**CSE 520: Assignment 1**

**1) Execution time:**

Hyper-threading is a process which allows the computer’s Operating system to access two logical processors for each physical core. Therefore, it can process instructions from two threads simultaneously. This in-turn leads to a smaller number of execution units will be idle during each clock cycle. As a result, enabling hyper-threading may significantly boost system performance.

Observation: **The speed is always greater for without hyper threading than with hyper threading.** This is because hyperthreading works by duplicating some parts of a CPU core (The registers and a few other components), but other components, such as the scheduler and ALUs are shared. As a result, while you gain a maximum double throughput in some workloads, if two threads need the same resources at the same time, one thread needs to wait until the other finishes.  
**The speed increases as the number of threads increase.** This is because a single task will be split into smaller sizes and will be run at the same time. This is also called as parallelism. This helps in improving the performance.

**2)L1D cache load miss rate and MPKI:**

Observation: With the increase in the number of threads, the L1 Dcache miss rate also increases slightly. This is because, the L1 cache size is the smallest of them all. And as the number of threads increases, the miss rate also increases as instructions also increases. With hyperthreading, the number of misses increases because of the shared resources between them. As threads increases, number of misses also increases. But in MPKI, the increase in miss is very less because hardware does instruction prefetching, scheduling etc which leads to reduction in the number of misses.

**3) L2 Demand data read miss rate and MPKI:**

The demand data only considers the traffic for data needed by the core; excludes all the counts that is loaded into the cache due to data read prefetch or instruction prefetch.  
Observation: The miss rate is greater for without hyper threading than with hyper threading. This could be because during hyperthreading, a greater number of data read prefetch and instruction prefetches can be performed than without hyperthreading.   
Similarly, for MPKI there is increase in miss rate with the increase in number of threads. But the increase is a slight one.

**4) LLC Load Miss Rate and MPKI:**

LLC is the largest cache among all. And it is also furthest from the CPU. As the number of cores increases, the size of the LLC also increases. Therefore, the miss rate has reduced in all the graphs. The miss rate and MPKI is always greater for HT than without HT because as the number of threads increases, so does the number of instructions.

The value for all the events has been collected 3 times and their average has been documented in the excel sheet link below:

[Data for all 3 benchmark programs](https://drive.google.com/file/d/1pz_yci281t9BoqW7E3scIqQJJ8HKwcVZ/view?usp=sharing)