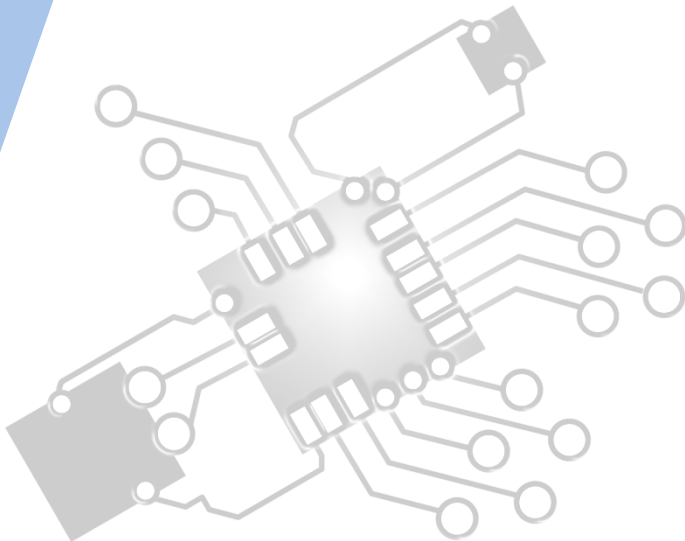




Abstract Data Structures

IB Computer Science



*Content developed by
Dartford Grammar School
Computer Science Department*



HL Topics 1-7, D1-4



1: System design



2: Computer Organisation



3: Networks



4: Computational thinking



5: Abstract data structures



6: Resource management



7: Control



D: OOP

HL only 5 Overview

Thinking recursively

- 5.1.1 Identify a situation that requires the use of recursive thinking
- 5.1.2 Identify recursive thinking in a specified problem solution
- 5.1.3 Trace a recursive algorithm to express a solution to a problem

Abstract data structures

- 5.1.4 Describe the characteristics of a two-dimensional array
- 5.1.5 Construct algorithms using two-dimensional arrays
- 5.1.6 Describe the characteristics and applications of a stack
- 5.1.7 Construct algorithms using the access methods of a stack
- 5.1.8 Describe the characteristics and applications of a queue
- 5.1.9 Construct algorithms using the access methods of a queue
- 5.1.10 Explain the use of arrays as static stacks and queues

Linked lists

- 5.1.11 Describe the features and characteristics of a dynamic data structure
- 5.1.12 Describe how linked lists operate logically
- 5.1.13 Sketch linked lists (single, double and circular)

Trees

- 5.1.14 Describe how trees operate logically (both binary and non-binary)
- 5.1.15 Define the terms: parent, left-child, right-child, subtree, root and leaf
- 5.1.16 State the result of inorder, postorder and preorder tree traversal
- 5.1.17 Sketch binary trees

Applications

- 5.1.18 Define the term dynamic data structure
- 5.1.19 Compare the use of static and dynamic data structures
- 5.1.20 Suggest a suitable structure for a given situation



1: System design

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4: Computational thinking



5: Abstract data structures

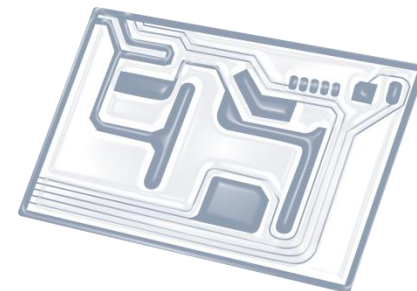
6: Resource management



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D: OOP





Topic 5.1.7

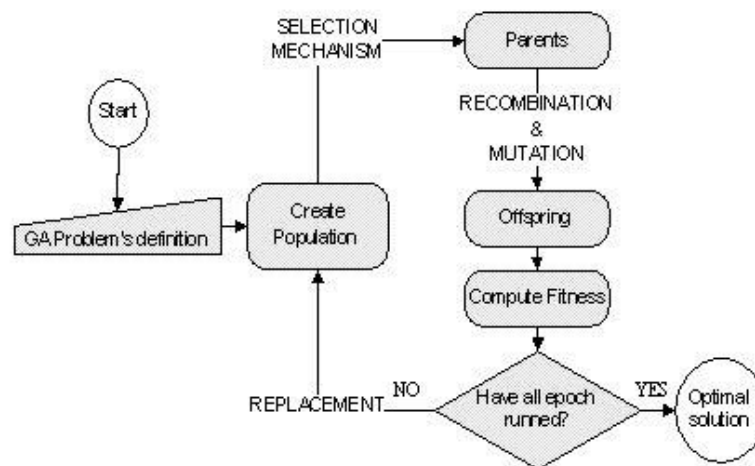
Construct algorithms using the **access methods** of a **stack**

Input: Instance $x \in I$ of Π_{opt}

```

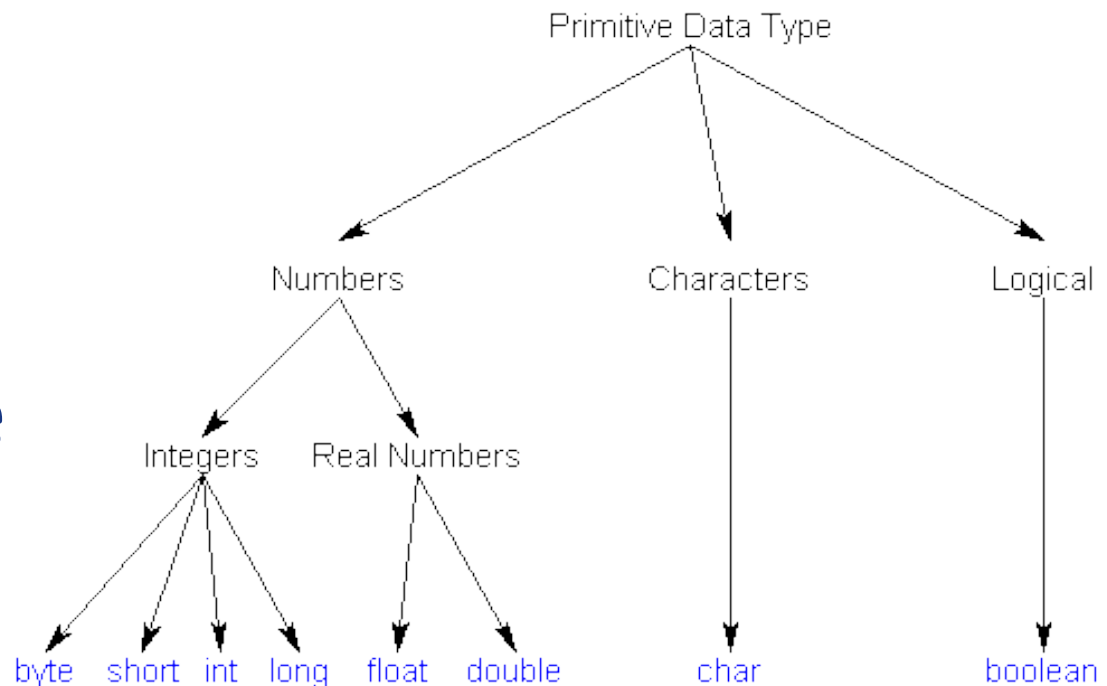
set algorithm parameters ()
 $i \leftarrow 0$ 
 $Pop_0 \leftarrow$  Initial population ()
Evaluate_fitness ( $Pop_0$ )
while not termination condition do
 $i \leftarrow i+1$ 
Selection  $Pop_i$  from  $Pop_{i-1}$ 
Crossover ( $Pop_i$ )
Mutation ( $Pop_i$ )
Fitness ( $Pop_i$ )
Replacement_procedure
end while
 $S_{best} \leftarrow$  optimal solution  $Pop_i$ 
    
```

Output: S_{best} : "candidate" to be the best found solution $x \in I$



Abstract Data Structures (ADTs)

- 2D array
- **Stack**
- Queue
- Linked List
- (Binary) Tree



3 Stack Methods

Stacks

A stack stores a set of elements in a particular order: Items are retrieved in the order in which they are inserted (Last-in, First-out). The elements may be of any type (numbers, objects, arrays, Strings, etc.).

Method name	Brief description	Example: OPS, a stack of integers	Comment
<code>push()</code>	Push an item onto the stack	<code>OPS.push(42)</code>	Adds an element that contains the argument, whether it is a value, String, object, etc. to the top of the stack.
<code>pop()</code>	Pop an item off the stack	<code>NUM = OPS.pop()</code>	Removes and returns the item on the top of the stack.
<code>isEmpty()</code>	Test: stack contains no elements	<code>if OPS.isEmpty() then</code>	Returns TRUE if the stack does not contain any elements.

Example 1: **Move from array to stack**

Write an algorithm that will move all the elements from a linear integer array LINE to a stack called S.

```
int COUNTER = 0
```

```
loop COUNTER from 0 to LINE.length
```

```
    S.push(LINE[COUNTER])
```

```
end loop
```

Example 2: **Print out a stack**

Write an algorithm that will print all the String values of a stack called S.

```
loop while not S.isEmpty()  
    output( S.pop() )  
end loop
```