CS 225

#13: Trees
September 25, 2018 · *G Carl Evans*

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			
Hypercube			

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:

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

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Locations of ::begin and ::end iterators:

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

Using an Iterator

stlList.cpp

```
#include <vector>
#include <string>
#include <iostream>

struct Animal {
  std::string name, food;
  bool big;
  Animal(std::string name = "blob", std::string food = "you",
bool big = true) :
    name(name), food(food), big(big) { /* nothing */ }
};

int main() {
  Animal g("giraffe", "leaves", true),
         p("penguin", "fish", false), b("bear");
  std::vector<Animal> zoo;

  zoo.push_back(g);
  zoo.push_back(p);   // std::vector's insertAtEnd
  zoo.push_back(b);

  for ( std::vector<Animal>::iterator it = zoo.begin();
                                  it != zoo.end(); it++ ) {
    std::cout << (*it).name << " " << (*it).food << std::endl;
  }

  return 0;
}
```

Q: What does the above code do?

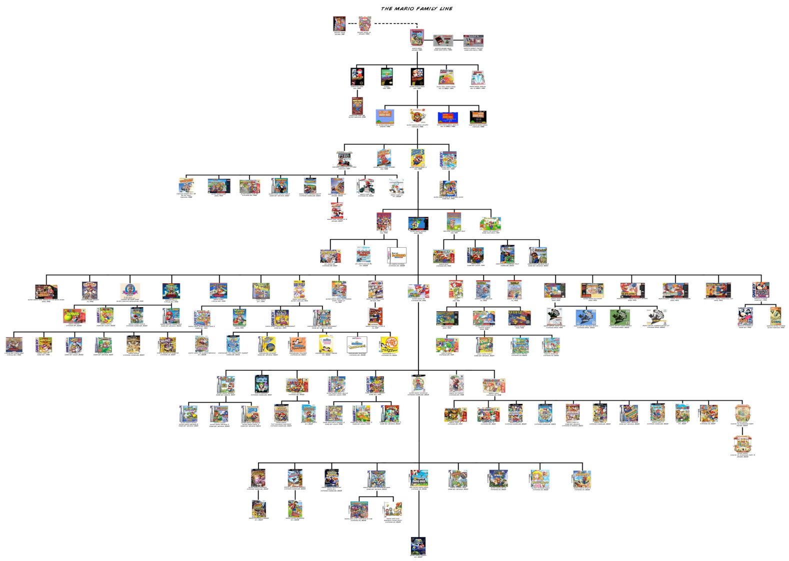
For-Each loop with Iterators

stlList-forEach.cpp

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

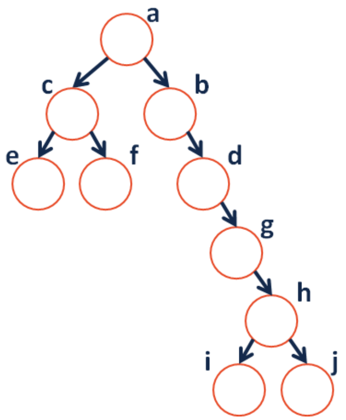
Trees!

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



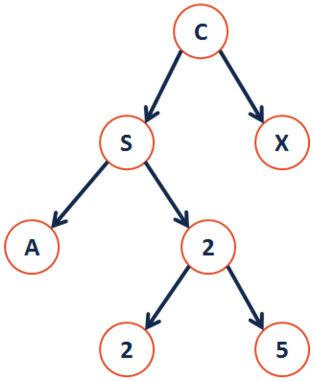
We will primarily talk about **binary trees:**

- What's the longest **English 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 a "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.



Definition: Binary Tree

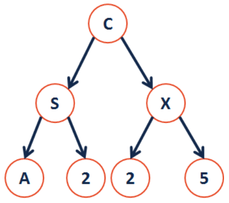
A *binary tree* **T** is either:



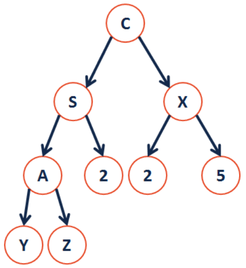
Tree Property: Tree Height

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