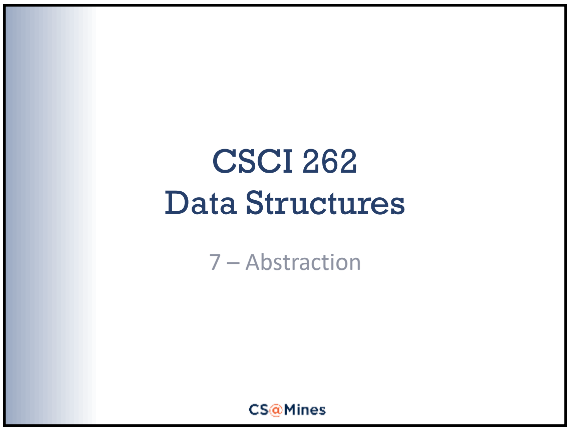

CSCI 262
Data Structures

7 – Abstraction

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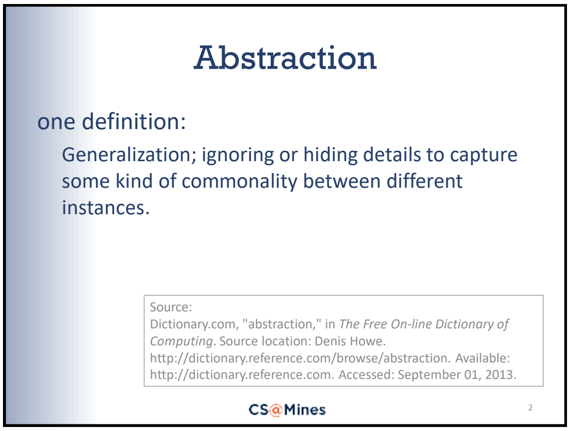

Abstraction

one definition:

Generalization; ignoring or hiding details to capture some kind of commonality between different instances.

Source:
Dictionary.com, "abstraction," in *The Free On-line Dictionary of Computing*. Source location: Denis Howe. http://dictionary.reference.com/browse/abstraction. Available: http://dictionary.reference.com. Accessed: September 01, 2013.

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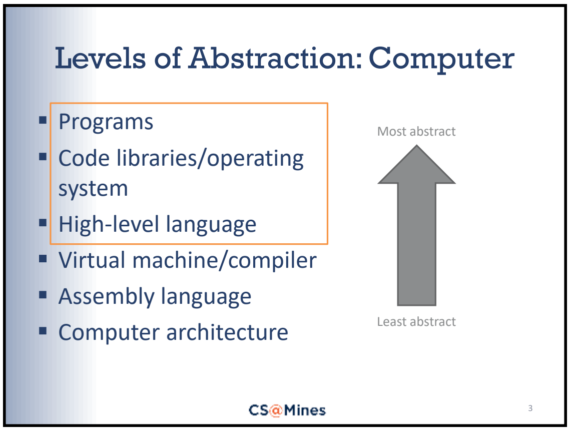

Levels of Abstraction: Computer

- Programs
- Code libraries/operating system
- High-level language
- Virtual machine/compiler
- Assembly language
- Computer architecture

Most abstract

Least abstract

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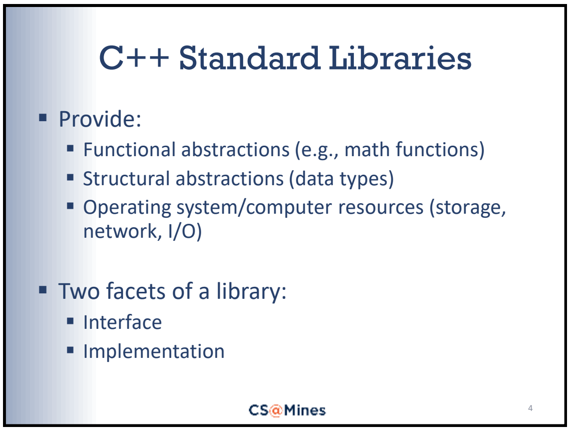

C++ Standard Libraries

- Provide:
  - Functional abstractions (e.g., math functions)
  - Structural abstractions (data types)
  - Operating system/computer resources (storage, network, I/O)
- Two facets of a library:
  - Interface
  - Implementation

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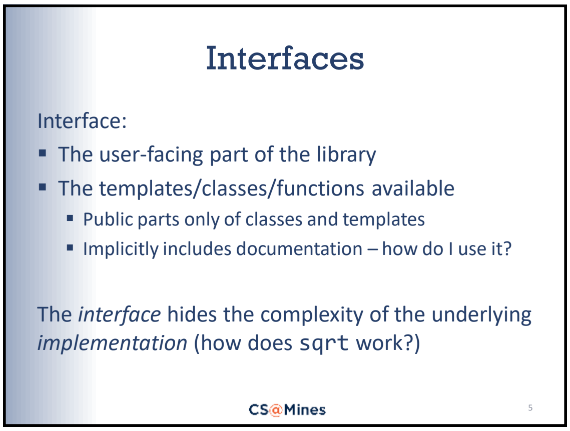

Interfaces

Interface:

- The user-facing part of the library
- The templates/classes/functions available
  - Public parts only of classes and templates
  - Implicitly includes documentation – how do I use it?

The *interface* hides the complexity of the underlying *implementation* (how does `sqrt` work?)

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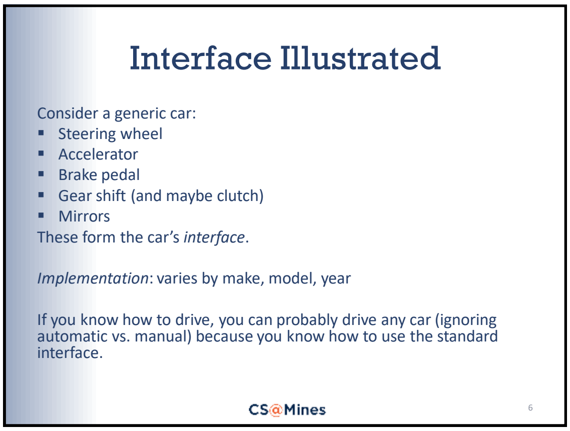

Interface Illustrated

Consider a generic car:

- Steering wheel
- Accelerator
- Brake pedal
- Gear shift (and maybe clutch)
- Mirrors

These form the car's *interface*.

Implementation: varies by make, model, year

If you know how to drive, you can probably drive any car (ignoring automatic vs. manual) because you know how to use the standard interface.

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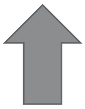
Same interface?

Levels of Abstraction: Data

- Abstract Data Types
- Concrete Data Types
- Storage (bits & bytes)



Example: Integer

- Abstract Data Type
  - Domain: positive and negative integers
    - Max, min values may be bounded
  - Interface: +, –, ×, ÷, =, etc.
- Concrete data type:
  - E.g., `int`
  - Implementation: in compiler
- Storage:
  - 1 word = 4 bytes = 32 bits
  - 2's complement representation (CSCI 341, others)

Abstract Data Type

- Defines a domain of values for the type
- Specifies a general *interface* for a type
  - Primarily specifies behaviors
  - Can also specify properties
  - May specify performance characteristics
- *Implementations* allowed to vary
  - Generally hidden
  - Generally irrelevant (except when not – RTFM*)

*Read The Fine Manual

Containers

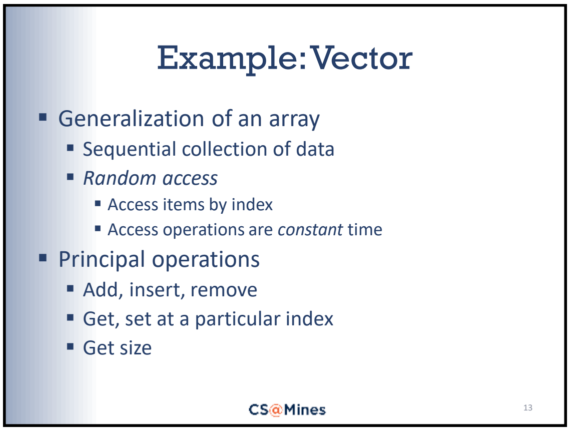
Structures which *contain* collections of objects:

- Vectors/Lists
- Stacks
- Queues
- Sets
- Maps

We will study all of these container types!

Why Study Containers

- They are incredibly useful:
  - Data naturally occur in collections
  - Key to many if not most important applications
    - Spreadsheets, databases
    - Signal processing/compression/cryptography
    - MapReduce (Google)
    - …
- They are instructive:
  - Good examples of ADTs
  - (Relatively) easy to understand and program
  - Good models for complexity analysis



Example: Vector

- Generalization of an array
  - Sequential collection of data
  - *Random access*
    - Access items by index
    - Access operations are *constant* time
- Principal operations
  - Add, insert, remove
  - Get, set at a particular index
  - Get size

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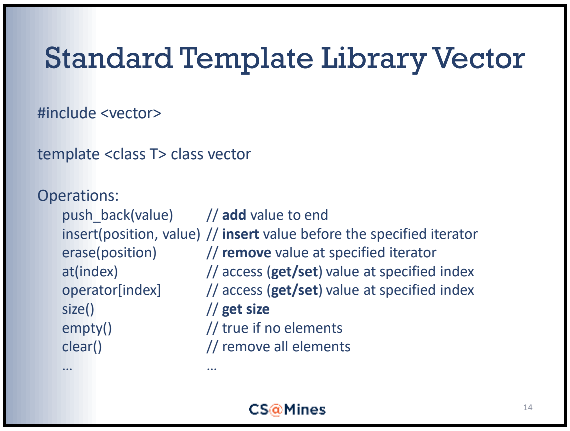

Standard Template Library Vector

#include <vector>

template <class T> class vector

Operations:

push_back(value)	// **add** value to end
insert(position, value)	// **insert** value before the specified iterator
erase(position)	// **remove** value at specified iterator
at(index)	// access (**get/set**) value at specified index
operator[index]	// access (**get/set**) value at specified index
size()	// **get size**
empty()	// true if no elements
clear()	// remove all elements
…	…

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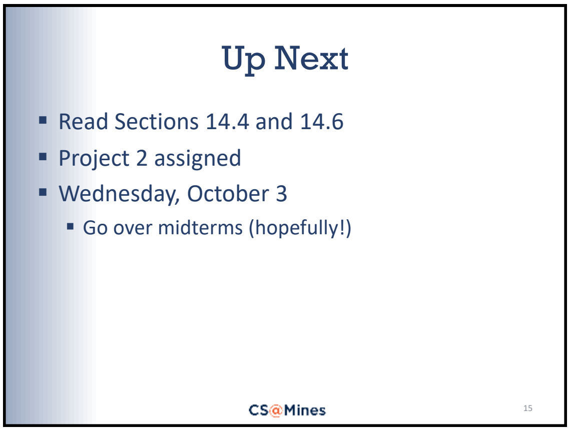

Up Next

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

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