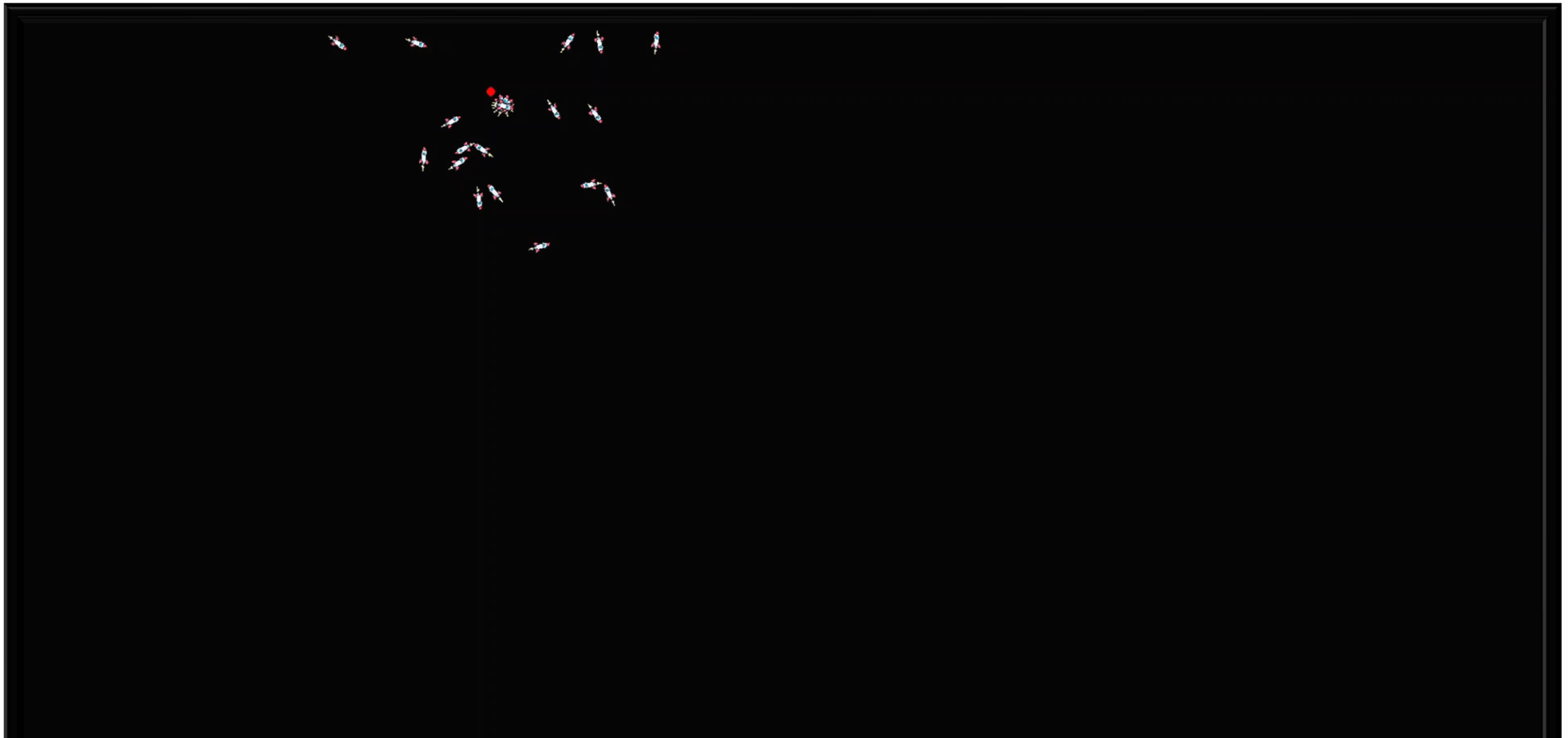
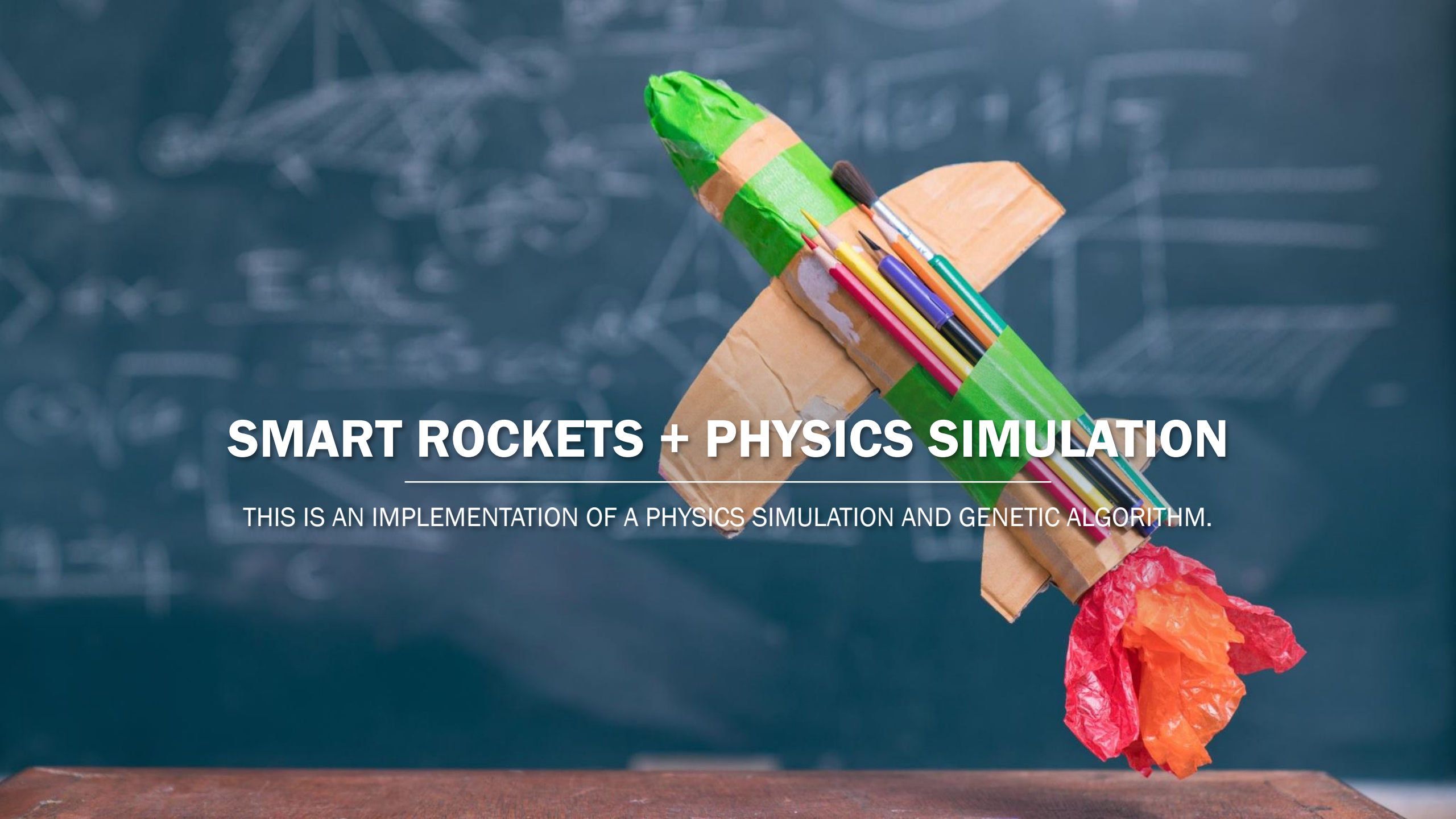
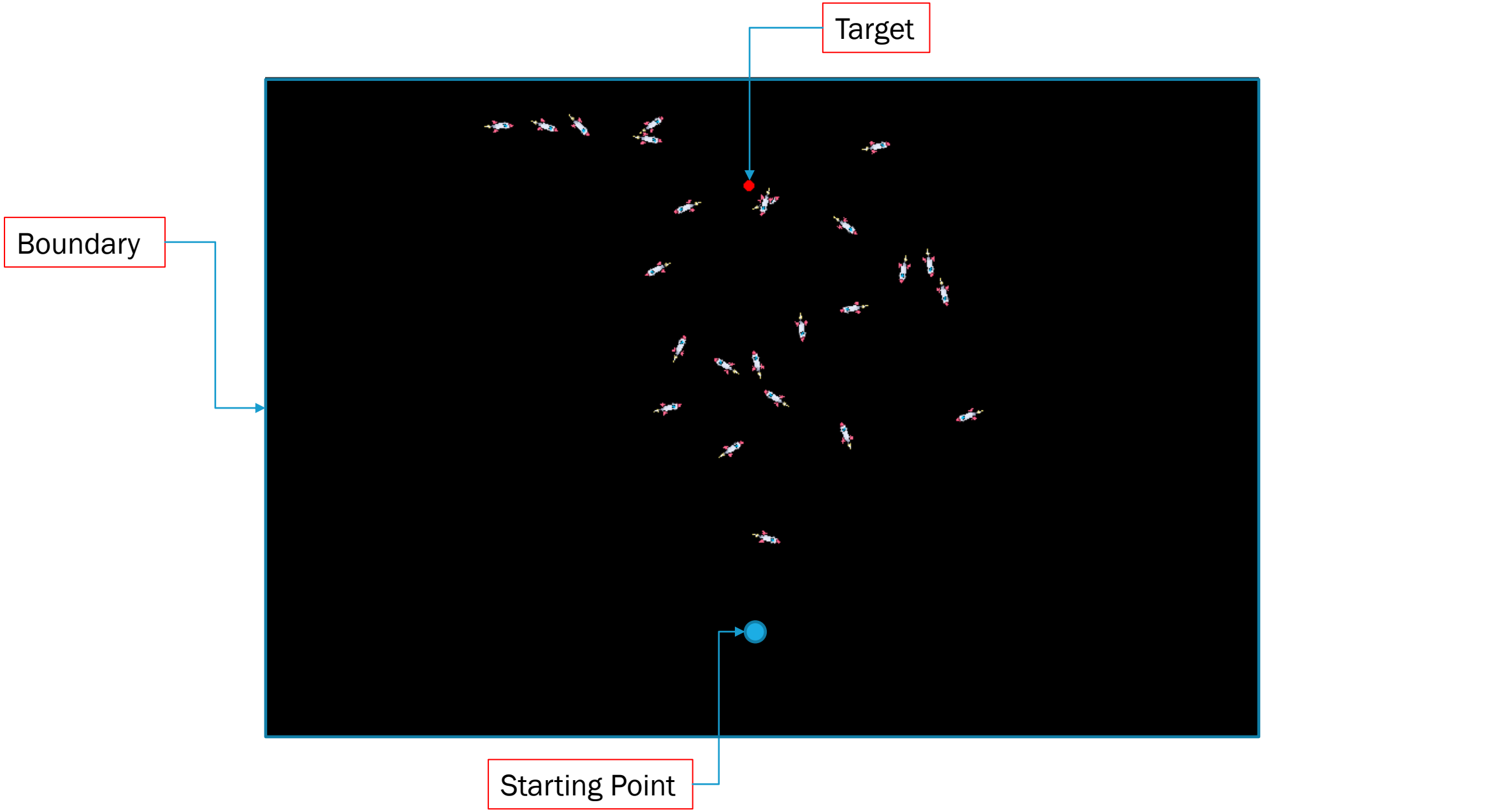
SMART ROCKETS





SMART ROCKETS + PHYSICS SIMULATION

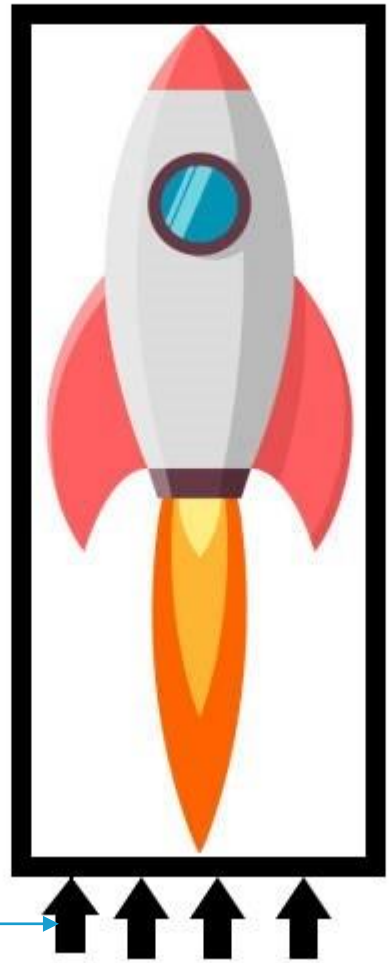
THIS IS AN IMPLEMENTATION OF A PHYSICS SIMULATION AND GENETIC ALGORITHM.


Target
Boundary
Starting Point

DESCRIPTION

- We have multiple rockets, All of them at the starting Position. We want to train them to find the Target.
- Rockets start towards a given direction with random forces acting on it from It's thrusters.
- After a certain time period the population of rockets are dissolved, and new rockets are launched from the same position.
- The rockets formed in the new iteration are better than their previous counter parts as they inherit the properties of the best among the previous population.

Rocket is a Rectangle object.



Thrusters:
Positions where the force vectors act

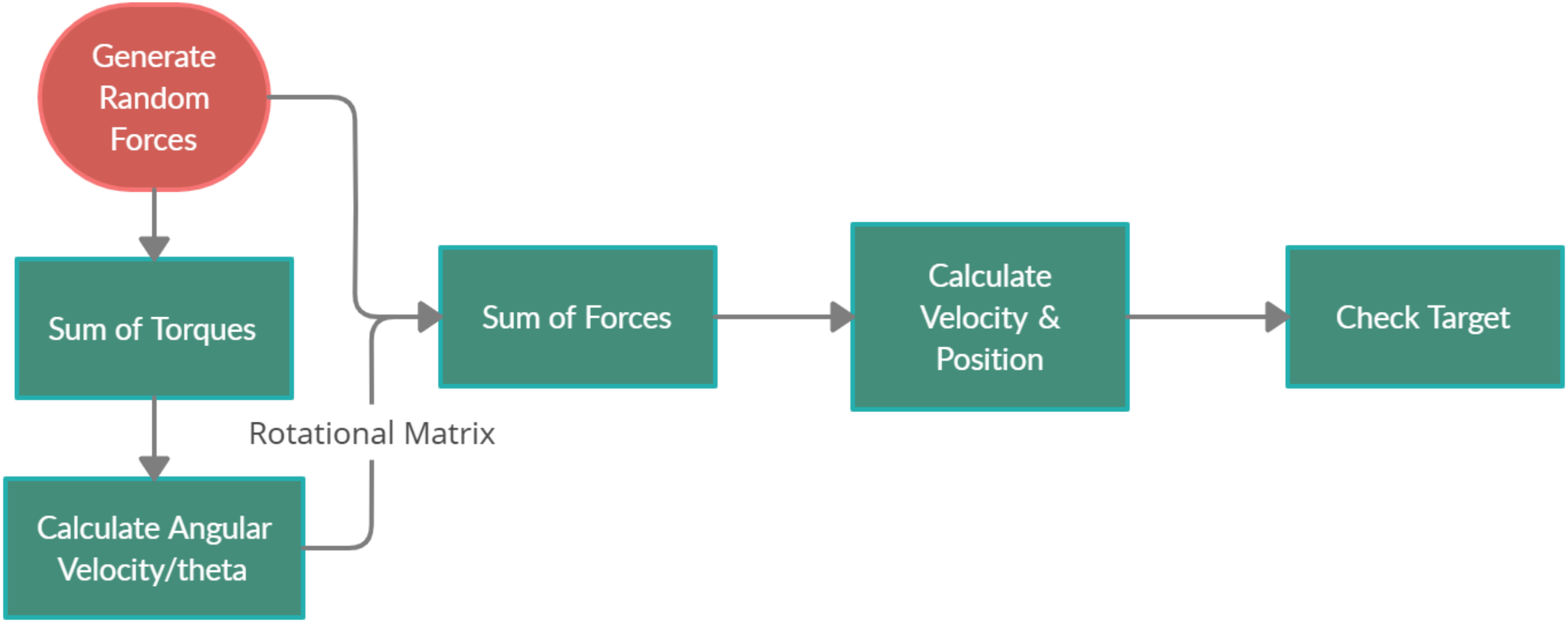
ROTATIONAL MOTION

- For rotational motion, we calculate the torque, then sum of all torques
  - **T = r × F**
- Using the sum of torques to find angular velocity.
  - $\omega f = \omega i + \alpha t$
- We use the final and initial angular velocity to then calculate the final theta
  - $\theta f = \theta i + (\omega f + \omega i)/2 * t$

TRANSLATIONAL MOTION

- Using the theta, we find the rotational matrix and multiply it with sum of all the forces.
  - This is done to describe the of sum of all the forces w.r.t to the screen..
- The sum of all forces is used to find final velocity, and final position
  - ***vf = vi + at***
- We can then calculate the final position based on final and initial velocity
  - **xf = xi + (vf + vi)/2 * t**

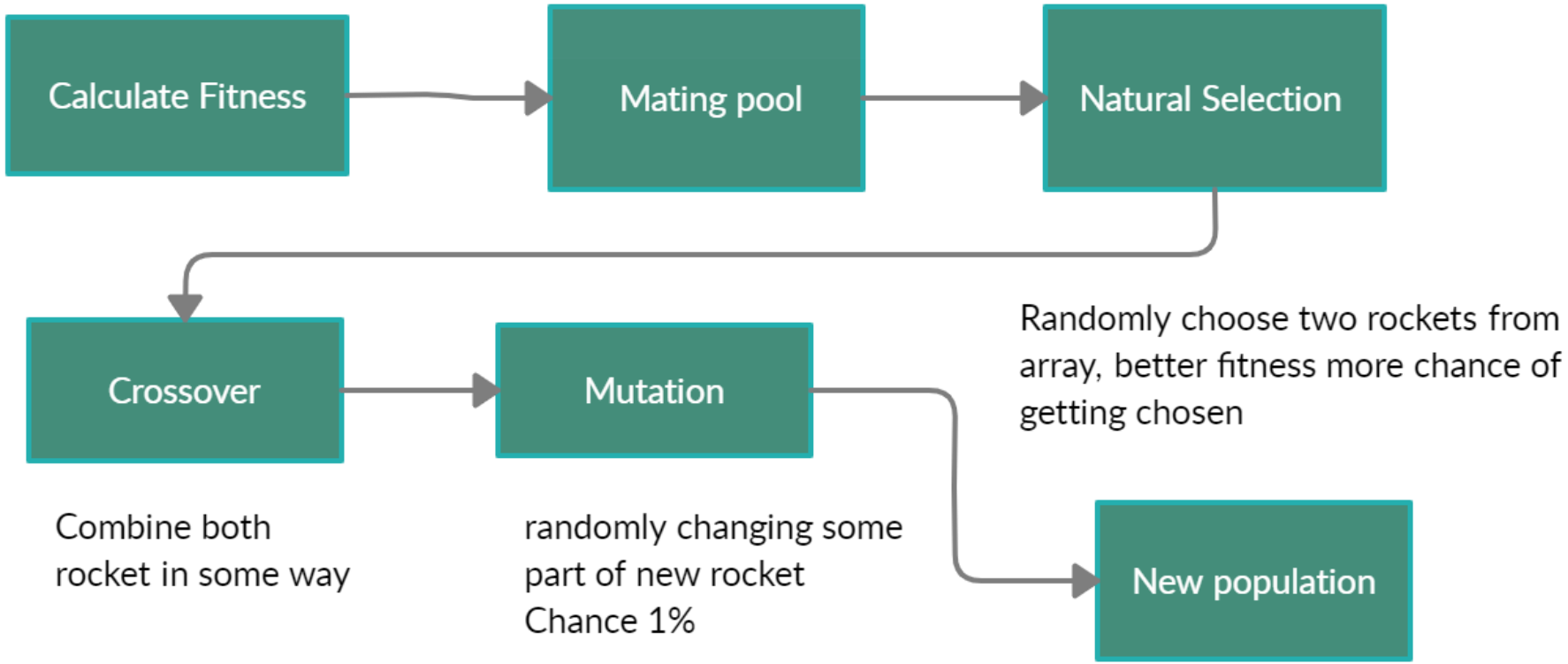
Physics Implementation



GENETIC ALGORITHM

- The forces acting on the rocket are then evolved to reach the target. Genetic algorithm is used to evolve our forces. The algorithm has three steps
- Selection
- Crossover
- Mutation

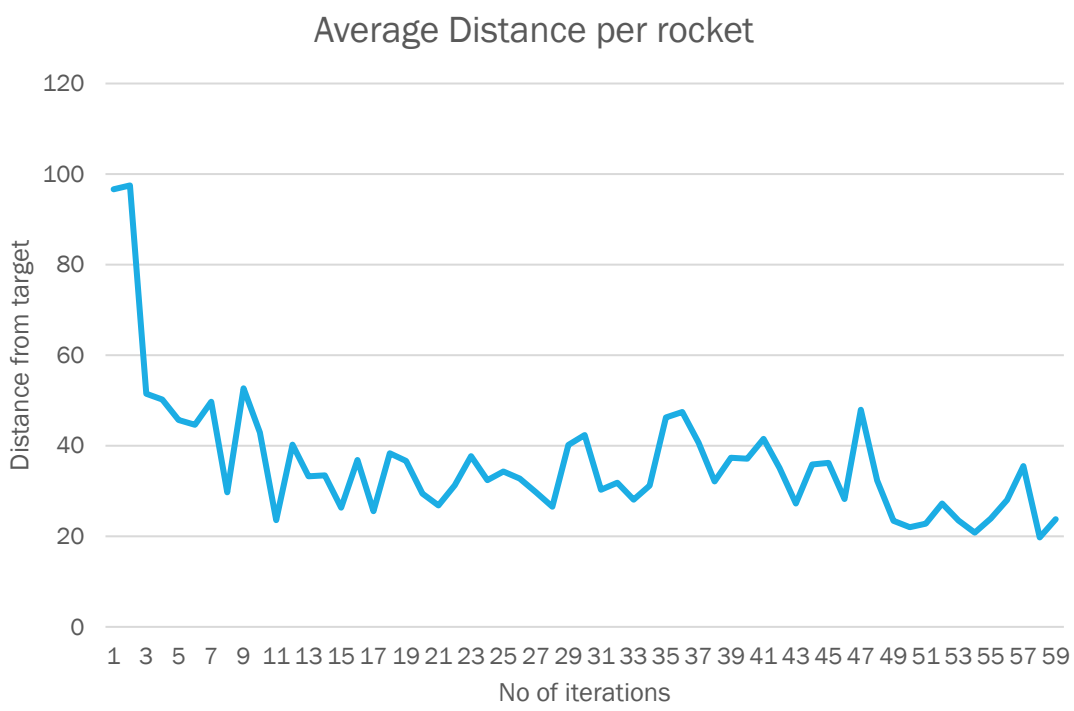
Make copies of all rockets based on the fitness, better fitness more copies

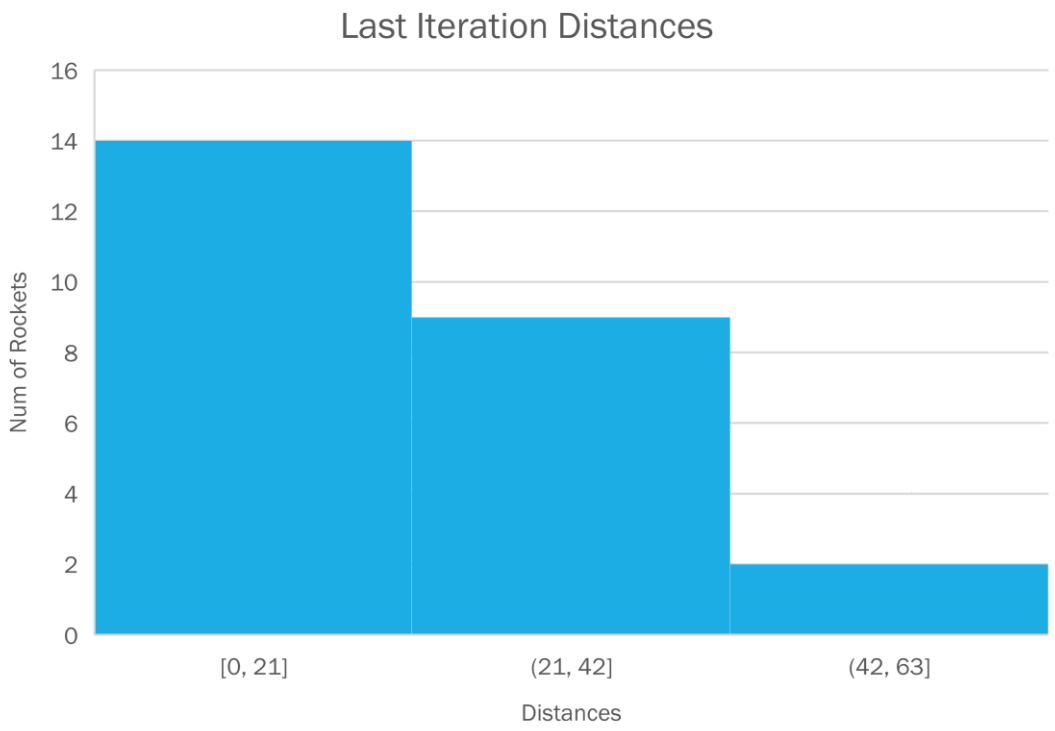


Randomly choose two rockets from array, better fitness more chance of getting chosen

Combine both rocket in some way

randomly changing some part of new rocket
Chance 1%

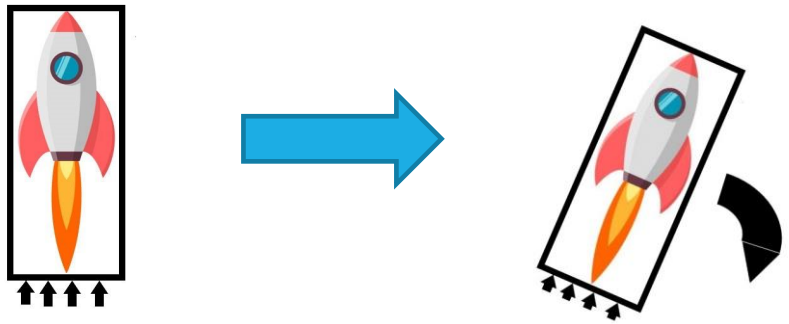

Average Distance per rocket
Distance from target
120
100
80
60
40
20
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51 53 55 57 59
No of iterations


Last Iteration Distances
Num of Rockets
16
14
12
10
8
6
4
2
0
[0, 21]
(21, 42]
(42, 63]
Distances

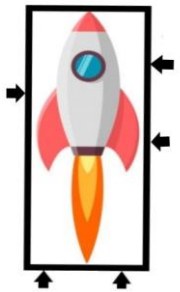
RESULTS

- From the data above, its clear that the distance is average distance of rockets is improving gradually.
- After about 15 iterations, the results stop improving.
- Due to certain limitations, we cannot achieve better our results further.

LIMITATIONS



- Since all the forces are acting from the bottom, its hard to maintain a smooth flight.
- The rocket rotates continuously while trying to reach the Target.
- However, if we apply forces at better positions, we can achieve better results and controlled flight.



MOTIVATION

- I got the motivation to do this project.