Adaptive Neural Network Usage in Computer Go

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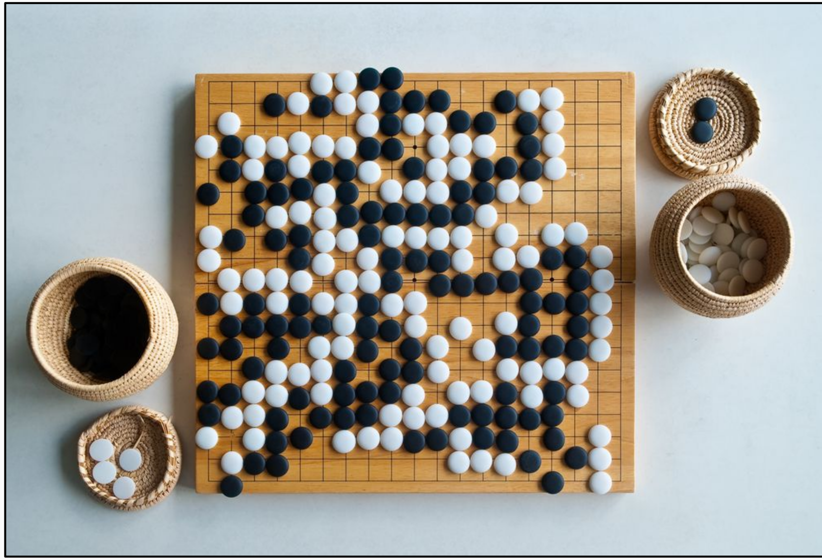
Outline

- The Game of Go
- Computer Go Techniques
- Our Project
- Conclusions
- Future Work

What is Go?

- Two-player alternating stone placing game
- 19x19 board
- **Group**: Connected pieces
- **Liberty**: Empty adjacent position to group
- **Captured**: When a group has no liberties
- **Territory**: Empty locations “controlled” by a player
- No stone sacrifice
- Winner determined by territory and stone captures



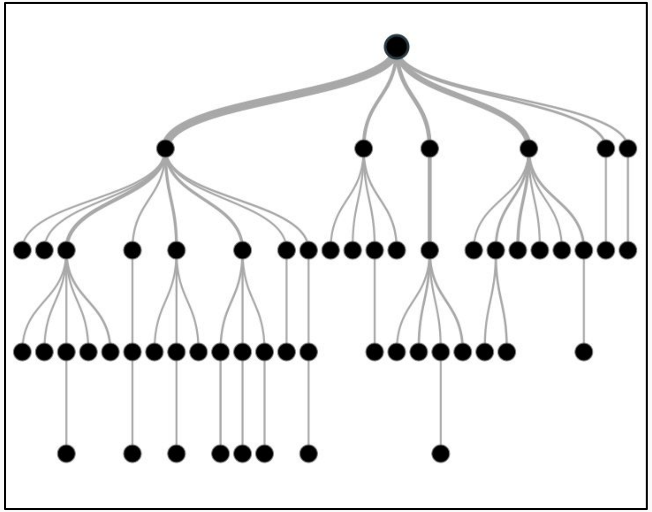
What Makes Go Interesting?

- Incredibly complex
- ~10^{81} atoms in the known universe
- Orders of magnitude harder than chess
- Complexity closely resembles real world
- Can lead to advances in artificial intelligence

	Chess	Go
Possible board states	10^{47}	10^{170}
Possible legal move sequences	10^{123}	10^{360}

Why Study Go AI?

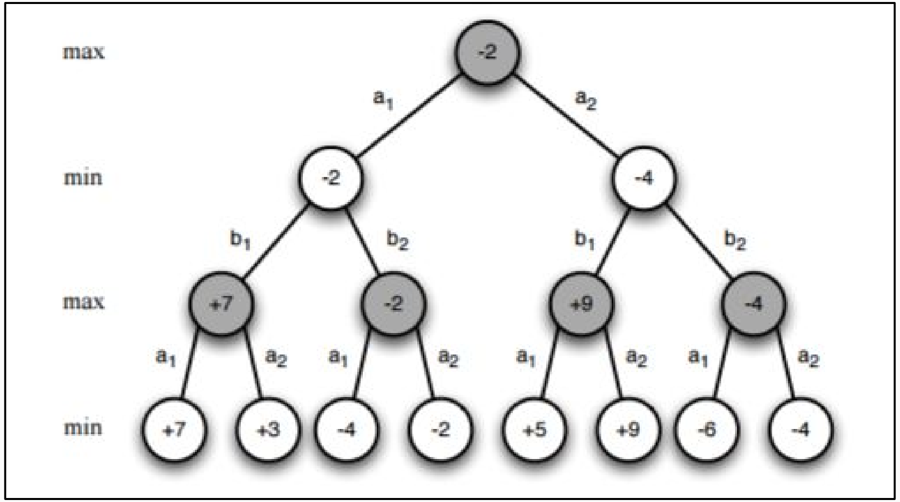
- Functionally infinite states and sequences
- Actions have long term influences
- States are not always as they appear
- In short, **very** hard
- Similar to sequential decision based problems



Previous Techniques

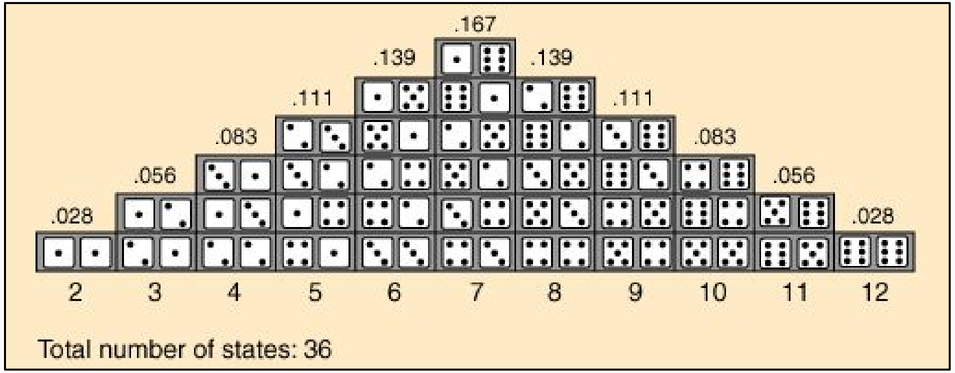
Minimax

- Tree of possible move sequences
- Assumes perfect play
- One player maximizes tree
- One player minimizes tree
- Best move chosen for root player
- Requires the entire tree mapped
  OR
- A heuristic function



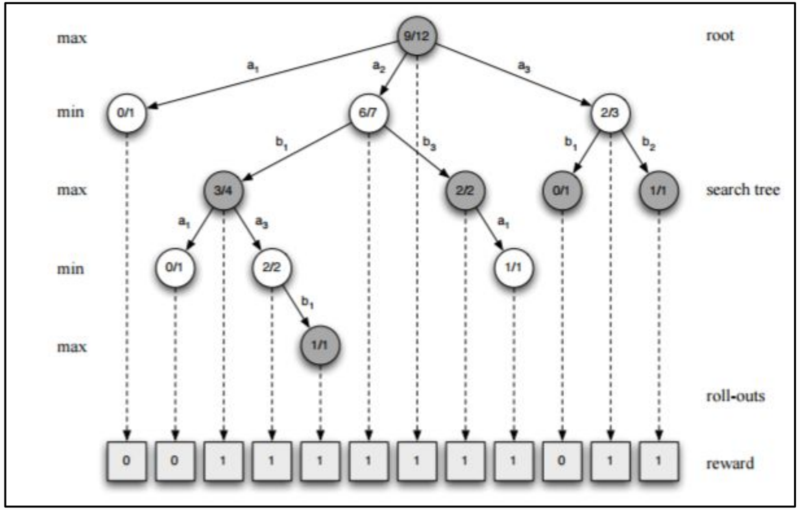
Monte Carlo Simulation

- Policy based
- Value estimation
- Simulate games based on policy
- Sensitive to policy choice
- Randomization of policy



Monte Carlo Tree Search

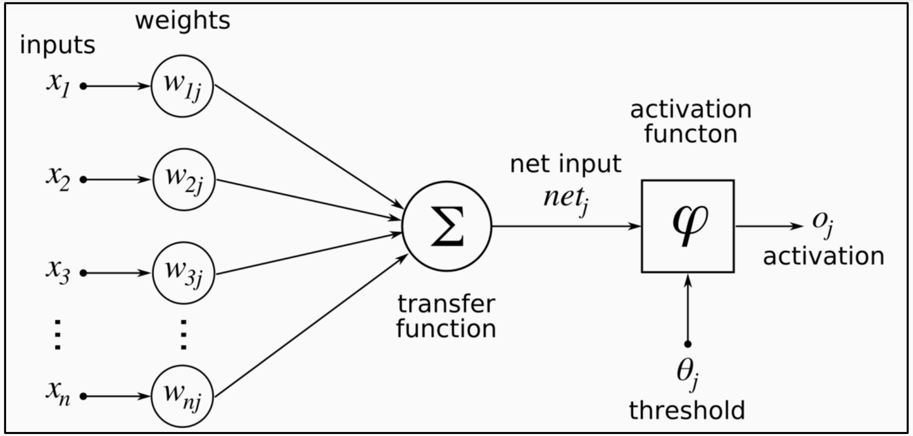
- A combination of game tree search and Monte Carlo simulation
- Limited minimax with heuristic
- Gradually adapt Monte Carlo policy
- Rely on fixed policy for “leaf” nodes
- Works well with Go

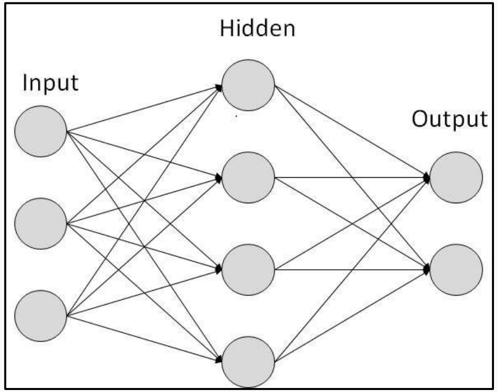


Upper Confidence on Trees

- Action selection is treated as separate problem for every node
- Select action *a* that maximizes following equation
  - (estimated value of action *a*) + (modified bias sequence)
- Bias sequence is higher for less explored states/actions
- More likely to choose unexplored nodes
- Handles exploration-exploitation dilemma

Convolutional Neural Networks





- Functions similarly to normal neural network
- Processes overlapping tiles from input
- Great at visual identification

AlphaGo

- Developed by Google
- Two neural networks and MCTS
- Massive computing resources
- Plays moves that humans would not
- Beat best human player, Lee Sedol, in 2016

Last Year’s MQP

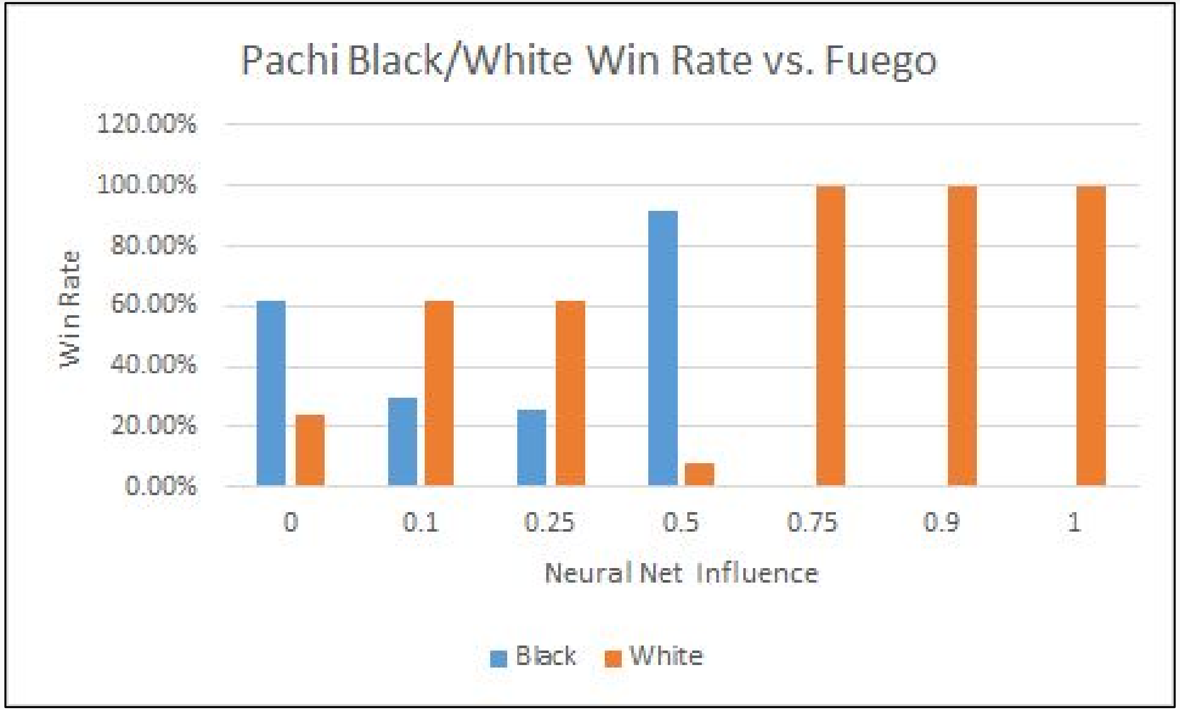
- 4 approaches to help move selection
  - Introduce a neural network to Pachi
  - Change the neural network used based on tree depth
  - Train a neural network to inform Pachi search
  - Teach a neural network to use Pachi’s search
- Using a single neural network gave the best result
- Anomalous results

Our Project

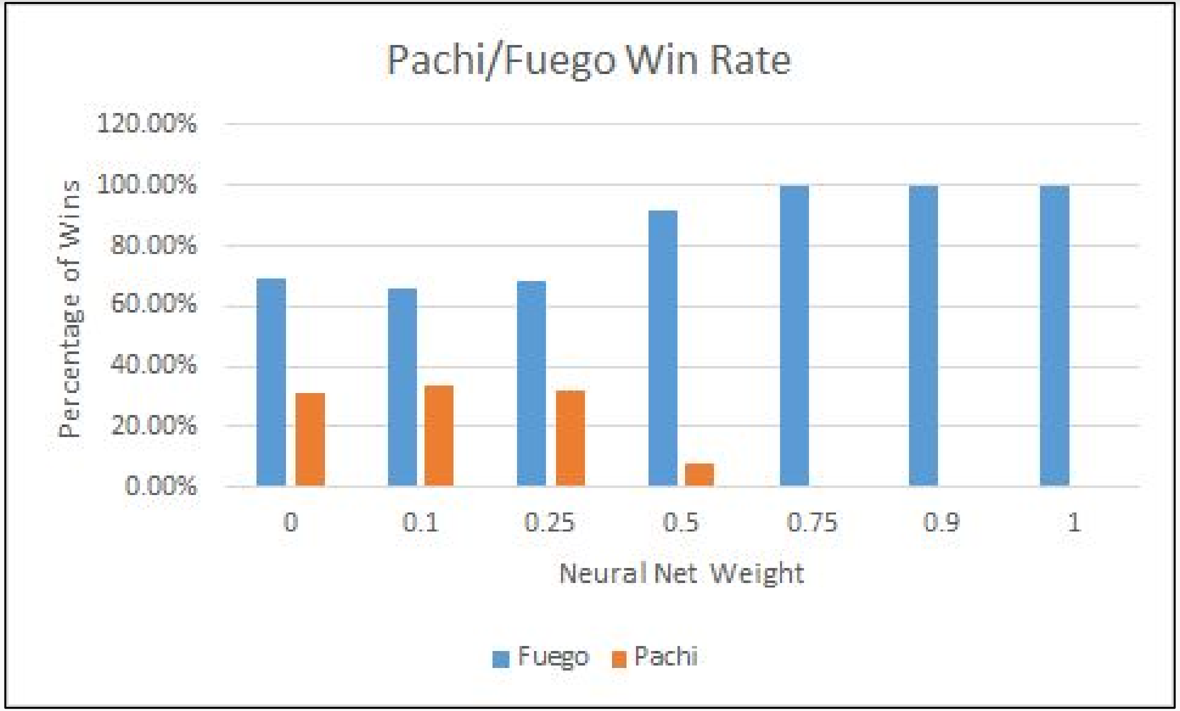
Overview

- Investigated anomalous data
- Reinterpreted last year’s results
- Adaptive neural network weighting
- Compared optimized neural network Pachi to default Pachi

Anomalous Data



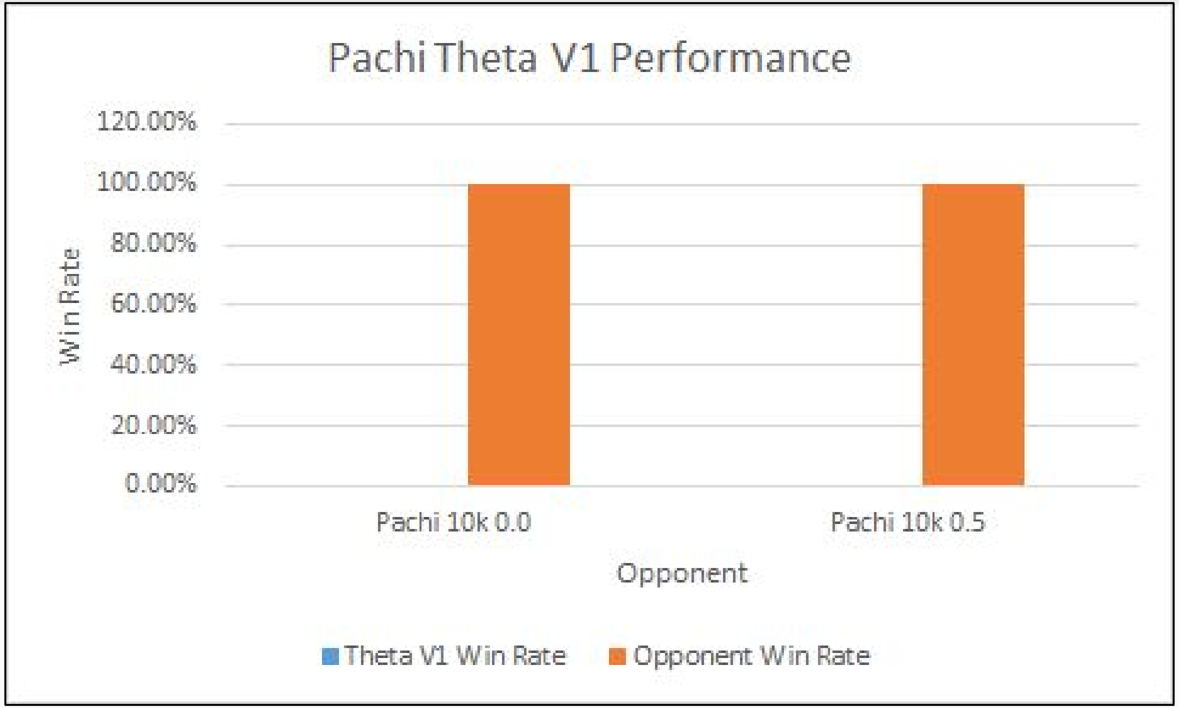
Reinterpreted Results



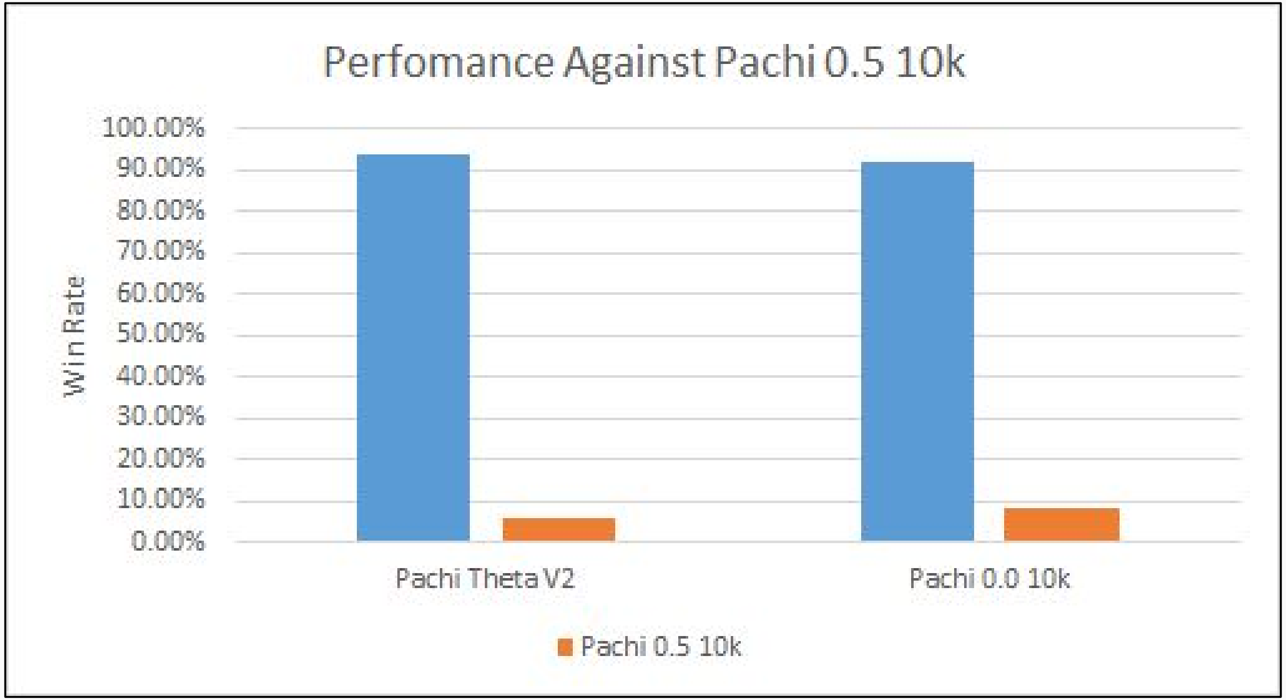
Adaptive Neural Network Weighting

- Determine the optimal weighting
- Go is complex, static weighting won’t work
- Based on
  - Board state
  - Game turn
- Trained using Fuego
- Trained two different functions

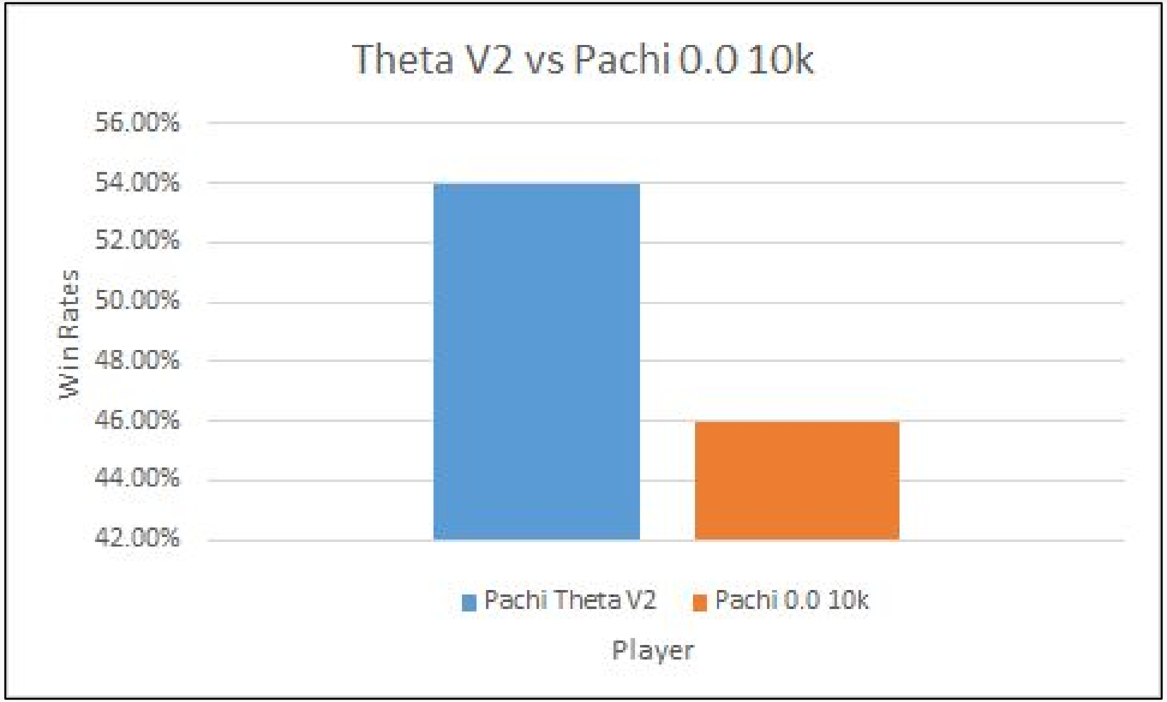
First Round Performance



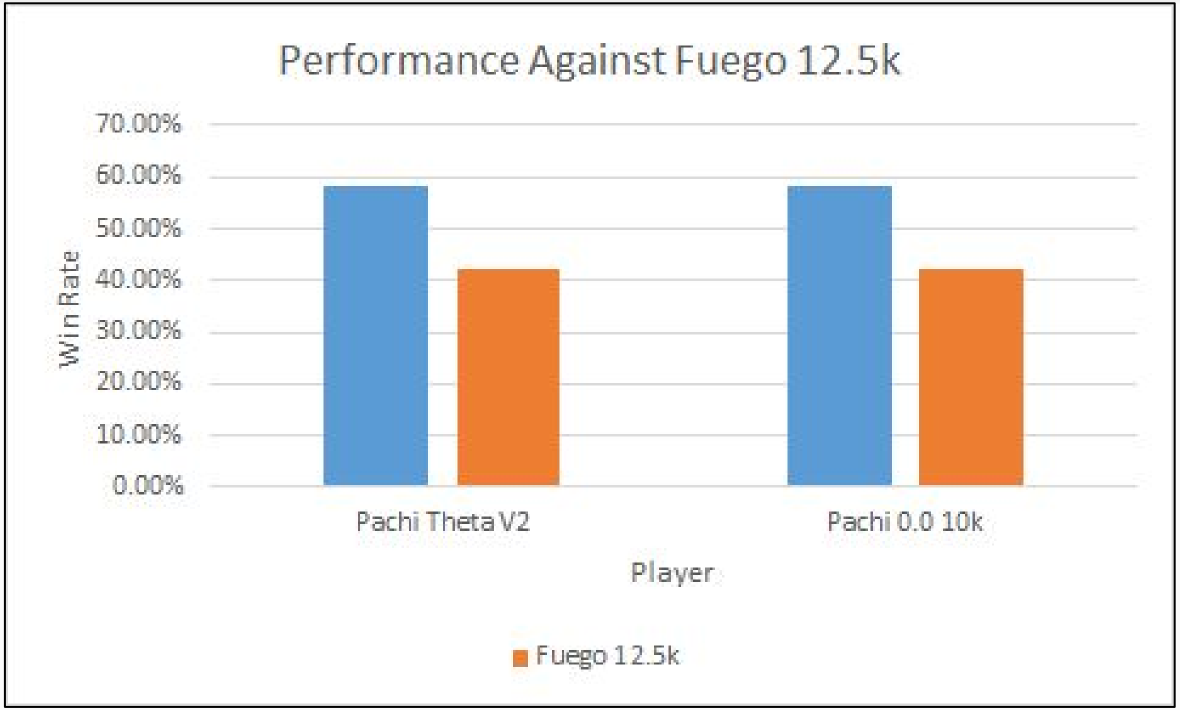
Second Round Performance



V2 vs. Default Pachi

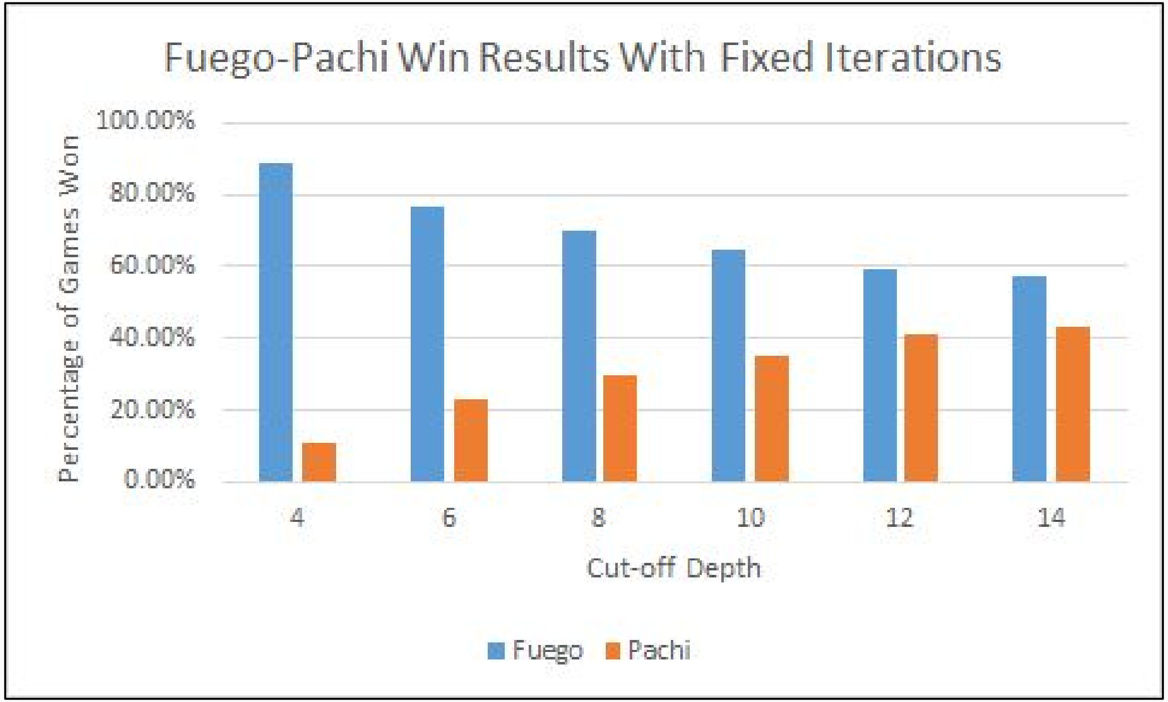


V2 vs. Fuego



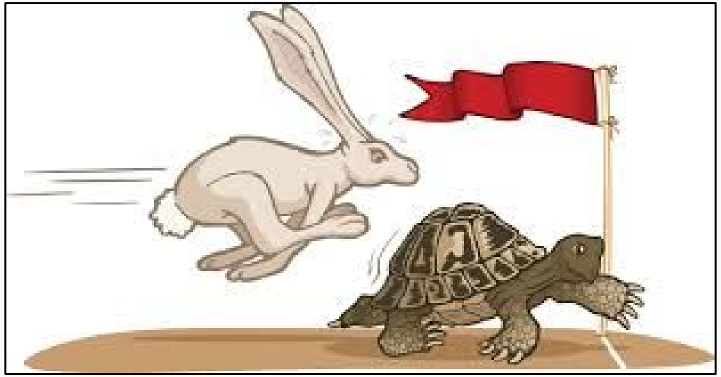
Performance Against Fuego 12.5k
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
Win Rate
Pachi Theta V2
Pachi 0.0 10k
Player
Fuego 12.5k

Depth Based Neural Network



Conclusions

- Adaptive weighting is powerful
- The faster neural network is not very good
- The slower neural network is strong



Future Work

- Use the slower, more accurate neural network
- Train function longer
- Experiment with more parameters
- Revisit the two other approaches from last year

Acknowledgements

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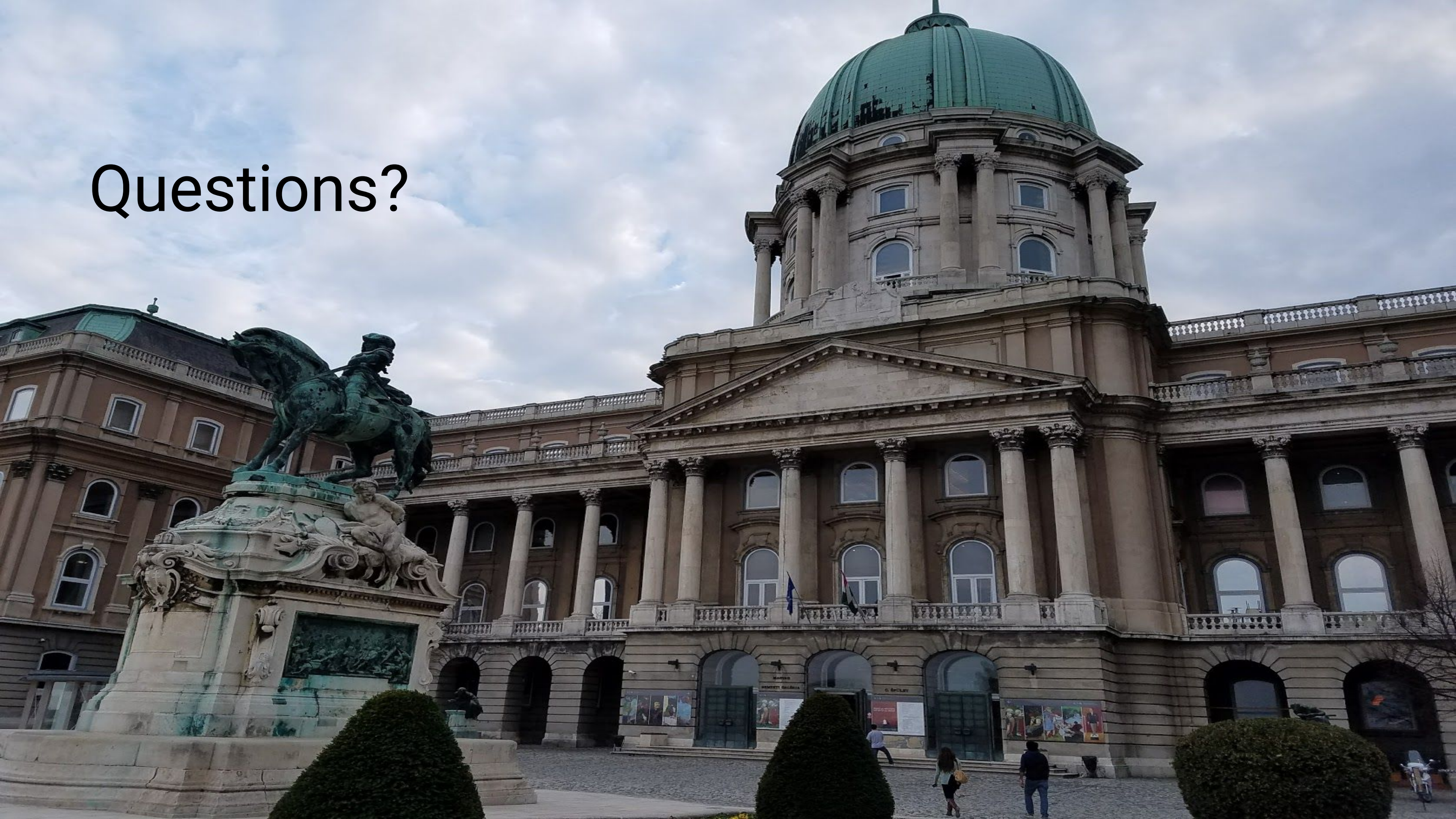
Questions?



Köszönöm!