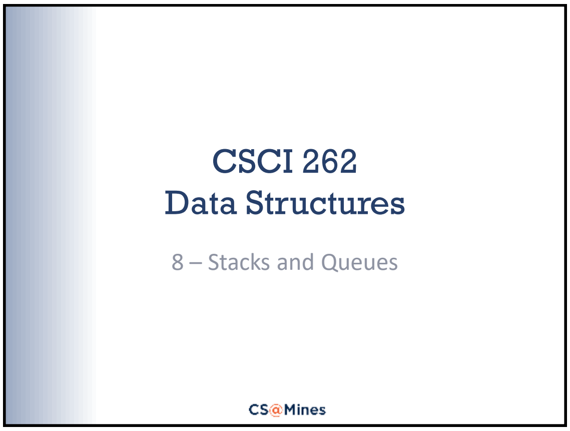
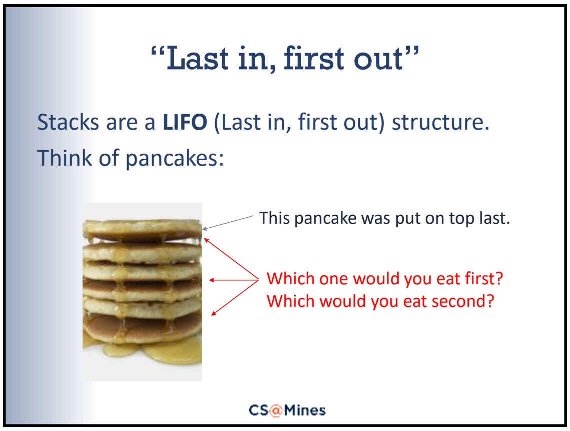


CSCI 262
Data Structures

8 – Stacks and Queues

Last in, first out:

STACKS



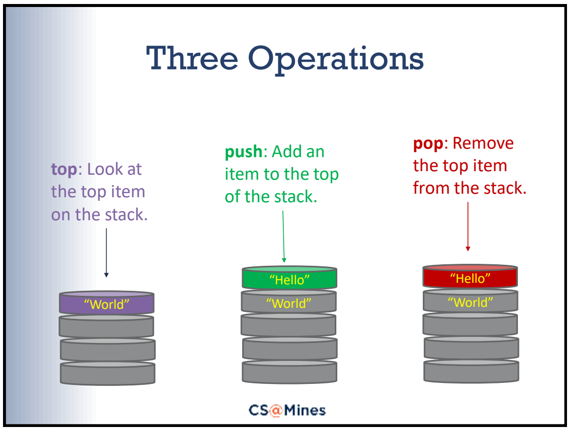
"Last in, first out"

Stacks are a **LIFO** (Last in, first out) structure.

Think of pancakes:

This pancake was put on top last.

Which one would you eat first?
Which would you eat second?

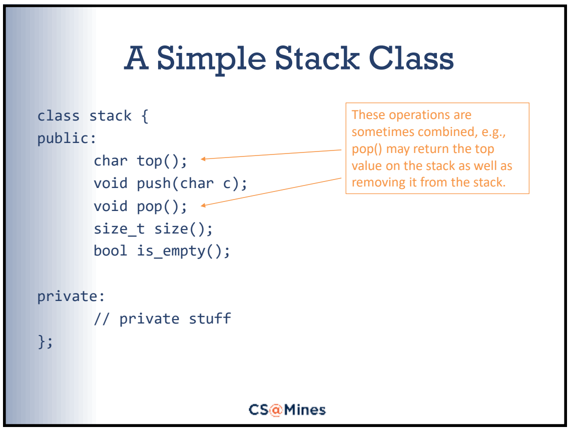


Three Operations

top: Look at the top item on the stack.

push: Add an item to the top of the stack.

pop: Remove the top item from the stack.

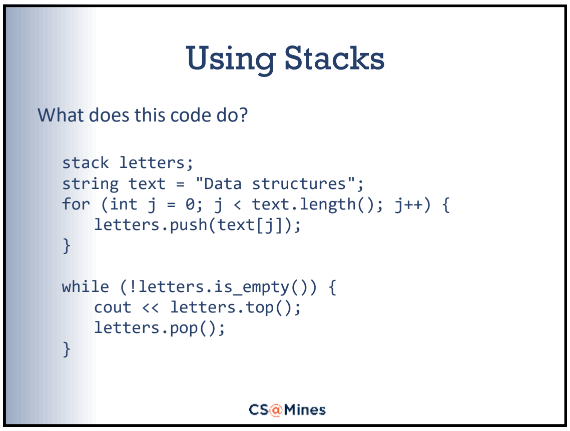


A Simple Stack Class

```
class stack {
public:
        char top();
        void push(char c);
        void pop();
        size_t size();
        bool is_empty();

private:
        // private stuff
};
```

These operations are sometimes combined, e.g., pop() may return the top value on the stack as well as removing it from the stack.



Using Stacks

What does this code do?

```
stack letters;
string text = "Data structures";
for (int j = 0; j < text.length(); j++) {
    letters.push(text[j]);
}

while (!letters.is_empty()) {
    cout << letters.top();
    letters.pop();
}
```

Applications

- Syntax analysis
  - Are parentheses, brackets, etc. balanced?
  - Nested structures (e.g., functions & variable scopes)
- Traversing/searching branching structures
  - Trees
  - Mazes
- Programming languages/processors
  - Forth, Postscript
  - Stack machines (e.g., Java virtual machine)

CS@Mines

Balancing Game

Rules:

- To start, make an empty stack.
- If you see a (, {, or [, push it onto the stack
- If you see a), }, or], try to pop the *matching* delimiter from the stack, but:
  - If the stack is empty, yell "UNDERFLOW!"
  - If wrong character is at the top, yell "SYNTAX ERROR!"
- When the game ends, if your stack is empty, yell "I WIN!" else yell "SYNTAX ERROR!"

CS@Mines

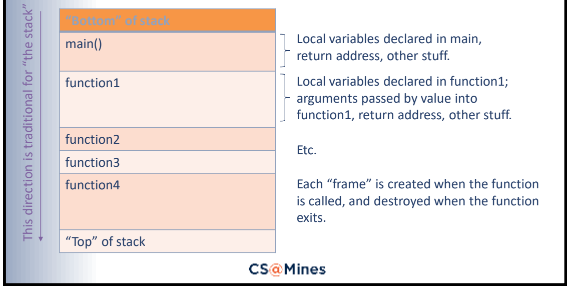
Balancing Game Inputs

- (easy)
- [[x];
- {um}]-
- {(a)|(b)}(c)
- ((x + y)*(m[a)]{z})
- ((x + y)*(m[a]){z})

CS@Mines

"The Stack"

When we talk about "the stack", we usually mean a very specific stack; the memory stack of a running program:



Local variables declared in main, return address, other stuff.

Local variables declared in function1; arguments passed by value into function1, return address, other stuff.

Etc.

Each "frame" is created when the function is called, and destroyed when the function exits.

CS@Mines

STL Stack

#include <stack>

template <class ValueType> class stack

Operations:

push(ValueType v)	// **push** value onto top of stack
pop()	// **pop** (remove) top value
top()	// return **top** value
size()	// return number of elements
empty()	// true if no elements

CS@Mines

First in, first out:

QUEUES

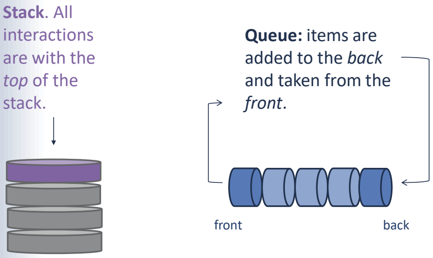
CS@Mines

"First in, first out"

Queues are a **FIFO** (first in, first out) structure. Think of a line of people waiting their turn:

If people are polite, the first in line is done first.

Queue vs. Stack

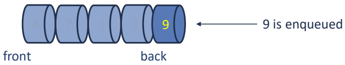


Stack. All interactions are with the *top* of the stack.

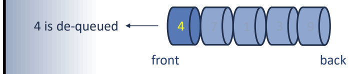
Queue: items are added to the *back* and taken from the *front*.

Operations

- Adding an item to a queue: *enqueue**



- Removing an item from a queue: *de-queue**



*These are the modern names. You'll find lots of implementations using "push" and "pop" instead, including the STL.

A Simple Queue Class

```
class queue {
public:
        char front();
        void enqueue(char c);
        void dequeue();
        size_t size();
        bool is_empty();

private:
        // private stuff
};
```

Using Queues

What does this code do?

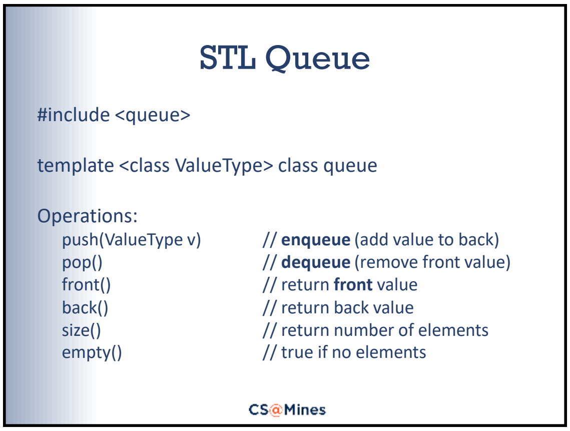
```
queue letters;
string text = "Data structures";
for (int j = 0; j < text.length(); j++) {
    letters.enqueue(text[j]);
}

while (!letters.is_empty()) {
    cout << letters.front();
    letters.dequeue();
}
```

Uses for Queues

Anywhere you need to keep things in order, particularly by time of arrival:

- Buffering character input
- Print jobs
- Process scheduling
- I/O request scheduling
- Web page request servicing
- Event handling (GUI, simulations, etc.)



STL Queue

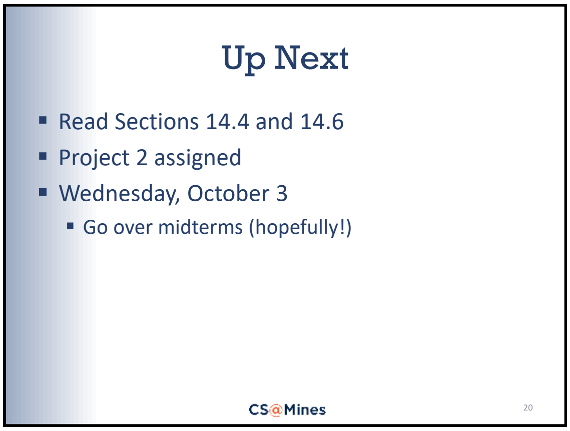
#include <queue>

template <class ValueType> class queue

Operations:

```
push(ValueType v)      // enqueue (add value to back)
pop()                  // dequeue (remove front value)
front()                // return front value
back()                 // return back value
size()                 // return number of elements
empty()                // true if no elements
```

CS@Mines



Up Next

- Read Sections 14.4 and 14.6
- Project 2 assigned
- Wednesday, October 3
  - Go over midterms (hopefully!)

CS@Mines

20