# Input and Output for O ( m + nK ) implementation of Dijkstra's algorithm (q<2)

Where 
$$q = \frac{nK}{m}$$
.

### NOTE:

-1 value in Parent indicates that the corresponding node is source and doesn't have a Parent. Also, Parent for New-Dijkstra and Dijkstra may vary since there may be more than one shortest path.

# 1. V=5 E=10 k=3 q=1.5 (Sparse graph)

## Input:

## Output:

## New-Dijkstra:

### SSSP

Vertex	Distance	from	Source	Parent
0	0			-1
1	9			0
2	15			1
3	6			0
4	10			3

From 0:	:			
Vertex	Distance	from	Source	Parent
0	0			-1
1	9			0
2	15			1
3	6			0
4	10			3
From 1:	:			
Vertex	Distance	from	Source	Parent
0	12			4
1	0			-1
2	6			1
3	4			1
4	8			3
From 2:	:			
Vertex	Distance	from	Source	Parent
0	8			4

1	17			0
2	0			-1
3	14			0
4	4			2
From 3:				
Vertex	Distance	from	Source	Parent
0	8			4
1	6			3
2	9			3
3	0			-1
4	4			3
From 4:				
Vertex	Distance	from	Source	Parent
0	4			4
1	13			0
2	6			4
3	10			0
4	0			-1

# SSSP

Vertex	Distance	from	Source	Parent
0	0			-1
1	9			0
2	15			3
3	6			0
4	10			3

## APSP

From 0	:			
Vertex	Distance	from	Source	Parent
0	0			-1
1	9			0
2	15			3
3	6			0
4	10			3
From 1	:			
Vertex	Distance	from	Source	Parent
0	12			4
1	0			-1
2	6			1
3	4			1
4	8			3
From 2	:			
Vertex	Distance	from	Source	Parent
0	8			4
1	17			0
2	0			-1
3	14			0
4	4			2

From 3:

Vertex Distance from Source Parent

0	8			4
1	6			3
2	9			3
3	0			-1
4	4			3
From 4:	:			
Vertex	Distance	from	Source	Parent
Vertex 0	Distance 4	from	Source	Parent 4
Vertex 0 1		from	Source	Parent 4 0
Vertex 0 1 2	4	from	Source	Parent 4 0 4
0	4 13	from	Source	Parent 4 0 4 0

# 2.V=9 E=14 k=3 q=1.9 (Sparse graph)

# Input:

# Output:

# New-Dijkstra:

## SSSP

Distance	from	Source	Parent
0			-1
2			0
8			1
14			2
20			3
10			6
8			7
6			0
10			2
	0 2 8 14 20	0 2 8 14 20	20

From	0	:

110111 0	•			
Vertex	Distance	from	Source	Parent
0	0			-1
1	2			0
2.	8			1

3 4 5 6 7 8 From 1:	14 20 10 8 6 10			2 3 6 7 0 2
	Distance 2 0 6 12 18 8 10 8	from	Source	Parent     1     -1     1     2     3     2     5     0     2
	Distance 8 6 0 6 12 2 4 6 2	from	Source	Parent  1 2 -1 2 3 2 5 6 2
	Distance 14 12 6 0 6 8 10 12 8	from	Source	Parent 1 2 3 -1 3 2 5 6 2
Vertex 0 1 2 3 4 5 6 7	Distance 20 18 12 6 0 14 16 18	from	Source	Parent 1 2 3 4 -1 2 5 6 2
From 5: Vertex 0 1 2	Distance 10 8 2 8	from	Source	Parent 1 2 5 2

4 5 6 7 8 From 6:	14 0 2 4 4			3 -1 5 6 2
	Distance 8 10 4 10 16 2 0 2 6	from	Source	Parent 7 0 5 2 3 6 -1 6 2
	Distance 6 8 6 12 18 4 2 0 6	from	Source	Parent 7 0 5 2 3 6 7 -1 7
	Distance 10 8 2 8 14 4 6 6	from	Source	Parent 1 2 8 2 3 2 5 8 -1

# SSSP

Vertex	Distance	from	Source	Parent
0	0			-1
1	2			0
2	8			1
3	14			2
4	20			3
5	10			6
6	8			7
7	6			0
8	10			2

From 0:				
Vertex Dista	ance	from	Source	Parent
0	0			-1
1	2			0
2	8			1
3	14			2
4	20			3
5	10			6
6	8			7
7	6			0
8	10			2
From 1:		£	0	D +
Vertex Dista		irom	Source	
0	2			1 -1
2	6			1
3	12			2
4	18			3
5	8			2
6	10			7
7	8			0
8	8			2
From 2:	Ü			_
Vertex Dista	ance	from	Source	Parent
0	8			1
1	6			2
2	0			-1
3	6			2
4	12			3
5	2			2
6	4			5
7	6			6
8	2			2
From 3:				
Vertex Dista	ance	from	Source	
0				1
1	12			2
2 3	6			2 3 -1
4	0			
5	8			3 2
6	10			5
7	12			6
8	8			2
From 4:	Ü			_
Vertex Dista	ance	from	Source	Parent
0	20			1
1	18			2
2	12			3
3	6			4
4	0			-1
5	14			4
6	16			5
7	18			6

8 From 5:	14			2
Vertex Di 0 1 2 3 4 5 6 7 8 From 6:	10 8 2 8 14 0 2 4 4	from	Source	Parent 7 2 5 2 5 -1 5 6 2
Vertex Di 0 1 2 3 4 5 6 7 8 From 7:	8 10 4 10 16 2 0 2	from	Source	Parent 7 2 5 2 5 6 -1 6 6
Vertex Di 0 1 2 3 4 5 6 7 8 From 8:	1.5 tance 6 8 6 12 18 4 2 0 6	from	Source	Parent 7 0 5 2 5 6 7 -1 7
Vertex Di 0 1 2 3 4 5 6 7	10 8 2 8 14 4 6 6	from	Source	Parent 1 2 8 2 3 2 8 8 -1

# 3.V=15 E=97 k=12 q=1.8 (Dense graph)

# Input:

```
15 97
12
0 2 7 3 6 7 7 12 4 0 11 11 0 11 5
2 0 3 10 5 8 4 2 8 5 2 10 6 6 1
7 3 0 9 10 5 0 3 3 7 10 9 5 0 5
```

```
3 10 9 0 1 12 8 5 4 6 10 9 2 4 4
6 5 10 1 0 2 6 6 10 4 2 0 4 8 11
7 8 5 12 2 0 5 6 12 9 2 11 5 11 11
7 4 0 8 6 5 0 2 3 2 4 8 8 10 4
12 2 3 5 6 6 2 0 5 5 12 12 0 8 12
4 8 3 4 10 12 3 5 0 10 10 0 5 8 9
0 5 7 6 4 9 2 5 10 0 5 4 4 0 12
11 2 10 10 2 2 4 12 10 5 0 10 11 2 10
11 10 9 9 0 11 8 12 0 4 10 0 5 10 6
0 6 5 2 4 5 8 0 5 4 11 5 0 11 5
11 6 0 4 8 11 10 8 8 0 2 10 11 0 6
5 1 5 4 11 11 4 12 9 12 10 6 5 6 0
1 2 3 4 5 6 7 8 9 10 11 12
```

# **Output:**

## New-Dijkstra:

### SSSP

Vertex	Distance	from	Source	Parent
0	0			-1
1	2			0
2	5			1
3	3			0
4	4			3
5	6			4
6	6			7
7	4			1
8	4			0
9	7			1
10	4			1
11	9			14
12	5			3
13	6			10
14	3			1

From 0:	:			
Vertex	Distance	from	Source	Parent
0	0			-1
1	2			0
2	5			1
3	3			0
4	4			3
5	6			4
6	6			7
7	4			1
8	4			0
9	7			1
10	4			1
11	9			14

12 13 14 From 1:	5 6 3			3 10 1
	Distance 2 0 3 5 4 4 4 2 6 5 2 7 6 4 1	from	Source	Parent  1 -1 1 4 10 10 7 1 2 1 14 14 10 11
	Distance 5 3 0 7 7 5 5 3 7 5 9 5 7 4	from	Source	Parent  1 2 -1 12 10 2 7 2 2 6 1 2 2 10 1
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 From 4	Distance     3     5     7     0     1     3     7     5     4     5     3     7     2     4     4			3 14 8 -1 3 4 9 3 3 4 4 12 3 3 3
. 51 5621			204100	_

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 From 5:	4 4 7 1 0 2 6 6 5 4 2 8 3 4 5			3 10 1 4 -1 4 9 1 3 4 4 9 3 10 1
	Distance 6 4 5 3 2 0 5 6 7 6 2 10 5 4 5	from	Source	Parent     1     10     5     4     5     -1     5     1     3     4     5     9     3     10     1
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 From 7:	Distance 6 4 5 7 6 5 0 2 3 2 4 6 6 6 4		Source	1 7 7 4 10 6 -1 6 6 6 9 9 10 6
	Distance 4 2 3 5 6	from	Source	Parent     1     7     7     7     3

5 6 7 8 9 10 11 12 13 14 From 8	6 2 0 5 4 4 8 7 6 3			10 7 -1 6 6 1 9 3 10
	Distance 4 6 3 4 5 7 3 5 0 5 7 9 5 8 7	from	Source	Parent     8     0     8     8     3     4     8     6     -1     6     4     9     8     3     1
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 From 10	Distance 7 5 7 5 4 6 2 4 5 0 5 4 4 7 6	from	Source	Parent  1 9 7 4 9 4 9 6 6 -1 9 9 10 1
	Distance 4 2 5 3 2 2	from	Source	Parent

10 11 12 13 14 From 11:	0 9 5 2 3			-1 9 3 10 1	
Vertex Dista		from	Source		
0	9 7			1 14	
2	9			11	
3	7			12	
4 5	8 10			3 4	
6	6			9	
7	8			6	
8 9	9 4			6 11	
10	9			1	
11	0			-1	
12	5 10			11	
13 14	6			11 11	
From 12:					
Vertex Dista		from	Source		
0	5 6			3 14	
2	5			12	
3	2			12	
4 5	<i>3</i>			3 4	
6	6			9	
7	7			3	
8 9	5 4			12 12	
10	5			4	
11	5			12	
12 13	0 6			-1 3	
14	5			12	
From 13:		-			
Vertex Dista	ance 6	irom	Source	Parent 1	
1	4			10	
2	7			1	
3 4	4 4			13 10	
5	4			10	
6	6			10	
7 8	6 8			1 3	
9	7			10	
10	2			13	
11 12	10 6			13 3	
13	0			-1	
14	5			1	

From 14	4:			
Vertex	Distance	from	Source	Parent
0	3			1
1	1			14
2	4			1
3	4			14
4	5			3
5	5			10
6	4			14
7	3			1
8	7			2
9	6			6
10	3			1
11	6			14
12	5			14
13	5			10
14	0			-1

# SSSP

Vertex	Distance	from	Source	Parent
0	0			-1
1	2			0
2	5			1
3	3			0
4	4			3
5	6			10
6	6			1
7	4			1
8	4			0
9	7			1
10	4			1
11	9			14
12	5			3
13	6			10
14	3			1

From 0:

	•			
Vertex	Distance	from	Source	Parent
0	0			-1
1	2			0
2	5			1
3	3			0
4	4			3
5	6			10
6	6			1
7	4			1
8	4			0
9	7			1
10	4			1
11	9			14

12 13 14 From 1:	5 6 3			3 10 1
	Distance 2 0 3 5 4 4 4 2 6 5 2 7 6 4 1	from	Source	Parent  1 -1 1 14 10 10 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 From 3	Distance 5 3 0 7 7 5 5 3 3 7 5 9 5 7 4	from	Source	Parent  1 2 -1 8 10 2 7 2 2 2 1 2 1 1 1 1
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 From 4	Distance     3     5     7     0     1     3     7     5     4     5     3     7     2     4     4			3 10 12 -1 3 4 4 3 3 4 4 12 3 3 3
. 02 0021			300100	_ 3_ 3110

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 From 5:	4 4 7 1 0 2 6 6 5 4 2 8 3 4 5			3 10 5 4 -1 4 4 4 3 4 12 3 10 3
	Distance 6	from	Source	Parent 3
1	4			10
2	5			5
3	3			4
4	2			5
5 6	0 5			-1 5
7	6			5
8	7			3
9	6			4
10	2			5
11	10			12
12 13	5 4			5 10
14	5			1
14 From 6:	5	from	Source	1
14 From 6: Vertex 0	5: Distance 6	from	Source	1 Parent 1
14 From 6: Vertex 0 1	5: Distance 6 4	from	Source	1 Parent 1 6
14 From 6: Vertex 0 1	5: Distance 6 4 5	from	Source	1 Parent 1 6 7
14 From 6: Vertex 0 1	5: Distance 6 4 5 7	from	Source	1 Parent 1 6 7 7
14 From 6: Vertex 0 1	5: Distance 6 4 5 7 6	from	Source	1 Parent 1 6 7 7 6
14 From 6: Vertex 0 1 2 3 4 5	5: Distance 6 4 5 7 6 5 5	from	Source	1 Parent 1 6 7 7
14 From 6: Vertex 0 1 2 3 4 5 6 7	5: Distance 6 4 5 7 6 5 0	from	Source	1 Parent 1 6 7 7 6 6 -1 6
14 From 6: Vertex 0 1 2 3 4 5 6 7	5: Distance 6 4 5 7 6 5 0 2 3	from	Source	1 Parent 1 6 7 7 6 6 -1 6 6
14 From 6: Vertex 0 1 2 3 4 5 6 7 8 9	5: Distance 6 4 5 7 6 5 0 2 3 2	from	Source	1 Parent 1 6 7 7 6 6 -1 6 6 6
14 From 6: Vertex 0 1 2 3 4 5 6 7 8 9 10	5: Distance 6 4 5 7 6 5 0 2 3 2 4	from	Source	1 Parent 1 6 7 7 6 6 -1 6 6 6 6
14 From 6: Vertex 0 1 2 3 4 5 6 7 8 9 10 11	5: Distance 6 4 5 7 6 5 0 2 3 2 4 6	from	Source	1 Parent 1 6 7 7 6 6 -1 6 6 6 9
14 From 6: Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12	5: Distance 6 4 5 7 6 5 0 2 3 2 4 6 6 6	from	Source	1 Parent 1 6 7 7 6 6 -1 6 6 9 9
14 From 6: Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14	5: Distance 6 4 5 7 6 5 0 2 3 2 4 6 6 6 4	from	Source	1 Parent 1 6 7 7 6 6 -1 6 6 6 9
14 From 6: Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 From 7:	5: Distance 6 4 5 7 6 5 0 2 3 2 4 6 6 6 4 :			1 Parent 1 6 7 7 6 6 -1 6 6 9 9 10 6
14 From 6: Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 From 7: Vertex	5: Distance 6 4 5 7 6 5 0 2 3 2 4 6 6 6 4 : Distance			1 Parent 1 6 7 7 6 6 6 -1 6 6 9 9 10 6 Parent
14 From 6: Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 From 7: Vertex 0	5 Distance 6 4 5 7 6 5 0 2 3 2 4 6 6 6 4 : Distance 4			1 Parent 1 6 7 7 6 6 6 -1 6 6 9 9 10 6 Parent 1
14 From 6: Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 From 7: Vertex 0 1	5: Distance 6 4 5 7 6 5 0 2 3 2 4 6 6 6 4 : Distance 4 2			1 Parent 1 6 7 7 6 6 6 -1 6 6 9 9 10 6 Parent 1 7
14 From 6: Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 From 7: Vertex 0 1	5: Distance 6 4 5 7 6 5 0 2 3 2 4 6 6 6 4 : Distance 4 2 3			1 Parent 1 6 7 7 6 6 6 -1 6 6 9 9 10 6 Parent 1
14 From 6: Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 From 7: Vertex 0	5: Distance 6 4 5 7 6 5 0 2 3 2 4 6 6 6 4 : Distance 4 2			1 Parent 1 6 7 7 6 6 6 -1 6 6 9 9 10 6 Parent 1 7 7

5 6 7 8 9 10 11 12 13 14 From 8	6 2 0 5 4 4 8 7 6 3			7 7 -1 7 6 1 9 3 10
	Distance 4 6 3 4 5 7 3 5 0 5 7 9 5 8 7	from	Source	Parent 8 2 8 8 3 4 8 8 -1 6 9 8 8 6
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 From 10	Distance 7 5 7 5 4 6 2 4 5 0 5 4 7 6	from	Source	Parent  1  9  9  4  9  6  6  -1  9  9  10  6
	Distance	from	Source	Parent

10 11 12 13 14 From 11	0 9 5 2 3			-1 14 3 10 1
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 From 12	Distance 9 7 9 7 8 10 6 8 9 4 9 0 5 10 6	from	Source	Parent  1 14 11 12 9 12 9 6 6 11 9 -1 11 11 11
	Distance 5 6 5 2 3 5 6 7 5 4 5 5 0 6 5 5	from	Source	Parent 3 12 12 12 3 12 9 3 12 12 4 12 -1 3 12
	Distance 6 4 7 4 4 4 6 6 8 7 2 10 6 0 5	from	Source	Parent  1 10 1 13 10 10 10 10 13 13 10 13 11 13 11 13 11 11

### From 14:

Vertex	Distance	from	Source	Parent
0	3			1
1	1			14
2	4			1
3	4			14
4	5			10
5	5			10
6	4			14
7	3			1
8	7			0
9	6			1
10	3			1
11	6			14
12	5			14
13	5			10
14	0			-1

### 4.V=20 E=183 k=14 q=1.5 (Dense graph)

### Input:

```
20 183
14
0 11 2 4 10 14 4 3 3 7 14 5 5 1 12 1 11 10 2 12
11 0 6 6 9 2 3 7 7 6 11 8 5 2 6 11 3 9 7 2
2 6 0 4 10 9 8 6 2 3 3 14 6 1 8 13 2 14 7 12
4 6 4 0 12 4 8 6 4 13 1 5 5 12 3 1 10 2 4 13
10 9 10 12 0 11 0 5 9 10 5 6 6 3 8 9 8 9 4 6
14 2 9 4 11 0 5 1 11 11 13 9 9 11 13 2 13 8 12 9
4 3 8 8 0 5 0 11 3 5 4 3 9 0 12 11 8 6 11 5
3 7 6 6 5 1 11 0 14 7 0 9 2 3 12 12 1 0 11 6
3 7 2 4 9 11 3 14 0 5 2 0 4 11 7 5 10 6 4 1
7 6 3 13 10 11 5 7 5 0 10 12 11 7 12 7 2 3 3 5
14 11 3 1 5 13 4 0 2 10 0 14 4 8 11 3 2 1 11 10
5 8 14 5 6 9 3 9 0 12 14 0 3 8 0 11 12 5 10 14
5 5 6 5 6 9 9 2 4 11 4 3 0 9 2 8 3 10 6 2
1 2 1 12 3 11 0 3 11 7 8 8 9 0 5 1 11 14 10 6
12 6 8 3 8 13 12 12 7 12 11 0 2 5 0 6 3 9 3 4
1 11 13 1 9 2 11 12 5 7 3 11 8 1 6 0 1 9 8 4
11 3 2 10 8 13 8 1 10 2 2 12 3 11 3 1 0 3 8 0
10 9 14 2 9 8 6 0 6 3 1 5 10 14 9 9 3 0 8 7
2 7 7 4 4 12 11 11 4 3 11 10 6 10 3 8 8 8 0 2
12 2 12 13 6 9 5 6 1 5 10 14 2 6 4 4 0 7 2 0
1 2 3 4 5 6 7 8 9 10 11 12 13 14
```

### **Output:**

### New-Dijkstra:

### **SSSP**

Vertex Distance from Source Parent

0	0	-1
1	3	13
2	2	13
3	2	15
4	4	13
5	3	15
6	4	0
7	3	16
8	3	0
9	4	16
10	3	3
11	5	0
12	5	7
13	1	0
14	5	3
15	1	0
16	2	15
17	4	10
18	2	0
19	4	8

## APSP

F	'n	om	0	:

Vertex	Distance	from	Source	Parent
0	0			-1
1	3			13
2	2			13
3	2			15
4	4			13
5	3			15
6	4			0
7	3			16
8	3			0
9	4			16
10	3			3
11	5			0
12	5			7
13	1			0
14	5			3
15	1			0
16	2			15
17	4			10
18	2			0
19	4			8
From 1.	•			

### From 1:

Vertex	Distance	from	Source	Parent

0	3	13
1	0	-1
2	3	13
3	4	15
4	5	13
5	2	1
6	3	1
7	3	5
8	3	19

9 10 11 12 13 14 15 16 17 18	5 5 6 4 2 6 3 3 6 4 2			16 3 6 19 1 12 13 1 10 19
From 2: Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 3:	Distance 2 3 0 3 4 4 5 3 2 3 7 5 1 5 2 2 4 4 3	from	Source	Parent 13 13 -1 15 13 7 8 16 2 2 0 19 2 16 13 2 10 0 8
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 4:	Distance 2 4 3 0 5 3 5 3 4 1 5 2 3 1 2 4 4	from	Source	Parent 15 13 13 -1 13 15 10 16 10 16 3 3 7 15 3 3 15 10 0 8

Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 5:	Distance 4 5 4 5 0 6 8 5 6 7 5 6 6 3 7 4 5 6 4 6	from	Source	Parent 13 13 13 15 -1 7 1 4 2 16 4 4 4 18 13 15 10 4 18
	Distance     3     2     4     3     6     0     5     1     5     4     4     6     3     3     5     2     2     5     4	from	Source	Parent 15 5 13 15 13 -1 1 5 19 16 3 12 7 15 12 5 7 10 0 1
	Distance 4 3 5 5 8 5 0 6 3 5 4	from	Source	Parent 6 6 8 10 13 1 -1 5 6 6 6

11 3 12 6 13 5 14 8 15 5 16 6 17 5 18 6 19 4 From 7:			6 19 0 12 0 15 10 19
Vertex Distance  0	e from	Source	Parent 15 5 16 15 7 7 1 -1 19 16 16 12 7 15 12 16 7 10 0 12
Vertex Distance 0		Source	Parent  8 19 8 10 13 1 8 16 -1 2 8 12 19 2 12 13 2 10 19 8 Parent
Vertex Distance 0 4	e irom	Source	Parent 15

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 10	5 3 4 7 4 5 3 5 0 4 8 5 4 5 3 2 3 3 5			16 9 15 13 7 9 16 2 -1 17 12 7 15 16 9 9 9 18
Vertex 0 1 2 3 4 5 6 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 11	Distance     3     5     3     1     5     4     4     3     2     4     0     6     4     3     4     2     2     1     5     3	from	Source	Parent
	Distance 5 6 7 5 6 6 3 5 6 8 6 0 3	from	Source	Parent 11 6 13 11 11 7 11 12 19 16 3 -1 11

13 14 15 16 17 18 19 From 12	6 5 6 5 7 5			0 12 0 7 11 19
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	Distance     5     4     5     5     6     3     6     2     3     5     4     3     0     5     2     4     3     5     4    3    5    4    4	from	Source	Parent 15 19 16 15 12 7 8 12 19 16 12 12 -1 15 12 16 7 10 19
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 14	Distance 1 2 1 2 3 3 5 3 4 3 6 5 0 5 1 2 4 3 4 1:			12  Parent 13 13 13 15 13 15 1 16 2 16 3 0 7 -1 3 13 15 10 0 8
Vertex 0 1 2	Distance 5 6 5	from	Source	Parent 15 19 16

3 3 4 7 5 5 6 8 7 4 8 5 9 5 10 4 11 5 12 2 13 5 14 0 15 15 18 19 18 19 15 :			14 18 7 8 16 19 16 3 12 14 15 -1 3 14 10 14	
Vertex Distance	from	Source		
0 1 1 3 2 2 3 1 4 4 5 2 6 5 7 2 8 4 9 3 10 2 11 6 12 4 13 1 14 4 15 0 16 1 17 3 18 3 19 4 From 16:			15 13 13 15 13 15 0 16 10 16 3 0 7 15 3 -1 15 10 0 15	
Vertex Distance 0 2 1 3 2 2	from	Source	Parent 15 16 16	
3 2			15	
4 5 5 2			13 7	
6 6			1	
7 1 8 4			16 2	
9 2 10 2			16 16	
11 6			12	
12 3 13 2			7 15	
14 3			16	

15 16 17 18 19	1 0 3 4 5			16 -1 10 0 8	
From 17	:				
Vertex 0 1 2 3 4	Distance 4 6 4 2 6	from	Source	Parent 15 13 10 10	
5 6 7 8 9	5 5 4 3 3			7 10 16 10	
10 11 12 13	1 5 5 4			17 17 10 15	
14 15 16 17 18	5 3 3 0 6			3 3 10 -1 0	
19 From 18	4			8	
	Distance	from	Source	Parent	
0	2			18	
1 2	4 4			19 13	
3	4			15	
4	4			18	
5	5			15	
6	6			8	
7 8	5 3 3			16 19	
9	3			18	
10	5			3	
11	7			12	
12	4			19	
13	3			0	
14	3			18	
15 16	3 4			0 15	
17	6			10	
18	0			-1	
19	2			18	
From 19					
	Distance	from	Source	Parent	
0	4			18	
1	2			19	
2	3 4			8	
_	//			1.11	
4	6			10 18	

5	4	1
6	4	8
7	4	12
8	1	19
9	5	18
10	3	8
11	5	12
12	2	19
13	4	2
14	4	12
15	4	19
16	5	7
17	4	10
18	2	19
19	0	-1

# SSSP

Vertex	Distance	from	Source	Parent
0	0			-1
1	3			13
2	2			0
3	2			15
4	4			13
5	3			15
6	4			0
7	3			0
8	3			0
9	4			16
10	3			3
11	5			0
12	5			0
13	1			0
14	5			18
15	1			0
16	2			15
17	4			3
18	2			0
19	4			18

# APSP

# From 0:

Vertex	Distance	from	Source	Parent
0	0			-1
1	3			13
2	2			0
3	2			15
4	4			13
5	3			15
6	4			0

7 8 9 10 11 12 13 14 15 16 17 18 19 From 1:	3 4 3 5 5 1 5 1 2 4 2 4			0 0 16 3 0 0 0 18 0 15 3 0
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 2:	Distance     3     0     3     4     5     2     3     3     5     6     4     2     6     3     3     6     4     2	from	Source	Parent 13 -1 13 15 13 1 1 5 19 16 16 6 19 1 1 13 1 16 19 1
	Distance 2 3 0 3 4 4 5 3 2 3 7 5 1 5 2 2 4 4	from	Source	Parent 2 13 -1 15 13 15 8 16 2 2 2 0 16 2 16 13 2 10 0

19 From 3:	3			8
	Distance 2 4 3 0 5 3 5 3 4 1 5 5 2 3 1 2 4 4	from	Source	Parent 15 13 13 -1 13 15 10 16 10 16 3 3 15 3 15 3 8
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19	Distance 4 5 4 5 0 6 8 5 6 7 5 6 6 3 7 4 5 6 4 6	from	Source	Parent 13 13 13 15 -1 15 0 4 2 18 4 4 4 18 13 15 10 4 4
From 5: Vertex 0 1 2 3 4 5 6 7	Distance 3 2 4 3 6 0 5 1 5	from	Source	Parent 15 5 16 15 7 -1 5 19

9 10 11 12 13 14 15 16 17 18 19 From 6:	4 4 6 3 5 2 2 5 4			16 16 12 7 15 16 5 7 16 0
	Distance 4 3 5 8 5 0 6 3 5 4 3 6 5 8 5 6 4 4	from	Source	Parent 6 6 8 10 13 6 -1 5 6 6 6 11 1 19 0 1 10 19 8
	Distance     3     3     3     5     1     6     0     5     3     3     5     2     3     4     2     1     4     5     4	from	Source	Parent 7 5 16 15 7 7 5 -1 10 16 16 12 7 7 16 16 0 12

Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 9:	Distance 3 3 2 3 6 5 3 5 0 5 2 6 3 3 5 4 4 3 3 1	from	Source	Parent 8 19 8 10 13 1 8 12 -1 8 8 12 19 2 19 13 10 10 19 8
	Distance 4 5 3 4 7 4 5 3 5 0 4 8 5 4 5 3 2 3 3 5	from	Source	Parent 15 16 9 15 18 7 9 16 9 -1 16 17 16 15 16 9 9 9
Vertex 0 1 2 3 4 5 6 6 7 8 9 10		from	Source	Parent 15 16 10 10 10 15 10 16 10 17 -1

11 6 12 4 13 3 14 4 15 2 16 2 17 1 18 5 19 3 From 11:			17 10 15 3 3 10 10 3 8
	ce from	Source	Parent 11 6 0 11 11 7 11 12 6 6 17 -1 11 0 12 3 12 11 19 12
Vertex Distance 0			12 19 16 12 12 7 11 12 19 16 12 12 -1 7 12 16 12 10 19 12
Vertex Distant 0 1	ce from	Source	Parent 13

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 14:	2 1 2 3 3 5 3 4 3 6 5 0 5 1 2 4 3 4 3 4			13 13 15 13 15 0 13 2 2 2 3 0 16 -1 13 13 15 3
Vertex Distant  1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 15:	ance 5 6 5 3 7 5 8 4 5 5 2 5 0 4 3 5 3 4	from	Source	Parent     18     14     16     14     18     7     10     12     19     16     3     12     14     14     -1     16     14     3     14     14
Vertex Distance  1 2 3 4 5 6 7 8 9 10 11 12	ance 1 3 2 1 4 2 5 2 4 3 2 6 4	from	Source	Parent     15     13     13     15     13     15     0     16     0     16     3     3     16

13 14 15 16 17 18 19 From 16:	1 4 0 1 3 3 4			15 16 -1 15 3 0 15
Vertex Distance 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19	nce 2 3 2 2 5 2 6 1 4 2 2 6 3 1 0 3 4 5 5	from	Source	Parent 15 16 16 15 13 7 10 16 10 16 12 16 15 16 16 15 16 15 16 15 16 17 18 18 18 18 18 18 18 18 18 18 18 18 18
From 17: Vertex Dista 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 18:	nce 4 6 4 2 6 5 5 4 3 3 1 5 5 4 5 3 3 0 6 4 4 5 6 4 5 6 6 6 7 8 7 8 7 8 7 8 7 8 7 8 7 8 7 8 7	from	Source	Parent 15 16 10 17 10 15 10 16 10 17 17 17 17 17 17 17 18 3 3 17 -1 3 8
Vertex Dista 0 1	nce 2 4 4	from	Source	Parent 18 19 0

3	4			18
4	4			18
5	5			15
6	6			0
7	5			0
8	3			19
9	3			18
10	5			8
11	7			0
12	4			19
13	3			0
14	3			18
15	3			0
16	4			15
17	6			9
18	0			-1
19	2			18
From 19:		£	0	D +
Vertex Di 0	stance.	from	Source	Parent 8
1	2			0 19
2	3			8
3	4			10
4	6			19
5	4			1
6	4			8
7	4			12
8	1			19
9	5			19
10	3			8
11	5			12
12	2			19
13	4			1
14	4			19
15	4			19
16	5			12
17	4			10
18	2			19

# 5.V=25 E=274 k=9 q=0.8 (Dense graph)

0

# Input:

19

```
25
274
9
0 1 7 4 0 9 4 8 8 2 4 5 5 1 7 1 1 5 2 7 6 1 4 2 3
1 0 2 2 1 6 8 5 7 6 1 8 9 2 7 9 5 4 3 1 2 3 3 4 1
7 2 0 1 3 8 7 4 2 7 7 9 3 1 9 8 6 5 0 2 8 6 0 2 4
4 2 1 0 8 6 5 0 9 0 0 6 1 3 8 2 9 1 3 5 9 8 4 0 7 6 3 6
9 6 8 6 4 0 1 5 4 2 0 9 7 3 7 2 6 0 1 6 5 7 5 4 1
4 8 7 5 9 1 0 2 0 0 1 4 6 0 7 1 7 7 7 3 3 5 9 9
```

-1

```
8 5 4 0 6 5 2 0 8 1 8 2 6 6 0 3 8 0 1 2 5 0 9 4 7
8 7 2 9 3 4 0 8 0 8 3 5 1 2 0 1 6 4 0 6 1 8 9 8 4
2 6 7 0 7 2 0 1 8 0 1 4 3 9 8 8 0 8 7 7 8 3 8 3 7
4 1 7 0 8 0 1 8 3 1 0 1 0 7 3 4 9 6 5 1 0 9 9 6 8
5 8 9 6 8 9 4 2 5 4 1 0 3 4 8 4 9 9 2 5 5 3 3 3 7
5 9 3 1 2
          7
            6 6 1
                  3 0 3 0 4
                             3 8 0 8 8 0
                                         6
                                             1
1 2 1 3 9 3 0 6 2 9 7 4 4 0 9 7 2 2 8 2 8 9 0 7 8
7 7 9 8 1 7 7 0 0 8 3 8 3 9 0 1 5 8 6 1 2 4 2 5 8
1 9 8 9 3 2 1 3 1 8 4 4 8 7 1 0 6 2 6 5 3 9 2 4 6
1 5 6 3 5 6 7 8 6 0 9
                      9 0 2
                             5 6 0 1 8 2 1 1 9 7
5 4 5 4 9 0 7 0 4 8 6 9 8 2 8 2 1 0 2 9
                                         5 2 0 0 3
2 3 0 4 8 1 7 1 0 7 5 2 8 8 6 6 8 2 0 9 1 8 1 9 5
7\ 1\ 2\ 6\ 4\ 6\ 7\ 2\ 6\ 7\ 1\ 5\ 0\ 2\ 1\ 5\ 2\ 9\ 9\ 0\ 3\ 2\ 5\ 2\ 5
6 2 8 0 0 5 3 5 1 8 0 5 6 8 2 3 1 5 1
                                       3 0 8 6 7 7
          7
            3 0 8 3 9 3 8 9 4 9 1
                                   2 8 2 8 0 2
  3 6 6 7
4 3 0 6 6 5 5 9 9 8 9 3 1 0 2 2 9 0 1 5 6 2 0 4 1
2 4 2 1 3 4 9 4 8 3 6 3 9 7 5 4 7 0 9 2 7 2 4 0 9
3 1 4 8 6 1 9 7 4 7 8 7 8 8 8 6 6 3 5 5 7 9 1 9 0
1 2 3 4 5 6 7 8 9
```

### **Output:**

## New-Dijkstra:

### **SSSP**

Vertex	Distance	from	Source	Parent
0	0			-1
1	1			0
2	2			13
3	3			2
4	2			1
5	3			24
6	2			15
7	3			9
8	2			15
9	2			0
10	2			1
11	3			10
12	3			8
13	1			0
14	2			15
15	1			0
16	1			0
17	2			16
18	2			0
19	2			1
20	2			16
21	1			0
22	3			24
23	2			0
24	2			1

From 0:				
Vertex Distand	ce from	Source	Parent -1	
1 1			0	
2 2			13	
3 4 2			2 1	
5 3			24	
6 2 7 3			15	
			9 15	
9 2			0	
10 2 11 3			1 10	
12 3			8	
13 1			0	
14 2 15 1			15 0	
16 1			0	
17 2 18 2			16 0	
19 2			1	
20 2			16	
21 1 22 3			0 24	
23 2			0	
24 2 From 1:			1	
IIOIII I.				
Vertex Distan	ce from	Source		
0 1	ce from	Source	1	
0 1 1 0 2 2	ce from	Source		
0 1 1 0 2 2 3 2	ce from	Source	1 -1 1 1	
0 1 1 0 2 2 3 2 4 1	ce from	Source	1 -1 1 1	
0 1 1 0 2 2 3 2 4 1 5 2 6 2	ce from	Source	1 -1 1 1 24 10	
0 1 1 0 2 2 3 2 4 1 5 2 6 2	ce from	Source	1 -1 1 1 24 10 9	
0 1 1 0 2 2 3 2 4 1 5 2 6 2	ce from	Source	1 -1 1 1 24 10 9 15	
0 1 1 0 2 2 3 2 4 1 5 2 6 2	ce from	Source	1 -1 1 1 24 10 9 15 10	
0 1 1 0 2 2 3 2 4 1 5 2 6 2 7 3 8 3 9 2 10 1 11 2	ce from	Source	1 -1 1 1 24 10 9 15	
0 1 1 0 2 2 3 2 4 1 5 2 6 2 7 3 8 3 9 2 10 1 11 2	ce from	Source	1 -1 1 1 24 10 9 15 10 1 10 22 0	
0 1 1 0 2 2 3 2 4 1 5 2 6 2 7 3 8 3 9 2 10 1 11 2	ce from	Source	1 -1 1 1 24 10 9 15 10 1 10 22 0 4	
0 1 1 0 2 2 3 2 4 1 5 2 6 2 7 3 8 3 9 2 10 1 11 2	ce from	Source	1 -1 1 1 24 10 9 15 10 1 10 22 0 4 0	
0 1 1 0 2 2 3 2 4 1 5 2 6 2 7 3 8 3 9 2 10 1 11 2 12 3 13 2 14 2 15 2 16 2 17 3	ce from	Source	1 -1 1 1 24 10 9 15 10 1 10 22 0 4 0 0	
0 1 1 0 2 2 3 2 4 1 5 2 6 2 7 3 8 3 9 2 10 1 11 2 12 3 13 2 14 2 15 2 16 2 17 3 18 3 19 1	ce from	Source	1 -1 1 1 24 10 9 15 10 1 10 22 0 4 0 0 16 5	
0 1 1 0 2 2 3 2 4 1 5 2 6 2 7 3 8 3 9 2 10 1 11 2 12 3 13 2 14 2 15 2 16 2 17 3 18 3 19 1	ce from	Source	1 -1 1 1 24 10 9 15 10 1 10 22 0 4 0 0 16 5 1	
0 1 1 0 2 2 3 2 4 1 5 2 6 2 7 3 8 3 9 2 10 1 11 2 12 3 13 2 14 2 15 2 16 2 17 3 18 3 19 1	ce from	Source	1 -1 1 1 24 10 9 15 10 1 10 22 0 4 0 0 16 5 1 1 0 24	
0       1         1       0         2       2         3       2         4       1         5       2         6       2         7       3         8       3         9       2         10       1         11       2         12       3         13       2         14       2         15       2         16       2         17       3         18       3         19       1         20       2         21       2         22       2         23       3	ce from	Source	1 -1 1 1 24 10 9 15 10 1 10 22 0 4 0 0 16 5 1	
0 1 1 0 2 2 3 2 4 1 5 2 6 2 7 3 8 3 9 2 10 1 11 2 12 3 13 2 14 2 15 2 16 2 17 3 18 3 19 1	ce from	Source	1 -1 1 1 24 10 9 15 10 1 10 22 0 4 0 0 16 5 1 1 0 24	

Vertex	Distance	from	Source	Parent.
0	2		200200	13
1	2			2
2	0			-1
3	1			2
4	3			1
5	4			24
6	4			15
7	4			19
8	2			2
9	4			10
10	3			1
11	4			10
12	2			3
13	1			2
14	3			19
15	3			0
16	3 3 3			0
17	3			13
18	4			22
19	2 3 3 3 2			2
20	3			8
21	3			0
22	3			12
23 24	3			3 1
From 3:				Т
	Distance	from	Source	Parent
0	3	I I OIII	DOULCC	13
1	2			3
2	1			3
3	0			-1
4	3			1
5	4			18
6	4			15
7	4			18
8	2			12
9	4			10
10	3			1
11	4			10
12	1			3
13	')			')
	2			2
14	4			15
14 15	4 3			15 8
14 15 16	4 3 3			15 8 3
14 15 16 17	4 3 3 4			15 8 3 16
14 15 16 17 18	4 3 3 4			15 8 3 16 22
14 15 16 17 18 19	4 3 3 4			15 8 3 16 22 1
14 15 16 17 18 19 20	4 3 3 4			15 8 3 16 22 1 8
14 15 16 17 18 19 20 21	4 3 3 4 3 3 3 3			15 8 3 16 22 1 8 23
14 15 16 17 18 19 20 21 22	4 3 3 4 3 3 3 3 2			15 8 3 16 22 1 8 23 12
14 15 16 17 18 19 20 21 22 23	4 3 4 3 3 3 3 2 1			15 8 3 16 22 1 8 23 12 3
14 15 16 17 18 19 20 21 22 23 24	4 3 3 4 3 3 3 3 2 1 3			15 8 3 16 22 1 8 23 12
14 15 16 17 18 19 20 21 22 23 24 From 4:	4 3 3 4 3 3 3 3 2 1 3	from	Source	15 8 3 16 22 1 8 23 12 3 22

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 5:	1 3 0 3 3 4 3 2 3 2 3 1 2 3 4 4 2 3 3 3 3 4 2 3 3 3 3 4 4 2 3 3 3 3			4 1 12 -1 24 10 9 15 10 1 10 4 0 4 14 0 16 5 1 1 0 24 4 1 1 0 1 1 1 0 1 1 1 1 0 1 1 1 1 1 1
0 1 2 3 4	Distance 3 2 4 4 3	from	Source	Parent 15 24 13 12 1
5 6 7 8 9	0 1 2 3 2			-1 5 18 15 5
11 12 13 14 15	2 3 3 3 3 2 3 3			10 22 5 15 6 20
17 18 19 20 21 22 23 24	3 1 3 2 4 2 4 1			18 5 10 18 0 18 5
From 6: Vertex 0 1	Distance 2 2 2 4	from	Source	Parent 15 10 13

3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 7:	4 3 1 0 2 2 2 1 2 3 3 2 1 3 3 2 2 2 3 3 3 2 2 2 3 3 3 4 2 2 3 3 3 3			12 1 6 -1 6 15 10 6 10 8 0 15 6 0 15 5 10 18 0 18 19 5
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24	Distance     3     3     4     4     4     2     2     0     3     1     2     2     3     4     3     3     3     1     2     2     4     2     4     3	from	Source	Parent 9 10 19 12 1 18 7 -1 20 7 9 7 22 0 19 6 20 18 7 7 18 16 18 19 5
From 8: Vertex 0 1 2 3 4	Distance 2 3 2 2 3	from	Source	Parent 15 0 8 12 14

5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 9:	3 2 3 0 4 3 4 1 2 2 1 2 3 2 3 1 3 2 3 3			6 15 18 -1 10 6 10 8 8 15 8 20 16 20 14 8 0 12 3 22
Vertex Dist	tance 2 2 4	from	Source	Parent 9 10 13
3 4	4 3			12 1
5	2			9
6 7	2 1			10 9
8	4			20
9 10	0 1			-1 9
11	1 2 3 3			10
12 13	3 3			9 0
14	_			19
15 16	3 3			6 0
17	4			16
18 19	2			7 10
20	3			18
21 22	3			0 18
23	3 3 4 2 2 3 3 3 3			9
24 From 10:	3			1
Vertex Dis	tance	from	Source	
0	2 1			1 10
2 3				1
3 4	3			1 1
5	3 3 2 2 1			6
6	1			10

7 2 8 3 9 1 10 0 11 1 12 4 13 3 14 2 15 2 16 3 17 4 18 3 19 1 20 3 21 3 22 3 23 3 24 2 From 11:			9 15 10 -1 10 22 0 19 6 0 16 5 10 1 0 24 19
Vertex Distance 0	ce from	Source	Parent  1 10 1 12 1 6 10 11 15 10 11 -1 11 0 19 6 0 18 11 10 18 11 10 18 11 11 1
Vertex Distance 0	ce from	Source	Parent     15     24     3     12     12     18     15     18     12

9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 13:	3 4 3 0 3 2 3 4 2 4 2 3 1 2 2			12 6 12 -1 2 15 8 20 16 22 14 8 22 12 3 22
Vertex Dista 0 1 2 3	1 2 1 2		Source	Parent 13 0 13 2
4 5 6 7 8	3 3 4 2			1 13 15 9 13
9 10 11 12	3 3 4 3			0 1 10 3
13 14 15 16 17	0 3 2 2 2			-1 15 0 0 13
18 19 20 21	3 2 3 2			0 13 16 0
22 23 24 From 14:	4 3 3			24 3 1
Vertex Dista 0 1 2 3 4 5 6	ance 2 2 3 4 1 3 2 3 2 3	irom	Source	15 4 19 12 14 6 15
8 9 10	2 3 2			15 10 19

11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 15	3 3 0 1 3 3 3 1 2 3 2 3 3			10 8 0 -1 14 0 15 20 14 14 0 14
Vertex 0 1	Distance 1 2	from	Source	Parent 15
2	3			13
3	3			12 14
4 5	2 2 1			6
6	1			15
7 8	3 1			6 15
9	3			10
10	2 3			6
11 12	3 2			10 8
13	2			0
14 15	1 0			15
16				-1 0
17	2 2 3			15
18 19	3 2			5 14
20	2			8
21	2			0
22 23	2 2 2 3			15 0
24	3			1
From 16		<i>C</i>	0	D +
vertex 0	Distance 1	irom	Source	Parent 16
1				0
2 3	3			13 16
4	3			1
4 5	3			18
6 7	3 3			15 18
8	2 3 3 3 3 3 3 2 3			20
9	3			0 1
10 11	3 4			10
12	3			8

13 14 15 16 17 18 19 20 21 22 23 24 From 17	2 3 2 0 1 2 2 1 1 3 3 3			0 15 0 -1 16 20 16 16 16 18 0
Vertex 0 1	Distance 2 3	from	Source	Parent 16 0
2	3			13
3	4			2
4	4			1
5	3 3			18
6 7	3 3			15 18
8	3			20
9	4			7
10	4			1
11	4			18
12	4			8
13 14	2 3			17 15
15	2			17
16	1			17
17	0			-1
18	2 3			17
19	3 2			16
20 21	2			16 16
22	3			18
23	4			0
24	3			17
From 18		e	0	D +
vertex 0	Distance 2	Trom	Source	Parent 18
1	2 3			24
2	4			3
2 3 4	3			12
4	4			1
5 6	1			18 5
7	2 1			18
8	2			20
9	2 2 3 2 2 3			7
10	3			6
11 12	2			18 22
13	3			0
14	3			20
	-			-

15 16 17 18 19 20 21 22 23 24 From 19	3 2 2 0 3 1 3 1 4 2			6 20 18 -1 7 18 16 18 3
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 20	Distance 2 1 2 3 2 3 2 2 3 2 1 2 4 2 1 2 2 3 3 0 3 2 2 3 2 2 2 2 3 3 2 2 2 2 2	from	Source	Parent  1 19 19 2 1 24 10 19 15 10 19 10 22 19 19 14 19 16 7 -1 16 19 24 19 1
	Distance 2 2 3 3 3 2 1 3 3 2 1 3 2 1 1 3 1 1 1 1	from	Source	Parent     16     20     8     12     1     18     15     18     20     7     1     18     8     0     20     8     20

17 18 19 20 21 22 23 24 From 21	2 1 3 0 2 2 4 3			16 20 1 -1 16 18 3 5
	Distance     1     2     3     3     4     3     4     3     3     3     2     3     2     1     2     3     2     0     2     2     3	from	Source	Parent 21 0 13 23 1 24 15 18 15 0 1 21 22 0 15 0 21 16 20 21 16 -1 21 21 21 1
	Distance     3     2     3     2     3     2     3     2     3     2     3     3     1     4     2     2     3     3     1	from	Source	Parent  1 24 3 12 1 18 5 18 12 7 1 18 22 2 2 22 22 22 22 22 20 18 22

19 20 21 22 23 24 From 23:	3 2 2 0 3 1			1 18 22 -1 3 22
Vertex Distance  Vertex Distance  1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 24:	ance 2 3 2 1 3 4 4 4 3 3 3 3 3 3 4 4 2 4 2 3 0 4	from	Source	Parent 23 0 3 23 23 23 15 9 12 23 19 23 3 2 19 0 16 22 23 8 23 12 -1 22
Vertex Distance 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	ance 2 1 3 2 1 2 3 3 2 3 3 3 3 3 2 3 3 3 3 3	irom	Source	1 24 1 12 1 24 5 18 12 10 1 10 22 0 0 4 0 0 0 24 5 1 18

21	3	0
22	1	24
23	4	3
24	0	-1

# Dijkstra:

# SSSP

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21	Distance 0 1 2 3 2 3 2 3 2 2 2 1 1 2 2 2 1	from	Source	-1 0 13 1 15 15 15 18 15 0 1 10 8 0 15 0 0 16 0 16 0	
	1 3 2 2				

# **APSP**

# From 0:

Vertex	Distance	from	Source	Parent
0	0			-1
1	1			0
2	2			13
3	3			1
4	2			1
5	3			15
6	2			15
7	3			18
8	2			15
9	2			0
10	2			1
11	3			10
12	3			8
13	1			0
14	2			15

15 16 17 18 19 20 21 22 23 24 From 1:	1 1 2 2 2 2 2 1 3 2 2			0 0 16 0 1 16 0 21 0	
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 2:				1 -1 1 1 1 24 10 19 20 10 1 10 4 1 19 0 0 16 1 1 1 0 24 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	Distance 2 2 0 1 3 4 4 4 2 4 3 4 2 1 3 3 3 3	from	Source	Parent  13 2 -1 2 2 13 15 2 0 19 10 3 2 19 8 13	

17 18 19 20 21 22 23 24 From 3:	3 4 2 3 3 3 2 3			13 0 2 8 0 12 2	
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24	Distance     3     2     1     0     3     4     4     4     2     4     3     4     1     2     4     3     3     4     3     3     3     3     2     1     3	from	Source	Parent 23 3 3 -1 12 24 15 18 12 23 1 23 3 2 12 8 3 22 23 8 23 12 3 22	
From 4:	:	£	C		
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	Distance 2 1 3 3 0 3 4 3 2 3 2 3 1 2 3 4 4	from	Source	Parent  1 4 4 1 -1 24 15 19 4 10 1 10 4 1 4 14 0 15 1	

19 20 21 22 23 24 From 5	2 3 3 3 3 2			14 14 0 14 4	
	Distance     3     2     4     4     3     0     1     2     3     2     2     3     3     3     3     2     4     4     2     4     1	from	Source	Parent 18 24 1 1 1 1 5 18 20 5 6 18 22 5 15 5 20 18 5 10 18 6 24 5 5	
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	Distance 2 2 4 4 3 1 0 2 2 2 1 2 3 3 3 2 1 3 3 2 1 3 3 3 2 1 3 3 3	from	Source	Parent 15 10 19 1 14 6 -1 6 15 10 8 0 15 6 0 15 5 10 6	

21 22	3			6 15
23	4			19
24	2			5
From 7:				
	Distance	from	Source	
0	3			18
1	3			19
2 3	4 4			7 12
4	4			14
5	2			18
6	2			7
7	0			-1
8	3			20
9	1			7
10	2 2 3			9
11 12	2			7 22
13	4			19
14	3			19
15	3 3 3			7
16	3			20
17	3			18
18	1			7
19 20	2 2			7 18
21	4			18 9
22	2			18
23	4			7
24	3			22
From 8:				
	Distance	from	Source	
0	2			15
1				20 8
2 3 4 5 6	2			12
4	3			8
5	3			15
	2 2 3 3 2 3			15
7 8	3			18
8	0 4			-1 12
9 10	4 3			8
11	3 4			12
11 12	1			8
13	2			8 8
14	2			15
15	1			8
16 17	2			20 15
18	2			20
19	3			14
20	1			8
21	2 2 1 2 3 2 3 1 3 2			16
22	2			12

23 24 From 9:	3			3 22
Vertex Di 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 10:	2 2 4 4 3 2 2 1 4 0 1 2 3 3 3 3 3 4 2 2 3 3 3 3 3 3 3 3 3 3 3	from	Source	Parent 9 10 19 1 1 9 10 9 10 -1 9 10 9 10 18 7 10 18 9 18 9 18 9 5
	stance 2 1 3 3 2 2 1 2 3 1 0 1 4 3 2 2 3 4 3 1 3 3 3 3 2	from	Source	Parent  1 10 19 1 1 6 10 9 10 10 -1 10 11 19 19 6 19 15 11 10 1 19 24 19 1

From 11	L :			
Vertex	Distance	from	Source	Parent
0	3			1
1	2			10
2	4			19
3	4			1
4	3			1
5	3			18
6	2 2			10
7	2			11
8	4			10
9	2			10
10	1			11
11	0			-1
12	3			11
13	4			11
14	3			19
15	3			6
16	4			19
17	4			18
18	2			11
19	2 2 3 3 3 3			10
20	3			18
21	3			11
22	3			11
23	3			11
24	3			1
From 12	2:	c		<b>.</b>
Vertex	2: Distance	from	Source	
Vertex 0	2: Distance 3	from	Source	15
Vertex 0 1	2: Distance 3	from	Source	15 3
Vertex 0 1 2	2: Distance 3	from	Source	15 3 3
Vertex 0 1 2	2: Distance 3	from	Source	15 3 3 12
Vertex 0 1 2 3 4	Distance 3 3 2 1 2	from	Source	15 3 3 12 12
Vertex 0 1 2 3 4 5	2: Distance 3 3 2 1 2 3	from	Source	15 3 3 12 12 24
Vertex 0 1 2 3 4 5 6	2: Distance 3 3 2 1 2 3 3	from	Source	15 3 3 12 12 24 15
Vertex 0 1 2 3 4 5 6 7	2: Distance 3 3 2 1 2 3 3	from	Source	15 3 3 12 12 24 15
Vertex 0 1 2 3 4 5 6 7	Distance 3 3 2 1 2 3 3 3 1	from	Source	15 3 3 12 12 24 15 18 12
Vertex 0 1 2 3 4 5 6 7 8 9	Distance 3 3 2 1 2 3 3 3 1 3 1 3	from	Source	15 3 3 12 12 24 15 18 12
Vertex 0 1 2 3 4 5 6 7 8 9	Distance 3 3 2 1 2 3 3 3 4	from	Source	15 3 12 12 24 15 18 12 12
Vertex 0 1 2 3 4 5 6 7 8 9 10	Distance 3 3 2 1 2 3 3 3 4 3 4 3	from	Source	15 3 3 12 12 24 15 18 12 12 8
Vertex 0 1 2 3 4 5 6 7 8 9 10 11	Distance 3 3 2 1 2 3 3 3 4 3 0	from	Source	15 3 12 12 24 15 18 12 12 8 12 -1
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13	Distance 3 3 2 1 2 3 3 3 4 3 0	from	Source	15 3 3 12 12 24 15 18 12 12 8 12 -1 8
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13	Distance 3 3 2 1 2 3 3 3 4 3 0	from	Source	15 3 12 12 24 15 18 12 12 8 12 -1 8
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	Distance 3 3 2 1 2 3 3 3 4 3 0	from	Source	15 3 3 12 12 24 15 18 12 12 8 12 -1 8
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	Distance 3 3 2 1 2 3 3 3 4 3 0 3 3 2 3 3 3 3 4 3 0 3 3 3 3 3 4 3 0 3 3 3 3 3	from	Source	15 3 3 12 12 24 15 18 12 12 8 12 -1 8 12 8
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17	Distance 3 3 2 1 2 3 3 3 4 3 0 3 3 2 3 4 3 4 3 0 3 4 3 4 3 0 3 4 4 3 0 3 4 4 3 0 3 4 4 4 4	from	Source	15 3 3 12 12 24 15 18 12 12 8 12 -1 8 12 8 20 18
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17	Distance 3 3 2 1 2 3 3 3 1 3 4 3 0 3 3 4 2 3 4 2	from	Source	15 3 3 12 12 24 15 18 12 12 8 12 -1 8 12 8 20 18 22
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	Distance 3 3 2 1 2 3 3 3 1 3 4 3 0 3 3 2 3 4 4 3 0 4 4 4 4 4	from	Source	15 3 3 12 12 24 15 18 12 12 8 12 -1 8 12 8 20 18 22 23
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	Distance 3 3 2 1 2 3 3 3 1 3 4 3 0 3 3 2 3 4 2 4 2	from	Source	15 3 3 12 12 24 15 18 12 12 8 12 -1 8 12 8 20 18 22
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21	Distance 3 3 2 1 2 3 3 3 4 3 0 3 3 4 2 3 4 2 3 4 2 3	from	Source	15 3 3 12 12 24 15 18 12 12 8 12 -1 8 20 18 22 23 8 22
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22	Distance 3 3 2 1 2 3 3 3 4 3 0 3 3 4 2 3 4 2 3 1	from	Source	15 3 3 12 12 24 15 18 12 12 8 12 -1 8 20 18 22 23 8
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21	Distance 3 3 2 1 2 3 3 3 4 3 0 3 3 4 2 3 4 2 3 4 2 3	from	Source	15 3 3 12 12 24 15 18 12 12 8 12 -1 8 20 18 22 23 8 22 12
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23	Distance 3 3 2 1 2 3 3 3 1 3 4 3 0 3 3 2 3 4 2 3 4 2 3 1 2 2 2	from	Source	15 3 3 12 12 24 15 18 12 12 8 12 -1 8 12 20 18 22 23 8 22 23 8

Vertex Distance from Source Parent

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 14	1 2 1 2 3 3 4 2 3 4 3 0 3 2 2 2 2 3 3 2 4 3 3 2 4 3 3 3 2 4 3 3 3 4 3 3 2 3 3 3 3			13 13 13 2 1 13 15 19 13 0 19 13 8 -1 19 0 13 13 0 13 15 12 1 13 15 19 13 15 19 13 15 19 19 19 19 19 19 19 19 19 19 19 19 19
	Distance 2	from	Source	Parent 15
1 2 3	2 3 4			19 19 1
4 5 6	1 3 2			14 15 15
7 8	3 2			19 15
9 10	3 2			10 19
11 12	3 2 3 3 3			10 14
13 14	3			19 -1
15	1			14
16 17	3 3 1 2 3 2 3			19 15
18 19	3 1			22 14
20 21	2			14 19
22	2			14
23 24	3 3			19 22
From 15 Vertex	Distance	from	Source	Parent
0	1	_ 3	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	15
1	2			0

2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 16:	3 3 2 2 1 3 1 3 2 2 2 1 0 2 2 2 3 2 2 2 3 3 2 2 3 3 3 2 2 3 3 3 3 2 2 3 3 3 3 2 3			8 12 14 15 15 15 0 6 10 8 0 15 -1 0 15 0 14 8 0 15 0 22
Vertex Dist 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24	ance 1 2 3 3 3 3 3 2 3 4 3 2 0 1 2 2 1 1 3 3 3	from	Source	Parent     16     0     13     16     1     18     15     18     20     0     19     21     8     16     20     0     -1     16     20     16     16     21     21     1
From 17: Vertex Dist 0 1 2	ance 2 3 3	from	Source	Parent 16 0 13 17

4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 18				14 18 15 18 20 0 19 18 22 17 15 17 -1 17 16 16 16 17 18 21
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 19	2 3 4 1 2 1 2 2 3 2 2 3 3 3 3 2 2 0 3 1 3 1 4 4 1 2 1 2 1 3 1 1 3 1 4 1 2 1 2 1 2 1 2 1 3 1 1 3 1 1 3 1 2 1 2	from	Source	Parent 18 18 8 12 12 18 5 18 20 7 11 18 22 0 22 20 18 -1 7 18 22 18 0 22 22
	Distance 2 1 2 3 2 3 3	from	Source	Parent 1 19 19 1 14 24

6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 20	2 2 3 2 1 2 4 2 1 2 2 3 3 0 3 2 3 2			10 19 15 10 19 10 14 19 14 19 16 7 -1 19 19
	Distance 2 2 3 3 3 2 1 3 3 2 1 3 2 1 3 0 2 4 3	from	Source	Parent     16     20     8     12     14     18     20     7     1     18     8     16     20     8     20     16     20     -1     16     18     21     22
	Distance	from	Source	Parent 21 0 13 23 1 15 21 19

8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 22:	3 3 3 3 2 3 2 1 2 3 2 2 0 2 2 3			20 21 19 21 22 0 19 0 21 21 0 21 16 -1 21 21 21
	Distance	from	Source	Parent
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 23:	3 2 3 2 3 2 2 3 3 1 4 2 2 3 3 1 3 2 2 3 3 1 3 1 3 1 3 1 3 1 3			18 24 3 12 12 24 15 18 12 7 1 22 22 22 21 18 22 21 18 22 14 18 22 14 18 22 21 3 22 21 3 22 21 21 3 22 21 21 21 21 21 21 21 21 21 21 21 21
	Distance 2 3 2 1 3 4 4 4 3 3	from	Source	Parent 23 3 23 23 23 23 23 15 23 12 23

10 11 12 13 14 15 16 17 18 19 20 21 22 23 24	3 3 2 3 3 3 4 4 4 2 4 2 3 0 4			19 23 3 2 19 0 21 21 0 23 16 23 12 -1 22
From 24 Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24		from	Source	Parent  1 24 1 1 1 24 5 18 12 5 1 10 22 1 22 22 0 24 22 1 1 22 24 19 -1

## Input and Output for A faster algorithm if K is permitted to grow with problem size (q ≥2)

# 1.V=5 E=10 k=8 q=4 (Sparse graph)

## Input:

5 10 0 9 0 5 0 0 0 1 2 0 0 0 0 0 4 0 3 9 0 2 7 0 6 0 0 1 2 3 4 5 6 7 9

## Output:

## New-Dijkstra1:

#### SSSP

Vertex	Distance	from	Source	Parent
0	0			-1
1	8			3
2	9			1
3	5			0
4	7			3

#### **APSP**

From 0:	:			
Vertex	Distance	from	Source	Parent
0	0			-1
1	8			3
2	9			1
3	5			0
4	7			3
From 1:	:			
Vertex	Distance	from	Source	Parent
0	11			4
1	0			-1
2	1			1
3	2			1
4	4			3
From 2:				

Vertex Distance from Source Parent

0	11			4
1	19			3
2	0			-1
3	16			0
4	4			2
From 3:	:			
Vertex	Distance	from	Source	Parent
0	9			4
1	3			3
2	4			1
3	0			-1
4	2			3
From 4:	:			
Vertex	Distance	from	Source	Parent
0	7			4
1	15			3
2	6			4
3	12			0
4	0			-1

# Dijkstra:

# SSSP

Vertex	Distance	from	Source	Parent	
0	0			-1	
1	8			3	
2	9			1	
3	5			0	
4	7			3	

# APSP

From 0:				
Vertex	Distance	from	Source	
0	0			-1
1	8			3
2	9			1
3	5			0
4	7			3
From 1	•			
Vertex	Distance	from	Source	Parent
0	11			4
1	0			-1
2	1			1
3	2			1
4	4			3
From 2	:			
Vertex	Distance	from	Source	Parent
0	11			4
1	19			3
2	0			-1
3	16			0
4	4			2
From 3	•			

Distance	from	Source	Parent
9			4
3			3
4			1
0			-1
2			3
:			
Distance	fnom	00117000	Da +
Distance	TTOIII	Source	Parent
Distance 7	TTOIII	Source	4
7 15	TTOIII	Source	4 3
7	TTOIII	source	4 3 4
7 15	TTOIII	Source	4 3 4 0
	9 3 4 0 2	9 3 4 0 2	Distance from Source 9 3 4 0 2 Distance from Source

## 2. V=9 E=14 k=6 q=3.8 (Sparse graph)

#### Input:

#### Output:

#### New-Dijkstra1:

#### **SSSP**

Vertex Distance from Source Parent -1 

#### **APSP**

#### From 0:

Vertex Distance from Source Parent
0 0 -1
1 4 0

2 3 4 5 6 7 8 From 1:	12 13 17 11 9 8 14			1 6 3 6 7 0 2
Vertex Di 0 1 2 3 4 5 6 7 8 From 2:	stance 4 0 8 15 19 12 12 11 10	from	Source	Parent     1     -1     1     2     3     2     7     1     2
Vertex Di 0 1 2 3 4 5 6 7	stance 12 8 0 7 11 4 6 9	from	Source	Parent     1     2     -1     2     3     2     5     8     2
From 3: Vertex Di 0 1 2 3 4 5 6 7 8	stance 15 15 7 0 4 4 6 7	from	Source	Parent 7 2 3 -1 3 5 6 2
From 4: Vertex Di 0 1 2 3 4 5 6 7	stance 19 19 11 4 0 8 10 11	from	Source	Parent 7 2 3 4 -1 3 5 6 2
From 5: Vertex Di 0 1	stance 11 12 4	from	Source	Parent 7 2 5

3 4 5 6 7 8 From 6:	6 10 0 2 3 6			6 5 -1 5 6 2
	Distance 9 12 6 4 8 2 0 1 6	from	Source	Parent 7 7 5 6 3 6 -1 6 6
Vertex 0 1 2 3 4 5 6 7 8 From 8:	Distance 8 11 9 5 9 3 1 0 7	from	Source	Parent 7 7 8 6 3 6 7 -1 7
	Distance 14 10 2 9 13 6 6 7 0	from	Source	Parent     1     2     8     2     3     2     8     8     -1

# Dijkstra:

# SSSP

Vertex	Distance	from	Source	Parent
0	0			-1
1	4			0
2	12			1
3	13			6
4	17			3
5	11			6
6	9			7
7	8			0
8	14			2

# **APSP**

From 0:				
Vertex	Distance	from	Source	
0	0			-1
1	4			0
2	12			1
3 4	13 17			6 3
5	11			3 6
6	9			7
7	8			0
8	14			2
From 1:				_
	Distance	from	Source	Parent
0	4			1
1	0			-1
2	8			1
3	15			2
4	19			3
5	12			2
6	12			7
7	11			1
8	10			2
From 2:		£	0	D +
	Distance 12	irom	Source	Parent 1
0	8			2
2	0			-1
3	7			2
4	11			3
5	4			2
6	6			5
7	7			6
8	2			2
From 3:				
Vertex	Distance	from	Source	
0	15			7
1	15			2 3
2 3	7			3 -1
	0 4			
4 5	4			3 3
6	6			5
7	7			6
8	9			2
From 4:				_
	Distance	from	Source	Parent
0	19			7
1	19			2
2	11			3
3	4			4
4	0			-1
5	8			3
6	10			5

```
7
                                 6
             11
             13
From 5:
Vertex Distance from Source Parent
0
             11
             12
                                 2
1
2
             4
                                 5
3
             6
                                 6
4
             10
                                 5
                                 -1
5
             0
             2
6
                                 5
7
             3
                                 6
                                 2
8
From 6:
Vertex Distance from Source Parent
0
             9
                                 7
1
             12
2
             6
                                 5
                                 6
3
             4
             8
                                 3
4
5
             2
                                 6
                                 -1
7
             1
                                 6
8
             6
                                 6
From 7:
Vertex Distance from Source Parent
0
             8
                                 7
                                 7
1
             11
2
             7
                                 5
3
             5
                                 6
             9
4
                                 3
5
             3
                                 6
6
             1
                                 7
7
             0
                                 -1
             7
8
                                 7
From 8:
Vertex Distance from Source Parent
0
             14
                                 1
1
             10
                                 2
             2
2
                                 8
3
             9
                                 2
                                 3
4
             13
                                 2
5
             6
6
                                 8
             6
7
             7
                                 8
             0
                                 -1
```

## 3. V=15 E=104 k=63 q=9 (Dense graph)

## Input:

0 41 67 34 0 69 24 78 58 62 64 5 45 81 27

```
41 0 61 91 93 42 27 36 91 4 2 53 92 82 21
67 61 0 16 18 93 47 26 71 38 69 12 67 94 35
34 91 16 0 94 3 11 22 33 73 64 41 11 53 68
0 93 18 94 0 47 44 62 57 37 59 23 41 29 78
69 42 93 3 47 0 16 35 90 42 88 6 40 42 64
24 27 47 11 44 16 0 48 46 5 90 29 70 50 6
78 36 26 22 62 35 48 0 1 93 48 29 23 84 54
58 91 71 33 57 90 46 1 0 56 40 66 76 31 8
62 4 38 73 37 42 5 93 56 0 44 39 26 23 37
64 2 69 64 59 88 90 48 40 44 0 38 18 82 29
5 53 12 41 23 6 29 29 66 39 38 0 41 33 15
45 92 67 11 41 40 70 23 76 26 18 41 0 39 58
81 82 94 53 29 42 50 84 31 23 82 33 39 0 4
27 21 35 68 78 64 6 54 8 37 29 15 58 4 0
1 2 3 4 5 6 8 11 12 15 16 18 21 22 23 24 26 27 29 31 33 34 35
36 37 38 39 40 41 42 44 45 46 47 48 50 53 54 56 57 58 59 61 62 64 66
67 68 69 70 71 73 76 78 81 82 84 88 90 91 92 93 94
```

## **Output:**

#### New-Dijkstra1:

#### **SSSP**

Vertex	Distance	from	Source	Parent
0	0			-1
1	33			9
2	17			11
3	14			5
4	28			11
5	11			11
6	24			0
7	29			8
8	28			14
9	29			6
10	35			1
11	5			0
12	25			3
13	24			14
14	20			11

#### **APSP**

#### From 0:

Vertex	Distance	from	Source	Parent
0	0			-1
1	33			9
2	17			11
3	14			5
4	28			11
5	11			11
6	24			0
7	29			8
8	28			14

9 10 11 12 13 14 From 1:	29 35 5 25 24 20			6 1 0 3 14 11
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 From 2:	Distance	from	Source	Parent 6 -1 3 6 9 3 9 8 14 1 1 5 10 14 6
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14	Distance 17 36 0 16 18 18 27 26 27 32 38 12 27 31 27	from	Source	Parent 11 9 -1 2 2 11 3 2 7 6 1 2 3 14 11
From 3: Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13	Distance 14 20 16 0 32 3 11 22 23 16 22 9 11 21	from	Source	Parent 11 9 3 -1 11 3 3 7 6 1 5 3 14

14 17			6
From 4:  Vertex Distance 0 28 1 41 2 18 3 32 4 0 5 29 6 39 7 42 8 41 9 37 10 43 11 23 11 23 12 41 13 29 14 33 From 5:	from	Source	Parent 11 9 4 5 -1 11 14 8 14 4 1 4 1 3
Vertex Distance 0 11 1 23 2 18 3 3 4 29 5 0 6 14 7 25 8 26 9 19 10 25 11 6 12 14 13 24 14 14 20 From 6:	from	Source	Parent
Vertex Distance 0 24 1 9 2 27 3 11 4 39 5 14 6 0 7 15 8 14 9 5 10 11 11 20 12 22 13 10 14 6 From 7:			6 9 3 6 13 3 -1 8 14 6 1 5 3 14 6
Vertex Distance 0 29 1 24	from	Source	Parent 11 9

2 3 4 5 6 7 8 9 10 11 12 13 14 From 8:	26 22 42 25 15 0 1 20 26 24 23 13 9			7 7 13 3 14 -1 7 6 1 14 7 8
Vertex Dist. 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 From 9:	28 23 27 23 41 26 14 1 0 19 25 23 24 12 8	from	Source	Parent 11 9 7 7 13 3 14 8 -1 6 1 14 7 14 8
Vertex Dist. 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 From 10: Vertex Dist.	29 4 32 16 37 19 5 20 19 0 6 25 24 15 11		Source	6 9 3 6 9 3 9 8 14 -1 1 5 10 14 6
Vertex Dist. 0 1 2 3 4 5	35 2 38 22 43 25	TIOM	Source	9 9

7 8 9 10 11 12 13 14 From 11:	26 25 6 0 31 18 21			8 14 1 -1 5 10 14 6
	stance 5 29 12 9 23 6 20 24 23 25 31 0 20 19	from	Source	Parent 11 9 11 5 11 11 3 8 14 6 1 -1 3 14 11
Vertex Dis 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14	25 20 27 11 41 14 22 23 24 24 18 20 0 32 28	from	Source	Parent 11 10 3 12 12 3 3 12 7 1 12 5 -1 14 6
From 13: Vertex Dis 0 1 2 3 4 5 6 7 8 9 10 11	tance 24 19 31 21 29 24 10 13 12 15 21	from	Source	Parent 11 9 11 6 13 3 14 8 14 6 1 14

12	32			3
13	0			-1
14	4			13
From 14	:			
Vertex 1	Distance	from	Source	Parent
0	20			11
1	15			9
2	27			11
3	17			6
4	33			13
5	20			3
6	6			14
7	9			8
8	8			14
9	11			6
10	17			1
11	15			14
12	28			3
13	4			14
14	0			-1

# Dijkstra:

### SSSP

Vertex	Distance	from	Source	Parent
0	0			-1
1	33			9
2	17			11
3	14			5
4	28			11
5	11			11
6	24			0
7	29			8
8	28			14
9	29			6
10	35			1
11	5			0
12	25			3
13	24			14
14	20			11

# APSP

### From 0:

O				
Vertex	Distance	from	Source	Parent
0	0			-1
1	33			9
2	17			11
3	14			5
4	28			11
5	11			11
6	24			0
7	29			8
8	28			14

9 10 11 12 13 14 From 1:	29 35 5 25 24 20			6 1 0 3 14 11
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 From 2:	Distance	from	Source	Parent 6 -1 3 6 9 3 9 8 14 1 1 5 10 14 6
	Distance 17 36 0 16 18 18 27 26 27 32 38 12 27 31 27	from	Source	Parent 11 9 -1 2 2 11 3 2 7 6 1 2 3 14 11
	Distance 14 20 16 0 32 3 11 22 23 16 22 9 11 21	from	Source	Parent 11 9 3 -1 11 3 3 7 6 1 5 3 14

14 From 4:	17		6
Vertex Dista 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 From 5:	ance fro 28 41 18 32 0 29 39 42 41 37 43 23 41 29 33	m Source	Parent 11 9 4 5 -1 11 14 8 14 4 1 4 1 3
Vertex Dista 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 From 6:	ance fro 11 23 18 3 29 0 14 25 26 19 25 6 14 24 20	m Source	Parent     11     9     11     5     11     -1     3     3     7     6     1     5     3     14     6
Vertex Distance  0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 From 7: Vertex Distance 0	24 9 27 11 39 14 0 15 14 5 11 20 22 10 6		6 9 3 6 13 3 -1 8 14 6 1 5 3 14 6
1	24		9

2 3 4 5 6 7 8 9 10 11 12 13 14 From 8:	26 22 42 25 15 0 1 20 26 24 23 13 9			7 7 13 3 14 -1 7 6 1 14 7 8
Vertex Dist. 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 From 9:	28 23 27 23 41 26 14 1 0 19 25 23 24 12 8	from	Source	Parent 11 9 7 7 13 3 14 8 -1 6 1 14 7 14 8
Vertex Dist. 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 From 10: Vertex Dist.	29 4 32 16 37 19 5 20 19 0 6 25 24 15 11		Source	6 9 3 6 9 3 9 8 14 -1 1 5 10 14 6
Vertex Dist. 0 1 2 3 4 5	35 2 38 22 43 25	TIOM	Source	9 9

7 8 9 10 11 12 13 14 From 11:	26 25 6 0 31 18 21			8 14 1 -1 5 10 14 6
	stance 5 29 12 9 23 6 20 24 23 25 31 0 20 19	from	Source	Parent 11 9 11 5 11 11 3 8 14 6 1 -1 3 14 11
Vertex Dis 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14	25 20 27 11 41 14 22 23 24 24 18 20 0 32 28	from	Source	Parent 11 10 3 12 12 3 3 12 7 1 12 5 -1 14 6
From 13: Vertex Dis 0 1 2 3 4 5 6 7 8 9 10 11	tance 24 19 31 21 29 24 10 13 12 15 21	from	Source	Parent 11 9 11 6 13 3 14 8 14 6 1 14

12	32			3
13	0			-1
14	4			13
From 14	1:			
Vertex	Distance	from	Source	Parent
0	20			11
1	15			9
2	27			11
3	17			6
4	33			13
5	20			3
6	6			14
7	9			8
8	8			14
9	11			6
10	17			1
11	15			14
12	28			3
13	4			14
14	0			-1

#### 4. V=20 E=187 k=80 q=8.5 (Dense graph)

#### Input:

```
2.0
187
80
0 41 67 34 0 69 24 78 58 62 64 5 45 81 27 61 91 95 42 27
41 0 36 91 4 2 53 92 82 21 16 18 95 47 26 71 38 69 12 67
67 36 0 97 35 94 3 11 22 33 73 64 41 11 53 68 47 44 62 57
34 91 97 0 37 59 23 41 29 78 16 35 90 42 88 6 40 42 64 48
0 4 35 37 0 46 5 90 29 70 50 6 1 93 48 29 23 84 54 56
69 2 94 59 46 0 40 66 76 31 8 44 39 26 23 37 38 18 82 29
24 53 3 23 5 40 0 41 33 15 39 58 4 30 77 6 73 86 21 45
78 92 11 41 90 66 41 0 24 72 70 29 77 73 97 12 86 90 61 36
58 82 22 29 29 76 33 24 0 55 67 55 74 31 52 50 50 41 24 66
62 21 33 78 70 31 15 72 55 0 30 7 91 7 37 57 87 53 83 45
64 16 73 16 50 8 39 70 67 30 0 9 9 58 21 88 22 46 6 30
5 18 64 35 6 44 58 29 55 7 9 0 13 68 0 91 62 55 10 59
45 95 41 90 1 39 4 77 74 91 9 13 0 24 37 48 83 95 41 2
81 47 11 42 93 26 30 73 31 7 58 68 24 0 50 91 36 74 20 96
27 26 53 88 48 23 77 97 52 37 21 0 37 50 0 21 48 97 68 84
61 71 68 6 29 37 6 12 50 57 88 91 48 91 21 0 81 34 53 97
91 38 47 40 23 38 73 86 50 87 22 62 83 36 48 81 0 18 38 0
95 69 44 42 84 18 86 90 41 53 46 55 95 74 97 34 18 0 88 27
42 12 62 64 54 82 21 61 24 83 6 10 41 20 68 53 38 88 0 67
27 67 57 48 56 29 45 36 66 45 30 59 2 96 84 97 0 27 67 0
1 2 3 4 5 6 7 8 9 10 11 12 13 15 16 18 20 21 22 23 24 26 27 29 30 31
33 34 35 36 37 38
                  39 40 41 42 44 45 46 47 48 50 52 53 54 55 56 57 58
59 61 62 64 66 67 68 69 70 71 72 73 74 76 77 78 81 82 83 84 86 87 88
90 91 92 93 94 95 96 97
```

#### **Output:**

# New-Dijkstra1:

## SSSP

		_		
Vertex	Distance	from	Source	Parent
0	0			-1
1	15			4
2	19			6
3	28			15
4	11			11
5	17			1
6	16			4
7	30			2
8	39			18
9	12			11
10	14			11
11	5			0
12	12			4
13	19			9
14	27			0
15	22			6
16	34			4
17	35			5
18	15			11
19	14			12

## APSP

	_	
Erom	$\cap$	
From	U	

From U:	•			
Vertex	Distance	from	Source	Parent
0	0			-1
1	15			4
2	19			6
3	28			15
4	11			11
5	17			1
6	16			4
7	30			2
8	39			18
9	12			11
10	14			11
11	5			0
12	12			4
13	19			9
14	27			0
15	22			6
16	34			4
17	35			5
18	15			11
19	14			12
From 1:				
Vertex	Distance	from	Source	Parent
0	15			11
1	0			-1
2	12			6

3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 2:	21 4 2 9 23 33 17 10 10 5 23 25 15 27 20 12 7			15 1 12 2 4 11 5 4 4 2 5 6 4 5 1 12
	Distance     19     12     0     15     8     14     3     11     22     18     16     14     7     11     30     9     31     32     22     9	from	Source	Parent 11 4 -1 15 6 1 2 2 13 12 4 6 2 15 6 4 5 10 12
	Distance 28 21 15 0 17 23 12 18 29 27 16 23 16 23 16 26 27	from	Source	Parent 11 4 6 -1 12 1 15 15 3 6 3 4 6 2 15

15 16 17 18 19 From 4:	6 38 40 22 18			3 10 15 10
	Distance 11 4 8 17 0 6 5 19 29 13 10 6 1 19 29 11 23 24 16 3	from	Source	Parent 11 4 6 15 -1 1 4 2 4 11 12 4 4 2 5 6 4 5 10 12
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 6:	Distance 17 2 14 23 6 0 11 25 35 19 8 12 7 25 23 17 29 18 14 9	from	Source	Parent 11 5 6 15 1 -1 12 2 4 11 5 4 4 2 5 6 4 5 10 12
	Distance 16 9 3 12 5	from	Source	Parent

5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 7	11 0 14 25 15 13 11 4 14 27 6 28 29 19 6			1 -1 2 2 6 12 4 6 2 15 6 4 5 10
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19	Distance	from	Source	Parent 11 4 7 15 6 1 2 -1 7 13 12 4 6 2 15 7 4 5 10 12
From 8: Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	Distance	from	Source	Parent 11 4 8 8 8 1 2 8 -1 13 18 18 6 8 10 6 8

1 1	7 8 .9 'rom 9:	41 24 31			8 8 12
V 0 1 2 3 4 5 6 7 8 9 1 1 1 1 1 1 1	rertex D:	istance 12 17 18 27 13 19 15 29 38 0 16 7 14 7 21 36 37 17	from	Source	Parent 11 4 6 15 11 1 9 2 13 -1 11 9 4 9 10 6 4 5 11 12
V 0 1 2 3 4 5 6 7 8 9 1 1 1 1 1 1 1 1	Tertex D:  0 1 2 3 4 5 6 7 8 9	14 10 16 16 10 8 13 27 30 16 0 9 9 23 21 19 22 26 6	from	Source	Parent 11 5 6 10 12 10 12 2 18 11 -1 10 10 9 10 6 10 5 10 12
		10 14 23 6 12 11	from	Source	Parent

7 8 9 10 11 12 13 14 15 16 17 18 19 From 12:	25 34 7 9 0 7 14 30 17 29 30 10 9			2 18 11 11 -1 4 9 10 6 4 5 11
Vertex Distance 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 13:	ance 12 5 7 16 1 7 4 18 29 14 9 7 0 18 30 10 24 25 15 2	from	Source	Parent 11 4 6 15 12 1 12 2 2 11 12 4 -1 2 5 6 4 5 10 12
Vertex Dista 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	ance 19 23 11 26 19 25 14 22 31 7 23 14 18 0 41 20 36 43 20	from	Source	Parent 11 4 13 15 12 1 2 2 13 13 11 9 6 -1 15 6 13 5 13

19 From 14:	20			12
Vertex Di	stance	from	Source	Parent
0	27	LLOIN	Doulee	14
1	25			5
2	30			6
3	27			15
4	29			1
5	23			14
6	27			15
7	33			15
8	51			18
9 10	37 21			11 14
11	30			10
12	30			4
13	41			2
14	0			-1
15	21			14
16	43			10
17	41			5
18	27			10
19	32			12
From 15:	a+ an aa	fnom	C 0 1 1 1 0 0	Damant
Vertex Di	.stance 22	TTOIII	Source	11
1	15			4
2	9			6
3	6			15
	O			10
4	11			12
4 5	11 17			12 1
4 5 6	11 17 6			12 1 15
4 5 6 7	11 17 6 12			12 1 15 15
4 5 6 7 8	11 17 6 12 31			12 1 15 15 2
4 5 6 7 8 9	11 17 6 12 31 21			12 1 15 15 2 6
4 5 6 7 8 9	11 17 6 12 31 21			12 1 15 15 2 6 12
4 5 6 7 8 9 10 11	11 17 6 12 31 21			12 1 15 15 2 6
4 5 6 7 8 9	11 17 6 12 31 21 19			12 1 15 15 2 6 12 4
4 5 6 7 8 9 10 11 12 13 14	11 17 6 12 31 21 19 17 10 20 21			12 1 15 15 2 6 12 4 6 2
4 5 6 7 8 9 10 11 12 13 14 15	11 17 6 12 31 21 19 17 10 20 21			12 1 15 15 2 6 12 4 6 2 15 -1
4 5 6 7 8 9 10 11 12 13 14 15 16	11 17 6 12 31 21 19 17 10 20 21 0 34			12 1 15 15 2 6 12 4 6 2 15 -1
4 5 6 7 8 9 10 11 12 13 14 15 16 17	11 17 6 12 31 21 19 17 10 20 21 0 34 34			12 1 15 15 2 6 12 4 6 2 15 -1 4 15
4 5 6 7 8 9 10 11 12 13 14 15 16 17	11 17 6 12 31 21 19 17 10 20 21 0 34 34 25			12 1 15 15 2 6 12 4 6 2 15 -1 4 15
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	11 17 6 12 31 21 19 17 10 20 21 0 34 34			12 1 15 15 2 6 12 4 6 2 15 -1 4 15
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 16:	11 17 6 12 31 21 19 17 10 20 21 0 34 34 25 12	from	Source	12 1 15 15 2 6 12 4 6 2 15 -1 4 15 10
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 16: Vertex Di	11 17 6 12 31 21 19 17 10 20 21 0 34 34 25 12	from	Source	12 1 15 15 2 6 12 4 6 2 15 -1 4 15 10 12
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 16: Vertex Di 0	11 17 6 12 31 21 19 17 10 20 21 0 34 34 25 12	from	Source	12 1 15 15 2 6 12 4 6 2 15 -1 4 15 10
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 16: Vertex Di 0	11 17 6 12 31 21 19 17 10 20 21 0 34 34 25 12	from	Source	12 1 15 15 2 6 12 4 6 2 15 -1 4 15 10 12 Parent
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 16: Vertex Di 0 1 2 3	11 17 6 12 31 21 19 17 10 20 21 0 34 34 25 12 stance 34 27 31 38	from	Source	12 1 15 15 2 6 12 4 6 2 15 -1 4 15 10 12 Parent 11 4 6
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 16: Vertex Di 0 1 2 3 4	11 17 6 12 31 21 19 17 10 20 21 0 34 34 25 12 stance 34 27 31 38 23	from	Source	12 1 15 15 2 6 12 4 6 2 15 -1 4 15 10 12 Parent 11 4 6
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 16: Vertex Di 0 1 2 3 4 5	11 17 6 12 31 21 19 17 10 20 21 0 34 34 25 12 .stance 34 27 31 38 23 29	from	Source	12 1 15 15 2 6 12 4 6 2 15 -1 4 15 10 12 Parent 11 4 6 10 16 1
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 16: Vertex Di 0 1 2 3 4 5 6	11 17 6 12 31 21 19 17 10 20 21 0 34 34 25 12 stance 34 27 31 38 23 29 28	from	Source	12 1 15 15 2 6 12 4 6 2 15 -1 4 15 10 12 Parent 11 4 6 10 16 1
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 16: Vertex Di 0 1 2 3 4 5	11 17 6 12 31 21 19 17 10 20 21 0 34 34 25 12 .stance 34 27 31 38 23 29	from	Source	12 1 15 15 2 6 12 4 6 2 15 -1 4 15 10 12 Parent 11 4 6 10 16 1

9 10 11 12 13 14 15 16 17 18 19 From 17:	36 22 29 24 36 43 34 0 18 28 26			11 16 4 4 16 10 6 -1 16 10
Vertex Di 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 18:	1stance 35 20 32 40 24 18 29 43 41 37 26 30 25 43 41 34 18 0 32 27	from	Source	Parent 11 5 6 15 1 17 12 2 17 11 5 4 4 2 5 17 17 -1 10 12
Vertex Di 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 19:	15 12 22 22 16 14 19 33 24 17 6 10 15 20 27 25 28 32 0 17	from	Source	Parent     11     18     6     10     11     10     12     2     18     11     18     10     18     10     6     10     5     -1     12

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	Distance 14 7 9 18 3 9 6 20 31 16 11 9 2 20 32 12	from	Source	11 4 6 15 12 1 12 2 2 11 12 4 19 2 5 6
16 17 18 19	26 27 17 0			4 5 10 -1

# Dijkstra:

### SSSP

Vertex	Distance	from	Source	Parent
0	0			-1
1	15			4
2	19			6
3	28			15
4	11			11
5	17			1
6	16			4
7	30			2
8	39			18
9	12			11
10	14			11
11	5			0
12	12			4
13	19			9
14	27			0
15	22			6
16	34			4
17	35			5
18	15			11
19	14			12

## APSP

### From 0:

Vertex	Distance	from	Source	Parent
0	0			-1
1	15			4
2	19			6

3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 1:	28 11 17 16 30 39 12 14 5 12 19 27 22 34 35 15 14			15 11 1 4 2 18 11 11 0 4 9 0 6 4 5 11 12	
	Distance	from	Source	Parent	
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 2:	15 0 12 21 4 2 9 23 33 17 10 10 5 23 25 15 27 20 12 7			11 -1 6 15 1 1 4 2 4 11 5 4 4 2 5 6 4 5 1 1	
	Distance 19 12 0 15 8 14 3 11 22 18 16 14 7 11 30	from	Source	Parent	

15 16 17 18 19 From 3:	9 31 32 22 9			6 4 5 10 12	
0 1 2 3 4 5	Distance 28 21 15 0 17 23 12	from	Source	11 4 6 -1 6 1	
7 8 9 10 11 12 13 14 15	18 29 27 16 23 16 26 27 6			15 3 6 3 4 6 2 15 3	
16 17 18 19 From 4:	38 40 22 18	from	Source	10 15 10 12	
0 1 2 3 4 5	11 4 8 17 0 6 5			11 4 6 15 -1 1	
7 8 9 10 11 12 13	19 29 13 10 6 1			2 4 11 12 4 4 2	
14 15 16 17 18 19 From 5:	29 11 23 24 16 3			5 6 4 5 1	
Vertex 0 1 2 3 4	Distance 17 2 14 23 6	from	Source	Parent	

5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 6:	0 11 25 35 19 8 12 7 25 23 17 29 18 14 9			-1 4 2 4 11 5 4 4 2 5 6 4 5 1
Vertex D	istance	from	Source	Parent
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 7:	16 9 3 12 5 11 0 14 25 15 13 11 4 27 6 28 29 19 6			11 4 6 15 6 1 -1 2 2 6 12 4 6 2 15 6 4 5 10 12
Vertex D: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	istance 30 23 11 18 19 25 14 0 24 29 27 25 18 22 33 12 42	from	Source	Parent 11 4 7 15 6 1 2 -1 7 6 12 4 6 2 15 7 4

17 18 19 From 8:	43 33 20			5 10 12	
	Distance	from	Source	Parent     11     4     8     8     8     1     2     8     -1     13     18     18     6     8     10     6     8     8     12	
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19	Distance 12 17 18 27 13 19 15 29 38 0 16 7 14 7 37 21 36 37 17 16	from	Source	Parent 11 4 13 15 11 1 9 2 13 -1 11 9 4 9 9 11 11 11 11 11 11 11 11 11 11 11 11	
From 10 Vertex 0 1 2 3 4 5	EDISTANCE 14 10 16 16 10 8 13	from	Source	Parent 11 5 6 10 12 10 12	

7 8 9 10 11 12 13 14 15 16 17 18 19 From 11:	27 30 16 0 9 23 21 19 22 26 6			2 18 11 -1 10 10 9 10 6 10 5 10
Vertex Distance 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 12:	ance 5 10 14 23 6 12 11 25 34 7 9 0 7 14 30 17 29 30 10 9	from	Source	Parent 11 4 6 15 11 1 4 2 18 11 11 -1 4 9 10 6 4 5 11 12
Vertex Distance 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	ance 12 5 7 16 1 7 4 18 29 14 9 7 0 18 30 10 24 25 15	from	Source	Parent 11 4 6 15 12 1 12 2 2 11 12 4 -1 2 5 6 4 5 10

19	2			12	
19 From 13: Vertex Dista 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17		From	Source		
18 19	20 20			13 12	
From 14: Vertex Dista 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 15:	27 25 30 27 29 23 27 33 51 30 30 41 0 21 43 41 27 32			14 5 6 15 1 14 15 15 18 14 14 10 2 -1 14 10 5 10 2	
Vertex Dista 0 1 2 3 4 5 6 7	ance f 22 15 9 6 11 17 6 12 31	From	Source	Parent	

9 10 11 12 13 14 15 16 17 18 19 From 16	21 19 17 10 20 21 0 34 34 25 12			6 12 4 6 2 15 -1 4 15 10
	Distance	from	Source	Parent     11     4     6     10     16     1     4     2     16     11     16     4     4     16     10     6     -1     16     10     12
	Distance	from	Source	Parent 11 5 6 15 1 17 4 2 17 11 5 4 4 2 5 17 17 -1 1 17

Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 From 19	Distance 15 12 22 22 16 14 19 33 24 17 6 10 15 20 27 25 28 32 0 17	from	Source	Parent 11 18 6 10 11 10 12 2 18 11 18 18 10 6 10 5 -1 12
	Distance 14 7 9 18 3 9 6 20 31 16 11 9 2 20 32 12 26 27 17 0	from	Source	Parent 11 4 6 15 12 1 12 2 2 11 12 4 19 2 5 6 4 19 10 -1

### 5. V=25 E=298 k=91 q=7.6 (Dense graph)

### Input:

```
25
298
91
0 41 37 29 19 60 10 32 64 93 20 79 15 1 46 67 6 85 11 74 4 90 54 22
56
```

```
41 0 1 63 58 92 27 10 15 93 27 92 26 27 59 12 60 0 88 46 88 69 19 8
37 1 0 48 26 78 36 94 70 68 55 55 90 41 78 2 94 28 74 93 94 36 19 18
29 63 48 0 47 92 40 79 36 23 24 68 61 46 56 35 13 28 69 35 6 19 4 60
21
19 58 26 47 0 66 41 85 71 8 4 16 45 37 51 80 75 80 73 6 36 9 75 51
60 92 78 92 66 0 74 33 55 60 62 9 5 53 53 22 27 1 43 12 45 32 84 54
54
10 27 36 40 41 74 0 24 93 83 63 93 92 35 67 24 62 85 34 65 11 4 7 82
5
32 10 94 79 85 33 24 0 58 68 61 20 17 55 32 20 68 27 94 41 6 47 54
76 70
64 15 70 36 71 55 93 58 0 14 81 47 64 13 3 9 87 62 59 37 62 91 16 74
40
93 91 68 23 8 60 83 68 14 0 36 78 53 59 34 2 13 5 85 79 42 52 10 76
56
20 27 55 24 4 62 63 61 81 36 0 93 51 21 18 8 50 50 20 88 36 11 29 31
3
79 92 55 68 16 9 93 20 47 78 93 0 39 16 47 24 17 51 13 91 18 86 84
65 35
15 26 90 61 45 5 94 17 64 53 51 39 0 20 94 76 77 72 22 16 8 54 52 92
1 27 41 46 37 53 35 55 13 59 21 16 20 0 73 94 5 51 11 70 24 26 51 72
46 59 78 56 51 53 67 32 3 34 18 47 94 73 0 80 27 93 47 65 3 15 22 73
67 12 2 35 80 22 24 20 9 2 8 24 76 94 80 0 45 75 36 57 12 90 63 79
58
6 60 94 13 75 27 62 68 87 13 50 17 77 5 27 45 0 56 85 40 27 30 73 65
5.5
85 0 28 28 80 1 85 27 62 5 50 51 72 51 93 75 56 0 53 42 31 42 78 85
51
11 88 74 69 73 43 34 94 59 85 20 13 22 11 47 36 85 53 0 0 13 41 15
89 26
74 46 94 35 6 12 65 41 37 79 88 91 16 70 65 57 40 42 0 0 30 55 12 29
4 88 94 6 36 45 11 6 62 42 36 18 8 24 3 12 27 31 13 30 0 25 92 2 89
90 69 36 19 9 32 4 47 91 52 11 86 54 26 15 90 30 42 41 55 25 0 35 86
54 19 19 4 75 84 7 54 16 10 29 84 52 51 22 63 73 78 15 12 94 35 0 20
16
22 8 18 60 51 54 82 76 74 76 31 65 92 72 73 79 65 85 89 29 2 86 20 0
56 9 58 21 76 54 5 70 40 56 3 35 40 4 55 58 55 51 26 3 89 90 16 20 0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
27 28 29 30 31 32 33 34 35 36 37 39 40 41 42 43 45 46 47 48 50 51 52
53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75
76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
```

#### **Output:**

#### New-Dijkstra1:

## SSSP

Vertex	Distance	from	Source	Parent
0	0			-1
1	14			23
2	15			1
3	10			20
4	12			10
5	17			12
6	10			24
7	10			20
8	10			14
9	18			15
10	8			24
11	17			13
12	12			20
13	1			0
14	7			20
15	16			10
16	6			0
17	18			5
18	11			0
19	8			24
20	4			0
21	14			6
22	14			3
23	6			20
24	5			13

### **APSP**

### From 0:

FIOIII U	•			
Vertex	Distance	from	Source	Parent
0	0			-1
1	14			23
2	15			1
3	10			20
4	12			10
5	17			12
6	10			24
7	10			20
8	10			14
9	18			15
10	8			24
11	17			13
12	12			20
13	1			0
14	7			20
15	16			10
16	6			0
17	18			5
18	11			0
19	8			24
20	4			0
21	14			6

22 23 24 From 1:	14 6 5			3 20 13
	0istance 14 0 1 16 13 11 14 10 12 5 11 20 16 13 13 3 18 10 23 12 10 18 15 8	from	Source	Parent 20 -1 1 20 9 17 24 1 15 15 5 5 24 20 2 13 9 20 24 23 6 9 1 1
	Distance 15 1 0 17 12 10 15 11 11 4 10 19 15 14 14 2 17 9 24 13 11 19 14 9	from	Source	Parent 13 2 -1 20 9 17 24 1 15 15 5 24 20 2 9 9 20 24 23 6 9 1

24 From 3:	10			1
	10 16 17 0 22 19 11 12 12 14 18 24 14 11 9 16 13 19 19 16 6 15 4 8 15	from	Source	Parent 20 23 1 -1 19 12 22 20 14 22 24 20 20 0 20 9 3 9 20 22 3 6 3 20 13
	Distance 12 13 12 22 0 14 12 22 19 8 4 16 19 11 19 10 16 13 22 6 16 9 18 18 7	from	Source	Parent 13 2 15 20 -1 17 24 20 15 4 4 5 24 20 9 13 9 13 9 13 4 0 4 9 20 10

	Distance	from	Source		
0	17			20	
1	11			2	
2	10			15	
3	19			20 9	
4 5	14 0			9 <b>-</b> 1	
6	20			24	
7	19			20	
8	17			15	
9	6			17	
10	16			15	
11	9			5	
12	5			5	
13	18			0	
14 15	16 8			20 9	
16	° 19			9	
17	1			5	
18	22			11	
19	12			5	
20	13			12	
21	23			4	
22	16			9	
23	15			20	
24 From 6:	. 15			19	
	Distance	from	Source	Parent	
0	10	II Om	Doulee	13	
1	14			24	
2	15			1	
3	11			22	
4	12			10	
5	20			19	
6 7	0 17			-1 20	
8	17			14	
9	17			22	
10	8			24	
11	25			13	
12	19			20	
13	9			24	
14	14			20	
15	16			10	
16 17	14 21			13 5	
18	20			13	
19	8			24	
20	11			6	
21	4			6	
22	7			6	
23	13			20	
24	5			6	
From 7:		£	0	De +	
vertex	Distance	irom	source		
0	10			20	

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 8	10 11 12 22 19 17 0 12 15 18 20 14 11 9 13 16 20 19 18 6 21 16 8 15			7 1 20 10 12 20 -1 14 15 24 7 20 0 20 2 13 5 20 24 7 6 3 20 13
Vertex 0 1	Distance 10 12	from	Source	Parent 20 2
2 3	11 12			15 20
4 5	19 17			9 17
6 7	17 12			20 20
8 9	0 11			-1 15
10	17			15
11 12	24 14			20 20
13	11 3			0 8
14 15	9			8
16 17	16 16			0 9
18	19			20
19 20	18 6			24 14
21	18			14
22 23	16 8			3 20
24 From 9:	15 •			13
Vertex	Distance	from	Source	
0 1	18 5			13 2
2	4			15

3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 10:	14 8 6 17 15 11 0 10 15 11 17 14 2 13 5 25 14 14 17 10 13 13			22 9 17 22 1 15 -1 15 5 24 8 9 9 22 4 15 4 9 1
Vertex Dista	ance 8 11	from	Source	Parent 13 2
2 3	10 18			15 20
4	4			10
5	16			17
6	8			24
7 8	18 17			20 15
9	10			15
10	0			-1
11	20			4
12 13	20 7			20 24
14	15			20
15	8			10
16	12			13
17 18	15 18			9 13
19	6			24
20	12			0
21	11			10
22 23	15 14			6 20
24	3			10
From 11:				
Vertex Dista	ance 17	from	Source	Parent 13
0	20			2
	19			15
2	24			20
4	16			11

5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 12:	9 25 20 24 15 20 0 14 16 21 17 17 10 13 21 18 25 20 20			11 24 11 14 17 4 -1 5 11 20 9 11 5 11 4 9 20 13
Vertex Dista 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 13:	12 16 15 14 19 5 19 14 11 20 13 11 13 18 6 21 16 8 23 17	from	Source	Parent 20 2 15 20 9 12 20 20 14 17 24 5 -1 0 20 9 13 5 20 12 12 6 3 20 13
Vertex Dista 0 1 2 3 4 5	1 13 14 11 11 18 9	from	Source	Parent     13     24     1     20     10     12     24

7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 14:	11 11 17 7 16 13 0 8 15 5 19 11 7 5 13 15 7			20 14 15 24 13 20 -1 20 10 13 5 13 24 0 6 3 20 13
Vertex Distance  0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 15:	ance 7 13 14 9 19 16 14 9 3 14 15 21 11 8 0 12 13 17 16 15 3 15 13	from	Source	Parent 20 23 15 20 10 12 20 20 14 15 24 20 20 0 -1 8 0 5 20 24 14 14 3 20 13
Vertex Dista 0 1 2 3 4 5 6 7	ance 16 3 2 16 10 8 16 13 9	from	Source	Parent 13 2 15 22 9 17 24 1 15

9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 16	2 8 17 13 15 12 0 15 7 25 14 12 19 12 11			15 15 5 5 24 8 -1 9 20 24 15 10 9
Vertex 0	Distance 6	from	Source	Parent 13
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 17	18 17 13 16 19 14 16 16 13 12 17 18 5 13 15 0 18 16 12 10 18 17 12 9			13 2 15 16 10 17 24 20 14 16 20 16 20 9 -1 9 13 24 0 6 3 20 13
	Distance 18 10 9 19 13 1 21 20 16 5 15	from	Source	Parent 20 2 15 22 9 17 24 20 15 17 15

11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 18:	10 6 19 17 7 18 0 23 13 14 22 15 16			5 5 0 20 9 -1 11 5 12 4 9 20 19
Vertex D: 0 1	11 23	irom	Source	18 23
2 3	24 19			1 22
4	22			10
5	22			11
6 7	20 19			24 20
8	19			14
9 10	25 18			22 24
11	13			18
12	21			20
13 14	11 16			18 20
15	25			20
16	16			13
17 18	23 0			5 <b>-</b> 1
19	18			24
20	13			18
21 22	24 15			6 18
23	15			20
24	15			13
From 19: Vertex D:	istance	from	Source	Parent
0	8			13
1 2	12 13			24 1
3	16			22
4	6			19
5 6	12 8			19 24
7	18			20
8	18			14
9 10	14 6			4 24
11	21			5
12	16			19

13 14 15 16 17 18 19 20 21 22 23 24 From 20	7 15 14 12 13 18 0 12 12 12 14 3			24 20 10 13 5 13 -1 0 6 19 20 19
	Distance 4 10 11 6 16 13 11 6 6 14 12 18 8 5 3 12 10 14 13 12 0 15 10 2 9	from	Source	Parent 20 23 1 20 10 12 20 20 14 15 24 20 20 0 20 0 5 20 21 6 3 20 13
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14	Distance	from	Source	Parent 13 24 1 22 21 17 21 20 14 4 21 4 20 24 21

15 16 17 18 19 20 21 22 23 24 From 22:	19 18 22 24 12 15 0 11 17 9			9 13 9 13 24 6 -1 6 20 6
Vertex Distance  0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 23:	14 15 14 4 18 16 7 16 10 15 25 18 15 13 12 17 15 15 12 10 11 0 12 12			20 2 15 22 19 17 22 20 14 22 24 5 20 0 20 9 3 9 3 9 22 22 3 6 -1 20 6
Vertex Distant  0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	ance 6 8 9 8 18 15 13 8 13 14 20 7 5 11 12	from	Source	Parent 20 23 1 20 10 12 20 20 14 15 24 20 20 0 20 0 20 0

17 18 19 20 21 22 23 24 From 24:	16 15 14 2 17 12 0 11			5 20 24 23 6 3 -1 13
Vertex Dist.  0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24	ance 5 9 10 15 7 15 15 15 13 3 20 17 4 12 11 9 16 15 3 9 9 12 11	from	Source	Parent 13 24 1 20 10 19 24 20 14 15 24 13 20 24 20 10 13 5 13 24 0 6 6 20 -1

## Dijkstra

## SSSP

Vertex	Distance	from	Source	Parent
0	0			-1
1	14			24
2	15			1
3	10			20
4	12			10
5	17			12
6	10			0
7	10			20
8	10			14
9	18			15
10	8			24
11	17			13
12	12			20
13	1			0

14	7	20
15	16	20
16	6	0
17	18	5
18	11	0
19	8	24
20	4	0
21	14	6
22	14	3
23	6	20
24	5	13

## APSP

L'rom	( )	
$\Gamma \perp OIII$	U	

Vertex	Distance	from	Source	Parent
0	0			-1
1	14			24
2	15			1
3	10			20
4	12			10
5	17			12
6	10			0
7	10			20
8	10			14
9	18			15
10	8			24
11	17			13
12	12			20
13	1			0
14	7			20
15	16			20
16	6			0
17	18			5
18	11			0
19	8			24
20	4			0
21	14			6
22	14			3
23	6			20
24	5			13
From 1:	:			

				_
From 1:	:			
Vertex	Distance	from	Source	Parent
0	14			20
1	0			-1
2	1			1
3	16			20
4	13			9
5	11			17
6	14			24
7	10			1
8	12			15
9	5			15
10	11			15
11	20			5

12 13 14 15 16 17 18 19 20 21 22 23 24 From 2:	16 13 13 3 18 10 23 12 10 18 15 8			5 24 20 2 9 9 20 24 23 6 9 1
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 3:	Distance	from	Source	Parent 20 2 -1 20 9 17 24 1 15 15 5 24 20 2 9 9 20 24 23 6 9 1 1
	Distance 10 16 17 0 22 19 11 12 12 14 18 24 14	from	Source	Parent 20 23 1 -1 9 12 22 20 14 22 24 20 20 0

14 15 16 17 18 19 20 21 22 23 24 From 4:	9 16 13 19 19 16 6 15 4 8 15			20 9 3 9 22 22 3 6 3 20 13
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 5:	Distance	from	Source	Parent 13 2 15 20 -1 17 24 20 15 4 4 5 24 20 9 13 9 13 4 0 4 19 20 10
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15	Distance 17 11 10 19 14 0 20 19 17 6 16 9 5 18 16 8	from	Source	Parent 20 2 15 20 9 -1 24 20 15 17 15 5 0 20 9

16 17 18 19 20 21 22 23 24 From 6:	19 1 22 12 13 23 16 15			9 5 11 5 12 4 9 20 19
Vertex Dist 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 7:	ance 10 14 15 11 12 20 0 17 17 17 8 25 19 9 14 16 14 21 20 8 11 4 7 13 5	from	Source	Parent 6 24 1 22 10 19 -1 20 14 22 24 13 20 24 20 10 13 5 13 24 6 6 6 6 20 6
Vertex Dist 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17	ance 10 10 11 12 22 19 17 0 12 15 18 20 14 11 9 13 16 20	from	Source	Parent 20 7 1 20 10 12 20 -1 14 15 24 7 20 0 20 2 0 9

18 19 20 21 22 23 24 From 8:	19 18 6 21 16 8 15			20 24 7 6 3 20 13	
Vertex 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 9:	Distance	from	Source	Parent 20 2 15 20 9 17 20 20 -1 15 15 20 20 0 8 8 0 9 20 24 14 14 8 20 13	
	Distance	from	Source	Parent 20 2 15 22 9 17 22 1 15 -1 15 5 5 24 8 9 9 9 22 4	

20 21 22 23 24 From 10:	14 17 10 13 13		15 4 9 1 10
Vertex Distance 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 11:	ance from 8 8 11 10 18 4 16 8 17 10 0 20 20 7 15 8 12 15 18 6 12 11 15 14 3	Source	Parent  13 2 15 20 10 17 24 20 15 15 -1 4 20 24 20 10 13 9 13 24 0 10 6 20 10
Vertex Distance  0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21	ance from 3 17 20 19 24 16 9 25 20 24 15 20 0 14 16 21 17 17 10 13 21 18 25	Source	Parent  13 2 15 20 11 11 24 11 14 17 4 -1 5 11 20 9 11 5 11 4

22 23 24 From 12:	25 20 20			9 20 13	
Vertex Dist.  0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 13:	ance 12 16 15 14 19 5 19 14 11 20 13 11 13 18 6 21 16 8 23 18 10 17	from	Source	Parent 20 2 15 20 9 12 20 20 14 17 24 5 -1 0 20 9 0 5 20 12 12 6 3 20 13	
Vertex Distance  0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23	ance 1 13 14 11 18 9 11 17 7 16 13 0 8 15 5 19 11 7 5 13 15 7	from	Source	Parent 13 24 1 20 10 12 24 20 14 15 24 13 20 -1 20 10 13 5 13 24 0 6 3 20	

24 4 From 14: Vertex Distance from Source	13
0 7 1 13 2 14 3 9 4 19 5 16 6 14 7 9 8 3 9 14 10 15 11 21 12 11 13 8 14 0 15 12 16 13 17 17 18 16 19 15 20 3 21 15 20 3 21 15 22 13 23 5 24 12 From 15:	20 23 15 20 10 12 20 20 14 15 24 20 20 0 -1 8 0 5 20 24 14 14 14 3 20 13
Vertex Distance from Source 0 16 1 3 2 2 3 16 4 10 5 8 6 16 7 13 8 9 9 2 10 8 11 17 12 13 13 15 14 12 15 0 16 15 17 7 18 25 19 14 20 12 21 19 22 12 23 11 24 11 From 16:	Parent 20 2 15 22 9 17 24 1 15 15 5 24 8 -1 9 20 24 15 10 9 1 10

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 1	Distance 6 18 17 13 16 19 14 16 16 13 12 17 18 5 13 15 0 18 16 12 10 18 17 12 9 7: Distance			16 24 15 16 10 17 24 20 14 16 20 16 20 9 -1 9 13 24 0 6 3 20 13	
0 1 2 3 4 5 6 7 8 9	18 10 9 19 13 1 21 20 16 5			20 2 15 22 9 17 24 1 15 17	
11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 18	10 6 19 17 7 18 0 23 13 14 22 15 16 16			5 0 20 9 9 -1 11 5 12 4 9 20	
Vertex 0	Distance 11	from	Source	Parent 18	

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 19:	23 24 19 22 22 20 19 19 25 18 13 21 16 25 16 23 0 18 13 24 15 15			23 1 20 10 11 24 20 14 22 24 18 20 13 5 -1 24 18 20 13
Vertex Dista	8 12	from	Source	13 24
2	13 16			1 22
4 5	6 12			19 19
6 7	8 18			24 20
8	18			14
9 10	14 6			4 24
11	21			5
12 13	16 7			19 24
14	15			20
15 16	14 12			10 13
17	13			5
18 19	18 0			13 -1
20	12			0 6
21 22	12 12			19
23 24	14 3			20 19
From 20:				
Vertex Dista	ance 4	from	Source	Parent 20
1	10			23
2	11			1

3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24	6 16 13 11 6 6 14 12 18 8 5 3 12 10 14 13 12 0 15 10 2 9			20 10 12 20 20 14 15 24 20 20 0 20 20 20 20 6 3 20 13
From 21: Vertex Dista 0 1	ance 14 18	from	Source	Parent 6 24
2	19			1
3 4	15 9			22 21
5	23			17
6 7	4 21			21
8	18			20 14
9	17			4
10	11			21
11	25			4
12 13	23 13			20 24
14	15			21
15	19			10
16	18			13
17 18	22 24			9 13
19	12			24
20	15			6
21 22	0 11			<del>-</del> 1 6
23	17			20
24	9			6
From 22:		۶.	0 -	D
Vertex Dista	ance 14	rom	source	Parent 20
1	15			2
2 3	14			15
3	4			22
4	18			9

5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 From 23	16 7 16 16 10 15 25 18 15 13 12 17 15 15 12 10 11 0 12 12			17 22 20 22 22 24 5 20 0 20 9 3 9 22 22 3 6 -1 20 6
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21	Distance 6 8 9 8 18 15 13 8 8 13 14 20 10 7 5 11 12 16 15 14 2 17	irom	Source	Parent 20 23 1 20 10 12 20 20 14 15 24 20 20 20 0 20 20 20 20 20 20 3 6
22 23 24 From 24 Vertex 0 1 2 3 4 5	12 0 11 4: Distance 5 9 10 15 7 15 5	from	Source	3 -1 13 Parent 13 24 1 20 10 19 24

7	15	20
8	15	14
9	13	15
10	3	24
11	20	13
12	17	20
13	4	24
14	12	20
15	11	10
16	9	13
17	16	5
18	15	13
19	3	24
20	9	0
21	9	6
22	12	6
23	11	20
24	0	-1