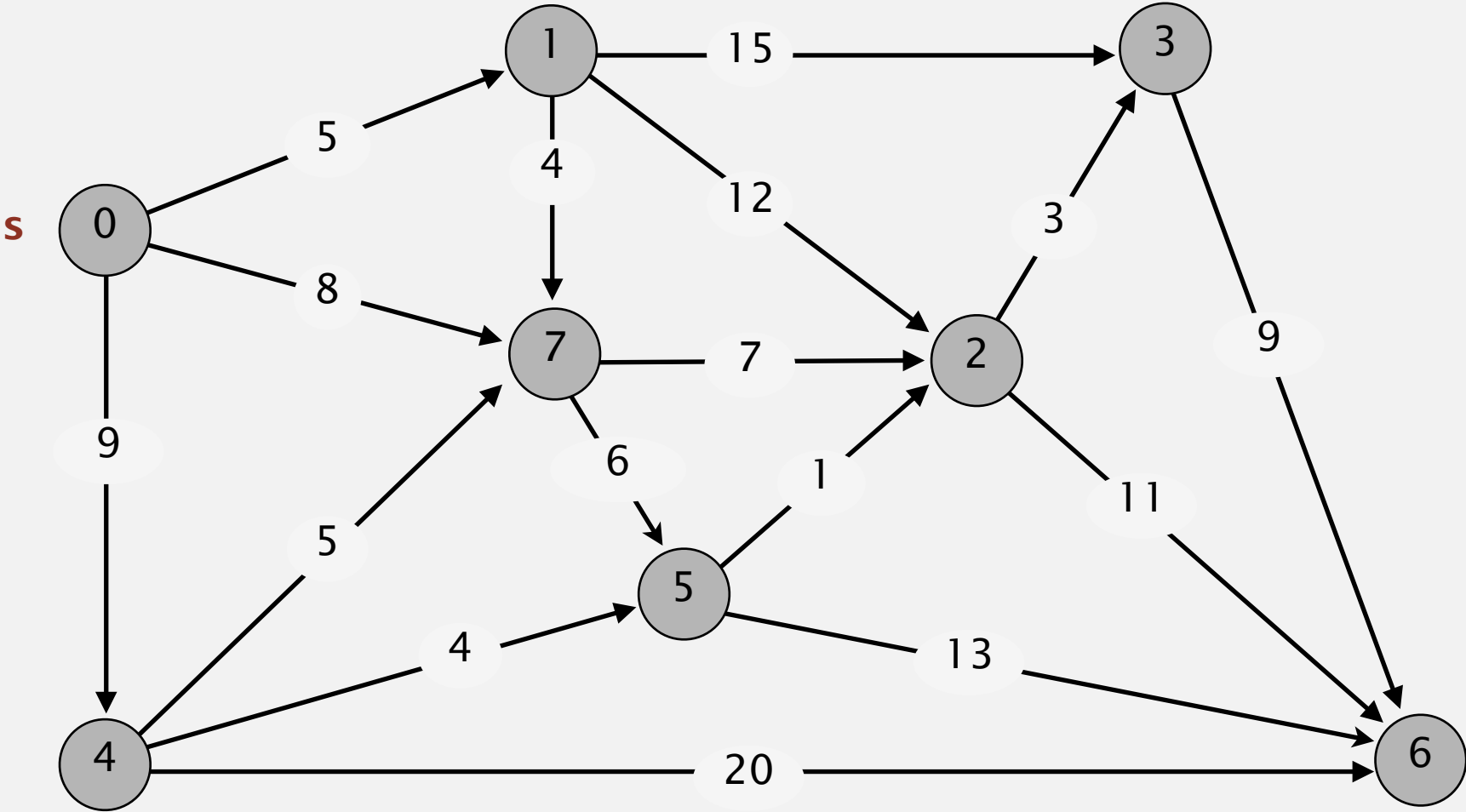


# 4.4 BELLMAN-FORD DEMO



# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.

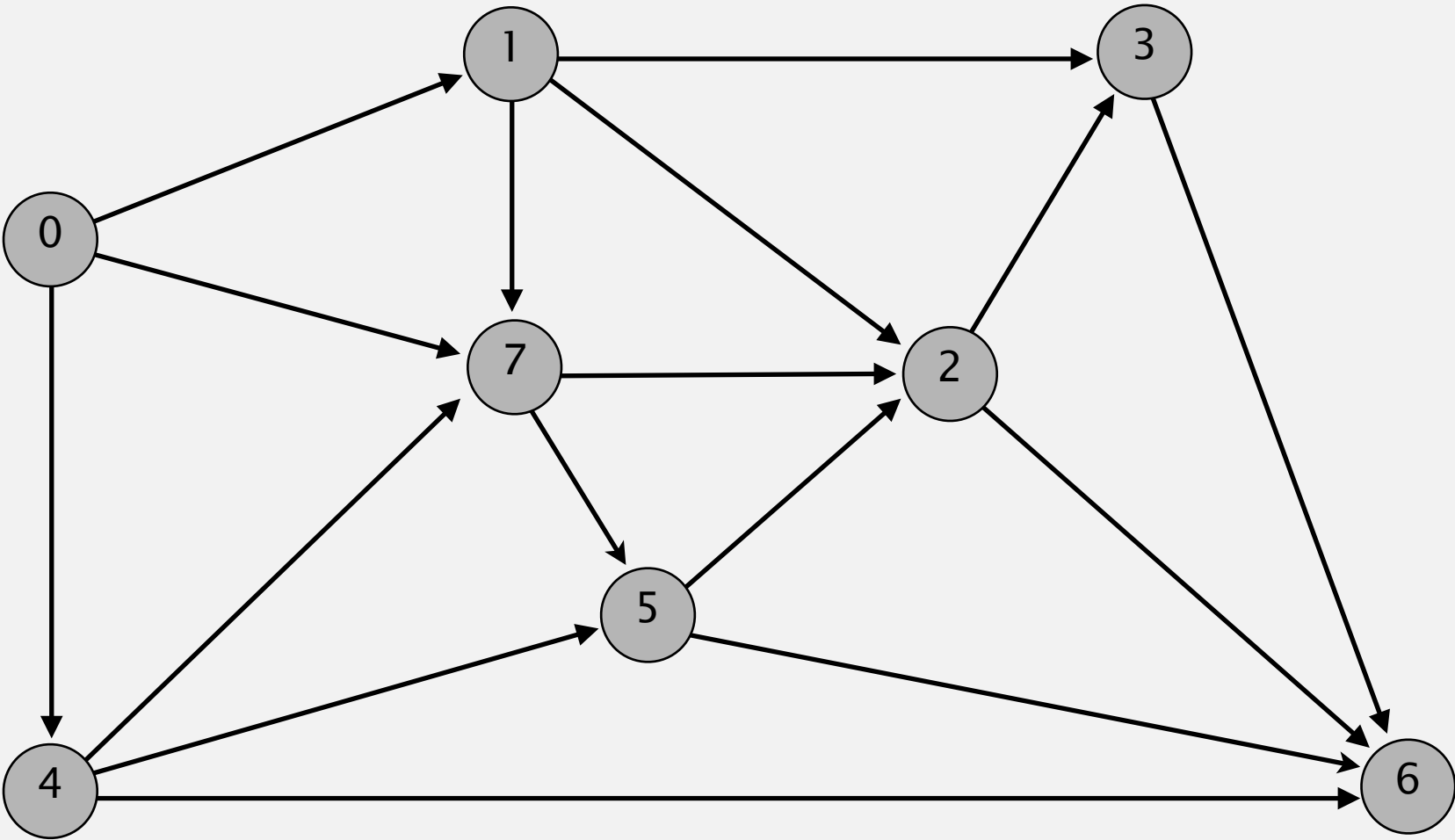


an edge-weighted digraph

0→1	5.0
0→4	9.0
0→7	8.0
1→2	12.0
1→3	15.0
1→7	4.0
2→3	3.0
2→6	11.0
3→6	9.0
4→5	4.0
4→6	20.0
4→7	5.0
5→2	1.0
5→6	13.0
7→5	6.0
7→2	7.0

# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.

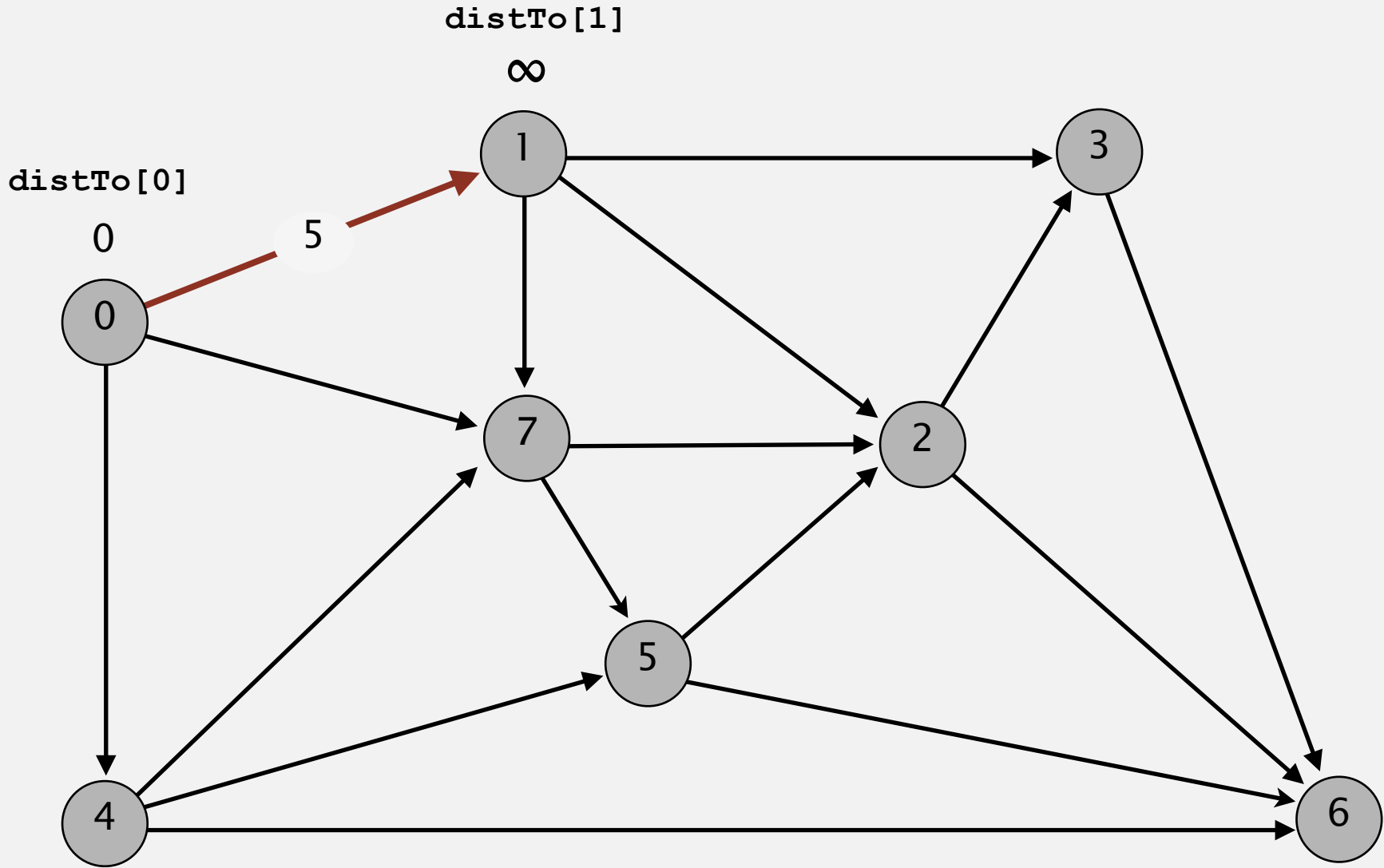


v	distTo[]	edgeTo[]
0	0.0	-
1		
2		
3		
4		
5		
6		
7		

**initialize**

# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



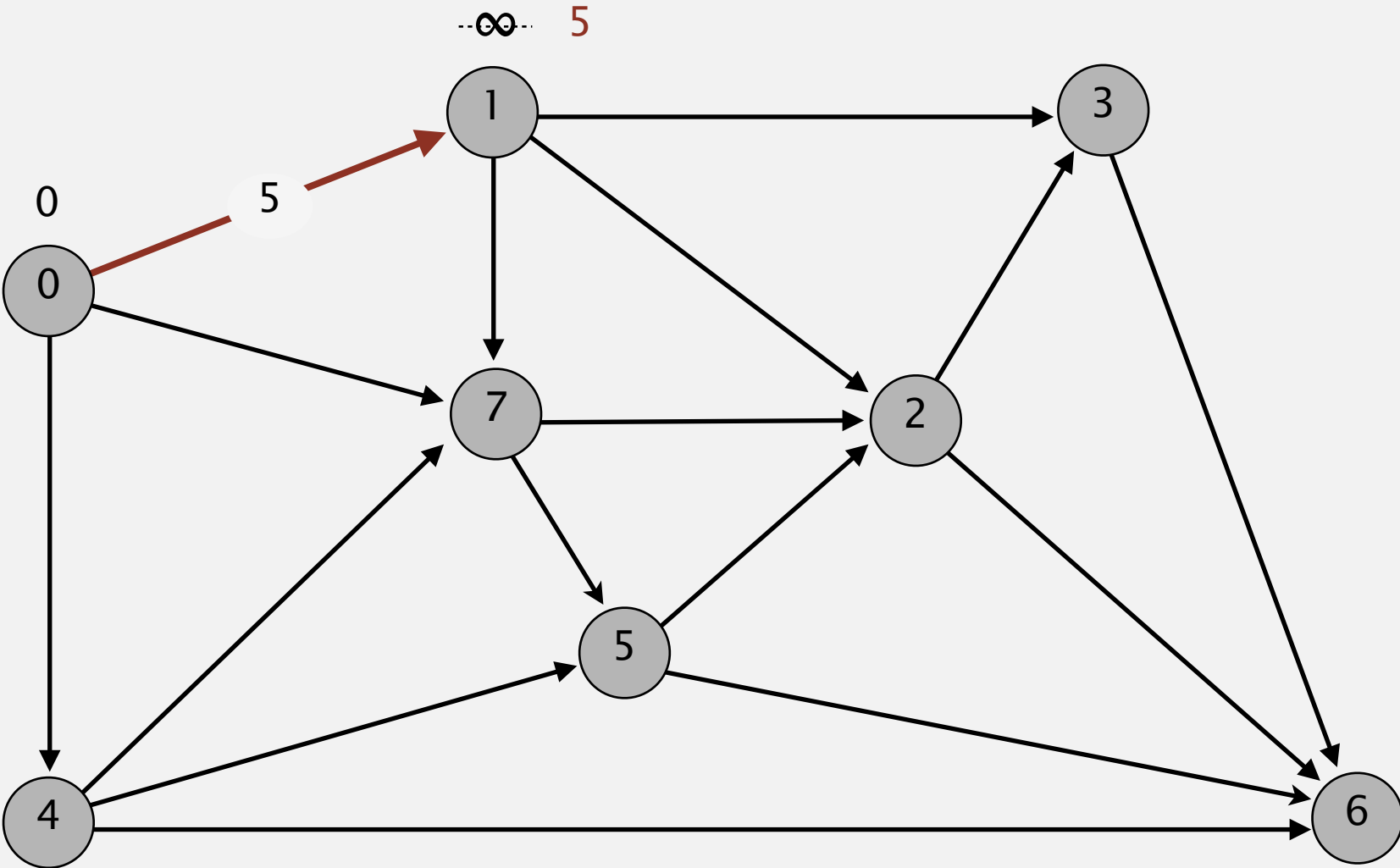
v	distTo[]	edgeTo[]
0	0.0	-
1		
2		
3		
4		
5		
6		
7		

pass 0

- 0 → 1
- 0 → 4
- 0 → 7
- 1 → 2
- 1 → 3
- 1 → 7
- 2 → 3
- 2 → 6
- 3 → 6
- 4 → 5
- 4 → 6
- 4 → 7
- 5 → 2
- 5 → 6
- 7 → 5
- 7 → 2

# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2		
3		
4		
5		
6		
7		

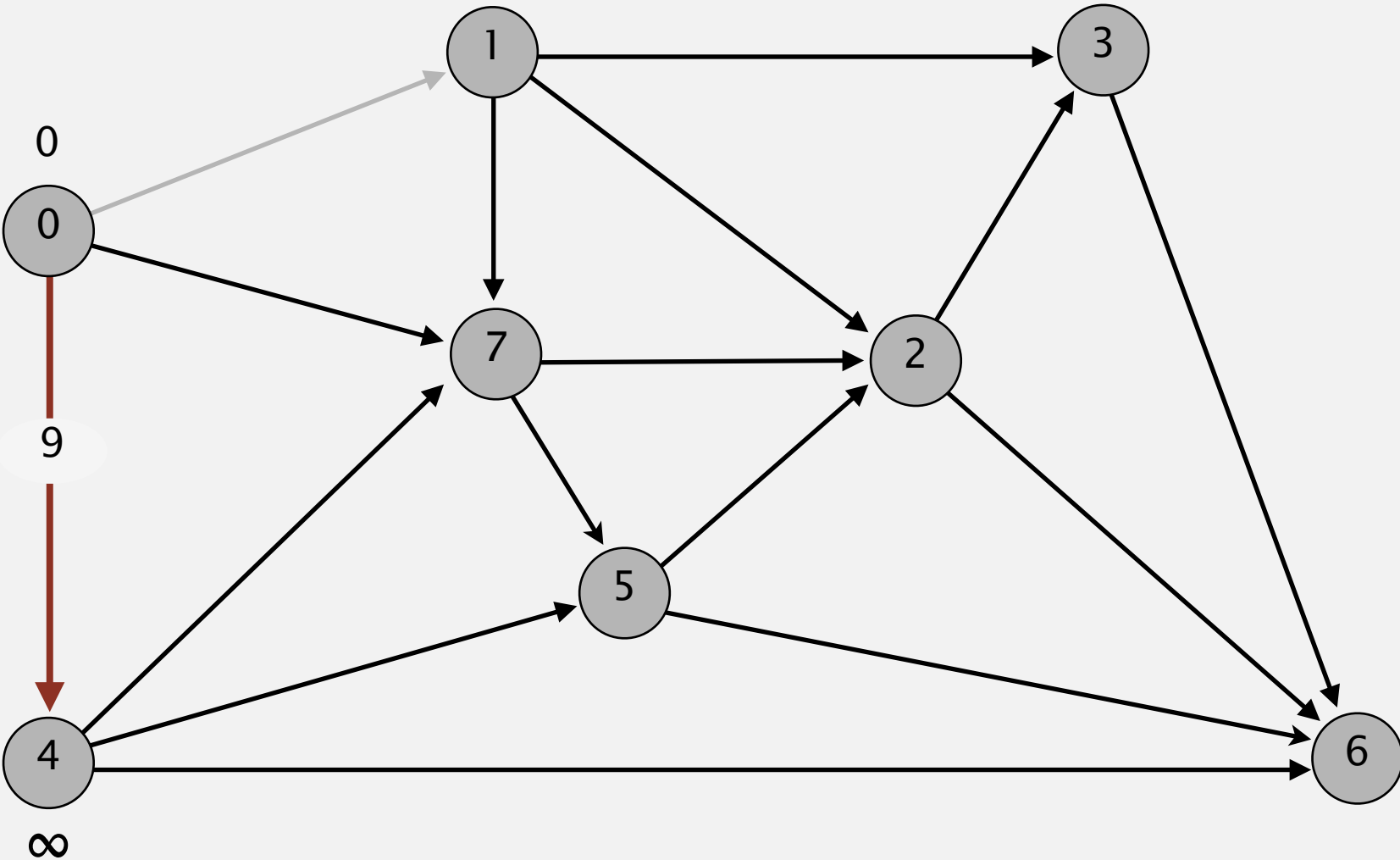
pass 0

- 0→1
- 0→4
- 0→7
- 1→2
- 1→3
- 1→7
- 2→3
- 2→6
- 3→6
- 4→5
- 4→6
- 4→7
- 5→2
- 5→6
- 7→5
- 7→2



# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



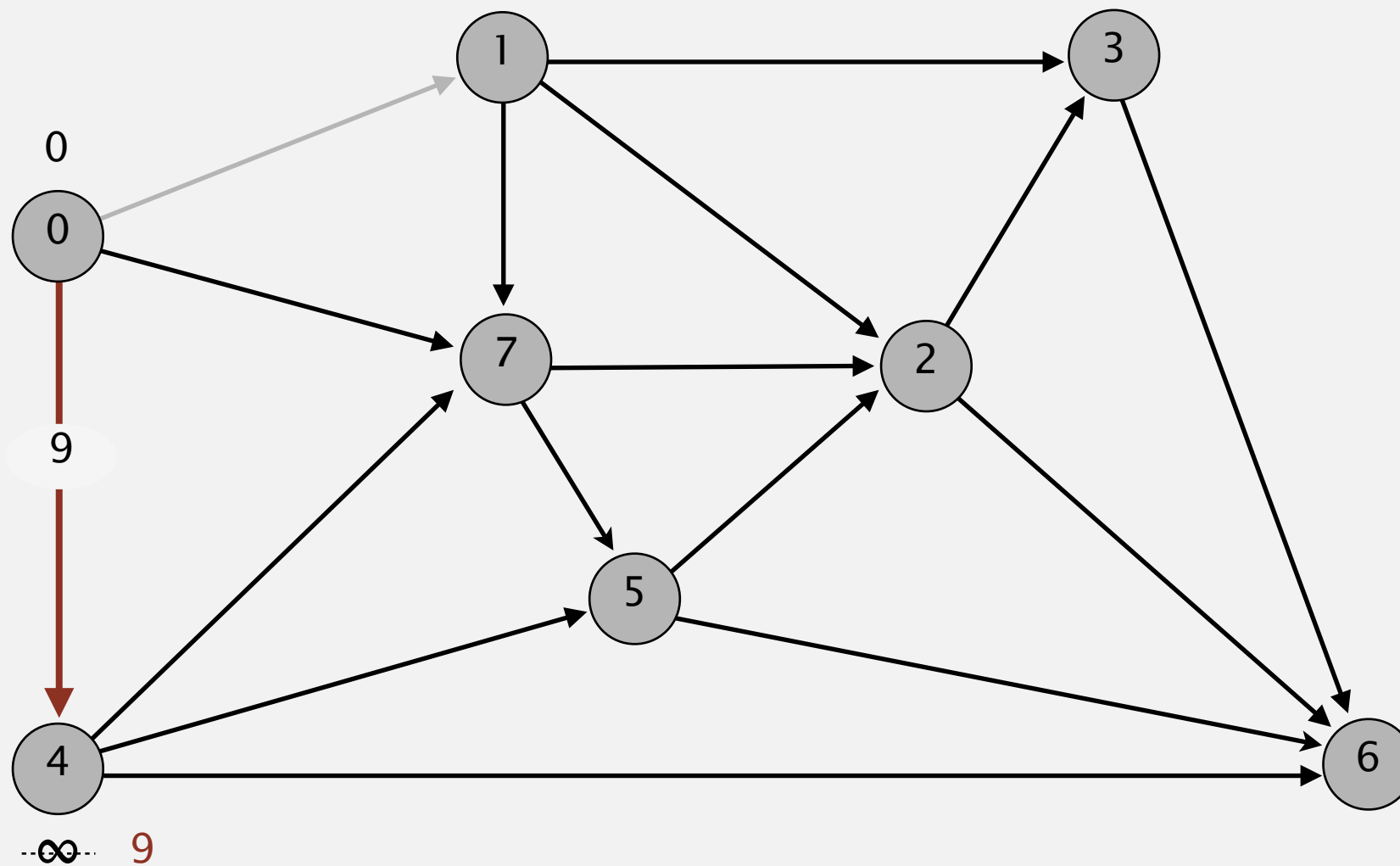
v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2		
3		
4		
5		
6		
7		

pass 0

- 0→1
- 0→4
- 0→7
- 1→2
- 1→3
- 1→7
- 2→3
- 2→6
- 3→6
- 4→5
- 4→6
- 4→7
- 5→2
- 5→6
- 7→5
- 7→2

# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2		
3		
4	9.0	0→4
5		
6		
7		

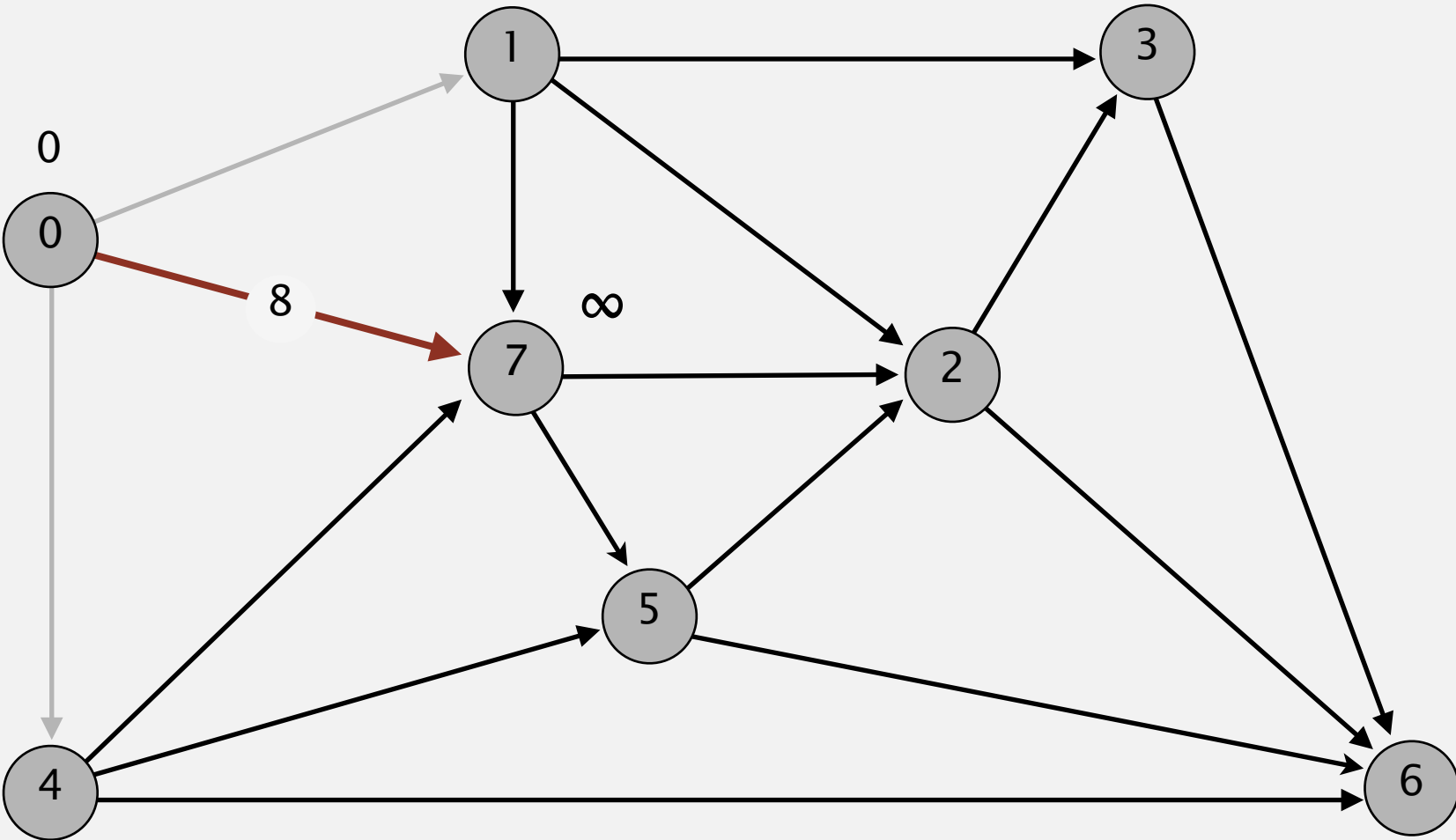
pass 0

0→1 0→4 0→7 1→2 1→3 1→7 2→3 2→6 3→6 4→5 4→6 4→7 5→2 5→6 7→5 7→2



# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2		
3		
4	9.0	0→4
5		
6		
7		

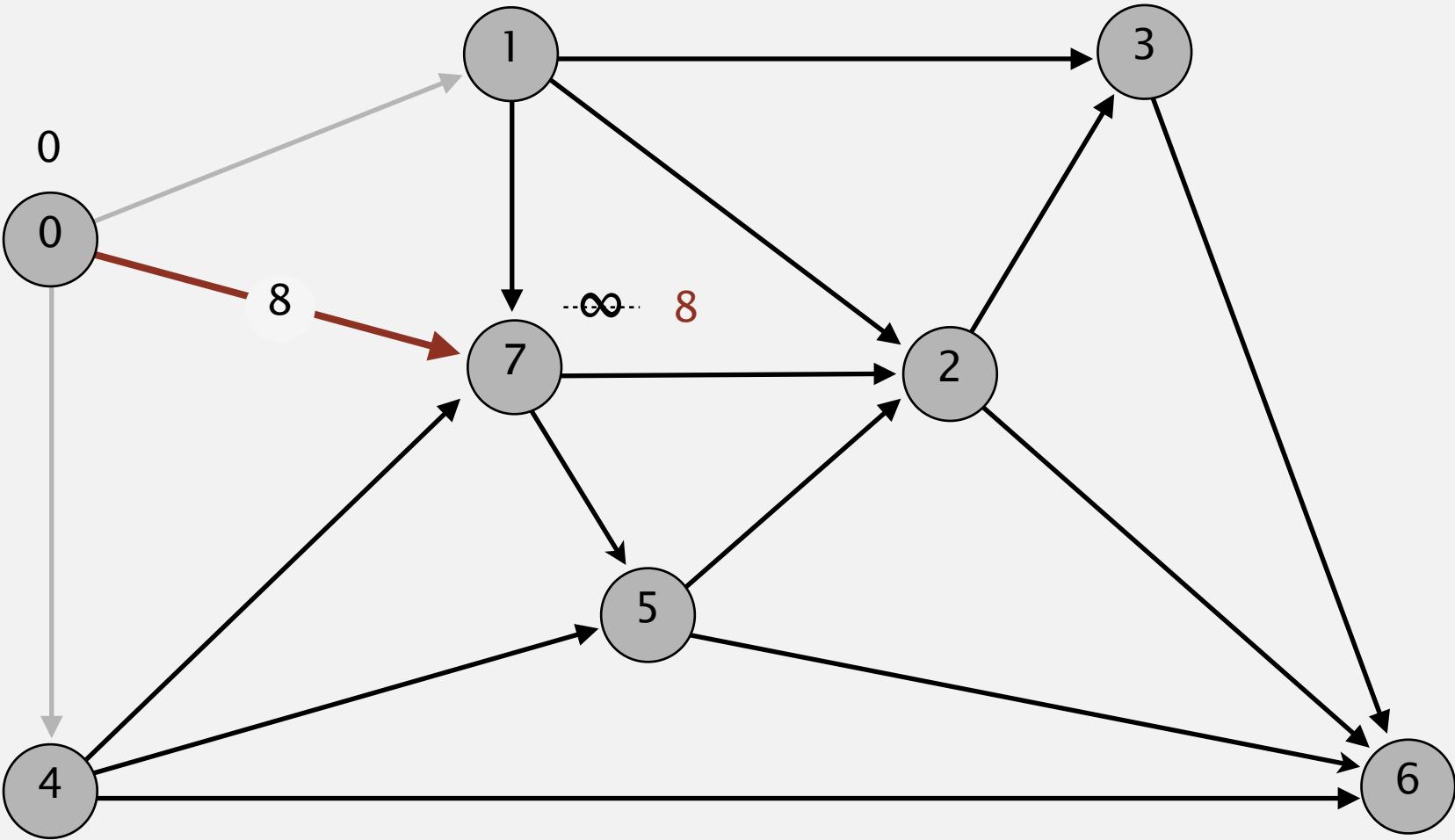
pass 0

- 0→1 0→4 0→7 1→2 1→3 1→7 2→3 2→6 3→6 4→5 4→6 4→7 5→2 5→6 7→5 7→2
- ↑



# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



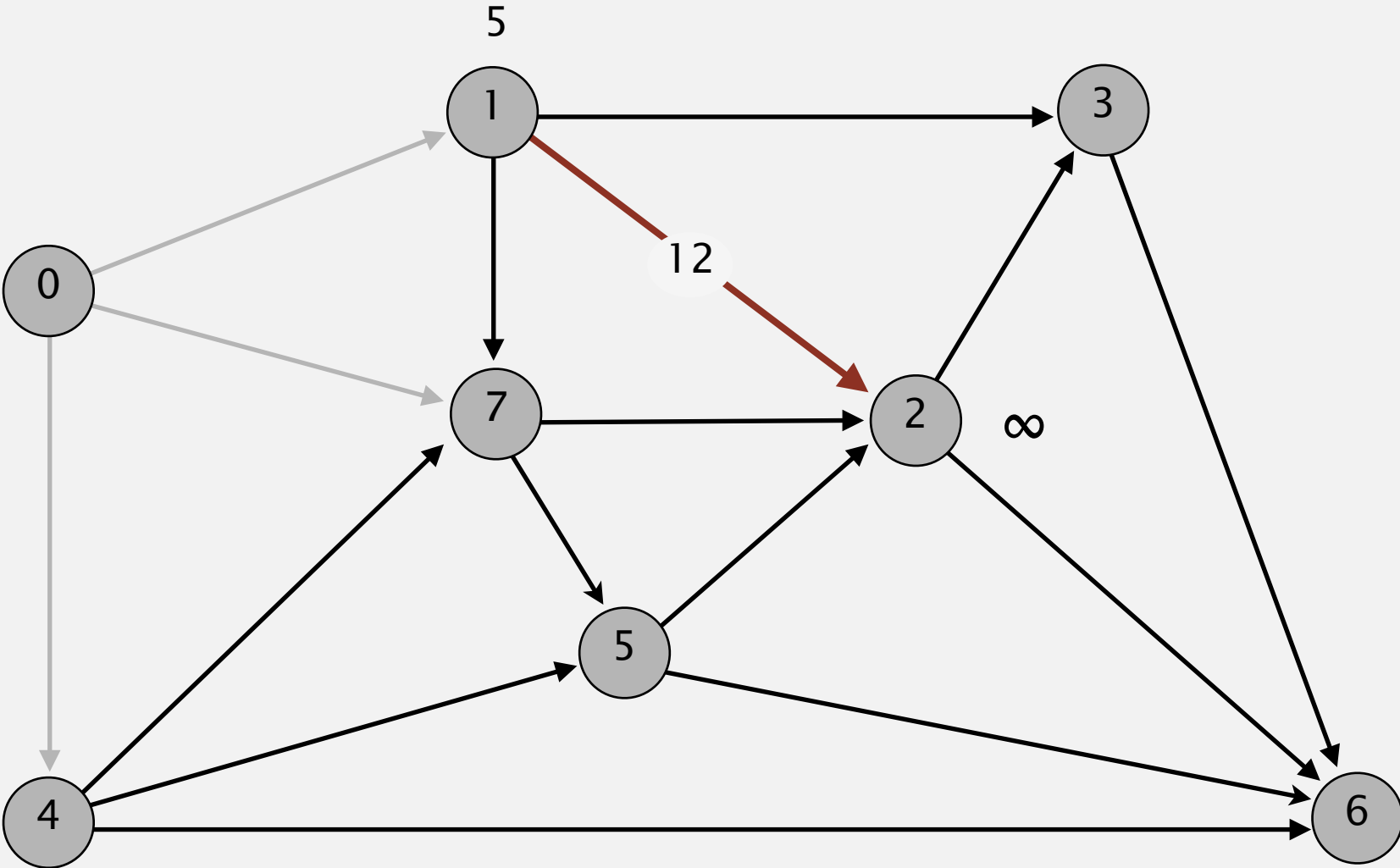
v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2		
3		
4	9.0	0→4
5		
6		
7	8.0	0→7

pass 0

- 0→1 0→4 0→7 1→2 1→3 1→7 2→3 2→6 3→6 4→5 4→6 4→7 5→2 5→6 7→5 7→2
- ↑

# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



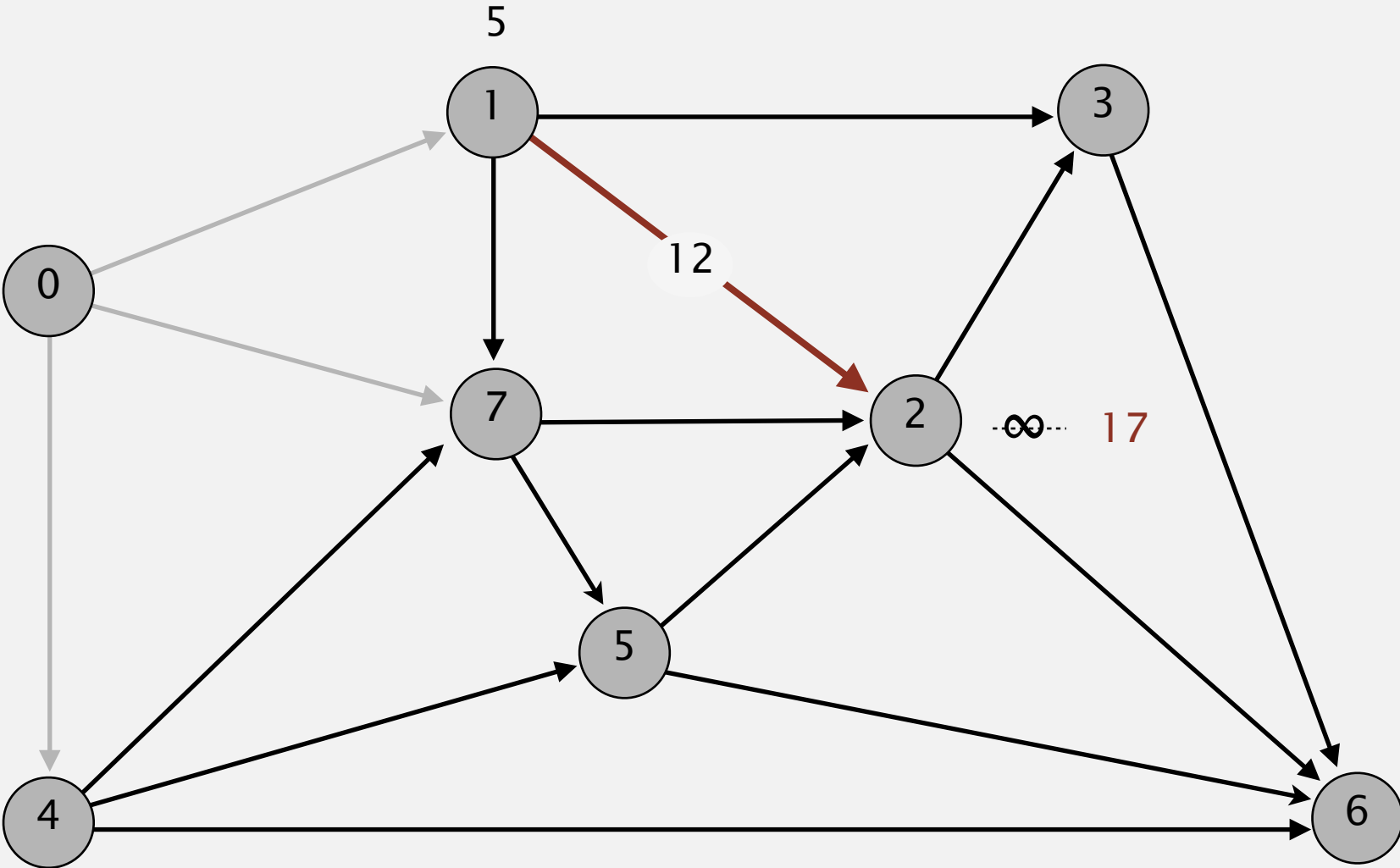
v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2		
3		
4	9.0	0→4
5		
6		
7	8.0	0→7

pass 0

- 0→1
  - 0→4
  - 0→7
  - 1→2
  - 1→3
  - 1→7
  - 2→3
  - 2→6
  - 3→6
  - 4→5
  - 4→6
  - 4→7
  - 5→2
  - 5→6
  - 7→5
  - 7→2
- ↑

# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	17.0	1→2
3		
4	9.0	0→4
5		
6		
7	8.0	0→7

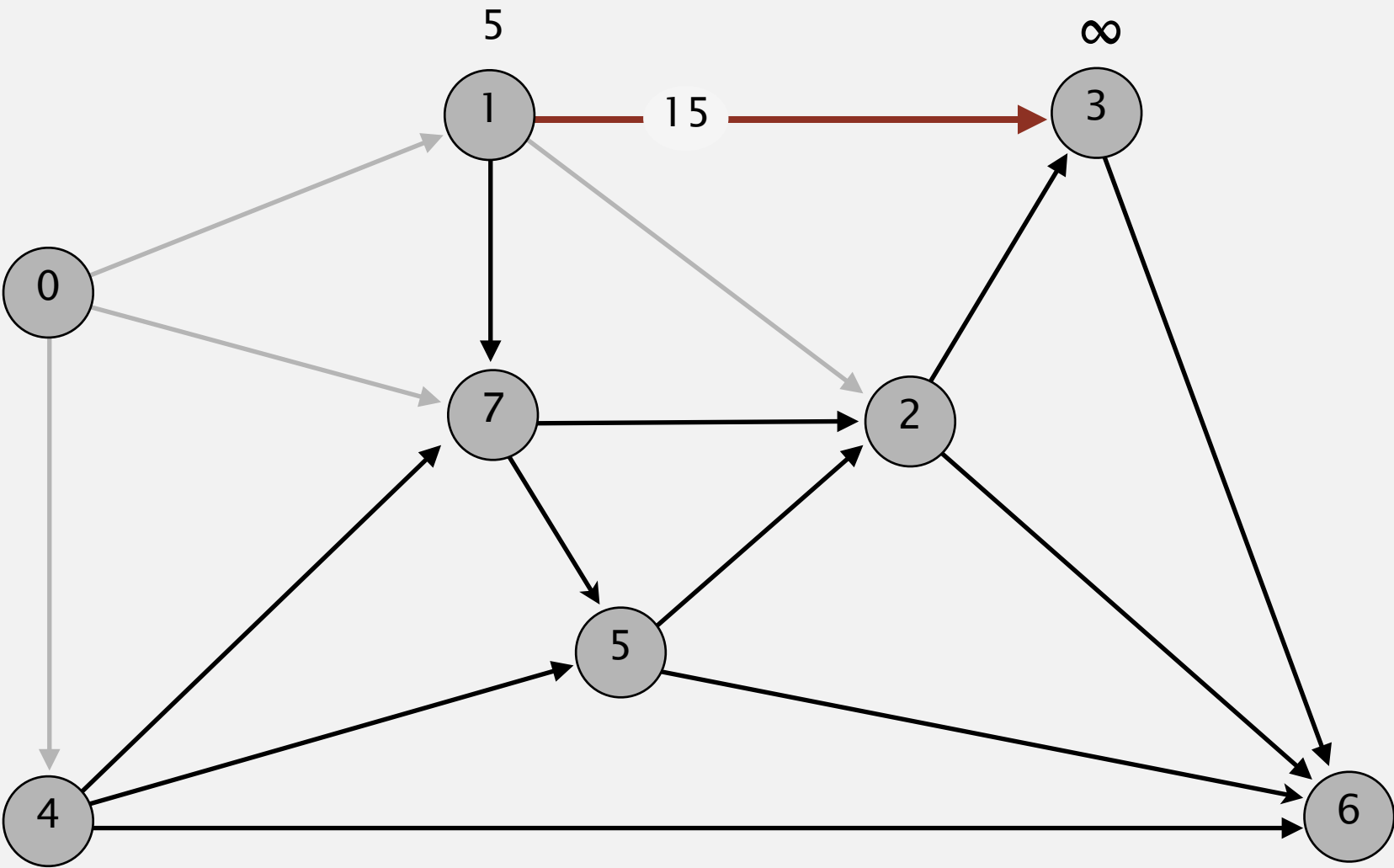
pass 0

- 0→1
- 0→4
- 0→7
- 1→2
- 1→3
- 1→7
- 2→3
- 2→6
- 3→6
- 4→5
- 4→6
- 4→7
- 5→2
- 5→6
- 7→5
- 7→2



# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



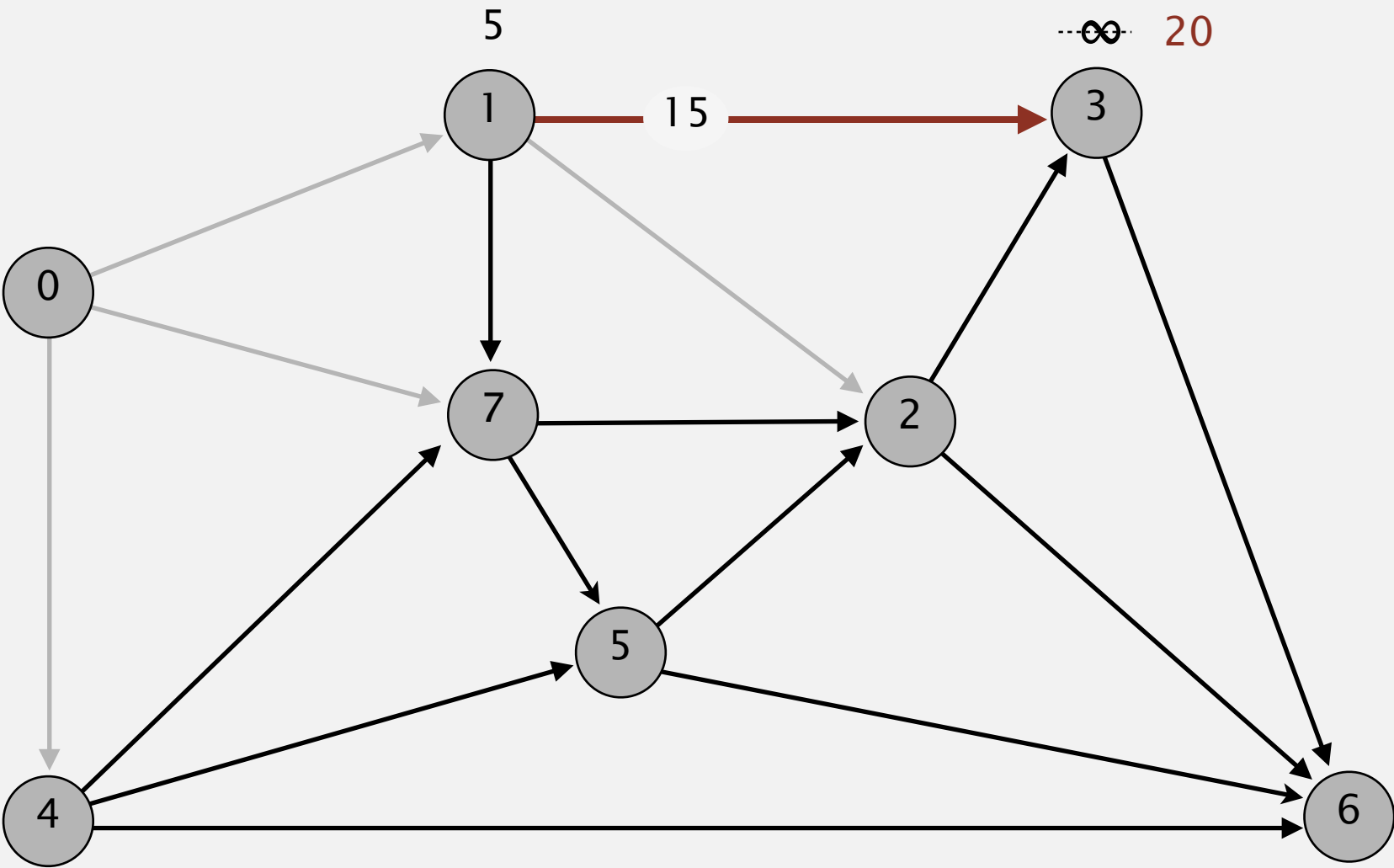
v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	17.0	1→2
3	∞	
4	9.0	0→4
5		
6		
7	8.0	0→7

pass 0

- 0→1 0→4 0→7 1→2 1→3 1→7 2→3 2→6 3→6 4→5 4→6 4→7 5→2 5→6 7→5 7→2
- ↑

# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



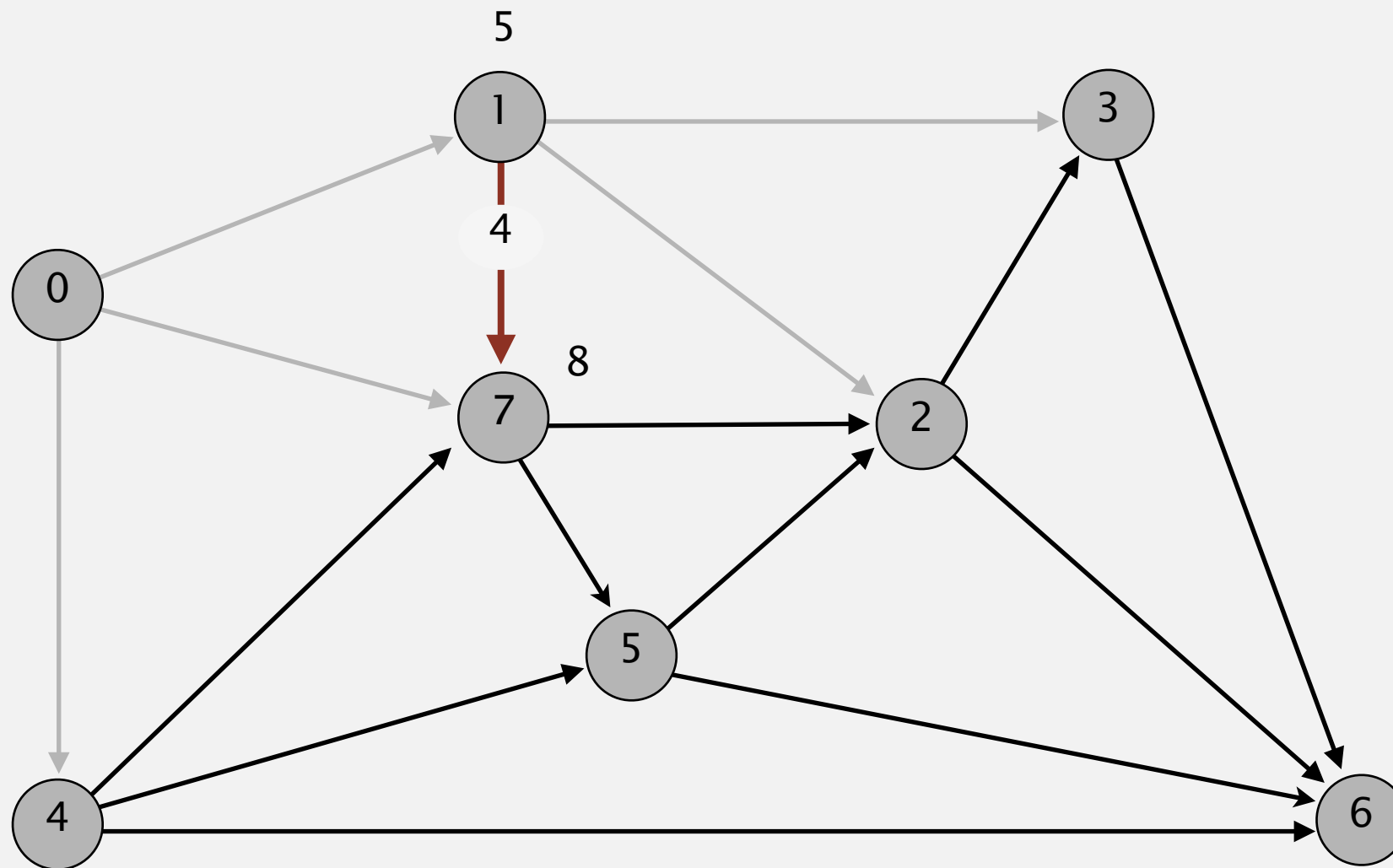
v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	17.0	1→2
3	20.0	1→3
4	9.0	0→4
5		
6		
7	8.0	0→7

pass 0

- 0→1 0→4 0→7 1→2 1→3 1→7 2→3 2→6 3→6 4→5 4→6 4→7 5→2 5→6 7→5 7→2
- ↑

# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



$v$	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	17.0	1→2
3	20.0	1→3
4	9.0	0→4
5		
6		
7	8.0	0→7

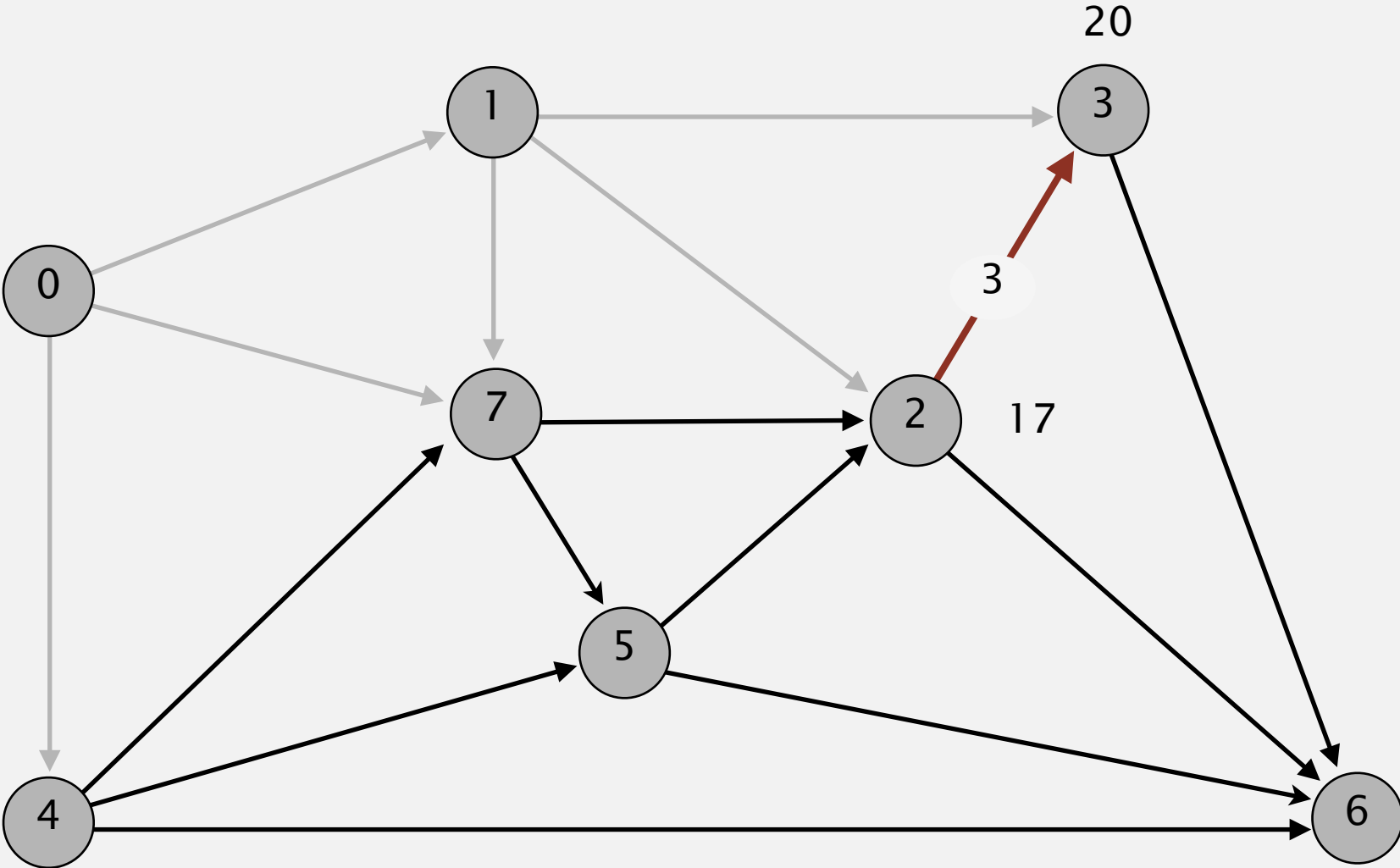
**pass 0**

0→1 0→4 0→7 1→2 1→3 1→7 2→3 2→6 3→6 4→5 4→6 4→7 5→2 5→6 7→5 7→2



# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	17.0	1→2
3	20.0	1→3
4	9.0	0→4
5		
6		
7	8.0	0→7

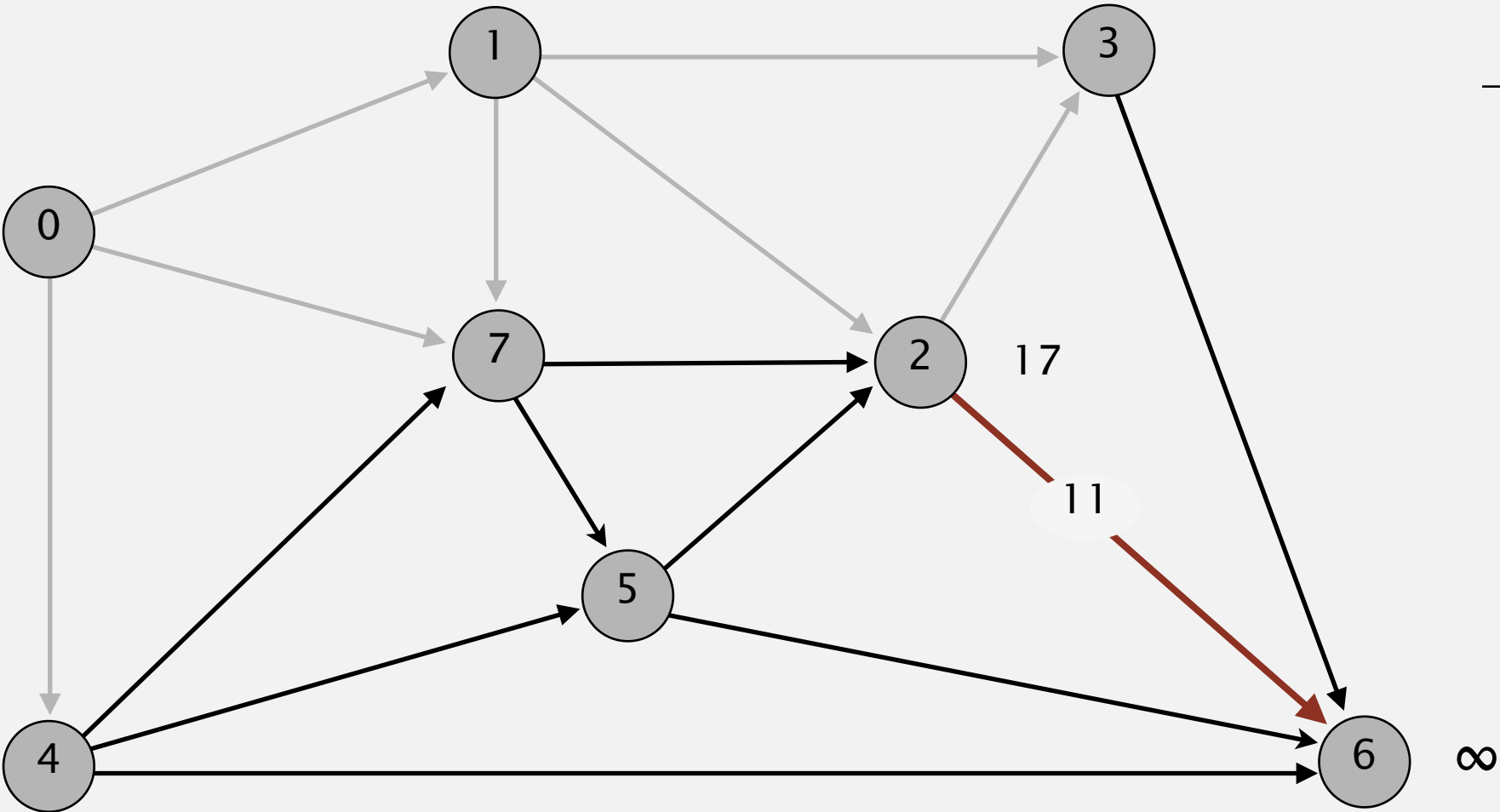
pass 0

- 0→1
- 0→4
- 0→7
- 1→2
- 1→3
- 1→7
- 2→3
- 2→6
- 3→6
- 4→5
- 4→6
- 4→7
- 5→2
- 5→6
- 7→5
- 7→2



# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	17.0	1→2
3	20.0	1→3
4	9.0	0→4
5		
6		
7	8.0	0→7

pass 0

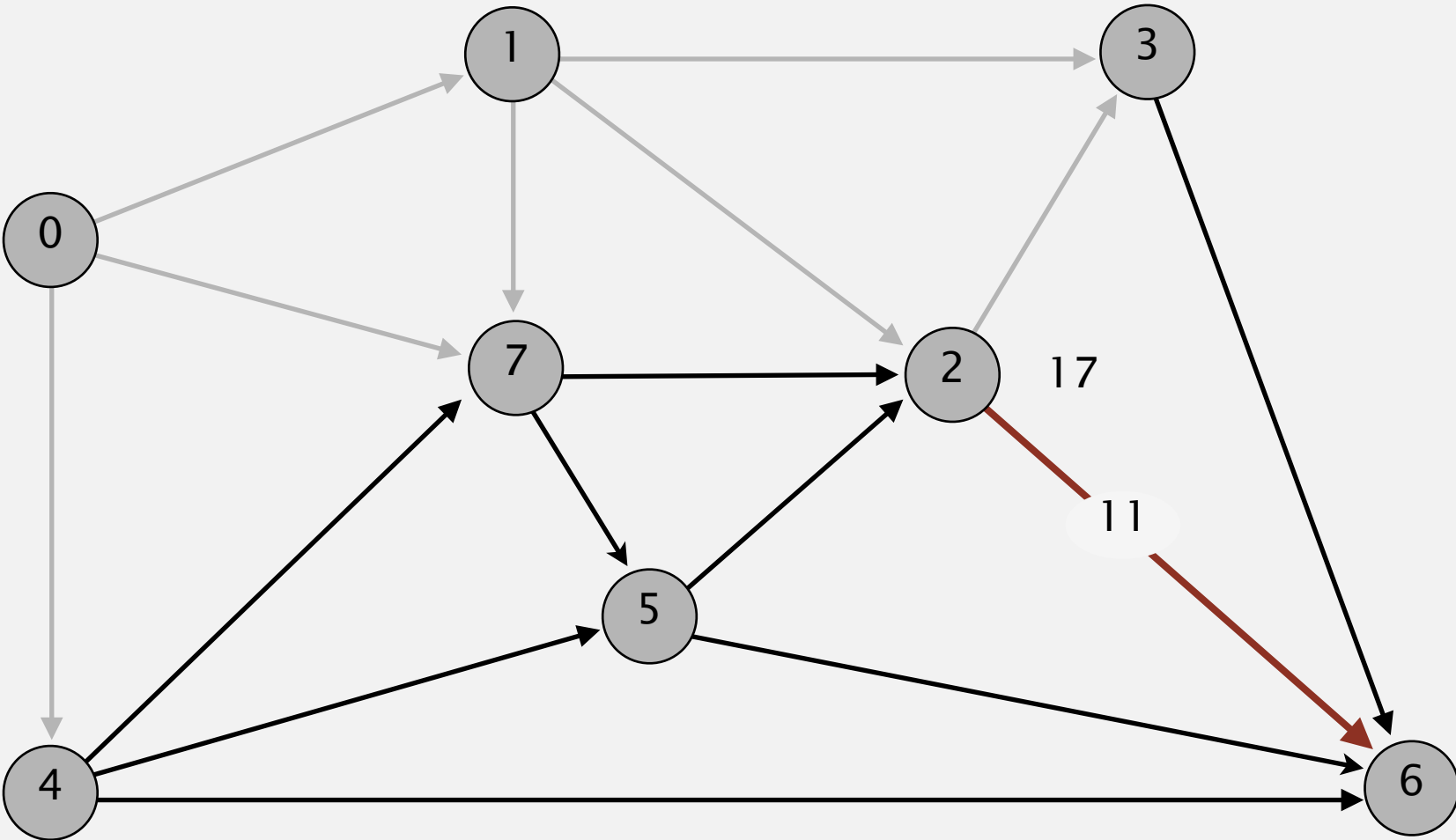
0→1 0→4 0→7 1→2 1→3 1→7 2→3 2→6 3→6 4→5 4→6 4→7 5→2 5→6 7→5 7→2





# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	17.0	1→2
3	20.0	1→3
4	9.0	0→4
5		
6	28.0	2→6
7	8.0	0→7

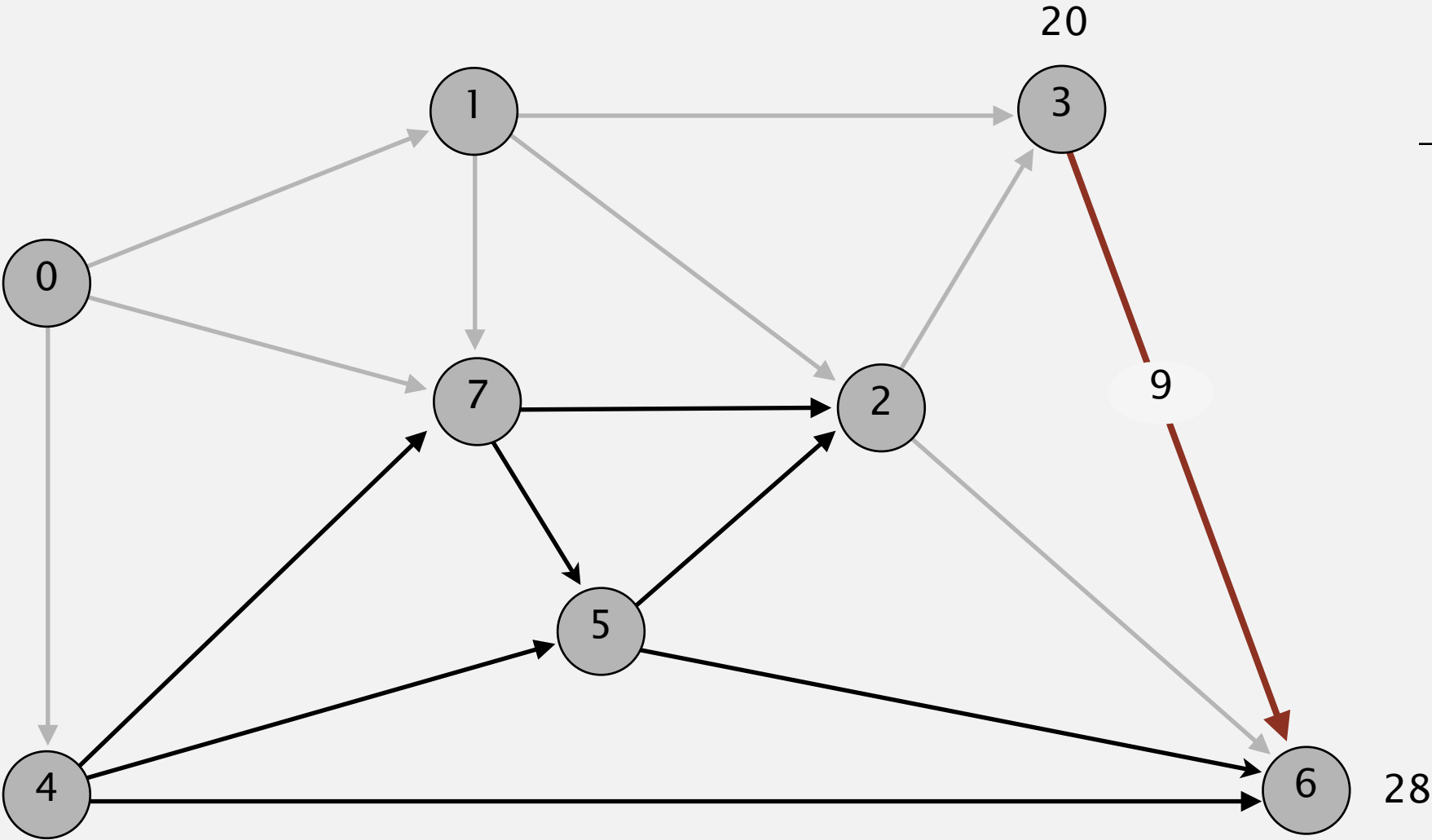
pass 0

- 0→1
- 0→4
- 0→7
- 1→2
- 1→3
- 1→7
- 2→3
- 2→6
- 3→6
- 4→5
- 4→6
- 4→7
- 5→2
- 5→6
- 7→5
- 7→2



# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	17.0	1→2
3	20.0	1→3
4	9.0	0→4
5		
6	28.0	2→6
7	8.0	0→7

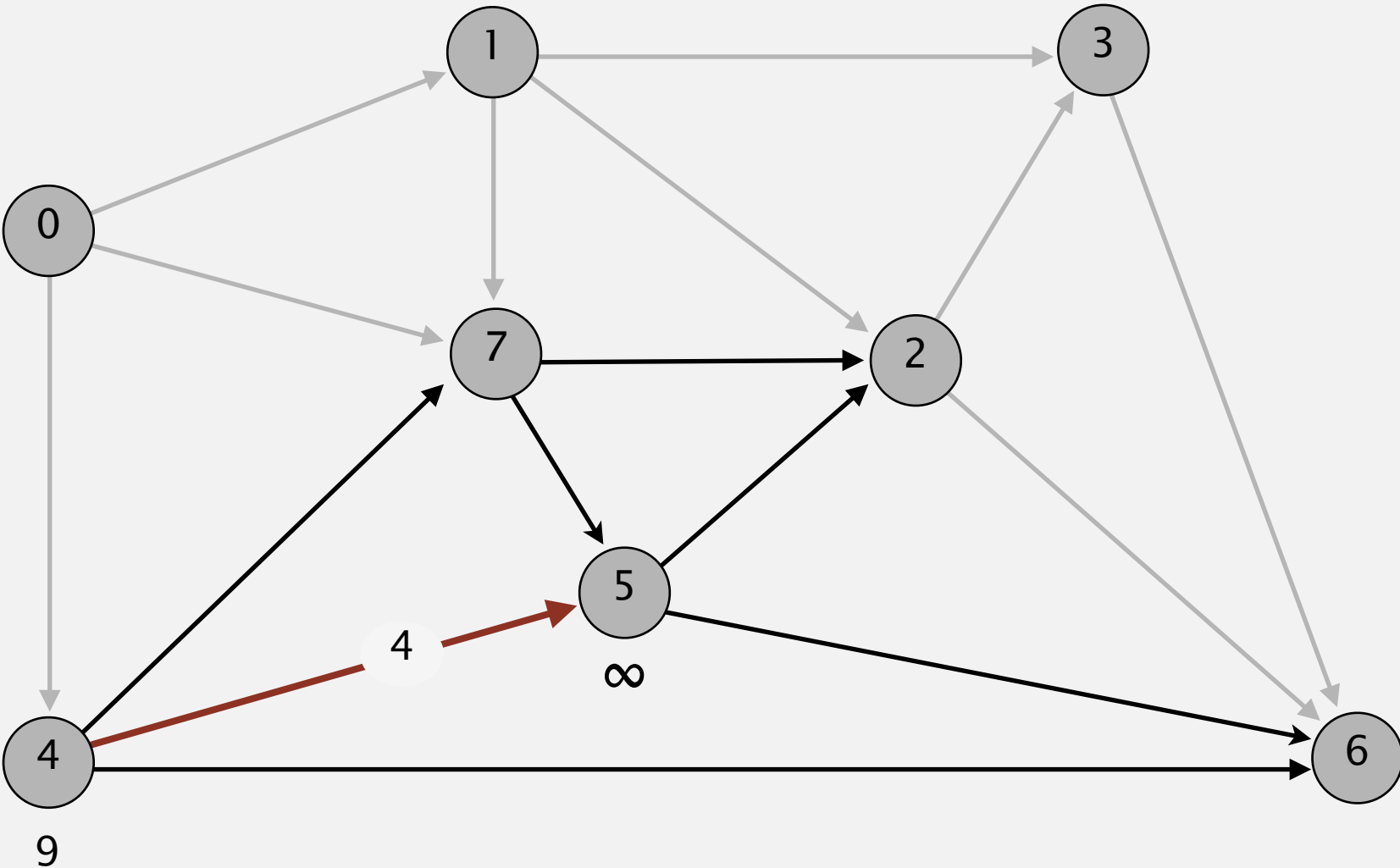
pass 0

0→1 0→4 0→7 1→2 1→3 1→7 2→3 2→6 3→6 4→5 4→6 4→7 5→2 5→6 7→5 7→2



# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	17.0	1→2
3	20.0	1→3
4	9.0	0→4
5		
6	28.0	2→6
7	8.0	0→7

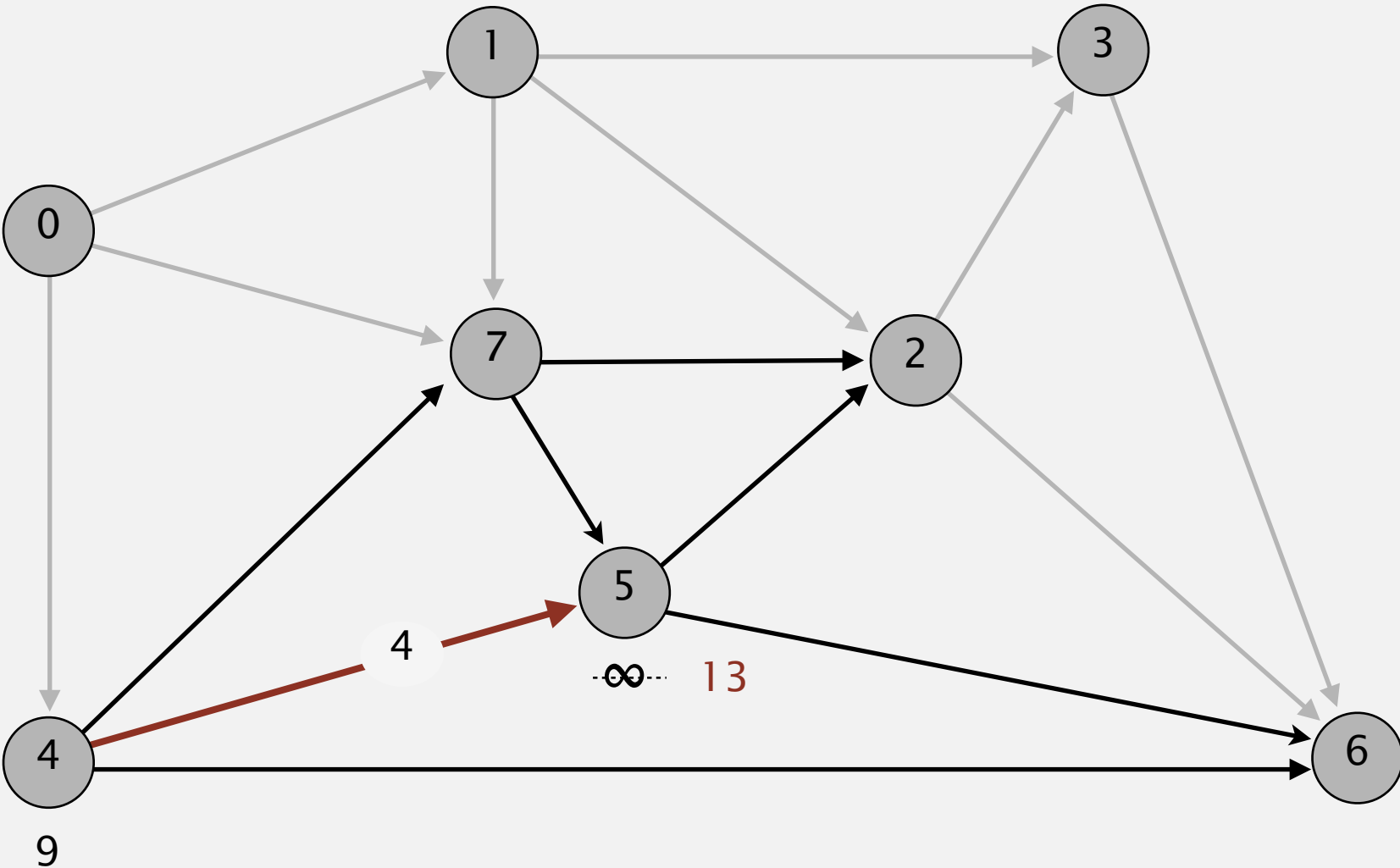
pass 0

- 0→1 0→4 0→7 1→2 1→3 1→7 2→3 2→6 3→6 4→5 4→6 4→7 5→2 5→6 7→5 7→2



# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



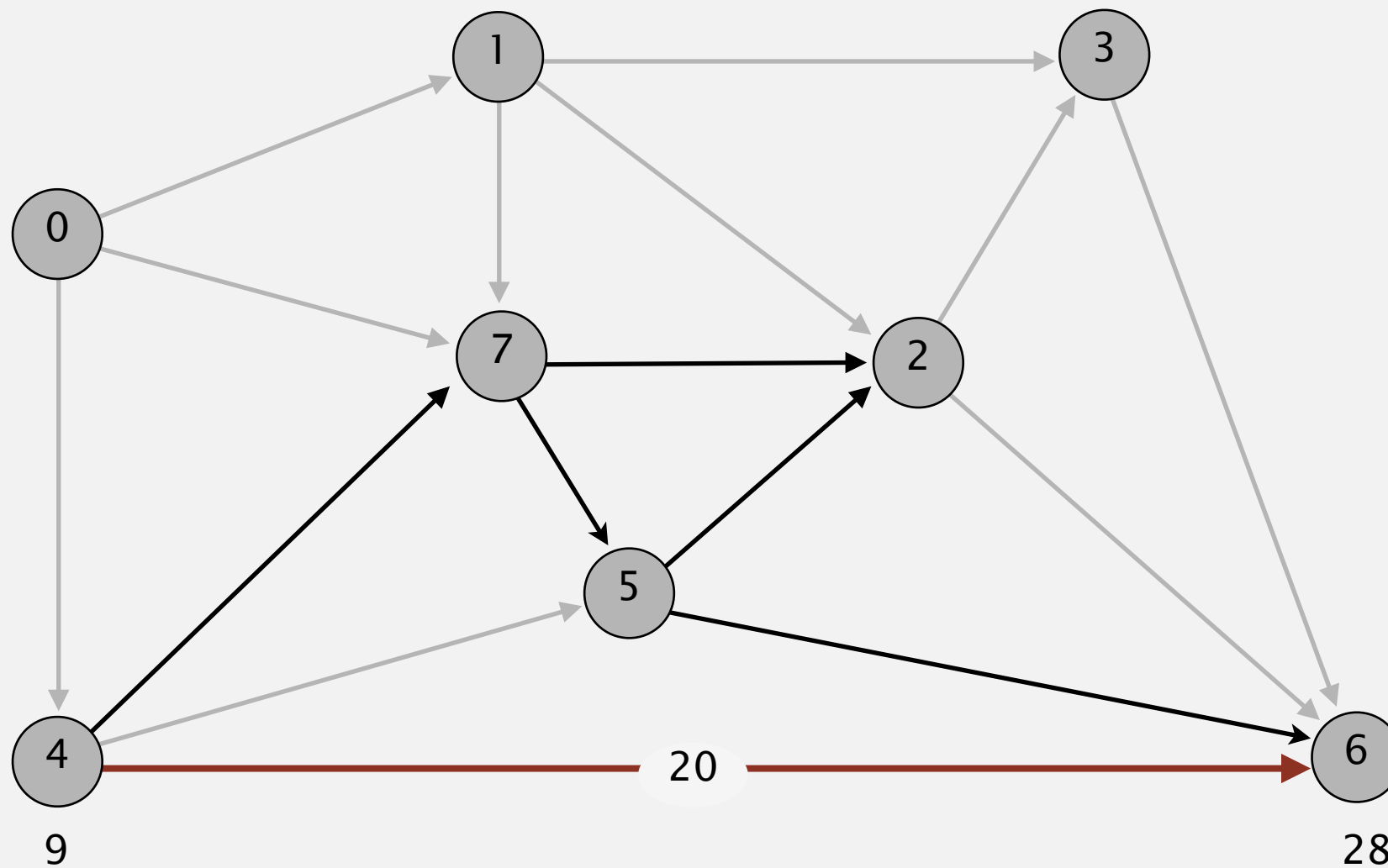
v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	17.0	1→2
3	20.0	1→3
4	9.0	0→4
5	13.0	4→5
6	28.0	2→6
7	8.0	0→7

pass 0

- 0→1
- 0→4
- 0→7
- 1→2
- 1→3
- 1→7
- 2→3
- 2→6
- 3→6
- 4→5
- 4→6
- 4→7
- 5→2
- 5→6
- 7→5
- 7→2

# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	17.0	1→2
3	20.0	1→3
4	9.0	0→4
5	13.0	4→5
6	28.0	2→6
7	8.0	0→7

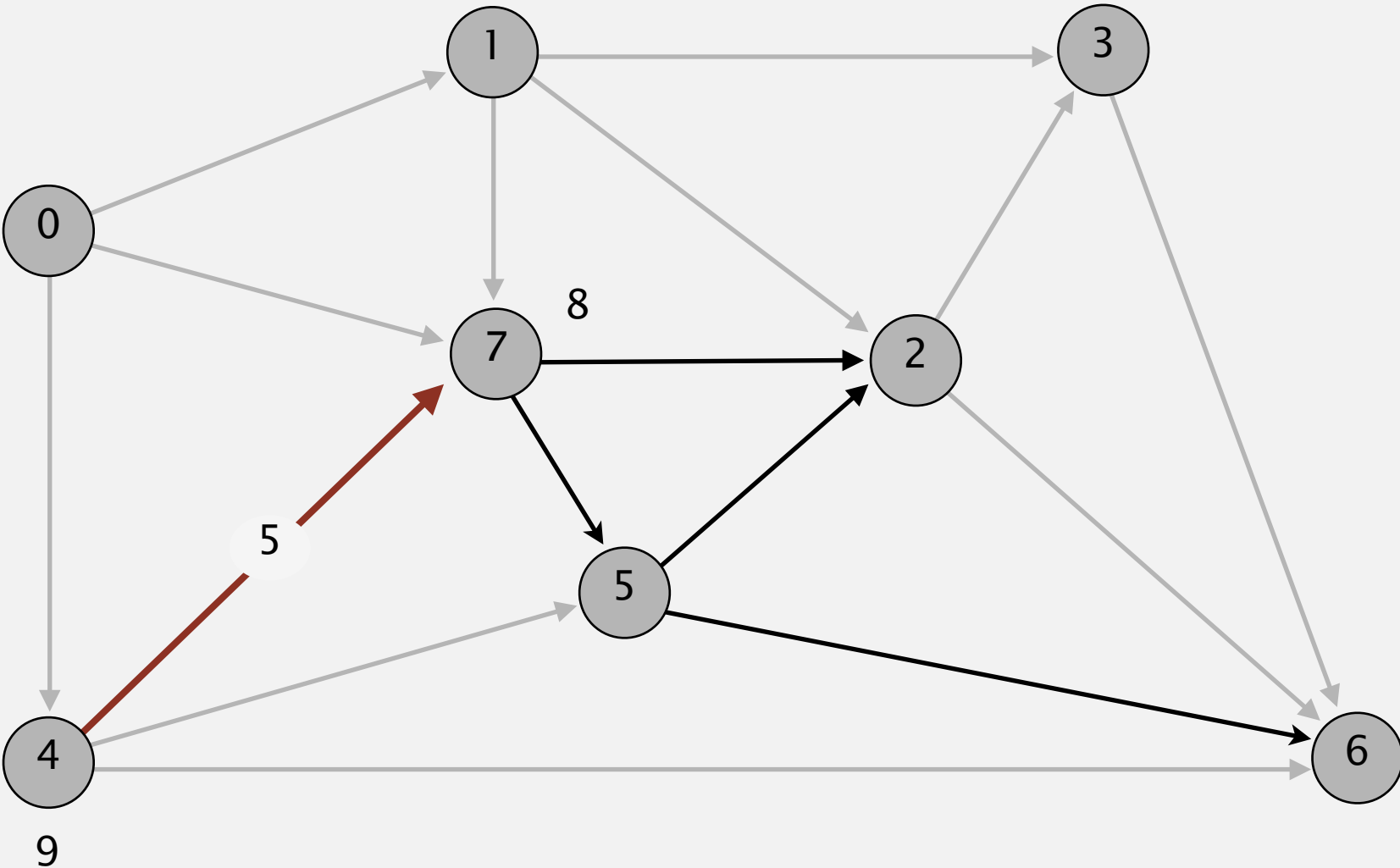
**pass 0**

0→1 0→4 0→7 1→2 1→3 1→7 2→3 2→6 3→6 4→5 4→6 4→7 5→2 5→6 7→5 7→2



# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	17.0	1→2
3	20.0	1→3
4	9.0	0→4
5	13.0	4→5
6	28.0	2→6
7	8.0	0→7

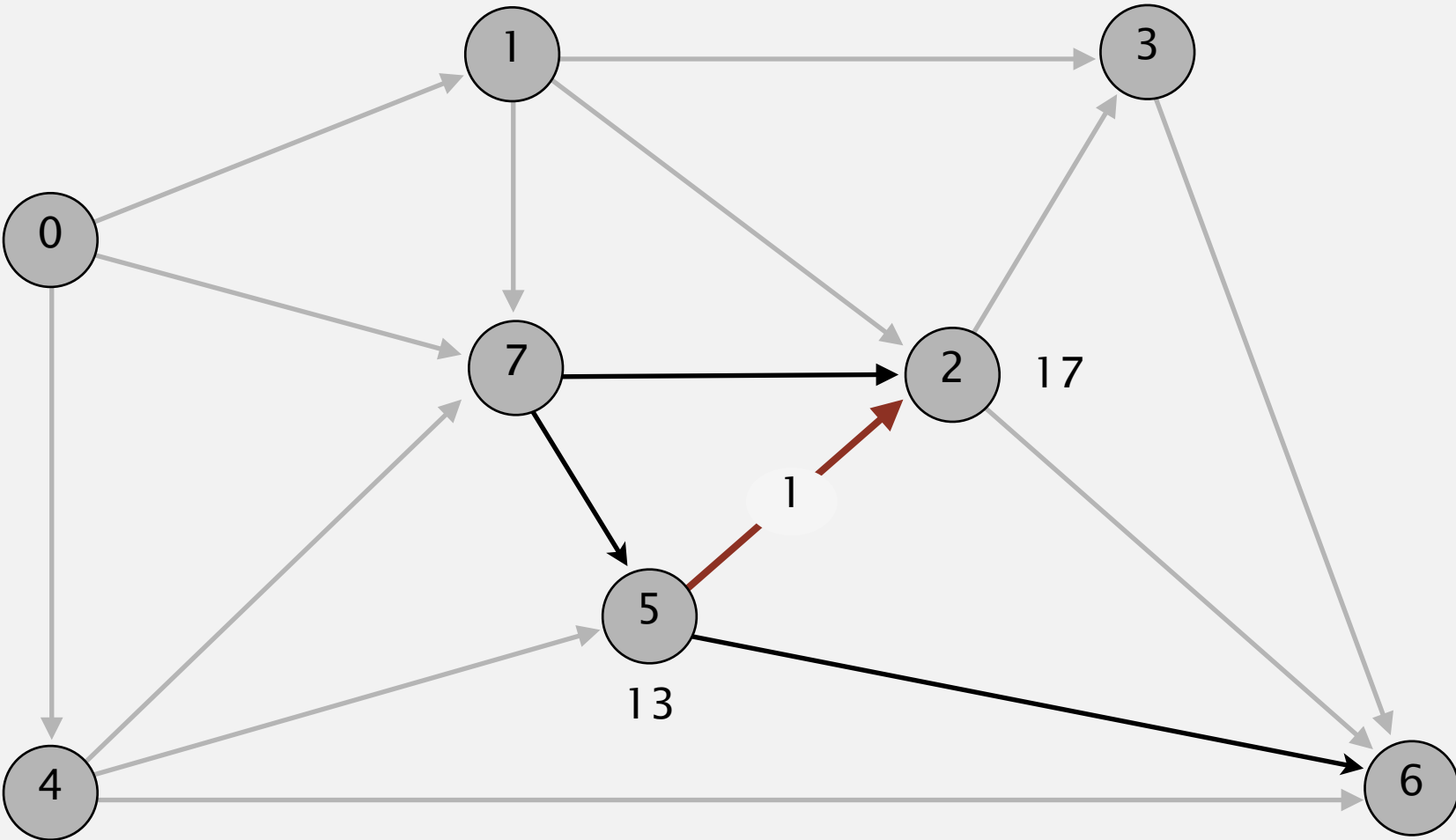
pass 0

- 0→1
- 0→4
- 0→7
- 1→2
- 1→3
- 1→7
- 2→3
- 2→6
- 3→6
- 4→5
- 4→6
- 4→7
- 5→2
- 5→6
- 7→5
- 7→2



# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	17.0	1→2
3	20.0	1→3
4	9.0	0→4
5	13.0	4→5
6	28.0	2→6
7	8.0	0→7

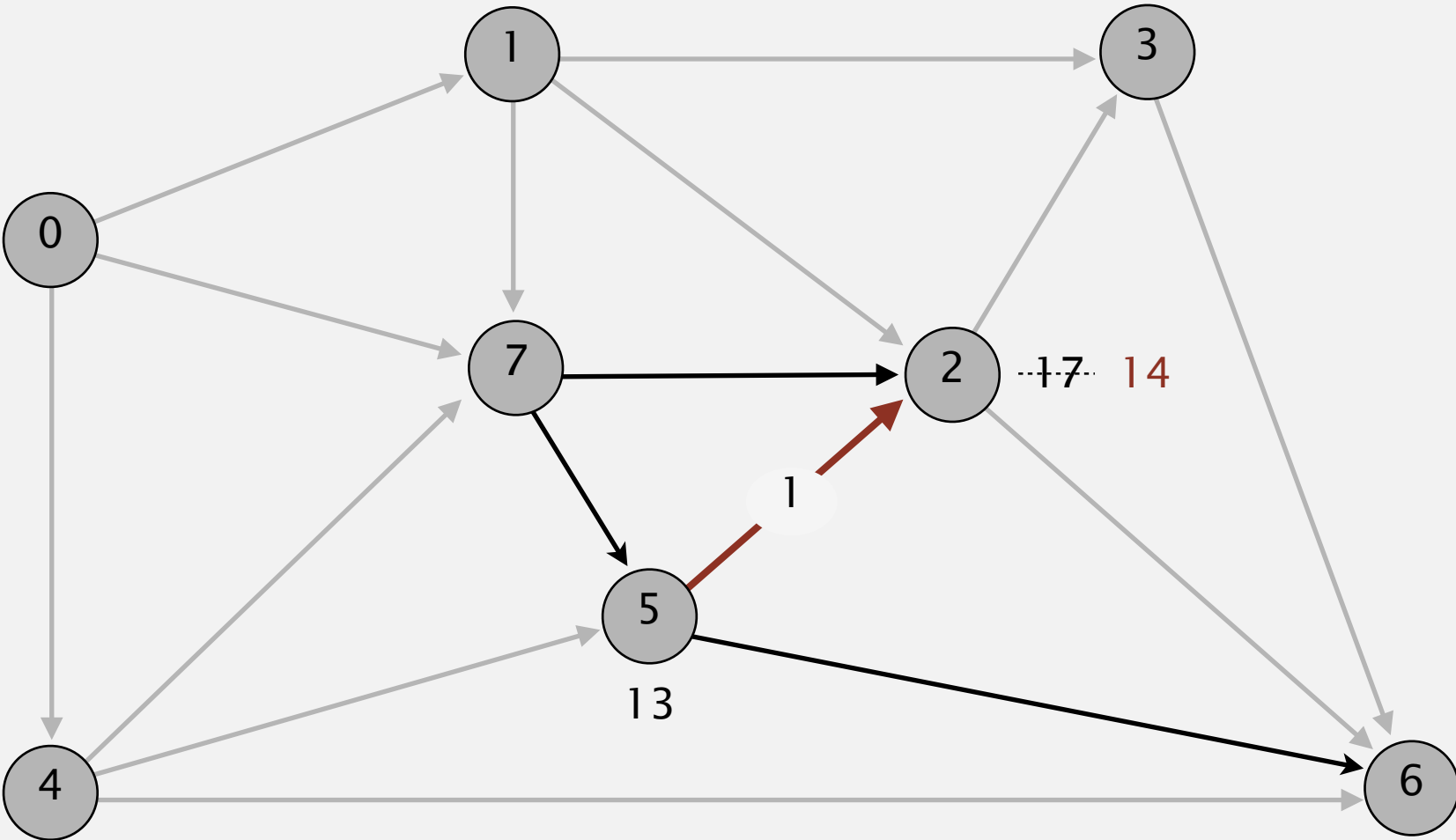
pass 0

0→1 0→4 0→7 1→2 1→3 1→7 2→3 2→6 3→6 4→5 4→6 4→7 5→2 5→6 7→5 7→2



# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	14.0	5→2
3	20.0	1→3
4	9.0	0→4
5	13.0	4→5
6	28.0	2→6
7	8.0	0→7

pass 0

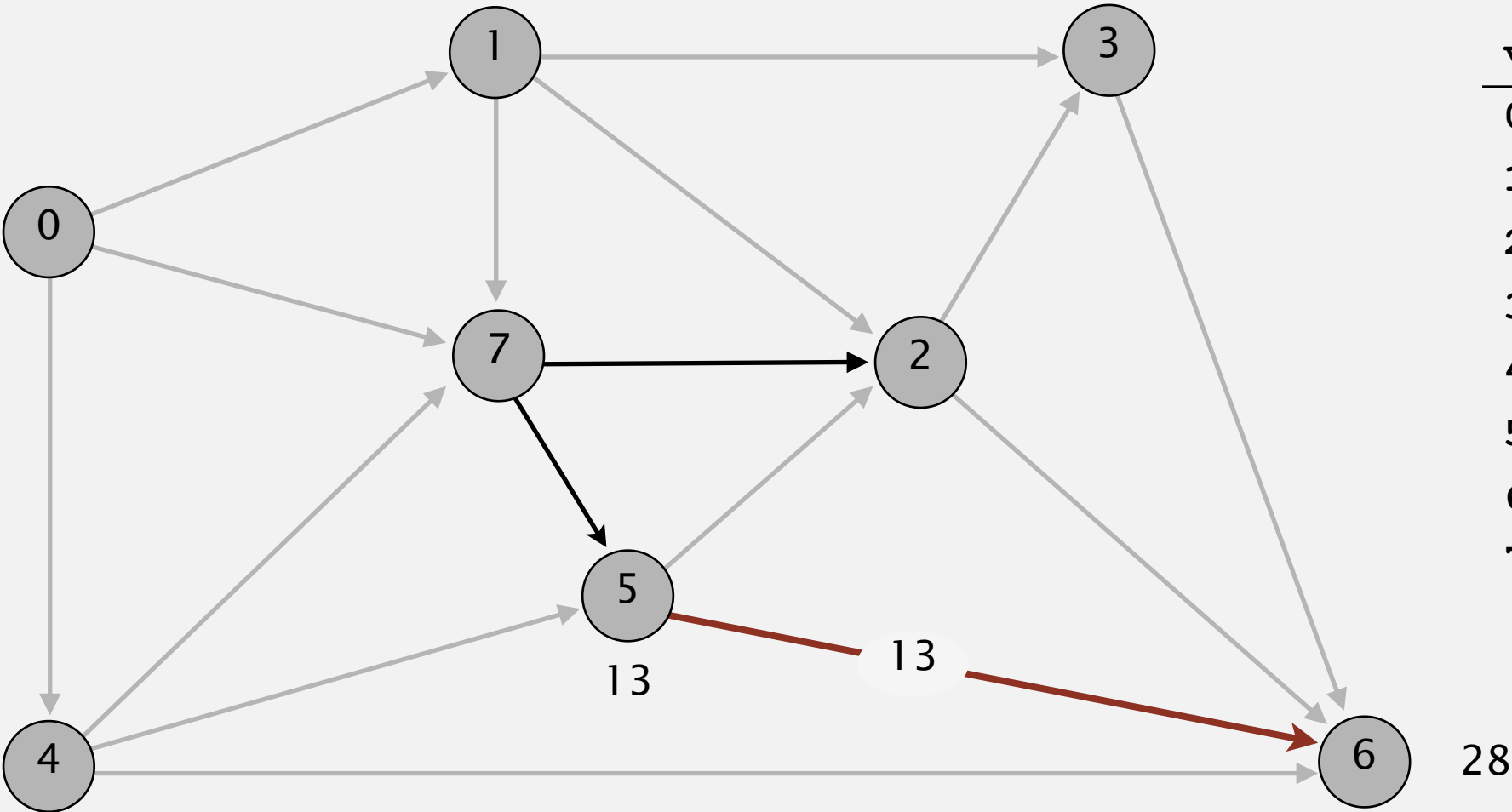
- 0→1
- 0→4
- 0→7
- 1→2
- 1→3
- 1→7
- 2→3
- 2→6
- 3→6
- 4→5
- 4→6
- 4→7
- 5→2
- 5→6
- 7→5
- 7→2





# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	14.0	5→2
3	20.0	1→3
4	9.0	0→4
5	13.0	4→5
6	28.0	2→6
7	8.0	0→7

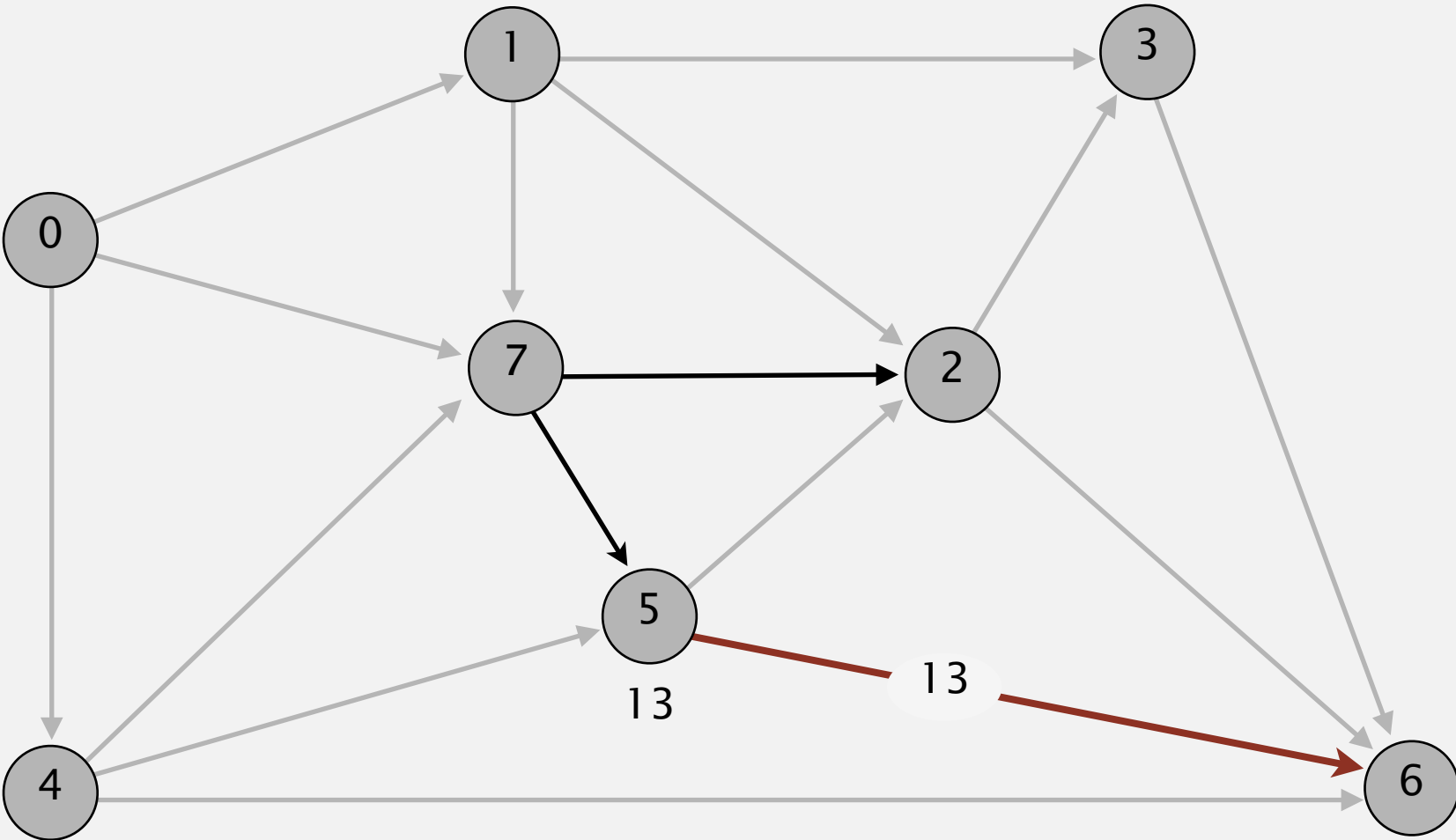
pass 0

- 0→1
- 0→4
- 0→7
- 1→2
- 1→3
- 1→7
- 2→3
- 2→6
- 3→6
- 4→5
- 4→6
- 4→7
- 5→2
- 5→6
- 7→5
- 7→2



# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	14.0	5→2
3	20.0	1→3
4	9.0	0→4
5	13.0	4→5
6	26.0	5→6
7	8.0	0→7

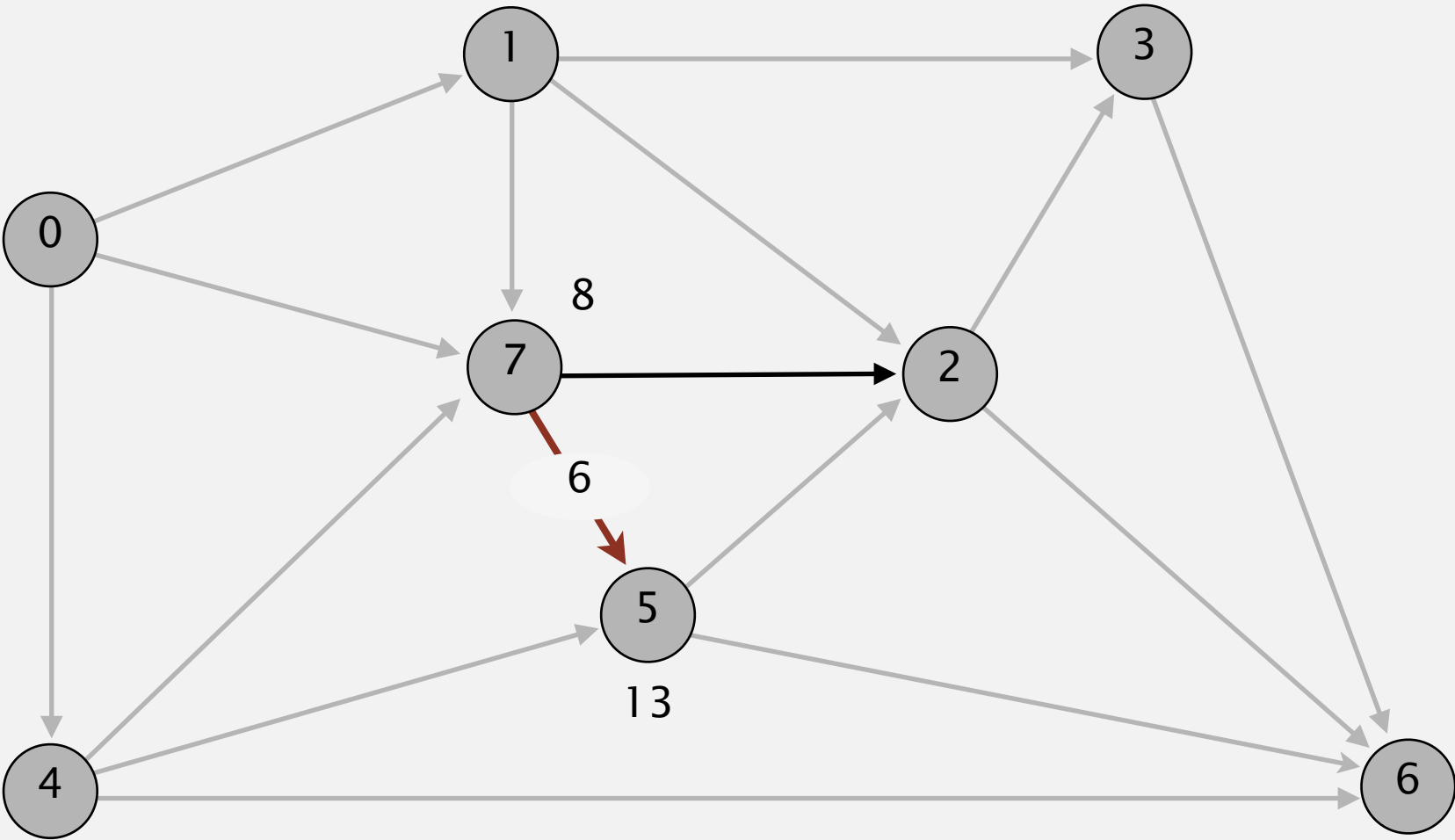
pass 0

- 0→1
- 0→4
- 0→7
- 1→2
- 1→3
- 1→7
- 2→3
- 2→6
- 3→6
- 4→5
- 4→6
- 4→7
- 5→2
- 5→6
- 7→5
- 7→2



# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	14.0	5→2
3	20.0	1→3
4	9.0	0→4
5	13.0	4→5
6	26.0	5→6
7	8.0	0→7

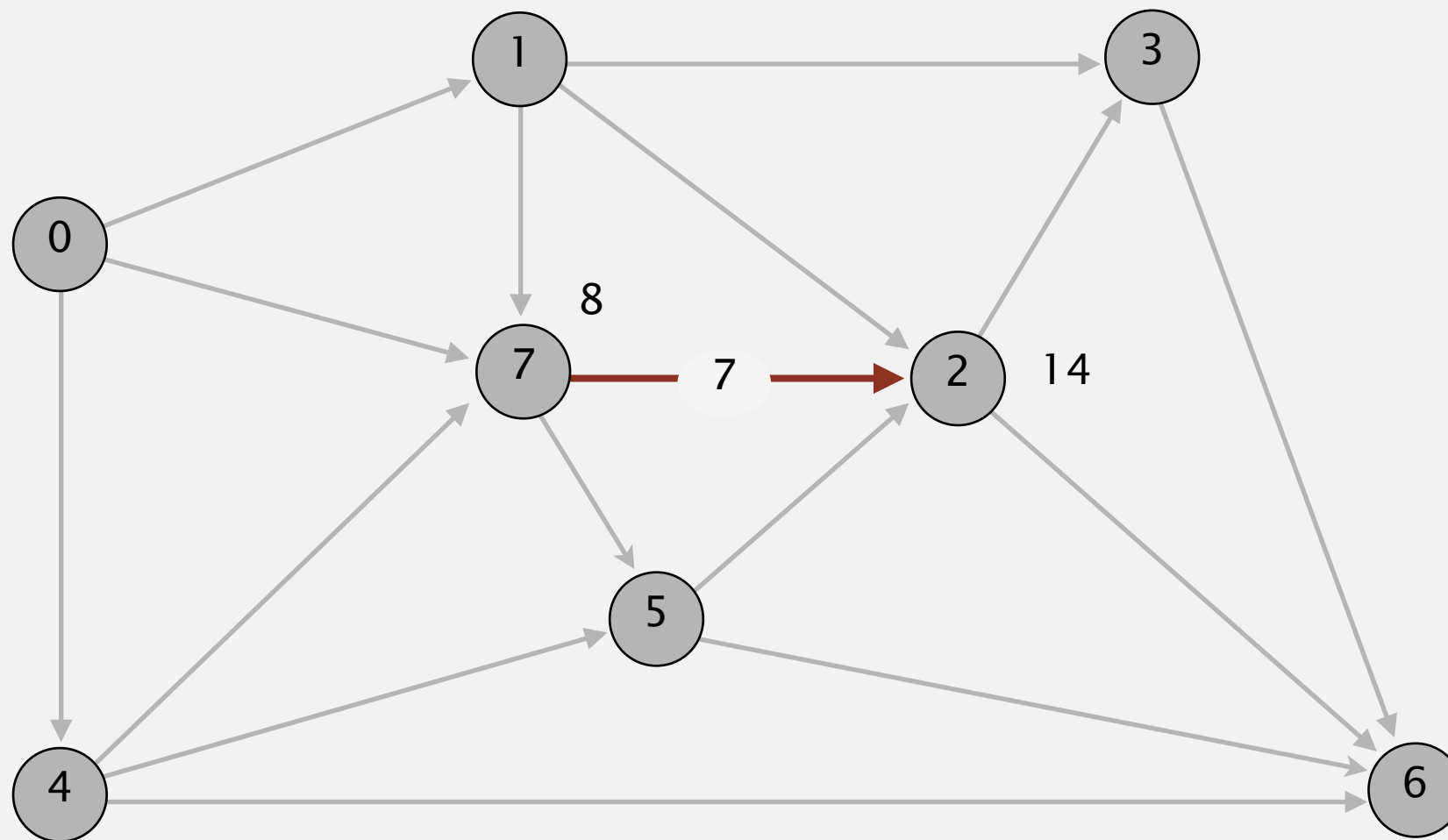
pass 0

0→1 0→4 0→7 1→2 1→3 1→7 2→3 2→6 3→6 4→5 4→6 4→7 5→2 5→6 7→5 7→2



# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	14.0	5→2
3	20.0	1→3
4	9.0	0→4
5	13.0	4→5
6	26.0	5→6
7	8.0	0→7

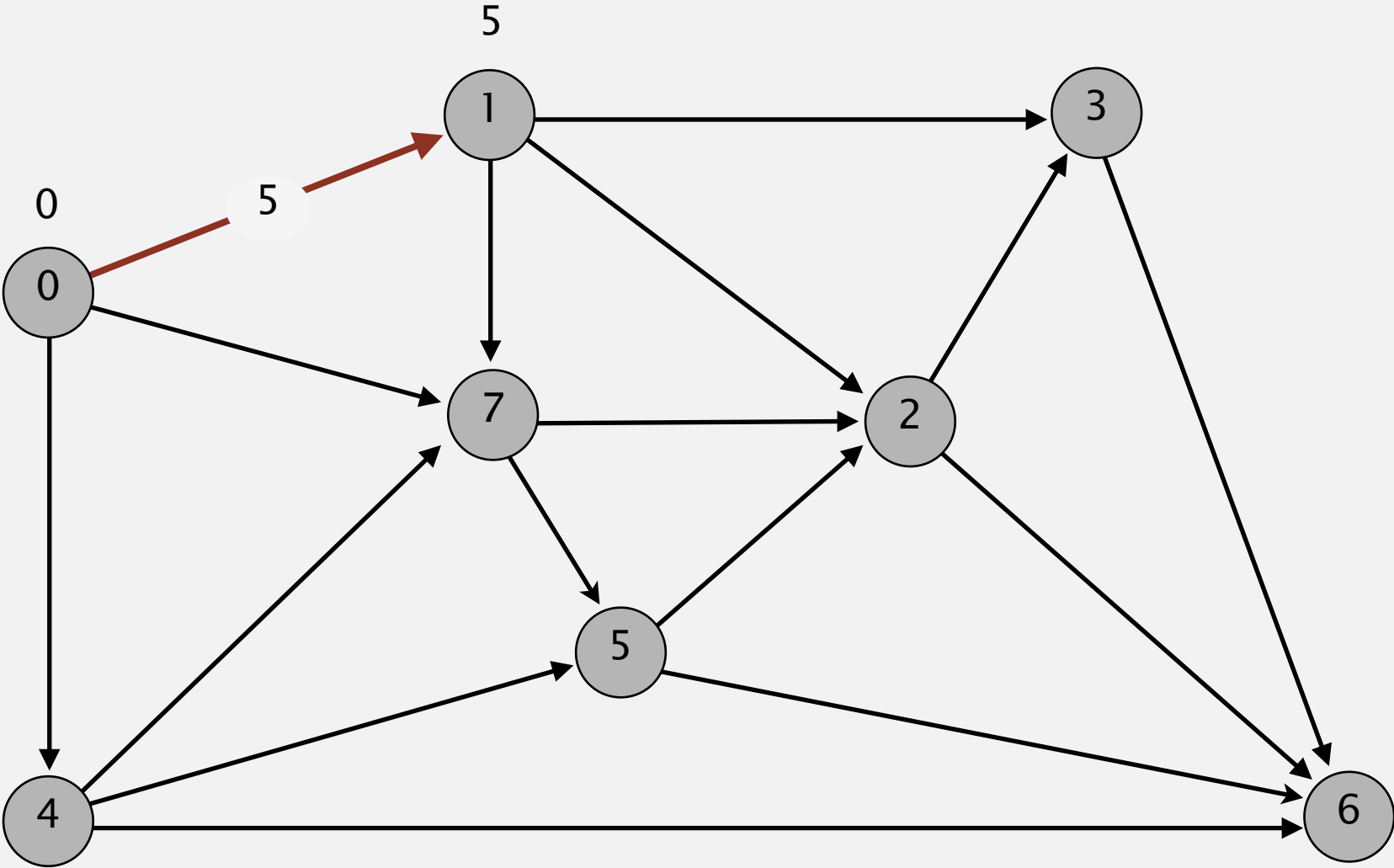
**pass 0**

0→1 0→4 0→7 1→2 1→3 1→7 2→3 2→6 3→6 4→5 4→6 4→7 5→2 5→6 7→5 7→2



# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



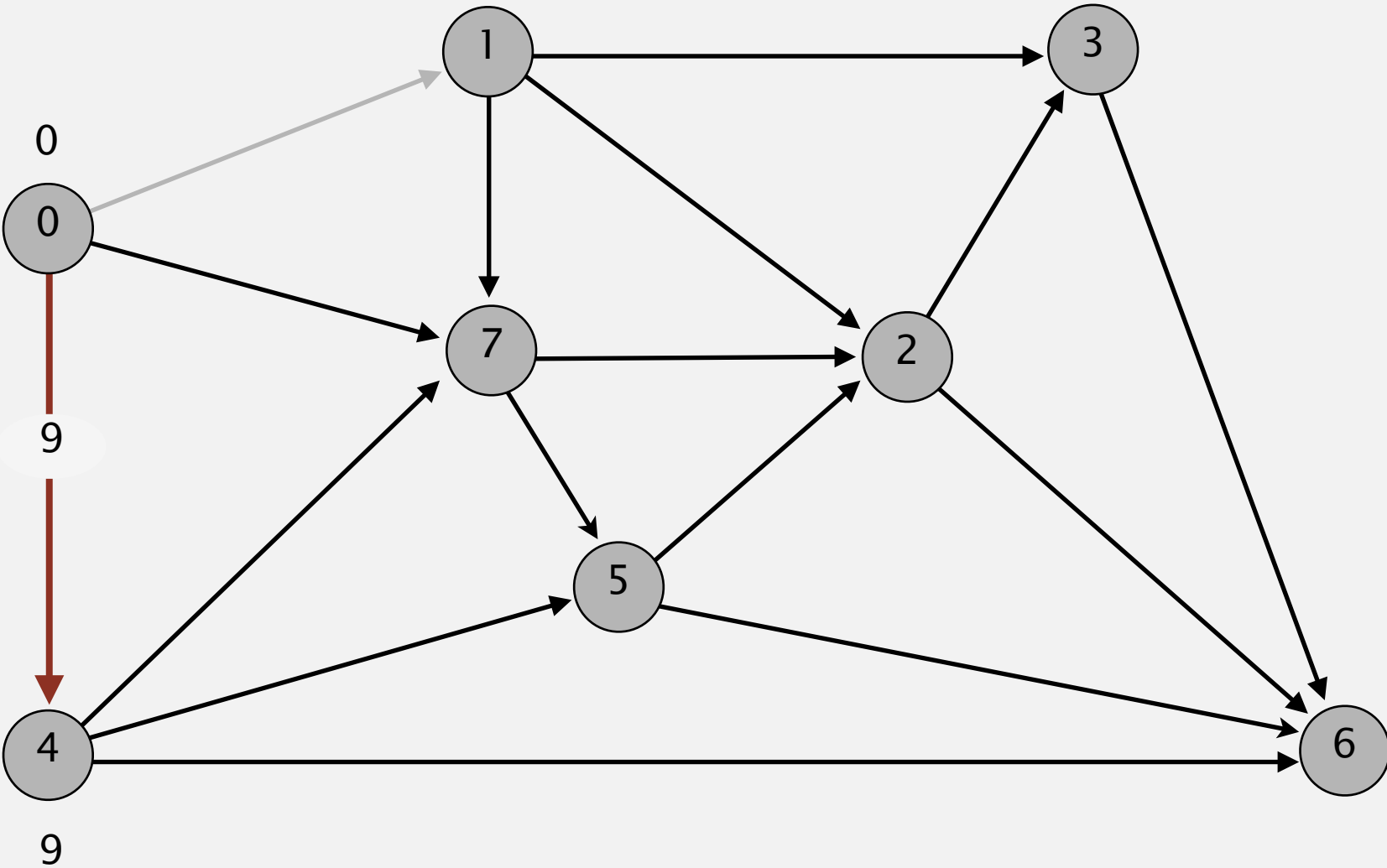
v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	14.0	5→2
3	20.0	1→3
4	9.0	0→4
5	13.0	4→5
6	26.0	5→6
7	8.0	0→7

pass 1

- 0→1 0→4 0→7 1→2 1→3 1→7 2→3 2→6 3→6 4→5 4→6 4→7 5→2 5→6 7→5 7→2
- ↑

# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	14.0	5→2
3	20.0	1→3
4	9.0	0→4
5	13.0	4→5
6	26.0	5→6
7	8.0	0→7

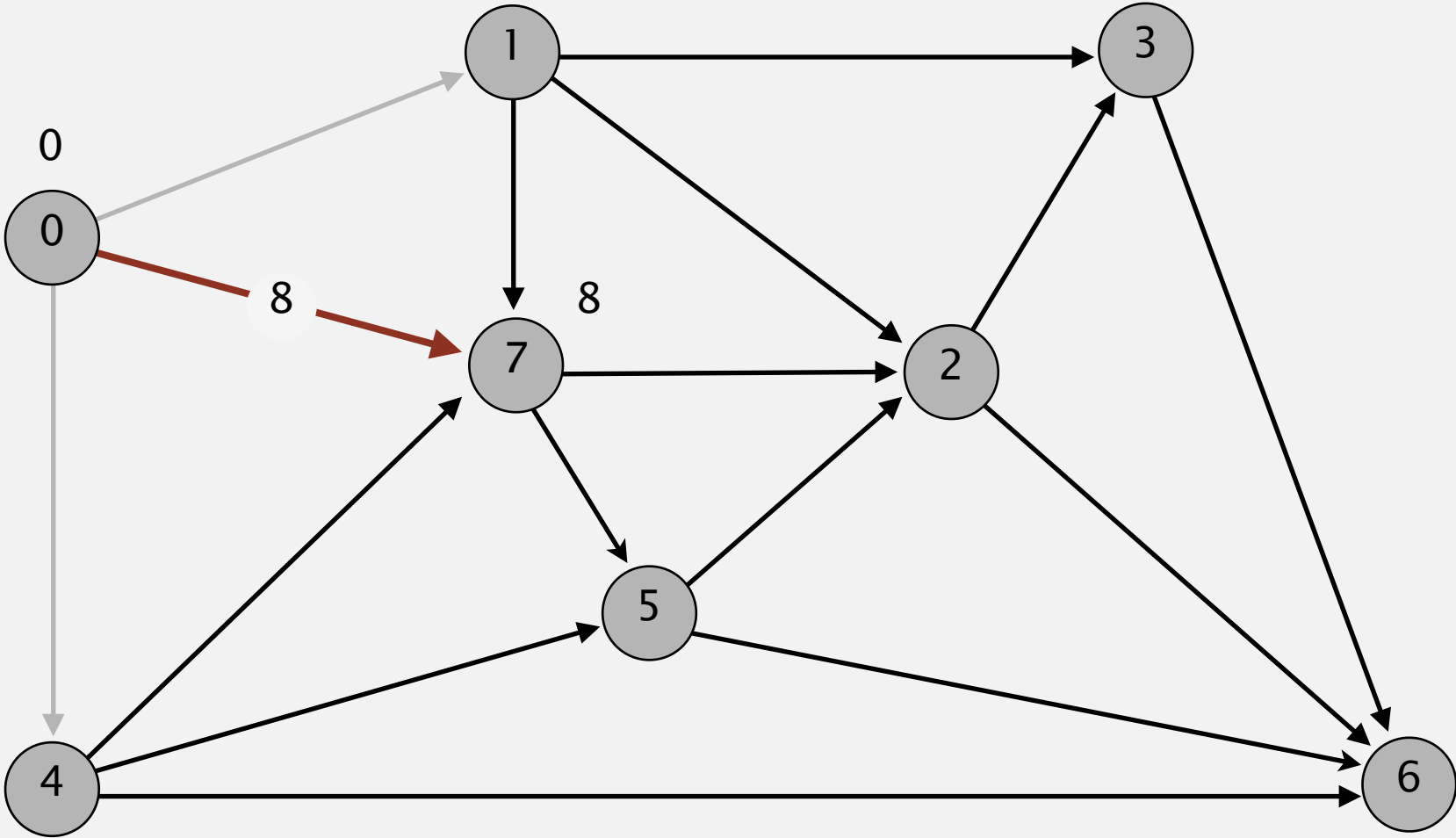
pass 1

- 0→1
- 0→4
- 0→7
- 1→2
- 1→3
- 1→7
- 2→3
- 2→6
- 3→6
- 4→5
- 4→6
- 4→7
- 5→2
- 5→6
- 7→5
- 7→2



# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



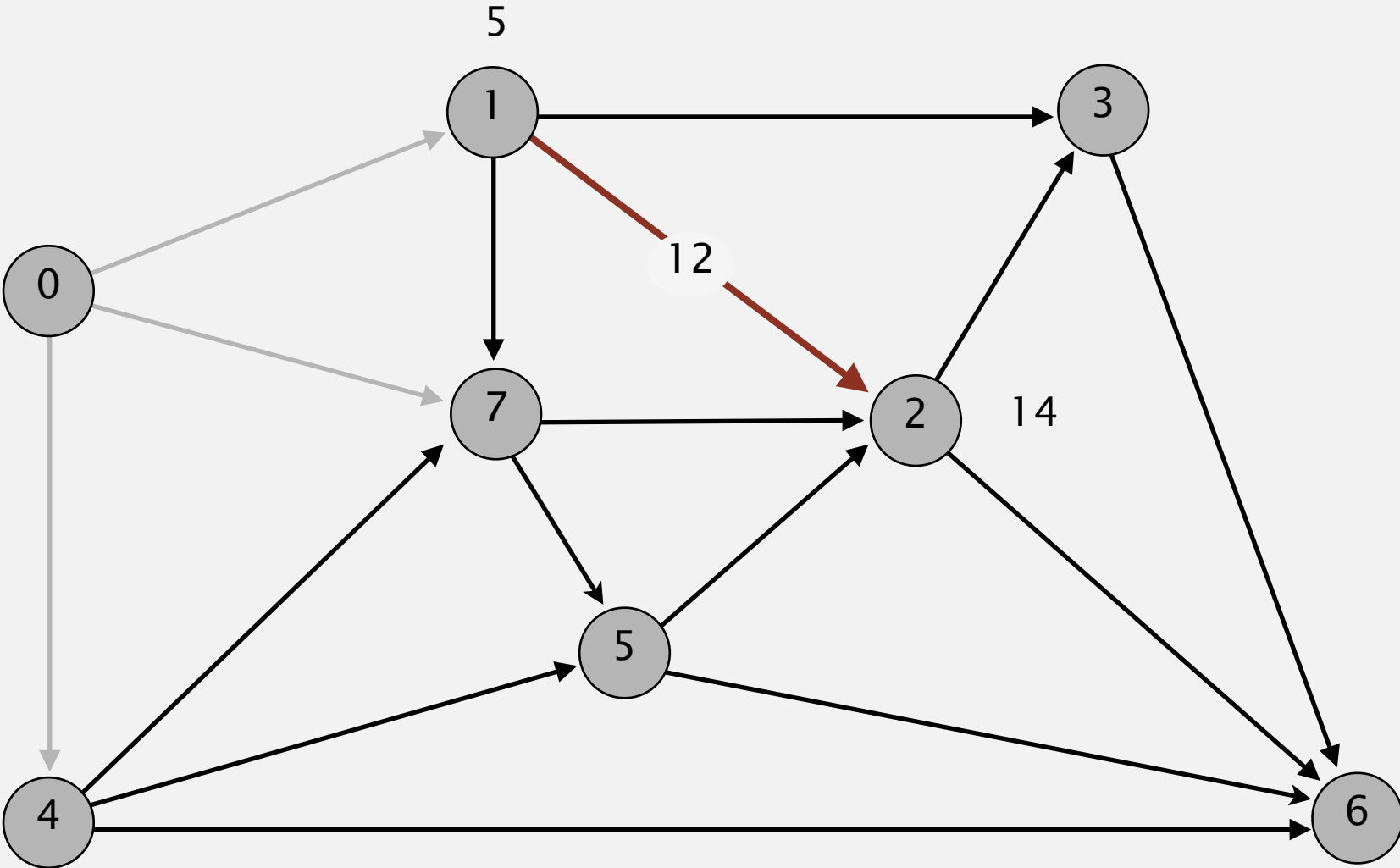
v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	14.0	5→2
3	20.0	1→3
4	9.0	0→4
5	13.0	4→5
6	26.0	5→6
7	8.0	0→7

pass 1

- 0→1 0→4 0→7 1→2 1→3 1→7 2→3 2→6 3→6 4→5 4→6 4→7 5→2 5→6 7→5 7→2
- ↑

# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	14.0	5→2
3	20.0	1→3
4	9.0	0→4
5	13.0	4→5
6	26.0	5→6
7	8.0	0→7

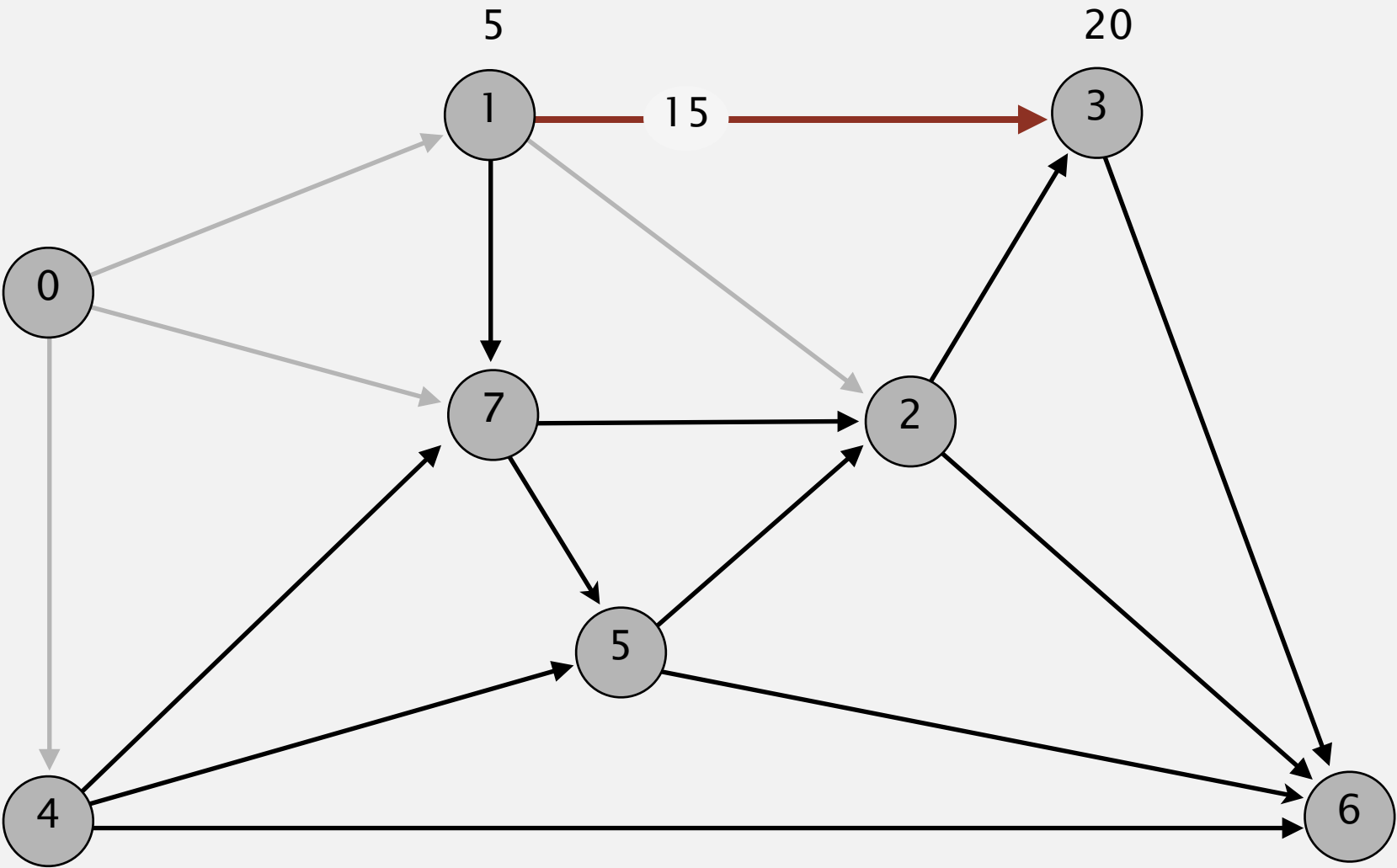
pass 1

- 0→1 0→4 0→7 1→2 1→3 1→7 2→3 2→6 3→6 4→5 4→6 4→7 5→2 5→6 7→5 7→2
- ↑



# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



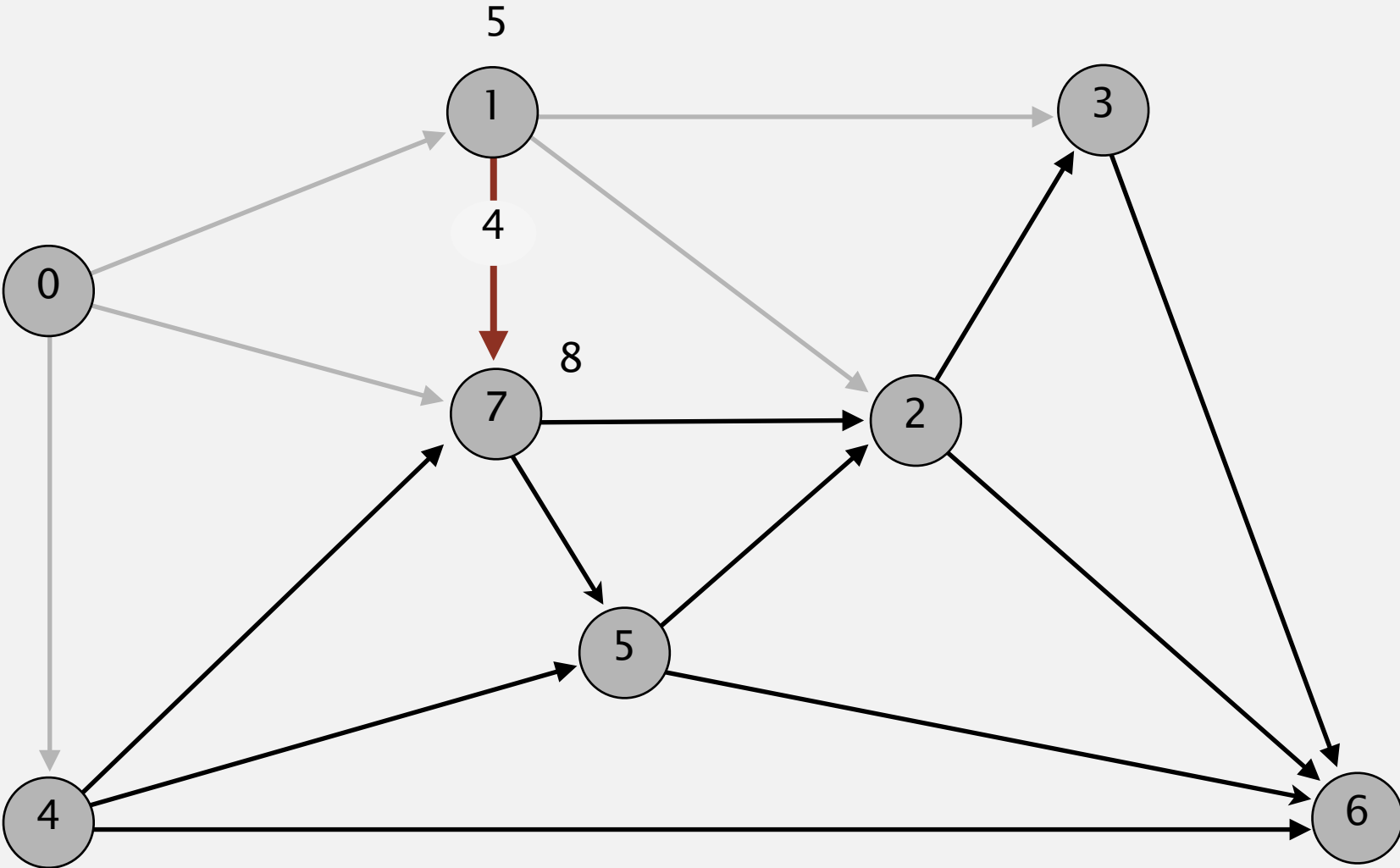
v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	14.0	5→2
3	20.0	1→3
4	9.0	0→4
5	13.0	4→5
6	26.0	5→6
7	8.0	0→7

pass 1

- 0→1 0→4 0→7 1→2 1→3 1→7 2→3 2→6 3→6 4→5 4→6 4→7 5→2 5→6 7→5 7→2
- ↑

# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



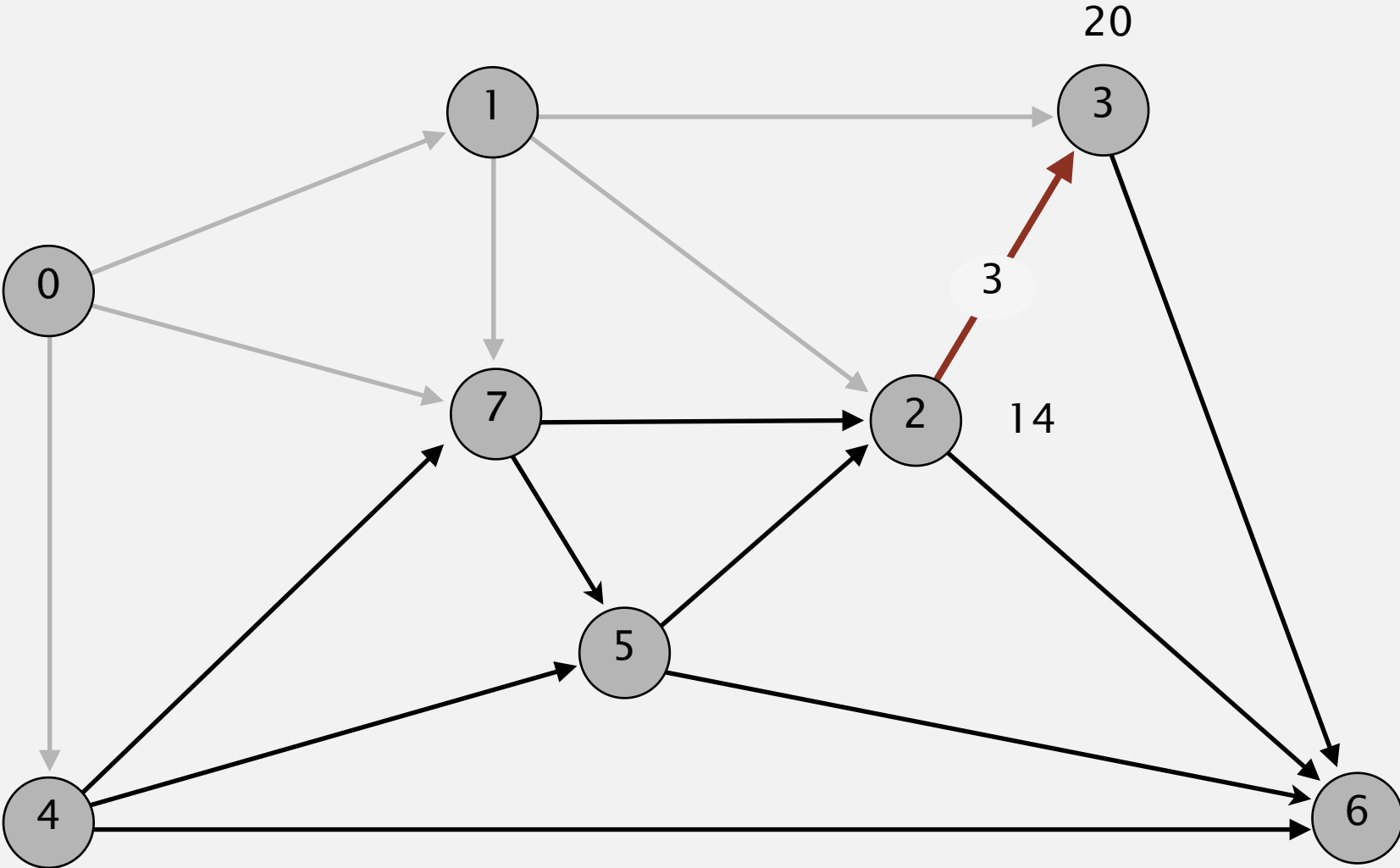
v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	14.0	5→2
3	20.0	1→3
4	9.0	0→4
5	13.0	4→5
6	26.0	5→6
7	8.0	0→7

pass 1

- 0→1 0→4 0→7 1→2 1→3 1→7 2→3 2→6 3→6 4→5 4→6 4→7 5→2 5→6 7→5 7→2
- ↑

# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	14.0	5→2
3	20.0	1→3
4	9.0	0→4
5	13.0	4→5
6	26.0	5→6
7	8.0	0→7

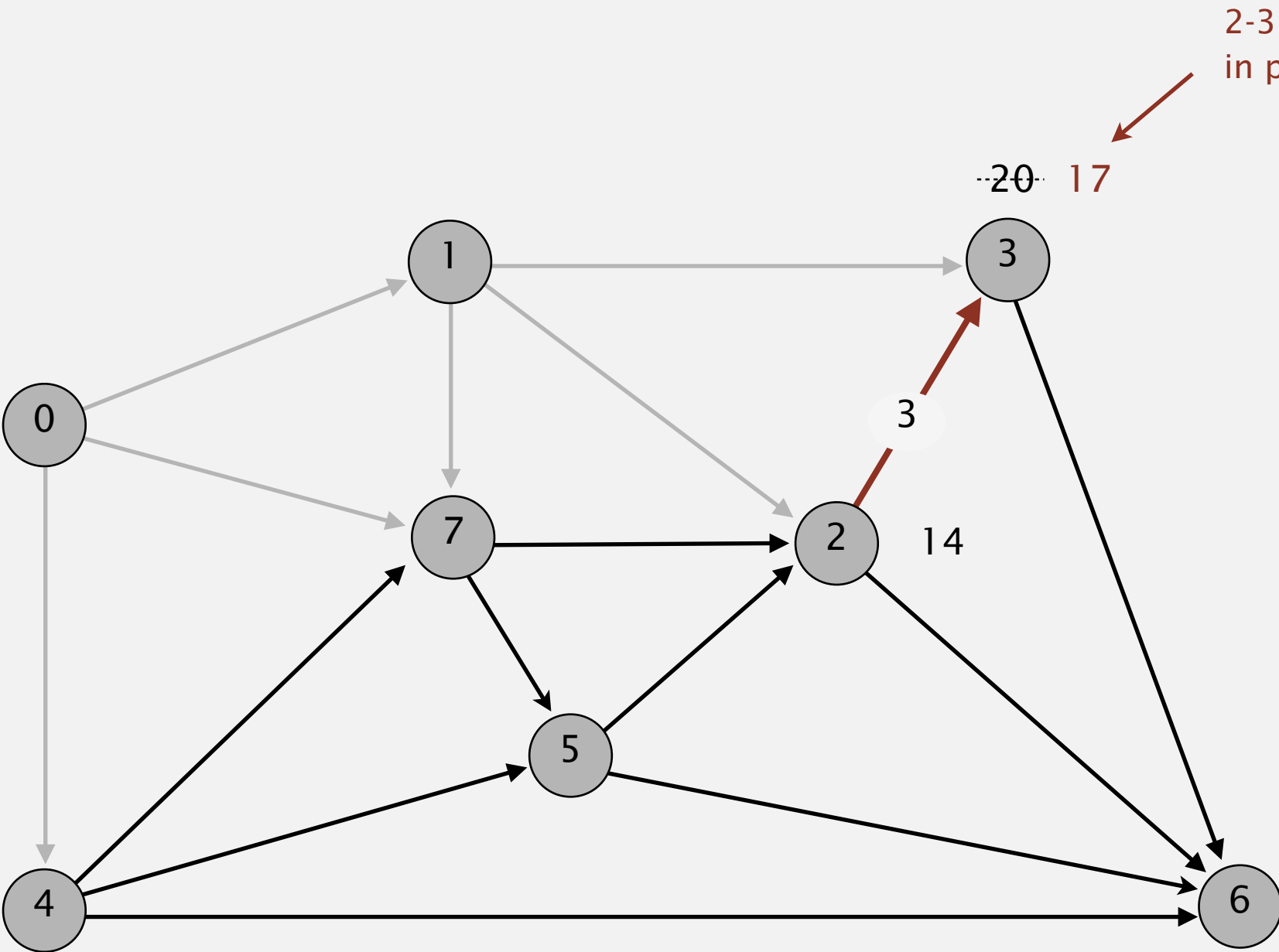
pass 1

- 0→1
- 0→4
- 0→7
- 1→2
- 1→3
- 1→7
- 2→3
- 2→6
- 3→6
- 4→5
- 4→6
- 4→7
- 5→2
- 5→6
- 7→5
- 7→2



# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



2-3 successfully relaxed in pass 1, but not pass 0

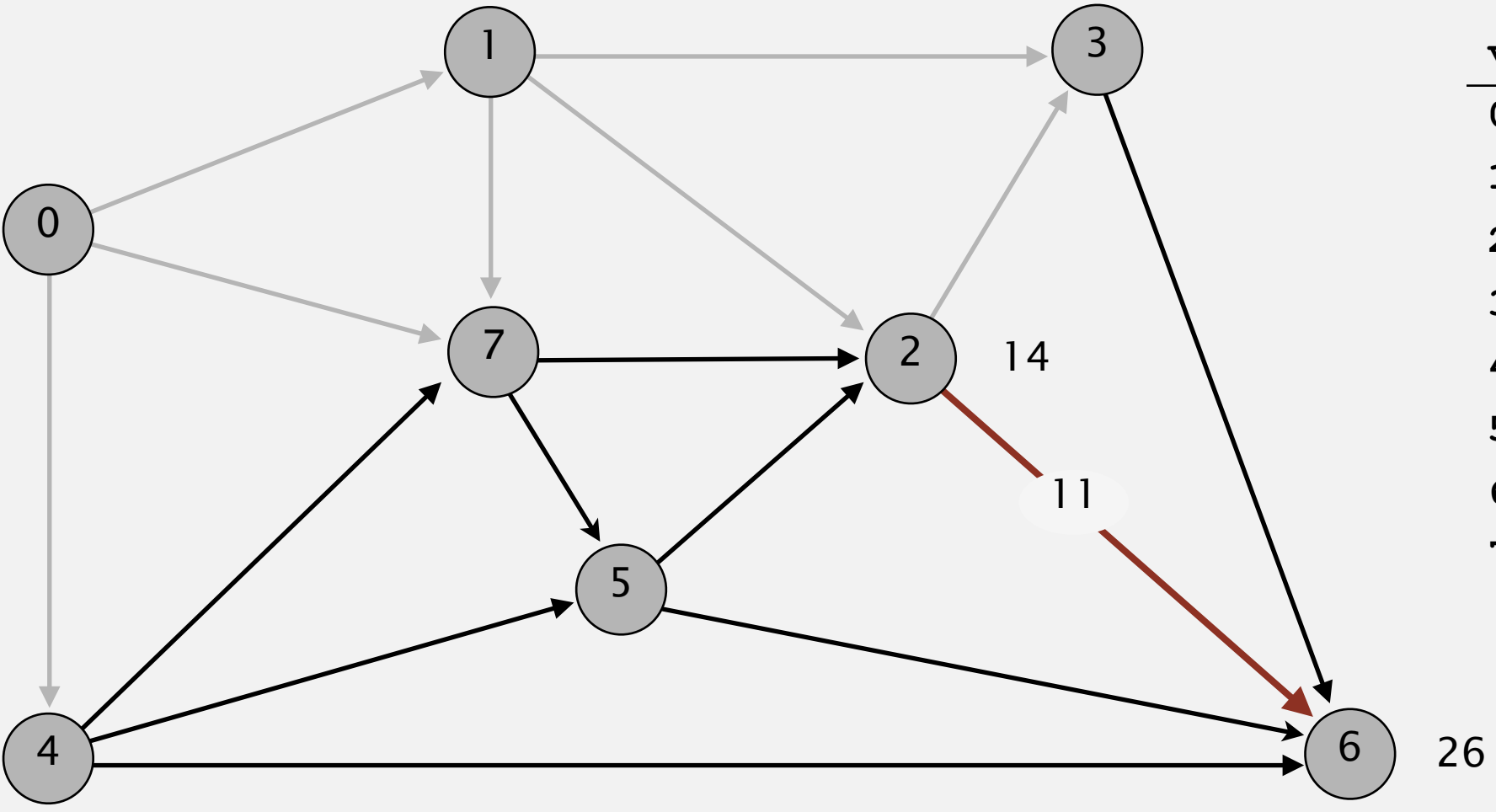
v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	14.0	5→2
3	17.0	2→3
4	9.0	0→4
5	13.0	4→5
6	26.0	5→6
7	8.0	0→7

pass 1

- 0→1 0→4 0→7 1→2 1→3 1→7 2→3 2→6 3→6 4→5 4→6 4→7 5→2 5→6 7→5 7→2
- ↑

# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	14.0	5→2
3	17.0	2→3
4	9.0	0→4
5	13.0	4→5
6	26.0	5→6
7	8.0	0→7

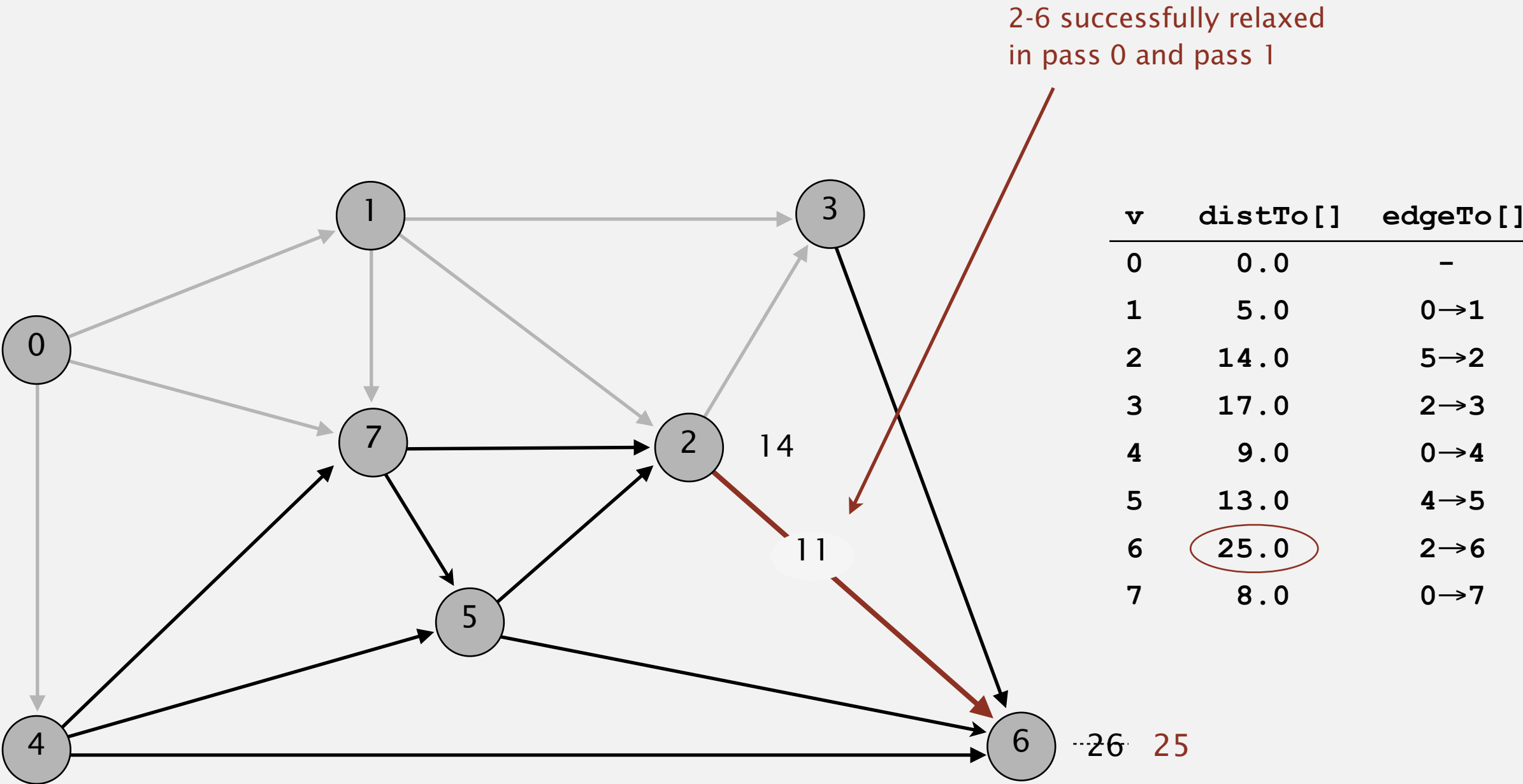
pass 1

- 0→1
- 0→4
- 0→7
- 1→2
- 1→3
- 1→7
- 2→3
- 2→6
- 3→6
- 4→5
- 4→6
- 4→7
- 5→2
- 5→6
- 7→5
- 7→2



# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.

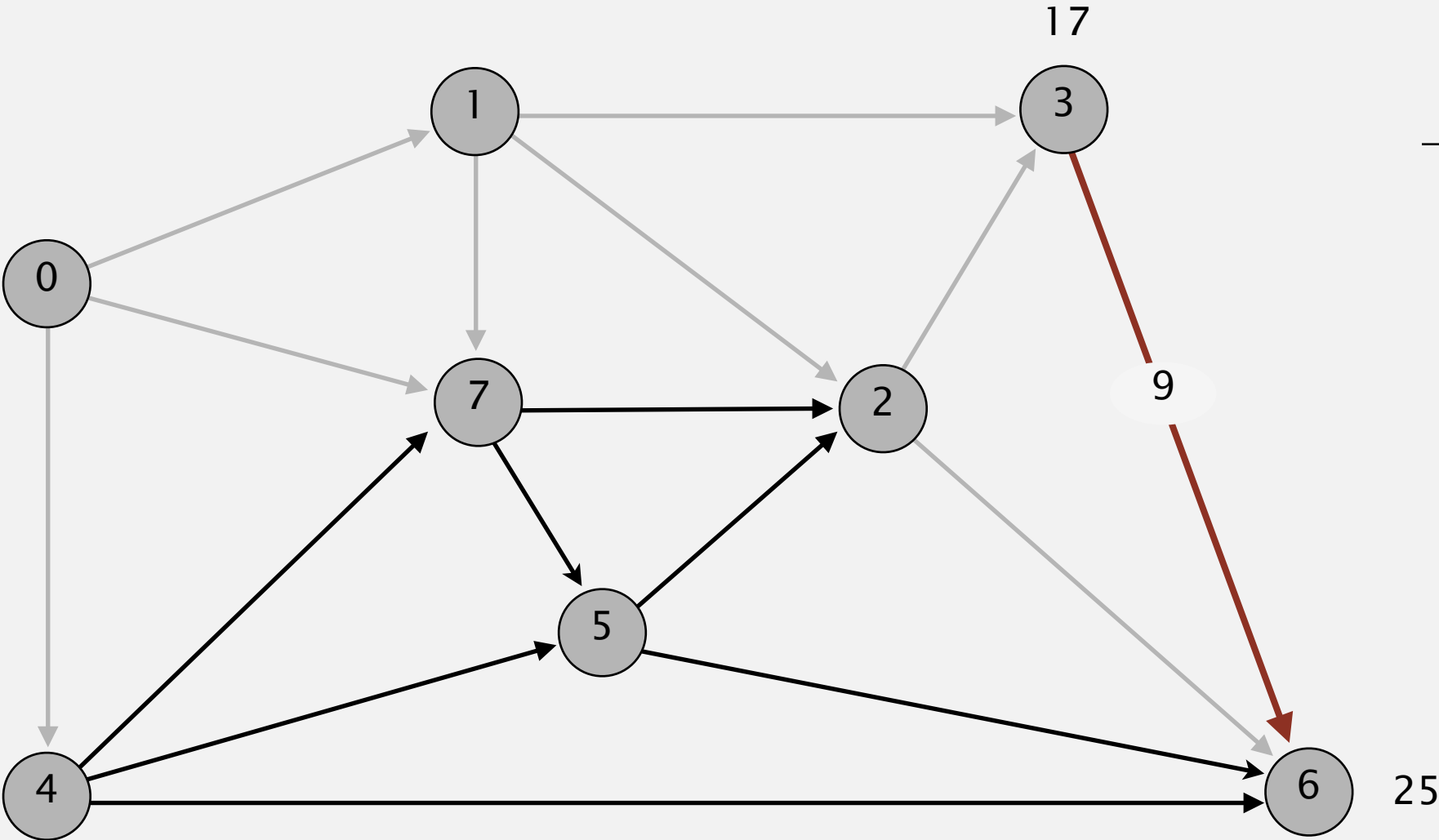


pass 1

- 0→1
- 0→4
- 0→7
- 1→2
- 1→3
- 1→7
- 2→3
- 2→6
- 3→6
- 4→5
- 4→6
- 4→7
- 5→2
- 5→6
- 7→5
- 7→2

# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	14.0	5→2
3	17.0	2→3
4	9.0	0→4
5	13.0	4→5
6	25.0	2→6
7	8.0	0→7

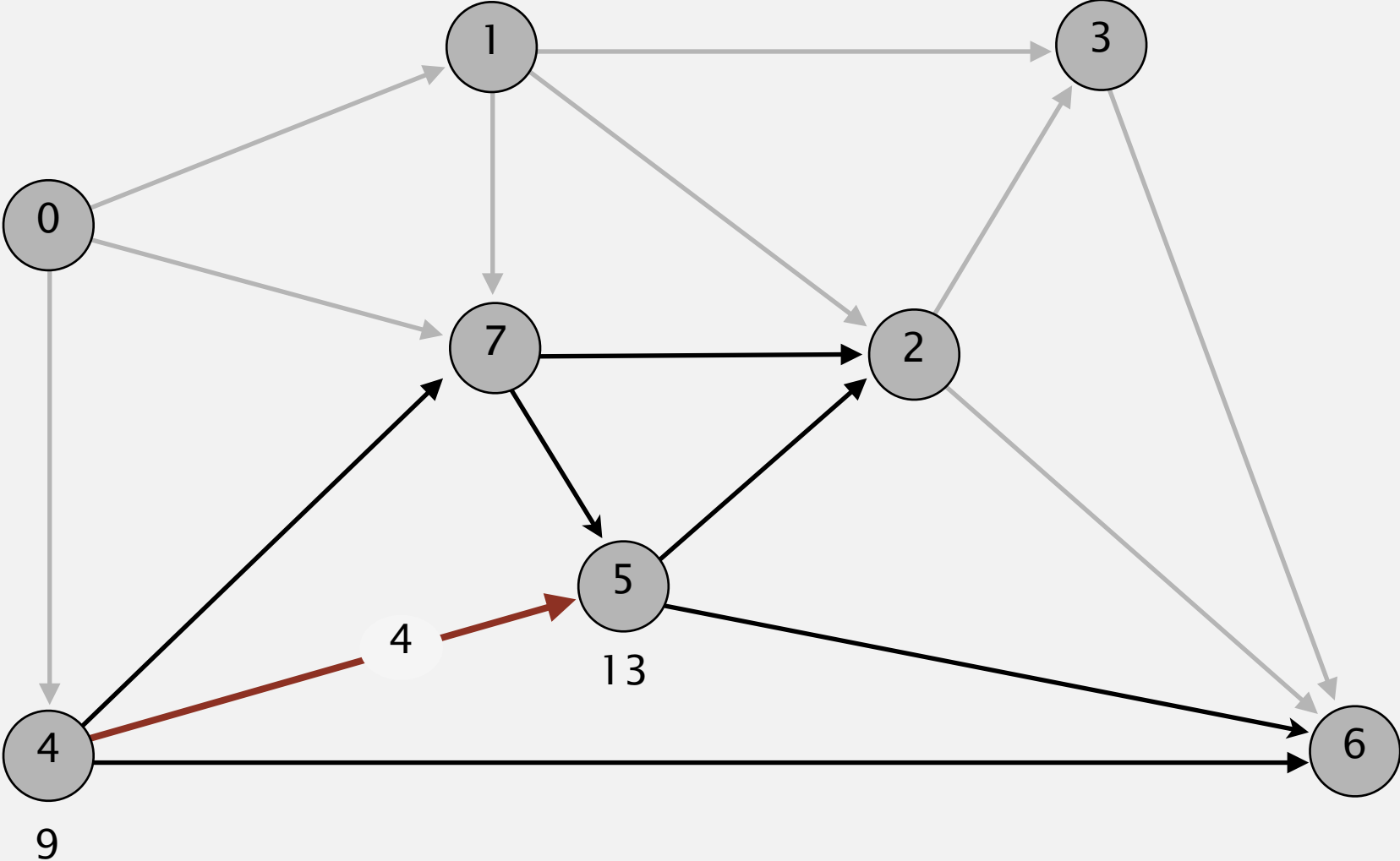
**pass 1**

- 0→1
- 0→4
- 0→7
- 1→2
- 1→3
- 1→7
- 2→3
- 2→6
- 3→6
- 4→5
- 4→6
- 4→7
- 5→2
- 5→6
- 7→5
- 7→2



# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	14.0	5→2
3	17.0	2→3
4	9.0	0→4
5	13.0	4→5
6	25.0	2→6
7	8.0	0→7

pass 1

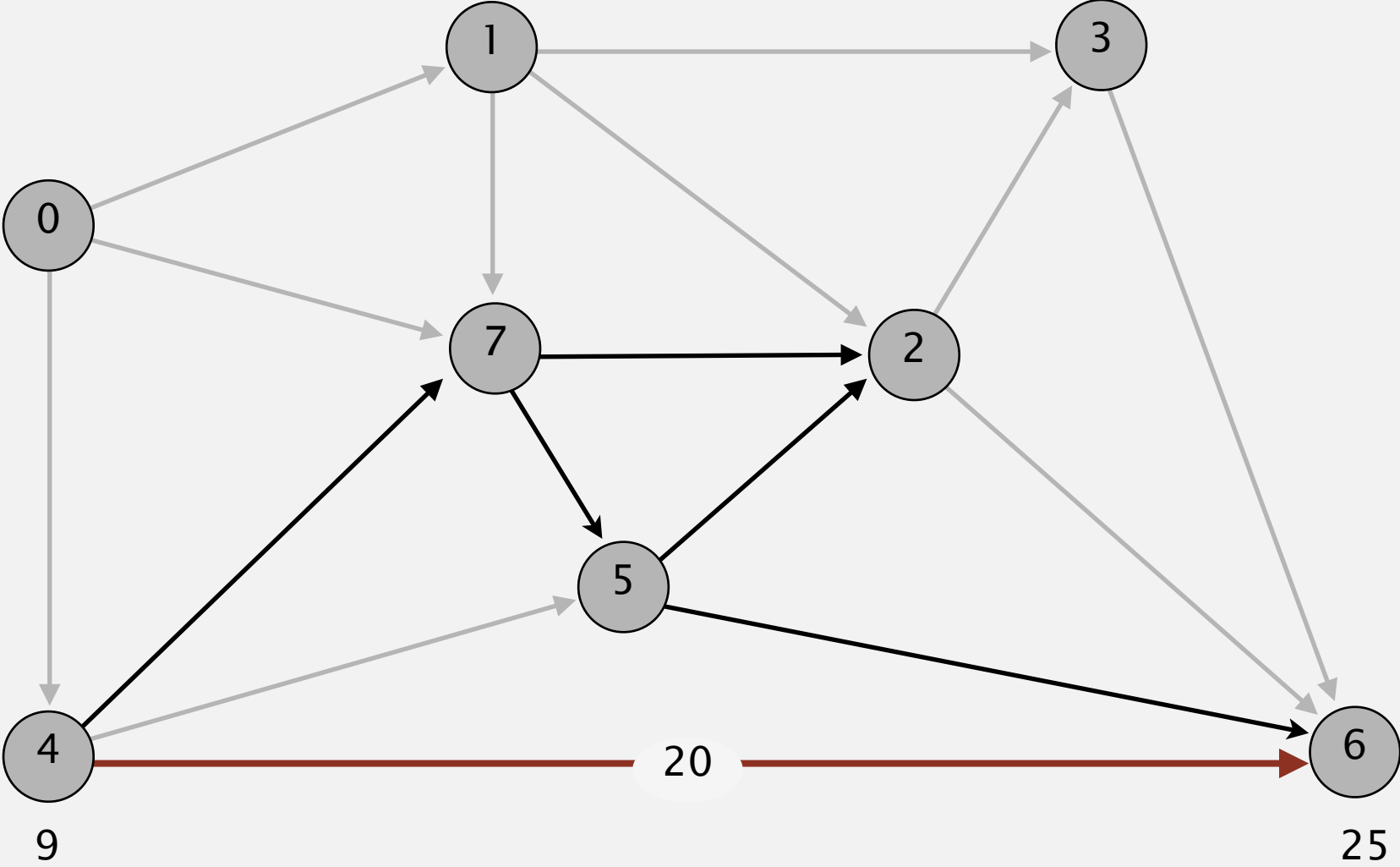
0→1 0→4 0→7 1→2 1→3 1→7 2→3 2→6 3→6 4→5 4→6 4→7 5→2 5→6 7→5 7→2





# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



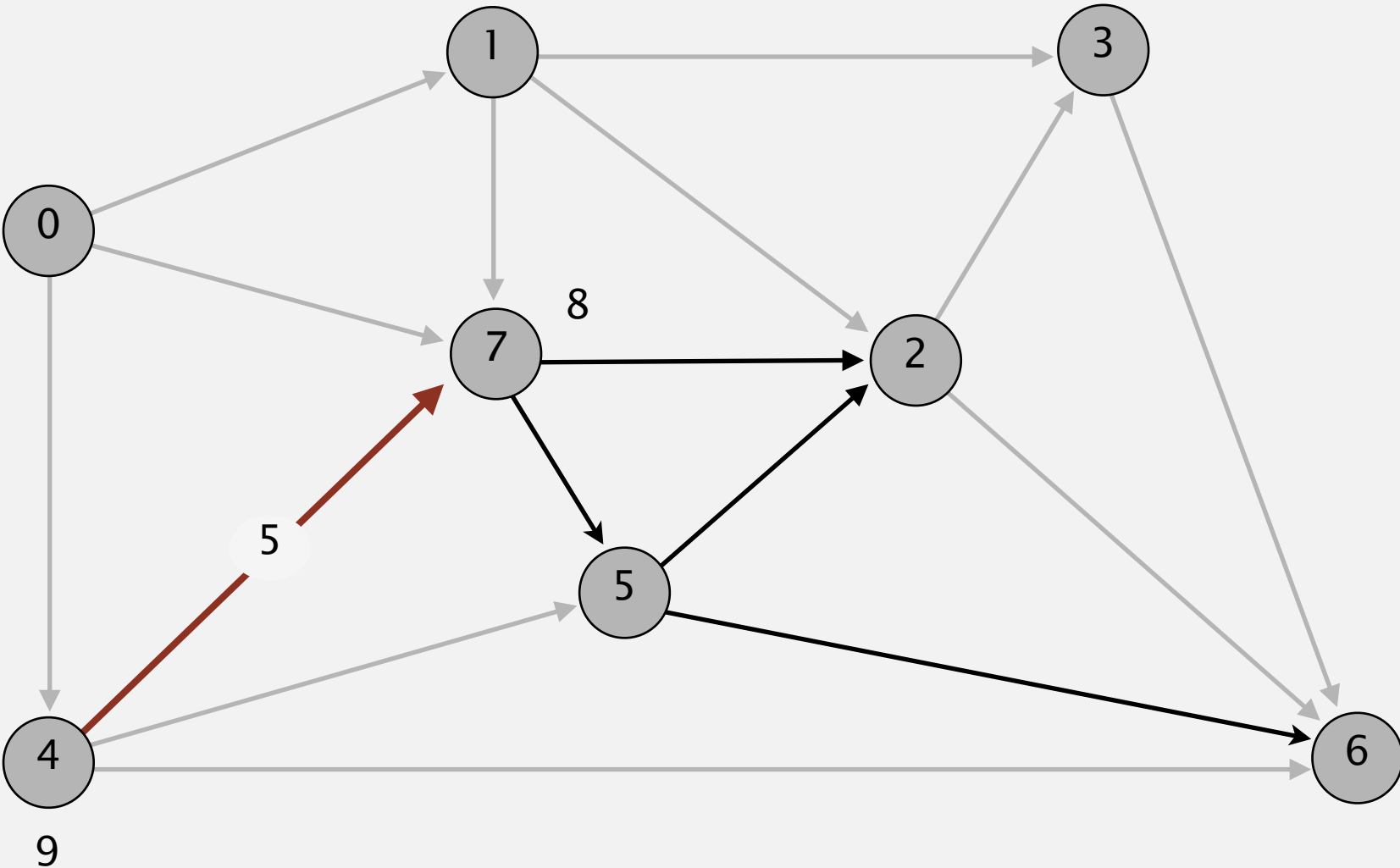
v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	14.0	5→2
3	17.0	2→3
4	9.0	0→4
5	13.0	4→5
6	25.0	2→6
7	8.0	0→7

pass 1

- 0→1 0→4 0→7 1→2 1→3 1→7 2→3 2→6 3→6 4→5 4→6 4→7 5→2 5→6 7→5 7→2
- ↑

# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



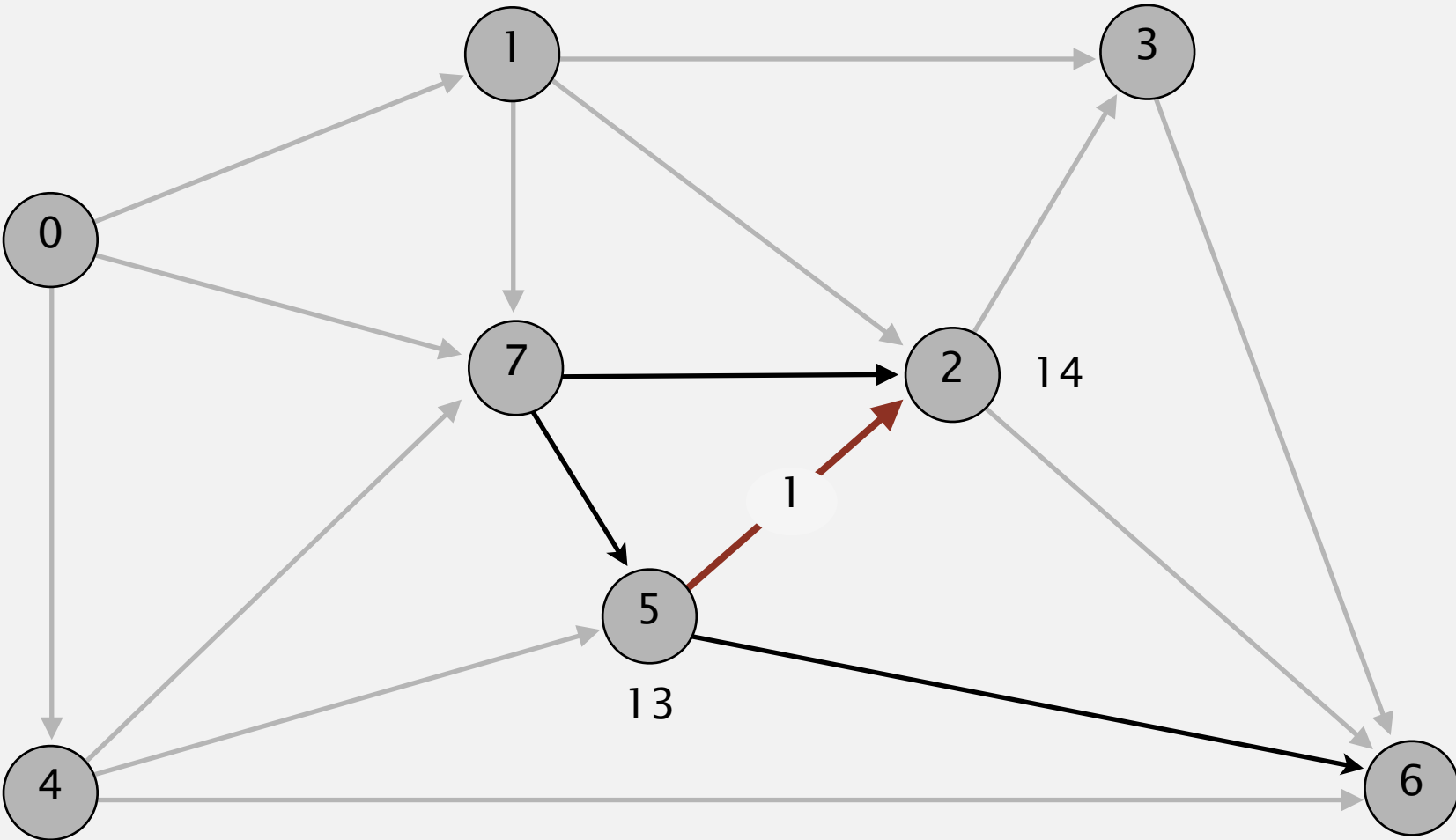
v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	14.0	5→2
3	17.0	2→3
4	9.0	0→4
5	13.0	4→5
6	25.0	2→6
7	8.0	0→7

**pass 1**

- 0→1 0→4 0→7 1→2 1→3 1→7 2→3 2→6 3→6 4→5 4→6 4→7 5→2 5→6 7→5 7→2
- ↑

# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	14.0	5→2
3	17.0	2→3
4	9.0	0→4
5	13.0	4→5
6	25.0	2→6
7	8.0	0→7

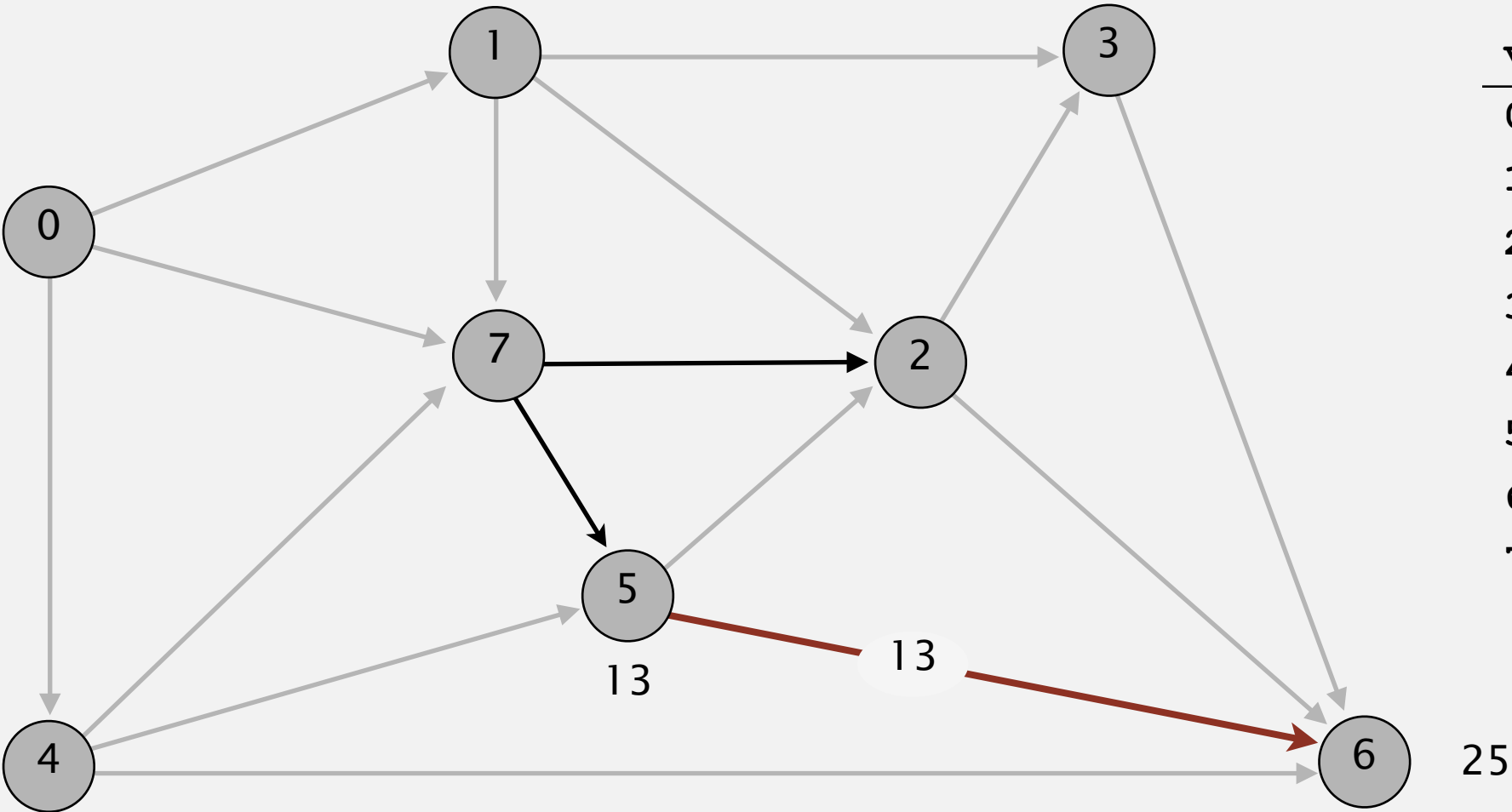
pass 1

- 0→1
- 0→4
- 0→7
- 1→2
- 1→3
- 1→7
- 2→3
- 2→6
- 3→6
- 4→5
- 4→6
- 4→7
- 5→2
- 5→6
- 7→5
- 7→2



# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	14.0	5→2
3	17.0	2→3
4	9.0	0→4
5	13.0	4→5
6	25.0	2→6
7	8.0	0→7

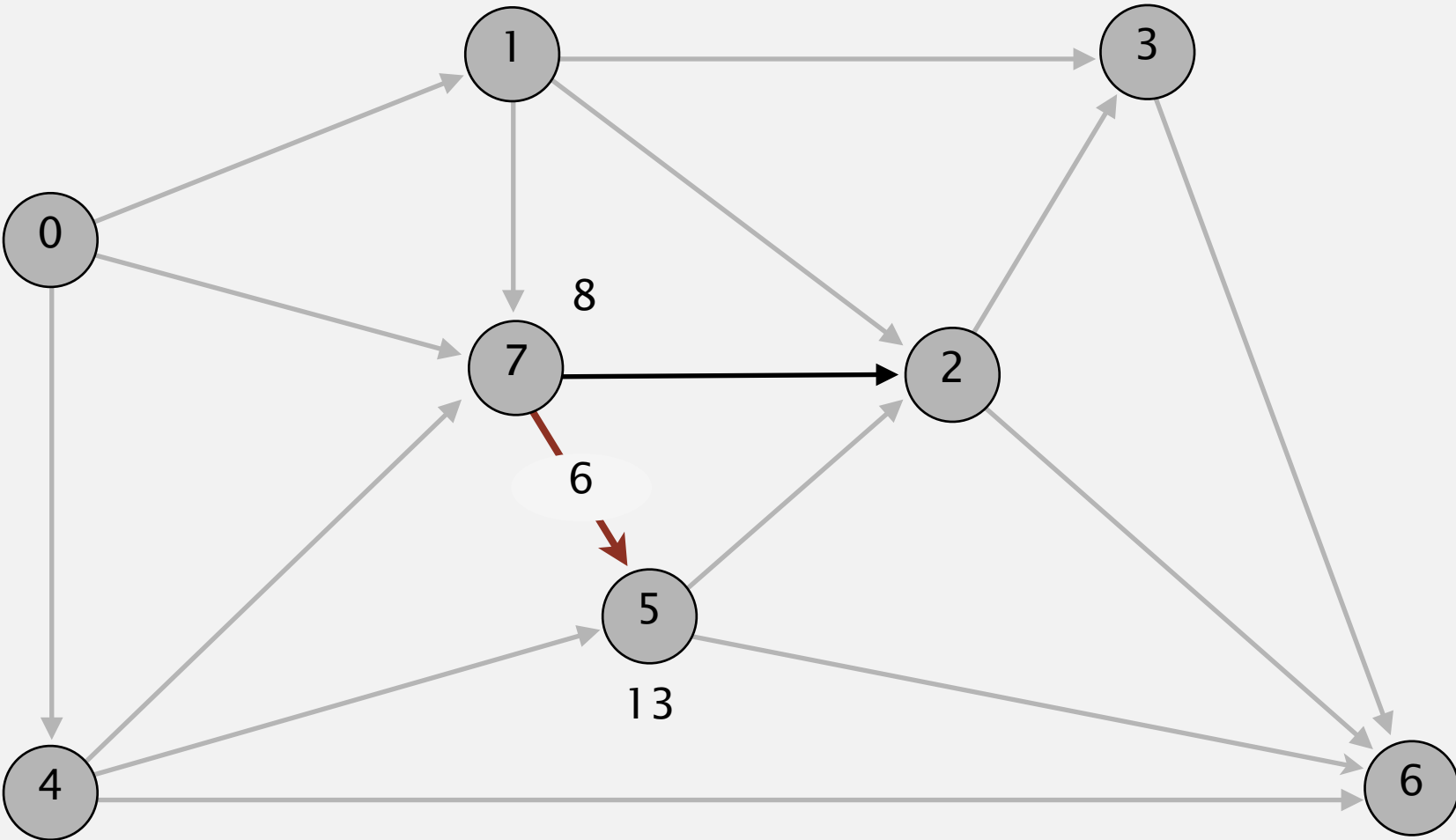
pass 1

- 0→1
- 0→4
- 0→7
- 1→2
- 1→3
- 1→7
- 2→3
- 2→6
- 3→6
- 4→5
- 4→6
- 4→7
- 5→2
- 5→6
- 7→5
- 7→2



# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



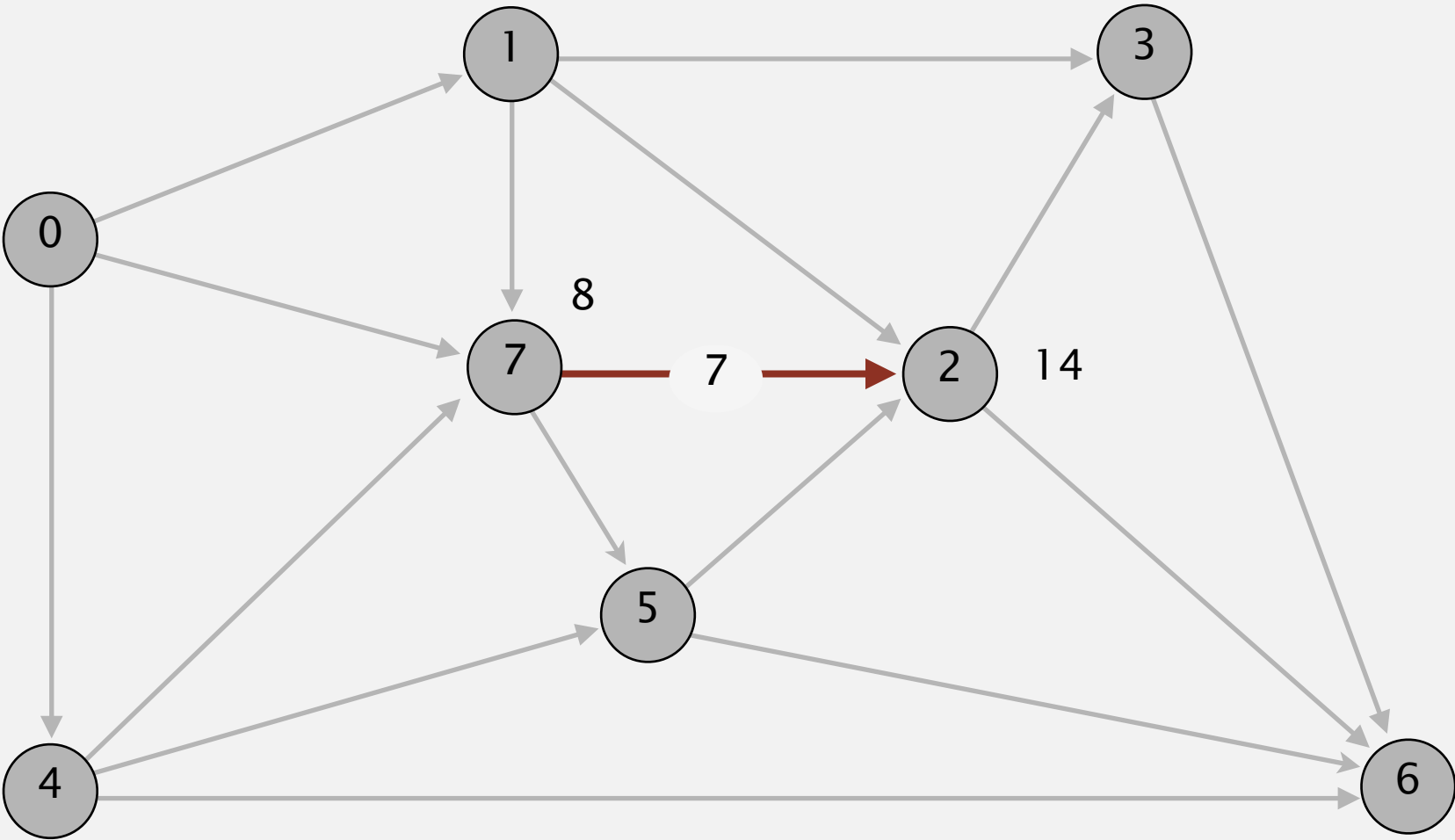
v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	14.0	5→2
3	17.0	2→3
4	9.0	0→4
5	13.0	4→5
6	25.0	2→6
7	8.0	0→7

**pass 1**

- 0→1 0→4 0→7 1→2 1→3 1→7 2→3 2→6 3→6 4→5 4→6 4→7 5→2 5→6 7→5 7→2
- ↑

# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	14.0	5→2
3	17.0	2→3
4	9.0	0→4
5	13.0	4→5
6	25.0	2→6
7	8.0	0→7

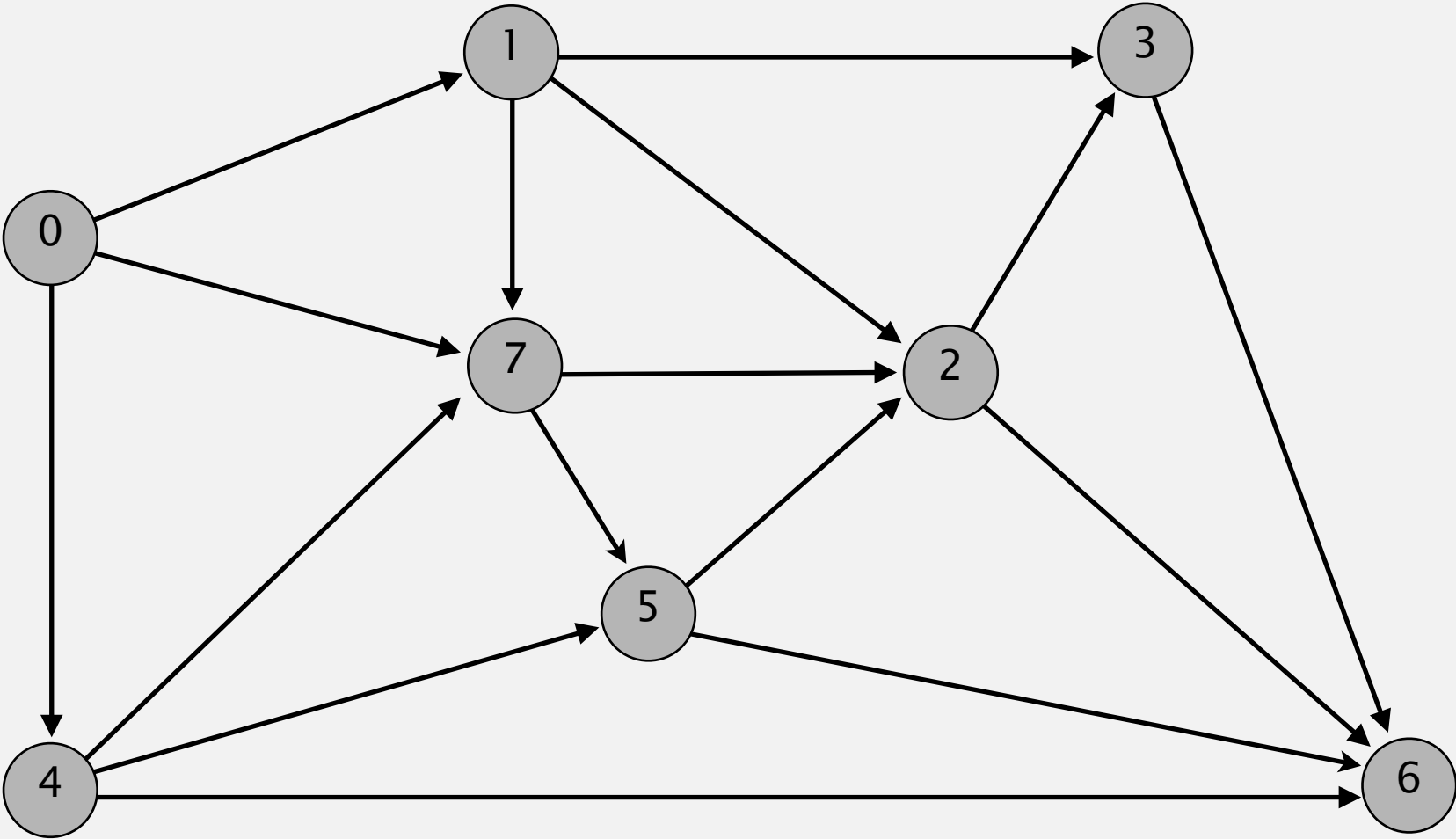
pass 1

0→1 0→4 0→7 1→2 1→3 1→7 2→3 2→6 3→6 4→5 4→6 4→7 5→2 5→6 7→5 7→2



# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	14.0	5→2
3	17.0	2→3
4	9.0	0→4
5	13.0	4→5
6	25.0	2→6
7	8.0	0→7

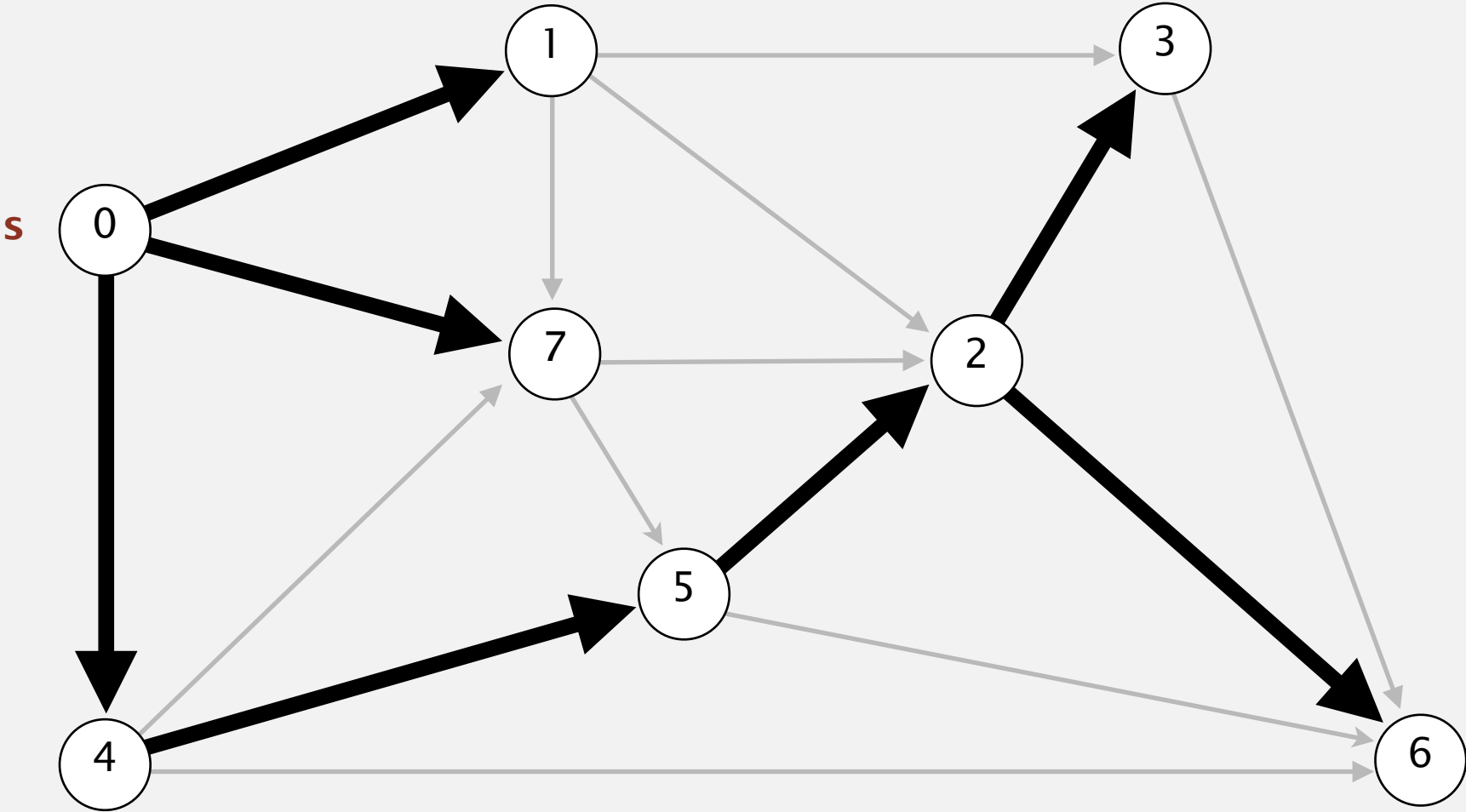
pass 2, 3, 4, ... (no further changes)

0→1 0→4 0→7 1→2 1→3 1→7 2→3 2→6 3→6 4→5 4→6 4→7 5→2 5→6 7→5 7→2



# Bellman-Ford algorithm demo

Repeat  $V$  times: relax all  $E$  edges.



v	distTo[]	edgeTo[]
0	0.0	-
1	5.0	0→1
2	14.0	5→2
3	17.0	2→3
4	9.0	0→4
5	13.0	4→5
6	25.0	2→6
7	8.0	0→7

shortest-paths tree from vertex s