

Outline and Reading

The Vector ADT (§2.2.1) Array-based implementation (§2.2.1)

The Vector ADT

The Vector ADT extends the notion of array by storing a sequence of arbitrary objects

 An element can be accessed, inserted or removed by specifying its rank (number of elements preceding it)

 An exception is thrown if an incorrect rank is specified (e.g., a negative rank)

Main vector operations:

- object elemAtRank(integer r): returns the element at rank r without removing it
- object replaceAtRank(integer r, object o): replace the element at rank with o and return the old element
- insertAtRank(integer r, object o): insert a new element o to have rank r
- object removeAtRank(integer r): removes and returns the element at rank r
- Additional operations size() and isEmpty()

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Applications of Vectors

Direct applications

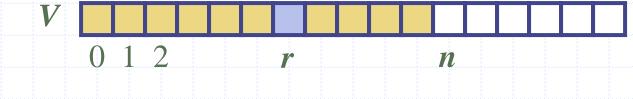
Sorted collection of objects (elementary database)

Indirect applications

- Auxiliary data structure for algorithms
- Component of other data structures

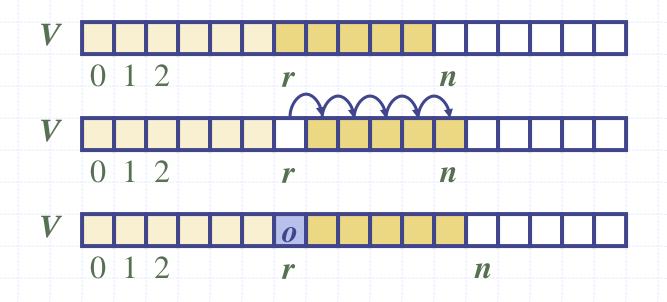
Array-based Vector

- Use an array V of size N
- A variable *n* keeps track of the size of the vector (number of elements stored)
- Operation *elemAtRank(r)* is implemented in O(1) time by returning V[r]



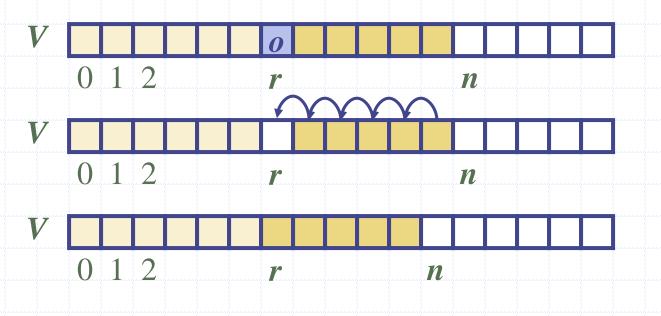
Insertion

- In operation *insertAtRank*(r, o), we need to make room for the new element by shifting forward the n - r elements V[r], ..., V[n - 1]
- In the worst case (r = 0), this takes O(n) time



Deletion

◆ In operation *removeAtRank(r)*, we need to fill the hole left by the removed element by shifting backward the *n* − *r* − 1 elements *V*[*r* + 1], ..., *V*[*n* − 1]
◆ In the worst case (*r* = 0), this takes *O*(*n*) time



Performance

In the array based implementation of a Vector • The space used by the data structure is O(n)size, isEmpty, elemAtRank and replaceAtRank run in O(1) time insertAtRank and removeAtRank run in O(n) time If we use the array in a circular fashion, insertAtRank(0) and removeAtRank(0) run in O(1) time In an *insertAtRank* operation, when the array is full, instead of throwing an exception, we

can replace the array with a larger one