SEMINAR 6: GENETIC ALGORITHMS

Grado en Ingeniería Informática

Curso 2014 / 15
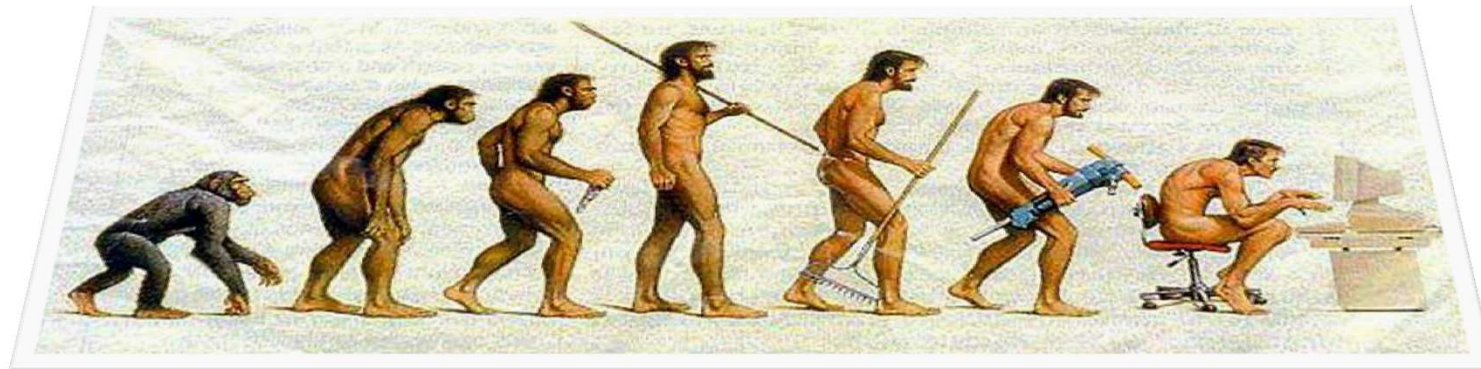
Objectives

❑ By the end of this lesson, students will:

    ❑ **Define** what a **Genetic algorithm** is

    ❑**Apply** PPN and Genetic algorithms to predict the weather

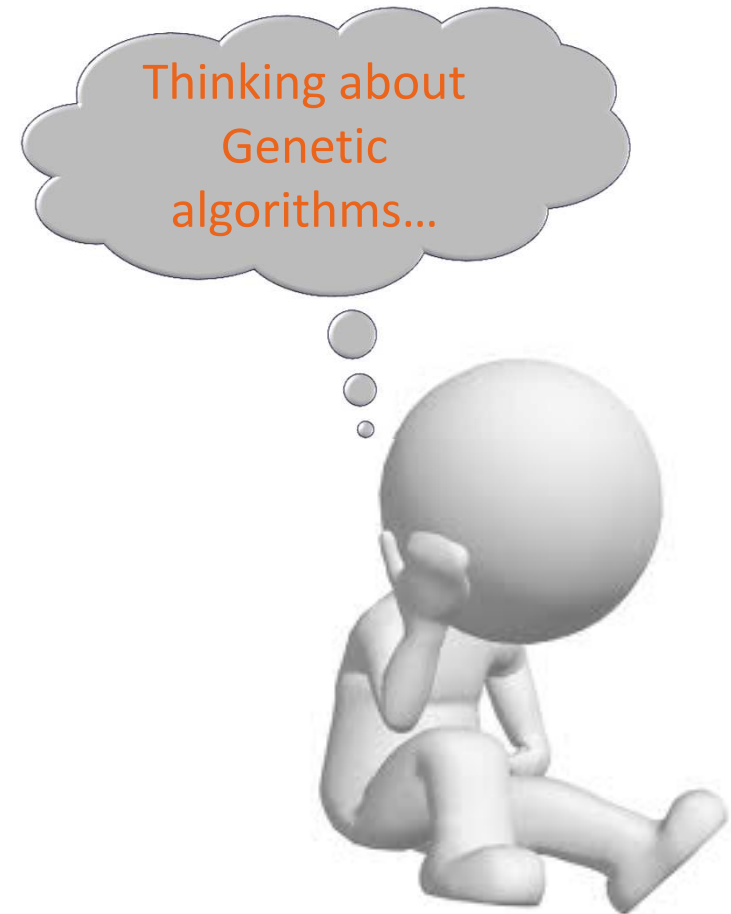# Introduction

❑ https://www.youtube.com/watch?v=Y-XMh-iw07w

Introduction

□ Questions about the video:

1. What do you think about Genetic algorithm?

2. In your opinion, what are the applications of Genetic algorithms?
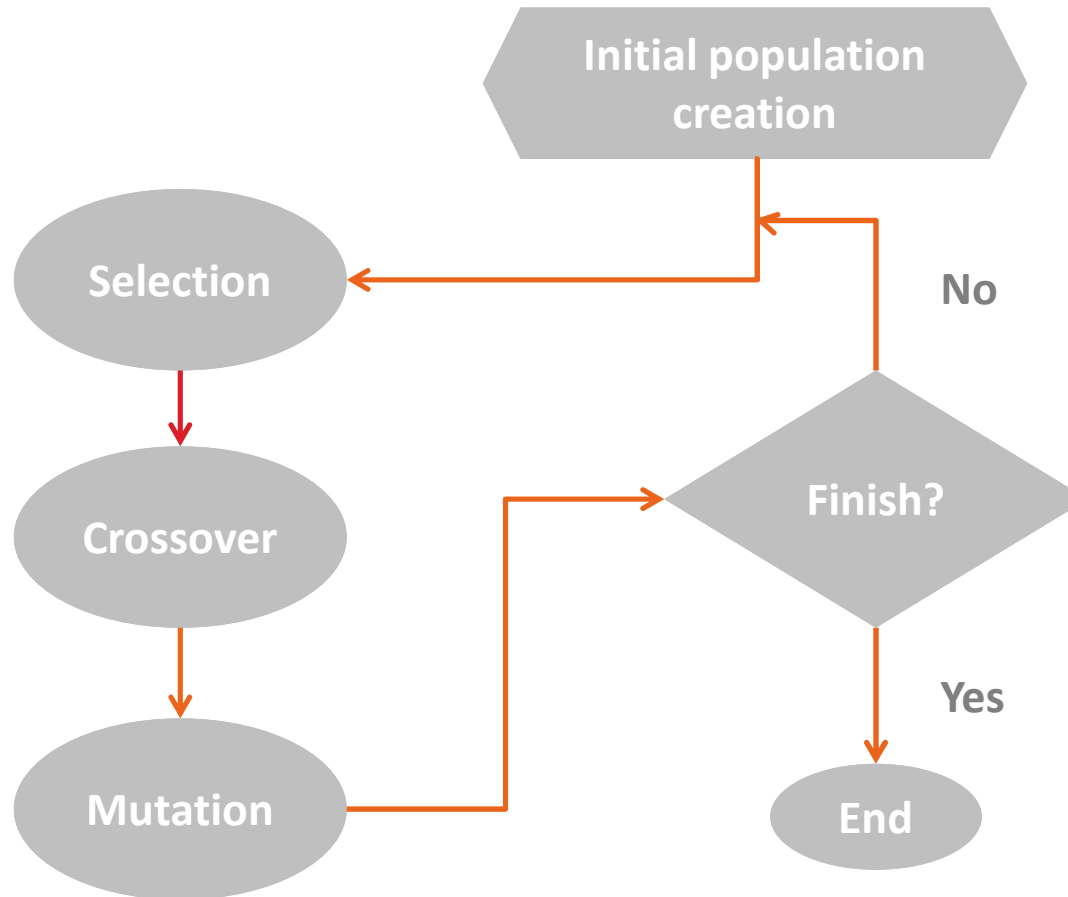
Thinking about Genetic algorithms...

Genetic Algorithm

- ❑ It was invented by John Holland (University of Michigan)

- ❑ It is a method of search and optimization solving problems

- ❑ It is a particular class of evolutionary algorithms

- ❑ It is based on biological evolution inspired techniques

How do they work?

Genetic Algoritm component

- ❏ A genetic representation of the solutions of the problem
- ❏ One way to create an initial population of solutions
- ❏ An evaluation function can measure the goodness of any solution
- ❏ A set of genetic operators such as probabilistic transition rules to guide the search
- ❏ The value of some input parameters that the genetic algorithm used to guide its evolution

Representation

❑ Genetic algorithms are applied to a population represented abstractly as *chromosomes* (encoding candidate solutions to a problem)

❑ Types of representation (depending on the type of data that each gene is encoded):

   ❑ Binary: 1 1 0 0 1

   ❑ Integer: 3 4 5 3 2

   ❑ Float: 3.2 4.21 5.1 -3.2 2.4

Initial population

❑ A random initial value is assigned of each gen

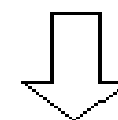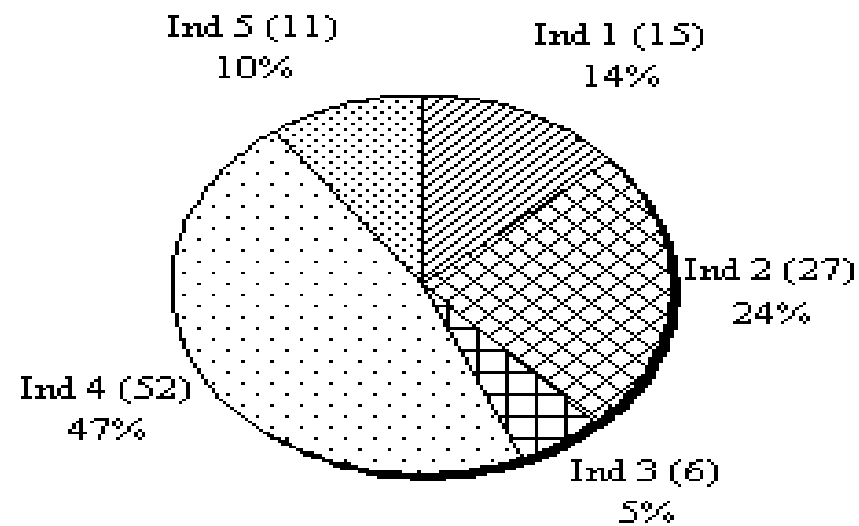| |
|---|
| 0 1 1 0 1 1 0 0 ……………………… |
| 1 1 0 0 0 1 1 1 ……………………… |
| 0 1 0 0 0 0 1 0 ……………………… |
| 1 0 0 1 1 1 1 0 ……………………… |

Fitness function

❑ **Goal**: Measuring the quality of the solution with respect to the problem to solve

Solution	Fitness
0 1 1 0 1 1 0 0	169
1 1 0 0 0 1 1 1	576
0 1 0 0 0 0 1 0	64
1 0 0 1 1 1 1 0	361
...	...

Genetic operations: selection

Population	Fitness
Individual 1	15
Individual 2	27
Individual 3	6
Individual 4	52
Individual 5	11

Ind 5 (11) 10%

Ind 1 (15) 14%

Ind 2 (27) 24%

Ind 4 (52) 47%

Ind 3 (6) 5%

Randomly generated number = 21
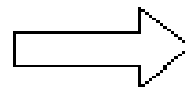
Individual 2 is selected

UCA
Universidad
de Cádiz

| | Initial strings | Crossover Mask | Offspring |

Single-point crossover:

11101001000   11111000000   11101010101

00001010101   00001001000

Two-point crossover:

11101001000   00111110000   11001011000

00001010101   00101000101

Uniform crossover:

11101001000   10011010011   10001000100

00001010101   01101011001

Point mutation:

11101001000   ⟶   11101011000
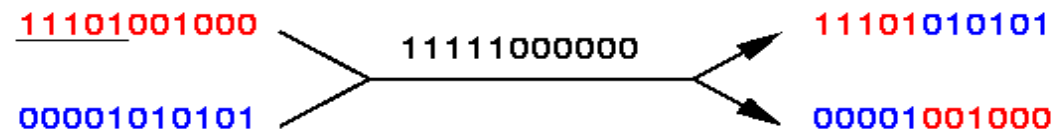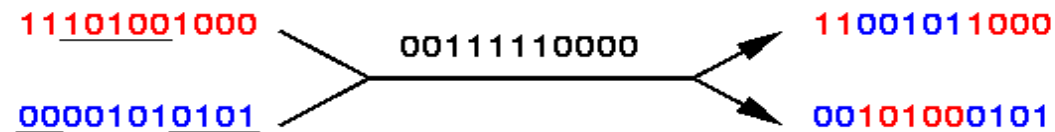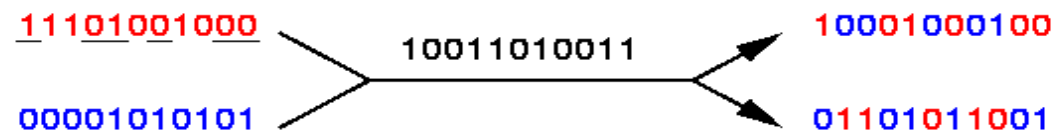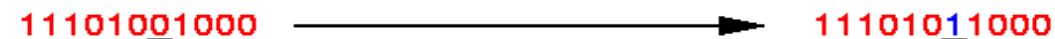
Genetic operations: mutation

❑ Based upon the probability of mutation, a gene on chromosome is disrupted

❑ **Goal**: To produce diverse population

Before mutation:
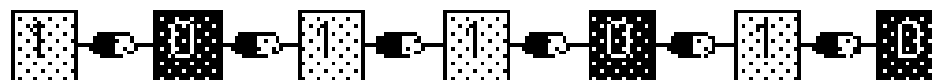
After mutation:
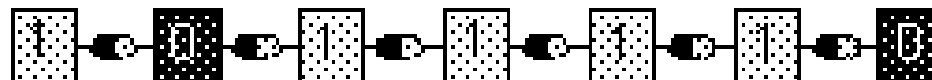
Parameters

❑ Population size

❑ Generarion number

❑ Crossover probability

❑ Mutation probability

Example: Sudoku – Basic concepts

❑ 9x9 grid cells subdivided into boxes or regions (sectors 3x3) with numbers 1-9

❑ Some cells have initials values

❑ The values can not be repeated in any row, column or box

UCA
Universidad
de Cádiz

Possible combiations:

$$9^{31} = 3.8152 * 10^{29}$$

1	3	6	4	2	8	9	5	7
4	5	9	1	7	6	8	3	2
2	8	7	3	9	5	6	4	1
6	9	3	5	8	1	7	2	4
8	4	5	2	6	7	1	9	3
7	2	1	9	4	3	5	6	8
5	6	8	7	3	4	2	1	9
9	1	4	8	5	2	3	7	6
3	7	2	6	1	9	4	8	5

		6	4	2	8			
4	5		1	7	6		3	2
	8	7	3	9	5		4	1
	9	3	5	8		7		
	4		2		7		9	3
7	2		9			5	6	
5	6	8		3	4	2		9
	1		8			3	7	6
	7		6	1		4	8	
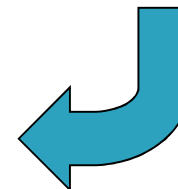
Example: Sudoku – Representation

1	3	6	4	2	8	9	5	7
4	5	9	1	7	6	8	3	2
2	8	7	3	9	5	6	4	1
6	9	3	5	8	1	7	2	4
8	4	5	2	6	7	1	9	3
7	2	1	9	4	3	5	6	8
5	6	8	7	3	4	2	1	9
9	1	4	8	5	2	3	7	6
3	7	2	6	1	9	4	8	5

136428957 459176832 287395641 693581724
845267193 721943568 568734219 914852376
372619485

1 3 6	4 2 8	9 5 7
4 5 9	1 7 6	8 3 2
2 8 7	3 9 5	6 4 1
6 9 3	0 0 0	7 2 4
8 4 5	0 0 0	1 9 3
7 2 1	0 0 0	5 6 8
5 6 8	7 3 4	2 1 9
9 1 4	8 5 2	3 7 6
3 7 2	6 1 9	4 8 5

Gen.	Fit.	Rep.
1	82	8
3	83	7
13	84	6
15	88	2
50	90	0

Example: Sudoku – Example

1	3	6	4	2	8	9	5	7
4	5	0	1	7	6	0	3	2
0	0	7	3	9	5	0	4	1
0	9	3	5	8	1	7	0	0
0	4	0	2	0	7	1	9	3
7	2	0	9	4	3	5	6	0
0	6	8	7	3	4	2	1	9
0	0	0	8	5	2	3	7	6
0	0	2	6	1	9	4	8	5

Gen.	Fit.	Rep.
1	61	29
3	63	27
4	66	24
7	68	22
24	73	17
61	75	15
74	76	14
121	77	13
147	78	12
428	83	7
2755	85	5
3139	86	4
3230	87	3
4776	90	0