Algorithms

Graph Searching Techniques - DFS

Graph Searching

- Given: a graph G = (V, E), directed or undirected
- Goal: methodically explore every vertex and every edge
- Ultimately: build a tree on the graph
  - Pick a vertex as the root
  - Choose certain edges to produce a tree
  - Note: might also build a *forest* if graph is not connected

- There are two standard graph traversal techniques:
  - Breadth-First Search (BFS)
  - Depth-First Search (DFS)

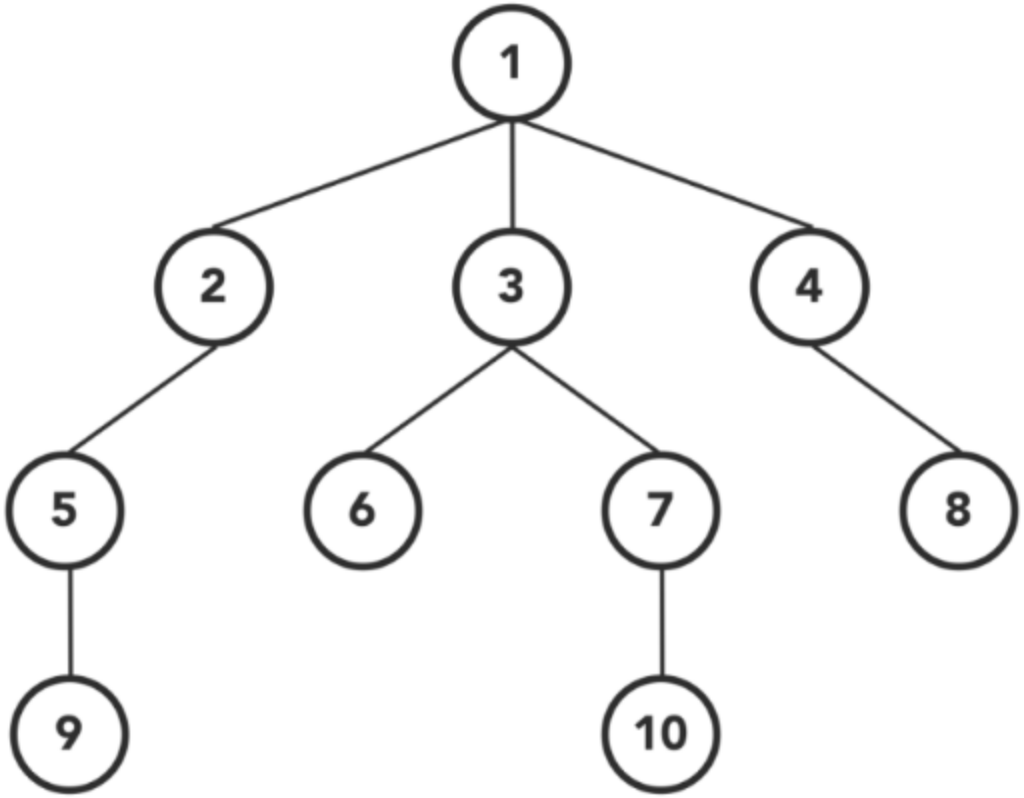
Depth-First Search

- Depth-first search is another strategy for exploring a graph
  - Explore “deeper” in the graph whenever possible
  - Edges are explored out of the most recently discovered vertex v that still has unexplored edges
  - When all of v’s edges have been explored, backtrack to the vertex from which v was discovered

Depth-First Search

- Again will associate vertex "colors" to guide the algorithm
  - White vertices have not been discovered
    - All vertices start out white
  - Gray vertices are discovered but not fully explored
    - They may be adjacent to white vertices
  - Black vertices are discovered and fully explored
    - They are adjacent only to black and grey vertices
- Explore vertices by scanning adjacency list of grey vertices

Depth-First Search

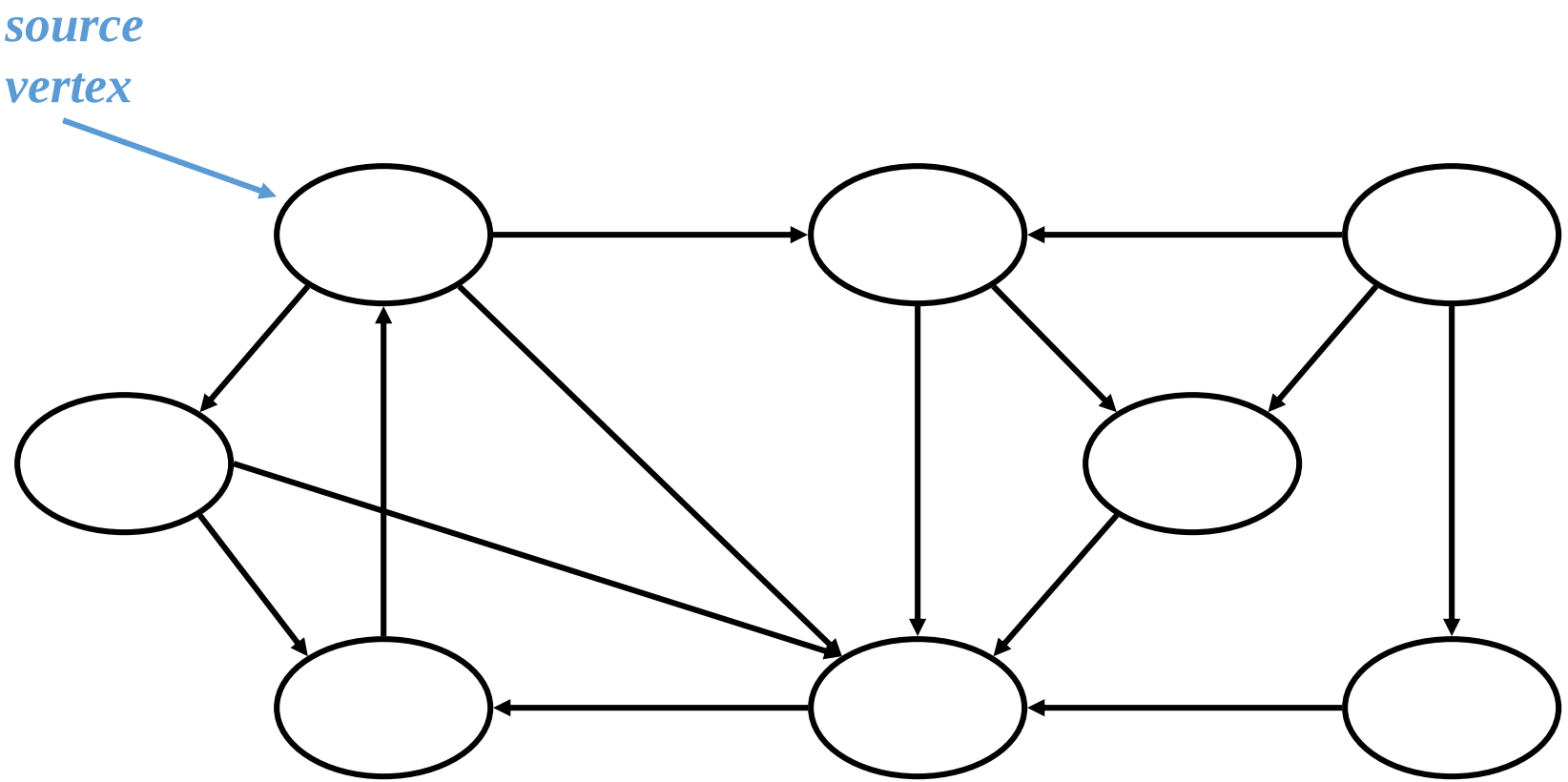


Depth-First Search

```
DFS(G)
1  for each vertex u ∈ G.V
2      u.color = WHITE
3      u.π = NIL
4  time = 0
5  for each vertex u ∈ G.V
6      if u.color == WHITE
7          DFS-VISIT(G, u)
```

```
DFS-VISIT(G, u)
1  time = time + 1                  // white vertex u has just been discovered
2  u.d = time
3  u.color = GRAY
4  for each v ∈ G.Adj[u]            // explore edge (u, v)
5      if v.color == WHITE
6          v.π = u
7          DFS-VISIT(G, v)
8  u.color = BLACK                  // blacken u; it is finished
9  time = time + 1
10 u.f = time
```

DFS Example



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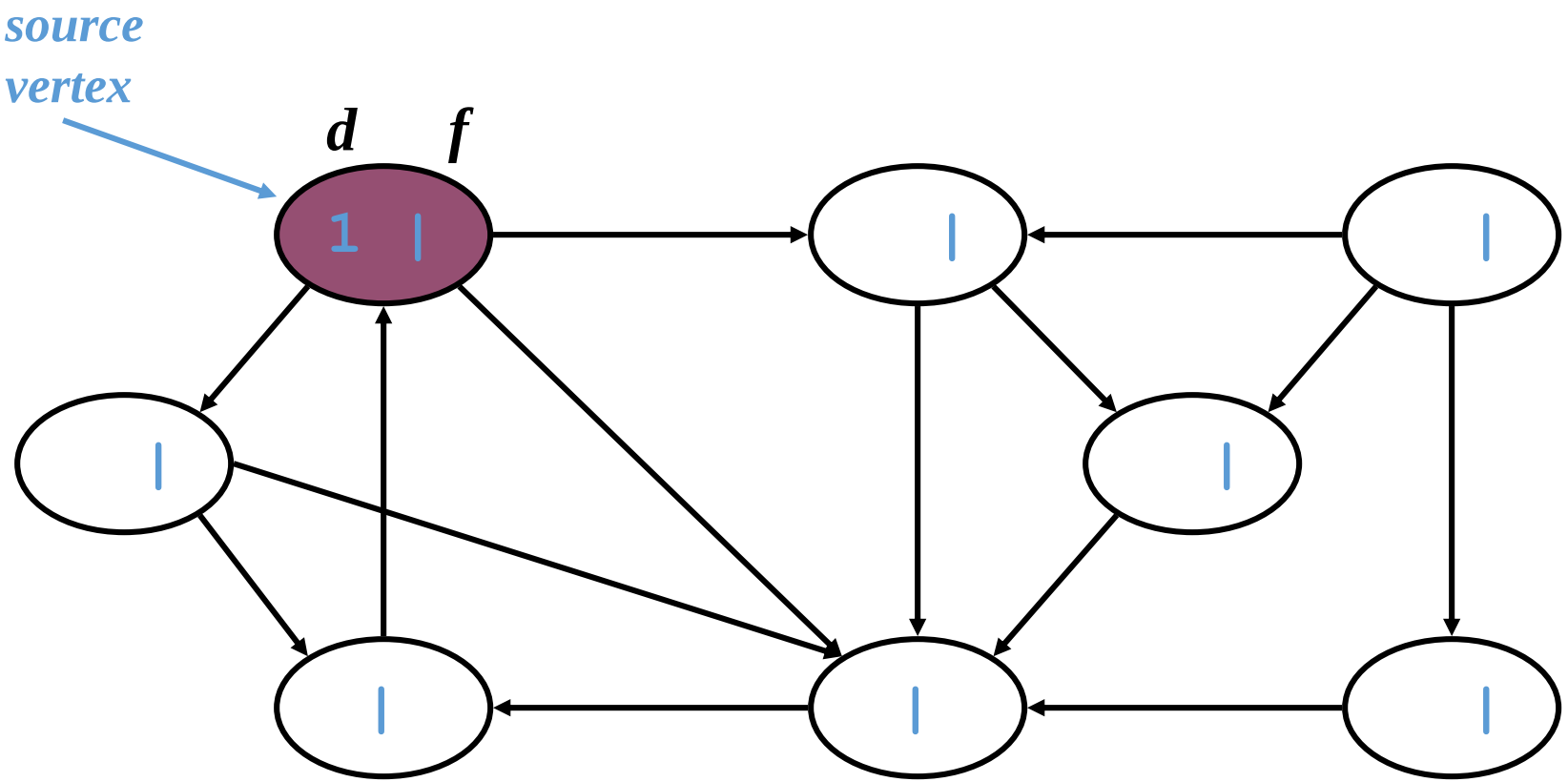

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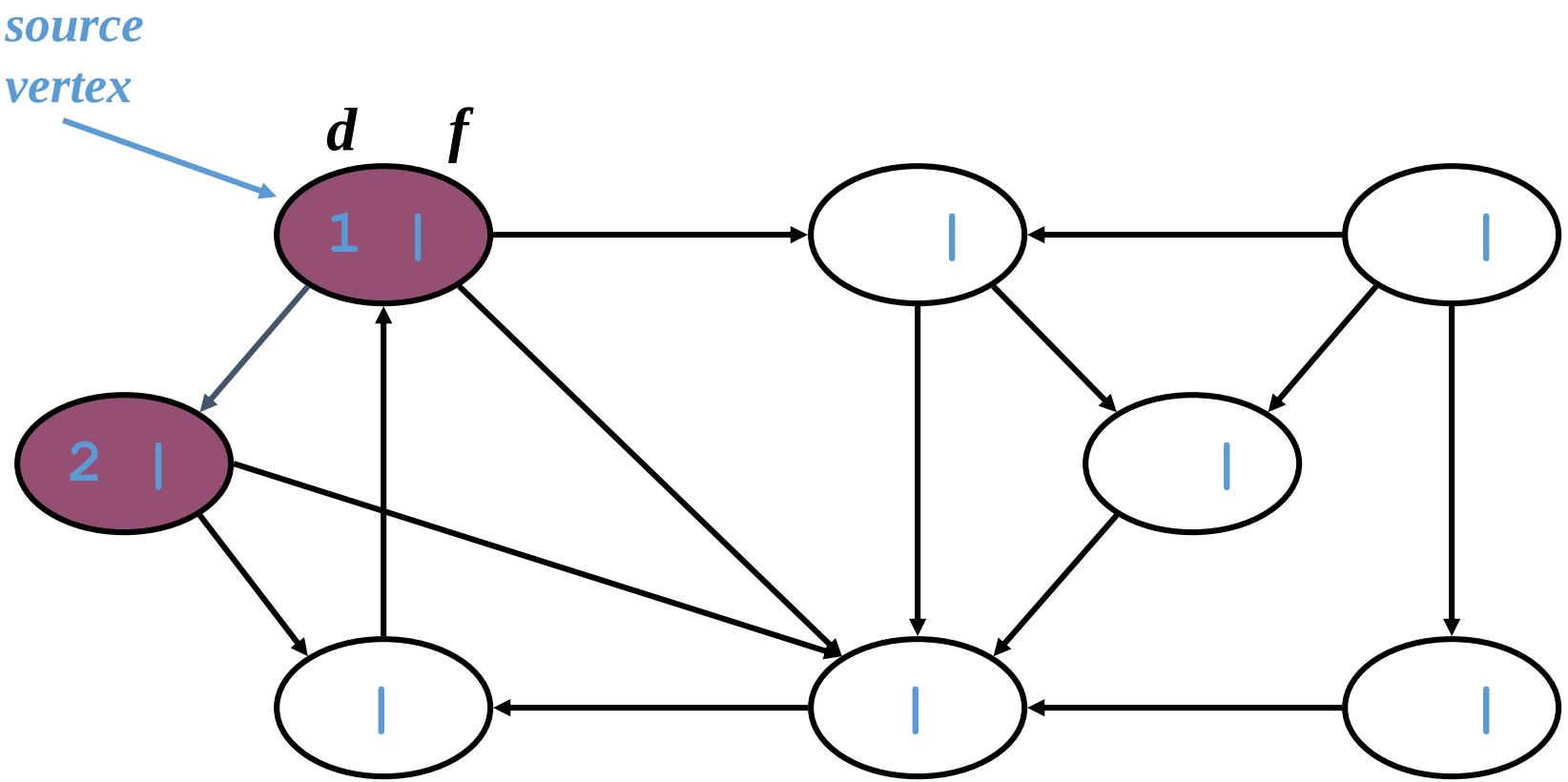

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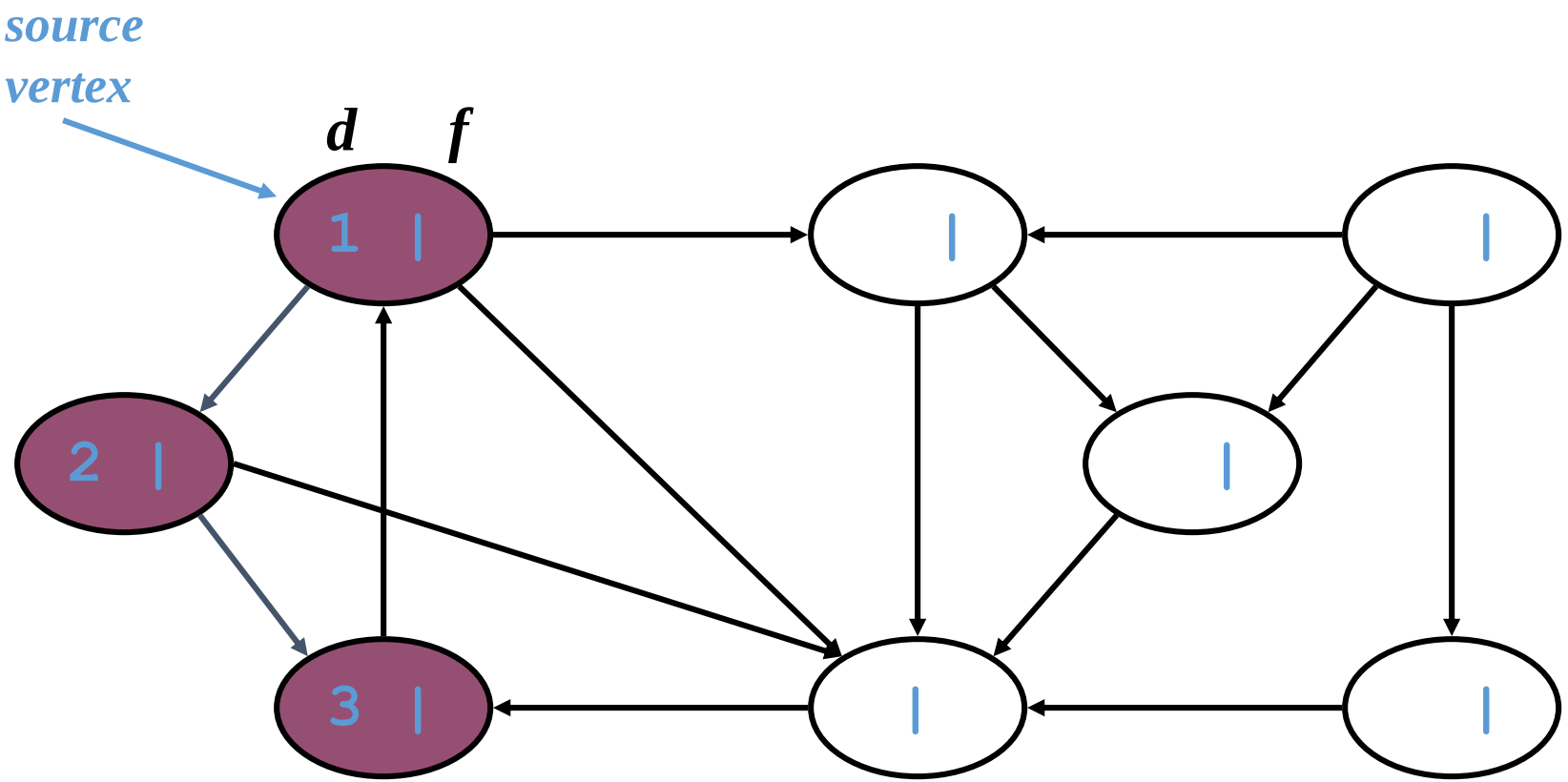

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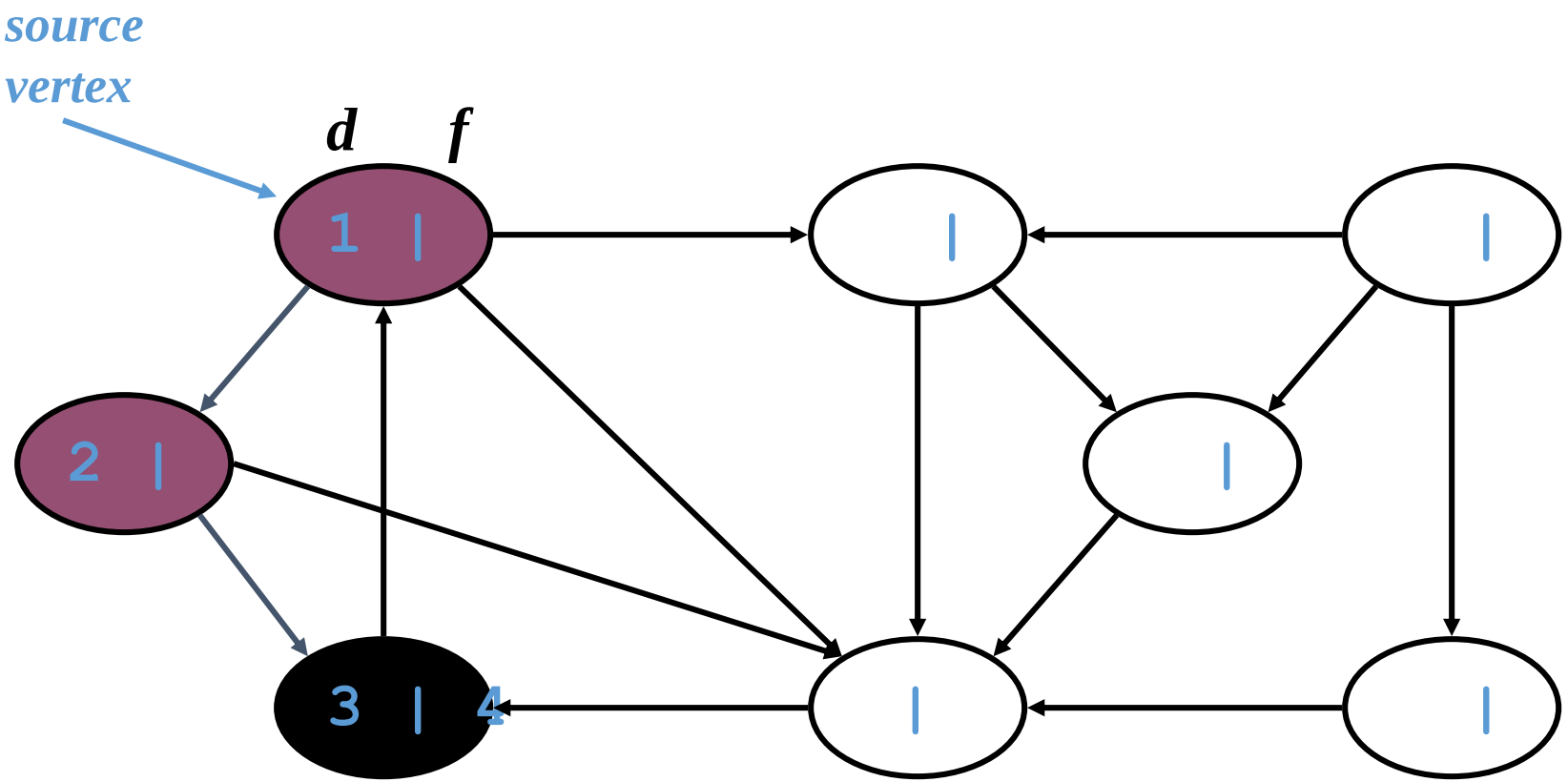

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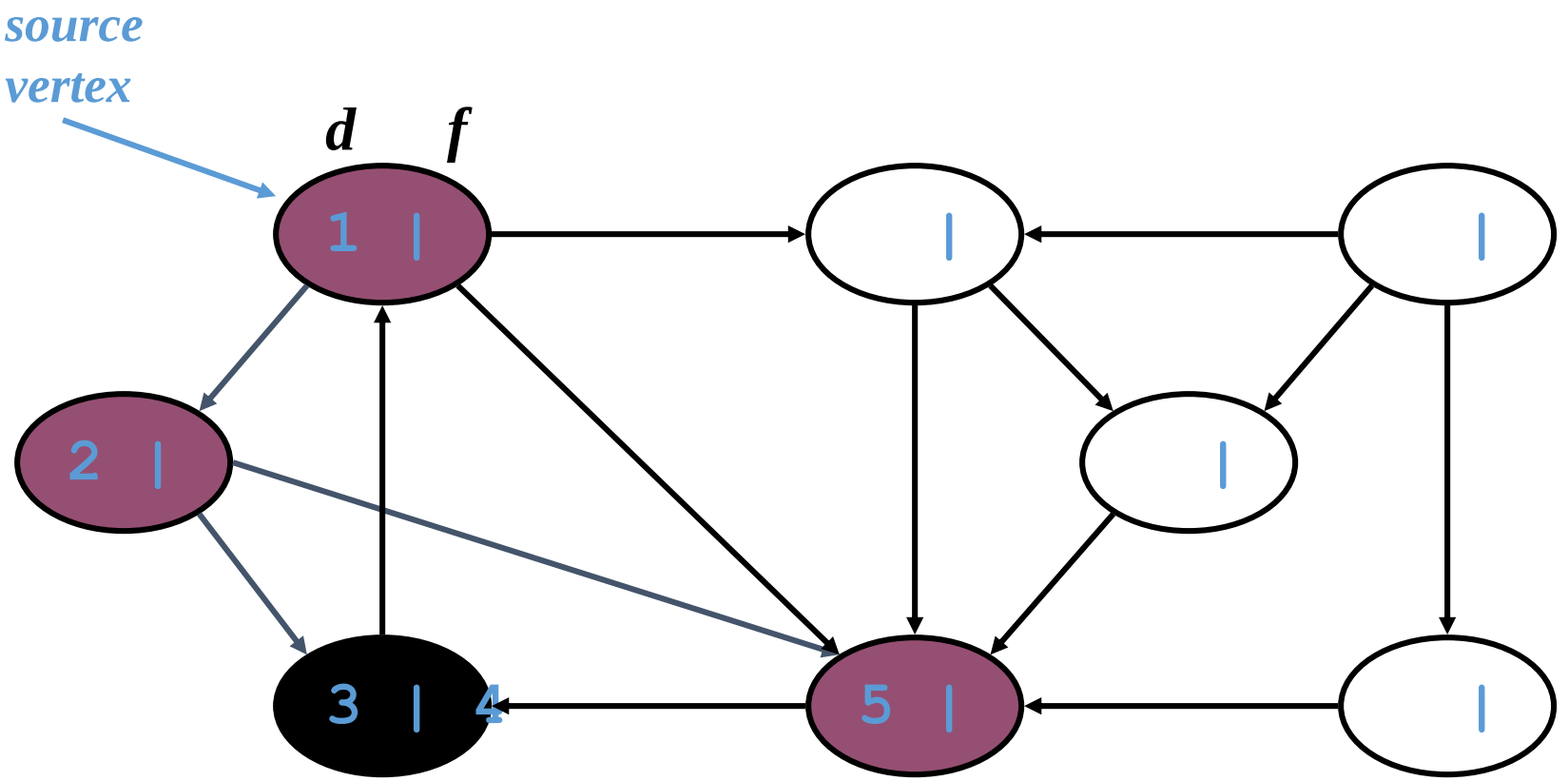

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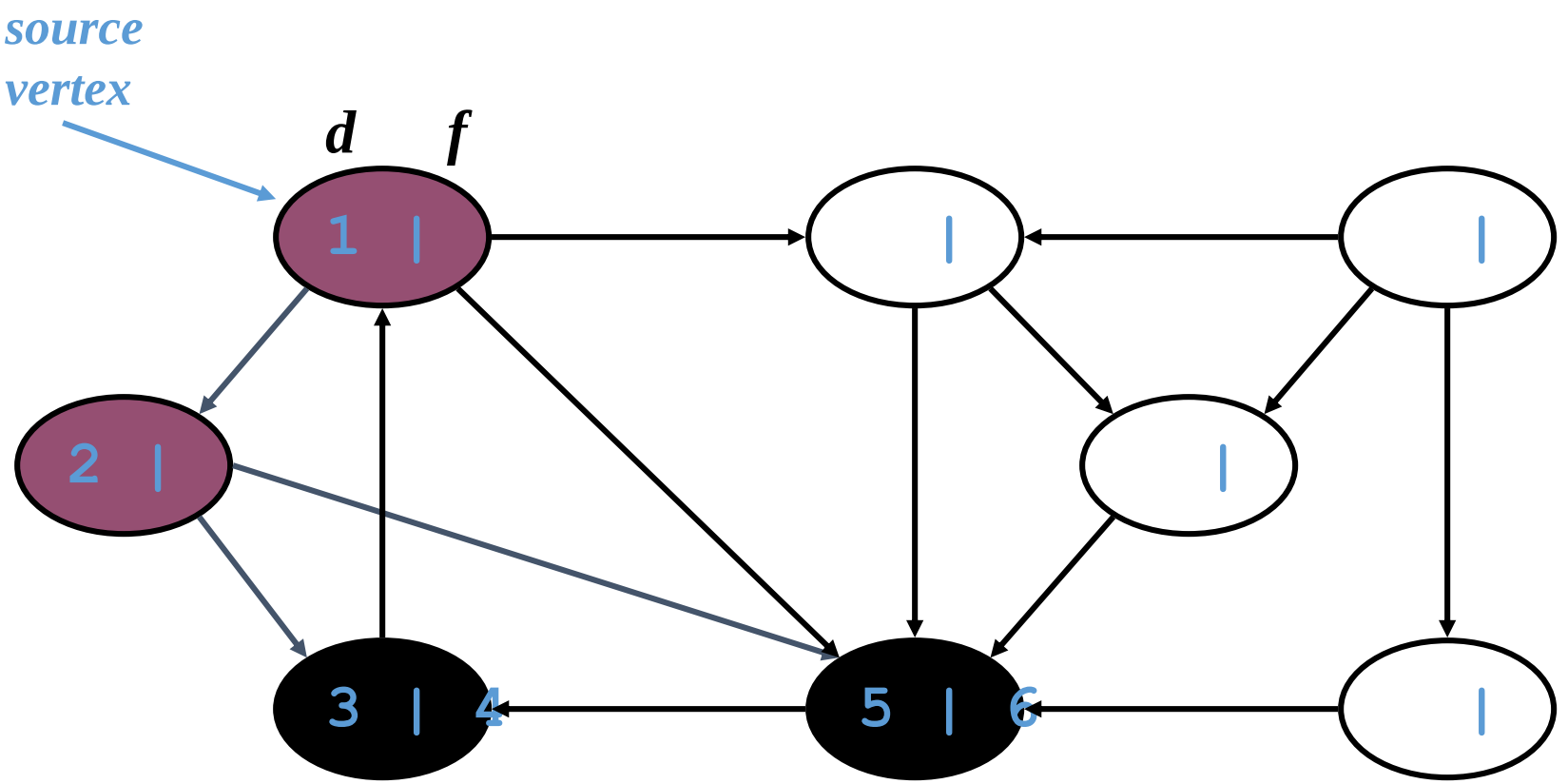

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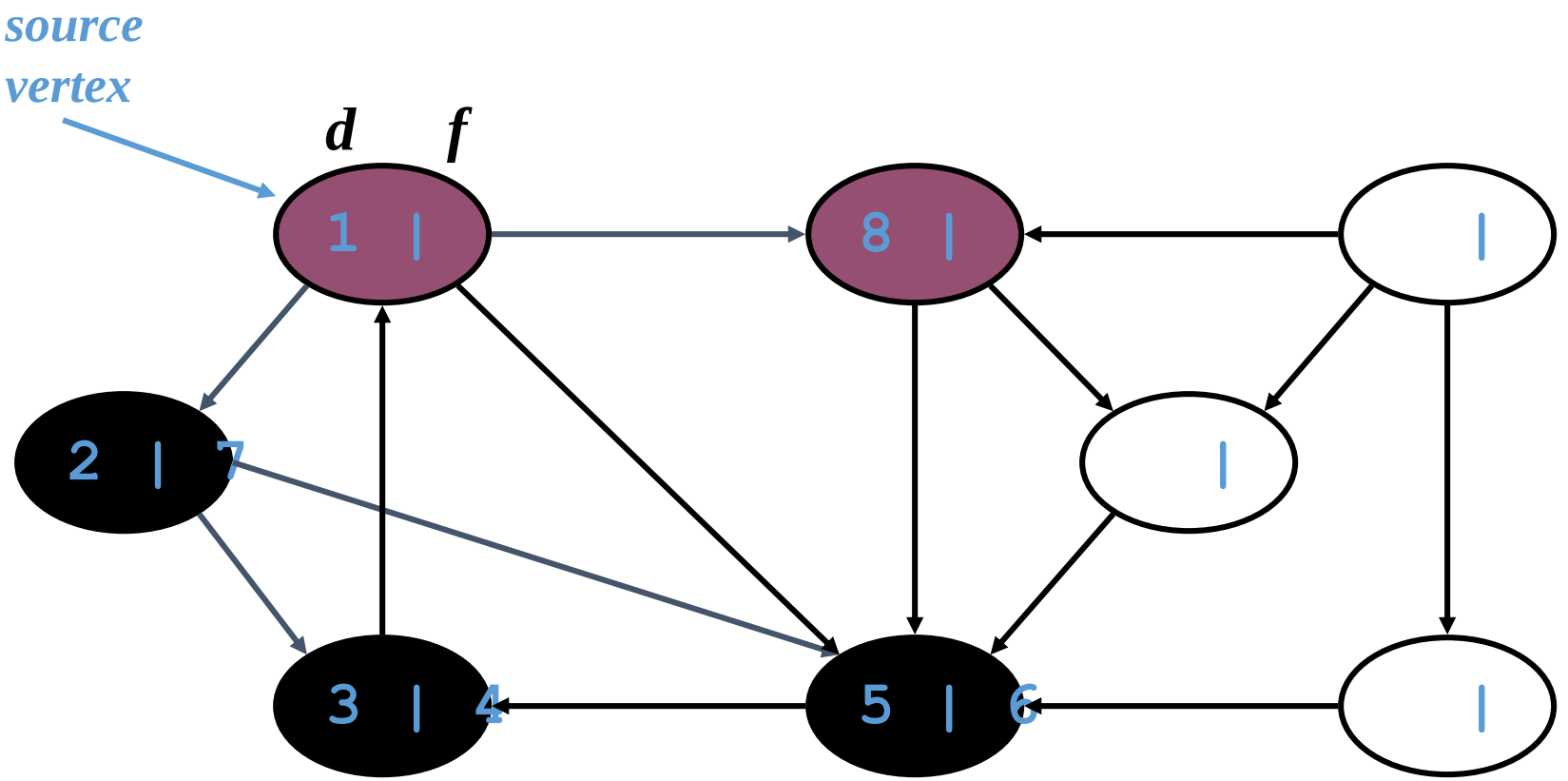

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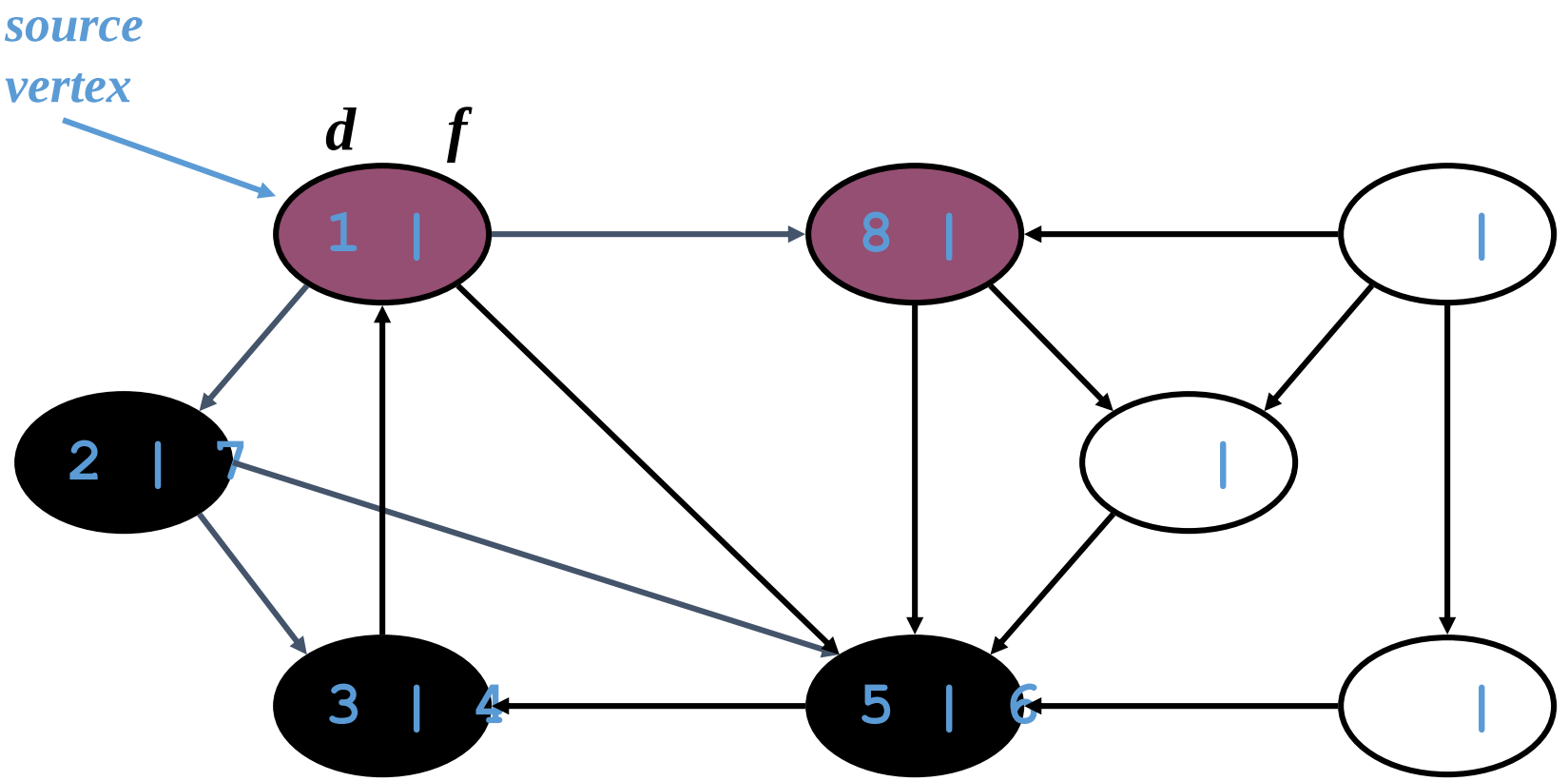

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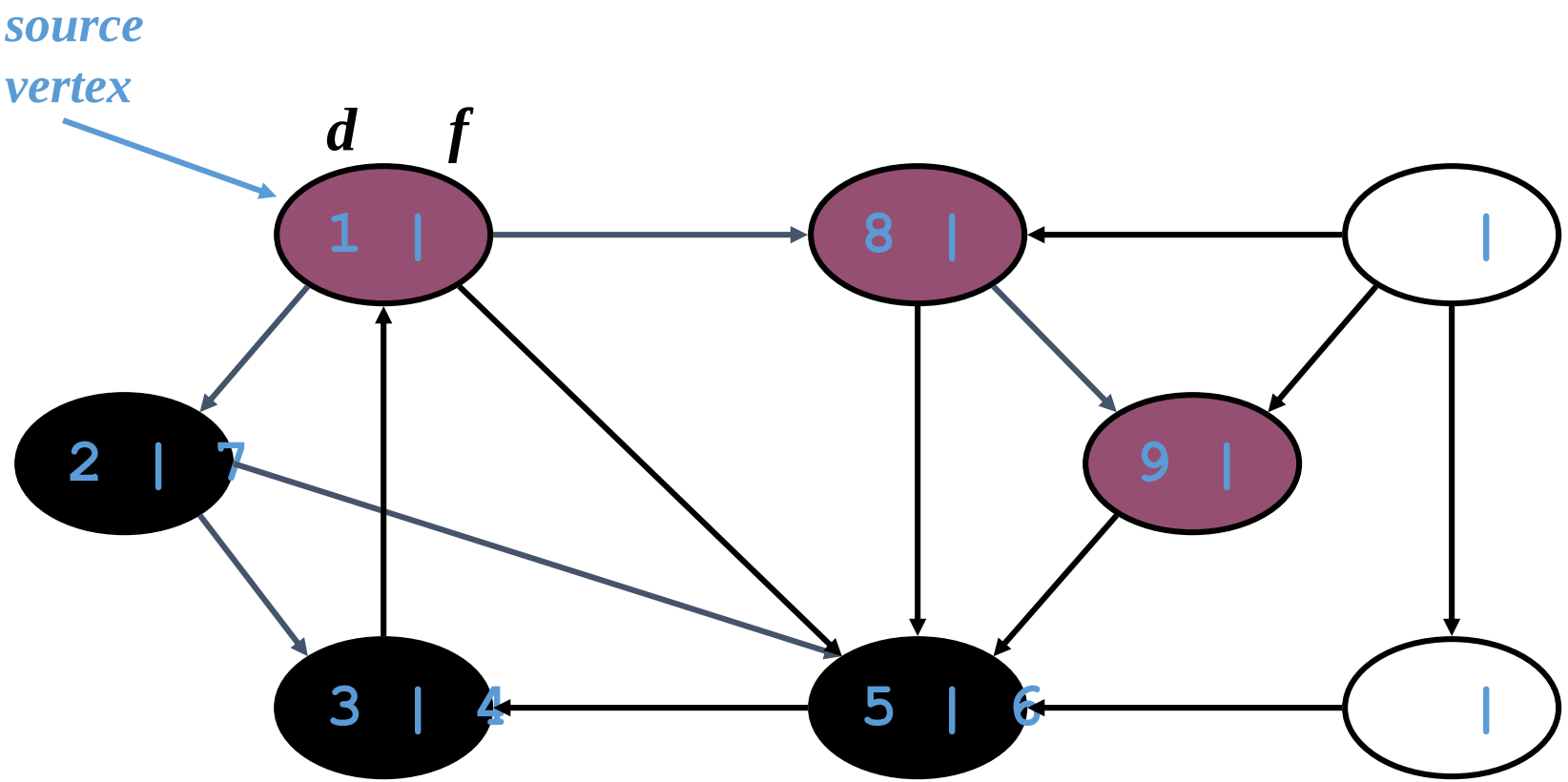

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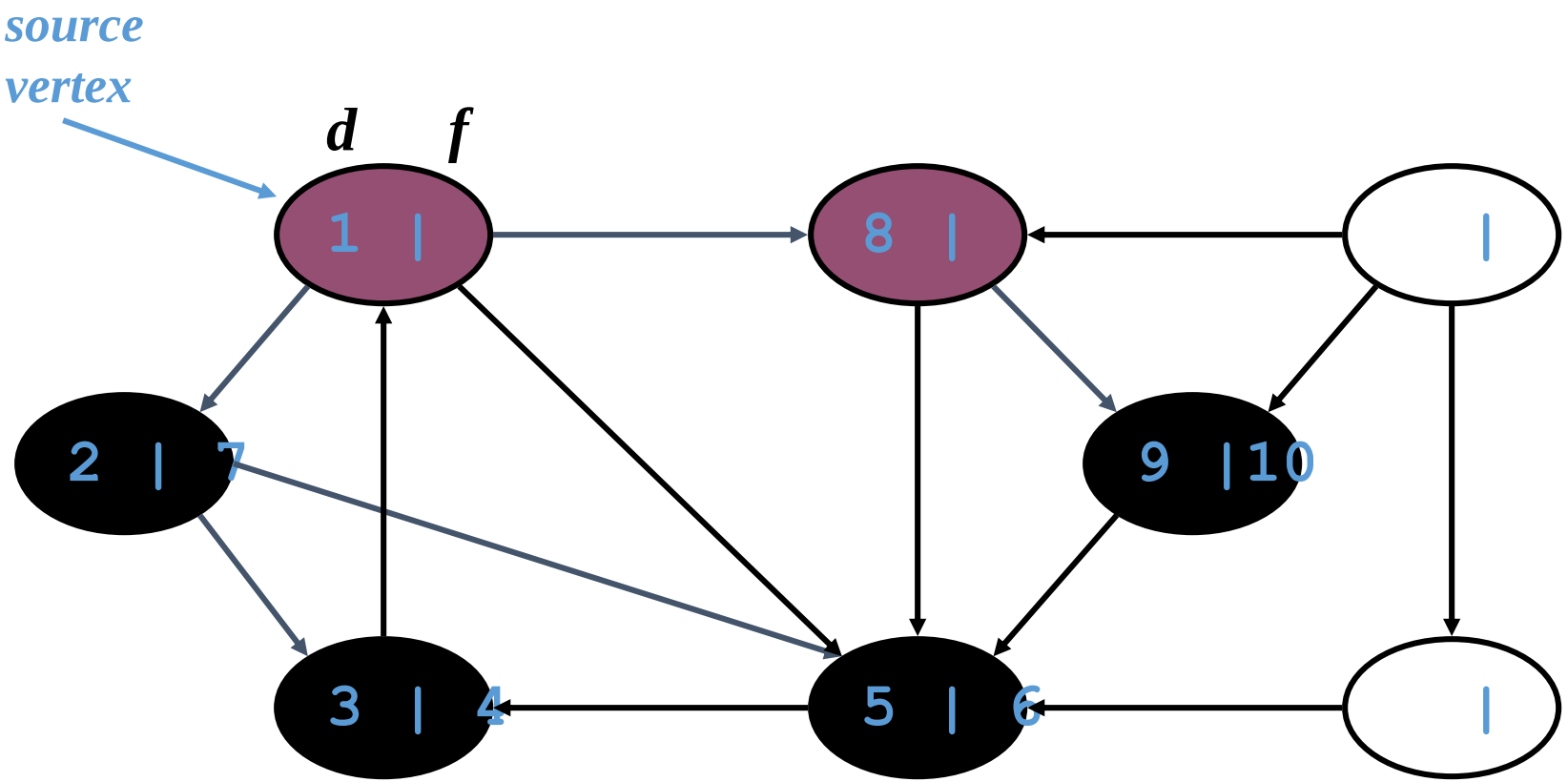

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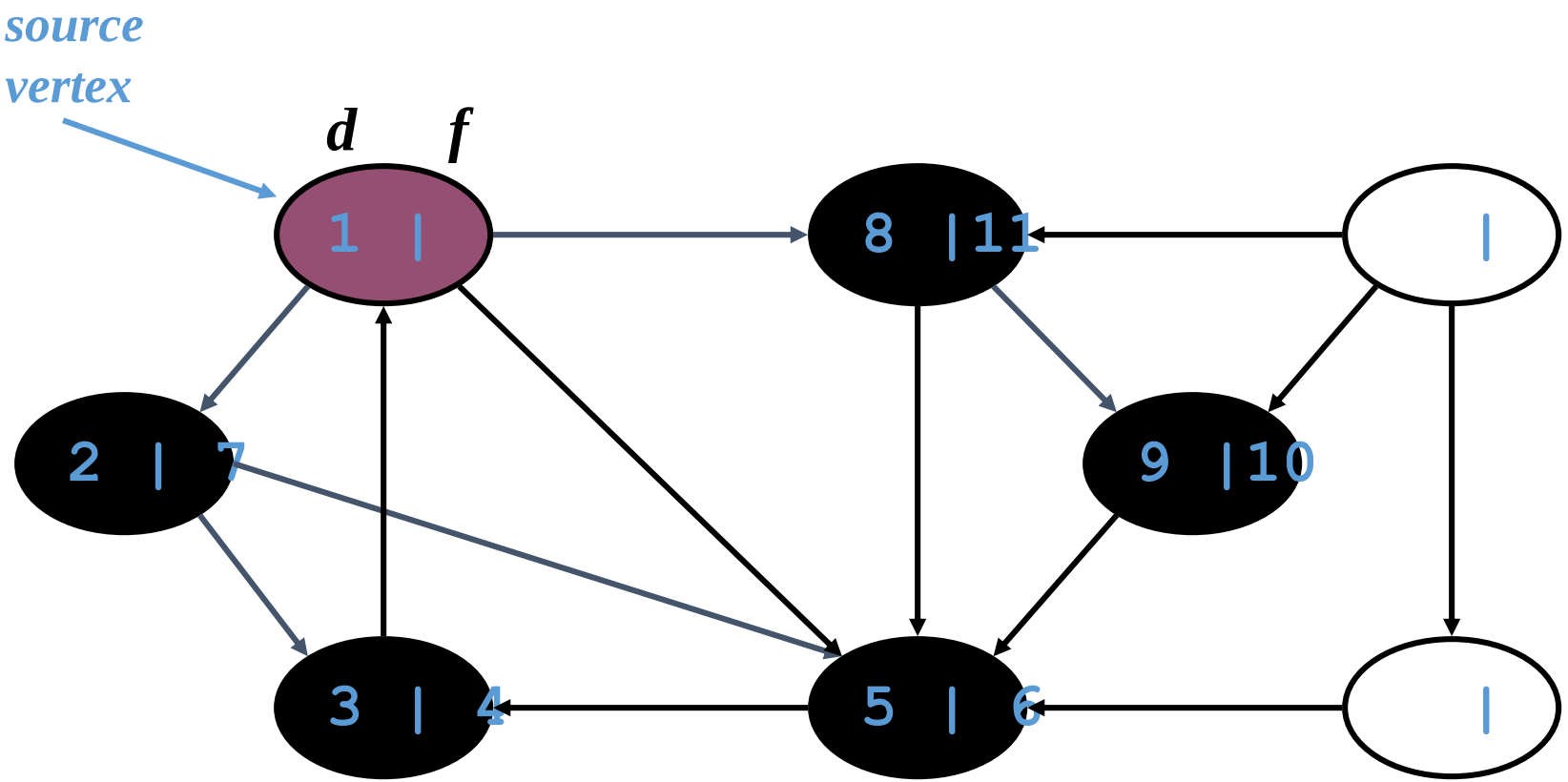

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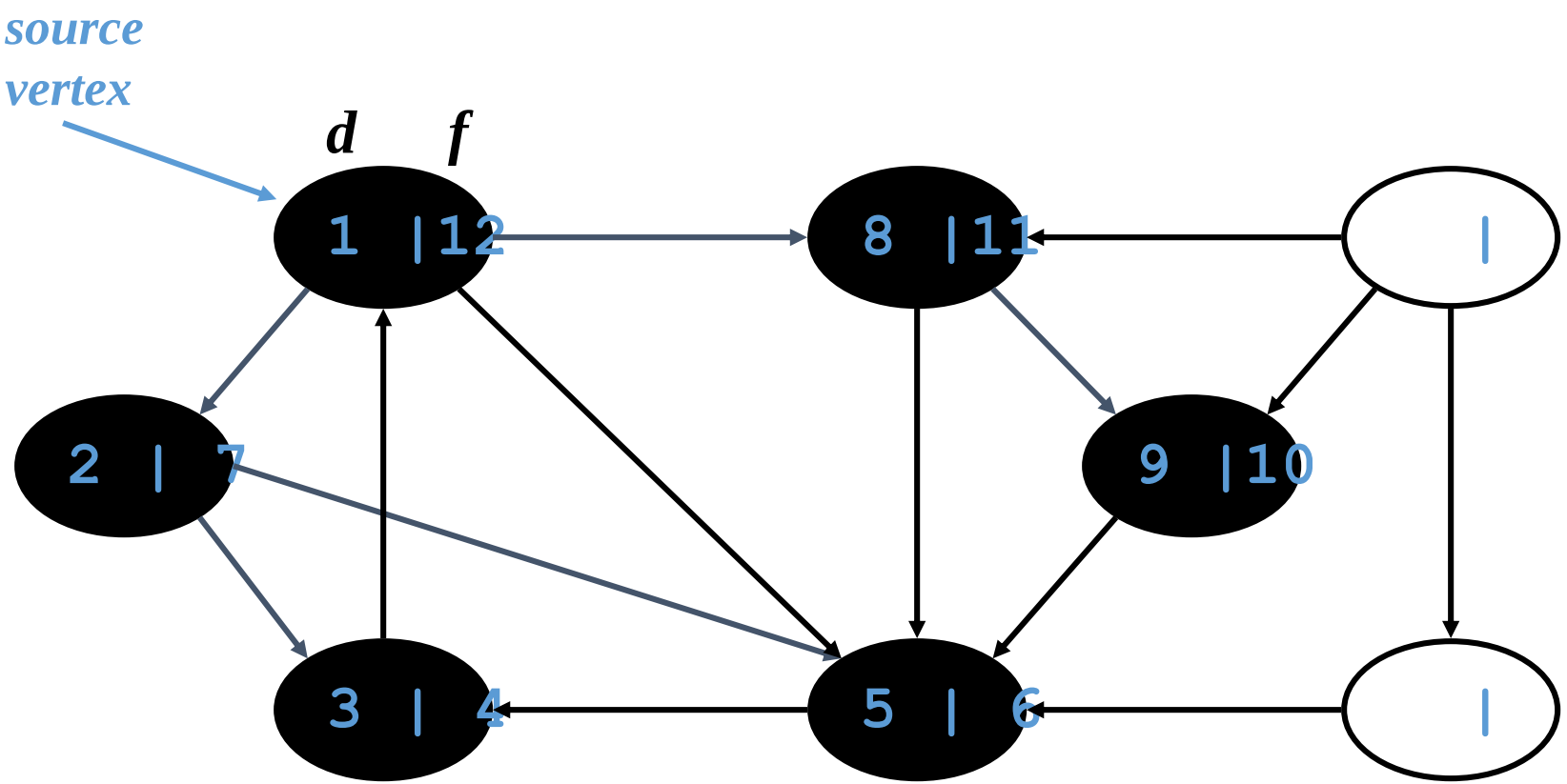

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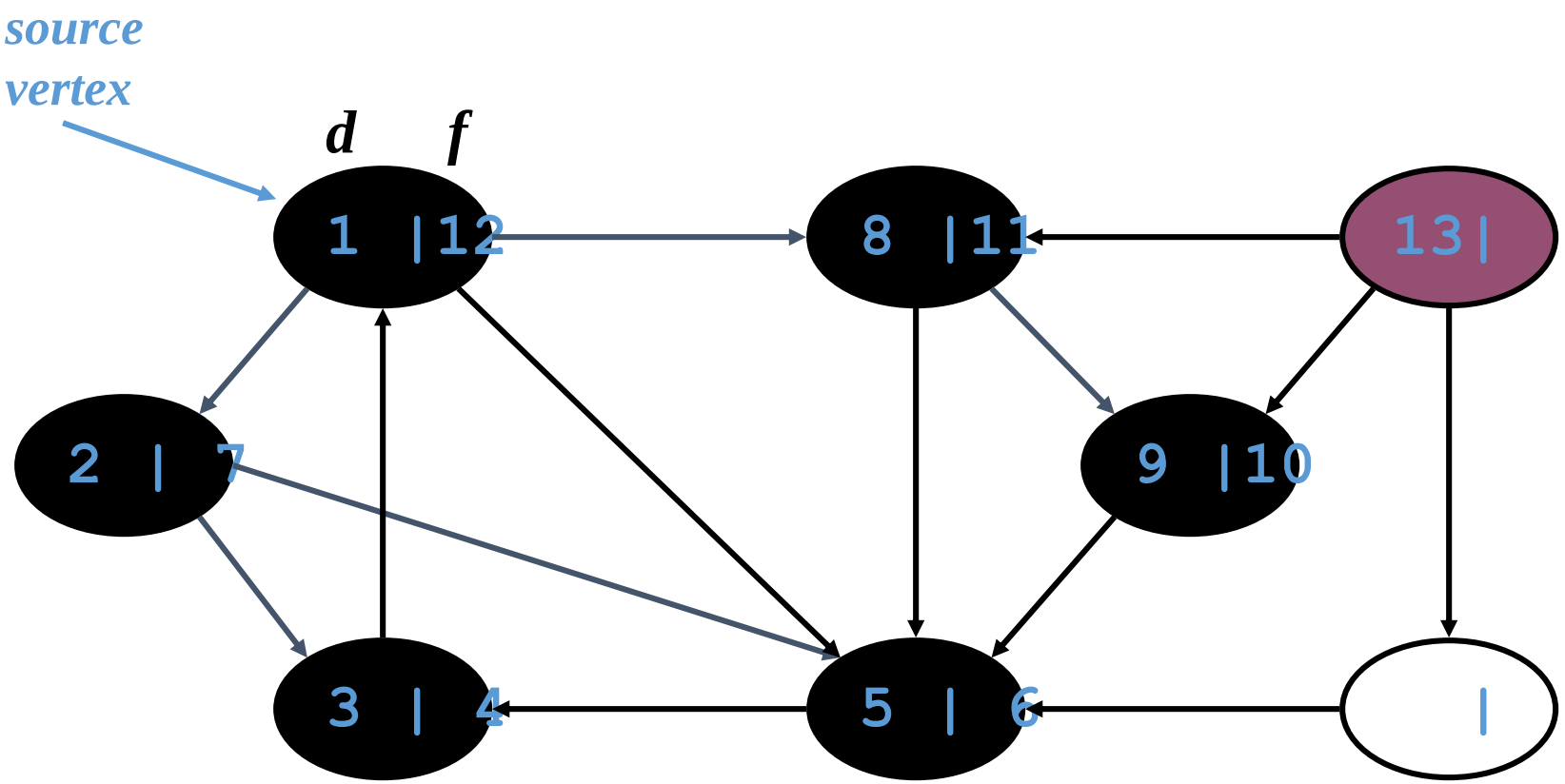

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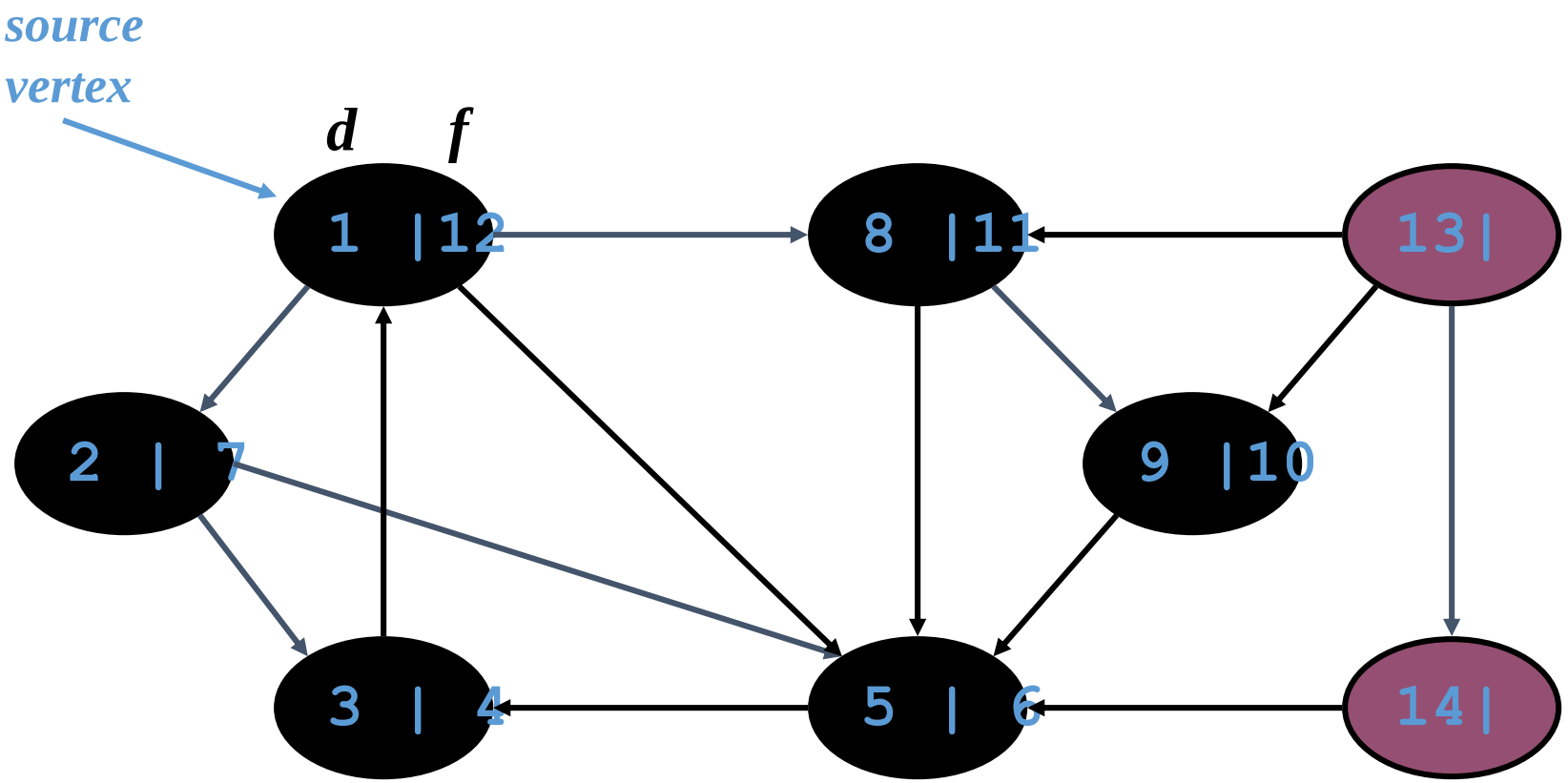

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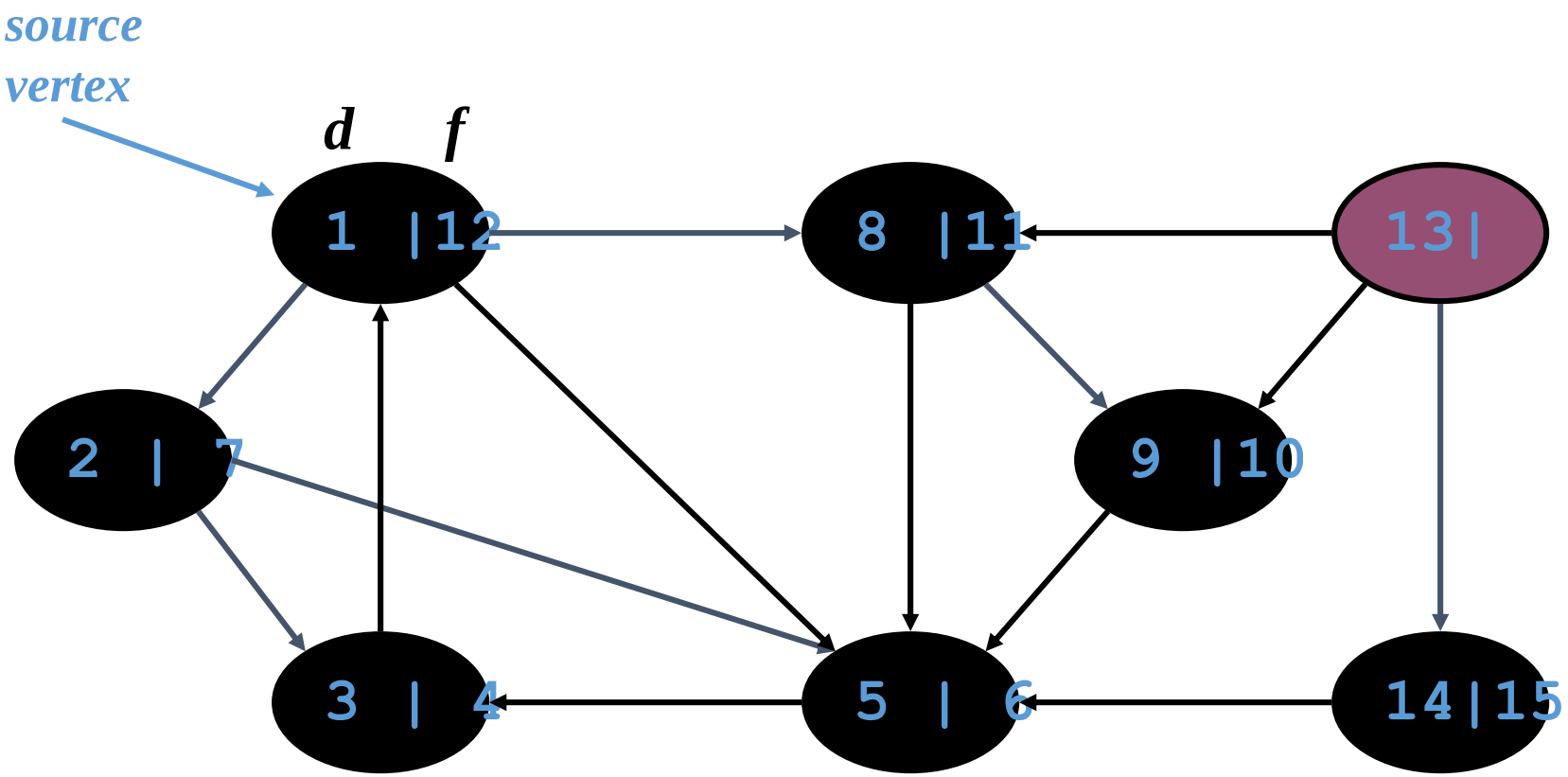

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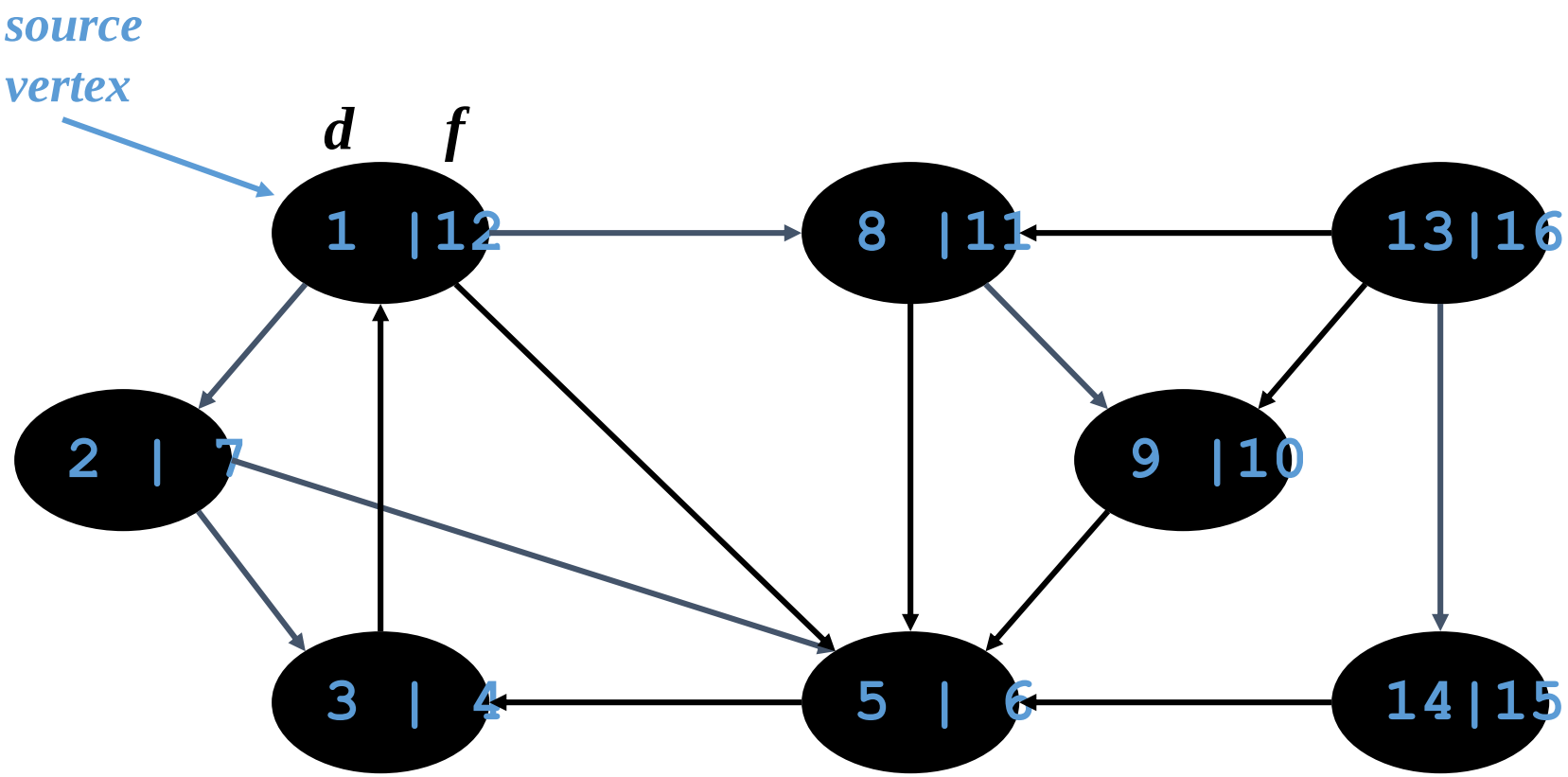
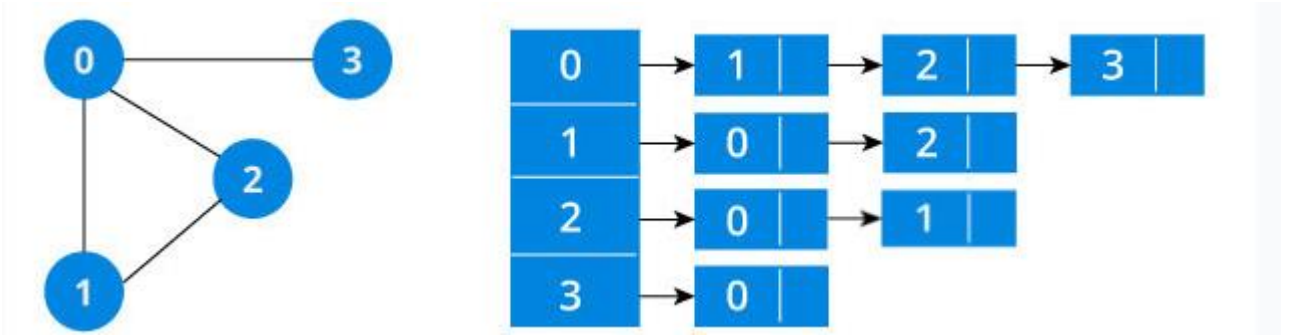


Depth-First Search - Implementation

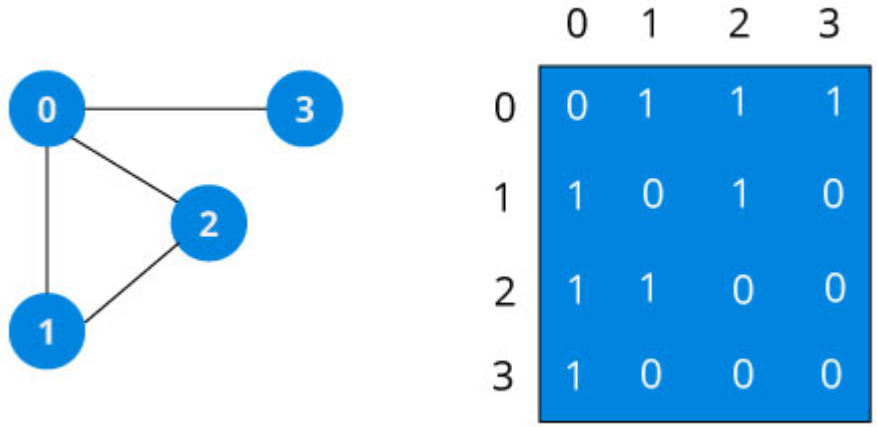
- Graph Input from FILE
- Adjacency List/ Matrix – DS: Array of linked list or 2D Array
- DFS – recursive
- Output sequence of vertices for the DFS traversal

Depth-First Search - Implementation

- Adjacency List (list)



- Adjacency Matrix (2D Array)



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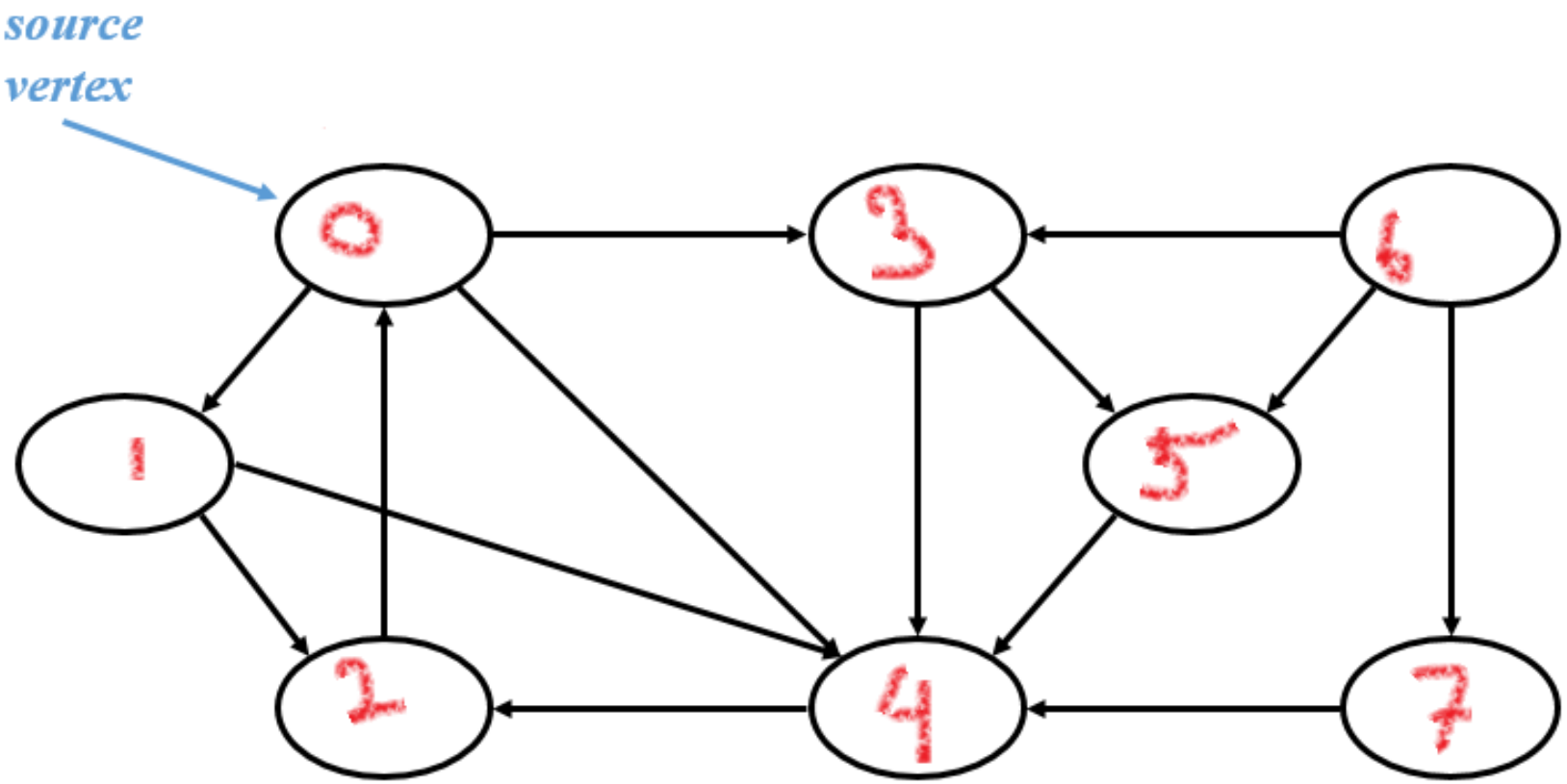

Let’s Implementation