Finding Two-Hop Neighbors

V = {0, 1, 2, 3}

0	1	1	0
0	0	0	1
0	1	0	1
0	0	0	0

Assignment: Find all two-hop neighbors from given vertex (Adjacency Matrix)
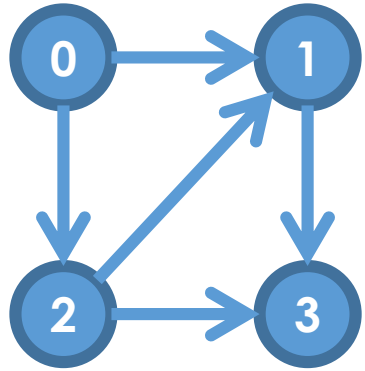
```java
public List<Integer> getDistance2(int v) {
    List<Integer> twoHop = new ArrayList<Integer>();
    for (int i = 0; i < getNumVertices(); i ++) {
        for (int j=0; j< adjMatrix[v][i]; j ++) {
            // Instead of adding i directly, add the
            // neighbors of i
        }
    }
    return neighbors;
}
```

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0	1	0	1
0	0	0	0

Matrix multiplication for finding two-hop neighbors

V = {0, 1, 2, 3}

$$\begin{pmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{pmatrix}$$
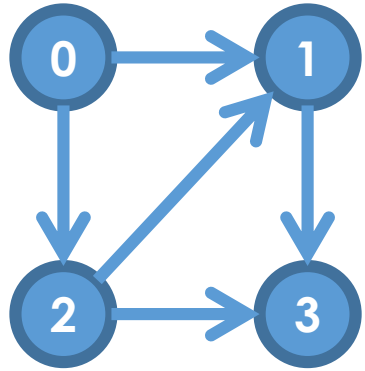
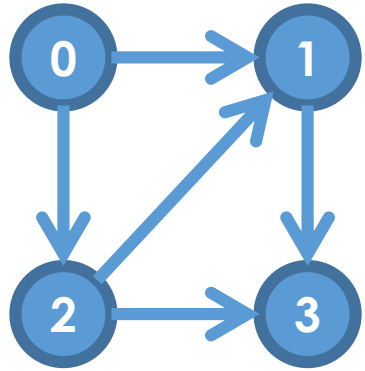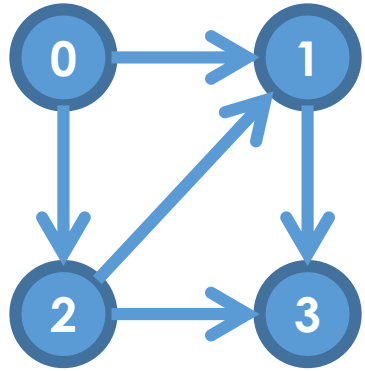**Matrix multiplication for finding two-hop neighbors**

V = {0, 1, 2, 3}

$$\begin{pmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{pmatrix}^2 = $$

matrix whose entries are two-hop neighbors!

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Matrix multiplication for finding two-hop neighbors

$$\begin{pmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} & & & \\ & & & \\ & & & \\ & & & \end{pmatrix}$$

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Matrix multiplication for finding two-hop neighbors

$$\begin{pmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} & & & \\ & & & \\ & & & \\ & & & \end{pmatrix}$$
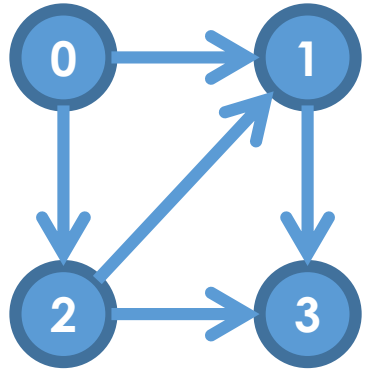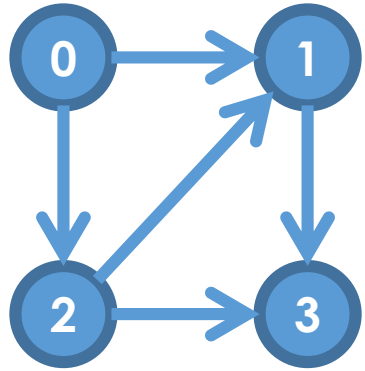
$$0*0 + 1*0 + 1*0 + 0*0 = 0$$
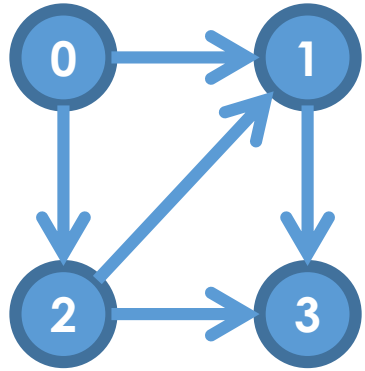
Matrix multiplication for finding two-hop neighbors

V = {0, 1, 2, 3}

$$\begin{pmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & & & \\ & & & \\ & & & \\ & & & \end{pmatrix}$$

$$0 * 0 + 1 * 0 + 1 * 0 + 0 * 0 = 0$$

V = {0, 1, 2, 3}

$$\begin{pmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 1 & & \\ & & & \\ & & & \\ & & & \end{pmatrix}$$

$$0 * 1 + 1 * 0 + 1 * 1 + 0 * 0 = 1$$

$V = \{0, 1, 2, 3\}$

$$\begin{pmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 1 & 0 & \\ & & & \\ & & & \\ & & & \end{pmatrix}$$

$$0 * 1 + 1 * 0 + 1 * 0 + 0 * 0 = 0$$

$V = \{0, 1, 2, 3\}$

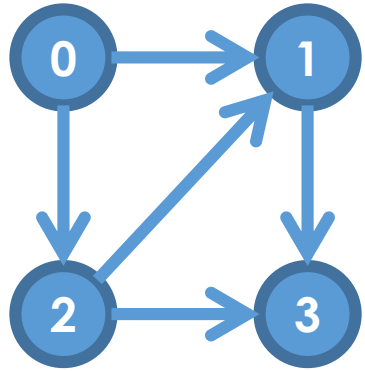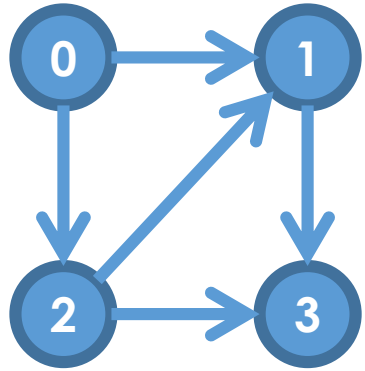$$\begin{pmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 1 & 0 & 2 \\ & & & \\ & & & \\ & & & \end{pmatrix}$$

$$0 * 0 + 1 * 1 + 1 * 1 + 0 * 0 = 2$$

V = {0, 1, 2, 3}

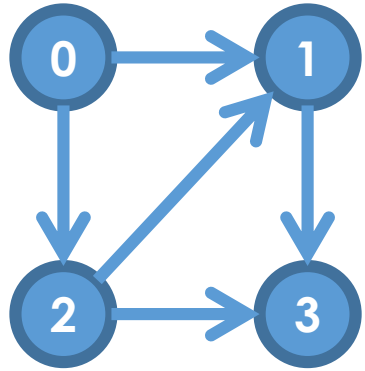$$\begin{pmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 1 & 0 & 2 \\ 0 & & & \\ & & & \\ & & & \end{pmatrix}$$

$$0 * 0 + 0 * 0 + 0 * 0 + 1 * 0 = 0$$

V = {0, 1, 2, 3}

$$\begin{pmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & 1 & 0 & 2 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 \end{pmatrix}$$