

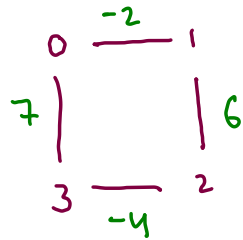
Bellman-Ford : (i) single src to all dest shortest path (edge wt)

(ii), DP based

(iii) works on -ve edge wt

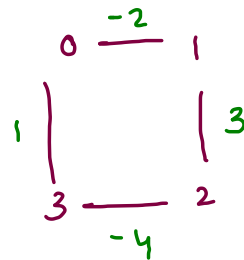
(iv) detects -ve wt cycle  $\rightarrow$  there is no meaning shortest path

-ve edge wt



CW = +7

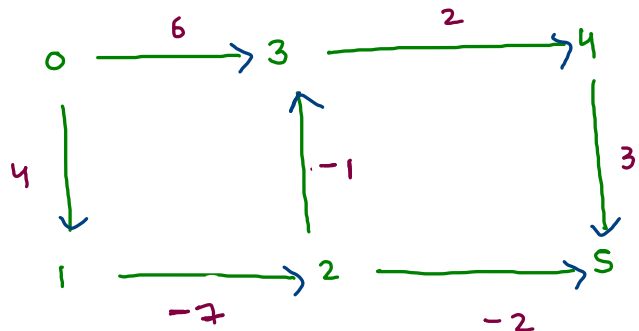
-ve wt cycle



CW = -2

src = 0

Shortest path has  
no meaning



$u \rightarrow v$  SPL (it<sub>i</sub>)  
 1 → 1 (1)  
 2 → 2 (2)  
 3 → 3 (3)  
 5 → 3 (3)  
 4 → 4 (4)

edges:

u	v	wt
4	5	3
3	4	2
2	5	-2
2	3	-1
1	2	-7

(V-1) iterations

work in each iterations.

$$\begin{array}{ccc}
 0 & 3 & 6 \\
 0 & 1 & 4
 \end{array}
 \quad
 \begin{array}{l}
 \text{path}[u] + \text{wt} < \text{path}[v] \\
 \text{src to } u \quad u-v \quad \text{src to } v
 \end{array}$$

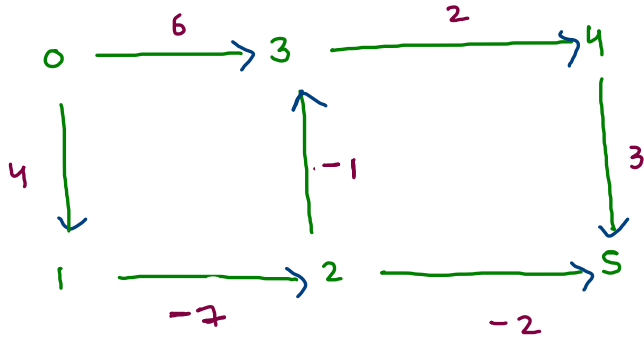
path

0	<del>∞</del> 4	<del>∞</del> -3	<del>∞</del> -4	<del>∞</del> -2	<del>∞</del> -5
0	1	2	3	4	5

src = 0

final [path[i] : src to i  
min cost

needs mod [ i<sup>th</sup> iteration : all shortest paths having i edges



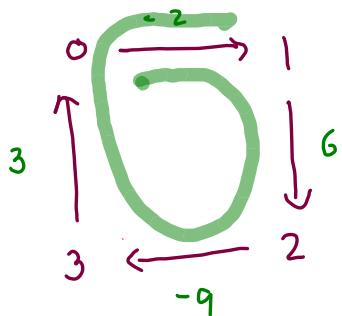
u	v	wt
0	1	4
1	2	-7
4	5	3
3	4	2
2	5	-2
2	3	-1
0	3	6

for undirected graph:  
u, v & v, u

shortest paths having length  $i$   
will get solved till  $i^{\text{th}}$  iteration.

v \ x	SPL	itr
1	1	1
2	2	1
3	3	1
5	3	1
4	4	2

0	<del>4</del>	<del>-3</del>	<del>-4</del>	<del>-2</del>	<del>-5</del>
0	1	2	3	4	5



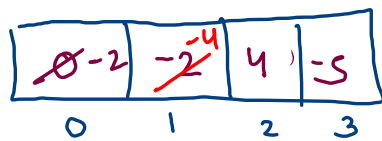
1 2 6      -ve wt cycle

0 1 -2

3 0 3

2 3 -9

Src -> 0



```
for(int itr = 1; itr <= graph.length-1;itr++) {
    for(Edge edge : edges) {
        int u = edge.u;
        int v = edge.v;
        int wt = edge.wt;

        if(path[u] != Integer.MAX_VALUE && path[u] + wt < path[v]) {
            path[v] = path[u] + wt;
        }
    }
}
```

$T: V \times E$

i)  $v^{th}$  iteration updates  
any  $path[i]$   
└ -ve wt cycle

# Floyd Warshall

(i) all pairs shortest path

(ii) dp based

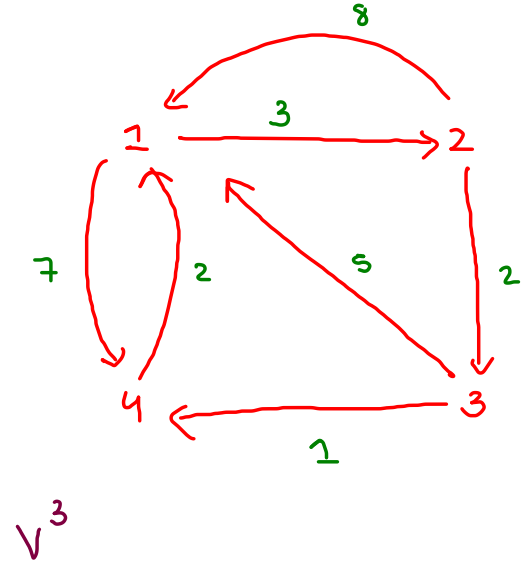
(iii) -ve edge wt

intermediate  $\rightarrow k$   
 Src  $\rightarrow u$   
 dest  $\rightarrow v$

$$\text{path}[u][k] + \text{path}[k][v] < \text{path}[u][v]$$

	1	2	3	4
1	$\infty$	3	$\infty$	7
2	8	$\infty$	2	$\infty$
3	5	$\infty$	$\infty$	1
4	2	$\infty$	$\infty$	$\infty$

no intermediates



	1	2	3	4
1	$\infty$	3	$\infty$	7
2	8	$\infty$	2	$\infty$
3	5	$\infty$	$\infty$	1
4	2	$\infty$	$\infty$	$\infty$

$uv$

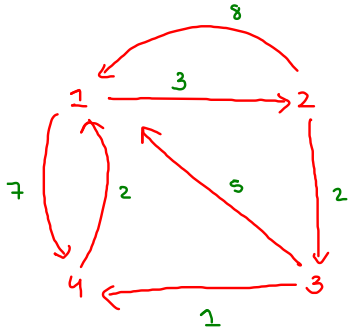
As  $\rightarrow$  no intermediate

	1	2	3	4
1	$\infty$	3	$\infty$	7
2	8	$\infty$	2	15
3	5	$\infty$	$\infty$	1
4	2	5	$\infty$	$\infty$

$uv$

$u_{i,v}$

1 as intermediate



	1	2	3	4
1	$\infty$	3	5	7
2	8	$\infty$	2	15
3	5	$\infty$	$\infty$	1
4	2	5	7	$\infty$

2 as intermediate

$uv \rightarrow 1,4$

$u_{i,v} \rightarrow 2,4$

$u_{i_2,v} \rightarrow 1,3$

$u_{i,i_2,v} \rightarrow 4,3$