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HPC Week 1

1. Estimate the runtime for a matrix-matrix product for various number of unknowns systems
   that can sustain 1 MegaFLOP and 1 PetaFLOP. Provide a runtime graph.
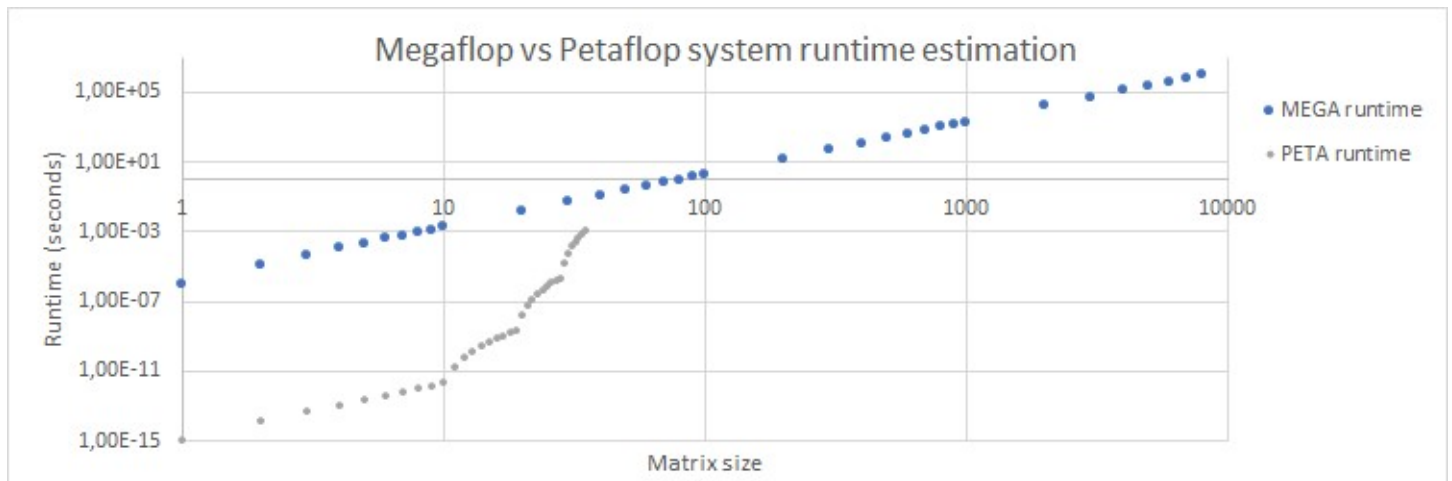
Assumptions and definitions:
1. Estimation scope applies only to matrix multiplication
2. Matrix A is of dimension A x C
3. Matrix B is of dimension C x B
4. Computation is serial

Floating point operations = (AB)(2(C-1)) = (2ABC - AB)

For a set of square matrices...

Floating point operations = (2C^3 - C^2)

Megaflop vs Petaflop system runtime estimation

(See Appendix for Megaflop and Petaflop system runtimes given multiple nodes)

2. Verify the theoretical performance (Rpeak) that can be reached by the top 3 computers in
   the Top500 list. Show all calculations and assumptions.

$$Performance := Node_{count} \cdot Node_{TOTAL\_Performance}$$

$$Node_{TOTAL\_Performance} := Node_{CPU\_Performance} + Node_{GPU\_Performance}$$

$$Node_{CPU\_Performance} := CPU_{Count} \cdot CPU_{Core} \cdot CPU_{Clock} \cdot CPU_{FP64\_PerCycle}$$

$$Node_{GPU\_Performance} := GPU_{Count} \cdot GPU_{FP64\_Performance}$$

2.1 Summit

$$CPU_{Count} := 2 \quad CPU_{Core} := 22 \quad CPU_{Clock} := 3,01 \text{ GHz} \quad CPU_{FP64\_PerCycle} := 8$$

$$Node_{CPU\_Performance} = 1,0595 \text{ THz}$$

$$GPU_{Count} := 6 \quad GPU_{FP64\_Performance} := 7,8 \text{ THz}$$

$$Node_{GPU\_Performance} = 46,8 \text{ THz}$$

$$Node_{count} := 4608$$

$$Performance = 220536,6682 \text{ THz}$$

Top500 RPeak = 200 795 TFlops

2.2 Sierra

$CPU_{Count} := 2$ $CPU_{Core} := 22$ $CPU_{Clock} := 3,4$ GHz $CPU_{FP64\_PerCycle} := 8$

$Node_{CPU\_Performance} = 1,1968$ THz

$GPU_{Count} := 4$ $GPU_{FP64\_Performance} := 7$ THz

$Node_{GPU\_Performance} = 28$ THz

$Node_{count} := 4320$

$Performance = 126130,176$ THz
Top500 RPeak = 125 712 TFlops

2.3 Sunway TaihuLight

$CPU_{Count} := 1$ $CPU_{Core} := 260$ $CPU_{Clock} := 1,45$ GHz $CPU_{FP64\_PerCycle} := 8$

$Node_{CPU\_Performance} = 3,016$ THz

Assume Sunway TaihuLight does not implement GPU processing

$GPU_{Count} := 0$

$Node_{count} := 40960$

$Performance = 123535,36$ THz
Top500 RPeak = 125 436 TFlops

Appendix