INDIAN INSTITUTE OF INFORMATION TECHNOLOGY DESIGN AND MANUFACTURING KANCHEEPURAM

PROJECT REPORT
ON
K-MEAN CLUSTERING ALGORITHM
USING CUDA

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Problem Statement

A Pizza company wants to open its delivery centres across a very big city.
The challenges they will face is that they need to analyze areas from where pizza is being ordered frequently.
They need to figure out the locations for the pizza stores within all these areas in order to keep the distance between the store and delivery points minimum.
Resolving these challenges includes a lot of analysis and mathematics. We would learn here about how clustering can provide a meaningful and easy method of sorting out such real life challenges.

My Solution to this problem

I have used an unsupervised machine learning algorithm to solve this problem. I have used the K-Means clustering algorithm for solving the above problem.

My dataset contains x and y coordinates of locations of different people/their houses across the city and some randomly generated pizza centers(According to my algorithm, the number of pizza centers can vary from 1 to 100).
We have to find the optimum location for these pizza centers so that each house can get the delivery fastest.

Step1 : For this, I have calculated the distance of every house from every pizza center. The house which is nearest to a particular pizza center, will be served by that particular pizza center in the first iteration.

Step2 : Now the location of the pizza center will change according to the location of houses which come under it. X coordinate of the pizza center will be calculated by taking the mean of x coordinates of the location of houses. Similarly Y coordinate of the pizza center will be calculated by taking the mean of y coordinates of the location of the houses.

Step3 : For further iteration repeat from Step1

Note 1 : More the number of iterations, more optimal will be the location of the pizza center. But the location of the pizza center will not vary after a certain number of iterations as it will start converging to an optimal location of the pizza center such that a house can get its delivery faster.

Note 2 : This implementation of k-mean clustering algorithm in CUDA is done on Google Colab.

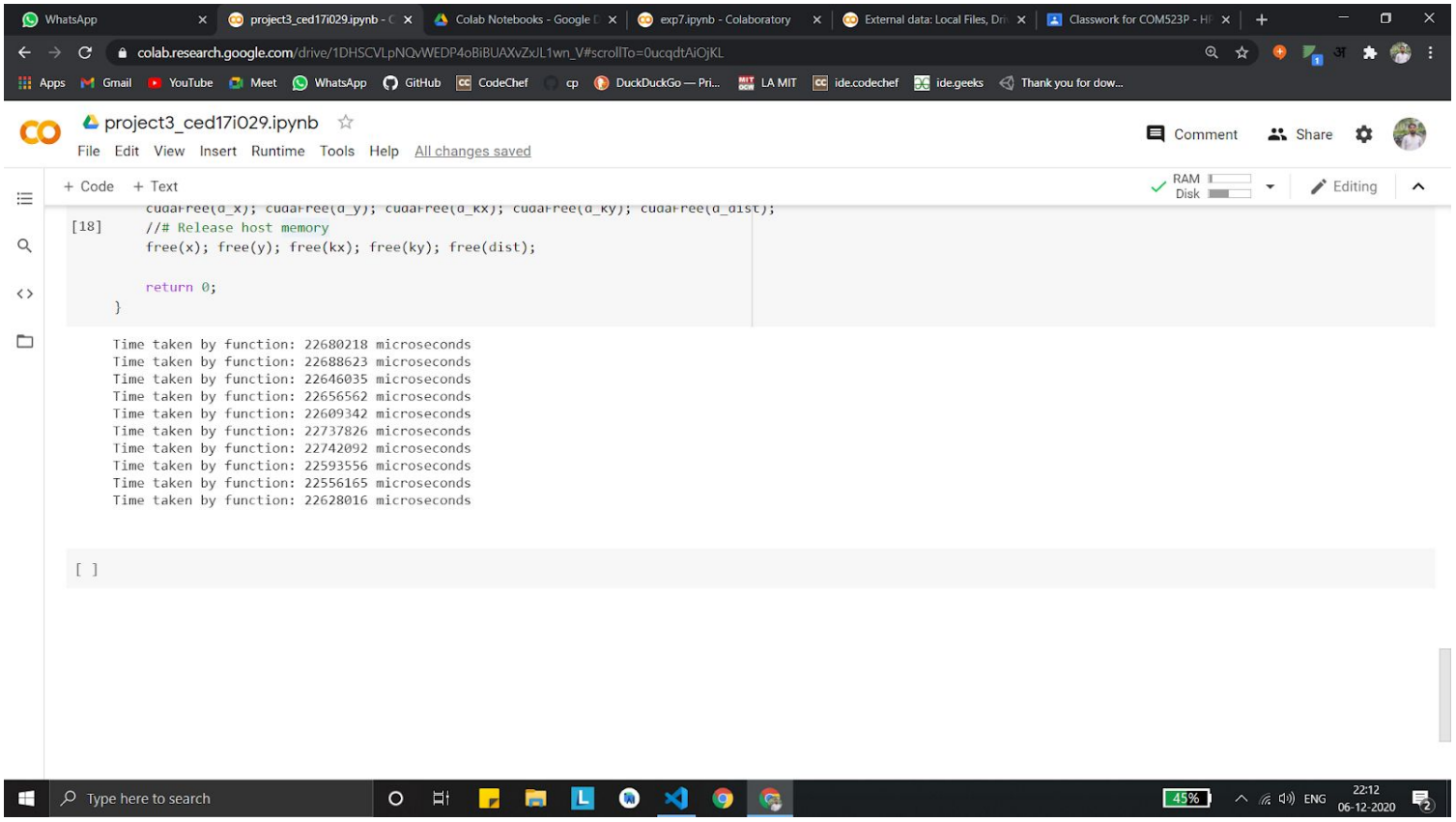
How did i do parallel programming

I have used CUDA technique to parallelize my program.

From my solution to the problem statement, we can clearly see that we have to calculate the distance between pizza center and location of houses. So I have parallelized the program for calculating the distance by running calculateDistance function in device parallely.

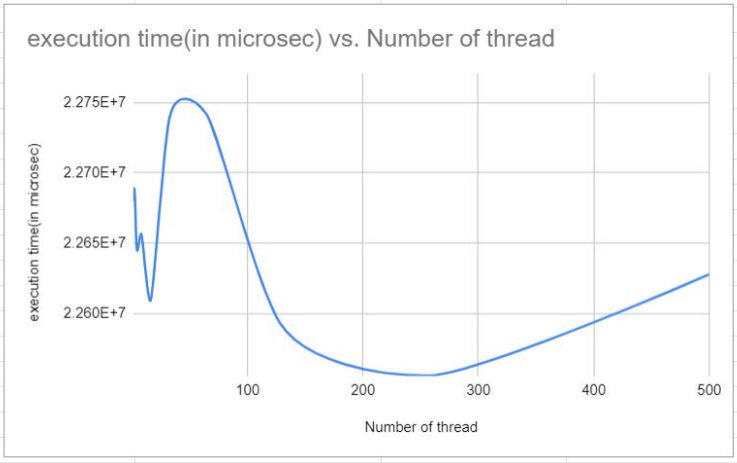
Graph and table

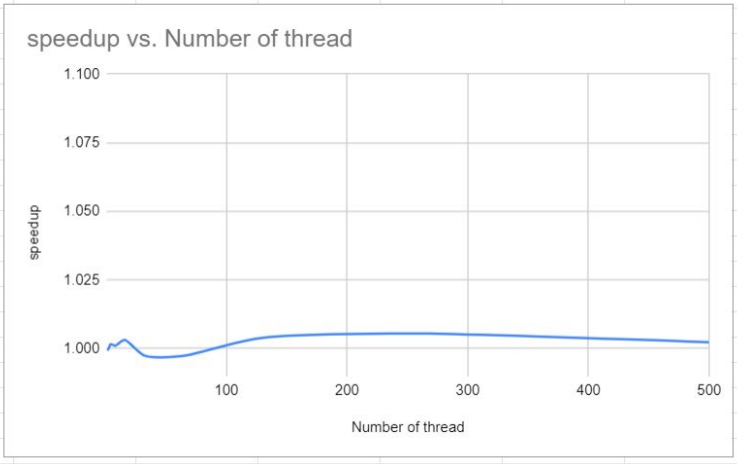
https://docs.google.com/spreadsheets/d/1RiWsOftH94EjRSFfPNMegSW8tQSAgpQqePwF_0k2A04/edit#gid=0



CUDA implementation of Project Problem

Number of thread	execution time(in microsec)	speedup	parallelization fraction(f)
1	22680218	1	0
2	22688623	0.99962955	-0.0007411745337
4	22646035	1.001509447	0.002009563283
8	22656562	1.001044113	0.001192026839
16	22609342	1.00313481	0.003333348324
32	22737826	0.9974664245	-0.002621946693
64	22742092	0.997279318	-0.002771407532
128	22593556	1.003835695	0.003851126032
256	22556165	1.005499738	0.005491106053
500	22628016	1.002306963	0.002306265893





Calculation of parallelization fraction

T(1) = 22680218 microseconds
Here , for P = 256 the execution time is minimum
T(P) = 22556165 microseconds

Speedup = $\frac{T(1)}{T(P)}$ = $\frac{22680218}{22556165}$ = 1.005499738

From Amdahl's Law,

Speedup = $\frac{1}{(f/P) + (1-f)}$ Where , f = Parallelization factor P = Thread Number

So, f = $\frac{(1-T(P)/T(1))}{(1-(1/P))}$

Therefore, f = 0.005491106053 which means that approx. 0.55% of the program is parallelized.