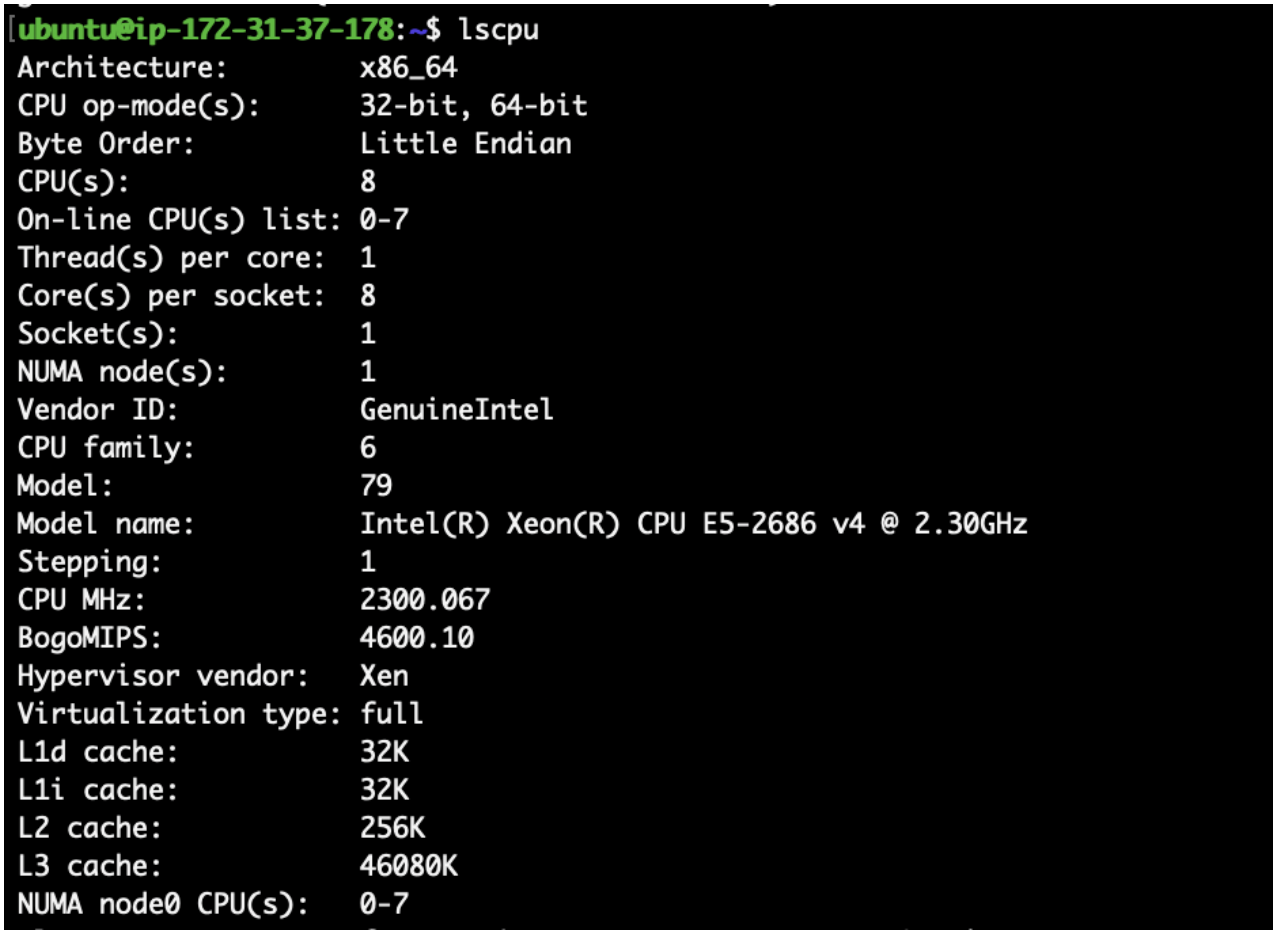
> Jiahui Tang

Spec: (Same as 4.1)

- OS: AWS VM Ubuntu 18.04 (x2.2large)
- Kernal: Linux ip-172-31-37-178 5.4.0-1039-aws #41~18.04.1-Ubuntu SMP Fri Feb 26 11:20:14 UTC 2021 x86_64 x86_64 x86_64 GNU/Linux
- Compiler: gcc version 7.5.0 (Ubuntu 7.5.0-3ubuntu1~18.04)
- Flag: -Ofast
- Details:

```
ubuntu@ip-172-31-37-178:~$ uname -a
Linux ip-172-31-37-178 5.4.0-1039-aws #41~18.04.1-Ubuntu SMP Fri Feb 26 11:20:14 UTC 2021 x86_64 x86_64 x86_64 GNU/Linux
ubuntu@ip-172-31-37-178:~$ cat /proc/cpuinfo
processor       : 0
vendor_id       : GenuineIntel
cpu family      : 6
model           : 79
model name      : Intel(R) Xeon(R) CPU E5-2686 v4 @ 2.30GHz
stepping        : 1
microcode       : 0xb000038
cpu MHz         : 2299.914
cache size      : 46080 KB
physical id     : 0
siblings        : 8
core id         : 0
cpu cores       : 8
apicid          : 0
initial apicid  : 0
fpu             : yes
fpu_exception   : yes
cpuid level     : 13
wp              : yes
flags           : fpu vme de pse tsc msr pae mce cx8 apic sep mtrr pge mca cmov pat pse36 clflu
 x2apic movbe popcnt tsc_deadline_timer aes xsave avx f16c rdrand hypervisor lahf_lm abm cpuid_
bugs            : cpu_meltdown spectre_v1 spectre_v2 spec_store_bypass l1tf mds swapgs itlb_mul
bogomips        : 4600.10
clflush size    : 64
cache_alignment : 64
address sizes   : 46 bits physical, 48 bits virtual
power management:
```



4.2. Scheduling Policies (15 points)

The goal of this exercise is to illustrate the impact of the scheduling algorithm in performance. The code `mandelbrot_omp.c` generates an ASCII Portable Pixel Map (PPM) image of the Mandelbrot set using OpenMP.

Run the parallel code and take the execution time for a growing number of threads. Record the timing in a table. Try with the three scheduling algorithms. To change the schedule, you can either change the environment variable with `export OMP_SCHEDULE=type` where `type` can be any of `static`, `dynamic`, or `guided`. Alternatively, you can change the schedule in the source code as `omp parallel for schedule(type)`.

Note: if you change the environment, then you don't have to change anything inside the code.

[2] http://www.cs.cornell.edu/~bindel/class/cs5220-f11/hw2.html

Submission

- `P42.pdf`: with replicability information (see Submission note above), Explain your results, what is the scheduling that provides the best performance? What is the reason for that?
- `P42.c`: Complete source code

(4.2). Table for improvements in elapsed execution time

(*unit: seconds*)

OMP_NUM_THREADS	2 cores	3 cores	4 cores	5 cores	6 cores	7 cores	8 cores
type = static	0.119479	0.213677	0.11835	0.151437	0.106952	0.117311	0.0903508
type = dynamic	0.118285	0.0788323	0.0592294	0.0474653	0.03963	0.0340479	0.0299404
type = guided	0.11817	0.153298	0.11719	0.0840822	0.0789541	0.0672873	0.0567206

Discussion:

- The `type=dynamics` provides the best performance. We could observe the performance of `dynamic > guided > static`
    - It makes sense as static assigns each thread into a fixed-size chunk, and it is the default schedule version.
    - However, if using dynamic, work is assigned as a thread requests it.
    - For guided type, big chunks are allocated first and smaller and smaller chunks later.
    - For this task, we need dynamic to allocate tasks so that all threads could be parallelly and fully utilized, acheiving fastest execution time.
- Besides, we could also see **even** number of cores perform much better than **odd** number of cores, relatively. It may be due to task could be distributed evenly for all cores if it is an even number. And if it's an odd number, there are always core that is not fully utilized and not saturated, thus resulting in slower performance.

- We could also observe, as number of cores increases, the time it takes become less and less for odd number and even number of cores, respectively. This is as expected, as explained in 4.1, as more cores allow more concurrency when shared same memory, that could simultaneously execute statements in the parallel region.