

Data Structures

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June 23, 2017



Who am I?

- ▶ Master of Engineering: Computer Science (KUL)
 - ▶ Computational informatics
- ▶ Realdolmen: acADDemICT in 09/2015
- ▶ Current project: Planning infrastructure @ Infrabel



Outline

1 Introductory Data Structures

- Array
- Linked List
- Hash Table
- Heap
- Red-Black Tree

2 Java Collection API & Map API

- Java Collection API
- Java Map API

3 Advanced Data Structures

- Stuff. . .



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What are Data Structures?

Data Structure¹

A way in which data are stored for efficient search and retrieval. Different data structures are suited for different problems.

- ▶ Data type \neq data structure
- ▶ `java.util.HashSet` vs. hash table
- ▶ array vs. array

¹Encyclopædia Britannica

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Array

Definition

- ▶ An indexed set of related elements.²
- ▶ An assemblage of items that are randomly accessible by integers, the index.³
- ▶ Example: linear array



²Oxford Dictionary

³National Institute of Standards & Technology

Array

Operations

- ▶ `get`
- ▶ `set`
- ▶ `indexOf`



Array

Operations

- ▶ `get`
- ▶ `set`
- ▶ `indexOf`



`get(1)`

Array

Operations

- ▶ `get`
- ▶ `set`
- ▶ `indexOf`



`get(1)`

Array

Operations

- ▶ `get` $O(1)$
- ▶ `set`
- ▶ `indexOf`



`get(1)`

Array

Operations

- ▶ `get` $O(1)$
- ▶ `set`
- ▶ `indexOf`



`set(2)`

Array

Operations

- ▶ `get` $O(1)$
- ▶ `set`
- ▶ `indexOf`



`set(2)`

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`indexOf(object)`

Array

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- ▶ `get` $O(1)$
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Linked List

Definition

A linked list is a data structure in which the objects are arranged in a linear order. Unlike arrays in which the linear order is determined by indices, the order is determined by a pointer in each object.⁴

- ▶ Different types: singly, doubly, multiply, circular, ...
- ▶ Example: doubly linked list



⁴ Introduction to Algorithms By Cormen, Leieron, Rivest & Stein

Linked List

Operations

- ▶ add/remove first/last
- ▶ get/insertAt
- ▶ indexOf



Linked List

Operations

- ▶ add/remove first/last
- ▶ get/insertAt
- ▶ indexOf

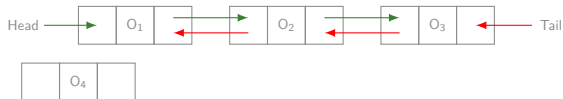


`addFirst(O4)`

Linked List

Operations

- ▶ add/remove first/last
- ▶ get/insertAt
- ▶ indexOf

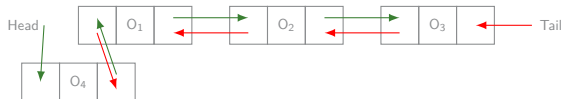


`addFirst(O4)`

Linked List

Operations

- ▶ add/remove first/last
- ▶ get/insertAt
- ▶ indexOf

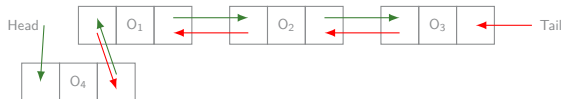


`addFirst(O4)`

Linked List

Operations

- ▶ add/remove first/last $O(1)$
- ▶ get/insertAt
- ▶ indexOf



`addFirst(O4)`

Linked List

Operations

- ▶ add/remove first/last $O(1)$
- ▶ get/insertAt
- ▶ indexOf

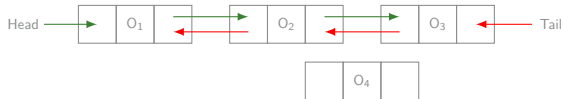


insertAt(2)

Linked List

Operations

- ▶ add/remove first/last $O(1)$
- ▶ get/insertAt
- ▶ indexOf

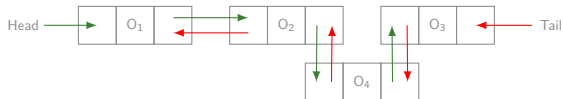


insertAt(2)

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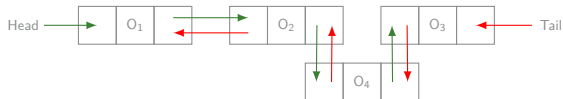


insertAt(2)

Linked List

Operations

- ▶ add/remove first/last $O(1)$
- ▶ get/insertAt $O(n)$
- ▶ indexOf



insertAt(2)

Linked List

Operations

- ▶ add/remove first/last $O(1)$
- ▶ get/insertAt $O(n)$
- ▶ indexOf



`indexOf(O_2)`

Linked List

Operations

- ▶ add/remove first/last $O(1)$
- ▶ get/insertAt $O(n)$
- ▶ indexOf



`indexOf(O2)`

Linked List

Operations

- ▶ add/remove first/last $O(1)$
- ▶ get/insertAt $O(n)$
- ▶ indexOf



`indexOf(O_2)`

Linked List

Operations

- ▶ add/remove first/last $O(1)$
- ▶ get/insertAt $O(n)$
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`indexOf(O_2)`

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Hash Table

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Hash Table

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Tree

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Binary Heap

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Binary Min-Heap

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Red-Black Tree

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Red-Black Tree

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Java Collection API

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Java Collection API

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Java Map API

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Java Map API

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