# Game Tree Searching by Min / Max Approximation

*Artem Larionov*

*2/19/2017*

## Goals of the research

The paper suggests a method for reducing the computational expenses of exploring a game tree, which will always expand the node that is expected to have the largest effect on the value.

## Min/Max Approximation

Min/Max approximation method attempts to focus the computer's attention on the important lines of play. The key idea is to approximate the "min" and "max" operators with generalized mean-value operators. These are good approximations to the min/max operators, but have continuous derivatives with respect to all arguments.

## Results

The game of Connect-Four was chosen as a basis the experiments because it is commercially available and well known, yet simple to describe and implement.

## Experimental results

| Resource bound per turn | MM wins | AB wins | Ties |
|---|---|---|---|
| 1 second | 41 | 46 | 11 |
| 2 second | 40 | 42 | 16 |
| 3 seconds | 36 | 44 | 18 |
| 4 seconds | 39 | 52 | 7 |
| 5 seconds | 30 | 55 | 13 |
| **Total** | **186** | **239** | **65** |
| 1000 moves | 47 | 35 | 16 |
| 2000 moves | 50 | 35 | 13 |
| 3000 moves | 42 | 47 | 9 |
| 4000 moves | 49 | 42 | 7 |
| 5000 moves | 61 | 31 | 6 |
| **Total** | **249** | **190** | **51** |

## Conclusion

Based on time usage alone, alpha-beta seems to be superior to the implementation of the min/max approximation approach. However, if comparison was based on move-based resource limits, the story is reversed: min/max approximation is definitely superior.