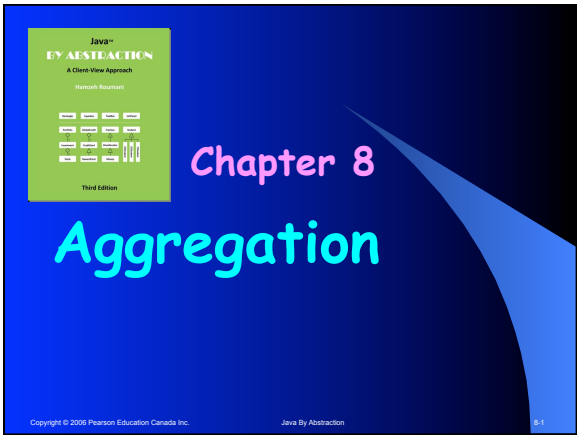
Java
BY ABSTRACTION
A Client-View Approach
Hamish Roumani
Third Edition
Chapter 8
Aggregation
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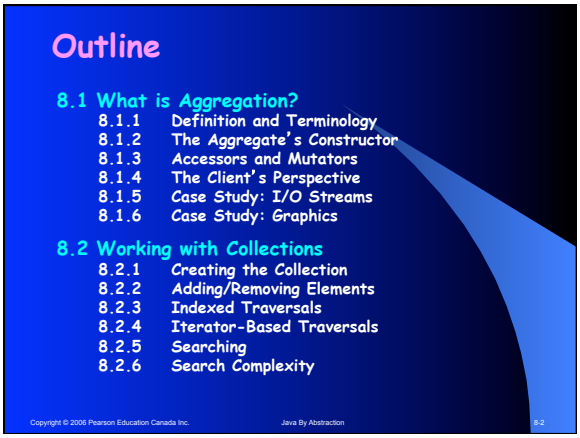
8-1


Outline
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8.1.3 Accessors and Mutators
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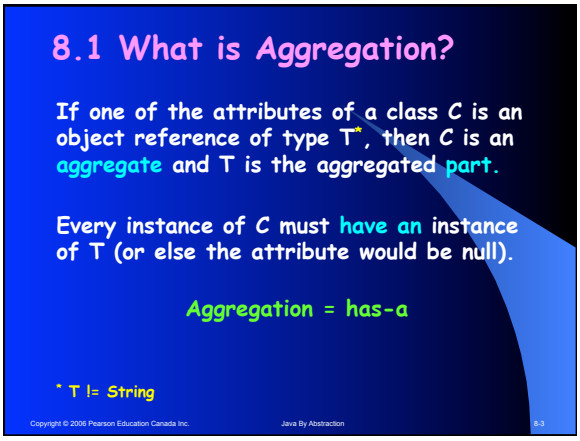
8.1 What is Aggregation?
If one of the attributes of a class C is an object reference of type T*, then C is an aggregate and T is the aggregated part.
Every instance of C must have an instance of T (or else the attribute would be null).
Aggregation = has-a
* T != String
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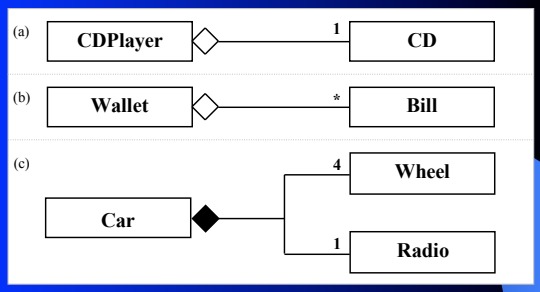
Examples



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8.1.1 Definition and Terminology

- Multiplicity
- Variable Multiplicity
- Collections (part=element)
- Composition (shared lifetime)

The Camera - Film Relation

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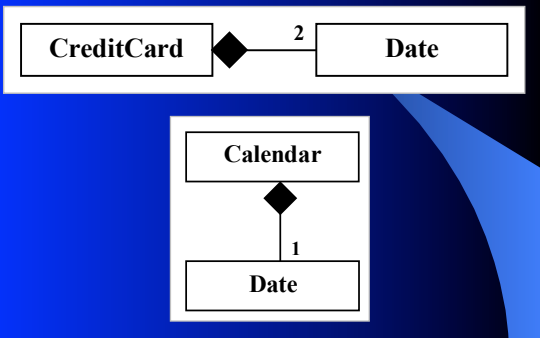
Examples



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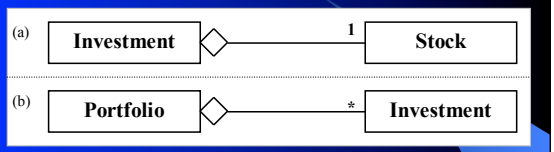
Examples



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8.1.2 The Aggregate's Constructor

- When a client instantiates C, who instantiates T?
- Create an Investment
- Create a CreditCard
- What signature (for the Investment constructor) makes Investment a composition?

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8.1.3 Accessors and Mutators

- Aggregates must provide an accessor thru which the part can be accessed
- In a composition, the accessor returns a clone of the part
- An aggregate may provide a mutator so the client can mutate the part
- In a non-composition, such a mutator is not needed (why?)

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8.1.4 The Client's Perspective

- Aggregation = Layered Abstraction
- Sounds like an implementer's concern
- Why don't implementers hide it? If they did:
  - Investment would have to handle symbol, name, and price
  - CreditCard would have to accept day, month, and year.

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Example-1: Copying an Aggregate

Given a reference x to an aggregate, make a copy of it and call it y.

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Example-1: Copying an Aggregate

Given a reference x to an aggregate, make a copy of it and call it y.

Three different copies:

- An Alias
- A Shallow Copy
- A Deep Copy

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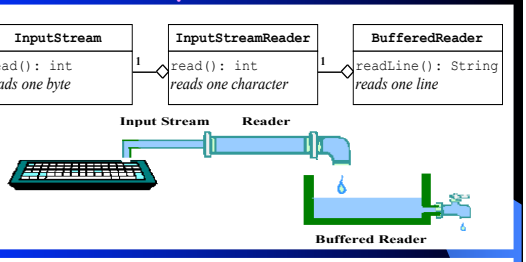
8.1.5 Case Study: I/O Streams




```
BufferedReader buffer =
  new BufferedReader(
  new InputStreamReader(System.in));
```

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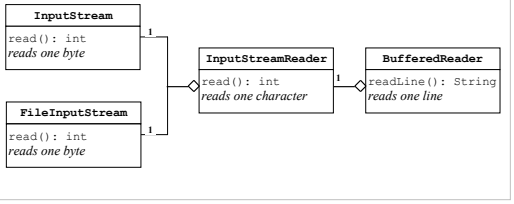
File Input:




```
BufferedReader filer =
  new BufferedReader(
  new InputStreamReader(
  new FileInputStream(filename));
```

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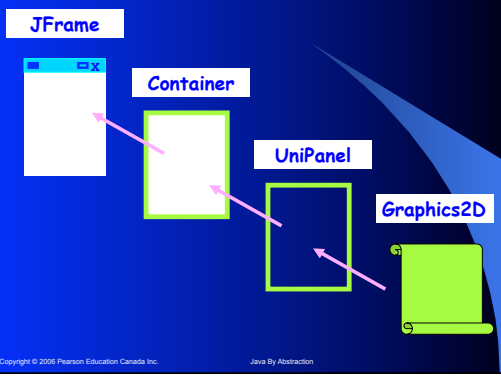
8.1.6 Case Study: Graphics



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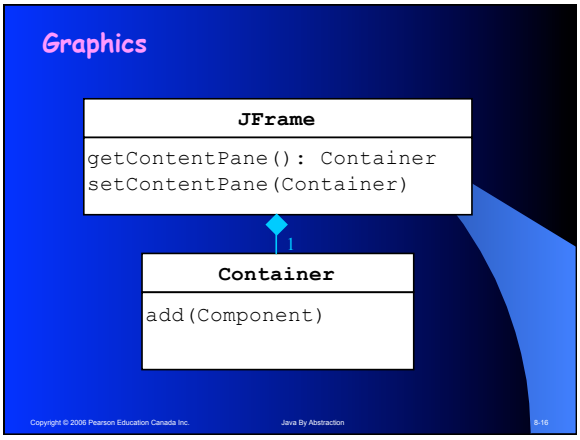
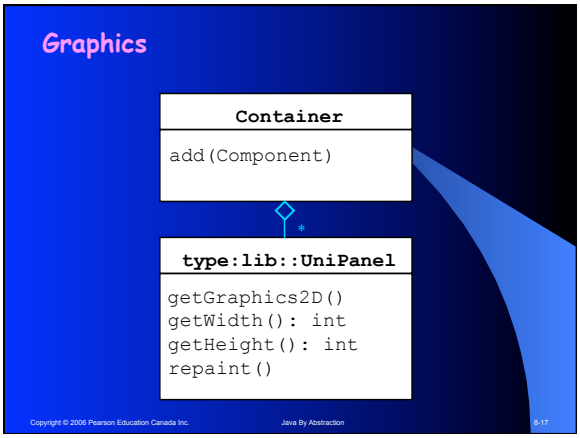
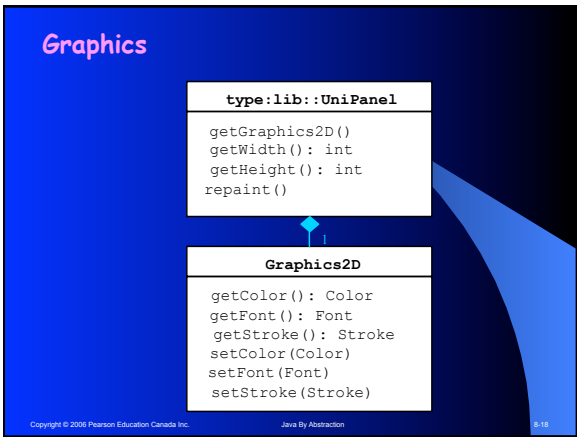
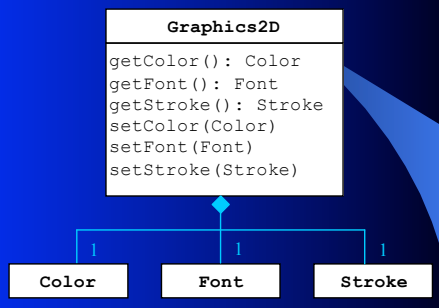






Graphics



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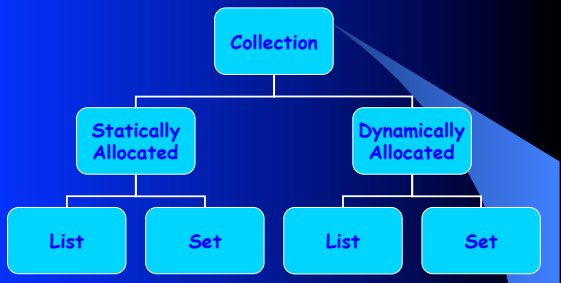
8.2 Working with Collections



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8.2.1 Creating the Collection

- Cannot specify elements as parameters
- Create an empty one then populate

Constructor Summary - Portfolio

`Portfolio(java.lang.String title, int capacity)`
Construct an empty portfolio having the passed name and capable of holding the specified number of investments.

Constructor Summary - GlobalCredit

`GlobalCredit()`
Construct a GC processing centre having the name "NoName".

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8.2.2 Adding / Removing Elements

- All collections provide a void or a boolean add to enable clients to populate.
- These methods are boolean for diff reasons:

Method Summary - Portfolio	
boolean	**add**(Investment inv) Attempt to add the passed investment to `this` portfolio.

Method Summary - GlobalCredit	
boolean	**add**(CreditCard card) Attempt to add the passed credit card to `this` GCC.

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8.2.3 Indexed Traversals

- Traversal in lieu of accessors
- Traverse = Visit each element once. Don't miss and don't over-visit.
- Indexed = Pretend the elements are numbered (0 offset).
- Two methods: get(int) and size()

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Example of an indexed traversal

Given a reference x to a Portfolio, list all its investments in a tabular fashion:

```
Inv.     Market      Book        Net
001     3450.00     2870.00     580.00
002      450.00      500.00     -50.00
 .          .           .          .
 .          .           .          .
-------------------------------------
Total
```

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8.2.4 Iterator-Based Traversals

- More abstract than indexed
- Relies on the enhanced for loop
- Works if the collection implements Iterable

```
for (E e : bag)
{
    // visit element e
}
```

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Example of a chained traversal

Given a reference x to a GlobalCredit, list all its credit cards in a tabular fashion:

Card No	Balance	Exp 36m?
907321-5	76.85	
671282-1	81.64	
464184-0	134.49	<
755917-2	232.43	
.	.	.
.	.	.

The last column indicates if the card will expire within 36 months

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8.2.5 Searching

Searching can be done via a traversal:

- Set up a traversal loop
- In each iteration, compare the element we are searching for with an element of the collection. Set a boolean flag accordingly
- The result (found or not found) must be somehow remembered after the loop is exited.

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A search example:

Given a reference gc to a random GlobalCredit, determine whether a given card c is in it.

Attempt #1 (incorrect):

```
boolean found = false;
for (CreditCard card : gc)
{
   found = card.equals(c);
}
```

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A search example, cont.

Correct it by adding the loop invariant:

The value of found is the same as the sentence:
c is equal to one of the elements seen so far

Attempt #2 (correct):

```
boolean found = false;
for (CreditCard card : gc)
{
   found = found || card.equals(c);
}
```

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8.2.6 Search Complexity

- Traversal-based search is Exhaustive
- N comparisons in the worst case. It is thus a linear search

A bag contains N numbered balls and you can pick one ball one at a time. Can you determine if ball number 55 is in the bag by picking less than N times? In the worst case?

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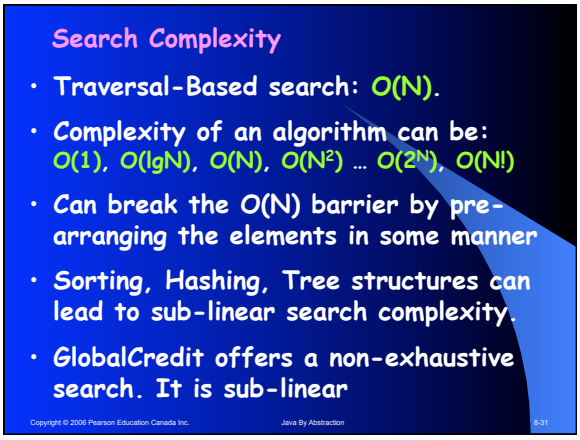
Search Complexity
• Traversal-Based search: O(N).
• Complexity of an algorithm can be: O(1), O(lgN), O(N), O(N²) … O(2ᴺ), O(N!)
• Can break the O(N) barrier by pre-arranging the elements in some manner
• Sorting, Hashing, Tree structures can lead to sub-linear search complexity.
• GlobalCredit offers a non-exhaustive search. It is sub-linear
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