DATA STRUCTURE AND ALGORITHMS

LECTURE 8

Graph

Reference links:

https://cs.nyu.edu/courses/fall17/CSCI-UA.0102-007/notes.php

https://www.comp.nus.edu.sg/~stevenha/cs2040.html

https://visualgo.net/en/graphds

https://graphonline.ru/

[M.Goodrich, chapter 14]

Lecture outline

- Graph definitions
  - Definitions and terminologies
  - Graph ADT
- Data Structure for Graphs
  - Adjacency Matrix – Ma trận kề
  - Adjacency List – Danh sách kề
  - Edge List – Danh sách cạnh
- Graph Algorithms and Applications
  - *So many*

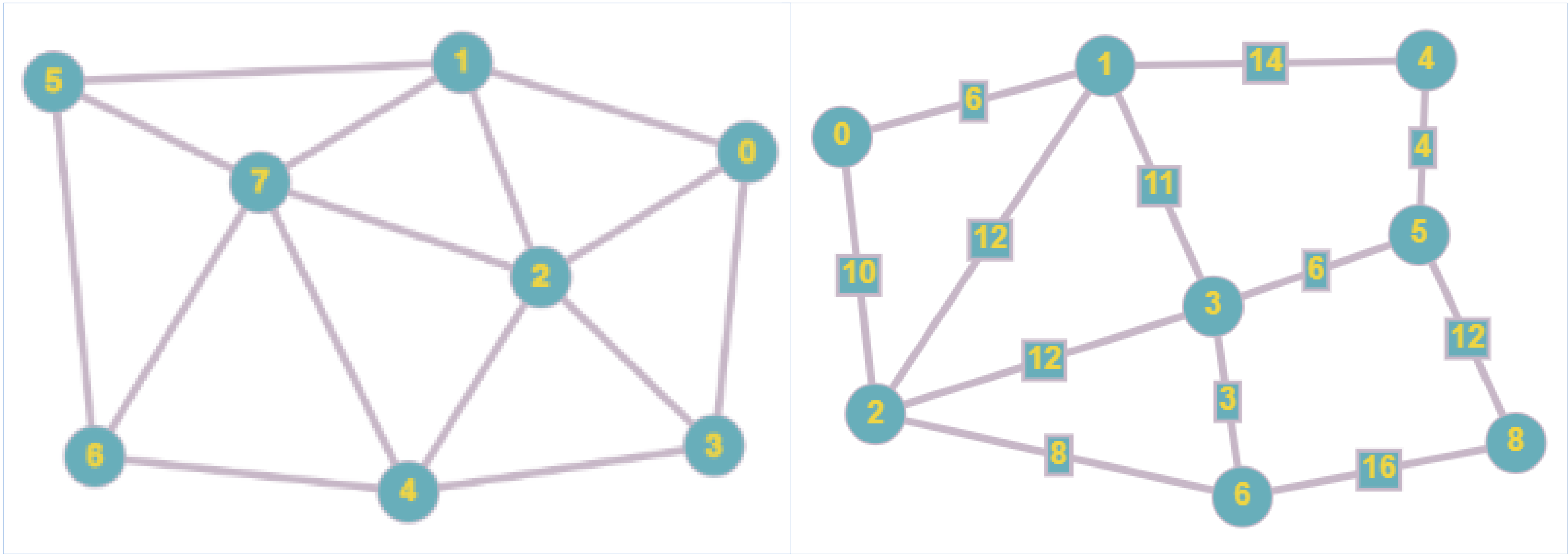
Lecture outline

- Method to study
  - Listen to the skim lecture in class
  - Read book chapter and provided documents
  - Run illustration programs
  - Choose favorite algorithms and applications
  - Code

Graph

- Definition and terminologies
- Graph ADT

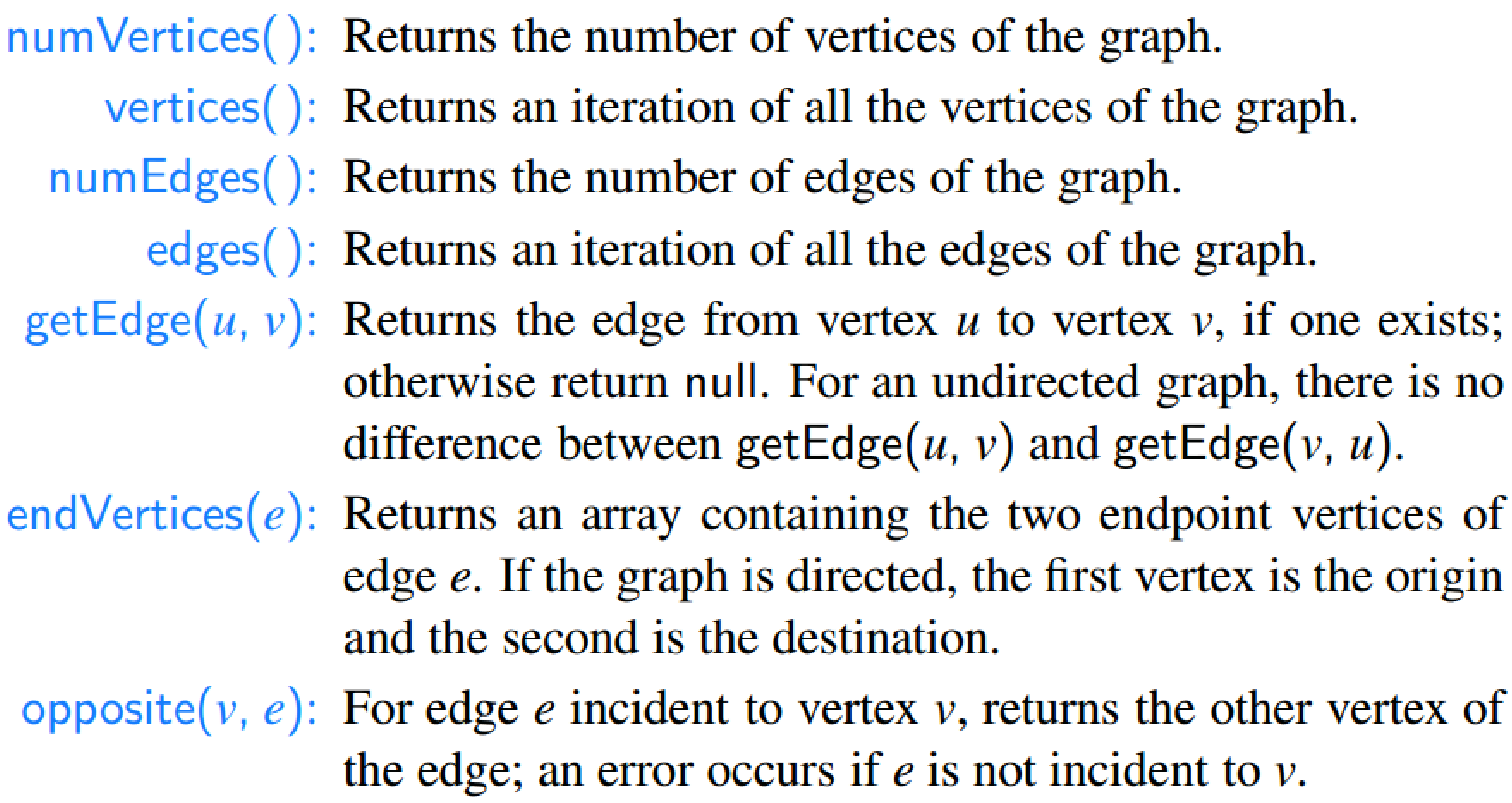
Graph definitions & terminologies



Planar graph examples

https://visualgo.net/en/graphds?slide=1

Graph ADT



numVertices( ): Returns the number of vertices of the graph.

vertices( ): Returns an iteration of all the vertices of the graph.

numEdges( ): Returns the number of edges of the graph.

edges( ): Returns an iteration of all the edges of the graph.

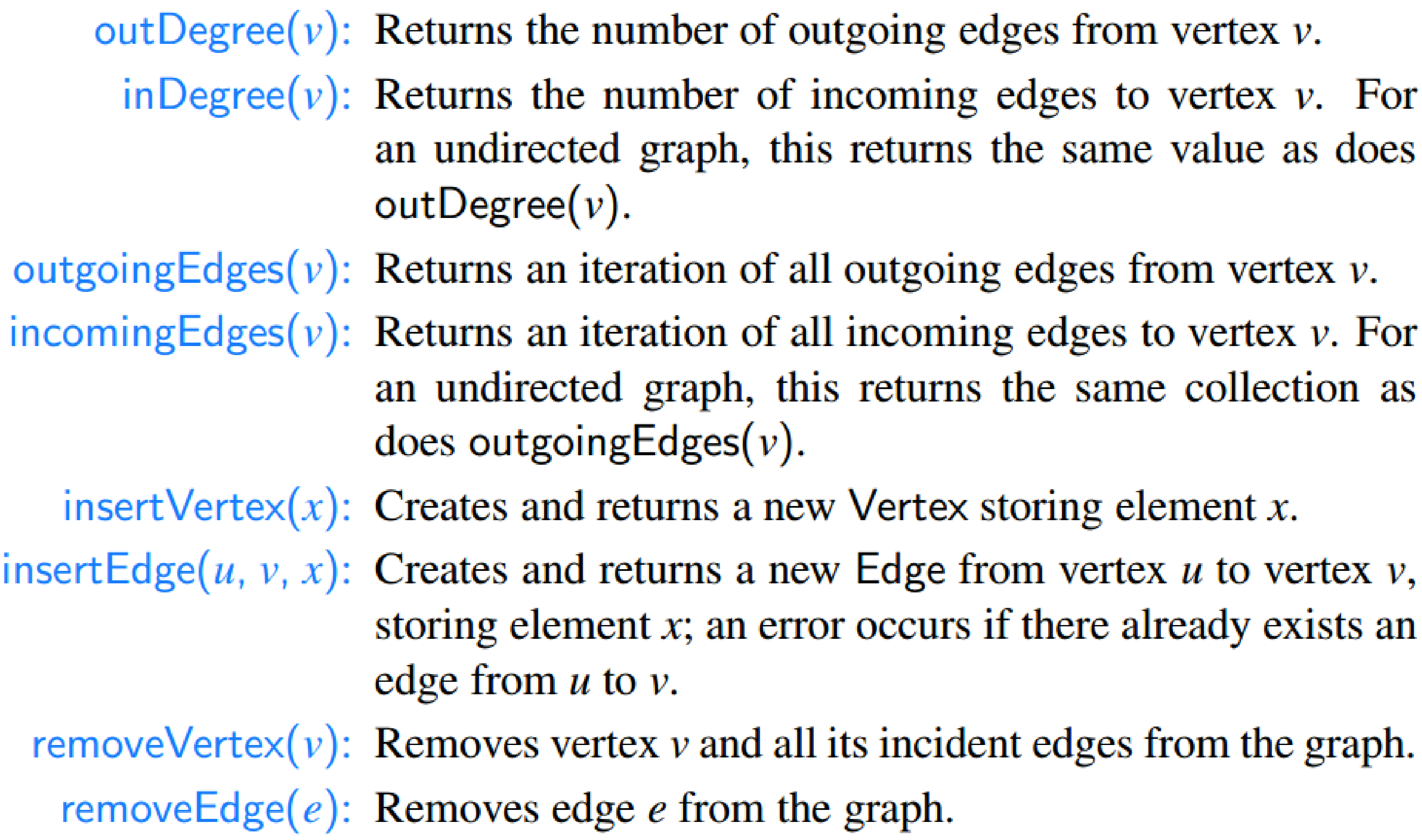
getEdge(u, v): Returns the edge from vertex u to vertex v, if one exists; otherwise return null. For an undirected graph, there is no difference between getEdge(u, v) and getEdge(v, u).

endVertices(e): Returns an array containing the two endpoint vertices of edge e. If the graph is directed, the first vertex is the origin and the second is the destination.

opposite(v, e): For edge e incident to vertex v, returns the other vertex of the edge; an error occurs if e is not incident to v.

[M.Goodrich, sec. 14.1.1, p. 618]

Graph ADT



outDegree(v): Returns the number of outgoing edges from vertex v.

inDegree(v): Returns the number of incoming edges to vertex v. For an undirected graph, this returns the same value as does outDegree(v).

outgoingEdges(v): Returns an iteration of all outgoing edges from vertex v.

incomingEdges(v): Returns an iteration of all incoming edges to vertex v. For an undirected graph, this returns the same collection as does outgoingEdges(v).

insertVertex(x): Creates and returns a new Vertex storing element x.

insertEdge(u, v, x): Creates and returns a new Edge from vertex u to vertex v, storing element x; an error occurs if there already exists an edge from u to v.

removeVertex(v): Removes vertex v and all its incident edges from the graph.

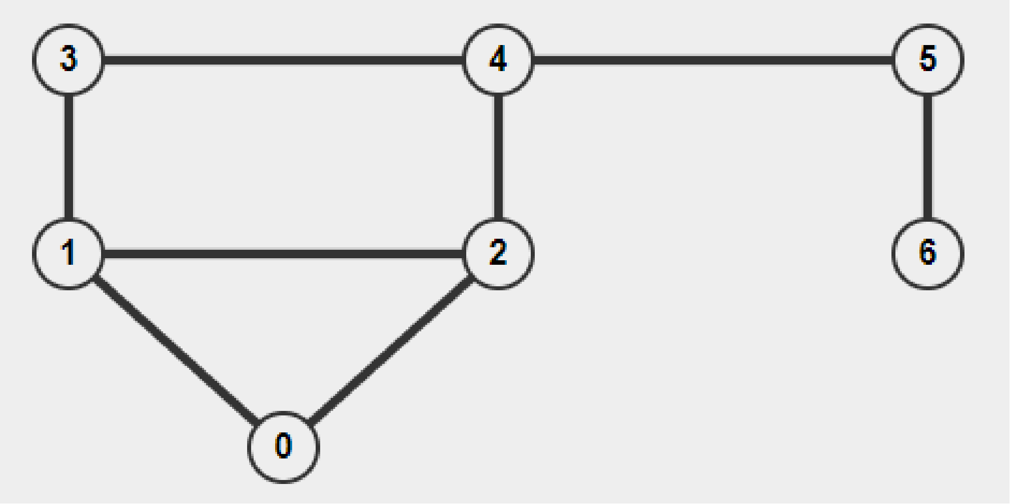
removeEdge(e): Removes edge e from the graph.

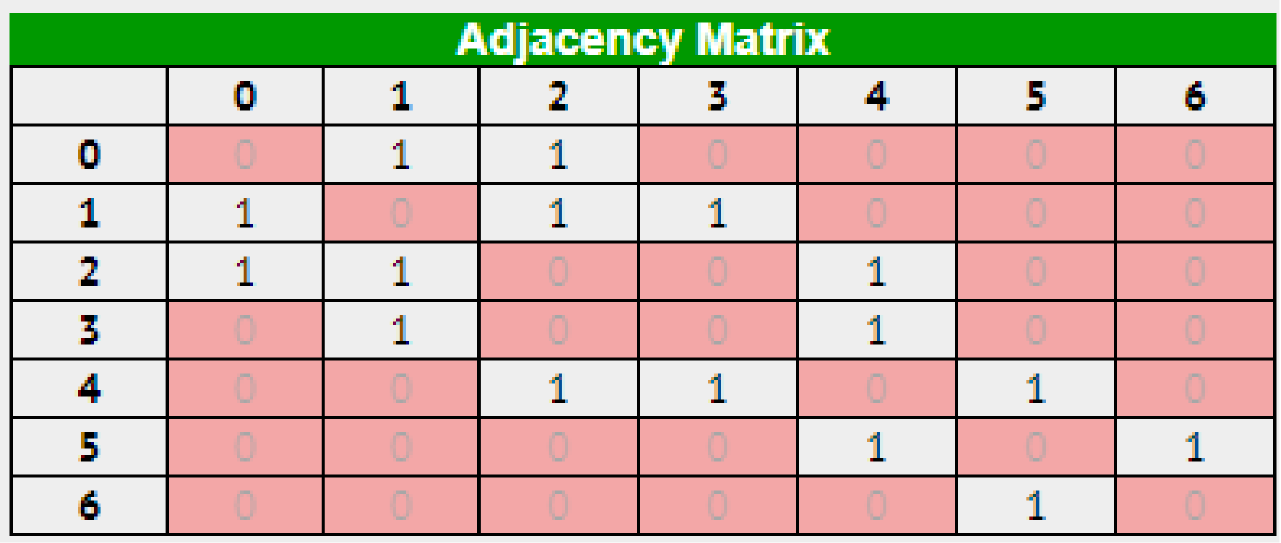
[M.Goodrich, sec. 14.1.1, p. 618]

Data Structures for Graph

- Adjacency Matrix
- Adjacency List
- Edge List

Adjacency Matrix

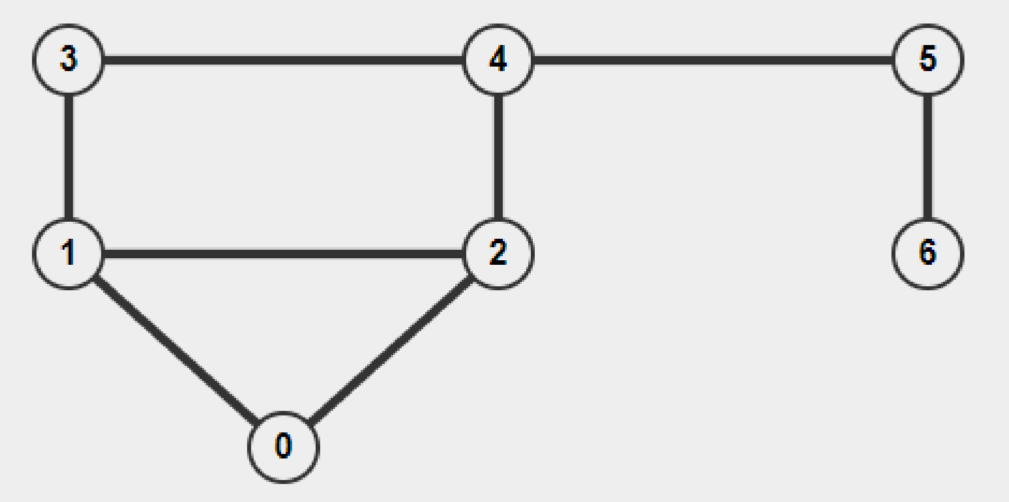


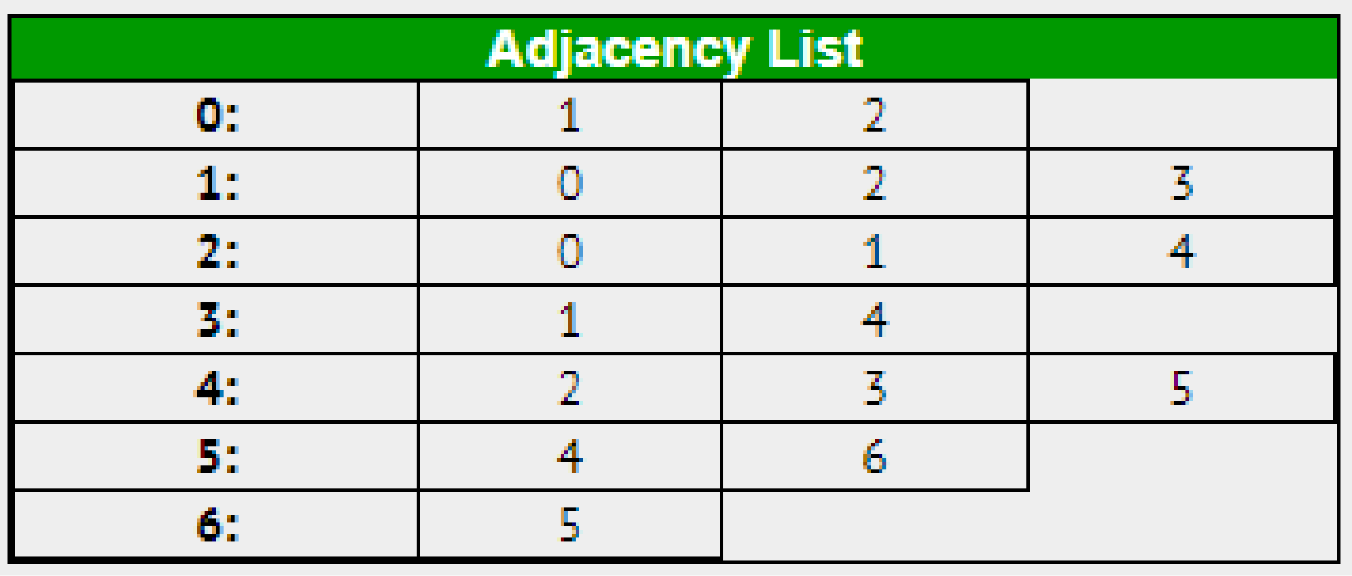


Adjacency Matrix

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

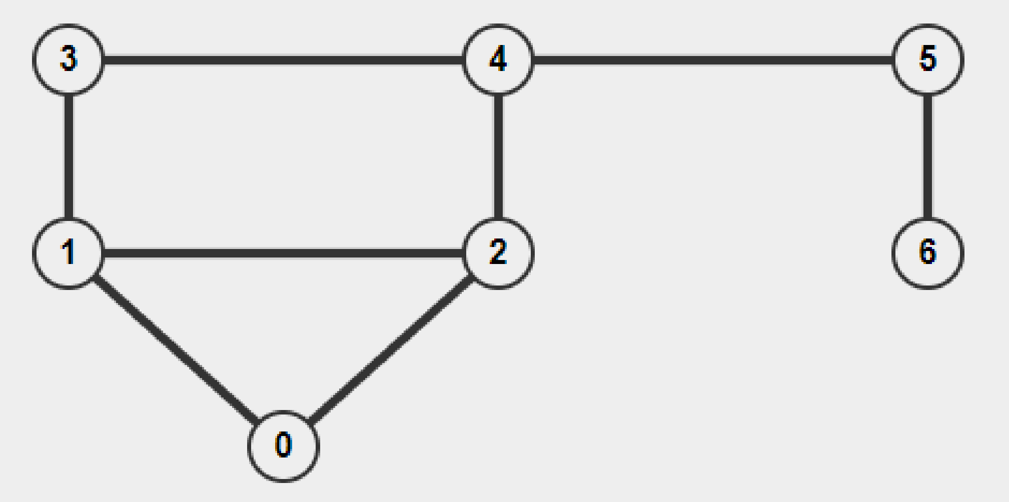
Adjacency List

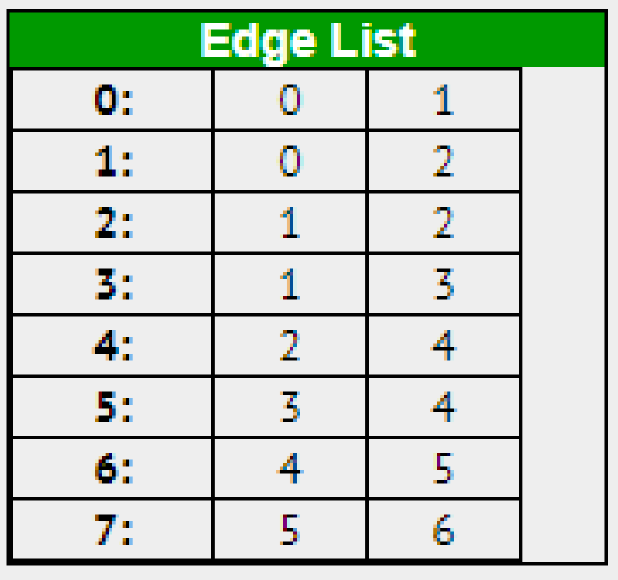




Adjacency List			
0:	1	2	
1:	0	2	3
2:	0	1	4
3:	1	4	
4:	2	3	5
5:	4	6	
6:	5		

Edge List



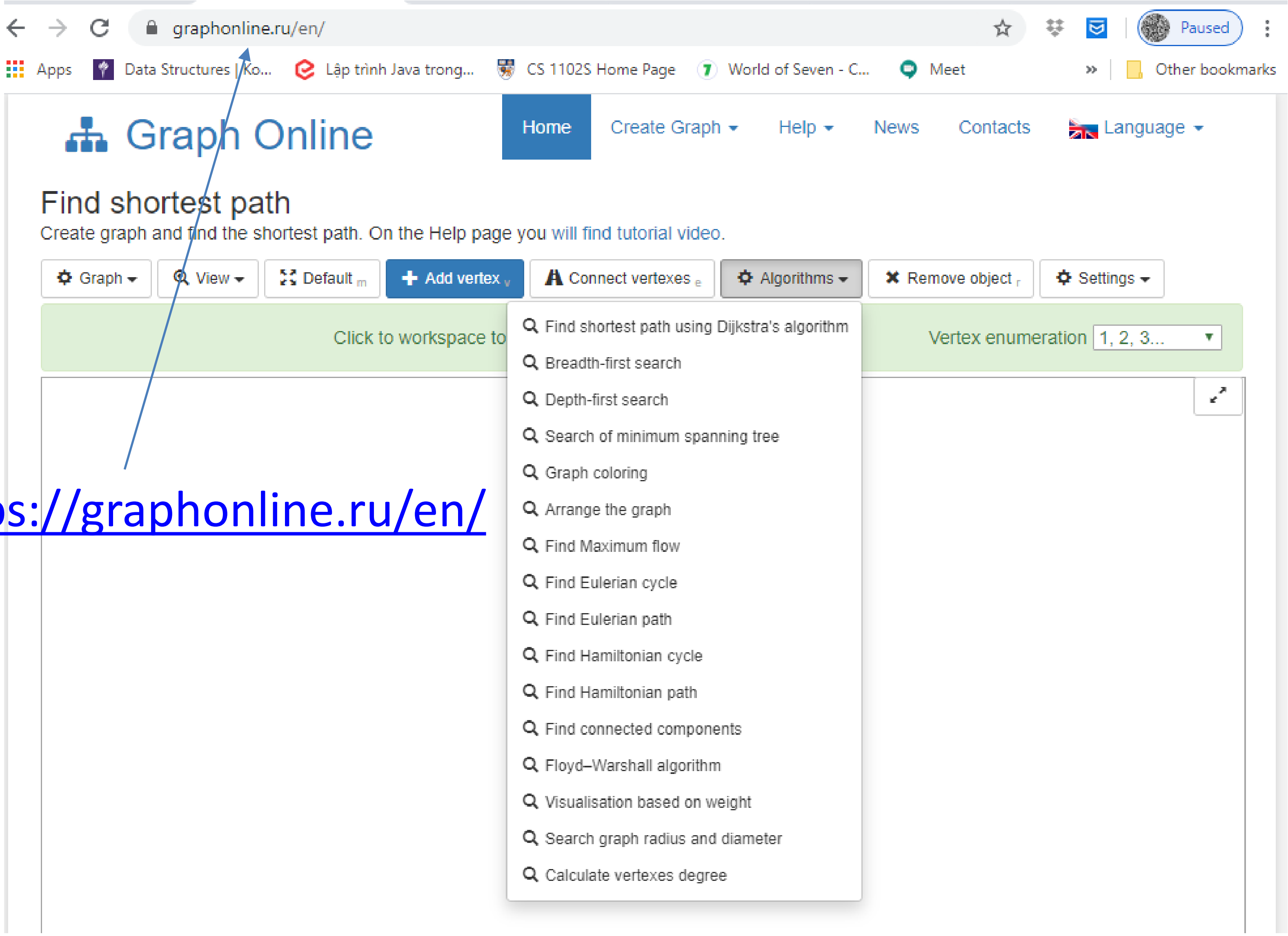


Edge List

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

Graph Algorithms and Applications

Algorithms



Find shortest path

Create graph and find the shortest path. On the Help page you will find tutorial video.

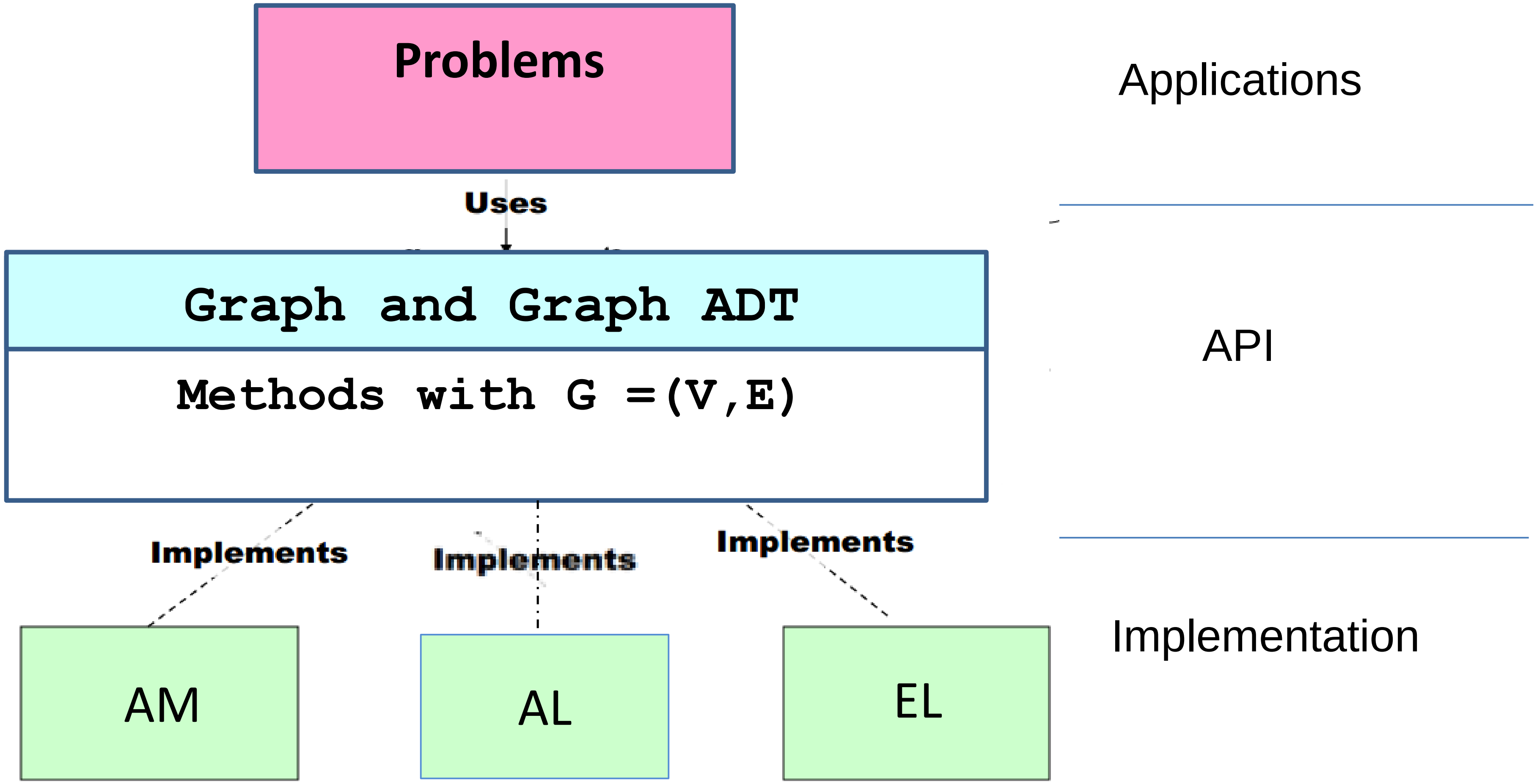
https://graphonline.ru/en/

Algorithms and pplications

https://www.sanfoundry.com/java-programming-examples-graph-problems-algorithms/

https://www.geeksforgeeks.org/applications-of-graph-data-structure/

Summary


Problems
Uses
Graph and Graph ADT
Methods with G =(V,E)
Implements
Implements
Implements
AM
AL
EL
Applications
API
Implementation