INDIVIDUAL WORK: Deadline: 09/02/2023
Sent the pdf file with answers by email to
leandro.coelho@ufpr.br **SUBJECT**: List of exercises 02

List of exercises 02
Metaheuristics

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Question 01 (a)

❶ **Complete the following tables** with the steps of a genetic algorithm (GA) during an evolutionary cycle.

a) Generation of the **initial population** of solutions and **evaluation of objective function**

Set the initial generations counter: *generation* = 0

Member of population	Genotype (binary representation) Base 2			Phenotype (floating point representation) Base 10			(maximization) objective function, f
	g_1	g_2	g_3	x_1	x_2	x_3	$f = x_1+x_2+x_3$
1	001.110	001.100	011.100	1.750	1.500	3.500	6.750
2		000.010		0.125		1.875	
3	101.010	110.011	100.110				
4	010.011	010.110	000.000			0.000	
Best member							

Question 01 (b), (c)

Example: In the member 1, g_1 with 001.11 has cut in 00|1.11

b) Apply the **crossover operation** after selection using roulette selection

Selected the same cut point in the **3rd** position (left to right)

Selected members to match (parents)	Genotype (binary representation) Base 2			Phenotype (floating point representation) Base 10		
	g_1'	g_2'	g_3'	x_1'	x_2'	x_3'
1': 1 and 2						
2': 1 and 2						
3': 2 and 3						
4': 2 and 3						

c) Apply the **mutation operation**

Members to apply the mutation (offspring)	Genotype (binary representation) Base 2			Phenotype (floating point representation) Base 10		
	g_1''	g_2''	g_3''	x_1''	x_2''	x_3''
1': yes						
2': no						
3': yes						
4': no						

Question 01 (d)

d) New **population** of solutions and **evaluation of objective function**

Update the generation counter i.e. *generation* = *generation* +1 and return to Step b

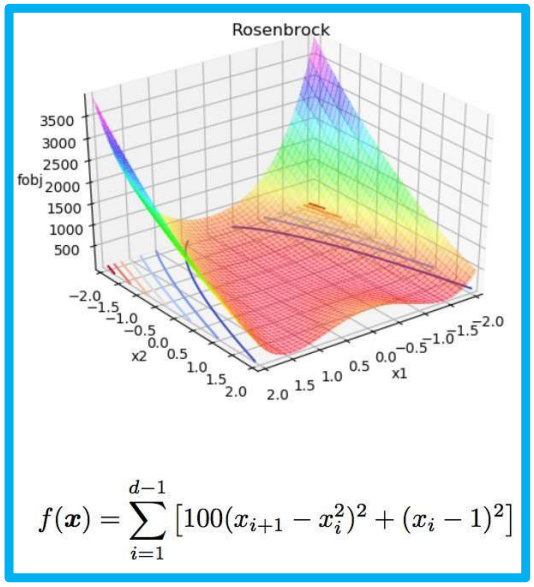
Member of population	Genotype of the current population (binary representation) Base 2			Phenotype of the current population (floating point representation) Base 10			(maximization) objective function, f New
	g_1''	g_2''	g_3''	x_1''	x_2''	x_3''	$f = x_1+x_2+x_3$
1"							
2"							
3"							
4"							
Current best member							

Question 02

What are the **differences** between heuristics, metaheuristics, and hyperheuristics?

Question 03

Considering the optimization problem min $f(x)$ illustrated in figure.



a) What are the independent variables of $f(x)$?

b) What are the decision variables of $f(x)$?

c) Rewrite this problem as a maximization problem.

Question 04

a) What is the **difference** between exploration and exploitation?

b) What is the **difference** between intensification and diversification?

c) What is the **difference** between global search and local search?

Question 05

How the exploration and exploitation strategies are designed in a standard particle swarm optimization approach?

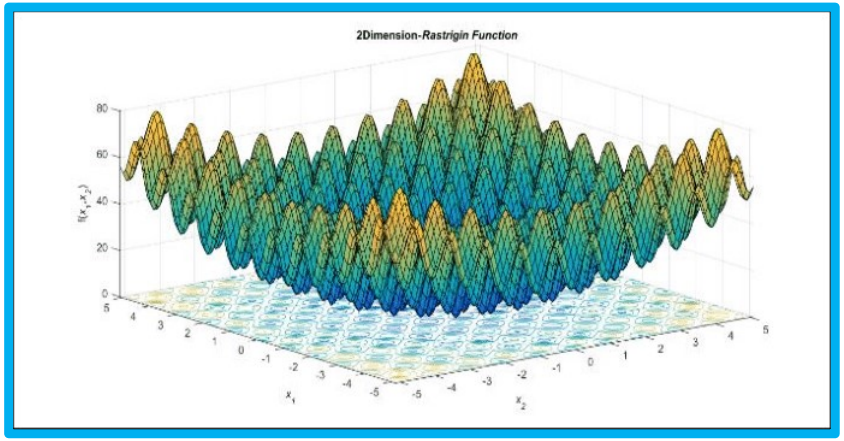
Question 06

We want to a binary GA (Genetic Algorithm) to find x to a resolution of 0.1 to minimize the two-dimensional Rastrigin function (n=2) on the domain [-5,5].

$$f(x_1 \cdots x_n) = 10n + \sum_{i=1}^{n}(x_i^2 - 10cos(2\pi x_i))$$

$$-5 \leq x_i \leq 5$$

$$\text{minimum at } f(0, \cdots, 0) = 0$$



a) How many genes do we need for each chromosome:
b) How many bits do we need in each gene?
c) Given your answer to part (b), what is the resolution of each element of x?

Question 07

How could you change the differential evolution algorithm to be non-elitist?

Question 08

What are the differences between standard (classical) evolutionary programming and evolution strategy when applied to continuous optimization?

Question 09

Present step-by-step the approach named harmony search algorithm (Geem et al., 2001) applied to a general continuous optimization problem?

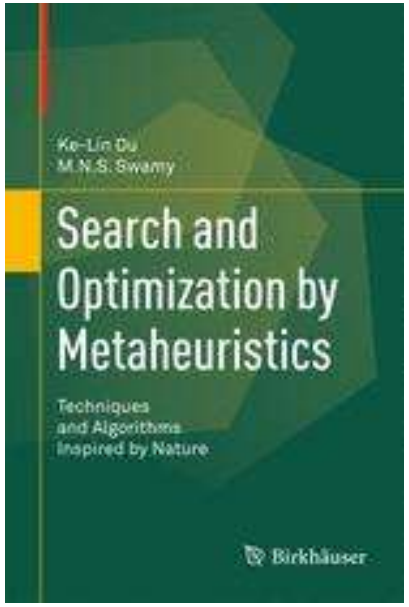
See

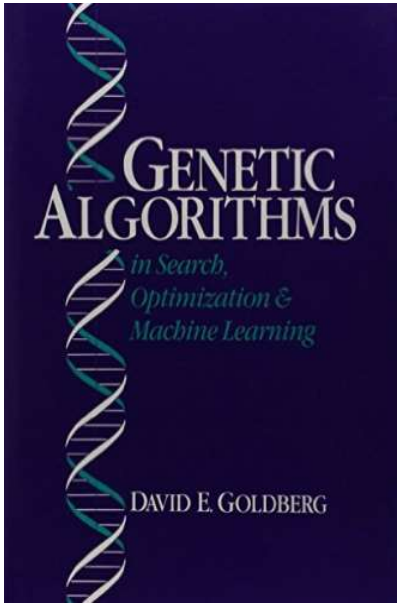
https://sites.google.com/a/hydroteq.com/www/

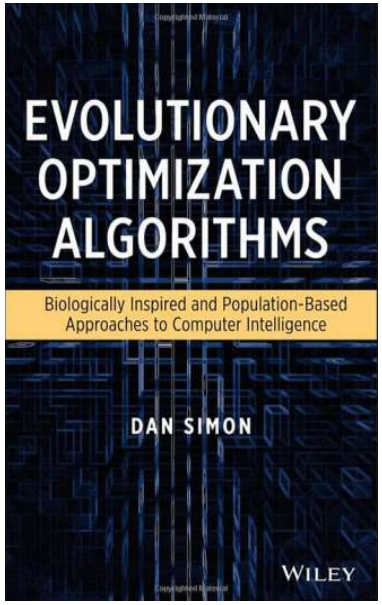
https://www.sciencedirect.com/science/article/abs/pii/S2210650218303791

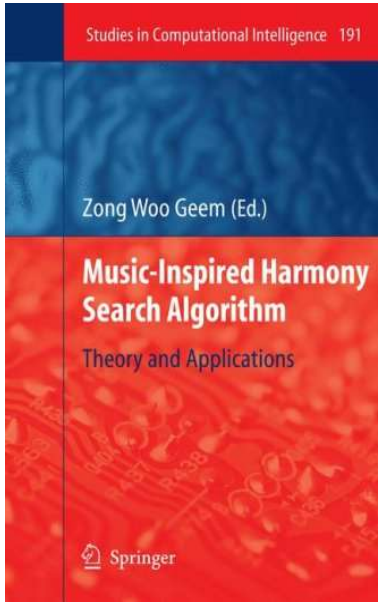
Geem, Z. W., Kim, J. H., Loganathan, G. V., 2001. A new heuristic optimization algorithm: Harmony search. Simulation. 76(2), pp. 60–68. *10.1177/003754970107600201*

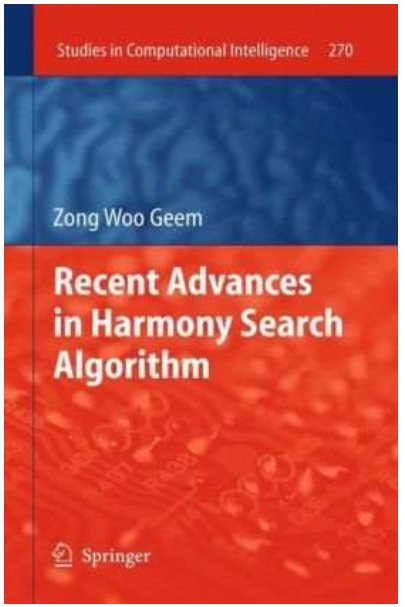
Support materials











Quote

It is during our darkest moments that we must focus to see the light.

Aristotle (384-322 BC)

Greek philosopher and polymath during the Classical period in Ancient Greece.