**ITS 470**

**Homework 1**

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Please put Course number, your Full Name, Assignment number on top right. Submit your homework on Blackboard. Please name your file as “ITS470HW1FirstNameLastName.(doc or docx)”. Any failure to do so will result in deduction.

1. Problem 1.1 (5 points)

Go to the Top 500 Supercomputers site (<http://www.top500.org/>) and list the five most powerful supercomputers along with their FLOPS rating.

| **Rank** | **System** | **Cores** | **Rmax (TFlop/s)** | **Rpeak (TFlop/s)** | **Power (kW)** |
| --- | --- | --- | --- | --- | --- |
| 1 | [**Sunway TaihuLight** - Sunway MPP, Sunway SW26010 260C 1.45GHz, Sunway](https://www.top500.org/system/178764), NRCPC  [National Supercomputing Center in Wuxi](https://www.top500.org/site/50623) China | 10,649,600 | 93,014.6 | 125,435.9 | 15,371 |
| 2 | [**Tianhe-2 (MilkyWay-2)** - TH-IVB-FEP Cluster, Intel Xeon E5-2692 12C 2.200GHz, TH Express-2, Intel Xeon Phi 31S1P](https://www.top500.org/system/177999), NUDT  [National Super Computer Center in Guangzhou](https://www.top500.org/site/50365) China | 3,120,000 | 33,862.7 | 54,902.4 | 17,808 |
| 3 | [**Piz Daint** - Cray XC50, Xeon E5-2690v3 12C 2.6GHz, Aries interconnect , NVIDIA Tesla P100](https://www.top500.org/system/177824), Cray Inc.  [Swiss National Supercomputing Centre (CSCS)](https://www.top500.org/site/50422) Switzerland | 361,760 | 19,590.0 | 25,326.3 | 2,272 |
| 4 | [**Titan** - Cray XK7, Opteron 6274 16C 2.200GHz, Cray Gemini interconnect, NVIDIA K20x](https://www.top500.org/system/177975), Cray Inc.  [DOE/SC/Oak Ridge National Laboratory](https://www.top500.org/site/48553) United States | 560,640 | 17,590.0 | 27,112.5 | 8,209 |
| 5 | [**Sequoia** - BlueGene/Q, Power BQC 16C 1.60 GHz, Custom](https://www.top500.org/system/177556), IBM  [DOE/NNSA/LLNL](https://www.top500.org/site/49763) United States | 1,572,864 | 17,173.2 | 20,132.7 | 7,890 |

1. Problem 1.2 (5 points each)

List three major problems requiring the use of supercomputing in the following domains:

1. **Structural Mechanics. Car and plane design simulation or building simulation**
2. **Computational Biology. Genomics research and ocean modeling**
3. **Commercial Applications. Financial analysis and population statistics**
4. Moore’s Law indicates that CPU speed is doubling every 18 months, which means computation time will be at least twice faster as the same time. Explain why still we need parallel computing. (10 points)

Minimize the computation time . Multiple processors work together . Solve larger problem . Multiple processors and memory . Concurrency . Multiple instructions at the same time . Access to databases, search engine

Use of non-local resources on a wide area network (grid computing) . Cost saving . Use of multiple cheap computing resources instead of a high-end CPU . Relaxation of memory constraints . Use the memories of multiple computers

Weather forecasting . Ocean modeling . Oil reservoir simulations . Car and airplane design simulation . Genomics research . Financial analysis . Medical imaging

Design of parallel computers . Design of efficient parallel algorithms . Methods for evaluating parallel algorithms . Parallel computer languages . Parallel programming tools . Portable parallel programs

1. Which countries have the most power supercomputer in the past 4 years? What applications are the main targets of these supercomputers? (10 points)

**China has the top 2 consuming of 15,000kW each.**

Switzerland **has the 3rd consuming almost 13,000kW.**

**USA has the 4th consuming just over 8,000kW.**

Bigdata process application

Unify theory, experiment, and simulation

Data captured by instruments or generated by simulator

Processed by software

Knowledge stored in computer

Scientist analyes database

1. What is the difference between shared and distributed memory? What are the advantages and disadvantages? (10 points)

Distributed memory:

Advantages . Easily scalable with number of processors . No cache-coherency needed among processors . Cost effective . Disadvantages . Communication is user responsibility . Non-uniform memory access . Difficult to map shared-memory data structures . More complex programming model

Shared memory:

Advantages . User-friendly programming perspective to memory . Global address space – simple programming model . Fast data sharing ϒ Disadvantages . Difficult and expensive to scale . Correct data access is user responsibility

1. In Flynn’s taxonomy of parallel computers, explain the difference between SIMD and MIMD. (10 points)

SIMD : A type of parallel computer . All PU’s run the same instruction at any given clock cycle . Each PU can act on a different data item . Synchronous (lockstep) execution .Two types ▪ Processor array and vector pipelines . Ex: GPUs

MIMD : A type of parallel computer . Synchronous / asynchronous execution . Ex: supercomputer, parallel computing cluster, multicore PCs