DUE DATE: **By the deadline specified on Canvas**

CSE-443/543: High Performance Computing

Exercise #5

Max Points: 20

You should save/rename this document using the naming convention MUid_ex5.docx (example: `raodm_ex5.docx`).

Objective: The objective of this exercise is to:

- Explore key characteristics of a CPU

Fill in answers to all of the questions. For almost all the questions you can simply copy-paste appropriate text from the shell/output window into this document. You may discuss the questions with your instructor.

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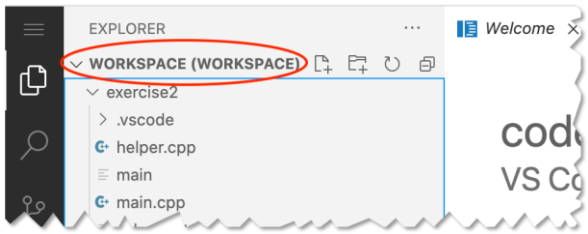
Wait for your instructor to cover the necessary topics in class prior to working on this exercise.

Part #0: Setting up the exercise on OSC

Estimated time: < 10 minutes

Exercise

1. Log into OSC's OnDemand portal via https://ondemand.osc.edu/. Login with your OSC id and password.
2. Startup a VS-Code server and connect to VS-Code. Ensure you switch to your workspace. Your VS-Code window should appear as shown in the adjacent screenshot.



Part #1: Exploring CPU characteristics

Expected time for completion 10 minutes

1. Start a new terminal window via VS-Code. Record the host name below using the `hostname` command:

   Hostname: `pitzer-login03.hpc.osc.edu`

2. Now let's find out some details on the CPU for head node you are logged into. In Linux, almost all of the system information is made available by the kernel via a virtual file system called `proc`. Information regarding all the CPUs/cores (computers may have multiple processors and

each processor may have multiple cores). For this view the file `/proc/cpuinfo` using the `less` command (use arrow keys to navigate and press `q` to quit) as shown below:

```
$ less /proc/cpuinfo  ↵
```

Using the output from the above command (along with some educated guess work) answer the following questions:

1. What is the `model name` of CPU(s): Intel(R) Xeon(R) Gold 6148 CPU @ 2.40GHz

2. From `model name`, What is the CPU speed in **MHz**: 2400

3. What is the cache size (in KB) 28160

4. Using `flags`, indicate the different classes of SSE instructions supported by the CPU There are usually several generations listed in the form: `see`, `see2`, `sse2.3` etc. Sse,sse2,ss,sse3,sse4_1,sse4_2

5. Scroll down the list and indicate the number of logical cores the machine has by counting the number of `processor` entries 1

6. Number of physical CPUs (count number of unique values for `physical id`) 1

7. Estimated approximate MIPS, i.e., `bogomips` 4800

8. Now using the following relation (for exams you must memorize this formula):

$$Instructions/\text{sec}ond = \frac{CPU\ Clock\ Frequency}{Cycles\ Per\ Instruction\ (CPI)}$$

   What is the CPI of the CPU? 2Ghz/4800 000 000 = 0.5

9. Based on CPI how many ALUs should each core of the CPU have?

   9.a. Theoretical minimum number of ALUs: 2

Part #2: Exploring compute node CPU characteristics

Expected time for completion 10 minutes

1. From the VS-Code terminal, start a new interactive job on the cluster via the following command:

```
$ sinteractive -A PMIU0184
```

   The above job will be queued and then take several seconds to start. Once the job starts, you will automatically be moved to a compute node on the cluster.

2. Record the compute node's host name below using the `hostname` command:

   Hostname: `p0223.ten.osc.edu`

3. Now let's find out some details on the CPU for the compute node. View the CPU properties in the virtual file `/proc/cpuinfo` using the `less` command (use arrow keys to navigate and press `q` to quit) as shown below:

```
$ less /proc/cpuinfo  ↵
```

   Using the output from the above command (along with some educated guess work) answer the following questions:

   1. What is the `model name` of CPU(s): Intel(R) Xeon(R) Gold 6148 CPU @ 2.40GHz
   2. From `model name`, What is the CPU speed in **MHz**: 2400
   3. What is the cache size (in KB) 28160
   4. Using `flags`, indicate the different classes of SSE instructions supported by the CPU There are usually several generations listed in the form: `see`, `see2`, `sse2.3`, **`avx`** etc. See, see2,ssse3,sse4_1,sse4_2 Avx2, avx512f, avx512f, avx512dq, avx512cd, avx512bw, axv512vl
   5. Scroll down the list and indicate the number of logical cores the machine has by counting the number of `processor` entries 1
   6. Number of physical CPUs (count number of unique values for `physical id`) 1
   7. Estimated approximate MIPS, i.e., `bogomips` 4804.74

8. Now using the following relation (for exams you must memorize this formula):

$$Instructions/\text{sec}ond = \frac{CPU\ Clock\ Frequency}{Cycles\ Per\ Instruction\ (CPI)}$$

   What is the CPI of the CPU? 0.4995

9. Based on CPI how many ALUs should each core of the CPU have?

   9.a. Theoretical minimum number of ALUs: 3

10. Ensure you stop your interactive job using the `exit` command.

Part #3: Submit files to Canvas

Upload the following files to Canvas:

1. Upload this MS-Word document (duly filled with the necessary information) saved as PDF using the naming convention **`MUid_ex5.pdf`**.