CHAPTER 14

Sparse matrix computation

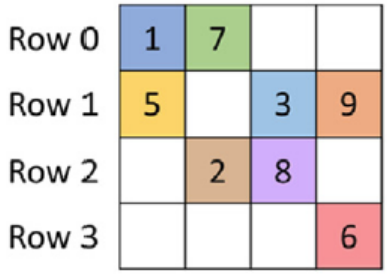

FIGURE 14.1

A simple sparse matrix example.

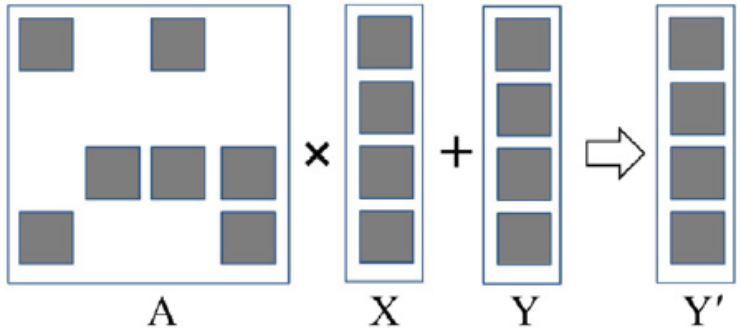

FIGURE 14.2

A small example of matrix-vector multiplication and accumulation.

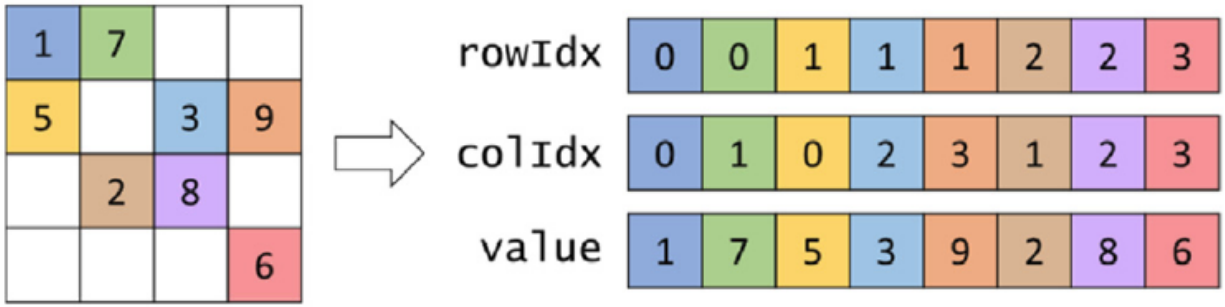

FIGURE 14.3

Example of the coordinate list (COO) format.

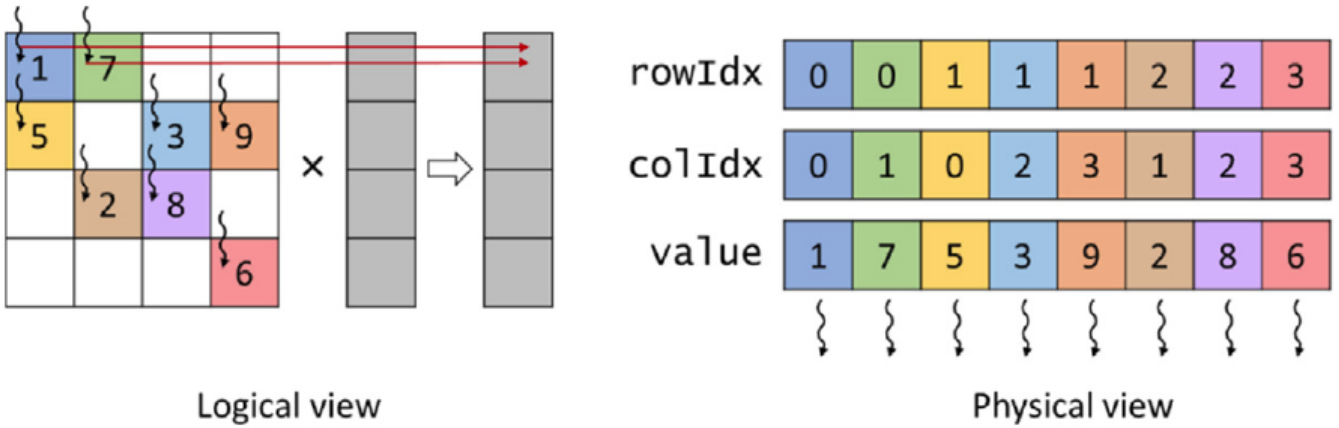

FIGURE 14.4

Example of parallelizing SpMV with the COO format.

```
01    __global__ void spmv_coo_kernel(COOMatrix cooMatrix, float* x, float* y) {
02        unsigned int i = blockIdx.x*blockDim.x + threadIdx.x;
03        if(i < cooMatrix.numNonzeros) {
04            unsigned int row = cooMatrix.rowIdx[i];
05            unsigned int col = cooMatrix.colIdx[i];
06            float value = cooMatrix.value[i];
07            atomicAdd(&y[row], x[col]*value);
08        }
09    }
```

FIGURE 14.5

A parallel SpMV/COO kernel.

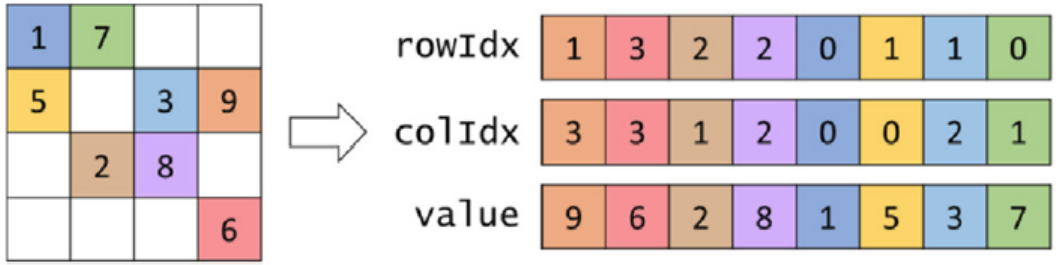

FIGURE 14.6

Reordering coordinate list (COO) format.

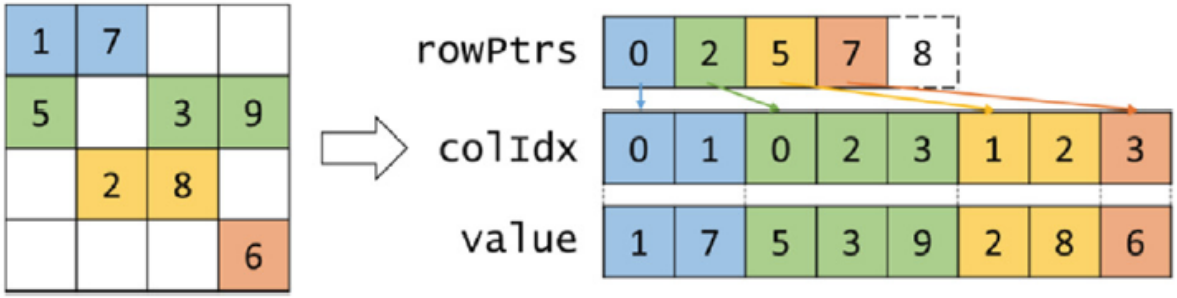

FIGURE 14.7

Example of compressed sparse row (CSR) format.

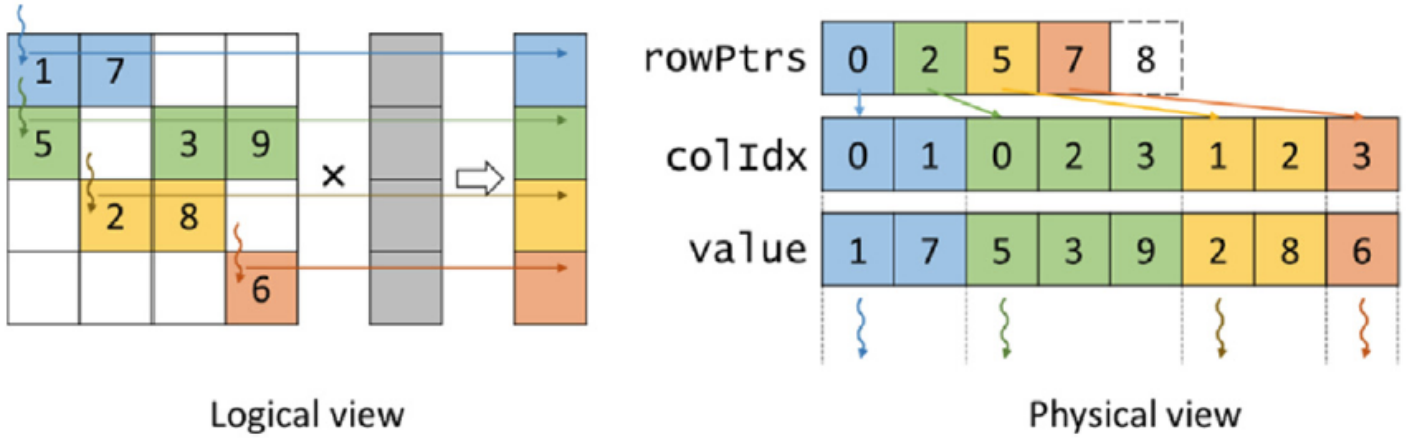

FIGURE 14.8

Example of parallelizing SpMV with the CSR format.

```
01  __global__ void spmv_csr_kernel(CSRMatrix csrMatrix, float* x, float* y) {
02     unsigned int row = blockIdx.x*blockDim.x + threadIdx.x;
03     if(row < csrMatrix.numRows) {
04       float sum = 0.0f;
05       for(unsigned int i=csrMatrix.rowPtrs[row]; i<csrMatrix.rowPtrs[row+1];
06                                                                    ++i) {
07          unsigned int col = csrMatrix.colIdx[i];
08          float value = csrMatrix.value[i];
09          sum += x[col]*value;
10       }
11       y[row] += sum;
12     }
13  }
```

FIGURE 14.9

A parallel SpMV/CSR kernel.

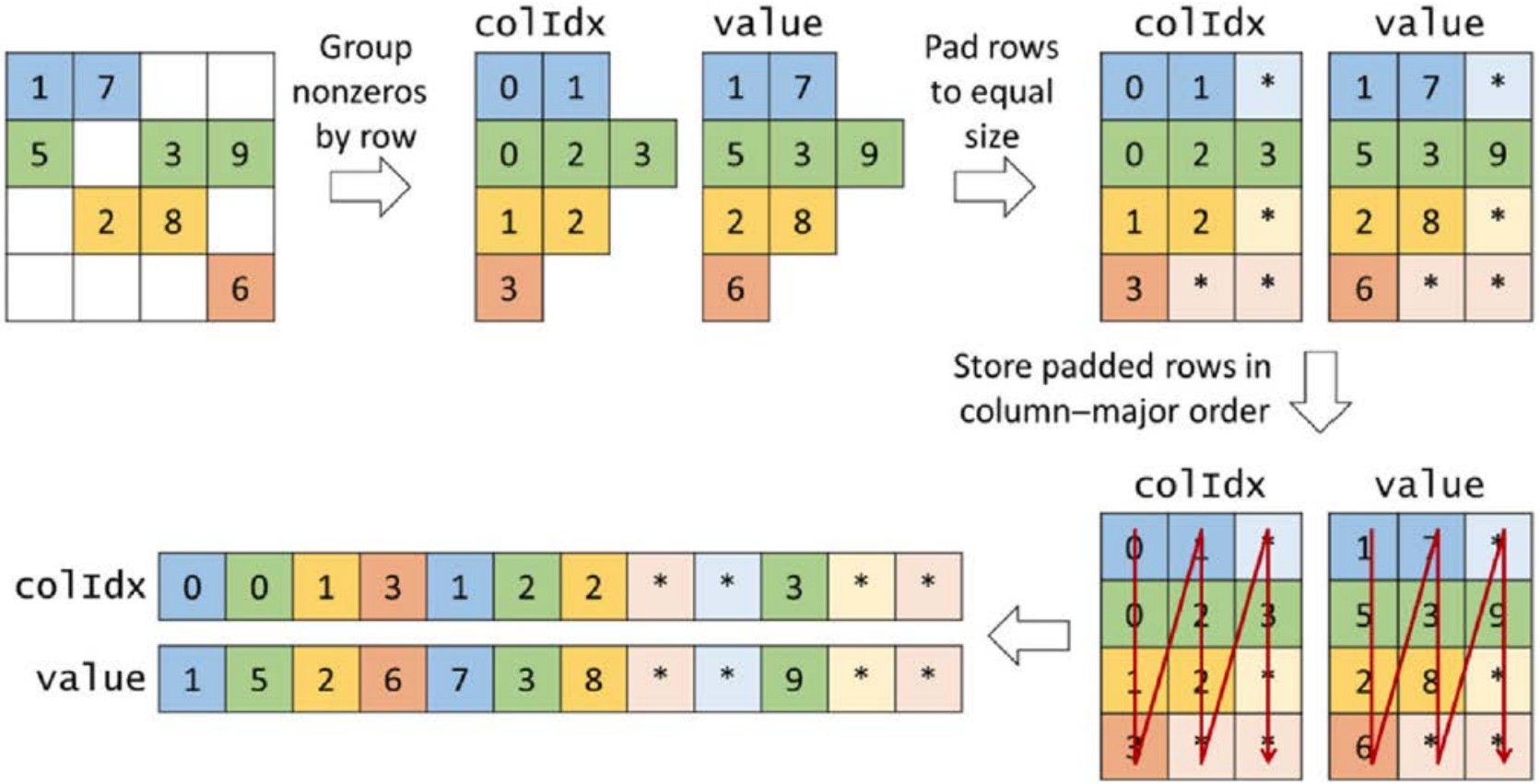

FIGURE 14.10

Example of ELL storage format.

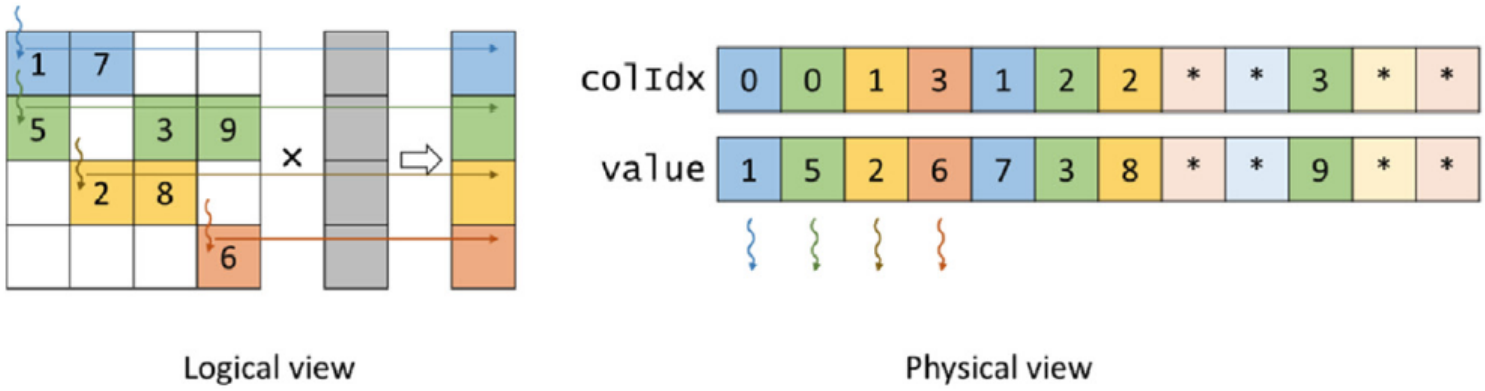

FIGURE 14.11

Example of parallelizing SpMV with the ELL format.

```
01    __global__ void spmv_ell_kernel(ELLMatrix ellMatrix, float* x, float* y) {
02        unsigned int row = blockIdx.x*blockDim.x + threadIdx.x;
03        if(row < ellMatrix.numRows) {
04            float sum = 0.0f;
05            for(unsigned int t = 0; t < ellMatrix.nnzPerRow[row]; ++t) {
06                unsigned int i = t*ellMatrix.numRows + row;
07                unsigned int col = ellMatrix.colIdx[i];
08                float value = ellMatrix.value[i];
09                sum += x[col]*value;
10            }
11            y[row] = sum;
12        }
13    }
```

FIGURE 14.12

A parallel SpMV/ELL kernel.

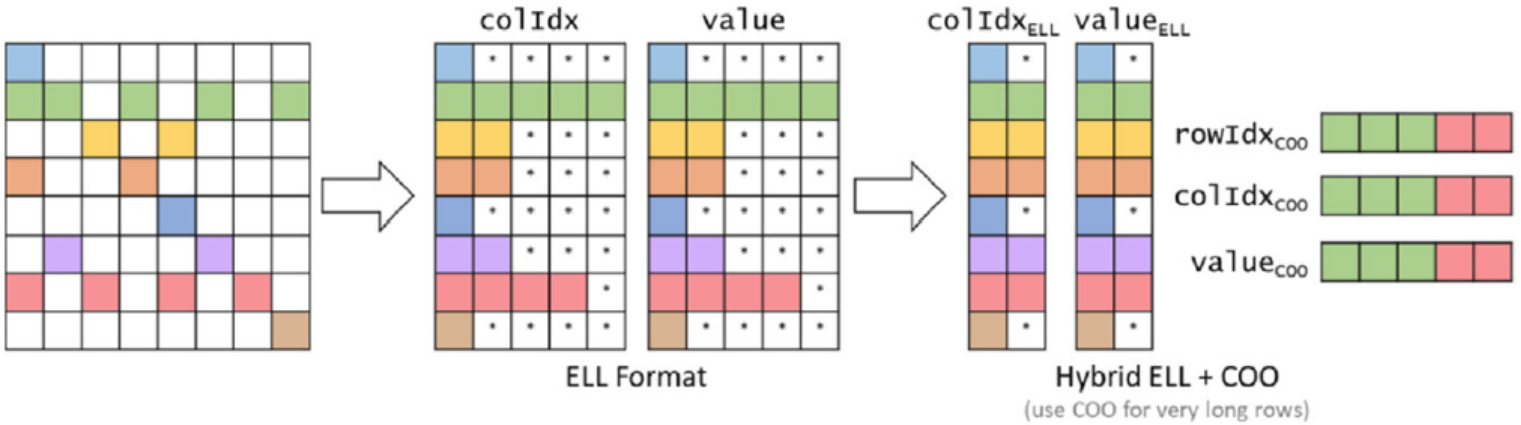

FIGURE 14.13

Hybrid ELL-COO example.

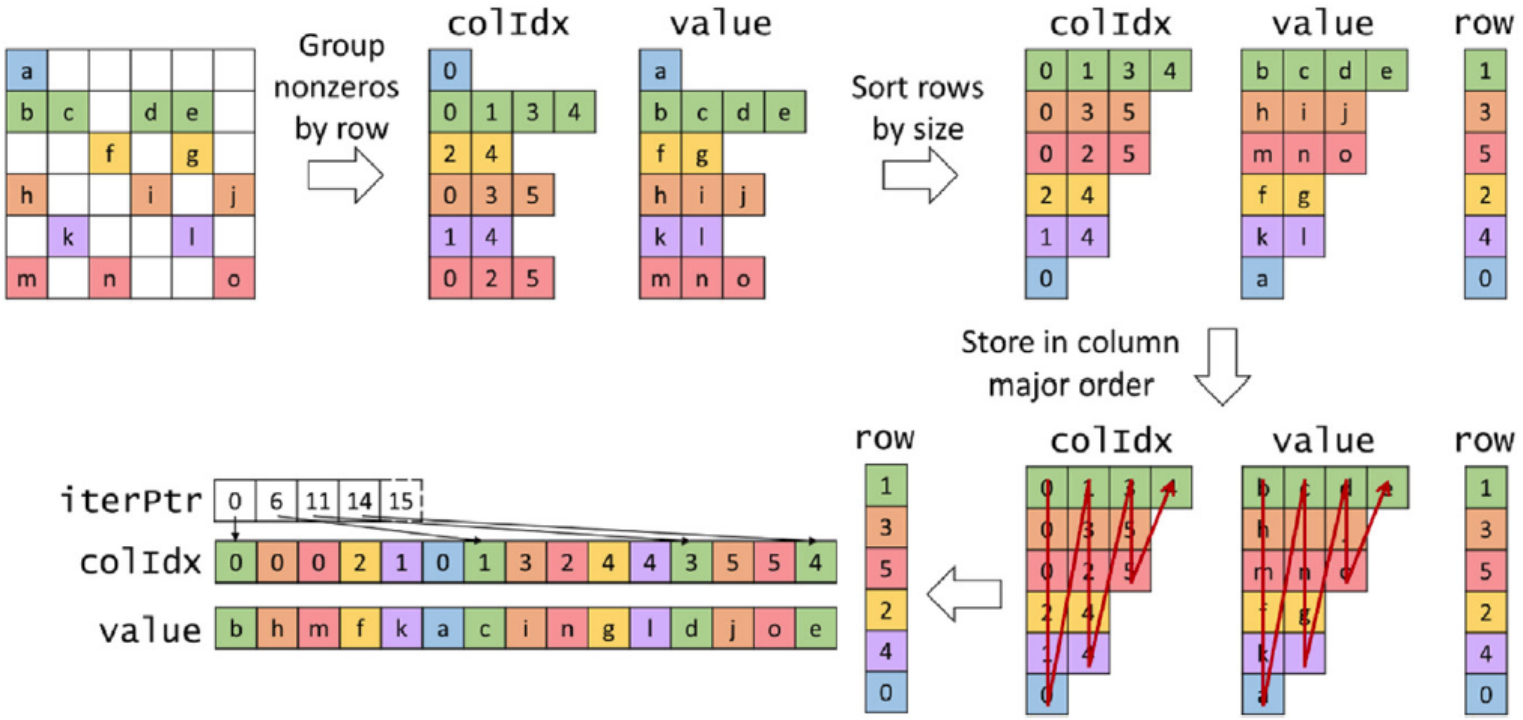

FIGURE 14.14

Example of JDS storage format.

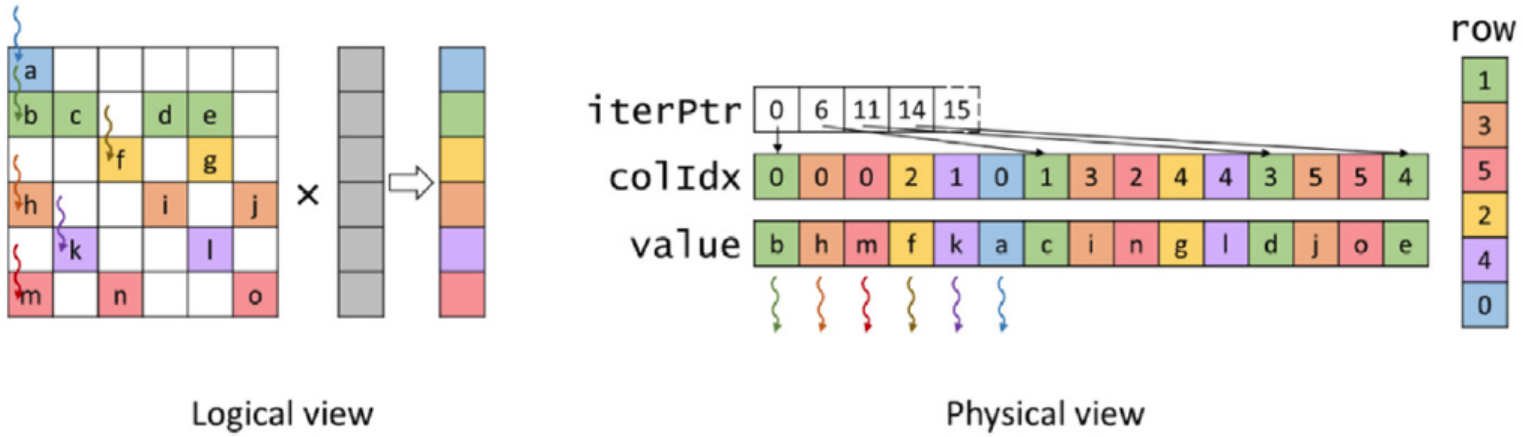

FIGURE 14.15

Example of parallelizing SpMV with the JDS format.

```
i = t*ellMatrix.numRows + row
```

In-text figure 1

```
row = i%ellMatrix.numRows
```

In-text figure 2