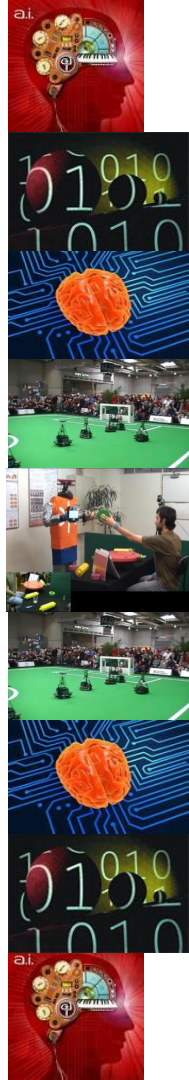
Genetic Programming

Genetic Programming (GP)

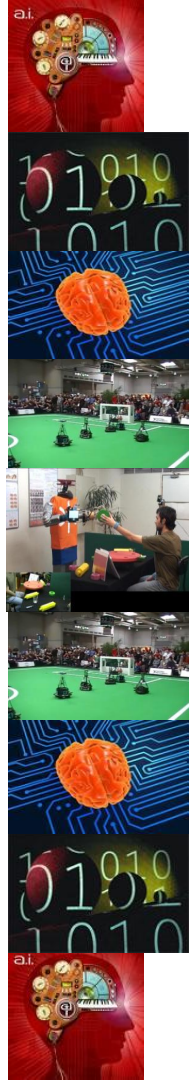
- GP is an extension of Genetic Algorithms.
- GP searches for a solution in a program space.
- An individual in GP is considered to be a program.
- It's actually an executable expression.



GP Algorithm

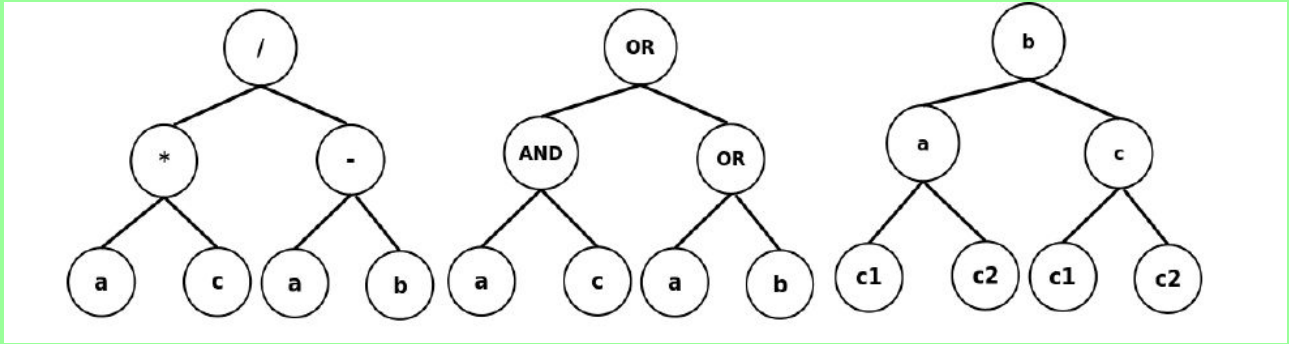
Algorithm 1 Genetic Programming

1: Create an initial population of programs
2: Execute each program and establish the fitness
3: **while termination condition not met do**
4: Select fitter programs to participate in reproduction
5: Create new programs using genetic operators and update the population
6: Execute each new program and establish the fitness
7: **end while**
8: **return** best program



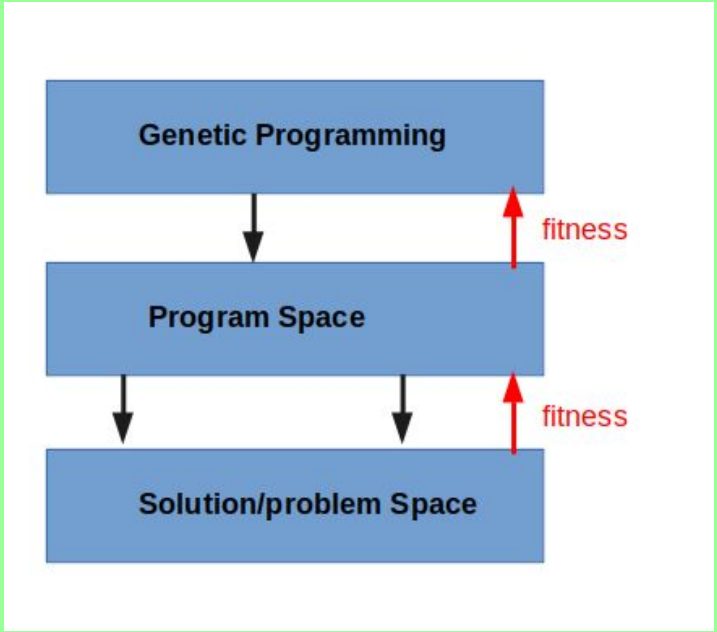
GP Representation

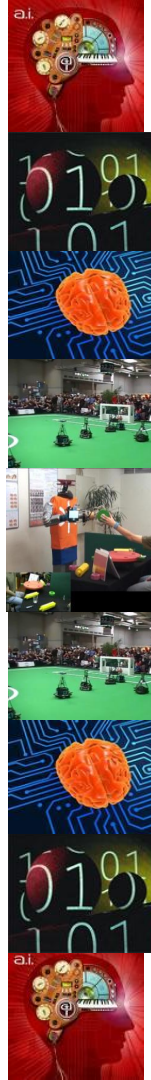
- **Syntax tree. Other representations linear etc.**



1. f= (a*c)/(a-b) (arithmetic tree)
2. f= (a AND c)OR(a OR b) (logical tree)
3. C1= b -> a (rules - decision tree)

GP Functionality

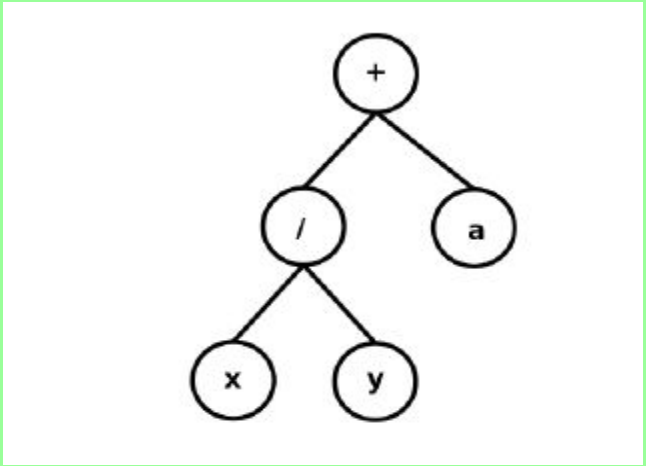




Initial Population Generation

- A population of executable expressions is generated.
- An individual in GP is a syntax tree.

f= (x/y) + a



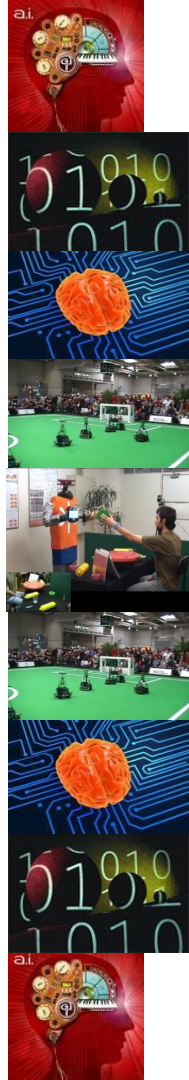
Initial Population

Tree Generation Methods

1. Full
2. Grow
3. Ramped-half and half

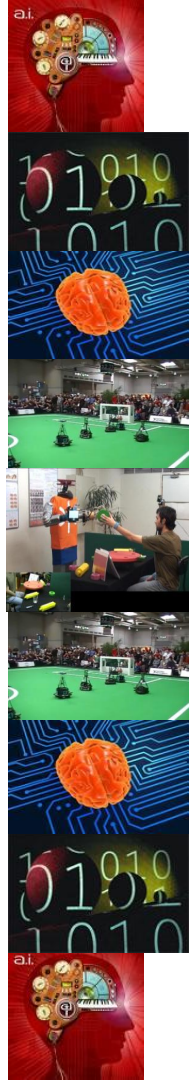
Parameters

1. Initial tree depth.
2. Maximum tree depth.
3. Population size.



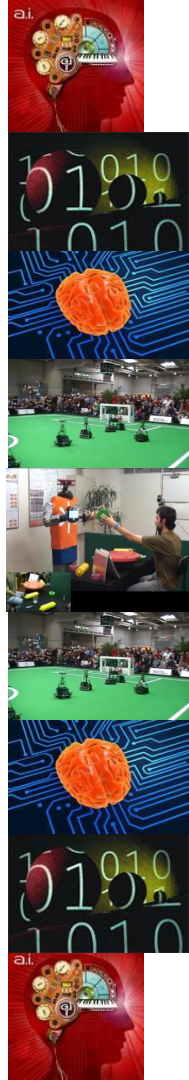
Initial Population Generation

- Function set is problem dependent {*,/, +,-}
- Terminal set is values e.g costants.
- The root and middle nodes obtain values from the function set.
- Leaf nodes obtain values from the terminal set.



Fitness Function

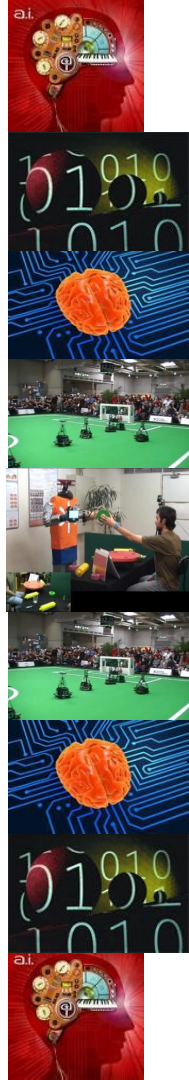
- **The Fitness function is problem dependant.**
- **It must be an effective measure of the goodness of the program to solve the problem.**



Selection Methods

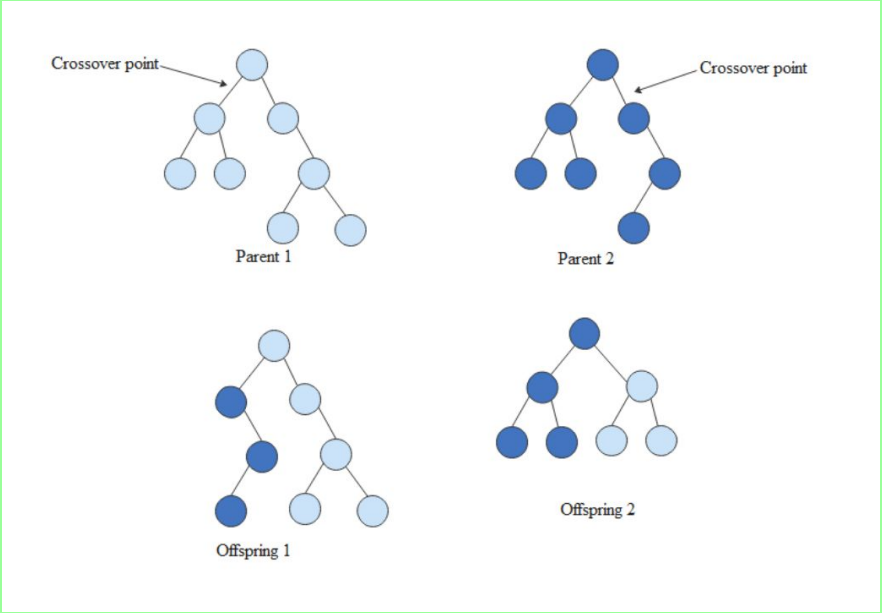
- **Tournament selection (tournament size)**

- **Fitness proportionate - mating pool**



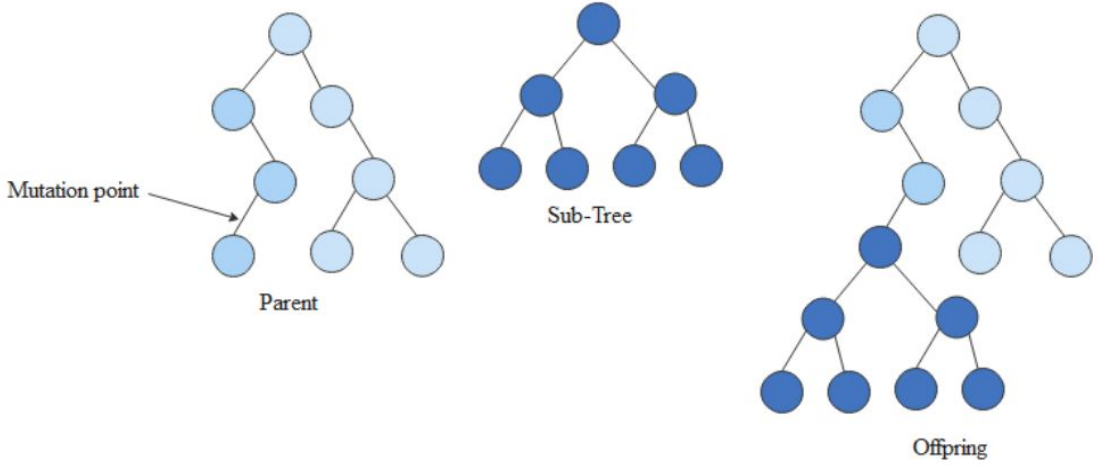
Genetic Operators

- **Subtree Crossover.**



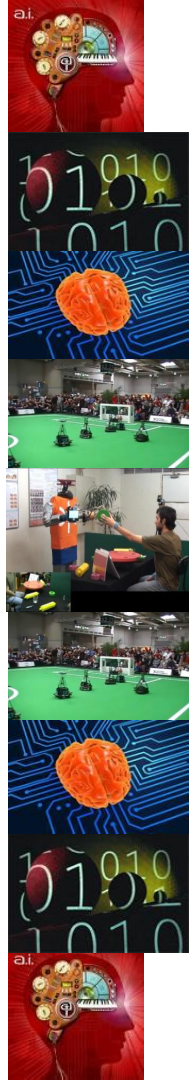
Genetic Operators

- **Grow mutation**



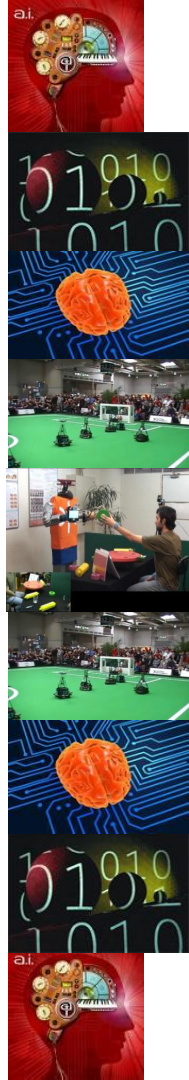
Genetic Operators

- Reproduction - move parents into the next population.
- If it's the fittest individual then its elitism.



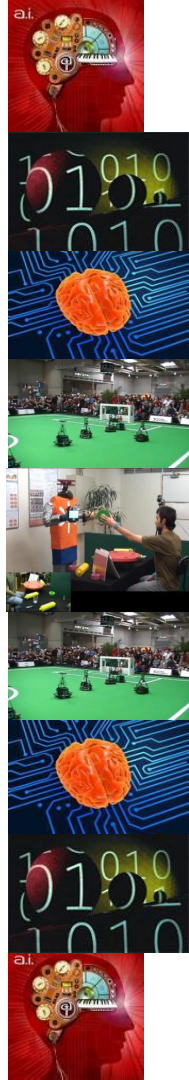
Population Update

- **Generational.**
- **Steady state.**



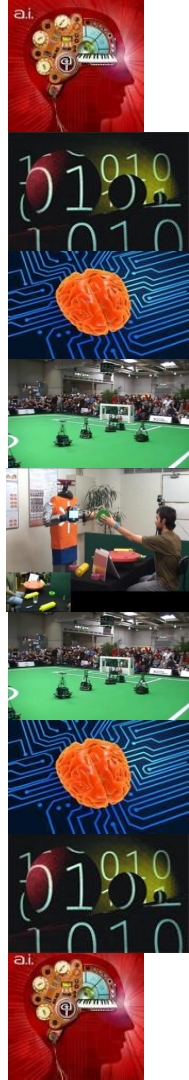
Termination

- **Objective function met.**
- **Number of generations achieved.**



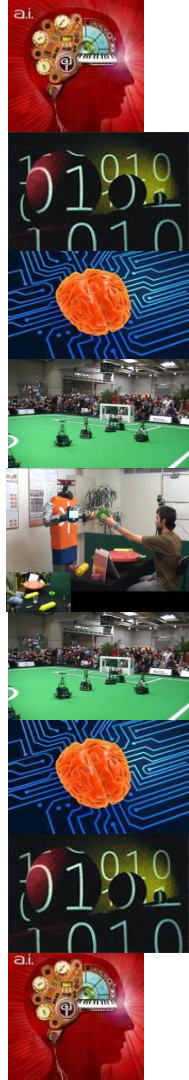
Applications

- Symbolic regression.
- Robotics.
- Cyber-security.
- Data mining …..because ???
- Finance stock performance.



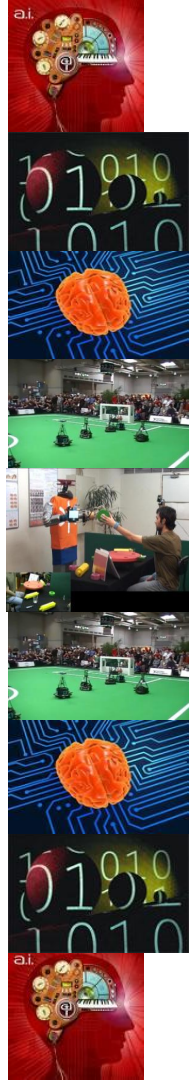
Variants

- Linear GP.
- Strongly typed GP.
- Cyber-security.
- Cartesian GP
- Grammar based GP.



Type Selection

- Problem dependant.
- Computational resources.
- Desired output structure - e.g explainability.



QUESTIONS.