Starptautiskā zinātniska konference
VIDE. TEHNOLOĢIJA. RESURSI
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PĒTERIS GRABUSTS

EVOLUTIONARY ALGORITHMS AT CHOICE: FROM GA TO GP

Evolutionary computation: an introduction

EC Evolutionary Computation

=

EP Evolutionary Programming (Fogal 1962)

+

ES Evolutionary Strategies (Rechenberg 1973)

+

GA Genetic Algorithms (Holland 1975)

+

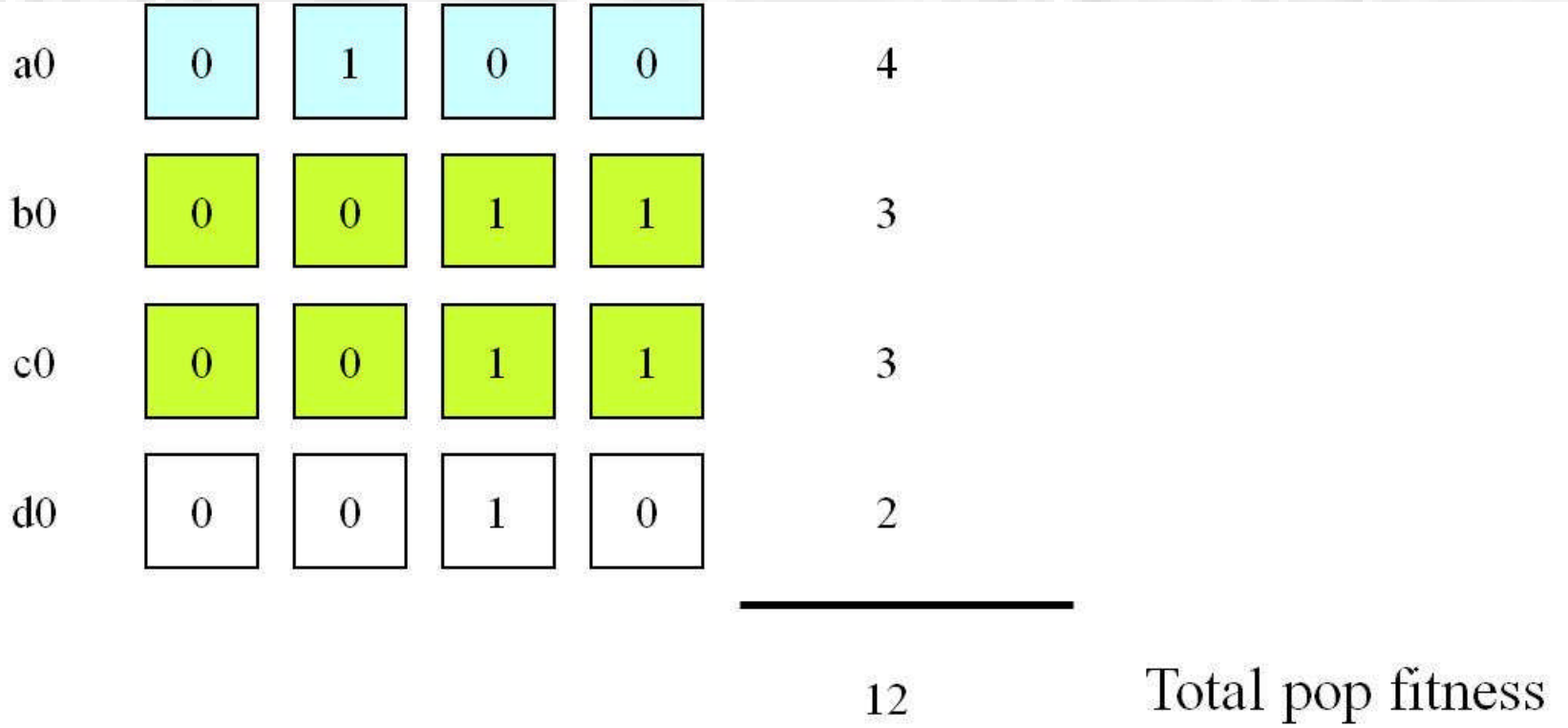
GP Genetic Programming (Koza 1992)

Three basic mechanisms drive natural evolution:

- *crossover*
- *mutation*
- *selection*

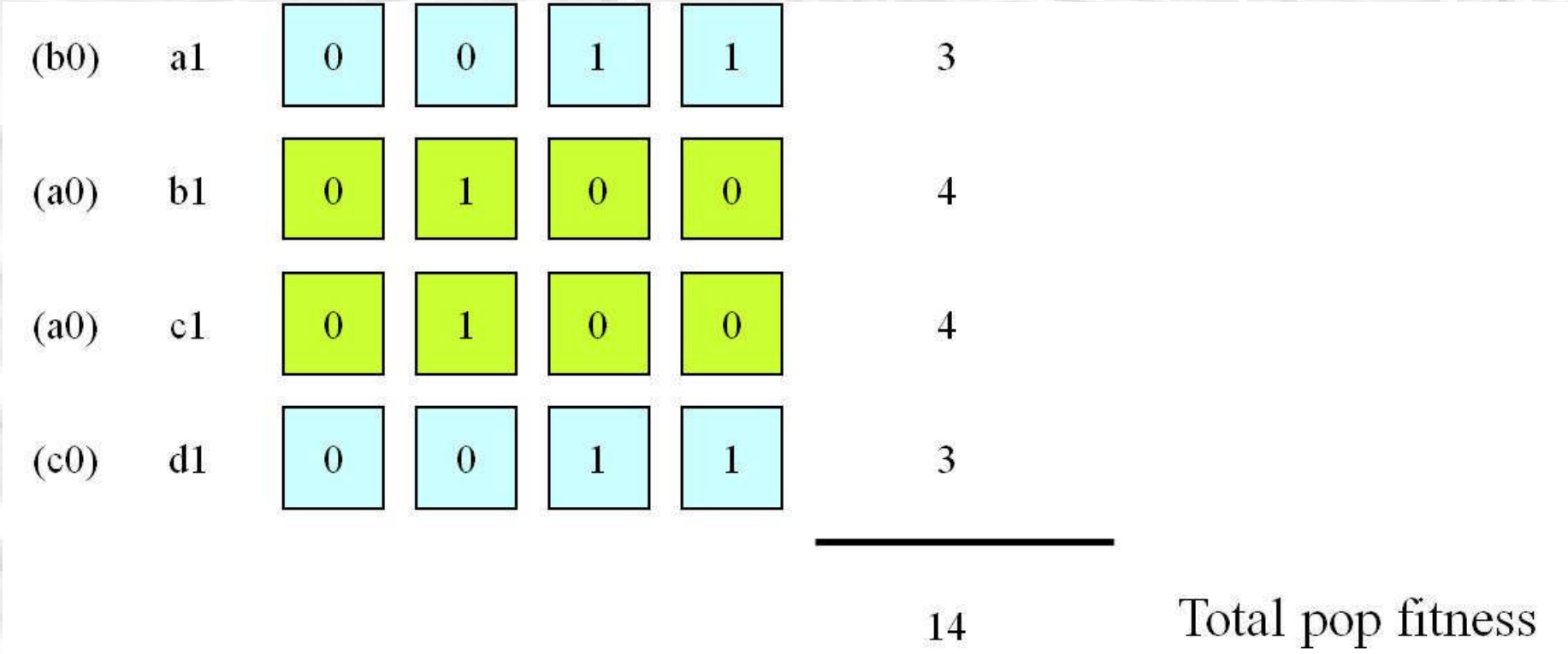
Initial

- For this very simple example we will use a population size M=4. These are generated randomly…..



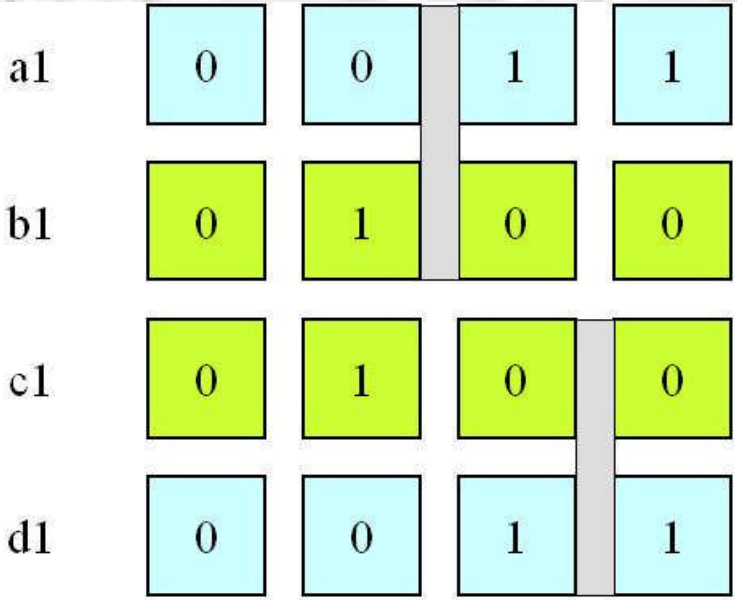
Selection

Select probabilistically according to fitness

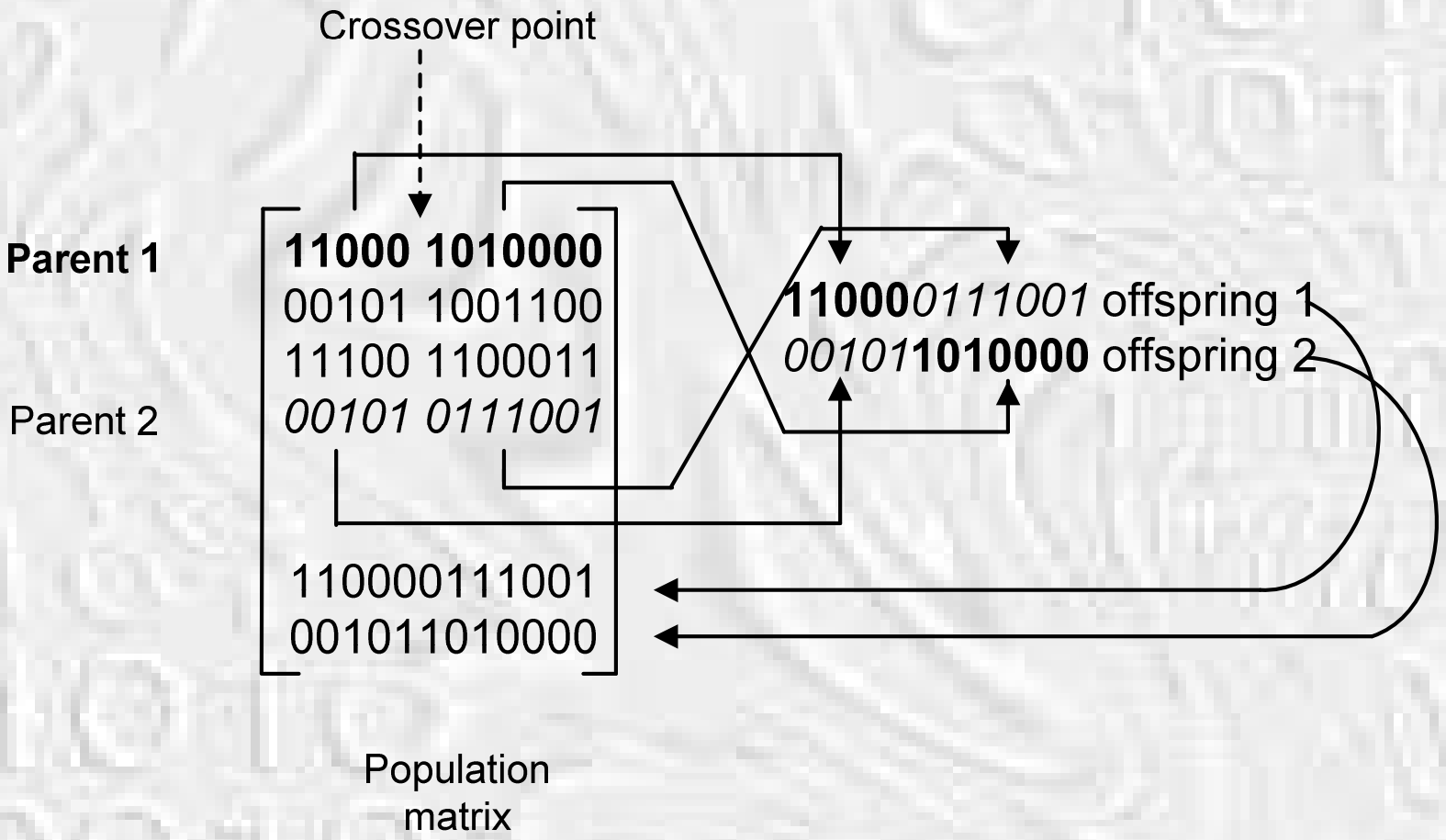


Crossover

Pick chromosome pairs and locus randomly…



The creation of offspring



Mutation

With small probability mutate (here flip the bit) each gene value.

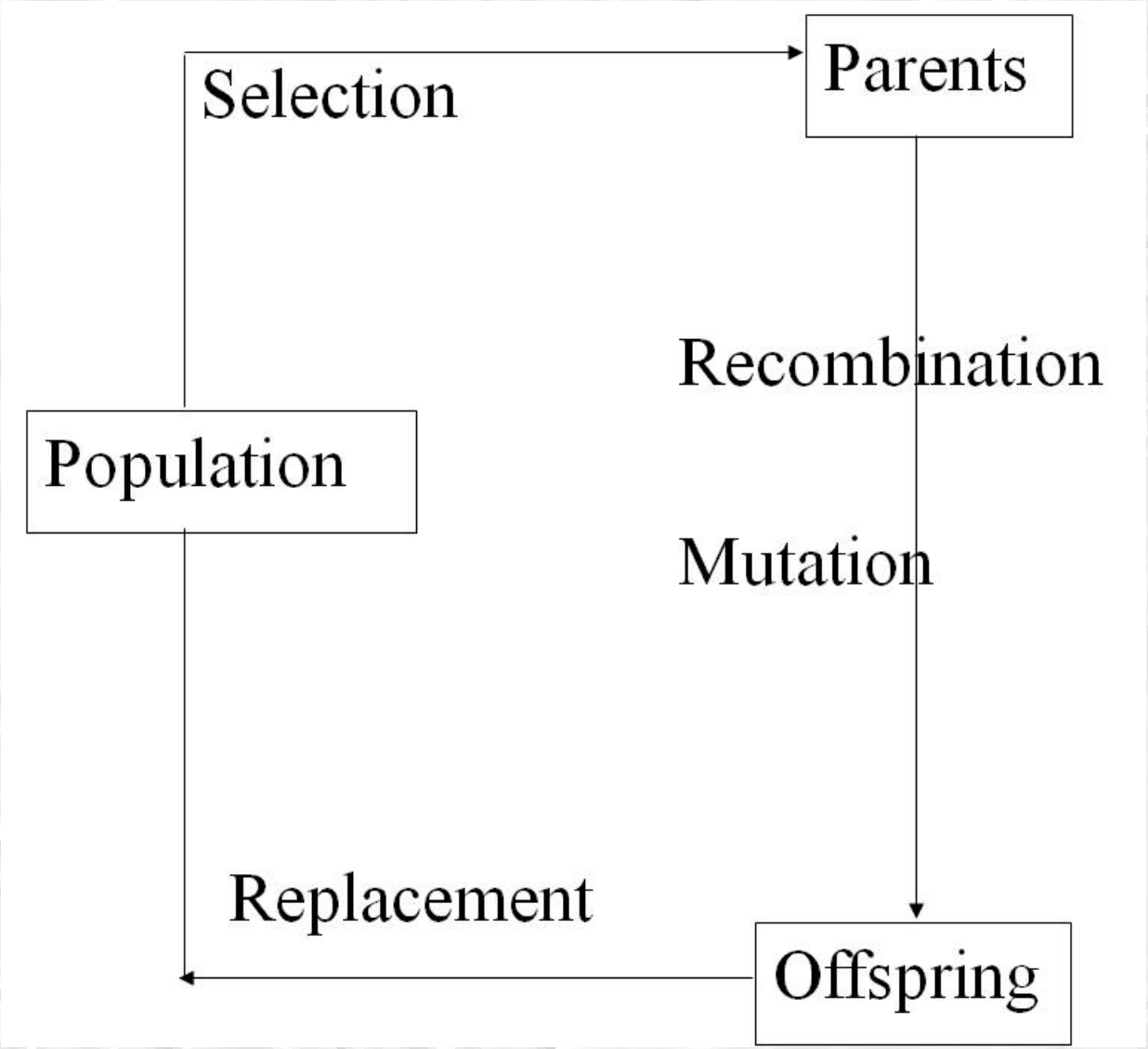
a	0	0	0	0	0
b	0	1	1	1	7
c	0	1	0	1	5
d	1	0	1	0	10
					22 Total pop fitness

Steps to Evolution

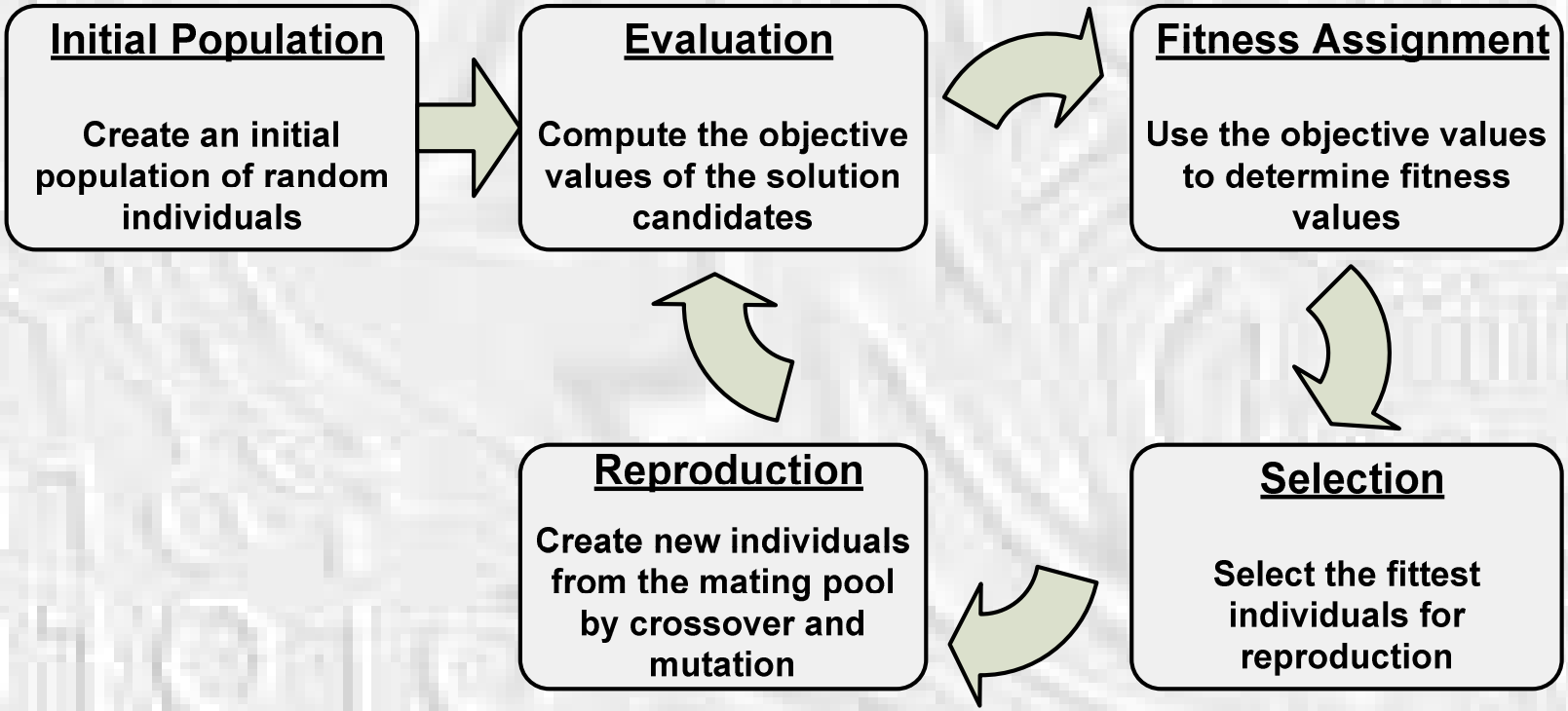
Select a problem domain then:

1. Create a population of individuals that represent potential solutions
2. Evaluate the individuals
3. Introduce some selective pressure to promote better individuals (or eliminate lesser quality individuals)
4. Apply some variation operators to generate new solutions
5. Repeat

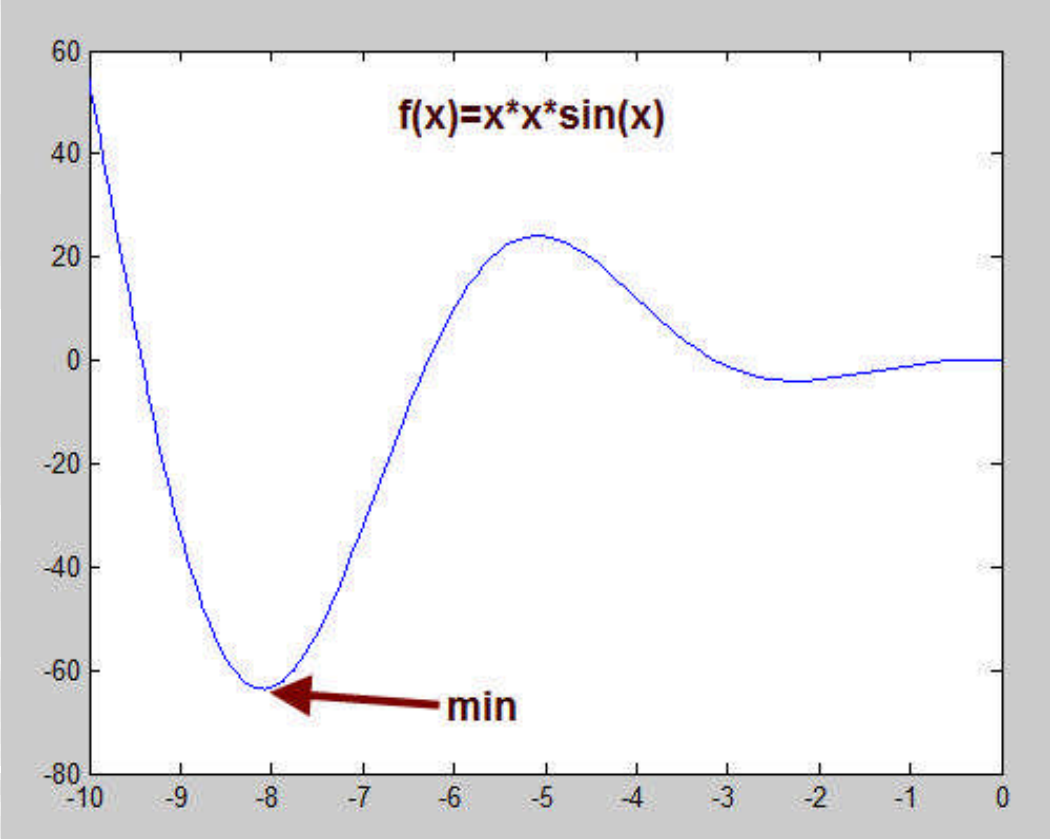
Evolution Mechanism



The basic cycle of EA



Test function $f(x)=x^2 *\sin(x)$



minimum: f(-8.0962)=-63.635 for $-10 \leq x \leq 10$

Best cost=-63.635 and best solution=-8.0962.

Experiment

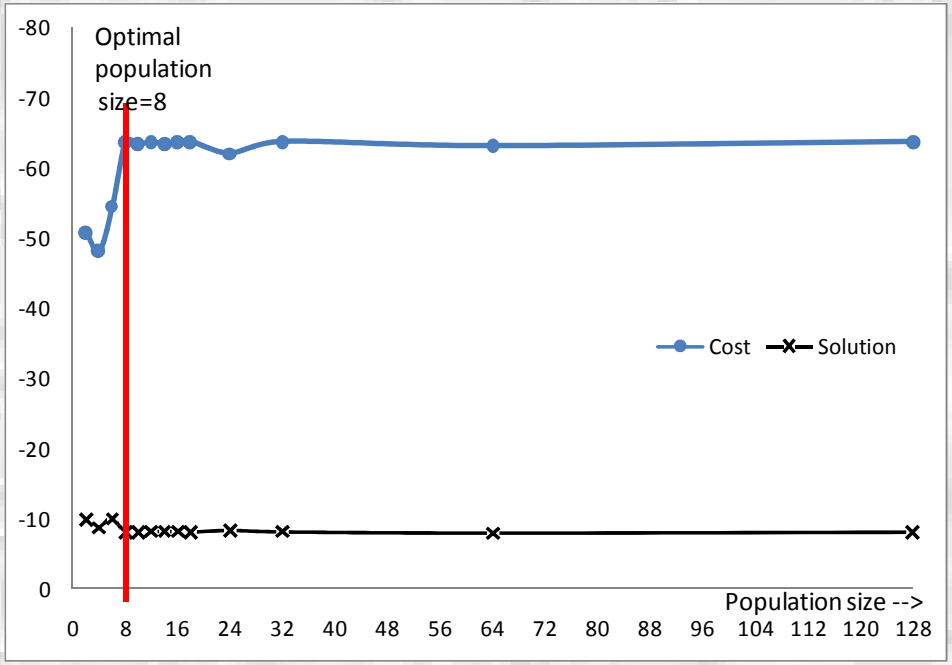
The goal of the experiment was to find the minimum of the function with the help of GA.

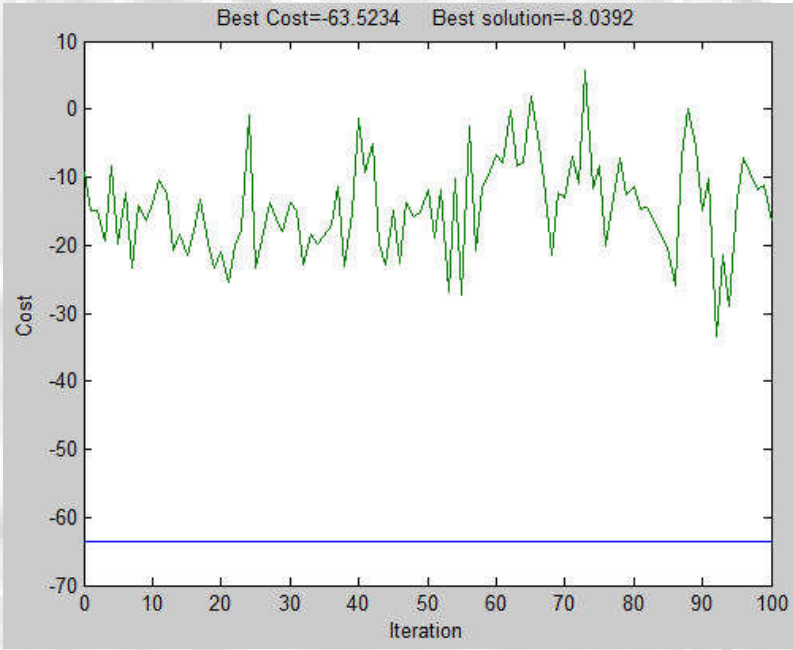
The influence of three parameters on the quality of optimization has been investigated:

- population size;
- mutation rate;
- number of bits in parameters.

population size

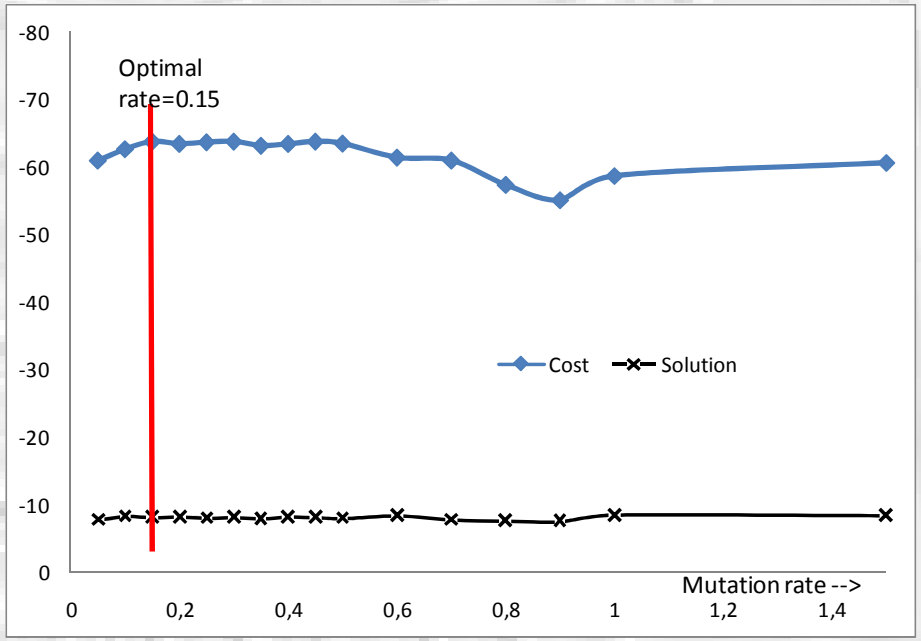
Optimization dependence on parameter *population size*

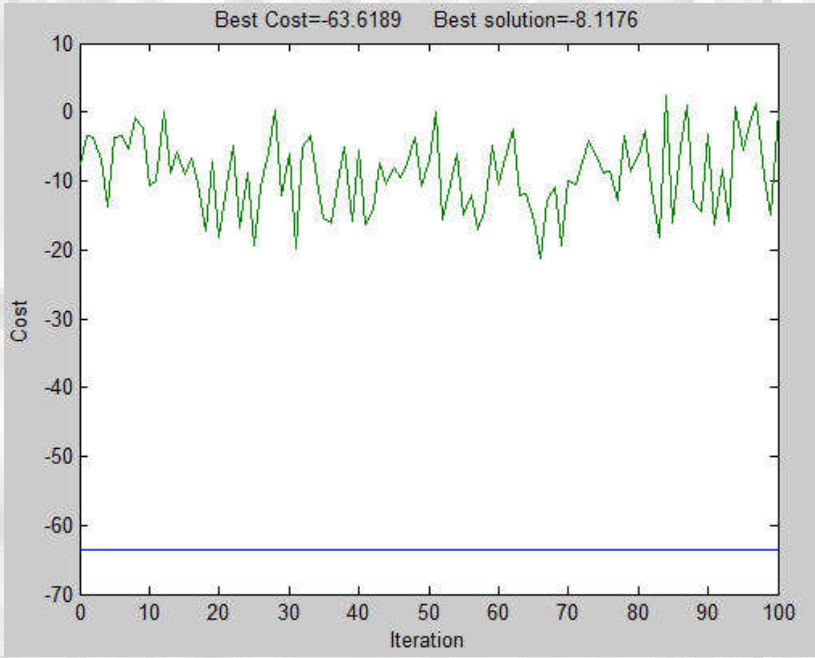




mutation rate

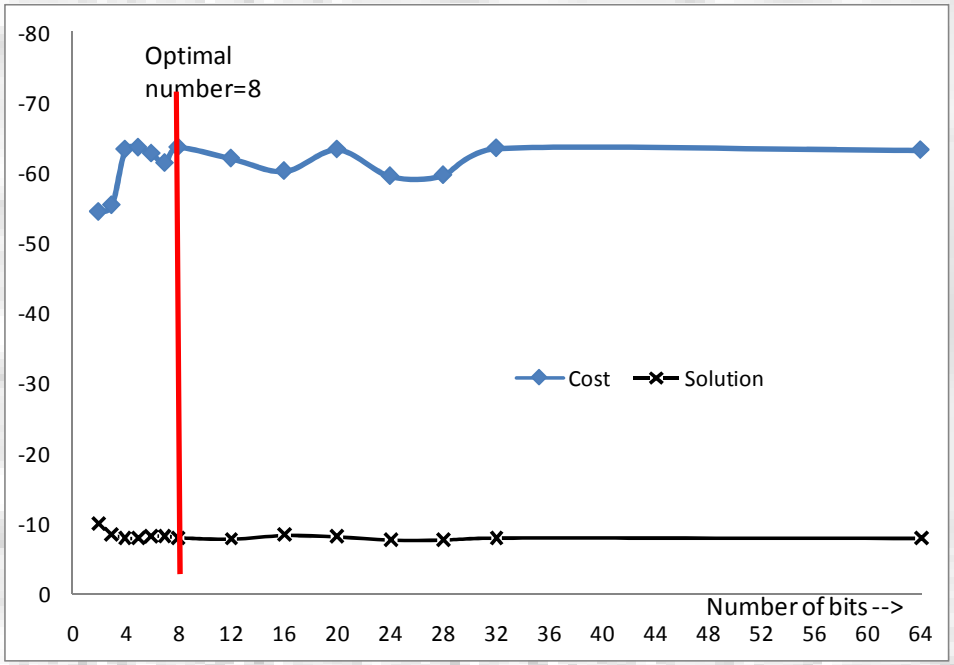
Optimization dependence on parameter *mutation rate*

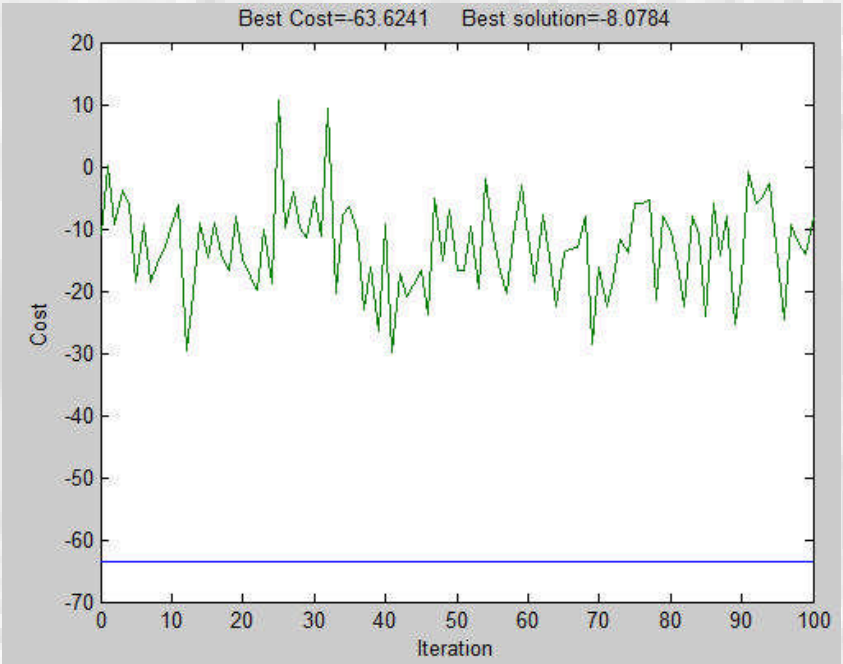




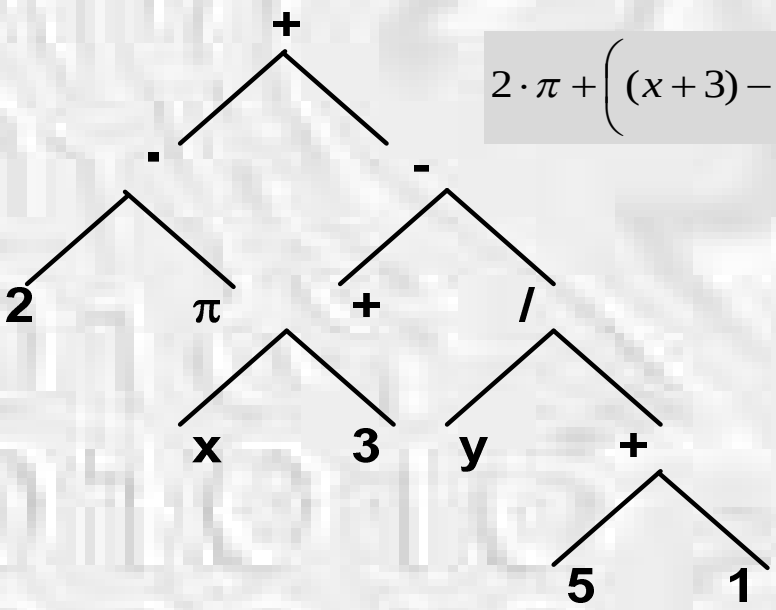
number of bits in parameters

Optimization dependence on parameter *number of bits*

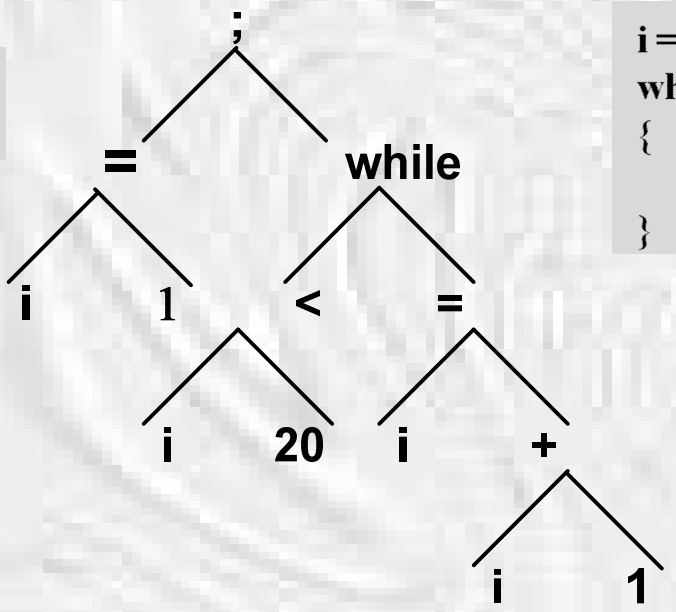




From GA to GP
An example of tree-based representation

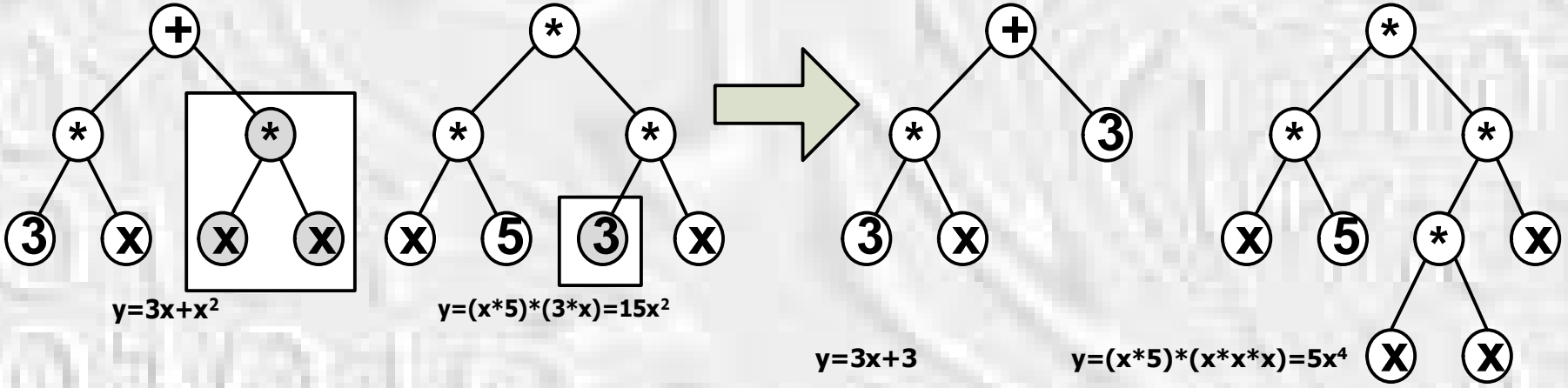


$$2 \cdot \pi + \left((x+3) - \frac{y}{5+1} \right)$$




```
i=1;
while (i < 20)
{
        i = i +1
}
```

Acquired new trees



Conclusions and future work

- GA are well suited for optimizing combinatorial problems.
- ES and EP are well suited for optimizing continuous functions;
- GP are well suited for problems that require the determination of a function that can be simply expressed in a functional form;

THANKS !