Sparse Matrices with Linked Lists

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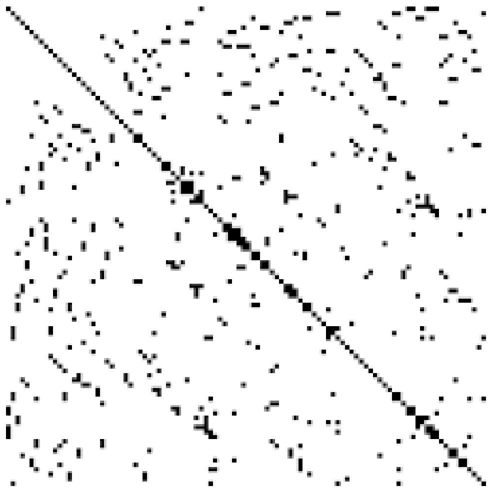
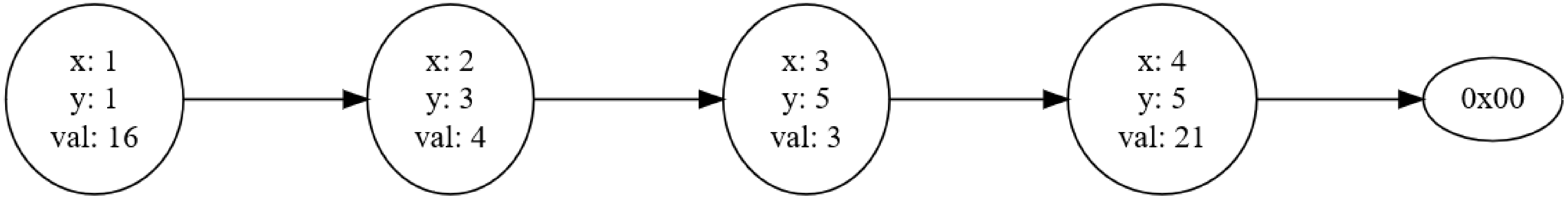
Sparse Matrices

- Matrices where most of the elements are 0
- Has many applications such as machine learning
- Often these matrices are very large and very few nonzero values



Linked Lists

- A list of nodes linked together by pointers.
- Contains data field and pointer.



Linked Lists vs Arrays

- Inserting elements in linked lists do not shift the other elements
- To access node in middle of list, the list needs to be traversed from the first node
- Array are static and linked lists are dynamically sized

Use of Linked Lists

- Stacks and queues, no need to remove elements from middle
- Photo library apps, each photo is linked to the next.
- Music apps, going though playlist.

Use of sparse matrices

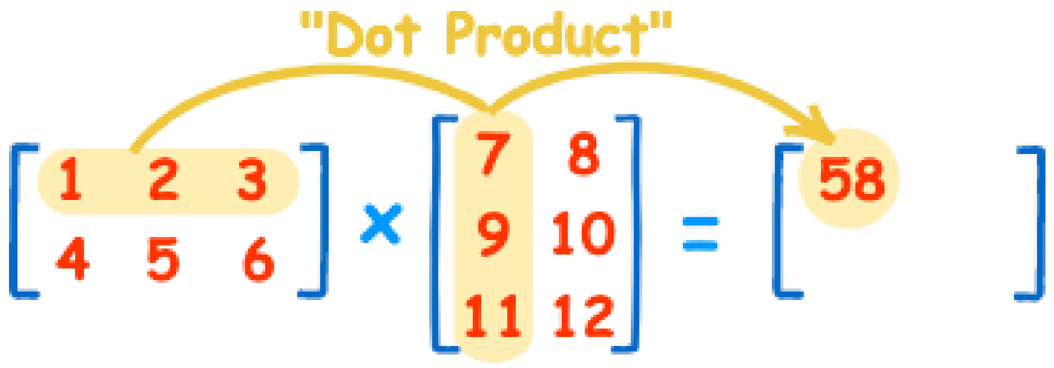
- Machine learning using large datasets
- Finding word count in a document
- Teams facing each other in soccer world cup

Append node

- Uses temp pointer that starts at head of list
- Then adds x, y and value fields to object.
- Goes through linked list with temp->next until it equals null.

Matrix multiplication

- Uses dot product method
- Columns of matrix 1 must equal rows of matrix 2
- Creates a matrix that has the rows of the first matrix and columns of the second matrix



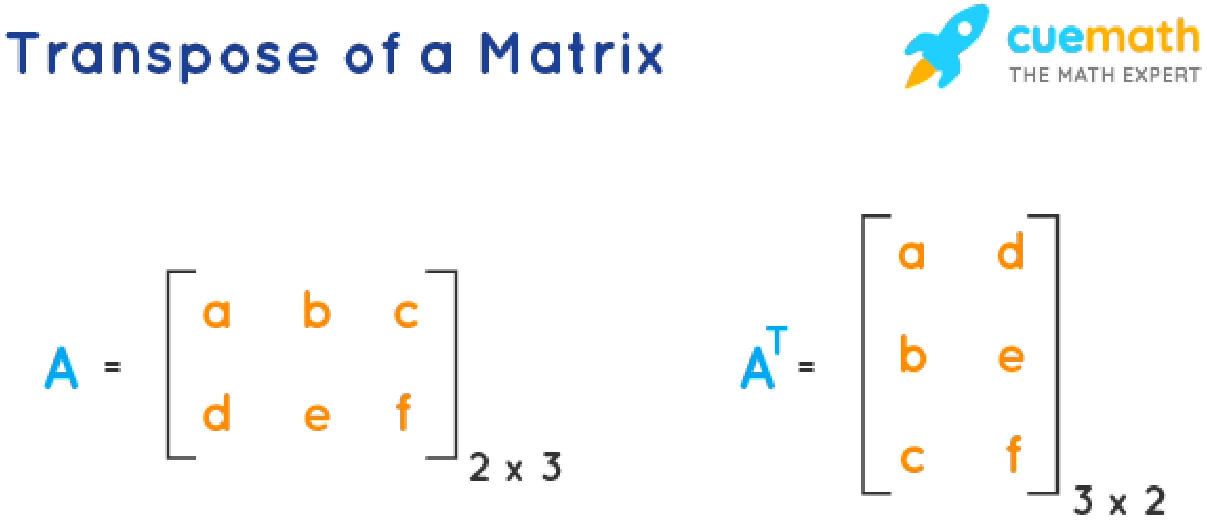
Matrix Addition

- Adds the corresponding element of the matrices
- Function searches for values of the same coordinates and adds them.

$$\begin{bmatrix} 4 & 8 \\ 3 & 7 \end{bmatrix} + \begin{bmatrix} 1 & 0 \\ 5 & 2 \end{bmatrix} = \begin{bmatrix} 4+1 & 8+0 \\ 3+5 & 7+2 \end{bmatrix}$$

Transpose

- Takes the i^{th} row and makes it the j^{th} column.
- Swaps x and y coordinates in linked list for the same value
- Node is then appended for new object



Scalar

- Every value of node is multiplied by scalar.
- Traverses through list and appends x, y and new value fields to new object

$$2 \cdot \begin{bmatrix} 10 & 6 \\ 4 & 3 \end{bmatrix} = \begin{bmatrix} 2 \cdot 10 & 2 \cdot 6 \\ 2 \cdot 4 & 2 \cdot 3 \end{bmatrix}$$

Code Demonstration

Sources

- https://www.mathsisfun.com/algebra/matrix-multiplying.html
- https://www.khanacademy.org/math/precalculus/x9e81a4f98389efdf:matrices/x9e81a4f98389efdf:adding-and-subtracting-matrices/a/adding-and-subtracting-matrices
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