SWARM INTELLIGENCE

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WHY?

WHAT KIND OF PROBLEMS?

WHAT KIND OF PROBLEMS?

Optimization

WHAT KIND OF PROBLEMS?

Optimization

Modeling

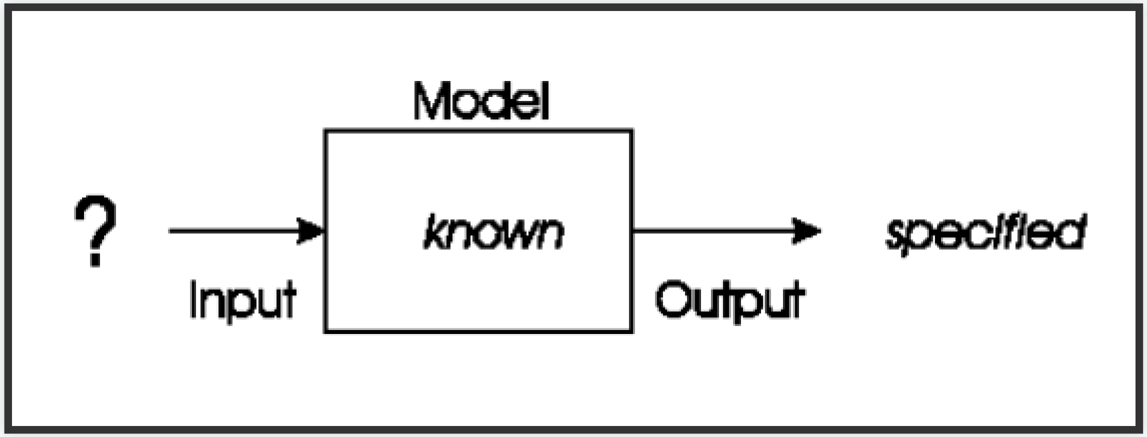
WHAT KIND OF PROBLEMS?

Optimization

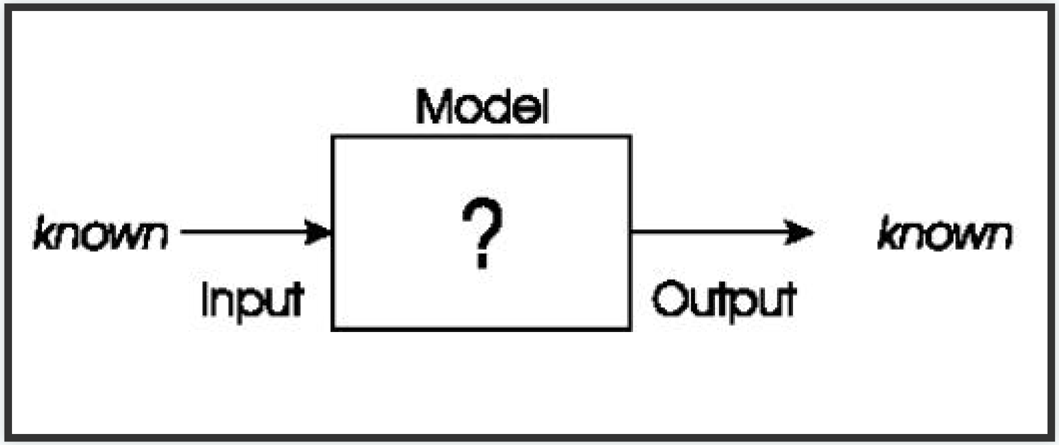
Modeling

Simulation

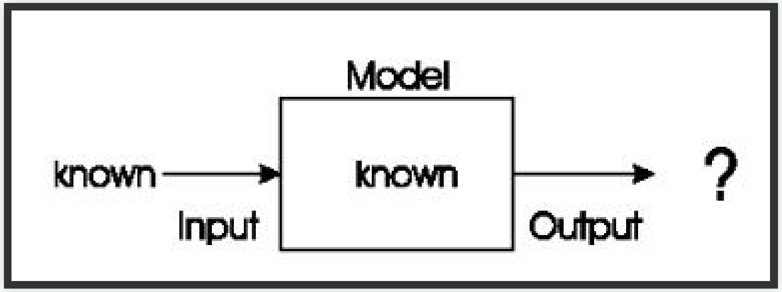
OPTIMIZATION



MODELING



SIMULATION



OPTIMIZATION

EXHAUSTIVE SEARCH

OTHER METHODS

OTHER METHODS

Analytical

OTHER METHODS

Analytical

Uninformed

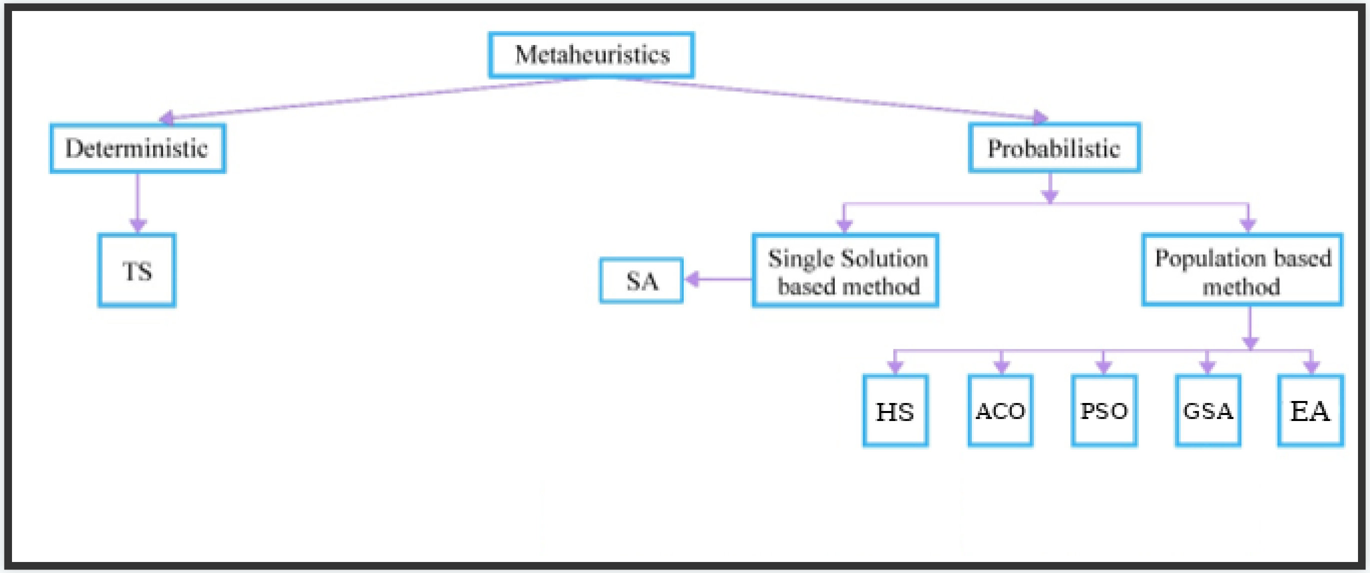
OTHER METHODS

Analytical

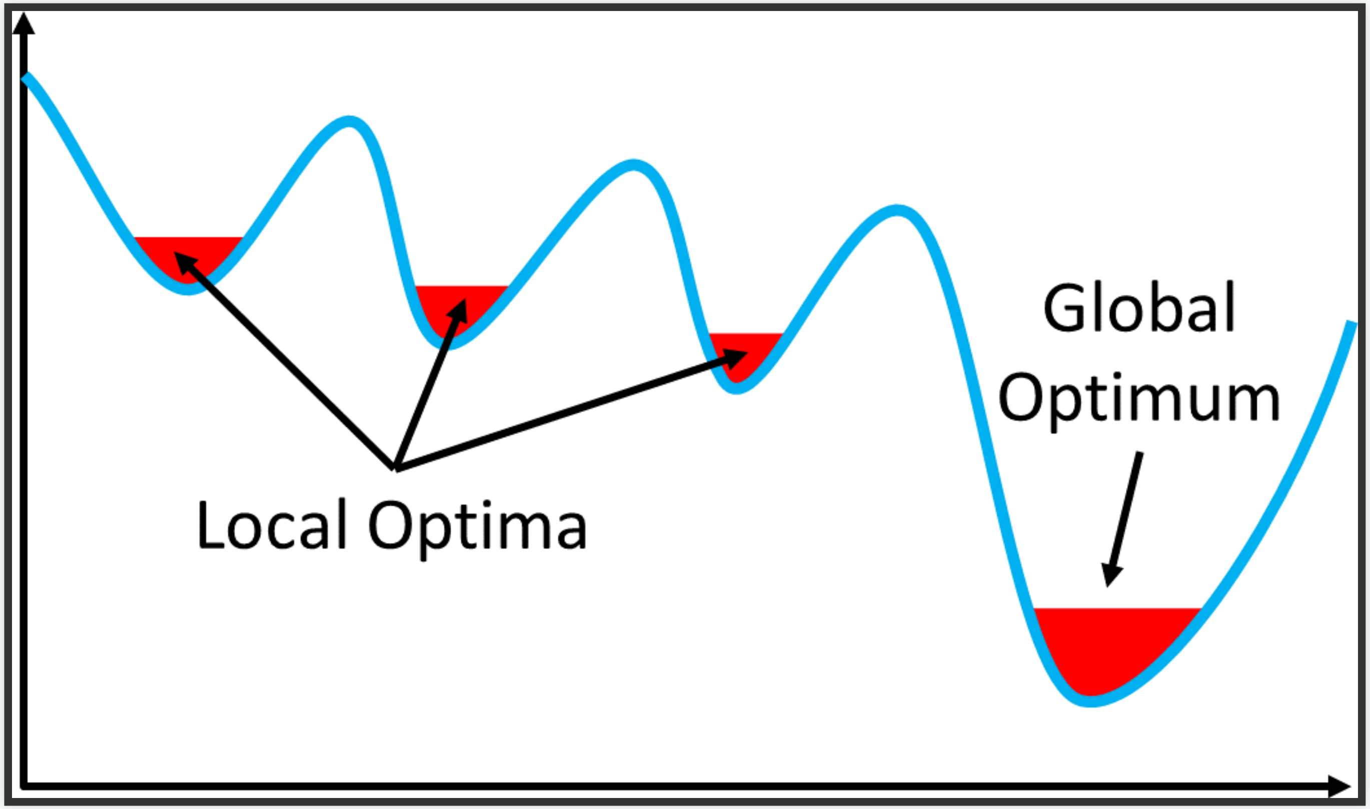
Uninformed

Informed

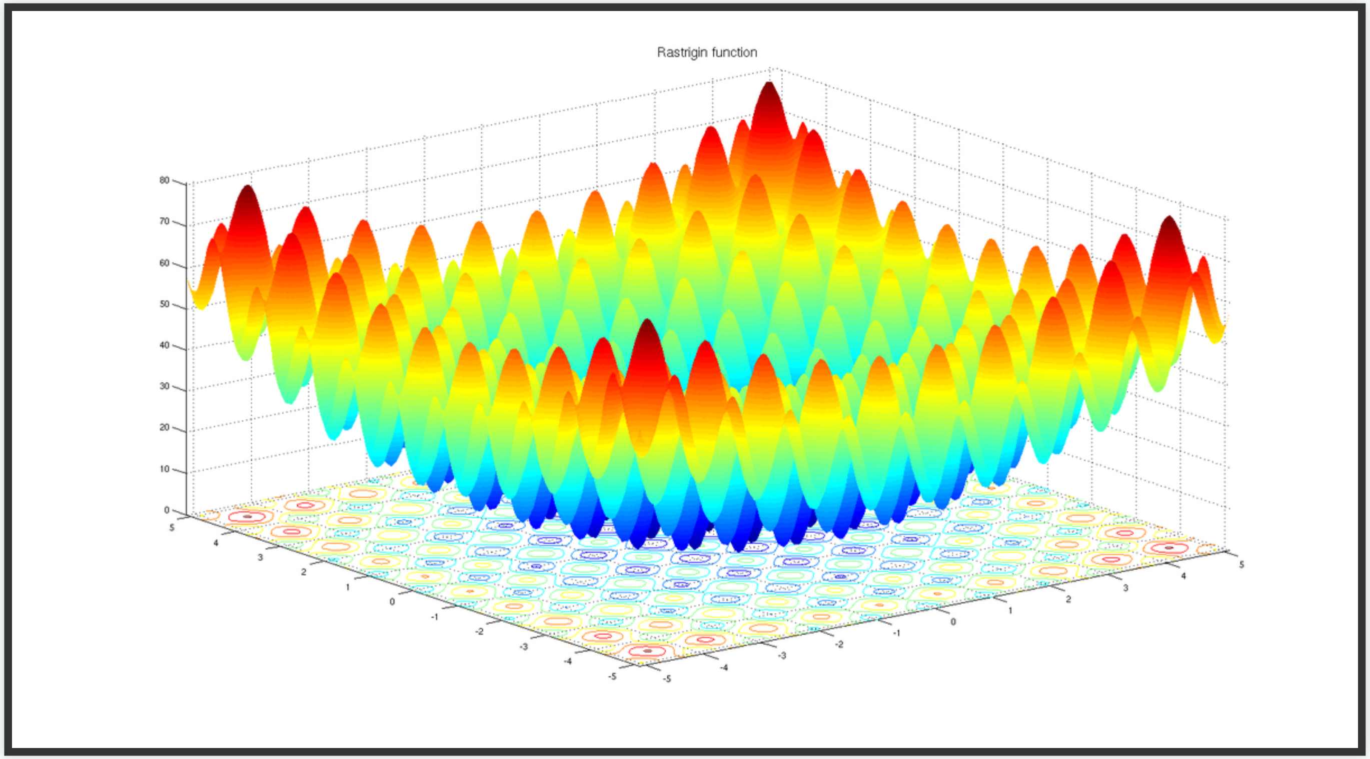
METAHEURISTIC



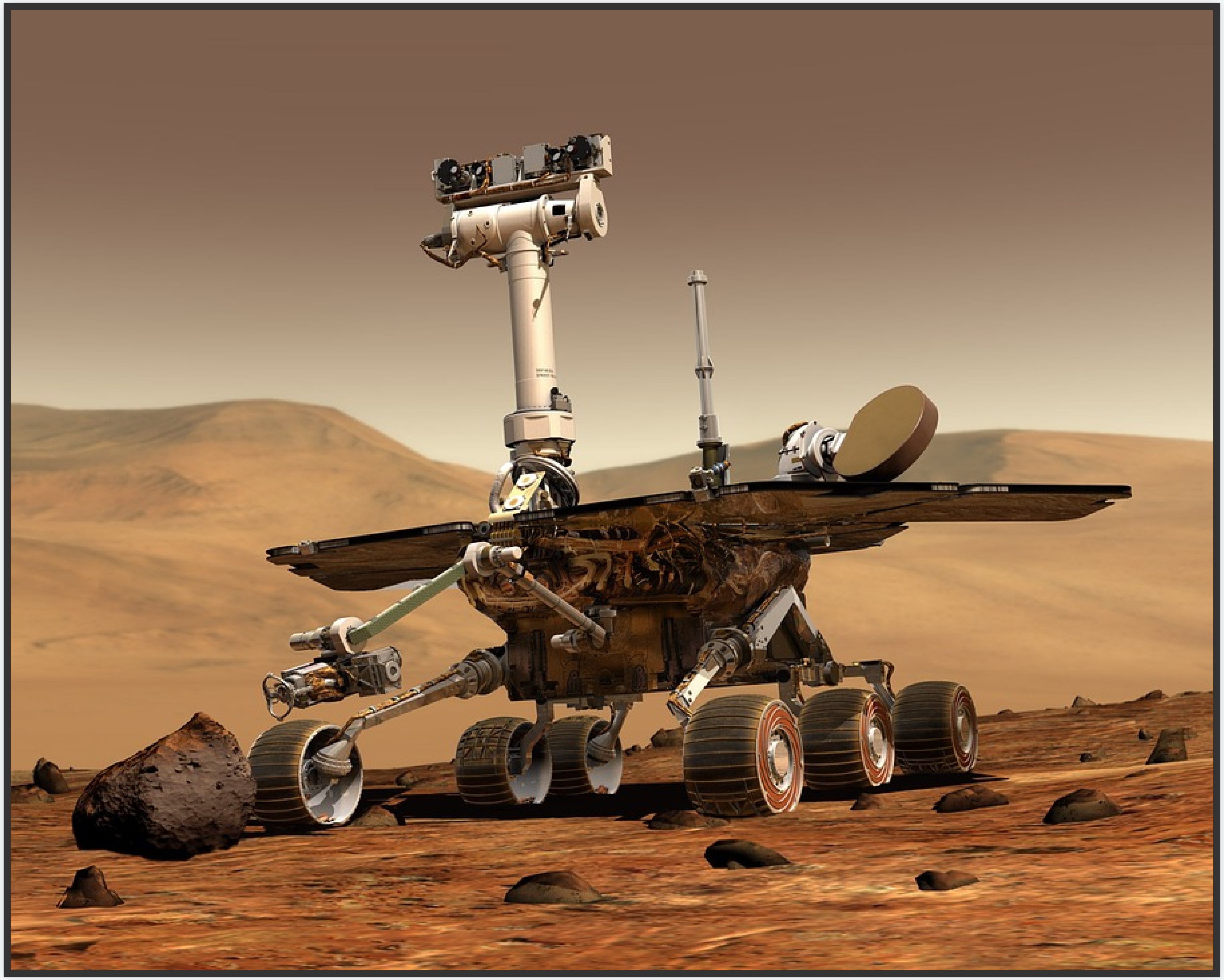
LOCAL & GLOBAL OPTIMUM



COMPLEX SPACES

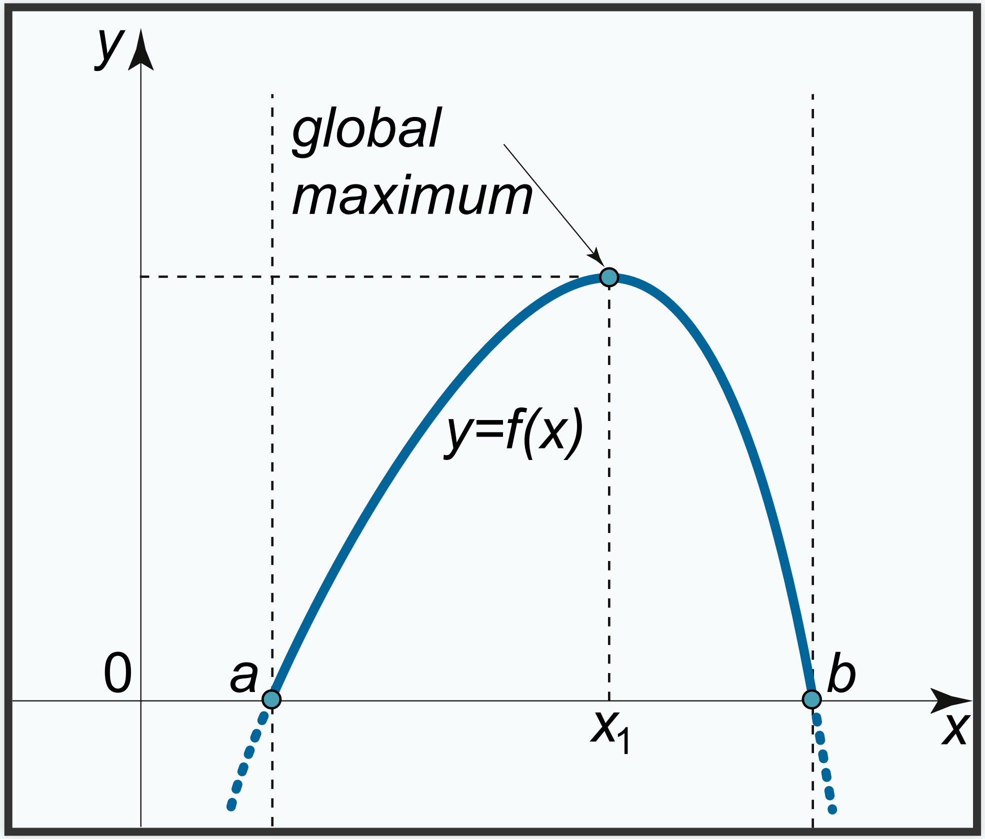


EXPLORATION

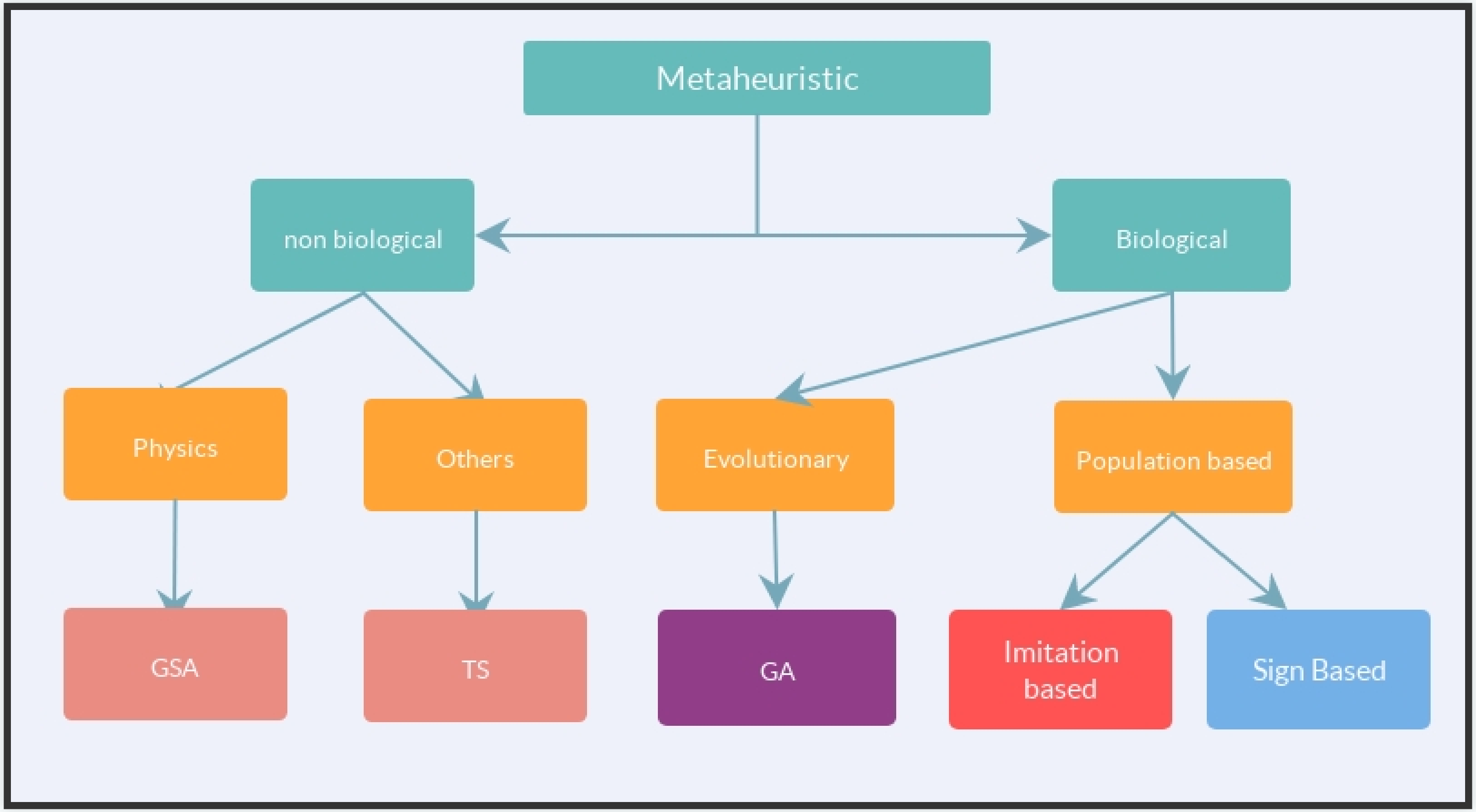


EXPLOITATION

EXPLOITATION



CATEGORIES



Metaheuristic
non biological
Biological
Physics
Others
Evolutionary
Population based
GSA
TS
GA
Imitation based
Sign Based

SWARM

GOAL

Is to model their simple behaviors to findout about more complex behaviors.

SIGN BASED ALGORITHMS

STEPS

STEPS

1. Init memory

STEPS

1. Init memory
2. Generate a solution

STEPS

1. Init memory
2. Generate a solution
3. Calculate the fitness of generated solution

STEPS

1. Init memory
2. Generate a solution
3. Calculate the fitness of generated solution
4. Continue this for all population

STEPS

1. Init memory
2. Generate a solution
3. Calculate the fitness of generated solution
4. Continue this for all population
5. Update signs memory

STEPS

1. Init memory
2. Generate a solution
3. Calculate the fitness of generated solution
4. Continue this for all population
5. Update signs memory
6. Repeat until stop condition meets

ACO

ACO

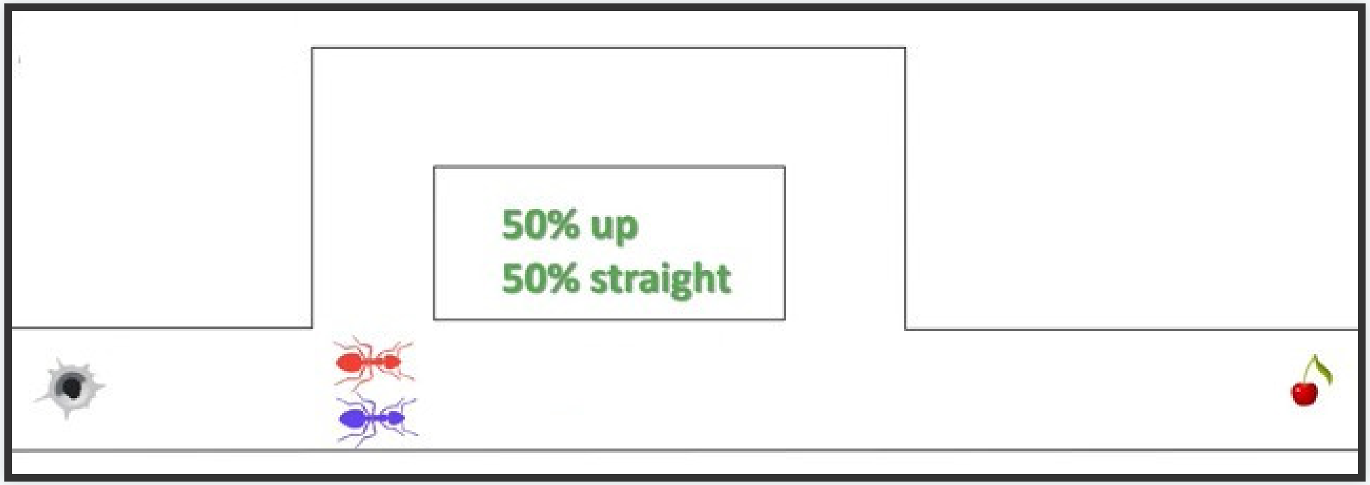
Marco Dorigo (1992)

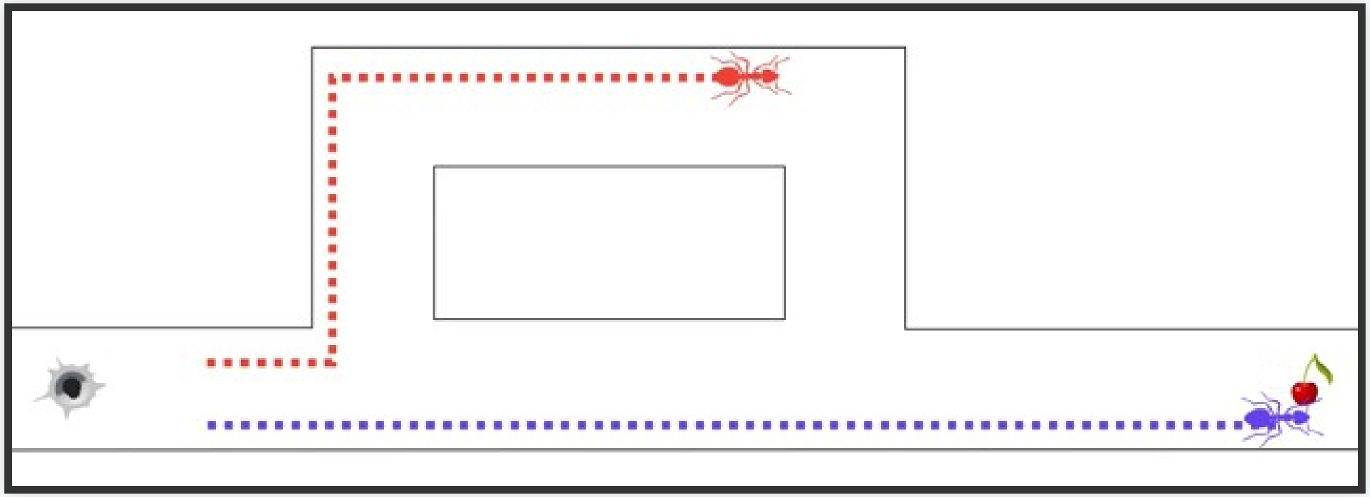
ACO

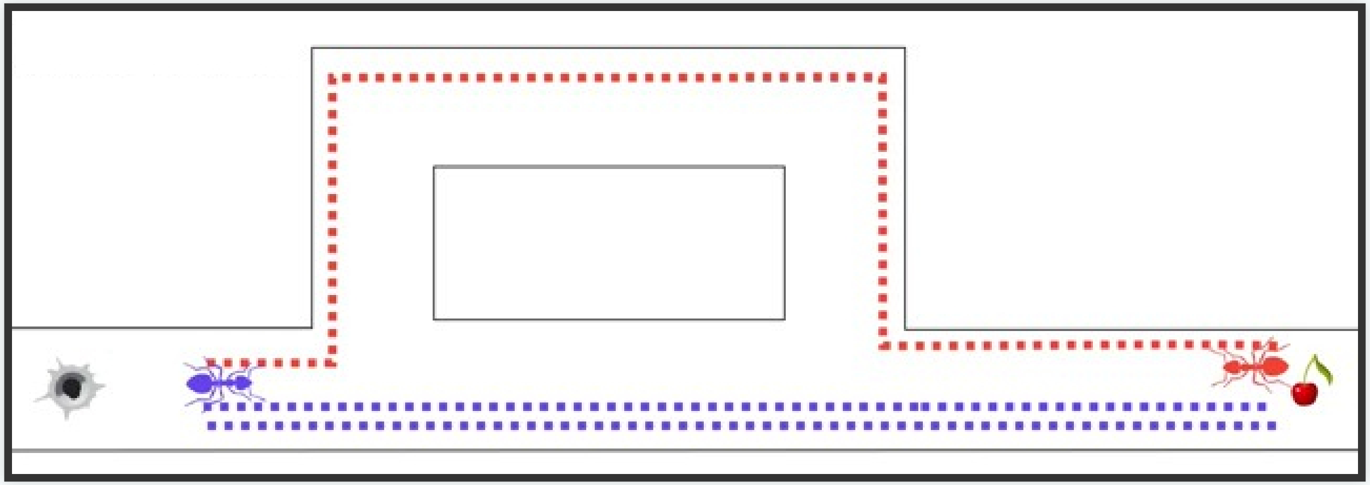
Marco Dorigo (1992)

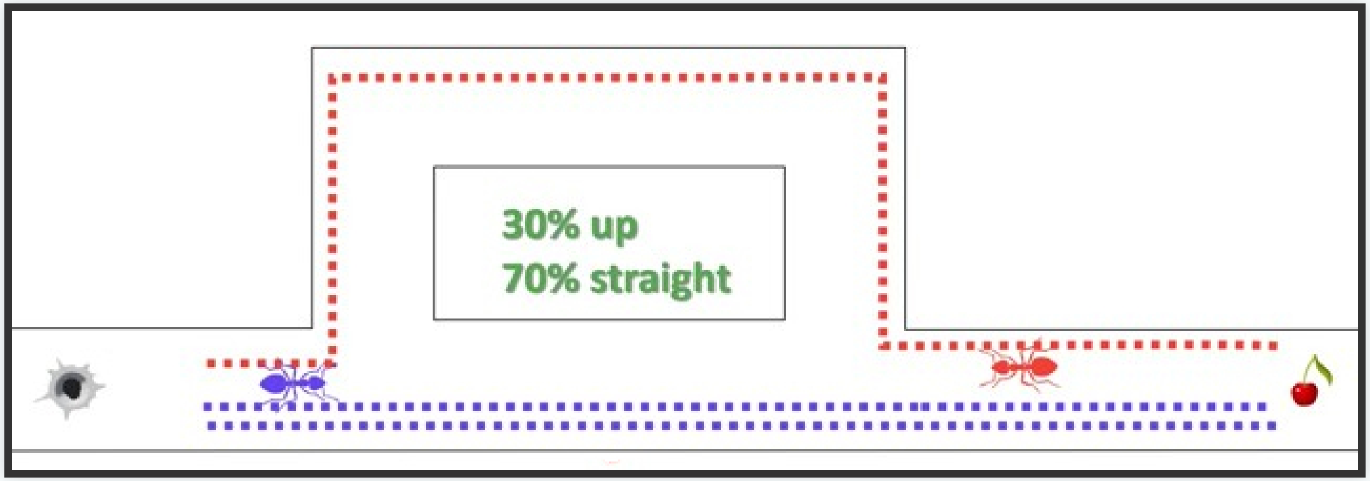
Finding good paths through graphs

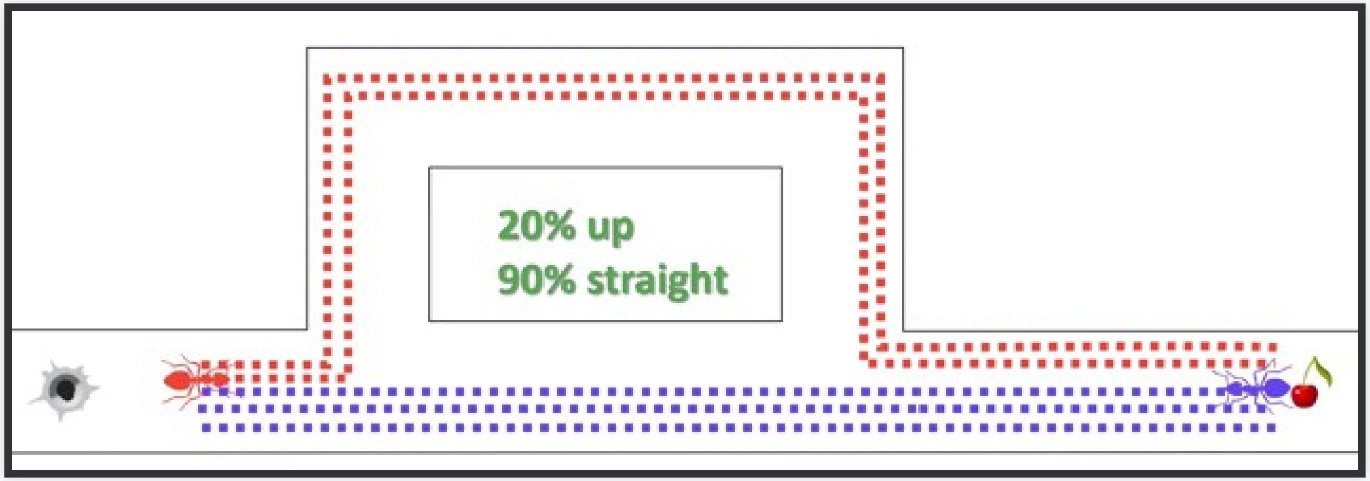
HOW IT WORKS?

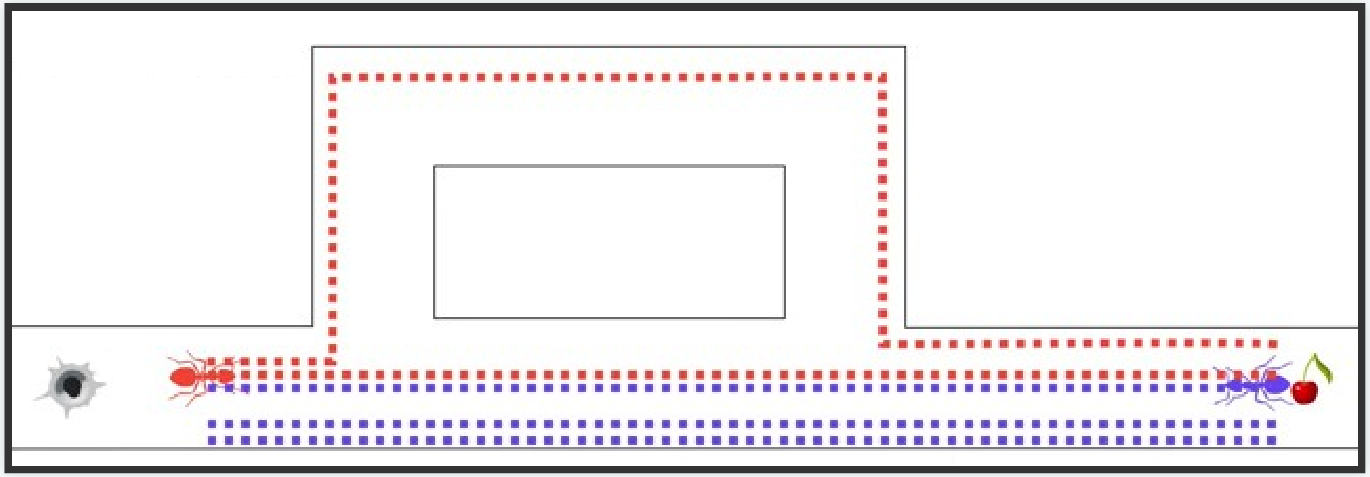

50% up
50% straight

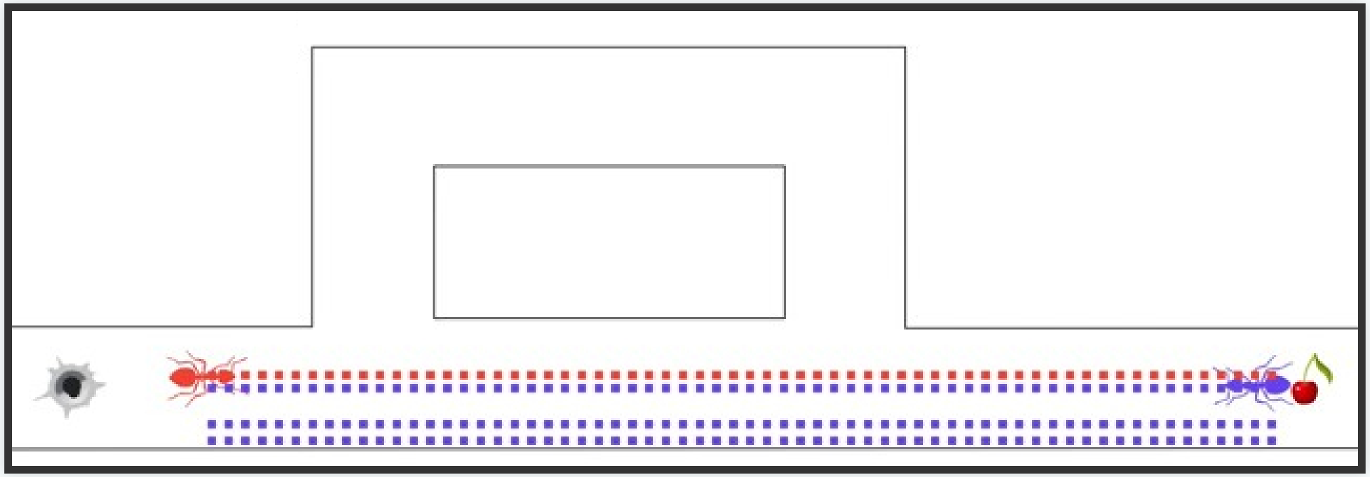


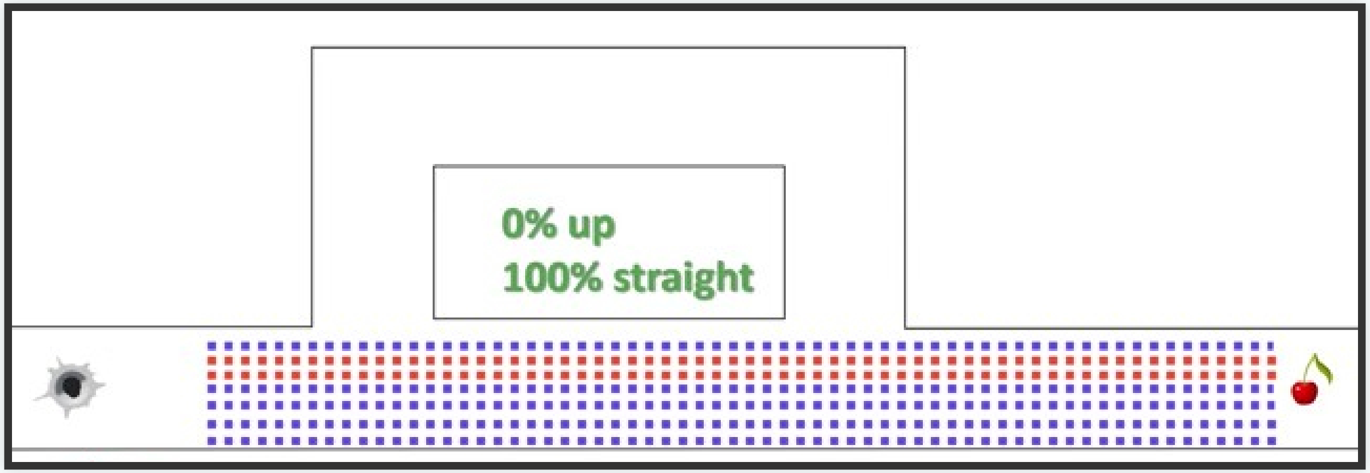


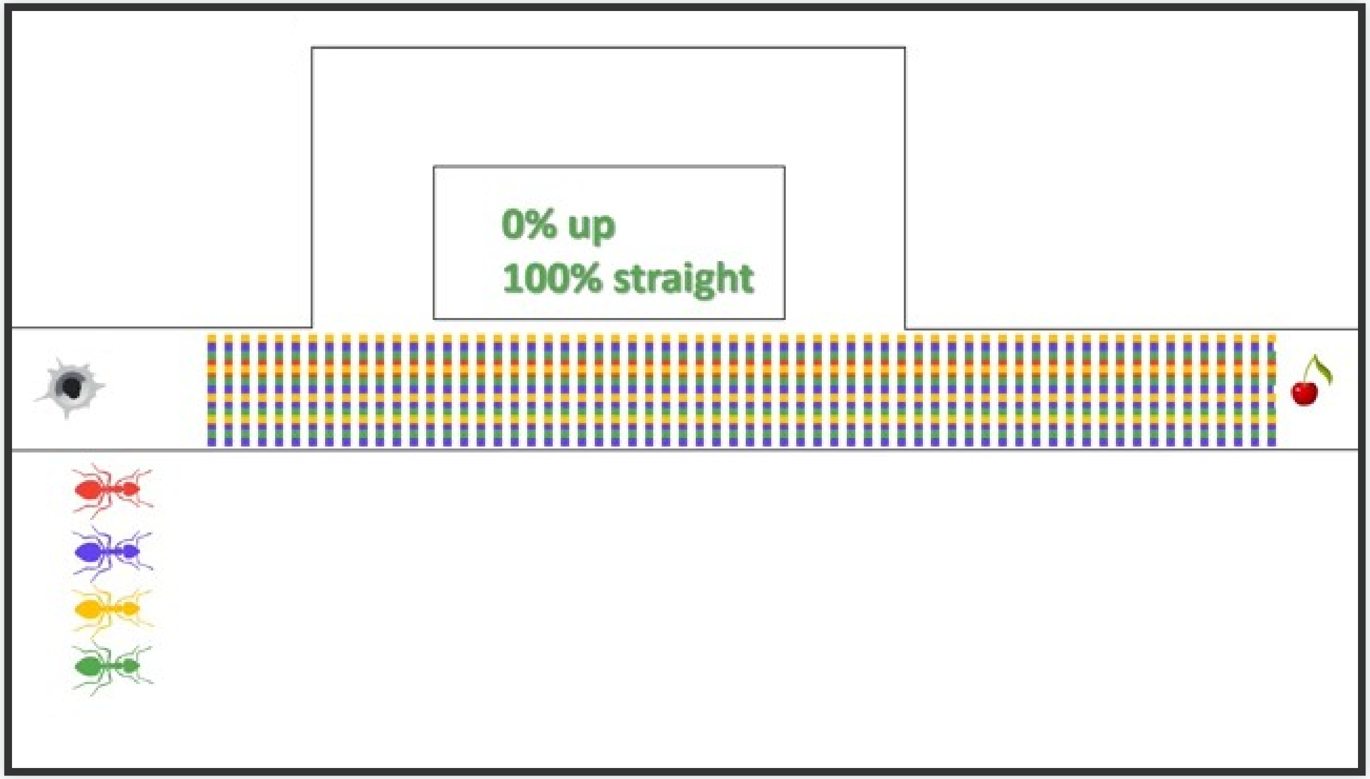

30% up
70% straight


20% up
90% straight






0% up
100% straight


0% up
100% straight

ACO ADVANTAGES

Search among a population in parallel

Can give rapid discovery of good solutions

Can adapt to changes in graph

ACO ADVANTAGES

Search among a population in parallel

Can give rapid discovery of good solutions

Can adapt to changes in graph

ACO DISADVANTAGES

Prone to stagnation

Premature convergence

Uncertain converge time

Long calculation time

Solutions might be far from optimum

IMITATION BASED ALGORITHMS

STEPS

STEPS

1. Init Parameters

STEPS

1. Init Parameters
2. Init Population

STEPS

1. Init Parameters
2. Init Population
3. Move Particles

STEPS

1. Init Parameters
2. Init Population
3. Move Particles
4. Calculate the fitness

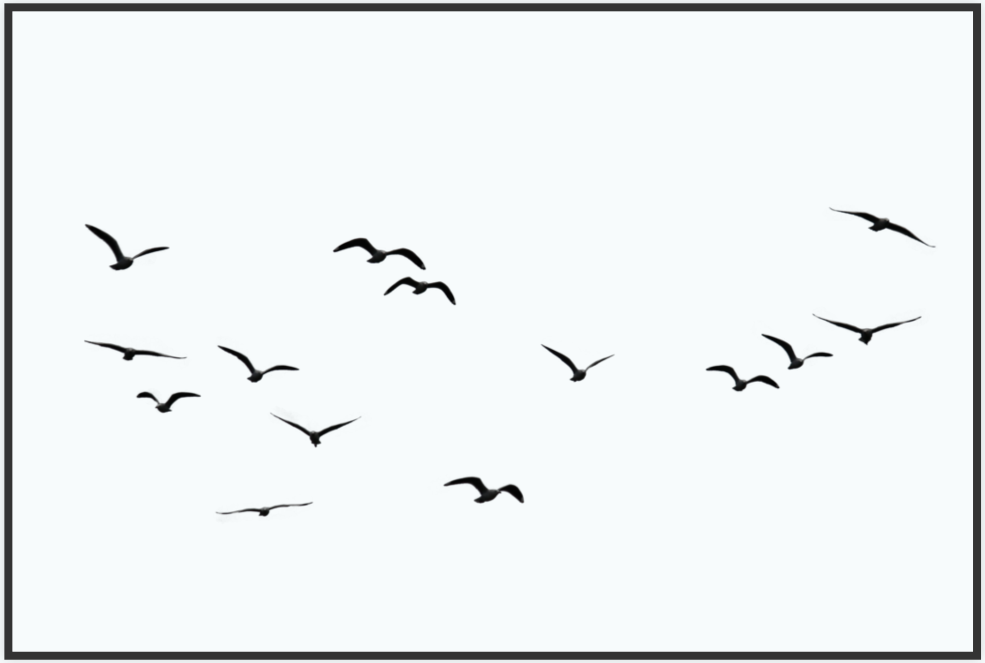
STEPS

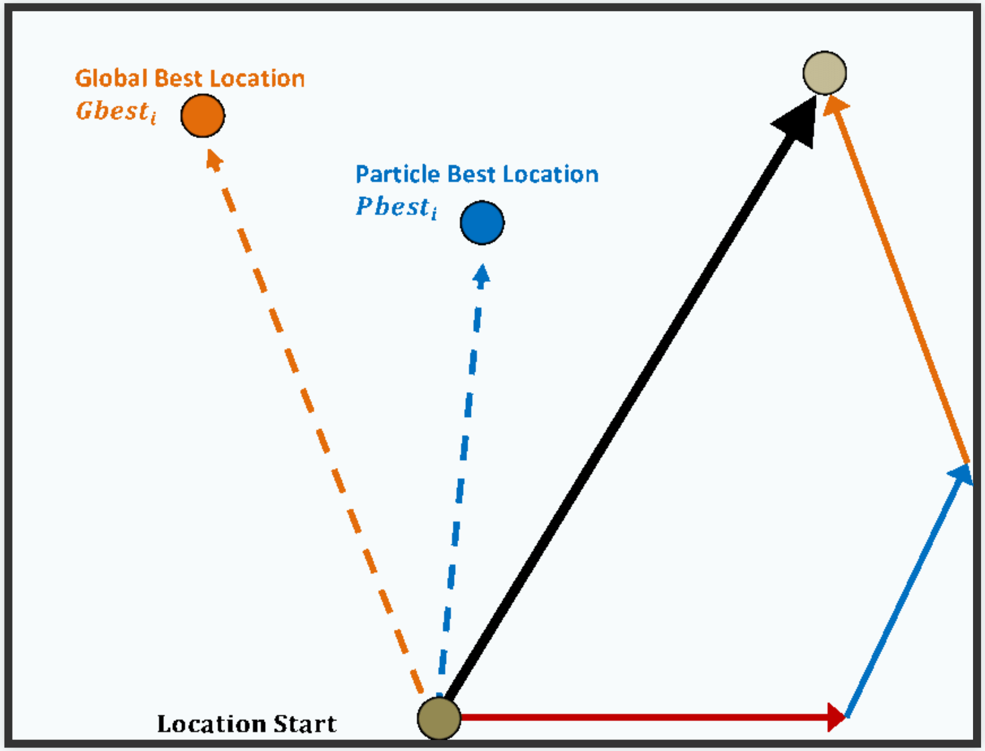
1. Init Parameters
2. Init Population
3. Move Particles
4. Calculate the fitness
5. Update particles memories

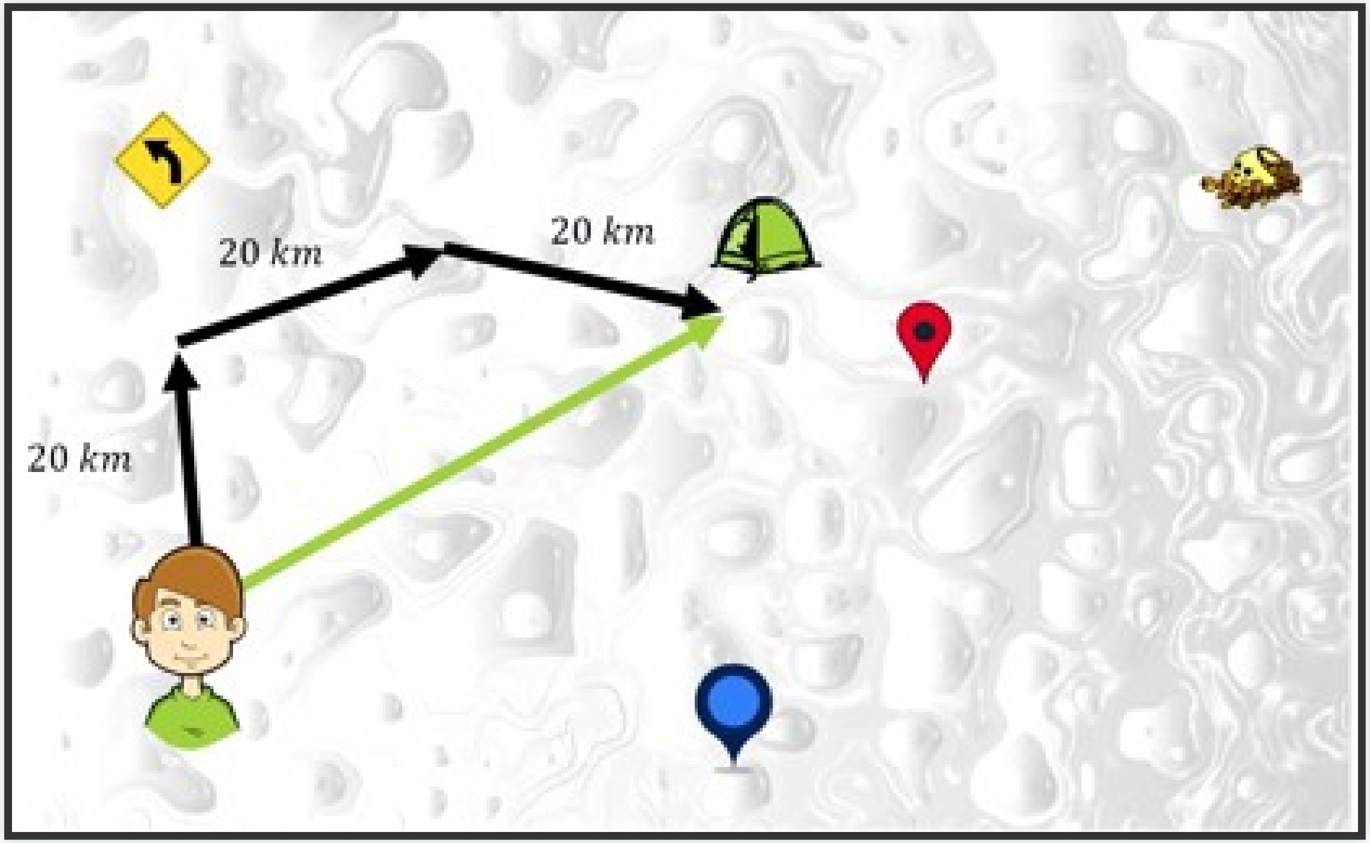
STEPS

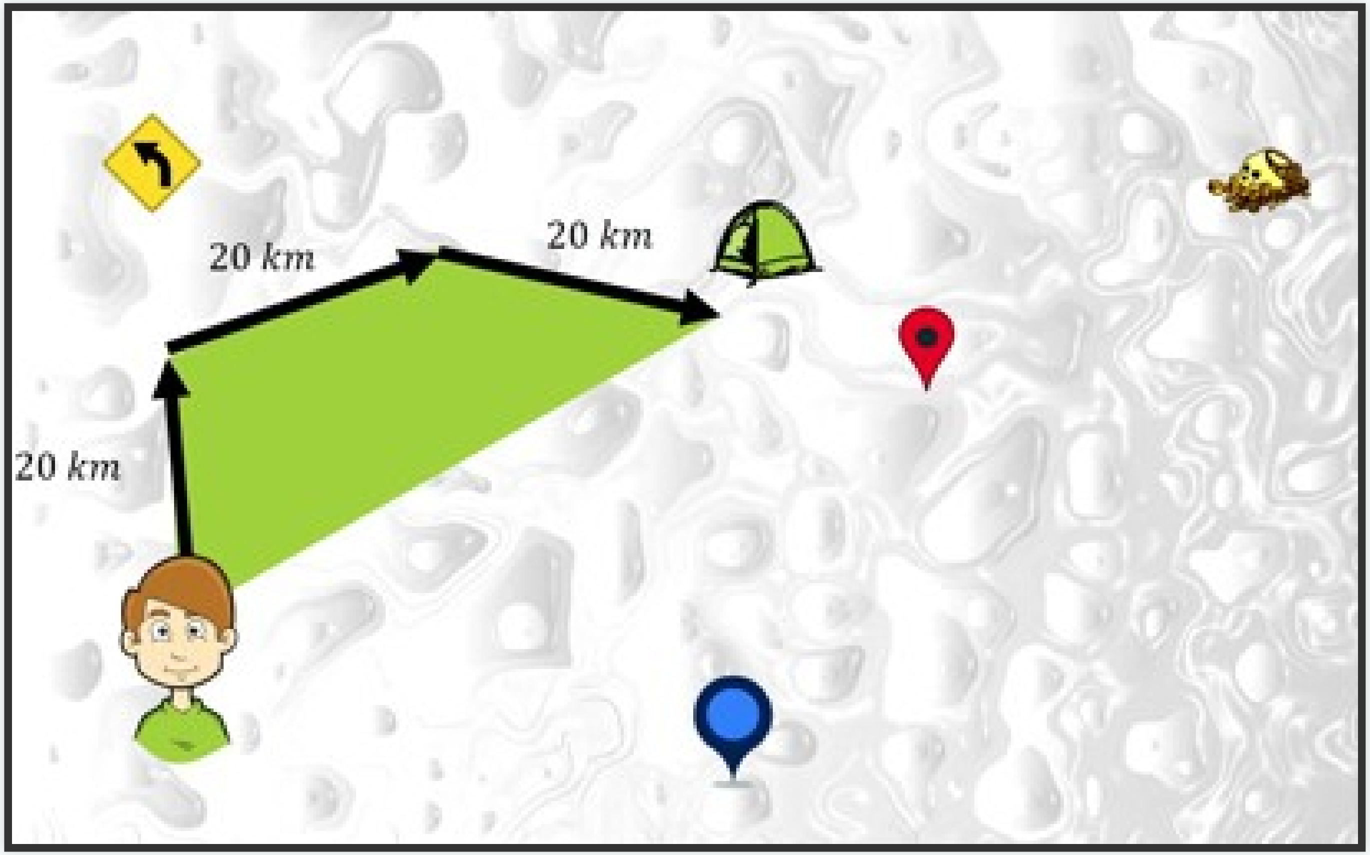
1. Init Parameters
2. Init Population
3. Move Particles
4. Calculate the fitness
5. Update particles memories
6. Repeat until stop condition meets

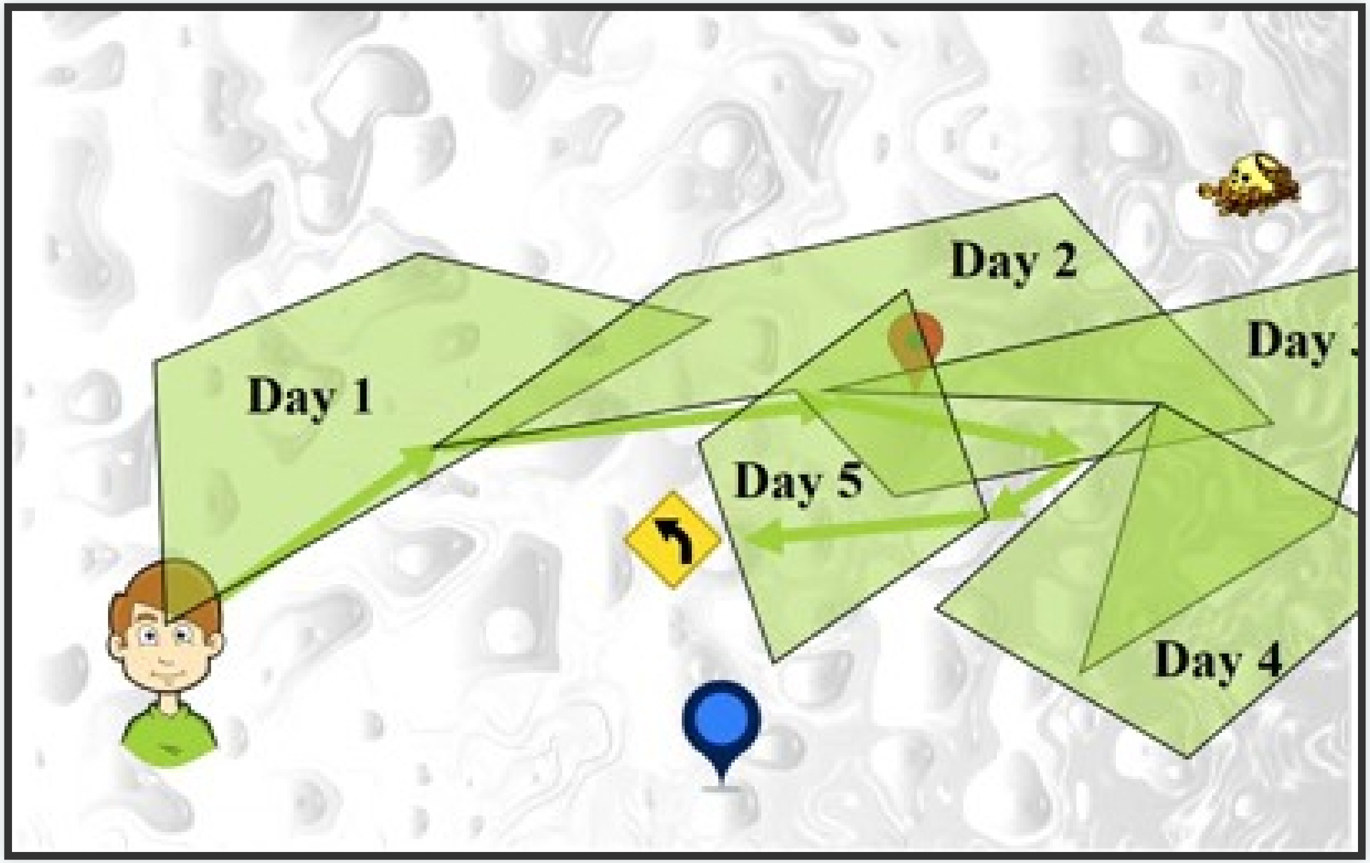
PSO

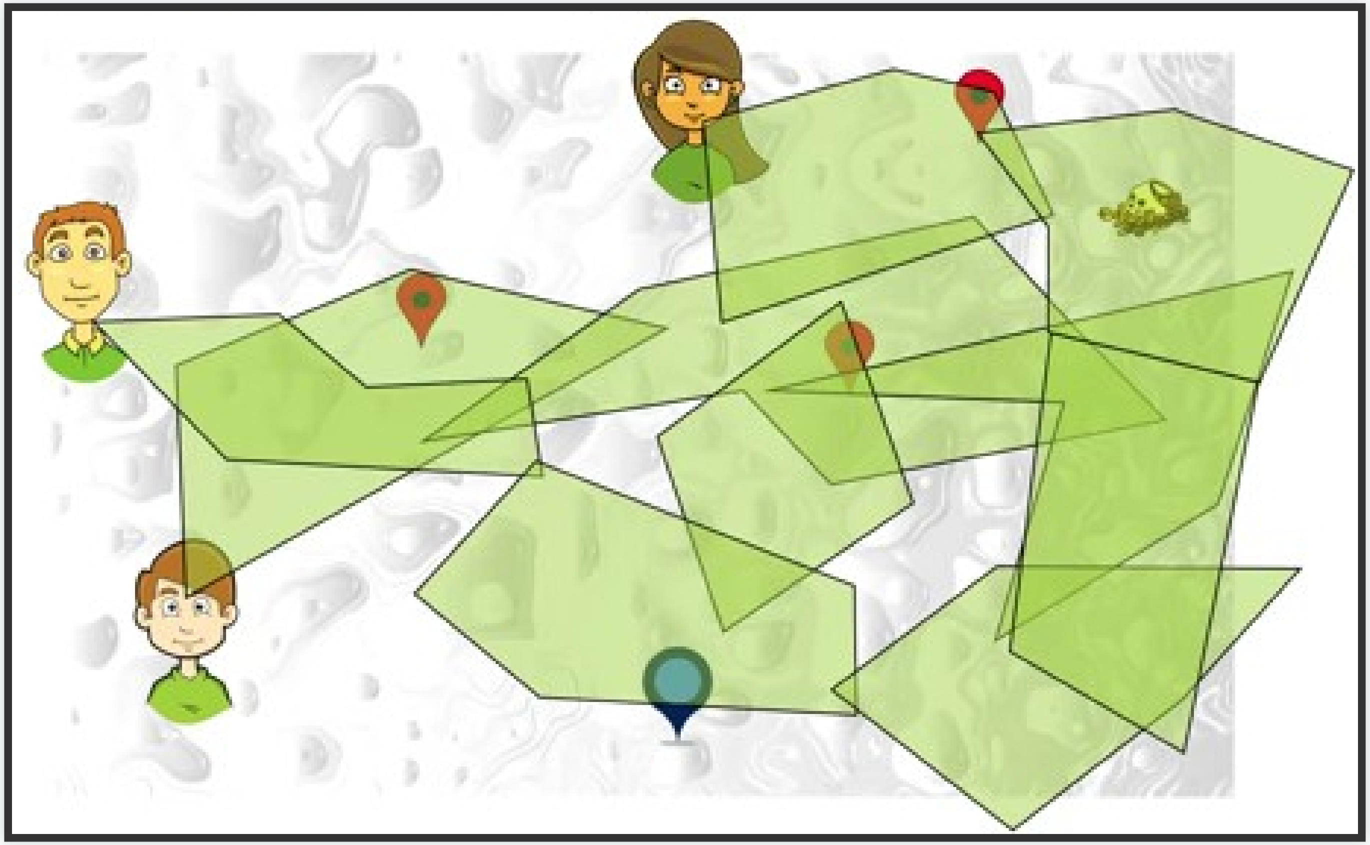


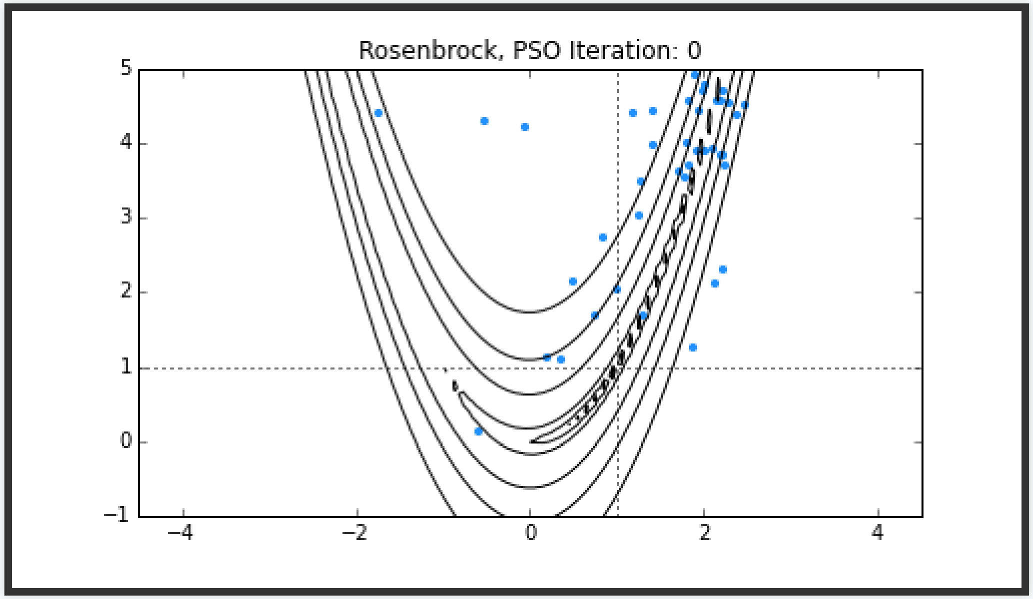

Global Best Location
$Gbest_i$
Particle Best Location
$Pbest_i$
Location Start

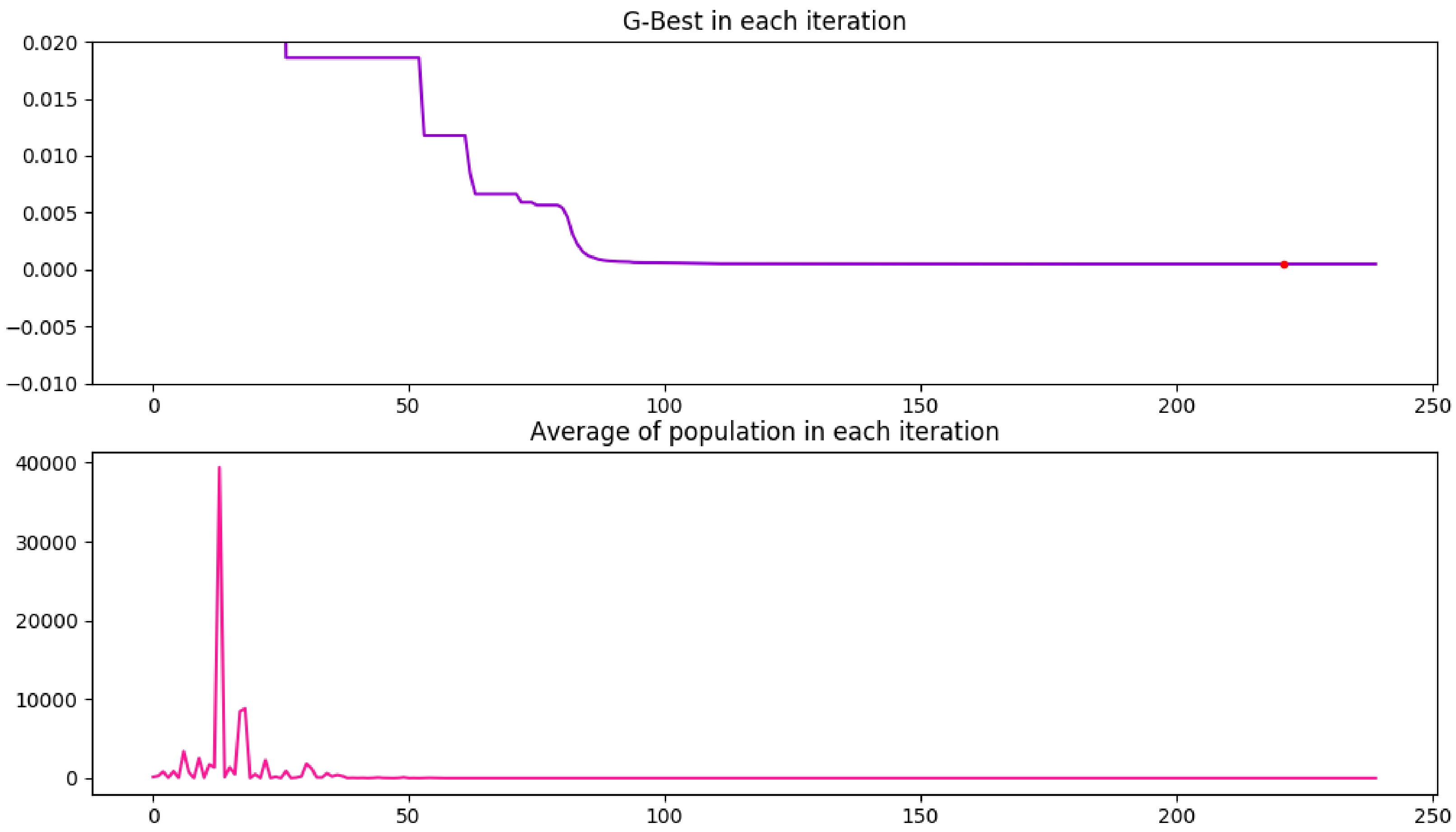

20 km
20 km
20 km


20 km
20 km
20 km


Day 1
Day 2
Day
Day 5
Day 4




Rosenbrock, PSO Iteration: 0
5
4
3
2
1
0
−1
−4
−2
0
2
4


G-Best in each iteration
0.020
0.015
0.010
0.005
0.000
−0.005
−0.010
0
50
100
150
200
250
Average of population in each iteration
40000
30000
20000
10000
0
0
50
100
150
200
250

PSO ADVANTAGES

PSO ADVANTAGES

Fast

PSO ADVANTAGES

Fast

Easy to implement

PSO ADVANTAGES

Fast

Easy to implement

No complex calculations

PSO ADVANTAGES

Fast

Easy to implement

No complex calculations

Doesn't have so much parameters

PSO DISADVANTAGES

PSO DISADVANTAGES

Prone to premature convergence

LET'S HAVE A LOOK TO OTHER ALGORITHMS

HARMONY SEARCH

HARMONY SEARCH

HARMONY SEARCH

Init Harmony Memory (RANDOM)

HARMONY SEARCH

Init Harmony Memory (RANDOM)

Improvise NEW harmony

HARMONY SEARCH

Init Harmony Memory (RANDOM)

Improvise NEW harmony

If NEW is better than min(HM)

HARMONY SEARCH

Init Harmony Memory (RANDOM)

Improvise NEW harmony

If NEW is better than min(HM)

Replace(min(HM), NEW)

HARMONY SEARCH

Init Harmony Memory (RANDOM)

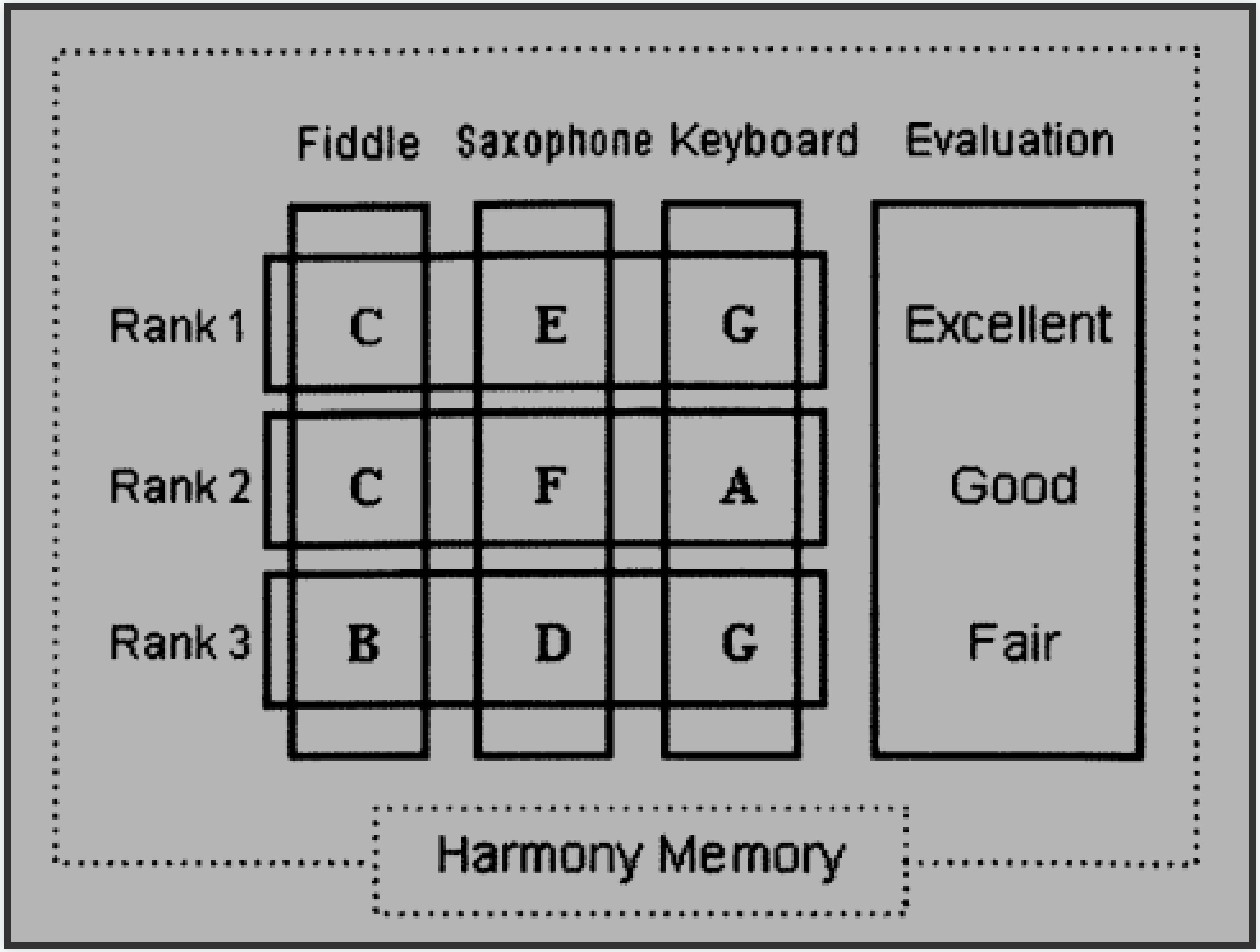
Improvise NEW harmony

If NEW is better than min(HM)

Replace(min(HM), NEW)

Loop till end condition meets

HARMONY SEARCH



HS ADVANTAGES

Quick convergence

Easy implementation

Less adjustable parameters

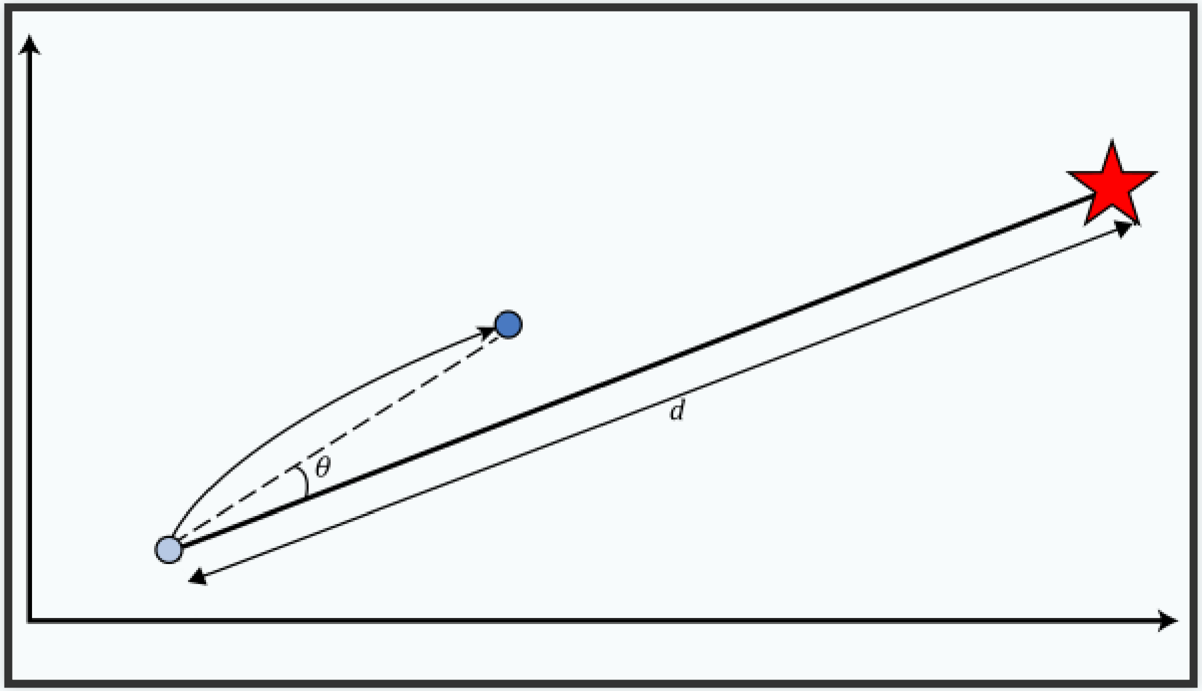
Fewer mathematical requirements

Generates a new solution, after considering all of the existing solutions

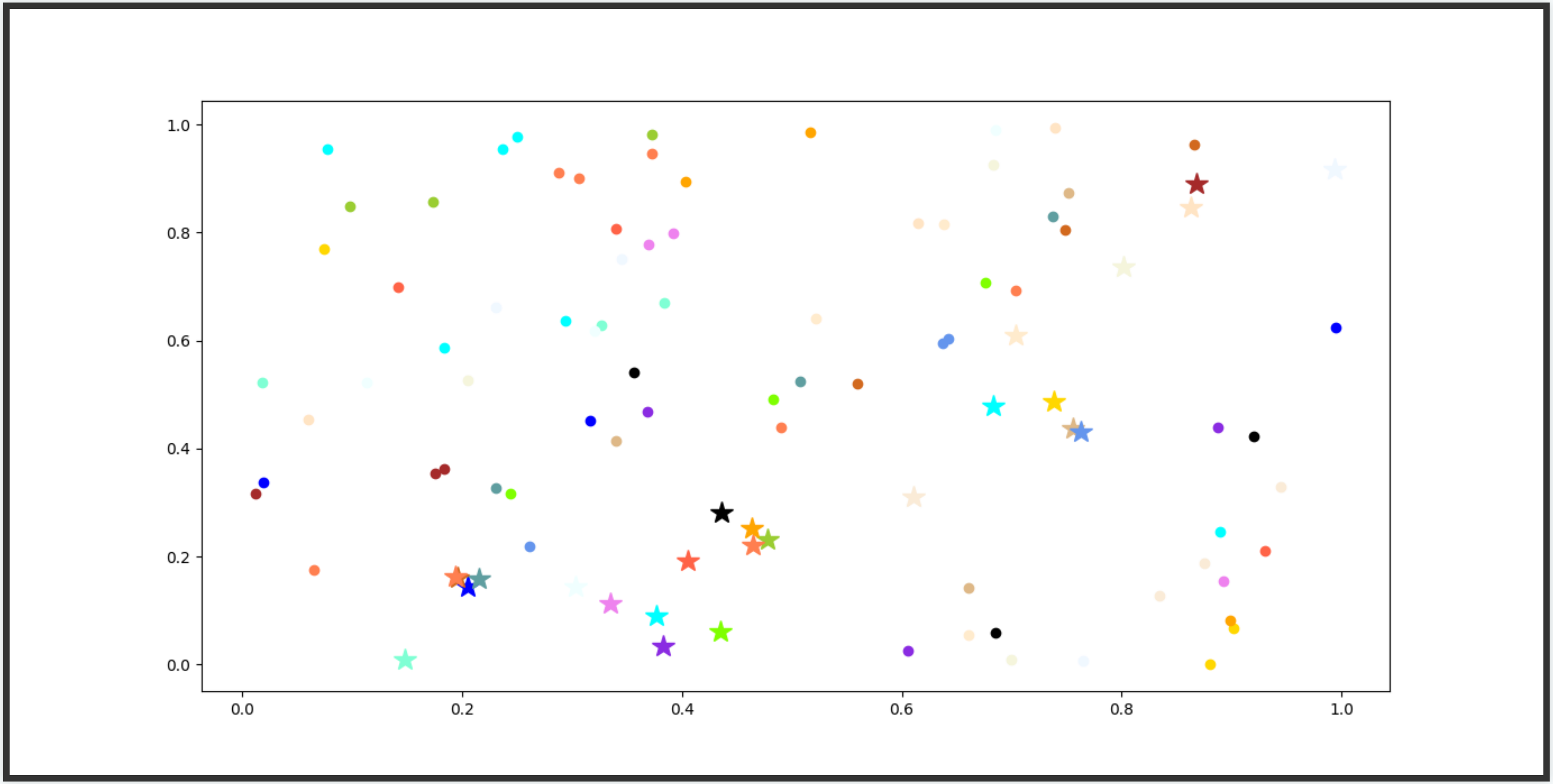
HS DISADVANTAGES

Premature convergence

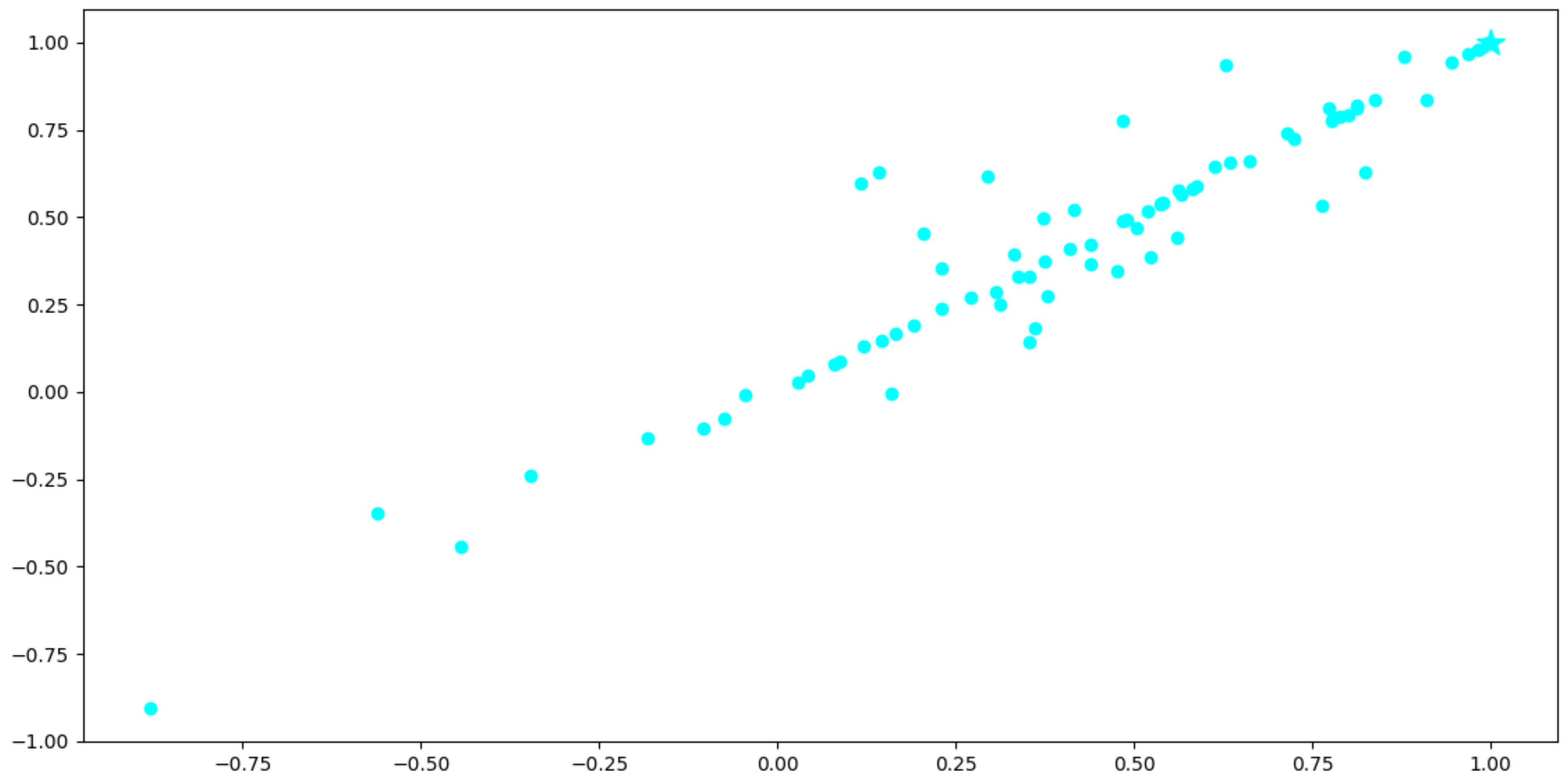
ICA



ICA



ICA



1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
0.75
1.00

ICA PROS & CONS

PROS

Good speed

Same and better solutions compared with other metaheuristic algorithms

PROS

Good speed

Same and better solutions compared with other metaheuristic algorithms

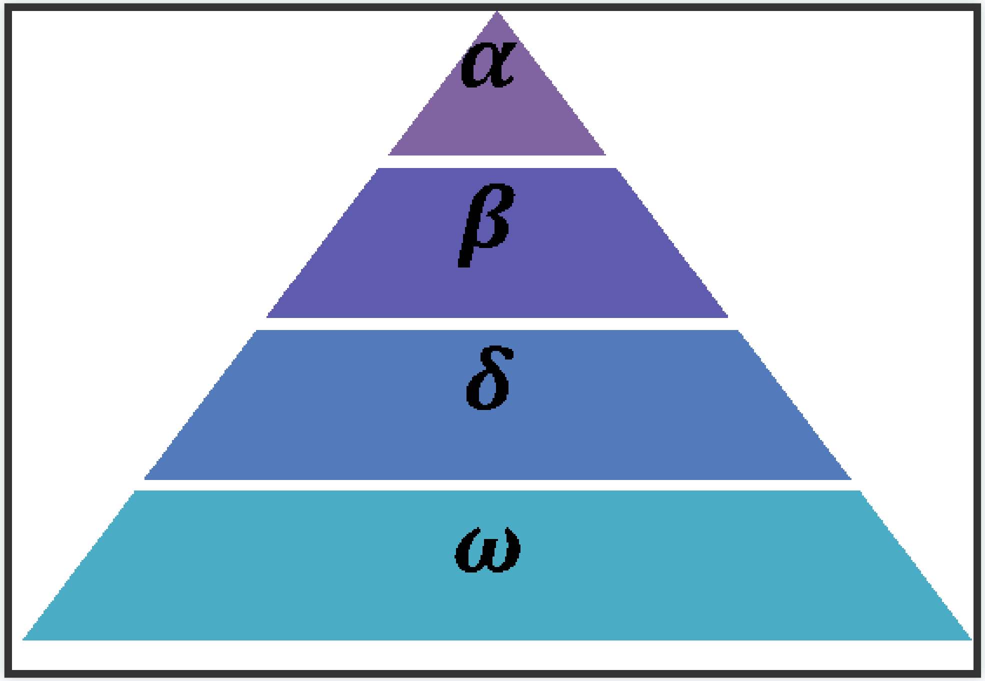
CONS

Complex implementation

GWO

Mimics leadership hierachy of wolves

GWO HIERACHY

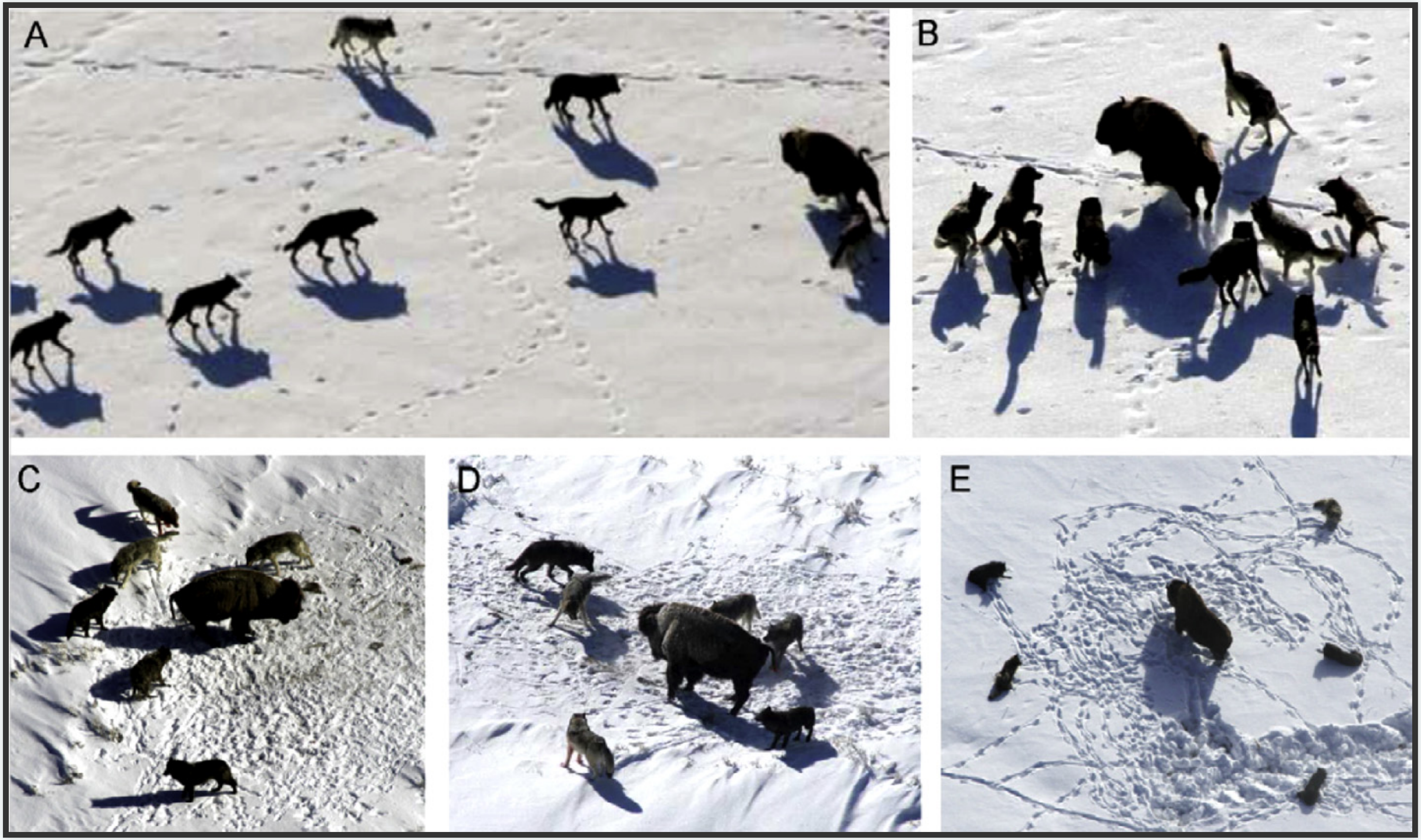


SOCIAL BEHAVIOR OF GREY WOLVES

Tracking, chasing, and approaching the prey.

Pursuing, encircling, and harassing the prey until it stops moving.

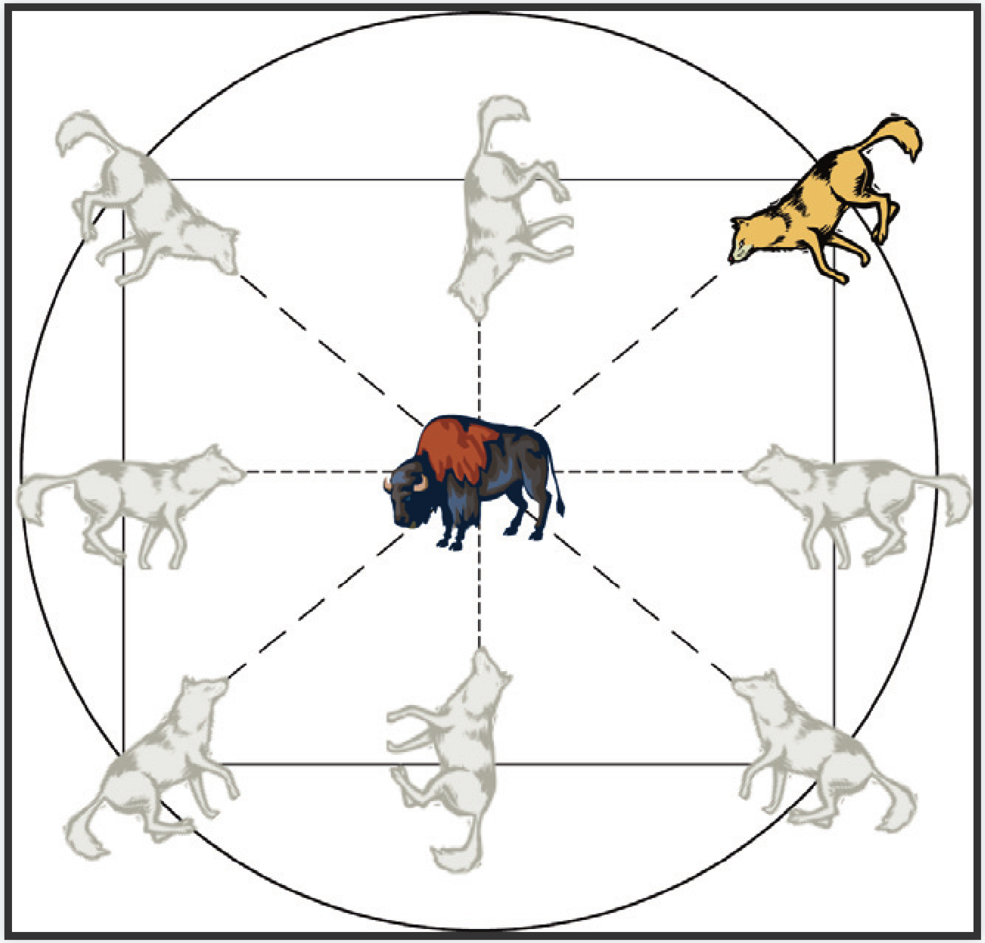
Attack towards the prey.

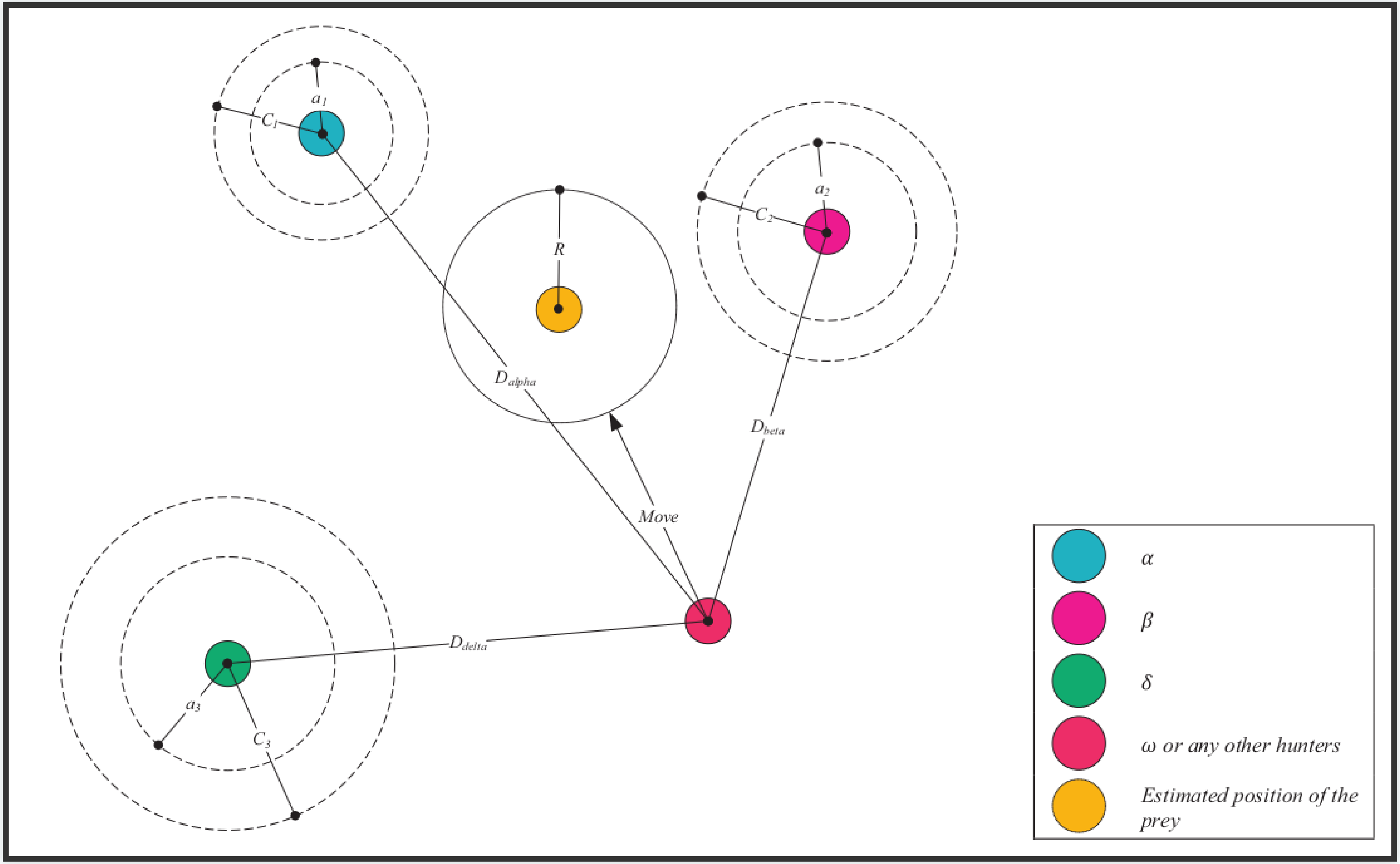


A
B
C
D
E

GWO

ENCIRCLING PREY

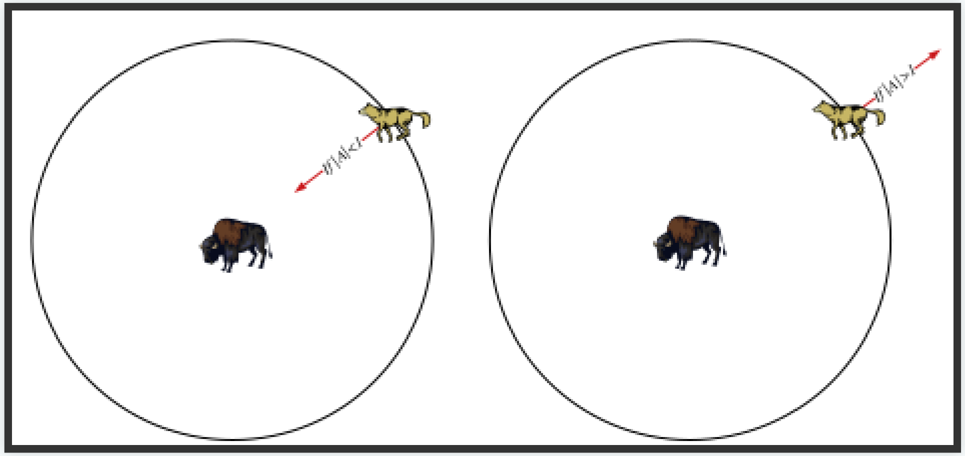




a_1
C_1
R
a_2
C_2
D_{alpha}
D_{beta}
Move
D_{delta}
a_3
C_3
α
β
δ
ω or any other hunters
Estimated position of the prey

GWO

ATTACK



TO SUM UP:

TO SUM UP:

Creating a random population of grey wolves

TO SUM UP:

Creating a random population of grey wolves

Alpha, beta, and delta wolves estimate the probable position of the prey

TO SUM UP:

Creating a random population of grey wolves

Alpha, beta, and delta wolves estimate the probable position of the prey

Each candidate solution updates its distance from the prey

TO SUM UP:

Creating a random population of grey wolves

Alpha, beta, and delta wolves estimate the probable position of the prey

Each candidate solution updates its distance from the prey

The parameter a is decreased from 2 to 0 in order to emphasize exploration and exploitation

TO SUM UP:

Creating a random population of grey wolves

Alpha, beta, and delta wolves estimate the probable position of the prey

Each candidate solution updates its distance from the prey

The parameter a is decreased from 2 to 0 in order to emphasize exploration and exploitation

Candidate solutions tend to diverge from the prey when $j > 1$ and converge towards the prey when $A < 1$

TO SUM UP:

Creating a random population of grey wolves

Alpha, beta, and delta wolves estimate the probable position of the prey

Each candidate solution updates its distance from the prey

The parameter a is decreased from 2 to 0 in order to emphasize exploration and exploitation

Candidate solutions tend to diverge from the prey when j > 1 and converge towards the prey when A < 1

GW terminated by the satisfaction of an end criterion

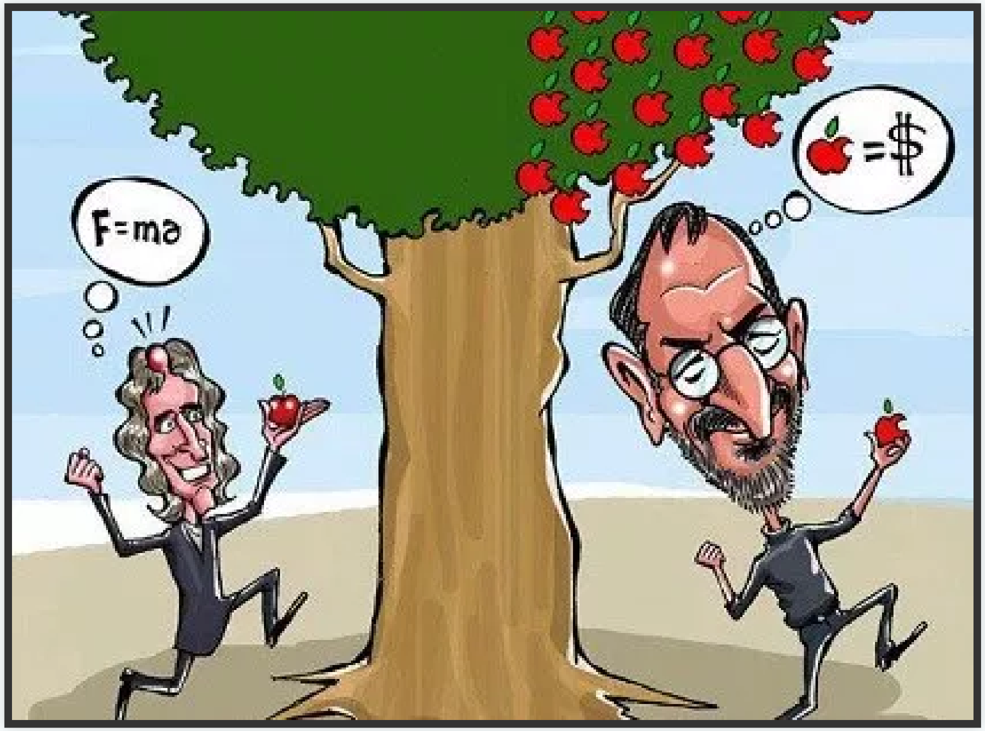
GWO ADVANTAGES

Free from the initialization of inputparameters

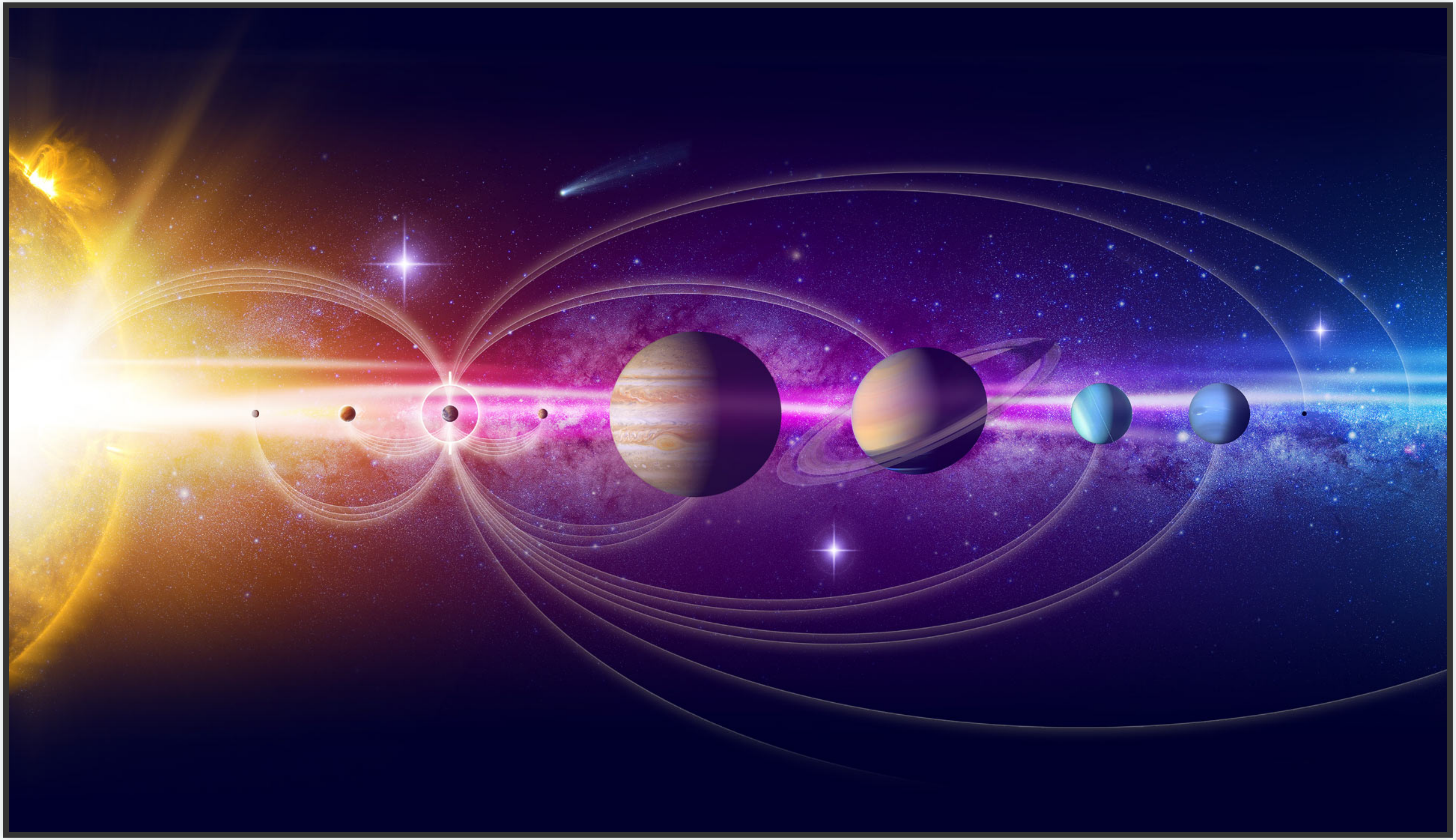
Free from computational complexity

Ease of understanding and implementation

GSA



GSA



HOW DOES IT WORKS?

ADVANTAGES

Easy implementation

Fast convergence

Low computational cost

DISADVANTAGES

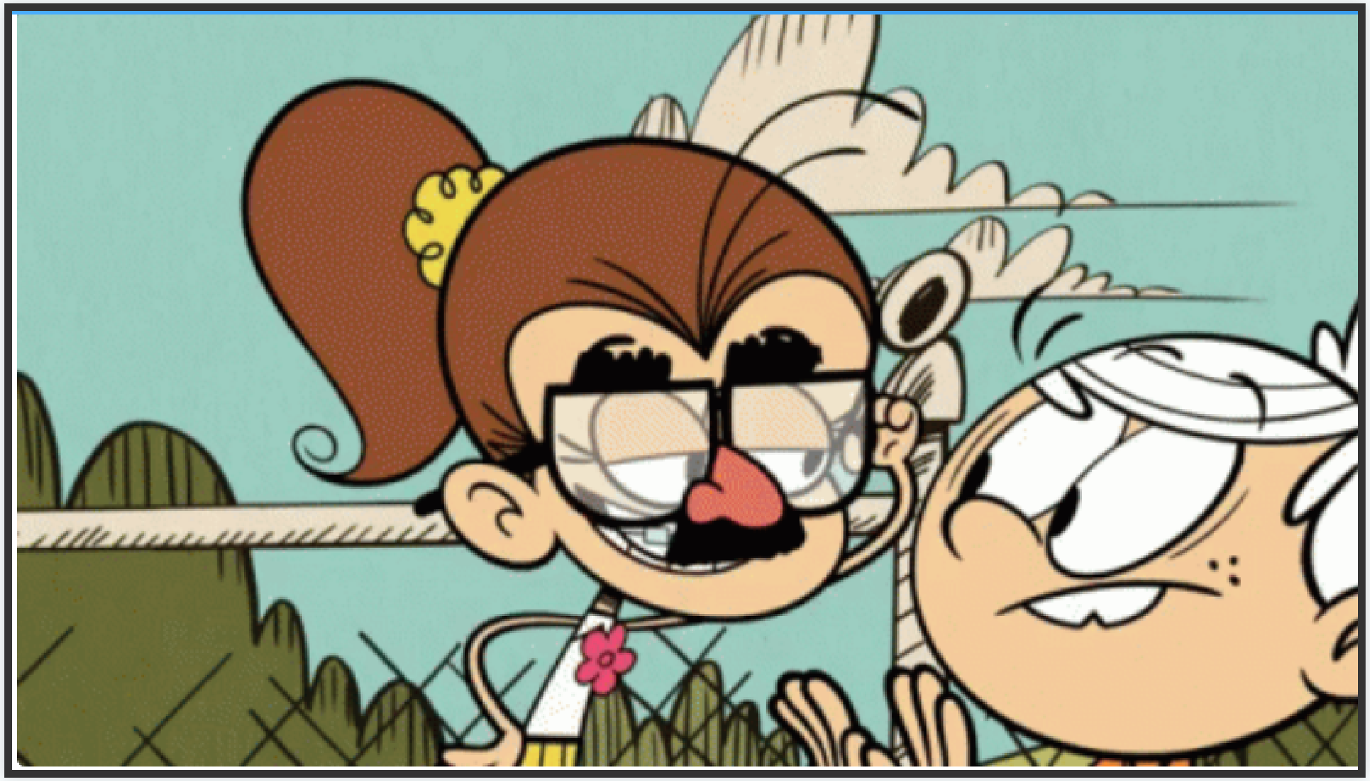
Premature converge

Complexity in calculation

It is easy to fall into local optimum solution

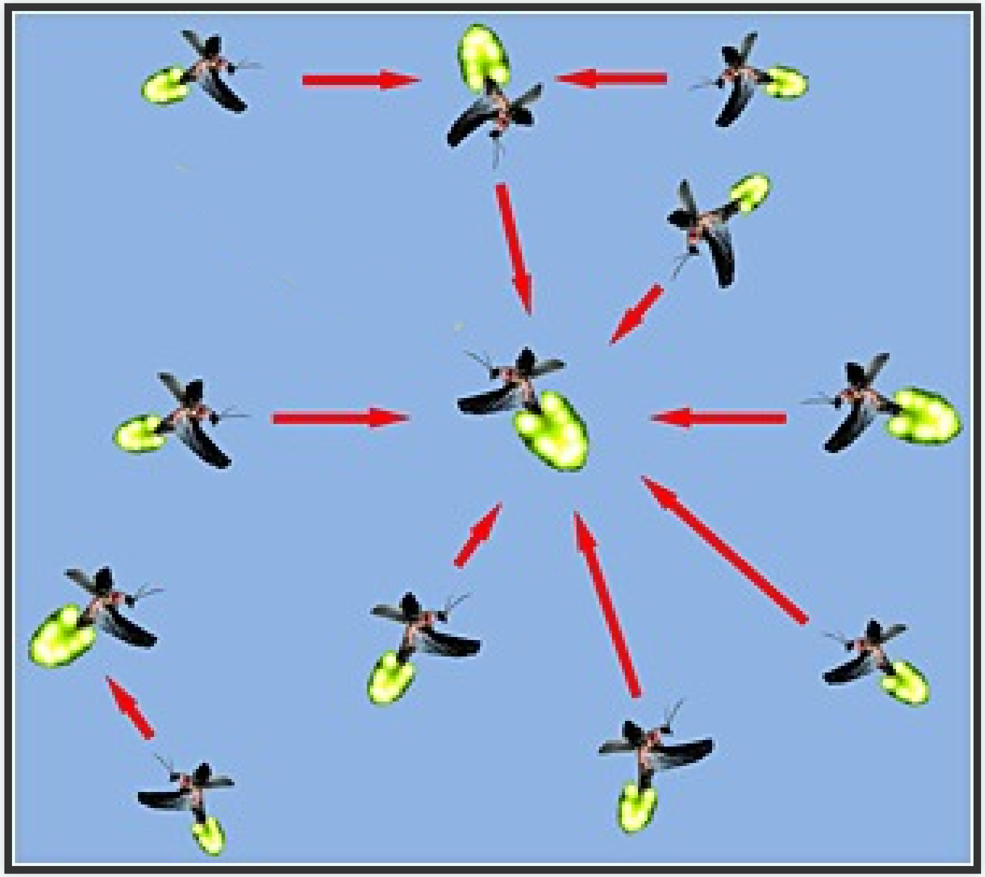
FIREFLY

HUNTING



HYPOTHESES

HYPOTHESES



ADVANTAGES

Automatical Subdivision

Ability of dealing with multimodality

DISADVANTAGES

Getting trapped into several local optima

Does not memorize or remember any history of better situation for each firefly and this causes them to move regardless of its previous better situation

IDEA

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