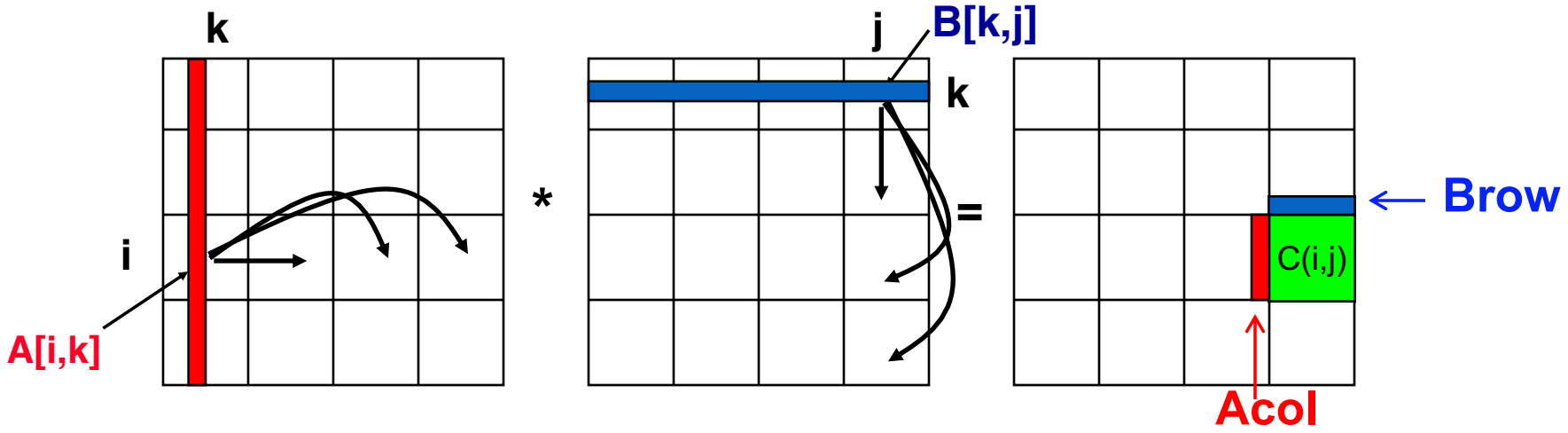
Lab 3

- Assigned on Feb. 14
- Due midnight on Feb. 27 (2 weeks)

- Use MPI to implement the lectured SUMMA algorithm
  - You may assume NxN matrix.
  - You may assume rxc processes and r=c. (up to 16x16).
  - You may assume N is divisible by b (b is the block size).
  - Local bxb matrix multiplication should utilize Cray LibSci's dgemm function.
  - In your report, show your pseudo code, describe how you implement it, show your performance results (Given different N, different #processes, what is the best performance in Gflops), and discuss the effect of b.
    - Explain the figures for why your results are like this
    - What is the parallel efficiency of your SUMMA program
  - Write down how you tested if your computation result is correct or not.
- I have attached two slides from our our lectures.

SUMMA– n x n matmul on $P^{1/2}$ x $P^{1/2}$ grid



For k=0 to n/b-1

for all i = 1 to $P^{1/2}$

owner of A[i,k] broadcasts it to whole processor row (using binary tree)

for all j = 1 to $P^{1/2}$

owner of B[k,j] broadcasts it to whole processor column (using bin. tree)

Receive A[i,k] into Acol

Receive B[k,j] into Brow

C_myproc = C_myproc + Acol * Brow

SUMMA Costs

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for k=0 to n/b-1
    for all i = 1 to P^1/2
          owner of A[i,k] broadcasts it to whole processor row (using binary tree)
           … #words  = log (P^1/2 )*b*n/P^1/2 ,     #messages = log (P^1/2)
    for all j = 1 to  P^1/2
          owner of B[k,j] broadcasts it to whole processor column (using bin. tree)
           …  same #words and same #messages
    Receive A[i,k] into Acol
    Receive B[k,j] into Brow
    C_myproc = C_myproc + Acol * Brow     … #flops = 2n^2*b/P
```

- Total #words = logP * $n^2/P^{1/2}$ (for n/b iterations)
  - Within factor of log P of lower bound
  - (more complicated implementation removes log P factor)
- Total #messages = logP * n/b
  - Choose b close to maximum, $n/P^{1/2}$, to approach lower bound $P^{1/2}$
  - Show the lower bound later
- Total #flops = $2n^3/P$

Reference

- Read the SUMMA paper from van de Geijn and Watts
  - www.netlib.org/lapack/lawns/lawn96.ps
- Simplification: you don't have to call MPI_Bcast to broadcast messages. Just use point2point message passing functions.
- http://www.cs.berkeley.edu/~knight/cs267/hw1/dgemm-blas.c
- Fortran implementation of pdgemm from ScaLAPACK:
  - It might be too complicated to be helpful. Just for your interest.

  http://www.netlib.org/scalapack/explore-html/d6/da2/pdgemm___8c_source.html