CS 261 – Data Structures

Abstract Data Types

What is an abstraction?

Merriam Webster

1. remove, separate
2. to consider apart from application to or association with a particular instance
3. to make an abstract of : summarize
4. to draw away the attention of

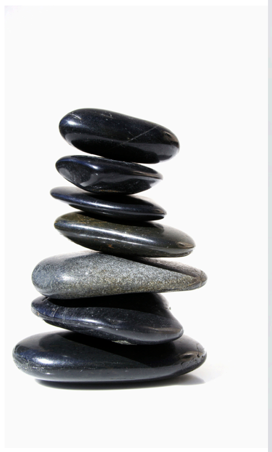
Wikipedia

Abstraction is the process or result of generalization by reducing the information content of a concept or an observable phenomenon, typically to retain only information which is relevant for a particular purpose. For example, abstracting a leather soccer ball to the more general idea of a ball retains only the information on general ball attributes and behaviour, eliminating the characteristics of that particular ball

Container Abstractions

- Over the years, programmers have identified a small number of different ways of organizing collections of data
- These container abstractions are now the fundamental heart of the study of data structures

Examples: bag, stack, queue, set, map, etc



Three Levels of Abstraction

There are at least three levels of abstraction in the study of data structures:

- Specification/Interface: Properties and behaviors (what)
- Application: How it's used (why)
- Implementation: the various implementations in a particular library (how)

stack

Can you describe the three levels of abstraction of the stack ADT?

Stack ADT

stack

Specification/Interface View

initStack( );

pushStack(val);

valType **top**Stack( );

popStack( );

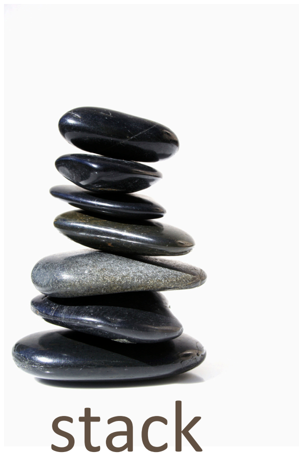
bool isEmptyStack( );

Properties: A Stack is a collection that has the property that an item removed is the most recently entered item [LIFO]

In C, we'll describe the interface in the .h files with function prototypes and comments

Stack ADT

Implementation View



```
void pushStack(struct Stack *stk, double val) {
  arrayAdd(stk->data, val);
}

int stackIsEmpty(struct Stack *stk) {
  return (arraySize(stk->data) == 0)
}
```

In C, our implementation will go in .c files

Note that an ADT can have MANY implementations using several different data structures

Stack ADT

Application View

Given an expression ((2+3) * 4) , can you describe how you would use a stack to ensure that the (parens) are properly balanced?

(See explanation in Chapter 6)

```
(2 + 3))          // not balanced
(2 – 3 (          // not balanced
(( 5 + 6) * 2)    // balanced
```

Classic ADTs

Simple collections:

- Bag
- Ordered bag

Arranged by position:

- List (Indexed)

Ordered by insertion(linear):

- Stack
- Queue
- Deque

Ordered by removal:

- Priority Queue

Unique Elements

- Set

Key/Value Associations

- Map or Dictionary

Your Turn

Worksheet 0: ArrayBagStack – Stack Interface only!

The Bag ADT

Application: Used in applications where you need to maintain an unordered collection of elements (duplicates allowed), without needing to know how it is organized.

(e.g. shopping cart)

Interface/Behavior Specification:

Add (val)

bool Contains (val)

Remove (val)

Implementation: Worksheet 0: Bag Interface