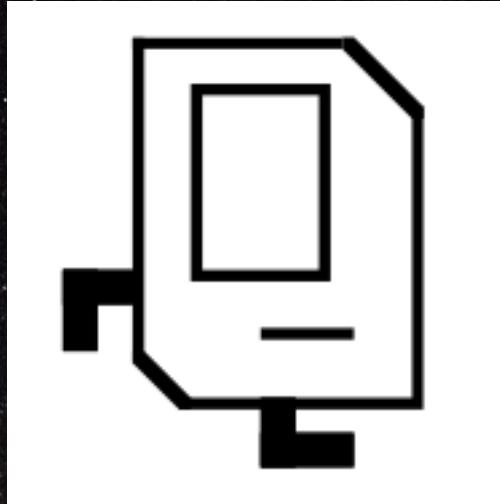


"BREAKOUT" IS A STUPID GAME.

<https://xkcd.com/347/>

Piech, CS106A, Stanford University





File Processing & ArrayLists

Nick Troccoli
CS106A, Stanford University

Learning Goals

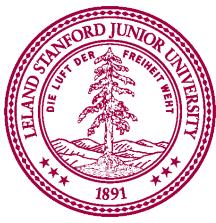
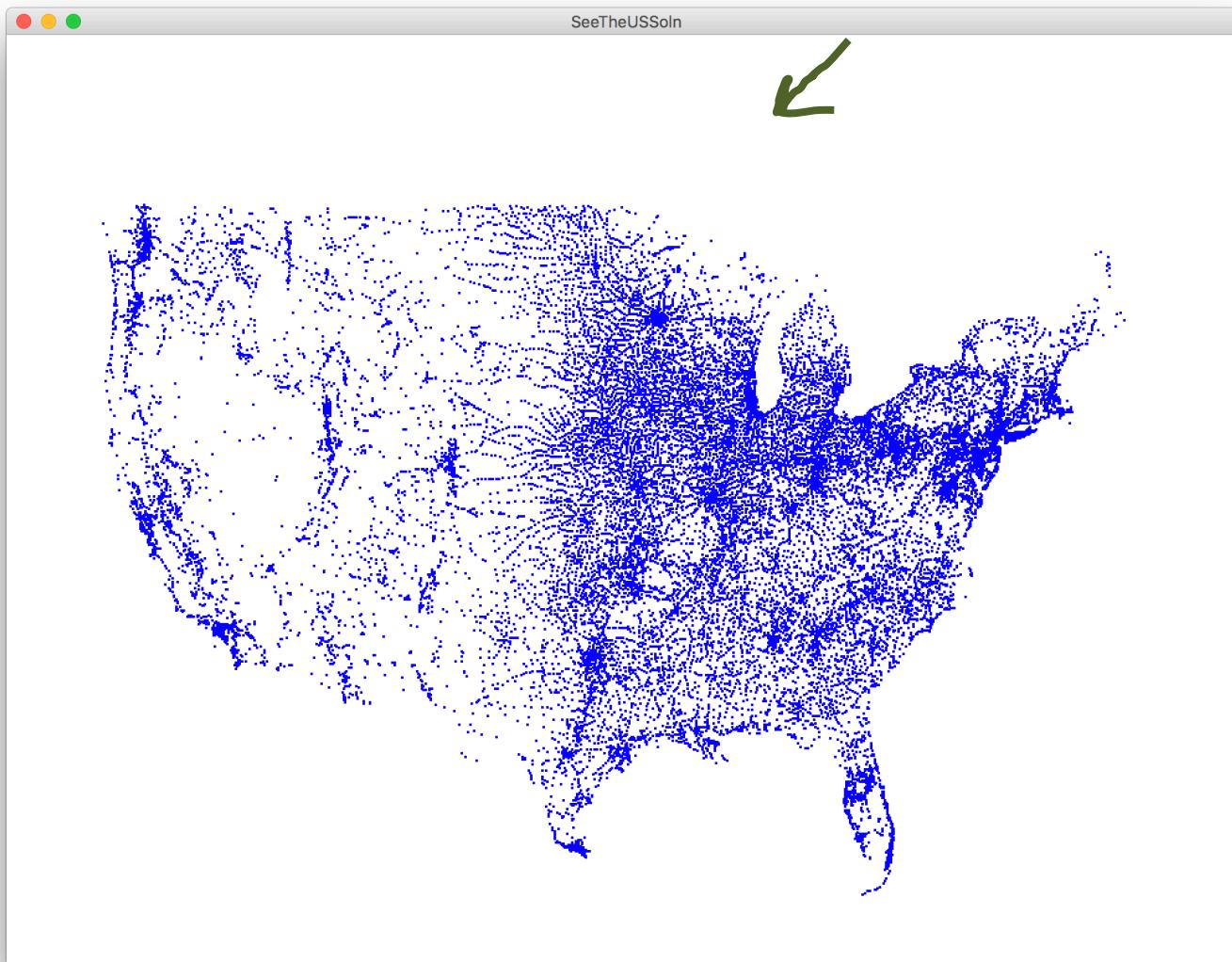
1. Know how to read a file line by line.
2. Know how to store and retrieve data from an ArrayList.



File Processing

Thanks Keith Schwarz for some great slides to build off!

Each blue dot is a tiny
GRect



Files Are Cool!

- Virtually all programs that you've used at some point read files from disk:
 - Word processing (documents)
 - Web browser (cookies)
 - Games (saved progress)
 - Eclipse (Java files)
 - Music player (songs)



The structure of files

- A file is just a series of **bits** (ones and zeros).
- Those bits can have structure:
 - Plain-text: Bits represent characters.
 - JPEG: Bits encode information about the structure of an image.
 - MP3: Bits encode frequency information about music.
 - etc.



The structure of files

- A file is just a series of *bits* (ones and zeros).
- Those bits can have structure:
 - Plain-text: Bits represent characters.
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Yesterday, upon the stair,
I met a man who wasn't there
He wasn't there again today
I wish, I wish he'd go away...
- Hughes Mearns, "Antagonish"



Yesterday, upon the stair,
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Step one:
Open the file for reading.



Yesterday, upon the stair,
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He wasn't there again today
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```
BufferedReader br =  
    new BufferedReader(new FileReader("poem.txt"));
```



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```
BufferedReader br =  
    new BufferedReader(new FileReader("poem.txt"));
```

To use the **BufferedReader** and **FileReader**
types, you need to

```
import java.io.*;
```



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```
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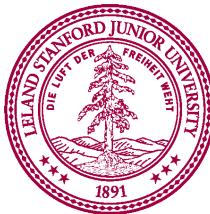
```
BufferedReader br =  
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```

Step Two:
Read the file,
one line at a time.



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```
BufferedReader br =  
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String line1 = br.readLine();
```



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BufferedReader br =  
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String line1 = br.readLine();
```



Yesterday, upon the stair,

I met a man who wasn't there

He wasn't there again today

I wish, I wish he'd go away...

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```
BufferedReader br =
```

```
    new BufferedReader(new FileReader("poem.txt"));
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```
String line1 = br.readLine(); // Yesterday, upon the stair,
```



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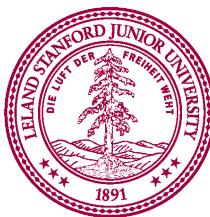
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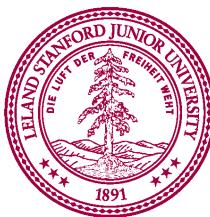
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String line3 = br.readLine(); // He wasn't there again today  
String line4 = br.readLine(); // I wish, I wish he'd go away...  
String line5 = br.readLine();
```



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I met a man who wasn't there
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I wish, I wish he'd go away...

- Hughes Mearns, "Antagonish"

```
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String line4 = br.readLine(); // I wish, I wish he'd go away...  
String line5 = br.readLine(); // - Hughes Mearns, "Antagonish"  
String line6 = br.readLine();
```



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String line6 = br.readLine(); // *Returns null*
```



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String line5 = br.readLine(); // - Hughes Mearns, "Antagonish"  
String line6 = br.readLine(); // *Returns null*
```

Step Three:
Close the file.



Yesterday, upon the stair,
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String line4 = br.readLine(); // I wish, I wish he'd go away...  
String line5 = br.readLine(); // - Hughes Mearns, "Antagonish"  
String line6 = br.readLine(); // *Returns null*  
  
br.close();
```



Yesterday, upon the stair,
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```
BufferedReader br =  
    new BufferedReader(new FileReader("poem.txt"));  
  
String line = br.readLine();  
while (line != null) {                // while there are more lines...  
    println(line);                    // print out each line  
    line = br.readLine();  
}  
br.close();
```



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```
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    println(line);                    // print out each line  
    line = br.readLine();  
}  
br.close();
```



Sometimes things break

- Programs sometimes encounter unexpected errors.
- Sometimes these are bugs:
 - Dividing by zero.
 - Sending a message to a **null** object.
- Sometimes these are due to external factors:
 - Network errors.
 - Missing files.



Exceptional cases

- An ***exception*** occurs if Java encounters a case where it can't proceed as normal.
- Java requires that your program handle certain types of exceptions.
- Think of exceptions as rerouting control in an emergency:
 - If all goes well, program continues as usual.
 - If something goes wrong, handle the emergency.
- File processing exceptions: file not found, corrupted, etc.



try-ing your best

- To use a method or class that might cause an exception, you must tell Java to **try** its best, knowing it might fail.

```
try {  
    BufferedReader br =  
        new BufferedReader(new FileReader("poem.txt"));  
  
    String line = br.readLine();  
    while (line != null) {  
        println(line); // print out each line  
        line = br.readLine();  
    }  
    br.close();  
}
```



try and catch me

- If an exception occurs, you need to tell Java to **catch** that exception, and what to do after that.

```
try {  
    BufferedReader br =  
        new BufferedReader(new FileReader("poem.txt"));  
  
    String line = br.readLine();  
    while (line != null) {                // while there are more lines...  
        println(line);                  // print out each line  
        line = br.readLine();  
    }  
    br.close();  
} catch (IOException e) {  
    // Handle the exception if there is one  
    println("An error occurred: " + e);  
}
```



try and catch me

- If an exception occurs, you need to tell Java to **catch** that exception, and what to do after that.

If something fails up here...

```
try {  
    BufferedReader br =  
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    String line = br.readLine();  
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        line = br.readLine();  
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} catch (IOException e) {  
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    println("An error occurred: " + e);  
}
```



try and catch me

- If an exception occurs, you need to tell Java to **catch** that exception, and what to do after that.

If something fails up here...

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try {  
    BufferedReader br =  
        new BufferedReader(new FileReader("poem.txt"));  
  
    String line = br.readLine();  
    while (line != null) {  
        println(line); // print out each line  
        line = br.readLine();  
    }  
    br.close();  
} catch (IOException e) {  
    // Handle the exception if there is one  
    println("An error occurred: " + e);  
}
```

// while there are more lines...
// print out each line

... we immediately jump down here.



try and catch me

- If an exception occurs, you need to tell Java to **catch** that exception, and what to do after that.

```
try {  
    BufferedReader br =  
        new BufferedReader(new FileReader("poem.txt"));  
  
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        println(line);            // print out each line  
        line = br.readLine();  
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    String line = br.readLine();  
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        println(line);           // print out each line  
        line = br.readLine();  
    }  
    br.close();  
} catch (IOException e) {  
    // Handle the exception if there is one  
    throw new RuntimeException(e);  
}
```



try and catch me

- If an exception occurs, you need to tell Java to **catch** that exception, and what to do after that.

```
try {  
    BufferedReader br =  
        new BufferedReader(new FileReader("poem.txt"));  
  
    String line = br.readLine();  
    while (line != null) {          // while there are more lines...  
        println(line);           // print out each line  
        line = br.readLine();  
    }  
    br.close();  
} catch (IOException e) {  
    // Handle the exception if there is one  
    e.printStackTrace();  
}
```



File concepts in one slide

1. Make a BufferedReader to open a file to read

```
BufferedReader br = new BufferedReader(new FileReader("poem.txt"));
```

2. Use br.readLine to get one line from the file, usually in a loop

```
br.readLine(); // returns the next line, or null
```

3. Both the above operations are “dangerous” so we need to use a try/catch block

```
try {
    // you can do it!
} catch (Exception e){
    // ok maybe not
}
```

4. You can either handle the problem or throw a runtime exception

```
throw new RuntimeException("AHHHH!");
```



Canonical File Processing Program

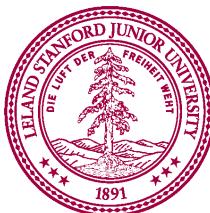
```
try {
    BufferedReader br = /*...open the file...*/
    String line = br.readLine();
    while (line != null) {

        /* ... process current line ... */

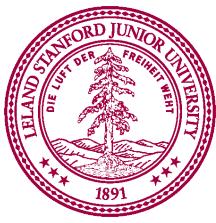
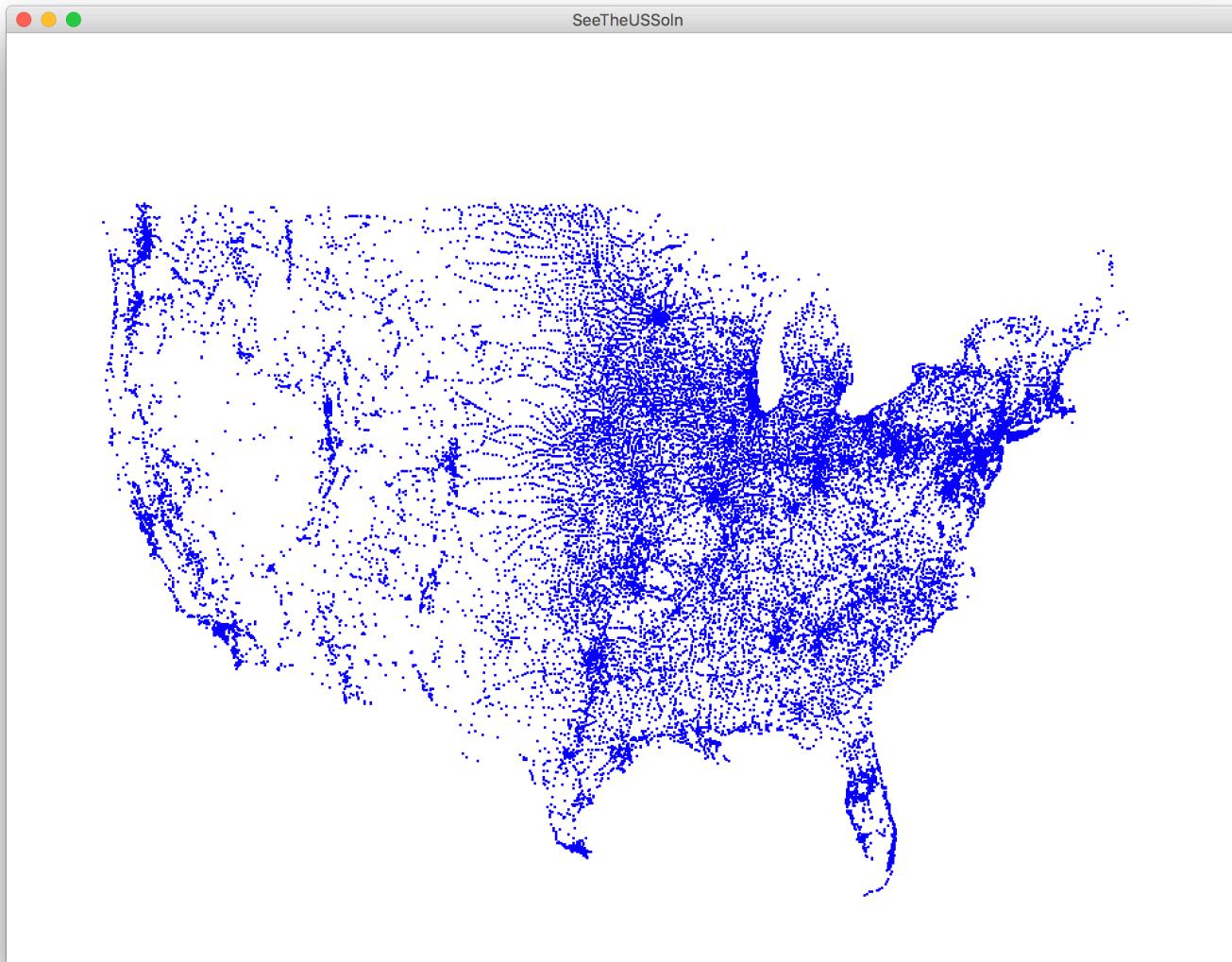
        line = br.readLine(); /* get next line */
    }
    br.close();
} catch (IOException e) {
    throw new RuntimeException(e);
}
```



Understanding this code is about 95%
of what we want you to know for files in
CS106A



Example: US Census Data



Example: US Census Data

```
us-cities.txt — Edited ▾  
Abbeville, AL  
31.566367  
-85.251300  
Adamsville, AL  
33.590411  
-86.949166  
Addison, AL  
34.200042  
-87.177851  
Akron AL
```



Example: US Census Data

City name

```
us-cities.txt — Edited ▾  
Abbeville, AL  
31.566367  
-85.251300  
Adamsville, AL  
33.590411  
-86.949166  
Addison, AL  
34.200042  
-87.177851  
Akron AL
```



Example: US Census Data

Latitude

```
us-cities.txt — Edited ▾  
Abbeville, AL  
31.566367  
-85.251300  
Adamsville, AL  
33.590411  
-86.949166  
Addison, AL  
34.200042  
-87.177851  
Akron AL
```



Example: US Census Data

Longitude →

```
us-cities.txt — Edited ▾  
Abbeville, AL  
31.566367  
-85.251300  
Adamsville, AL  
33.590411  
-86.949166  
Addison, AL  
34.200042  
-87.177851  
Akron AL
```



Example: US Census Data

... →

```
us-cities.txt — Edited ▾
```

Abbeville, AL
31.566367
-85.251300
Adamsville, AL
33.590411
-86.949166
Addison, AL
34.200042
-87.177851
Akron AL



Recap: File Processing

1. Make a BufferedReader to open a file to read

```
BufferedReader br = new BufferedReader(new FileReader("poem.txt"));
```

2. Use br.readLine to get one line from the file, usually in a loop

```
br.readLine(); // returns the next line, or null
```

3. Both the above operations are “dangerous” so we need to use a try/catch loop

```
try {
    // you can do it!
} catch (Exception e){
    // ok maybe not
}
```

4. You can either handle the problem or throw a runtime exception

```
throw new RuntimeException("AHHHH!");
```



ArrayLists

Thanks Keith Schwarz for some great slides to build off!

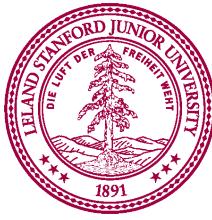
ArrayList

- An ordered, resizable list of information
- Homogeneous
- Can add and remove elements (among other cool functionality)
- Can store any **object** type
- Requires importing **java.util.***;



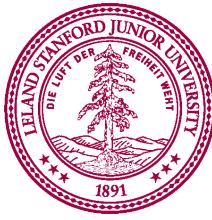
Our First ArrayList

```
ArrayList<String> myArrayList = new ArrayList<String>();
```



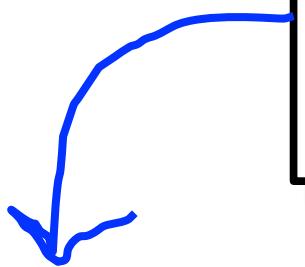
Our First ArrayList

```
ArrayList<String> myArrayList = new ArrayList<String>();
```



Our First ArrayList

Type of thing your
ArrayList will store.

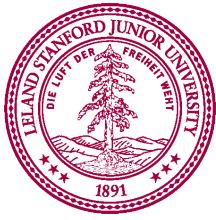


```
ArrayList<String> myArrayList = new ArrayList<String>();
```



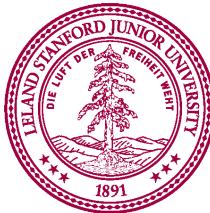
Our First ArrayList

```
ArrayList<String> myArrayList = new ArrayList<String>();
```



Our First ArrayList

```
ArrayList<String> myArrayList = new ArrayList<String>();
```



Our First ArrayList

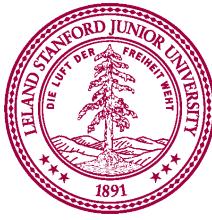
Same type here, but
followed by ()�

```
ArrayList<String> myArrayList = new ArrayList<String>();
```



Our First ArrayList

```
ArrayList<String> myArrayList = new ArrayList<String>();
```



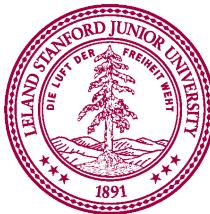
Our First ArrayList

```
ArrayList<String> myArrayList = new ArrayList<String>();  
  
// Adds elements to the back  
myArrayList.add("hi");
```



Our First ArrayList

```
ArrayList<String> myArrayList = new ArrayList<String>();  
  
// Adds elements to the back  
myArrayList.add("hi");  
myArrayList.add("there");
```



Our First ArrayList

```
ArrayList<String> myArrayList = new ArrayList<String>();  
  
// Adds elements to the back  
myArrayList.add("hi");  
myArrayList.add("there");  
  
// Access elements by index (starting at 0!)  
println(myArrayList.get(0)); // prints "hi"  
println(myArrayList.get(1)); // prints "there"
```



Our First ArrayList

```
ArrayList<String> myArrayList = new ArrayList<String>();  
  
// Adds elements to the back  
myArrayList.add("hi");  
myArrayList.add("there");  
  
// Access elements by index (starting at 0!)  
println(myArrayList.get(0)); // prints "hi"  
println(myArrayList.get(1)); // prints "there"  
  
// Wrong type - bad times! Won't compile  
GLabel label = new GLabel("hi there");  
myArrayList.add(label);
```



Our First ArrayList

```
ArrayList<String> myArrayList = new ArrayList<String>();  
  
// Adds elements to the back  
myArrayList.add("hi");  
myArrayList.add("there");  
  
// Access elements by index (starting at 0!)  
println(myArrayList.get(0)); // prints "hi"  
println(myArrayList.get(1)); // prints "there"  
  
// Wrong type - bad times! Won't compile  
GLabel label = new GLabel("hi there");  
myArrayList.add(label);  
  
// Invalid index – crashes! IndexOutOfBoundsException Exception  
println(myArrayList.get(2));
```



Our First ArrayList

```
ArrayList<String> myArrayList = new ArrayList<String>();  
  
// Adds elements to the back  
myArrayList.add("hi");  
myArrayList.add("there");  
  
// Access elements by index (starting at 0!)  
for (int i = 0; i < myArrayList.size(); i++) {  
    println(myArrayList.get(i));  
}  
  
// hi  
// there
```



Methods in the `ArrayList` Class

`boolean add(<T> element)`

Adds a new element to the end of the `ArrayList`; the return value is always `true`.

`void add(int index, <T> element)`

Inserts a new element into the `ArrayList` before the position specified by `index`.

`<T> remove(int index)`

Removes the element at the specified position and returns that value.

`boolean remove(<T> element)`

Removes the first instance of `element`, if it appears; returns `true` if a match is found.

`void clear()`

Removes all elements from the `ArrayList`.

`int size()`

Returns the number of elements in the `ArrayList`.

`<T> get(int index)`

Returns the object at the specified index.

`<T> set(int index, <T> value)`

Sets the element at the specified index to the new value and returns the old value.

`int indexOf(<T> value)`

Returns the index of the first occurrence of the specified value, or `-1` if it does not appear.

`boolean contains(<T> value)`

Returns `true` if the `ArrayList` contains the specified value.

`boolean isEmpty()`

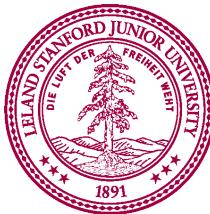
Returns `true` if the `ArrayList` contains no elements.



ArrayLists + Primitives = 💔

```
// Doesn't compile 😞  
ArrayList<int> myArrayList = new ArrayList<int>();
```

ArrayLists can only store **objects**!



ArrayLists + Primitives = ❤️

Primitive	“Wrapper” Class
int	Integer
double	Double
boolean	Boolean
char	Character



ArrayLists + Wrappers = ❤

```
// Just use wrapper class when making an ArrayList
ArrayList<Integer> numList = new ArrayList<Integer>();

numList.add(123);
numList.add(546);

int firstNum = numList.get(0);      // 123
int secondNum = numList.get(1);    // 456
```

Conversion happens automatically!



Demo: File Processing + ArrayLists



Piech, CS106A, Stanford University



Summary of Today

- `BufferedReader`s let us read a file line by line.
- Since bad things can happen outside our control when reading files, we must use `try/catch`.
- `ArrayLists` are homogeneous lists of objects.
- You can add, remove, get, find, etc. on `ArrayLists`.



ArrayList

Good luck on the
midterm!

