Topic 8
Iterators

"First things first, but not necessarily in that order "

-Dr. Who

Iterators

- ArrayList is part of the *Java Collections Framework*
- *Collection* is an interface that specifies the basic operations every collection (data structure) shall have
- Some Collections don't have a definite order
  - Sets, Maps, Graphs
- How to access all the items in a Collection with no specified order?

Iterator Interface

- An iterator object is a "one shot" object
  - it is designed to go through all the elements of a Collection once
  - if you want to go through the elements of a Collection again you have to get another iterator object
- Iterators are obtained by calling a method from the Collection

Iterator Iterface Methods

- The Iterator interface 3 methods we will use:

```
boolean hasNext()
```

//returns true if this iteration has more elements

```
E next()
```

//returns the next element in this iteration

//pre: hastNext()

```
void remove()
```

/*Removes from the underlying collection the last element returned by the iterator.

pre: This method can be called only once per call to next. After calling, must call next again before calling remove again.

*/

Clicker 1

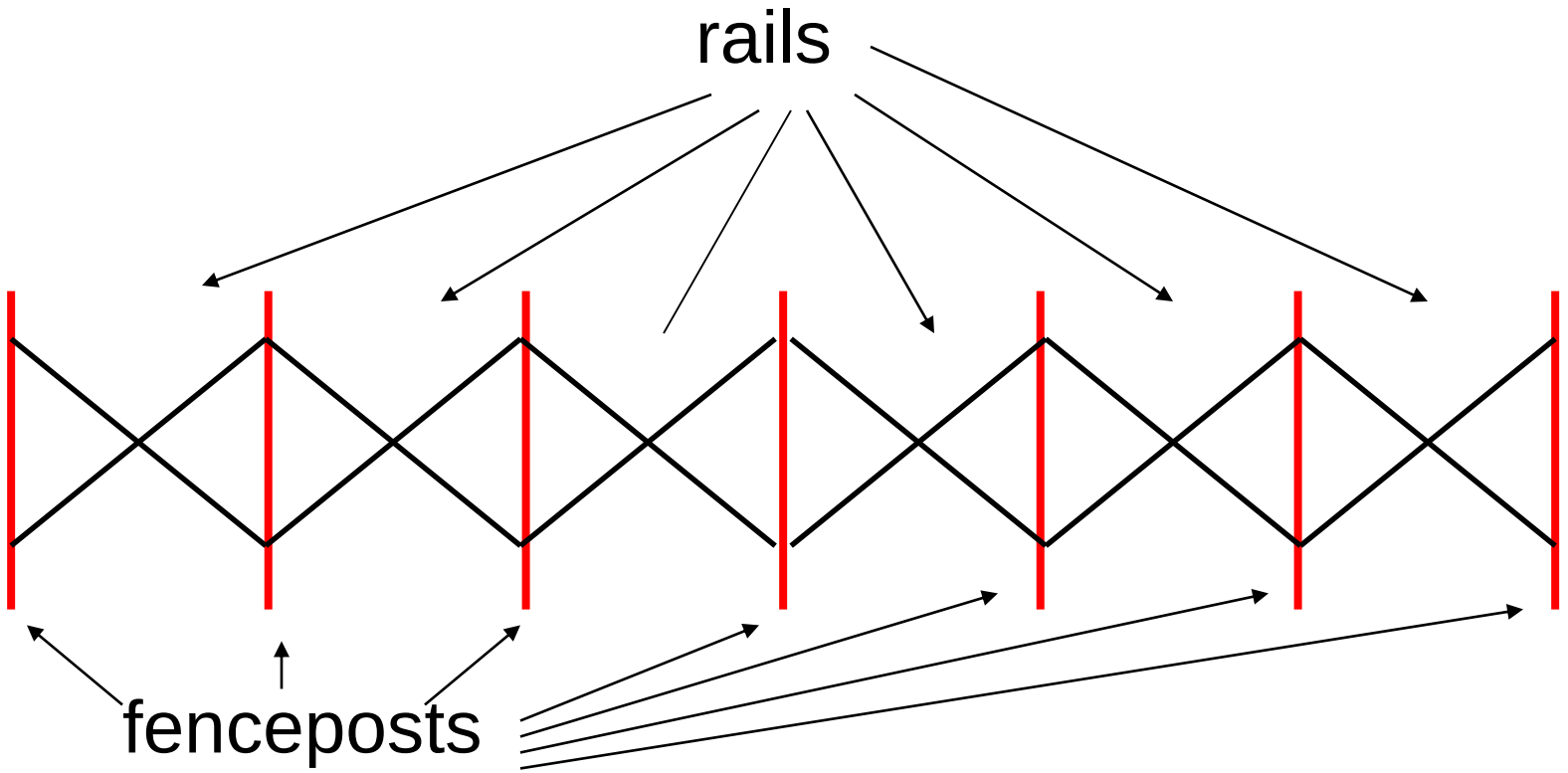
- Which of the following produces a syntax error?

```
ArrayList<String> list = new ArrayList<>();
Iterator<String> it1 = new Iterator(); // I
Iterator<String> it2 = new Iterator(list); // II
Iterator<String> it3 = list.iterator(); // III
```

A. I
B. II
C. III
D. I and II
E. II and III

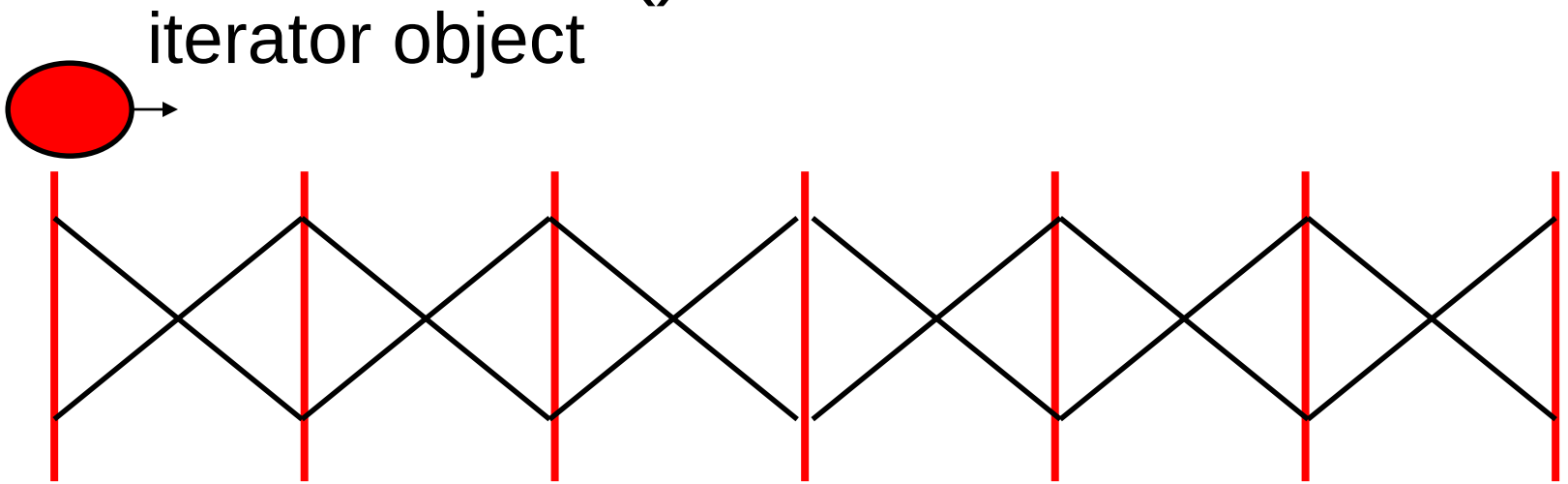
Iterator

- Imagine a fence made up of fence posts and rail sections



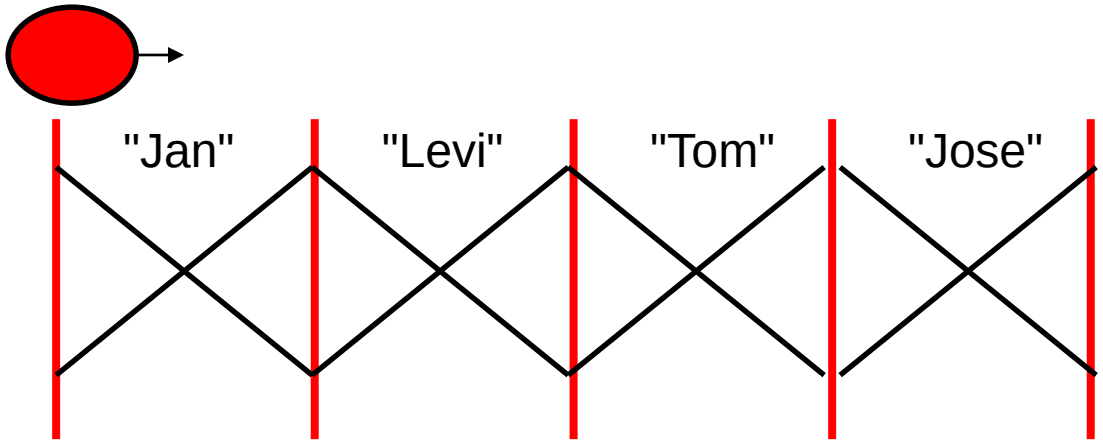
Fence Analogy

- The iterator lives on the fence posts
- The data in the collection are the rails
- Iterator created at the far left post
- As long as a rail exists to the right of the Iterator, hasNext() is true



Fence Analogy

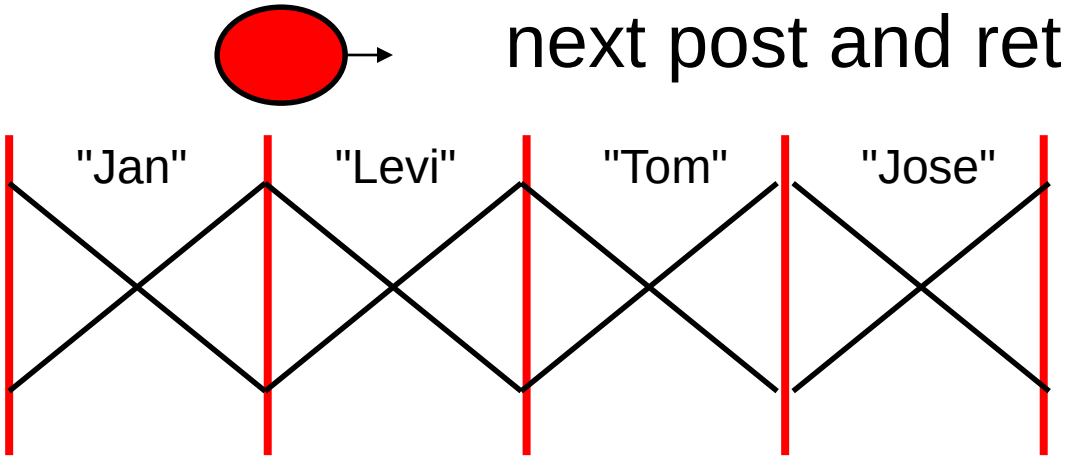
```
ArrayList<String> names = new ArrayList<>();
names.add("Jan");
names.add("Levi");
names.add("Tom");
names.add("Jose");
Iterator<String> it = names.iterator();
int i = 0;
```



Fence Analogy

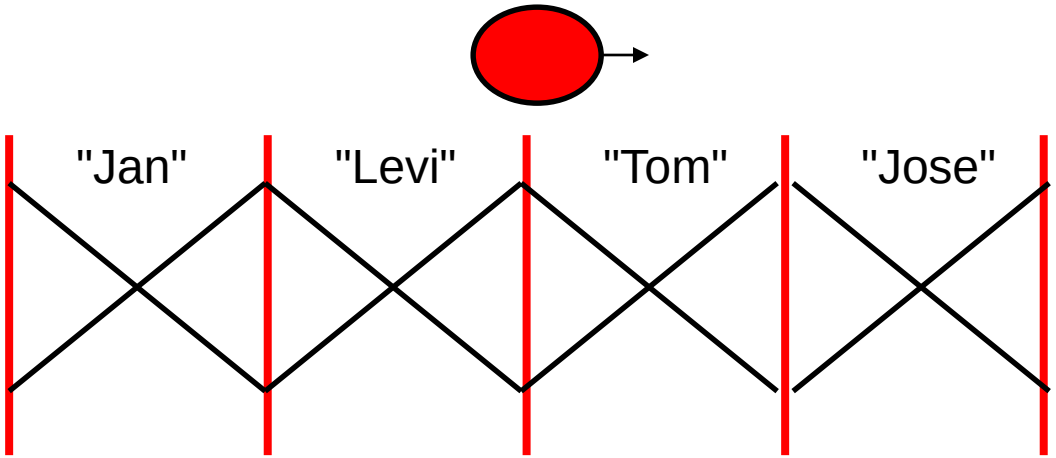
```
while(it.hasNext()) {
     i++;
     System.out.println(it.next());
}
// when i == 1, prints out Jan
```

first call to next moves iterator to next post and returns "Jan"



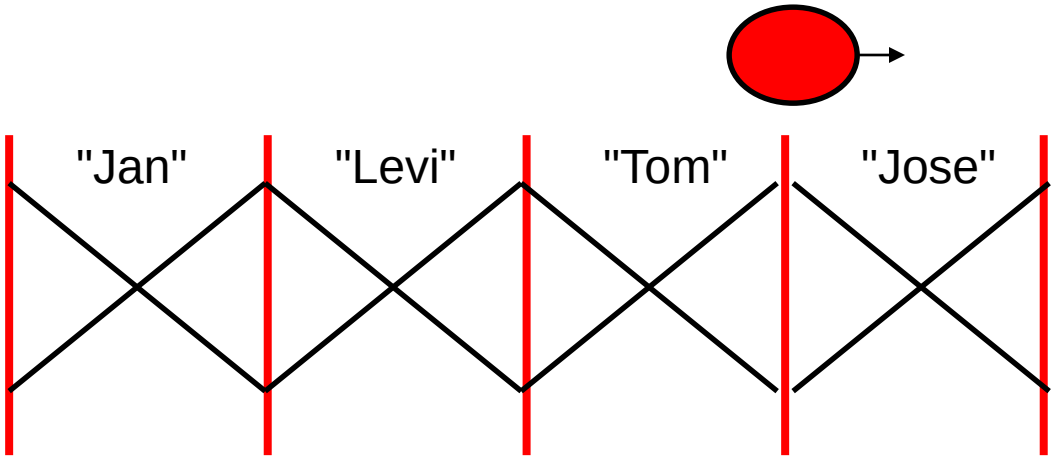
Fence Analogy

```
while(it.hasNext()) {
     i++;
     System.out.println(it.next());
}
// when i == 2, prints out Levi
```



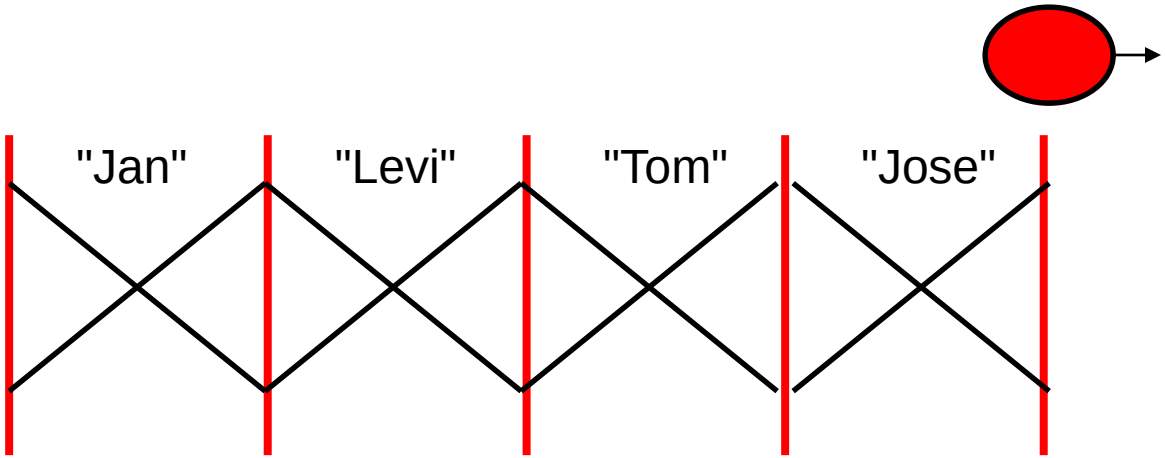
Fence Analogy

```
while(it.hasNext()) {
     i++;
     System.out.println(it.next());
}
// when i == 3, prints out Tom
```



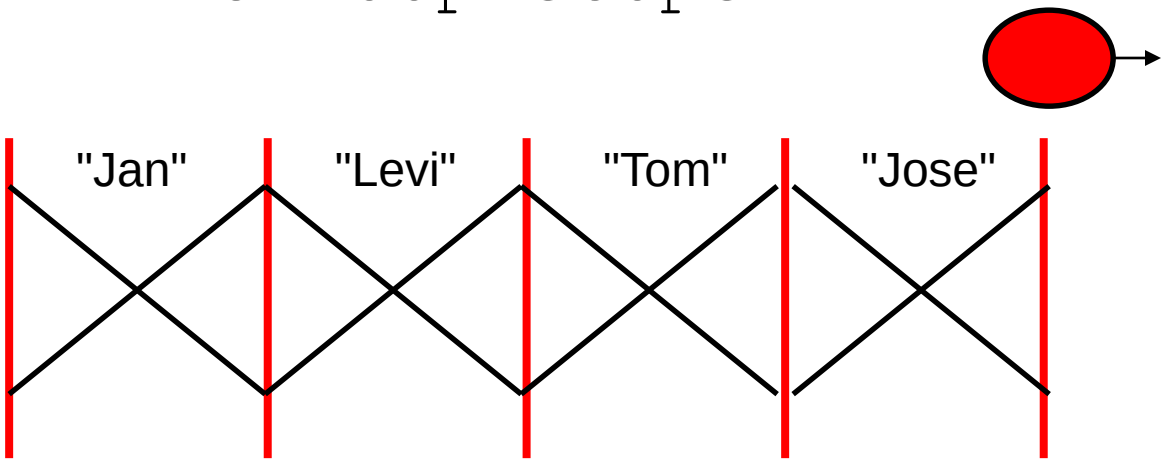
Fence Analogy

```
while(it.hasNext()) {
     i++;
     System.out.println(it.next());
}
// when i == 4, prints out Jose
```



Fence Analogy

```
while(it.hasNext()) {
    i++;
    System.out.println(it.next());
}
// call to hasNext returns false
// while loop stops
```



Typical Iterator Pattern

```
public void printAll(Collection<String> col) {
    Iterator<String> it = col.iterator();
    while (it.hasNext()) {
        String temp = it.next();
        System.out.println(temp);
    }
}
```

OR……

```
for (String temp : col) {
    System.out.println(temp);
}
```

Clicker Question 2

- What is output by the following code?

```
ArrayList<Integer> list = new ArrayList<>();
list.add(3);
list.add(3);
list.add(5);
Iterator<Integer> it = list.iterator();
System.out.print(it.next() + " ");
System.out.print(it.next() + " ");
System.out.print(it.next());
```

A. `3`

B. `3 5`

C. `3 3 5`

D. `3 3`

E. `3 3` then a runtime error

remove method

- An `Iterator` can be used to remove things from the `Collection`
- Can only be called once per call to `next()`

```
public void removeWordsOfLength(int len) {
   Iterator<String> it = myList.iterator
   while(it.hasNext()) {
      String temp = it.next();
      if (temp.length() == len) {
           it.remove();
      }
    }
}
// original list = ["dog", "cat", "hat", "sat"]
// resulting list after removeWordsOfLength(3) ?
```

Clicker 3

```
public void printTarget(Collection<String>
                                names, int len) {
    Iterator<String> it = names.iterator();
    while(it.hasNext())
        if(it.next().length() == len)
            System.out.println(it.next());
}
```

Given names = ["Jan", "Ivan", "Tom", "George"] and len = 3 what is output by the printTarget method?

A. Jan Ivan Tom George
B. Jan Tom
C. Ivan George
D. No output due to syntax error
E. No output due to runtime error

The Iterable Interface

- A related interface is `Iterable`
- The method of interest to us in the interface:

```
public Iterator<T> iterator()
```

- Why?
- Anything that implements the `Iterable` interface can be used in the for each loop.

```
ArrayList<Integer> list;
//code to create and fill list
int total = 0;
for (int x : list) {
    total += x;
 }
```

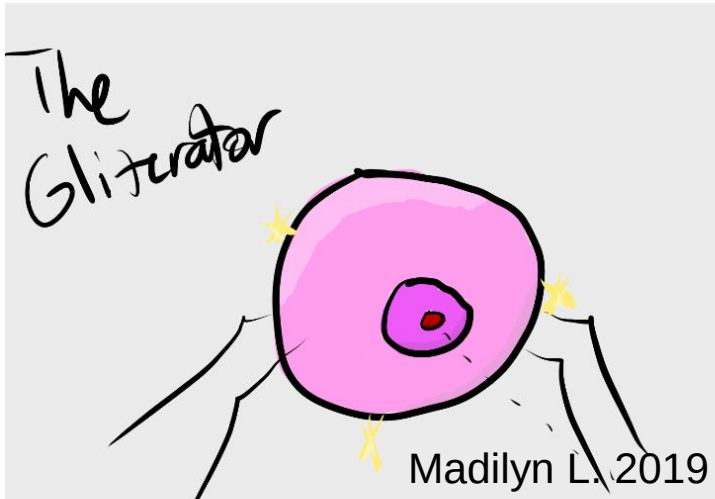
Iterable

- If you simply want to go through all the elements of a Collection (or Iterable thing) use the for each loop
  - hides creation of the Iterator

```
public void printAllOfLength(ArrayList<String> names,
                                                int len){
    //pre: names != null, names only contains Strings
    //post: print out all elements of names equal in
    // length to len
   for (String s : names)
      if (s.length() == len)
            System.out.println(s);
}
```

Implementing an Iterator

- Implement an Iterator for our GenericList class
  - Nested Classes
  - Inner Classes
  - Example of encapsulation
  - checking precondition on remove
  - does our GenricList *need* an Iterator?



Comodification

- If a `Collection` (`ArrayList`) is changed while an iteration via an iterator is in progress an Exception will be thrown the next time the `next()` or `remove()` methods are called via the iterator

```
ArrayList<String> names = new ArrayList<>();
names.add("Jan");
Iterator<String> it = names.iterator();
names.add("Andy");
it.next(); // exception occurs here
```