Lecture 13 - February 25

General Trees

Linear vs. Non-Linear Structures
General Trees: Terminology
Generic TreeNode in Java

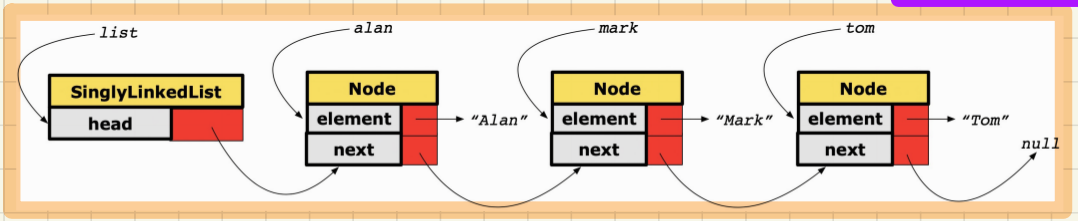
Announcements/Reminders

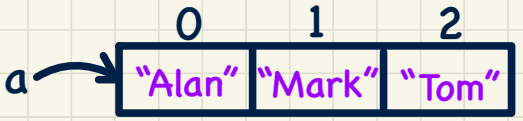
- Survey on **Makeup Lecture** for ProgTest1
- **Assignment 3** (on **linked** **Trees**) to be released
- **WrittenTest** guide to be released
- This week's office hour: 3pm, Wed

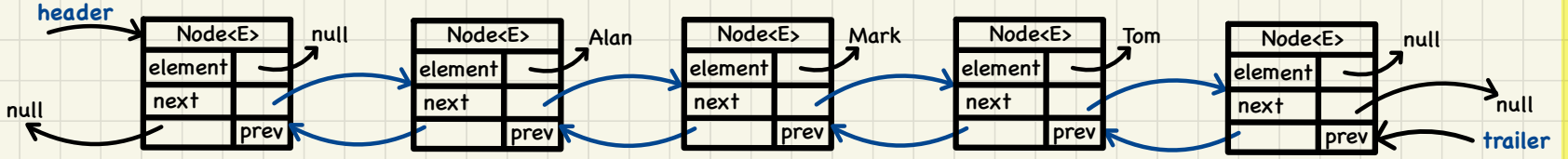
Running Time: Arrays vs. SLL vs. DLL

see earlier discussion

Operation \ Data Structure		Array	Singly-Linked List	Doubly-Linked List
size				O(1)
first/last element				O(n) → e.g. [illegible]
element at index i		O(1)	O(n)	
remove last element				
add/remove first element, add last element				O(1)
add/remove i^{th} element	given reference to $(i-1)^{th}$ element	O(n)	O(1)	
	not given			O(n)







Trees

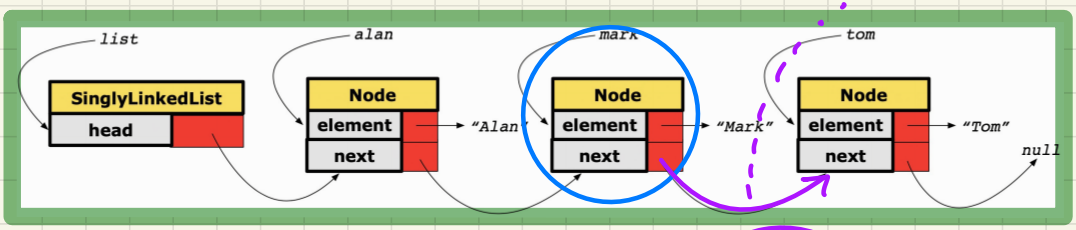
1. General Trees
2. Binary Trees (BTs)
3. Binary Search Trees (BSTs)
4. Balanced BSTs
5. Priority Queues
6. Heap
7. Heap Sort

a: 1, 2

b: 2, 3

c: 3, 4, 5, 6, 7

Linear vs. Non-Linear Structures

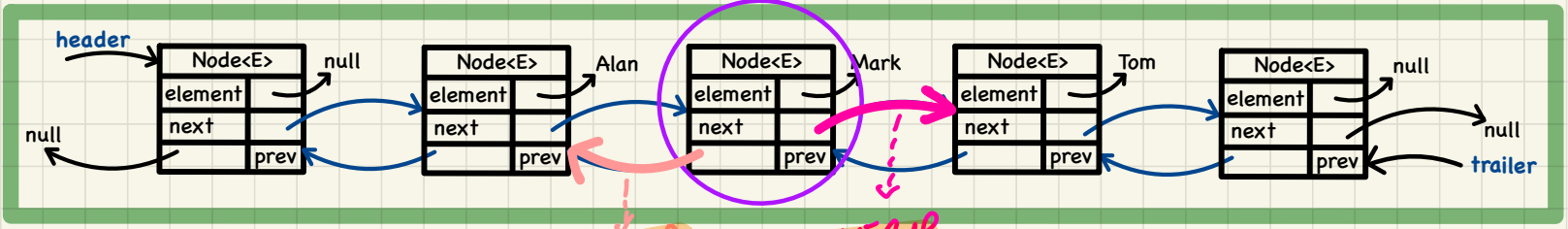


using next to access the unique successor

index of unique pred. $i-1$

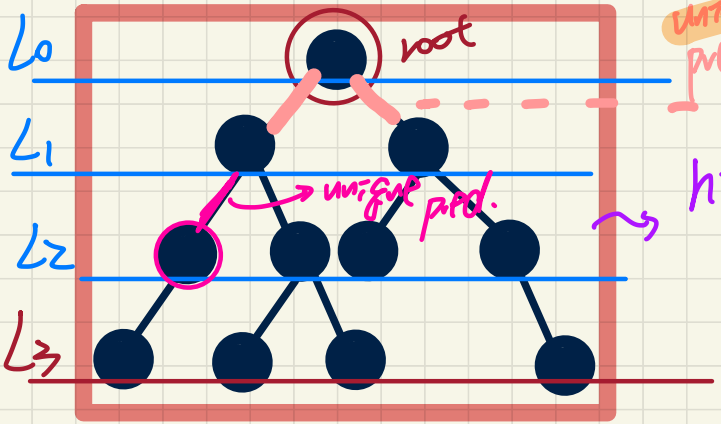
i

index of unique succ. $i+1$



unique predecessor

unique successor



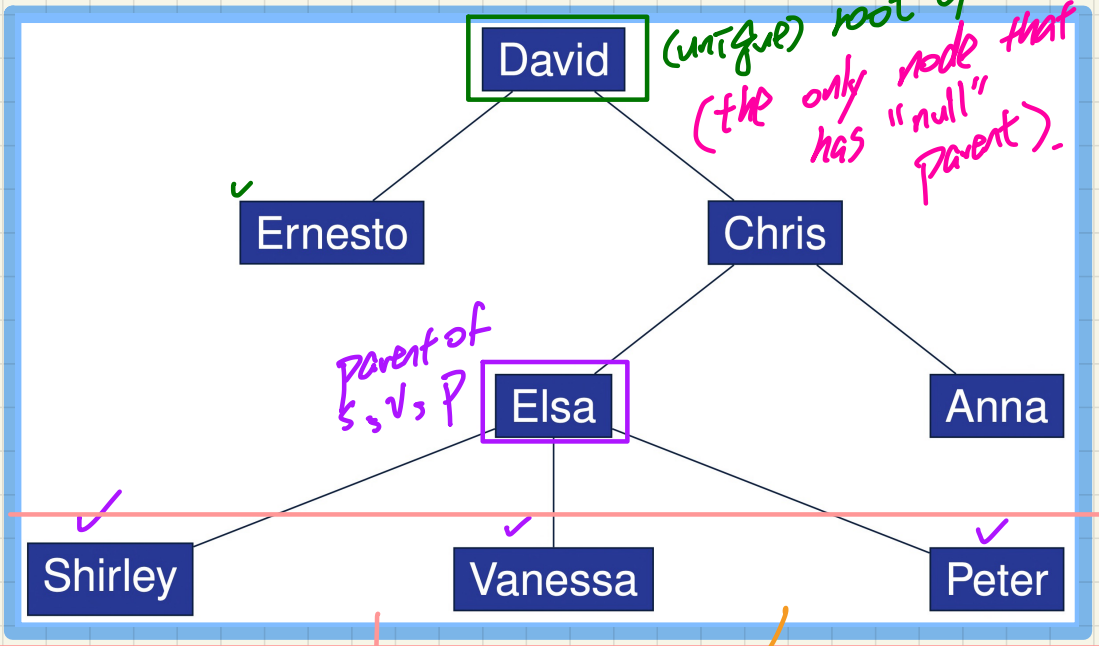
hierarchical structure (levels)

multiple "successors" of the root

↓

in programming they are stored in a tree DS (e.g. S2C)

General Trees: Terminology (1)



(unique) root of the tree (the only node that has "null" parent).

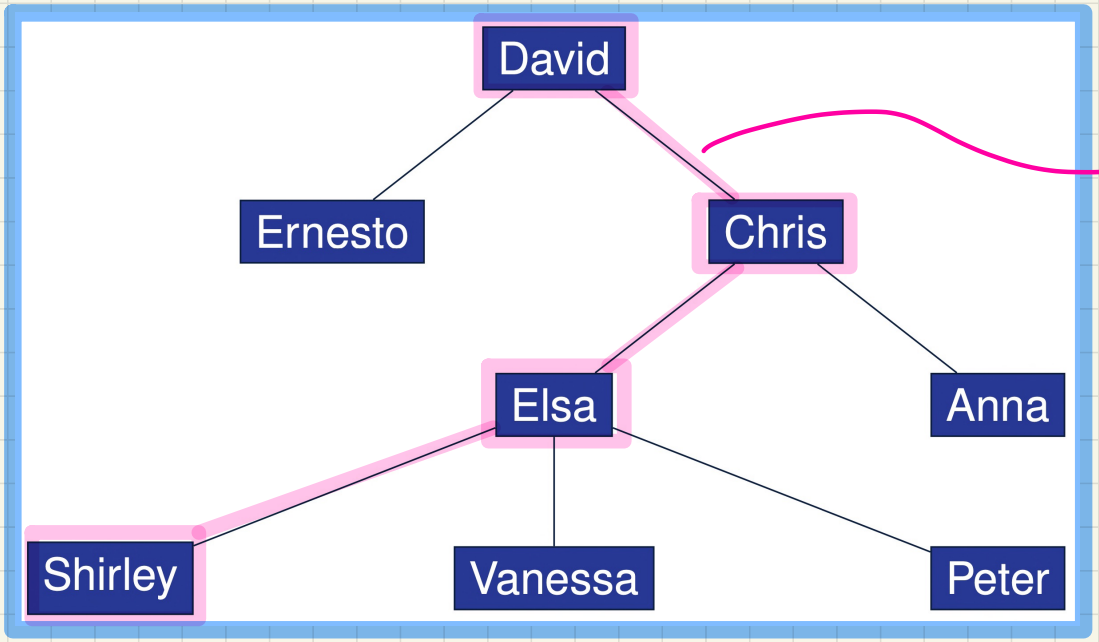
- root
- parent
- children
- ancestors
- descendants
- siblings

parent of S, V, P

children of Elsa

nodes without children

these 3 nodes are siblings. (at the same level).



unique ← parent is unique

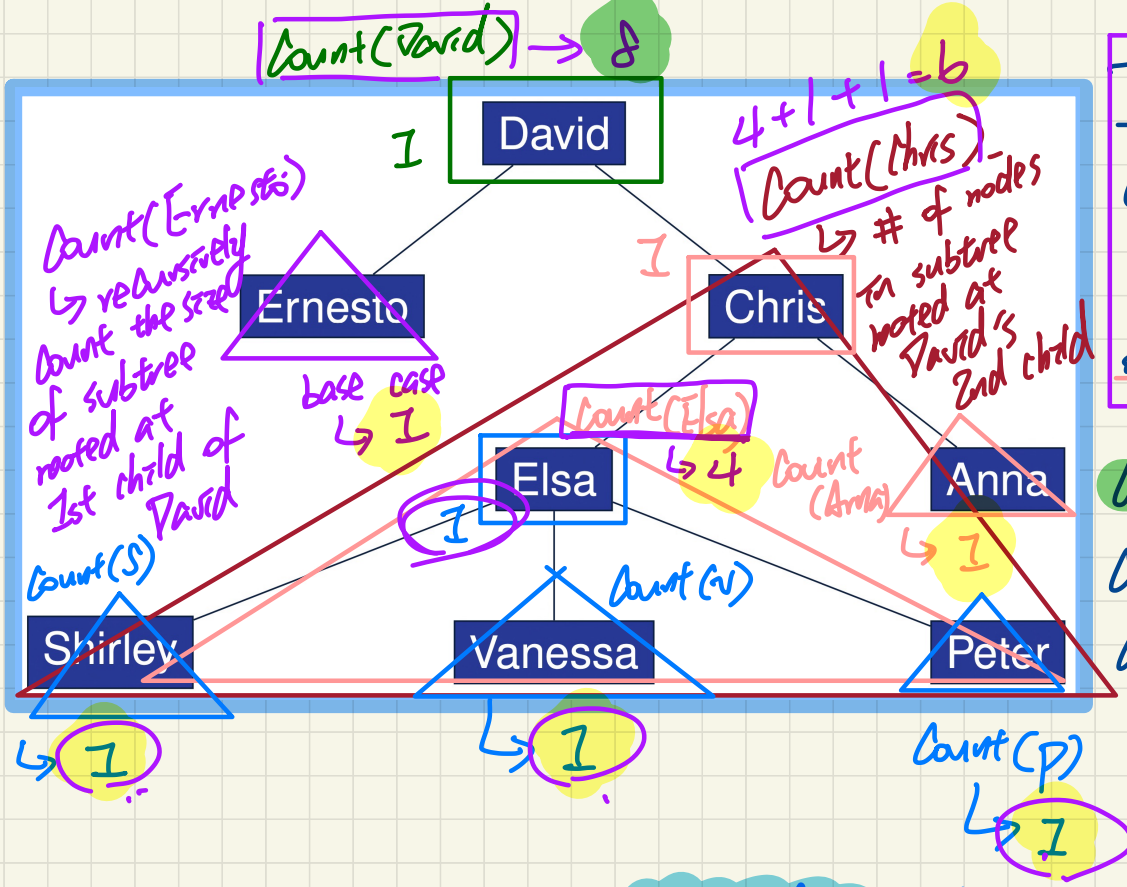
ancestor path of shirley

(shirley, Elsa, Chris, David)

node	Descendants
Vanessa	Vanessa
Elsa	Elsa, S, V, P
David	all nodes in the tree.

A node is both its ancestor and descendant.

General Trees: Terminology (2)



Problem:

Given a node n, return the size of subtree rooted at n.

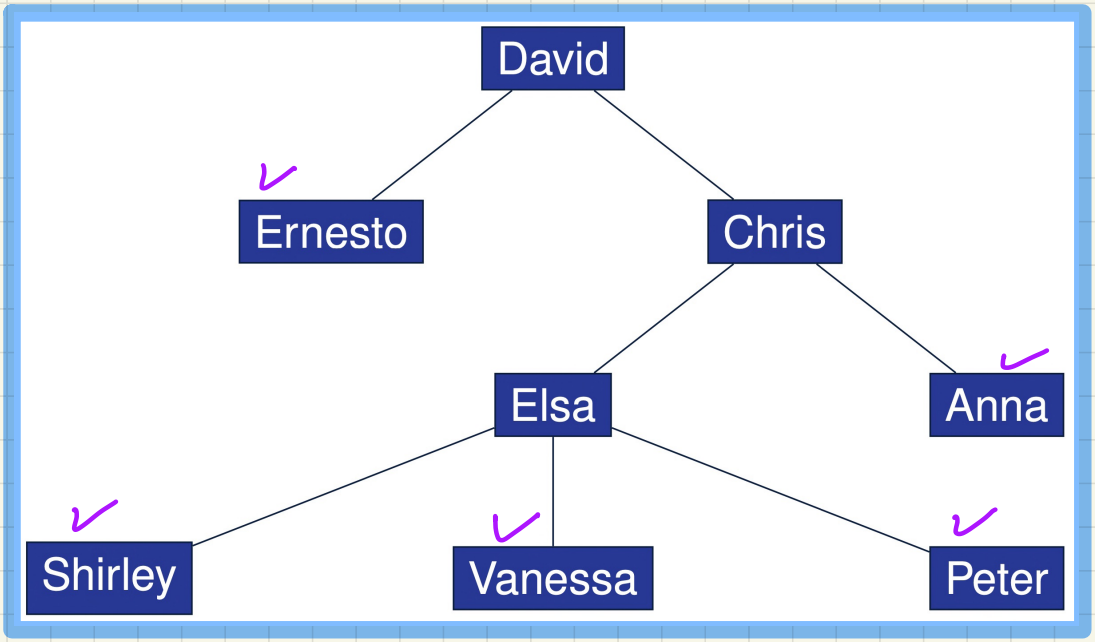
(# descendants)

Count(David) = 8

Count (Chris) = 6

Count (Shirley) = 1

- subtrees are the subproblems for you to make recursive calls on.

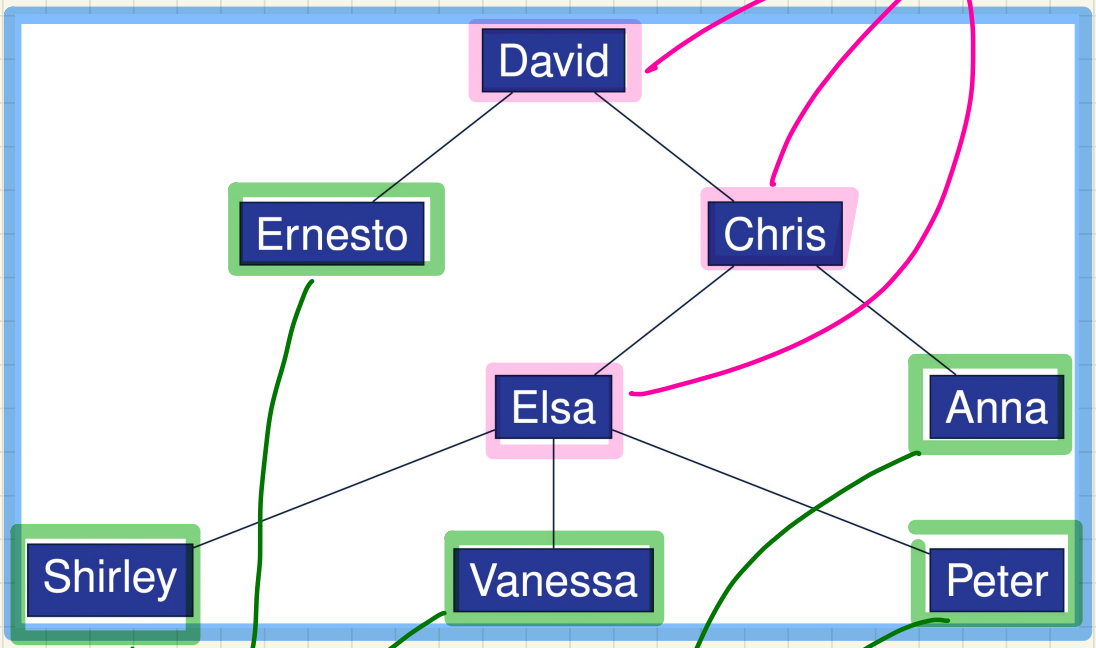


How many subtrees in total?

n = # nodes in the tree.

size	# subtrees
1	5
⋮	⋮
n	1 rooted at David.

General Trees: Terminology (3)

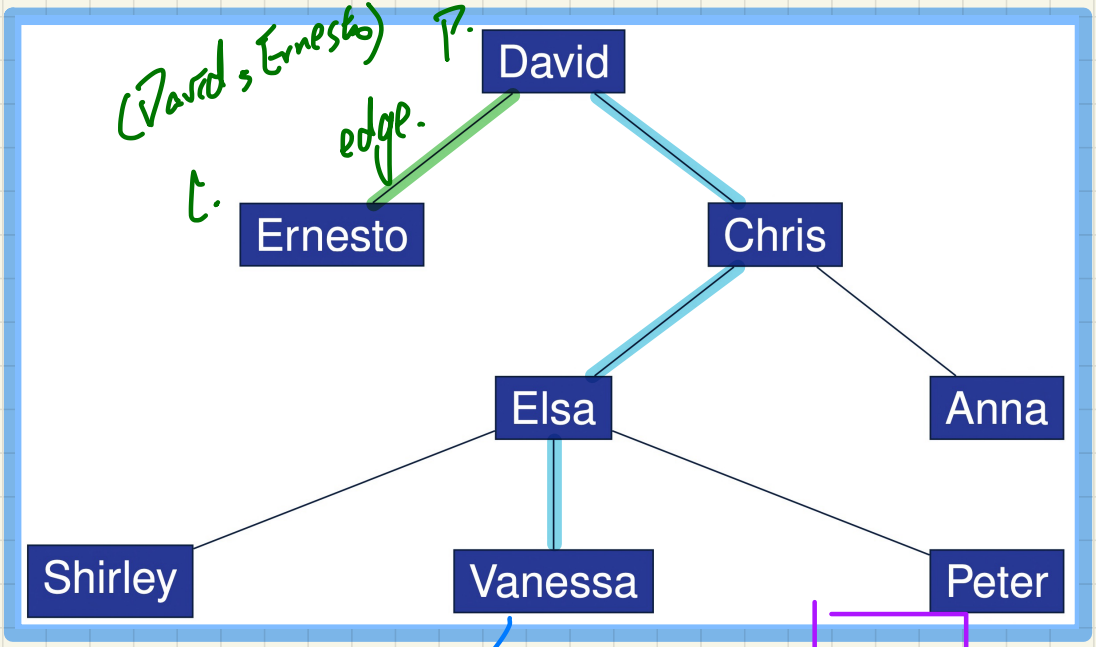


internal nodes → recursive cases

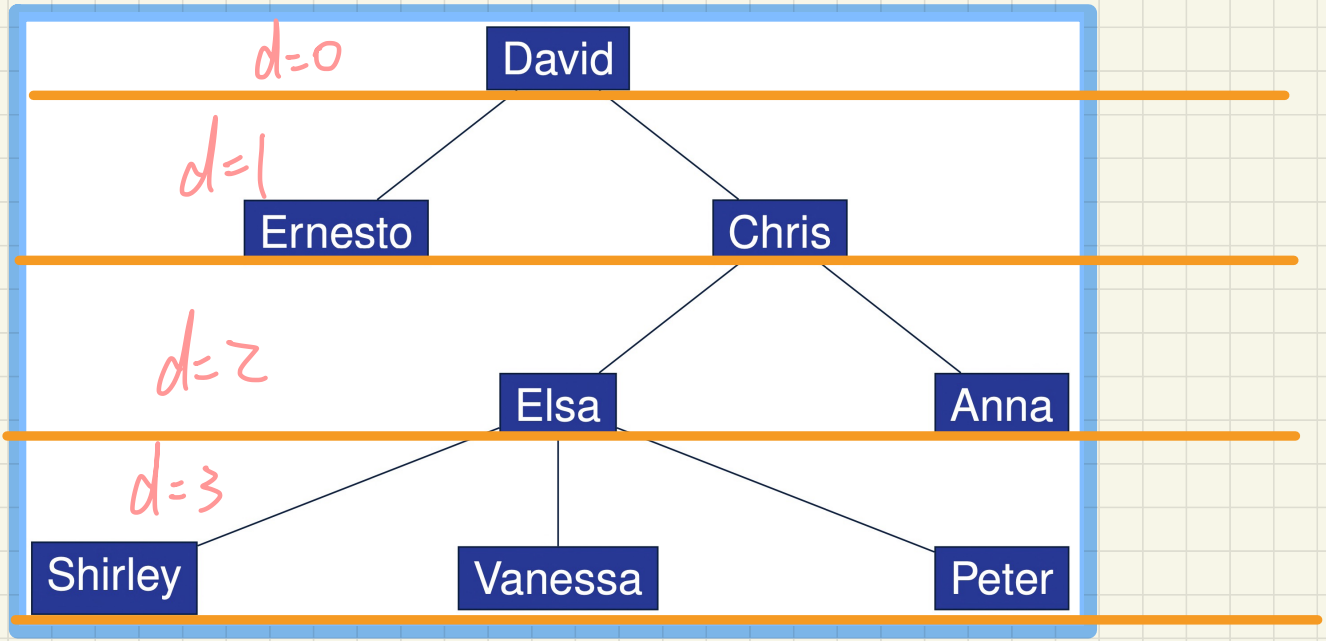
- external nodes
- internal nodes

external nodes (leaves) → base cases

General Trees: Terminology (4)

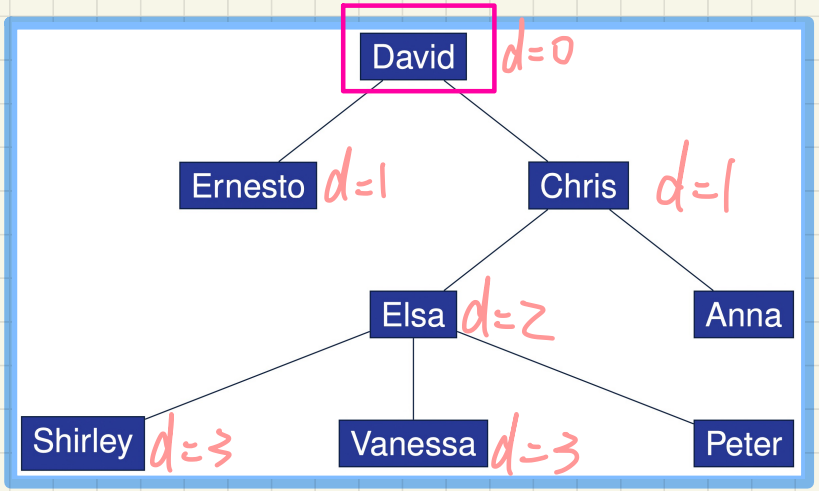


- edge
- path
- depth
- height



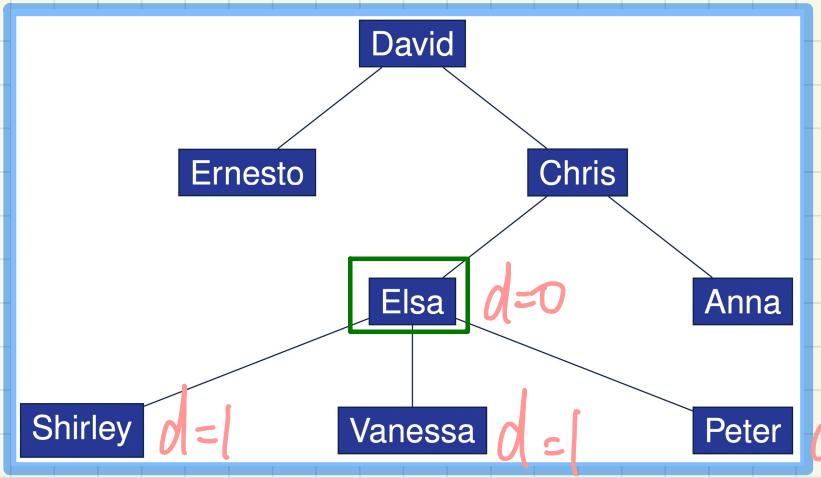
depth of a node n: # edges (parent links) from n to root.

height of a tree: max depth of descendants of its root.



Height of tree rooted at David:

(3)



Height of tree rooted at Elsa:

(1).