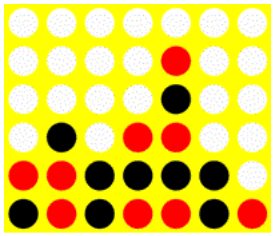
Neural Network Applications for Connect 4



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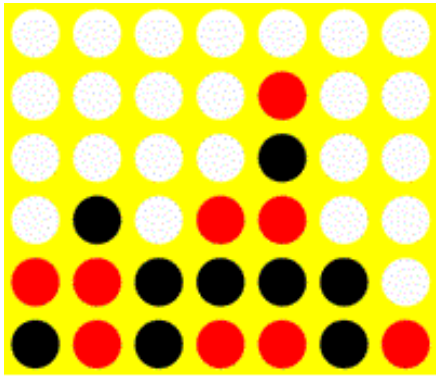
Problem

Create a competent and fast game AI that learns **only from game states**



Connect 4 was chosen because it is simple to learn but complex to master and has a limited number of game states

Neural Network-based Solution

- Supervised Learning
- Back propagation

Input Space: 42 parameters

Motivation for neural networks:

- Easy to train on
- Fast decision-making
- Have multiple neural networks to encapsulate different game logic

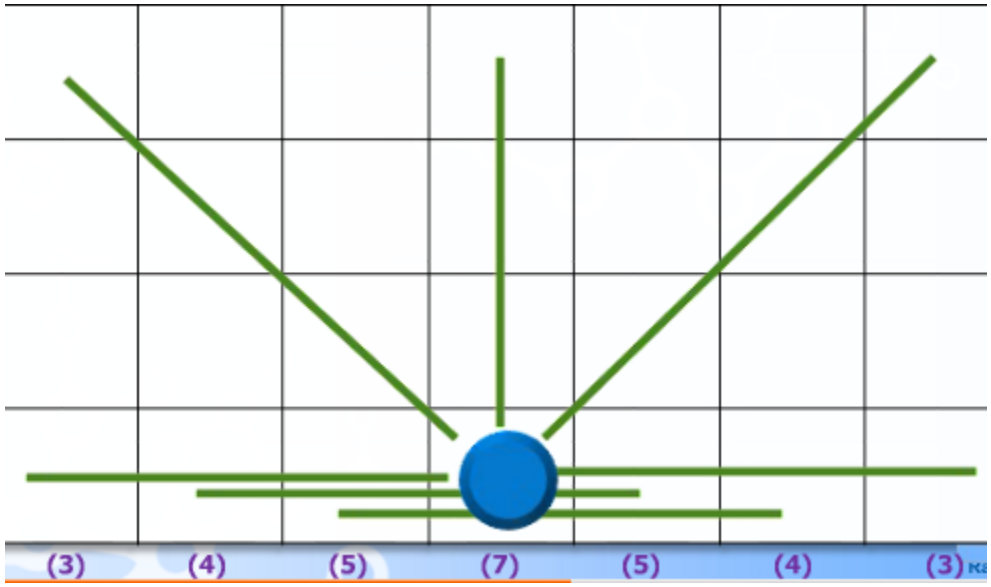
Training Data Generation

Heuristic AI: Play 100,000 games of Connect 4. When a game finishes, record each game state and whether it lead to victory, defeat or a draw

8-ply AI: Use predefined 8-ply database of game states where optimal play is assumed

Game-Playing Algorithms

Used a line completeness heuristic with occasional random move selection to create a competitive semi-random Connect 4 AI .

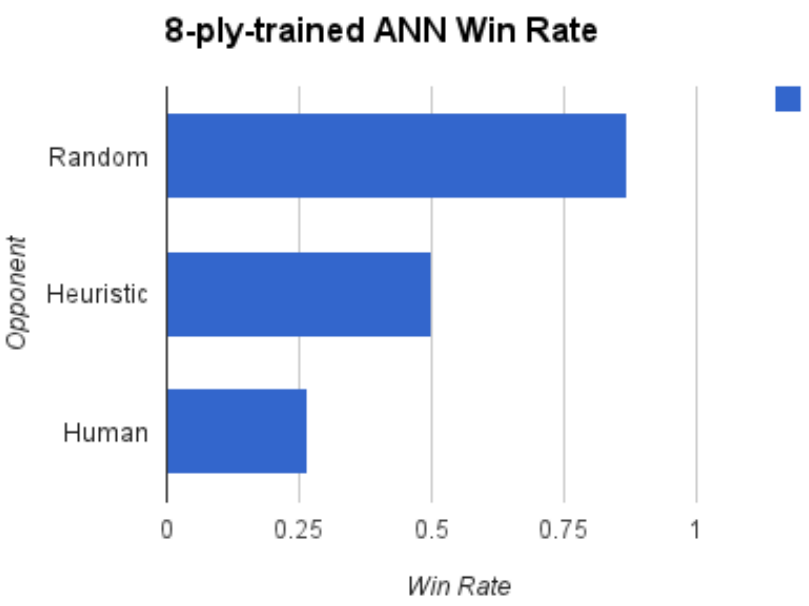


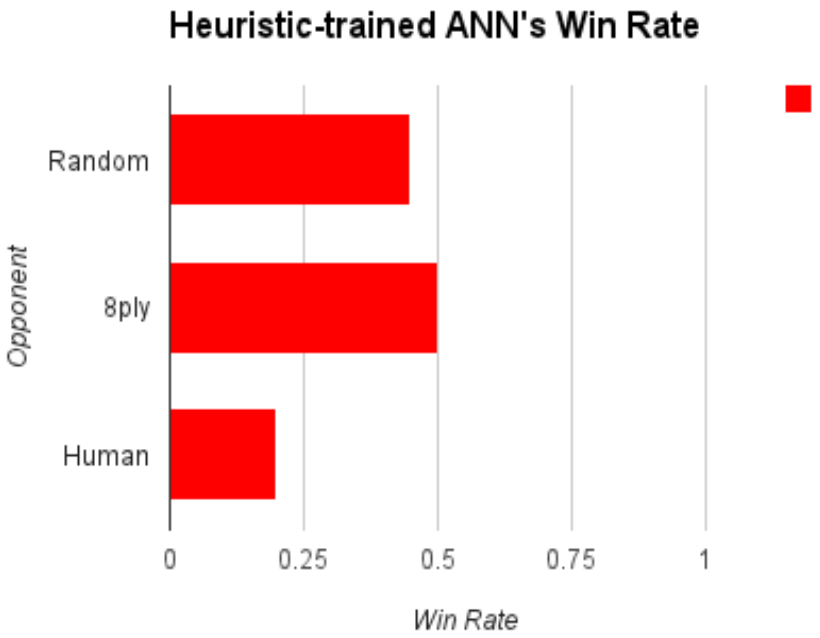
Results

Using the **8-ply ANN**:

- Beat random AI **87%** of the time
- Beat skilled human player **27%** of the time
- Beat heuristic game AI **50%** of the time
- Average of **0.15s** to calculate next move

Results


8-ply-trained ANN Win Rate
Random
Heuristic
Human
Opponent
0
0.25
0.5
0.75
1
Win Rate


Heuristic-trained ANN's Win Rate
Random
8ply
Human
Opponent
0
0.25
0.5
0.75
1
Win Rate

Conclusions

It's possible to create a competent Connect 4 AI by training only on game states

We beat a random AI **87%** of the time and a competent human player **27%** of the time

Easy to extend to other games with a finite number of game states (AI doesn't require knowledge of the rules of the game)