

# Introduction to Artificial Intelligence

**DA 221**

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# Adversarial Search

Given a state:

- MAX picks action  $a$  in  $\text{Actions}(s)$  that produces highest value of **min-value** ( $\text{Results}(s,a)$ )
- MIN picks action  $a$  in  $\text{Actions}(s)$  that produces lowest value of **max-value** ( $\text{Results}(s,a)$ )

Function **Max-value(state)**:

  If Terminal(state):

    Return Utility(s)

$v = -\text{inf}$

  For actions in Actions(state)

$v = \max(v, \text{Min-value}(\text{Result}(\text{state}, \text{action})))$

  Return  $v$

Function **Min-value(state)**:

  If Terminal(state):

    Return Utility(s)

$v = \text{inf}$

  For actions in Actions(state)

$v = \min(v, \text{Max-value}(\text{Result}(\text{state}, \text{action})))$

  Return  $v$

# Mechanical Turk Chess player


The Turk, also known as the Mechanical Turk or Automaton Chess Player was a fraudulent chess-playing machine constructed in the late 18th century.

From 1770 until its destruction by fire in 1854 it was exhibited by various owners as an automaton, though it was eventually revealed to be an elaborate hoax.

(see wikipedia)

**MAELZEL'S EXHIBITION,**  
*No. 29, St. James's Street.*

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**The Automaton**  **Chess Player**

Being returned from *Edinburgh* and *Liverpool*, where (giving the Pawn and Move) it baffled all Competition, in upwards of 200 Games, although opposed by ALL THE BEST PLAYERS.

**Was opened its Second Campaign,**  
WITH THE ADDITION OF THE  
**AUTOMATON TRUMPETER,**  
AND THE  
**Conflagration of Moscow,**

In which Mr. M. has endeavoured to combine the ARTS of DESIGN, MECHANISM, and MUSIC, so as produce, by a novel Imitation of Nature, a perfect Fac Simile of the real Scene. The View is from an elevated Station on the Fortress of the *Kremlin*, at the Moment when the Inhabitants are evacuating the Capital of the Cæars, and the Head of the French Columns commences its Entry. The gradual Progress of the Fire, the hurrying Bastle of the Fugitives, the Eagerness of the Invaders, and the Din of warlike Sounds, will tend to impress the Spectator with a true Idea of a Scene which baffles all Powers of Description.

—————  
The MORNING EXHIBITIONS begin at 1 and 3 o'Clock, and the EVENING EXHIBITION at 8 precisely, when GAMES will be played AGAINST ANY OPPONENT, to whom the double Advantage of A PAWN AND THE MOVE WILL BE GIVEN.

*Admission 2s.6d. Children 1s.6d. each.*

☞ Each Exhibition lasts One Hour. Should a Game not be finished in that Time, the Party will be at Liberty to take it down with a View to its being resumed at another Opportunity.

*Mr. M. begs leave to announce that the ONCHESTRATION, the AUTOMATON TRUMPETER, the CONFLAGRATION of Moscow, and the Patent for the МАТРОНОМКА, are to be disposed of.*

# Games and AI: Adversarial search

Fascination to outperform humans continues

- Chess
- Checkers
- Go
- Atari games
- and more

# Developments leading to beating human in Chess

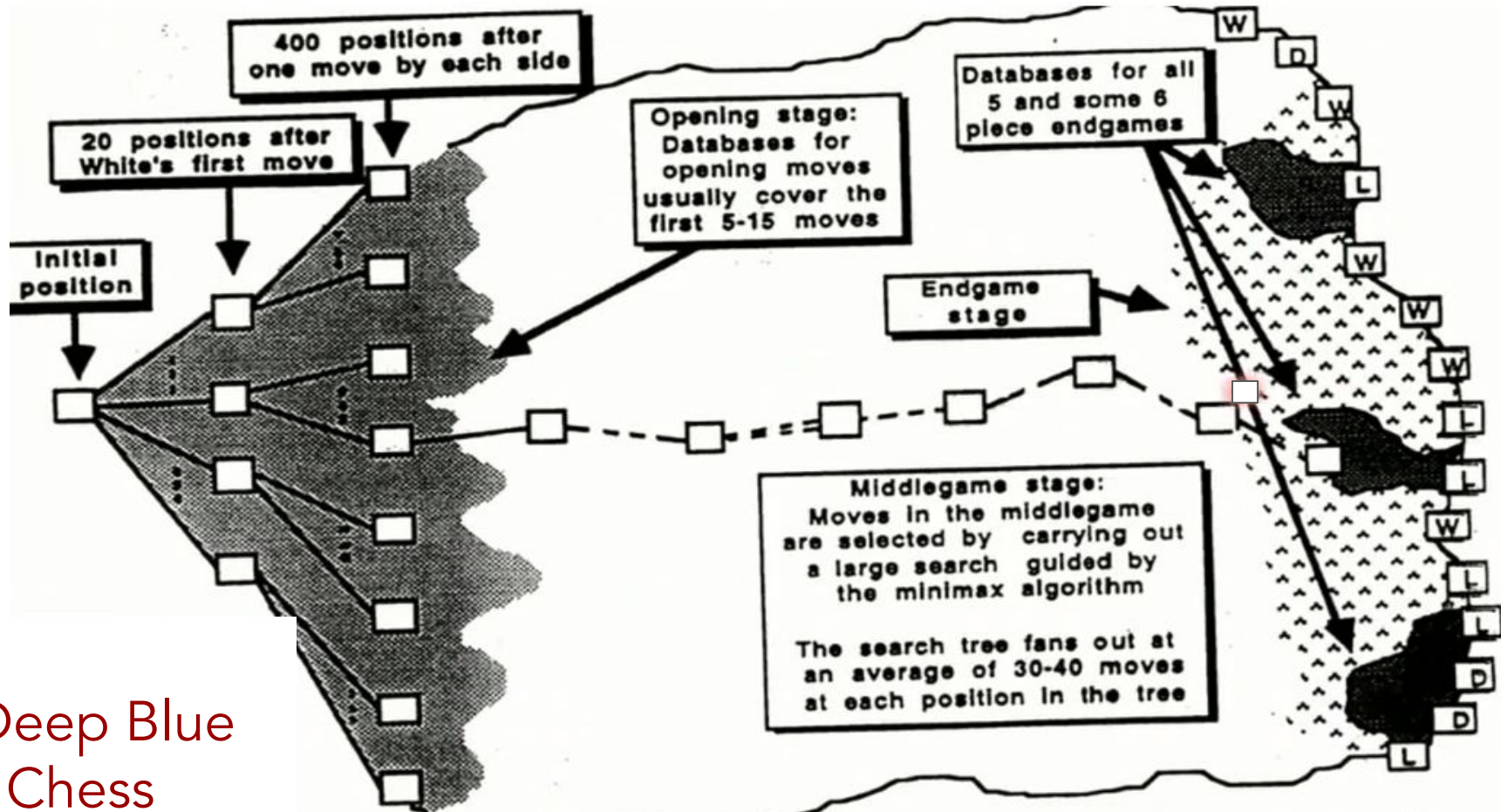
- Alpha-beta search (1966)
- Transposition tables
- Iterative deepening DFS
- Endgame databases, singular extensions
- Parallel search, evaluations

# Imperfect real-time decisions

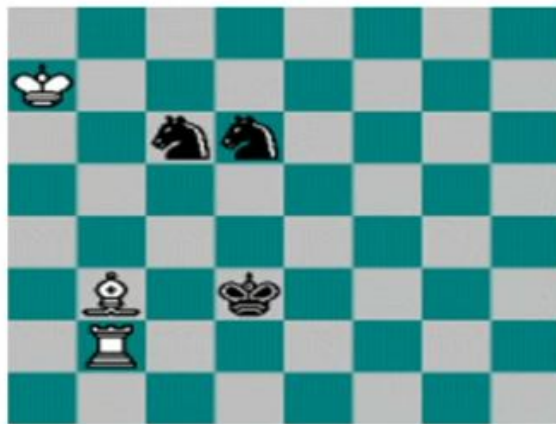
- Evaluation functions
- Cutting off search: horizon effect
- Forward pruning
- Search versus lookup: end game databases



# Deep Blue - Chess



## The MONSTER



White wins in 255 moves  
(Stiller, 1991)