Sparse Matrices in Coordinate Format (COO)

→ Save position & value of non-zero entries

global variables

- # rows (1 int)
- # cols (1 int)
- # non-zero (nnz) (1 int)

values

- i-coordinate (nnz int)
- j-coordinate (nnz int)
- values (nnz doubles)

Example

$$\underline{\underline{A}} = \begin{bmatrix} 2 & 0 & 0 & 2 & 0 \\ 3 & 4 & 2 & 5 & 0 \\ 5 & 0 & 0 & 8 & 17 \\ 0 & 0 & 10 & 16 & 0 \\ 0 & 0 & 0 & 0 & 14 \end{bmatrix}$$

5 rows, 5 cols

→ 12 nnz

nnz_id	0	1	2	3	4	5	....	11	
i	0	0	1	1	1	1	...		I
j	0	3	0	1	2	3	...		J
value	2	2	3	4	2	5	...		V

Matrix-Vector Product

$$\underline{\underline{A}}\,\underline{b} = \underline{c}$$

Dense

```
for i=0:n_rows
    c[i] = 0
    for j=0:n_cols
        c[i] = c[i] + A[i,j] * b[j]
    end
end
```

Coordinate sparse

```
for i = 0: n_rows
    c[i] = 0
end
for nnz_id = 0: nnz
    i = I[nnz_id]
    j = J[nnz_id]
    v = V[nnz_id]
    c[i] = c[i] + v * b[j]
end
```