Blast Off!

Lecture 7

Genetic Algorithm

What is it?

Genetic Algorithm is a probabilistic search algorithm that iteratively transforms a set (population) of mathematical objects each with an associated fitness value into a new population of offsprings objects using Darwinian principle of natural selection using patterns such as mutation and crossover

How does it work?

1. Individuals in a population compete for resources
2. Those that are successful (fittest) mate to create more offsprings
3. Each inherent quality of the parent can be thought of as it’s gene.
4. Genes from the “fittest” parents are passed on to the offspring, which is better than the parent
5. Hence, the offspring is better suited for the environment (more optimized)

Pseudo Code

Initialize *population with random candidates*
Evaluate *all individuals*
While *termination criteria not met*
    Select *parents*
    Apply *crossover*
    Mutate *offspring*
    Replace *current generation*
end while

Fitness Function

Since GAs operate on survival of the fittest, we need to give a score based on how good an individual at surviving. Fitness can be a function of the initial parameters and used in successive genetic operations.

Individuals with higher fitness have a higher chance to reproduce and pass on their genes. Hence, that's why the population is usually sorted based on it's fitness.

Multi Objective

Genetic Algorithm

What is it?

As the name suggests, it involves optimization in an n-dimensional space, contrary to normal optimization in 1D space.

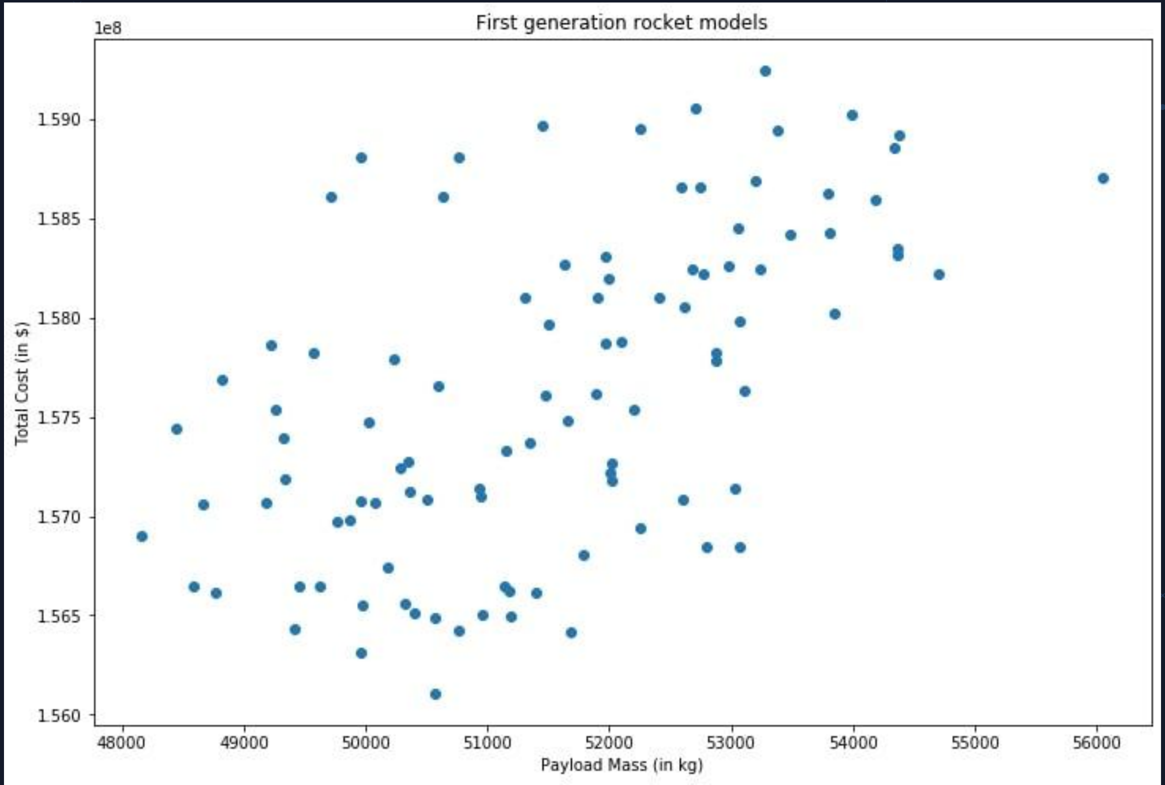
Optimization here might refer to minimization along one axis while simultaneously maximization along another. A good example is rocket construction.

Rocket Optimization

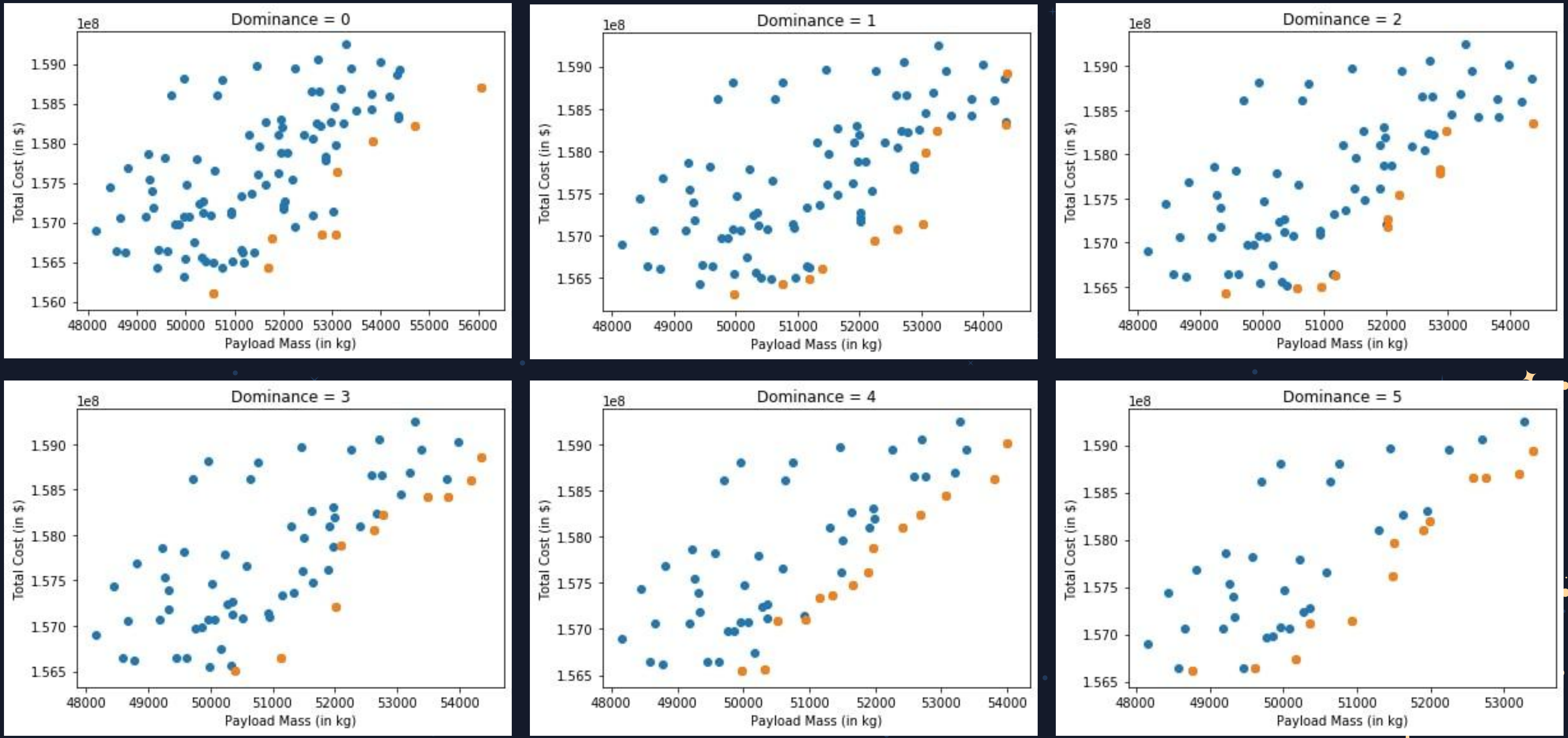
While making a rocket, we have to increase payload mass going into orbit while simultaneously minimizing the cost it takes to do so. Hence, optimization plays a crucial role.

But how do you define optimization in say a 2D space? Enter, Pareto Fronts. A commonly used library to find pareto dominance is *pygmo*

Sample Plot


First generation rocket models
1e8
1.590
1.585
1.580
1.575
1.570
1.565
1.560
Total Cost (in $)
48000
49000
50000
51000
52000
53000
54000
55000
56000
Payload Mass (in kg)

Pareto Front and Dominance



Pareto Front and Dominance