Collection Classes

(Part 1: Vectors, Grids, Stacks, and Queues)

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CS 106B
January 12, 2015

Computer Forum Career Fair

STANFORD COMPUTER FORUM

Computer Forum Career Fair (For CS and EE Students)

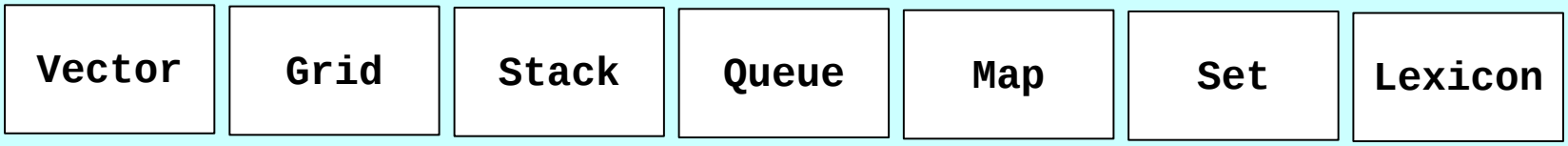
When:	**Wed, January 14, 11am – 4pm**
What:	**Computer Forum Career Fair**
Date:	**Wednesday, January 14**
Time:	**Time: 11am - 4pm**
Location:	**Lawn between the Mudd Chemistry and the Gates CS Buildings**
Description:	**The Computer Forum Career Fairs enable Stanford Engineering students, specifically CS and EE, to get a head start on careers and internships with Forum member companies.**

Outline

1. Introduce the idea of collection classes
2. Introduce the **`Vector`** class
3. Use vectors to read an entire file
4. Introduce the **`Grid`** class
5. Introduce the **`Stack`** class
6. Use stacks to balance parentheses
7. Introduce the **`Queue`** class

The Collection Classes

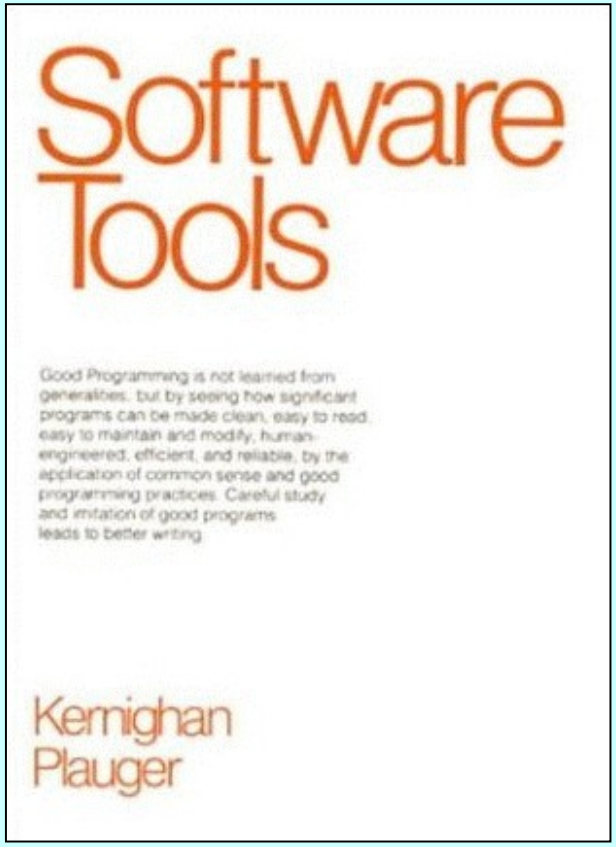
- For the rest of this week, we will be learning about the classes in Chapter 5. These classes contain other objects and are called ***container*** or ***collection classes***.



- Here are some general guidelines for using these classes:
  - These classes represent ***abstract data types*** whose details are hidden.
  - Each class (except **`Lexicon`**) requires type parameters.
  - Declaring variables of these types always invokes a ***constructor***.
  - Any memory for these objects is freed when its declaration scope ends.
  - Assigning one value to another *copies* the entire structure.
  - To avoid copying, these structures are usually passed by reference.

ADTs as Software Tools

- Over the relatively short history of software development, one of the clear trends is the increasing power of the tools available to you as a programmer.
- One of the best explanations of the importance of tools is the book *Software Tools* by Brian Kernighan and P. J. Plauger. Even though it was published in 1976, its value and relevance have not diminished over time.
- The primary theme of the book is that the best way to extend your reach in programming is to build on the tools of others.



Template Classes

- The collection classes are implemented as ***template classes***, which make it possible for an entire family of classes to share the same code.
- Instead of using the class name alone, the collection classes require a type parameter that specifies the element type. For example, **`Vector<int>`** represents a vector of integers. Similarly, **`Grid<char>`** represents a two-dimensional array of characters.
- It is possible to nest classes, so that, for example, you could use the following definition to represent a list of chess positions:

```
Vector<Grid<char>> chessPositions;
```

Constructors for the **`Vector<`***type***`>`** Class

`Vector<type> vec;` Initializes an empty vector of the specified element type.
`Vector<type> vec(n);` Initializes a vector with **`n`** elements all set to the default value of the type.
`Vector<type> vec(n, value);` Initializes a vector with **`n`** elements all set to **`value`**.

Methods in the **`Vector<`***type*`>`** Class

`vec.size()` Returns the number of elements in the vector.
`vec.isEmpty()` Returns **`true`** if the vector is empty.
`vec.get(i)` *or* **`vec[i]`** Returns the **`i`**th element of the vector.
`vec.set(i, value)` *or* **`vec[i] = value;`** Sets the **`i`**th element of the vector to **`value`**.
`vec.add(value)` *or* **`vec += value;`** Adds a new element to the end of the vector.
`vec.insert(index, value)` Inserts the value before the specified index position.
`vec.remove(index)` Removes the element at the specified index.
`vec.clear()` Removes all elements from the vector.

The `readEntireFile` Function

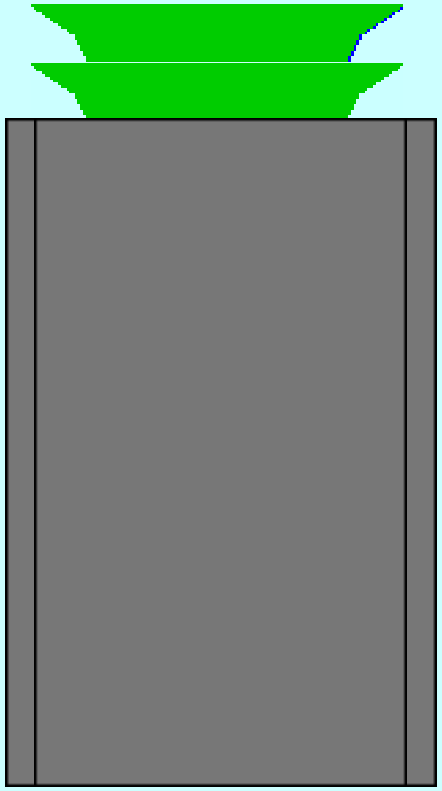
```
/*
 * Function: readEntireFile
 * Usage: readEntireFile(is, lines);
 * ---------------------------------
 * Reads the entire contents of the specified input stream
 * into the string vector lines.  The client is responsible
 * for opening and closing the stream
 */

void readEntireFile(istream & is, Vector<string> & lines) {
   lines.clear();
   string line;
   while (getline(is, line)) {
      lines.add(line);
   }
}
```

Methods in the **`Grid<`***type*`>`** Class

`Grid<type> grid(nrows, ncols);` Constructs a grid with the specified dimensions.
`grid.numRows()` Returns the number of rows in the grid.
`grid.numCols()` Returns the number of columns in the grid.
`grid[i][j]` Selects the element in the **`i`**th row and **`j`**th column.
`resize(nrows, ncols)` Changes the dimensions of the grid and clears any previous contents.
`inBounds(row, col)` Returns **`true`** if the specified row and column position is within the grid.

The Stack Metaphor

- A ***stack*** is a data structure in which the elements are accessible only in a ***last-in/first-out*** order.
- The fundamental operations on a stack are **push**, which adds a new value to the top of the stack, and **pop**, which removes and returns the top value.
- One of the most common metaphors for the stack concept is a spring-loaded storage tray for dishes. Adding a new dish to the stack pushes any previous dishes downward. Taking the top dish away allows the dishes to pop back up.



Methods in the **`Stack<`***type*`>`** Class

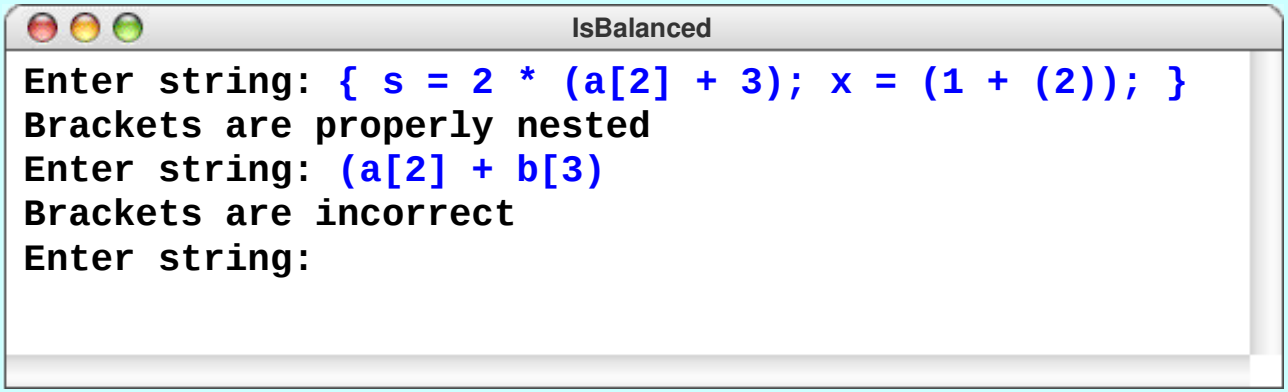
`stack.size()` Returns the number of values pushed onto the stack.
`stack.isEmpty()` Returns **`true`** if the stack is empty.
`stack.push(value)` Pushes a new value onto the stack.
`stack.pop()` Removes and returns the top value from the stack.
`stack.peek()` Returns the top value from the stack without removing it.
`stack.clear()` Removes all values from the stack.

Exercise: Stack Processing

Write a C++ program that checks whether the bracketing operators (parentheses, brackets, and curly braces) in a string are properly matched. As an example of proper matching, consider the string

```
{ s = 2 * (a[2] + 3); x = (1 + (2)); }
```

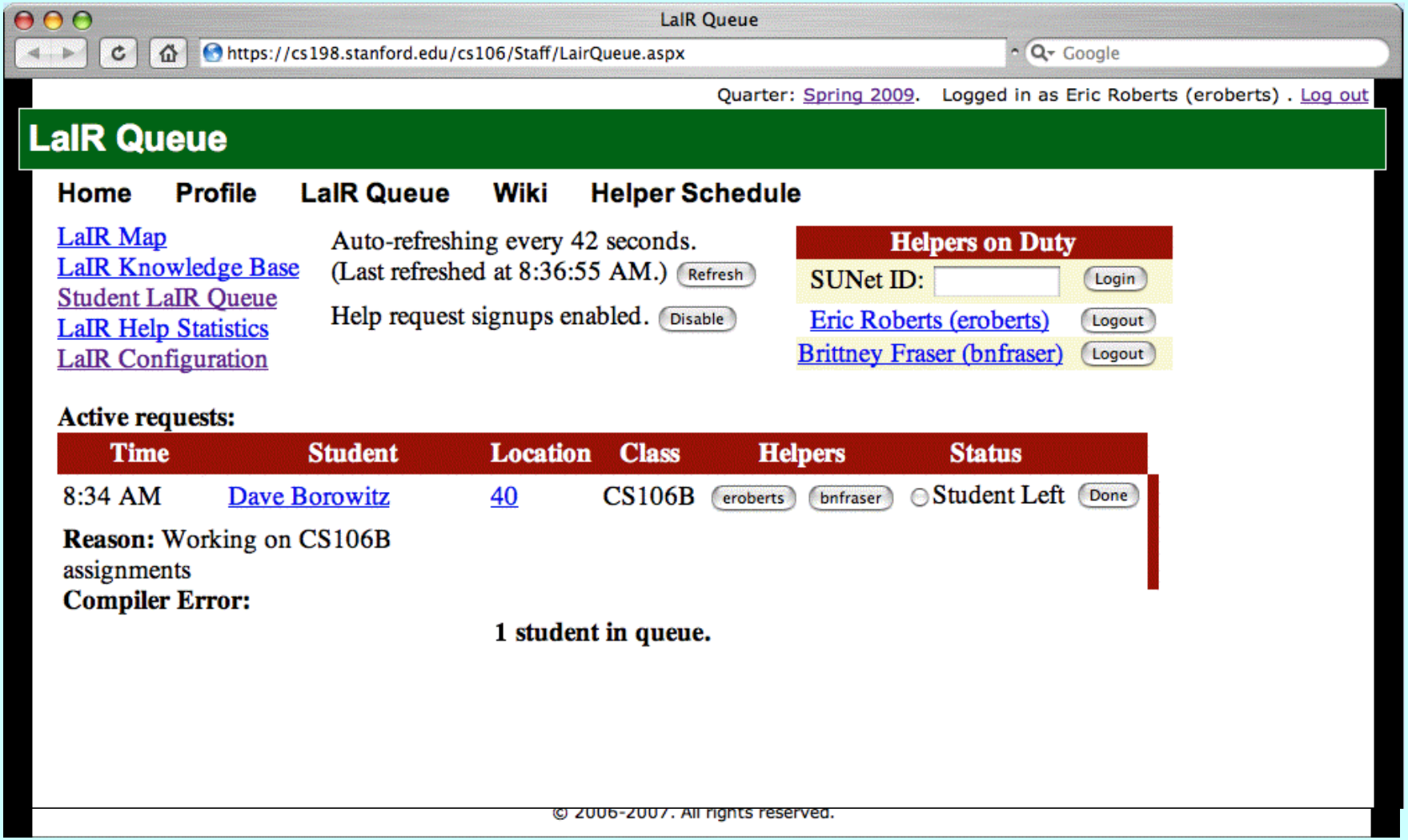
If you go through the string carefully, you discover that all the bracketing operators are correctly nested, with each open parenthesis matched by a close parenthesis, each open bracket matched by a close bracket, and so on.



Methods in the **`Queue<`***type*`>`** Class

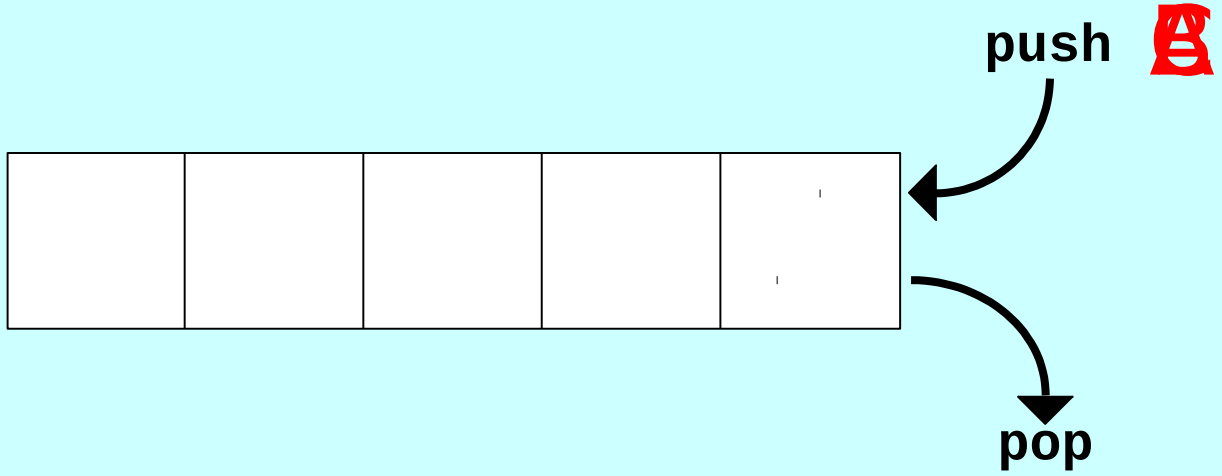
`queue.size()` Returns the number of values in the queue.
`queue.isEmpty()` Returns **`true`** if the queue is empty.
`queue.enqueue(value)` Adds a new value to the end of the queue (which is called its ***tail***).
`queue.dequeue()` Removes and returns the value at the front of the queue (which is called its ***head***).
`queue.peek()` Returns the value at the head of the queue without removing it.
`queue.clear()` Removes all values from the queue.

The LaIR Queue

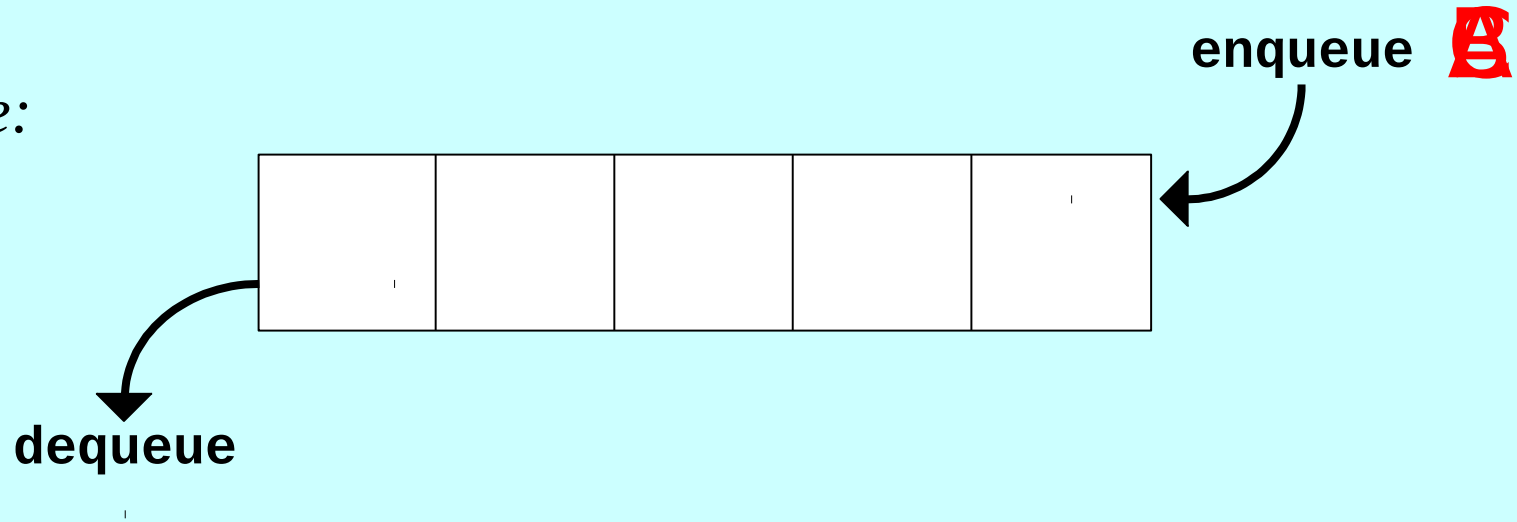


Comparing Stacks and Queues

Stack:



Queue:



The End