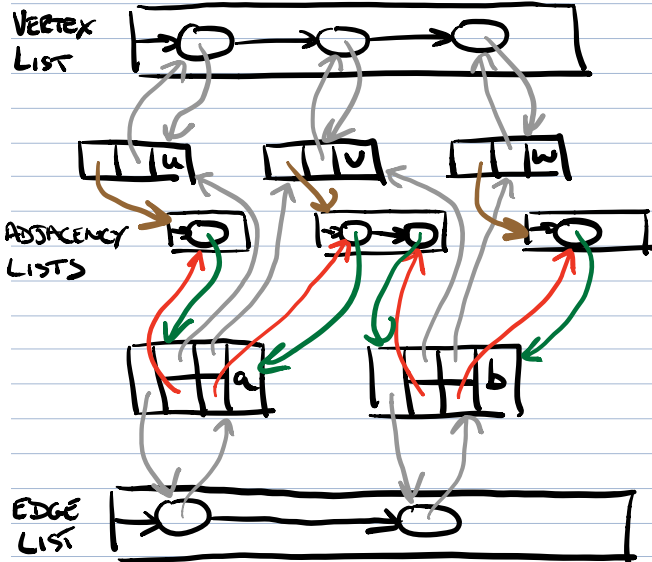




$n$  VERTICES  
 $m$  EDGES

- SAME AS FOR EDGE LIST
- REFERENCE TO LIST NODE
- REFERENCE TO EDGE
- REFERENCE TO LINKED LIST (ADJACENCY LIST)



### SPACE

VERTICES  $n$  VERTEX OBJECTS  
+  $n$  NODES IN VERTEX LIST  
 $O(n)$

EDGES  $m$  EDGE OBJECTS  
+  $m$  NODES IN EDGE LIST  
+  $2m$  NODES IN ADJACENCY LISTS  
 $O(m)$

OVERALL  $O(m+n)$

INSERT VERTEX  
SAME AS BEFORE  $O(1)$

### INSERT EDGE

1. CREATE EDGE OBJECT
2. INSERT INTO EDGE LIST AND STORE REFERENCE
3. INSERT INTO TWO ADJACENCY LISTS AND STORE REFERENCE  $O(1)$

### INCIDENT EDGES ( $v$ )

1. ITERATE THE ADJACENCY LIST OF THE VERTEX

$O(\deg(v))$   
ARE ADJACENT ( $v, w$ )

1. ITERATE THE SHORTER ADJACENCY LIST

2. CHECK IF THE EDGE CONNECTS  $v$  AND  $w$ .

$O(\min(\deg(v), \deg(w)))$

### REMOVE EDGE

1. REMOVE FROM 3 LISTS  
 $O(1)$  BECAUSE WE HAVE THE NODE REFERENCES

### REMOVE VERTEX ( $v$ )

1. REMOVE ALL INCIDENT EDGES  
 $O(1)$  operation performed  $O(\deg(v))$  times
2. REMOVE FROM VERTEX LIST  
 $O(1)$

OVERALL:  $O(\deg(v))$