Homework #1
Due: Thursday January 16, 2020 10:00 AM

Reading assignment:
Lecture notes 1, 2 and 3.

Homework problems:

1. Find out the number of cores of the processors in your cell phone and laptop/desktop. Specify their types, if known.

2. What is Dennard Scaling? What caused its breakdown?

3. Please compute the power efficiency of the Top-10 supercomputers announced in Nov. 2019, and list the top-3 most power efficient supercomputers. Please use the measurement in terms of Rmax/Power (you can compute only those whose Power numbers are available).

4. Given an integer array *a[ ]* of *N* elements. Please write an OpenMP function to sort it by the Quicksort algorithm using the *task* directive. The function header is: `void quicksort(int *a, int p, int r)`. (p represents the start index and r represents the end index)

5. For the all-pair shortest path code provided in Lecture 2:
    (i)   Please list all data dependencies and their types; and
    (ii)   Please examine the following loop transformation operations discussed in Lecture 3:
        i.   Loop Permutation
        ii. Loop Distribution
        iii. Loop Fusion
        iv. Loop Peeling
        v.   Loop Shifting
        vi. Loop Unrolling
        vii. Loop Strip-Mining
        viii. Loop Unroll-and-Jam
        ix. Loop Tiling
        x.   Loop Parallelization
        xi. Loop Vectorization
    Please discuss which one can be applied and which one cannot be. For some transformations, they can be applied to some loops, but not others. Please discuss both cases.

6. There is a list of n independent tasks with known (but considerably different) runtimes to be performed by m processors. We order the tasks in a list and assign each task in the order of the list to the first available idle processor until all tasks are completed (so called the list scheduling). Once a processor finishes a task, it requests a new task. Alice sorts the list in decreasing order of the task runtimes and then performs list scheduling. Bob sorts the list in increasing order of the task runtimes and then performs list scheduling. Who do you expect to finish first? Please explain why.

Late submission policy:
We allow one-day delay with 10% penalty. After that, no submission will be accepted and the solutions may be discussed in the discussion sessions.