

# Static and Dynamic Arrays

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# Outline

- Discussion and examples about Arrays
  - What is an Array?
  - When and where is a Array used?
  - Complexity
  - Static array usage example
- Dynamic Array implementation details
- Code Implementation

# Discussion and examples

# What is a static Array?

A static array is a fixed length container containing  $n$  elements **indexable** from the range  $[0, n-1]$ .

Q: What is meant by being 'indexable'?

A: This means that each slot/index in the array can be referenced with a number.

# When and where is a static Array used?

- 1) Storing and accessing sequential data
- 2) Temporarily storing objects
- 3) Used by IO routines as buffers
- 4) Lookup tables and inverse lookup tables
- 5) Can be used to return multiple values from a function
- 6) Used in dynamic programming to cache answers to subproblems

# Complexity

Static Array   Dynamic Array

Access	$O(1)$	$O(1)$
Search	$O(n)$	$O(n)$
Insertion	N/A	$O(n)$
Appending	N/A	$O(1)$
Deletion	N/A	$O(n)$

# Static Array

A =	44	12	-5	17	6	0	3	9	100
	↕	↕	↕	↕	↕	↕	↕	↕	↕
	0	1	2	3	4	5	6	7	8

Elements in *A* are referenced by their index. There is no other way to access elements in an array. Array indexing is zero-based, meaning the first element is found in position zero.

# Static Array

A =	44	12	-5	17	6	0	3	9	100
	↕	↕	↕	↕	↕	↕	↕	↕	↕
	0	1	2	3	4	5	6	7	8

A[0] = 44

A[1] = 12

A[4] = 6

A[7] = 9

A[9] => index out of bounds!



# Static Array

A =	-1	12	-5	17	6	0	3	9	100
	↕	↕	↕	↕	↕	↕	↕	↕	↕
	0	1	2	3	4	5	6	7	8

A[0] = 44

A[0] := -1

A[1] = 12

A[4] = 6

A[7] = 9

A[9] => index out of bounds!

# Static Array

A =	-1	12	-5	17	6	18	3	9	100
	↕	↕	↕	↕	↕	↕	↕	↕	↕
	0	1	2	3	4	5	6	7	8

A[0] = 44

A[0] := -1

A[1] = 12

A[5] := 18

A[4] = 6

A[7] = 9

A[9] => index out of bounds!

# Static Array

A =	-1	12	-5	17	6	18	25	9	100
	↕	↕	↕	↕	↕	↕	↕	↕	↕
	0	1	2	3	4	5	6	7	8

A[0] = 44

A[0] := -1

A[1] = 12

A[5] := 18

A[4] = 6

A[6] := 25

A[7] = 9

A[9] => index out of bounds!

# Operations on Dynamic Arrays

# Dynamic Array

The dynamic array can **grow** and **shrink** in size.

A = 

34	4
----	---

A.add(-7)      A = 

34	4	-7
----	---	----

A.add(34)      A = 

34	4	-7	34
----	---	----	----

A.remove(4)      A = 

34	-7	34
----	----	----

# Dynamic Array

**Q:** How can we implement a dynamic array?

**A:** One way is to use a static array!

- 1) Create a static array with an initial capacity.
- 2) Add elements to the underlying static array, keeping track of the number of elements.
- 3) If adding another element will exceed the capacity, then create a new static array with twice the capacity and copy the original elements into it.

# Dynamic Array

Suppose we create a dynamic array with an initial capacity of two and then begin adding elements to it.

