Genetic Algorithm: A global Optimization Technique

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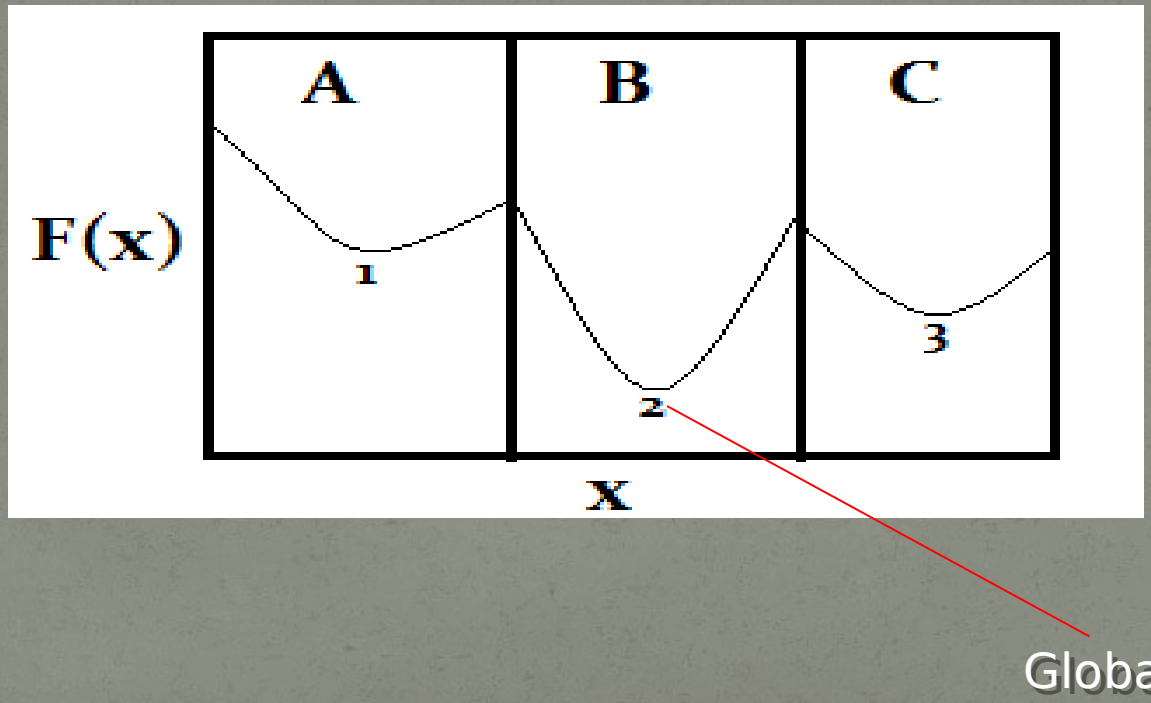
What is Optimization??

- “ The selection of a best element (with regard to some criteria) from some set of available alternatives” {Source: Wikipedia}
- Picking the “best” option from several ways of accomplishing the same task.
- We require the model which can give us the best result.

Global vs. Local Optimization

- Consider a hypothetical multi-modal function:



What is Genetic Algorithm??

- Developed by Prof. John Holland in 1975.
- Search algorithm that mimic the process of evolution.
- Based on the “Survival of the Fittest” concept. (Darwinian Theory)
- Successive generations are becoming better and better.

Genetic Algorithm: Key Idea

- Evolution is an Optimizing process.
- We seek the improvement in the predefined objective function:

$$y = f(x_1, x_2, x_3, x_4 \ldots)$$

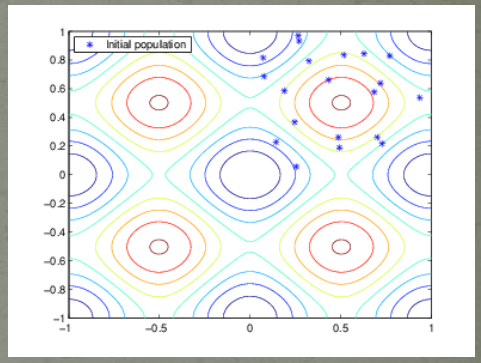
  - With successive generations, y should keep on optimizing.
- Central theme of the algorithm is “Robustness”.

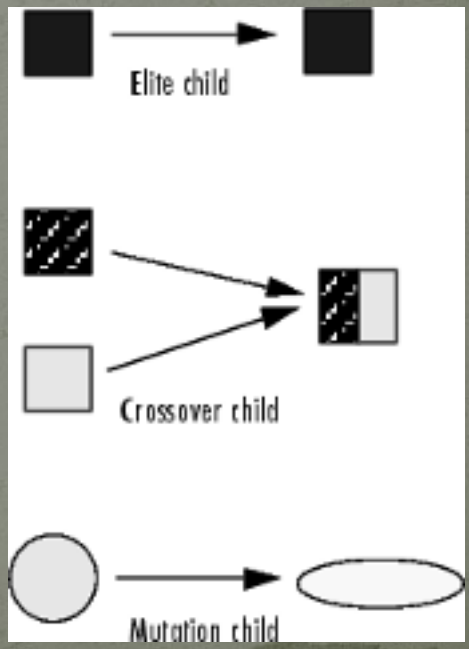
Algorithm

1. Initialization
2. Fitness Calculation
3. Selection
4. Crossing Over
5. Mutation
6. Repetition of the steps from 2-5 for the new population generated.

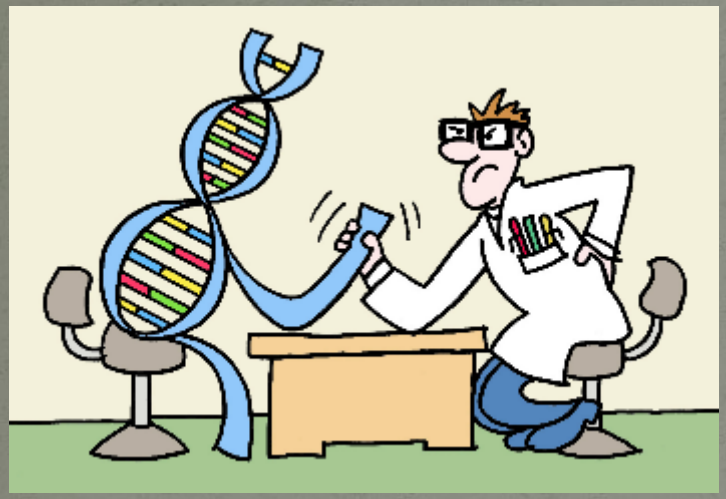
Outline of Basic Genetic Algorithm (GA)

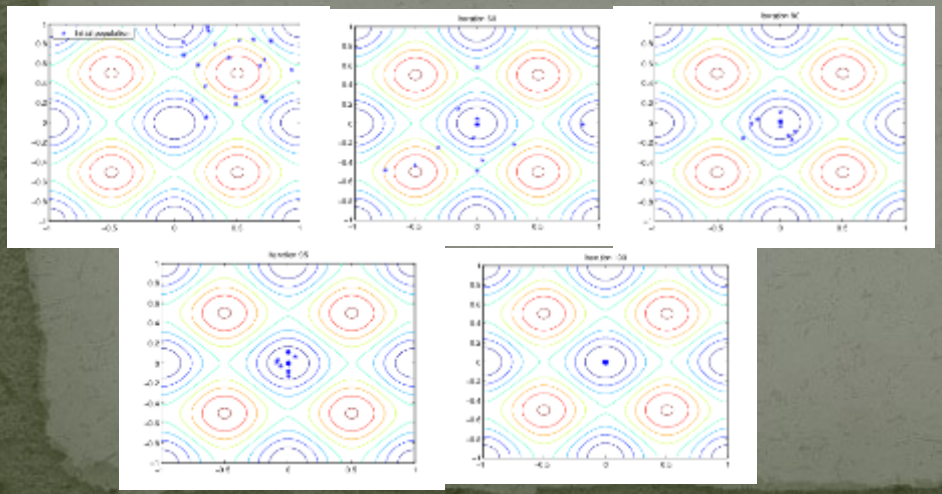
- Start: Randomly generate a population of N chromosomes.
- Fitness: Calculate the fitness of all chromosomes.
- Create a new population:
  - Selection: According to the selection method select 2 chromosomes from the population.
  - Crossover: Perform crossover on the 2 chromosomes selected.
  - Mutation: Perform mutation on the chromosomes obtained.

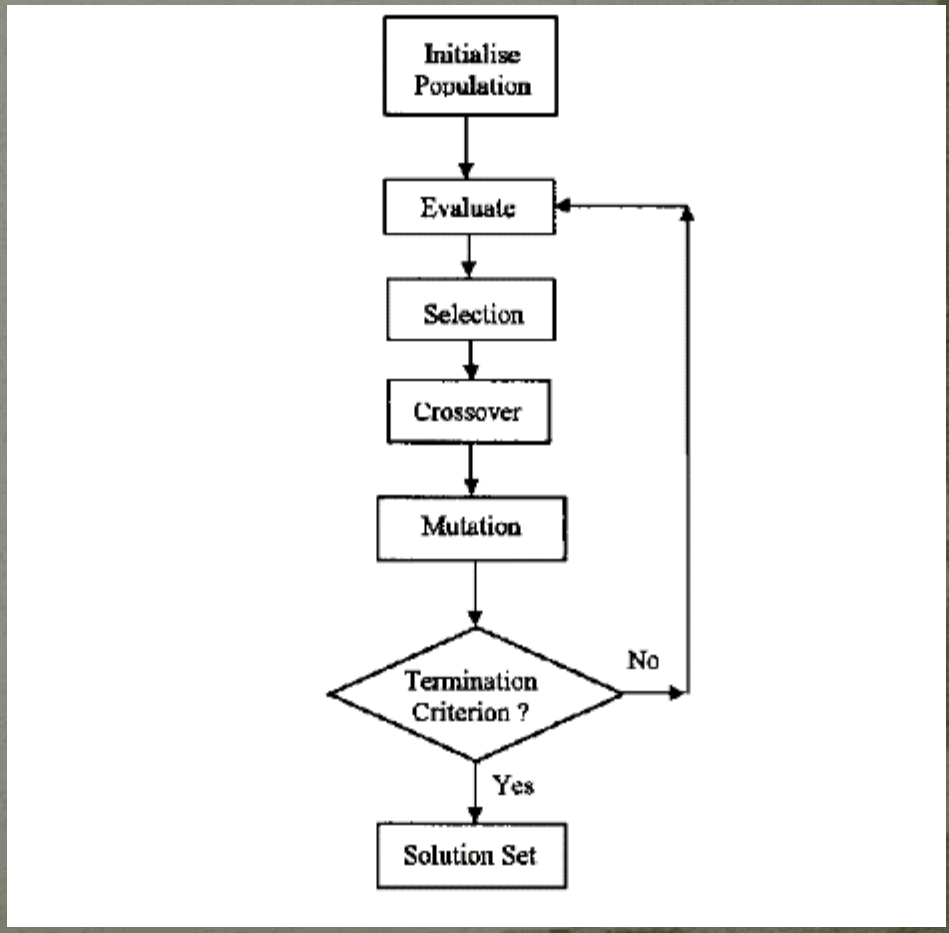




Inversion using Genetic Algorithm

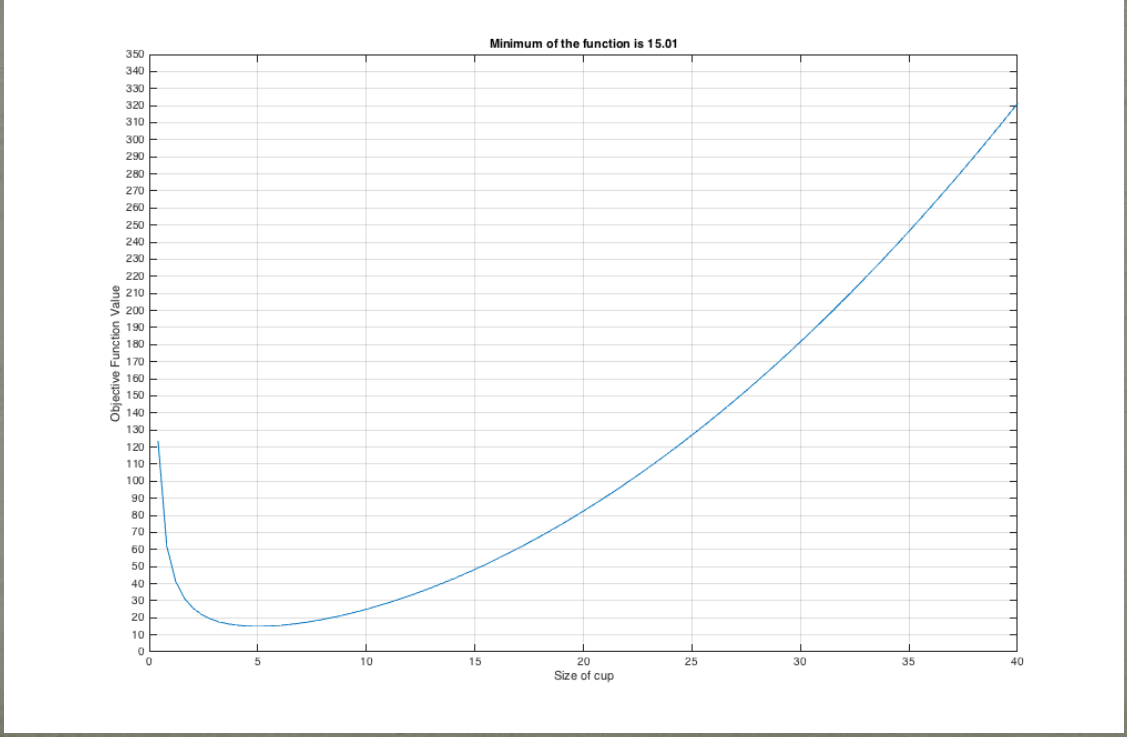






Optimum Size of the "Coffee/Drinks Cup"

- Objective Function (y): Loss of Café owner
- $y=0.2x^2+50/x$ where x is the dimension of the cup.
- Assumption: The price of the coffee/drinks is fixed.



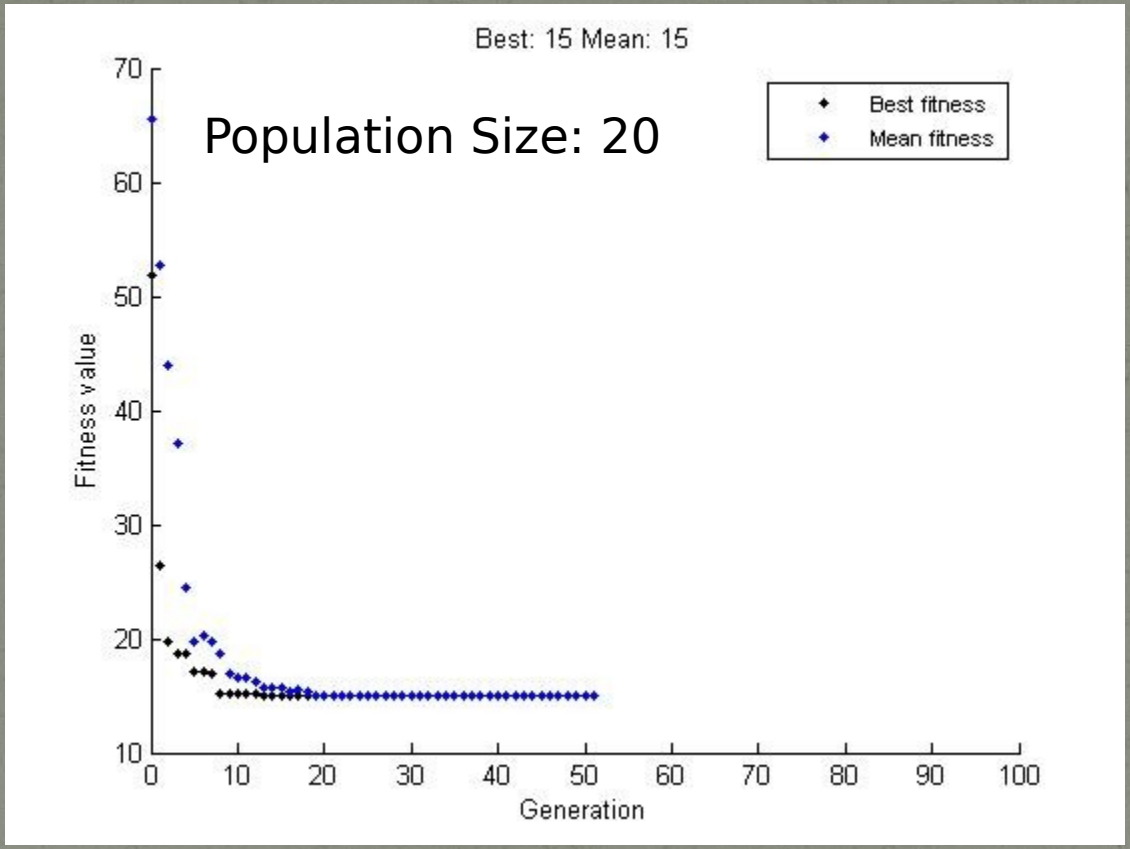
Optimum Size of the "Coffee/Drinks Cup"---SOLVED

		Generation	**1**			
Sl No.	Init. Pop	Init. Pop(bi)	Yi	Yi/∑Yi	Wt.	Mating Pool
1	4.2	00101010	15.43	0.073	2	00101010
2	10.1	01100101	25.35	0.121	1	00101010
3	16.4	10100100	56.84	0.270	1	01100101
4	23.5	11101011	112.58	0.536	0	10100100
		Avg. Fitness	52.55			

Optimum Size of the "Coffee/Drinks Cup"---SOLVED

			Generation	**2**				
Mating Pool(2)	Mate	Crrsovr Site	New Pop (bi)	New Pop (dec)	Yi	Yi/∑Yi	Wt.	Mating Pool (3)
0010101010	4	4	00100100	3.6	16.48	0.141	1	00101101
0010101010	3	5	00101101	4.5	15.16	0.130	2	00101101
01100101	2	5	01100010	9.8	24.31	0.208	1	00100100
10100100	1	4	10101010	17.0	60.74	0.521	0	01100010
			Avg. Fitness	29.17				

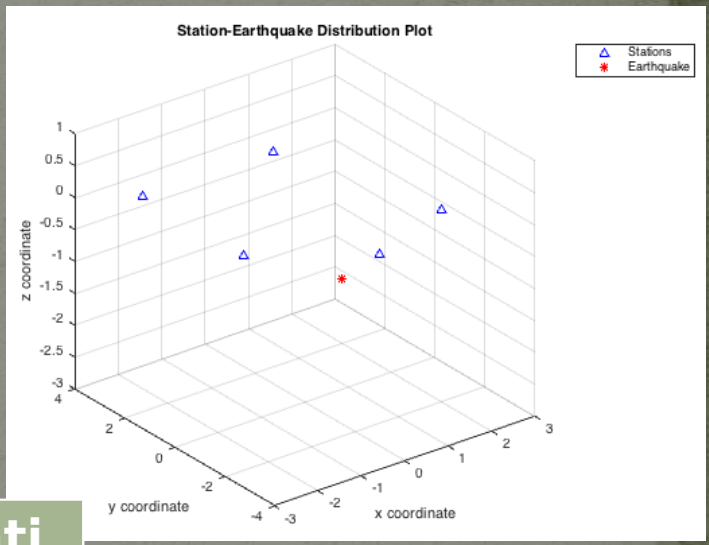
Optimum Size of the “Coffee/Drinks Cup”---SOLVED



Optimum dimension: 5 units

Genetic Algorithm Example

- Let us take an arbitrary objective function to visualize the algorithm. Let us try to locate an earthquake using a hypothetical data.



$$t_p = \sqrt{(x - x_i)^2 + (y - y_i)^2 + (z - z_i)^2}/v$$

Statio nx	Stati ony	Stati onz
-2	3	0
1	3	0
-2	-1	0
0	-3	0
2	-2	0

EQ-x	EQ-y	EQ-z
2	2	-2

Velocity of the seismic Wave=6 km/s

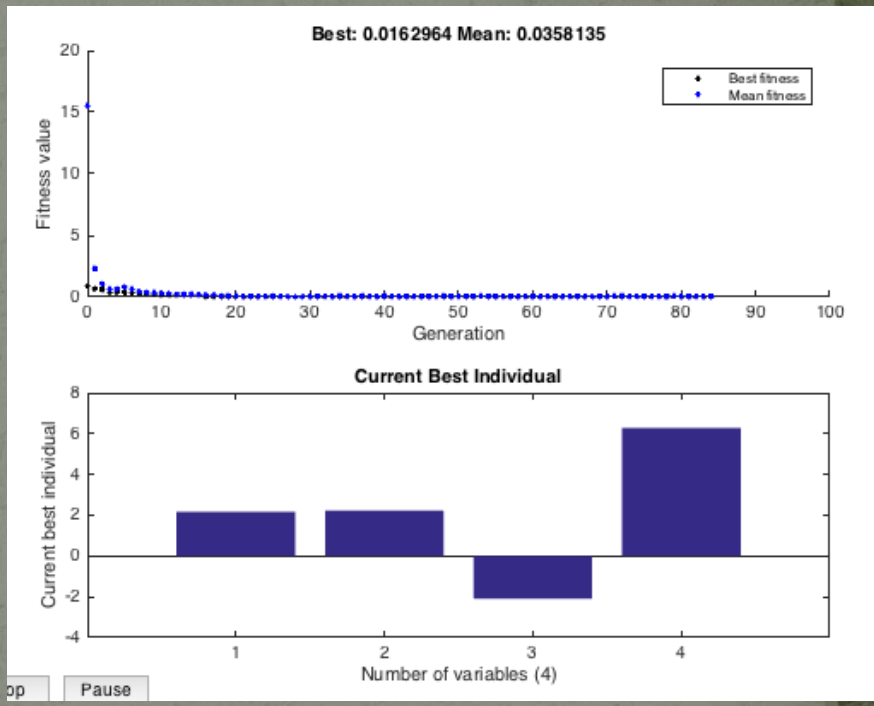
$$rms = \sqrt{\frac{1}{N-4}(t_p - t_o)^2}$$

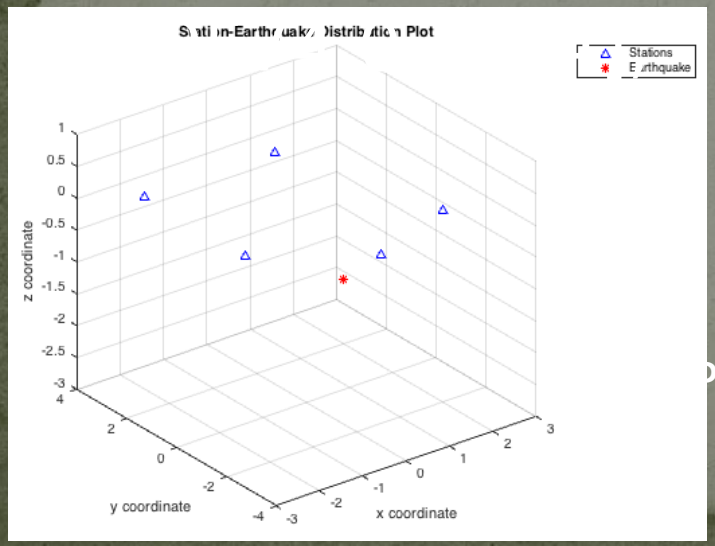
Genetic Algorithm Example

$$t_p = \sqrt{(x - x_i)^2 + (y - y_i)^2 + (z - z_i)^2}$$

$$rms = \sqrt{\frac{1}{N-4}(t_p - t_o)^2}$$

to=[0.7638 0.4082 0.8975





Parameter=[2.1726 2.2327 -2.0946 6.2851]

Genetic Algorithm: Summary