

E	F	I	D	C	A	J	L	G	K	B	H
0	1	2	3	4	5	6	7	8	9	10	11
0	1	2	3	4	5	6	7	8	9	10	11

### Instructions:

Union(C,K)

Union(F,E)

Union(A,J)

Union(A,B)

Union(C,D)

Union(D,I)

Union(L,F)

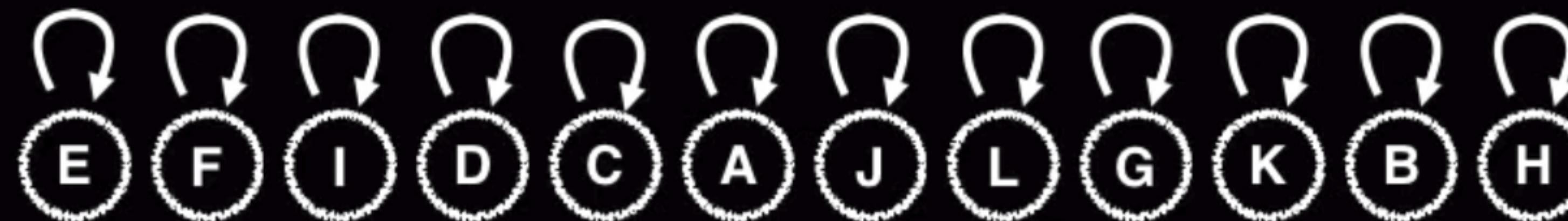
Union(C,A)

Union(A,B)

Union(H,G)

Union(H,F)

Union(H,B)



(This example does not use path compression)

E	F	I	D	C	A	J	L	G	K	B	H
0	1	2	3	4	5	6	7	8	4	10	11
0	1	2	3	4	5	6	7	8	9	10	11

## Instructions:

Union(C,K) ←

Union(F,E)

Union(A,J)

Union(A,B)

Union(C,D)

Union(D,I)

Union(L,F)

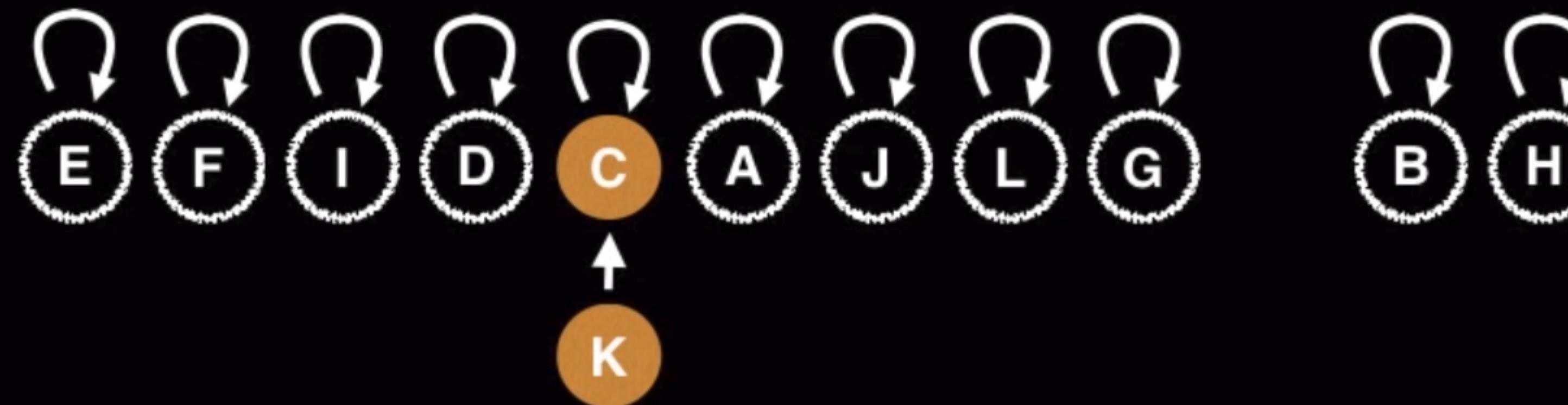
Union(C,A)

Union(A,B)

Union(H,G)

Union(H,F)

Union(H,B)



(This example does not use path compression)

E	F	I	D	C	A	J	L	G	K	B	H
0	0	2	3	4	5	6	7	8	4	10	11
0	1	2	3	4	5	6	7	8	9	10	11

## Instructions:

Union(C,K)

Union(F,E) ←

Union(A,J)

Union(A,B)

Union(C,D)

Union(D,I)

Union(L,F)

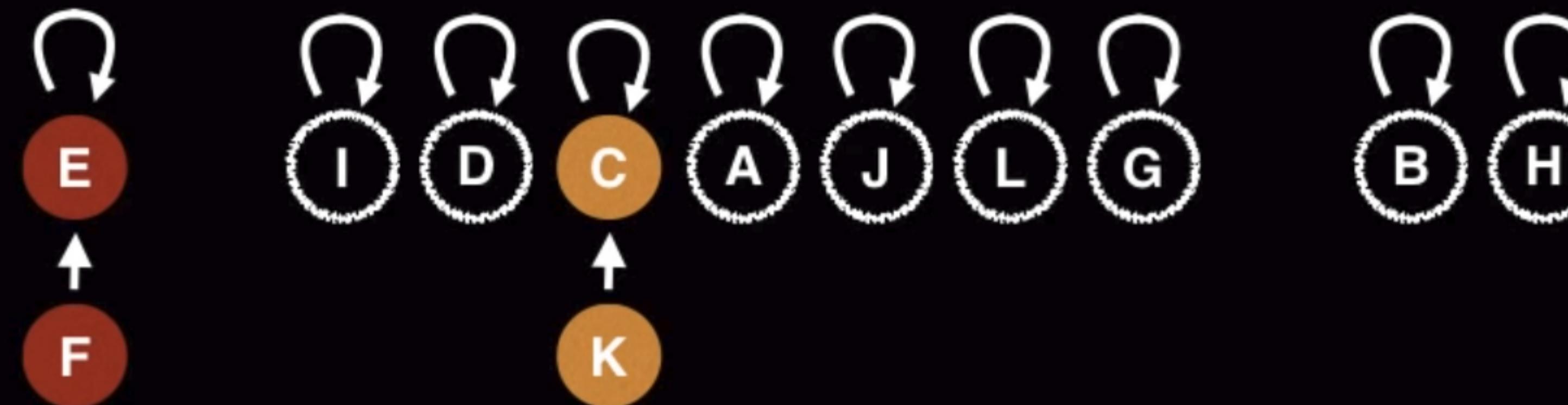
Union(C,A)

Union(A,B)

Union(H,G)

Union(H,F)

Union(H,B)



(This example does not use path compression)

E	F	I	D	C	A	J	L	G	K	B	H
0	0	2	3	4	6	6	7	8	4	10	11
0	1	2	3	4	5	6	7	8	9	10	11

## Instructions:

Union(C,K)

Union(F,E)

Union(A,J) ←

Union(A,B)

Union(C,D)

Union(D,I)

Union(L,F)

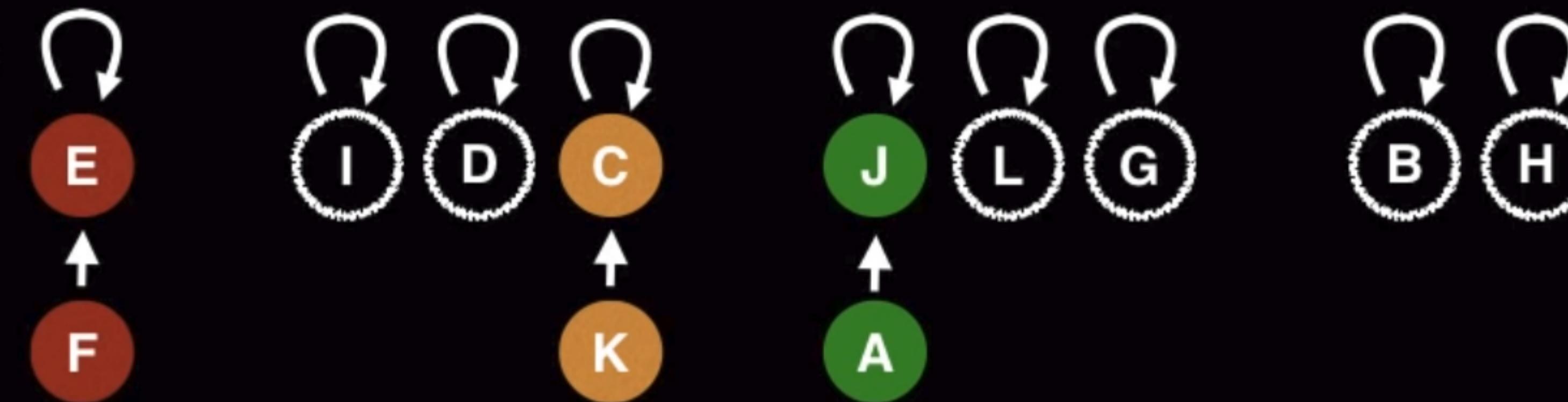
Union(C,A)

Union(A,B)

Union(H,G)

Union(H,F)

Union(H,B)



(This example does not use path compression)

E	F	I	D	C	A	J	L	G	K	B	H
0	0	2	3	4	6	6	7	8	4	6	11
0	1	2	3	4	5	6	7	8	9	10	11

## Instructions:

Union(C,K)

Union(F,E)

Union(A,J)

Union(A,B) ←



E

Union(C,D)



I



D



C



J



L



G



H

Union(D,I)



F

Union(L,F)



K

Union(C,A)



A

Union(A,B)



B

Union(H,G)

(This example does not use path compression)

E	F	I	D	C	A	J	L	G	K	B	H
0	0	2	4	4	6	6	7	8	4	6	11
0	1	2	3	4	5	6	7	8	9	10	11

## Instructions:

Union(C,K)

Union(F,E)

Union(A,J)

Union(A,B)

Union(C,D) ←

Union(D,I)

Union(L,F)

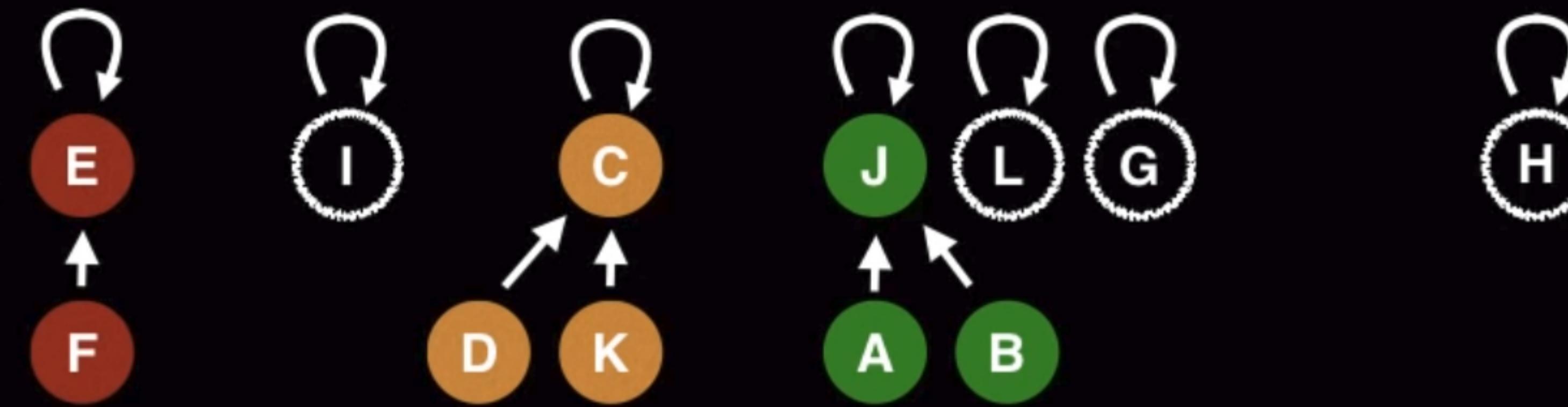
Union(C,A)

Union(A,B)

Union(H,G)

Union(H,F)

Union(H,B)



(This example does not use path compression)

E	F	I	D	C	A	J	L	G	K	B	H
0	0	4	4	4	6	6	7	8	4	6	11
0	1	2	3	4	5	6	7	8	9	10	11

## Instructions:

Union(C,K)

Union(F,E)

Union(A,J)

Union(A,B)

Union(C,D)

Union(D,I) ←

Union(L,F)

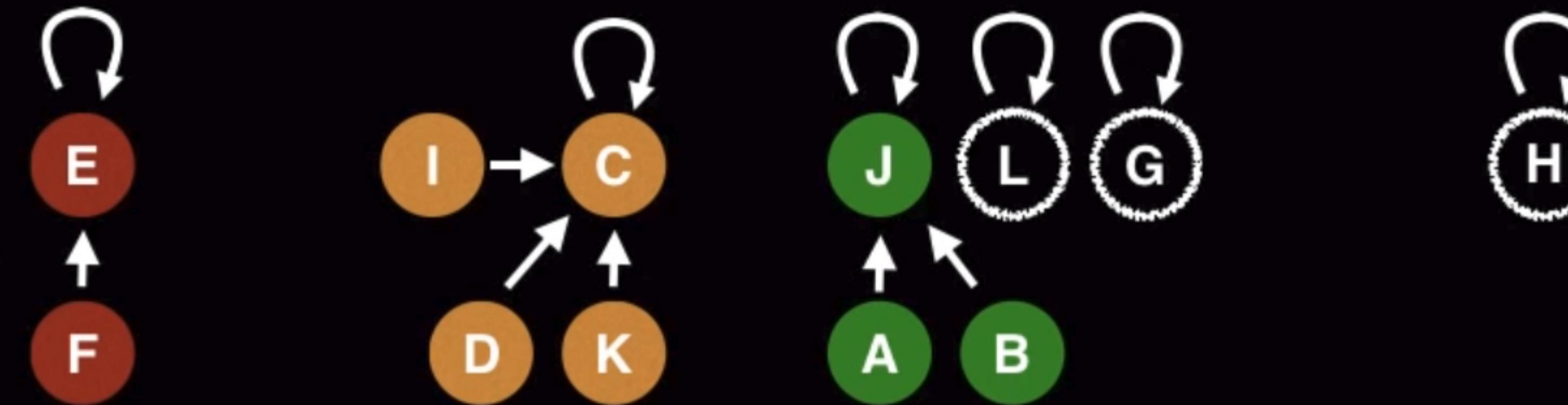
Union(C,A)

Union(A,B)

Union(H,G)

Union(H,F)

Union(H,B)



(This example does not use path compression)

E	F	I	D	C	A	J	L	G	K	B	H
0	0	4	4	4	6	6	0	8	4	6	11
0	1	2	3	4	5	6	7	8	9	10	11

## Instructions:

Union(C,K)

Union(F,E)

Union(A,J)

Union(A,B)

Union(C,D)

Union(D,I)

Union(L,F) ←

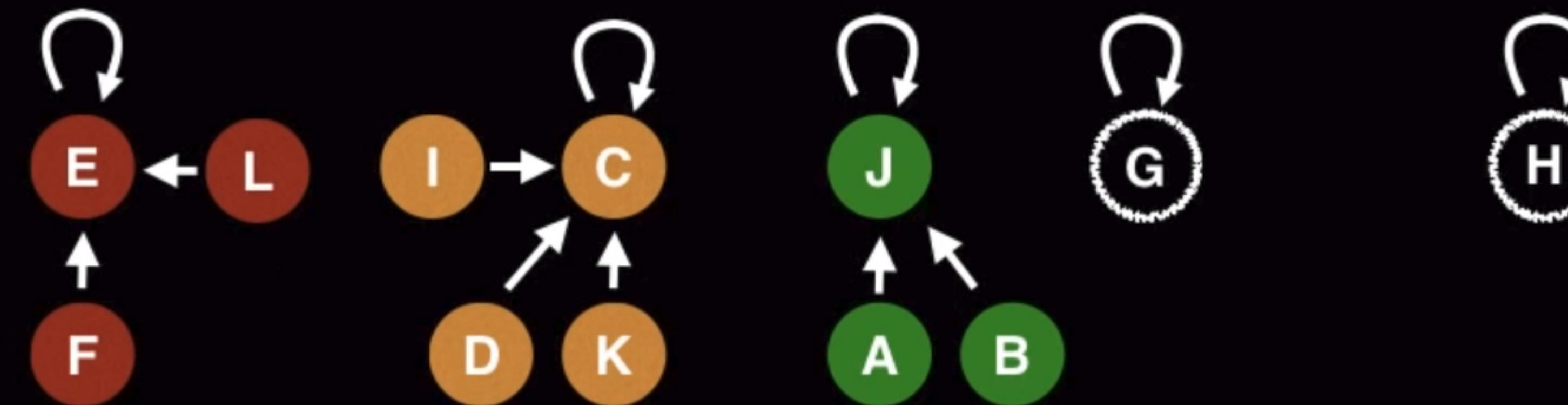
Union(C,A)

Union(A,B)

Union(H,G)

Union(H,F)

Union(H,B)



(This example does not use path compression)

E	F	I	D	C	A	J	L	G	K	B	H
0	0	4	4	4	6	4	0	8	4	6	11
0	1	2	3	4	5	6	7	8	9	10	11

## Instructions:

Union(C,K)

Union(F,E)

Union(A,J)

Union(A,B)

Union(C,D)

Union(D,I)

Union(L,F)

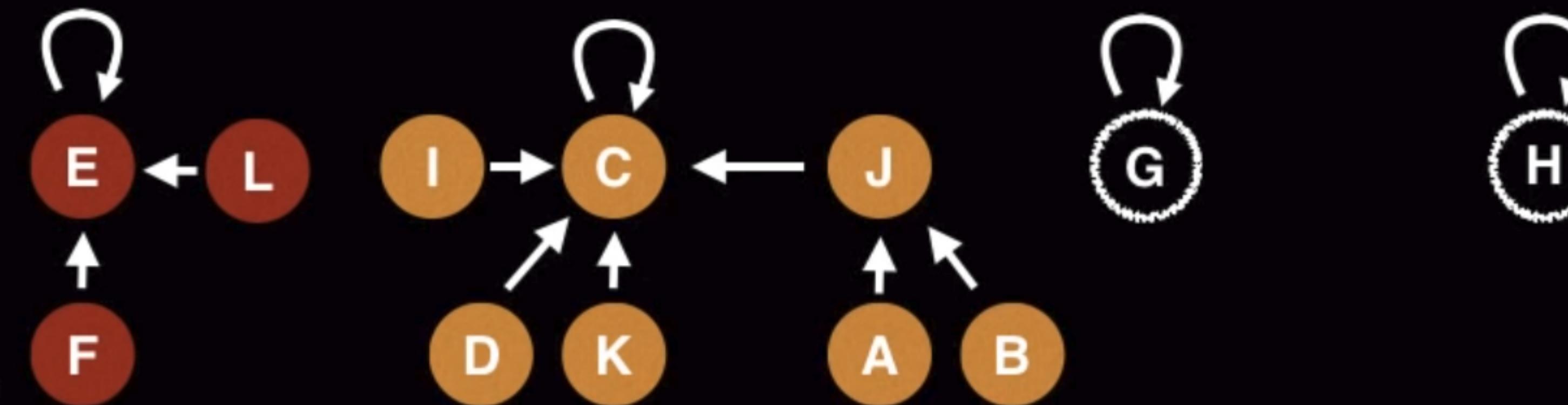
Union(C,A) ←

Union(A,B)

Union(H,G)

Union(H,F)

Union(H,B)



(This example does not use path compression)

E	F	I	D	C	A	J	L	G	K	B	H
0	0	4	4	4	6	4	0	8	4	6	11
0	1	2	3	4	5	6	7	8	9	10	11

## Instructions:

Union(C,K)

Union(F,E)

Union(A,J)

Union(A,B)

Union(C,D)

Union(D,I)

Union(L,F)

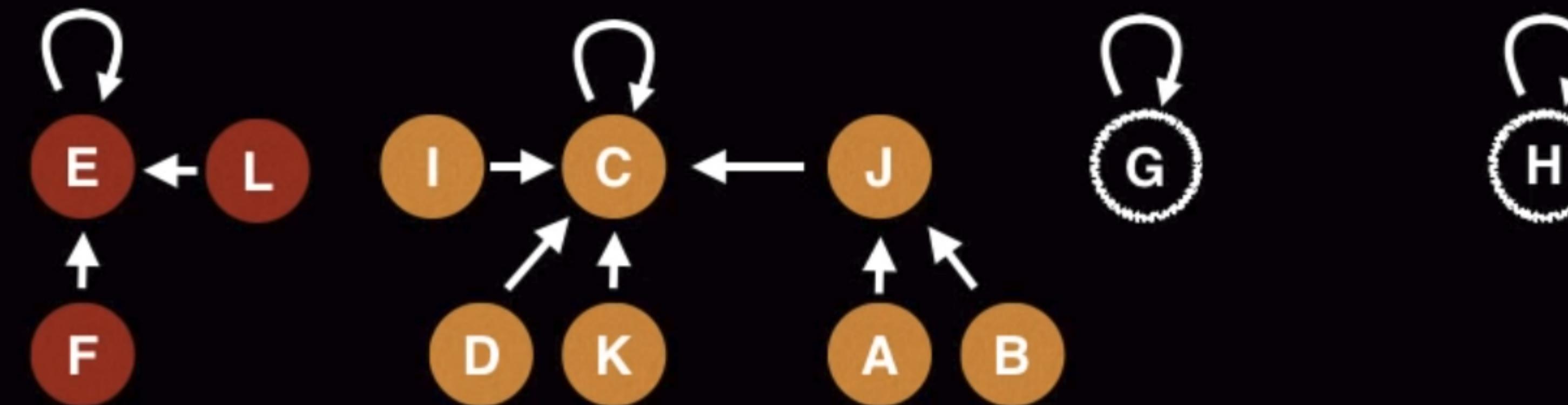
Union(C,A)

Union(A,B) ←

Union(H,G)

Union(H,F)

Union(H,B)



(This example does not use path compression)

E	F	I	D	C	A	J	L	G	K	B	H
0	0	4	4	4	6	4	0	8	4	6	8
0	1	2	3	4	5	6	7	8	9	10	11

## Instructions:

Union(C,K)

Union(F,E)

Union(A,J)

Union(A,B)

Union(C,D)

Union(D,I)

Union(L,F)

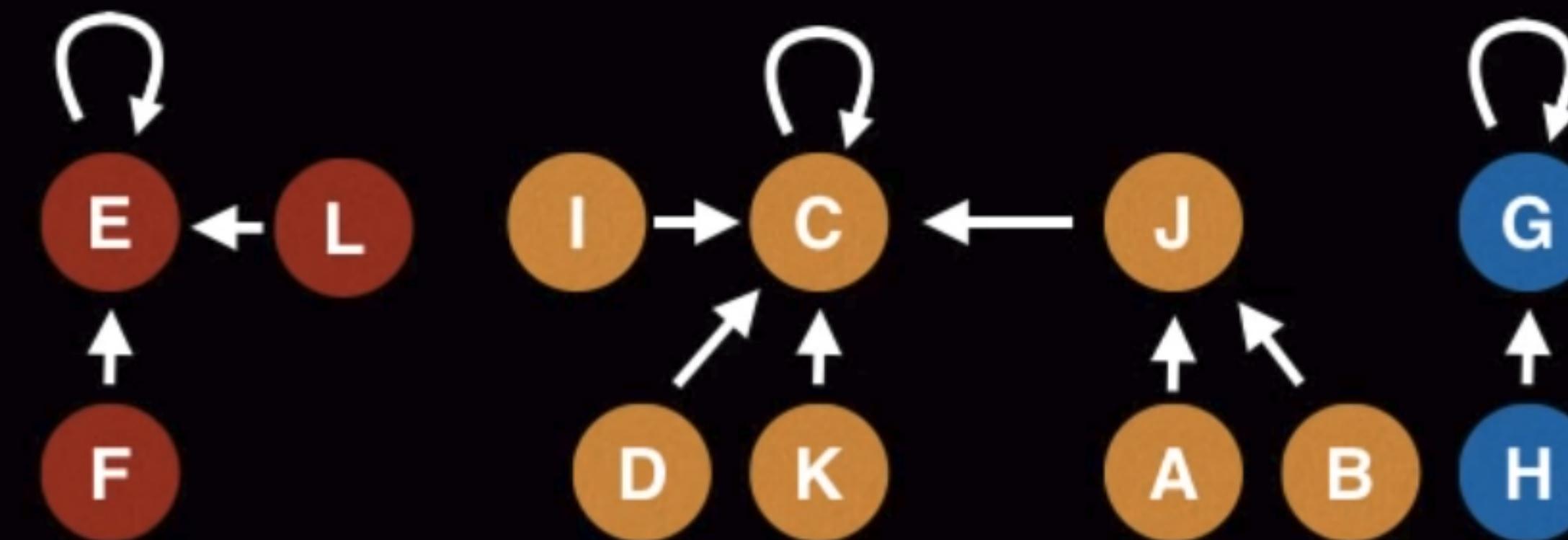
Union(C,A)

Union(A,B)

Union(H,G) ←

Union(H,F)

Union(H,B)



(This example does not use path compression)

E	F	I	D	C	A	J	L	G	K	B	H
0	0	4	4	4	6	4	0	0	4	6	8
0	1	2	3	4	5	6	7	8	9	10	11

## Instructions:

Union(C,K)

Union(F,E)

Union(A,J)

Union(A,B)

Union(C,D)

Union(D,I)

Union(L,F)

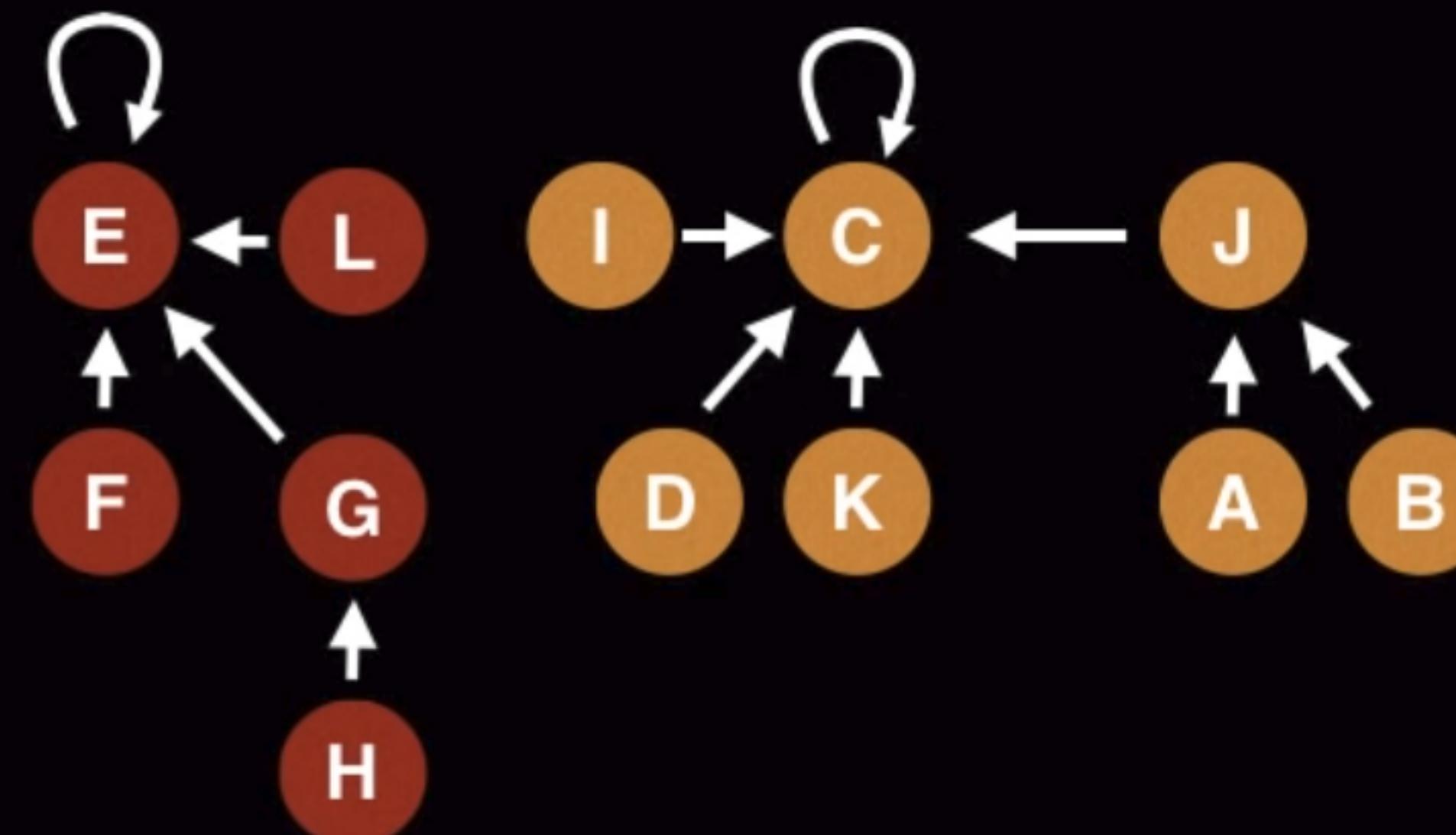
Union(C,A)

Union(A,B)

Union(H,G)

Union(H,F) ←

Union(H,B)

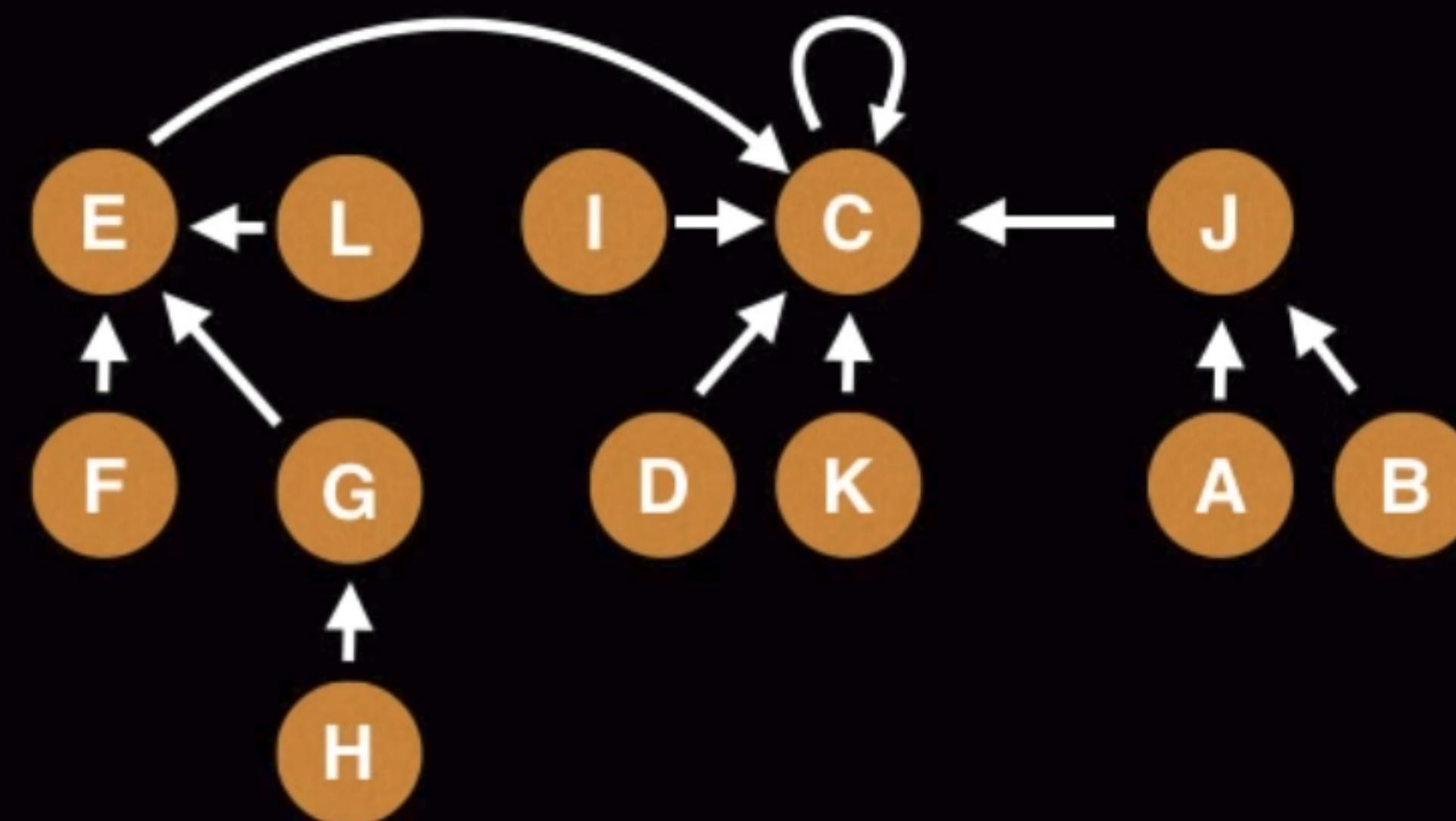


(This example does not use path compression)

E	F	I	D	C	A	J	L	G	K	B	H
4	0	4	4	4	6	4	0	0	4	6	8
0	1	2	3	4	5	6	7	8	9	10	11

## Instructions:

Union(C,K)  
 Union(F,E)  
 Union(A,J)  
 Union(A,B)  
 Union(C,D)  
 Union(D,I)  
 Union(L,F)  
 Union(C,A)  
 Union(A,B)  
 Union(H,G)  
 Union(H,F)  
 Union(H,B) ←



(This example does not use path compression)

# Summary

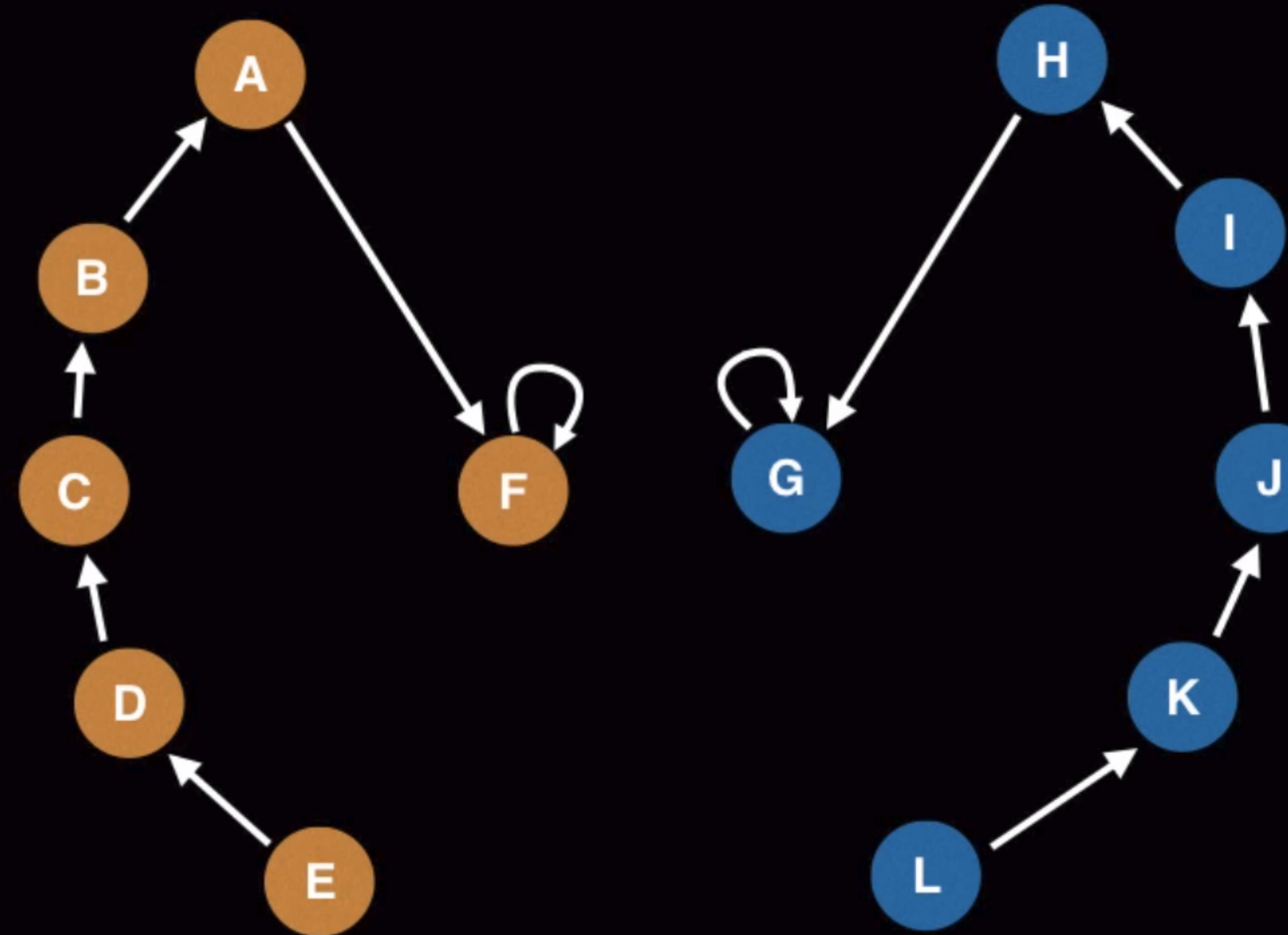
## Find Operation

To **find** which component a particular element belongs to find the root of that component by following the parent nodes until a self loop is reached (a node who's parent is itself)

## Union Operation

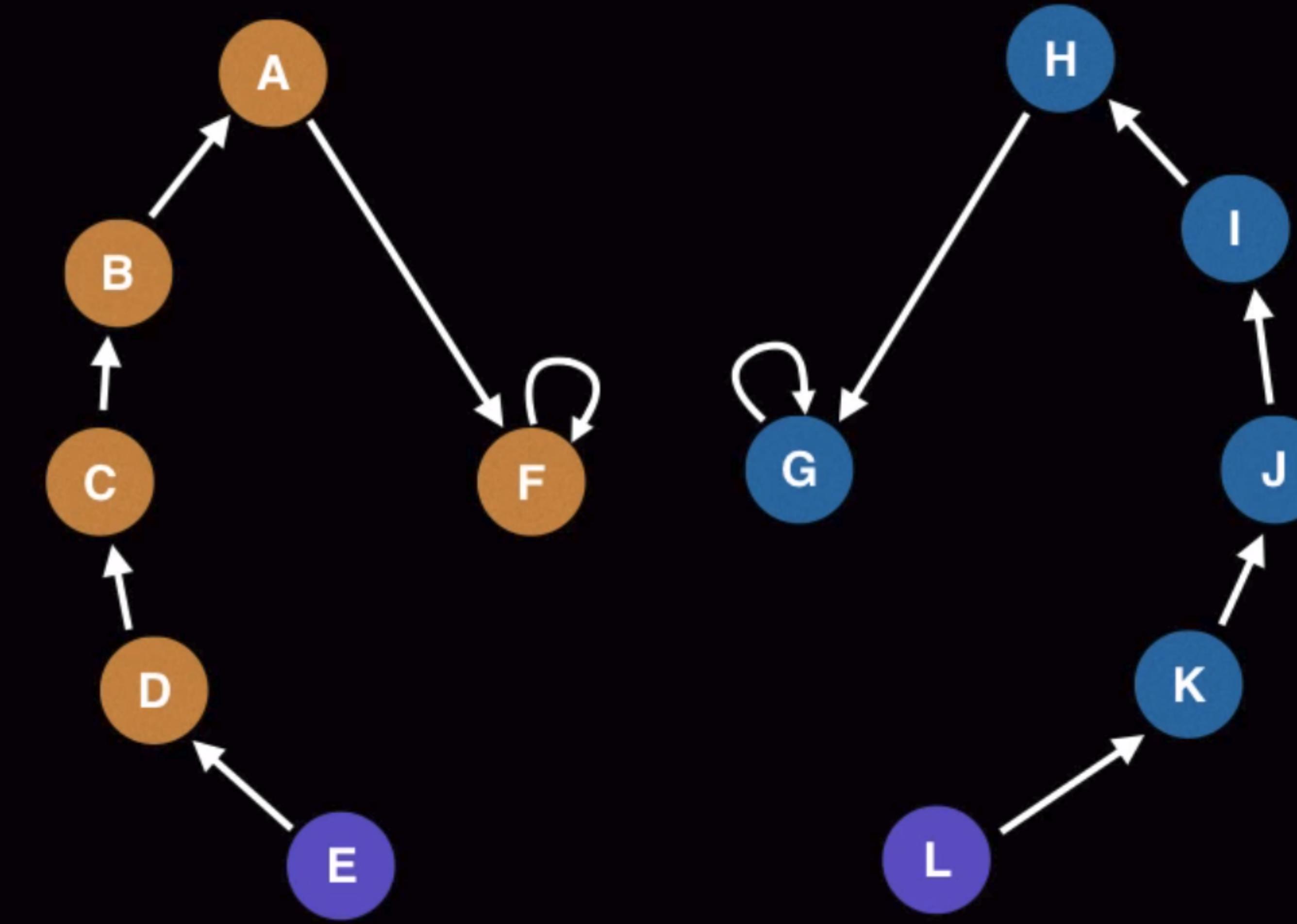
To **unify** two elements find which are the root nodes of each component and if the root nodes are different make one of the root nodes be the parent of the other.

# Hypothetical Union Find path compression example



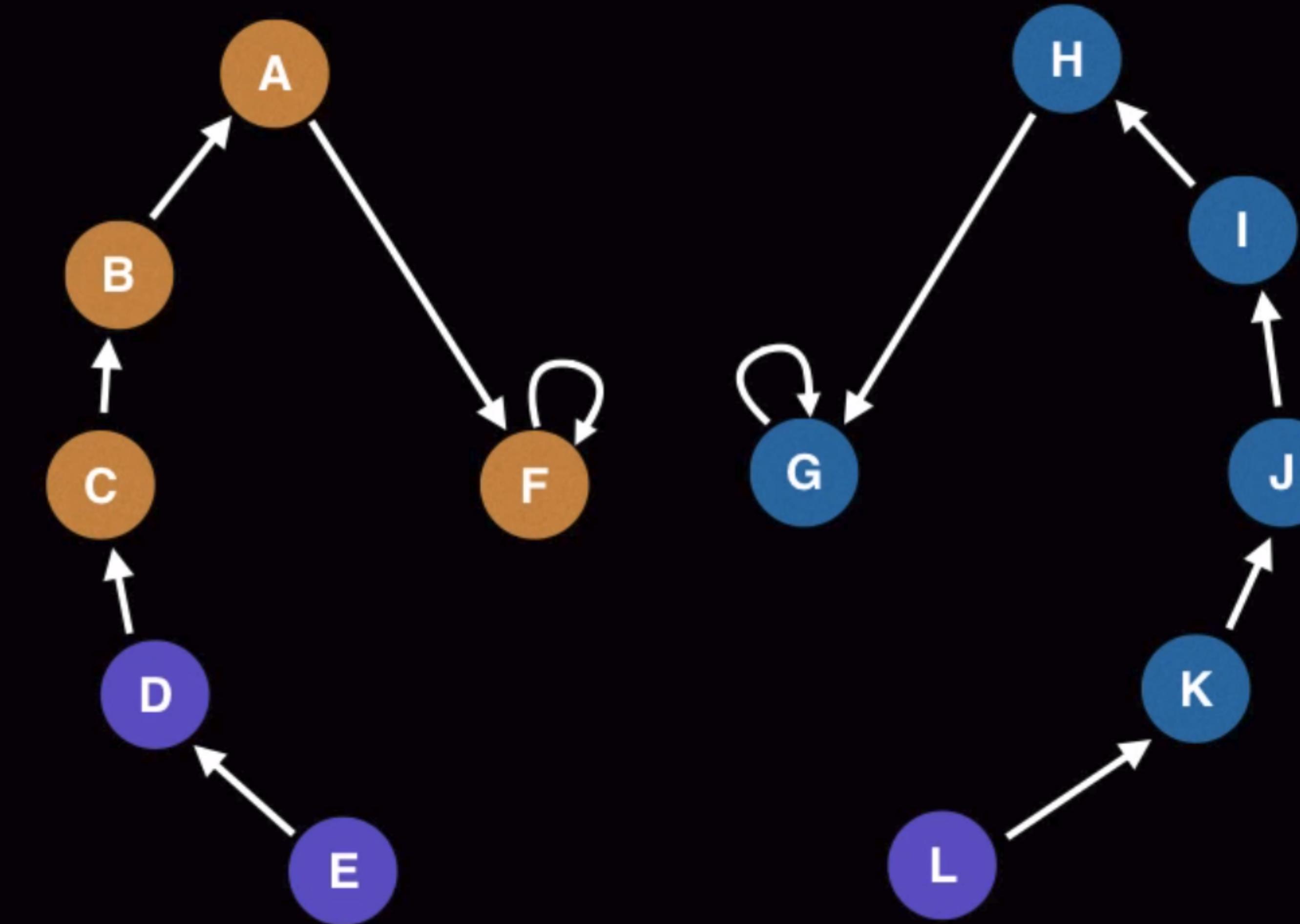
Operation: Take the union of **E** and **L**

# Hypothetical Union Find path compression example



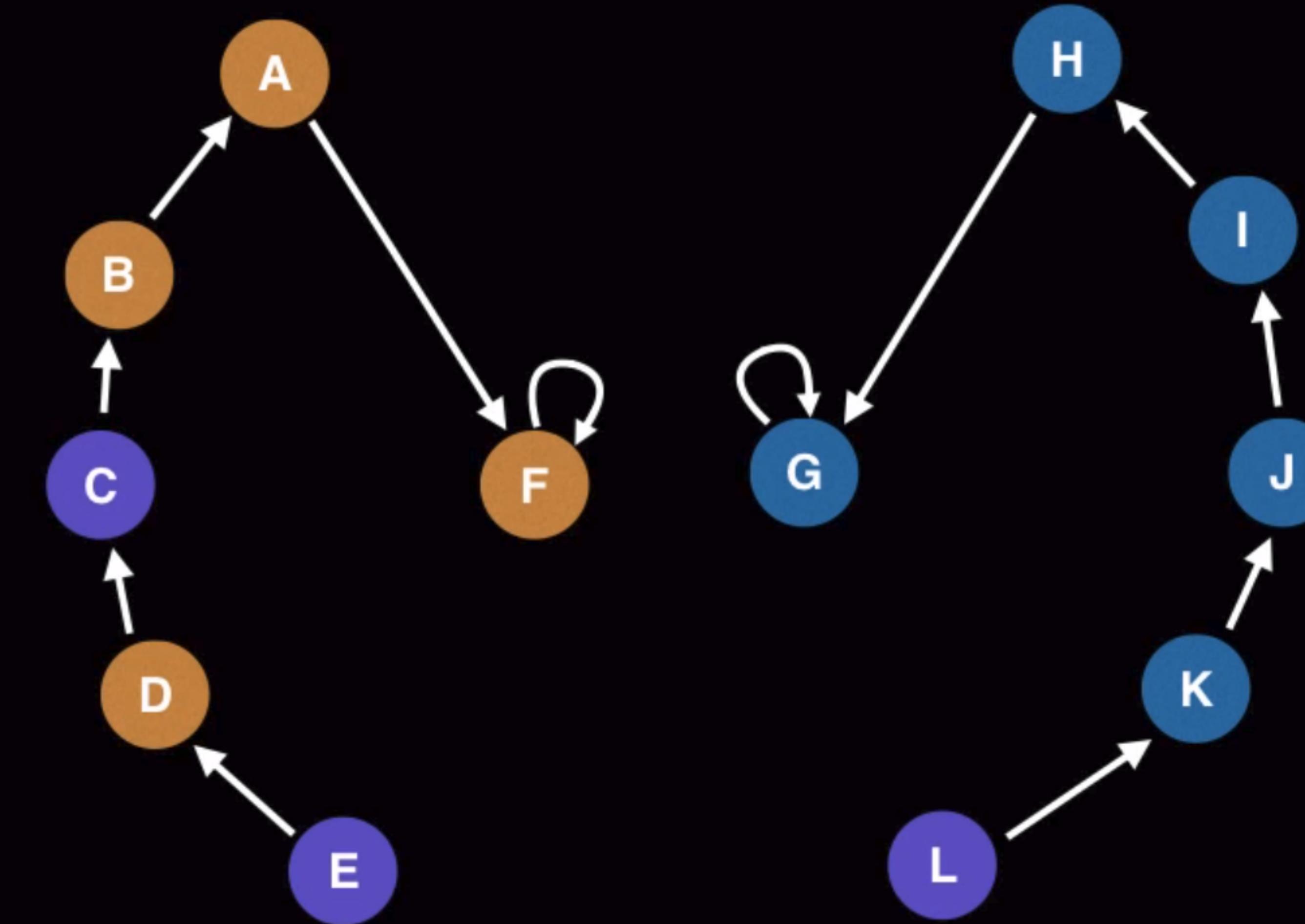
Indicates that there is a pointer to this node

# Hypothetical Union Find path compression example



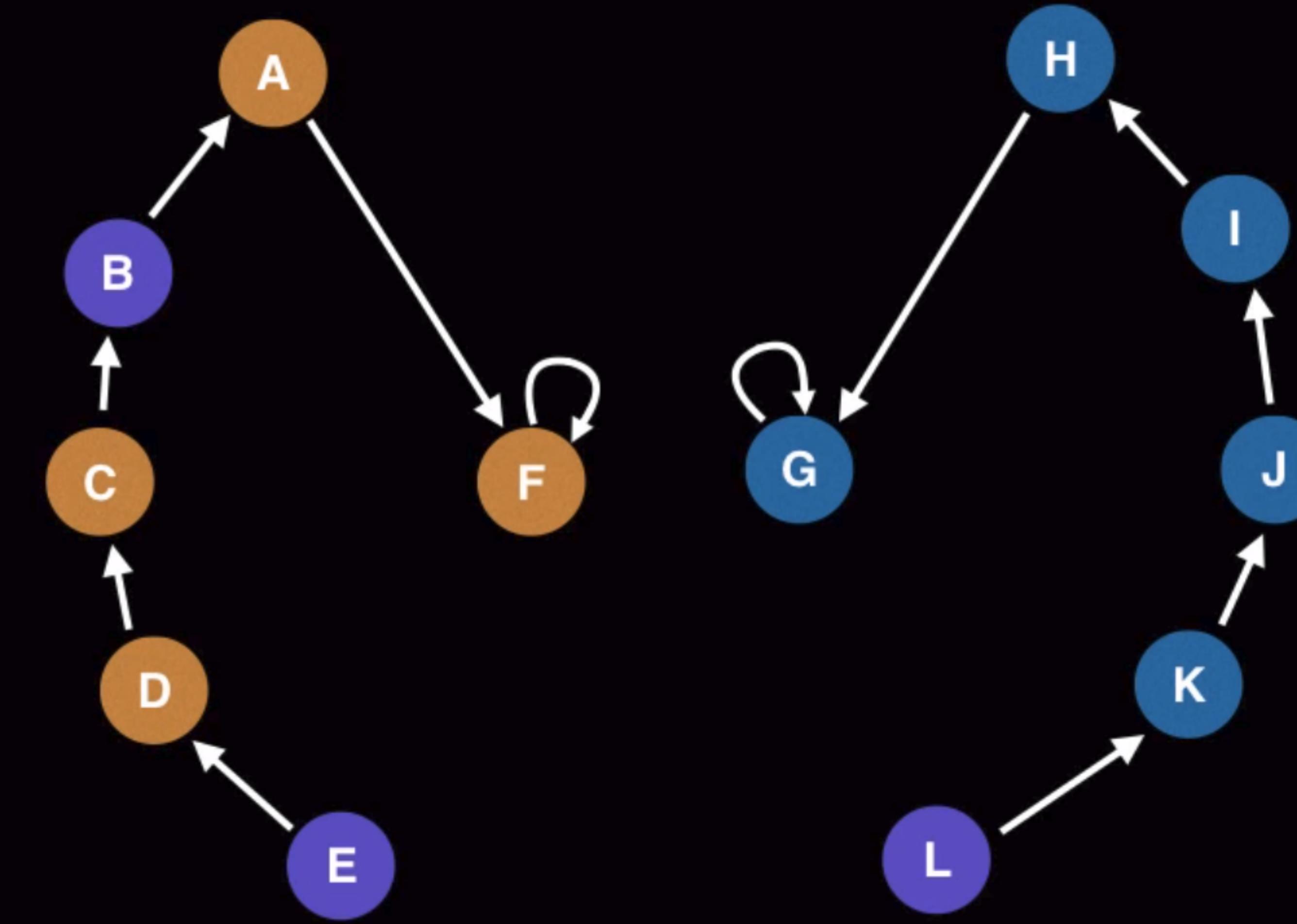
Indicates that there is a pointer to this node

# Hypothetical Union Find path compression example



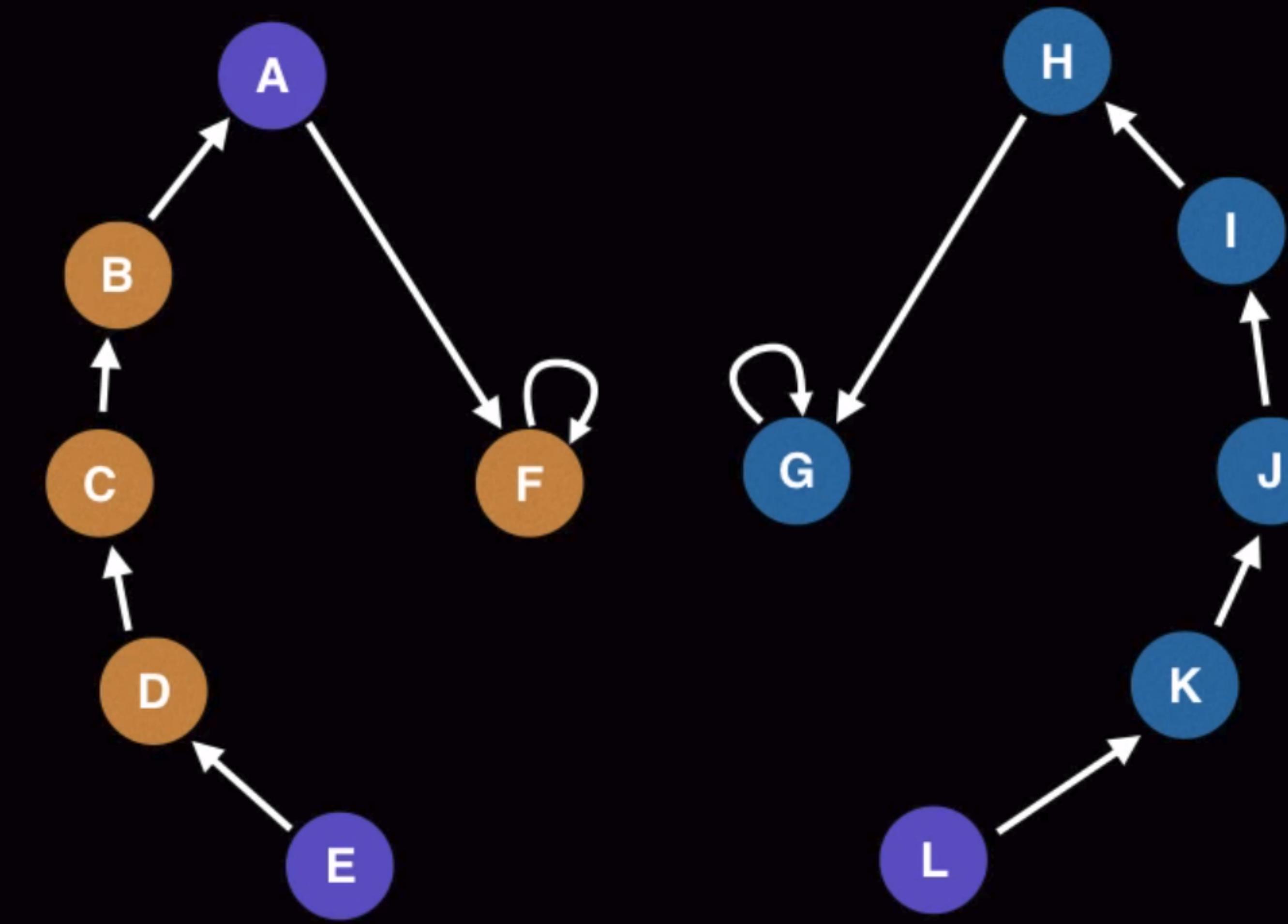
Indicates that there is a pointer to this node

# Hypothetical Union Find path compression example



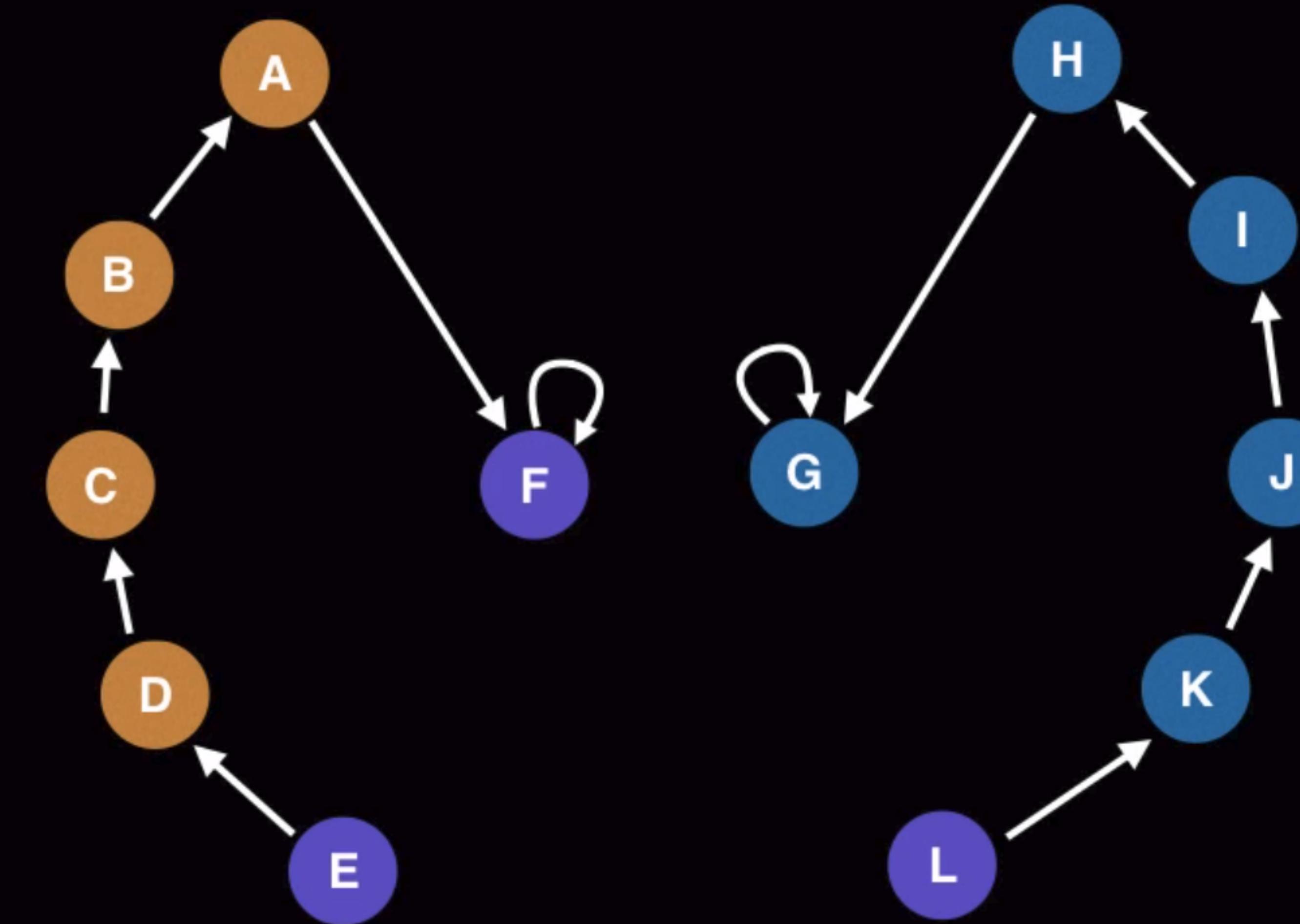
Indicates that there is a pointer to this node

# Hypothetical Union Find path compression example



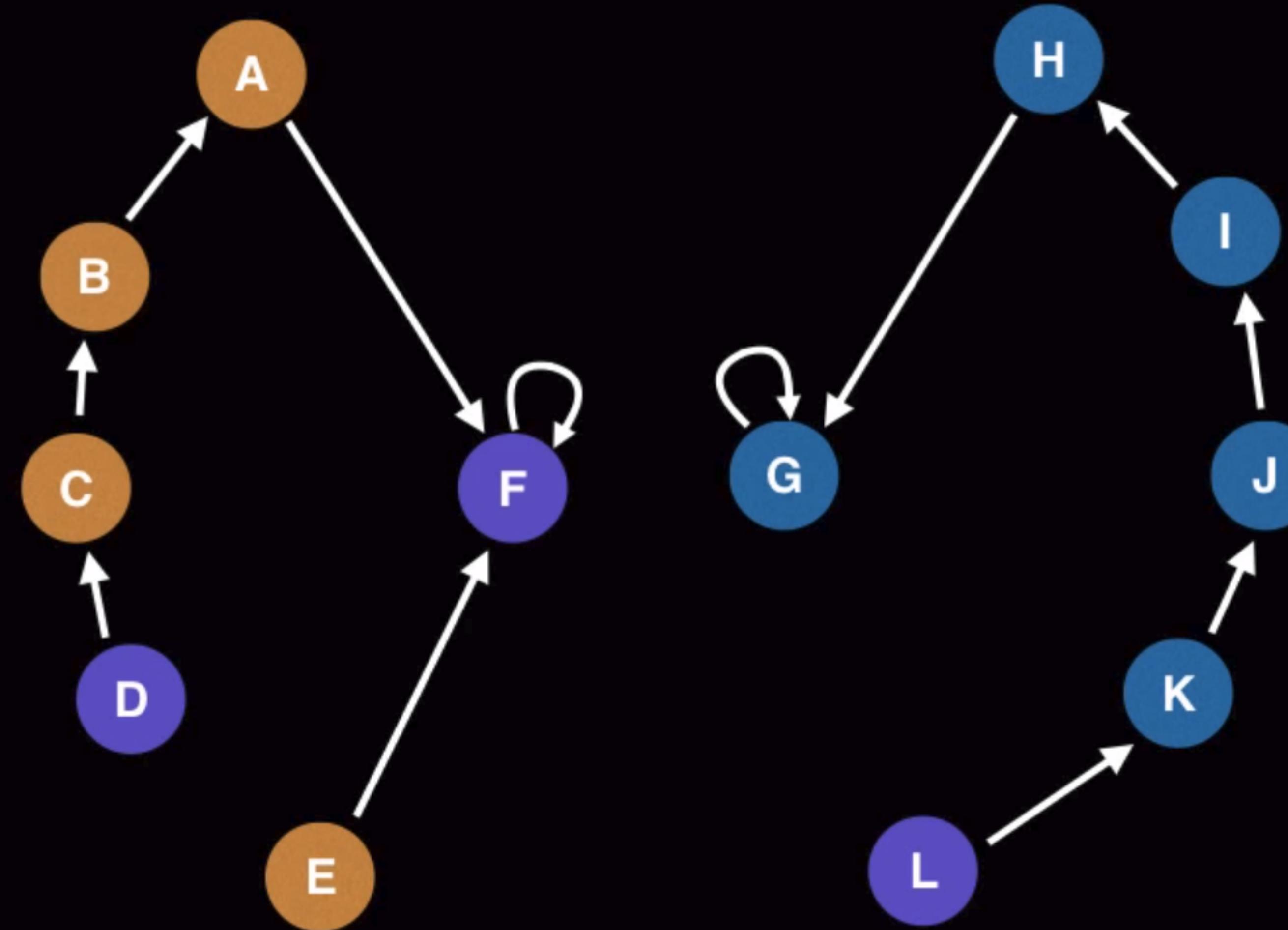
Indicates that there is a pointer to this node

# Hypothetical Union Find path compression example



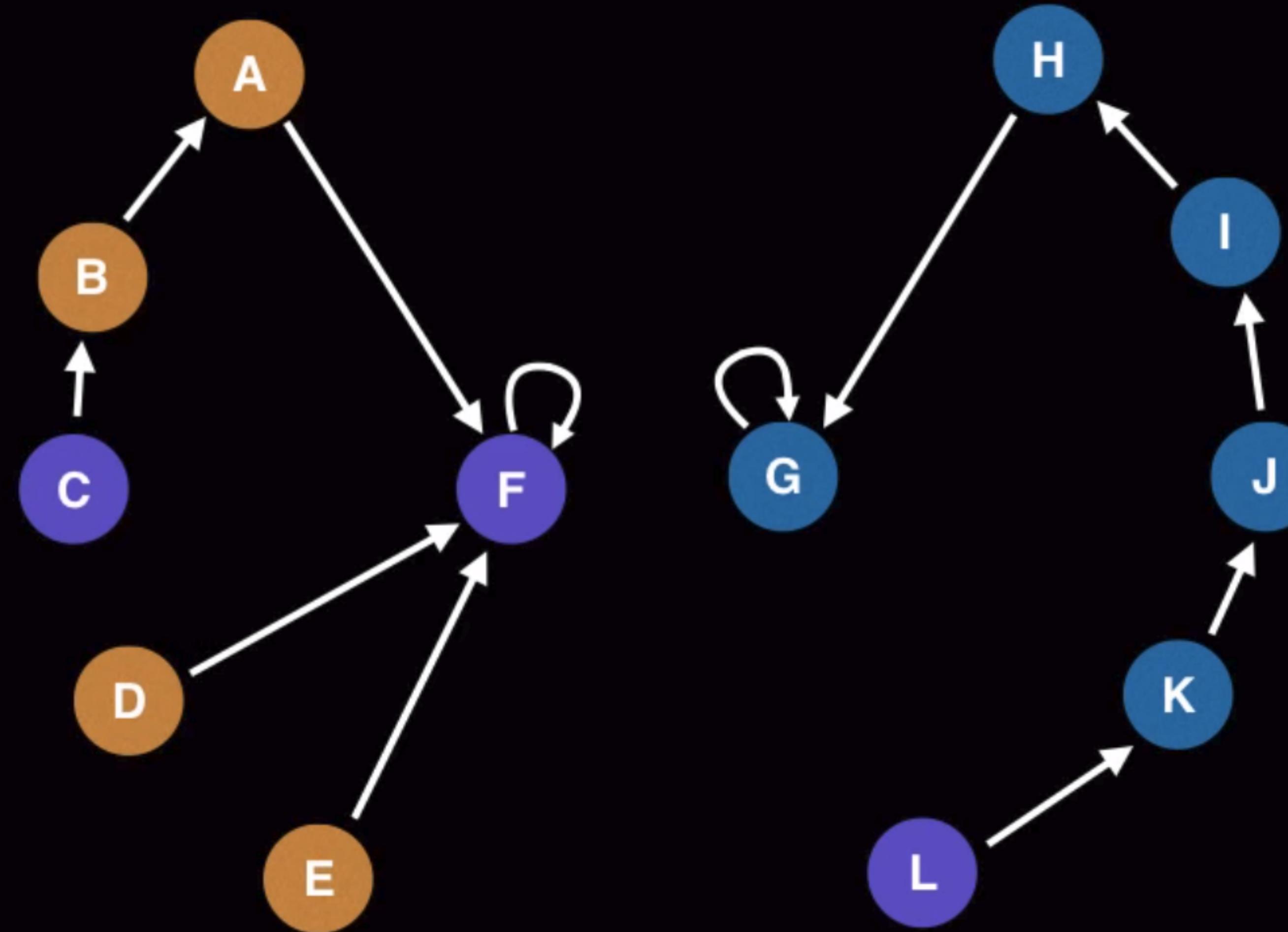
Indicates that there is a pointer to this node

# Hypothetical Union Find path compression example



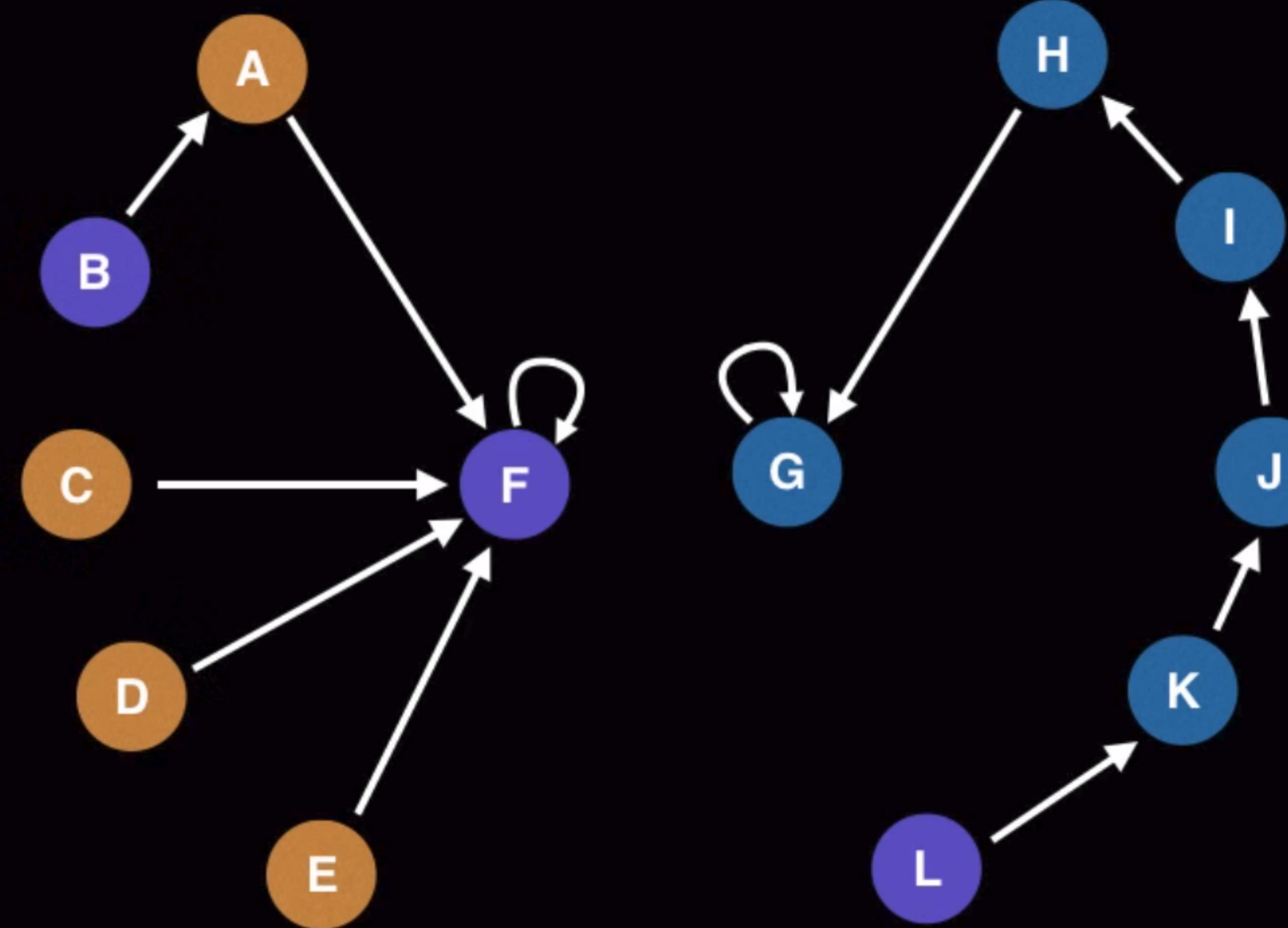
Indicates that there is a pointer to this node

# Hypothetical Union Find path compression example



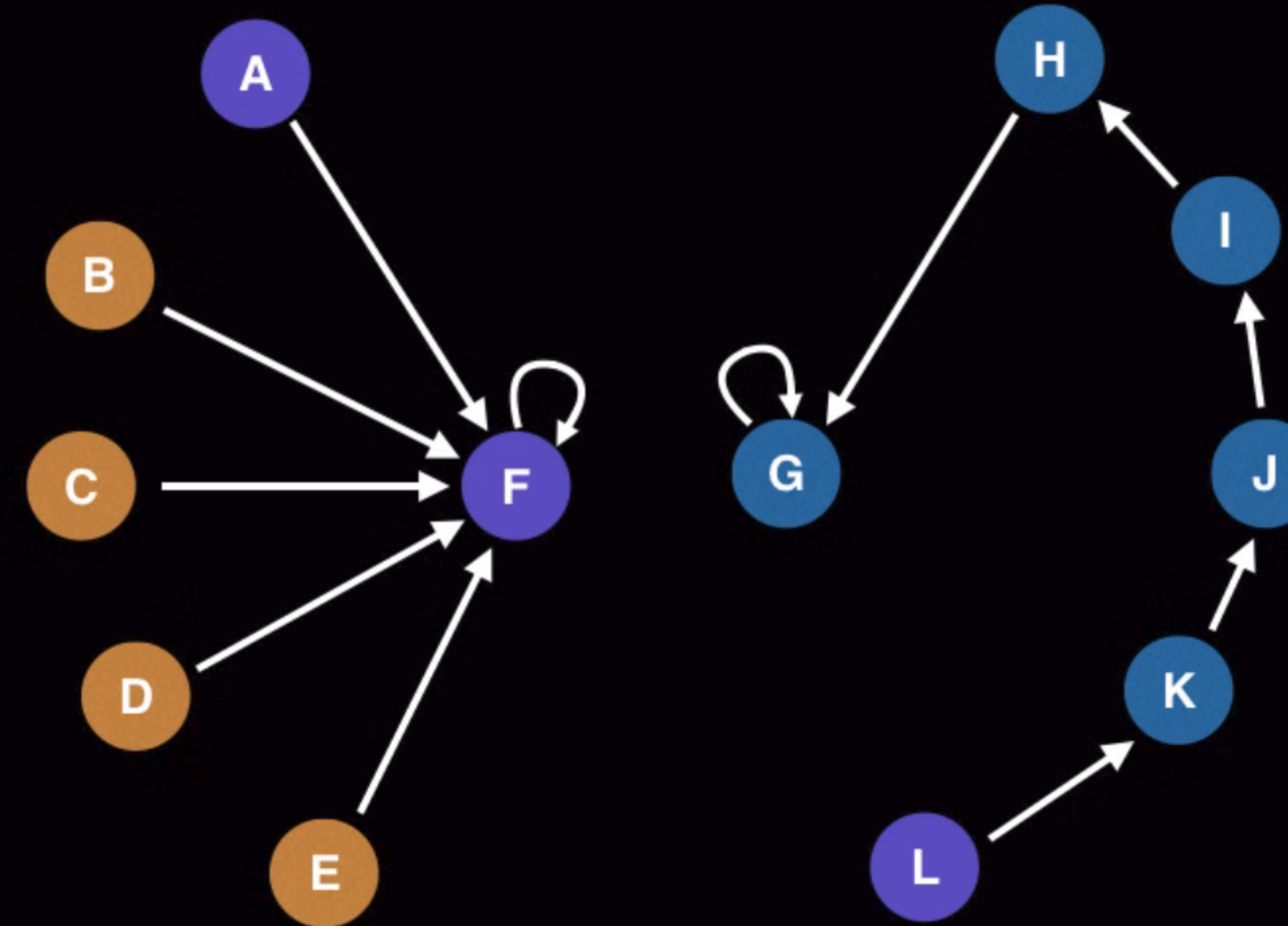
Indicates that there is a pointer to this node

# Hypothetical Union Find path compression example



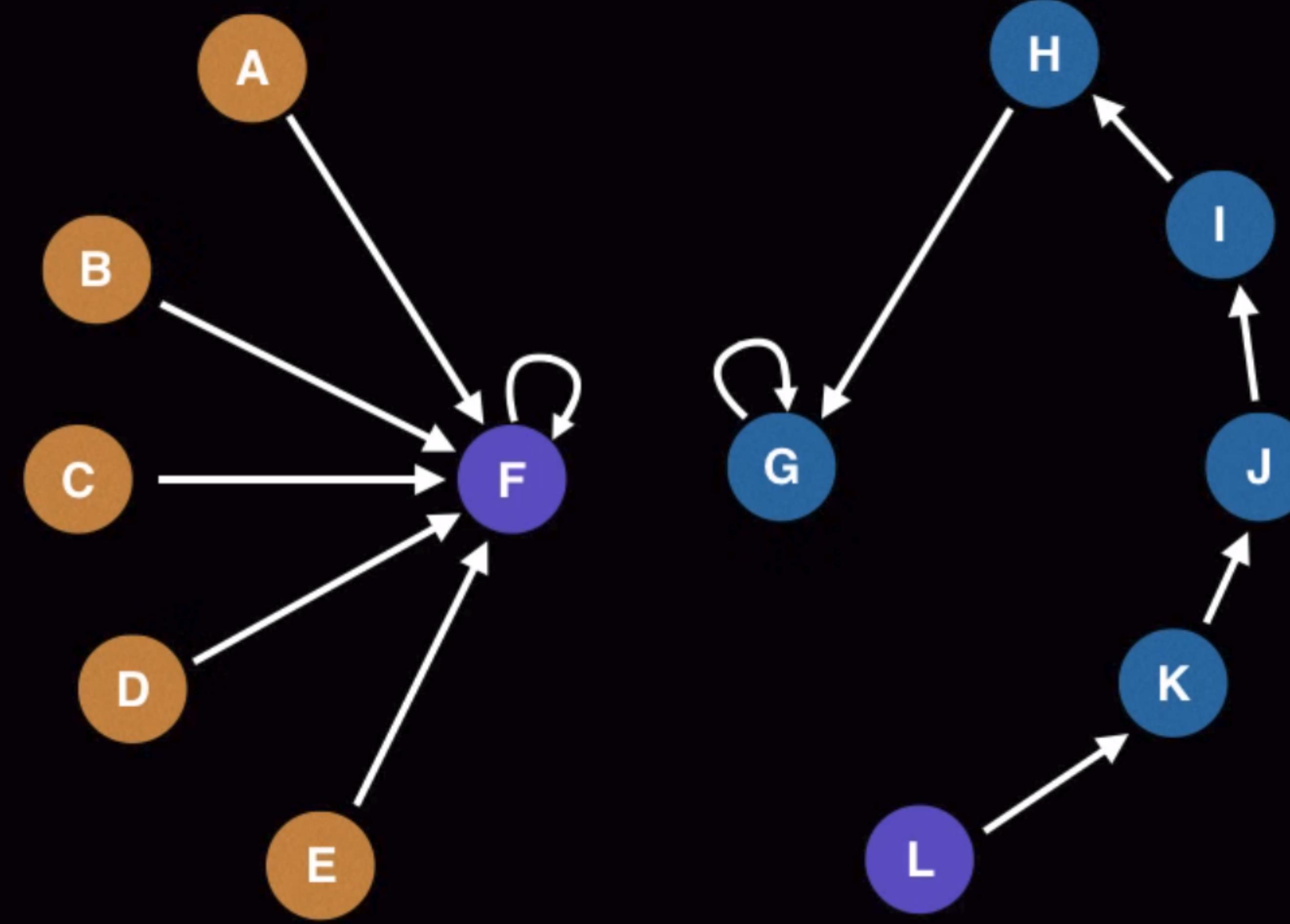
Indicates that there is a pointer to this node

# Hypothetical Union Find path compression example



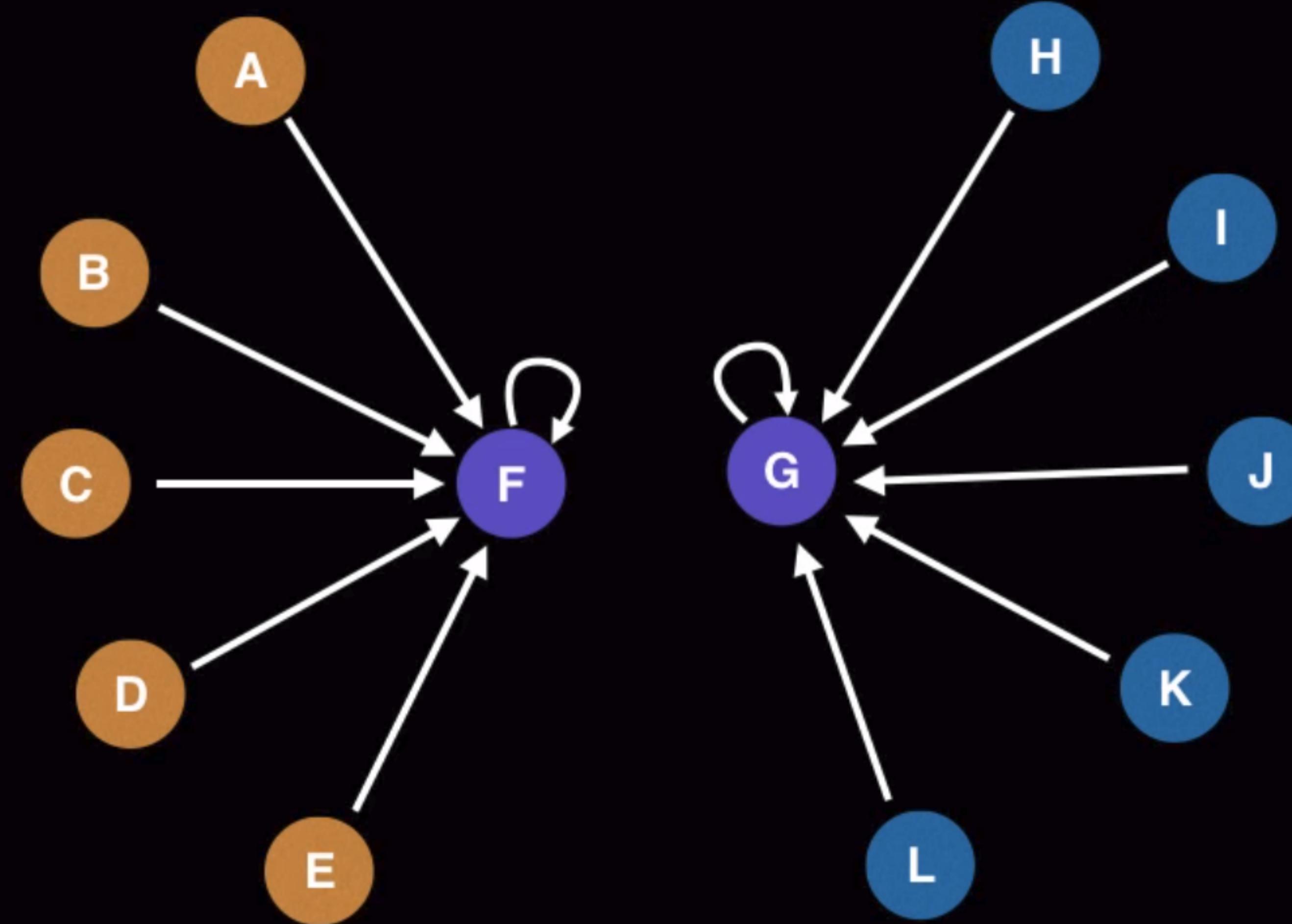
Indicates that there is a pointer to this node

# Hypothetical Union Find path compression example



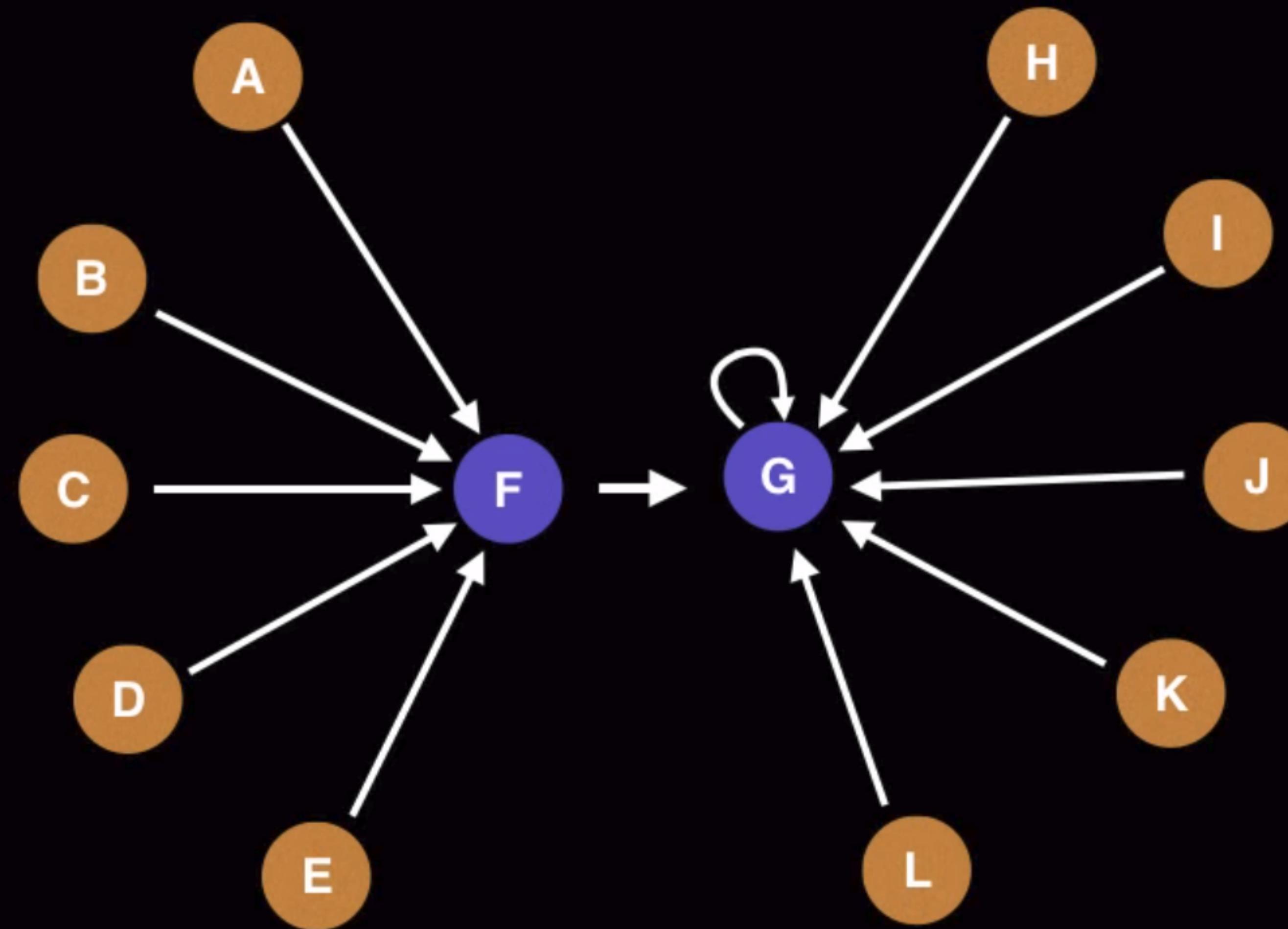
Indicates that there is a pointer to this node

# Hypothetical Union Find path compression example



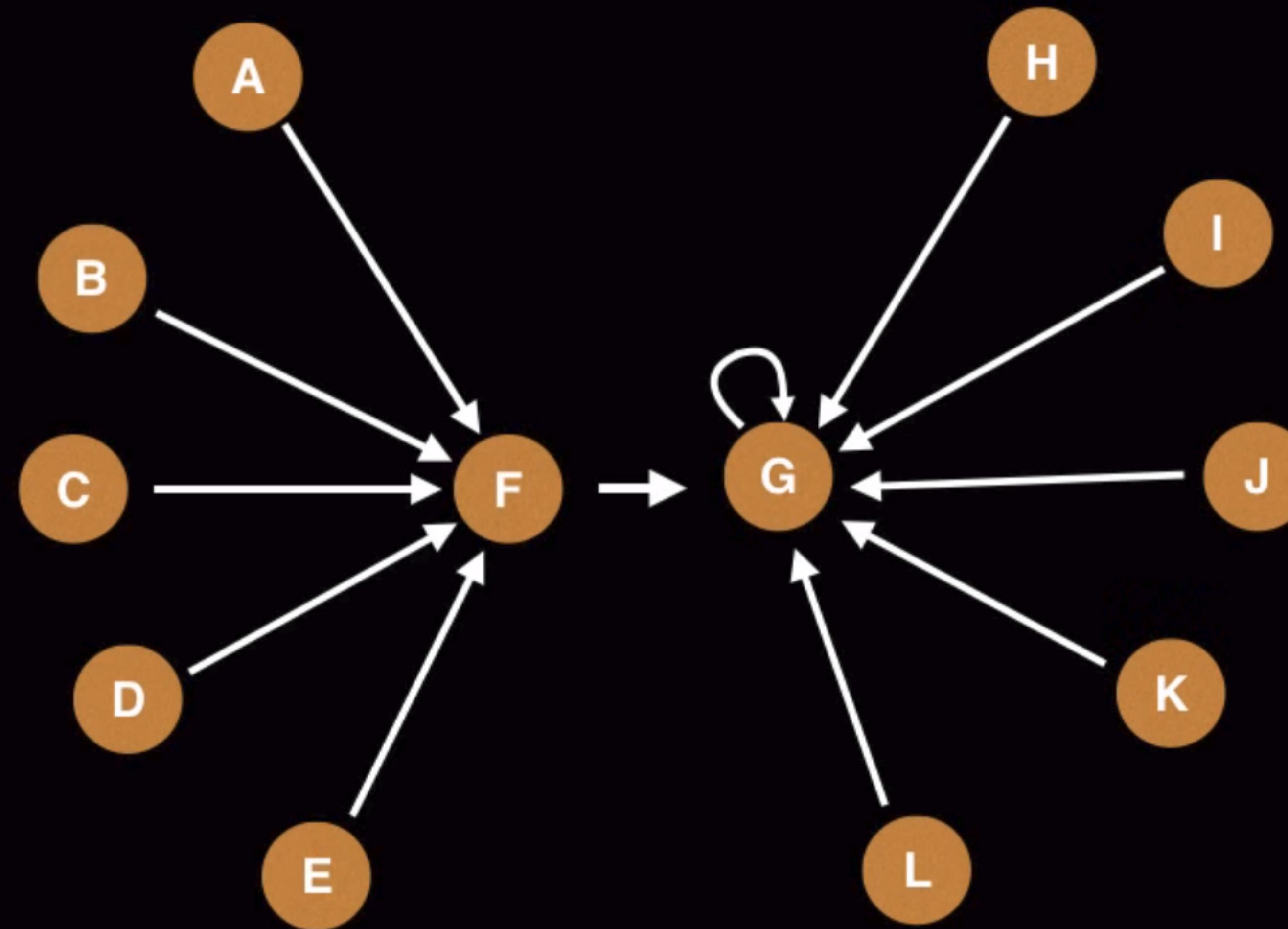
Indicates that there is a pointer to this node

# Hypothetical Union Find path compression example



Indicates that there is a pointer to this node

# Hypothetical Union Find path compression example





Using regular union find method

**Instructions:**

Union(A,B)

Union(C,D)

Union(E,F)

Union(G,H)

Union(I,J)

Union(J,G)

Union(H,F)

Union(A,C)

Union(D,E)

Union(G,B)

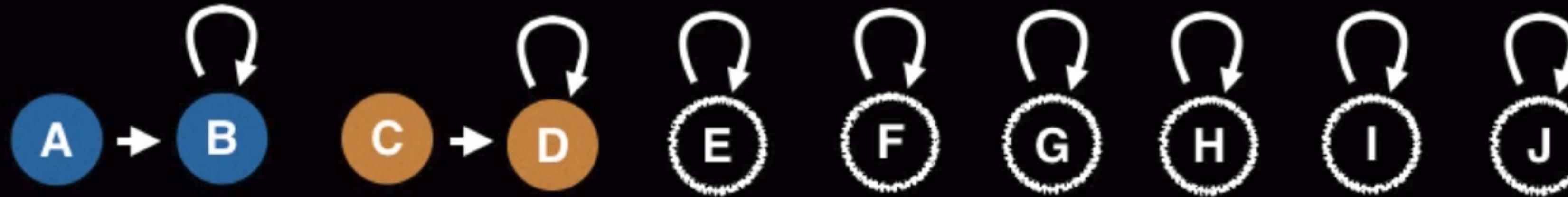
Union(I,J)



Using regular union find method

**Instructions:**

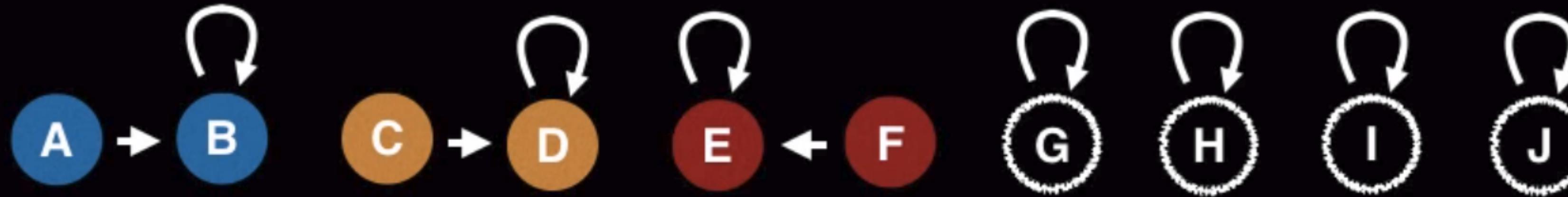
Union(A,B)	Union(J,G)
Union(C,D)	Union(H,F)
Union(E,F)	Union(A,C)
Union(G,H)	Union(D,E)
Union(I,J)	Union(G,B)
	Union(I,J)



Using regular union find method

**Instructions:**

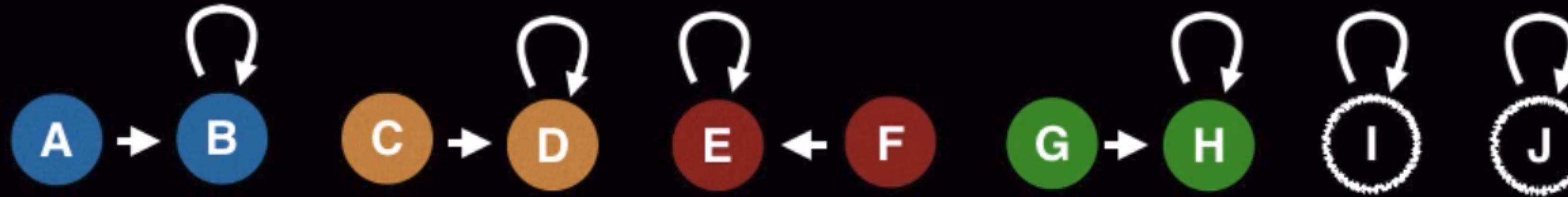
Union(A,B)	Union(J,G)
Union(C,D)	Union(H,F)
Union(E,F)	Union(A,C)
Union(G,H)	Union(D,E)
Union(I,J)	Union(G,B)
	Union(I,J)



Using regular union find method

**Instructions:**

Union(A,B)	Union(J,G)
Union(C,D)	Union(H,F)
Union(E,F)	Union(A,C)
Union(G,H)	Union(D,E)
Union(I,J)	Union(G,B)
	Union(I,J)

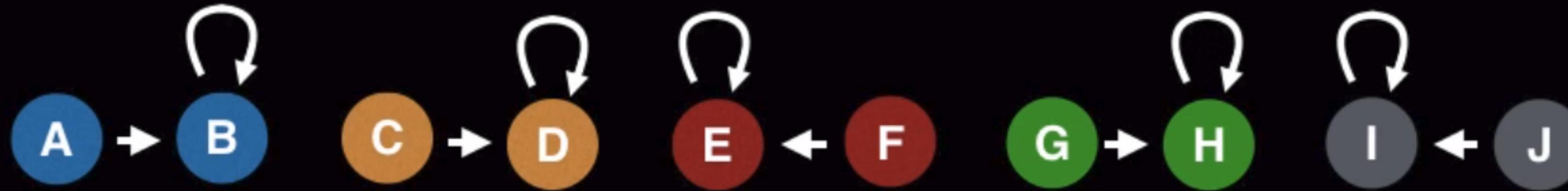


Using regular union find method

**Instructions:**

Union(A,B)  
Union(C,D)  
Union(E,F)  
Union(G,H)  
Union(I,J)

Union(J,G)  
Union(H,F)  
Union(A,C)  
Union(D,E)  
Union(G,B)  
Union(I,J)

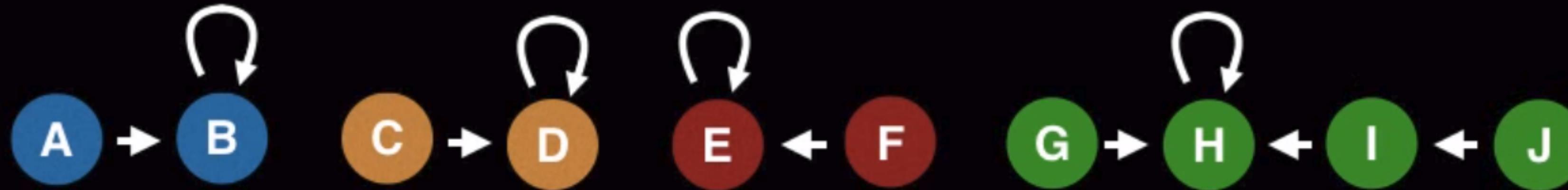


Using regular union find method

**Instructions:**

Union(A,B)  
Union(C,D)  
Union(E,F)  
Union(G,H)  
Union(I,J)

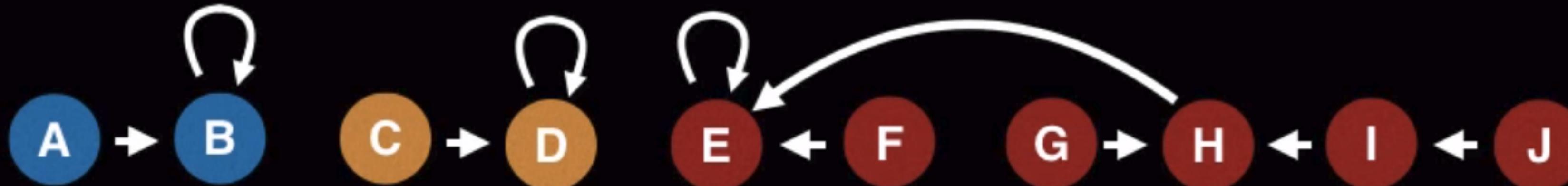
Union(J,G)  
Union(H,F)  
Union(A,C)  
Union(D,E)  
Union(G,B)  
Union(I,J)



Using regular union find method

**Instructions:**

Union(A,B)	Union(J,G)
Union(C,D)	Union(H,F)
Union(E,F)	Union(A,C)
Union(G,H)	Union(D,E)
Union(I,J)	Union(G,B)
	Union(I,J)

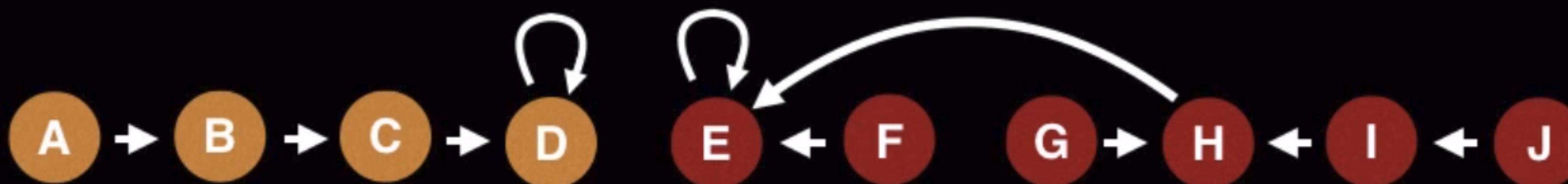


Using regular union find method

**Instructions:**

Union(A,B)  
Union(C,D)  
Union(E,F)  
Union(G,H)  
Union(I,J)

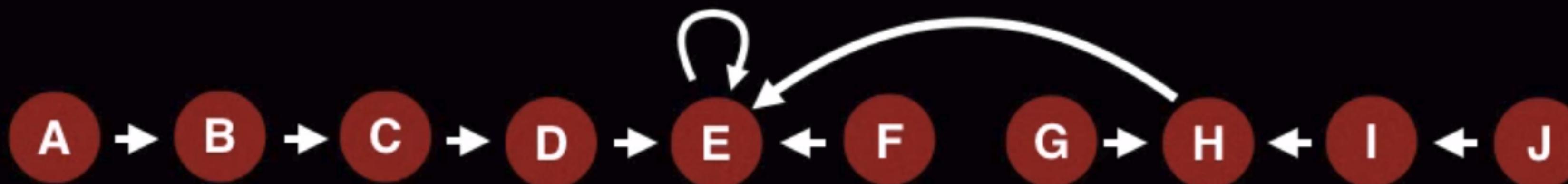
Union(J,G)  
Union(H,F)  
Union(A,C)  
Union(D,E)  
Union(G,B)  
Union(I,J)



Using regular union find method

**Instructions:**

Union(A,B)	Union(J,G)
Union(C,D)	Union(H,F)
Union(E,F)	Union(A,C)
Union(G,H)	Union(D,E)
Union(I,J)	Union(G,B)
	Union(I,J)



Using regular union find method

**Instructions:**

Union(A,B)	Union(J,G)
Union(C,D)	Union(H,F)
Union(E,F)	Union(A,C)
Union(G,H)	Union(D,E)
Union(I,J)	Union(G,B)
	Union(I,J)



Using **path compression**

**Instructions:**

Union(A,B)

Union(C,D)

Union(E,F)

Union(G,H)

Union(I,J)

Union(J,G)

Union(H,F)

Union(A,C)

Union(D,E)

Union(G,B)

Union(I,J)



Using **path compression**

**Instructions:**

Union(A,B)

Union(C,D)

Union(E,F)

Union(G,H)

Union(I,J)

Union(J,G)

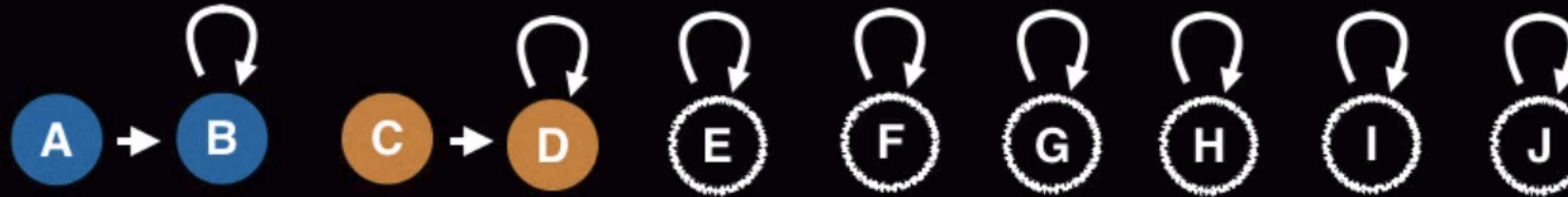
Union(H,F)

Union(A,C)

Union(D,E)

Union(G,B)

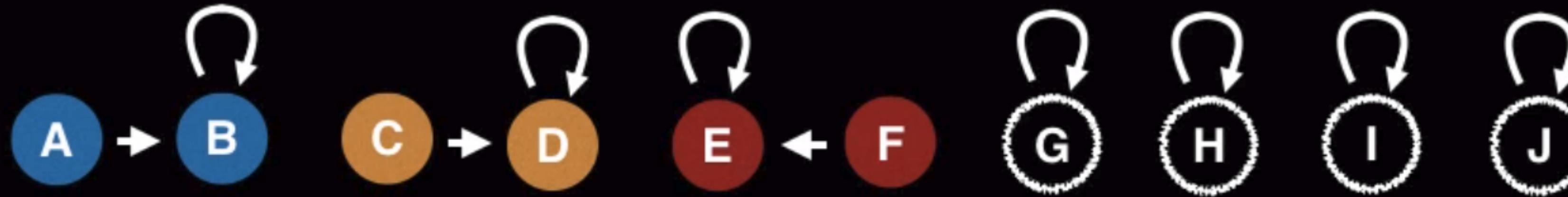
Union(I,J)



Using **path compression**

**Instructions:**

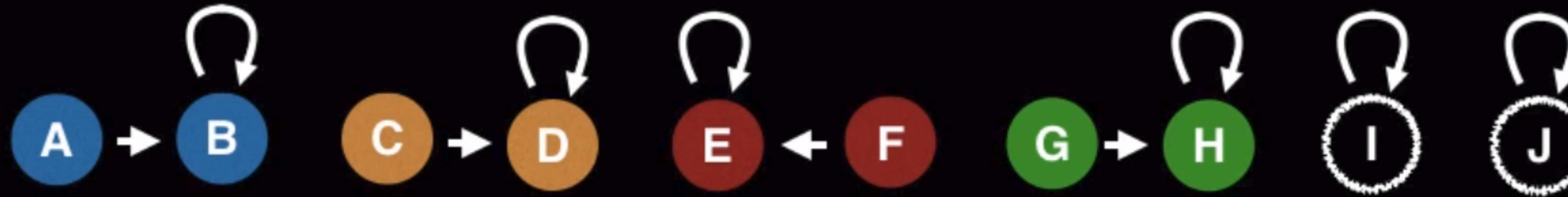
Union(A,B)	Union(J,G)
Union(C,D)	Union(H,F)
Union(E,F)	Union(A,C)
Union(G,H)	Union(D,E)
Union(I,J)	Union(G,B)
	Union(I,J)



Using **path compression**

**Instructions:**

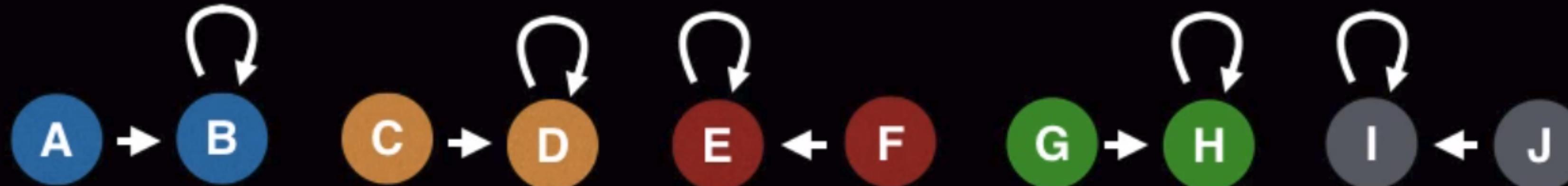
Union(A,B)	Union(J,G)
Union(C,D)	Union(H,F)
Union(E,F)	Union(A,C)
Union(G,H)	Union(D,E)
Union(I,J)	Union(G,B)
	Union(I,J)



Using **path compression**

**Instructions:**

Union(A,B)	Union(J,G)
Union(C,D)	Union(H,F)
Union(E,F)	Union(A,C)
Union(G,H)	Union(D,E)
Union(I,J)	Union(G,B)
	Union(I,J)

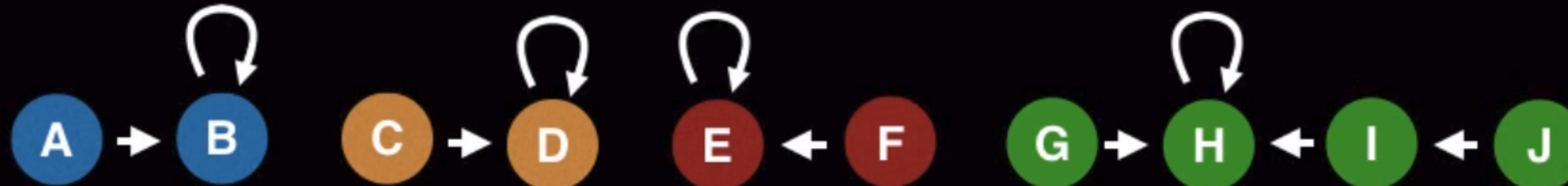


Using **path compression**

**Instructions:**

Union(A,B)  
Union(C,D)  
Union(E,F)  
Union(G,H)  
Union(I,J)

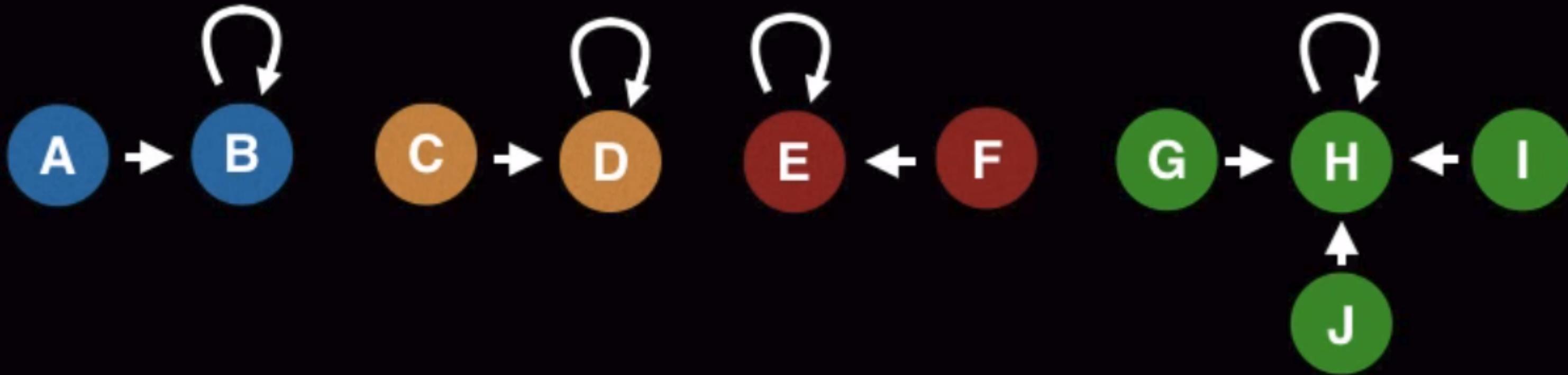
Union(J,G)  
Union(H,F)  
Union(A,C)  
Union(D,E)  
Union(G,B)  
Union(I,J)



Using **path compression**

Instructions:

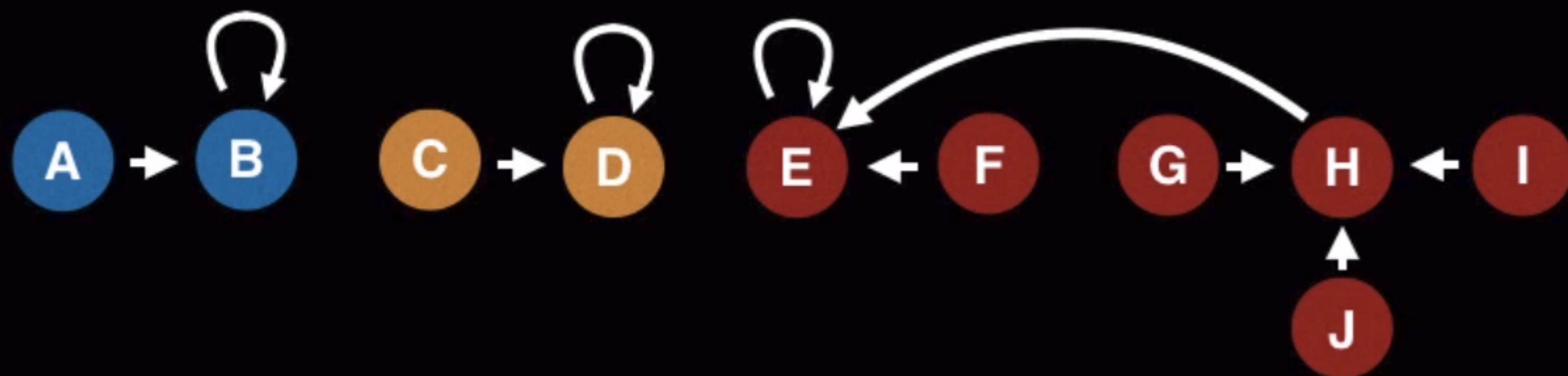
Union(A,B)	Union(J,G)
Union(C,D)	Union(H,F)
Union(E,F)	Union(A,C)
Union(G,H)	Union(D,E)
Union(I,J)	Union(G,B)
	Union(I,J)



Using **path compression**

**Instructions:**

Union(A,B)	Union(J,G)
Union(C,D)	Union(H,F)
Union(E,F)	Union(A,C)
Union(G,H)	Union(D,E)
Union(I,J)	Union(G,B)
	Union(I,J)

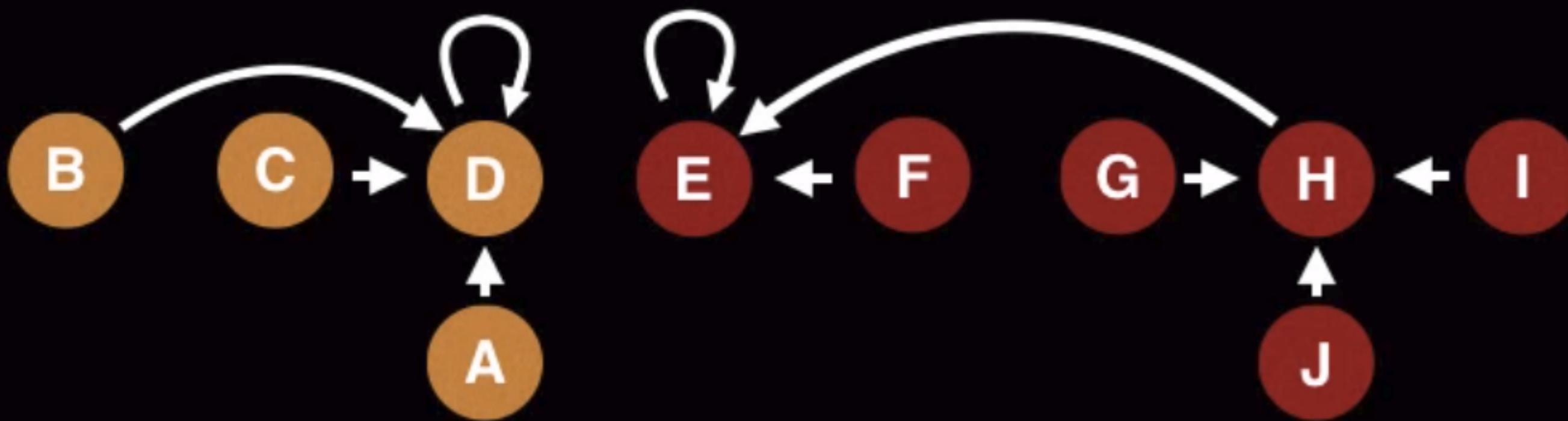


Using **path compression**

**Instructions:**

Union(A,B)  
Union(C,D)  
Union(E,F)  
Union(G,H)  
Union(I,J)

Union(J,G)  
Union(H,F)  
Union(A,C)  
Union(D,E)  
Union(G,B)  
Union(I,J)

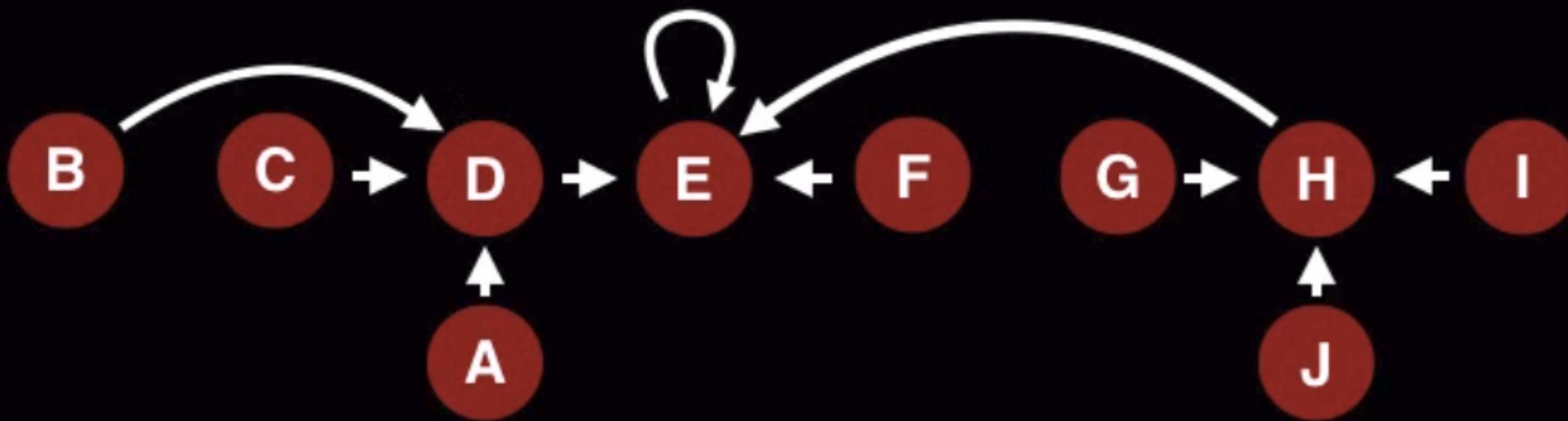


Using **path compression**

**Instructions:**

Union(A,B)  
Union(C,D)  
Union(E,F)  
Union(G,H)  
Union(I,J)

Union(J,G)  
Union(H,F)  
Union(A,C)  
Union(D,E)  
Union(G,B)  
Union(I,J)

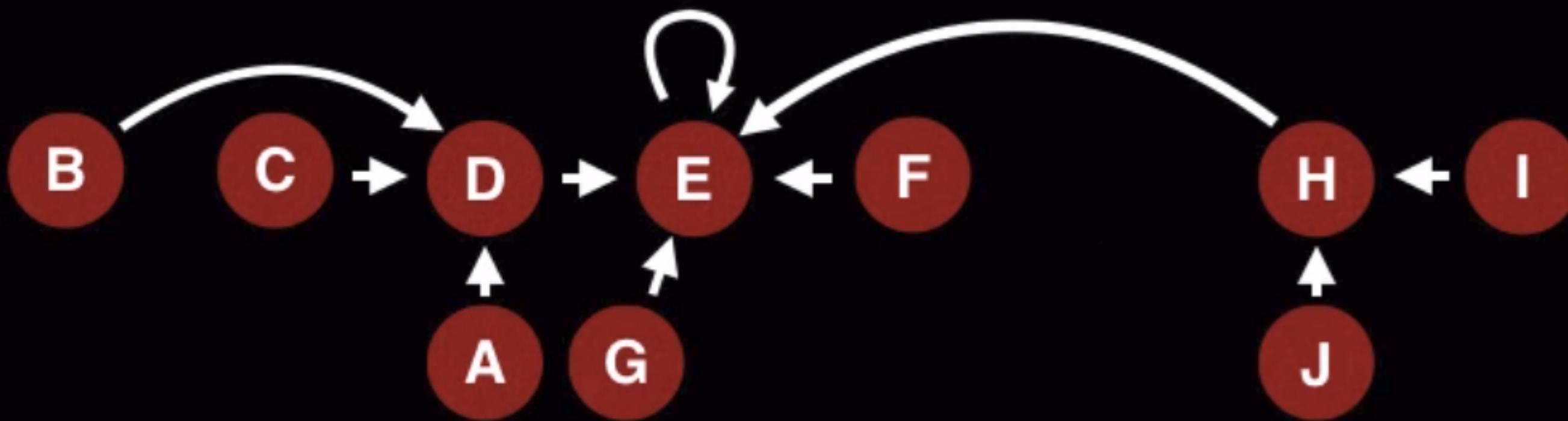


Using **path compression**

**Instructions:**

Union(A,B)  
Union(C,D)  
Union(E,F)  
Union(G,H)  
Union(I,J)

Union(J,G)  
Union(H,F)  
Union(A,C)  
Union(D,E)  
Union(G,B)  
Union(I,J)

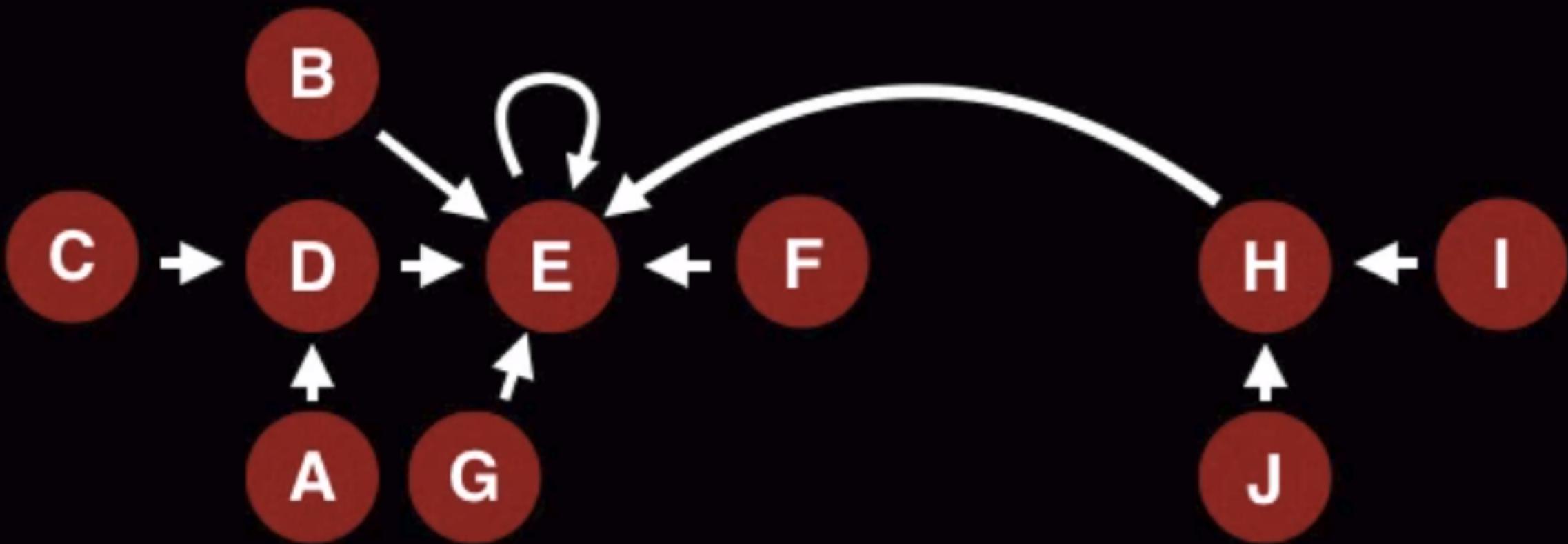


Using **path compression**

**Instructions:**

Union(A,B)  
Union(C,D)  
Union(E,F)  
Union(G,H)  
Union(I,J)

Union(J,G)  
Union(H,F)  
Union(A,C)  
Union(D,E)  
Union(G,B)  
Union(I,J)

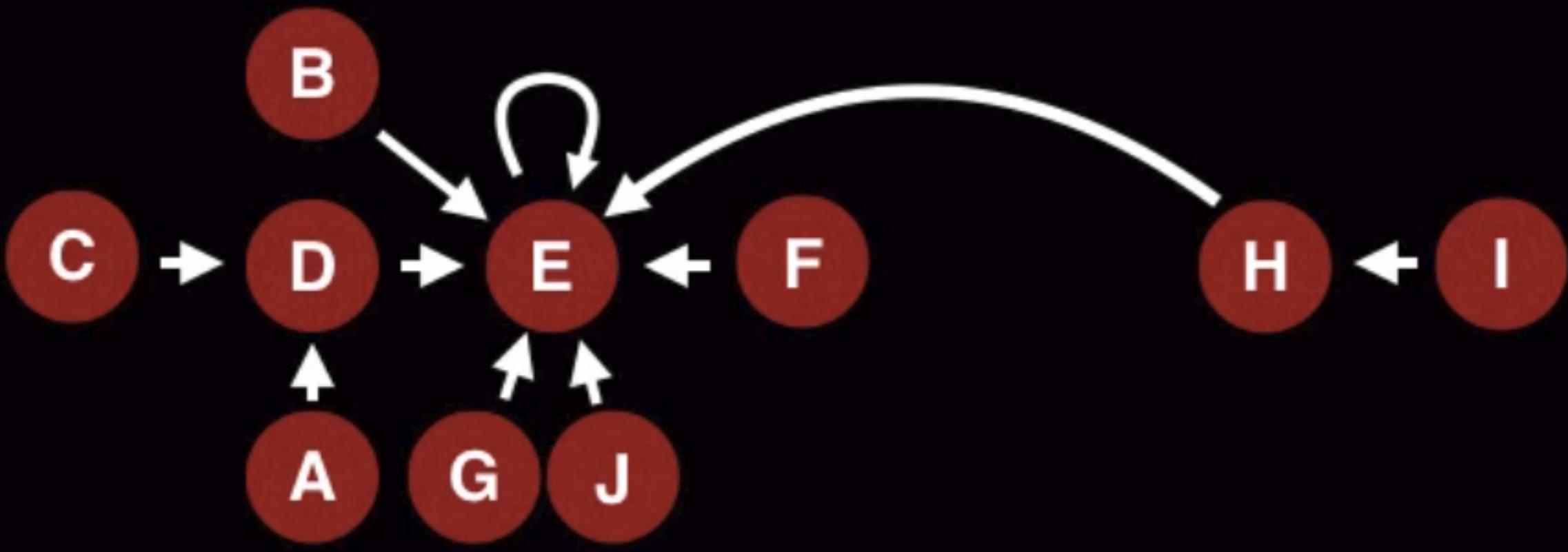


Using **path compression**

**Instructions:**

Union(A,B)  
Union(C,D)  
Union(E,F)  
Union(G,H)  
Union(I,J)

Union(J,G)  
Union(H,F)  
Union(A,C)  
Union(D,E)  
Union(G,B)  
Union(I,J)

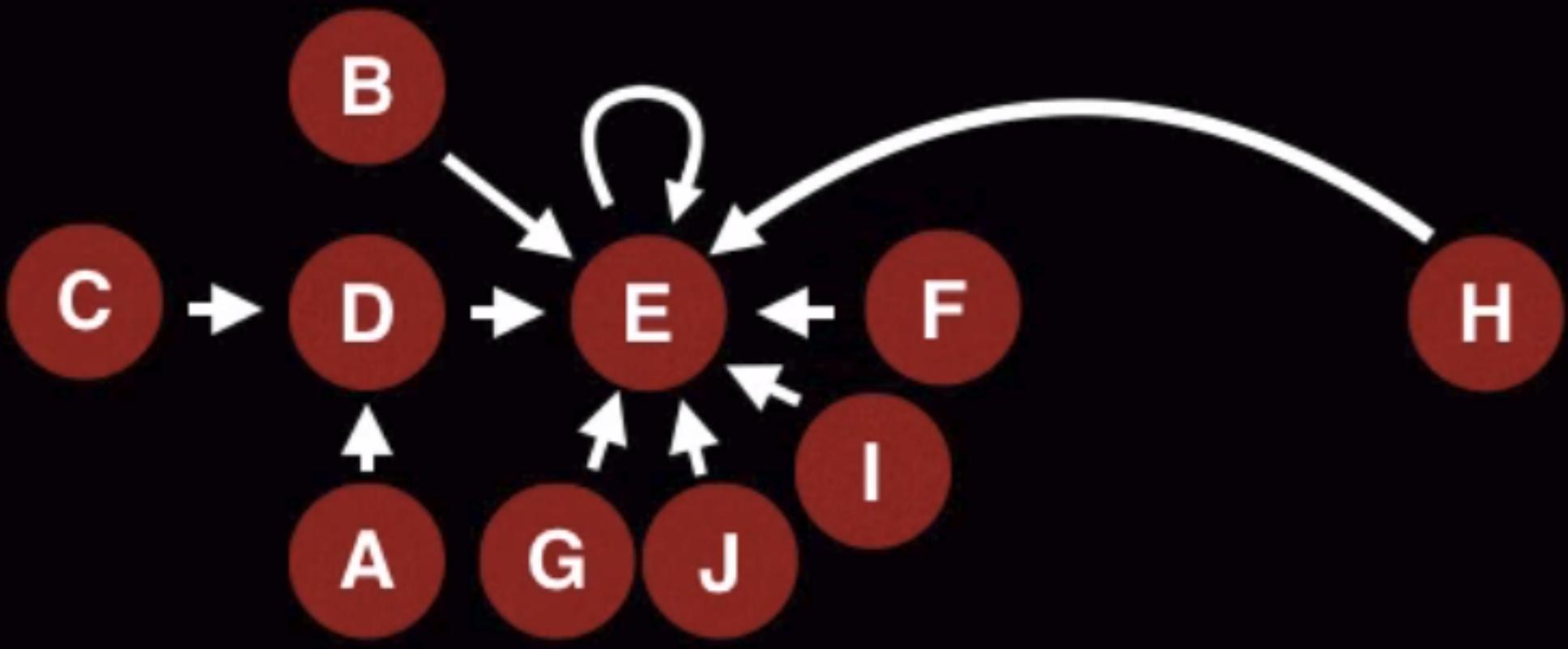


Using **path compression**

**Instructions:**

Union(A,B)  
Union(C,D)  
Union(E,F)  
Union(G,H)  
Union(I,J)

Union(J,G)  
Union(H,F)  
Union(A,C)  
Union(D,E)  
Union(G,B)  
Union(I,J)



## Instructions:

Union(A,B)  
Union(C,D)  
Union(E,F)  
Union(G,H)  
Union(I,J)

Union(J,G)  
Union(H,F)  
Union(A,C)  
Union(D,E)  
Union(G,B)  
Union(I,J)