6.189 IAP 2007

Student Project Presentation

Backgammon Tutor

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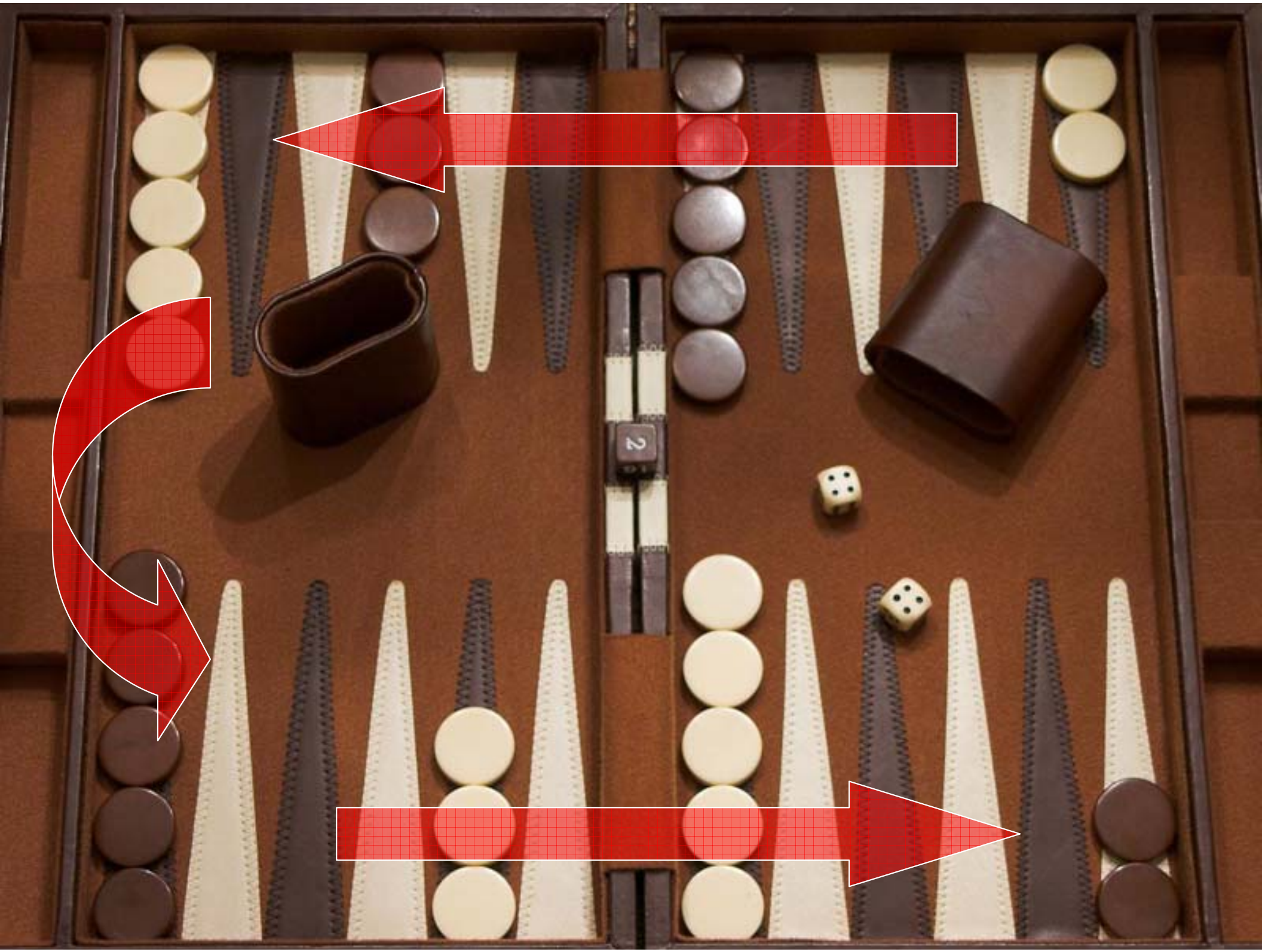
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Goals

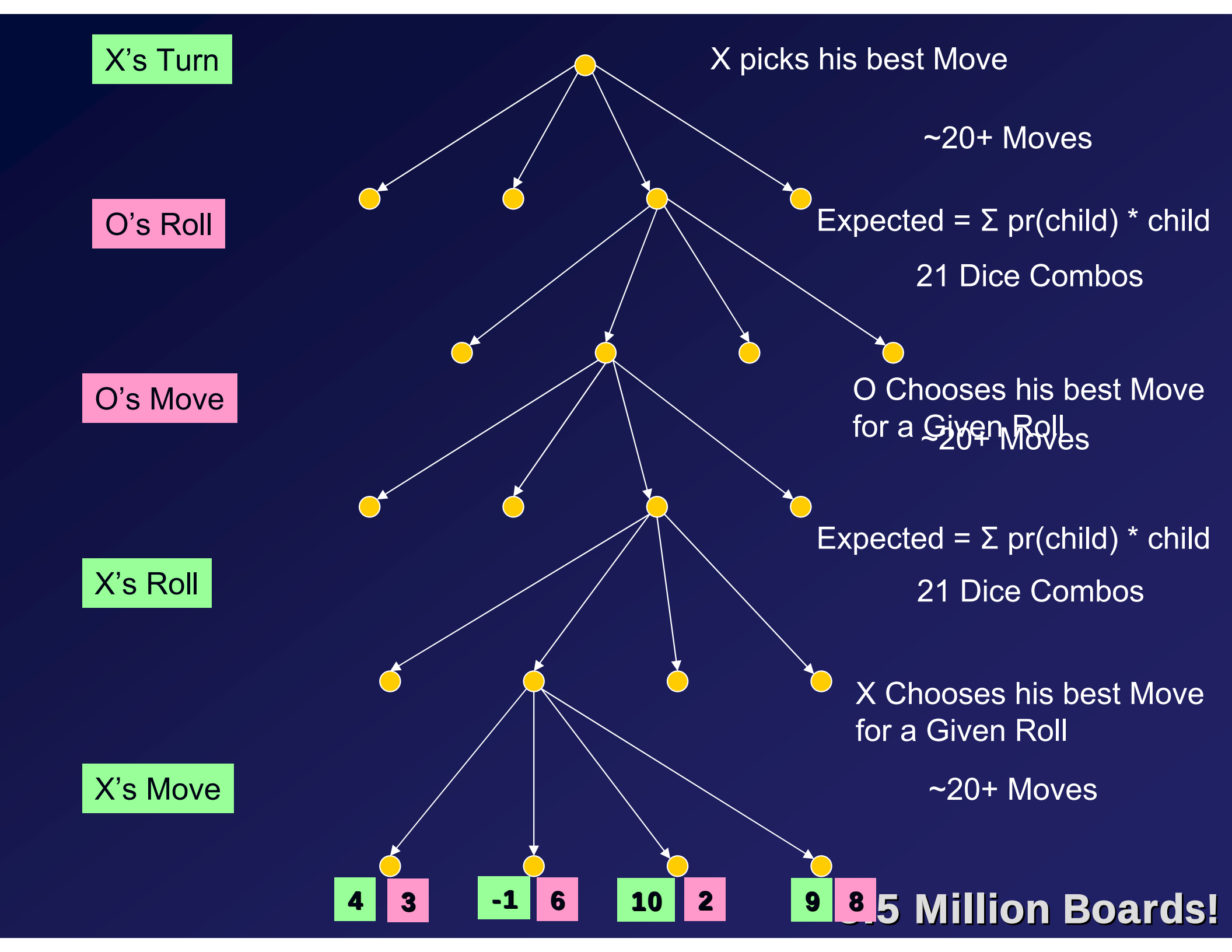
- Implement the rules of backgammon
- Create/Find a function that evaluates how “good” a board is
- Parallelize the evaluation of future board states in order to determine help determine what the best move is this turn
- Teach the player by suggesting a better move and explaining why it is a better move

Board Evaluation

- Static Evaluator
  - Linear sum of weighted board features
  - 1979 – BKG 9.8 (Hans Berliner – CMU) beat ruling world champion
    - Adjusted weights as game progressed
- Neural Nets
  - Traditionally most successful
  - Trained over 100,000+ games
  - Pubeval – Gerry Tesauro, IBM Research 1993
    - Released as benchmark evaluator that produces play at the intermediate level

Search

- Look at future turns in order to choose best move now
- Large Branching Factor
  - Checkers 10
  - Chess 35-40
  - Backgammon 400
- Uncertainty of future dice rolls (21 possible combinations)
- Pubeval is not zero-sum
- Does searching deeper produce a better play?
  - Most papers say search is less important than a good evaluator
  - Search produces slightly better play – Can still make a big difference

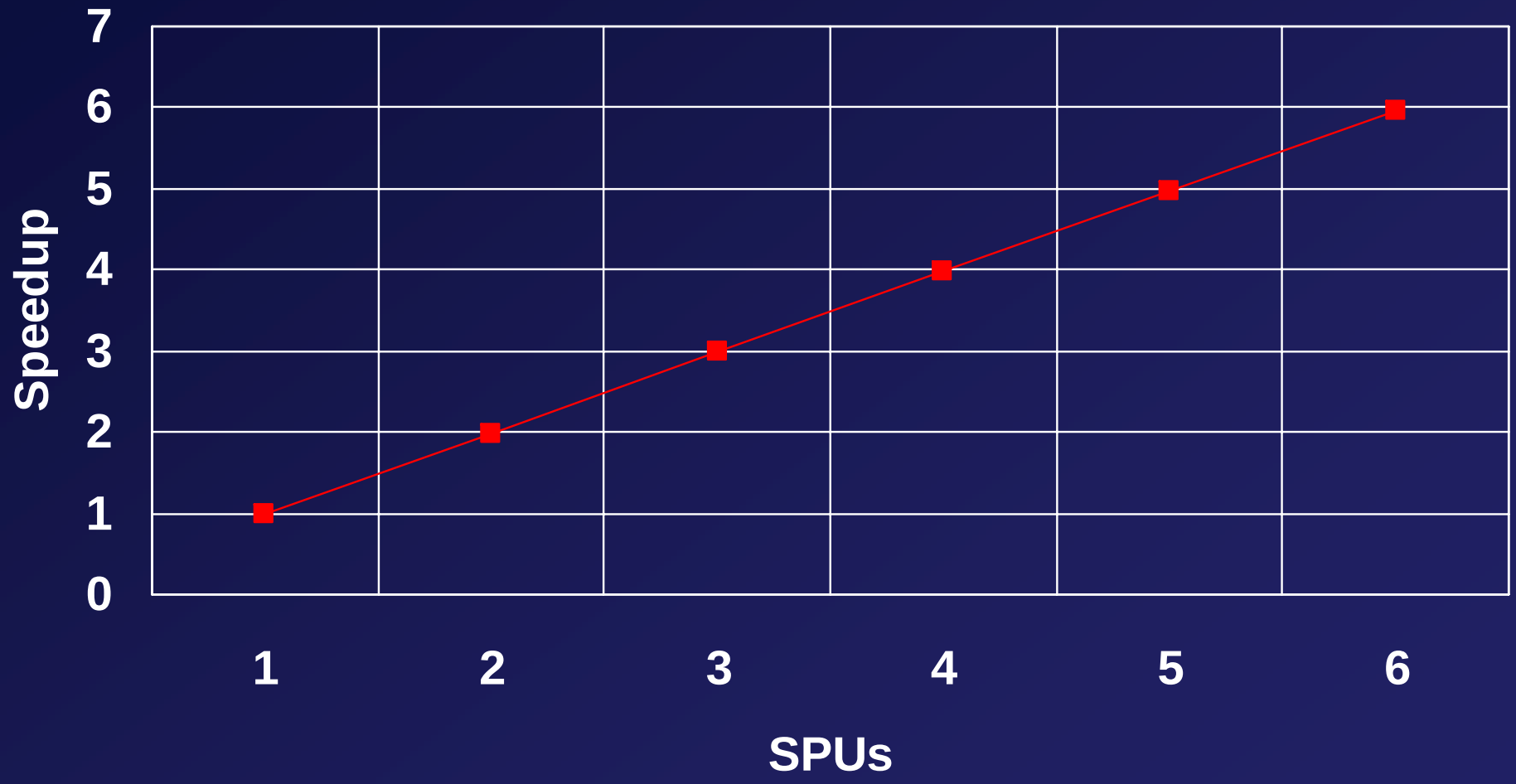

X's Turn
X picks his best Move
~20+ Moves
O's Roll
Expected = Σ pr(child) * child
21 Dice Combos
O's Move
O Chooses his best Move
for a Given Roll
~20+ Moves
X's Roll
Expected = Σ pr(child) * child
21 Dice Combos
X's Move
X Chooses his best Move
for a Given Roll
~20+ Moves
4
3
-1
6
10
2
9
8
3.5 Million Boards!

Parallelizing Board Evaluation

- Millions of leaf nodes that each represent a board state
- Attempt to split evenly between SPUs
- Each has a multiple of 4 boards
- All boards (~170,000 in benchmarks) can't go over to the SPU at once
- SPU knows how much it has to process, takes as much as it can, evaluates, returns, and gets more
- Each should finish at roughly the same time
- SIMDize code to evaluate 4 boards at once
- Double buffer so we can DMA and compute at the same time

Performance – Evaluating 1 Million Boards

Speedup – Evaluating 1 Million Boards



Demo

Development Techniques

- Get sequential code working correctly on single core
  - Squash bugs and memory leaks
- Implement parallel code as sequential code to make sure algorithm works
- Convert parallel code to run on 1 SPU
- Get code working on all 6 SPUs
- Most debugging done with printf statements

Challenges

- We aren’t backgammon experts or even intermediate players
- Getting the game to a playable state took a good chunk of our total time
- Managing search tree
- Memory management
- Cell Debugging
- Bit packing the boards so when we are storing millions of them they fit into memory

Future Work

- Finish move tree traversal after board evaluation
- Move tree pruning (beam search)
- Parallelize move tree creation and traversal
- SIMDize and buffer board evaluation
- Training Board Evaluators
- Monte Carlo approach to finding the best move
- Explaining in English why one move is better than another