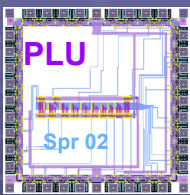


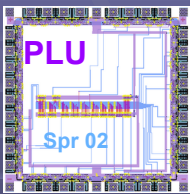
Genetic Algorithms



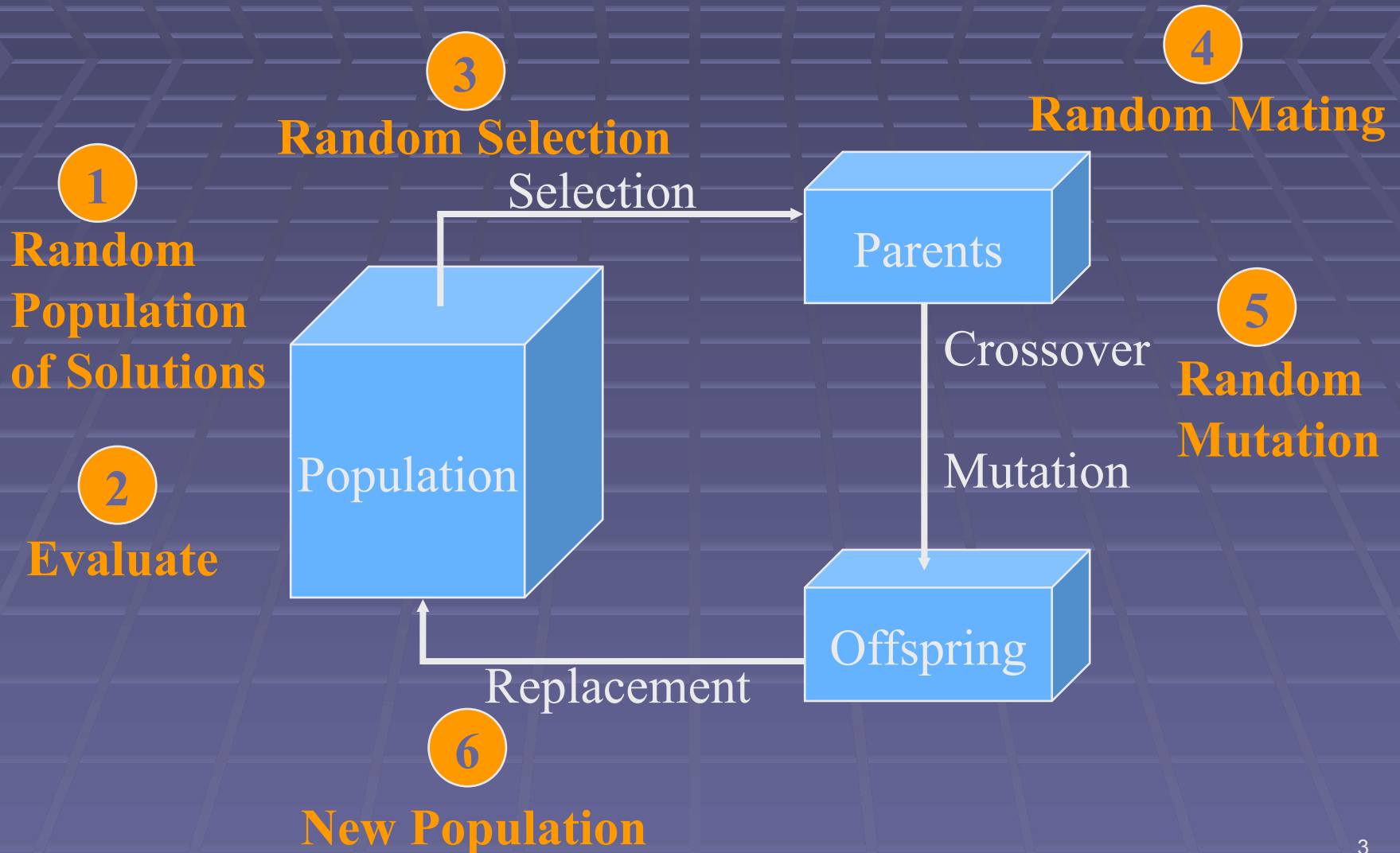
Definition

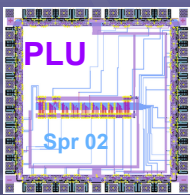
- Goldberg, 1989: “Genetic Algorithms are search algorithms based on the mechanics of natural selection and natural genetics.”
- A genetic algorithms is a directed random search procedure

A genetic algorithm borrows ideas from biology to search a solution space for a target value.

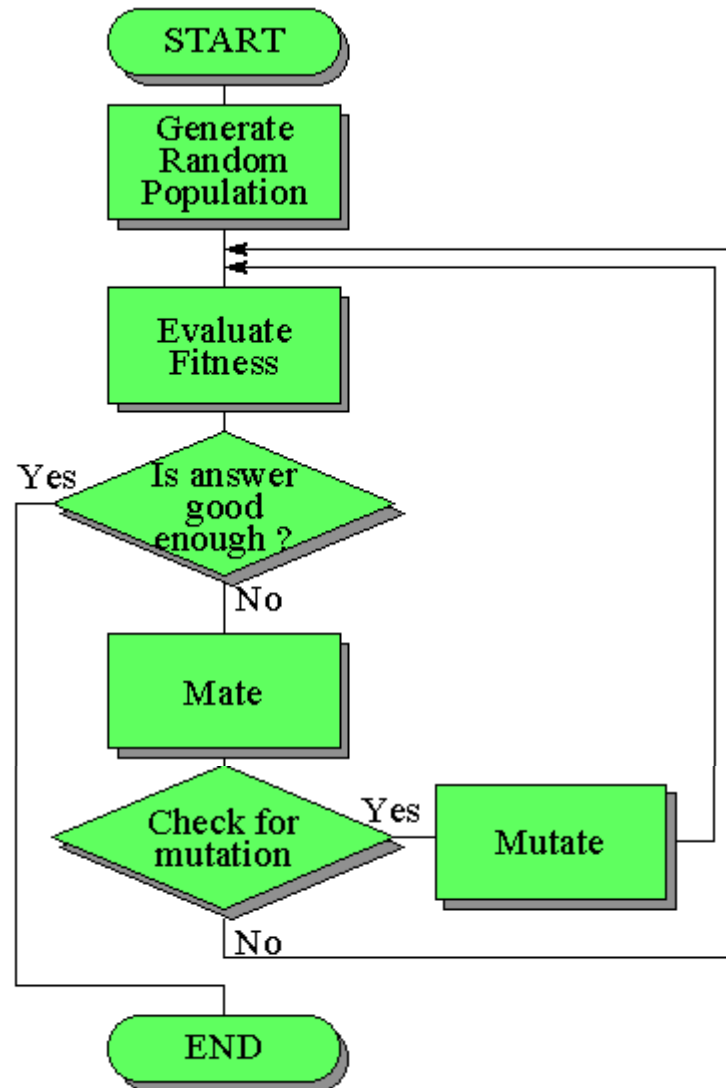


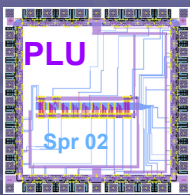
General Approach





GA Flow Chart

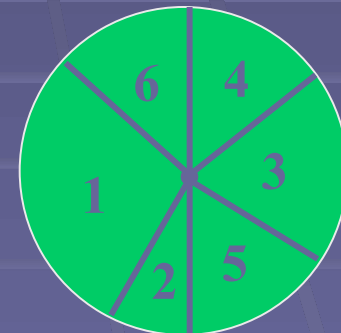


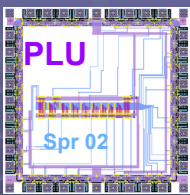


Parent Selection

- The process in which individual strings in the population are selected to contribute to the next generation is called **parent selection**
 - based on fitness
 - strings with a high fitness have a higher probability of contributing one or more offspring to the next generation
- Biased Roulette Wheel Selection

When you spin the wheel, items 1 and 5 have the greatest chance of coming up while item 2 has the smallest





Example

- Given the following population of chromosomes, select two parents:

Chromosome	Fitness	% fitness	cf
(1 0 1 0 0 1)	23	0.28	0.28
(1 1 1 0 0 1)	12	0.15	0.43
(0 1 1 0 1 1)	25	0.30	0.73
(0 1 0 1 1 0)	5	0.06	0.79
(0 1 1 0 1 0)	17	0.21	1.00
Total Fitness		82	

Find the total fitness of the population

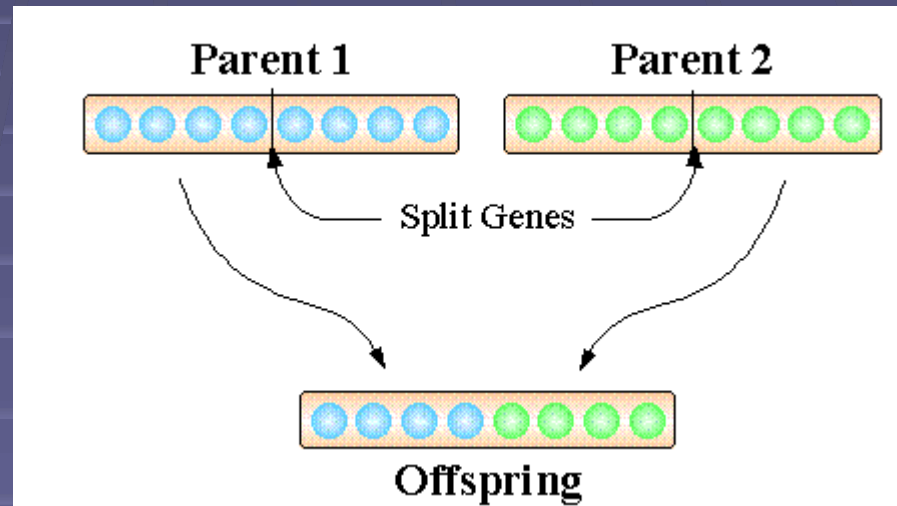
Find the %fitness of each element

Find the cumulative fitness

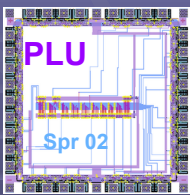
Now, throw a random number between 0 and 1, if it is in the range 0 to 0.28 select element 1, between 0.28 and 0.43 select element 2, . . .

Crossover

- Once two parents are selected, their chromosomes are mixed to create the children for the next generation

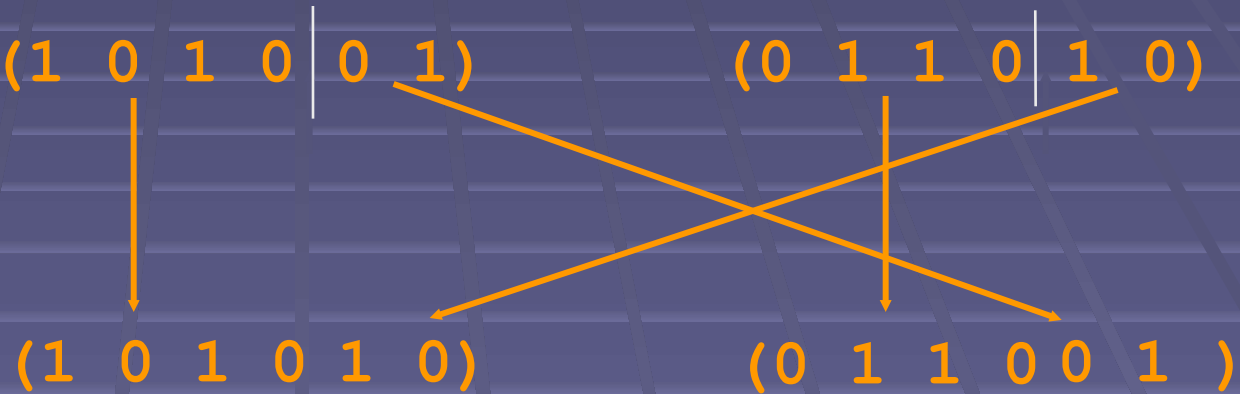


Called single point crossover



Example

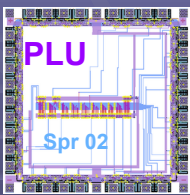
- Assume the parents selected from the previous example are:



These are the two children which are now part of the next generation

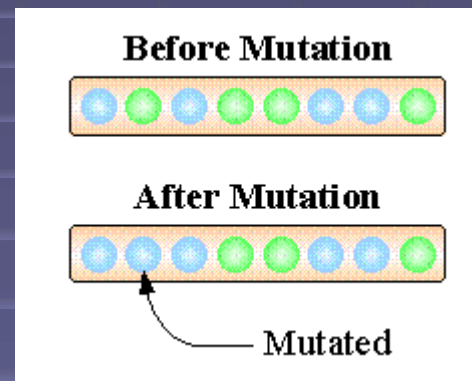
Find a random crossover point

Swap the bits after the crossover point



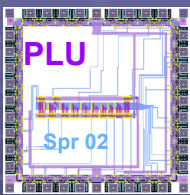
Mutation

- A bit in a child is changed (from 1 to 0 or from 0 to 1) at random



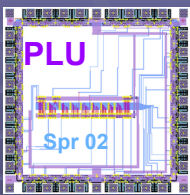
This is a small probability event

The effect is to prevent a premature convergence to a local minimum or maximum



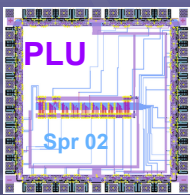
GA Performance

- Increasing diversity by genetic operators
 - mutation
 - Recombination
- Decreasing diversity by selection
 - of parents
 - of survivors



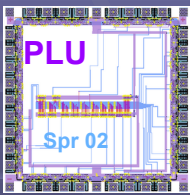
Effects of the Genetic Operators

- Using selection alone will tend to fill the population with copies of the best individual from the initial population
- Using selection and crossover will tend to cause the algorithm to converge on a good but sub-optimal solution
- Using mutation alone induces a random walk through the search space
- Using selection and mutation creates a parallel, noise-tolerant, hill climbing algorithm



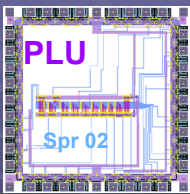
The Algorithm

- randomly initialize population(t)
- determine fitness of population(t)
- repeat
 - select parents from population(t)
 - perform crossover on parents creating population($t+1$)
 - perform mutation on population($t+1$)
 - determine fitness of population($t+1$)
- until best individual is good enough



GA Applications

- GA's can be applied to several parts of the physical design problem
 - Partitioning
 - Placement
 - Other . . .
- Scope of the Partitioning problem
 - A standard layout benchmark suite has circuits ranging from 13,000 to 200,000 nodes.
 - The number of links range from 50,000 to 800,000

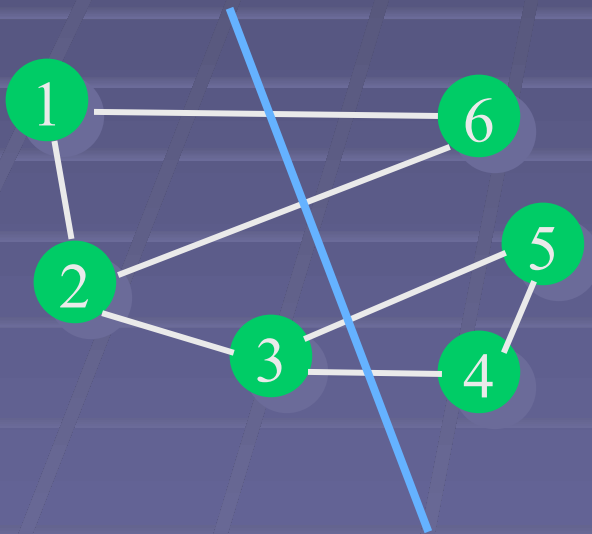


Representation

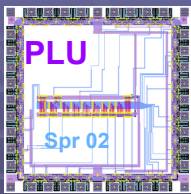
- A graph partition is represented by a binary string

Each node is represented by a bit

The 0 nodes are in one segment, the 1 nodes are in the other segment

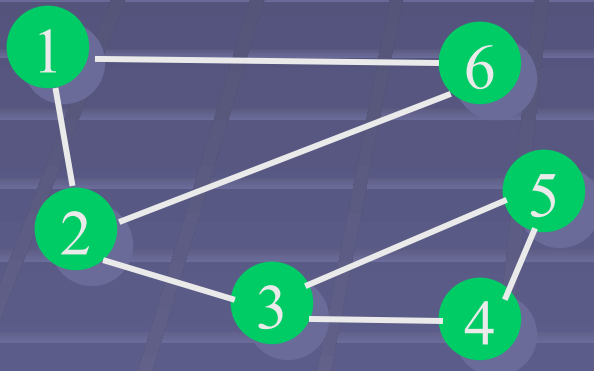


(0 0 0 1 1 1)



Population

- A random population of binary strings is produced



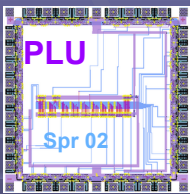
The fitness is the number
of links

(0 0 0 1 1 1) 4

(1 0 0 1 0 1) 4

(1 0 1 1 0 0) 5

(1 0 0 1 1 0) 4

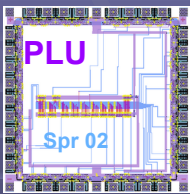


Crossover

- Parents are randomly selected (with a bias to the better fit elements)
- The parents are combined to create two children (single point crossover)

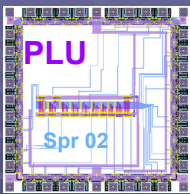
(0 1 0 1 0 1)
(1 0 0 1 0 1)

(1 1 0 1 0 1)
(0 0 0 1 0 1)



Mutation

- For a small number of the new population elements perform a mutation operation
 - Randomly select two nodes and swap their positions



Thank you