Advanced Programming

Containers — Java Data Structures

Instructor: Ali Najimi

Author: Hossein Masihi

Department of Computer Engineering

Sharif University of Technology

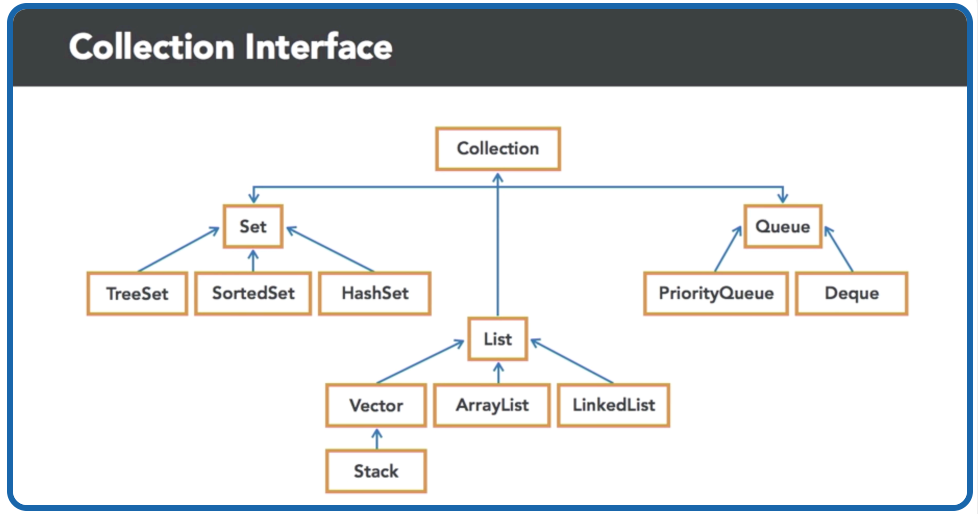
Fall 2025

Table of Contents

Containers — Concept

- A **container** is a data structure that stores and organizes objects.
- Java provides the **Collections Framework**, offering reusable data structures.
- Key Concepts:
  - Storage
  - Access rules
  - Performance characteristics

> Containers impact time complexity, memory use, and app performance.



Java Collections Framework Overview

Interface	Implementations	Key Feature
List	ArrayList, LinkedList	Ordered, allows duplicates
Set	HashSet, TreeSet	No duplicates
Map	HashMap, TreeMap	Key-value storage
Queue	PriorityQueue, ArrayDeque	FIFO ordering

List — Ordered Collection

```
List<String> names = new ArrayList<>();
names.add("Ali");
names.add("Hossein");
names.add("Ali"); // duplicates allowed
```

Characteristics:

- Maintains **insertion order**
- Allows **indexed access**
- Allows **duplicate elements**

Use when:

- You need **order** and **random access**

Set — Unique Collection

```
Set<String> ids = new HashSet<>();
ids.add("A1");
ids.add("A1"); // ignored
ids.add("B3");
```

Characteristics:

- **No duplicates**
- No guaranteed order (unless using TreeSet)
- Efficient membership testing

Use when:

- You care about **uniqueness** of stored items

Map — Key-Value Structure

```
Map<String, Integer> age = new HashMap<>();
age.put("Ali", 21);
age.put("Sara", 20);
age.put("Ali", 25); // overwrites value
```

Characteristics:

- Fast lookup by **key**
- Keys are unique
- Values may repeat

Use when:

- You need **associative lookup** (dictionary behavior)

Choosing the Right Container

Requirement	Best Choice
Fast Random Access	`ArrayList`
Frequent Insert/Delete	`LinkedList`
Unique Elements	`HashSet`
Sorted Elements	`TreeSet`
Key-Value Lookup	`HashMap`
Sorted Key-Value	`TreeMap`

> The right container reduces complexity dramatically.

Example Comparison

```
List<Integer> list = new ArrayList<>();
Set<Integer> set = new HashSet<>();
Map<String, Integer> map = new HashMap<>();
```

Feature	List	Set	Map
Stores duplicates	Yes	No	N/A
Indexed access	Yes	No	No
Key-value behavior	No	No	Yes

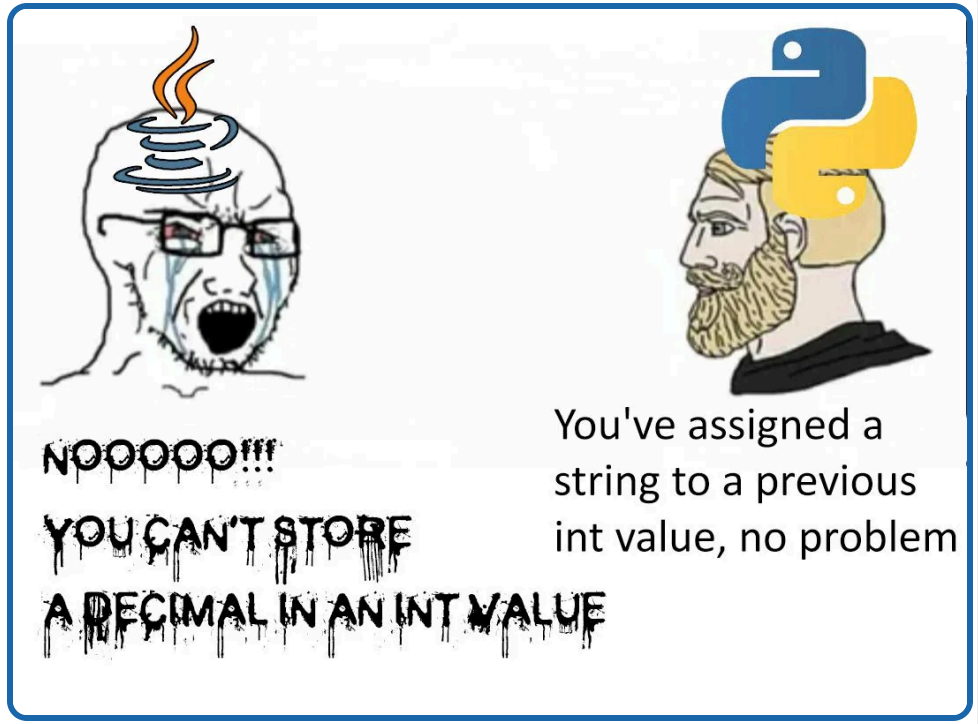
Summary

Concept	Description
Containers	Structures for storing and organizing data
Lists	Ordered, allow duplicates
Sets	Unique elements only
Maps	Key-value associations
Choosing	Depends on behavior and performance needs

> Strong programming requires **choosing the right data structure**.

Thank You!

Java Data Structures — Core Containers



Sharif University of Technology — Advanced Programming — Fall 2025