[320] Implementing Various Graph Structures

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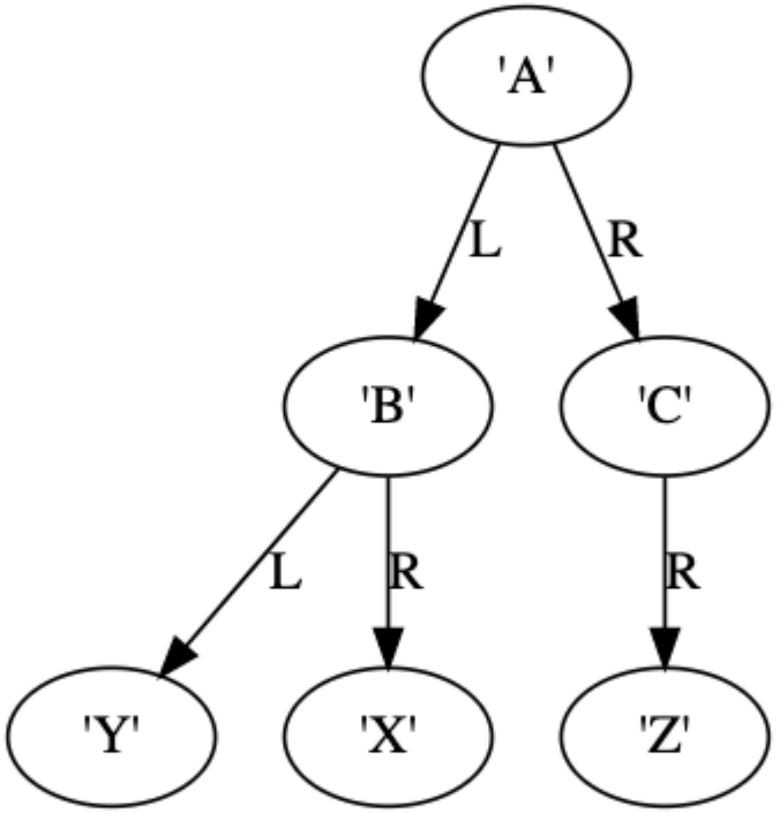
Review

```
def contains(node, target):
    if node == None:
        return False

    if node.val == target:
        return True

    return (contains(node.left, target) or
            contains(node.right, target))
```



How many nodes will **contains(root, "Z")** check?

1. one
2. six

What will **contains(root, "C")** check first?

1. node X
2. node C

How many nodes will **contains(root, "C")** check?

1. five
2. six

Hierarchy of Graphs

Graph: nodes+edges

Directed Graph: graph with
- one-way edges

DAG: directed graph that
- does not have cycles

Tree: DAG that
- has exactly one root
- non-roots have exactly one parent

Binary Tree: tree such that
- nodes have at most 2 children

Linked List: tree such that
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BST: tree such that
- vals in left subtree < parent val
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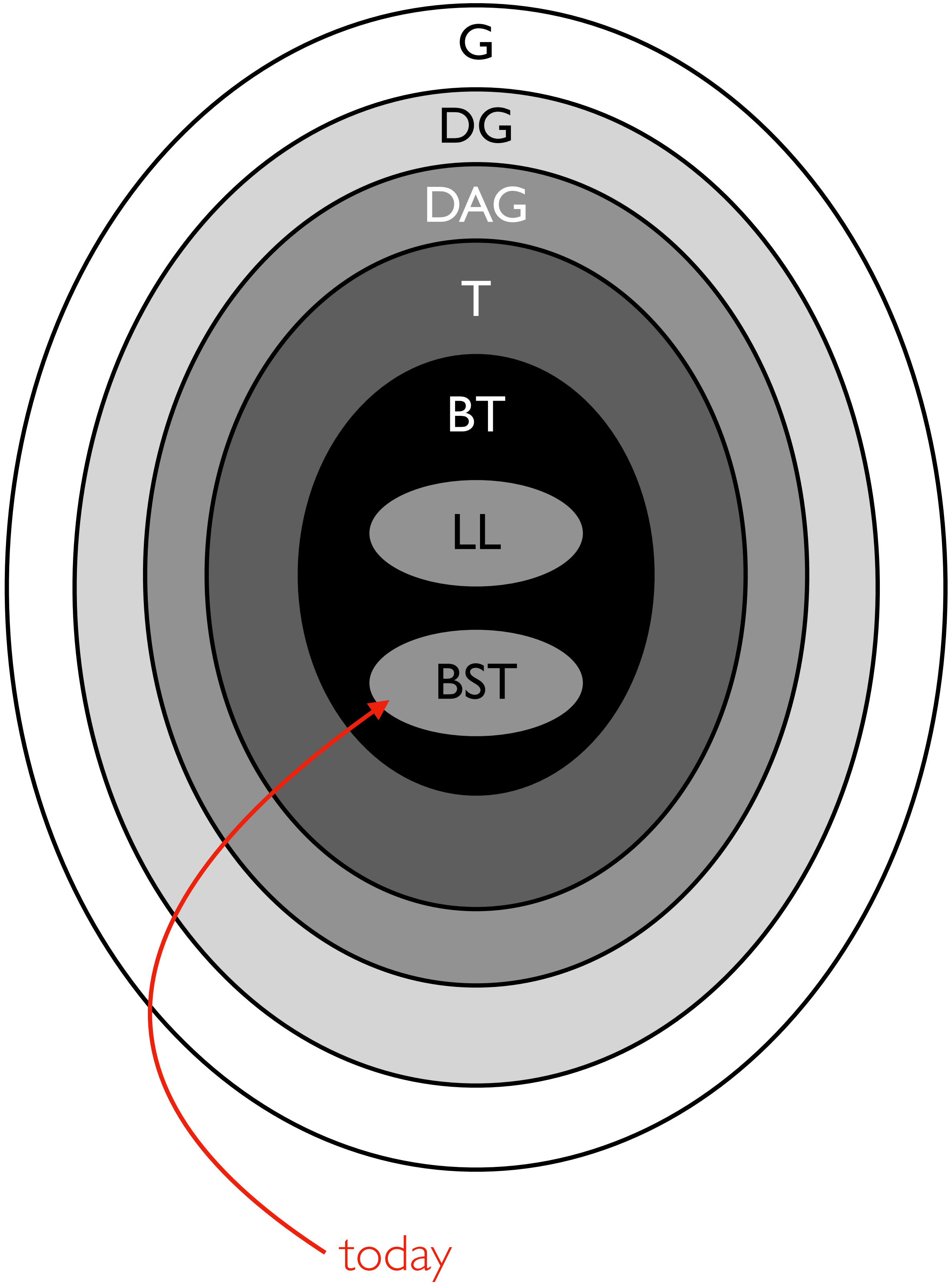

today

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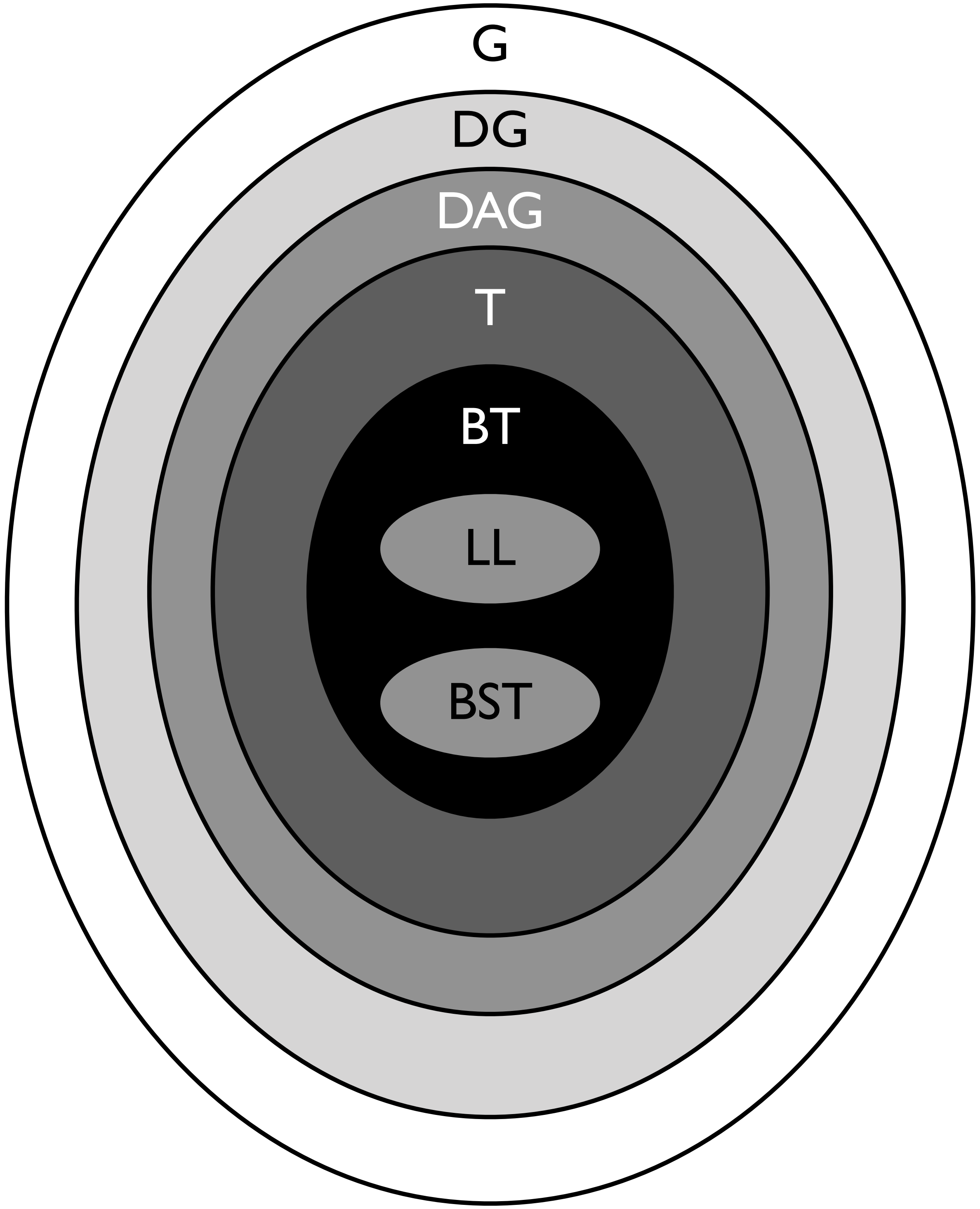
all these are "weakly connected"



Weakly Connected

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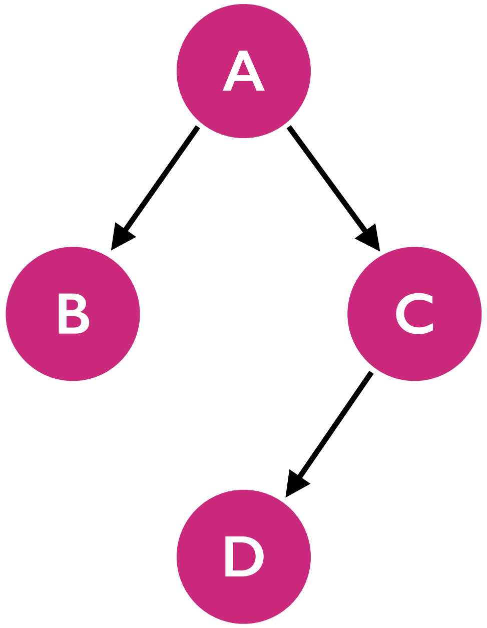
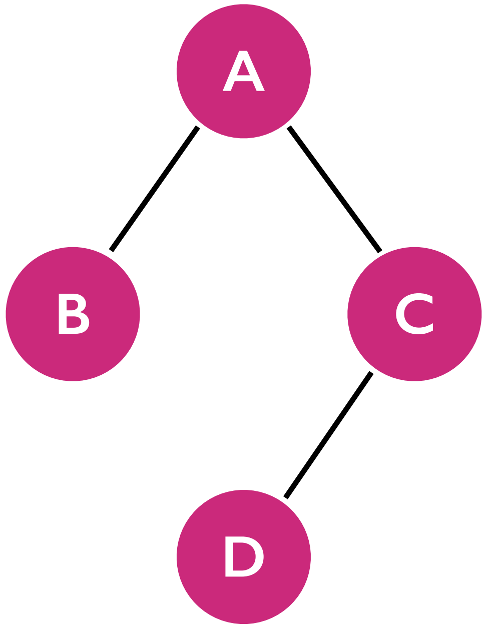
Not technically connected because no D → A path



it is weakly connected because there is a path between every pair if we ignore edge direction



Node Attributes

what kind of graph is each class for?

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class Node:
  def __init__(self, val):
    self.next = None
    ...
```

A

```
class Node:
  def __init__(self, val):
    self.children = []
    ...
```

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class Node:
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```

be careful to never add a child that creates a cycle

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class Node:
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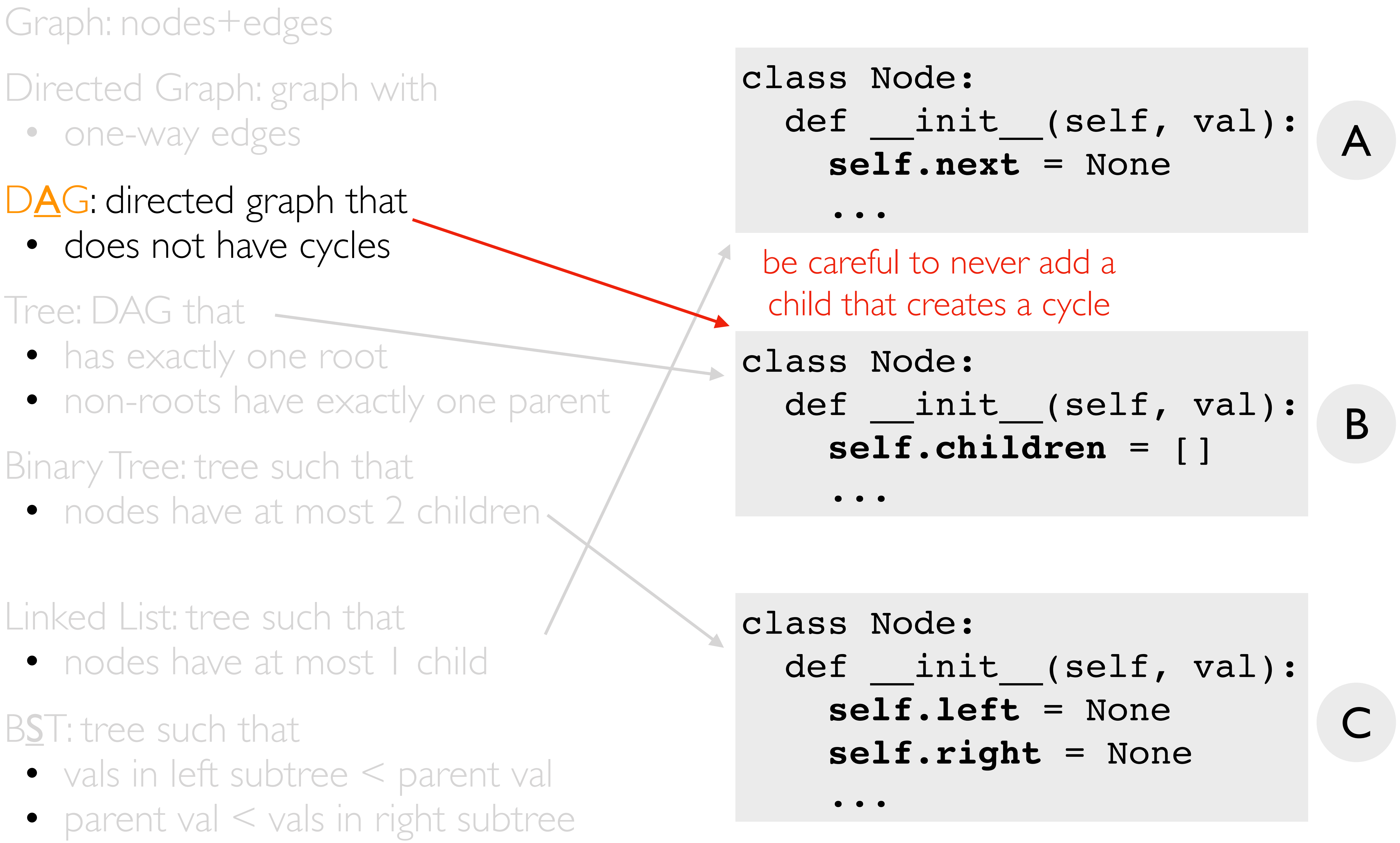

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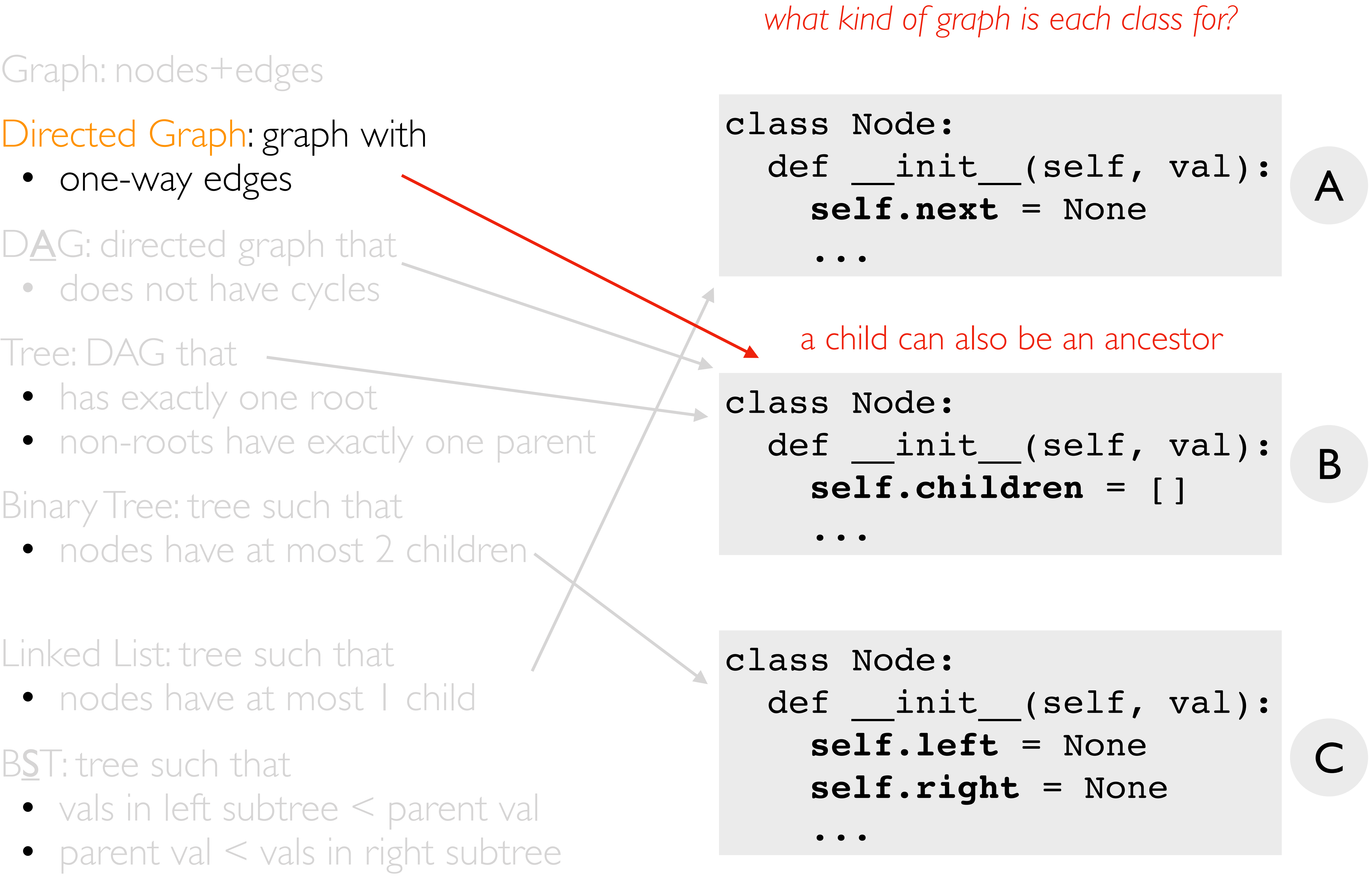

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a child can also be an ancestor

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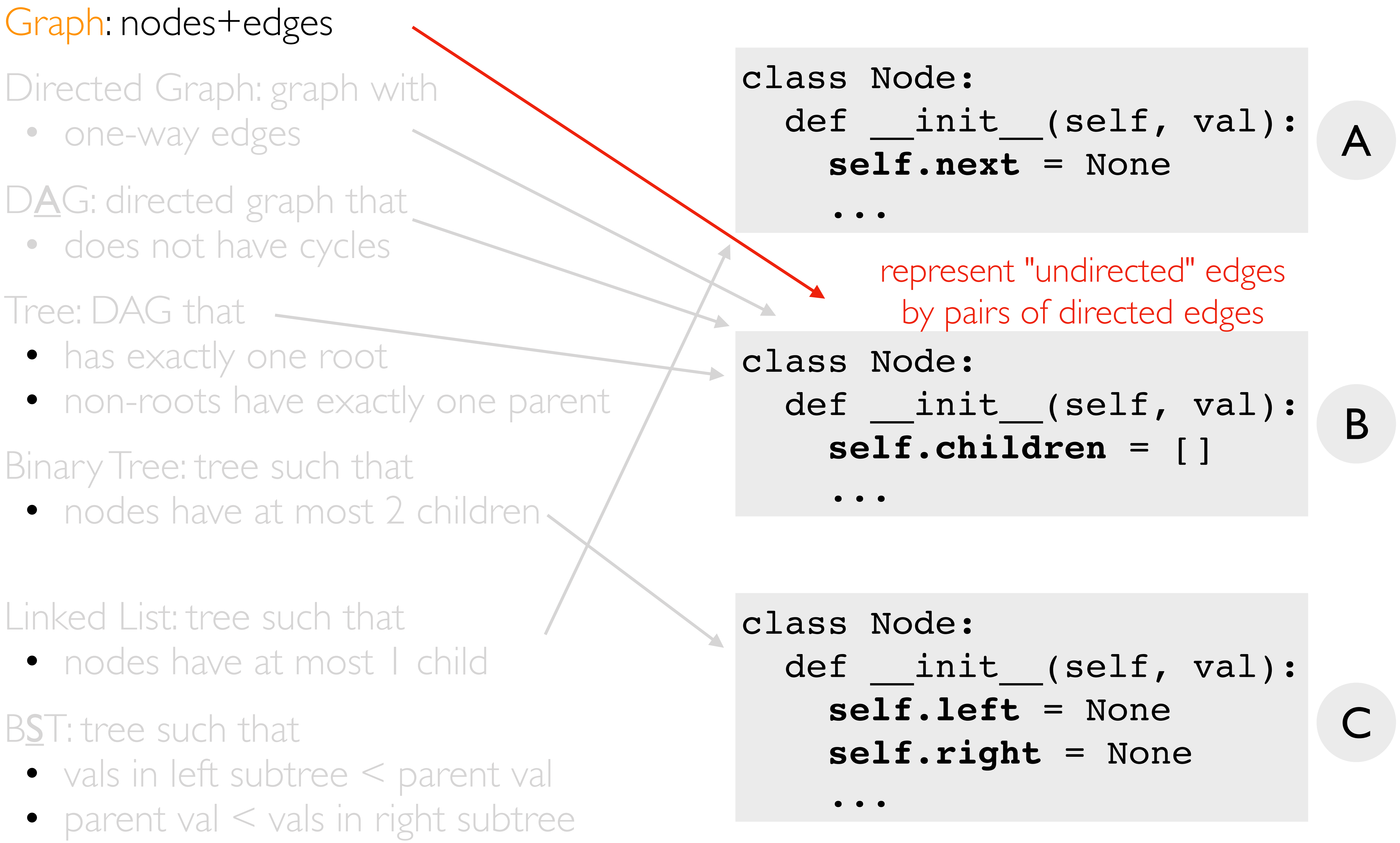

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represent "undirected" edges by pairs of directed edges

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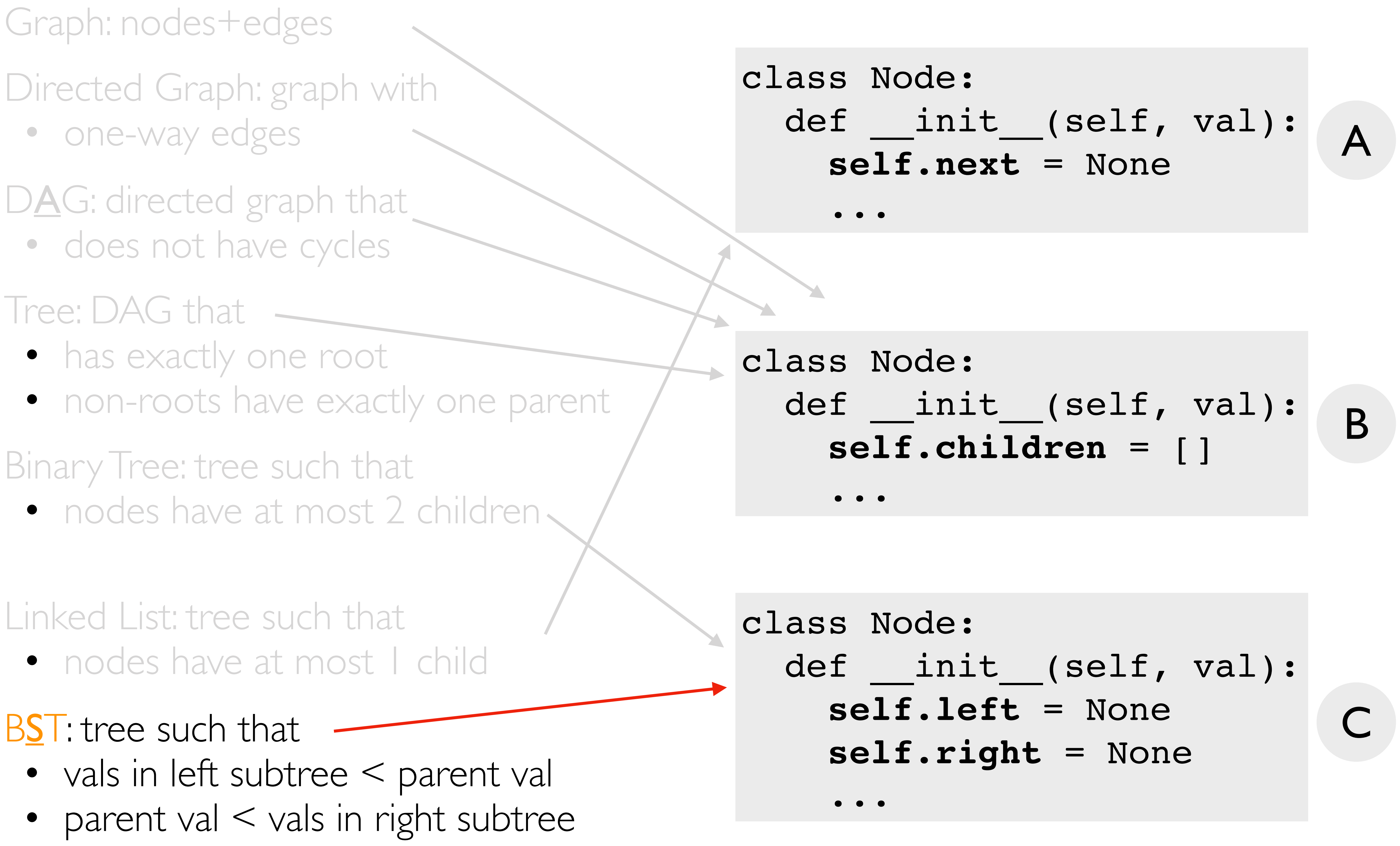

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```

be careful about what nodes go in each subtree

Implementing Graphs: Classes and Attributes

Nodes:

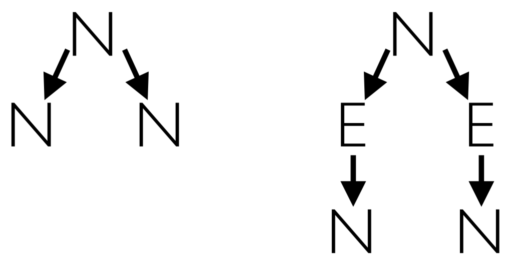
- usually have class for this

Edges:

- often just an attribute in a Node
- if there is edge metadata, might be a separate class just for this

Graph:

- often have a class for this to handle various cases:
  - graphs with zero nodes
  - graphs with multiple roots
  - enforce constraints (if not directed, edges come in pairs)



```
class Graph: # undirected
    def __init__(self):
        self.nodes = {}

    def add_node(self, name, val):
        self.nodes[name] = Node(name, val)

    def add_edge(self, name1, name2):
        node1 = self.nodes[name1]
        node2 = self.nodes[name2]
        node1.children.append(node2)
        node2.children.append(node1)
```