Matrix Multiplication

CIS 510

Department of Computer and Information Science
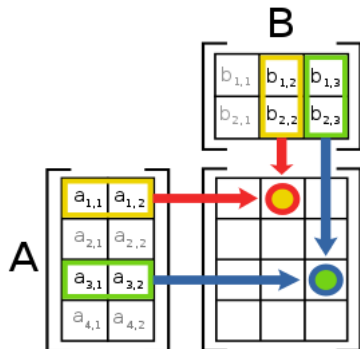*University of Oregon*

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Definition

$$A = \begin{bmatrix} A_{11} & A_{12} & \ldots & A_{1p} \\ A_{21} & A_{22} & \ldots & A_{2p} \\ \vdots & \vdots & \ddots & \vdots \\ A_{m1} & A_{m2} & \ldots & A_{mp} \end{bmatrix}, B = \begin{bmatrix} B_{11} & B_{12} & \ldots & B_{1n} \\ B_{21} & B_{22} & \ldots & B_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ A_{p1} & B_{p2} & \ldots & B_{pn} \end{bmatrix}$$

$$C = A \times B = \begin{bmatrix} C_{11} & C_{12} & \ldots & C_{1n} \\ C_{21} & C_{22} & \ldots & C_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ C_{m1} & C_{m2} & \ldots & C_{mn} \end{bmatrix}$$

$$C_{ij} = \sum_{k=1}^{p} A_{ik} B_{kj}$$

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[1]Picture from wikipedia

Naive implementation

```
for (i=0; i<M; i++) {
    for (j=0; j<N; j++) {
        C[i][j] = 0;
        for (k=0; k<P; k++) {
            C[i][j] += A[i][k] * B[k][j];
        }
    }
}
```

Warm up

- A serial implementation is provided
- FIXME: need unified method to get sample code
- Compile and run
- Discussion: What's the problem with this program?
- Fix it, try again

OpenMP Quick Review

- #pragma omp parallel
- #pragma omp for
- #pragma omp parallel for
- int omp_set_num_threads();
- int omp_get_num_threads();
- int omp_get_thread_num();
- double omp_get_wtime();

Parallel Matrix Multiplication

- Try to parallelize the serial implementation
- Compile and run
- Speed up?
- What is the theoretical peak FLOPS of a single MIST node?
- Can you reach it?

Want More?

- Blocked (Tiled) Matrix Multiply
- Strassen's Algorithm
- BLAS / ATLAS