CS 261 – Data Structures

Abstract Data Types

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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

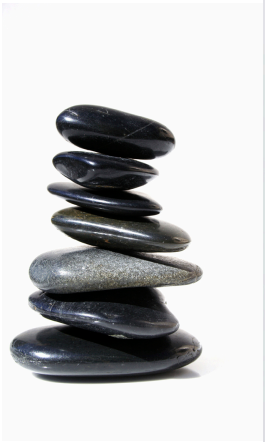
Wikipedia

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 and operating on collections of data
- These container abstractions are now the fundamental heart of the study of data structures

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



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Three Levels of Abstraction

There are three levels of abstraction that we will consider 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?

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Stack ADT

stack

Specification/Interface View

```
initStack( );
pushStack(val);
valType    topStack( );
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


stack

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

int arrayIsEmpty(struct arrayStack *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

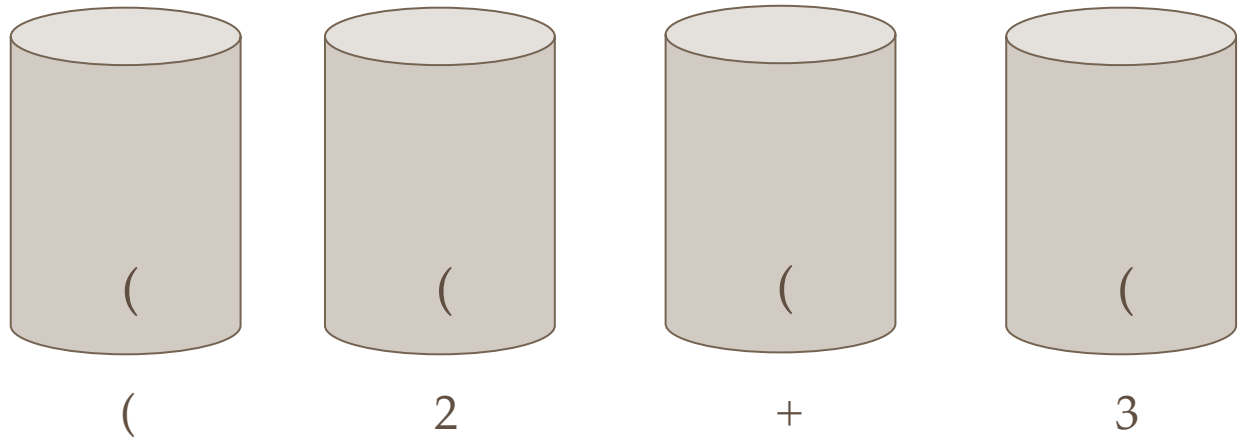
Application View

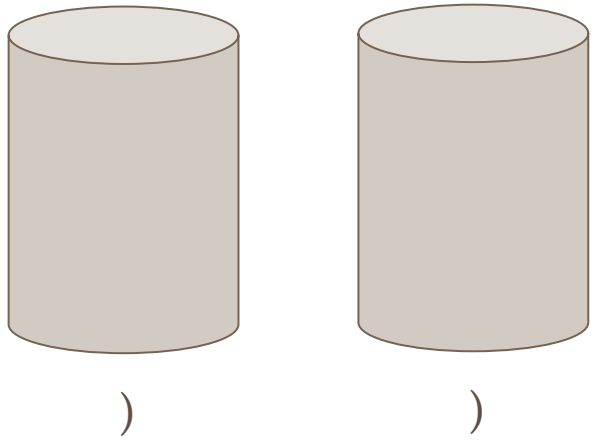
Given an expression ((2+3) * 4) , can you describe how you would use a stack to ensure that the (parens) are properly balanced?

(See explanation in Chapter 6)

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

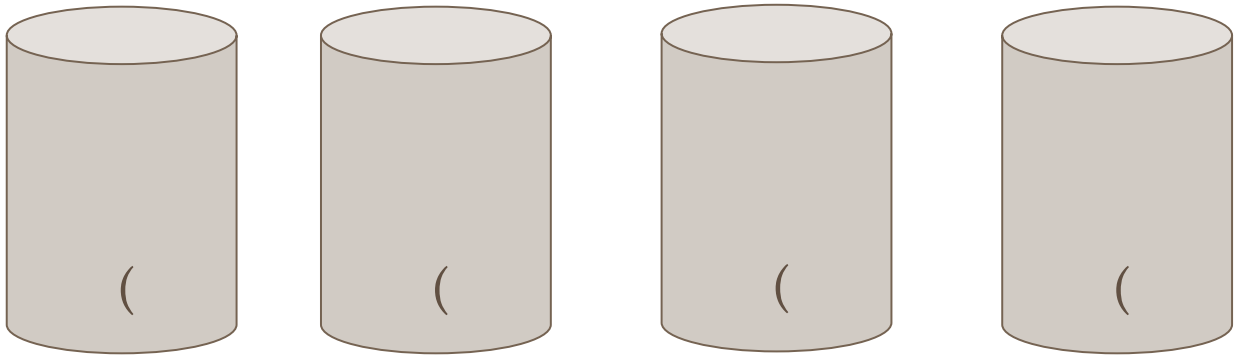
(2+3))



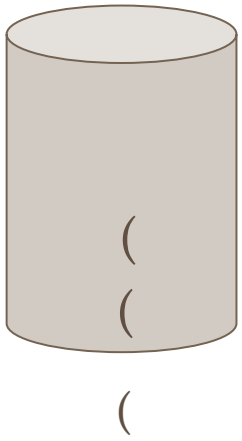


Error: attempt to pop from empty stack

(2-3(



(2 - 3



Error: Done processing tokens and the stack is not empty

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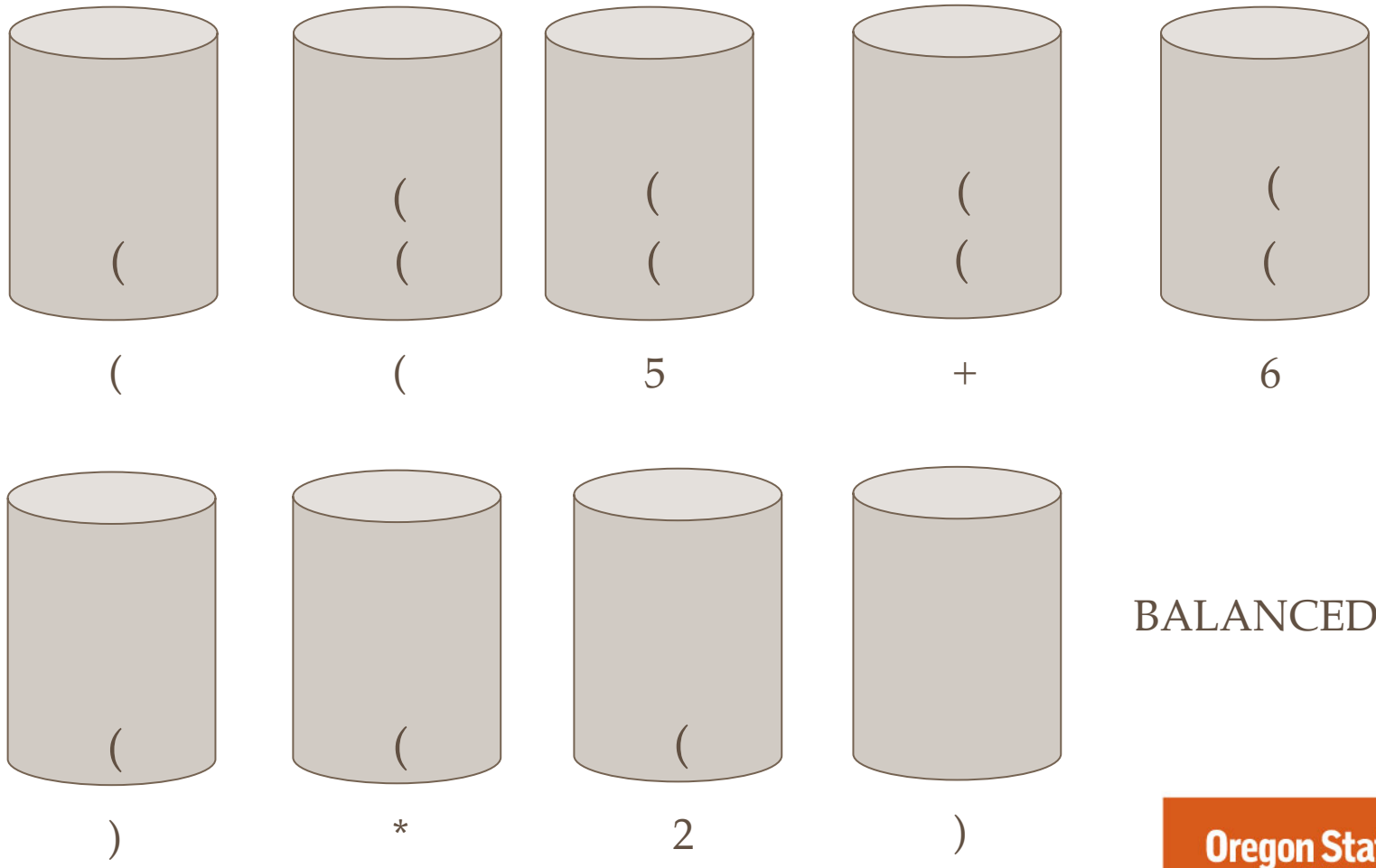
((5+6) * 2)



Classic ADTs

Simple collections:

- Bag
- Ordered bag

Arranged by position:

- List (Indexed)

Ordered by insertion:

- Stack
- Queue
- Deque

Ordered by removal:

- Priority Queue

Unique Elements

- Set

Key/Value Associations

- Map or Dictionary

Array Implementation of the Stack ADT

Example Usage:

```
struct arrayStack  myStack;
initArray (myStack);
pushArray(&myStack, 5);
```

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. Very commonly used ADT.

(e.g. shopping cart)

Interface/Behavior Specification:

Add (val)

bool Contains (val)

Remove (val)

Implementation: Worksheet 0: Bag Interface

Your Turn

Worksheet 0: array implementaiton of ***Bag*** & Stack

Example Usage:

```
struct arrayBagStack myBag;
initArray(&myBag);
addArray (&myBag, 5);
addArray (&myBag, 23);
if(containsArray (&myBag, 24))
        printf("Bag contains a 24!\n");
```

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