CS 225

Data Structures

Oct. 2 – Trees

Queue.h

```
 4 template <class QE>
 5 class Queue {
 6   public:
 7     class QueueIterator : public std::iterator<std::bidirectional_iterator_tag, T> {
 8       public:
 9         QueueIterator(unsigned index);
10         QueueIterator& operator++();
11         bool operator==(const QueueIterator &other);
12         bool operator!=(const QueueIterator &other);
13         QE& operator*();
14         QE* operator->();
15       private:
16         int location_;
17
18     };
19
20
21   /* ... */
22
23   private:
24     QE* arr_; unsigned capacity_, count_, entry_, exit_;
25 };
26
```

Big Ideas

Member functions and variables are only inherited in derived classes.

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Member functions and variables are only inherited in derived classes.

Class scope determines access to private members.

Mattox Monday

Exam 2

Exam 2 Re-take

- **Public**: Can be taken anywhere (**not** a CBTF exam)
- **Time Limited**: 50 minute exam
- **Availability Limited:** Must take before Tuesday, Oct 2nd @ 11:59pm

Exam 4

Exam 4 (MP2-like)

- Programming Exam
- Ongoing right now!

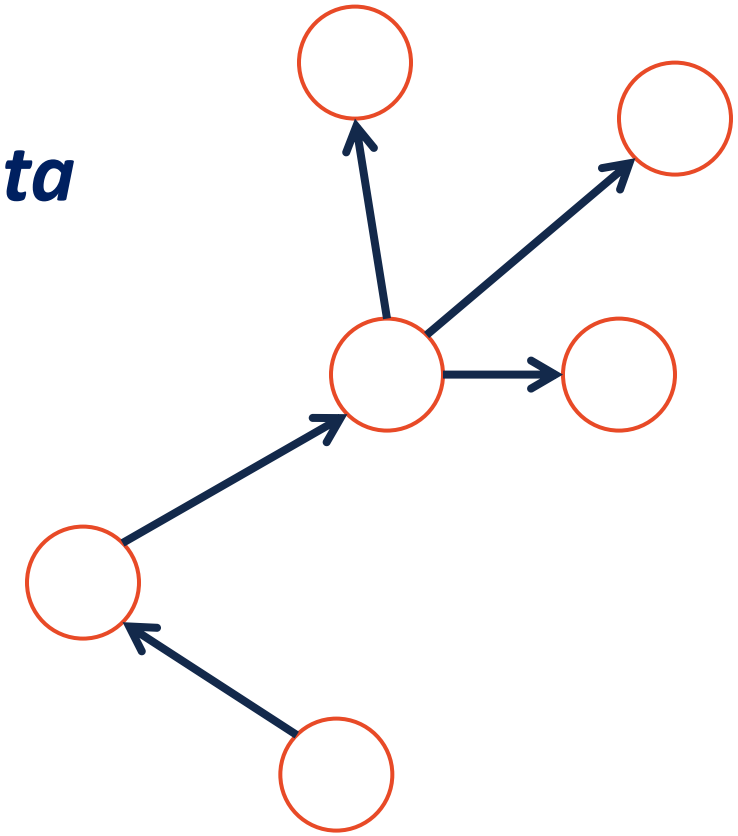
Exam 5

- Theory Exam
- **Topics**: Lists, Stacks, Queues, and related topics
  - All topics covered in lecture/lab/MPs through **right now**!

Trees

"The most important non-linear data structure in computer science."

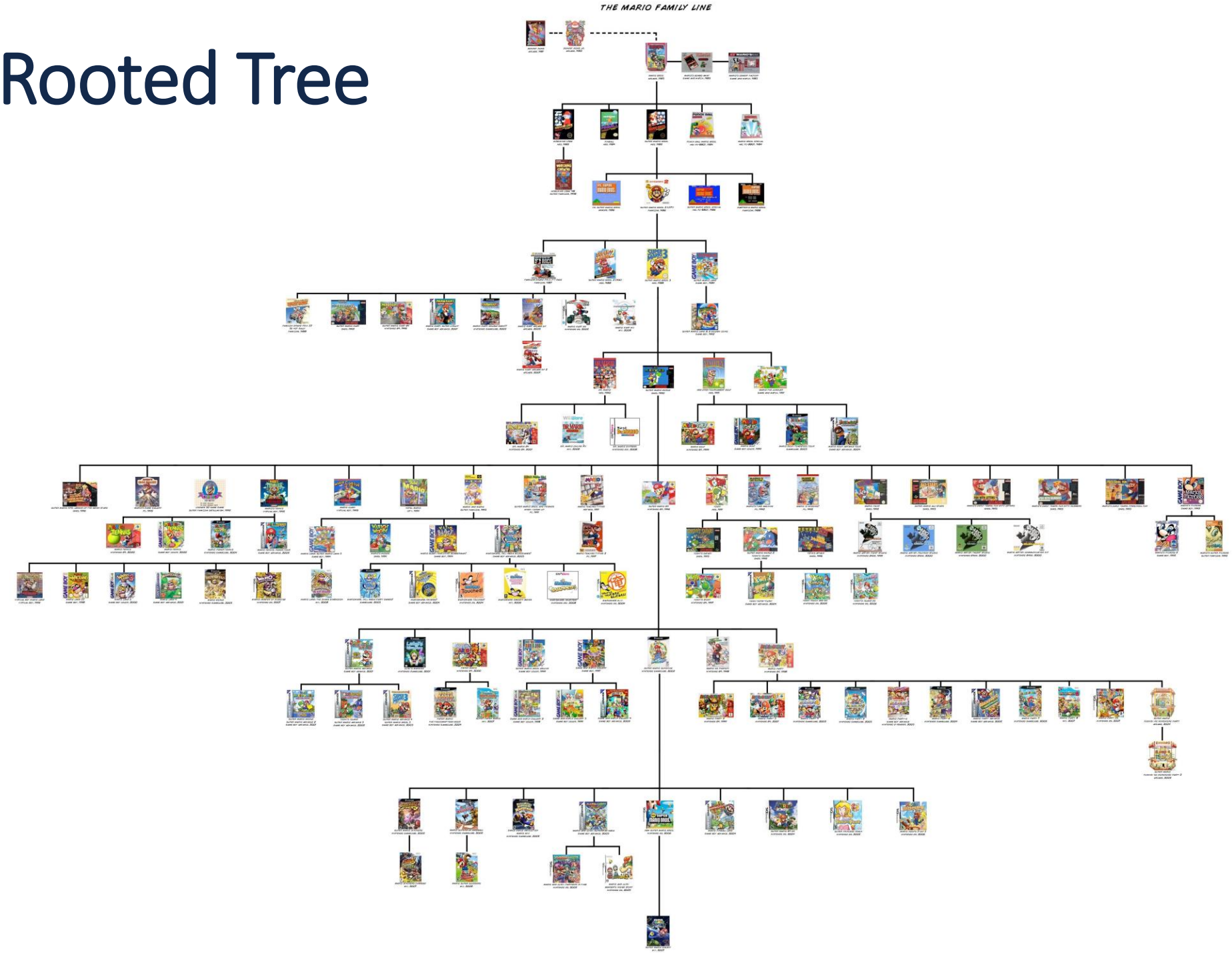
- David Knuth, The Art of Programming, Vol. 1



A tree is:

-
-

A Rooted Tree



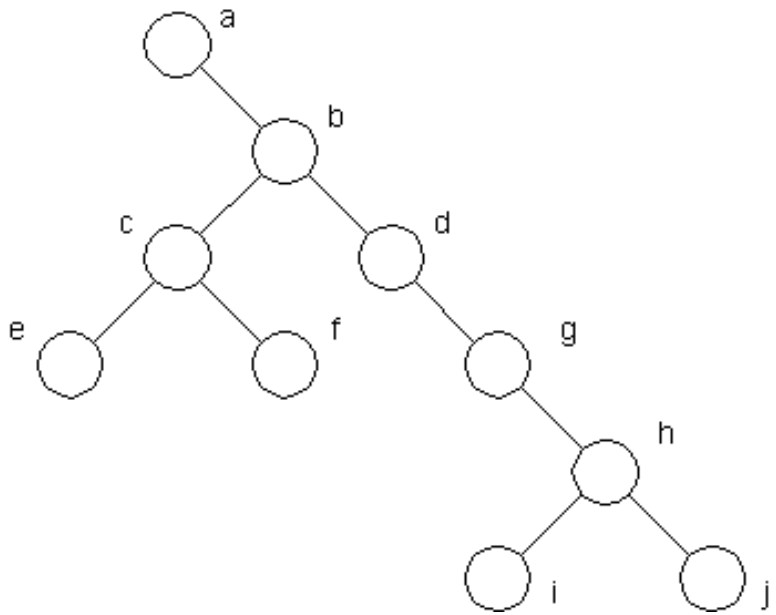
More Specific Trees

We'll focus on a specific type of trees:

-
-

Tree Terminology

- What's the longest "word" you can make using the vertex labels in the tree (repeats allowed)?
- Find an edge that is not on the longest path in the tree. Give that edge a reasonable name.
- One of the vertices is called the root of the tree. Which one?
- Make an "word" containing the names of the vertices that have a parent but no sibling.
- How many parents does each vertex have?
- Which vertex has the fewest children?
- Which vertex has the most ancestors?
- Which vertex has the most descendants?
- List all the vertices is b's left subtree.
- List all the leaves in the tree.



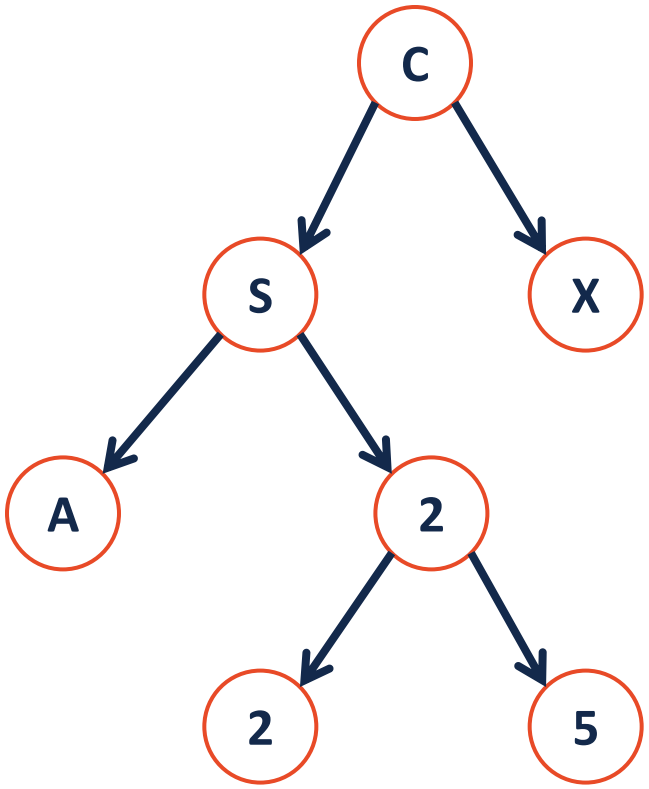
Binary Tree – Defined

A *binary tree* T is either:

-

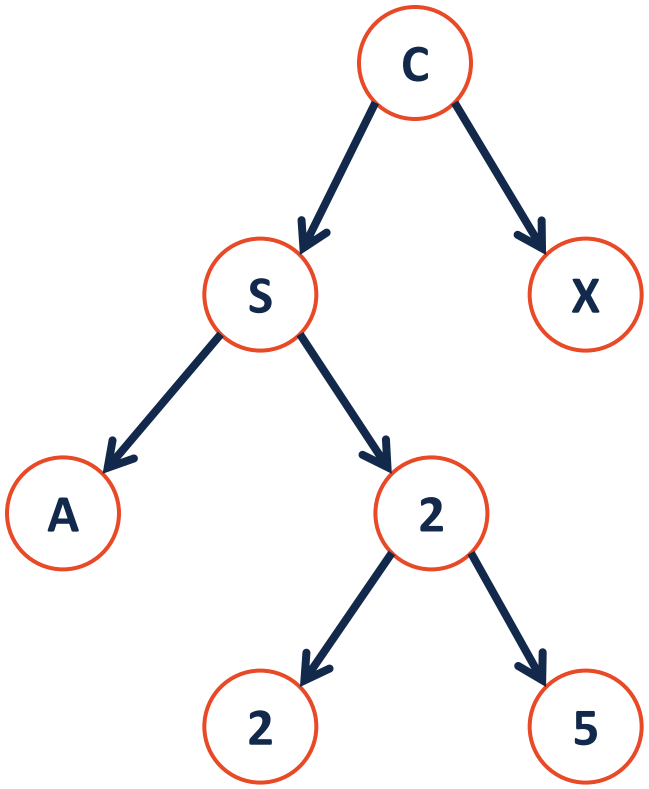
OR

-



Tree Property: height

***height(T)*: length of the longest path from the root to a leaf**



Given a binary tree T:

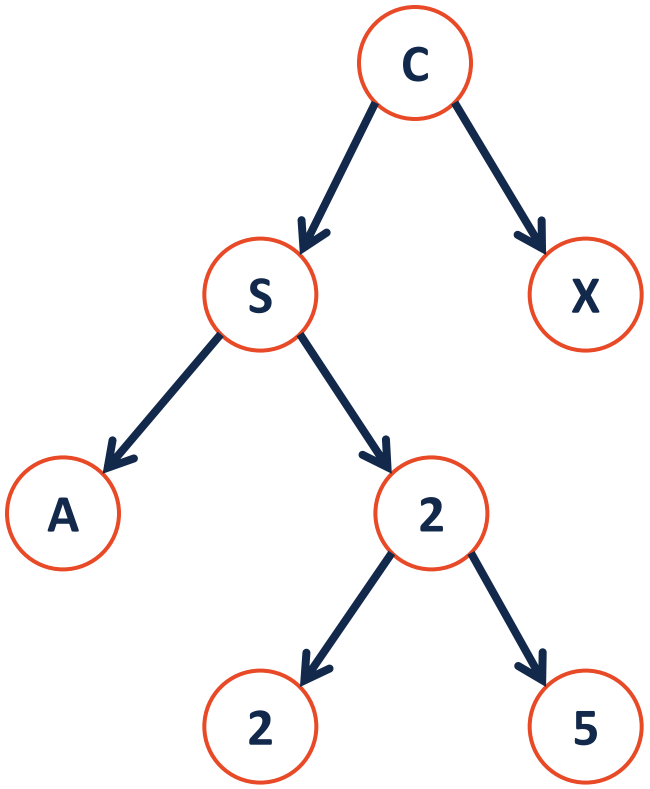
height(T) =

Tree Property: full

A tree ***F*** is **full** if and only if:

1.

2.

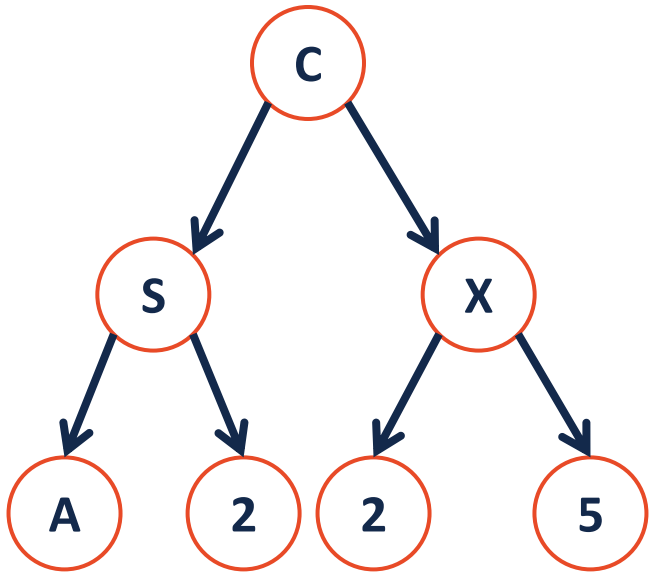


Tree Property: perfect

A **perfect** tree ***P*** is:

1.

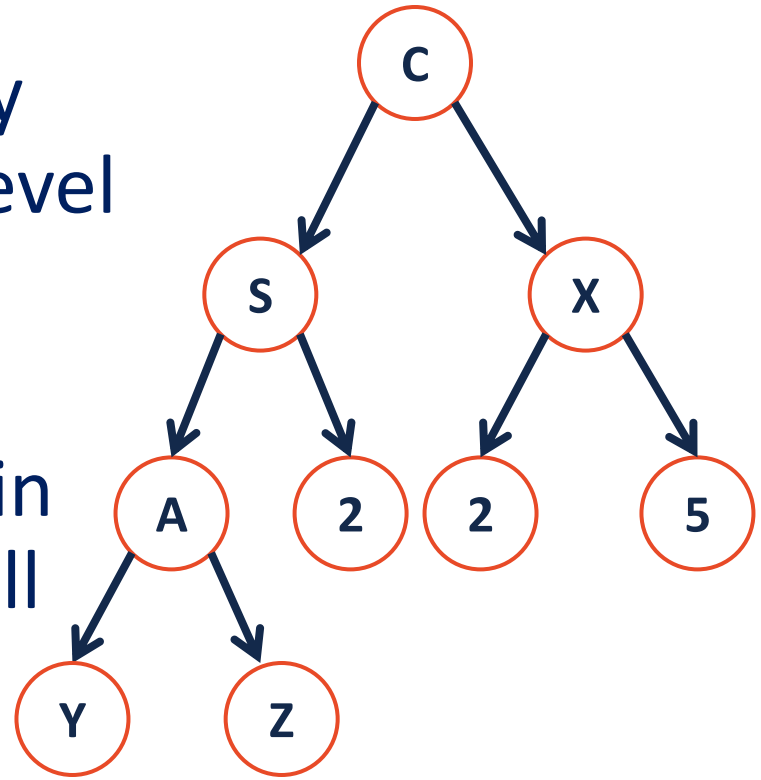
2.



Tree Property: complete

Conceptually: A perfect tree for every level except the last, where the last level if "pushed to the left".

Slightly more formal: For any level k in [0, h-1], k has 2^k nodes. For level h, all nodes are "pushed to the left".



Tree Property: complete

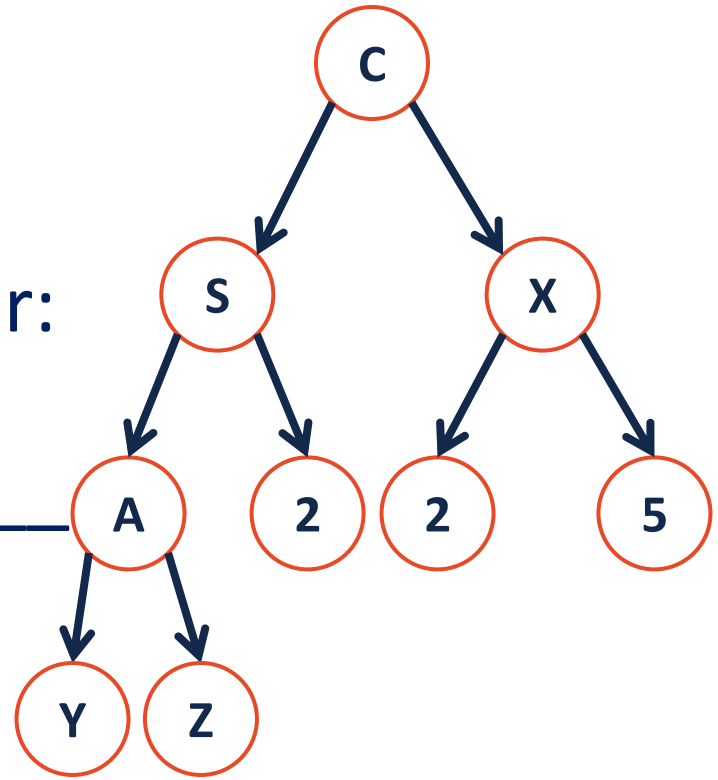
A **complete** tree ***C*** of height **h**, $\mathbf{C_h}$:

1. $\mathbf{C_{-1}} = \{\}$
2. $\mathbf{C_h}$ *(where h>0)* **= {r, $\mathbf{T_L}$, $\mathbf{T_R}$}** and either:

T_L is _____ and T_R is _____

OR

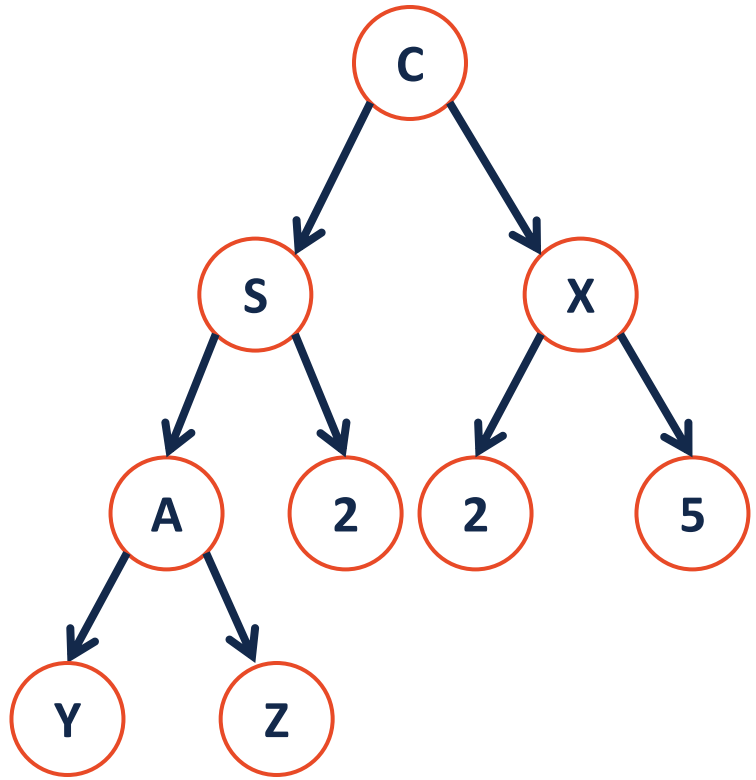
T_L is _____ and T_R is _____



Tree Property: complete

Is every **full** tree **complete**?

If every **complete** tree **full**?



CS 225 – Things To Be Doing

Exam 4 (Programming/MP2) currently ongoing!

More Info: https://courses.engr.illinois.edu/cs225/fa2017/exams/

MP3: Available now!

Up to +7 extra for submission by tonight!

Lab: lab_tree coming this week!

+6 for completion and +4 for attendance

POTD

Every Monday-Friday – *Worth +1 Extra Credit /problem (up to +40 total)*