end
- the first player can force a win by starting in the middle column. Starting in the two adjacent columns allows the second player to reach a draw; starting with the border columns even allows the second player to force a win.
- Why play the game if the outcome is already known (assuming perfect play)?



(content copied from http://encyclopedia.thefreedictionary.com/Connect%20Four)

Complexity of Game Trees

- Most games cannot be planned to the end -> combinatorial explosion
- Number of states to search = $(N)^D$
  - Branching factor (N):
    number of legal moves at each position (on average)
  - Depth (D) = number of moves till the end

Branching factor

- Chess:
  Branching factor = about 35 moves/ positions
  Depth = about 100 moves total

  $(35)^{100} \approx (10)^{120}$ number of positions to search
- Intelligent Search: decrease the branching factor

  $(35)^2=1225$ $(35)^6=1,838,265,625$ vs.:
  $(5)^2=25$ $(5)^6=15,625$

Chess Computers

- 1997: IBM's Deep blue played world champion Gary Kasparov

  Deep blue: 250,000,000 positions/sec
  Kasparov: ?? positions/sec
- Brute force vs. Intelligent search

Comparing Brains & Computers

BRAINS	COMPUTERS
Neurons/organic	Silicon/ Metallic
Parallel computation	Serial Computation
Distributed Memory	Localized Memory
Unreliable parts	Reliable parts
Resistant to damage	Vulnerable
Not understood	Understood
Conscious/Intelligent	??

Ask Yourself

Do you consider your own mind to be a bunch of software programs?

Probably not!

Turing's challenge was this:

Can you really say what the difference is between the mind of a human being and the artificial 'mind' of a computer which simulates a human mind?

Turing Test

1.Interrogator
2.Human
3.Computer Program

Interrogator tries to determine who is the human and who is the Computer program

Loebner Prize

JUDGE: Is it April or May?
ENTRANT: Um. I believe it's April.
JUDGE: Why do you say that?
ENTRANT: That's a very good question. Because months and days and so on are arbitrary - I suppose.
JUDGE: It seems you are taking a certain tone with me. An agitated, human tone.
ENTRANT: Really? You are somewhat reticent yourself.
JUDGE: I never said you were reticent.
ENTRANT: I know.
JUDGE: Smug.
ENTRANT: Moi*?
JUDGE: I think you might be human.

Some clever programs

- Computer therapist ELIZA:
  - http://www-ai.ijs.si/eliza/eliza.html
  - http://www.manifestation.com/neurotoys/eliza.php3
- Modern chatter boxes:
  - http://cogsci.ucsd.edu/~asaygin/tt/ttest.html
  - http://www.abenteuermedien.de/jabberwock/
  - http://www.turinghub.com/turinghub.html
- Computer programs that learn: 20 Questions
  - http://y.20q.net:8095/btest