Genetic Fuzzy based Tetris Player

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Outline

- Introduction & Objective
- Approach
- Genetic Algorithm
- Inputs & Membership Functions
- Rule Base
- Results
- Conclusions / Future Topics

Introduction

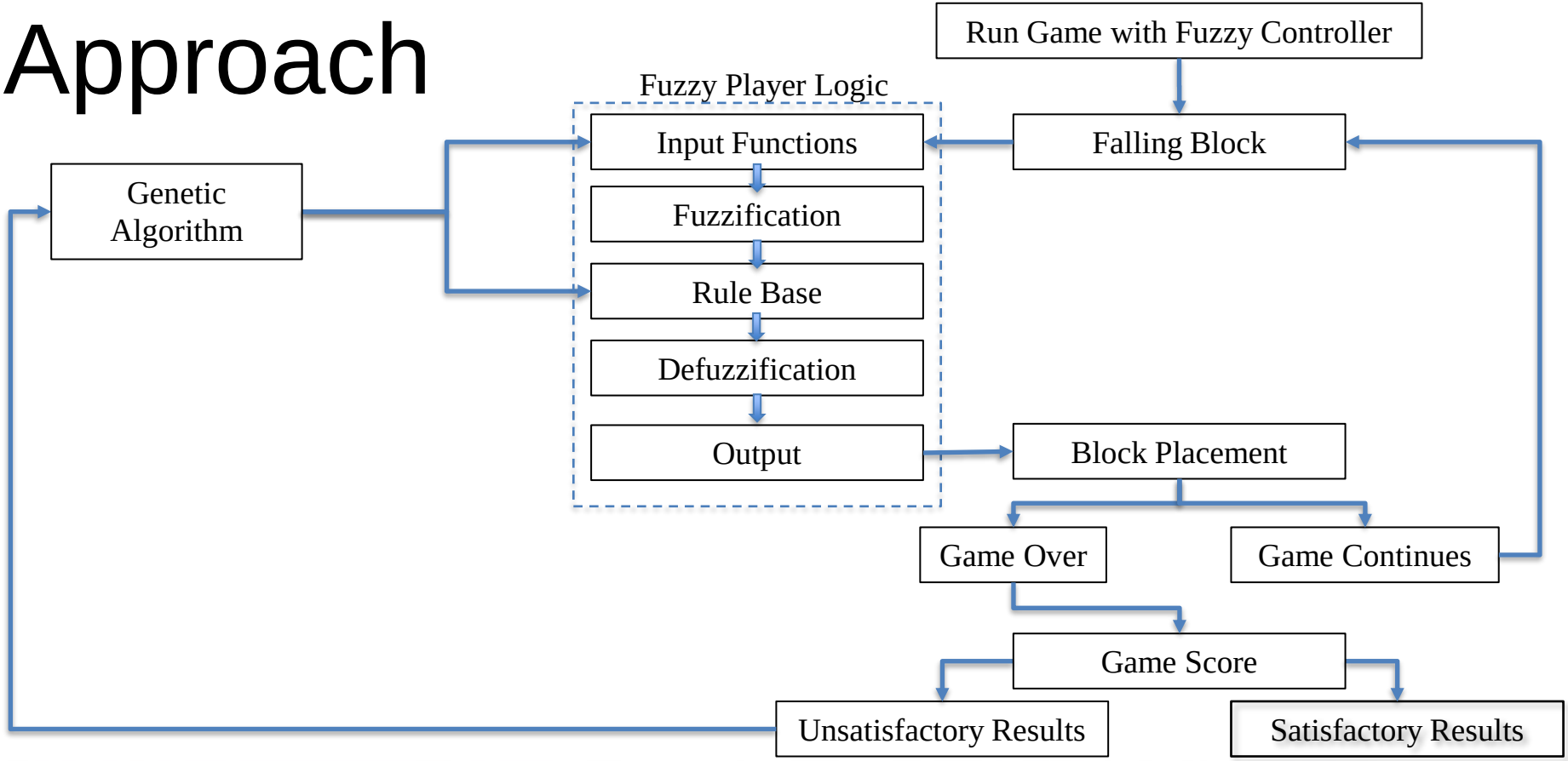
- Tetris is a single player game, the objective being to place four-piece blocks and clear as many rows of blocks as possible

- The game requires quick decisions and flexibility in its decision making, which makes it a good candidate for Fuzzy Logic

Project Objective

Build upon a Fuzzy Logic Tetris Player (previously created using expert knowledge) by training the FLTP using a genetic algorithm

Approach


Run Game with Fuzzy Controller
Fuzzy Player Logic
Input Functions
Falling Block
Genetic Algorithm
Fuzzification
Rule Base
Defuzzification
Output
Block Placement
Game Over
Game Continues
Game Score
Unsatisfactory Results
Satisfactory Results

Genetic Algorithm

"… reflects the process of natural selection where the fittest individuals are selected for reproduction in order to produce offspring of the next generation" [1]

Genetic Algorithm: Stochastic Parameters

Elitism: 0.2

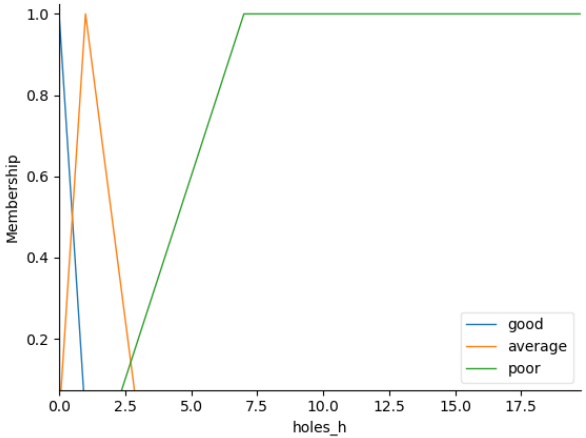
Mutation: 0.4

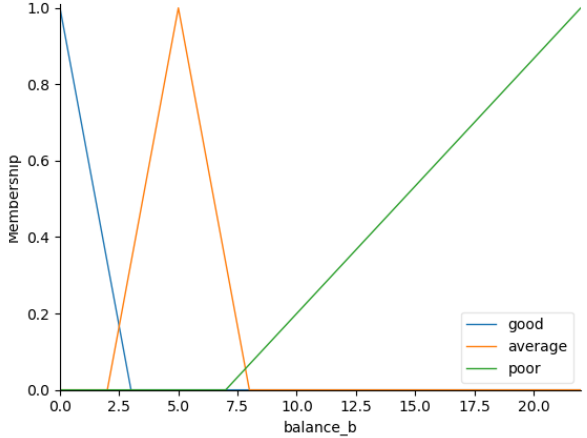
Probability of Crossover: 0.95

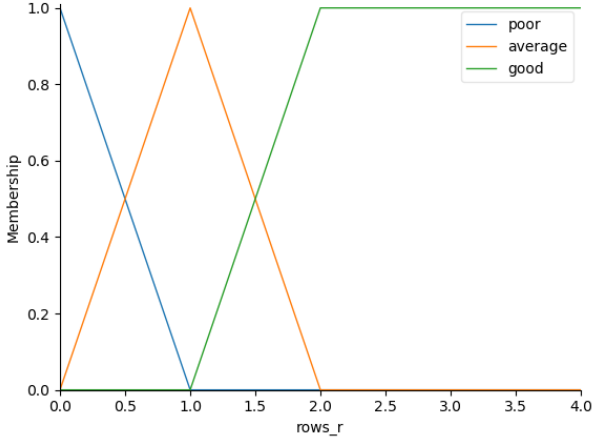
Inputs

- Holes: The number of holes created for a block placement
- Balance: The height the blocks will reach for a block placement
- Rows: The number of rows for a block placement

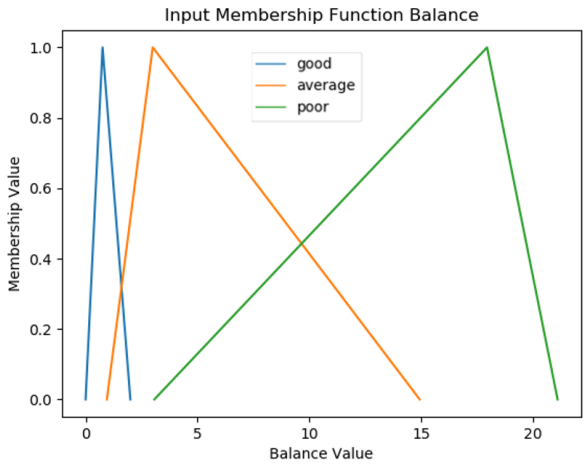
Membership Functions of Inputs: Expert Training

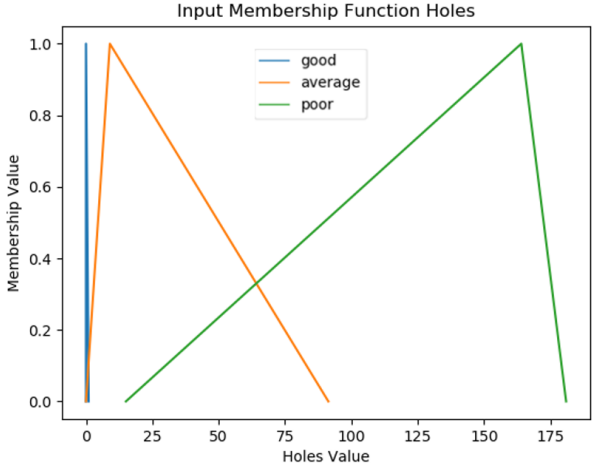


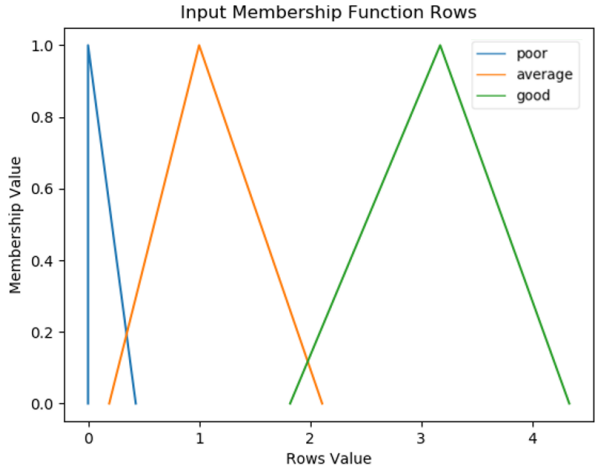




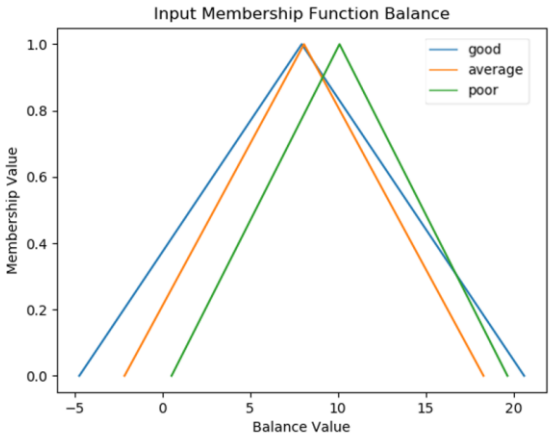
Membership Functions of Inputs: Genetic Algorithm Training (Just Membership Functions)

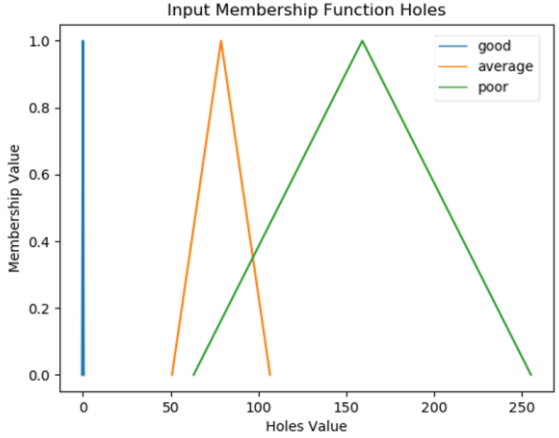


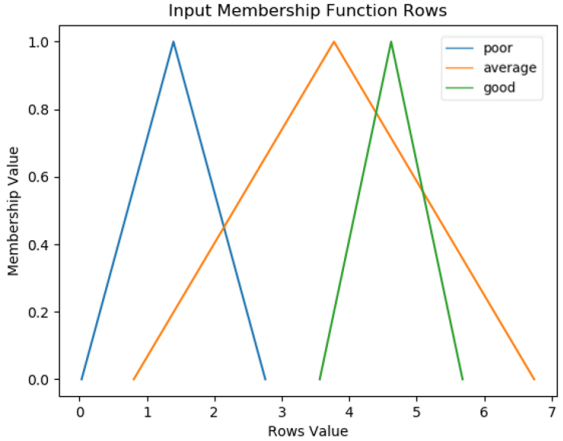




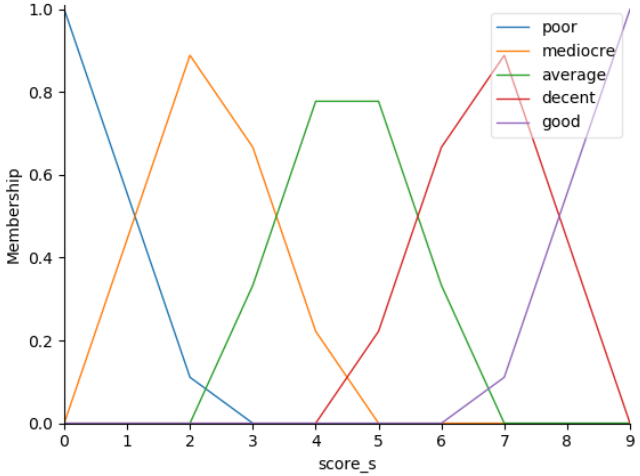
Membership Functions of Inputs: Genetic Algorithm Training



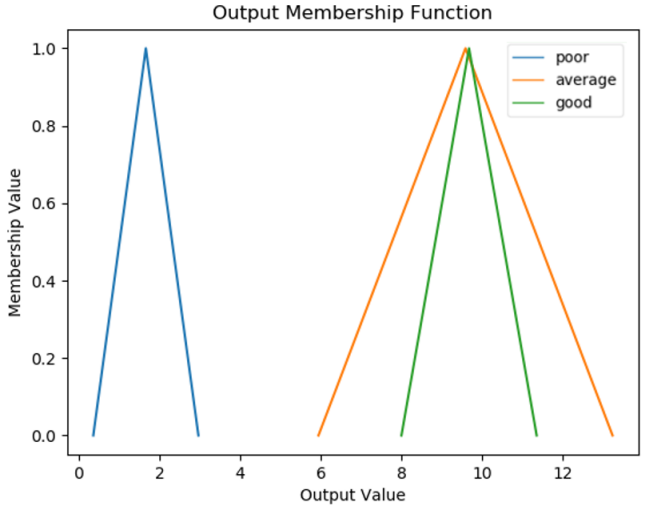




Membership Function of Outputs



Expert Knowledge Training



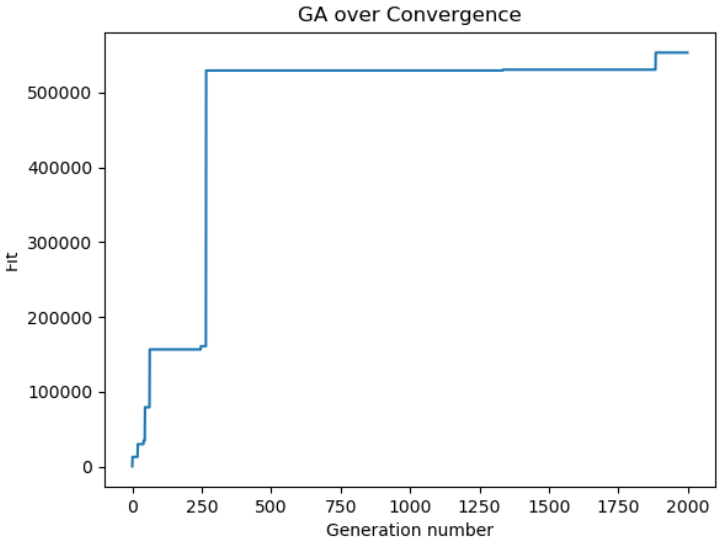
GA Training

Rule Base

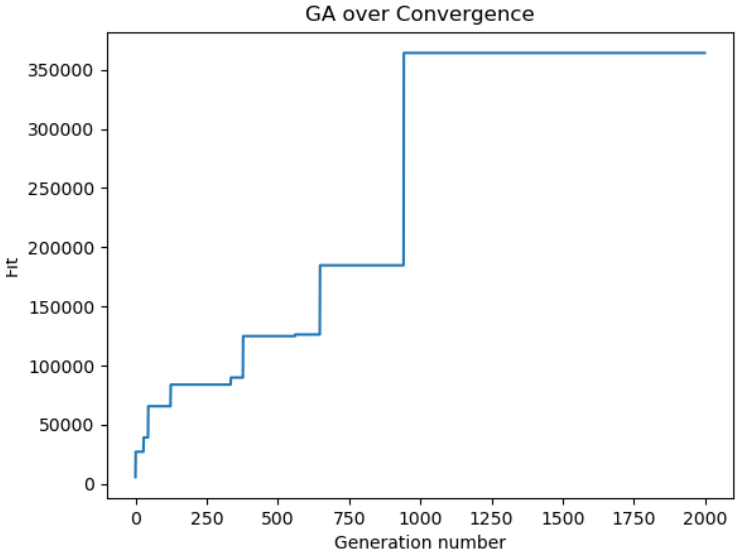
The rules are in linguistic form: a great strength of a fuzzy logic system. The rule that defines a good score in the expert trained system:

IF *'holes' is good* ***AND*** *'balance' is average* ***AND*** *'rows' is good* ***OR***
'holes' is good ***AND*** *'balance' is good* ***AND*** *'rows' is average* ***OR***
'holes' is good ***AND*** *'balance' is good* ***AND*** *'rows' is good*
THEN *'score' is good.*

Convergence of Genetic Algorithms



FLTP Genetic Algorithm Convergence



FLTP Genetic Algorithm Convergence
(Just membership functions)

Results

Run	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Score (1000s)	5.2	5.3	0.6	0.7	0.6	2.1	2.7	1.5	1.0	17.6	1.2	0.5	0.5	0.6	12	0.6	2.2	0.7	0.7	0.8
Level	5	5	1	1	1	3	4	2	2	7	2	1	1	1	7	1	3	1	1	1

Table 1: Results FLTP Expert Training

Run	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Score (1000s)	2.1	29.2	0.4	0.9	33.6	3.1	10.8	0.7	17.9	5.7	1.6	3.7	1.1	4.3	5.9	59.7	0.6	16.4	5.9	27.2
Level	3	12	1	2	14	4	8	1	11	5	3	4	2	5	6	17	1	9	6	12

Table 2: Results FLTP Genetic Algorithm Training

Run	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Score (1000s)	20.1	24.3	0.5	1.2	8.5	2.1	5.7	1.7	2.2	2.7	1.2	0.6	1.2	8.2	11.1	136.9	0.8	84.5	8.1	0.6
Level	9	9	1	2	5	3	4	3	3	3	2	1	2	7	7	24	1	18	7	1

Table 3: Results FLTP Genetic Algorithm Training (Just membership functions)

Results Summary

- FLTP Expert Training
  - Average Score: 2873.0
  - Highest Score: 17600
- FLTP Genetic Algorithm Training
  - Average Score: 11532.0
  - Highest Score: 59700
- FLTP Genetic Algorithm Training (Just membership functions)
  - Average Score: **16122.1**
  - Highest Score: **136900**

Conclusions

- The FLTP has greatly varying scores on the test set games
- The best FLTP was the FLTP trained by the genetic algorithm, with the rules and output membership functions fixed

Future Topics of Interest

- Increase the speed of the genetic algorithm so that more generations can be run
- Create a more diverse training data set

Acknowledgements

Without the help and Guidance of my mentor, Dr. Kelly Cohen, and the support from the Ohio Space Grant Consortium, this project would have not been possible. Thank you!

References

1. Mallawaarachchi, Vijini. “Introduction to Genetic Algorithms - Including Example Code.” *Medium*, Towards Data Science, 1 Mar. 2020, towardsdatascience.com/introduction-to-genetic-algorithms-including-example-code-e396e98d8bf3.

Questions ?