

# Floyd Warshall

Dr. Mattox Beckman

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN  
DEPARTMENT OF COMPUTER SCIENCE

# Objectives

Your Objectives:

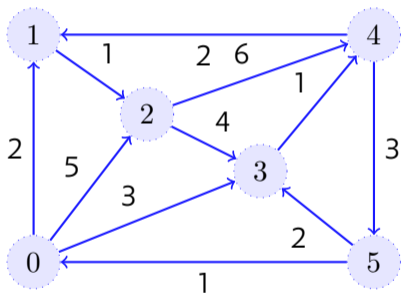
- ▶ Implement the Floyd Warshall algorithm.
- ▶ Determine when this algorithm is “safe” to run.

## The Algorithm

```
0 // From Competitive Programming 3
1 for (int k = 0; k < V; k++)
2   for (int i = 0; i < V; i++)
3     for (int j = 0; j < V; j++)
4       AdjMat[i][j] = min(AdjMat[i][j], AdjMat[i][k] + AdjMat[k][j]);
```

- ▶ Each run of the  $k$  loop adds node  $k$  to our shortest path collection.
- ▶ On today's machines, this can work up to  $V = 500$ .

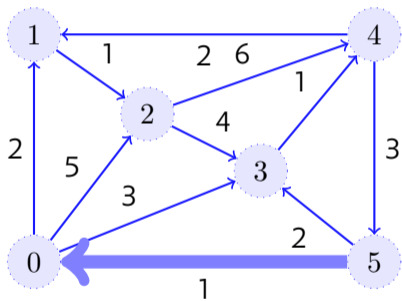
## An Example



k = -1:

	0	1	2	3	4	5
0	0	2	5	9	$\infty$	$\infty$
1	$\infty$	0	1	$\infty$	$\infty$	$\infty$
2	$\infty$	$\infty$	0	4	6	$\infty$
3	$\infty$	$\infty$	$\infty$	0	1	$\infty$
4	2	$\infty$	$\infty$	$\infty$	0	3
5	1	$\infty$	$\infty$	2	$\infty$	0

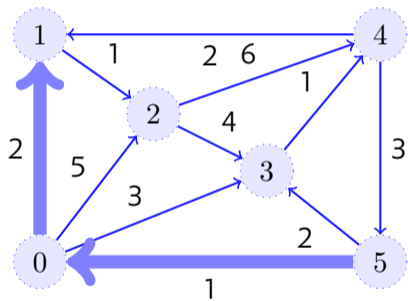
# An Example



k = -1:

	0	1	2	3	4	5
0	0	2	5	9	$\infty$	$\infty$
1	$\infty$	0	1	$\infty$	$\infty$	$\infty$
2	$\infty$	$\infty$	0	4	6	$\infty$
3	$\infty$	$\infty$	$\infty$	0	1	$\infty$
4	2	$\infty$	$\infty$	$\infty$	0	3
5	1	$\infty$	$\infty$	2	$\infty$	0

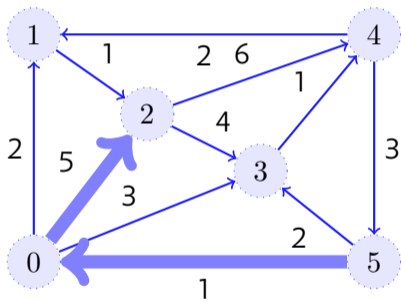
## An Example



k = -1:

	0	1	2	3	4	5
0	0	2	5	9	$\infty$	$\infty$
1	$\infty$	0	1	$\infty$	$\infty$	$\infty$
2	$\infty$	$\infty$	0	4	6	$\infty$
3	$\infty$	$\infty$	$\infty$	0	1	$\infty$
4	2	$\infty$	$\infty$	$\infty$	0	3
5	1	<b>3</b>	$\infty$	2	$\infty$	0

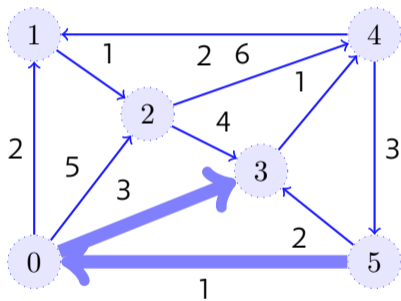
# An Example



k = -1:

	0	1	2	3	4	5
0	0	2	5	9	$\infty$	$\infty$
1	$\infty$	0	1	$\infty$	$\infty$	$\infty$
2	$\infty$	$\infty$	0	4	6	$\infty$
3	$\infty$	$\infty$	$\infty$	0	1	$\infty$
4	2	$\infty$	$\infty$	$\infty$	0	3
5	1	<b>3</b>	<b>6</b>	2	$\infty$	0

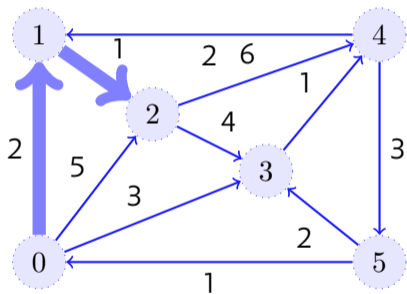
## An Example



k = -1:

	0	1	2	3	4	5
0	0	2	5	9	$\infty$	$\infty$
1	$\infty$	0	1	$\infty$	$\infty$	$\infty$
2	$\infty$	$\infty$	0	4	6	$\infty$
3	$\infty$	$\infty$	$\infty$	0	1	$\infty$
4	2	$\infty$	$\infty$	$\infty$	0	3
5	1	<b>3</b>	<b>6</b>	<b>2</b>	$\infty$	0

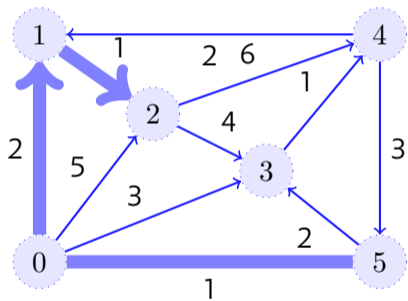


Example,  $k = 1$ 

$k = 0$

	0	1	2	3	4	5
0	0	2	<b>3</b>	9	$\infty$	$\infty$
1	$\infty$	0	1	$\infty$	$\infty$	$\infty$
2	$\infty$	$\infty$	0	4	6	$\infty$
3	$\infty$	$\infty$	$\infty$	0	1	$\infty$
4	2	4	5	11	0	3
5	1	3	6	2	$\infty$	0

## Example, $k = 1$



$k = 0$

	0	1	2	3	4	5
0	0	2	<b>3</b>	9	$\infty$	$\infty$
1	$\infty$	0	1	$\infty$	$\infty$	$\infty$
2	$\infty$	$\infty$	0	4	6	$\infty$
3	$\infty$	$\infty$	$\infty$	0	1	$\infty$
4	2	4	5	11	0	3
5	1	3	<b>4</b>	2	$\infty$	0

## Printing the Paths

```
0 for (int i = 0; i < V; i++)
1   for (int j = 0; j < V; j++)
2     p[i][j] = i;
3 for (int k = 0; k < V; k++)
4   for (int i = 0; i < V; i++)
5     for (int j = 0; j < V; j++)
6       if (AdjMat[i][k] + AdjMat[k][j] < AdjMat[i][j]) {
7         AdjMat[i][j] = AdjMat[i][k] + AdjMat[k][j];
8         p[i][j] = p[k][j];
9 }
10 void printPath(int i, int j) {
11   if (i != j) printPath(i, p[i][j]);
12   printf(" %d", j);
13 }
```