

CS553 HW #3 - Extra Credit

Matrix Multiplication with Intel OneAPI

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1. Mode:
 - a. Matrix: Implement matrix multiplication (https://en.wikipedia.org/wiki/Matrix_multiplication) supporting square matrices, of arbitrary size. For example, you should be able to support matrices of size 2, where 2x2 matrix is multiplied by another 2x2 matrix, and result in a 2x2 matrix. You need to implement the matrix multiplication to support multiple cores, as you will evaluate its performance in a multi- core environment.
2. Type:
 - a. Single: single precision 4-byte int data types
 - b. Double: double precision 8-byte double data types
3. Size:
 - a. Small: for matrix, this should be set to 1000 (e.g. 1000x1000 matrix) requiring 12MB to 32MB depending on the algorithm and data type
 - b. Medium: for matrix, this should be set to 4000 (e.g. 4000x4000 matrix) requiring 0.2GB to 0.6GB depending on the algorithm and data type
 - c. Large: for matrix, this should be set to 16000 (e.g. 16000x16000 matrix) requiring 3GB to 8GB depending on the algorithm and data type
4. Threads:
 - a. 4: Use 4 threads to execute your benchmark in parallel on the specified size/4 dataset/operations per thread
 - b. N: Use N threads to execute your benchmark in parallel on the specified size/N dataset/operations per thread; N should be the number of hardware-threads/cores your system

(if your system has 4 hardware-threads/cores, simply state that your hardware has a maximum concurrency of 4 threads) Using max threads = 4

Mode	Type	Size	Threads	OneAPI Throughput (GFlops/s)	PThread Throughput (GFlops/s)	HPL Throughput (GFlops/s)
matrix	single	small	4	5.37589	0.22	-
matrix	single	medium	4	1.92373	0.170	-
matrix	single	large	4	3.2764	0.1694	-
matrix	double	small	4	3.01613	0.1587	23.43
matrix	double	medium	4	2.29873	0.1686	32.37

matrix	double	large	4	5.29375	0.2510	31.89
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Using values for PThreads and HPL Throughput from HW3-report, also previously couldn't measure for shpl mode, as was using **HPLinpack 2.3**, Using intel **i7-6700HQ 2.3GHz** quad core processor for HPL benchmark (**4*2.3GHz*16**)

1. Using the documentation provided had set oneAPI account and userID,
2. after connecting via ssh devcloud
3. created Makefile, run.sh and code with SYCL
4. The values taken are 1024(small), 4096(medium) and 16386(large) for matrix sizes

2 What you will submit

When you have finished implementing the complete assignment as described above, you should submit your solution to your private git repository. Each program must work correctly and be detailed in-line documented. You should hand in:

1. **Source code and compilation (50%):** All of the source code in C and Bash; in order to get full credit for the source code, your code must have in-line documents, must compile (with a Makefile), and must be able to run a variety of benchmarks through command line arguments. Must have working code that compiles and runs correctly.
2. **Report / Performance (50%):** A separate (typed) design document (named hw3-ec-report.pdf) describing the results in a table format. You must evaluate the performance of the various parameters outlined and fill in the 1 table specified to showcase the results. You must summarize your findings and explain why you achieve the performance you achieve, and how the results compare between the various approaches.

You will have to submit your solution to a private git repository created for you at `git@github.com:datasys- classrooms/cs553-fall2022-hw3ec-<team name>.git`. Make sure you have all the relevant files in your repo. The repository is created through GitHub Classroom and you will need to accept the assignment before you can clone it at <https://classroom.github.com/a/ufLTIH4p>. You will also need to create a new team or join an existing team. Your submission will not be graded unless you submit a confirmation document through BlackBoard (BB) that clearly shows the pushing of your final homework to your GIT repository. This confirmation document can simply be a screen shot of your final commands to push your repository to GIT. The timestamp on the BB submission will be used to determine if the submission is on-time. *You must also include the names and A# of*

all your team members in this confirmation document. If you cannot access your repository contact the TAs. You can find a git cheat sheet here:
<https://www.git-tower.com/blog/git-cheat-sheet/>.

Late submission will not be accepted.