Submitted by: Ranji Raj

Assignment 21 (∈ - MOEA)

Make yourself familiar with the ϵ-Multi Objective Evolutionary Algorithm and answer the following questions:

- How are mating solutions selected in ϵ-MOEA?

From Population:
Use binary **tournament selection:** select two individuals randomly, choose the non-dominated one among them (using normal domination definition) or if both the participants are non-dominated select one at random as solution ***p***.

From Archive:
Already contained with non-dominated ones, then randomly select ***e*** from the archive.

- How many children are produced in one iteration?

After selection of ***p*** and ***e***, exactly produce **one** offspring by using the crossover.

- How are the update mechanisms performed on the population and the archive?

Updation @ Population, ***P(t+1) (NORMAL DOMINATION)***

C1: If c **dominates one** or **more** population member(s), it replaces **one** among those at **random.**

C2: If c is **dominated** by any population member, we **discard** c.

C3: If c is **non-dominated** in comparison to the population, we **replace one** of the population members by c, to ensure that the population size remains unchanged.

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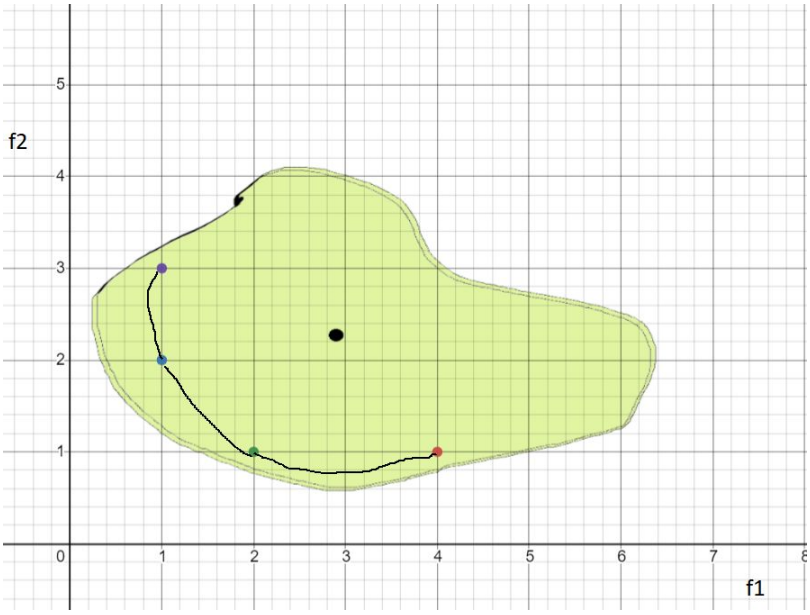
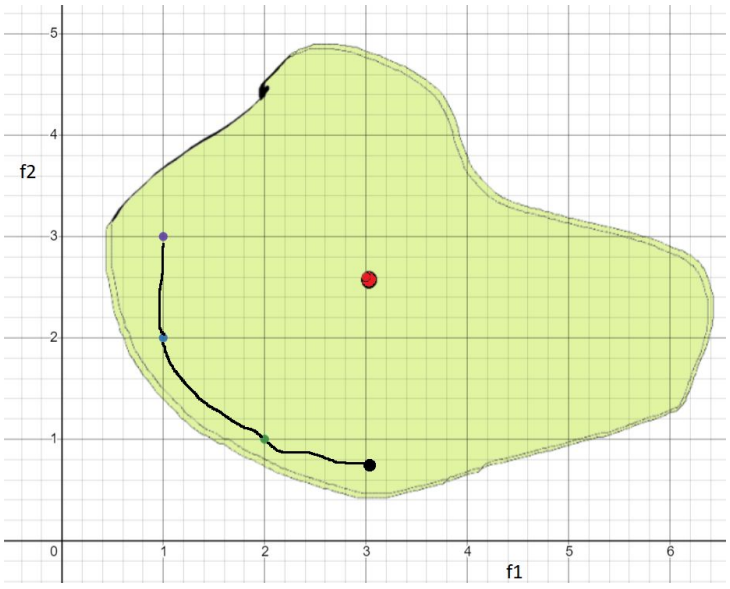
Updation @ Archive, ***A(t+1) (∈ - DOMINATION)***

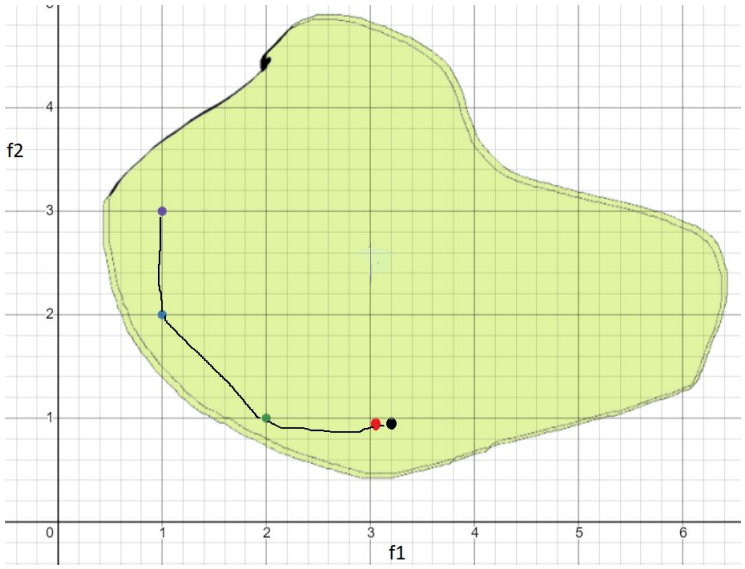
C1: If any one of the archive members ∈ - dom c, ⇒ c is **rejected**.



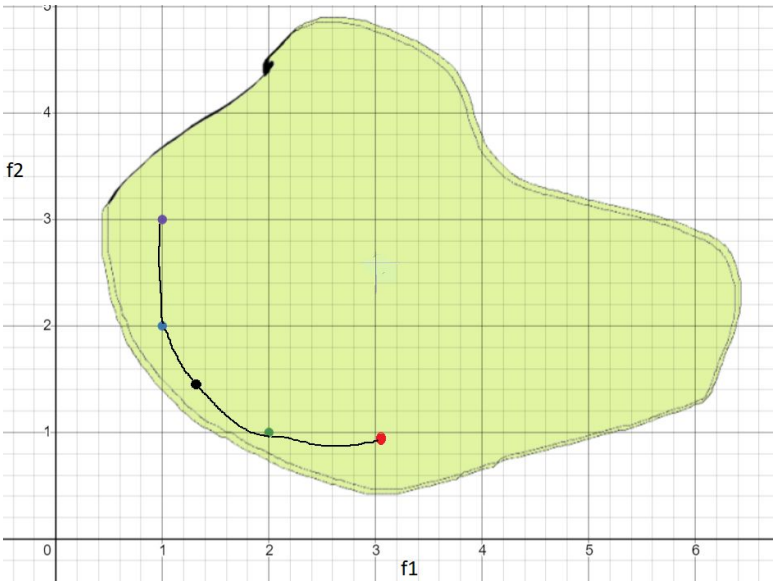
C2: If c **∈ - dom** any member of A, ⇒ c **replaces** that member.



C3: If c **shares** the same box as the archive member, ⇒ keep that one which is **non** ∈ - dom.



C4: If c is **non** ∈ - dom ⇒ **add** it to archive.



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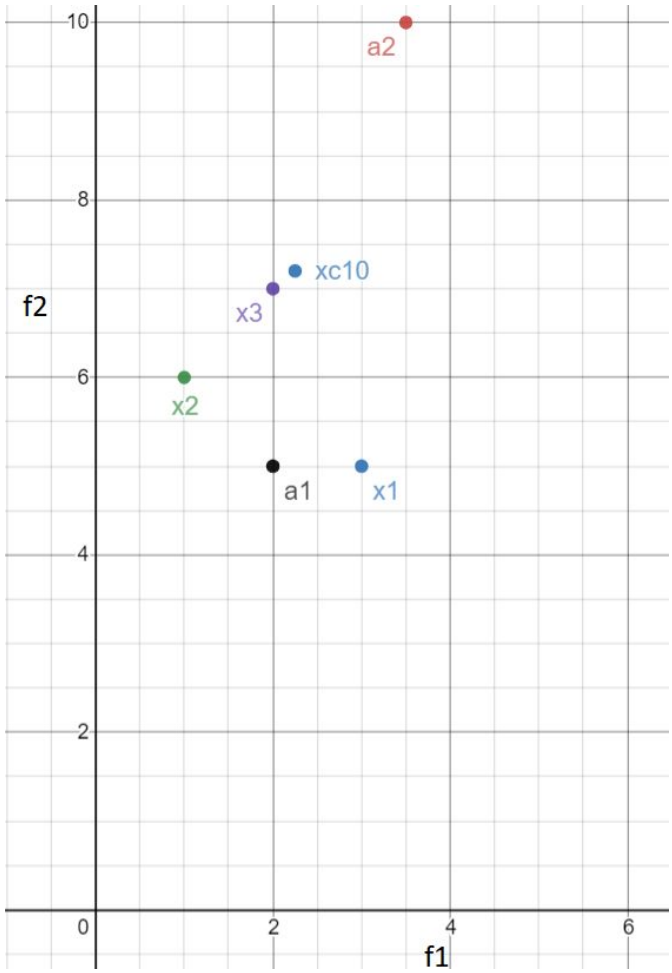
- For a two-objective problem where f_1 is to be minimized and f_2 is to be maximized, the following solutions compose the population and archive at time step 10:

Solution	$f_1(x)$	$f_2(x)$
Population		
x_1	3	5
x_2	1	6
x_3	2	7
Archive		
a_1	2	5
a_2	3.5	10

The ϵ-MOEA method being applied has an archive size of $N_A = 2$ and $\epsilon_1 = \epsilon_2 = 1$. After selecting solutions from the population and the archive, the crossover operation produces a child x_{c10} at time step 10. The result of the evaluation of x_{c10} is $f_1(x_{c10}) = 2.25$ and $f_2(x_{c10}) = 7.2$. Perform the population and archive update for time step 10 with the child x_{c10}. What are the solutions in the updated population and archive?



Updation @ Population

Case 1 is observed, as x_{c10} **dominates** x_1 so replace x_1 with x_{c10}.

Updation @ Archive

For $\in$ - domination we use the simpler definition
i.e. $(f_i(\vec{x}_1) - \epsilon)$
Our solutions get transformed as a_1 (1, 4) & a_2(2.5, 9)

Case 1 is observed as x_{c10} is **dominated by** a_1 & a_2. So reject x_{c10}.

Final solutions in P(t+1) and A(t+1):

Solution	$f_1(x)$	$f_2(x)$
x_{c10}	2.25	7.2
x_2	1	6
x_3	2	7
a_1	1	4
a_2	2.5	9

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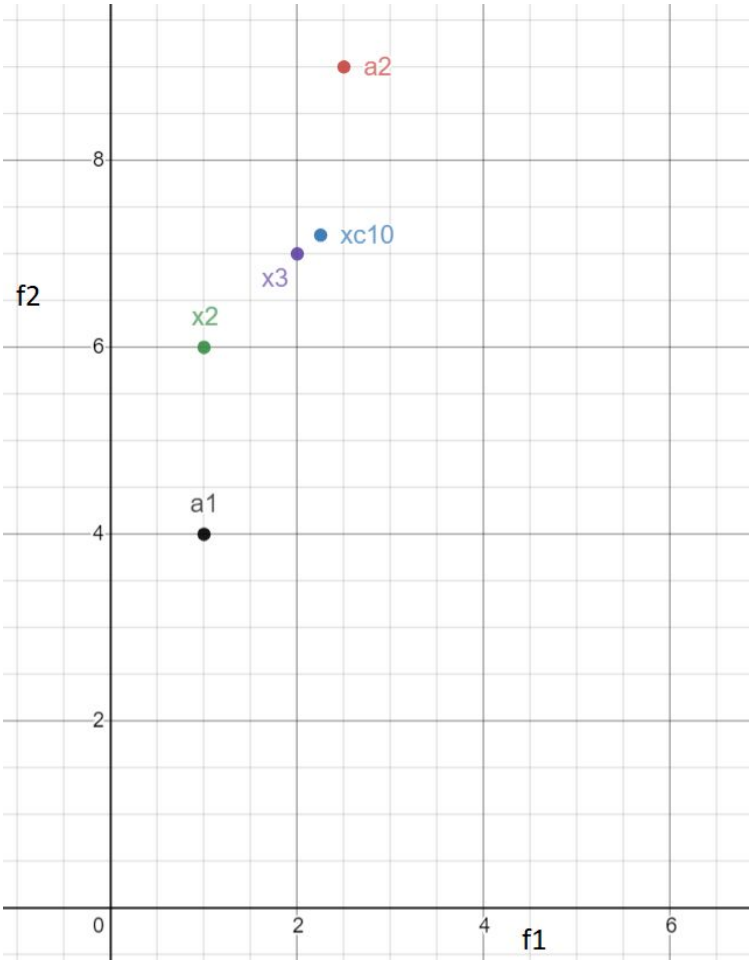

- At time step 11, a child x_{c11} is generated, whose fitness values are $f_1(x_{c11}) = 2.5$ and $f_2(x_{c11}) = 8$. What are the solutions in the updated population and archive after time step 11? This task requires the correctly updated population and archive in time step 10.

Updation @ Population

Case 2 is observed as x_{c11} is **dominated by** all members. Hence discard.

Updation @ Archive

Case 1 is observed as x_{c11} is **dominated by** both members. Hence discard.