Practical 2 – MATLAB Parallel Computing Toolkit

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Abstract—

I. INTRODUCTION

This report details an investigation into MATLAB's Parallel Computing Toolkit

A. Part 1 Question A

No, the spmd block does not necessarily parallelize code in the GPU. The spmd block or Run Single Programs on Multiple Data Sets is used to parallelize code across multiple workers in a parallel pool but not specifically the GPU. To use a GPU to process code you would use the matlab functions gpuArray() function garrayfun() will force the code to use the GPU.

B. Part 1 Question B

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II. METHODOLOGY OF PART 2

A. Question A

Create a bubble sort function that can sort an array of randomised values. The function will be used to sort the columns of a 100x100 matrix.

B. Question B

Using the bubble sort function created in the previous question, test it against the inbuilt MATLABsort function. The testing will be conducted on square matrices of sizes 100, 200, 500, 1000, 10000 and calculate the speed up from the user created function to MATLAB's inbuilt function. It is expected that the inbuilt function should be faster for all sizes, and the speed up should increase as the size goes up.

C. Question C

Using MATLABparallelism to create a new bubble sort function which using explicit parallelism using a 'parfor' or 'spmd' block The testing will be conducted on square matrices of sizes 100 and 5000 and calculate the speed up from the user created function to MATLAB's inbuilt function It is expected that the inbuilt function should be faster for all sizes, but the explicit parallelism bubble sort should be faster than the user created bubble sort without parallelism.

III. RESULTS OF PART 2

A. Question A

The bubble sort function was created based off of sudo code for a generalised bubble sort. The code is shown below

```
function array = BubbleSort(array)
 for i = 1:length(array)
  for j = length(array):-1:i+1
   if array(j) > array(j-1)
    temp = array(j);
    array(j) = array(j-1);
    array(j-1) = temp;
   end
  end
 end
return;
end
```

This code took 0.0087 seconds to sort the 100x100 matrix

B. Question B

The code to test the user function is shown below. 'timetaken' is a matrix for storing the times of both the user and inbuilt functions.

```
% Initialize the cell array
testsizes = [100; 200; 500; 1000; 1200];
timetaken = cell(1+length(testsizes),4);
timetaken(1,:) = {"size", "bubble sort time", "inbuilt sort time", "speed up"};
timetaken(2:end,1) = num2cell(testsizes); % should use [100; 200; 500; 1000; 10000] but takes too long so

% Loop over each row in timetaken
for i = 2:size(timetaken,1)
 % Call the timetest function with the value in the first column of the i-th row
 [timeBubble, timeInbuilt] = timetest(timetaken{i,1});
 timetaken{i,2} = timeBubble;
 timetaken{i,3} = timeInbuilt;
 % Calculate speed up
 timetaken{i,4} = timeBubble/timeInbuilt;
end
% Display the results
disp(timetaken)
```

The function 'timetest' is given below. It takes a matrix size, creates a square matrix, and then outputs the sort time for both the user and inbuilt functions.

```
function [t_user,t_inbulit ] = timetest(size)

 X=rand(size, size);
 Y=X;

 tic
 for i = 1:size
  X(:,i) = BubbleSort(X(:,i));
 end
 t_user = toc();

 tic
 for i = 1:size
  Y(:,i) = sort(Y(:,i));
 end
 t_inbulit = toc();

 display("Time tacken by the bubble sort function was " + t_user + " s. Time tacken by the inbuilt sort fu

 return;
end
```

The results from the tests are shown in the table below

TABLE I

USER VS INBUILT SORT FUNCTION

Matrix size	User	Inbuilt	Speed up
100	0.0087	0.0002	40.507
200	0.0205	0.0003	62.791
500	0.1780	0.0012	145.18
1000	2.1324	0.0048	445.16
1000	1813.9	1.5631	1160.4

TABLE II

USER VS INBUILT SORT FUNCTION

Matrix size	User	Inbuilt	Speed up
100	0.7921	0.0011	690.97
5000	0.2.1446	0.4808	4.4607

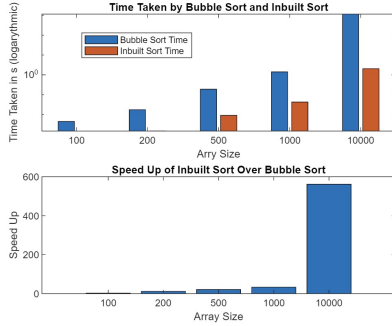Fig. 1: User vs inbuilt sort function
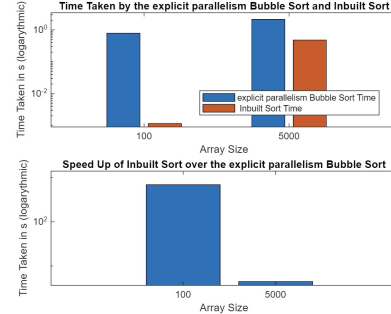
Fig. 2: User parallelism vs inbuilt sort function

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C. Question C

The code to test the parallelism user function is shown below. 'timetaken' is a matrix for storing the times of both the user and inbuilt functions.

```
testsizes = [100, 5000];
timetaken_par = cell(1+length(testsizes),4);
timetaken_par(1,:) = {"size", "bubble sort time", "inbuilt sort time", "speed up"};
timetaken_par(2:end,1) = num2cell(testsizes); % should use [100; 200; 500; 1000; 10000] but takes too long so using 1100 for know

% Loop over each row in timetaken_par
for i = 2:size(timetaken_par,1)
  % Call the timetest function with the value in the first column of the i-th row
  timeBubble = timebubble_parallelism(timetaken_par{i,1});
  timeInbuilt = timesort_parallelism(timetaken_par{i,1});
  timetaken_par{i,2} = timeBubble;
  timetaken_par{i,3} = timeInbuilt;
  % Calculate speed up
  timetaken_par{i,4} = timeBubble/timeInbuilt;
end

% Display the results
disp(timetaken_par)
```

The function 'timesort_parallelism' simply returns the time to sort a square matrix of a given size using the inbuilt sort function. The function 'timebubble_parallelism' is given below. It takes a matrix size, creates a square matrix, and then outputs the sort time for the user parallelism bubble-sort function.

```
function t_user = timebubble_parallelism(size)

 X=rand(size, size);

 tic
 spmd
  myStart = (spmdIndex - 1) * 25 + 1;
  myEnd = myStart + 24;
  for i = myStart:myEnd
   X(:,i) = BubbleSort(X(:,i));
  end
 end
 t_user = toc();

 display("Time tacken by the parallelism bubble sort function was " + t_user )

 return;
end
```

The results from the tests are shown in the table below

IV. CONCLUSION

The conclusion should provide a summary of your findings. Many people only read the introduction and conclusion of a paper. They sometimes scan the tables and figures. If the conclusion hints at interesting findings, only then will they bother to read the whole paper.

You can also include work that you intend to do in future, such as ideas for further improvements, or to make the solution more accessible to the general user-base, etc.

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