Welcome everyone!

- You can find these slides on GitHub here: https://github.com/WomenWhoCode/WWCodePython

- Some housekeeping rules:
  - Everyone will be muted throughout the webinar, but there will be opportunities for participation!
  - Please share your thoughts on the chat and/or ask questions in the Q&A.
  - The entire team is here today. Please reach out to us with any technical questions!

WELCOME

WOMEN WHO CODE

Women Who Code Python

Intro to Data Structures with Python: Ace the Technical Interview

Session #8: Graphs

WOMEN WHO CODE®

MEET YOUR TEAM

Rishika Singh
Track Lead

Jasmeen Rajpal
Evangelist

WOMEN WHO CODE

OUR MISSION

Inspiring women to excel in technology careers.

WOMEN WHO CODE

OUR VISION

A world where women are representative as technical executives, founders, VCs, board members and software engineers.

WOMEN WHO CODE

OUR TARGET

Engineers with two or more years of experience looking for support and resources to strengthen their influence and levelup in their careers.

WOMEN WHO CODE

CODE OF CONDUCT

WWCode is an inclusive community, dedicated to providing an empowering experience for everyone who participates in or supports our community, regardless of gender, gender identity and expression, sexual orientation, ability, physical appearance, body size, race, ethnicity, age, religion, socioeconomic status, caste, creed, political affiliation, or preferred programming language(s).

Our events are intended to inspire women to excel in technology careers, and anyone who is there for this purpose is welcome. We do not tolerate harassment of members in any form. Our **Code of Conduct** applies to all WWCode events and online communities.

Read the full version and access our incident report form at **womenwhocode.com/codeofconduct**

WOMEN WHO CODE

230,000
Members

70 networks in 20 countries
Members in 97+ countries
10K+ events
$1025 daily Conference tickets
$2M Scholarships
Access to jobs + resources
Infinite connections

WOMEN WHO CODE

OUR MOVEMENT

As the world changes, we can be a connecting force that creates a sense of belonging while the world is being asked to isolate.

WOMEN WHO CODE

Upcoming Events

FRI
25
JUN

✨Intro to Data Structures with Python: Ace the Technical Interview (Session #8: Graphs)✨ *Featured*

Online | Python | 9:00 AM - 10:30 AM KST (UTC+0900)

Register

WED
30
JUN

✨Ask Me Anything with Jane Street Software Engineers✨ *Featured*

Online | Python | 12:00 AM - 1:00 AM KST (UTC+0900)

Register

FRI
09
JUL

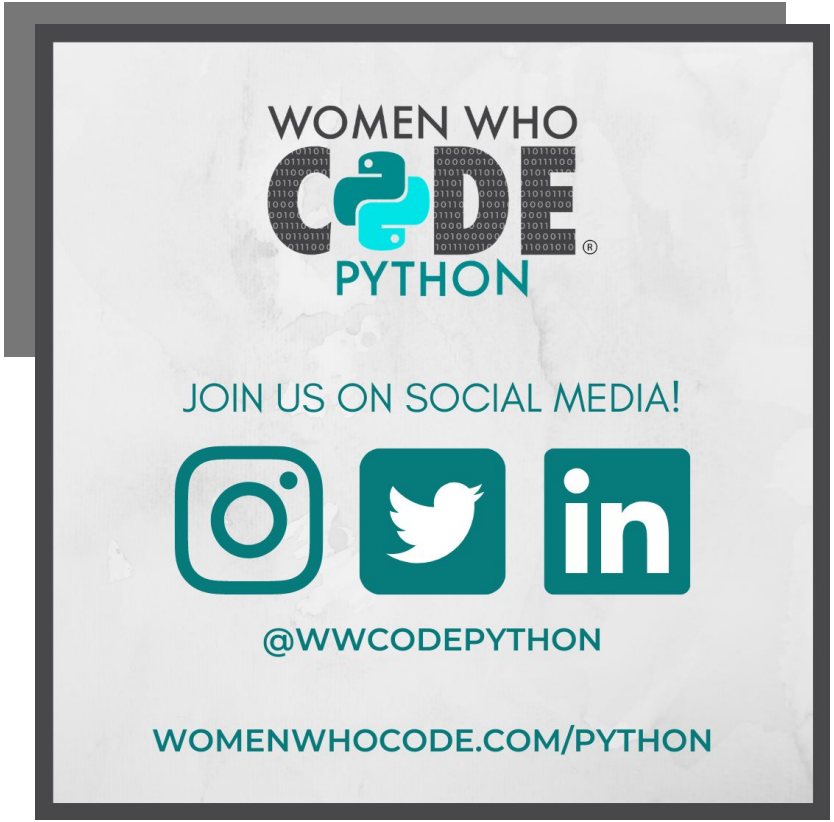
✨Intro to Data Structures with Python: Ace the Technical Interview (Session #9: Maps & Hash Tables)✨ *Featured*

Zoom | Python | 9:00 AM - 10:30 AM KST (UTC+0900)

Register

WOMEN WHO CODE PYTHON

Stay Connected



Nayeon

Sophomore CS & New Media Art Major | WWCode Python Track General Volunteer

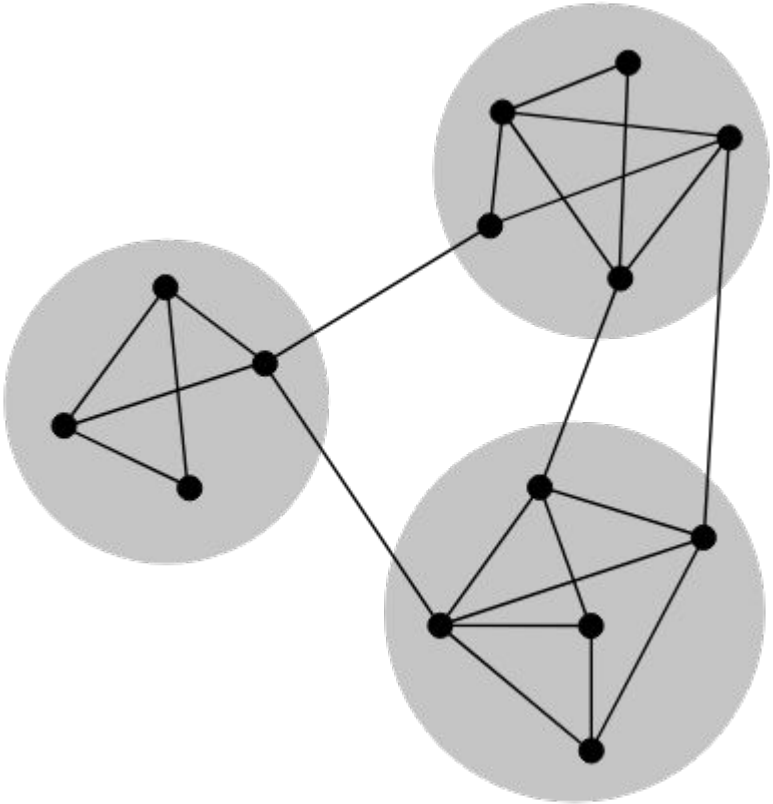
Today's Agenda

1. Definition
2. Applications
3. Concepts
4. Implementation
    a. Adjacency List
    b. Adjacency Matrix
5. Traversals
    a. Breadth-First Search
    b. Depth-First Search
6. Q&A
7. Live Coding

Definition

Definition - Graphs

- Not “charts”
- Relationships between data items
- Consists of nodes & edges



Applications

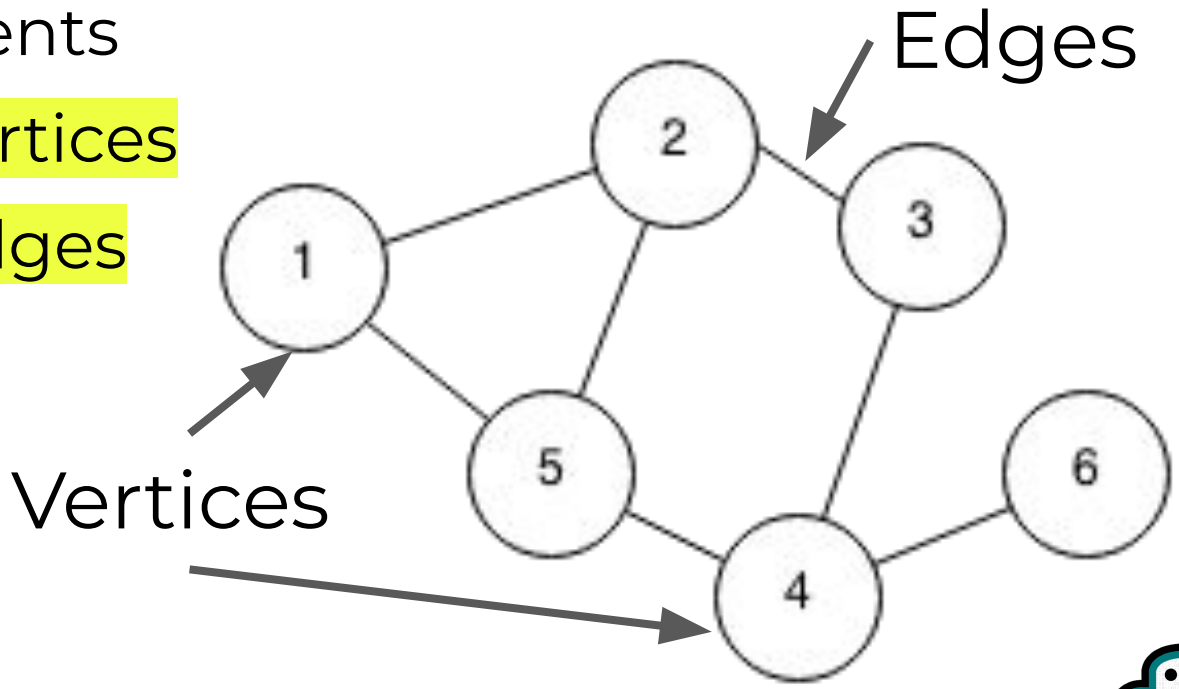
Applications - Graphs

- Many!
  - Networking
    - How the Internet is connected
  - Transportation
    - System of roads
    - Airline flights from city to city
  - Game playing
  - AI apps

Concepts

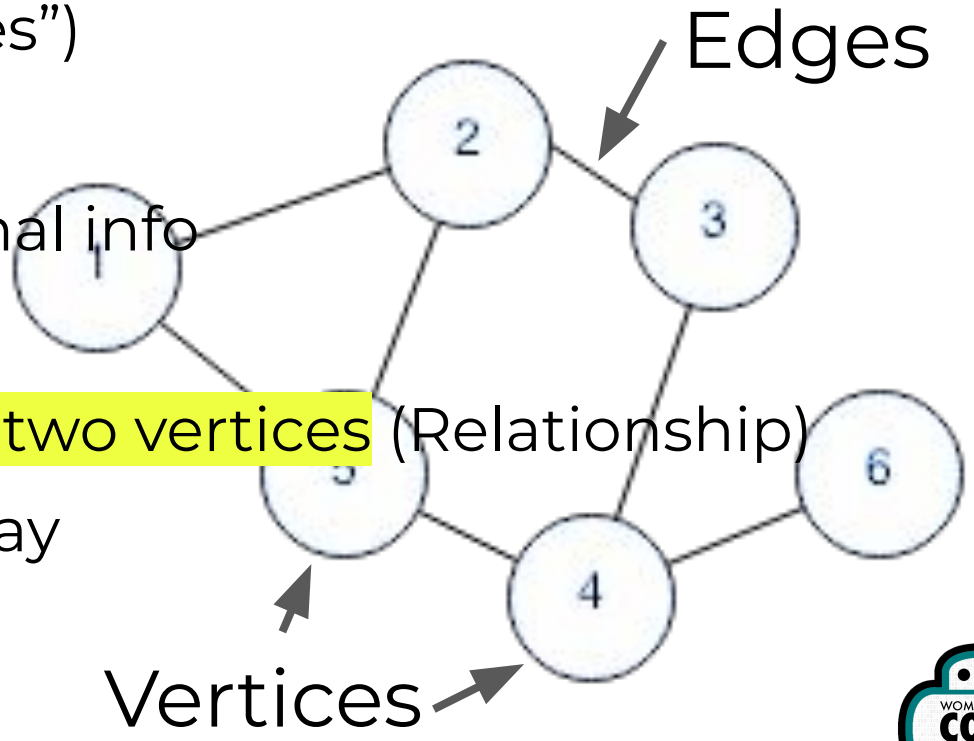
Components - Graphs

- Two components
  - V: Set of vertices
  - E: Set of Edges



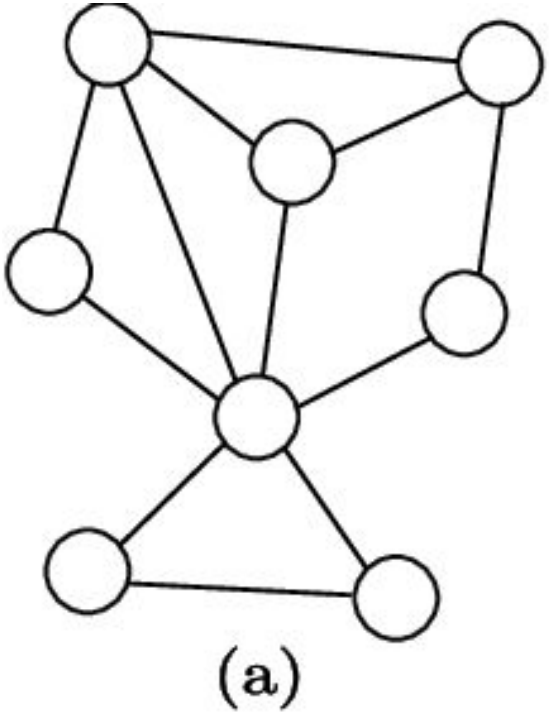
Components - Graphs

- Vertex (plural: “Vertices”)
  - “Key”: Name
  - “Payload”: Additional info
- Edge (a.k.a.: “Arc”)
  - An edge connects two vertices (Relationship)
  - One-way or two-way

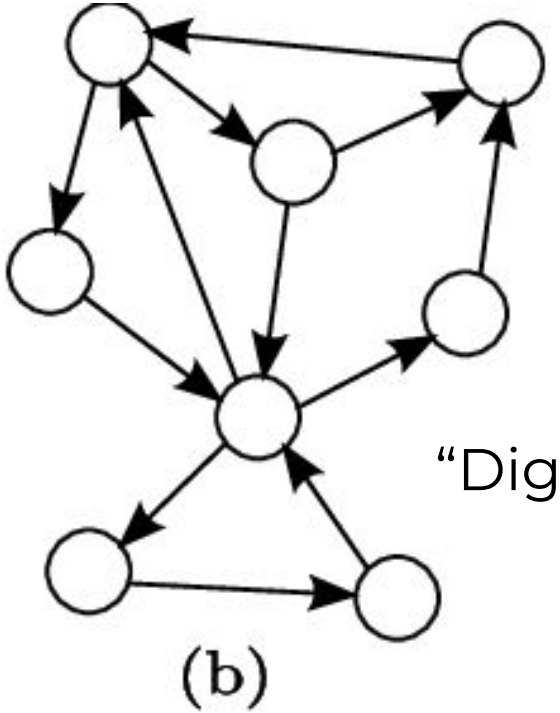


Undirected vs Directed Graphs

Undirected Graph (Two-way)



Directed Graph (One-way)

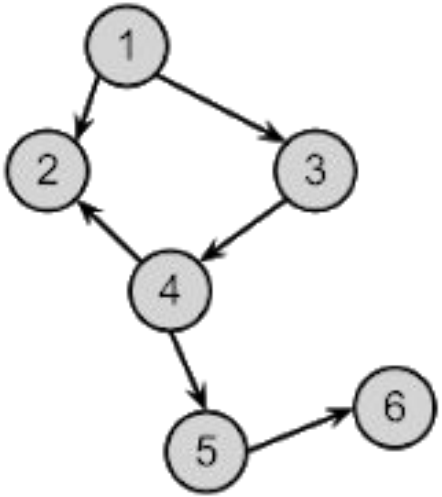


“Digraph”

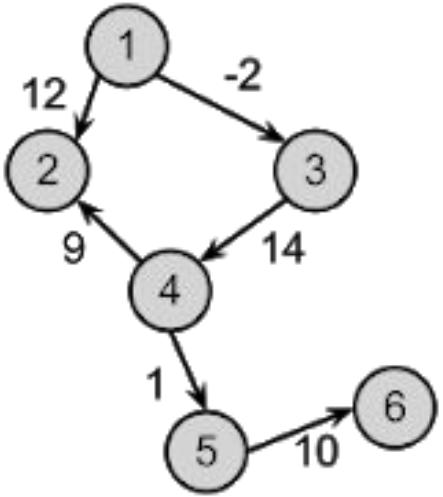
Unweighted vs Weighted Graphs

- Weight: Cost to go from one vertex to another
  - Example: Distance between two cities in graph of roads

Unweighted Graph

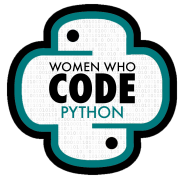


Weighted Graph



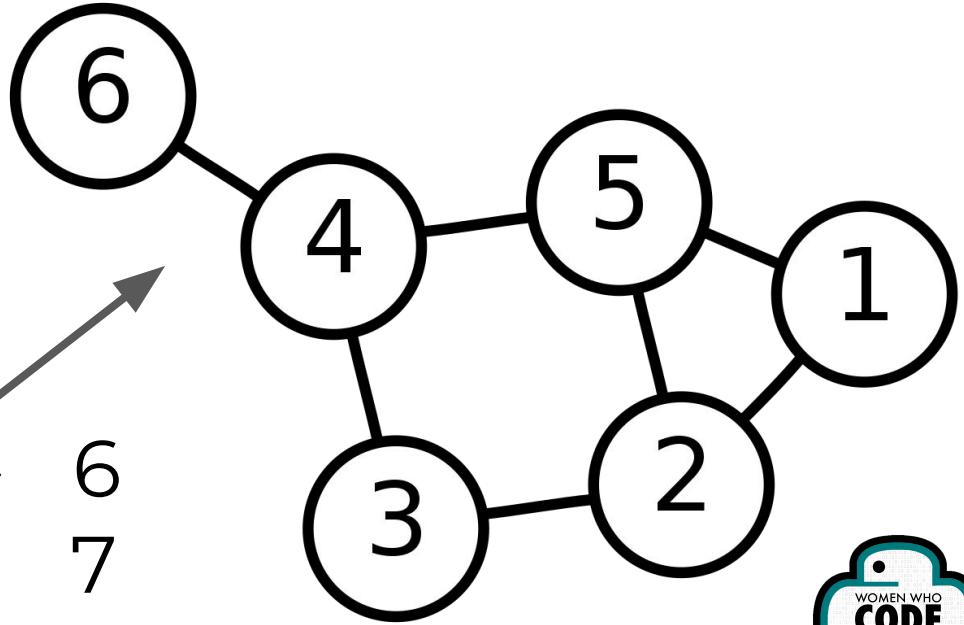
Additional Concepts - Graphs

- Cardinality
- Degree
- Adjacent Vertices
- Path
- Cycle



Cardinality - Graphs

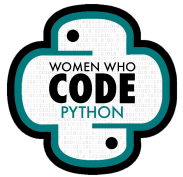
- Number of Vertices/Edges
- |V| → # of Vertices
- |E| → # of Edges



|V|? → 6
|E|? → 7

Additional Concepts - Graphs

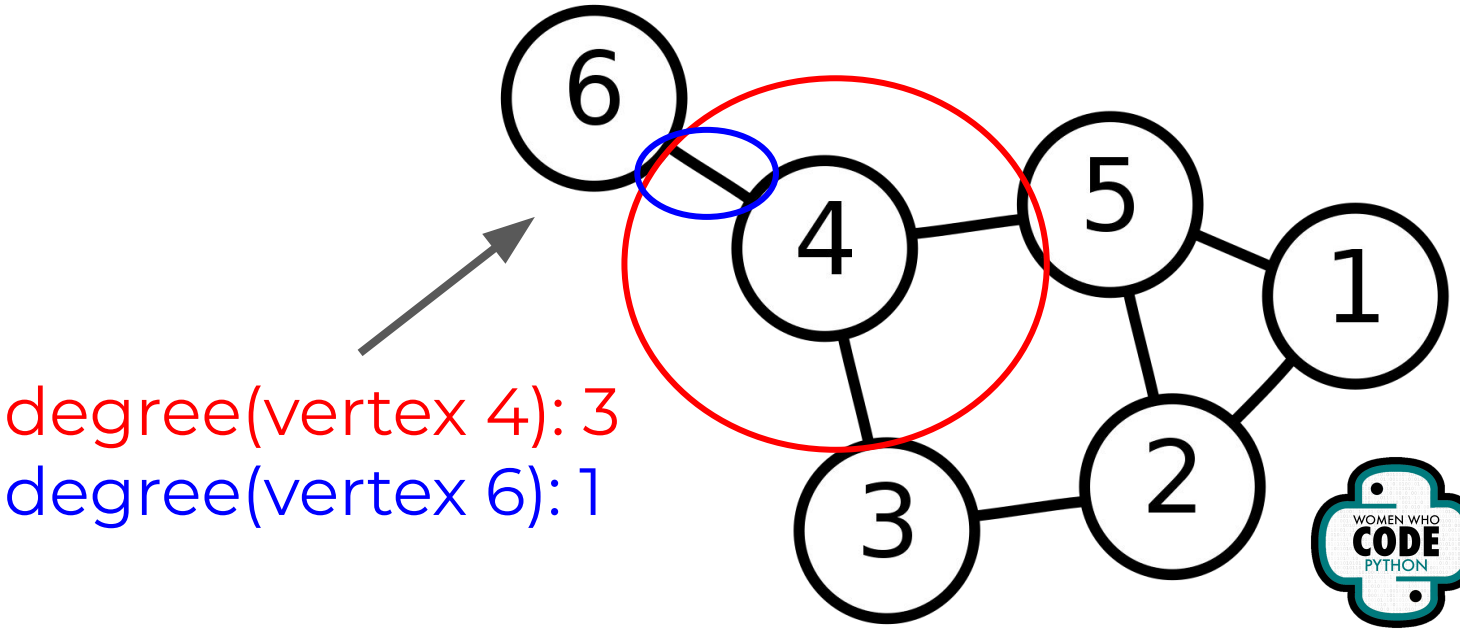
- Cardinality
- Degree
- Adjacent Vertices
- Path
- Cycle



Degree - Graphs

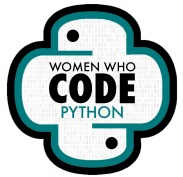
- Degree of a vertex:

  # of edges connected to a vertex



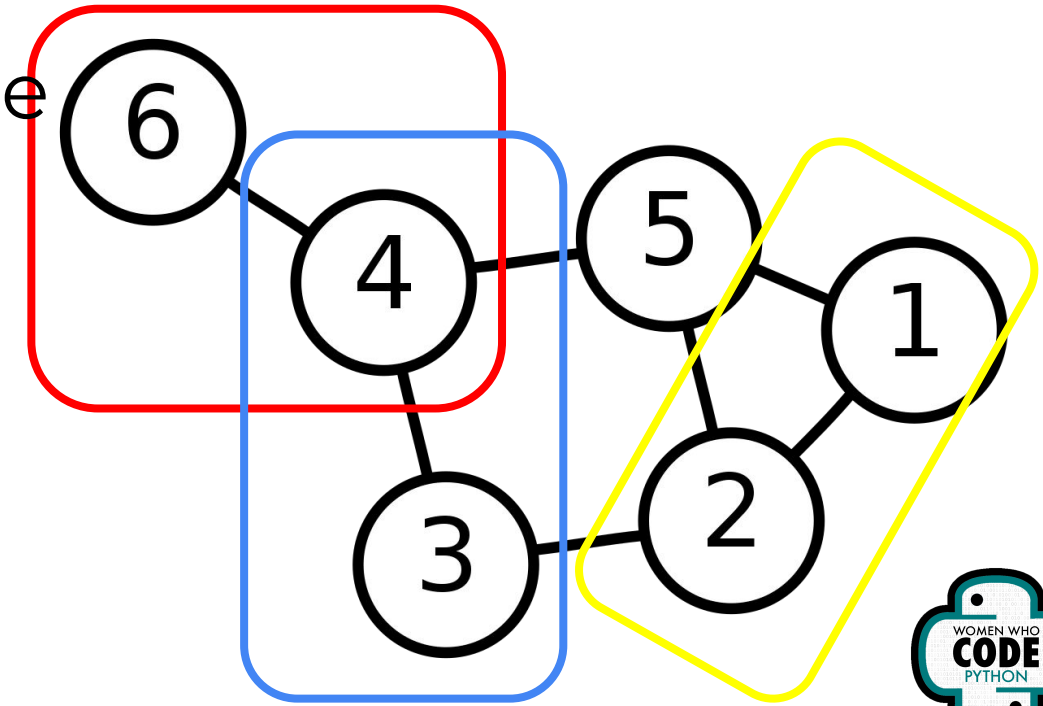
Additional Concepts - Graphs

- Cardinality
- Degree
- Adjacent Vertices
- Path
- Cycle



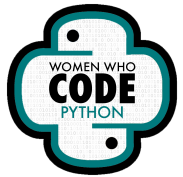
Adjacent Vertices - Graphs

- A pair of vertices that have an edge between them



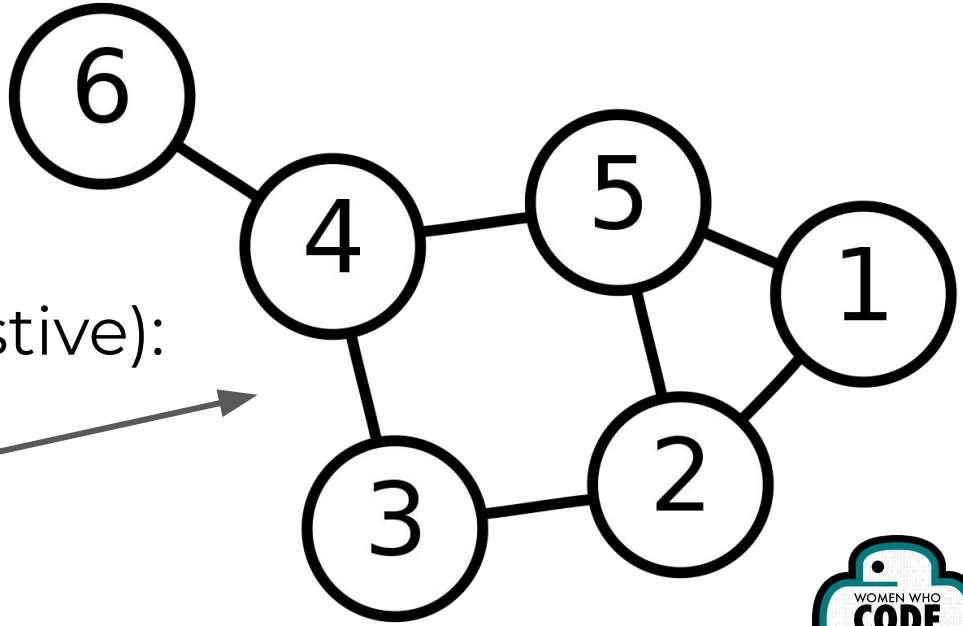
Additional Concepts - Graphs

- Cardinality
- Degree
- Adjacent Vertices
- Path
- Cycle



Path - Graphs

- Sequence of vertices that are connected by edges

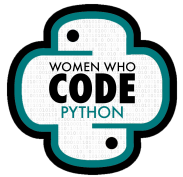


Paths (not exhaustive):

- 6, 4, 5, 2, 1
- 3, 4, 6
- 3, 2, 5, 4

Additional Concepts - Graphs

- Cardinality
- Degree
- Adjacent Vertices
- Path
- Cycle

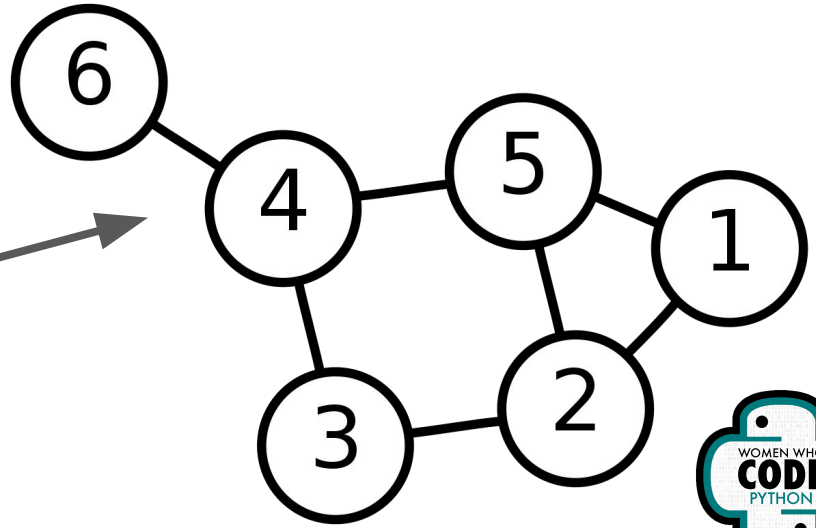


Cycle - Graphs

- Path that starts and ends at the same vertex
  - Acyclic graph: No cycle
    - & Directed: DAG (Directed Acyclic Graph)

Cycle (not exhaustive):

- 4, 3, 2, 5, 4
- 1, 5, 2, 1
- 3, 2, 5, 4, 3



Implementation

Implementation - Graphs

- Adjacency List
- Adjacency Matrix

Adjacency List - Graphs

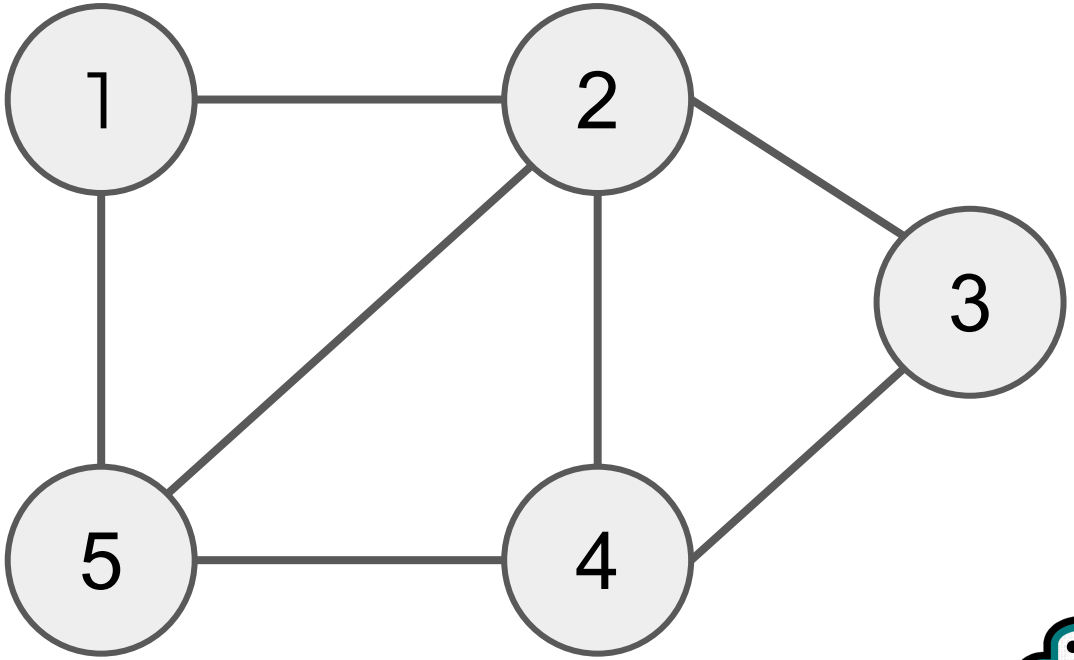
1 → 2 → 5

2 → 1 → 3 → 4 → 5

3 → 2 → 4

4 → 2 → 3 → 5

5 → 1 → 2 → 4



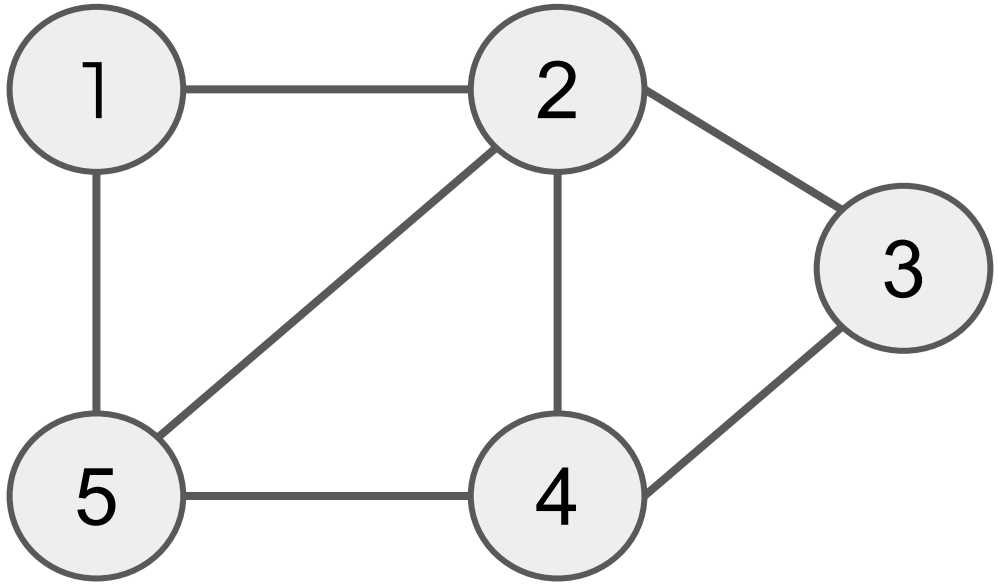
Implementation - Graphs

- Adjacency List
- Adjacency Matrix

Adjacency Matrix - Graphs

- 2D matrix

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



Implementation - Graphs

- Which implementation to use?
  - # of vertices doesn't matter
  - # of edges do!
    - Sparse graph → $|E| < |V|^2$
      - Use adjacency list
    - Dense graph → $|E|$ close to $|V|^2$
      - Doesn't matter

Implementation - Graphs

- Sparse graph
  - Most cells empty
- Adjacency Matrix

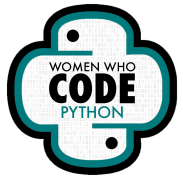
  → Learn quickly whether an edge exists between two vertices

	V0	V1	V2	V3	V4	V5
V0		5				2
V1			4			
V2				9		
V3					7	3
V4	1					
V5			1		8	

Traversals

Traversals - Graphs

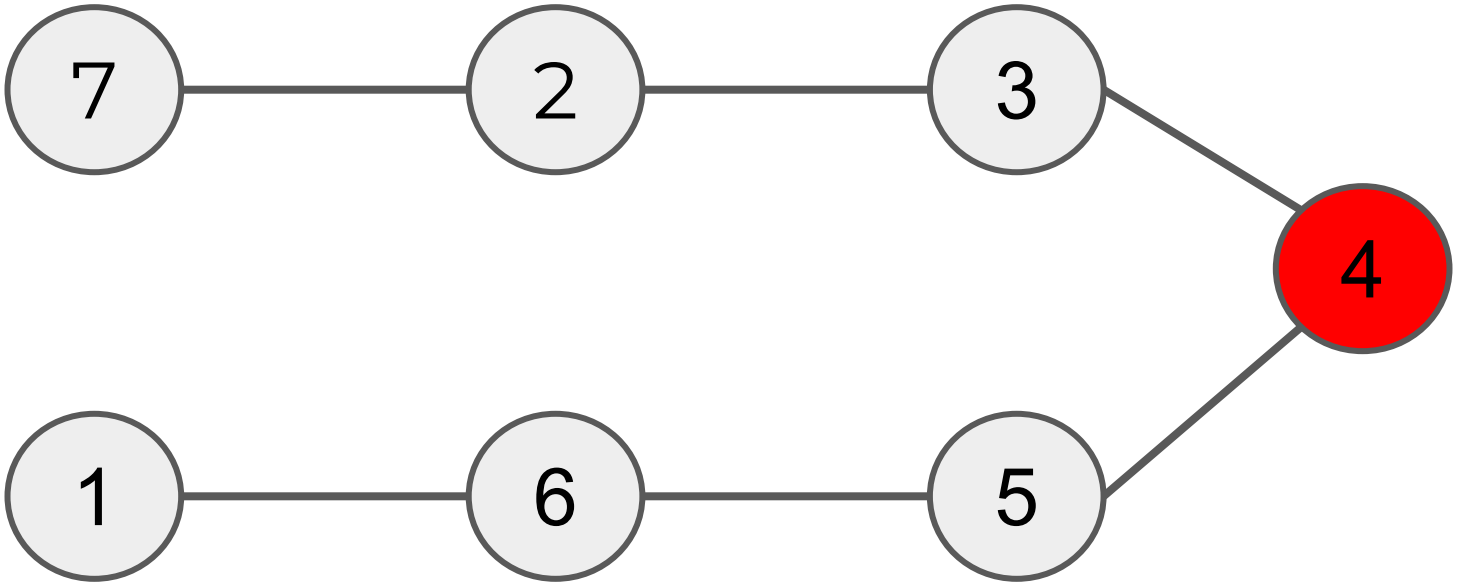
- Breadth-First Search
- Depth-First Search



Breadth-First Search - Graphs

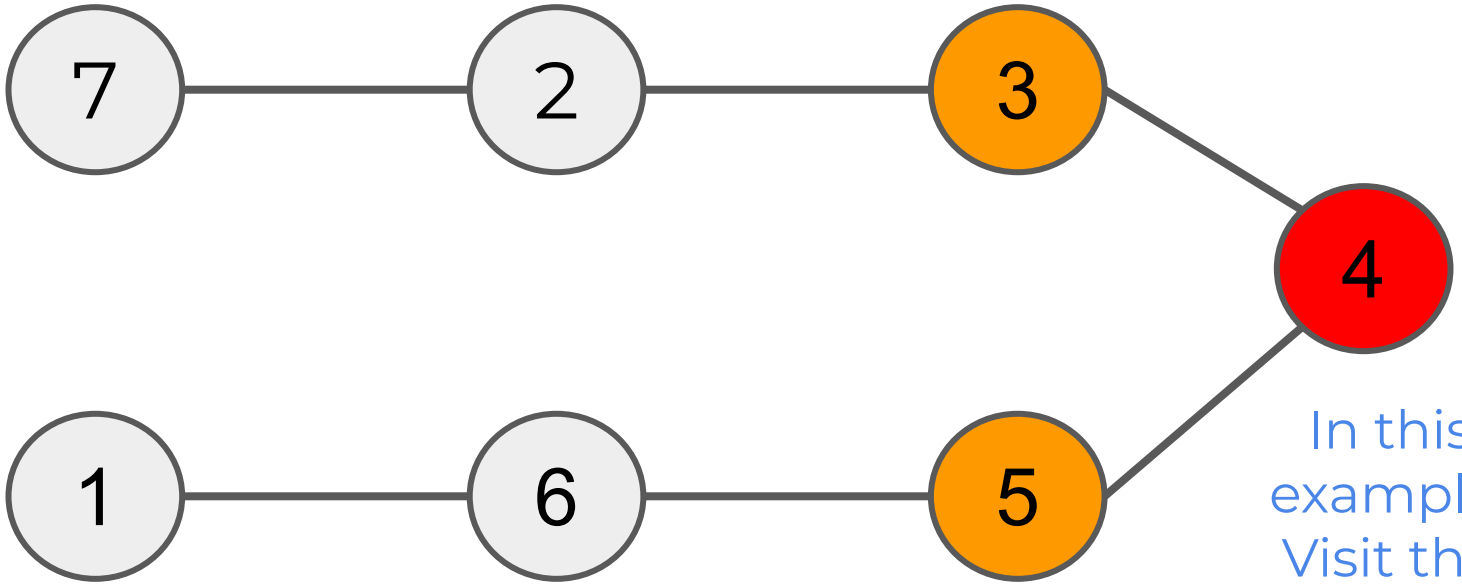
1. Visit all vertices at first level
2. Equivalently:
    a. Visit all vertices that are one step away
    b. then vertices that are 2 steps away
    c. then vertices that are 3 steps away.....
    d. Until all vertices have been visited

Breadth-First Search - Graphs



Visit Order: 4

Breadth-First Search - Graphs

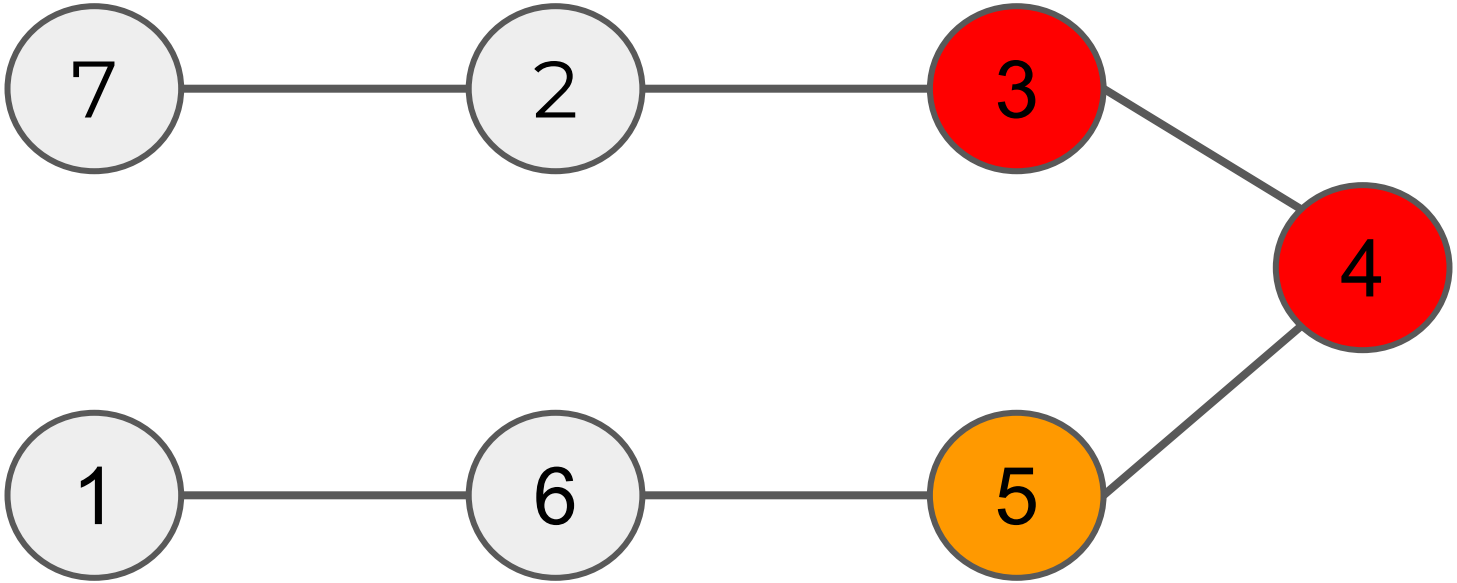


In this example: Visit the smaller ones first!

Visit Order: 4

Next level: 3, 5

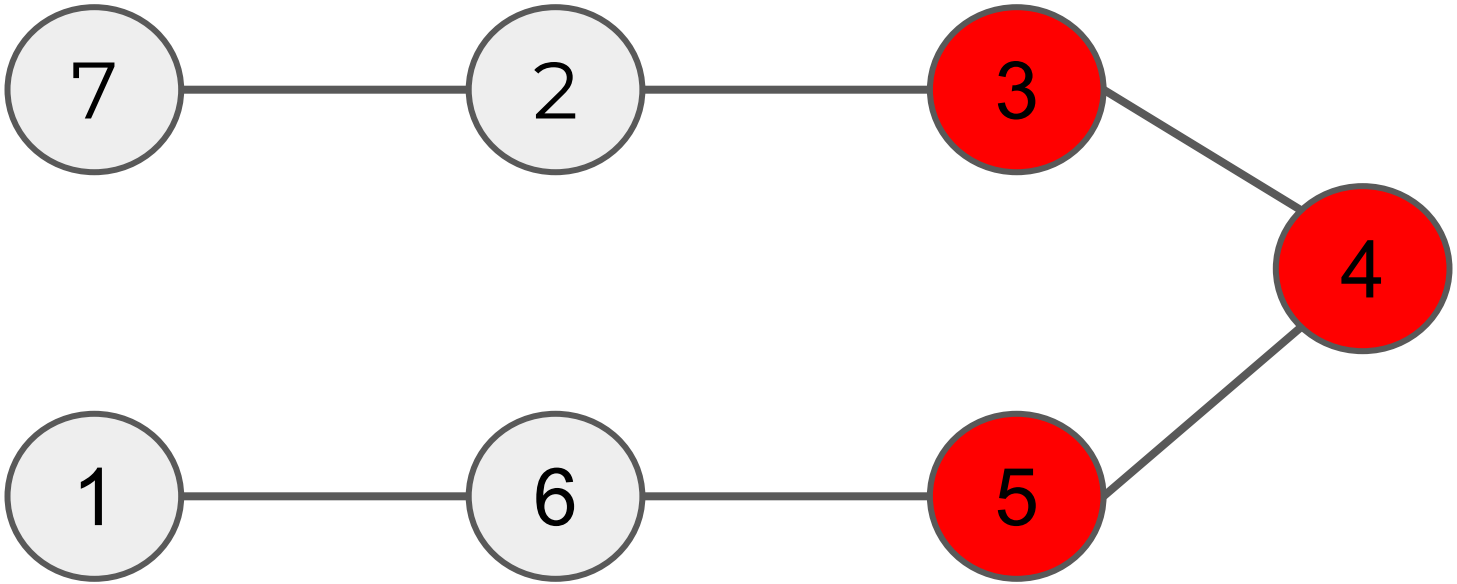
Breadth-First Search - Graphs



Visit Order: 4, 3

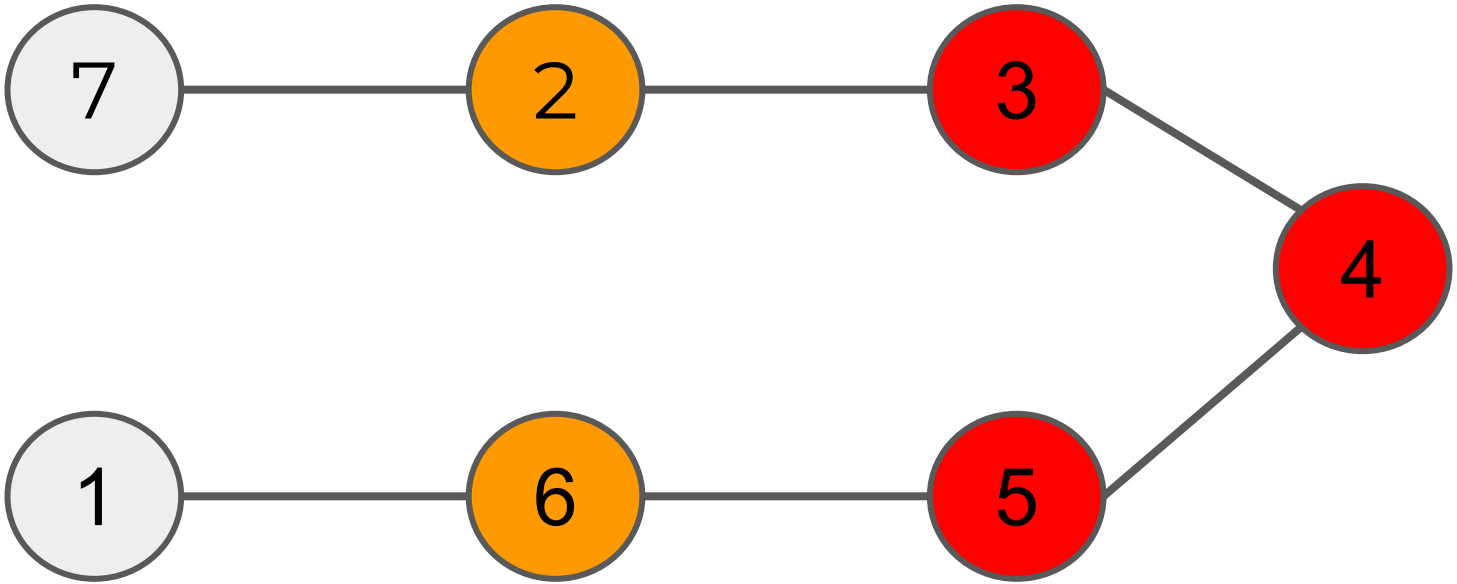
In holding: 5

Breadth-First Search - Graphs



Visit Order: 4, 3, 5

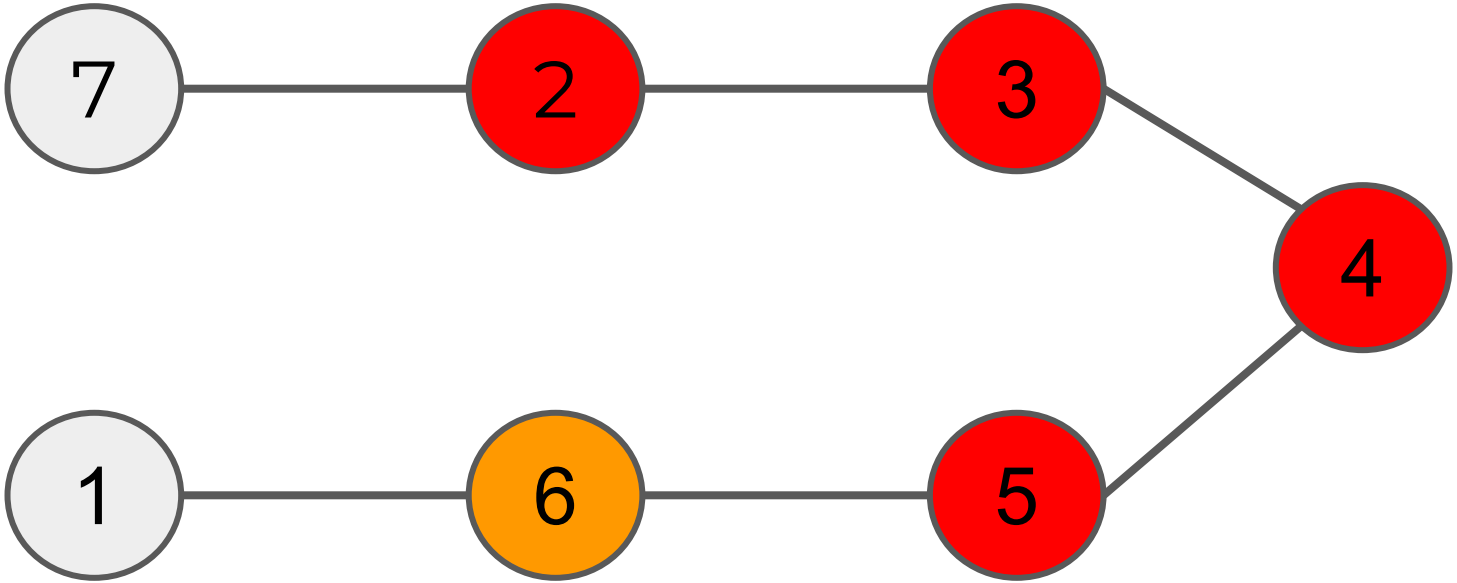
Breadth-First Search - Graphs



Visit Order: 4, 3, 5

Next level: 2, 6

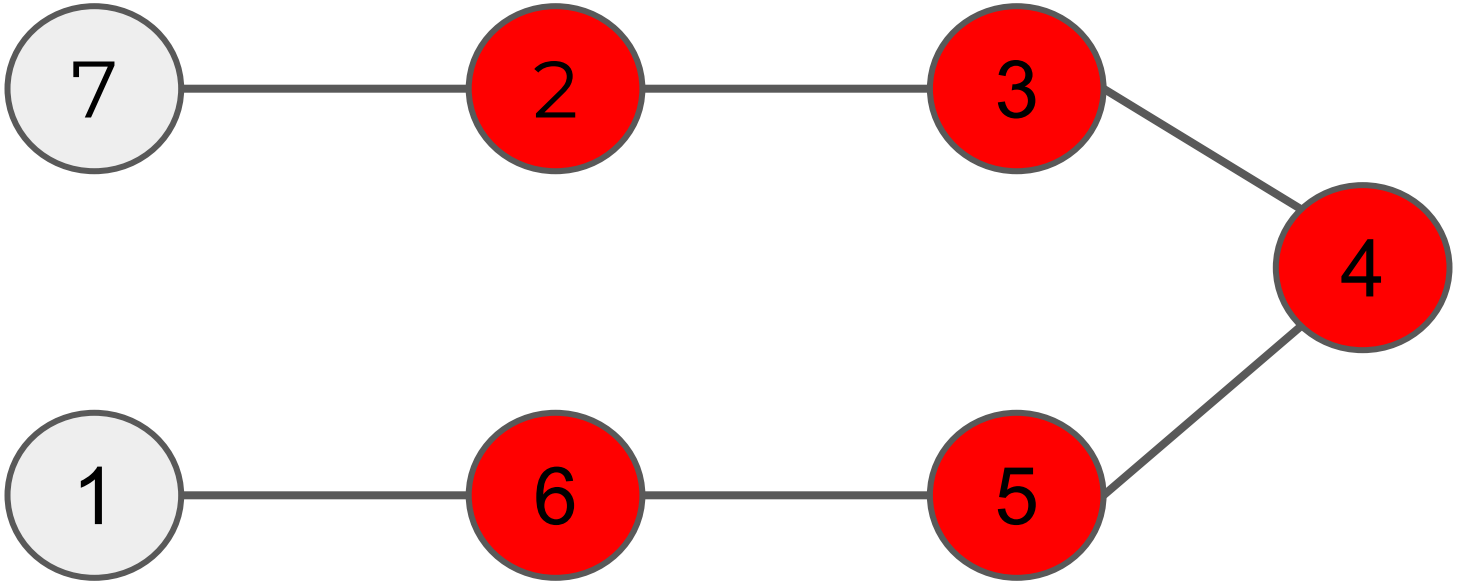
Breadth-First Search - Graphs



Visit Order: 4, 3, 5, 2

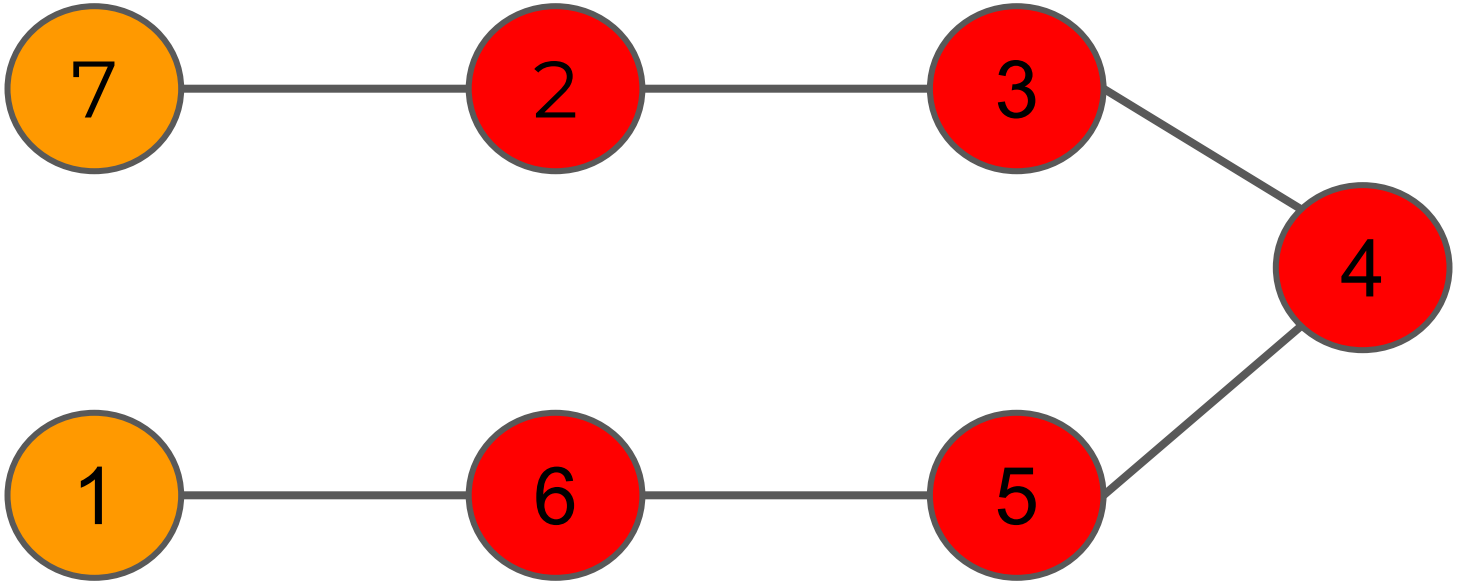
In holding: 6

Breadth-First Search - Graphs



Visit Order: 4, 3, 5, 2, 6

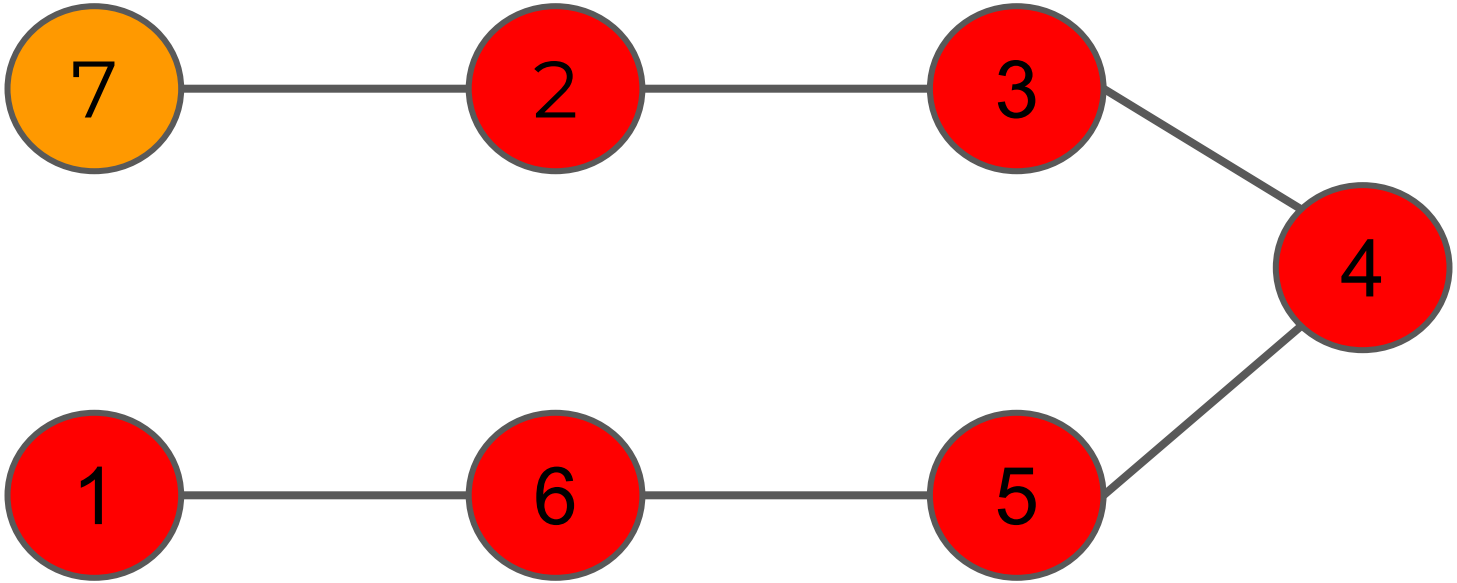
Breadth-First Search - Graphs



Visit Order: 4, 3, 5, 2, 6

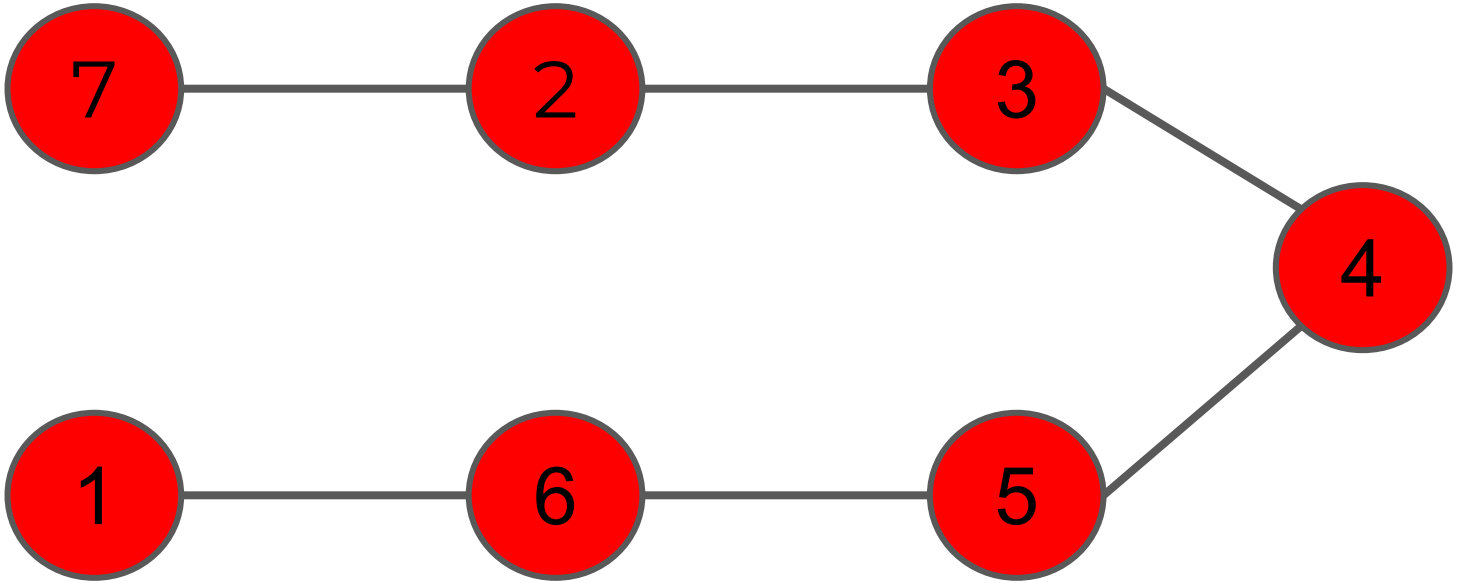
Next level: 7, 1

Breadth-First Search - Graphs



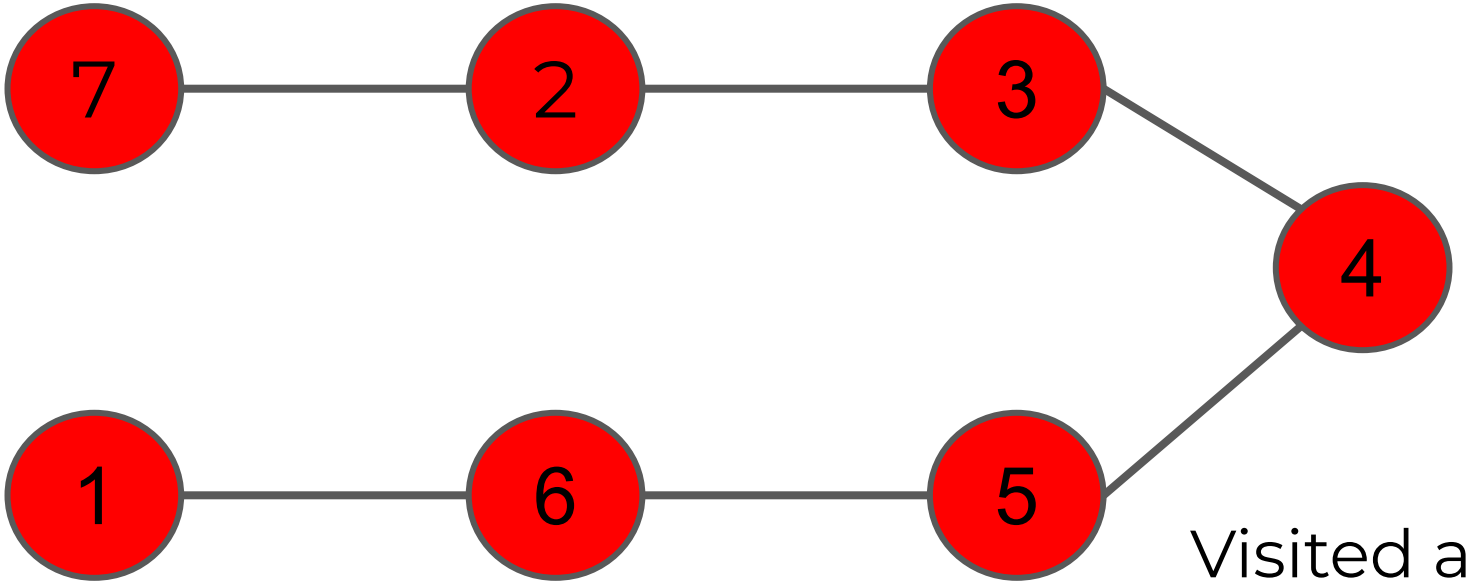
Visit Order: 4, 3, 5, 2, 6, 1 In holding: 7

Breadth-First Search - Graphs



Visit Order: 4, 3, 5, 2, 6, 1, 7

Breadth-First Search - Graphs



Visit Order: 4, 3, 5, 2, 6, 1, 7

Visited all vertices → Done

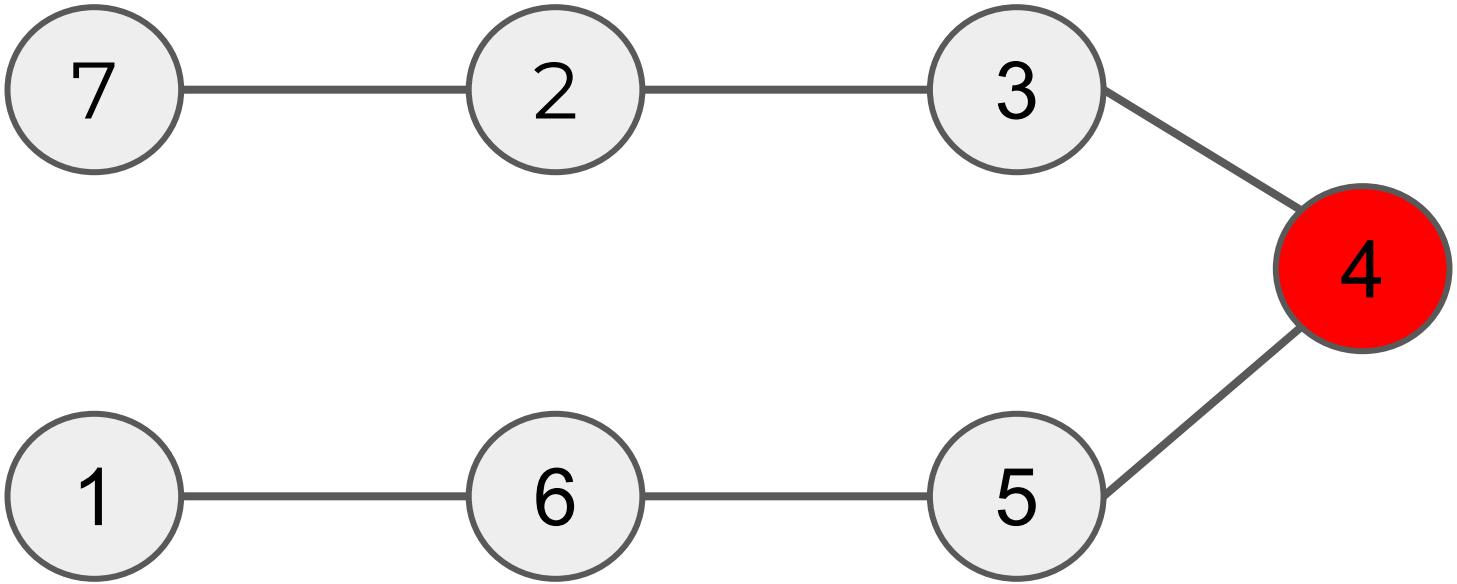
Depth-First Search - Graphs

1. Go as deep as possible

    → Until there's no adjacent vertex

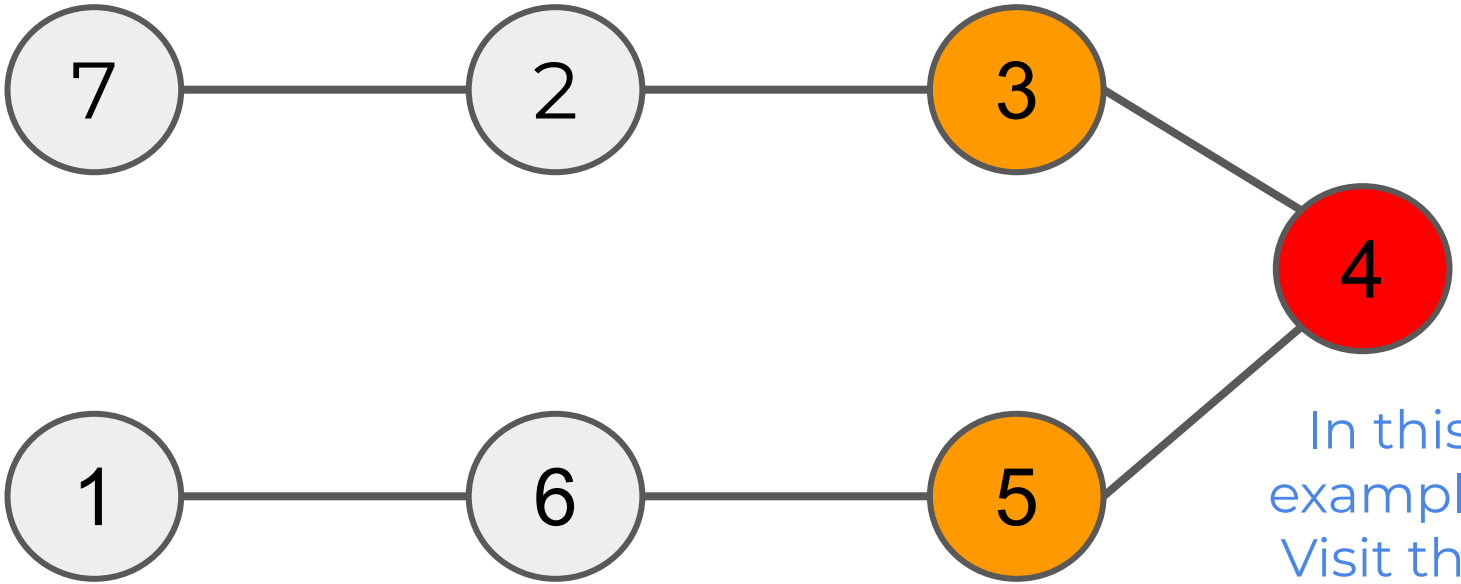
2. Backtrack and check for other vertices
3. Repeat until visiting all vertices

Depth-First Search - Graphs



Visit Order: 4

Depth-First Search - Graphs

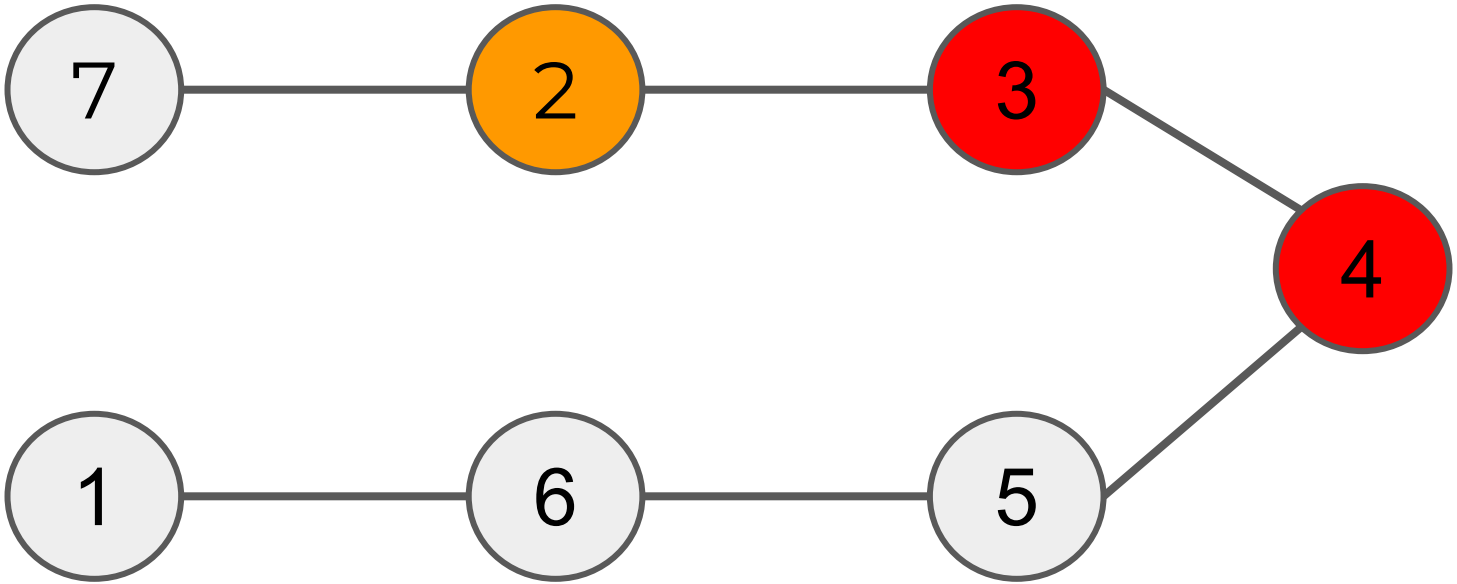


In this example: Visit the smaller ones first!

Visit Order: 4

Next level: 3, 5

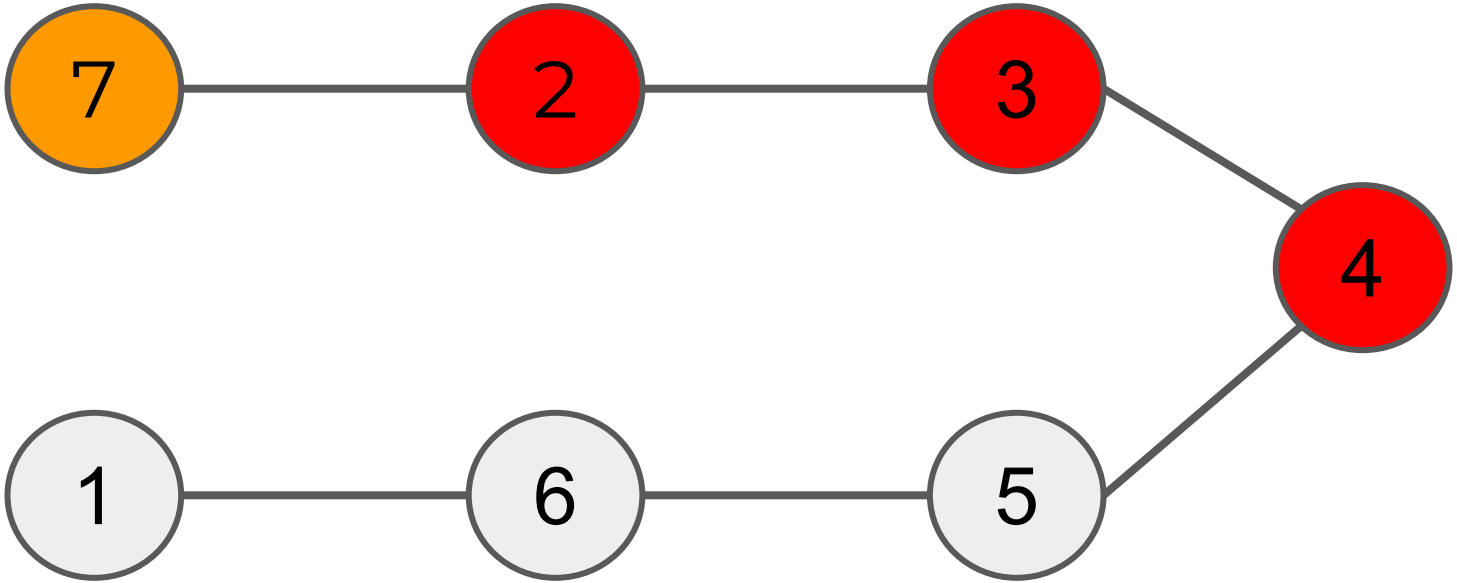
Depth-First Search - Graphs



Visit Order: 4, 3

Next level: 2

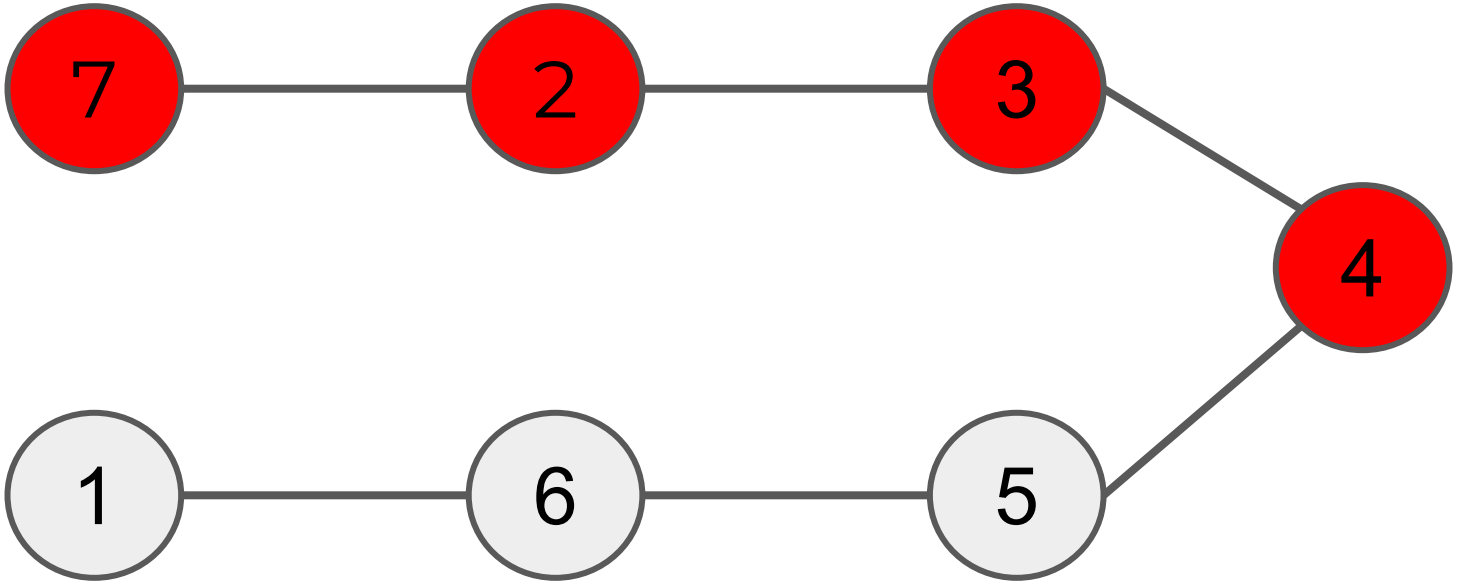
Depth-First Search - Graphs



Visit Order: 4, 3, 2

Next level: 7

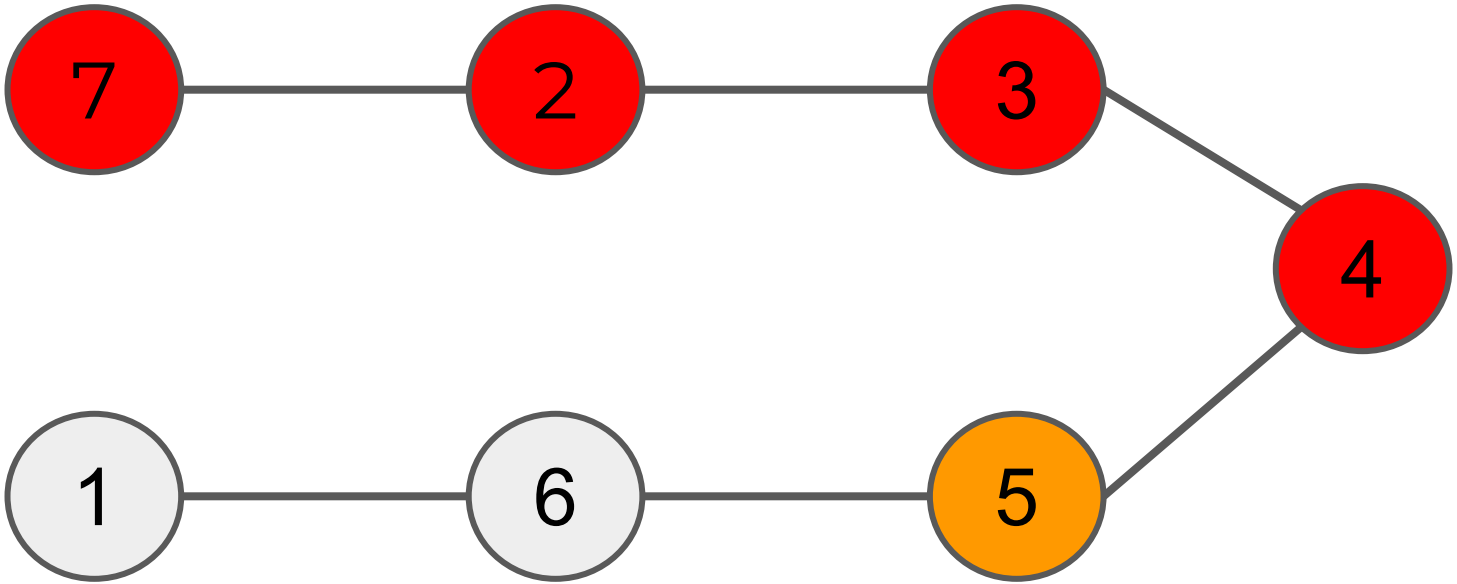
Depth-First Search - Graphs



Visit Order: 4, 3, 2, 7

Next level: None
→ Backtrack

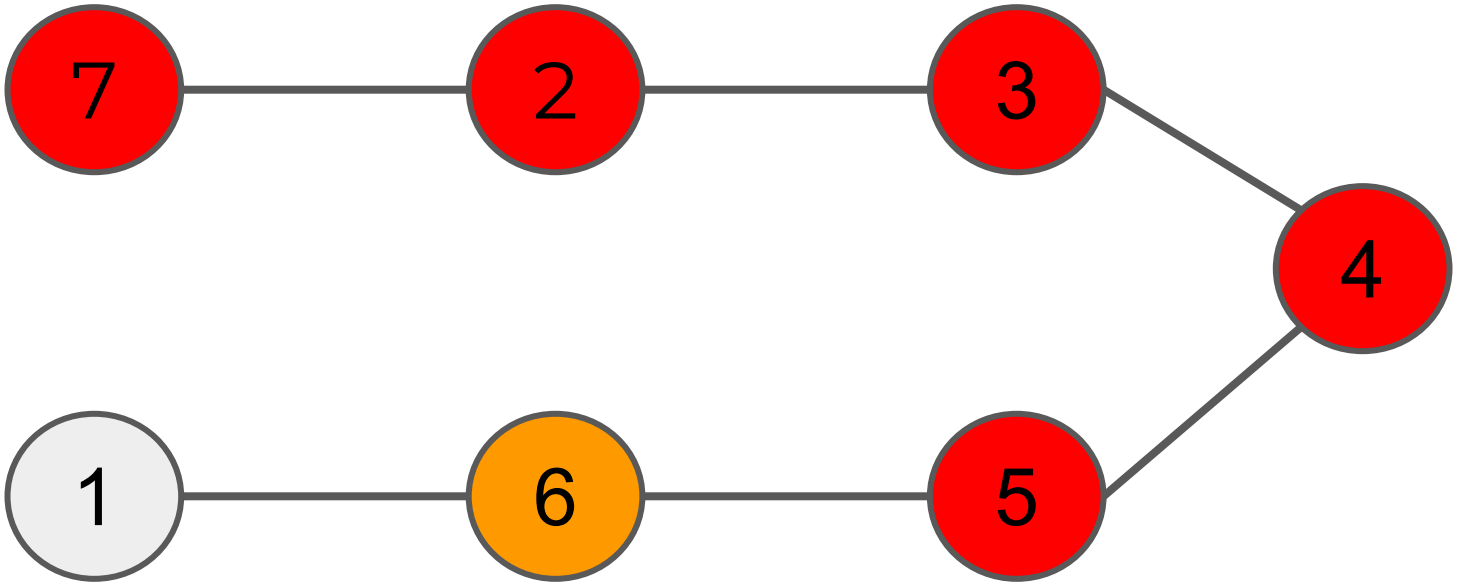
Depth-First Search - Graphs



Visit Order: 4, 3, 2, 7

Next: 5

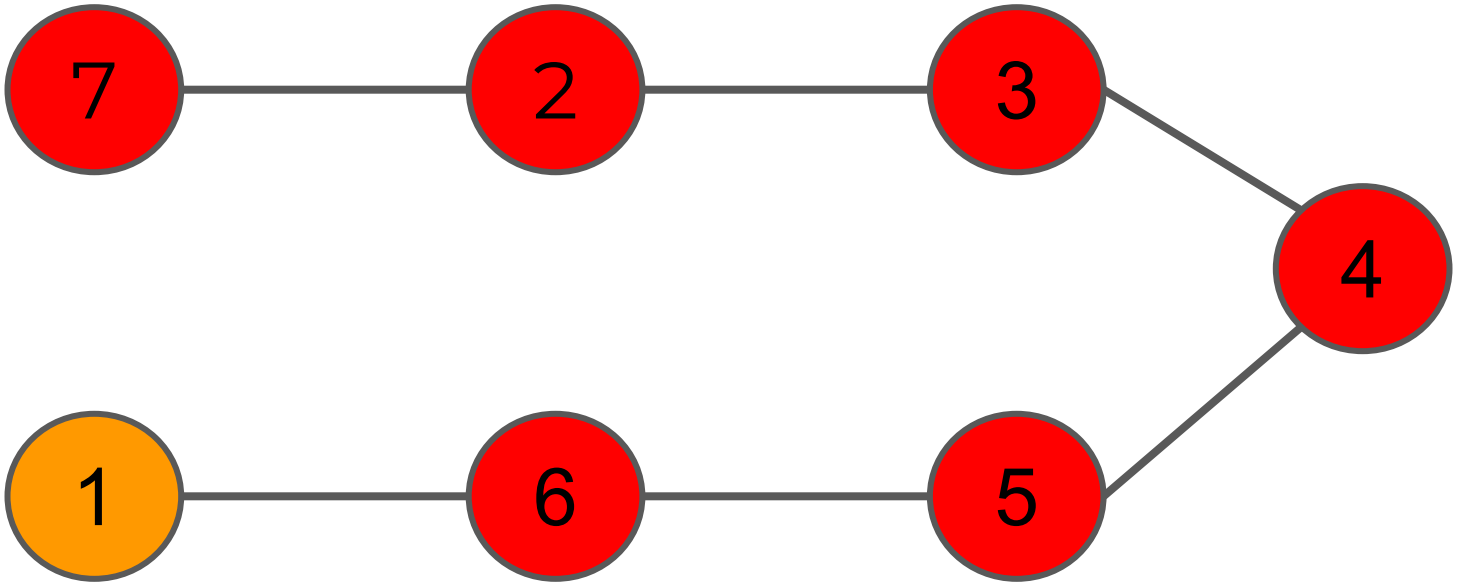
Depth-First Search - Graphs



Visit Order: 4, 3, 2, 7, 5

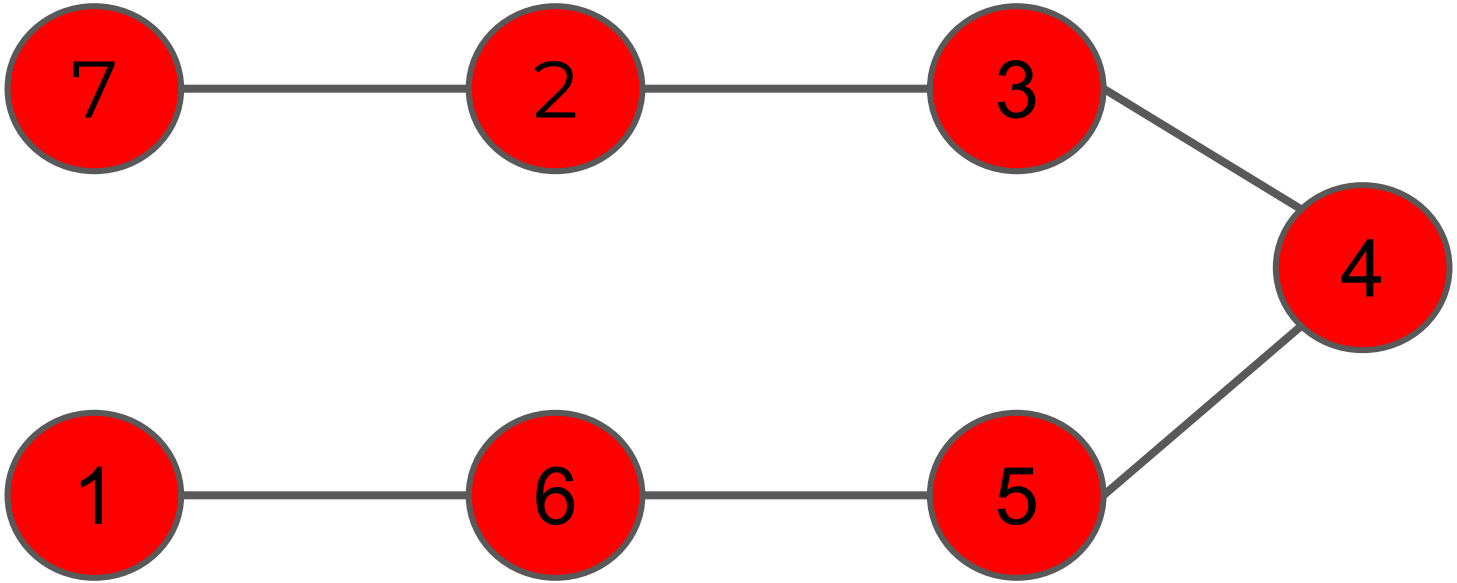
Next level: 6

Depth-First Search - Graphs



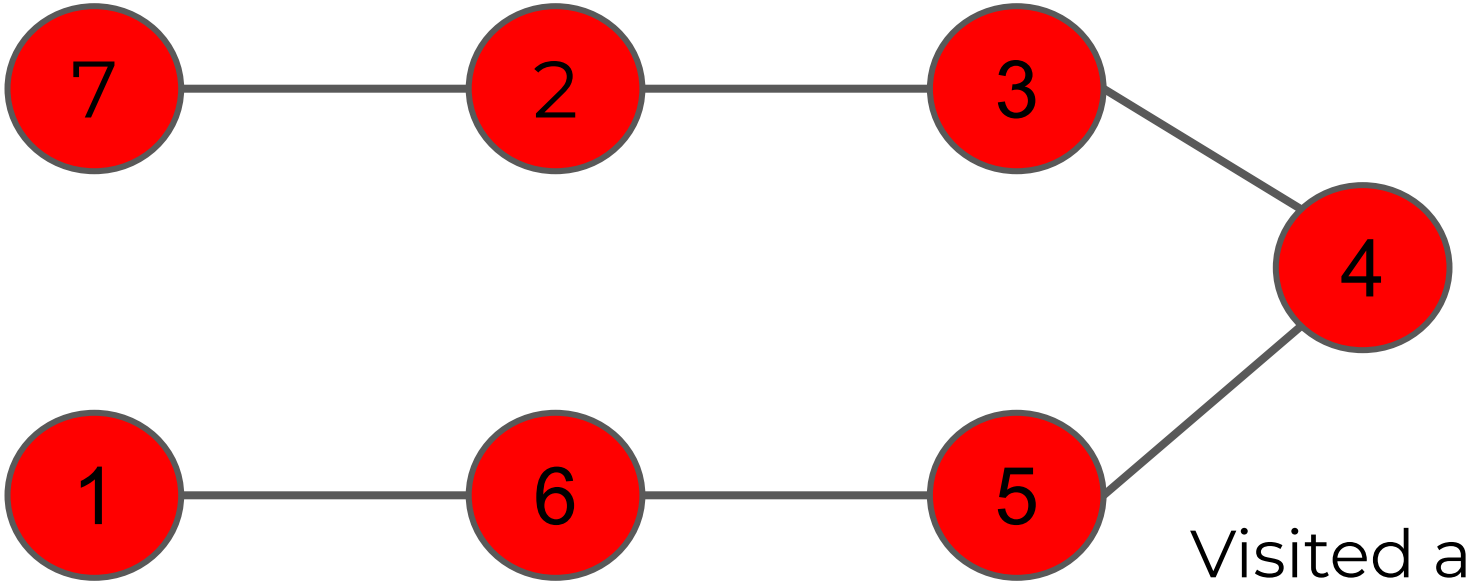
Visit Order: 4, 3, 2, 7, 5, 6 Next level: 1

Depth-First Search - Graphs



Visit Order: 4, 3, 2, 7, 5, 6, 1

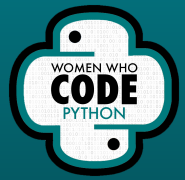
Depth-First Search - Graphs



Visit Order: 4, 3, 2, 7, 5, 6, 1

Visited all vertices → Done

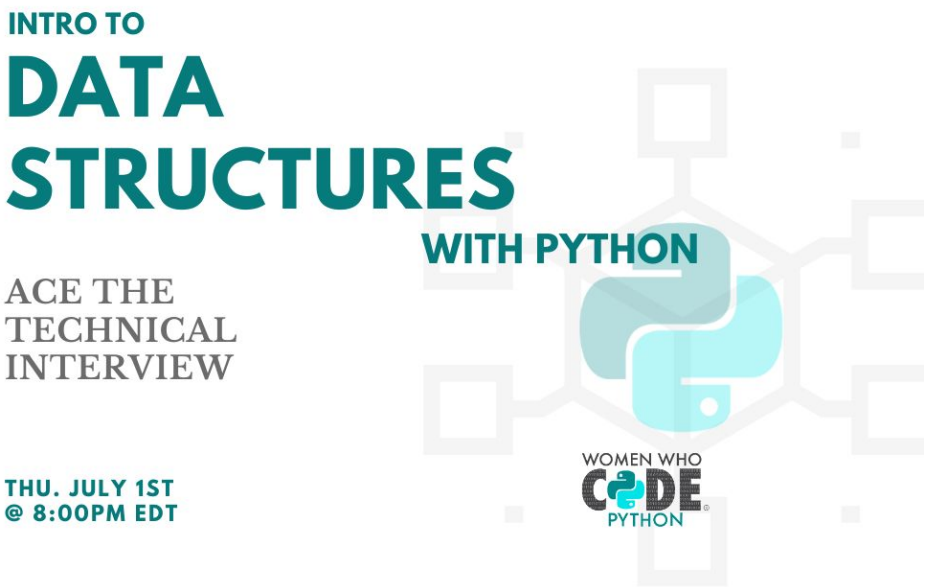
Q&A Time!



Time for Live Coding!

- https://colab.research.google.com/drive/1fFhbQcQguUPeB0GPxwK9s8X6MUme43NY?usp=sharing

Next Session!



WOMEN WHO CODE PYTHON

Questions?

Join our Slack channel:
#intro-data-structures-stdy-grp

Thank You!