CS 225

#14: Trees and our First Tree Proof

September 24, 2021 · *G Carl Evans*

Using an Iterator

stlList.cpp

```
1  #include <vector>
2  #include <string>
3  #include <iostream>
4
5  struct Animal {
6    std::string name, food;
7    bool big;
8    Animal(std::string name = "blob", std::string food = "you",
   bool big = true) :
9      name(name), food(food), big(big) { /* nothing */ }
10 };
11
12 int main() {
13   Animal g("giraffe", "leaves", true),
            p("penguin", "fish", false), b("bear");
14   std::vector<Animal> zoo;
15
16   zoo.push_back(g);
17   zoo.push_back(p);   // std::vector's insertAtEnd
18   zoo.push_back(b);
19
20   for ( std::vector<Animal>::iterator it = zoo.begin();
                                      it != zoo.end(); it++ ) {
21     std::cout << (*it).name << " " << (*it).food << std::endl;
22   }
23
24   return 0;
25 }
```

Q: What does the above code do?

For-Each loop with Iterators

stlList-forEach.cpp

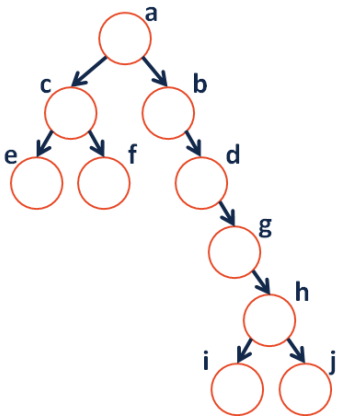
```
20 for ( const Animal & animal : zoo ) {
21   std::cout << animal.name << " " << animal.food << std::endl;
22 }
```

Trees!

"The most important non-linear data structure in computer science."
- David Knuth, The Art of Programming, Vol. 1

We will primarily talk about **binary trees:**

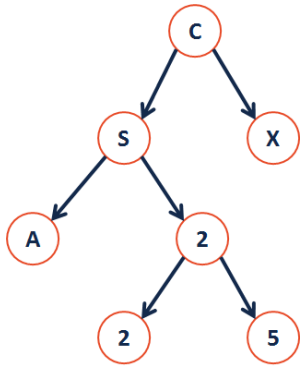
- How many parents does each vertex have?
- Which vertex has the fewest **children**?
- Which vertex has the most **ancestors**?
- Which vertex has the most **descendants**?
- List all the vertices is b's left **subtree**.
- List all the **leaves** in the tree.



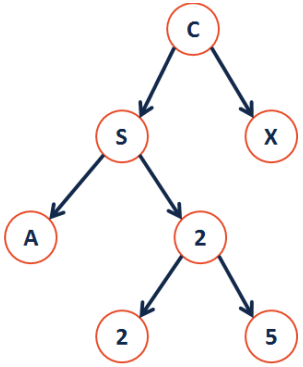
Definition: Binary Tree

A *binary tree* **T** is:

The height of a tree **T** is:

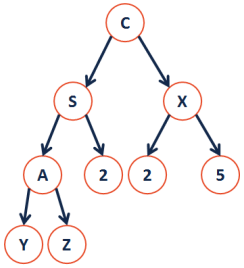


Tree Property: Full



Tree Property: Perfect

Tree Property: Complete



Towards a Tree Implementation – Tree ADT:

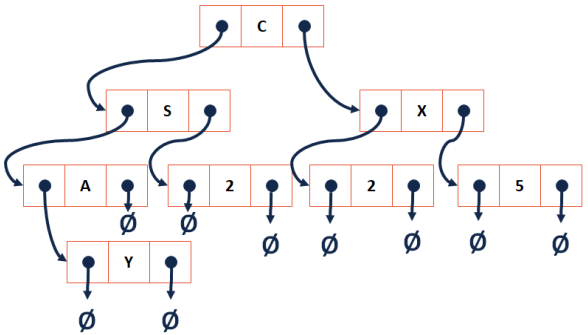
ADT Functionality (English Description)	Function Call

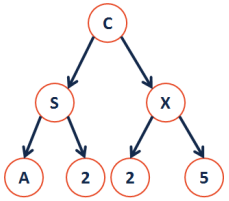
Tree Class

BinaryTree.h

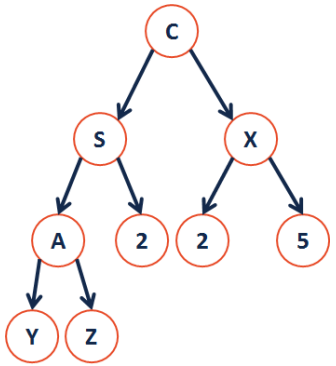
```
1  #pragma once
2
3  template <typename T>
4  class BinaryTree {
5    public:
6      /* ... */
7    private:
8
9
10
11
12 };
```

Trees are nothing new – they're fancy linked lists:





Theorem: If there are n data items in our representation of a binary tree, then there are _____ NULL pointers.



CS 225 – Things To Be Doing:

1. mp_lists extra credit deadline Monday
2. Practice for Exam 1 open.
3. Daily POTDs