Linear Algebra
HW1 Cycle Detection

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Outline

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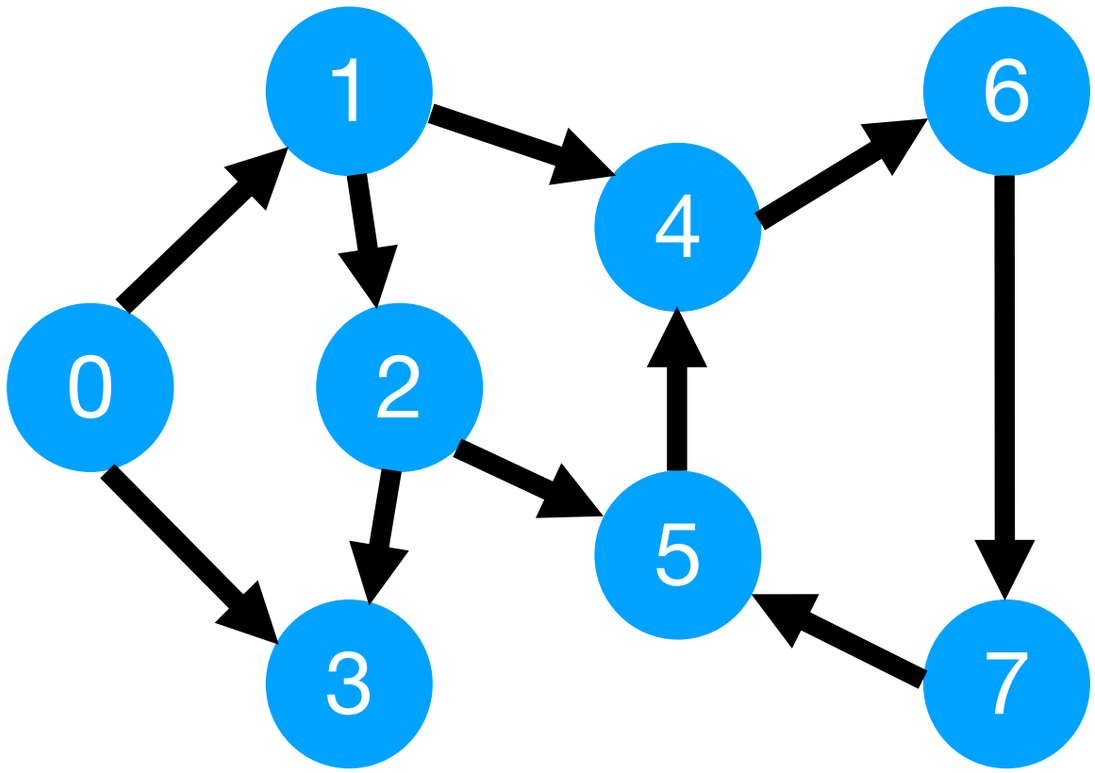
2. Problem 1
3. Problem 2
4. Python Tips
5. Rules

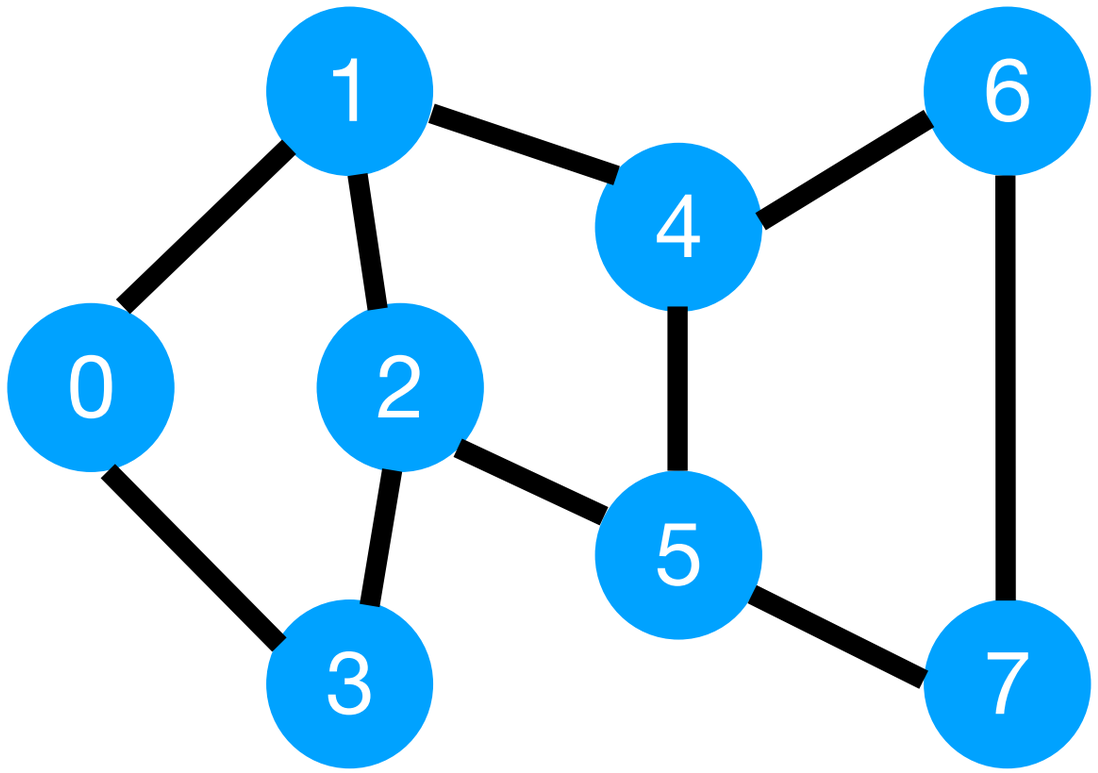
Task Introduction

Graph

- A graph contains some nodes and edges
- The edges can be directed or undirected
- This task is given the **directed graph**, we need to find out whether **there is a cycle** in the graph



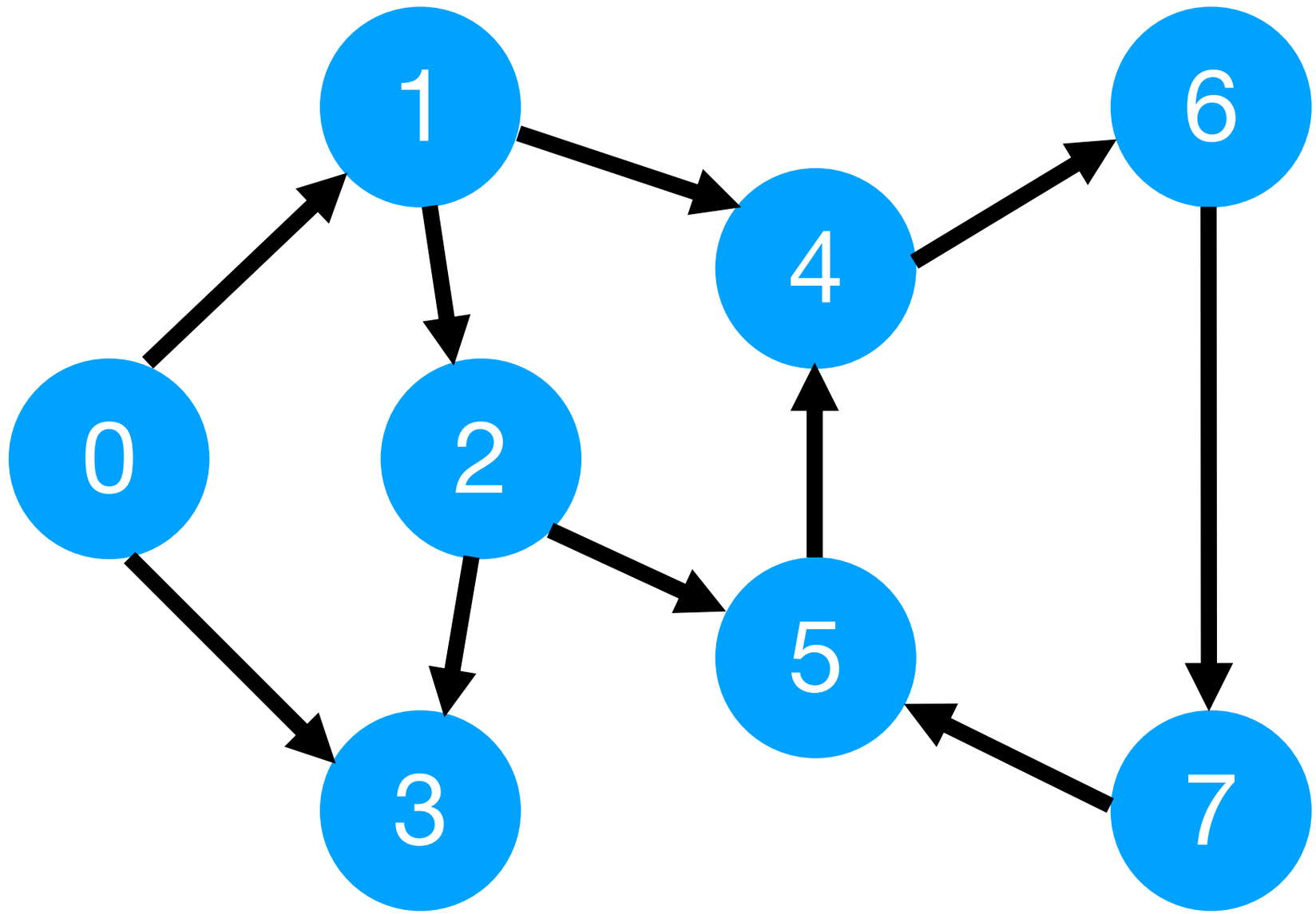
Directed Graph



Undirected Graph

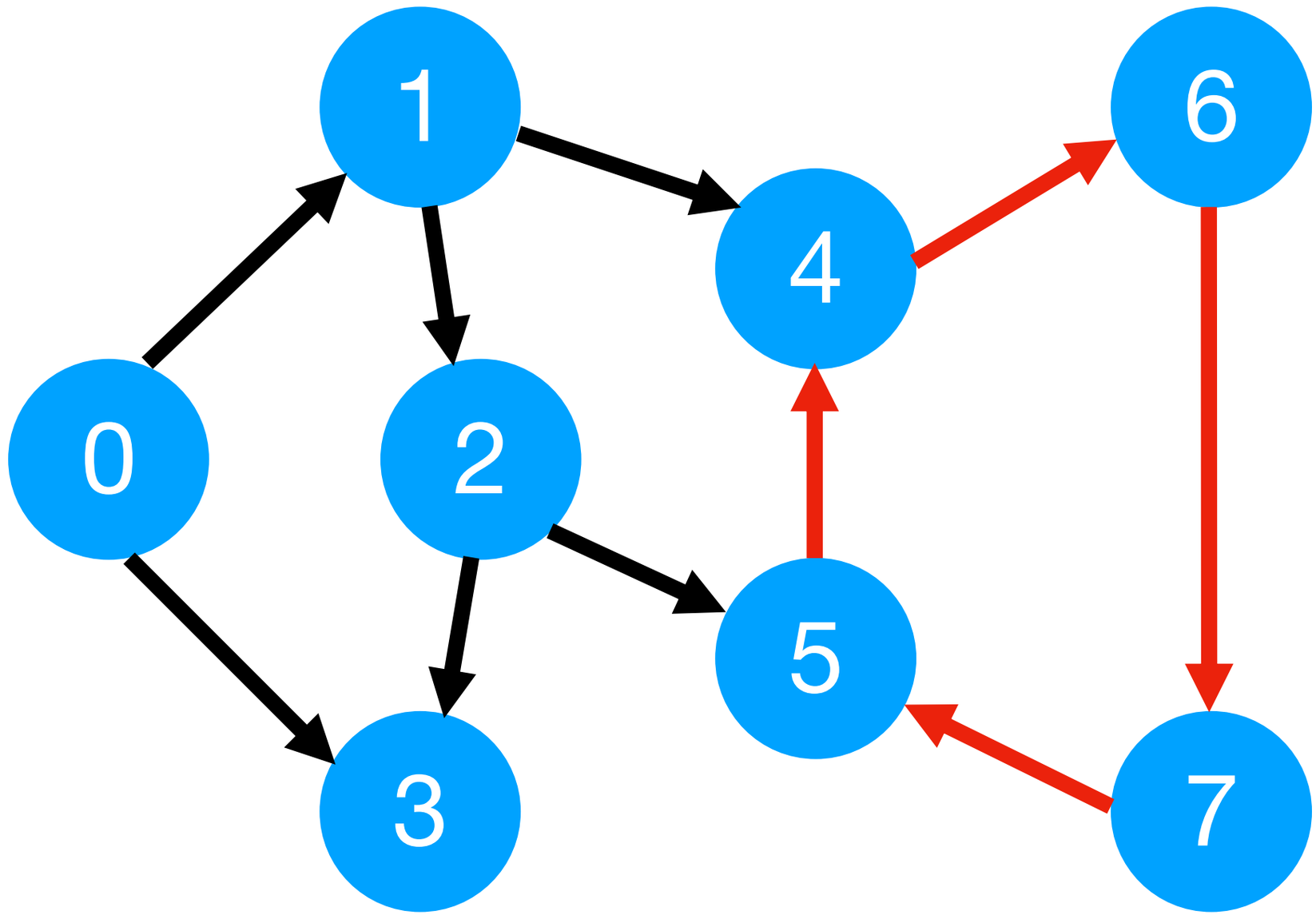
Directed Graph

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



Cycle Detection

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



Problem 1

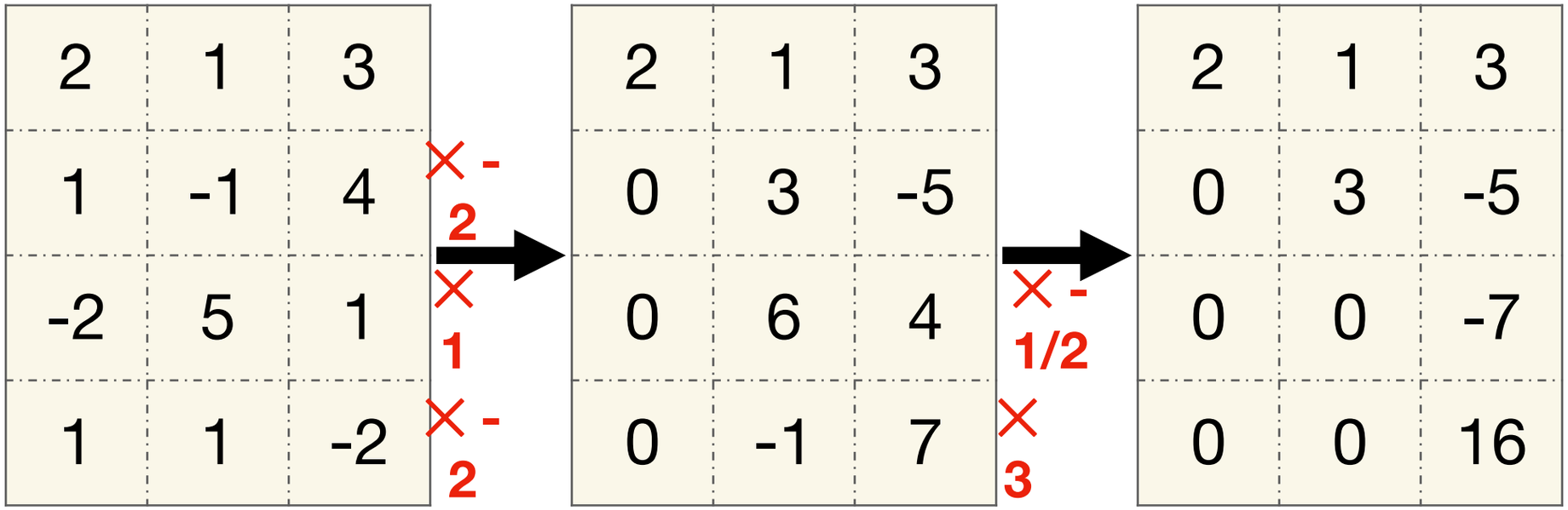
Graph Representation

	0	1	2	3	4	5	6	7
0 → 1	0	-1	1						
0 → 3	1	-1			1				
1 → 2	2		-1	1					
1 → 4	3		-1			1			
2 → 3	4			-1	1				
2 → 5	5			-1			1		
4 → 6	6					-1		1	
5 → 4	7					1	-1		
6 → 7	8							-1	1
7 → 5	9						1		-1

- A row is a connection
- If a connection is from 0 to 1, the value of column 0 will be -1 and the value of column 1 will be 1
- 0 otherwise

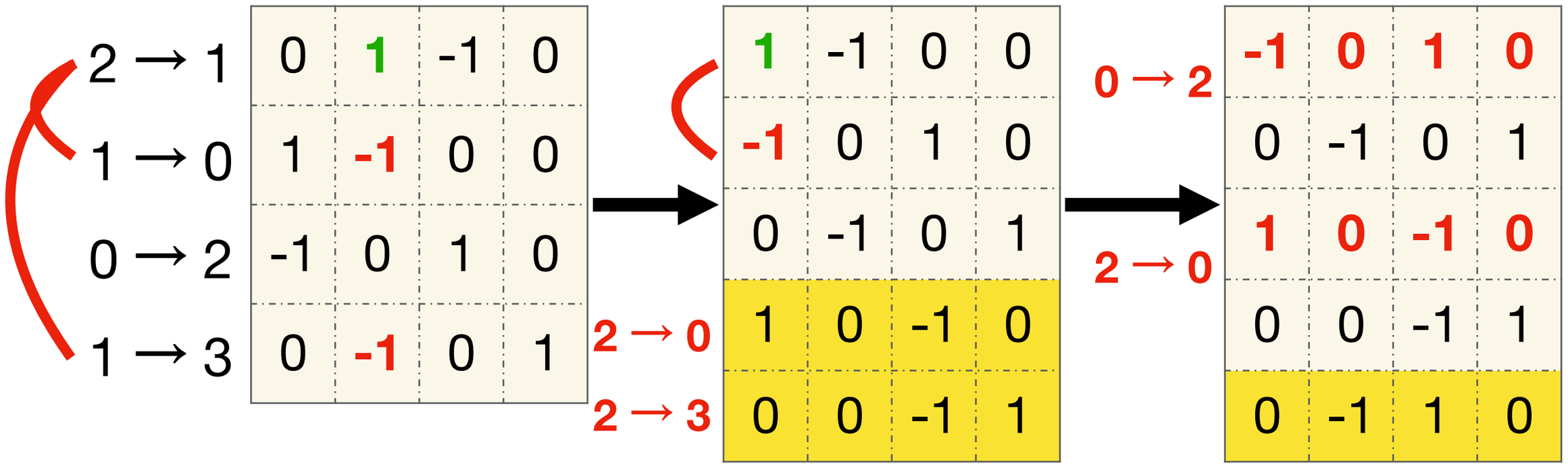
Linear Dependent

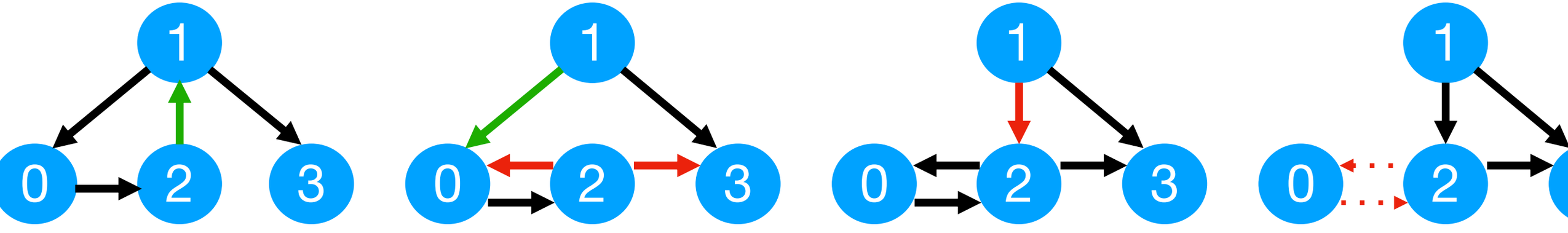
- Linear independence in row



- In cycle detection, we can only do **ADDITION**

Linear Dependent to Detect Cycle





Termination

- If we get a **ALL 0** row after addition, then the graph has a cycle.

- If we do addition on all the edges and we don’t get a ALL 0, then the graph does not have a cycle.

p1.py

```
def has_cycle(sets):
    # TODO
    # return True if the graph has cycle; return False if not

    return False
'''
  HINT: You can `print(sets)` to show what the matrix looks like
    If we have a directed graph with 2->3 4->1 3->5 5->2 0->1
           0  1  2  3  4  5
       0   0  0 -1  1  0  0
       1   0  1  0  0 -1  0
       2   0  0  0 -1  0  1
       3   0  0  1  0  0 -1
       4  -1  1  0  0  0  0
    The size of the matrix is (5,6)
'''
```

Problem 2

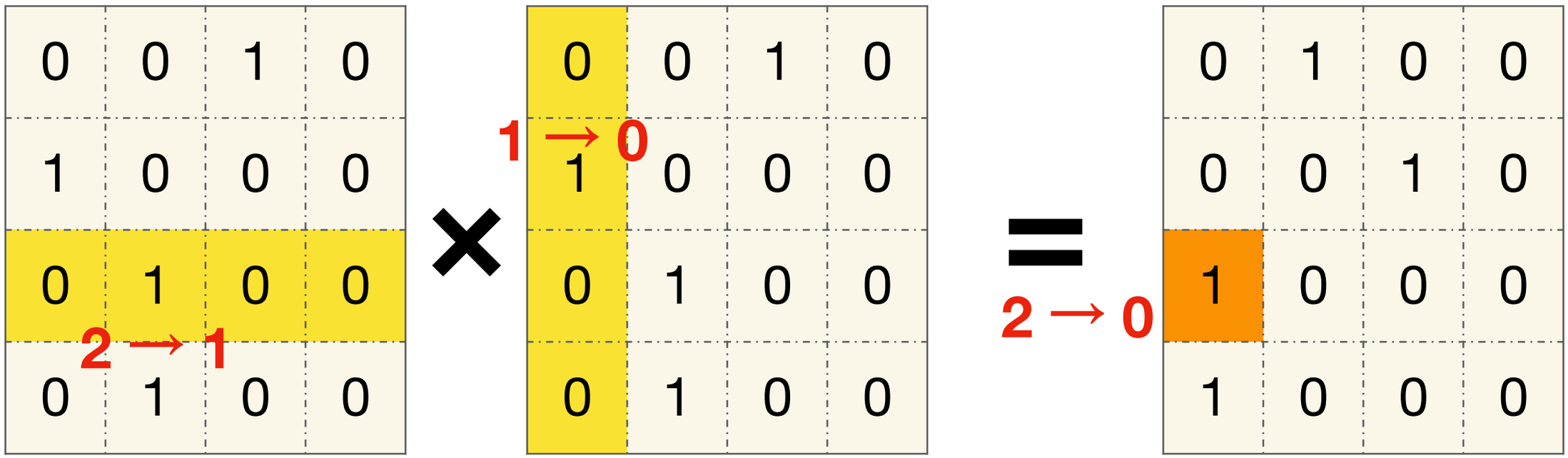
Graph Representation

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

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

- A cell(x,y) = 1 if there is a connection from x to y
- 0 otherwise

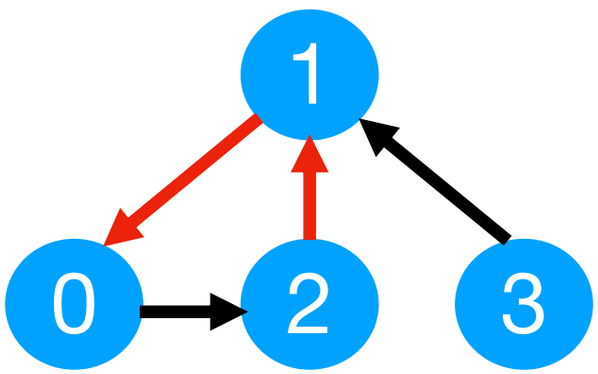
Matrix Multiplication

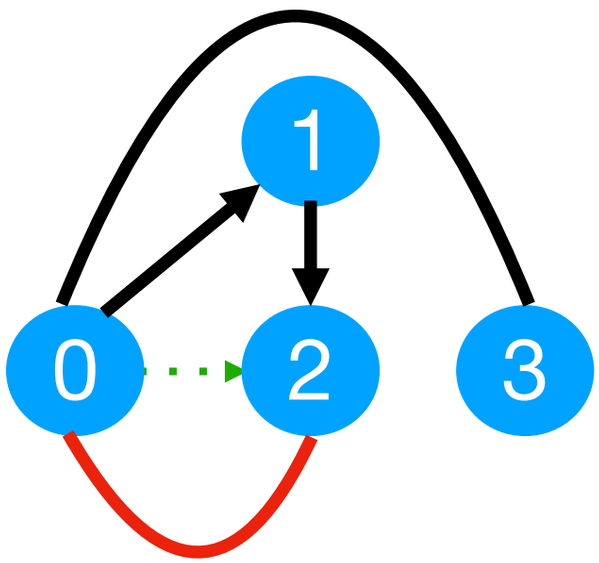


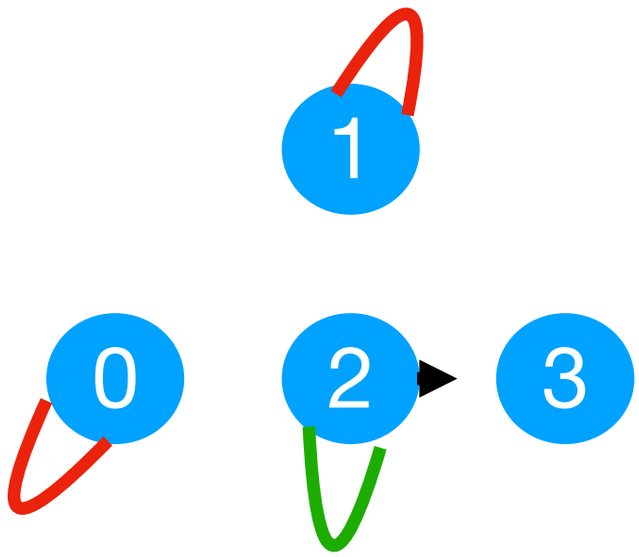
- Do multiplication at most N times. (N: # of nodes)

Matrix Multiplication

0 → 2	0	0	1	0	0 → 1	0	1	0	0	0 → 0	1	0	0	0
1 → 0	1	0	0	0	1 → 2	0	0	1	0	1 → 1	0	1	0	0
2 → 1	0	1	0	0	2 → 0	1	0	0	0	2 → 2	0	0	1	0
3 → 1	0	1	0	0	3 → 0	1	0	0	0	3 → 2	0	0	1	0







Termination

- If we find a value bigger than 1 in the diagonal of matrix, then the graph has a cycle.

- If we do N times of multiplication and all value in the diagonal are 0, then the graph does not have a cycle.

p2.py

```
def has_cycle(sets):
    # TODO
    # return True if the graph has cycle; return False if not

    return False
'''
  HINT: You can `print(sets)` to show what the matrix looks like
    If we have a directed graph with 2->3 4->1 3->5 5->2 0->1
          0  1  2  3  4  5
       0  0  1  0  0  0  0
       1  0  0  0  0  0  0
       2  0  0  0  1  0  0
       3  0  0  0  0  0  1
       4  0  1  0  0  0  0
       5  0  0  1  0  0  0
    The size of the matrix is (6,6)
'''
```

Code Implementation

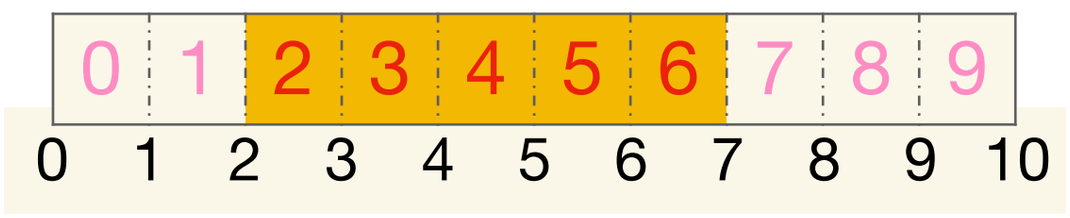
- You should only complete the function `has_graph(sets)` in p1.py and p2.py. **DO NOT** modify the other parts of code

- This function will return True or False
  - If the graph(sets) has cycles, this function should return True
  - Otherwise, return False

Python Tips

List

- Generate an empty list
  - L = list() or L = []
- Get a sublist of a list L
  - From A to B: L[A:B]
  - From begin to B: L[:B]
  - From A to end: L[A:]



- Push an object in list
  - L.append(object)

```
L = [ 2, 4, [1, 2], [3, 6] ]
object = 8
L.append(object)
>>> L = [ 2, 4, [1, 2], [3, 6], 8 ]
```

- Extend a list L2 and push it in list L
  - L.extend(L2)

```
L2 = [ 4, [2, 3] ]
L.append(L2)
>>> L = [ 2, 4, [1, 2], [3, 6], 8, 4, [2, 3] ]
```

NumPy

- Create a numpy object
  - L = numpy.array([3, 2, 5, 1])
- Two numpy matrix A, B multiplication
  - numpy.matmul(A, B)

    A = [[1, 2], [3, 4]]

    B = [[2, 3], [4, 5]]

    numpy.matmul(A, B)

    >>> [[10, 13], [22, 29]]

Rules

Run Code

- python p1.py r07922072
  Yes
  No
  No
  No
  … 12 outputs
- You should run your code with your 學號
  - You can generate answer text file by running command
    python p1.py 自己的學號 > p1_ans.txt
    python p2.py 自己的學號 > p2_ans.txt
  - Or just type them by yourself

```
Yes
No
No
Yes
No
Yes
Yes
Yes
No
No
Yes
No
```

Code Structure

- Code you **download**
  |—p1.py (TODO)
  |—p2.py (TODO)
  |—graph_gen.py

- Code you **submit** should be put in a folder and compressed in a zip file

  r07922072_hw1.zip
  r07922072_hw1
  |—p1.py
  |—p2.py
  |—graph_gen.py
  |—p1_ans.txt
  |—p2_ans.txt

Rules

- 不要抄作業，不要交別人的答案，作弊一律0分計算
- 上傳 zip 檔案到 CEIBA
- 注意繳交的資料夾學號開頭英文用**小寫**
- **DEADLINE: 2018/10/18(四) 23:59 (GMT+8:00)**
- **遲交每過一天：分數×0.8 (per day)**
- **格式、檔案、各種奇怪的錯誤讓我無法改作業：分數×0.8**

Q & A

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