Computational Science on Many-Core Architectures

360.252

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Sparse Matrices - Intro

Sparse Matrices

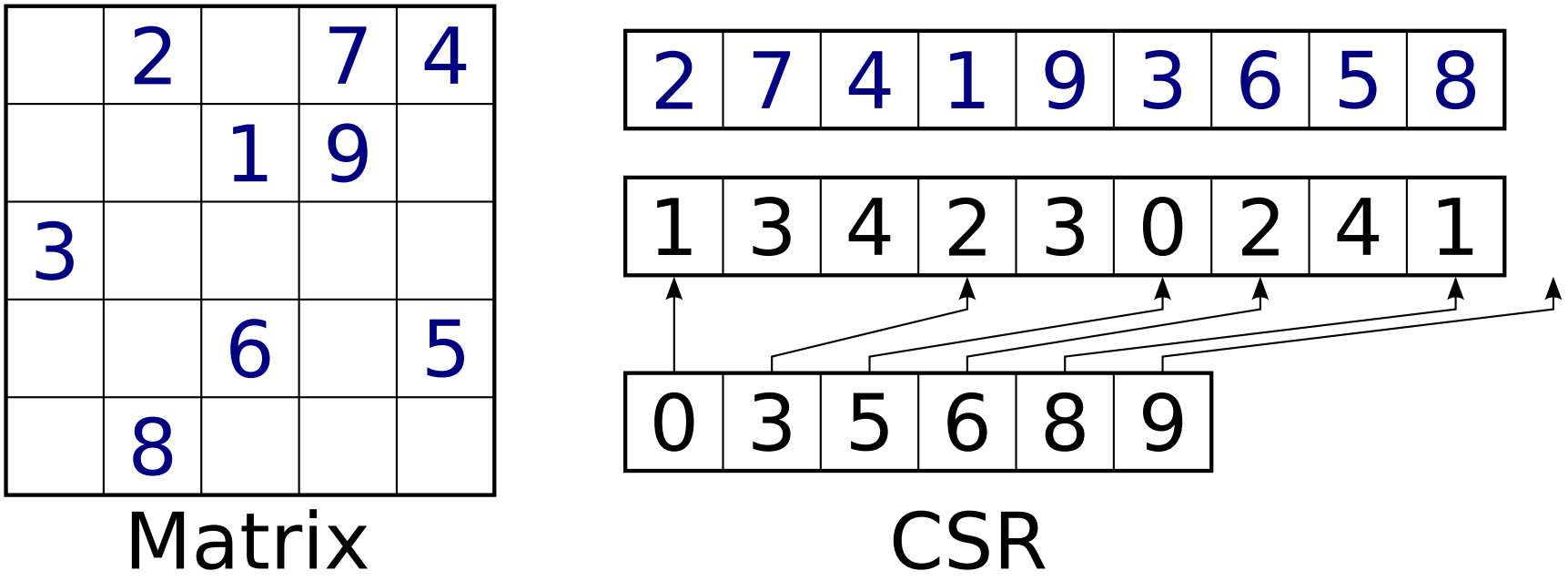
- Ubiquituous for: graph algorithms, numerical solution of PDEs
- Finite differences, finite elements, finite volumes, etc.

Algebraic Multigrid

- Asymptotically optimal solver
- Computation of coarse grid operator $\mathbf{A}^{\text{coarse}} = \mathbf{R}\mathbf{A}^{\text{fine}}\mathbf{P}$ expensive

Sparse Matrices - Intro

Compressed Sparse Row Format



Three Arrays

- Nonzero Values
- Column Indices
- Offset array for each row (typically size N+1)

Sparse Matrices - Intro

Typical Kernel for $y = Ax$

```
__global void csr_matvec(int N,
  int *rowoffsets, int *colindices, double *values, //CSR arrays
  double const *x, double *y) {

 for (int row = blockDim.x * blockIdx.x + threadIdx.x;
          row < N;
          row += gridDim.x * blockDim.x) {
   double val = 0;
   for (int jj = rowoffsets[row]; jj < rowoffsets[row+1]; ++jj)
   {
      val += values[jj] * x[colindices[jj]];
   }
   y[row] = val;
 }
}
```

- One thread per row
- Good starting point, but not the fastest option