CS4092 Thursday 9th January 2014

Lecture 1 : Case Study - SoloSnap

Shuffle Deck
- Deal Cards one by one until either
  - Snap - Player Wins
  - run out of cards - Player loses.

- 3 Classes
  - Card
  - DeckOfCards
  - SoloSnap

Left - Justified Array.

Achieve accurate, guaranteed Random, then choose 10 times the number of items (eg Cards) so Rand 520.

/~Kieran/cs2504 website

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Lecture 2 : Abstract Data Types

Abstraction : Idealised model that provides a simplified conceptual model that cloaks a more complex underlying reality.

eg. DVD player : plays movies, supports behaviours -> play, pause, stop, eject etc. End user version, dont have to know about how it does it, just how to use it.

The Stack :- Push, Pop, LIFO
eg cafeteria trays ≡ c b a -> c, b, a

E/t Type = refers to the type of the items (ints, strings etc)

stk.push(num); /* add to stack */
stk.pop(); /* remove from stack */

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ADT Queue → FIFO → disciplined ~~queue~~ queue

2 ended → added at back → removed at front.

△ enqueue (o): insert item o at rear of queue

△ dequeue (): remove and return item at front of queue
illegal if queue is empty.

size ()

isEmpty ()

front (): return but do not remove

Java Example

```
{
    QueueOfInt q = new QueueOfInt (); int num;
    for (num = 1; num <= 6; num ++)
    {
        SOP* - ("Enqueuing" + num);
        q . enqueue (num);
    }
    while (! q . isEmpty ())
    {
        num = q. dequeue ();
        SOP* - ("Dequeuing" + num);
    }
}
```

(SOP* - = System.out.println)

Psudo Code

- Setting up the circle (numbered players)
  for i ← 1 to n do
      circle. enqueue(i)

- Passing the ball clockwise once
  circle. enqueue (circle. dequeue ())

- Remove the victim (ball holder)
  circle. dequeue ()

- Determining the last (only) man standing
  circle. front()

for(int i = 1, i <= circleSize ; i++)
for(i ← 1 to n do) } same

Look out for clean solutions instead of most obvious!

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Floor ⌊ ⌋
Ceiling ⌈ ⌉
Brackets [ ]
Braces { }
Parentheses ( )

} Mathematical Expression

Example.

$$\overbrace{[\underbrace{(5+x)}_{B} - \underbrace{(y+z)}_{C}]}^{A}$$

△ Many "syntax checking" algorithms (eg programming language parsers) are stack based

○ Unbalanced
1. Mismatch
2. Close paren is encountered and the stack is empty
3. The stack is non-empty at end.
Otherwise it is balanced!

Expression	Stack
([( )])	(
([( )])	([
([( )])	([(
([( )])	([
([( )])	(
([( )])	

OK!

parenStack

<u>Postfix</u>

1 + 2 Standard "Infix"

1 2 + Operator after value / subexpression - Postfix

(STACK Example)

1 + 2	1 2 +	[1][2]
1 + 2 + 3	1 2 + 3 +	3 + [1][2][3] → +
1 * 2 + 3	1 2 * 3 + 4 +	[1][5]
(1 + 2) * 3	1 2 + 3 * (first)	4 - [1][5][4] → -
		[1][1]

1, 2, 3 etc operand

"-", "+", "*", "/" etc operator

The stuff on the stack are intermediate results.
They stay on the stack until we need them.

Token - constituent part. eg operands or/and operators

ExprScanner

- hasNext()
- next()
- currTkn (number or 4 operators)
  -> if (+) elseif (-) elseif (*) elseif (/) else. operator

  ↓ Stack PUSH, ↓ Stack PUSH, ↓ Stack PUSH, ↓ Stack PUSH

If operator Pop 2 items from stack, secondOpnd
firstOpnd.

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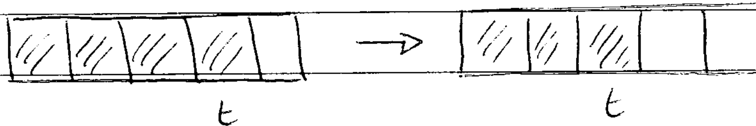
size()	return t+1	S = Stack
isEmpty()	return (t < 0)	t = top
top()	return S[t]	

pop()




```
pop(),
e ← S[t]          /* Whatever is on top of the stack, put in e */
t ← t - 1         /* Decrement t by 1 */
return e          /* Return the item stored in e */

push(o),          /* o is the item we are adding */
t ← t + 1         /* Increment t by 1 */
S[t] ← o          */ Put item in new Stack top */
```

```
public int pop()
{
    int elt = theElts[top];
    top--;
    return elt;
}
```

```
public void push(int element)
{
    top++;
    theElts[top] = element
}
```

```
// Other methods
public static final int ~~Capacity~~ CAPACITY = 100;
private int capacity;
private int theElts[];
private ~~top~~ top = -1;
```

Issues

- No error checking
- Size-limited (CAPACITY = 100)
- Int-Specific - what if ^(you wanted) it contained STRING?

→ Error Checking

```
public int pop ()
{
    if (this.isEmpty ())
    {
        sop (" empty ");
        System.exit (1);
    }
    int elt = theElts [top];
    top--;
    return elt;
}
```

SOP = SYSTEM.OUT.PRINT()

A better way is to use exceptions i.e. throws exception.

→ Size - limited

solution - create a new array, copy all items from original array into it and continue using the new array. So CAPACITY = 400

CAPACITY_2 = 200.

Then we simply point S to the new array.

```
if (this.size() == capacity)     <= Array is full.
{
  New Array
   int temp[] = new int [2 * capacity];

   for (int i = 0 ; i < capacity ; i++)
   {
        temp [i] = theElts [i];
   }

   Setting theElts to new array

    theElts = temp;
```

Point to
the new array!

```
   capacity = 2 * capacity
  }
  top ++;
  theElts [top] = element;
}
```

Doubling the size of the array has a far cheaper cost than just adding a new item to the stack, i.e. stack capacity + 1 (repeat, repeat, repeat ...)

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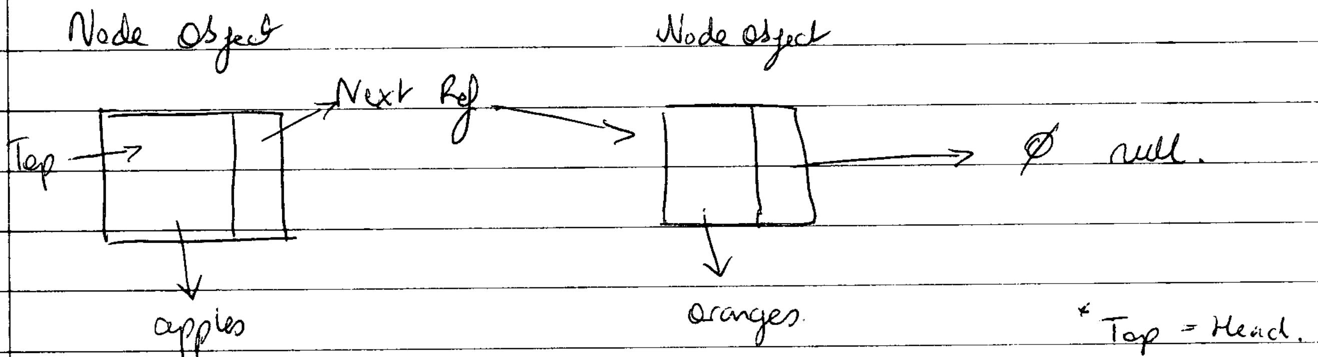
Linked Lists & ADT's Stack and Queue.



The nodes linked together give us a node list container
Manipulation is possible ie add to list, remove from list.

Must have a separate int to manage list leght. (size)

<u>Push</u>
Node is added to the top of the stack / list.

<u>Pop</u>
Node is removed from the top of the stack / list.

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top = null

↓

private LLNode <EltType> top;

↓

" " " next;

These two together set up the list.

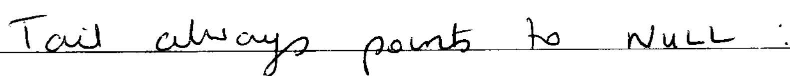
~~add to~~ next setter + getter

When some node is popped from the container, it gets garbage collected at some stage.

ADT Queue

A queue can be manipulated from either the front or rear (head or tail) so we need to keep track of both the head and tail in our program ie. FIFO / LIFO.

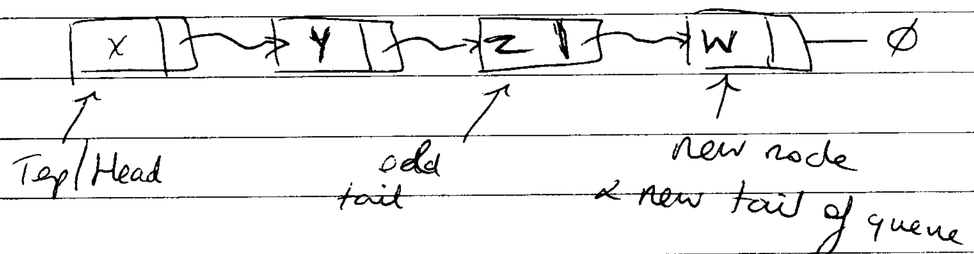
Tail always points to NULL :



Head always points to the next node in the queue :

Enqueue

As a queue works on the principle of adding items to the end of a queue (FIFO)



Dequeue

Remove the front item (top) so this is easier than enqueue.

Implementation

```
head = null;
tail = null;
size = 0;
```

node.setNext(null) – because this new node is the last node it should be set to null (ie reference null as it points to no other node.)

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Lecture 12: Reasoning About Recursive Algorithms

△ Proposition
for all $n \geq 1$
sum(n) returns the sum of the first n natural numbers

△ Proposition
for all $n \geq 1$, fib(n) returns f_n (the nth Fibonacci number)

○ IH = Inductive Hypothesis
By IH fib(n') returns $f_{n'}$ for all $n' < n$
For example consider fib(n): fib(n-2) returns f_{n-2}

Algorithm Computation