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→ features can be of any domain

- Objective function should be some minimisation or maximisation

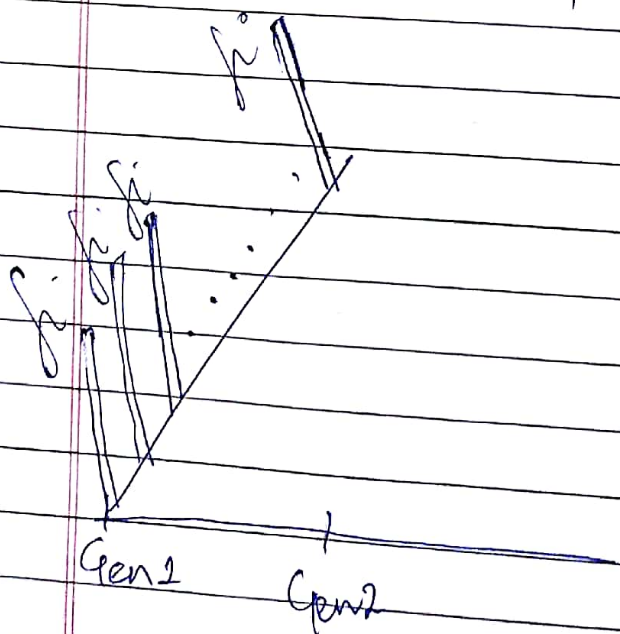
- fitness must lead to the objective function

- Determine the population size

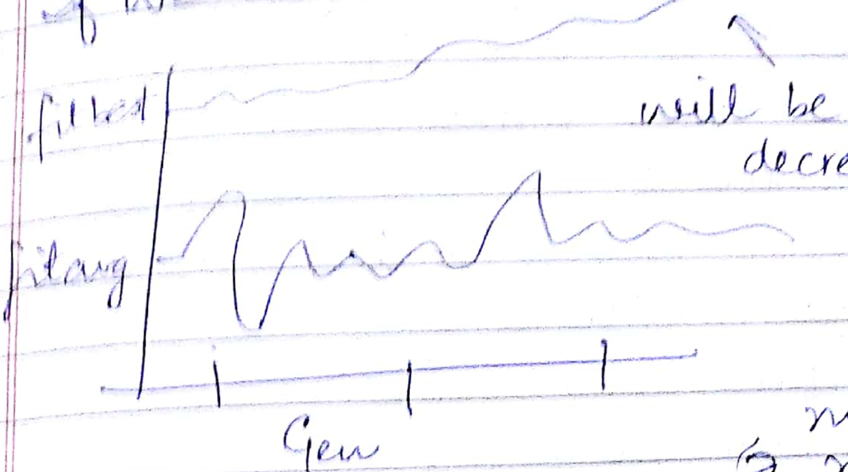
- If you have a smaller population, more evolution

- Computational complexity = Popul^n size * No. of gener^n

- you need to explore the search space



If we use elitism:



will be a non-decreasing function

not entirely random

→ Then we do a random walk.

— In crossover, you have to see whether the offspring does not violate any constraint.

$$\frac{w_1 OF_1}{\Sigma w} - \frac{w_2 OF_2}{\Sigma w} + \frac{w_2 OF_3}{\Sigma w}$$

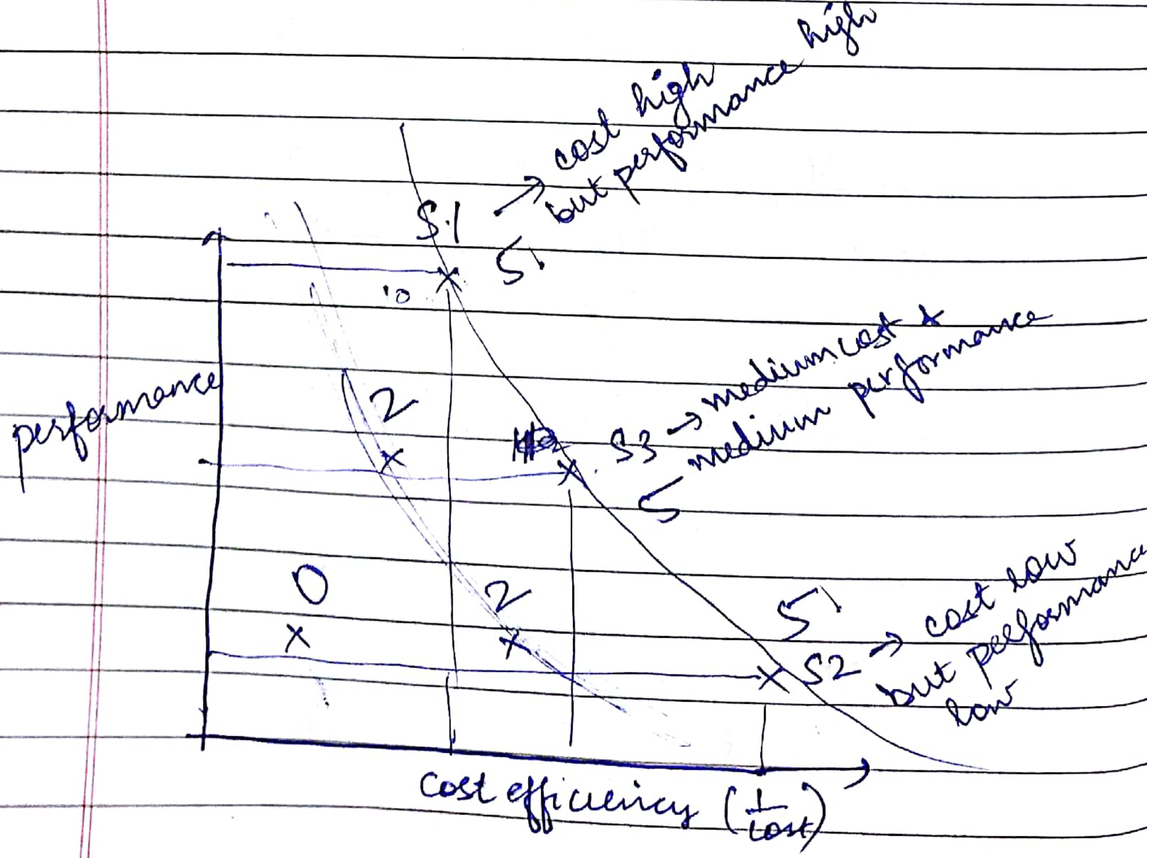
$$\frac{w_1 OF_1 + \frac{w_2}{OF_2} + w_3 OF_3}{\Sigma w}$$

$$\frac{OF_1 + OF_3}{1 + OF_2}$$

- Non-inferior solutions :
Those solutions who are not better than other non-inferior solutions in all respects.

- Step1 : features
Step2 : constraints
Step3 : threshold
Step4 : objective function

$OF = \frac{w_1}{\sum w_i} f_1 + \frac{w_2}{\sum w_i} f_2$



S1, S2, S3 are non-inferior solutions.

Through weighted mean, I will get the averagely best soln S3. S1 and S2 will be lost.

I would rather have a set of non-inferior solutions

↳ $\boxed{\text{pareto-optimal solution}}$

Rank: No. of solutions which are not superior in all dimensions

FORAGING BY ANIMALS:

Ant family:

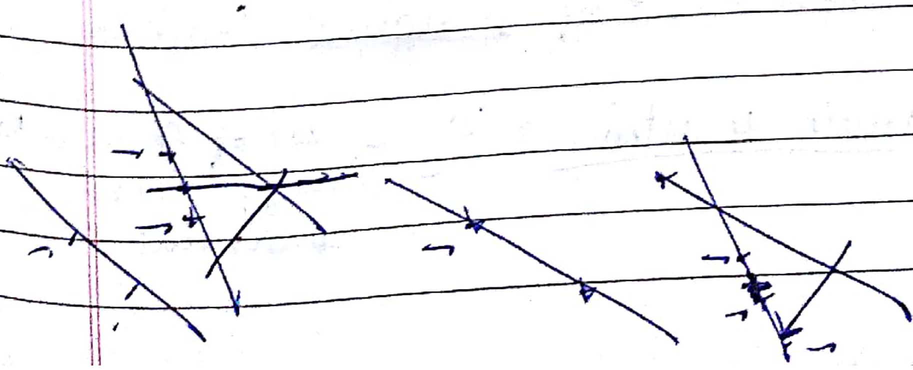
↓

release feromone

other ants sense pheromone & follow path with high ~~feromone~~ pheromone

⇓

$\boxed{\text{Ant Colony Optimisation}}$



Ant Colony Optimisation

Two parameters

Heuristic η ⟷ Pheromone τ

Heuristic η:
- greedy
- local search (finding the local best)

Pheromone τ:
- based on experience
- cooperation (kinda global search)

Combinatorial Optimisation Problem :

$$\langle S, C, \overset{\text{optimisation fn}}{f} : S \rightarrow R_0^+ \rangle$$

S : set of features = $\{x_i\}$ $i = 1$ to N
C : Set of constraints
f : Objective function

\# Features have values which belong to some domain

Solution ≡ Set of assigned features

→ Feasible solution : S_C → set of features which satisfy certain constraints

Define global minima/ max → you may not reach it but still we define it, because that is the ultimate goal

$$f(s_c^*) \leq f(s_i) \quad \forall \ s_i \in s_c$$

global optima

TSP using ACO:

Initialize
    Set Parameters
    Initialize pheromone levels for some paths
Do
  Begin
    Construct Ant Solution → give random starting points to ants
    → greedy/ probabilistic

    Synchronise (optional)

    Update pheromone
  End
Till (Stop criteria)
  ↳ convergence criteria

In ACO, it is often 'n' iterations

Construct Ant's solution ⇒

Probability of choosing a next node, given a set of neighbours

$$P(C_{ij} | S_P) = \frac{T_{ij}^{\alpha} \eta_{ij}^{\beta}}{\sum_{C_{i \to l} \in S_P} T_{il}^{\alpha} \eta_{il}^{\beta}}$$

neighbours

where:

$T_{ij} \equiv$ Pheromone trail b/w i & j

$\eta \equiv$ local factor (min distance)

$$\eta \propto \frac{1}{L_{ij}} = \frac{Q}{L_{ij}}$$

Synchronise ⇒

In GAs, solutions interact with each other using crossovers. That is not directly present here.

In ACO, there may also be communica between ants

∴ This optional step.

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Update ⇒

$$\tau_{ij} \leftarrow (1-\overset{\text{evaporation rate}}{\rho})\,\tau_{ij} + \rho \underbrace{\sum F(s)}_{\text{fitness fn of all the solutions}}$$

$$S_{upd} \in \underbrace{\{\ ,\ \}}_{\text{What should this set be?}} \Big|\ c_{ij} \in S$$

- All the ants who travelled from i to j
- or only the fittest ones who travel the $i \to j$

$$S_{upd} = \underbrace{\underset{S \in S_{iter}}{\arg\max}}_{\text{one whose argument has max value}} (F_s)$$

~~when you want to consider the~~ one whose argument has max value

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