Report for Assignment 10
Roll - 200050006

1.a Application - BFS (hugebubbles-00020.sg)

Performance Snapshot:
IPC - 0.172
Bad Speculation - 8.3%
Physical Core Utilization - 91.8%(3.671 out of 4)
DRAM Bound - 54.9%

MicroArchitecture Exploration:
Instructions Retired - 49576800000
CPI Rate -
Port Utilization - 70%
Average CPU Frequency - 8.7GHz

Hotspots:
Top Hotspot - TDStep._omp_fn.0 (71.1% CPU Time)

Memory Access:
Loads - 5999245814
Stores - 914240021
LLC Miss Count - 152172374
Average Latency - 35

Threading:
Total Thread Count - 8
Wait Time with poor CPU Utilization - 0.277sec (59.6% of wait time)

Memory Consumption:

Function	Memory Consumption	Allocation/Deallocation delta
TDStep._omp_fn.0	38.4 GB	0.0 B
DOBFS	2.8 GB	0.0 B
Reader<int,int,int,(bool)1>::ReadSerializedGraph	1.0 GB	3.3 KB
BitmapToQueue._omp_fn.0	19.9 MB	0.0 B
func@0x8f3f0	72.7 KB	72.7 KB
[Others]	39.5 KB	4.6 KB

HPC Performance Characterization:
Cache Bound - 3.8%
DRAM Bound - 57.8%

We can use the HPC Performance Characterization analysis to identify how effectively your compute-intensive application uses CPU, memory, and floating-point operation hardware resources.

1.b Application - BFS (soc-LiveJournal1.sg)

Performance Snapshot:
IPC - 0.598
Bad Speculation - 24.0%
Physical Core Utilization - 75.5%(3.018 out of 4)
DRAM Bound - 15.9%

MicroArchitecture Exploration:
Instructions Retired - 9769200000
CPI Rate - 1.608
Port Utilization - 82.3%
Average CPU Frequency - 3.3 GHz

Hotspots:
Top Hotspot - BUStep._omp_fn.0 (57.1% of CPU time)

Memory Access:
Loads - 1826181279
Stores - 256982163
LLC Miss Count - 4730474
Average Latency - 18

Threading:
Total Thread Count - 8
Wait Time with poor CPU Utilization - 0.258sec(100% of wait time)

Memory Consumption:

Function	Memory Consumption	Allocation/Deallocation delta
Reader<int,int,int,(bool)1>::ReadSerializedGraph	664.2 MB	3.3 KB
DOBFS	639.9 MB	0.0 B
TDStep._omp_fn.0	94.4 MB	0.0 B
BitmapToQueue._omp_fn.0	7.9 MB	0.0 B
func@0x8f3f0	72.7 KB	72.7 KB
[Others]	39.5 KB	4.6 KB

HPC Performance Characterization:
Cache Bound - 17.8%
DRAM Bound - 11.9%

2.a Application - PageRank (hugebubbles-00020.sg)

Performance Snapshot:

IPC - 0.194
Bad Speculation - 0.0%
Physical Core Utilization - 95.3% (3.813 out of 4)
DRAM Bound - 82.4%

MicroArchitecture Exploration:

Instructions Retired - 35845600000
CPI Rate - 5.044
Port Utilization - 38.9%
Average CPU Frequency - 7.2 GHz

Hotspots:

Top Hotspot - PageRankPullGS._omp_fn.1 (95.2% of CPU Time)

Memory Access:

Loads - 5461523571
Stores - 1612992439
LLC Miss Count - 980676897
Average Latency - 125 cycles

Threading:

Total Thread Count - 8
Wait Time with poor CPU Utilization - 0.231sec(95.9% of wait time)

Memory Consumption:

Function	Memory Consumption	Allocation/Deallocation delta
PageRankPullGS	2.7 GB	0.0 B
Reader<int,int,int,(bool)1>::ReadSerializedGraph	1.0 GB	3.3 KB
func@0x8f3f0	72.7 KB	72.7 KB
__aloc_dir	32.8 KB	0.0 B
PrintTime	4.1 KB	4.1 KB
[Others]	2.7 KB	528.0 B

HPC Performance Characterization:

Cache Bound - 2.1%

DRAM Bound - 82.0%

2.b Application - PageRank (soc-LiveJournal1.sg)

Performance Snapshot:
IPC - 0.464
Bad Speculation - 10.1%
Physical Core Utilization - 96.3% (3.853 out of 4)
DRAM Bound - 53.0%

MicroArchitecture Exploration:
Instructions Retired - 152462800000
CPI Rate - 2.134
Port Utilization - 78.3%
Average CPU Frequency - 7.8 GHz

Hotspots:
Top Hotspot - PageRankPullGS._omp_fn.1 (97.9% of CPU Time)

Memory Access:
Loads - 30240043581
Stores - 2713327747
LLC Miss Count - 761615055
Average Latency - 45 cycles

Threading:
Total Thread Count - 8
Wait Time with poor CPU Utilization - 0.299sec (98.5% of wait time)

Memory Consumption:

Function	Memory Consumption	Allocation/Deallocation delta
Reader<int,int,int,(bool)1>::ReadSerializedGraph	664.2 MB	3.3 KB
PageRankPullGS	620.5 MB	0.0 B
func@0x8f3f0	72.7 KB	72.7 KB
__aloc_dir	32.8 KB	0.0 B
PrintTime	4.1 KB	4.1 KB
[Others]	2.7 KB	528.0 B

HPC Performance Characterization:

Cache Bound - 2.1%

DRAM Bound - 82.7%

3.a Application - Connected Components (hugebubbles-00020.sg)

Performance Snapshot:
IPC - 0.204
Bad Speculation - 8.1%
Physical Core Utilization - 95.2%(3.807 out of 4)
DRAM Bound - 65.2%

MicroArchitecture Exploration:
Instructions Retired - 48056400000
CPI Rate - 5.101
Port Utilization - 41.9%
Average CPU Frequency - 12.6 GHz

Hotspots:
Top Hotspot - Link (79.3% of CPU Time)

Memory Access:
Loads - 7228958676
Stores - 1236359429
LLC Miss Count - 406179721
Average Latency - 55

Threading:
Total Thread Count - 8
Wait Time with poor CPU Utilization - 0.256sec(96.4% of wait time)

Memory Consumption:

Function	Memory Consumption	Allocation/Deallocation delta
main	1.4 GB	0.0 B
Reader<int,int,int,(bool)1>::ReadSerializedGraph	1.0 GB	3.3 KB
func@0x8f3f0	72.7 KB	72.7 KB
__alloc_dir	32.8 KB	0.0 B
SampleFrequentElement.constprop.0	4.7 KB	0.0 B
[Others]	6.6 KB	4.6 KB

HPC Performance Characterization:
Cache Bound - 14.1%
DRAM Bound - 64.3%

3.b Application - ConnectedComponents (soc-LiveJournal1.sg)

Performance Snapshot:
IPC - 0.475
Bad Speculation - 24.3%
Physical Core Utilization - 78.4% (3.138 out of 4)
DRAM Bound - 30.0%

MicroArchitecture Exploration:
Instructions Retired - 10799600000
CPI Rate - 2.071
Port Utilization - 64.1%
Average CPU Frequency - 4.6 GHz

Hotspots:
Top Hotspot - Link (43.1% of CPU Time)

Memory Access:
Loads - 1824776442
Stores - 328848037
LLC Miss Count - 16063904
Average Latency - 27 cycles

Threading:
Total Thread Count - 8
Wait Time with poor CPU Utilization - 0.208sec(99.6% of wait time)

Memory Consumption:

Function	Memory Consumption	Allocation/Deallocation delta
Reader<int,int,int,(bool)1>::ReadSerializedGraph	664.2 MB	3.3 KB
main	310.2 MB	0.0 B
func@0x8f3f0	72.7 KB	72.7 KB
SampleFrequentElement.constprop.0	36.2 KB	0.0 B
__alloc_dir	32.8 KB	0.0 B
[Others]	6.6 KB	4.6 KB

HPC Performance Characterization:

Cache Bound - 17.9%

DRAM Bound - 21.0%

1. **IPC**

IPC shows average number of retired instructions per cycle theoretical best IPC is 4 . But various effects(long-latency memory,floating point etc) operation tends to pull IPC down.

2. **Bad Speculation**
   Bad Speculation represents a pipeline slots fraction wasted due to incorrect speculations. This includes slots used to issue uOps that do not eventually get retired and slots for which the issue pipeline was blocked due to recovery from an earlier incorrect speculation.

3. **Physical Core Utilization**
   This metric represents how efficiently the application utilized the physical CPU cores available and helps evaluate the parallel efficiency of the application

4. **DRAM Bound**
   This metric shows how often the CPU was stalled on the main memory because of load or store.

5. **CPI Rate**
   Cycle per instruction shows how much time each executed instruction took in units of cycles and we can also predict performance based on this

6. **Port Utilization**
   This metric represents a fraction of cycles during which an application was stalled due to core non-driver related issue.

7. **Average CPU Frequency**
   Based on this value we can predict in which mode application is running . (i.e. values above nominal frequency indicates that the CPU is operating in a turbo boost mode).

8. **LLC Miss Count**
   The LLC(last-level-cache) is the last,and longest-latency level in the memory hierarchy before main memory. The LLC miss count metric shows total number of demand loads which missed LLC. Missed due to prefetcher are not included.

9. **Average Latency**
   This metric shows average load latency in cycles.

10. **Wait time with poor CPU Utilization**
    wait time occurs when software threads are waiting due to APIs that block or cause synchronization.wait time is per-thread so it can exceed the application elapsed time.

11. **DRAM Bound**
    This metric shows how often the CPU was stalled on the main memory because of load and store instruction.

12. **Cache Bound**
    This metric shows how often the machine was stalled on L1,L2,L3 caches (here L1,L2,L3 are intermediate caches that makes IF or WB fast (i.e. in less number of cycles)).