MCSE662

Assignment 09: Motivation to Artificial Bee Colony (ABC) Optimization

horizontal line

# 

Artificial Bee Colony Optimization Algorithm STEP-BY-STEP with Numerical Example ~xRay Pixy

Important Points-

Artificial Bee Colony Optimization Algorithm is a Swarm Intelligence Population-Based Metaheuristic Bees are flying insects with wings. Algorithm. The artificial Bee Colony Optimization Algorithm is inspired by the behavior of bees in nature. We can use an Algorithm— Artificial Bee Colony Optimization Algorithm to solve different Engineering Optimization Problems, Numerical Problems. Bees feed on nectar as Energy Source in their life.

Algorithms Inspired by the behavior of the bees:

Bees Algorithms

Bee Hives

Bee Colony Optimization Algorithm

Artificial Bee Colony (ABC) Algorithm

Marriage Bee Optimization (MBO) Algorithm

Bee Algorithms are used to solve different problems.

Bee System: Genetics Problems.

Bee Hive: Routing Protocols.

Honey Bee Marriage: Cluster Analysis.

Bee Colony Optimization: Travelling Salesman Problems (TSP), Vehicle Routing Problem, Ride Matching Problems, Job Scheduling Problems.

Artificial Bee Colony Optimization: Engineering Problems, Numerical Optimization.

Bee Colony (BC) is a population-based metaheuristic algorithm.

A bee colony is basically inspired by a bee’s behavior in nature.

Certain Features: Nectar Exploration, Waggle Dance, Food Foraging, Division of bees, Mating during Flight.

A bee colony is based on 3 different models:

Food foraging

Nest Site Search

Marriage in the Bee Colony

Artificial Bee Colony (ABC) Optimization Algorithm

Artificial Bee Colony (ABC) Optimization Algorithm is inspired by Bee’s behavior in Nature. Artificial Bee Colony (ABC) is a Meta-heuristic algorithm based on the intelligent search behavior of Honey Bee Colony. ABC optimization algorithm is combined with both local and global search. Artificial Bee Colony (ABC) optimization algorithm is used to solve different engineering problems.

In ABC, Bee’s / Agents search for rich artificial food sources [Good Solution]. Artificial Bee Colony (ABC) optimization algorithm provides better results as compare to the Particle Swarm Optimization algorithm (PSO).

Artificial Bee Colony (ABC) Optimization Algorithm Pseudocode

Initialization Phase

REPEAT

Employee Bees Phase

Onlooker Bees Phase

Scout Bees Phase

Memories the best solution achieved.

UNTIL Stopping criteria is met.

**Artificial Bee Colony Optimization Steps**

Step 01: Generate initial population randomly (𝑋\_𝑖), i = 1,2,3,4,….Population Size

Step 02: Calculate fitness values for each agent in the population.

Step 03: Memorize the best (𝑋\_𝐵𝑒𝑠𝑡) solution in the population.

Step 04: Set Current Iteration (t = 1)

Step 05: Generate new solutions for employee bee (𝑣\_𝑖) from old solutions 〖(𝑋〗\_𝑖).

Step 06: Compute the fitness of all new solutions in the population.

Step 07: Keep the best solution between current and candidate solutions.

Step 08: Calculate the Probability (𝑃\_𝑖) for the solution 〖(𝑋〗\_𝑖).

Step 09: Generate new solutions (𝑣\_𝑖) for onlooker bees from the solution selecting depending on its 𝑃\_𝑖.

Step 10: Calculate the fitness of all new solutions in the population.

Step 11: Determined the abandoned solution if exist, replace it with a new random solution 𝑋\_𝑖.

Step 12: Keep the best solution found in the population.

Step 13: t = t+1;

Step 14: Repeat until t<=MaxT.

How Do Honeybees Get Their Jobs? | National Geographic-

Important Points-

The honeybee is one of the most collaborative insects in the world. Each hive is comprised of thousands of bees working together in order to build and sustain a colony within the colony each bee has a specific role to play a job.

These are jobs like foraging for food, tending to young larvae and building a honeycomb but with a brain about the size of a sesame seed it begs the question how do bees know what specific job they need to do in order to keep a balance in the hive.

The answer is written into the genetic makeup of each bee and it starts with the queen bee who has the unique ability to designate the sex of her children which plays a pivotal role in their future.

If the queen wants to lay a female egg she will fertilize the egg by releasing spermatozoa that is stored in the spermatheca which sit behind her ovaries the spermatheca is filled during her first week of life when she mates with up to 20 drones or male bees.

If the Queen wants to lay a male egg she will not release any spermatozoa as the egg leaves the ovaries and drones have a singular job that job is to mate with Queens from other colonies to propagate the species when they're not trying to mate they eat leisurely from the honey reserves and wait for a queen to go on her nuptial flight.

Female bees or worker bees do literally everything else they keep the cells clean care for the larvae, build cells, tend to the Queen, store honey forage, pollinate, guard the nest and even feed male bees honey if they're begging for it

Each bee knows what to do because their hormones activate the part of their genetic makeup that tells them what jobs they have to tackle and when they have to tackle it they go through four phases of jobs before dying. In phase one bees go to work immediately after they emerge from metamorphosis about three weeks after they're born, they begin cleaning the cells from which they emerge after about three days. Their hormones shift them into nurse bee mode, in this job they feed the young brood, that succeeds them this lasts for about a week. Then phase three kicks in and then workers become general handyman moving farther away from the center of the hive and doing things like building honeycomb, storing food and guarding the nest. Entrances this lasts about a week the final phase is the most dangerous, it's the foraging feast where workers leave the nest to find pollen to bring home and feed the colony. This phase starts around day 41 and lasts until about day 50. After a short life of constant work, most workers will leave the nest. As death approaches the corpses of those that die inside the hive are carried out by an undertaker bees. It's a thankless life for the worker bee but this collaboration and process has made them one of the most successful super organisms in nature.

# Introduction

1. The Power of Bee Democracy

0:00

Making big decisions can be hard. Even after considering all options, doing research, and

0:07

selecting the best solution, there’s always a fear that you chose wrong.

0:13

To lessen that fear, a lot of us seek out advice from friends or even strangers on the

0:17

internet in the belief that two - or better yet, many - minds are better than just one.

0:23

This way of decision-making is like having a “hive mind,” where a large number of

0:28

individuals share their knowledge with each other which produces a collective intelligence.

0:33

This often leads to smarter decision-making among groups that is better than what one

0:38

individual could accomplish alone.

0:41

While often used in science fiction stories, hive minds actually do exist in real life.

0:47

There are lots of great examples of this in nature, but one stands out. And it comes from

0:52

the animal that inspired the phrase “hive mind” in the first place: bees.

0:58

These insects use nest-based communication to give their fellow bees important information,

1:04

and collectively make robust decisions. But their methods of communication aren’t what

1:09

you may expect.

1:10

Communication, or the passing of information from one individual to another, can take many

1:11

forms. Many animals, such as primates, whales, birds, and wolves, use sound to talk to one

1:12

another. Others, like many insects and even plants, use pheromones or chemicals to send

1:13

messages. But bees have developed a communication method that’s a little more peculiar.

1:14

They communicate via dance. And their dances can communicate to their peers the direction,

1:17

distance, and quality of food sources, the location of possible new hive sites, and sources

1:23

of nearby danger. And most surprisingly, they can even use their language to hold democratic

1:29

debates. This type of collective behavior is so powerful,

1:33

and the connection between the bees is so profound, that scientists are beginning to

1:38

understand that a bee colony acts a lot like a single organism - in fact, a lot like a

1:44

human brain.

1:46

And studying how these remarkable creatures interact could reveal answers about how our

1:51

own minds make decisions.

1:57

Although only about 10% of bee species are social, honeybees are very social indeed.

2:03

Apis mellifera, or the Western honey bee, is the most common of the 12 or so honey bee

2:08

species. They create large colonies with a single fertile queen, many non-reproductive

2:14

female workers, and a small number of fertile males. Individual colonies can house tens

2:20

of thousands of bees. And all of the activity carried out by these bees is organized by

2:25

complex communication between individuals.

2:29

In the early 1900s, scientists believed that bees might communicate the presence of nearby

2:35

food sources through scent - the fragrance of the flower adhering to the bees bodies

2:40

and alerting its peers of its nearby presence.

2:43

By this theory, the other bees should simply search in ever-expanding circles until they

2:48

discover the flowers with the memorized fragrance.

2:51

But in 1944, Karl von Frisch, a professor at the University of Munich made a discovery

2:57

that turned this assumption on its head - a discovery that would eventually win him the

3:02

Nobel Prize.

3:04

von Frisch noticed that after observing the returning scout bee, the other worker bees

3:09

did not search for flowers with a matching scent everywhere around the hive, but only

3:13

in the precise vicinity of where the foraging bee had been, even if that bee had been very

3:19

far away. Somehow, the exact location of the food source was being communicated by the

3:25

bees.

3:26

When von Frisch observed his bees more closely, he discovered that bees are constantly waggling,

3:32

running, and turning in circles inside the hive. He then realized that this performance

3:37

is a miniature reenactment of the bees’ recent flight outside the hive, indicating

3:42

the location of the food source it just visited.

3:46

Von Frisch had just discovered communication via dance.

3:50

And with it, foragers can share information about the direction and distance to patches

3:55

of flowers full of nectar and pollen with other members of the colony.

4:00

Their dance is called the waggle dance, and its main feature is the “waggle run,”

4:05

where they waggle back and forth while running in a straight line. The duration of the run

4:09

tells the other bees how far the resource is, where 1 second is equal to about 1000

4:15

meters. And the angle of their run, relative to a straight vertical line, tells the other

4:20

bees the angle of outward journey in relation to the sun. For example, if the dancing bee

4:26

walks 45 degrees to the right of the vertical line, the food source is 45 degrees to the

4:31

right of the position of the sun.

4:34

In addition to dancing, the bee also gives out some of the flower’s nectar to its audience

4:39

which, combined with the smell of the flower still lingering on the dancing bee help the

4:44

recruits locate the food source.

4:46

They communicate other things through dance as well. For instance, a “tremble dance,”

4:51

where they rock forward and backward and side to side, tells others that foragers have brought

4:57

so much nectar back to the hive that more bees are needed to process it into honey.

5:01

But not every bee conversation is about food sources, and not every piece of communication

5:06

is a one-way street, one bee communicating something to the rest. Bees can use these

5:12

same communication methods to discuss options about the future of the hive, and then make

5:17

decisions democratically - a type of collective behavior very rarely seen in the animal kingdom.

5:28

In late spring and early summer, honeybee colonies become overcrowded in their nesting

5:34

cavities. When this happens, it’s time for them to find a new home. One third of the

5:39

worker bees stay put and rear a new queen. And two thirds of the workers along with the

5:44

original queen begin the search for a new nest-site.

5:48

The quest starts with the swarm congregating on a temporary site - a branch, or a bush

5:53

outside the old hive. From here, scouts will go out and look for suitable nest sites - a

5:59

hollowed out tree, or an abandoned chimney or birdhouse. The bees are looking for a place

6:04

that will be protected from weather, predators, and is big enough for the new hive. Size is

6:10

perhaps the most important, since any colony occupying a hollow 10 liters or smaller can’t

6:16

store enough honey to make it through the winter.

6:18

Once a bee finds a location that it likes, it comes back to the group and does the waggle

6:23

dance, telling the others where the potential nest site is. Other bees then go check it

6:28

out for themselves. If these recruits like it, they’ll come back and do the same dance,

6:33

in the same direction. But it’s not always so clear which potential nest-site is the

6:38

best choice. And this is where a vigorous debate begins.

6:41

Here’s an example of how these debates typically go down, taken from one of the first studies

6:47

about bee debates in 1951.

6:50

On the first day, 2 nest-scout bees were identified and labeled. One bee reported a nest-site

6:56

candidate 1,500 meters to the north, while the other bee reported another site 300 meters

7:01

to the southeast. The next day, 11 new dancers were identified. 3 danced in support of the

7:07

site 1,500 meters to the north, 2 danced supporting the site 300 meters to the southeast, and

7:13

6 others danced about new sites all together. The next day, it rained, and only 2 new dancers

7:19

were recorded, one supporting the site to the north, and the other reported a new site,

7:23

400 meters to the southwest. The next day, many new sites were reported, but interestingly,

7:29

the site to the north was no longer being supported, perhaps because the rain leaked

7:33

into the site showing it was not such a good candidate after all. Over the next few days,

7:38

many sites were investigated and reported, but interest in most of them eventually faded.

7:44

Only one site, the one located 300 meters to the southeast, held the bees interest the

7:49

entire time. By the afternoon of the 4th day the bees dancing in support of the southeast

7:54

site completely dominated, with 61 bees dancing for it, and only 2 bees still holding out

8:00

for other sites. The next morning the decision was unanimous. The swarm then launched into

8:06

flight, flew 300 meters to the southeast, and took up residence in the wall of an abandoned

8:11

building.

8:12

By analyzing bee debates like this, the key features of the bee’s decision making process

8:17

becomes clear. The debate first starts with an information gathering phase, where many

8:22

alternatives are put on the table for discussion. The debate then progresses with all or almost

8:27

all the bees advocating for just one since, indicating that a consensus has been reached.

8:33

And during all of this, the process is highly distributed, involving dozens or even hundreds

8:38

of individuals - all the hallmarks of a democratic process.

8:42

The dances they perform are complex and indicate a lot of cognitive ability. The bees have

8:47

to remember the location of the resource or the nest-site, as well as the location of

8:52

the sun, and translate that information into the characteristics of the dance. The bees

8:57

in the audience then have to read this behavior and translate it into directions they will

9:01

then follow.

9:02

This, along with the coordinated decision to fly off in the same direction, at the same

9:08

time, supports the idea that a bee swarm acts as if it is one organism - a superorganism.

9:14

And recently, scientists have realized it’s even more profound than that. The way bees

9:19

work together is a lot like how the individual neurons in the human brain work together.

9:25

And studying their behavior may give insight into our own minds.

9:35

Psychophysical laws explain the relation between real world stimuli and the perception of those

9:40

stimuli. The brains of many organisms follow these laws, even quite simple ones.

9:46

Weber’s Law states that the change in a stimulus that will be just noticeable is a

9:50

constant ratio of the original stimulus.

9:53

For example, it might take 4 pounds before you notice your backpack getting heavier,

9:58

if your backpack was already loaded with heavy books.

10:01

Hick’s law says that the brain is slower to make decisions when the number of alternative

10:06

options increases.[9]

10:08

And Pieron's Law says that the brain is quicker to make decisions when the options to decide

10:13

from are of high quality.

10:15

These laws help relate the brain’s perception of reality to actual reality, and are important

10:20

when making decisions.. Many organisms adhere to these laws, even simple animals like fish

10:26

or insects. Fish, for example, can differentiate between a large school of fish and a small

10:31

one, opting to join the larger one, as long as the size difference was large enough for

10:36

them to be able to recognize it.

10:38

But do these laws only explain an individual’s brain and behavior? Could these laws also

10:43

apply to an entire colony of bees as one unit- the so-called ‘superorganism?’

10:48

In 2018, scientists started to get their answer. They analysed how quickly the colonies made

10:53

decisions between sites of varying qualities and compared the data with several psychophysics

10:58

laws to see how well the laws were adhered to.

11:01

And it turns out, the bee colony followed the laws closely. It followed Weber’s law,

11:06

in that the bees were able to choose the higher quality nest site, if and when the higher

11:11

quality, such as a larger size, exceeded the minimum noticeable difference.

11:16

They also found that the bee colony was slower to make decisions when the number of alternative

11:21

nest-sites increased, and that the colony was quicker to make a decision between two

11:26

high-quality nest-sites compared to two low-quality nest-sites.

11:31

Honeybee colonies adhere to the same laws as the brain when making collective decisions.

11:36

These finds give more support for the idea that bee colonies exist as superorganisms,

11:42

operating in the world much like a single, complete organism would.

11:46

And just as the bee colony is similar to a whole brain, the individual bee thus acts

11:51

like a single neuron. In the human brain, decisions are made when single nerves fire

11:56

waves of electrochemical signals. In bee colonies, decisions are made when individual bees communicate

12:03

their discoveries through a visual display to other bees.

12:06

And if bees follow the same laws as neurons, then observing them can lead to a better understanding

12:12

of our own minds - and more quickly too. Observing bee colonies is much easier than trying to

12:18

observe the neurons of a brain while a human makes a decision.

12:22

By understanding these parallels we can start to learn just how psychophysical laws work.

12:27

And with more data, bees could teach us how our entire psychology arises from a few chemical

12:33

actions from a few connected cells.

12:36

And outside understanding our own minds, computer scientists have created lots of different

12:41

algorithms based on bees decision-making methods.

12:45

One popular decision-making model is the Artificial Bee Colony (ABC) algorithm. It is used for

12:52

optimization problems, where users are looking for the best possible solution among many

12:57

different options.

12:58

In this model, each candidate solution is like a food source and the quality of that

13:03

solution is akin to the amount of nectar it holds. It begins with a number of employed

13:08

bees at each of the food sources. They then go out to neighboring food sources and compare

13:14

the amount of nectar to the previous source. They only remember the information of the

13:19

best food source they find.

13:21

After a certain number of steps, they share their information with onlooker bees who then

13:26

choose what they think is the best food source and sources that aren’t selected are abandoned.

13:32

This continues until the best food source, or solution, is identified.

13:37

This algorithm has been used to solve many real-world engineering problems across a variety

13:42

of fields. For instance, electrical engineers have used it to determine the optimal position

13:48

of solar panels for when they are in partial shade,[16] aerospace engineers have used it

13:53

to plan the re-entry trajectory of hypersonic vehicles, [17] and computer scientists have

13:58

used it to plan the path of robots, [18] proving the true power of the hive mind.

14:04

The intersection of biology and computer science is an exciting one, as the different ways

14:09

we can solve real world problems with solutions that nature has already made are basically

14:15

infinite. Algorithms are at the heart of this, and while they seem complicated, are easier

14:20

to wrap your head around than you might realize. If you’ve ever been put off by opaque coding

14:25

language, but really want to learn how algorithms work or even start making your own, you should

14:30

sign up for Brilliant.

14:32

Brilliant can help you learn how to program without having to dig through the weeds of

14:36

coding syntax through these fun, interactive challenges. You just shift around these blocks

14:42

of "pseudocode", and then you can get immediate feedback on your results. It's a good way

14:47

to understand how computer algorithms work, and then once you have that down, the coding

14:52

syntax becomes a lot less intimidating.

14:54

I don’t have a computer science background at all, but lately, it’s become more and

14:59

more important for me to understand it when making these videos, as it’s a topic that

15:03

keeps coming up. Brilliant’s Algorithm Fundamentals course has helped me learn that algorithms

15:08

really are just a set of instructions, and putting them together to get the computer

15:13

to do what you want is like a really fun puzzle. If you'd like to try out Brilliant for free

15:18

and get 20% off a year of STEM learning, click the link in the description down below or

15:24

visit Brilliant.org/RealScience.

Artificial Bee Colony Optimization

0:03

hey there so my name is

0:05

richard muthmani and my team's project

0:07

is artificial weak colony of

0:10

optimization all right so let's get

0:12

started with this additional b colony

0:14

optimization shall we see ya

0:17

okay

0:19

so what is this artificial weak

0:22

colony

0:23

see optimization algorithm

0:27

of course it is an optimization

0:29

which we do

0:30

by using this optimization algorithm

0:33

and the important thing is this has been

0:36

inspired by the food searching that is

0:39

done by bees in a colony all right so

0:41

how bees go about and search and find

0:44

food right

0:45

that is the inspiration for this

0:46

algorithm

0:48

you know like once again the bees over

0:50

there

0:51

the next thing is so bad our bees live

0:54

bees live in a colony all right so the

0:56

bees live in a colony and the bees they

0:59

leave the colony and they go out and

1:01

they search for food

1:03

all right

1:04

okay

1:06

and you know there's an example of food

1:08

over there

1:09

it's a

1:10

flower all right

1:12

so now

1:14

great so bees leave the colony to search

1:16

for food it's all fine and dandy but why

1:19

do we care about this

1:21

right so why do we care what bees do

1:24

that is the big question

1:27

why do we care

1:28

we care because

1:30

our bees are tiny little bees they are

1:32

solving an optimization problem

1:35

and what is this optimization problem

1:37

that they are trying to solve they are

1:38

trying to solve the optimization problem

1:40

of finding the best source of food for

1:44

the colony

1:45

so their optimization problem is finding

1:47

the best food source

1:48

all right

1:49

so it also turns out that our bees are

1:51

really smart and they're able to find

1:53

these optimal solutions like you know

1:55

really very well

1:56

so that leads us

1:58

now to the point that hey maybe we can

2:00

learn something from these tiny bees

2:02

right and if we can learn how they solve

2:04

their optimization

2:06

of you know trying to find out these

2:08

best foot sources

2:09

and do the optimization for that maybe

2:11

we could learn some of their tricks and

2:13

we could use that to solve our own

2:14

optimization problems

2:16

and this my friends

2:19

this is the reason why we care about

2:20

this and why we have this algorithm

2:23

right so this is the motivation for it

2:27

so now that we want to learn from the

2:29

bees how they do an optimal search for

2:32

food so let's see the steps

2:35

so here you have a couple of bees on the

2:36

screen they live in a colony

2:39

and you have a couple of food sources

2:40

the value of the food choices is a

2:42

reflection of the fact how much food is

2:44

available at those sources so like a

2:47

value of say seven indicates that you

2:49

got seven flowers from which you can get

2:51

food or extract food all right okay

2:54

the first thing that happens is known as

2:55

the exploration phase or the phase of

2:58

the scout

2:59

what happens here is a couple of random

3:01

bees

3:02

they go about exploring from the colony

3:04

in search of food sources so the first

3:06

bee he has you know locked on to value

3:09

to

3:10

both the flowers and the second bee he

3:12

goes zig zagging and he finds the single

3:14

flower with the value one

3:16

once they find out

3:18

their food sources these bees they

3:20

transition to the next stage which is

3:22

known as

3:23

exploitation stage in this stage the

3:26

bees start to harvest the food from the

3:29

food sources all right

3:31

so when they are done with that

3:33

they have to return back to the b high

3:36

and upon return to the beehive they will

3:39

do a dance which is known as a waggle

3:40

dance

3:42

so look at the b at value two he's going

3:43

back and he does a back dance same goes

3:46

for the other bee okay so what these

3:49

guys convey by the waggle dance is

3:52

how much food is available where they

3:54

are exploited it so the remaining bees

3:56

right they will look at the waggle

3:58

dances and they will judge

4:00

based on the information from the dances

4:03

which source of food is better

4:06

and

4:07

you know like naturally these bees are

4:09

smart they will choose to follow the bee

4:11

from the food source which has more

4:13

value here in our case it would be

4:16

you know source two

4:17

in this way

4:19

we get a sense of

4:21

reinforcement or feedback

4:23

this feedback make sure that uh

4:26

those paths with the richer foot sources

4:30

get more feedback they get reinforced

4:32

more and more and that's exactly what we

4:34

will see in the slide

4:36

all right

4:38

so

4:38

[Music]

4:40

yeah the bees go back

4:43

and the remaining bees they go to the

4:45

food source of value two all right

4:48

look at them all go over there all right

4:50

okay so now as you can see that all the

4:53

bees are centered around value too if

4:55

there are too many bees at a source they

4:57

will not be able to exploit the food

4:58

fully right so some of the bees they

5:01

transition back to the state of a scout

5:05

and they do exploring once again

5:09

and these bees

5:11

go about exploring and they find a new

5:14

source and they start to do their

5:16

exploitation here once again

5:18

so

5:19

when some

5:20

say sources of food

5:22

have started to lose resources

5:24

like some of the worker bees they go

5:26

back to the colony and they start to

5:27

wait so these two guys return back to

5:29

the colony to wait

5:31

now what happens is the bee

5:33

who's at the foot source of value 7

5:36

right he returns back with this new

5:38

updated information does a vagal dance

5:40

to tell these guys hey you know what

5:42

there's a more

5:43

uh

5:44

say like uh

5:46

so there is a source of food of value

5:48

seven if you guys follow me we can go

5:49

exploit it

5:51

so these bees they look at the bag and

5:53

dance and they follow him

5:55

all right and they go to exploit the say

5:57

the food source of value seven

6:00

so this is a gist of how the b colony

6:02

optimization works

6:06

now that you have an

6:08

intuition of how the algorithm is going

6:09

to run let's get into the details this

6:12

algorithm basically consists of four

6:14

phases the initialization phase foraging

6:16

b phase

6:18

onlooker b phase and finally scout b

6:20

phase

6:21

beginning with the initialization phase

6:23

we initialize b's across the solution

6:25

space randomly

6:27

and

6:28

we assign fitness to each position which

6:30

is analogous to

6:32

the quality of food the bees are looking

6:34

for and these always look for the best

6:36

quality of food

6:38

and

6:41

we update the position of the piece

6:43

using uh

6:45

this formula you can see here

6:48

x i j is nothing but the j component of

6:51

i b

6:53

and phi i j is a random variable which

6:55

basically controls the

6:58

food sources nearby

7:00

x i j

7:02

and as you can see as the b's converge

7:05

eventually uh the step size uh of the

7:08

updation keeps getting smaller which

7:10

ensures convergence which is a good

7:11

thing in a

7:12

optimization algorithm

7:15

this uh

7:16

update equation is basically uh meant is

7:19

meant for the bees to explore around and

7:23

uh once the exploration is done one step

7:25

of exploration is done they

7:27

um

7:28

they assess if the new fitness value is

7:32

better

7:33

then they stay there or they go back to

7:35

their initial position

7:39

now

7:40

moving on to the onlooker b phase now

7:43

that the foraging beef uh bees have gone

7:46

and explored possible solutions they

7:48

come back to the hive and they

7:50

communicate with onlooker bees so as to

7:52

recruit them

7:53

and

7:55

recruit them and

7:57

send them to these

7:59

possible solutions

8:01

they do this by communicating by

8:05

waggle dance which is a dance

8:07

that bees do to notify onlooker bees

8:11

about the possible locations of

8:14

good food sources

8:17

and now onlooker bees also go to the

8:20

solutions um based on

8:23

the onlooker b select

8:26

the onlooker b select

8:28

the

8:29

solution that they want to go to

8:32

proportionate to the fitness

8:35

which is

8:37

essentially the same as relative

8:39

selection that we've seen in genetic

8:40

algorithms

8:44

here also

8:45

onlooker bees

8:47

keep their

8:48

current position if the new positions

8:51

fitness is worse than the one they have

8:56

or update to the new solution if they

8:58

find a better

9:01

a higher fitness solution

9:05

every

9:05

solution has a trial counter associated

9:08

with it uh so that if a b doesn't update

9:11

its uh solution for certain amount of

9:13

cycles then it has to

9:16

discard that position and go to a new

9:17

position it's basically like mutation in

9:19

genetic algorithms

9:21

so the number of cycles that you have to

9:23

wait before you discard it is a

9:25

parameter in this algorithm called limit

9:28

and it's up completely up to uh us to

9:31

decide how we want to uh

9:33

how far we want to wait before we

9:34

discard a solution

9:37

and

9:38

once we decide that

9:40

we can

9:41

once we decide that the

9:43

and a solution does stay the same for a

9:46

certain number of cycles

9:48

we we convert that onlooker b into a

9:51

scout b which is the third phase in this

9:54

algorithm

9:55

and

9:56

the score b randomly migrates to a new

9:58

solution

9:59

please feel free to

10:00

pause the video and have a look at the

10:02

pseudo code for a better understanding

10:04

of the algorithm there are some

10:06

functions that we plan to test with our

10:08

b colony optimization

10:10

first function is this multimodal

10:12

landscape the next function we test is a

10:14

wicked function called the raster gun it

10:16

has

10:17

it's shaped like a boat but with a lot

10:19

of local traps

10:20

so our b colony has to make its way not

10:23

into any of these local minima traps but

10:25

into the global minima that's a

10:28

challenge actually the bottom line is

10:29

this bee colony optimization has to find

10:32

the value of the global lowest point or

10:34

the valley

10:35

the lowest value in all these functions

10:45

[Music]

12:09

i

12:12

[Music]

12:37

you