CS 225

#13: Trees

February 13, 2018 · *Fagen-Ulmschneider, Zilles*

Iterators

In C++, iterators provide an interface for client code access to data in a way that abstracts away the internals of the data structure.

An instance of an iterator is a current location in a pass through the data structure:

Type	Cur. Location	Current Data	Next
Linked List			
Array			
Cube			

The iterator minimally implements three member functions:
`operator*`, Returns the current data
`operator++`, Advance to the next data
`operator!=`, Determines if the iterator is at a different location

Implementing an Iterator

A class that implements an iterator must have two pieces:

1. [Implementing Class]: Must implement:

   -

   -

2. [Implementing Class' Iterator]:
   A separate class (usually an internal class) that extends `std::iterator` and implements an iterator. This requires:

   -

   -

   -

Locations of ::begin and ::end iterators:

Type	::begin()	::end()
Linked List		
Array		

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?

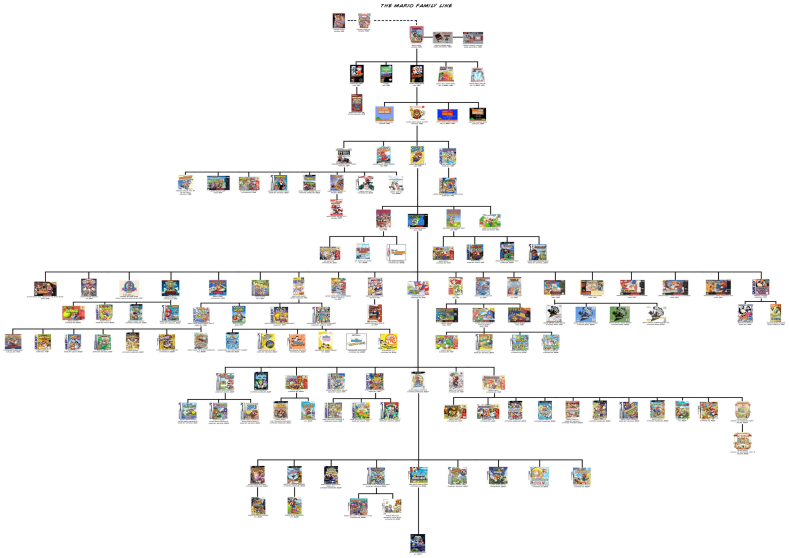
For-Each loop with Iterators

stlList-forEach.cpp

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

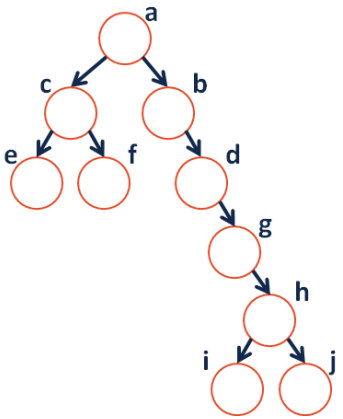
Trees!

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



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

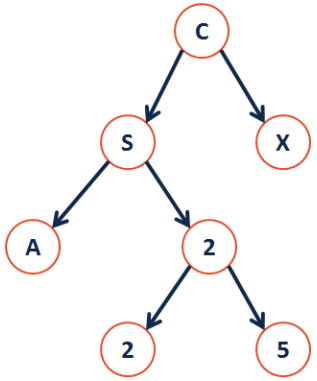
- **Vertices** (singular: vertex) are the nodes in the tree
- Find an **edge** that is not on the longest **path** in the tree. Give that edge a reasonable name.
- One of the vertices is called the **root** of the tree. Which one?
- Indentify the vertices that have a **parent** but no **sibling**.
- 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.



Definition: Binary Tree

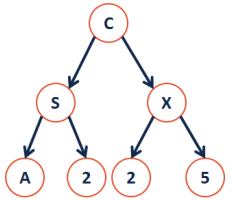
A *binary tree* **T** is either:

Tree Property: Tree Height

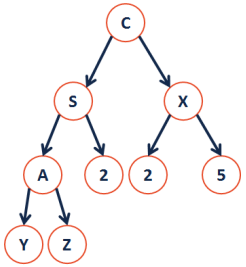


Tree Property: Full

Tree Property: Perfect



Tree Property: Complete



CS 225 – Things To Be Doing:

1. Programming Exam A starts tomorrow (Thursday!)
2. MP3 has been released; extra credit deadline is Monday!
3. lab_quacks in lab this week
4. Daily POTDs