Out-of-Core Cholesky Factorization Algorithm on GPU and the Intel MIC Co-processors

Ben Chan (Chinese University of Hong Kong)
Nina Qian (Chinese University of Hong Kong)
Mentors: Ed D'Azevedo (ORNL)
Shiquan Su (UTK)
Kwai Wong (UTK)
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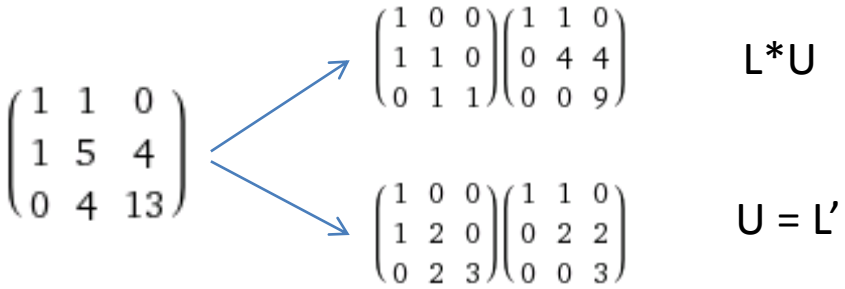
Cholesky Factorization

Similar to LU factorization



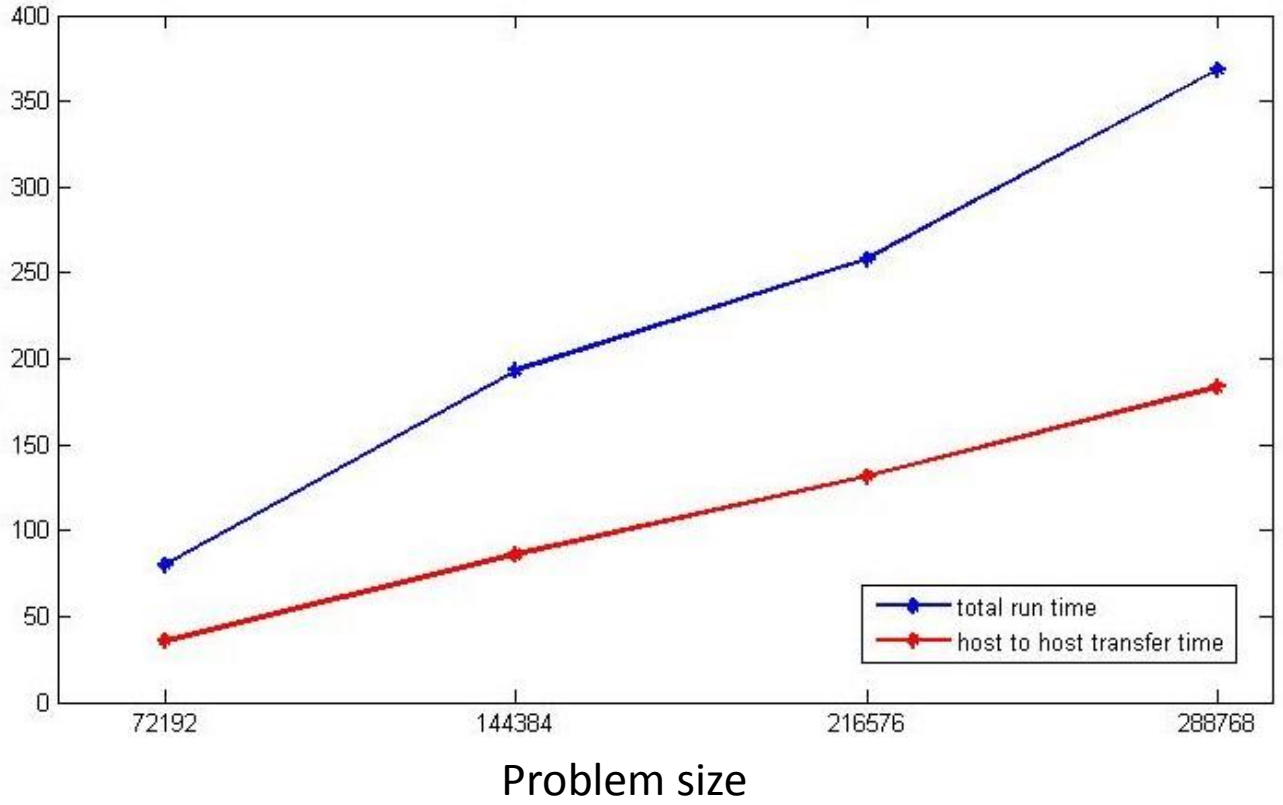
- LU works on a wider variety of matrices
- Cholesky factorization on symmetric positive-definite (SPD) matrices only

"Out-of-Core"

- Core – computing unit of the algorithm
  GPU or MIC
  high FLOPS, low storage
- Data stored outside of the core
- Solve larger problems quickly!

Performance Issue with GPU

4 test cases on Keeneland



~160 GFLOPS/PROC

Nvidia M2090 GPU peak performance: 665 GFLOPS

- Performance of algorithm constrained by the hardware architecture
- Quantify data transfer amount

Application: Large scale radiosity problem

- Calculate view factor between any two surfaces in space to form VF matrix

  (view3d program)
  - Need to separate obstruction-existing case

- Factorize VF matrix by using OOC algorithm
  - Transform VF matrix to SPD first

$$VF = \begin{pmatrix} F_{11} & \cdots & F_{1n} \\ \vdots & \ddots & \vdots \\ F_{n1} & \cdots & F_{nn} \end{pmatrix}$$

$$\downarrow$$

$$G = \begin{pmatrix} \frac{A_1}{\phi_1} - A_1F_{11} & -A_2F_{12} & \cdots & -A_nF_{1n} \\ -A_1F_{21} & \frac{A_2}{\phi_2} - A_2F_{22} & \cdots & -A_nF_{2n} \\ \vdots & & & \vdots \\ -A_1F_{n1} & -A_2F_{n2} & \cdots & \frac{A_n}{\phi_n} - A_nF_{nn} \end{pmatrix}$$

Which is a SPD matrix used to solve Boltzmann's Law

Application: Large scale radiosity problem

- Already done:
  - Serial code (Walton, 2008)➔GPU-based parallel code (Hu, 2012)
- Goal:
  - Improve detecting obstruction part
  - Transfer to Intel MIC co-processor instead of GPU
  - Also need to transfer the OOC algorithm to MIC

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