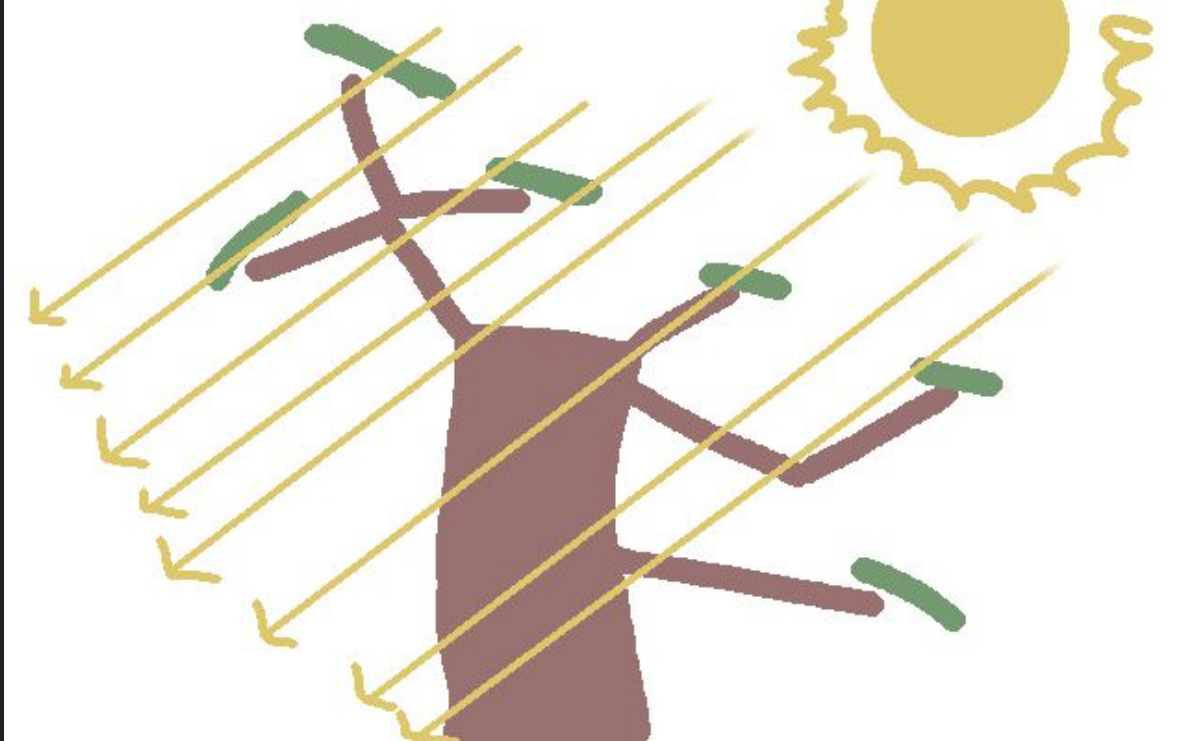


# Growing Trees with the Genetic Algorithm



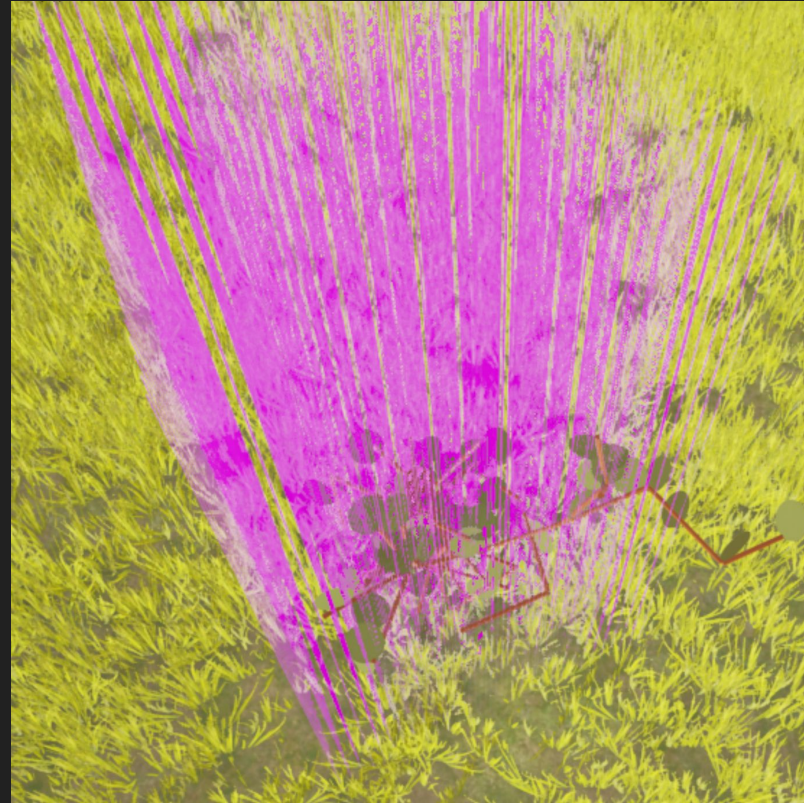
# Our Goal

- Catch as much sun as possible!



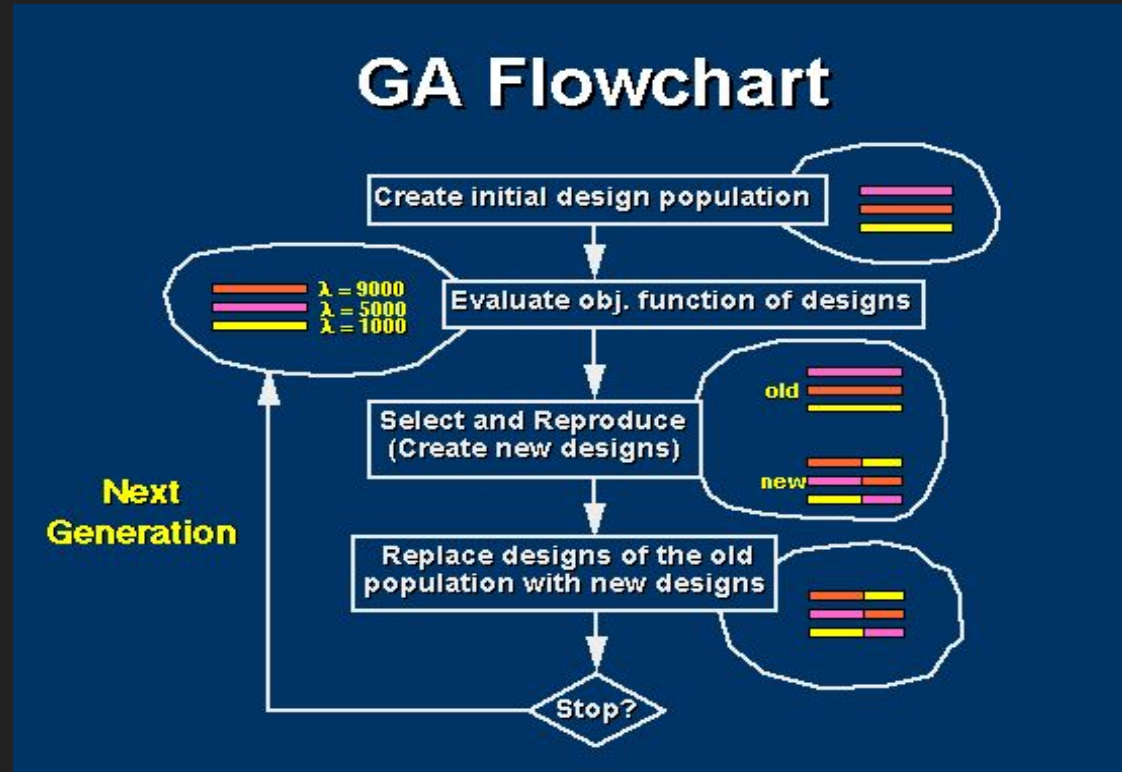
# Implementation - Setup

- Unreal Engine 4
- Ray traces
- Simple fitness function
- Building of graphical interface



# The Genetic Algorithm

- General idea - Evolution
- Fitness
- Stochastic selection
- Combining DNA
- Incremental improvement
- Complexity vs Creativity
- Why is GA suitable for our problem?



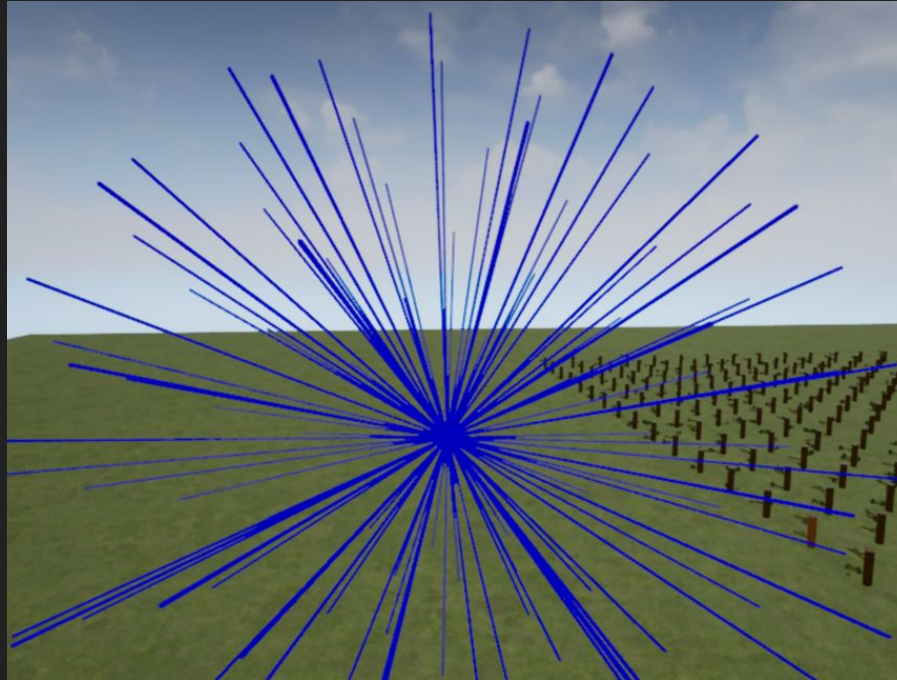
# Implementation - Algorithm

- A functioning algorithm
- Physical and DNA representation of tree, branches, leafs
- Mutation
- Sexual vs Asexual reproduction
- Fitness functions
- Convergence
- Population



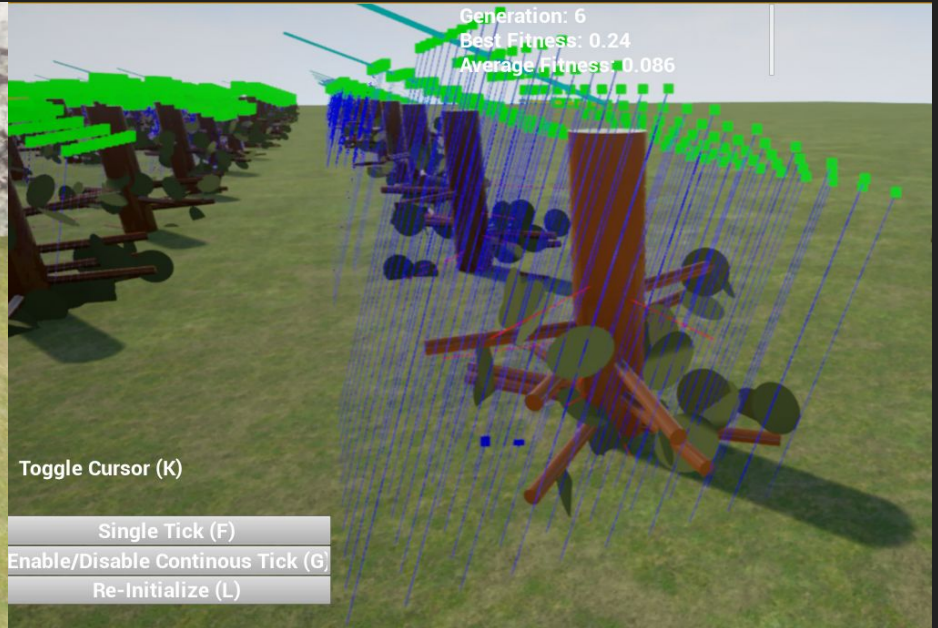
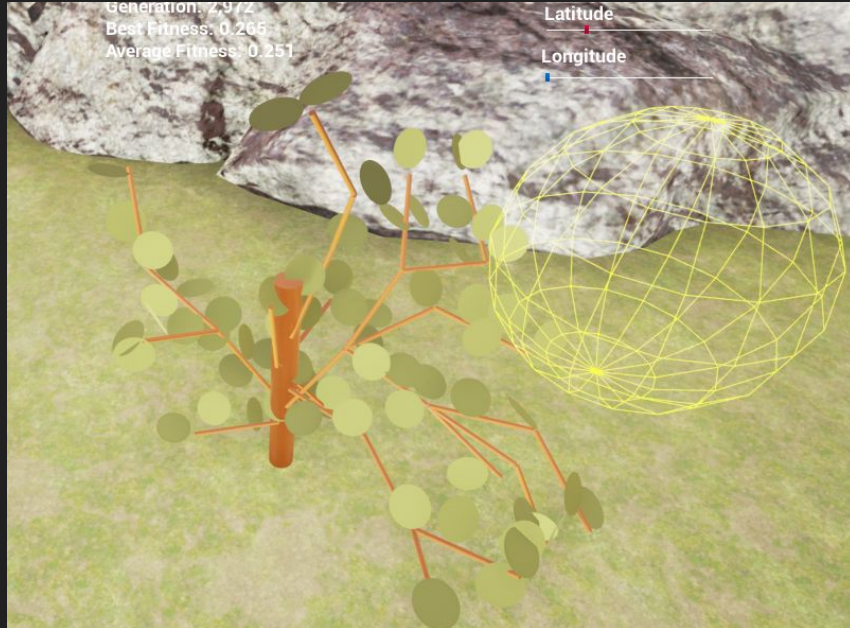
# Fitness Function

- A function that evaluates a tree for each generation tick
- Mimics the sun
- Different types
- Experimenting



# Fitness Function - Improvements

- Parallell rays
- Player controlled functions



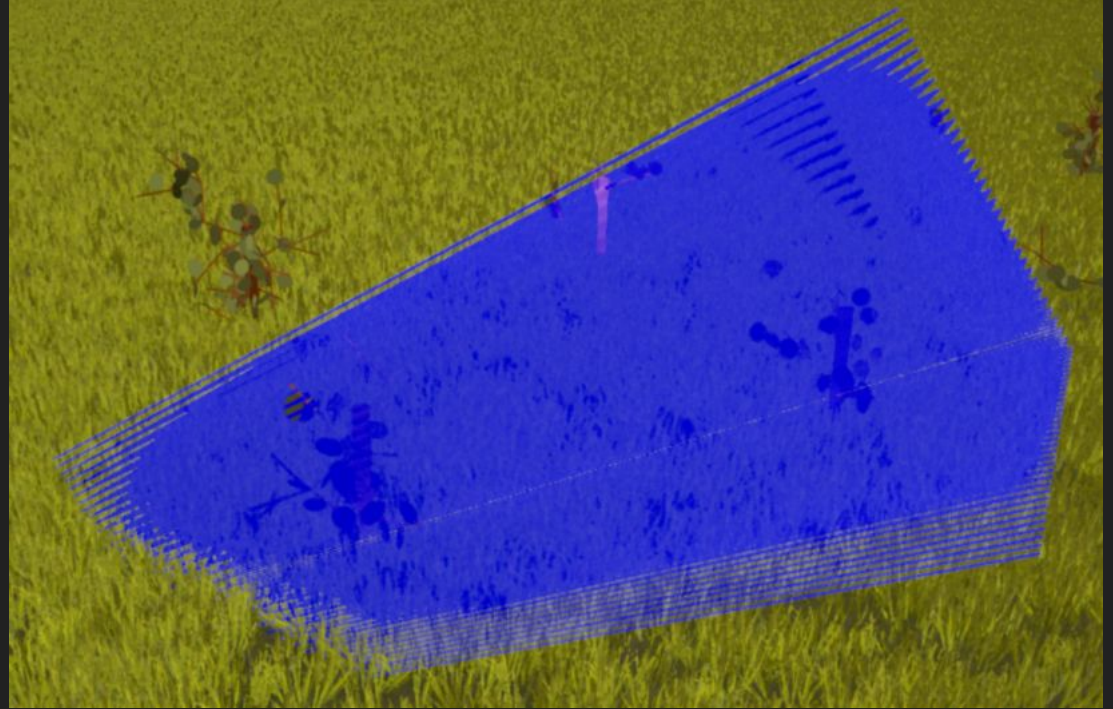
# Fitness Function type - Normal (straight above)





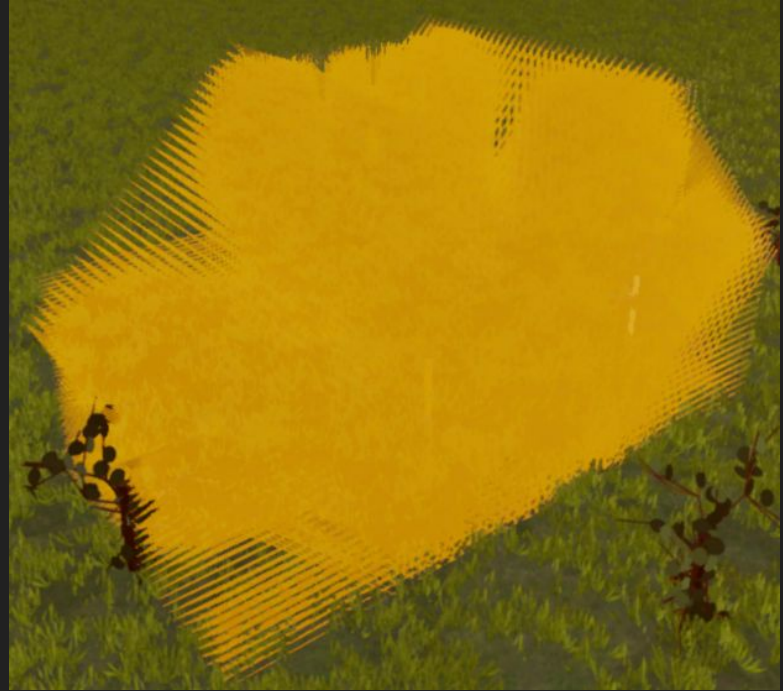
# Fitness Function type - Manual

- Any direction



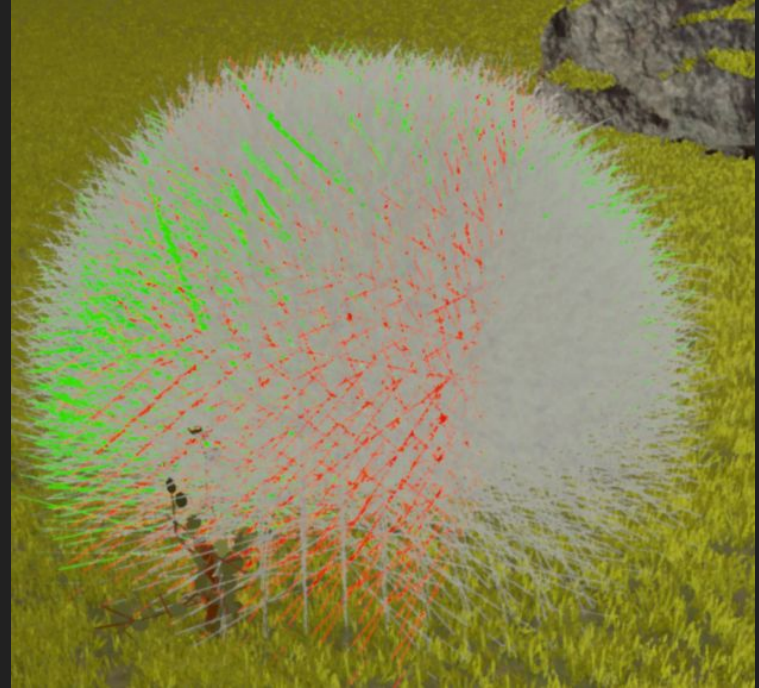
# Fitness Function type - Sweep

- Shoots rays from multiple angles
- Gave somewhat vague results



# Fitness Function type - Hemisphere

- Trail and error
- Gave good results with increased res.



# Fitness Straight Above

Generation 1



Generation 10 000



# Hemisphere Fitness

Generation 1



Generation 16 000

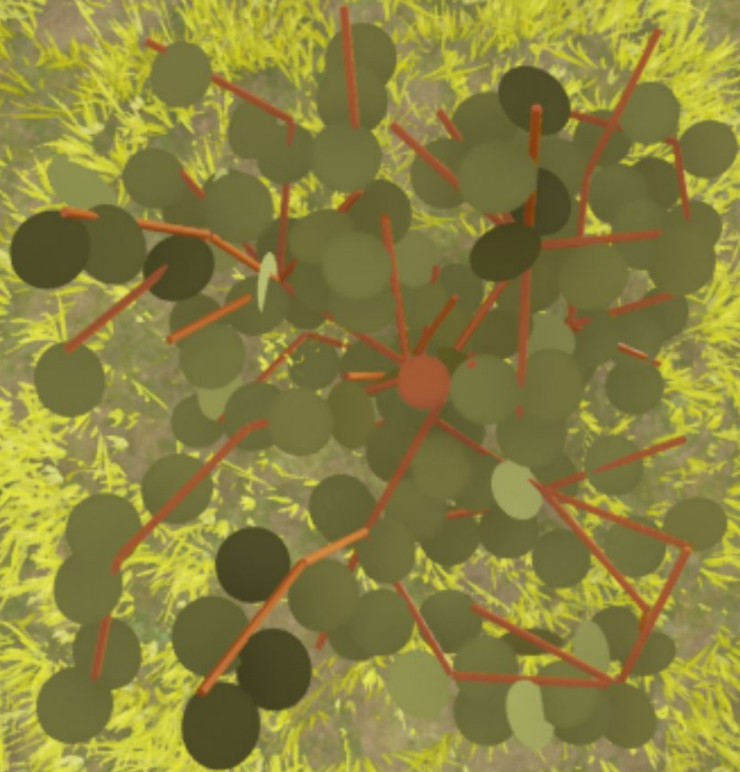


# Changing Environment

- User controlled obstacles
  - Cubes
  - Rocks
  - Plates
- 
- All scalable and rotatable



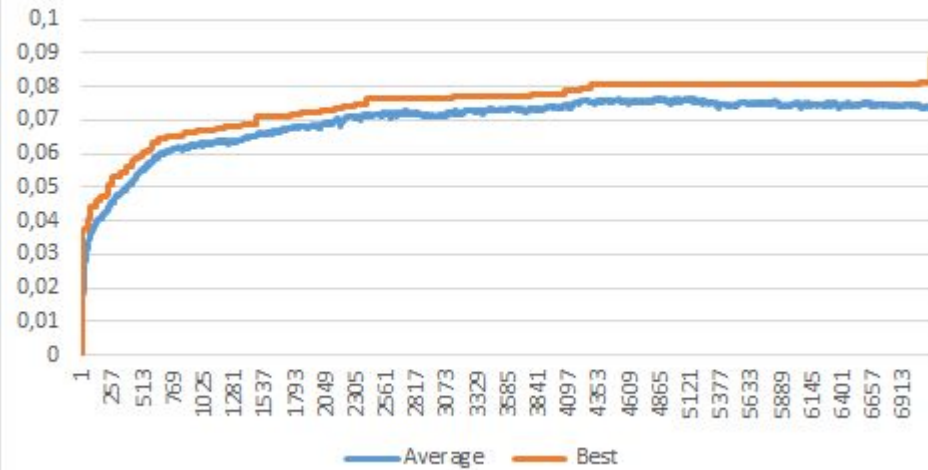
# Comparison - Fitness Straight Above



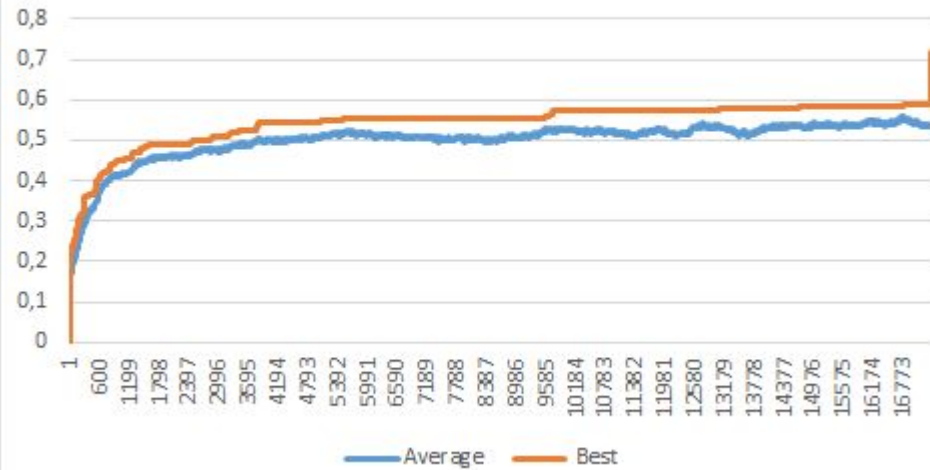
# Results

- With what can we compare our results?

### Hemisphere Fitness



### Straight raytrace fitness





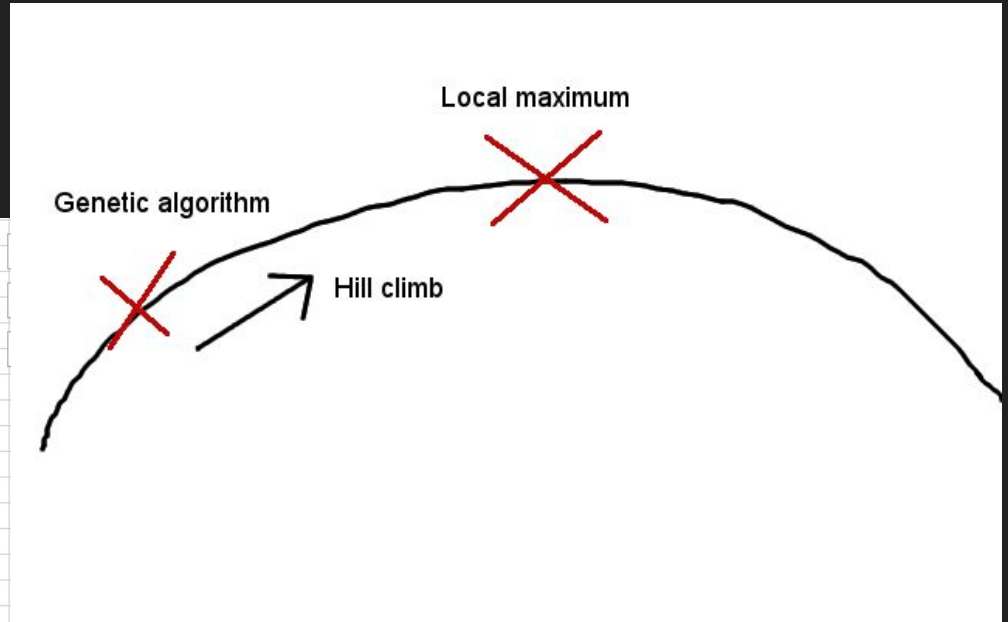
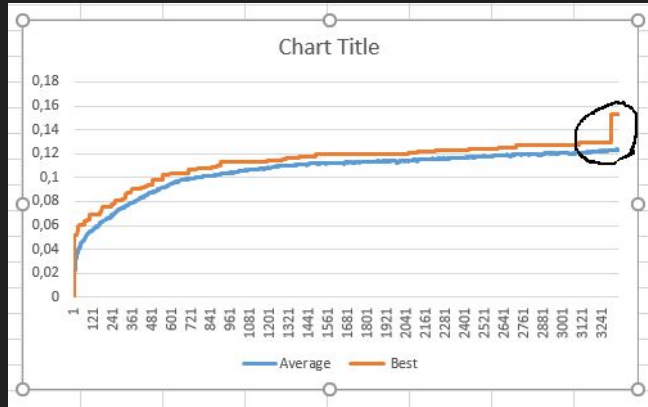
# Implementation - Improving the algorithm

- Sexual reproduction
- Modular data structure for branches
- Soft random selection
- Replacements per generation
- Lower mutation frequency, more possible mutations



# Hill climbing

- Should only be performed when GA seems to have converged.
- Reaches local maximum.
- Destroys possibility to continue genetic algorithm.



# GUI



# Conclusion

- Problems, solutions, lessons learned
  - Selection
  - Reproduction
  - Data structure
  - Fitness
- Weaknesses and strengths of GA
  - Creativity
  - Complexity
  - Dependent on ad-hoc algorithms.
- Overall, satisfying results and our goals were reached.