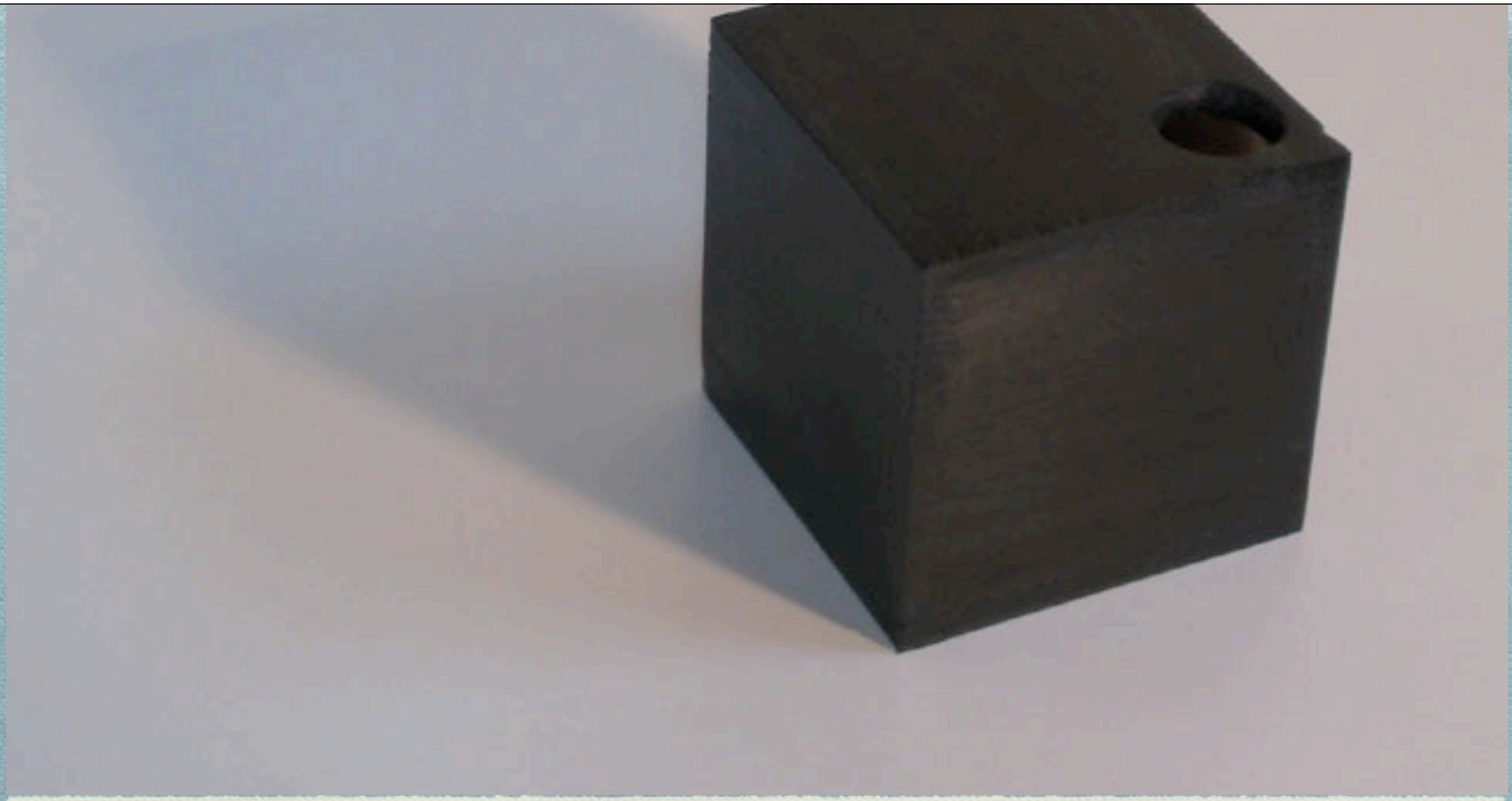


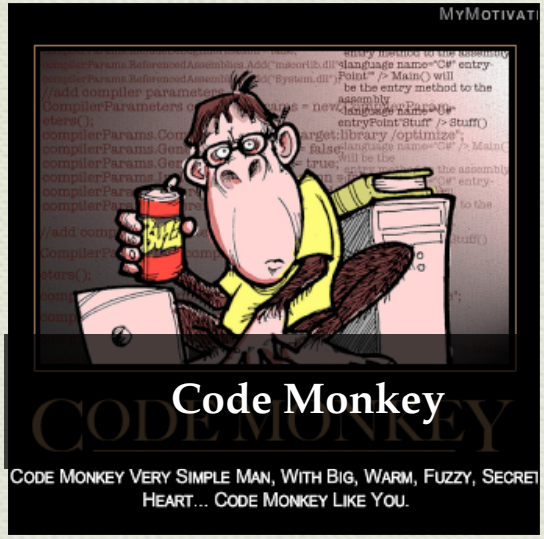
# Shallow Blue

by Commander Spock / Mr. Finney

# Chess AIs are tough

# … But we have a team! (and Red Bull)



# Creating a Chess AI is challenging

- The game itself has complicated rules and edge-cases
- Problem space grows exponentially (really bad)
  - $10^{120}$ game variations, $10^{43}$ board positions
  - It is computationally intractable to "solve" chess
- Developing good heuristics is challenging
- Performance
- Accuracy and weighting is non-trivial

# There is prior work

- Deep Blue (retroactively named after Shallow Blue)
  - Developed in 1993 at IBM
  - Used search and evaluation function
  - 200 Million positions for second, 12 ply search
- Crafty Chess Engine
  - One of the first to support multiple processors
  - Uses Alpha-Beta Pruning and quiescence search
- Fruit Engine
  - Uses Negascout search
  - Principal Variation Search

# There are a lot of moving parts

- Representing Chess
- Tournament master
- Research on techniques
- Building AIs

- The game itself has complicated rules and edge-cases
  - En-passant, 50-move-rule, castling, stalemates, etc.
- Existing systems are either:
  - Closed-source
  - Not extendable

# There are a lot of moving parts

- Representing Chess
- Tournament master
- Research on techniques
- Building AIs

- Full network-ready server and client system with APIs
- Controls boards and game state
- Allows for multiple simultaneous matches between humans and AIs
  - Useful for genetic algorithms

# There are a lot of moving parts

- Representing Chess
- Tournament master
- Research on techniques
- Building AIs

- Mini-max (also known as alpha/beta) pruning
- Iterative quiescence search
- Opening and end-game databases
- Heuristics to evaluate board
- Very thorough optimization in system-level languages

# There are a lot of moving parts

- Representing Chess
- Tournament master
- Research on techniques
- Building AIs

- **Random AI**
- **Mini-max (also known as alpha/beta) pruning**
- **Iterative quiescence search**
- Opening and end-game databases
- **Heuristics to evaluate board**
- Very thorough optimization in system-level languages

# Demo

yes... it works.

(caveat: Murphy's Law)

```
3 | B~ |    |    |    |    |    |    |    | 3
  ---------------------------------------
2 | W~ |    | B~ |    |    |    |    |    | 2
  ---------------------------------------
1 | WB |    | B~ |    | WK |    |    | B~ | 1
  ---------------------------------------
    A    B    C    D    E    F    G    H

INFO:maverick.players.ais.quiescenceSearchAI.QLAI:Calculating next move
INFO:maverick.players.ais.quiescenceSearchAI.QLAI:Elapsed CPU time for search was a
bout 148.5s
INFO:maverick.players.ais.quiescenceSearchAI.QLAI:Best found move was (0,4) -> (1,4
)
Evaluated 2052 nodes
 -- Waiting until turn

    A    B    C    D    E    F    G    H
  ---------------------------------------
8 | BR | BN | BN |    |    |    | W~ |    | 8
  ---------------------------------------
7 |    |    |    |    | BK | W~ | BB | B~ | 7
  ---------------------------------------
6 |    |    |    |    |    | BQ |    | W~ | 6
  ---------------------------------------
5 |    |    |    |    |    |    |    |    | 5
  ---------------------------------------
4 | B~ |    |    |    | W~ |    |    |    | 4
  ---------------------------------------
3 | B~ |    |    |    |    |    |    |    | 3
  ---------------------------------------
2 | W~ |    | B~ |    | WK |    |    |    | 2
  ---------------------------------------
1 | WB |    | B~ |    |    |    |    | B~ | 1
  ---------------------------------------
    A    B    C    D    E    F    G    H

INFO:maverick.players.ais.quiescenceSearchAI.QLAI:Calculating next move
INFO:maverick.players.ais.quiescenceSearchAI.QLAI:Elapsed CPU time for search was a
bout 150.31s
INFO:maverick.players.ais.quiescenceSearchAI.QLAI:Best found move was (1,4) -> (0,4
)
Evaluated 2049 nodes
 -- Waiting until turn

    A    B    C    D    E    F    G    H
  ---------------------------------------
8 | BR | BN | BN |    |    |    | W~ |    | 8
  ---------------------------------------
7 |    |    |    |    | BK | W~ | BB | B~ | 7
  ---------------------------------------
6 |    |    |    |    |    |    |    | W~ | 6
  ---------------------------------------
```

# We analyze boards

- Pieces on board
- Attack posture
- In check?
- Empty space coverage

# We have made progress

- Search AI **is** making sensible moves
  - Moves to control empty spaces
  - Captures enemy pieces and avoids self-capture
- However, we still have a lot of work to do...
  - Random AI beats search AI 
    - It is just more aggressive, and the search AI makes faultily assumes that its opponent is smart and only looks 4 plies deep
  - Search AI is very slow (4.5 minutes for a reasonable move)