

Linked List

Equivalence Relations, Sparse Matrices & Doubly Linked Lists

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Outline

- 1 Equivalence Relations
- 2 Sparse Matrices Revisted
- 3 Doubly Linked Lists

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1 Equivalence Relations

2 Sparse Matrices Revisted

3 Doubly Linked Lists

Equivalence Relation

A relation over a set S is said to be an **equivalence relation** over S iff it is symmetric, reflexive, and transitive over S .

- reflexive: $x \equiv x$ for each $x \in S$.
- symmetric: for $x, y \in S$, if $x \equiv y$, then $y \equiv x$.
- transitive: for x, y, z , if $x \equiv y$ and $y \equiv z$, then $x \equiv z$.

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Example

Given $0 \equiv 4, 3 \equiv 1, 6 \equiv 10, 8 \equiv 9, 7 \equiv 4, 6 \equiv 8, 3 \equiv 5, 2 \equiv 11, 11 \equiv 1$.

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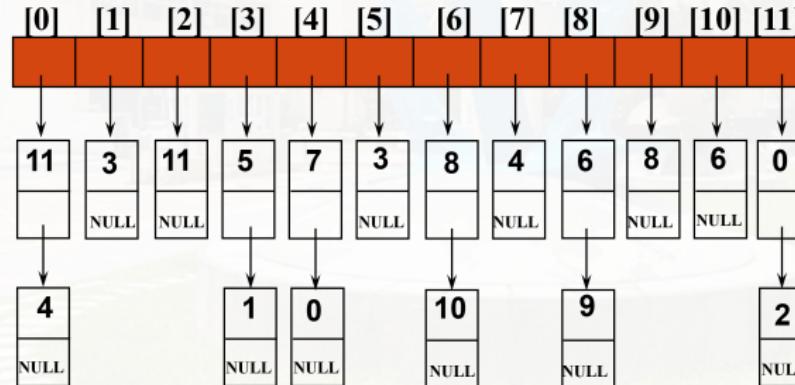
We have three equivalent classes:

$$\{0, 2, 4, 7, 11\}, \{1, 3, 5\}, \{6, 8, 9, 10\}.$$

Lists after Giving Pairs as the Input

$0 \equiv 4, 3 \equiv 1, 6 \equiv 10, 8 \equiv 9, 7 \equiv 4,$
 $6 \equiv 8, 3 \equiv 5, 2 \equiv 11, 11 \equiv 0.$

```
typedef struct node *nodePointer;
typedef struct node {
    int data;
    nodePointer link;
};
```



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Issues for Previous Representation

- When we performed matrix operations such as $+$, $-$, or $*$, the number of **nonzero terms** varied.
- The sequential representation of sparse matrices suffered from the same inadequacies as the similar representation of polynomials.

Solution:

- Linked list representation for sparse matrices.

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Solution:

- Linked list representation for sparse matrices.
- Two types of nodes in the representation: **header nodes** and **element nodes**.

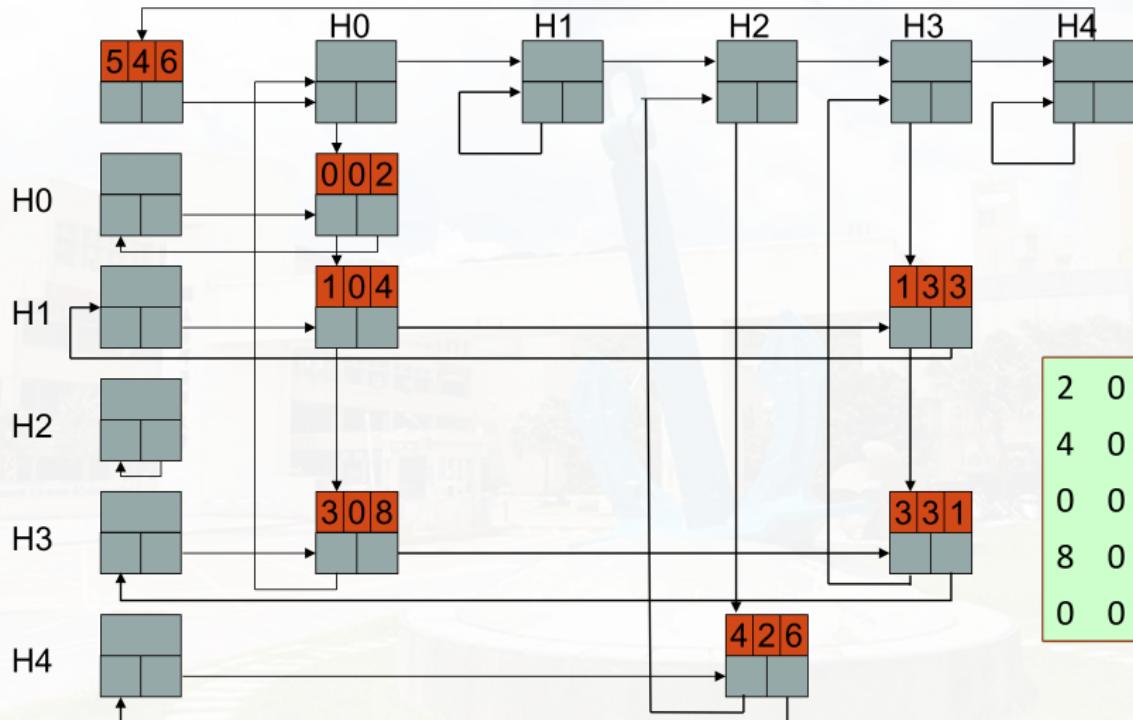
next	
down	right

header node

row	col	value
down	right	

element node





Sparse Matrix Representation

- We represent each column (row) of a sparse matrix as a circularly linked list with a header node.
- The header node for row i is also the header node for column i . The number of header nodes is $\max\{\text{numRows}, \text{numCols}\}$.
- Each element node is **simultaneously** linked into two lists: a **row** list, and a **column** list.
- Each head node is belonged to three lists: a **row** list, a **column** list, and a **header node** list.

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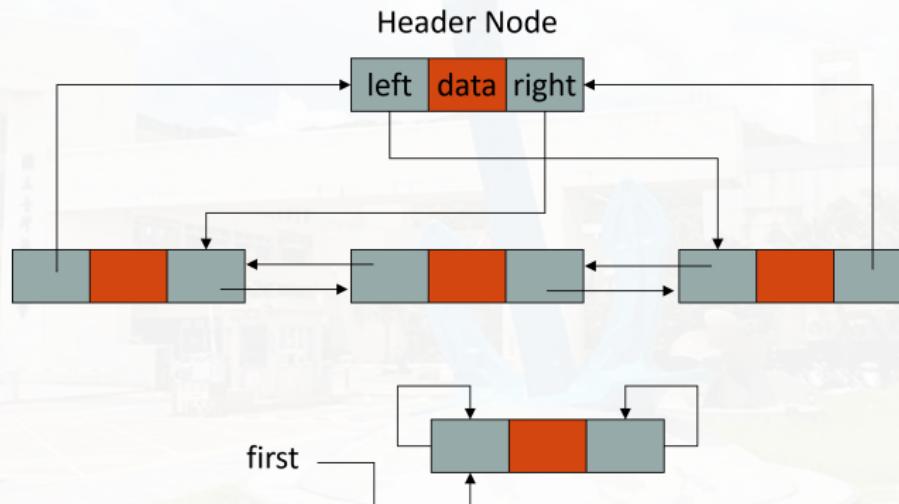
Issues for Singly Linked Lists

- The only way to find the node that precedes some node p is to start at the beginning of the list.
- Sometimes it is necessary to move in either direction.

Doubly linked lists:

```
typedef struct node *nodePointer;
typedef struct node {
    nodePointer llink;
    element data;
    nodePointer rlink;
};
```

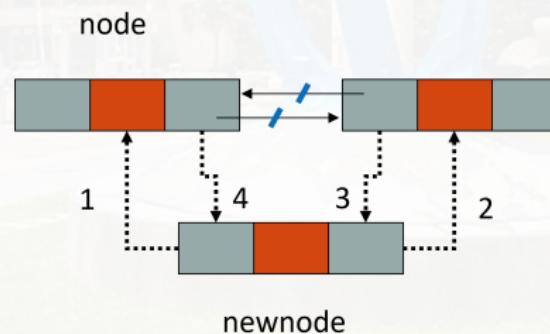
```
ptr = ptr->llink->rlink = ptr->rlink->llink
```



Empty doubly linked circular list with header node

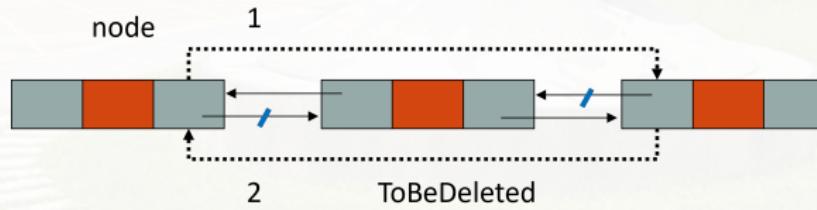
Insertion into a doubly linked circular List

```
void d_LCL_insert(nodePointer node, nodePointer newnode) {  
    /* insert newnode to the right of node */  
    newnode->llink = node;          // 1  
    newnode->rlink = node->rlink;   // 2  
    node->rlink->llink = newnode;   // 3  
    node->rlink = newnode;          // 4  
}
```



Deletion from a doubly linked circular List

```
void d_LCL_delete(nodePointer node, nodePointer ToBeDeleted) {  
    /* delete from the doubly linked list */  
    if (node == ToBeDeleted)  
        printf("Deletion of header node not permitted.\n");  
    else {  
        ToBeDeleted->llink->rlink = ToBeDeleted->rlink; // 1  
        ToBeDeleted->rlink->llink = ToBeDeleted->llink; // 2  
        free(ToBeDeleted);  
    }  
}
```



Discussions

