Bees behaviors algorithm and probably technological replacement in the future.

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ABSTRACT
The problem we are against of is the detection of possibly collision between a certain number of bees and give a warning with all of these bees. The importance of this problem is that for a not far future the humanity wants to help the pollination of the bees and for that they are creating tiny drones that are going to manage has bees, doing the same work, in consequence they will not have to crashed between one an another, because a lot of work would not be done, making the task of helping impossible. Some other problems that could happen are like waggle dance, hive distributions, The travelling salesman problem and task allocation in swarm of robots. To solve collisions problem, a data structure based on hashmap is a fast an accurate option, having a average processing time of 3 seconds and 90% of exactitude.

Keywords
Hash map, Bees, Array List, Distance, Coordinates, Collisions, Data structure, Optimization, Arrays.

ACM CLASSIFICATION Keywords
CCS → Information systems → Data managment systems → Data structures → Data access methods → Proximity search

1. INTRODUCTION

As we all probably know climate change has been affecting us and our environment for the last seventy (70) years, according to the NASA for the last four thousands (4000) centuries the atmospheric carbon dioxide level had been above three hundred (300) parts per million but after 1950's the level have risen considerably over the normal level already established. This demonstrate that atmospheric CO2 has increased since the Industrial Revolution. All this caused by the greenhouse gases, emitted by the every day of humans, that are making the earth warmer "ten times faster than the average rate of ice-age-recovery warming"[1], affecting not just us, but more important our ecosystems and animals.

The best example for that are bees best known for their their role in pollination, has one of the most important species that makes this duty, bees are flying insects very related to wasps or even ants and we all know for their most common specie the "honey bee" for the honey that we consume and beeswax. The bees that we often see are the workers which are female bees that are not fertile, they are in charge of recollenting the pollen, build the nest, protect the nest and clean all the mess, when a queen dies the workers create a new queen by given her nutrients in a special diet until she transforms into a fertil queen. On the other hand we have the drones which are the male picture of the bees and his work is to reproduce with the queen, in the winter they often get expulse from the nest, while the other bees live inside the nest thanks to all the nectar they have been recollecting.[2]

Bees are legitimately important for humans, we depend on them for pollination, this means that without bees it would be impossible to crop any kind of food or there would not be any kind of vegetation. Global warming is affecting them too, the increase in temperature lead to a change in flower morphology, phenology, flower sex ratios and nectar chemistry, and this can "altered attractiveness of flowers or nutritional rewards to pollinators could dramatically alter pollinator fitness and plant-pollinator mutualisms."[3]

On the other hand, according Marla Spivak "bees in fact have been in decline since World War II. We have half the number of managed hives in the United States now compared to 1945" and mainly this is because of multiple and interactive causes, for example, flowerless landscapes, after that period of time the organization of how the farms harvested the lands change making thousands of kilometers with only one specie of plant making harder for bees to found real food for them, that cause a disfuncional food system; pesticides, that produce intoxication and afterwards death; diseases parasites and monoculture. All this together can lead to a colossal disaster, called Colony Collapse Disorder (CCD).[4]

Thanks to all these problems 10 years ago a group of investigator along with the Harvard University and the Northeastern University, started to think how difficult it would to create a robot bee colony, the task seems impossible due to the physiology of bees and the amount of tasks they can perform thanks to it a tiny can fly for hours with an incredible stability while they search for flowers and avoid predators, making us see how millions of years of evolution have became into outstanding flying machines.

Now let's imagine the whole picture, they had to create a hive, which contains thousands of bees that rarely do not have an specific authority to tell them what to do, even so they all accomplish singular tasks for the health of the hives and in cases

such as the dead of the queen the bees adapt rapidly through these changes without causing "without taking forever or causing havoc through miscommunication"[5] The invention of something as the robobees is in a perspective something very difficult, but it would make a lot of things better, because of the multiple things it may do, it would not be the same exact bees, they would be a better bee, the problem of it is that the construction, the materials and other programming are still evolving to get there.

2. PROBLEM

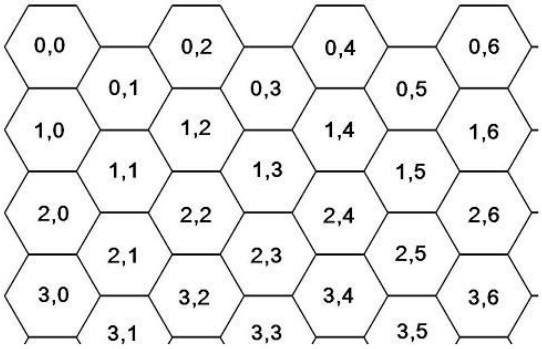
The problem that will show is to see which bees are in risk of collisions with others before it happens so it can be prevented, while they are pollinating.

3. RELATED WORK

3.1. How to distribute the hives.

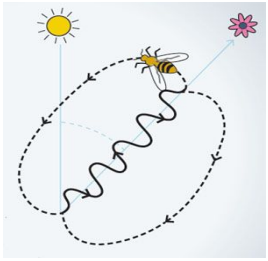
It is very important for scientist to study correctly the hives, to answer any question, that is why you can visualize a hive as a rectangular matrix of size NxM. assigning coordinates to each cell which contains honey.

You can ask to the program to sum the honey for over all cells from one specific cell to another.[6]



3.2. Waggle dance

How do the bees found their way to their food previously found, variations of this algorithm has been us to solve engineering problems and so on."Without loss of generality, it will be hereafter assumed that the optimisation problem entails the minimisation of a specified cost measure. A candidate solution to the problem is defined by a given number of parameters, and its cost is measured via an objective function (*fitness function*) of these parameters."

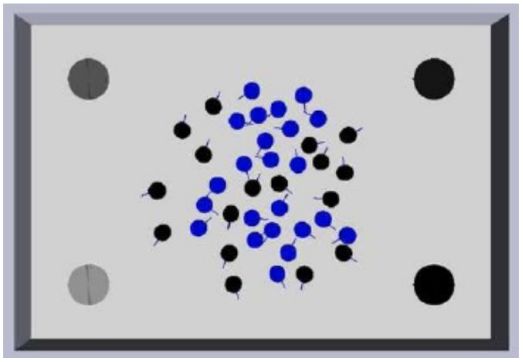


photo[1]

"Given a minimisation problem defined over the n-dimensional continuous solution space $U = \{x \in Rn; \min i < xi < \max i, i = 1, \dots, n\}$, each candidate solution is represented as an n-dimensional vector of decision variables $x = \{x1, \dots, xn\}$. The goal of the optimisation task is to find the solution that minimises the set cost function $f(x): U \rightarrow R$."[7]

3.3 Distributed Bees Algorithm for Task Allocation in Swarm of Robots.

The proposed problem consist in assigning a certain number of robot in an 2D area. A decision making mechanism is assigned to all the robot in the area and autonomously choose their assignments taking into account targets, qualities and distances. This problem is tested in different amount of robots and taskings. The results of the simulations show that by increasing the robots swarm size, the distribution of tasks and robots were more efficient than with less amount of them. [9]

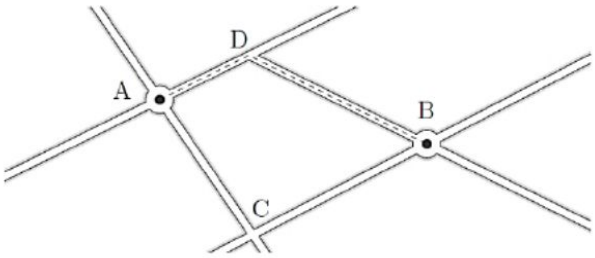


3.4 The travelling salesman problem(TPS)

The Travelling Salesman Problem (TPS) can be defined as finding a Hamiltonian path with minimum cost. The salesman starts his tour from a city and returns back to his starting city while determining a minimum distance passing through each city once and only once. It is a easy to describe but difficult to solve problem, which is why it draws so much attention from the scientific community.

The Vantage Point Bees Algorithm (VPBA) proposed a hybridization technique which involves the Bees Algorithm and a local search technique based on Vantage Point Trees(VPTs).[10]

[1] Retrieved from [8]



4. Hash Map.
We chose a hash table with a string as key and a bee object as value.

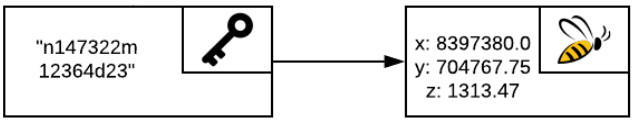


Figure 1: Hash table of strings and Bee objects.

4.1 Operations of the data structure
Our hash function is define by a simple algorithmic method, we take a Bee object, from the array, and take its attributes that are x, y, z coordinates in meters (Figure 2).

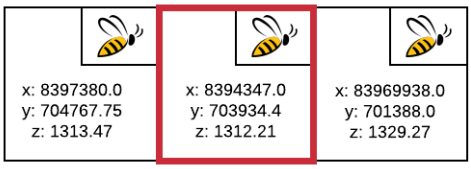
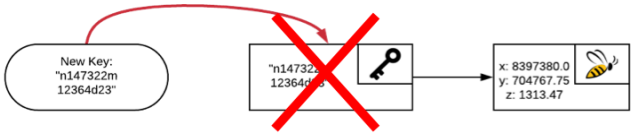


Figure 2: Select a bee from the array.

Then to find the key, in order to divide the area into imaginary cubes, we set as key a string by concatenating: the coordinate x of the bee divided by 57 that is de side of the cubes, then the same to the other two coordinates (y,z), so as to add this key and the value bee, if the key is not already defined in the hash map (Figure 3).



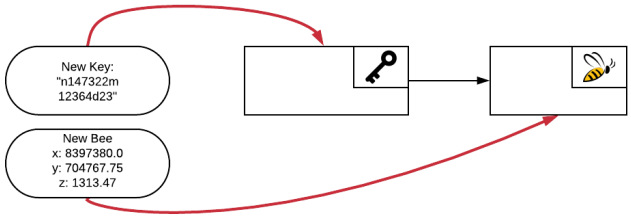


Figure 3: how addition works.

If the key is already defined in the hashmap the value will be printed in the document, with the rest of the values that had gone through the same case. After that we check just adjacent "cubes" to each key, to see if the bee at that key could collision against any other at any adjacent cube.

4.2 Design criteria of the data structure

The criteria that we think carefully about to use hashmap has our data structure was the complexity of the functions that a hashmap has, which is O(1) in the best cases and O(n) in the worst cases for Access, Insertion, Search and Deletion, these helps in the execution time. It also helps to save memory because the algorithm creates a memory space (key) only if there is a bee in the imaginary cube.

However, implementing a 3D matrix in time complexity it would be $O(n^3)$ so it will take more or less 11.5 years to run with a million of bees, also is mandatory

4.3 Complexity analysis

Method	Worst	Best
readFile()	O(n)	O(1)
hashFunction()	O(m*k)	O(1)

n = number of lines that the file has.

m = number of bees.

k = number of in the hashmap.

Table 1: Table to report complexity analysis

4.4 Execution time

Operations	10 bees	100 bees	1500 bees	100000 bees	1000000 bees	1500000 bees
readFile()	0ms	1ms	42ms	334 ms	805 ms	1055ms
hashFunction()	1ms	2ms	17ms	571ms	2427 ms	13076 ms

Table 2: Execution time of the operations of the data structure for each data set.

4.5 Memory used

Operations	100000 bees	1000000 bees	1500000 bees
readFile()	31.3 MB	232 MB	180 MB
hashFunction()	13MB	232 MB	371 MB

Table 3: Memory used for each operation of the data structure and for each data set.

4.6 Result analysis

The results that the algorithm throw were precise and given in a short time, but nevertheless the algorithm has an error due to the classification of the keys in the hashmap. On the other hand the algorithm uses a not significant space of memory.

6. CONCLUSIONS

In conclusion, is easier to prevent bee collisions, so having a fast algorithm to solve this problem is the best way, due to it will make easier to move bees to other spaces and avoid hardware damages between them. Such as, using hashmap as a fast and accurate solution.

As results, we obtained an average time of 10 seconds testing 1.5 million bees, and an accuracy of 90%, this solving the previous mentioned problems. At the designing moment, the hardest part of the algorithm was how to divide every spaces at the hashmap and finding the way to give accurate keys to every space; in order to find the best function that cover all the specified requirements.

At the end, we consider our algorithm as a successful result, but there are some things that could be improved, such as, the accuracy, check adjacent cubes and rounding problems, to give a better result of the algorithm.

6.1 Future work

We would like to improve the precision of the algorithm, because our structure has a 10% error in accuracy, due to rounding in coordinates and keys.

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