Mid-term exam

- Fecha de entrega 30 de sep en 13:00
- Puntos 22
- Preguntas 22
- Disponible 30 de sep en 10:00 - 30 de sep en 13:20 3 horas y 20 minutos
- Límite de tiempo 180 minutos

Instrucciones

General guidelines, please read carefully:

The students outside campus CEM must-have cameras active during the Zoom session. Every student must bring their white sheets to do their exam exercises.

You can only use a pencil/pen to respond to the exercise exam.

It is mandatory to use your computer to answer the exam. You can use your cell phone to photograph your answers inside your sheets for students outside CEM. The only resources allowed during the exam are the Canvas platform, a phone camera, and an application to send and receive photos from your phone to the computer.

To take photos or screenshots to the exam is forbidden.

An individual calculator is allowed.

Any suspicious behavior, cheating, copy detection, or use of tools and resources that are not permitted, the exam will be canceled and result in a 0 grade.

You will have a limited time (15 minutes) to upload your evidence, please consider that time, in case the time is not respected you will be penalized with 5 points over the final grade.

All doubts related to the exam will be solved during the session.

Historial de intentos

	Intento	Hora	Puntaje
MÁS RECIENTE	Intento 1	180 minutos	1 de 22 *

* Algunas preguntas no se han calificado

Las respuestas correctas están ocultas.

Puntaje para este examen: 1 de 22 *
* Algunas preguntas no se han calificado
Entregado el 30 de sep en 13:09
Este intento tuvo una duración de 180 minutos.

Pregunta 1
Aún no calificado / 1 pts

(Special question) What does one have to do to transform a maximization problem into a minimization and vice versa?

Su respuesta:

In order to transform between maximization and minimization problems it is necessary to just change the direction (sign) of the function. Just like in the case of the test function on HW1 and additional step of multiplying by -1 was needed in order to transform the problem to a minimization function.

Pregunta 2
Aún no calificado / 1 pts

Assume the following objective function for minimization:

$$f(x, y, z) = x^2 + 2y^2 + 3z^2 - 2xy + 4xz - 8yz$$

Consider this as a starting point: $(x_0, y_0, z_0) = (1, 2, -1)$

and

$$\frac{\partial f}{\partial x} = 2x - 2y + 4z$$

$$\frac{\partial f}{\partial y} = -2x + 4y - 8z$$

$$\frac{\partial f}{\partial z} = 4x - 8y + 6z$$

Perform one iteration of the steepest descent method using $t = 0.06$ and $t = 0.1$. Include every step of the process. State which of the two options of t obtain a better value.

Remember that

$$d = -\nabla f \text{ and } x^{i+1} = x^i + td$$

Su respuesta:

2. ②

$f(x,y,z) = x^2 + 2y^2 + 3z^2 - 2xy + 4xz - 8yz$

$(x_0, y_0, z_0) = (1, 2, -1)$

$\frac{\partial f}{\partial x} = 2x - 2y + 4z$

$\frac{\partial f}{\partial y} = -2x + 4y - 8z$

$\frac{\partial f}{\partial z} = 4x - 8y + 6z$

$x^{i+1} = x^i + td$

$d = -\nabla f$

$t = 0.06$

$X_{(0)} = (1, 2, -1)$

$c = 0$

Evaluate on starting point

$f(x_0) = (1)^2 + 2(2)^2 + 3(-1)^2 - 2(1)(2) + 4(1)(-1) - 8(2)(-1)$

$f(x_0) = 20$

Compute gradient

$-\nabla f(x_0) = \left(\frac{\partial f}{\partial x}, \frac{\partial f}{\partial y}, \frac{\partial f}{\partial z}\right) = -(-6, 14, -18) = p^{(c)}$

Line search and wolfe conditions using $t = 0.06$

$C_1 = 10^{-4}$ $C_2 = 0.9$

check Armijo condition

$f(x_0 + \alpha p_0) \leq f(x_0) + C_1 \alpha \nabla f(X_0)^T p_0$

$f((1,2,-1) + 0.06(6, -14, 18)) \leq 20 + (10^{-4})(0.06)(-6, 14, -18)(6, -14, 18)$

$f(1.36, 1.16, 0.08) \leq 20 + 6 \times 10^{-6}(-36 + 84 - 108 + 84 - 196 + 252 - 108 + 252 - 324)$

$0.816 \leq 20 + 6 \times 10^{-6}(-100)$

$0.816 \leq 19.9994$ Armijo Condition holds for $t = 0.06$

Check Curvature Condition ①

$\nabla f(x_0 + \alpha p_0)^T (p_0) \geq C_2 \nabla f(x_0)^T p_0$

$\nabla f(1.36, 1.16, 0.08)(6, -14, 18) \geq 0.9\,(-6, 14, -18)(6, -14, 18)$

$(0.72, 1.28, -3.36)(6, -14, 18) \geq 0.9\,(-100)$

$9.32 - 10.08 + 12.96 + 7.68 - 17.92 + 23.04 - 20.16 + 47.04 - 60.48 \geq -90$

$-13.6 \geq -90$ Curvature condition checks for $t = 0.06$

Update solution

$X_1 = X_0 - t \nabla f(X_0)$

$X_1 = (1, 2, -1) - 0.06(-6, 14, -18)$

$X_1 = (1, 2, -1) - (-0.36, 0.84, -1.08)$ $X_1 = (1.36, 1.16, 0.08)$

$t = 0.1$

$f(x_0) = 20$

Gradient

$-\nabla f(x_0) = -(-6, 14, -18) = p^{(1)}$

Line search for $t = 0.1$

Armijo condition

$f((1, 2, -1) + 0.1(6, -14, 18)) \leq 19.999$

$f(1.6, 0.6, 0.8) \leq 19.999$

$4.56 \leq 19.999$ Armijo checks for $t = 0.1$

Curvature condition

$\nabla f(1.6, 0.6, 0.8)(6, -14, 18) \geq 0.9\,(-100)$

$(5.2, -7.2, 6.4)(6, -14, 18) \geq 0.9\,(-100)$

$31.2 - 72.8 + 93.6 - 43.2 + 100.8 - 129.6 + 138.4 - 89.6 + 115.2 \geq -90$

$44 \geq -90$ Curvature condition checks

update solution

③

$X_1 = (1,2,-1) - 0.1(-6, 14, -18)$

$X_1 = (1.6, 0.6, -0.8)$

Pregunta 3

1 / 1 pts

Match correctly the following columns.

Hill climber

An example of an heuristic

GP

Use tree representation to repre

[2, 4, 5, 6, 1, 3]

Example of a permutation

SBX and PM

Simulated binary genetic operat

Newton method for minimization

Example of a second order optir

Pregunta 4

Aún no calificado / 1 pts

1. Describe the advantages and disadvantages by considering the following dimensions: convergence speed, assumptions, number of function evaluations needed, and difficulty to implement of derivative-based methods (consider the steepest descent and Newton method together) against direct search methods when solving a single objective minimization problem.

Remember to consider every dimension is your analysis.

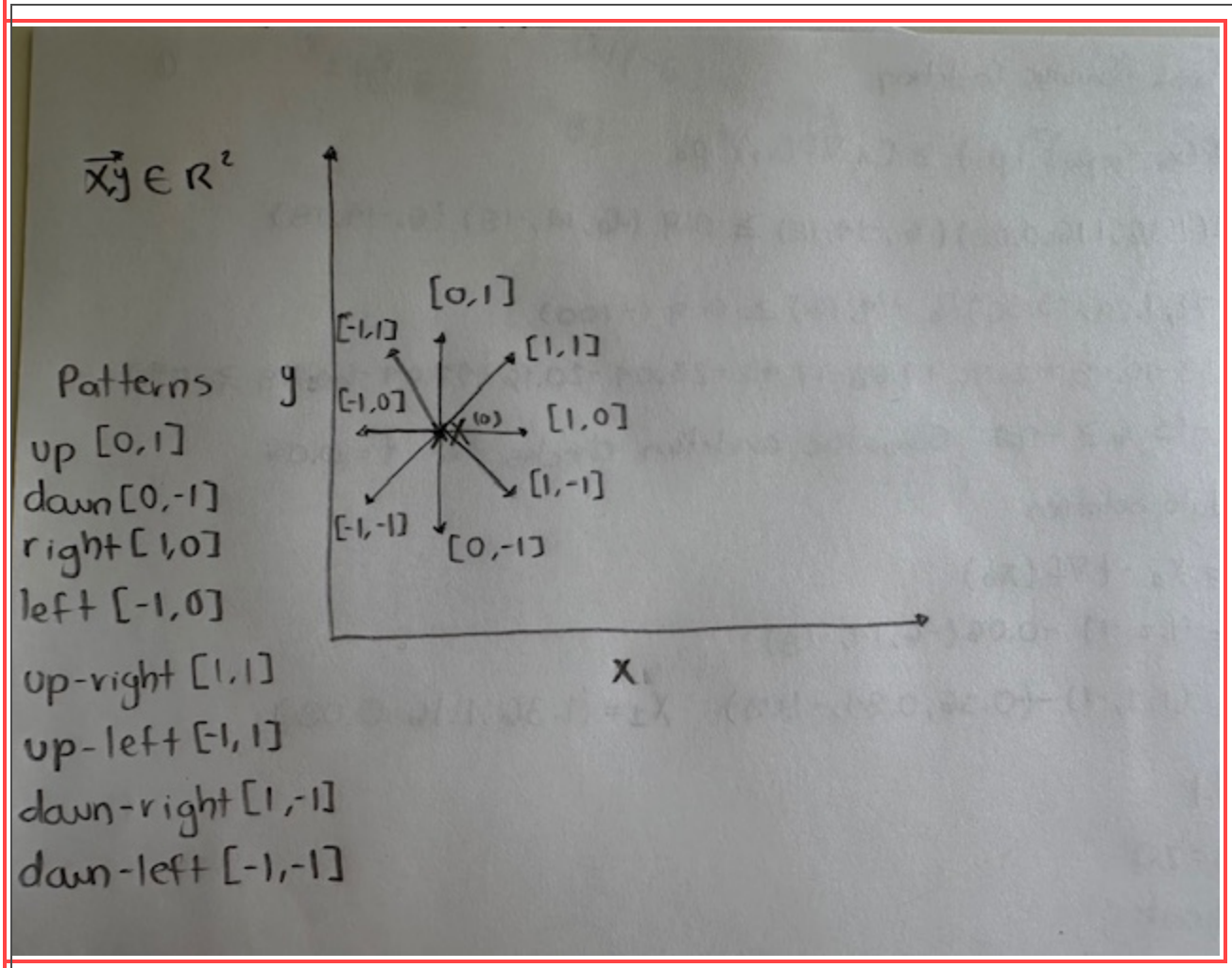
Su respuesta:

	Derivative based methods	Direct search methods
Convergence speed:	Fast convergence speed specially for convex problems.	Slow convergence speed takes many time exploring the search space.
Assumptions	The existence of a first and/or second order derivative is assumed to exist and be computed.	No need to know the gradient or hessian of a function. A black box could also be assumed.
Number of function evaluations	Gradient based method requires a little bit more operation than Newton method. Both require much less operations than Direct search.	Computes a lot of function evaluations to get to the optimal point.
Difficulty of implementation	May be expensive to compute operations such as Hessian matrix computation and Jacobian computation.	The function evaluation may be a cheaper computation but may require more iterations of this operation.

Pregunta 5
Aún no calificado / 1 pts

Draw a figure in a 2D space by specifying the corresponding axes to illustrate eight possible search directions when you use the general pattern search method from a starting point: $(x_0, y_0) \in \mathbb{R}^2$. For every direction, write their associated vector.

Su respuesta:



search.jpg

Pregunta 6

Aún no calificado / 1 pts

Which are considered the main paradigms of evolutionary computing (please, include the whole names)?

Su respuesta:

The main paradigms are:

- Evolutionary Strategies
- Evolutionary Programming
- Genetic Programming
- Genetic Algorithms

Pregunta 7
Aún no calificado / 1 pts

(Special question) List the names of the researchers that proposed the main evolutionary computing paradigms.

Su respuesta:

- Genetic Algorithms: Holland
- Evolutionary programming: Lawrence Fogel
- Evolutionary strategies: Rachenberg
- Genetic programming: John Koza

Pregunta 8
Aún no calificado / 1 pts

Which of the main paradigms of evolutionary computing integrates self-adaptation, and why is it important?

Su respuesta:

Evolutionary strategies use self adaptation which is a process in which the whole process evolves, meaning that individuals are not only mutated but also the parameters get adapted to this changes. It is important because it allows the configuration parameters to change with the individuals.

Pregunta 9
Aún no calificado / 1 pts

Explain the difference between $(\mu + 1) - \mathbf{ES}$ and $(\mu + \lambda) - \mathbf{ES}$, then compare with the population scheme followed by a GA.

Su respuesta:

(μ+1) - ES is a notation of evolutionary strategies where a parents produce a single child. If the child resulted better than the parent then the child replaces the parent.

($\mu + \lambda$)- ES in this case multiple children can result from parents, where only the best resulted children survives along its parents.

In the case of GA a population μ is determined where depending of the selection method the best parents can only reproduce, so only the generation of the selected parents and their offsprings are kept.

Pregunta 10
Aún no calificado / 1 pts

Explain why performing recombination using EP is impossible, and describe an example.

Su respuesta:

Evolutionary Programming simulates the evolutionary process at species level therefore recombination or corssover is not possible. This is why only mutations are possible. For instance an example would be that two different species (wolfs and tigers) cannot recombine... they can only evolve as a species only.(wolfs and tigers) -> (dogs and cats)

Pregunta 11
Aún no calificado / 1 pts

What is the main evolutionary operator of EP and ES?

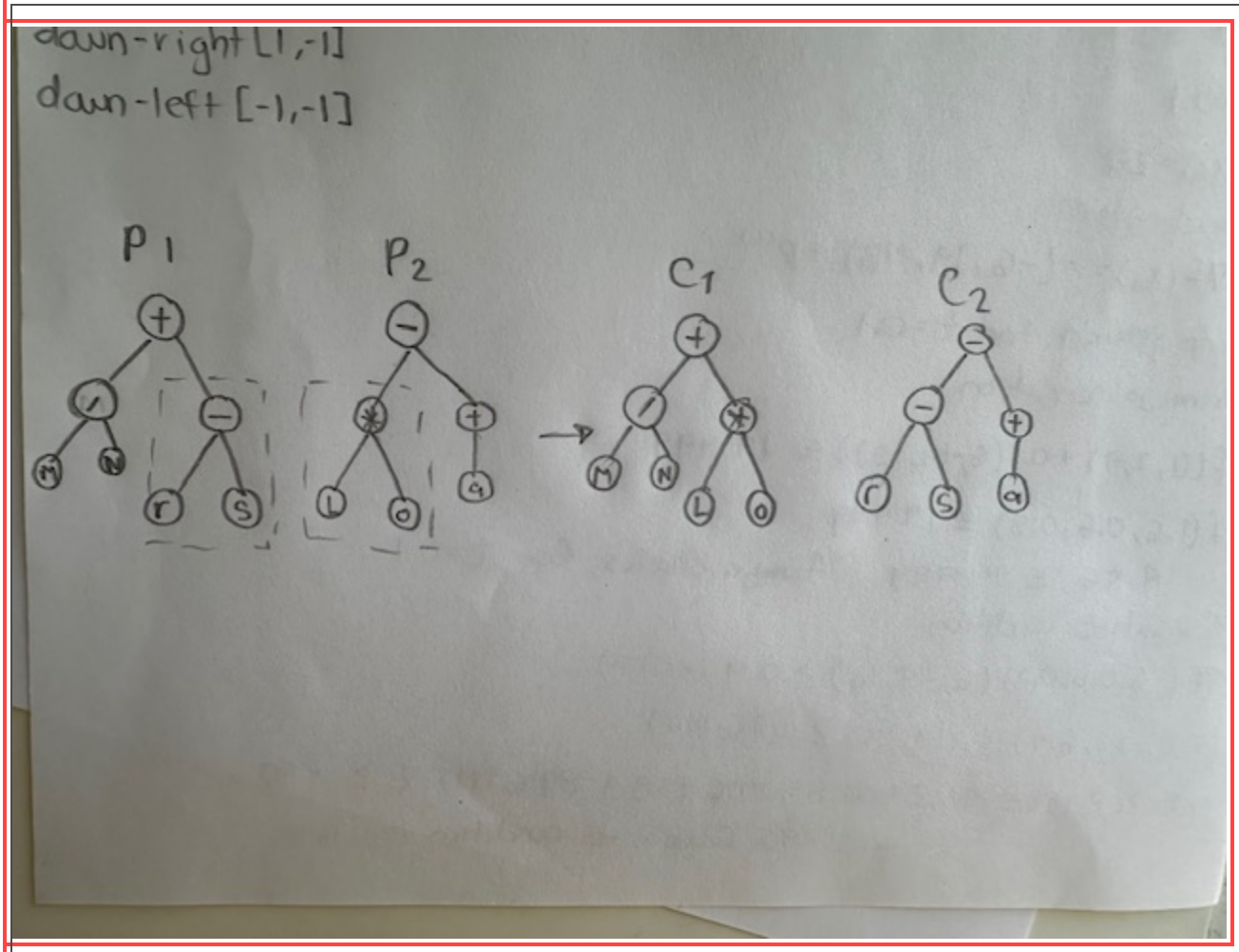
Su respuesta:

Mutation is the main operator for EP and ES.

Pregunta 12
Aún no calificado / 1 pts

Represent two valid individuals using a tree representation (consider arithmetic operations only), then recombine them to generate two children,

Su respuesta:



tree.jpg

Pregunta 13

Aún no calificado / 1 pts

What is the representation used for an individual in the canonical version of an ES? Generate an example individual considering $\vec{x} \in \mathbb{R}^4$.

Su respuesta:

The representation is using real values.

f([0.3,3.4,5.4,8])

Pregunta 14

Aún no calificado / 1 pts

Consider the following parents:

P1=[1,0,0,0,1,1,1,1]

P2=[0,0,1,0,0,0,0,1]

a) Perform a single-point crossover using [X,X,X | X,X,X,X,X] as the crossover point.

b) Apply mutation to the generated children by selecting a random element in the string for both children. Specify which allele you take.

Su respuesta:

P1=[1,0,0,0,1,1,1,1]

P2=[0,0,1,0,0,0,0,1]

By applying single-point crossover using [X,X,X | X,X,X,X,X] as the crossover point, we obtain:

C1: [1,0,0, **0,0,0,0,1**] and C2: [0,0,1, **0,1,1,1,1**]

Mutating a random allele: r = 5 and setting individual[r] = not individual[r]

allele in position 5

C1: [1,0,0,0,0,**0**,0,1] -> C1: [1,0,0,0,0,**1**,0,1]

C2: [0,0,1,0,1,1,1,1] -> C2: [0,0,1,0,1,**0**,1,1]

Sin responderPregunta 15
Aún no calificado / 1 pts

Perform one roulette wheel selection for **minimization** using the following fitness values:

1. Individual A: Fitness = 0.3
2. Individual B: Fitness = 0.5
3. Individual C: Fitness = 1.9
4. Individual D: Fitness = 0.4
5. Individual E: Fitness = 1.3
6. Individual F: Fitness = 1.4

Compute the accumulated fitness and normalize the values. Which individual or individuals will be selected when the random numbers are $r \in [0.5, 0.8]$ (If you think it is needed, you can make a circle (roulette) to represent your answer)

Su respuesta:

Pregunta 16

Aún no calificado / 1 pts

Perform an SBX using the following two parents:

Consider $-5 \leq x_1, x_2, x_3, x_4 \leq 5$

P1=[3.4, 1.7, -1.3, -1]

P2=[-1.9, 2.9, 1.5, 2.3]

Assume u=0.6 and η_c=2

$$\bar{\beta} = \begin{cases} (2u)^{\frac{1}{n_c+1}} & \text{if } u \leq 0.5 \\ \left(\frac{1}{2(1-u)}\right)^{\frac{1}{n_c+1}} & \text{else} \end{cases}$$

$$\text{H1} = 0.5[(P1 + P2) - \bar{\beta}|P2 - P1|]$$
$$\text{H2} = 0.5[(P1 + P2) + \bar{\beta}|P2 - P1|]$$

Su respuesta:

sbx.jpg

Pregunta 17

Aún no calificado / 1 pts

Explain why single-point crossover cannot form any scheme. Use an example of length 5.

Su respuesta:

Single point cross over can only produce shemes with 1****0 and 0****1 therefore this schemes are not that exploitative as other types of crossovers. Most of the times single point cross over will break a scheme and wont allow that building block to be pass down compared to for example double point crossover.

An example

P1: [1,0,0,1,1]

P2: [1,1,0,1,0]

At any single point crossover the children will produce only schemes with ****0 and ****1.

Pregunta 18
Aún no calificado / 1 pts

Consider a canonical genetic algorithm (as the one asked in homework 2). Could two parents go to the next generation as they are? Why?

Su respuesta:

Yes two parents can get to the following generation as they are if they get selected but by probability (crossover and mutation probabilities, Pc and Pm) they did not undergo crossover and mutation operations. In those cases the parents produce offspring with their same characteristics.

Pregunta 19
Aún no calificado / 1 pts

Consider the following variable and its boundaries: $-2.5 \leq x_5 \leq 3$.

By using the following formula:

$$size = (int)(\log_2((l_u - l_i) * 10^{precision}) + 0.99)$$

1. Encode the variable values to a binary representation using three digits of precision, remember to first determine the size of the string.

2. Which binary individual represents -2.496?

Su respuesta:

size =

Pregunta 20
Aún no calificado / 1 pts

Explain briefly the difference between a probabilistic and a deterministic binary tournament. Then, explain what it means that $q = \infty$ when using the deterministic tournament selection mechanism.

Su respuesta:

A deterministic approach means that the selection will be dictated by the best individual, meaning that only those individuals with better fitness values will be selected. Whereas a probabilistic approach (stochastic) means that parent selection will be done based on the probability of their fitness value to be chosen.

The q value is infinity when using deterministic since the selection pressure is determined only by the best fitness value, there is no random or probabilistic element that will affect the selection.

Pregunta 21
Aún no calificado / 1 pts

Discuss in which scenarios the use of an evolutionary algorithm is not the best option.

Su respuesta:

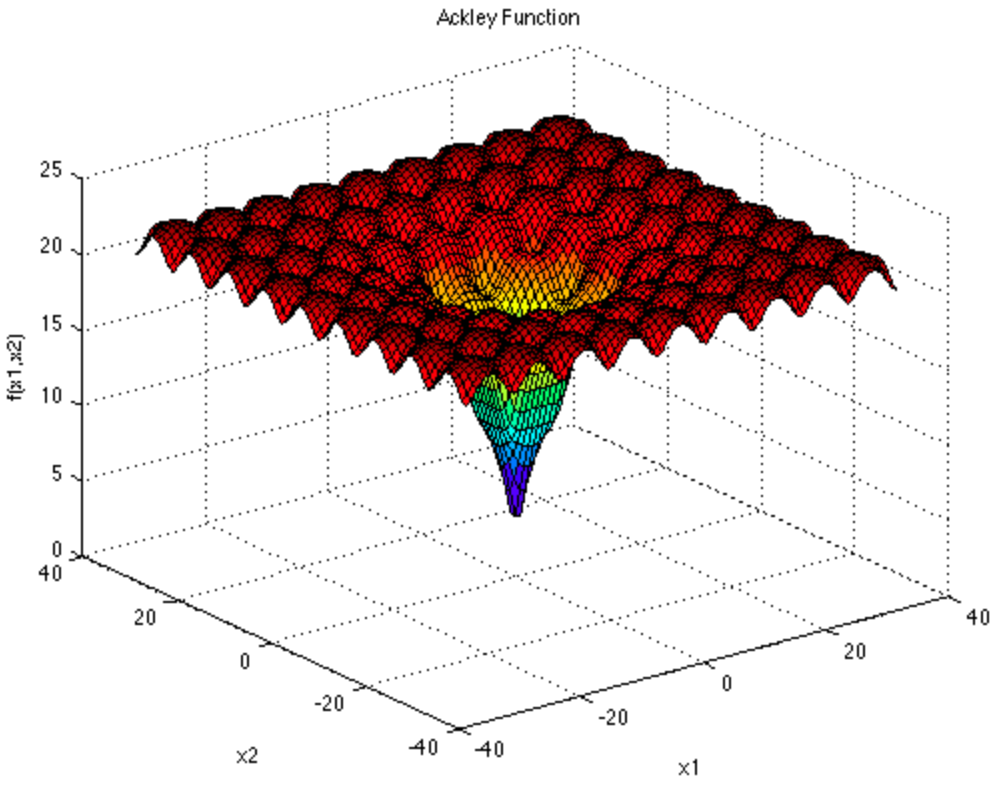
It is best to choose Evolutionary algorithms as the last resource, when it is already know that traditional optimization methods will not work.

Evolutionary algorithms are not the best option when:

- The function has feasible computing derivatives
- The function can be optimized using traditional methods.
- When the function is smooth, therefore it is unlikely to get stuck in local optima.

Pregunta 22
Aún no calificado / 1 pts

Which optimization method should be used to solve the following minimization problem? Explain your decision.



Su respuesta:

That problem can be minimized using a direct search method or hill climber algorithm since it has a lot of local minimum which can can easily be escaped using that type of method. Whereas a derivative based method may converge to any of the local minima.

Puntaje del examen: 1 de 22

* Algunas preguntas no se han calificado