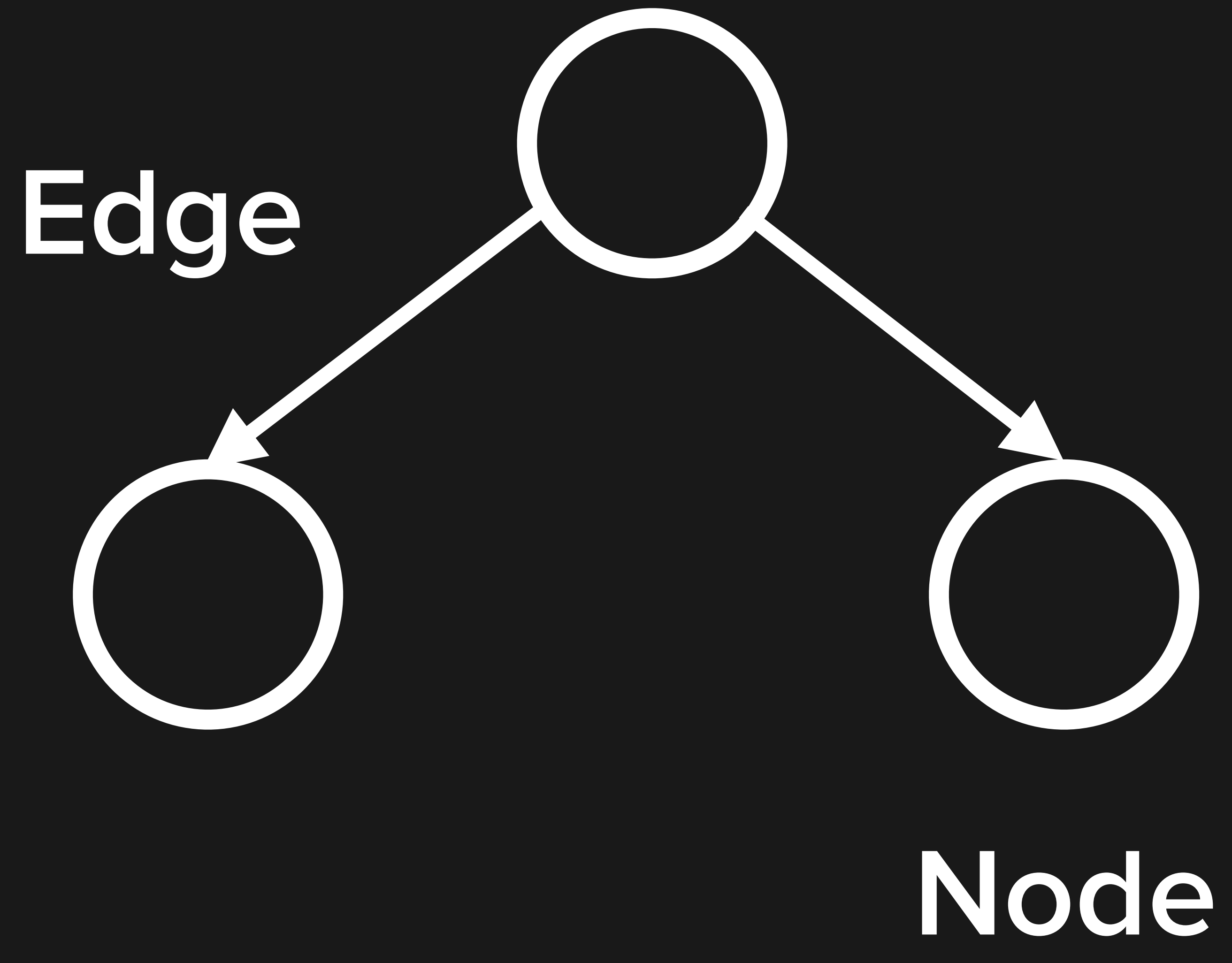
MAKE
SCHOOL

TREES

So log-arithmic. (Get it!?)

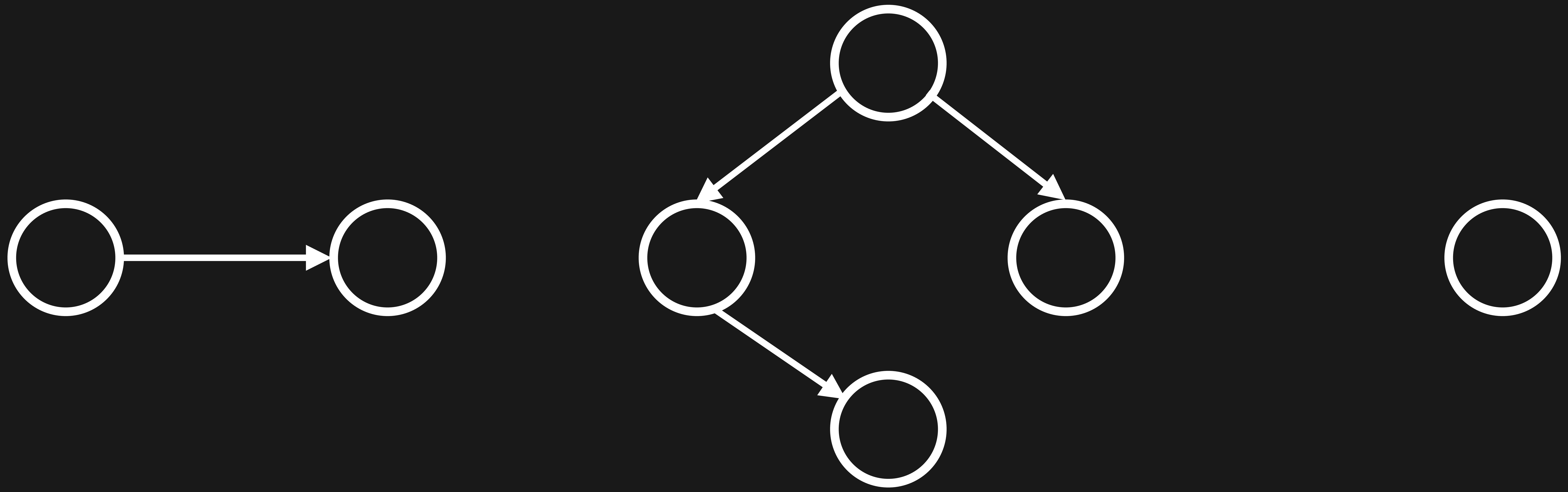
TREE

Nodes and edges (references to child nodes) without any cycle

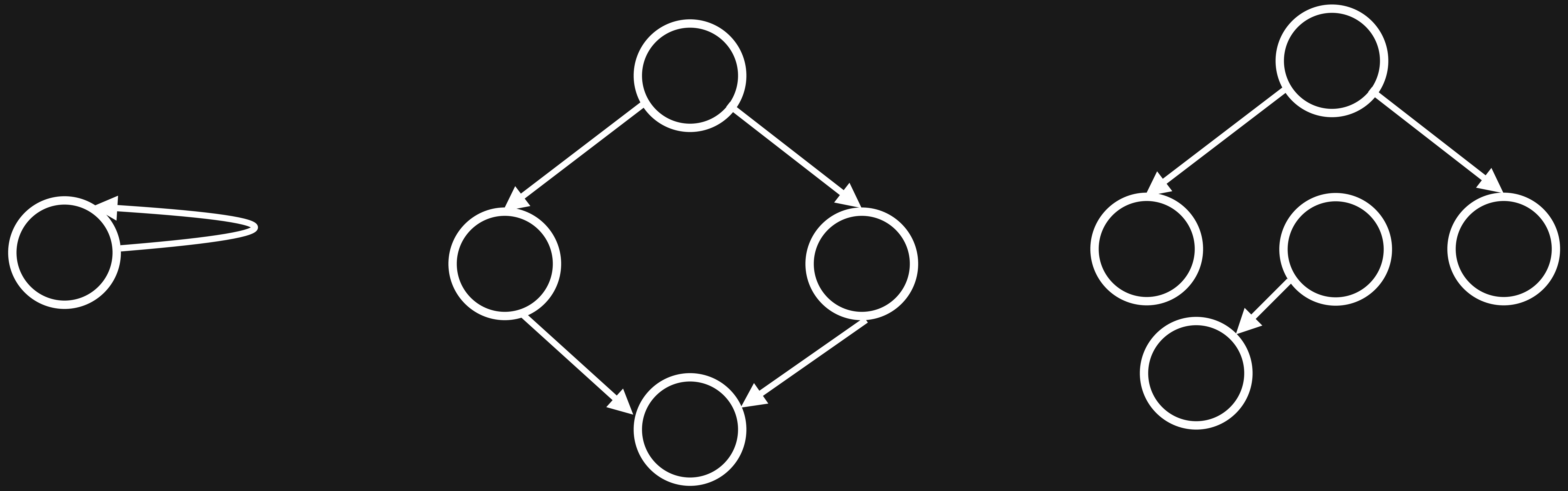


http://en.wikipedia.org/wiki/Tree_(data_structure)

TREES



NOT TREES



root
topmost node

parent
converse of child

descendant
node reachable from parent to child

ancestor
node reachable from child to parent

leaf / external node
node with no children

internal node
node with at least one child

height (tree)
number of edges on longest downward path from root to leaf

height (node)
number of edges on longest downward path from node to leaf

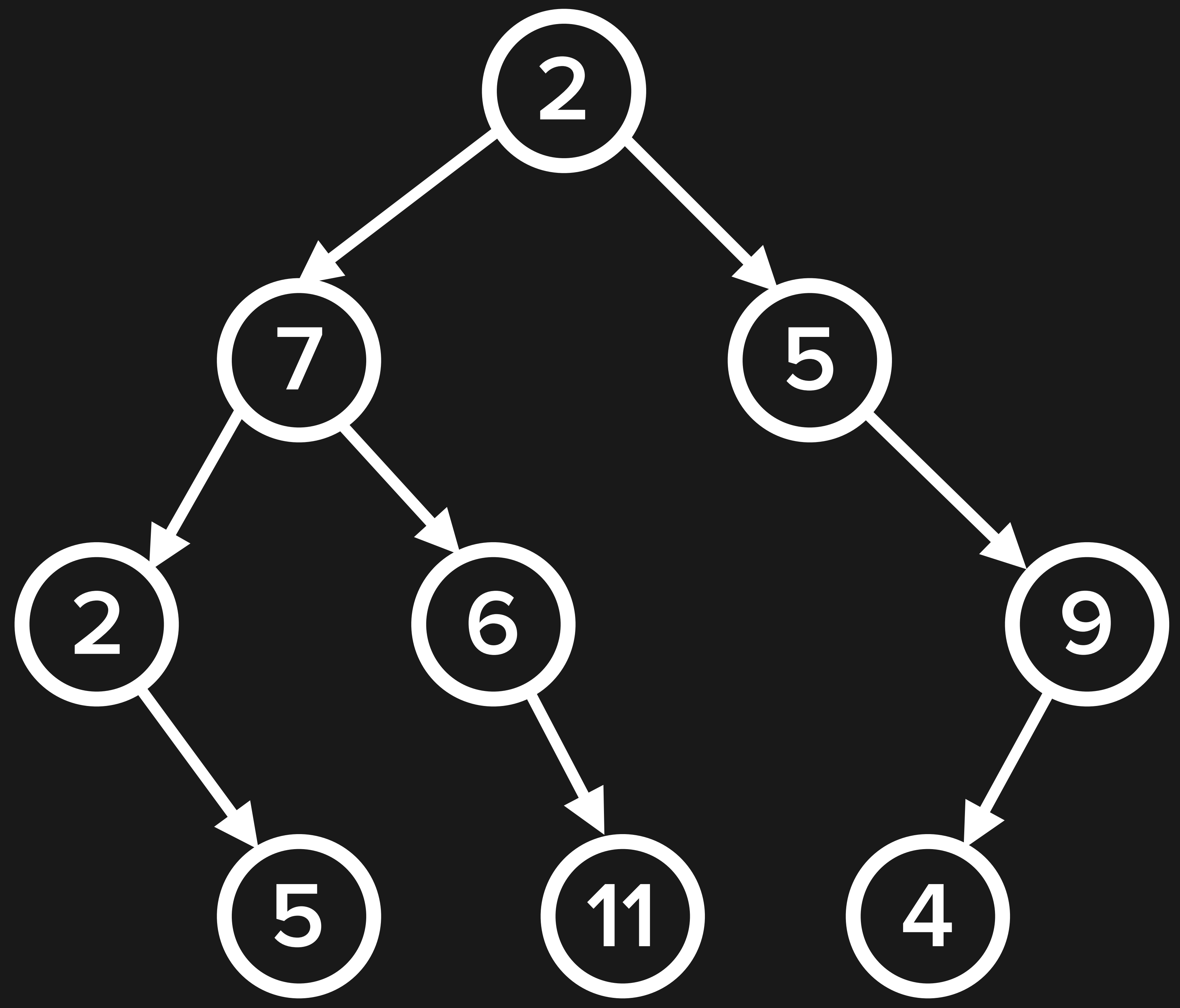
level
1 + number of edges between the node and the root

depth
number of edges between the node and the root

size
number of nodes in the tree

BINARY TREE

Tree in which each node has at most two children



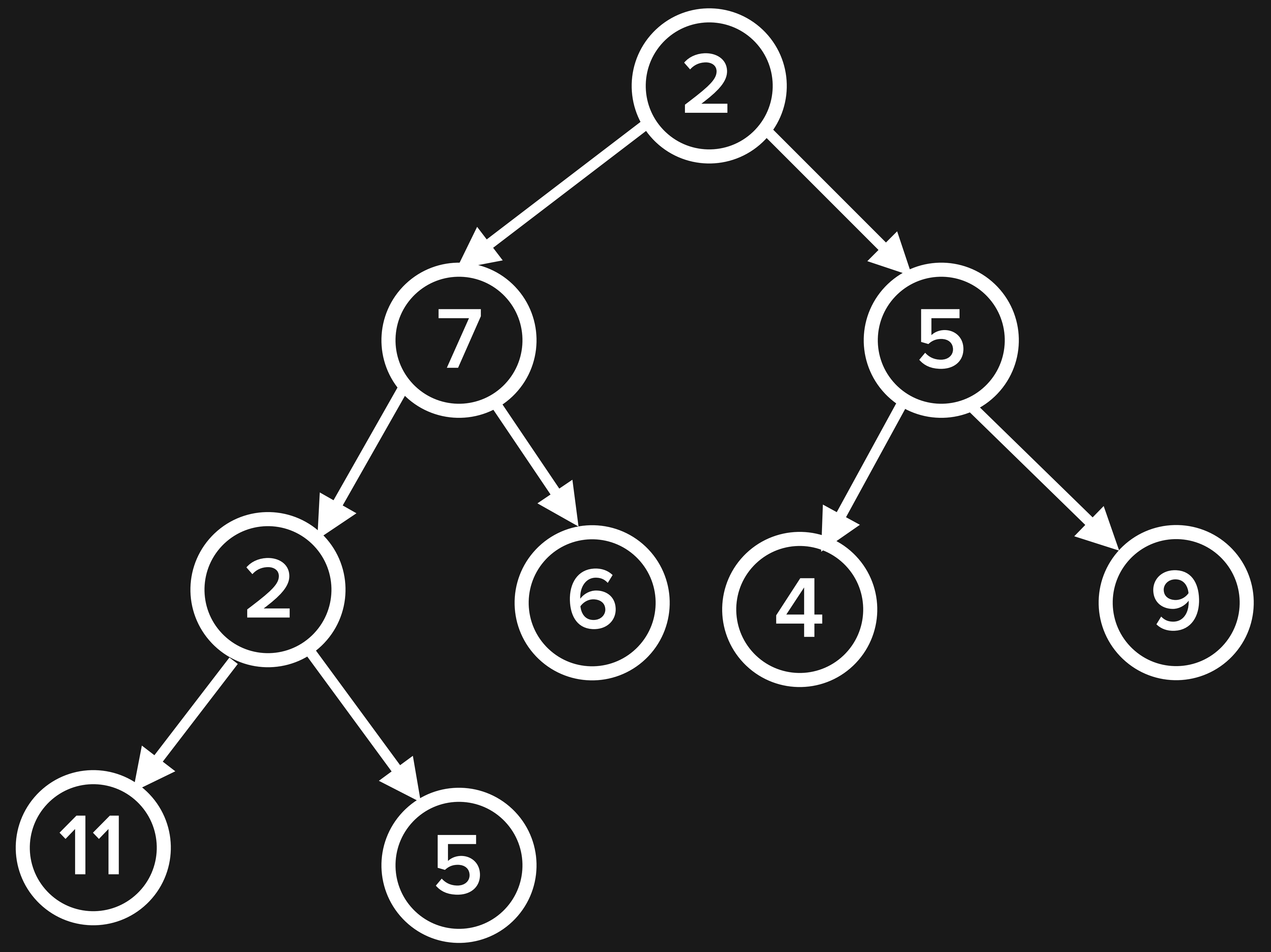
Size ***9*** *Height* ***3***

http://en.wikipedia.org/wiki/Binary_tree

MAKE SCHOOL

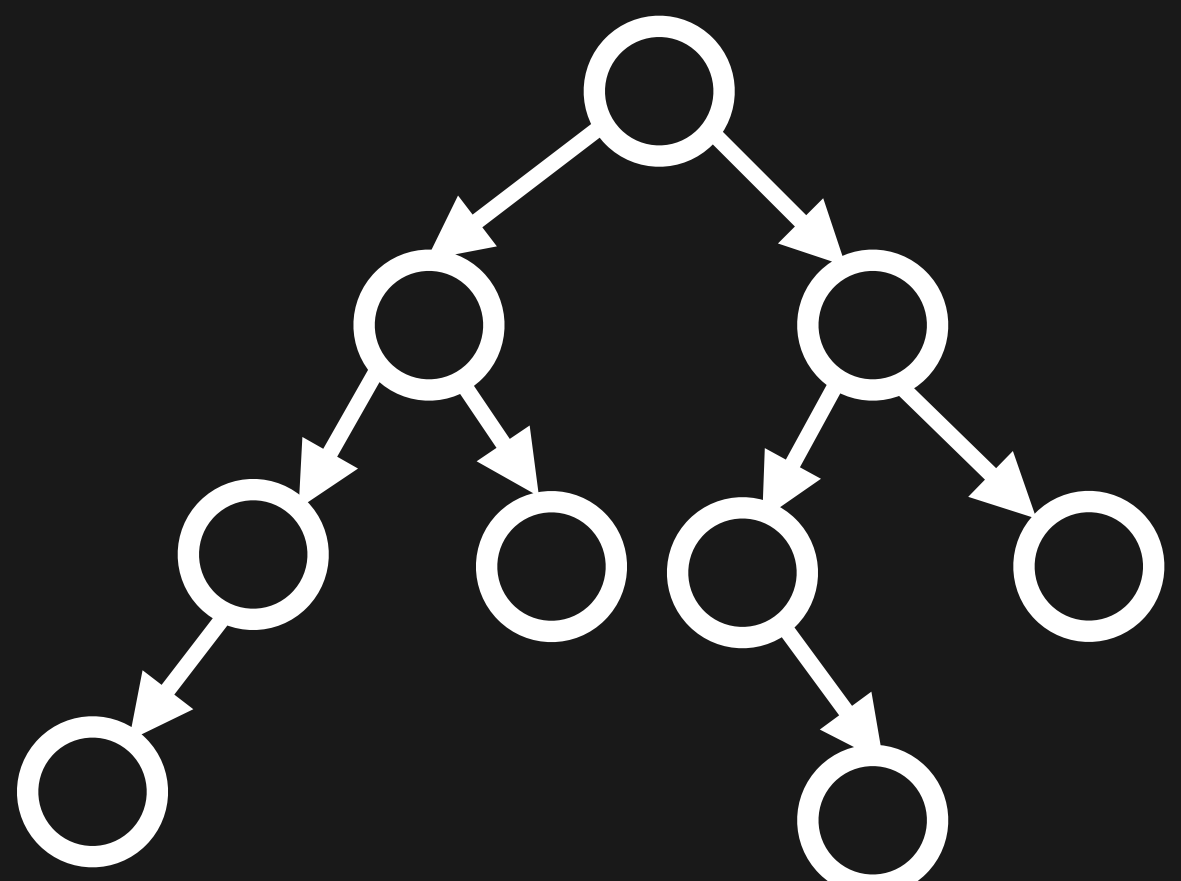
COMPLETE TREE

Every level except possibly last is completely filled and nodes are as far left as possible

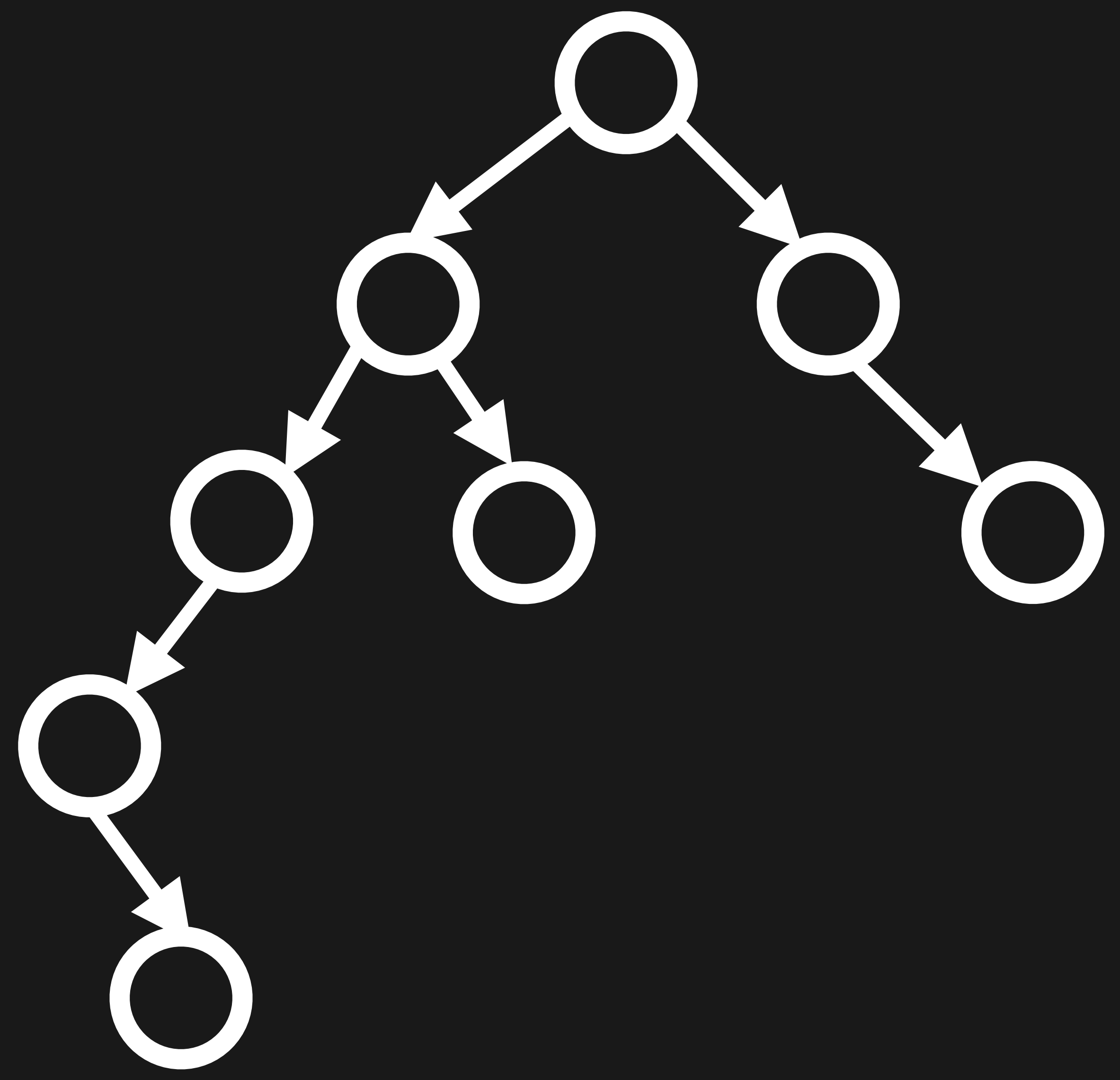


BALANCED TREE

All leaves are at minimum possible depth



Balanced



Unbalanced

MAKE SCHOOL

BINARY SEARCH TREE

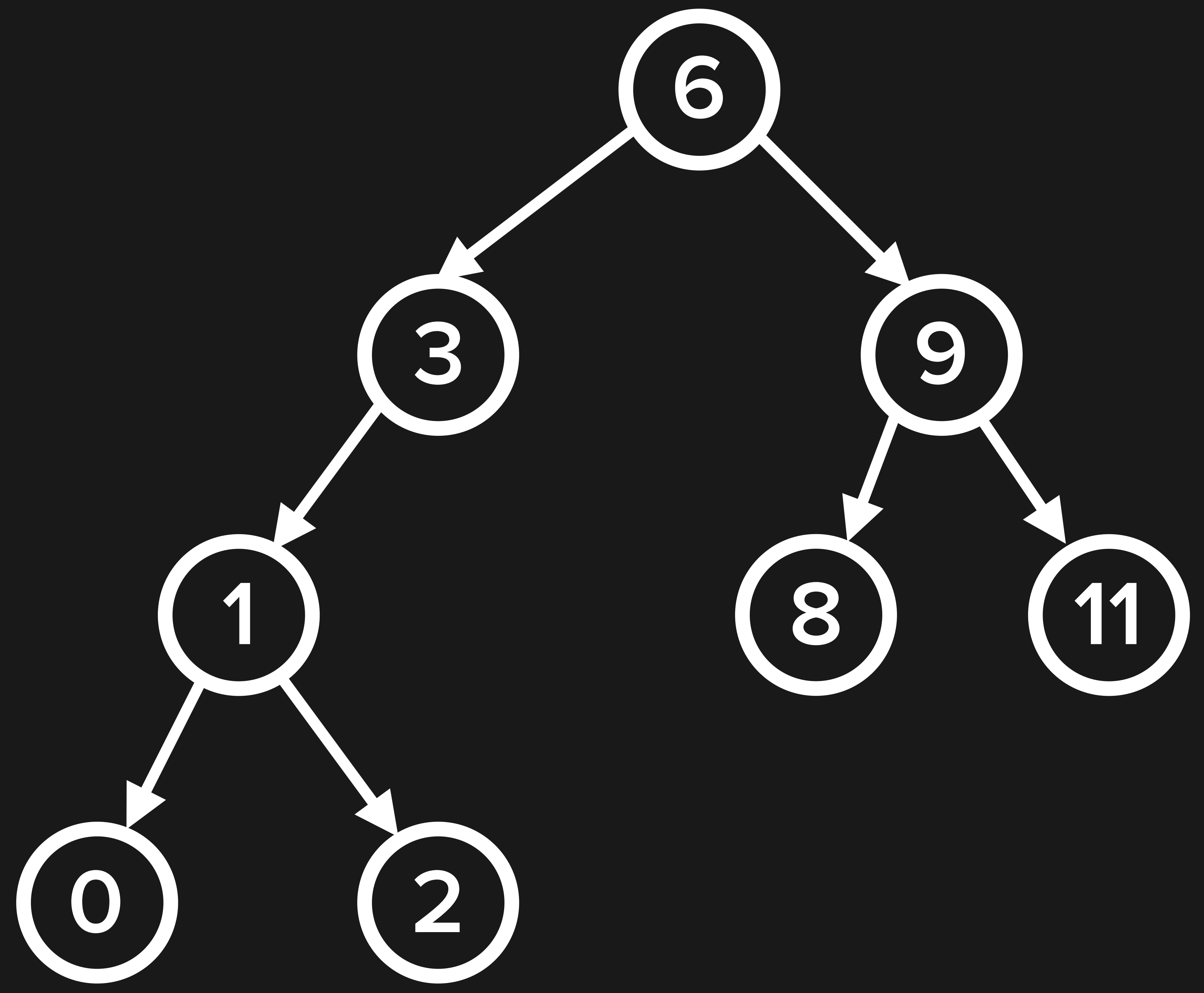
Always sorted

For each node

 Left children are smaller

 Right children are larger

No duplicate keys



WHY USE A BST?

Fast search, insertion, deletion - especially when balanced

Sort as you go instead of all at once

Fairly simple implementation for good performance

WHY USE A BST?

Only allocates memory as it’s needed

Doesn’t have to reallocate memory to grow (like a hash table)

MAKE SCHOOL

A NOTE ON LOG N

When discussing complexity of computational algorithms, log n means $\log_2 n$

BINARY LOGARITHM

$$\log_2 n = x \leftrightarrow 2^x = n$$

the power by which 2 must be raised by to obtain n

$\log_2 16 = 4$ $\log_2 32 = 5$ $\log_2 143 = 7.15987$

http://en.wikipedia.org/wiki/Binary_logarithm

MAKE SCHOOL

SEARCH

```
#  call initially with node == root node
def find_recursive(key, node):
    if node is None or node.key == key:
        return node
    elif key < node.key:
        return find_recursive(key, node.left)
    else:
        return find_recursive(key, node.right)
```

http://en.wikipedia.org/wiki/Binary_search_tree#Searching

MAKE SCHOOL

INSERTION

Same as search except once you find a node without a child on the next side you're traversing, add it there.

http://en.wikipedia.org/wiki/Binary_search_tree#Insertion

DELETION

Three cases

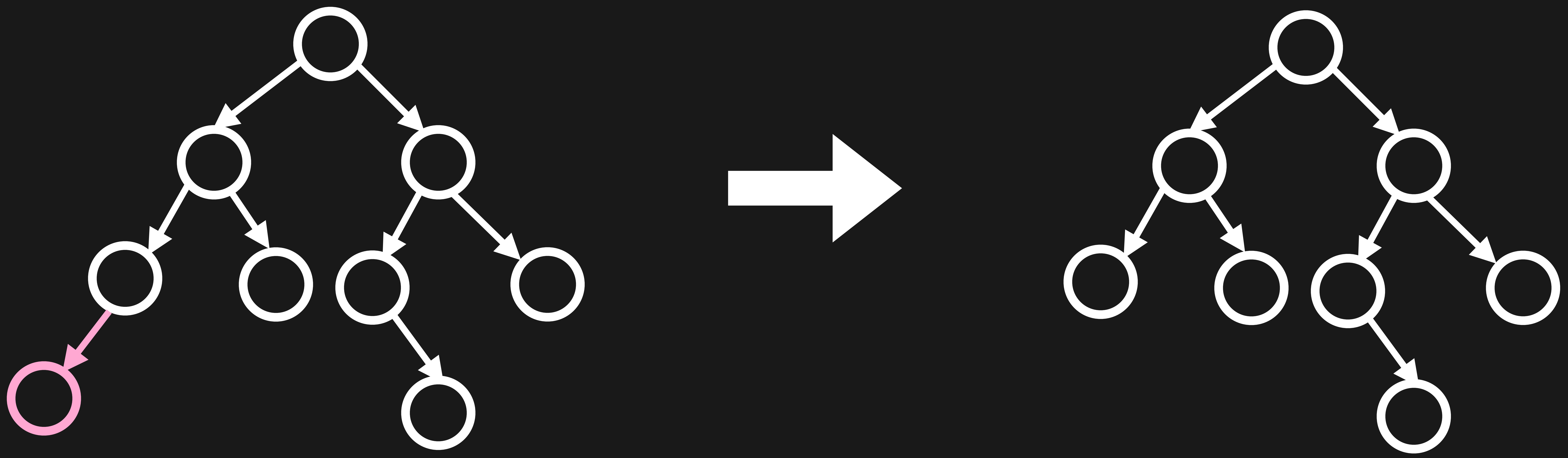
No children

One child

Two children

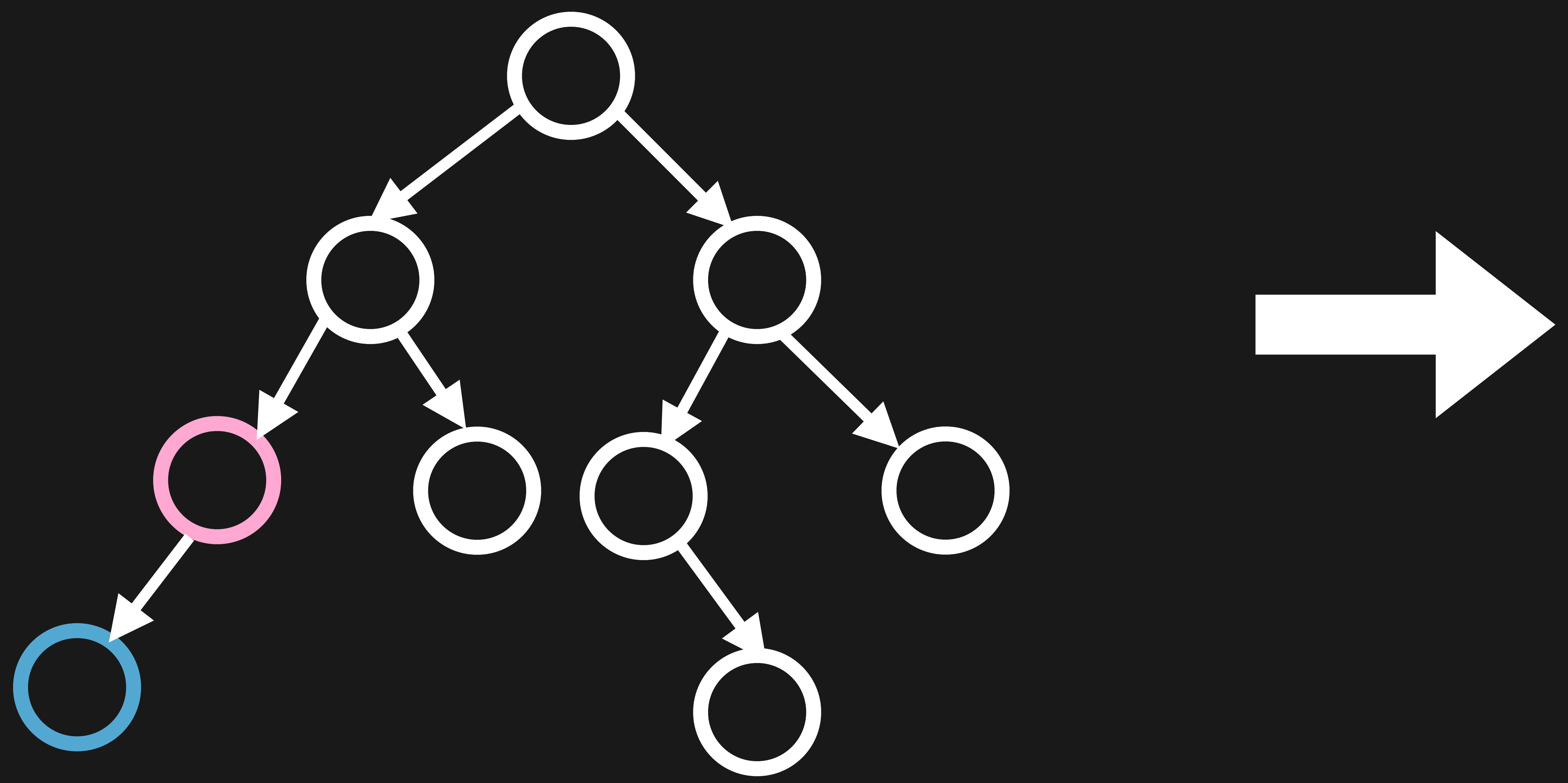
http://en.wikipedia.org/wiki/Binary_search_tree#Deletion

NO CHILDREN



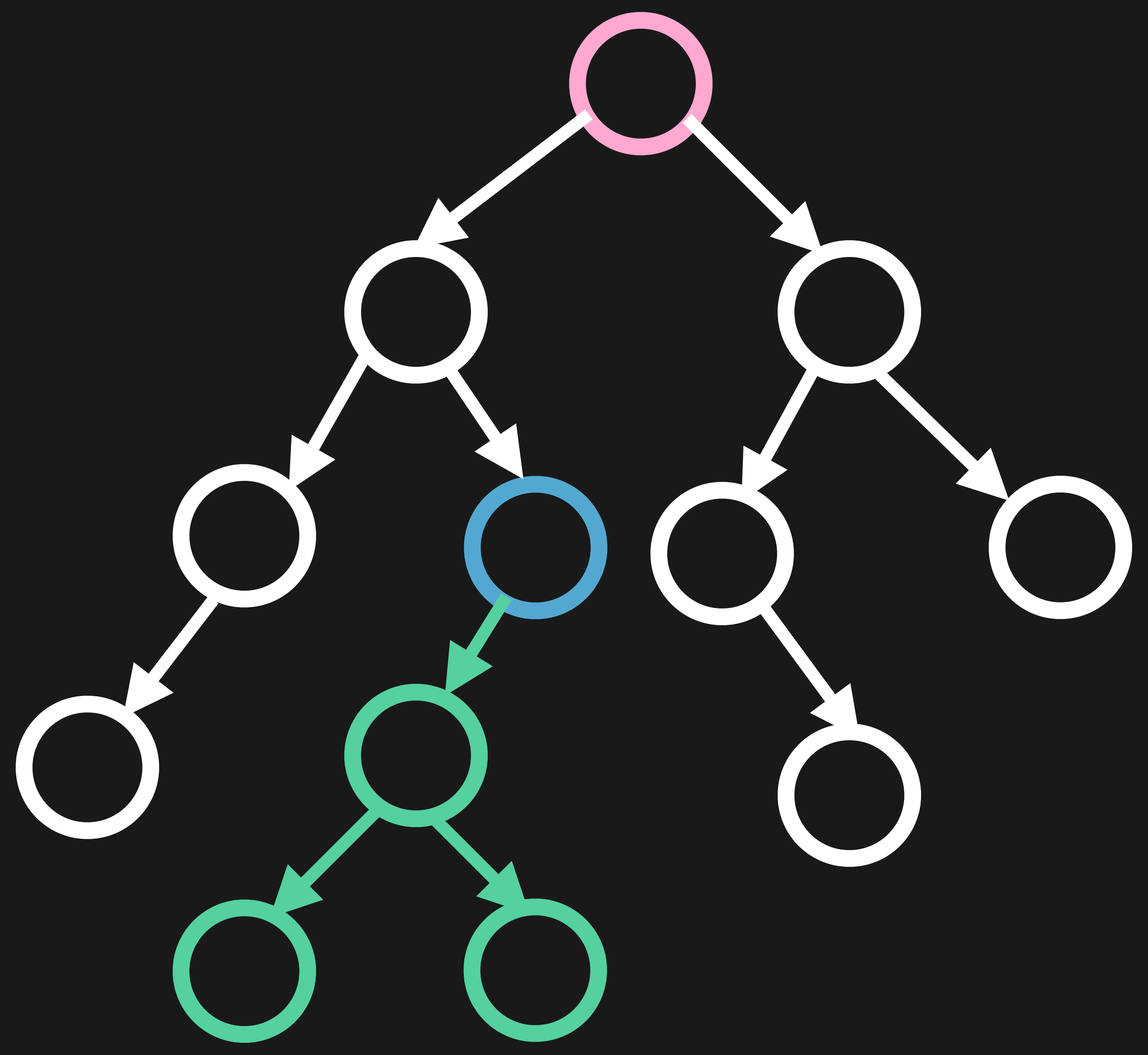
http://en.wikipedia.org/wiki/Binary_search_tree#Deletion

ONE CHILD



http://en.wikipedia.org/wiki/Binary_search_tree#Deletion

TWO CHILDREN



http://en.wikipedia.org/wiki/Binary_search_tree#Deletion

MAKE SCHOOL

COMPLEXITY

	Average Case	Worst Case
Space	O(n)	O(n)
Search	O(log n)	O(n)
Insert	O(log n)	O(n)
Delete	O(log n)	O(n)

WHY IS LOG N GOOD?

Imagine a BST with 2^{32} items

2^{32} is 4,294,967,296

When searching, we only have to touch a maximum of 32 nodes to find the node we're looking for