Zhen Luo (001528318)

**Program Structures & Algorithms**

**Fall 2021**

**Assignment No. 5**

* **Task：** 
  + A cutoff (defaults to, say, 1000) which you will update according to the first argument in the command line when running. It's your job to experiment and come up with a good value for this cutoff. If there are fewer elements to sort than the cutoff, then you should use the system sort instead.
  + Recursion depth or the number of available threads. Using this determination, you might decide on an ideal number (*t*) of separate threads (stick to powers of 2) and arrange for that number of partitions to be parallelized (by preventing recursion after the depth of *lg t* is reached).
  + An appropriate combination of these.
* **Relationship Conclusion:** 
  + In most cases, using the number of threads exactly equal to the number of physical threads in CPU of the computer may be the best choice. (See figure 2.1 to figure 2.6, in my case, my CPU is intel I7-6700HQ and has 8 physical threads, so you may find 8-thread has a better performance in the figure)
  + It’s hard to find a reasonable mathematical expression to express the relationships between runtime(***t***), cutoff(***c***), and array length(***a***). But we can roughly assume the relationship as ***t = N a (*c 的 負 2 次方*)*** (1 < ***c*** < ***a***/2000) where ***N*** represents a formula that cannot be obtained. And according to this experiment, when cutoff(***c***) is less than 1, it has no meaning, and when cutoff is more than approximately ***a***/2000(This is not accurate, but you can find it in all the figure) the runtime will keep at approximately the same value.
  + We can find a little rises at the end of the line. We find all the cases have this phenomenon. We simply see it as the warmup for CPU.
* **Evidence to support the conclusion:**

1. **Output**

**电脑萤幕的截图

描述已自动生成**

(Figure 1.1 commend line output)

1. **Graphical Representation**

图表, 折线图

描述已自动生成图表, 折线图

描述已自动生成

(Figure 2.1 and 2.2)1E+06 Array length runtime in different threads

图表

描述已自动生成图表, 折线图

描述已自动生成

(Figure 2.3 and 2.4)2E+06 Array length runtime in different threads

图表

描述已自动生成图表, 折线图

描述已自动生成

(Figure 2.5 and 2.6)4E+06 Array length runtime in different threads

图表

描述已自动生成图表

描述已自动生成

(Figure 2.7 and 2.8) Different array length runtime in 4-thread

图表

描述已自动生成图表, 折线图

描述已自动生成

(Figure 2.9 and 2.10) Different array length runtime in 8-thread

图表

描述已自动生成图表, 折线图

描述已自动生成

(Figure 2.11 and 2.12) Different array length runtime in 16-thread

* **Unit tests result:**
  + N/A